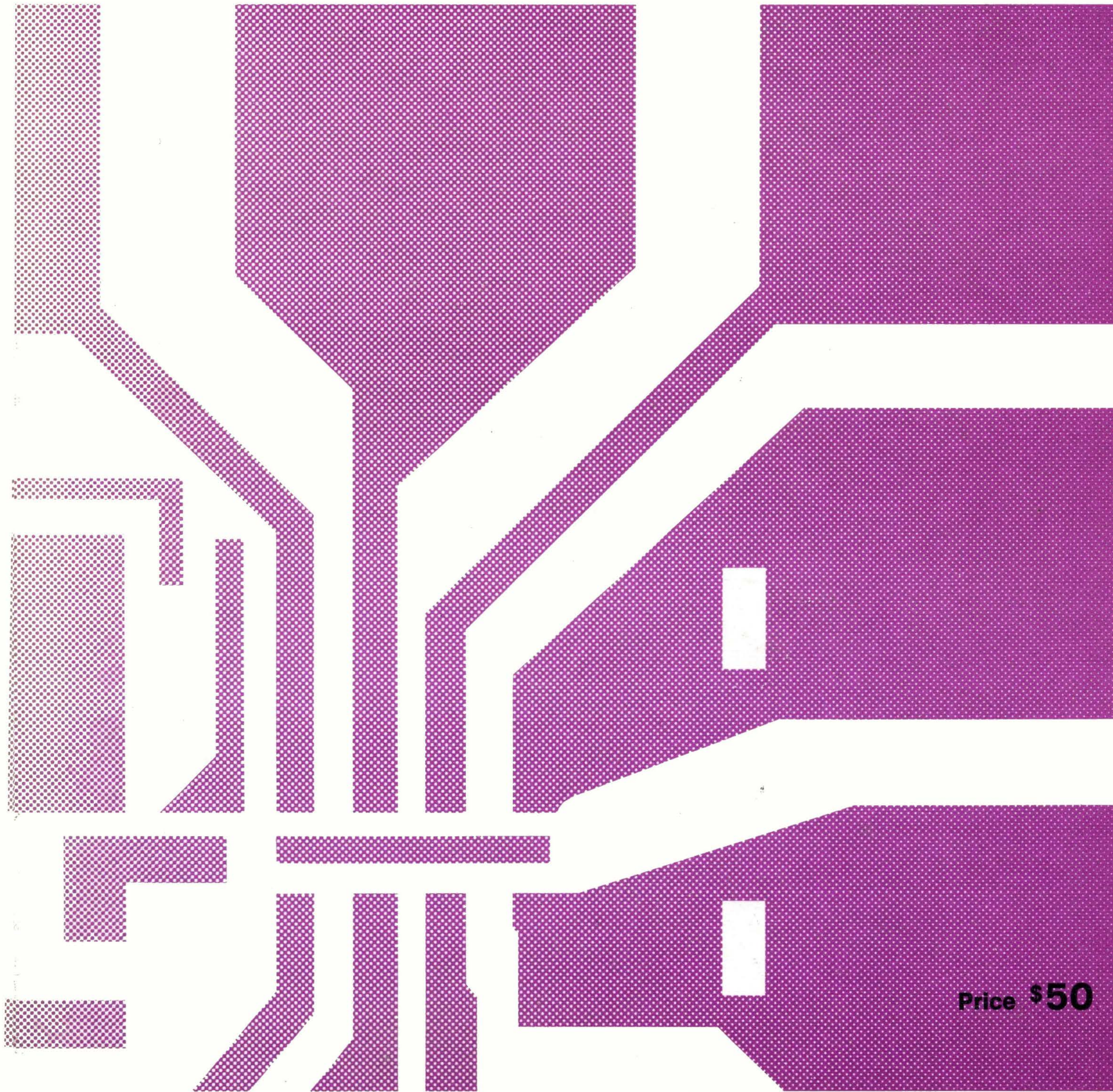
1976 IC UPDATE MASTER

- **Master Selection Guide**
  Every IC listed by function, number, source
- **Alternate Source Directory**
  The industry's first comprehensive reference
- **Application Note Directory**
  Synopsizes key notes and handbooks
- **Part Number Directory/Product Index**
  Complete listing by manufacturer and part number
- **Military Parts Directory**
  Fully cross referenced
- **Manufacturer/Distributor Directory**
  Addresses, phone numbers, who to ask for

1976 IC UPDATE MASTER



Price $50

THE FIRST STEP

For more than two years, the editorial/research staff of one of the largest publishers in the electronics industry has been gathering, correlating and updating the rapidly changing product profile of the IC industry.

The result is a significant innovation in the product literature of the industry, and a significant milestone in engineering reference tools: IC UPDATE MASTER, and its companion publication, IC UPDATE.

For IC UPDATE MASTER is the industry's only **comprehensive** guide to integrated circuits. But more than that. More than just a collection of product catalogs, IC UPDATE MASTER and IC UPDATE are tools you will turn to gladly, as your first step in the selection and purchase of IC devices.

IC UPDATE MASTER gathers for you, in one easy-to-access volume, information either never before available, or that has been scattered throughout many time consuming pages and library shelves of individual catalogs, data sheets, application notes and handbooks.

Not that we claim the MASTER to be an end in itself. You will still want to refer to manufacturers' catalogs and data sheets for detailed specifications and parameters. Of course, you will find much of this manufacturers' data already included in IC UPDATE MASTER, conveniently located for rapid access.

What the MASTER will do for you is put an end to that tedious need to struggle through catalog after catalog and data sheet after data sheet, digging out widely scattered information. The MASTER, in a single, comprehensive source document, lets you know exactly what alternatives are available to you. It helps you select one or more for further investigation, and tells you exactly where to look for further information on specific design details.

Because IC UPDATE MASTER puts all IC source data in one place, the hours you save will run into the hundreds . . . perhaps thousands. And your decisions will be made firm in the knowledge that you have been able to review and compare every available alternative.

For manufacturers of ICs, IC UPDATE MASTER solves many problems that have been, for many, either involvable, or solvable only at an unwarrantable cost. One is distribution — the physical task of getting catalogs into the hands of those who will use them. Another problem many manufactures must face is the fact that their catalogs wind up in the waste basket rather than the reference shelf. Timeliness is a problem the manufacturer can solve, but only at incredible expense. For most, the catalog is either an annual or bi-annual project and is, therefore, outdated almost as soon as published. And finally, many catalogs simply are not very easy to use!

On the other hand, IC UPDATE MASTER and IC UPDATE eliminate or minimize these problems economically. But even more, they add much valuable information not available at all in manufacturers' literature.

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A quick guide to your IC UPDATE MASTER

ALTERNATE SOURCE DIRECTORY A unique contribution to the literature of integrated circuits, the Alternate Source Directory provides the first comprehensive reference to pin-for-pin functional equivalents in the industry. Not only does the Directory provide over 14,000 cross references, it shows literally thousands of alternates that are not obvious since the model numbers are different. It is the most complete directory of alternate IC sources now available.

IC Update Master's Alternate Source Directory ends, finally, the time consuming task of checking through shelves of references in order to find pin-for-pin functional alternates.

The Alterate Source Directory starts on page 1030.

APPLICATION NOTE DIRECTORY This is the most complete directory of its kind. It permits you to survey rapidly this entire field of literature, and locate any and all information on any device. The Application Note Directory provides a synopsis and source for both application notes and microprocessor design books. The notes are arranged by subject and cross referenced by device number in the Part Number and Product Indexes. This permits you to find information either by topic or part number.

The Application Note Directory starts on page 66.

MANUFACTURERS & DISTRIBUTORS DIRECTORY This directory is literally your communications guide for ICs. It places at your fingertips the names and phone numbers of manufacturers, field sales offices, representatives and distributors. In addition, if you need to contact the manufacturer directly, it provides special information on where and whom to call to quickly and efficiently obtain the information you need.

The Manufacturers and Distributors Directory starts on page 1084.

PART NUMBER GUIDE The Part Number Guide describes each manufacturer's system of prefixes and suffixes. It allows you to decode the manufacturer's model numbers into temperature range, packages, functions, etc.

MILITARY PARTS DIRECTORY The Military Parts Directory shows which manufacturers will test devices to MIL-STD-883 and/or perform other environment screening. This directory also provides a translation of the Defense Electronic Centers Qualified Products List. It shows all the devices on the list, translates the military numbers into commercial equivalents, gives functional titles and tells which manufacturers are currently authorized to supply each type.

The Part Number Guide starts on page 57.

The Military Parts Directory starts on page 123.

PART NUMBER INDEX This index strips away the prefixes and suffixes and lists all ICs in numerical sequence. The index shows the complete model number, manufacturer, and page locations on which each item appears. It covers device listings in both the reference and data portions of the Master Selection Guide as well as the Application Note Directory, and tells you quickly and concisely where to find information on any IC listed in the Master.

The Part Number Index begins on page 4.

PRODUCT INDEX The Product Index is similar to the Part Number Index but is arranged by manufacturer. All of a manufacturer's products listed in the Master are indicated here along with convenient page and line references.

The Product Index starts on page 1122.

If you don't have a copy of IC UPDATE MASTER of your own . . .

We think ten minutes with it will convince you you must have one of your own.
If it's yours, and others are always borr[illegible] it, here's how they can get copies for thems[illegible]

MASTER SELECTION GUIDE

You will probably use the Master Selection Guide more often, more intensively, than any other part of this book. It is unique in the field of integrated circuit products. This Guide, covering virtually every facet of the industry, organizes ICs into these categories: Digital, Interface, Linear, Memory and Microprocessors. In each category, products are further classified by type (CMOS, ECL, TTL, etc.) and function (Arithmetic, Counters, Gates, etc.). You'll find every IC performing that function listed by part number and manufacturer. Furthermore, within each category you'll find data on those products selected as being particularly significant by the manufacturer.

For the first time, in a single source reference, you have at your fingertips the identity of each individual IC you will want to consider for a given application, and data on the most important ones. Inevitably, it will be your first source of information when you are looking for a product.

DETAILED INFORMATION ON MANUFACTURERS' MOST SIGNIFICANT PRODUCTS

Many manufacturers have submitted detailed information on their latest and most significant products. This data has been included in the MASTER, and we know it will help you select the ICs you need.

Of course, the more complete the information supplied, the more useful a tool the MASTER will be. A number of firms have made the investment to inform you. We know they would appreciate feedback from you on what they've done and how they could improve their presentations in future issues.

Some firms did not submit data sheets for inclusion in this edition of the MASTER. You may find this lack of data an inconvenience. Don't hesitate to give them your opinion.

We expect future editions of the MASTER to contain more of the kind of information you need and want, on an even greater representation of manufacturers and product lines. But only if you tell them what you think.

, subscription to the '76 MASTER and its Quarterly Updates is $54.50, including postage and handling. Send check, BankAmericard or Master Charge number, or request for billing to:

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PART NUMBER INDEX

This index shows the page and line on that page where each device appears in the Master Selection Guide and the Application Note Directory. The list is prepared by a computer from the data in these sections so every device in them is listed. The devices are arranged in order by basic numbers so similarly numbered devices from various manufacturers are grouped together. Bold faced listings lead to the data supplied by the manufacturers. Use this index to locate key operational characteristics, application notes, and devices data whenever you have a model number.

how to use the part number index

This Part Number Index is arranged in alphanumeric sequence, ignoring the manufacturer's prefixes and suffixes and using the basic model numbers. This basic number sequence is sorted by reading the digits from **left** to **right,** assuming that letters come before numbers. (As an example, these numbers would appear in the following order: 5301, 531, 54H01, 54139, 5414.) Under each basic number, the manufacturer's name and full model number is listed. The page references to 69 through 120 lead to application notes. Page references saying "see page —" lead to manufacturers' data. Each page number is followed by a dash number that indicates the location on the page where the data appears.

The arrangement of this index by base number gives you several advantages. It allows you to find a device by its basic number whether or not you know the name of the manufacturer or the manufacturer's prefixes. Also it groups similar devices together so that when you are looking for data you can quickly determine if the data has been provided in the book by any of the manufacturers and where that data is. Similarly it groups any references to application notes close together so that you do not need to guess which manufacturer might publish application notes on a device before you can locate them.

Once you become familiar with the alpha-numeric numbering sequence, you'll find that this index is very easy to use.

Note: Devices identified by Alpha-characters only, are listed first.

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	SW	SW4002AE	208- 60
	TI	TF4002A/B	208- 61
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	Mostek	MK4007	688- 38
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	SSS	SCL4010AE	201- 88
	Solitron	CM4010A	201- 89
	Solitron	CM4010AE	201- 90
	TI	TF4010A/B	201- 91
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	GI	MEM4011P	207- 12
	Harris	HD4011A-2	207- 13
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	SSS	SCL4022AE	204- 99
	Solitron	CM4022A	204-100
	Solitron	CM4022AE	204-101
	TI	TF4022A	204-102
	TI	TP4022A	204-103
	Toshiba	TC4022	204-104
4023	Fairchild	F4023C	206-139
	Fairchild	F4023M	206-140
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	Solitron	CM4023AE	207- 1
	SW	SW4023AE	207- 2
	TI	TF4023A/B	207- 5
	TI	TP4023A/B	207- 6
	Toshiba	TC4023	207- 7
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	SSS	SCL4024A	202-102
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4025	National	CD4025M	208- 73
	National	MM4025	698- 50
	RCA	**CD4025A/B**	**see page 375**
	RCA	**CD4025A/BE**	**see page 375**
	SGS	HBF4025AE	208- 76
	SSS	SCL4025A	208- 77
	SSS	SCL4025AE	208- 78
	Solitron	CM4025A	208- 79
	Solitron	CM4025AE	208- 80
	SW	SW4025AE	208- 81
	TI	TF4025A/B	208- 82
	TI	TP4025A/B	208- 83
	Toshiba	TC4025	208- 84
40257	**RCA**	**CD40257A/B**	**see page 375**
	RCA	**CD40257A/BE**	**see page 375**
4026	Harris	HD4026A-2	204- 24
	Harris	HD4026A-9	204- 25
	National	MM4026	698- 51
	RCA	**CD4026A**	**see page 375**
			204- 26
	RCA	**CD4026AE**	**see page 375**
	SSS	SCL4026A	72- 14
			204- 28
	SSS	SCL4026AE	204- 29
	Solitron	CM4026A	204- 32
	Solitron	CM4026AE	204- 33
4027	Fairchild	F4027C	206- 11
	Fairchild	F4027M	206- 12
	Harris	HD4027A-2	206- 13
	Harris	HD4027A-9	206- 14
	Mostek	MK4027	685- 86
	National	CD4027C	206- 19
	National	CD4027M	206- 20
	National	MM4027	698- 63
	RCA	**CD4027A/B**	**see page 375**
	RCA	**CD4027A/BE**	**see page 375**
	SGS	HBF4027AE	206- 25
	SSS	SCL4027A	206- 26
	SSS	SCL4027AE	206- 27
	Solitron	CM4027A	206- 28
	Solitron	CM4027AE	206- 29
	SW	SW4027AE	206- 30
	TI	TF4027A	206- 33
	TI	TP4027A	206- 34
	Toshiba	TC4027	206- 35
4028	Fairchild	F4028C	204-123
	Fairchild	F4028M	204-124
	Harris	**HD4028A-2**	**see page 266**
	Harris	**HD4028A-9**	**see page 266**
	National	CD4028C	204-131
	National	CD4028M	204-133
	RCA	**CD4028A**	**see page 375**
	RCA	**CD4028AE**	**see page 375**
	SGS	HBF4028AE	204-137
	SSS	SCL4028A	204-138
	SSS	SCL4028AE	204-139
	Solitron	CM4028A	204-140
	Solitron	CM4028AE	204-141
	SW	SW4028AE	204-142
	TI	TF4028A	205- 3
	TI	TP4028A	205- 4
	Toshiba	TC4028	205- 5
40283	Fairchild	F40283C	201- 5
	Fairchild	F40283M	201- 6
4029	Fairchild	F4029C	204- 69
	Fairchild	F4029M	204- 70
	Harris	**HD4029A-2**	**see page 266**
	Harris	**HD4029A-9**	**see page 266**
	National	CD4029C	204- 73
	National	CD4029M	204- 74
	RCA	**CD4029A**	**see page 375**
4029	**RCA**	**CD4029AE**	**see page 375**
	SGS	HBF4029AE	204- 77
	SSS	SCL4029A	72- 14
			204- 78
	SSS	SCL4029AE	204- 79
	Solitron	CM4029A	204- 80
	Solitron	CM4029AE	204- 81
	SW	SW4029AE	204- 82
	TI	TF4029A/B	204- 83
	TI	TP4029A/B	204- 84
	Toshiba	TC4029	204- 85
403	Sprague	UHC/D-403	226-141
			527- 12
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			527- 16
4030	Fairchild	F4030C	207- 82
	Fairchild	F4030M	207- 83
	Harris	**HD4030A-2**	**see page 266**
	Harris	**HD4030A-9**	**see page 266**
	National	CD4030C	207- 92
	National	CD4030M	207- 93
	RCA	**CD4030A**	**see page 375**
	RCA	**CD4030AE**	**see page 375**
	SGS	HBF4030AE	207-102
	SSS	SCL4030A	207-103
	SSS	SCL4030AE	207-104
	Solitron	CM4030A	207-107
	Solitron	CM4030AE	207-108
	SW	SW4030AE	207-111
	TI	TF4030A/B	207-114
	TI	TMS4030	114- 7
			686- 43
	TI	TMS4030-1	686- 7
	TI	TMS4030-2	685- 94
	TI	TP4030A/B	207-115
	Toshiba	TC4030	207-120
4031	Fairchild	F4031C	211- 71
	Fairchild	F4031M	211- 72
	National	CD4031C	211- 75
	National	CD4031M	211- 76
	RCA	**CD4031A**	**see page 375**
			702- 8
	RCA	**CD4031AE**	**see page 375**
			702- 7
4032	GI	SL5-4032	701- 91
	GI	SL6-4032	701- 92
	RCA	**CD4032A**	**see page 375**
	RCA	**CD4032AE**	**see page 375**
	Solitron	CM4032A	201- 29
	Solitron	CM4032AE	201- 30
	Toshiba	TC4032	201- 31
4033	**RCA**	**CD4033A**	**see page 375**
			204- 34
	RCA	**CD4033AE**	**see page 375**
	SGS	HBF4033AE	204- 36
	SSS	SCL4033A	204- 37
	SSS	SCL4033AE	204- 38
	Solitron	CM4033A	204- 41
	Solitron	CM4033AE	204- 42
	TI	TMS4033	691- 85
4034	EA	EA4034	679- 57
			679- 69
	Fairchild	F4034C	211- 41
	Fairchild	F4034M	211- 42
	RCA	**CD4034A**	**see page 375**
			701- 24
	RCA	**CD4034AE**	**see page 375**
	SSS	SCL4034A	211- 45
			701- 25
	SSS	SCL4034AE	211- 46
			701- 21
	Solitron	CM4034A	211- 47
			701- 26
4034	Solitron	CM4034AE	211- 48
			701- 22
	TI	TMS4034	692- 15
	Toshiba	TC4034	211- 51
			701- 27
4035	EA	EA4035	679- 19
			679- 58
	Fairchild	F4035C	210- 77
	Fairchild	F4035M	210- 78
	Harris	**HD4035A-2**	**see page 266**
			699-106
	Harris	**HD4035A-9**	**see page 266**
			699- 97
	National	CD4035C	210- 83
	National	CD4035M	210- 84
	RCA	**CD4035A**	**see page 375**
			700- 1
	RCA	**CD4035AE**	**see page 375**
			699- 99
	SGS	HBF4035AE	210- 87
	SSS	SCL4035	699-100
	SSS	SCL4035A	210- 88
	SSS	SCL4035AE	210- 89
	Solitron	CM4035A	210- 90
			700- 2
	Solitron	CM4035AE	210- 91
			699-101
	TI	TF4035A/B	210- 92
	TI	TMS4035	692- 30
	TI	TP4035A	700- 3
	TI	TP4035A/B	210- 93
	Toshiba	TC4035	210- 94
			699-102
4036	**RCA**	**CD4036A**	**see page 375**
			686- 88
	RCA	**CD4036AE**	**see page 375**
	Solitron	CM4036A	209- 60
			686- 90
	Solitron	CM4036AE	209- 61
	TI	TMS4036	687-104
	TI	TMS4036-1	687-103
	TI	TMS4036-2	687-102
4037	**RCA**	**CD4037A**	**see page 375**
	RCA	**CD4037AE**	**see page 375**
	Solitron	CM4037A	207- 41
	Solitron	CM4037AE	207- 42
4038	Motorola	MC4038	80- 7
			225-140
	RCA	**CD4038A**	**see page 375**
	RCA	**CD4038AE**	**see page 375**
	Solitron	CM4038A	201- 36
	Solitron	CM4038AE	201- 37
	Toshiba	TC4038	201- 38
4039	Motorola	MC4039	515- 60
	RCA	**CD4039A**	**see page 375**
			686- 89
	RCA	**CD4039AE**	**see page 375**
	Solitron	CM4039A	209- 56
			686- 91
	Solitron	CM4039AE	209- 57
	TI	TMS4039	690- 84
	TI	TMS4039-1	690- 66
	TI	TMS4039-2	690- 17
4040	Fairchild	F4040C	202-112
	Fairchild	F4040M	202-113
	Harris	HD4040A-2	202-114
	Harris	HD4040A-9	202-115
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	National	CD4040C	202-118
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	RCA	**CD4068A/BE**	**see page 375**
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	Solitron	CM4068A/BE	206-107
	Toshiba	TC4068	206-108
4069	Fairchild	F4069C	202- 21
	Fairchild	F4069M	202- 22
	Motorola	MCM4069A	679- 61
	National	CD4069BC	202- 29
	National	CD4069BM	202- 31
	RCA	**CD4069A/B**	**see page 375**
	RCA	**CD4069A/BE**	**see page 375**
	SSS	SCL4069	202- 34
	SSS	SCL4069A	202- 35
	SSS	SCL4069AE	202- 36
	Solitron	CM4069A/B	202- 39
	Solitron	CM4069A/BE	202- 40
	Toshiba	TC4069	202- 45
407	CMA	FX407	611- 55
	Sprague	UHC/D-407	226-131
			526-125
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			526-129
4070	Fairchild	F4070C	207- 84
	Fairchild	F4070M	207- 85
	Motorola	MCM4070A	679- 62
	National	CD4070BC	207- 94
	National	CD4070BM	207- 95
	RCA	**CD4070A/B**	**see page 375**
	RCA	**CD4070A/BE**	**see page 375**
	SSS	SCL4070A	207-105
	SSS	SCL4070AE	207-106
	Solitron	CM4070A/B	207-109
	Solitron	CM4070A/BE	207-110
4071	Fairchild	F4071C	208- 5
	Fairchild	F4071M	208- 6
	RCA	**CD4071A/B**	**see page 375**
	RCA	**CD4071A/BE**	**see page 375**
	SSS	SCL4071A	208- 15
	SSS	SCL4071AE	208- 16
	Solitron	CM4071A/B	208- 17
	Solitron	CM4071A/BE	208- 18
	TI	TF4071B	208- 19
	TI	TP4071B	208- 20
	Toshiba	TC4071	208- 21
4072	Fairchild	F4072C	207-133
	Fairchild	F4072M	207-134
	RCA	**CD4072A/B**	**see page 375**
	RCA	**CD4072A/BE**	**see page 375**
	SSS	SCL4072A	207-139
	SSS	SCL4072AE	207-140
	Toshiba	TC4072	207-141
4073	Fairchild	F4073C	206- 62
	Fairchild	F4073M	206- 63
	RCA	**CD4073A/B**	**see page 375**
	RCA	**CD4073A/BE**	**see page 375**
	SSS	SCL4073A	206- 68
	SSS	SCL4073AE	206- 69
	Solitron	CM4073A/B	206- 70
	Solitron	CM4073A/BE	206- 71
	TI	TF4073B	206- 72
	TI	TP4073B	206- 73
	Toshiba	TC4073	206- 74
4075	Fairchild	F4075C	207-142
	Fairchild	F4075M	207-143
	RCA	**CD4075A/B**	**see page 375**
	RCA	**CD4075A/BE**	**see page 375**
	SSS	SCL4075A	208- 2
	SSS	SCL4075AE	208- 3
	Toshiba	TC4075	208- 4
4076	Fairchild	F4076C	205-130
	Fairchild	F4076M	205-131
4076	National	CD4076BC	205-138
	National	CD4076BM	205-139
	RCA	**CD4076A/B**	**see page 375**
	RCA	**CD4076A/BE**	**see page 375**
	SSS	SCL4076A	205-143
	SSS	SCL4076AE	205-142
	Solitron	CM4076A/B	205-144
	Solitron	CM4076A/BE	205-145
4077	Fairchild	F4077C	207-121
	Fairchild	F4077M	207-122
	RCA	**CD4077A/B**	**see page 375**
	RCA	**CD4077A/BE**	**see page 375**
	Solitron	CM4077A/B	207-131
	Solitron	CM4077A/BE	207-132
4078	Fairchild	F4078C	208- 22
	Fairchild	F4078M	208- 23
	RCA	**CD4078A/B**	**see page 375**
	RCA	**CD4078A/BE**	**see page 375**
	Solitron	CM4078A/B	208- 30
	Solitron	CM4078A/BE	208- 31
	Toshiba	TC4078	208- 32
408	Sprague	UHC/D-408	226-132
			526-126
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			526-130
4081	Fairchild	F4081C	206- 75
	Fairchild	F4081M	206- 76
	RCA	**CD4081A/B**	**see page 375**
	RCA	**CD4081A/BE**	**see page 375**
	SSS	SCL4081A	206- 85
	SSS	SCL4081AE	206- 86
	Solitron	CM4081A/B	206- 87
	Solitron	CM4081A/BE	206- 88
	TI	TF4081B	206- 89
	TI	TP4081B	206- 90
	Toshiba	TC4081	206- 91
4082	Fairchild	F4082C	206- 53
	Fairchild	F4082M	206- 54
	RCA	**CD4082A/B**	**see page 375**
	RCA	**CD4082A/BE**	**see page 375**
	SSS	SCL4082A	206- 59
	SSS	SCL4082AE	206- 60
	Toshiba	TC4082	206- 61
4085	Fairchild	F4085C	207- 68
	Fairchild	F4085M	207- 69
	RCA	**CD4085A/B**	**see page 375**
	RCA	**CD4085A/BE**	**see page 375**
4086	Fairchild	F4086C	207- 74
	Fairchild	F4086M	207- 75
	RCA	**CD4086A/B**	**see page 375**
	RCA	**CD4086A/BE**	**see page 375**
	SSS	SCL4086A	494- 11
	SSS	SCL4086AE	494- 12
4089	**RCA**	**CD4089**	**see page 375**
	RCA	**CD4089A/B**	**see page 375**
	RCA	**CD4089A/BE**	**see page 375**
4093	**RCA**	**CD4093A/B**	**see page 375**
			212- 60
	RCA	**CD4093A/BE**	**see page 375**
4094	**RCA**	**CD4094A/B**	**see page 375**
	RCA	**CD4094A/BE**	**see page 375**
4095	**RCA**	**CD4095A/B**	**see page 375**
	RCA	**CD4095A/BE**	**see page 375**
4096	**AMI**	**S4096**	**see page 728**
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	AMI	**S4096-1**	**see page 728**
	AMI	**S4096-2**	**see page 728**
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	AMI	S4096-4	685- 76
	EMM/Semi	RO3-4096	694- 55
	Fairchild	4096-2	685- 80
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	Mostek	**MK4096-16**	**see page 778, 781**
	Mostek	**MK4096-6**	**see page 778, 781**
	RCA	**CD4096A/B**	**see page 375**
	RCA	**CD4096A/BE**	**see page 375**
40963	Fairchild	40963	685-105
40964	Fairchild	40964	686- 25
4098	**RCA**	**CD4098A/B**	**see page 375**
	RCA	**CD4098A/BE**	**see page 375**
4099	**RCA**	**CD4099A/B**	**see page 375**
	RCA	**CD4099A/BE**	**see page 375**
410	Micro Net	MN410	509- 6
	Micro Net	MN410H	509- 7
4102	Mostek	MK4102	692- 22
	Mostek	MK4102-1	691- 82
	Mostek	MK4102-6	691- 57
	Solitron	CM4102A	204- 43
	Solitron	CM4102AE	204- 44
4103	TI	TMS4103	678- 22
4104	**EMM/Semi**	**4104**	**see page 743**
	Fairchild	F4104C	211- 92
	Fairchild	F4104M	211- 93
	National	MM4104H	697- 80
	Solitron	CM4104A	211- 96
	Solitron	CM4104AE	211- 97
411	Micro Net	MN411	509- 4
	Micro Net	MN411H	509- 5
	NEC	µPD411-3	685- 65
4116	EA	EA4116	685- 78
	Solitron	CM4116A	494- 15
4117	Solitron	CM4117A	205- 82
			515-127
	Solitron	CM4117AE	515-128
412	Micro Net	MN412	510- 19
	Micro Net	MN412H	510- 20
	Rockwell	PPS-412	858- 4
4122	EA	EA4122	686- 24
	EA	EA4122-1	685-104
	EA	EA4122-2	685- 79
4127	Burr-Brown	4127	568- 33
413	Micro Net	MN413	510- 17
	Micro Net	MN413H	510- 18
4131	Burr-Brown	4131	623- 13
	Raytheon	RC4131	597- 9
	Raytheon	RM4131	594- 13
4132	Raytheon	RC4132	592- 28
	Raytheon	RM4132	591- 9
4136	**Exar**	**XR4136C**	**see page 640**
	Exar	**XR4136M**	**see page 640**
	Raytheon	**RC4136**	**see page 647**
	Raytheon	RC4136C	608- 26
	Raytheon	**RM4136**	**see page 647**
	TI	RC4136	608- 7
	TI	RM4136	607- 38
41363	TI	RC41363	608- 27
4137	Raytheon	RC4137	581- 94
4137	Raytheon	RM4137	581- 95
	Raytheon	RV4137	581- 96
4151	**Raytheon**	**RC4151**	**see page 653**
	Raytheon	**RM4151**	**see page 653**
	Raytheon	RV4151	623- 25
417	Ferranti	ZN417	580- 21
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4194	Exar	RX4194M	620- 59
	Exar	XR4194CK	620- 56
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	Exar	XR4194MK	620- 61
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	Raytheon	**RC4194TK**	**see page 655**
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	Raytheon	**RM4194D**	**see page 655**
	Raytheon	**RM4194TK**	**see page 655**
4195	**Raytheon**	**RC4195**	**see page 657, 658**
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	Raytheon	**RM4195**	**see page 657**
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4199	Hitachi	HDP4199	234- 85
42	Teledyne C	CAG42	492- 86
420	Sprague	UHP-420	226-117
			526- 53
4200	**EMM/Semi**	**4200**	**see page 740**
			113- 2
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	Mostek	**MK4200-16**	**see page 783**
	TI	TMS4200	693- 5
4201	Burr-Brown	4201J	622- 34
4202	Exar	XR4202	581- 43
			607- 35
4203	Burr-Brown	4203J	622- 35
	Burr-Brown	4203K	622- 36
	Burr-Brown	4203S	622- 37
	National	MM4203D	683- 43
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	National	MM4203Q	683- 26
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4204	Burr-Brown	4204J	622- 38
	Burr-Brown	4204K	622- 39
	National	MM4204	684- 21
4205	Burr-Brown	4205J	622- 40
	Burr-Brown	4205K	622- 41
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	Micropac	42050-188	616- 15
	Micropac	42050-208	616- 25
	Micropac	42050-224	616- 28
	Micropac	42050-244	616- 60
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	Micropac	42050-610	614-110
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42051	Micropac	42051-055	616-104
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	Micropac	42051-075	617- 21
	Micropac	42051-085	617- 34
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	Fairchild	F4519M	207- 46
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			209-136
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452	Datel	AM-452	599- 15
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	Intersil	MM452	499- 73
4520	Fairchild	F4520C	203- 26
	Fairchild	F4520M	203- 27
	National	CD4520C	203- 32
	National	CD4520M	203- 33
	RCA	CDS4520	203- 36
			203- 37
	RCA	**CD4520A/B**	**see page 375**
			203- 34
	RCA	**CD4520A/BE**	**see page 375**
	SSS	SCL4520A	203- 38
	SSS	SCL4520AE	203- 39
	Solitron	CM4520B	203- 40
	Solitron	CM4520BE	203- 41
	TI	TF4520A	203- 42
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	Toshiba	TC4520	203- 44
4522	Fairchild	F4522C	204- 17
	Fairchild	F4522M	204- 18
	TI	TF4522A	204- 21
	TI	TP4522A	204- 22
4526	Fairchild	F4526C	203- 72
	Fairchild	F4526M	203- 73
	TI	TF4526A	203- 76
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4527	**RCA**	**CD4527**	**see page 375**
	RCA	**CD4527A/B**	**see page 375**
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82S71	Signetics	N82S71	250-139
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82S82	Signetics	N82S82	70- 1
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8201	Raytheon	RC8201	235- 17
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8234	Raytheon	RC8234	232- 59
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	Raytheon	RC8242	230-137
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8252	Raytheon	RC8252	225- 30
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8264	Raytheon	RC8264	232- 69
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8277	Raytheon	RC8277	235- 29
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8280	National	DM8280	223-140
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8283	National	DM8283	69- 13
8284	AMD	N8284	223- 48
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848	Beckman	848-B10	510- 16
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8654	National	DS8654	527- 82
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ABBREVIATIONS OF COMPANY NAMES

AD	Analog Devices
AMD	Advanced Micro Devices
AMI	American Microsystems, Inc.
AMS	Advanced Memory Systems
Analogic	Analogic Corp.
Beckman	Beckman Instruments, Helipot Division
Burr-Brown	Burr-Brown Research
Cermetek	Cermetek
CMA	Consumer Microcircuits of America
Collins	Collins Radio
Datel	Datel Systems
DDC	ILC Data Devices Corp.
EA	Electronic Arrays
EMM/Semi	EMM Semi, Div. of Electronic Memories & Magnetics
Exar	Exar Integrated Systems
Fairchild	Fairchild Semiconductor
Ferranti	Ferranti Electric
GI	General Instrument
Harris	Harris Semiconductor
Hitachi	Hitachi America, Ltd.
Hughes	Hughes Aircraft Co., MOS Divison
Hybrid Sys.	Hybrid Systems
IMI	International Microcircuits, Inc.
Intech	Intech
Intel	Intel
Interdesign	Interdesign
Intersil	Intersil
IPI	Integrated Photomatrix, Inc.
ITT	ITT Semiconductors
Lithic Sys.	Lithic Systems
Litronix	Litronix
LSI Comp.	LSI Computer Systems
Micro Net	Micro Networks
Micropac	Micropac Industries
Micro Power	Micro Power Systems
Mitsubishi	Mitsubishi International
MMI	Monolithic Memories, Inc.
MOS	MOS Technology
Mostek	Mostek
Motorola	Motorola Semiconductor
National	National Semiconductor
NCR	National Cash Register, Microelectronics Div.
NEC	NEC Microcomputers
Nippon	Nippon Electric Co.
Nitron	Nitron
Nortec	Nortec Electronics
NPC	Nucleonic Products Co.
OKI	OKI Electronics of America, Inc.
Panasonic	Panasonic, Matsushita Electric Corp.
Plessey	Plessey Semiconductors
PMC	Power Monolithics Co.
PMI	Precision Monolithics, Inc.
Ragen	Ragen Semiconductor
Raytheon	Raytheon Semiconductor
RCA	RCA Solid State Division
Reticon	Reticon
Rockwell	Rockwell International, Microelectronic Div.
Sanken	Sanken Electric
SGS	SGS-ATES Semiconductor
Signetics	Signetics
Silicon G	Silicon General
Siliconix	Siliconix
SMC	SMC Microsystems Corp.
Solitron	Solitron Devices
Sprague	Sprague Electric Company
SSS	Solid State Scientific
SW	Stewart-Warner Microcircuits
Synertek	Synertek
Teledyne C	Teledyne Crystalonics
Teledyne P	Teledyne Philbrick
Teledyne S	Teledyne Semiconductor
TI	Texas Instruments
TMX	TMX, Inc.
Toshiba	Toshiba
TRW	TRW
Transitron	Transitron Electronics
Western	Western Digital

PART NUMBER GUIDE

Each IC manufacturer has his own unique method at identifying products, usually through a system of device number prefixes and suffixes. This Part Number Guide is arranged alphabetically by manufacturer and describes each company's part number system. JAN nomenclature is also covered.

Manufacturer	Part Number: Prefix	Part Number: Suffix	Example
ADVANCED MEMORY SYSTEMS	**Classification** IC Circuits - 91 **Sub Category** **0** Custom MOS **1** Bipolar RAM **2** Bipolar **3** Bipolar ROM (1–3: Sequential Numbers 1-500 ECL, 501-999 TTL) **4** CMOS **5** SOS **6** PMOS **7** NMOS	**Package** 3A 16 Pin Flat Pack 3B 22 Pin Flat Pack 6A 14 Pin DIP 6B 16 Pin DIP 6C 24 Pin DIP 6D 22 Pin DIP 6E 18 Pin DIP P Plastic	Device: AMS 6003 Prefix / Device / Suffix 91 / G 003 / 11 6DP 91 = Classification G = Sub-Category 11 = Test Spec 6DP = Package Code
ADVANCED MICRO DEVICES Note: Alternate source devices follow original manufacturer's part number and marking system.	**Functional Group** **25** MSI **26** Computer Interface **27** Bipolar Memory **28** MOS **90** MOS **91** MOS **Type** **L** Low Power **S** Schottky **LS** Low Power Schottky **(Blank)** Standard	**Package** **D** Hermetic DIP **P** Molded **F** Flat **X** Dice **Temperature Range** **C** Commercial **M** Military	Prefix / Device / Suffix AM25 / S 05 / D M AM25 = Functional Group S = Type 05 = Device Number D = Package M = Temperature Range
AMERICAN MICROSYSTEMS	**Family** S Standard	**Package Type** 1 Plastic 2 Cer-DIP 3 SLAM 4 Ceramic (Three Layer) 5 TO Type **Package/Pins** **C** 22 Pin Plastic or Cer-DIP **D** 14 Pin Plastic or Ceramic **F** 12 Pin TO **H** 16 Pin Cer-DIP, SLAM, or Ceramic **I** 28 Pin Cer-DIP or SLAM **L** 24 Pin Cer-DIP **M** 40 Pin SLAM **P** 18 Pin Plastic or Cer-DIP **T** 40 Pin Plastic **U** 16 Pin Plastic **W** 24 Pin Plastic **Z** 28 Pin Plastic	Prefix / Device / Suffix S / 1103X / 2 P S = Family X = Version 2 = Package Type P = Number of Pins
ANALOG DEVICES	**AD** Analog Devices	**Temperature Range** **J,K,L** Commercial Grade **S,T** Military Grade **Package** **DN** Ceramic DIP **D** 8 Pin Ceramic DIP **E** 14 Lead Plastic DIP **F** Ceramic Flatpack **H** TO-5 type Can **N** Plastic DIP	Prefix / Device / Suffix AD / 7516 / JN J = Temperature Range N = Package
COLLINS RADIO		**Package** **1** Ceramic DIP **2** Flatpack **3** Plastic DIP **Temperature** **1** −55°C to 125°C **2** −25°C to 85°C **3** 0°C to 70°C	Prefix / Device / Suffix CRC / 1504 / -1 -2 -1 = Package -2 = Temperature Range

Manufacturer	Part Number: Prefix	Part Number: Suffix	Example
DATEL	**Family** **ADC** A/D Converters **AM** Amplifiers **SHM** Sample-Hold	**Package** **1** 14 Pin DIP **2** TO-99 **Temperature** **C** 0°C to 70°C **M** −55°C to 125°C	**Prefix** AM, **Device** 490, **Suffix** 2 A Package — 2 Selection — A DAC HY12B C Temperature — C
ELECTRONIC ARRAYS Note: Alternate source devices follow original manufacturer's part number and marking system.	**Family** **10** Static Shift Register **12** Dynamic Shift Register **15** N Channel RAM **20** Keyboard Encoder **3X** Dynamic ROM **4X** Static ROM	**Package** **D** Hermetic DIP **F** Flat Pack **P** Molded DIP **T** TO-Can **X** Dice **Temperature Range** **C** 0°C to 70°C **I** −55°C to 85°C **L** −55°C to 100°C **M** −55°C to 125°C **X** Other	**Prefix** EA, **Device** 1500A, **Suffix** DM Family — 15 Package — D Temperature Range — M
EMM/SEMI **A. Semi Product**		**Package** **D** Dice **C** Dual in Line, Ceramic **P** Dual in Line, Plastic **F** Flat Package, Ceramic **S** Special Packages **Temperature Range** **C** 0°C to 70°C **S** −25°C to 85°C **M** −55°C to 125°C	**Prefix** SEMI, **Device** 4402, **Suffix** X X Package — X Temperature Range — X
B. General Instrument Second Source Marking	**Family** **RO** ROM **RA** RAM **CP** Microprocessor	**Package** **3** Dual in Line	**Prefix** SEMI, **Device** RA-3-4256 Family — RA Package — 3
EXAR INTEGRATED SYSTEMS	**XR** Exar	**Grade** **C** Commercial **M** Military (Ceramic package and −55°C to 125°C) **( )** The absence of C or M indicates a commercial part with tighter specs **Package** **P** Plastic **N** Ceramic (Dice available)	**Prefix** XR, **Device** 567, **Suffix** CP Grade — C Package — P
FAIRCHILD Alternate source devices may follow original manufacturer's part number and marking systems.	**F** Fairchild **SH** Hybrid **μA** Linear	**Package** **C** Chip (Dice) **D** Ceramic DIP **E** Plastic Can **F** Flat Pac **H** Metal Can **J** Metal Power Package (TO-66) **K** Metal Power Package (TO-3) **P** Plastic DIP **T** Mini DIP **U** Power Package (Molded, TO-220) **W** Plastic TO-92 **Temperature — Check Device Data for Specific Values** **C** 0°C to 70°C/75°C (CMOS −40°C to 85°C) **L** MOS −55°C to 85°C; Hybrid −20°C to 85°C **M** −55°C to 125°C	**Prefix** μA, **Device** 741, **Suffix** AHM Electrical Class (if used) — A Package — H Temperature — M

Manufacturer	Part Number: Prefix	Part Number: Suffix	Example

GENERAL INSTRUMENT

Prefix

Designation
- **CU** Array
- **AY** Array
- **DL** Shift Register Dynamic ≥ 50 Bits
- **DS** Shift Register Dynamic < 50 Bits
- **LC** Linear Circuit
- **LG** Logic Cells
- **MEN** N an P Channel FETs
- **MU** Multiplexer
- **RA** RAM
- **RO** ROM
- **SL** Shift Register Static ≥ 50 Bits
- **SS** Shift Register Static < 50 Bits

Temperature and Processing
- **0** MTOS −55°C to 85°C
- **1** MTOS 0°C to 70°C
- **4** N Channel
- **5** MTNS 0°C to 70°C
- **6** −55°C to 125°C
- **7** MTNS
- **8** Silicon Gate −55°C to 125°C
- **9** Silicon Gate 0°C to 70°C

Description

Multiplexers
- **WX** Indicates Typical R_{ds} (on) in hundred ohms steps:
  - 01 ≤ 100 ohms
  - 02 ≤ 200 ohms
  - 03 ≤ 300 ohms, etc.
- **YZ** Total Number of Channels

Custom
- **Custom** Number Assigned

ROM/RAM
- **WXYZ** Total Number of Bits

Shift Registers
- **W** Indicates the number of redundant configurations:
  - 1 Single 3 Triple
  - 2 Dual 4 Quad, etc.
- **XYZ** Total number of bits per configuration

Arrays/Linear/Logic
- **WXYZ** Arbitrary Number Assigned

Suffix

Package Identification (Not Marked on Pkg.)
- **01** Dice
- **12** 8 Lead DIP
- **14** TO-5 4 Lead
- **15** TO-78 8 Lead
- **16** TO-5 8 Lead
- **17** TO-5 8 Lead High Profile
- **21** TO-5 10 Lead
- **22** TO-5 10 Lead Isolated
- **23** TO-100 10 Lead
- **29** 24 Lead Plastic DIP
- **30** 14 Lead Plastic DIP
- **31** 16 Lead Plastic DIP
- **32** 24 Lead Plastic DIP
- **33** 40 Lead Plastic DIP
- **35** 36 Lead Plastic Flat Pack
- **51** TO-8 12 Lead Low Profile
- **55** 16 Lead DIP
- **60** 10 Lead Flat Pack
- **61** 14 Lead Flat Pack
- **62** 16 Lead Flat Pack
- **63** 20 Lead Flat Pack
- **64** 24 Lead Flat Pack
- **65** 40 Lead Flat Pack
- **66** 36 Lead
- **68** 44 Lead Flat Pack
- **69** 14 Lead DIP
- **71** 16 Lead DIP
- **72** 24 Lead DIP .6 MIL Centers
- **73** 24 Lead DIP .5 MIL Centers
- **74** 40 Lead DIP .6 MIL Centers
- **75** 40 Lead DIP 1.05 MIL Centers
- **76** 28 Lead DIP
- **77** 18 Lead DIP
- **79** 24 Lead DIP .6 MIL Centers
- **80** 14 Lead Ceramic RIP
- **81** 16 Lead Ceramic DIP

Example

Prefix	Device	Suffix
RO-6	WXYZ	(XX)

- Designation
- Temp. & Processing
- Description
- Package Identification

HARRIS

Prefix

Family
- **A** Analog
- **D** Digital
- **I** Interface
- **M** Memory

Package
- **1** DIP
- **2** TO-5 Type
- **7** Mini DIP
- **9** Flat Pack
- **0** Chip Form

Exceptions
- **HPROMX-0152-X**
- **HPROMX-1024-X**
- **HPROMX-8256-X**

Suffix

Temperature Range
- **2** −55°C to 125°C
- **4** −25°C to 85°C
- **5** 0° to 75°C
- **6** 100% 25°C Probe (Dice only)
- **8** Dash 8 Program, MIL-STD-883, Class B. Example: HA-2700-8
- **9** −40°C to 85°C (4000 Series CMOS)

Exceptions

The 54C/74C CMOS Family temperature designation is contained in the Part Number

Example:
- 54CXX −55°C to 125°C
- 74CXX 0°C to 70°C

Example

Prefix	Device	Suffix
H M I	7620	5

- Family
- Package
- Temperature Range

ITT SEMICONDUCTOR

Prefix
- ITT
- SAK
- SAH
- TAA

Suffix

Temperature Range
- **1** −55°C to 125°C
- **5** 0°C to 70°C (0°C to 75°C Digital)

Package
- **B** Flat Package
- **C** TO-5 Style
- **D** Ceramic DIP
- **N** Plastic DIP

Example

Prefix	Device	Suffix
ITT	709A	1D

- Temperature Range
- Package

INTEL

Prefix

Package
- **C** Ceramic (Metal Lid) DIP (Hermetic)
- **D** CerDIP (Glass Seal) DIP (Hermetic)
- **F** Flat Package
- **P** Plastic DIP
- **M** Metal Can Package (Hermetic)

Example

Prefix	Device	Suffix
P	1101A	

- Package

INTERNATIONAL MICROCIRCUITS

Prefix
- **MM** Master MOS Array
- **SCC** Special Custom Circuit

Family
- **1** Small Chip
- **2** Special Size
- **3** Medium Chip
- **6** Large Chip

Suffix

Package
- **C** Ceramic
- **P** Plastic DIP
- **S** Special

Example

Prefix				Suffix
MM	6	013	B-P	28

- Family
- Metal Option
- Change Level
- Package
- No. of Pins

Manufacturer	Part Number: Prefix	Part Number: Suffix	Example
INTERSIL A. Hybrid	**Temperature** 1 −55°C to 125°C 4 0°C to 70°C	**Package** (see last example) **Pins** (see last example)	Prefix: DG 1 · Device: 26A · Suffix: D D DG = Analog Gate 1 = Temperature D = Package D = No. of Pins
	Characteristics 5 Analog 7 Digital 9 Interface **General Type** 0 Gates 1 Amplifiers	**Package** (see last example) **Pins** (see last example)	Prefix: IH 5 0 · Device: 01 · Suffix: P A IH = Intersil Hybrid 5 = Characteristics 0 = General Type P = Package A = No. of Pins
B. Linear, Low Power, Watch & Clock Circuits	**Circuit** L Linear CM Watch, Clock	**Temperature** C Commercial (0°C to 70°C) I Industrial (−20°C to 70°C) M Military (−55°C to 125°C) **Package** (see last example) **Pins** (see last example)	Prefix: IC X · Device: 8001 · Suffix: C T Z I = Intersil C X = Circuit C = Temperature T = Package Z = No. of Pins
C. Memory Circuits	**Process** 5 Bipolar 6 CMOS 7 MOS **General Type** 0 to 4 Digital 5 Random Access Memory (RAM) 6 Programmable Read Only Memory (PROM) 7 Shift Register	**Temperature** C Commercial (0°C to 75°C) M Military (−55°C to 125°C) N Reduced Military (−20°C to 125°C) **Package** D Dual-In-Line Package Ceramic E Small TO-8 Type F Flat Package, Ceramic G TO-8 Type H Flat Package, Silicon I 16 Pin DIP (0.6 x 0.7 Lead Space) J Dual-In-Line Cerdip L Leadless Ceramic P Dual-In-Line Package, Plastic T TO-5 Type **Pins (No. of)** H 6 · F 22 A 8 · G 24 B 10 · I 28 C 12 · J 32 D 14 · K 36 E 16 · L 40 N 18 V 8, .230″ Pin Circle W 10, .230″ Pin Circle Y 8, No. 4 Lead Connected to Case Z 10, No. 5 Lead Connected to Case	Prefix: I M 7 6 01 XX · Suffix: C D E I = Intersil M = Memory Circuit 7 = Process 6 = General Type 01 = Specific Type XX = ROM Pattern Identification (Applicable to ROM only) C = Temperature D = Package E = No. of Pins
JAN NOMENCLATURE	J / JAN } Qualified Device M38510 Military Designation **Device** The "Slash" numbering signifies the specification and specifies the device type. See Military Parts Directory.	**Device Class** A Missiles and Manned Spacecraft B General Military C Less Critical Military Applications **Case Outline** A ¼″ x ¼″ Flat Pack, 14-Pin B ⅛″ x ¼″ Flat Pack, 14-Pin C ¼″ x ¾″ Dual-In-Line, 14-Pin D ¼″ x ⅜″ Flat Pack, 14-Pin E ¼″ x ¾″ Dual-In-Line, 16-Pin F ¼″ x ⅜″ Flat Pack, 16-Pin G 8-Lead Can H ¼″ x ¼″ Flat Pack, 10-Lead I 10-Lead Can J ½″ x 1¼″ Dual-In-Line, 24-Pin K ⅜″ x ½″ Flat Pack, 24-Pin **Lead Finish** A Kovar or Alloy 42, with Hot Solder Dip B Kovar or Alloy 42, with Bright Acid Tin Plate C Kovar or Alloy 42, with Gold Plate	Prefix: JM38510 · Device: /XXXXX · Suffix: B C B B = Device Class C = Case Outline B = Lead Finish

Manufacturer	Part Number: Prefix	Part Number: Suffix	Example
LITHIC SYSTEMS	**Device Type** **LA** Array **LP** Proprietary **LSS** Second Source	**(Proprietary Devices)** **A** Premium **B** Super Premium **C** Commercial **E** Entertainment	Prefix: LP · Device: 2000 · Suffix: C LP = Device Type
MICRO NETWORKS	**MN** Micro Networks	**Temperature Range** (No suffix) 0°C to 70°C **E** −55°C to 85°C **H** −55°C to 125°C **B** Processing to 883A Method 5004.2	Prefix: MN · Device: 3000 · Suffix: H B H = Temperature Range B = Processing
MONOLITHIC MEMORIES	**Type** **0** Character Generator **2** ROM **3** PROM **5** RAM **7** Computer Logic **Temperature** **5** Military TTL **6** Commercial TTL **Performance** **A** And Enable **H** High Speed **L** Low Power	**Package** **D** Ceramic (Metal Cap) **F** Flatpac **J** CERDIP **N** Epoxy	Prefix: H 5 2 · Device: 05 · Suffix: D H = Performance 5 = Temperature 2 = Type D = Package
MOSTEK	**MK** Mostek	**Package** **E** Leadless Chip Carrier **M** Plastic Flat Package **N** Plastic Dual In-line **P** Ceramic Dual In-line	Prefix: MK · Device: 4096 · Suffix: P P = Package
MOTOROLA	**Description** **MC** Packaged Integrated Circuits **MCB** Packaged Beam-lead Integrated Circuits. (Followed by F suffix when in flat pack.) **MCBC** Beam-lead Integrated Circuit Chips **MCC** Unencapsulated Integrated Circuit Chips **MCCF** Flip-Chip Linear Integrated Circuits **MCE** Dielectrically Isolated Integrated Circuits **MCM** Integrated Circuit Memories **MFC** Low Cast Integrated Circuits packaged in Motorola's unique "Functional-Circuits" plastic package. (Package suffix not used in this device series.) **MLM** Pin-for-pin equivalent to Linear Integrated Circuits made by National Semiconductor.	**Package** **F** Flat Ceramic Package **G** Metal Can Package (TO-5 types) **K** Metal Power Package (TO-3 types) **L** Ceramic Dual-In-Line Case **P** Plastic Package **PQ** IC's Packaged in Staggered-Lead Plastic DIP Packages **R** Metal Power Packages (TO-66 types) **U** Ceramic Package	Prefix: MC · Device: 14510 · Suffix: AL MC = Description AL = Package
NATIONAL **DEVICE NUMBER (for Digital Devices):** **CDXXXX-CMOS** — C suffix −40°C to 85°C, M suffix −55°C to 125°C. **DM54XX** — All numbers beginning with 5 denote −55°C to 125°C temperature operation. **DM74XX** — If the "74" is indicated, the operating temperature is 0°C to 70°C. **DM7XXX** — All other numbers beginning with 7 (besides the "74" shown above) are NSC proprietary products and a 7 here indicates −55°C to 125°C. **DM8XXX** — All numbers beginning with 8 denote 0°C to 70°C temperature operation.	**Description** **AH** Analog Hybrid **AM** Analog Monolithic **CD** CMOS **DH** Digital Hybrid **DM** Digital Monolithic **DS** Digital Special **LF** Linear FET Monolithic **LH** Linear Hybrid **LM** Linear Monolithic **LX** Transducer **MH** MOS Hybrid **MM** MOS Monolithic **Linear Devices** With proprietary linear circuits, a 1-2-3 numbering system is employed. The 1 denotes a Military temperature range device (−55°C to 125°C), the 2 denotes an Industrial device (−25°C to 85°C), and the 3 denotes a Commercial device (0°C to 70°C). i.e. LM101/LM201/LM301. Exceptions to this are the LM1800 Series; some hybrid circuits which employ a "C" suffix; and second-source products which follow the original manufacturers numbering system.	**Characteristics** **A** Improved Electrical Specs **C** Reduced Temperature Range **Package** **D** Glass/Metal DIP **F** Flat Pack (0.25" wide) **G** TO-8 (12 lead) Metal Can **H** TO-5 (multi-lead) Metal Can **J** Glass/Glass **K** TO13 Power Pack **M** Wide Trak Power Pack **N** Molded DIP **P** TO-202 Plastic Power Pack **R** Low Temperature Ceramic Pack **S** 14 Lead Power Pack SGS Power Pack **T** TO-220 Plastic Power Pack **W** Flat Pack (0.275" wide) **Z** TO-92	Prefix: LM · Device: 101 · Suffix: A F A = Characteristics F = Package

Manufacturer	Part Number: Prefix	Part Number: Suffix	Example
NEC	µP Micropackage **Family** **A** Discrete **B** Digital Bipolar **C** Linear **D** Digital CMOS	**Package** **C** Plastic **D** Ceramic	Prefix: µP F · xxxxx · Suffix: P S F — Family P — Package S — Modification
NITRON	**Description** **NC** Packaged IC's (non-memory) **NCM** Packaged Memory IC's **NIT** Memory Modules		Prefix: NC · Device: 7010 · Suffix: NC — Description
NORTEC	**NE** Nortec Electronics **NE** 6003BZD **NE** 1103-1460	**Electrical Selections** 11, BZ, 146, etc. — Electrical Selections **Package** **D** Ceramic DIP **F** Flatpack **H** Metal Can **J** CerDIP **N** Molded DIP **P** 8-Pin DIP **Y** Dice	Prefix: NE · Device: 6003 · Suffix: 11 D 11 — Electrical Selections D — Package
PANASONIC	**Description** **AN** Analog **DN** Digital Bipolar **J** Development Type **MN** MOS		Prefix: DN · Device: 830
PLESSEY	**Description** **ML** MOS Linear (w/gate protection) **MP** MOS Digital **MT** MOS Linear (without gate protection) **NOM** MNOS Memory Elements and Arrays **SAA, SBA** Alternate Sourced Consumer Devices **SL** Bipolar Linear **SP** Bipolar Digital	**Characteristics** **A-D** Electrical/Temperature Variations **Package** **E** DIP **F** Flatpack **P** Power **Q** Quad In-Line **S** Stud **T** TO-5 and TO-18	Prefix: SL · Device: 421 · Suffix: A T A — Elec/Temp T — Package
PRECISION MONOLITHICS	**Description** **SSS** Second Source Devices **DAC** Digital to Analog Converter **AD** Analog to Digital Converter **MAT** Matched Transistors **OP** Operational Amplifier **CMP** Voltage Comparator	**Package (Last Alphabetical Character)** **G** 6-Pin TO-18 **H** 6-Pin TO-78 **J** 8-Pin TO-99 **K** 10-Pin TO-100 **L** 10-Pin Flatpack **M** 14-Pin Flatpack **N** 24-Pin Flatpack **P** 14-Pin Metal DIP **Q** 16-Pin Metal DIP **R** 22-Pin Hermetic DIP — .400" Centers **S** 14-Pin Plastic DIP **T** 16-Pin Plastic DIP **U** 18-Pin Hermetic DIP **V** 24-Pin Hermetic DIP — .600" Centers **W** 40-Pin Hermetic DIP — .600" Centers **X** 40-Pin Flatpack **Y** 14-Pin CerDIP **Z** 16-Pin CerDIP	Prefix: DAC · Device: 01 · Suffix: CP P — Package

Manufacturer	Part Number: Prefix	Part Number: Suffix	Example
RAYTHEON SEMICONDUCTOR	**Temperature** **LH1, LM1** −55°C to 125°C **LH2, LM2** −25°C to 85°C **LH3, LM3** 0°C to 70°C **RC** 0°C to 70°C **RM** −55°C to 125°C **RV** −40°C to 85°C **54** −55°C to 125°C **74** 0°C to 70°C	**Package** **Most Devices** **BL** Beam Lead Chip **BLB** BL Chip, Military Visual **CG** Gold-Backed Chip **CH** Standard Chip **D** 14-Pin Glass/Metal DIP (Linears Only) **DC** 14-Pin Ceramic DIP **DD** 16-Pin Ceramic DIP **DN** 8-Pin Plastic DIP **DP** 14-Pin Plastic DIP **G** 10-Pin Flatpack, 1/4″ x 9/64″ (Linears Only) **J** 14-Pin Glass/Metal Flatpack **L** 16-Pin Glass/Metal Flatpack **LK** TO-3 Power Pack **M** 16-Pin Glass/Metal DIP **MP** 16-Pin Plastic DIP **N** 24-Pin Glass/Metal Flatpack **Q** 10-Pin Flatpack, 1/4″ x 1/4″ (Linears Only) **R** 24-Pin Ceramic DIP **T** 3, 8, 10 or 12-Pin TO-5 Can **TK** 9-Pin TO-66 Power Pack **Y** TO-220 Plastic Power Pack **LH, LM Series** **F** Flat Pack (1/4″ Wide) **H** 3, 8 or 10-Pin TO-5 Can **K** TO-3 Power Pack **N** Plastic DIP	Prefix / Device / Suffix 54 153 DD RC 4136 DP LM 118 H Prefix: Temperature Suffix: Package
RCA	**Description** **CA** Linear IC's **CD** Digital IC's **MW** MOS IC's	**Version** **A** Modified Version, Unilaterally Interchangeable with Prototype **B** Modified Version, Unilaterally Interchangeable with A Version, and with Prototype **C** Modified Version, Unilaterally Interchangeable with B, A, and Prototype Versions **Package** **D** White Ceramic DIP **E** Plastic DIP **F** Ceramic DIP, frit seal **G** Hermetic Chip in Plastic Package **H** Chip **K** Ceramic Flat Package **L** Beam-Lead Device **Q** Quad-In-Line Plastic Package **S** TO-5 Package with DIL-CAN **T** TO-5 Package **X** Ceramic DIP, frit seal	Prefix / Device / Suffix CD 4070 BD Version Package
RETICON	**RA** Area Array **RL** Linear Array **SAD** Serial Analog Delay **SAM** Serial Analog Memory **SAP** Serial Analog Processor **TAD** Tapped Analog Delay	**Code** No. of columns and lines No. of elements No. of storage elements No. of storage elements No. of storage elements No. of Taps	Prefix / Device / Suffix RA 50x50 A RL 1024 C TAD 12 Device: Code Suffix: Revision
SGS-ATES SEMICONDUCTOR	**(Prefixes assigned by the European Association "PRO ELECTRON")** **H** High Level Logic **HBF** CMOS **L** Linear **M** MOS **TAA** Linear **TBA** Linear **TCA** Linear **TDA** Linear		Prefix / Device TDA 1200

Manufacturer	Part Number — Prefix	Part Number — Suffix	Example

SIGNETICS

Prefix — Temperature Range
- **N** 0°C to 70°C (N8 Series 0°C to 75°C)
- **S** −55°C to 125°C

Suffix — Package
- **A** 14-Pin Plastic DIP
- **B** 16-Pin Plastic DIP
- **DA** TO-3 Solid Header, Can
- **DB** TO-5 Solid Header, Can
- **F** 14- 16- 24-Pin Ceramic DIP
- **I** 14- 28- 40-Pin Ceramic DIP
- **K** 10-Lead, TO-5 Header, Short Can
- **L** 10-Lead, TO-5 Header, Long Can
- **N** 24-Pin Plastic DIP
- **Q** 10- 14- 16- 24-Pin Ceramic Flatpack
- **T** 8-Lead, TO-5 Header, Can
- **V** 8-Pin Plastic DIP
- **W** 10- 14- 16-Pin Ceramic Flatpack
- **X** 18- 22-Pin Plastic DIP

Example

Prefix	Device	Suffix
NE	555	T

Temperature (NE); Package (T)

SILICONIX

Prefix — Description
- **D** Driver for FET Switch
- **DG** Driver with FET Switches
- **DGM** Driver with FET Switches (Monolithic Version of Hybrid Device)
- **G** Multi-Channel FET Switches
- **H** High Voltage (28 v) Logic
- **L** Linear IC
- **LD** A/D Converter
- **LH** Hybrid Linear IC (2nd Source)
- **LM** Linear IC (2nd Source)
- **SI** 2nd Source Part

Suffix — Temperature
- **A** −55°C to 125°C
- **B** −20°C to 85°C
- **C** 0°C to 70°C

Package
- **A** Metal Can
- **F** Flatpack
- **J** Plastic DIP
- **L** Flatpack
- **P** Hermetic DIP
- **R** Hermetic DIP

MIL Process Option
- **1** MIL-883, Class A
- **2** MIL-883, Class B
- **3** MIL-883, Class C
- **4** In-House Screening Plus 168 Hr. Burn-In

Example

Prefix	Device	Suffix
DG	200	BA-X

Temperature; Package; MIL Process Option

SMC MICROSYSTEMS

Prefix — Family
- **CG** Character Generator
- **COM** Communications
- **KR** Keyboard Encoding

Suffix — Package
- **P** Plastic
- **C** Ceramic

Temperature
- **T** −25°C to 85°C
- **(Blank)** 0°C to 70°C

An H in the Suffix Indicates High Speed

Example

Prefix	Device	Suffix
COM	2502	P

Family; Package; Temperature Range

SOLID STATE SCIENTIFIC

Prefix — Reliability
- **A** MIL 883-A
- **B** MIL 883-B
- **C** MIL 883-C
- **S** Standard

Other Letters
- **CM** CMOS
- **C** Complementary
- **L** Logic
- **M** Memory

Suffix — Process
- **A** AL Gate Bulk
- **B** High Voltage AL Gate
- **S** Silicon on Sapphire

Package
- **C** Ceramic DIP
- **D** Ceramic DIP
- **E** Epoxy DIP
- **H** Chip
- **F** Flat Pack
- **T** TO5

Example

Prefix	Device	Suffix
SCL	4000	AE+

Reliability; Process; Package; Special Screening

SOLITRON

Prefix
- **CM** CMOS

Suffix — Package Style, Temperature Range
- **AD** Ceramic DIP, −55°C to 125°C
- **AE** Epoxy Encapsulated DIP, −40°C to 85°C
- **AF** CerDIP, −55°C to 125°C

Example

Prefix	Device	Suffix
CM	4000	AD

Package/Temperature

SPRAGUE ELECTRIC

A. UC Series, UD Series, UL Series

Prefix — Family
- **C** CMOS
- **D** Display Drivers
- **L** Linear Circuits

Temperature
- **N** Limited Temperature Range, −25°C to 70°C
- **S** Extended Temperature Range

Suffix — Package
- **A** Plastic DIP
- **C** Chip
- **D** TO-99
- **E** 8-Pin Plastic DIP with pins 1, 4, 5, & 8 only
- **F** TO-86 or 30 Lead Flat Package
- **G** TO-91
- **H** 14-Pin Hermetic DIP
- **J** TO-87
- **K** TO-100
- **L** TO-100
- **M** 8-Pin Plastic DIP
- **N** 14-Pin Plastic Quad-In-Line
- **P** Batwing DIP
- **Q** Batwing Quad-In-Line
- **R** 8-Lead DIP with Unformed Leads
- **S** 4-Pin SIP
- **W** TO-100 with Miniature Tube Base Adapter

Example

Prefix	Device	Suffix
ULN	2111	A

Family; Temperature; Package

B. UH Series

Suffix — Package
- **C** Hermetic Flatpack
- **D** Hermetic DIP
- **P** Plastic DIP

Example

Prefix	Device
UHP	400

Package

STEWART-WARNER

SW Stewart-Warner

Series
DTL 7XX to 93X

Package
2M Commercial (0°C to 70°C) Plastic DIP
2P Commercial (0°C to 70°C) Ceramic DIP
1P Military (−55°C to 125°C) Ceramic DIP
1F Military (−55°C to 125°C) Ceramic Flat Pack

Series
DTL 18XX to 19XX

Package
M Plastic
P Ceramic
F Flat Pack

Series
TTL 74XX to 9XXX

Package
N, PC Plastic
J, DC Ceramic

Series
CMOS 4XXX

Package
AE Plastic/Epoxy B (−40°C to 85°C)

Prefix	Device	Suffix
SW	7495	N

Series — 7495; Package/Temperature — N

TELEDYNE SEMICONDUCTOR

Temperature/Electrical
A −55°C to 125°C, Selected Electrical Performance (HiNIL −30°C to 70°C)
B −55°C to 125°C, Premium Electrical Performance
C 0°C to 70°C, Industrial Electrical Performance (HiNIL −30°C to 85°C)
M −55°C to 125°C

Package
E Metal Can
H Flat Pack
J Plastic DIP, 14- 16-Pin
L CerDIP, 14- 16-Pin
N Ceramic DIP, 14- 16-Pin
P Plastic Mini DIP, 8 Lead
Y Dice

Device	Suffix
709	BE

Temperature/Electrical — B; Package — E

For alternate source devices, the original manufacturer's part number and marking system is used.

TEXAS INSTRUMENTS

Description
RSN Radiation Hardened Circuit
SBP Bipolar Processor
SN Standard Prefix
SNM High Reliability, Level I
SNA High Reliability, Level II
SNC High Reliability, Level III
SNH High Reliability, Level IV
TMS MOS

Temperature (Most Devices)
52 Series −55°C to 125°C
54 Series −55°C to 125°C
55 Series −55°C to 125°C
62 Series −25°C to 85°C
72 Series 0°C to 70°C
74 Series 0°C to 70°C
75 Series 0°C to 70°C
TF Series −40°C to 85°C
TP Series −55°C to 125°C
TMS C Series −25°C to 85°C
TMS L Series 0°C to 70°C
TMS R Series −55°C to 85°C

Package
FA Flat Package
J Ceramic Flat Package
JA DIP
JB DIP
JP DIP
L Metal Can
LA Metal Can
N Plastic DIP
ND Plastic DIP with Tab
P Plastic DIP
RA Flat Package
SB Flat Package
T Metal Flat Package
W Ceramic Flat Package

A.

Prefix	Device	Suffix
SN 74	S188	J

Description — SN; Temperature Range — 74; Package — J

B.

Prefix	Device	Suffix
TMS	4030	JL

Package — J; Temperature Range — L

TOSHIBA

Description
TA Bipolar Linear
TC CMOS
TD Bipolar Digital
TM MOS

Package
P Plastic
M Metal
A Improved Type

Prefix	Device	Suffix
TA	7173	AP

WESTERN DIGITAL

Package
A 40 Lead DIP, Ceramic
B 40 Lead DIP, Plastic
C 24 Lead DIP, Ceramic
D 24 Lead DIP, Plastic
E 28 Lead DIP, Ceramic
F 28 Lead DIP, Plastic
G 22 Lead DIP, Ceramic
H 22 Lead DIP, Plastic

Prefix	Device	Suffix
TR1602	A	01

Package — A; Special Parameter — 01

ABBREVIATIONS OF COMPANY NAMES

AD	Analog Devices
AMD	Advanced Micro Devices
AMI	American Microsystems, Inc.
AMS	Advanced Memory Systems
Analogic	Analogic Corp.
Beckman	Beckman Instruments, Helipot Division
Burr-Brown	Burr-Brown Research
Cermetek	Cermetek
CMA	Consumer Microcircuits of America
Collins	Collins Radio
Datel	Datel Systems
DDC	ILC Data Devices Corp.
EA	Electronic Arrays
EMM/Semi	EMM Semi, Div. of Electronic Memories & Magnetics
Exar	Exar Integrated Systems
Fairchild	Fairchild Semiconductor
Ferranti	Ferranti Electric
GI	General Instrument
Harris	Harris Semiconductor
Hitachi	Hitachi America, Ltd.
Hughes	Hughes Aircraft Co., MOS Divison
Hybrid Sys.	Hybrid Systems
IMI	International Microcircuits, Inc.
Intech	Intech
Intel	Intel
Interdesign	Interdesign
Intersil	Intersil
IPI	Integrated Photomatrix, Inc.
ITT	ITT Semiconductors
Lithic Sys.	Lithic Systems
Litronix	Litronix
LSI Comp.	LSI Computer Systems
Micro Net	Micro Networks
Micropac	Micropac Industries
Micro Power	Micro Power Systems
Mitsubishi	Mitsubishi International
MMI	Monolithic Memories, Inc.
MOS	MOS Technology
Mostek	Mostek
Motorola	Motorola Semiconductor
National	National Semiconductor
NCR	National Cash Register, Microelectronics Div.
NEC	NEC Microcomputers
Nippon	Nippon Electric Co.
Nitron	Nitron
Nortec	Nortec Electronics
NPC	Nucleonic Products Co.
OKI	OKI Electronics of America, Inc.
Panasonic	Panasonic, Matsushita Electric Corp.
Plessey	Plessey Semiconductors
PMC	Power Monolithics Co.
PMI	Precision Monolithics, Inc.
Ragen	Ragen Semiconductor
Raytheon	Raytheon Semiconductor
RCA	RCA Solid State Division
Reticon	Reticon
Rockwell	Rockwell International, Microelectronic Div.
Sanken	Sanken Electric
SGS	SGS-ATES Semiconductor
Signetics	Signetics
Silicon G	Silicon General
Siliconix	Siliconix
SMC	SMC Microsystems Corp.
Solitron	Solitron Devices
Sprague	Sprague Electric Company
SSS	Solid State Scientific
SW	Stewart-Warner Microcircuits
Synertek	Synertek
Teledyne C	Teledyne Crystalonics
Teledyne P	Teledyne Philbrick
Teledyne S	Teledyne Semiconductor
TI	Texas Instruments
TMX	TMX, Inc.
Toshiba	Toshiba
TRW	TRW
Transitron	Transitron Electronics
Western	Western Digital

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APPLICATION NOTE DIRECTORY

The Application Note Directory is a comprehensive guide to the many IC application notes available. It lists the devices covered, describes each note, and tells who publishes each one.

how to use the application note directory

The application notes in this directory can be located by function, device number, or manufacturer.

1. To find out what is published by function, locate the closest topics in the index below, turn to the pages indicated, and scan through the listings.

2. To find all the application notes covering a given device, look up the device in the Part Number Index at the front of this book. The page references to pages 67 through 120 lead to application notes.

3. To find out what application notes are available from a particular manufacturer, look up the manufacturer in the table at the end of this section. The table gives you the titles and the page locations for each manufacturer's application notes in this directory.

The application note descriptions are organized under the headings: Digital, Linear, Memory and Microprocessor. Beneath those headings are functional and applications categories arranged alphabetically. Within each category the notes are arranged in alphabetical sequence by manufacturer. The mixing of functions and applications is necessary, since application notes do not lend themselves to classification entirely by function or entirely by application. When an application note fits under several categories, it is listed in one and cross referenced by the others. This may mean that you have to spend five minutes checking a number of categories to be sure you've found everything you want, but finding suitable information can save you considerable design time.

If an application note covers specific devices or it shows in some detail how certain devices are used, these device numbers are listed in parentheses just below the title. If any of these device numbers are in bold face type, data on them is presented in The Master Selection Guide Data Sections.

The application note descriptions are as short as possible. They are designed to save you time in reading while giving an overall sense of the contents. The length of each note is indicated in parentheses on the last line; if the note is bound into a book, the last line will show that it is part of a handbook, databook, catalog, etc.

Once you have determined which application notes you need, contact the manufacturer's sales office or write to the manufacturer. Be sure to give both the title and the application note number. Addresses and phone numbers are listed in the Manufacturers and Distributors Directory.

APPLICATION NOTE SUBJECTS

DIGITAL

Arithmetic

1 **"A Successive Approximation Register"**
(AM2502, AM2503, AM2504, AM25L02, AM25L03, AM25L04)
Operation, logic, coding of these 8 and 12 bit TTL devices. Describes applications in systems performing recursive arithmetic operations; as ring counters; serial-to-parallel converters.
Advanced Micro Devices Data Book, Catalog (11 pg.)

2 **"The Am2506 - A Latching ALU"**
(AM2506)
Combines four-bit arithmetic logic unit and four-bit latch. Describes application in high-speed multiple word adder, multiple master-slave registers, 16-word arithmetic register, multiplication at 16 MHz rate.
Advanced Micro Devices Data Book, Catalog (4 pg.)

3 **"TTL MSI Arithmetic Logic Units"**
(AM2506, 9340, 9341, 9342, SN54181, SN54182, SN74181, SN74182)
Functional descriptions, logic diagrams of 9340, 9341, 2506 parallel four-bit units incorporating 9342 look ahead carry circuit. Reviews adder operation and binary arithmetic. Discusses ALUs.
Advanced Micro Devices Data Book, Catalog (20 pg.)

4 **"The Am25S05, Am2505 and Am25L05 Schottky, Standard and Low Power TTL 2's Complement Digital Multipliers"**
(AM2505, AM25L05, AM25S05)
Discusses multiplication, two's complement notation, Booth's algorithm, iterative arrays, time-sequenced multipliers, integer and fractional multiplication, round-off, truncation and one's complement multiplication. Application to digital filters, square rooting and division.
Advanced Micro Devices Data Book (24 pg.)

5 **"Am25S10 Four-Bit Shifter"**
(AM25S10)
Provides functional description and discusses logic equivalents. Applications: up-shift, down and around end shifts, scaling and fixed multiplication.
Advanced Micro Devices Data Book (10 pg.)

6 **"MNOS Digital Differential Analyzer"**
(CRC1502, CRC1503, CRC1504, CRC9503, CRC9504)
Describes theory of operation of a DDA integrator for the real time solution of differential equations. Covers use of 3 LSI devices including mapping, scaling, initializing, and coding to simulate a given set of algebraic or differential equations.
Collins Radio Application Notes (7 pg.)

7 **"Applications of the TTL/MSI 93S43 4-Bit by 2-Bit Two's Complement Multiplier"**
(93S43)
How to implement a combinatorial multiplication array of any size for two's complement numbers. How to multiply in other number representations. Speed/hardware tradeoffs, normalization of floating point numbers after multiplying, rounding or truncation of double length products.
Fairchild Application, Note 329 (15 pg.)

Arithmetic (cont)

8 **"High-Speed Addition Using Lookahead Carry Techniques"**
Describes use of TTL and ECL to perform lookahead carry addition. Explains operation of adders in detail and gives examples of lookahead carry adders using MC5400/7400, MC3000/3100, and MC1000/1200 series circuits.
Motorola AN-488 (11 pg.)

9 **"High Speed Binary Multiplication using the MC10181"**
See listing under High Speed Logic
(Motorola)

10 **"MECL 10,000 Arithmetic Elements MC10179, MC10180, MC10181"**
See listing under High Speed Logic (Motorola)

11 **"NBCD Sign and Magnitude Adder/Subtracter"**
(MC14560, MC14561)
Describes CMOS parallel adder/subtracters for both signed and unsigned natural binary coded decimal (NBCD) numbers.
Motorola AN-738 (7 pg.)

12 **"Applications of the DM7200/DM8200 Digital Comparator"**
(DM7200, DM8200)
Describes use in word comparison, associative memory, bit exclusion, modulo N divider and servo system applications.
National AN-12 (6 pg.)

13 **"High-Speed TTL Adders"**
(DM7283, DM8283)
Describes 16-bit parallel adders, using the DM7283/DM8283, and connections for ripple-carry parallel addition. Also describes BCD adder techniques implemented with these devices. Shows how devices can be used to improve the performance of MOS storage systems.
National Semiconductor AN-35 (6 pg.)

14 **"Arithmetic Arrays Using Standard COS/MOS Building Blocks"**
(CD4001A, CD4008A, CD4011A, CD4013A, CD4019A)
Describes design of a 32-bit full adder/arithmetic logic system. Discusses four-bit full adder, quad AND-OR select gate, dual D-type flip-flop, input NAND gates, input NOR gates, and arithmetic register.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6600 (6 pg.)

15 **"COS/MOS Rate Multipliers-Versatile Circuits for Synthesizing Digital Functions"**
(CD4089, CD4527)
Describes operation of a rate multiplier, and the effects of cascading. Covers addition, subtraction, multiplication, division, square and higher order roots, frequency ratios, and integration. Also discusses symmetric operation.
RCA SSD-203 COS/MOS Databook, ICAN-6739 (12 pg.)

DIGITAL

Arithmetic (cont)

1 **"BCD Arithmetic"**
(N82S82, N82S83, S82S82, S82S83, N7483)
Discussion of BCD and serial or parallel arithmetic: application of the 82S82/83 as a bit serial BCD adder and as a bit parallel, digit serial adder.
Signetics Applications Handbook (4 pg.)

2 **"BCD Arithmetic Unit"**
(N82S82, S82S82)
Gives description and logic diagram of 82S82. Applications - 2 decade adder/subtractor; high speed BCD adder/subtractor using fast carry, sign and magnitude generation.
Signetics Applications Handbook (4 pg.)

3 **"BCD Adder"**
(N82S83, S82S83)
Gives logic diagram of 82S83. Covers applications as four decade BCD adder and bit parallel-word serial BCD multiplier.
Signetics Applications Handbook (3 pg.)

4 **"Gated Full Adder"**
(N8268, N8270, S8268, S8270)
Provides logic diagram and discusses application of 8268 as n-bit parallel add, n-bit binary subtract, serial binary add/subtract, and serial BCD add/subtract devices.
Signetics Applications Handbook (5 pg.)

5 **"Arithmetic Logic Element, Fast Carry Extender"**
(N8260, N8261, S8260, S8261)
Describes lookahead carry principle and implementation of various adder systems using 8260 and 8261.
Signetics Applications Handbook (9 pg.)

6 **"Converting To and From Binary Using the SN74184 and SN74185A"**
(SN74184, SN74185A, SN74283, SN74284, SN74285)
Compares conventional shift and add technique to conversion from binary to BCD using the 74185A. Tells how to interconnect these converter packages for 6-bit through 20-bit binary inputs and 4, 5 or 6 decade BCD inputs. Describes conversion of fractions using the 74283, 74284 and 74285.
Texas Instruments Application Report CA-171 (19 pg.)

7 **"Fast Multipliers Using TTL Read Only Memories"**
See listing under (Memory) ROMs. (Texas Instruments)

8 **"SN7497 Binary Rate Multiplier"**
(SN5497, SN7497)
Covers principles and internal operation of the binary rate multiplier (BRM); shows add, subtract, multiply, divide and square root operations with a minimum of control logic. Discusses the use of the BRM to solve differential equations and to generate functions.
Texas Instruments Application Report CA-160 (13 pg.)

CMOS

9 **"CMOS: Some Application Guidelines"**
Presents General Guidelines when using CMOS.
Harris Application Note 209 (7 pg.)

CMOS (cont)

10 **"Minimizing Gate Oxide Failures Due to Handling"**
Describes oxide failure mechanisms, evaluates input protection techniques, and recommends handling procedures to avoid failure.
Harris Applications Report 208 (3 pg.)

11 **"Using Junction Isolated CMOS"**
Covers problems and application rules related to forward biasing CMOS inputs and outputs.
Harris Application Note 210 (4 pg.)

12 **"MasterMos, a custom CMOS System"**
(MasterMos)
Describes the construction of these devices which are customized by changing the metalization pattern.
International Microcircuits (2 pg.)

13 **"A New CMOS Analog Gate Technology"**
See listing under (Linear) Switches. (Intersil)

14 **"NBCD Sign and Magnitude Adder/Subtracter"**
See listing under Arithmetic (Motorola)

15 **"A 3½ Digit DVM Using an Integrated Circuit Dual Ramp System"**
See listing under Linear-Instrumentation (Motorola)

16 **"Noise Immunity Comparison of CMOS Versus Popular Bipolar Logic Families"**
Compares the noise immunities of TTL,DTL,HTL, and CMOS logic families. Discusses common noise sources, precautions against noise, noise specification, and standard noise tests.
Motorola AN-707 (8 pg.)

17 **"Introduction To CMOS Integrated Circuits With Three-State Outputs"**
(MC14500 Series)
Describes a wide variety of CMOS ICs incorporating transmission gates with standard logic. Gives design rules. Covers applications in analog switching and multiplexing, digital multiplexing, and data bussing.
Motorola AN-715 (19 pg.)

18 **"Scanning Logic for RF Scanner-Receivers Using CMOS Integrated Circuits"**
Describes rf scanner-receiver control functions using standard CMOS devices. Covers crystal switching and priority channel monitoring with mention of phase-locked loop designs.
Motorola AN-753 (7 pg.)

19 **"CMOS, the Ideal Logic Family"**
(MM54C/74C Series)
Describes characteristics of CMOS circuits. Discusses system considerations, such as unused inputs, data bussing, paralleling circuits for extra drive, and interface to other logic families.
National AN-77 (8 pg.)

Bold face indicates additional data is provided, see the Product Index.

DIGITAL

CMOS (cont)

1 **"CMOS Linear Applications"**
(MM74C00, MM74C02, MM74C04)
Describes use of CMOS devices biased to operate at the midpoint of the transfer characteristics.
National AN-88 (3 pg.)

2 **"CMOS Oscillators"**
Describes square wave oscillators that can be built with CMOS logic elements.
National AN-118 (4 pg.)

3 **"CMOS Schmitt Trigger - A Uniquely Versatile Design Component"**
(MM54C14, MM54C914, MM74C14, MM74C914)
Describes CMOS Schmitt trigger ICs with emphasis on the advantages over TTL versions, including high input impedance, wide threshold range, high noise immunity and low power consumption.
National AN-140 (6 pg.)

4 **"Using the CMOS Dual Monostable Multivibrator"**
(MM54C221, MM74C221)
Gives MM54C/MM74C221 circuit characteristics and operating suggestions. Shows use in a retriggerable one-shot, frequency magnitude comparator, Linear VCO and an analog multiplier/divider.
National AN-138 (6 pg.)

5 **"MM54C/74C Voltage Translation/Buffering"**
See listing under Interface (National)

6 **"54C/74C Family Characteristics"**
(MM54C/74C Series)
Discusses output, noise and temperature characteristics, power consumption, and propagation delay for the 54C/74C logic family.
National AN-90 (6 pg.)

7 **"OKI's CMOS and it's Applications"**
Describes device construction, general characteristics, covers in general terms counter, camera and clock applications.
OKI (16 pg.)

8 **"Accelerated Testing of COS/MOS Integrated Circuits"**
(CD4000 Series)
Describes accelerated testing through the use of increased stress, constant and step stress methods, and application to CMOS.
RCA (3 pg.)

9 **"Gate-Oxide Protection Circuit In RCA COS/MOS Digital Integrated Circuits"**
(CD4000 Series)
Gives description and schematics for the protection circuits.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6218 (2 pg.)

10 **"Interfacing COS/MOS with Other Logic Families"**
(CD4000A Series)
Describes conditions governing interface of CMOS 4000A series with other logic families.
RCA SSD-203, COS/MOS Digital Databook, ICAN-6602 (12 pg.)

CMOS (cont)

11 **"Battery-Powered Digital-Display Clock/Timer and Metering Applications Utilizing the RCA CD4026A and CD4033A Decade Counters-7 Segment Output Types"**
(CD4009A, CD4010A, CD4026A, CD4033A)
Describes the CD4026A/33A ICs and their use with 7-segment display units. Discusses interface packages and methods to help the designer optimize his system. Includes a discussion of battery-operated systems for digital clocks and watches.
RCA SSD-203, COS/MOS Digital Databook, ICAN-6733 (16 pg.)

12 **"Radiation Resistance of the COS/MOS CD4000A Series"**
(CD4000A Series)
Provides a graph plotting permanent radiation resistance of CD4000A series. Discusses design considerations for increasing resistance.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6224 (2 pg.)

13 **"Astable and Monostable Oscillators Using RCA COS/MOS Digital Integrated Circuits"**
Describes techniques to compensate for normal threshold variation of MOS devices in the design of stable multivibrator circuits for operation at frequencies up to 1MHz. Describes applications, including VCOs, voltage controlled pulse-width circuits, frequency multipliers, and modulator/demodulators (envelope detectors).
RCA Digital Databook SSD-203 COS/MOS Application Note ICAN-6267 (8 pg.)

14 **"COS/MOS MSI Counter and Register Design and Applications"**
(CD4006A, CD4014A, CD4015A, CD4017A, CD4018A, CD4020A, CD4021A, CD4022A, CD4024A)
Includes logic and schematic diagrams for these counters and shift registers. Outlines circuit designs, discusses device-design tradeoffs and summarizes performance criteria.
RCA SSD-203 COS/MOS Digital Databook ICAN-6166 (16 pg.)

15 **"COS/MOS Interfacing Simplified"**
See listing under Interface (RCA)

16 **"COS/MOS Rate Multipliers-Versatile Circuits for Synthesizing Digital Functions"**
See listing under Arithmetic (RCA)

17 **"Noise Immunity of COS/MOS Integrated-Circuit Logic Gates"**
(CD4000A, CD4001A)
Evaluates noise immunity of the CD4000A/01A gates with respect to external noise, crosstalk, transmission-line reflections, power-line noise, and ground-line noise. Includes schematics and logic diagrams.
RCA SSD-203B COS/MOS Digital Databook, ICAN-6176 (8 pg.)

DIGITAL

CMOS (cont)

1 **"Micropower Crystal-Controlled Oscillator Design Using RCA COS/MOS Inverters"**
(CD4007)
Describes in depth the design of low power crystal controlled oscillators and the exact frequency of oscillation.
RCA Application Note ICAN-6539 (8 pg.)

2 **"A Typical Data-Gathering & Processing System Using CD4000A-Series COS/MOS Parts"**
(CD4000A Series)
Describes data-gathering and processing system using CMOS circuits. Includes discussion of input signal conditioning and transmission, the digital processor unit, receiver, memory, arithmetic unit, display unit, output buffer, output transmitter, receiver, and control unit.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6210 (11 pg.)

3 **"Power-Supply Considerations for COS/MOS Devices"**
(CD4000 Series)
Includes discussion of quiescent device dissipation, switching characteristics, ac dissipation and ac performance characteristics, calculating system power, power supply regulation and filtering requirements.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6576 (6 pg.)

4 **"Using the CD4047A In COS/MOS Timing Applications"**
(CD4047A)
Compares this monostable/astable multivibrator with simpler types of oscillator circuits and discusses applications, including a noise discriminator, low-pass and band-pass filters, a frequency discriminator, and a pulse generator.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6230 (13 pg.)

5 **"Handling and Operating Considerations for MOS Integrated Circuits"**
Discusses handling of unmounted chips and subassembly boards, working with automatic handling equipment, storing of p-c boards, operating voltage, connections to unused inputs, interfacing with other logic families, noise immunity, and device characteristics of CMOS ICs.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6000 (6 pg.)

6 **"Design of Fixed and Programmable Counters Using the RCA 4018A COS/MOS Presettable Divide-by-"N" Counter"**
See listing under Counters. (RCA)

7 **"The RCA COS/MOS Phase Locked-Loop—A Versatile Building Block for Micro- Power Digital and Analog Applications"**
See listing under (Linear) Phase Locked Loops. (RCA)

CMOS (cont)

8 **"Application of CD4016A Quad Bilateral Switch"**
See "Transmission and Multiplexing of Analog or Digital Signals Using the CD4016A Quad Bilateral Switch" Under Data Transmission. (RCA)

9 **"A COS/MOS PCM Telemetry and Remote Data Acquisition Design"**
(CD4000A Series)
Describes data transmission formats and the following data acquisition sections: analog and digital multiplexers, A/D converters, transmission formatters and system programmers.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6289 (12 pg.)

10 **"Power Supplies for COS/MOS"**
(CD4000A Series)
Discusses the factors involved in the selection of CMOS supply voltages including the system operating frequency, noise immunity and power dissipation. Examples of simple power supply circuits are also given.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6304 (5 pg.)

11 **"Applications of the RCA-CD4093B COS/MOS Schmitt Trigger"**
(CD4093A/B)
Describes characteristics of the CD4093 quad 2-input Schmitt trigger. Covers applications in waveshaping (sinewave to squarewave, edge delay, edge detection), power-on reset, astable multivibrators and use as a Schmitt trigger for noise immunity.
RCA Application Note ICAN-6346 (6 pg.)

12 **"CMOS Expandable Gates"**
(SCL4402A, SCL4412A)
Compares the transfer characteristics of ordinary CMOS gates to those gates using double buffered output. Includes performance characteristics and discusses expansion of SCL4412A and SCL4402A to 12-input NOR, 16-input OR, and other combinations.
Solid State Scientific AN-102 (3 pg.)

13 **"CMOS Wave Shaping and Level Detection"**
Describes methods to obtain modified transfer characteristics of double buffered NAND gates, by connecting inputs together, connecting extra inputs to V_{CC}, etc. Shows how to obtain variable amounts of hysteresis, and describes systems of level detection using trigger circuits.
Solid State Scientific AN-109 (5 pg.)

14 **"Using Complementary MOS Circuits"**
(SCL4013A, SCL4046A, SCL4018A, SCL4026A, SCL4029A, SCL4404A)
Reviews CMOS operation, cost, and reliability. Discusses application of the SCL4018A in a three decade rate multiplier; the SCL4029A in counting devices; the SCL4404A and SCL4031A in A/D converters; and SCL4016A in analog switching.
Solid State Scientific AN-101 (6 pg.)

15 **"Applications of CMOS Integrated Circuits In Communications Equipment"**
(SCL4000 Series)
Uses of SCL4000 Series circuits as frequency synthesizers, digital frequency displays, frequency scanners, and squelch circuits.
Solid State Scientific AN-108 (4 pg.)

Bold face indicates additional data is provided, see the Product Index.

DIGITAL

CMOS (cont)

1 **"A Simplified Approach to Testing CMOS Inverters and Gates"**
Bench tests using a power supply and a V-O-M are described. They include continuity, input leakage, quiescent device current, output voltage, noise immunity, output drive current, and threshold voltage.
Solid State Scientific AN-107 (4 pg.)

2 **"Improved CMOS Gate Design"**
(SCL4000 Series)
Description of the output buffering of the SCL4000 Series
Solid State Scientific AN-105 (3 pg.)

3 **"Interfacing with CMOS"**
(SCL4000 Series)
Describes electrical characteristics of CMOS inputs and outputs. Discusses interfacing CMOS with CMOS, PMOS, NMOS, DTL/TTL, HTL, and ECL.
Solid State Scientific AN-104 (5 pg.)

4 **"CMOS Integrated Circuits in Automotive Applications"**
General discussion, also includes discussion of high current circuits, constant current or constant impedance circuit, digital time delay circuit, digital low-pass filter.
Solid State Scientific AN-103 (5 pg.)

Consumer

5 **"S2144 8-digit, 4-function Calculator"**
(S2144)
Describes calculator circuit with parts list and cost estimate.
American Microsystems AP74-3 (2 pg.)

6 **"S9411 8-digit, 5-function Calculator"**
(S9411)
Describes complete calculator circuit with parts list and cost estimate.
American Microsystems AP75-4A (2 pg.)

7 **"S9412 8-digit, Multi-function Calculator with Fluorescent Display"**
(S9412)
Describes complete calculator circuit with parts list and cost estimate.
American Microsystems AP74-6 (2 pg.)

8 **"S9412 8-digit, Multi-function Calculator with LED Display"**
(S9412)
Describes complete calculator circuit with parts list and cost estimate.
American Microsystems AP74-5 (2 pg.)

9 **"A Navigation Receiver That Uses A Digital Frequency Synthesizer"**
(μA719)
Gives schematics for a navigation receiver. Discusses the digital frequency synthesizer, varactor tuned RF amplifier, AGC amplifier, mixer, IF amplifier, and detector portions.
Fairchild Application Note 178 (6 pg.)

Consumer (cont)

10 **"Industrial Clock/Timer Featuring Back-up Power Supply Operation"**
Describes the design and operation of a clock timer with digital readout suitable for industrial control applications. CMOS circuits are used for reduced power.
Motorola Application Note AN-718A

11 **"Calculator Learns to Keep Time"**
(MM5736)
Describes stopwatch and keyboard controlled interval timing functions using the MM5736 calculator chip.
National AN-119 (8 pg.)

12 **"Handheld Calculator Battery Systems"**
Describes the tradeoffs in battery performance for 6.5-9.5v calculators driven by 2, 3 and 4 cell as well as a 9v, batteries.
National AN-149 (pg.)

13 **"High Voltage Shift Registers Move Displays"**
See listing under (Memory) Shift Registers (National)

14 **"Timekeeping Advances Through COS/MOS Technology"**
Discusses basic oscillator design considerations, practical oscillator circuits, and some typical timing-circuit applications, including wristwatches, wall clocks, and auto clocks.
RCA SSD-203 COS/MOS Digital Datebook, ICAN-6086 (12 pg.)

15 **"CMOS Integrated Circuits in Automotive Applications"**
See listing under CMOS. (Solid State Scientific)

Converters

16 **"Binary D/A Converters Can Provide BCD-Coded Conversion"**
(MC1408, MC1508)
Describes the MC1508 D/A converter used as a 2 or 2 1/2 digit BCD converter. Describes application in a 2 1/2 digit digital voltmeter.
Motorola AN-713 (4 pg.)

Counters

17 **"Using the MK5009P MOS Counter Time-Base Circuit"**
(MK5009)
Describes the use of the MK5009 along with complete circuits for a digital frequency meter, pulse generator and digitally-programmable one-shot. Discusses operation of the units oscillator circuit.
Mostek AN-104 (4 pg.)

18 **"Application Information Using Mostek's Six-Decade Counter/Display Totalizer"**
(MK50395)
Covers circuit operation and input/output requirements. Describes use in a batch control system, a position measurement system and greater than-less than detection.
Mostek (8 pg.)

DIGITAL

Counters (cont)

1 **"Programmable Counters Using the MC10136 and MC10137 MECL Universal Counters"**
(MC10136, MC10137)
Circuit operation and use in programmable counters with no external gating. Also use in high-frequency counters operating up to 110 MHz.
Motorola AN-584 (4 pg.)

2 **"Battery-Powered 5-MHz Frequency Counter"**
Describes a battery operated 5 MHZ counter built with CMOS for low power operation. Discusses methods to minimize power consumption.
Motorola Application Note AN-717 (9 pg.)

3 **"Five Digit Accumulator/Elapsed Time Indicator"**
(MC14534)
Describes in detail the circuit for a CMOS 5 digit elapsed time indicator and a 99,999 count accumulator with a 1-999 prescaler.
Motorola AN-743 (5 pg.)

4 **"The Logical Design of Shift Counters"**
Presents two techniques to aid in designing shift-register counters. Gives results for "sequence tree" and "count multiplication" techniques for cycle lengths of 30 or less. Shows solutions for both "D" flip-flops and J-K flip-flops as the input elements of the shift register.
Motorola AN-576 (8 pg.)

5 **"A 200 MHz Autoranging MECL-McMOS Frequency Counter"**
(MC10138, MC14518)
Presents the principles of autoranging counters. Describes a counter using ECL for prescaling and the first two dividers. Covers the input buffer and ECL-CMOS translation.
Motorola AN-742 (10 pg.)

6 **"An MSI 500 MHz Frequency Counter Using MECL and MTTL"**
See listing under High Speed Logic. (Motorola)

7 **"Calculator Chip Makes A Counter"**
(MM5736, MM5739)
Discusses use of the MM5736 calculator chip as a counter operating up to 120 Hz.
National AN-112 (6 pg.)

8 **"Design of Fixed and Programmable Counters Using the RCA 4018A COS/MOS Presettable Divide-by-"N" Counter"**
(CD4018A)
Describes the use of this device in single-decade and multi-decade fixed and programmble divide-by"N" counters. System considerations, such as switch simplifications, components minimization, and speed are also discussed.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6498 (6 pg.)

Counters (cont)

9 **"Synchronous Up/Down Counters"**
(N8284, N8285, S8284, S8285)
Provides logic diagrams and discusses operation of 8284/85. Applications: cascading counters, 1's complement generator, synchronous and 1-out-of-N decoding, magnitude and sign generator, frequency multiplier, and variable modulus counter.
Signetics Applications Handbook (11 pg.)

10 **"Asynchronous MSI Counters/Storage Element"**
(N8280, N8281, N8288, N8290, N8291, N8292, N8293, N82S90, N82S91)
Gives logic diagrams for 8200 series ripple counters, signal processing input clock requirements, ac characteristics, and includes a discussion of cascading asynchronous counters.
Signetics Applications Handbook (12 pg.)

11 **"Using the SN74160 Family of Synchronous Counters"**
(SN74160, SN74161, SN74162, SN74163)
Describes carry circuit operation, cascading and programming.
Texas Instruments Application Report CA-174 (7 pg.)

12 **"ECL High Speed Counters"**
Discusses design considerations when constructing high speed counters using the TI ECL 2500 Series.
Texas Instruments Application Report CA-147 (8 pg.)

Data Transmission

13 **"A Typical Data-Gathering and Processing System using CD4000A-Series COS/MOS Parts"**
See listing under CMOS (RCA)

14 **"Line Drivers and Receivers"**
(AM2614, AM2615, 9614, 9615, 9620, 9621, DM7831, DM8831)
Discusses single ended, differential, unbalanced differential digital communications systems and line matching methods. Describes the above circuits and their use in systems.
Advanced Micro Devices Data Book, (12 pg.)

15 **"Using the Data Concentrator in Data Communications"**
(AY5-1016)
Describes counter, decoding matrix, and multiplexer switch sections of the AY-5-1016 data concentrator. Describes commutator-decommutator and polling system applications plus use as a digitally programmable gain amplifier, and as a clock generator.
General Instrument Microelectronics (11 pg.)

16 **"The AY-5-1011 Terminal Transmitter for Key-To-Tape Data Accumulation System and Other Applications"**
(AY5-1011)
Describes features of this parallel-to-serial converter and discusses its use in key-to-tape systems.
General Instrument Microelectronics (6 pg.)

Bold face indicates additional data is provided, see the Product Index.

DIGITAL

Data Transmission (cont)

1 **"Using the UAR/T in Data Communications"**
(AY5-1013)
Describes this full duplex receiver/transmitter and discusses its application in computer, terminal and slow speed device interfacing. Also covers use in polling.
General Instrument Microelectronics (4 pg.)

2 **"High Speed Digital Communications"**
(HD245, HD246, HD545, HD546)
Describes the use of the HD-245 family in a current mode digital communication system (up to 2 Mbs over 1,000-ft-long line.)
Harris Application Note 205 (4 pg.)

3 **"Receiver/Transmitter Noise Immunity"**
(HD245, HD246, HD545, HD546)
Discusses HD-245 transmitter/receiver system noise: External magnetic and capacitive effects, crosstalk, and ground line noise. Includes a comparison with voltage mode and differential voltage switching type systems.
Harris Application Note 207 (4 pg.)

4 **"Error Detection and Correction Using Exclusive-OR Gates and Parity Trees"**
(MC1030, MC4008, MC4010, MC10107, MCM10146, MC10160)
Discusses the use of Exclusive-Or gates and the parity trees available in the RTL,TTL,DTL, and ECL families for simple parity and single-error Hamming parity detection/correction circuits.
Motorola AN-496A (9 pg.)

5 **"Line Driver And Receiver Considerations"**
(MC1488, MC1489, MC75107, MC75110, MC75113)
Briefly describes transmission line systems using line drivers and receivers. Covers differential and single-ended systems. Discusses noise and line considerations.
Motorola AN-708 (14 pg.)

6 **"Bussing with MECL 10,000 Integrated Circuits"**
(MC10111, MC10123)
Describes use of MECL 10,000 circuits in high speed data transmission systems with emphasis on transmission line construction and termination.
Motorola AN-726 (6 pg.)

7 **"Device Operation and System Implementation of the Asynchronous Communications Interface Adapter (MC6850)"**
(MC6850)
Provides information on ACIA transmitter and receiver operation, initialization, status register bits, use in a microcomputer based communications system, software requirements, and transmission subroutines.
Motorola AN-754 (11 pg.)

8 **"Low Speed Modem Fundamentals"**
(MC6860)
Describes interface circuitry and performance of the MC6860 low speed modem. Evaluation of the system performance in the presence of Gaussian noise is given, as well as a brief description of data couplers.
Motorola Application Note AN-731 (15 pg.)

Data Transmission (cont)

9 **"Low-Speed Modem System Design Using the MC6860"**
(MC6860)
Describes the MC6860 modem. Provides filter design tables and equations to develop a complete 100 series compatible system.
Motorola AN-747 (13 pg.)

10 **"Operational Aspects of Motorola's Data Terminal Transmitter and Receiver"**
(MC2257, MC2259, MC2260)
Describes in detail the input and output signals for the synchronous/asynchronous operation of these parallel to serial transmitters and the serial to parallel receiver.
Motorola Application Note AN-724 (24 pg.)

11 **"Transmission Line Characteristics"**
(DM7400, DS7820A, DS7830, DS75452)
Describes the characteristics of digital signals in transmission lines and the characteristics of the line that effect transmission quality. Also compares the performance of unbalanced and balanced circuits in digital systems.
National Interface Handbook, AN-108 (6 pg.)

12 **"Integrated Circuits for Digital Data Transmission"**
(DS7830, DS7820)
Describes the operation and use of the DS7830 line driver and DS7820 line receiver for transmission systems using twisted-pair lines. Includes a mathematical design analysis of this line receiver.
National Interface Handbook, AN-22 (16 pg.)

13 **"Data Bus and Differential Line Drivers and Receivers"**
(DS7820, DS7830, DS7831, DS7832, DS7833, DS7834, DS7835, DS7836, DS7837, DS7838, DS7839, DS1488, DS1489)
Includes schematics and describes the operation of these line drivers, receivers and transceivers.
National AN-83 (12 pg.)

14 **"Operational Aspects of Nitron's Data Terminal Transmitter and Receiver"**
(NC2257, NC2259, NC2260)
Discusses basic operation of the NC2257/2259/2260 IC's, and application in various types of communications systems.
Nitron Communications Note 1 (24 pg.)

15 **"Using High Speed Memory in Pulse Code Modulated Systems for Switching Applications"**
Discusses digital message switching and implementation with a conventional digital crossbar switch as well as with a switch using high speed memory and data multiplexing.
Nortec Applications Note No. 29 (4 pg.)

DIGITAL

Data Transmission (cont)

1 **"Transmission and Multiplexing of Analog or Digital Signals Utilizing the CD4016A Quad Bilateral Switch"**
(CD4016A)
Describes features and operation of this switch. Discusses applications, including switching, gating digital or analog signals, multiplexing and demultiplexing, D/A conversion, sample and hold, and squelch-control.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6601 (12 pg.)

2 **"A COS/MOS PCM Telemetry and Remote Data Acquistion Design"**
See listing under CMOS (RCA)

3 **"9-Bit Parity Generator and Checker"**
(N8262, S8262)
Discusses examples of parity generator connections, even parity generator/checker as well as 27- and 12-bit word expansion using the 8262.
Signetics Applications Handbook (3 pg.)

4 **"8T23 Line Driver/8T24 Line Receiver"**
(N8T23, N8T24)
Provides device description, circuit characteristics and system considerations.
Signetics Applications Handbook (4 pg.)

5 **"Quad Bus Driver/Receiver"**
(N8T26)
Provides 8T26 description and covers applications in high speed memory buffer, differential data transmission, bus and MOS interface.
Signetics Applications Handbook (5 pg.)

6 **"8T09 Quad Bus Driver/8T10 Quad D-Type Bus Flip-Flop"**
(N8T09, N8T10, S8T09, S8T10)
Gives general description. Applications include bidirectional data bus, bus-organized minicomputer, and quad D-type bus flip-flop.
Signetics Applications Handbook (6 pg.)

7 **"8T13 Line Driver/8T14 Line Receiver"**
(N8T13, N8T14, S8T13, S8T14)
Gives circuit description and covers application to party-lines.
Signetics Applications Handbook (6 pg.)

8 **"8T15 Line Driver/8T16 Line Receiver"**
(N8T15, N8T16)
Covers circuit description, logic diagram, and applications including data transmission plus Schmitt trigger and sine-to-square wave converter. Tables summarize EIA Standard RS-232B, C, MILSTD-188 and CCITT v 24 requirements.
Signetics Applications Handbook (6 pg.)

9 **"ECL 10,000 Series 10124/10125"**
See listing under High Speed Logic (Signetics)

10 **"Quad Bus Receiver With Hysteresis Schmitt Trigger"**
See listing under Trigger Circuits. (Signetics)

Data Transmission (cont)

11 **"Data Transmission with SN55107 Series"**
(SN55107, SN55108, SN55109, SN55110, SN75107, SN75108, SN75109, SN75110, SN55107 Series)
Demonstrates the use of these line drivers and receivers in solving two multiplexing problems: a party line addressing system; and data/clock signals in a bipolar line. Receiver and driver characteristics are provided.
Texas Instruments Application Report CA-146 (8 pg.)

12 **"Line Drivers and Receivers"**
(SN55107, SN55108, SN55109, SN55110, SN75107, SN75108, SN75109, SN75110)
Circuit operation, circuit characteristics, and system applications are covered. Typical performance using different types and lengths of line are provided, as well as notes on selecting a transmission system. Also mentions use as a comparator, line repeator, window detector and temperature controller.
Texas Instruments Application Report CA-130 (33 pg.)

13 **"Asynchronous Receiver/Transmitter"**
(TR1602)
General description of asynchronous transmission and operation of TR1602, which is capable of full or half duplex operation. Describes application in distributed computer networks.
Western Digital Application Report 1 (12 pg.)

Decoders

See also Interface.

14 **"Applications of the 9538 ECL/MSI High Speed Decoder"**
See listing under High Speed Logic (Fairchild)
See also Interface.

15 **"MTTL Designers Note — The MC4006/MC4007 Decoders"**
(MC4006, MC4007)
Discusses basic modes of operation and expansion capabilities of the MC4006 binary to one-of-eight decoder and the MC4007 dual binary to one-of-four decoder. Describes use in various memory systems.
Motorola AN-465 (7 pg.)

16 **"Driving 7-Segment Gas Discharge Display Tubes With National Semiconductor Circuits"**
(DS7880, DS8880, DS8884A, DS8885, DS8887, DM8889)
Describes decoder/driver circuits and applications, including interfacing 7-segment fully decoded MOS chips to digit displays and interfacing with numeric display tubes.
National AN-84 (4 pg.)

17 **"Features and Applications of RCA-CD2500E-Series MSI BCD-to-7-Segment Decoder-Drivers"**
(CD2500, CD2501, CD2502, CD2503)
Discusses logic levels, operating characteristics, display-lamp turn-on characteristics, static drive applications, time multiplex systems, and a fail-safe circuit.
RCA SSD-202 Linear Application Note Databook, ICAN-6294 (11 pg.)

Bold face indicates additional data is provided, see the Product Index.

DIGITAL

Decoders (cont)

1 **"Octal/Decade Decoders"**
(N8250, N8251, N8252, S8250, S8251, S8252)
Provides general description and covers applications of 8250/1/2, including arbitrary 4-bit decoding, code conversion, demultiplexing.
Signetics Applications Handbook (6 pg.)

2 **"8T04/5/6 Seven Segment Decoder/Driver"**
(N8T04, N8T05, N8T06, S8T04, S8T05, S8T06)
Covers circuit characteristics, and use with LED incandescent and electroluminescent displays. Discusses ripple blanking, intensity modulation, floating decimal point applications and multiplexing of displays.
Signetics Applications Handbook (10 pg.)

3 **"8T01 Nixie Decoder/Driver"**
(N8T01, S8T01)
One-out-of-ten decoder for multiplex operation of Nixie tubes and for driving relays or other high voltage interface circuitry. Provides discussion of one 8T01 operating a 16 Nixie tube subsystem.
Signetics Applications Handbook (5 pg.)

DTL/RTL

4 **"Using MDTL Logic Blocks"**
(DTL, RTL)
Discusses applications of MDTL components, such as gates and flip-flops, emphasizing positive logic OR, NOR, NAND, and Exclusive-OR functions. Cites use as timing circuits, gated oscillators, monostables, latches. Discusses interfacing with other logic families.
Motorola AN-519 (11 pg.)

Encoders

5 **"Using the AY-5-9100 in Telephone Equipment"**
(AY5-9100)
Describes use of this four phase dynamic logic circuit in mains powered dialers, line powered telephones, card readers, and in standard multifrequency tone dialer keyboards.
General Instrument Microelectronics (10 pg.)

6 **"Designing with the HD-0165 Keyboard Encoder"**
(HD0165)
The organization and truth table for this encoder are presented. The use of two circuits for encoding up to 256 keys, battery operation, examples of a tele-typewriter keyboard and universal keyboard encoders are described.
Harris Application Note 204 (8 pg.)

7 **"90 Keyboard Encoder Arrays"**
(MCS1009, MCS1020, MCS1021)
Describes the operation of these keyboard arrays and illustrates their application in keyboard encoding systems.
MOS Technology Application Note AN1 (22 pg.)

8 **"64 Key Keyboard Encoder Arrays"**
(MCS1007, MCS1010)
Describes operation and optional features of these keyboard encoders.
MOS Technology Application Note AN2 (21 pg.)

Encoders (cont)

9 **"Using the MM5704 Keyboard Interface In Keyboard Systems"**
(MM5704)
Discusses features, operation, and programming of this device. Discusses use with the MM5702 timing and control chip of the Microprogrammable Arithmetic Processing System, and in a standard ASCII encode system.
National AN-52 (11 pg.)

10 **"MOS Encoder Plus PROM Yield Quick Turnaround Systems"**
(MM5740)
Describes use of a binary coded keyboard encoder with a PROM to build prototype or small volume keyboard systems.
National AN-139 (4 pg.)

11 **"MOS Keyboard Encoding"**
(MM5740)
Describes circuit and operation of the MM5740 keyboard interface circuit, including input-output interface, the repeat function key, data strobe control and output enable. Discusses applications, including a polling system for localized keyboards and a complete ASR-33 keyboard.
National MOS Handbook AN-80 (11 pg.)

Filters

12 **"Digital Filters"**
Summarizes four filter types covering transfer response, difference equations, and implementation in 5 arrays: multiplier, input/output, timing control, storage, and a MOS to MOS buffer.
Discusses general operational features, such as input/output word sample rate and word size. Describes operation of a two pole bandpass filter implemented with these arrays.
Collins Radio Application Note (14 pg.)

Gates

13 **"MSI Gating Arrays"**
(N8233, N8234, N8235, N8266, N8267, S8233, S8234, S8235, S8266, S8267)
Describes applications of these devices, including 2- and 4-input 4-bit multiplexers, and a high speed 8-bit binary adder-subtractor.
Signetics Applications Handbook (5 pg.)

14 **"MSI Gating Arrays"**
(N8241, N8242, S8241, S8242)
Describes applications of these quad exclusive OR/NOR gates as high speed equality comparators, parity tester/generators, binary or BCD adders, and conditional complementors.
Signetics Applications Handbook (8 pg.)

15 **"A Simplified Approach to Testing CMOS Inverters and Gates"**
See listing under CMOS. (Solid State Scientific)

General

16 **"MOS 100-Bit Word Generator"**
Describes how to build a 100-bit word generator using MOS ICs.
National MOS Brief 1 (2 pg.)

17 **"MOS Clock Savers"**
Design and use of MOS Clock-Drive Networks. Offers tips for saving power and lowering component costs.
National MOS Brief 5 (2 pg.)

DIGITAL

High Speed Logic

1 **"Applications of the 9538 ECL/MSI High Speed Decoder"**
(9538)
Includes applications of this 1 of 8 decoder in demultiplexing, code decoding, memory decoding, function generation.
Fairchild Applications Note 308 (10 pg.)

2 **"F10,000 Series ECL"**
(ECL Series)
Operation and circuit parameters are described for the Fairchild ECL series.
Fairchild Application Note 330 (6 pg.)

3 **"Measure Frequency and Propagation Delay with High-Speed MECL Circuits"**
(MECL)
Describes ECL frequency counter useful to 160 MHz and a propagation delay measuring circuit capable of 100-picosecond resolution.
Motorola AN-586 (2 pg.)

4 **"A High Speed FIFO Memory Using the MECL MC10143 Register File"**
(MCM10143)
Describes the required features of a high speed FIFO design. Different approaches are compared and a design is shown using the MC10143 Multiport Register File.
Motorola Application Note AN-730 (6 pg.)

5 **"Testing MECL 10,000 Integrated Logic Circuits"**
(MECL)
Describes AC and DC tests in a 50 ohm transmission-line environment for measuring logic levels or noise margins, circuit current, input currents, propagation delays, edge speeds, and flip-flop toggle rates.
Motorola AN-579 (6 pg.)

6 **"An MSI 500 MHz Frequency Counter Using MECL and MTTL"**
(MECL)
Describes design of 8-digit LED readout counter using MECL III, 10,000 and TTL. Discusses two prescalers using MECL, two input amplifier designs, and a time-base controller for the counter's multiphase clock.
Motorola AN-581 (9 pg.)

7 **"A 200 MHz Autoranging MECL-McMOS Frequency Counter"**
See listing under Counters (Motorola)

8 **"Bussing with MECL 10,000 Integrated Circuits"**
See listing under Data Transmission (Motorola)

9 **"Interconnection Techniques For Motorola's MECL 10,000 Series Emitter Coupled Logic"**
(MECL)
Describes some of the characteristics of high digital signal lines and gives wiring rules for MECL 10,000 circuits. Discusses p-c board interconnects, board-to-board interconnects, and wirewrapping techniques.
Motorola AN-556 (22 pg.)

High Speed Logic (cont)

10 **"Using Shift Registers As Pulse Delay Networks"**
(MC10135)
Discusses a high-speed delay shift register using the MC10135 flip flop.
Motorola AN-565 (3 pg.)

11 **"High Speed Binary Multiplication Using the MC10181"**
(MC10181)
Describes a 4-bit by 4-bit multiplier using this arithmetic unit. Shows expansion to 8-by-8-bit or 17-by-17-bit systems.
Motorola AN-566 (3 pg.)

12 **"MECL Positive and Negative Logic"**
(MECL)
Describes equivalences between positive and negative ECL logic and provides guides for converting between them.
Motorola AN-567 (2 pg.)

13 **"Interfacing With MECL 10,000 Integrated Circuits"**
(MC1650, MC1692, MC10115, MC10116, MC10124, MC10125, MC10128, MC10129, MC10216)
Discusses circuits to interface ECL with TTL, TTL and IBM busses, MOS, low level signals, and LEDs.
Motorola AN-720 (9 pg.)

14 **"The MC1600 Series MECL III Gates"**
(MC1660, MC1661, MC1662, MC1663, MC1664, MC1665)
Gives typical operating characteristics and explains the operation of various gates in the MECL III family. Describes recommended layout, breadboarding, and testing procedures.
Motorola AN-504 (14 pg.)

15 **"IC Crystal Controlled Oscillators"**
(MC1023, MC1662, MC10101, MC10116)
Describes use of MC1023 OR/NOR gate as an amplifier and oscillator. Discusses square wave oscillator circuits with crystal control capable of output frequencies up to 150 MHz. Examples use MC10116/10101, AND MC1662.
Motorola AN-417A (4 pg.)

16 **"High Speed Monostable Multivibrators Designed With MECL Integrated Circuits"**
(MC1023, MC1026)
Discusses two configurations using the MC1023 clock driver and a delay element that offer performance in excess of 70 MHz and pulse widths of 4 nanoseconds. Covers methods of obtaining the delay.
Motorola AN-418 (5 pg.)

17 **"MECL 10,000 Arithmetic Elements MC10179, MC10180, MC10181"**
(MC10179, MC10180, MC10181)
Describes 10180 dual adder/subtractor, 10181 4-bit arithmetic logic unit/function generator, and 10179 lookahead carry block. Discusses their operation in parallel adders, in both ripple and lookahead systems.
Motorola AN-709 (11 pg.)

Bold face indicates additional data is provided on the page noted.

DIGITAL

High Speed Logic (cont)

1 **"Simulate MECL System Interconnections With A Computer Program"**
Develops a basic computer program that allows the user to simulate the performance of signal lines and to analyze termination techniques. Applies to ECL and other high speed digital systems.
Motorola AN-700 (10 pg.)

2 **"Understanding MECL 10,000 DC and AC Data Sheet Specifications"**
(MECL)
Discusses basic MECL 10,000 gate structure, transfer curve and dc levels. Covers specifications data sheet, including power supply drain current, high and low output voltages, propagation delay, rise and fall times, and toggle frequency.
Motorola AN-701 (7 pg.)

3 **"AC Noise Immunity of MECL 10,000 Integrated Circuits"**
(MECL)
Discusses ac noise immunity. Describes test circuits for measuring this immunity and the results to be expected for MECL 10,000 circuits.
Motorola AN-592 (6 pg.)

4 **"ECL 10,000 Series/10124, 10125"**
(10124, 10125)
Discussion of the transfer characteristics of the 10124 Translator/Driver and 10125 Translator/Receiver. Covers TTL/DTL to ECL level translation, TTL to ECL interface, differential line driver and receiver for TTL systems, terminations for differential data transmission.
Signetics Applications Handbook (4 pg.)

High Speed TTL

5 **"The MC3000/MC3100 Series Transistor-Transistor Logic Flip-Flops"**
(MC3150, MC3151, MC3152, MC3160, MC3161, MC3162, MC54H79, MC54H115, MC54H116, MC54H117, MC54119, MC54120)
Describes basic operation of the various flip-flops available in the MC3000/3100 (54H/79H) series and gives typical operating characteristics of each.
Motorola AN-493 (14 pg.)

6 **"Series 54S/74S Schottky TTL Applications"**
(SN54S Series, SN74S Series)
Analyzes Schottky clamping techniques and circuits, reviews circuit performance, including discussion of transfer characteristics, switching times, and a-c noise. Discusses power supply considerations, line driving and receiving, noise sources and their abatement. Normalized loading/driving capability information and the pinouts of ICs are discussed.
Texas Instruments Application Report CA-176 (45 pg.)

HNIL/HTL

7 **"Converting Relay Control Systems To Digital I/C's"**
(MC660 Series)
Defines and discusses basic Boolean algebra and logic functions and presents method of converting relay diagrams to logic diagrams. Gives examples of conversion method using High Threshold Logic circuits and presents a system design to accomplish this.
Motorola AN-524 (14 pg.)

HNIL/HTL (cont)

8 **"Using Motorola High Threshold Logic"**
(MC660 Series)
Describes MC660 series ICs and provides many of the characteristics of these units. Application examples include logic translation, line driving, and trigger circuits.
Motorola AN-467 (11 pg.)

9 **"Operation and Application of MHTL I/C Flip-Flops"**
(MC663, MC664)
Describes operation and characteristics of the J-K MC663P and the master-slave R-S MC664P flip-flops. Discusses applications as ripple and decade shift counters.
Motorola AN-414 (8 pg.)

10 **"Noise Immunity With Motorola High Threshold Logic"**
(MC660 Series)
Compares noise immunity characteristics between High Threshold Logic (HTL) and standard saturated logic devices. Discusses noise injection and noise reduction techniques.
Motorola AN-298 (5 pg.)

11 **"High Noise Immunity Logic -- Powerful, Versatile, and Growing"**
(300 Series)
Generally describes the HiNIL family use and features. Covers interface to other families, noise immunity, operating considerations and input protection.
Teledyne Semiconductor Digital Application Note No. 5 (5 pg.)

12 **"The HiNIL 347-A Dual Retriggerable One Shot with High Noise Immunity"**
(347)
Description and application details for this device are provided along with diagrams showing its use in pulse generators, coincidence detectors, frequency dividers, voltage to frequency and frequency to voltage converters, a pulse absence detector and an ac line presence detector.
Teledyne Semiconductor Digital Application Note No. 6 (6 pg.)

13 **"HiNIL 375 Universal Shift Register"**
(375)
Operation and applications of this synchronous 4-bit device as a 4 and 8-bit shift-left, shift-right register, 7 and 8-bit parallel-to-serial and serial-to-parallel converters and various counters.
Teledyne Semiconductor HiNIL Application Note 4 (10 pg.)

14 **"High Noise Immunity Logic"**
(300 Series)
Discussion includes noise immunity, loading rules, fanout, passive pull-up loading, collector or-ing, second level gating, driver pull-up, system interfaces.
Teledyne Semiconductor HiNIL Catalog (7 pg.)

15 **"Design Techniques with HiNIL 367 Quad Schmitt Trigger"**
(367)
General discussion of Schmitt Trigger and the differences of the 367, which ignores open inputs and offers 3.5 v noise immunity. Applications include line receivers, pulse stretchers, ac detectors, free-running and voltage-controlled oscillators.
Teledyne Semiconductor HiNIL Application, Note 2 (4 pg.)

DIGITAL

HNIL/HTL (cont)

1 **"Designing Programmable Controllers with HiNIL"**
(380)
Applications of the HiNIL 380 BCD to decade decoder including the generation of odd sequences of output pulses, the controlling of more than one load, and the switching on and off of loads.
Teledyne Semiconductor Digital Microcircuits Application, Note 3 (4 pg.)

2 **"Using the CD4520B to Design Dividers with Symmetrical Outputs"**
(CD4520A/B)
Describes how to use this CMOS counter to divide an input frequency by N where N is any integer from 2 to 256 and obtain outputs with approximately 50% duty cycles.
RCA Application Note ICAN-6362 (10 pg.)

Interface

See also Decoders.

3 **"9616/9617 EIA Interface Driver and Receiver"**
(9616, 9617)
Gives performance characteristics for these devices and describes their use in data communications equipment. Describes EIA standard RS232-C.
Fairchild Application Note 320 (6 pg.)

4 **"The Interface Handbook, Line Drivers and Receivers"**
(9612, 9613, 9614, 9615, 9616, 9617, 9627, 9634, 9635, 9636, 9637, 9638, 9640, 8T13, 8T14, 8T23, 8T24, 55107, 55108, 55109, 55110, 55121, 55122, 75107, 75108, 75109, 75110, 75112, 75121, 75122, 75123, 75124, 75154, 75207, 75208)
This comprehensive book covers the basics of transmission line theory along with methods for determining signal quality. Major chapters are titled: Data Transmission Lines and their Characteristics; Reflections, Computations and Waveforms; Long Transmission Lines and Data Signal Quality; and Forms of Operation (single/differential, direction of flow, analysis of common interfaces, etc.)
Fairchild Interface Handbook (118 pg.)

5 **"Interfacing with MECL 10,000 Integrated Circuits"**
See listing under High Speed Logic (Motorola)

6 **"Interface Techniques Between Industrial Logic and Power Devices"**
(MC660 Series, MC14000 Series)
Presents worst case design approaches to illustrate methods of interfacing McMOS and MHTL logic to various ac and dc power load levels. Gives examples using transistors and thyristors as load drivers. Covers direct coupled and level translation interfacing as well as opto-electronic coupling for high isolation.
Motorola AN-712A (18 pg.)

7 **"Semiconductors For Plated-Wire Memories"**
(MC4006, MC4007, MC4038 MC4040, MC4043, MC1514, MC1546)
Discusses operation and electrical characteristics of plated wire memories. Covers applications of drivers, sense amplifiers, and decoders as interface circuits. Also discusses memory organization and memory-related semiconductor applications.
Motorola AN-533 (15 pg.)

Interface (cont)

8 **"CMOS: A New Logic Type for Control Systems"**
Includes interface to HTL, LTTL, TTL, and DTL.
Motorola AN-574 (4 pg.)

9 **"Interface Techniques Between Industrial Logic and Power Devices"**
Presents worst case design approaches to illustrate methods of interfacing McMOS and MHTL logic to various ac and dc power load levels.
Motorola Applications Report AN-712A (19 pg.)

10 **"Interface Considerations for Numeric Display Systems"**
(MC14511, MC14543)
Gives basic information on LCD, LED, gas discharge, fluorescent and incandescent displays. Discusses interfacing 7 segment displays to logic with emphasis on multiplexed systems.
Motorola AN-741 (25 pg.)
"MM54C/MM74C Voltage Translation/Buffering" (MM54C901, MM54C902, MM54C903, MM54C904, MM74C901, MM74C902, MM74C903, MM74C904)
Interfacing PMOS to CMOS, CMOS to CMOS with different voltage levels, and CMOS to two standard TTL loads, are illustrated using 74C901 series devices.
National MB-14 (2 pg.)

11 **"Interfacing With MECL 10,000 Integrated Circuits"**
See listing under High Speed Logic (Motorola)

12 **"Driving 7-Segment LED Displays with National Semiconductor Circuits"**
(DM5446A, DM5447A, DM5448A, DM7446A, DM7447A, DS75491, DS75492, DS7856, DS7858, DS8856, DS8857, DS8858, DS8861, DS8863, DS8864, DS8865, DS8866)
Discusses configurations and construction of 7-segment LEDs and drive modes. Describes BCD to 7-segment decoder drivers, BCD to 7-segment LED drivers, MOS to LED segment drivers, four and five segment drivers, as well as digit drivers. Describes calculator and digital clock applications.
National Interface Handbook, AN-99 (12 pg.)

13 **"Using the MM5704 Keyboard Interface in Keyboard Systems"**
See listing under Encoders. (National)

14 **"TTL/MOS/DTL Interfaces"**
Techniques for coupling the above devices and characteristics of the interfaces.
National MOS Brief 7 (2 pg.)

15 **"COS/MOS Interfacing Simplified"**
(CD4000 Series)
Covers interfacing 4000A and B series with TTL, DTL, ECL, NMOS, PMOS, industrial and power control circuits, op amps and displays.
RCA Application Note ICAN-6315 (7 pg.)

Bold face indicates additional data is provided, see the Product Index.

DIGITAL

Interface (cont)

1 **"Applications of the RCA-CD4093B COS/MOS Schmitt Trigger"**
See listing under CMOS (RCA)

2 **"Interfacing COS/MOS with Other Logic Families"**
See listing under CMOS (RCA)

3 **"Constant Current LED Drivers"**
(N8T51, N8T54, N8T59, N8T71, N8T74, N8T75, N8T79)
Covers logic diagram, truth table and applications of 8T50/70 drivers, including driving common anode LEDs, common cathode LEDs, lamp test, and use with frequency counters.
Signetics Applications Handbook (4 pg.)

4 **"8T80, 8T90 and 8T18 Interface Elements"**
(N8T18, N8T80, N8T90, S8T18, S8T80, S8T90)
Describes applications including high level buffer, relay driver, lamp driver, Miller integrator, quad gate, TTL-MOS-TTL interface, and voltage translation.
Signetics Applications Handbook (8 pg.)

5 **"ECL 10,000 Series 10124/10125"**
See listing under High Speed Logic
(Signetics)

6 **"Interfacing with CMOS"**
See listing under CMOS. (Solid State Scientific)

7 **"Completely Monolithic IC Series for Gas Discharge Display Interface"**
(UDN-6144, UDN-6164, UDN-6184, UDN-7183, UDN-7184, UDN-7186)
Describes operation of high voltage IC's to drive the digits and segments of 200v (Panaplex) gas discharge displays.
Sprague Electric Microcircuit Application Report MAR75-1 (8 pg.)

8 **"Using Bipolar Logic to Improve Performance in CMOS and Microprocessor Systems"**
Suggests the use of HiNIL for improving noise performance, input protection, and output drive, and of LP Schottky for improved speed/power.
Teledyne Semiconductor Digital Application Note 7 (4 pg.)

9 **"TTL to MOS and MOS to TTL Interface Circuits"**
(SN7400, SN75107, SN75207, SN75270, SN75370, SN75450, SN75451, TMS1103, TMS4062)
Describes MOS/TTL interface circuits using bipolar transistors, JFETS, MOSFETS, and ICs.
Texas Instruments Application Report CA-170 (11 pg.)

10 **"Monolithic Interfacing in Computers"**
(SN7520 Series, SN75107, SN75109, SN75308, SN75324)
Discusses linear integrated circuits for computer interface applications including line circuits, memory drivers, and sense amplifiers.
Texas Instruments Application Report CA-122 (12 pg.)

Interface (cont)

11 **"Peripheral Interface Circuits with the SN75450"**
(SN75450)
A variety of logic level translation, lamp driving and power control circuits are given using SN75450 series peripheral drivers.
Texas Instruments Application Report CA-150 (6 pg.)

Low Power Logic

12 **"A Designer's Guide to Low-Power MSI"**
(93L Series)
Discusses characteristics of Am93L family: input-output currents, logic levels, switching considerations, loading rules.
Advanced Micro Devices Data Book, Catalog (4 pg.)

LSI, General

13 **"Advances in LSI Using Silicon Gate Technology"**
Discusses the silicon gate process and silicon gate devices in general. Compares silicon gate with other MOS technologies with respect to device characteristics, the effects of these characteristics, chip interconnection, chip area, and device fabrication.
Fairchild Semiconductor Application Note 307 (6 pg.)

14 **"Design of Custom LSI Circuitry for Modern Digital Systems"**
Discusses design of LSI devices. Covers size considerations, number of input/output connections, number of output drivers, use of repetitive patterns, use of computer aided design techniques, speed versus size and power, and interfacing.
General Instrument Microelectronics (7 pg.)

Multiplexers

15 **"TTL MSI Multiplexers and Demultiplexers"**
(DM7210, DM7842, DM8210, DM8842)
Describes features of DM7210 multiplexer and DM7842 demultiplexer and discusses their use in a synchronous digital data transmission system, a keyboard entry decoder, and as minterm generators.
National AN-37 (8 pg.)

16 **"3-Input, 4 Bit Multiplexers"**
(N8263, N8264, S8263, S8264)
Describes logic diagrams for 8263/4, data outputs for each selection code, and expansion for six 4-bit inputs.
Signetics Applications Handbook (3 pg.)

17 **"8-Input Digital Multiplexers"**
(N8230, N8231, N8232, S8230, S8231, S8232)
Covers expansion of these multiplexers and use as variable frequency counters or Boolean function generators.
Signetics Applications Handbook (6 pg.)

PLAs

18 **"How To Design With Programmable Logic Arrays"**
(DM8575, DM8576)
Discusses operation of PLAs and use as code converters, decode elements in digital processors and sequential controllers.
National AN-89 (8 pg.)

DIGITAL

PLAs (cont)

1 **"MOS Programmable Logic Arrays"**
(TMS2000 Series, TMS2200 Series)
Describes TMS2000 and TMS2200 Series programmable logic arrays. Describes their internal logic and operation. Provides ordering instructions.
Texas Instruments Application Report CA-158 (13 pg.)

Pulse Handling

2 **"Nanosecond Pulse Handling Techniques in I/C Interconnections"**
Discusses problems of pulse transmission and measurement for TEM mode on coax, stripline, and above-ground wire systems.
Motorola AN-270 (6 pg.)

Scalers

3 **"Eight-Bit Position Scaler"**
(N8243, S8243)
Provides general description and discusses applications of the 8243 as a bidirectional 7-position scaler and sequence generator, 24-bit 8-position shift right/left scaling array, and as a demultiplexer.
Signetics Applications Handbook (11 pg.)

Trigger Circuits

4 **"Quad Bus Receiver With Hysteresis Schmitt Trigger"**
(N8T380, S8T380)
Covers these applications: bus interface Schmitt trigger, frequency measurement, frequency division with square wave output, digital clock, variable modulus and high speed counters.
Signetics Applications Handbook (7 pg.)

5 **"Dual Zero-Crossing Detector"**
(N8T363)
Describes applications of 8T363 as a zero crossing detector, frequency doubler, high stability or bi-directional one-shot, low frequency oscillator, frequency to voltage converter, and a linear amplifier.
Signetics Applications Handbook (6 pg.)

6 **"8T14 as a Schmitt Trigger"**
(N8T14, S8T14)
Describes applications as a sine-to-square wave converter, a monostable multivibrator, and an oscillator.
Signetics Applications Handbook (2 pg.)

7 **"8T20 Bi-Directional One-Shot"**
(N8T20, S8T20)
Provides device description and describes applications in disc, drum and tape playback systems, a di-phase to binary receiver, and a binary to di-phase transmitter.
Signetics Applications Handbook (10 pg.)

8 **"Retriggerable Monostable Multivibrator"**
(N8T22)
Covers operation and application of the 8T22, including oscillator circuits, delayed pulse generation, missing or double pulse detector, voltage to frequency converter, and pulse duration transmission systems.
Signetics Applications Handbook (8 pg.)

9 **"Design Techniques with HiNIL 367 Quad Schmitt Trigger"**
See listing under HNIL/HTL (Teledyne Semiconductor)

Trigger Circuits (cont)

10 **"The HiNIL 347 - A Dual Retriggerable One Shot with High Noise Immunity"**
See listing under HNIL/HTL (Teledyne Semiconductor)

11 **"TTL One-Shot: SN74121"**
(SN74121)
Brief description of the SN74121 monostable multivibrator or "one-shot". Applications: stable gated clock pulse generator and a digital frequency-to-voltage converter.
Texas Instruments Application Report CA-128 (4 pg.)

TTL, General

12 **"The Control Engineers Guide to IC Applications"**
See listing under (Linear) Industrial Control (Motorola)

13 **"The TTL Applications Handbook"**
(9300, 9301, 9302, 9304, 9305, 9307, 9308, 9309, 9310, 9311, 9312, 9313, 9314, 9315, 9316, 9317, 9318, 9321, 9322, 9324, 9328, 9334, 9338, 9340, 9341, 9342, 93S43, 9344, 9345, 9348, 9350, 9352, 9353, 9354, 9356, 9357, 9358, 9359, 9360, 9366, 9368, 9369, 9370, 93H72, 9375, 9377, 9383, 9390, 9391, 9392, 9393, 9394, 9395, 9396, 9600, 9601, 9602, 9603, 74121, 12122, 7442, 7443, 7444, 7446, 7447, 7448, 7449, 7475, 7477, 7483, 7490, 7491, 7492, 7493, 7494, 7495, 7496, 74123, 74141, 74150, 74153, 74164, 74165, 74181, 74182, 74192, 74193, 7488A, 93141, 93150, 93153, 93164, 93165, 93406, 93410, 93415, 93434)
Gives diagrams and short descriptions of many IC applications grouped under the following categories: multiplexers, decoders, displays, encoders, operators (adders/subtractors, multipliers/dividers, comparator systems, error detection/correction, code conversion), latches, memories, registers, counters, small scale integration, low power TTL, Schottky TTL, monostable multivibrators and transmission line interface elements. The introduction discusses the advantages of MSI and general design rules. The final chapter covers electrical properties, physical system considerations, and interfacing with other forms of logic. Each application is brief, and various uses are shown for the ICs.
Fairchild Semiconductor TTL Applications Handbook (355 pg.)

14 **"Medium Scale Integration In the Numerical Control Field"**
(MC4016, MC4018, MC4024, MC4044, MC4324, MC4344)
Discusses operation of MC4016 decade programmable cascadeable counter, MC4324/4024 dual voltage controlled multivibrator, and MC4344/4044 frequency phase detector. Describes applications of these devices in audio frequency comparator, frequency synthesizer, and motor speed control circuits.
Motorola AN-541 (10 pg.)

15 **"TTL Integrated Circuits -- Applications of MSI Devices"**
Covers counters, modulo-N dividers, decoders, switches, adders, comparators, parity generators, shift registers and bus-ORable flip-flop. Describes many applications, including up/down counters, a stepping waveform generator, shift registers, frequency synthesizers, digital data demultiplexer, analog commutator, minterm generator, ripple carry parallel adder and tape position locator.
National AN-36 (23 pg.)

16 **"Tri-State Logic In High-Speed Memories of Microprogrammed Computers"**
(DM8551)
Discusses tri-state logic in general and its use in scratchpad memories. Covers storage of microinstructions and program constants in high-speed ROMs.
National AN-47 (5 pg.)

Bold face indicates additional data is provided, see the Product Index.

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TTL, General (cont)

1 **"Tri-State Logic Applied In a Computer System Can Reduce System Cost and Provide Added Performance"**
(DM8556)
Analyzes Tri-State characteristics using the DM8556 counter/register as an example. Shows how performance of PDP-8 can be improved using TSL.
National AN-73 (7 pg.)

2 **"Characteristics and Applications of Tri-State IC's"**
(DM7093, DM7490, DM7214, DM7230, DM7551, DM7598, DS7831)
Describes application of the general configuration of the Tri-State logic family and discusses application of the following: quad bus-buffer gates, dual 4:1 multiplexer, demultiplexer and bus-interchange switch, quad-D flip-flop, expandable 256-bit ROM, and quad driver.
National AN-45 (12 pg.)

3 **"Tri-State Logic In Modular Systems"**
(DM8093, DM8094, DM8214, DM8230, DM8551, DM8552, DM8598, DS8831, DM8840, DM8842, DM8846)
Discusses output drive characteristics, logical control, safety factors in Tri-State Logic circuits. Describes applications, including complex switching functions, driving and transmitting, multiplexing, data storage, decoding, and data manipulation.
National AN-43 (16 pg.)

LINEAR

Active Filters

4 **"Active Filter Design Examples Using Universal Active Filters"**
(UAF11, UAF15, UAF21, UAF25)
Shows calculation of external component values for low pass and band reject filters.
Burr-Brown Application Note AN-61 (4 pg.)

5 **"High Q Notch Filter"**
(LM102, LM202, LM302)
Describes use of LM102 connected to a twin "T" network to form a high Q, 60Hz notch filter.
National Linear Applications LB-5 (2 pg.)

Amplifiers, Current

6 **"Application of the LH0002 Current Amplifier"**
(LH0002)
Circuit operation. Describes uses in a differential input-output op amp, booster amplifier, level shifter, pulse transformer driver, and transmission line driver.
National Linear Applications Handbook, AN-13 (4 pg.)

Amplifiers, Differential

7 **"AD520 Monolithic Instrumentation Amplifier"**
(AD520)
Describes performance of this instrumentation amplifier. Covers application as a bridge amplifier, ground loop eliminator, and floating measurement amp. Appendix compares instrumentation amplifier to several multiple op amp circuits.
Analog Devices (6 pg.)

8 **"Instrumentation Amplifiers-versatile differential input gain blocks"**
(3660, 3670)
Describes the features and general operation of instrumentation amplifiers. Depicts their use in bridge circuits, in reducing ground loop interference, and in driven guard input circuits.
Burr-Brown Application Note AN-75 (6 pg.)

9 **"Instrumentation Amplifier"**
(LM101A, LM102, LM107)
Describes a differential-input instrumentation amplifier using LM102 and LM107 and variable gain version that also uses LM101A.
National Linear Applications LB-1 (2 pg.)

10 **"A General Purpose IC Differential Output Operational Amplifier"**
(MC1420, MC1520)
Discusses application of the MC1520 as a wideband non-inverting operational amplifier, as well as inverting operational amplifier, a differential amplifier with either single-ended input or differential input/output. Also discusses circuit operation, power connections, frequency compensation and feedback.
Motorola AN-407 (5 pg.)

Amplifiers, Differential (cont)

11 **"Application of the RCA-CA3000 Integrated-Circuit DC Amplifier"**
(CA3000)
Describes circuit and application as modulated oscillator, crystal oscillator, low-frequency mixer, cascaded RC-coupled feedback amp, narrow-band tuned amp, and Schmitt trigger.
RCA SSD-202B Linear Application Notes Databook, ICAN-5030 (11 pg.)

Amplifiers, Operational

12 **"Specifying Selected Op Amps and Comparators"**
See listing under Comparators (National)

13 **"Radiation testing of Linear Microcircuits"**
See listing under (Linear) General (Fairchild)

14 **"AD513, AD516 IC FET Input Operational Amplifiers"**
(AD513, **AD514**)
Describes the circuit and operation. Applications include: comparator, precision clipper, current-to-voltage converter, and a timer.
Analog Devices Technical Bulletin (4 pg.)

15 **"Applying the AD504 Precision IC Operational Amplifier"**
(**AD504**)
Describes this amplifier and offers notes on its noise, thermal and dynamic performance, Applications: instrumentation amplifier, stable reference regulator, instrument input amplifier and high gain ac amplifier.
Analog Devices Technical Bulletin (7 pg.)

16 **"High Speed Op Amps—How Fast is Fast?"**
Comments on op-amp characteristics, including slew rate, settling time, stability and phase margin.
Analog Devices Reprint (6 pg.)

17 **"IC FET Input Operational Amplifiers"**
(**AD503, AD506**)
Describes these devices and their circuit characteristics. Applications: triangle and square wave generator, charge amplifier, track and hold amplifier, D. C. voltmeter, peak rectifier, bridge amplifier and current-to-voltage converters.
Analog Devices Technical Bulletin (6 pg.)

18 **"Combine Two Op Amps to Avoid the Speed Accuracy Compromise"**
(3521)
Discusses interconnecting low drift and wideband op amps to form a composite op amp.
Burr-Brown Application Note AN-64 (2 pg.)

Bold face indicates additional data is provided, see the Product Index.

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Amplifiers, Operational (cont)

1 **"Check Five Op Amp Specs in One Test"**
Describes a test circuit that generates signals providing measurements of open loop gain, offset voltage, input bias current, quiescent current, and output voltage swing.
Burr-Brown Application Note AN-65 (1 pg.)

2 **"Protect Op Amps from Overloads"**
Discusses protection from power-supply faults, keeping input voltages at safe levels, and limiting output currents.
Burr-Brown Application Note AN-60 (3 pg.)

3 **"A Non-Inverting Differentiator"**
Bootstrapping an RC differentiator yields a precision differentiator without the phase inversion of a conventional op amp circuit. Discusses technique and operation.
Burr-Brown Application Note AN-67 (1pg.)

4 **"Using Op Amps in Low Noise Applications"**
Discusses shot noise and noise from source resistances.
Burr-Brown AN-68 (2 pg.)

5 **"A Simplified Precision Rectifier with Variable Gain"**
Operational amplifiers are used to build a rectifier circuit with variable gain.
Burr-Brown AN-78 (2 pg.)

6 **"Design of a Unique Precision Controlled Current Source"**
Diagrams a current source using an op amp and a complementary FET pair to form a current source with differential input and bipolar current output.
Burr-Brown AN-74 (2 pg.)

7 **"The μA739 - A Low-Noise Dual Operational Amplifier"**
(μA739)
Describes the circuit and operating characteristics. Covers d-c circuit performance, low-frequency analysis, power consumption, noise, short-circuit protection, amplifier isolation, and compensation techniques.
Fairchild Application Note 175 (8 pg.)

8 **"Applications of the μA741 Operational Amplifier"**
(μA741)
Describes applications of this amplifier as a unity gain voltage follower, integrator, differentiator, voltage regulator reference amplifier, high voltage regulated power supply control element, clipping amplifier, and a comparator.
Fairchild Semiconductor Application Note 289/1 (4 pg.)

9 **"Applications of the μA777"**
(μA777)
Discusses use of this operational amplifier as a pulse amplifier, Wein Bridge oscillator, variable gain differential amplifier, power amplifier.
Fairchild Application Note 300 (3 pg.)

Amplifiers, Operational (cont)

10 **"Operational Amplifiers as Inductors"**
(μA777)
Includes derivation of equivalent circuit and necessary component values to obtain inductances from millihenries to kilohenries, using the μA777 as an example. Describes application in voltage controlled sinewave oscillators and in bandpass and notch filters.
Fairchild Application Note 321 (5 pg.)

11 **"Applications of the μA749 Dual Operational Amplifier"**
(μA749)
Describes applications as a dual level comparator, positive or negative peak detector, peak-to-peak detector, and as an offset null circuit.
Fairchild Application Note 268 (2 pg.)

12 **"The μA776, An Operational Amplifier with Programmable Gain, Bandwidth, Slew-Rate, and Power Dissipation"**
(μA776)
Describes methods for setting the master bias current, discusses amplifier frequency response as a function of this current. Discusses applications, including a 600 nano-watt amplifier, a low-cost sample and hold circuit, a current controlled oscillator, multiplexing, and phase shifting.
Fairchild Application Note 218 (5 pg.)

13 **"The μA749 Dual Operational Amplifier"**
(μA749)
Discusses the circuit, input voltage range, latch-up, output voltage range, power dissipation, noise, separation, high frequency compensation, and output capability.
Fairchild Application Note 269 (8 pg.)

14 **"The μA715 -- A Versatile High Speed Operational Amplifier"**
(μA715)
Describes application as an image orthicon head amplifier, general purpose video amplifier, 40dB high input impedance amplifier, and high speed sample and hold circuit.
Fairchild Application Note 265 (4 pg.)

15 **"A Low Drift, Low Noise Monolithic Operational Amplifier For Low Level Signal Processing"**
(μA725)
Describes operation of μA725, which offers low offset drifts, low input currents, low noise performance, and massive open loop gain. Shows how to minimize offset voltage drift with temperature in IC operational amplifiers and how to improve the common-mode rejection.
Fairchild Application Note 277 (10 pg.)

16 **"An Improved Sample and Hold Circuit Using the μA740"**
(μA740)
Basic discussion of acquisition and hold times. Description of circuit using this op amp as the buffer amplifier.
Fairchild Application, Note 297 (3 pg.)

LINEAR

Amplifiers, Operational (cont)

1 **"Frequency Compensation Techniques for an Integrated Operational Amplifier"**
(μA702A)
Presents design techniques for frequency compensation of μA702A which are applicable to other IC operational amplifiers.
Fairchild Application Bulletin 117/2 (8 pg.)

2 **"The HA-2530/2535 Wideband High Slew Inverting Amplifier"**
(HA-2530, HA-2535)
Briefly discusses internal circuit. Shows how closed-loop frequency response can be predicted. Describes application as a fast settling coaxial driver, a 10 MHz coaxial line driver, a wide range signal separator, a high frequency triangular wave generator, and a current-to-voltage converter.
Harris Application Note 516 (11 pg.)

3 **"Applications of a Monolithic Sample-and-Hold/Gated Operational Amplifier"**
(HA-2420, HA-2425)
Describes HA-2420/2425 circuit. Applications include various track-and-hold/sample-and-hold configurations, an A/D converter, a demultiplexer, an integrated-hold-reset amplifier, a gated operational amplifier, and a peak detector with reset.
Harris Application Note 517 (8 pg.)

4 **"The HA-2900 Monolithic Chopper Stabilized Amplifier"**
(HA-2900)
Discusses offset voltage and current drift and chopper stabilization, then describes the circuit. Applications include a high impedance differential instrumentation amplifier, use as an integrator, and several wide bandwidth configurations.
Harris Application Note 518 (8 pg.)

5 **"The HA-2400 PRAM Four Channel Operational Amplifier"**
(HA-2400, HA-2405)
This is a programmable input stage, operational amplifier. This note describes its applications including an analog multiplexer with buffered input and output, an inverting or non inverting amplifier with programmable gain, a sine wave oscillator with programmable frequency, and a track and hold/ sample and hold circuit.
Harris Application Note 514 (8 pg.)

6 **"Operational Amplifier Stability: Input Capacitance Considerations"**
(HA-2600, HA-2605)
Discusses overcoming stray capacitance in op amps, such as the HA-2600.
Harris Application Note 515 (2 pg.)

7 **"A Simple Function Generator Using Operational Amplifiers"**
(HA-2600, HA-2510)
Describes square and triangular waveform generator using HA-2600 and HA-2510 op amps.
Harris Application Note 507 (2 pg.)

Amplifiers, Operational (cont)

8 **"Test Procedures for Operational Amplifiers"**
Circuit for measuring offset voltage, bias current, offset current, open loop voltage gain, common mode and power supply rejection ratios, output voltage/current, power dissipation, and making continuity checks.
Harris Application Note 508 (2 pg.)

9 **"A Simple Comparator Using the HA-2620"**
(HA-2620)
Describes op amp comparator circuit capable of driving approximately ten logic gates.
Harris Application Note 509 (1 pg.)

10 **"A Simple Square-Triangle Waveform Generator"**
(HA-2510, HA-2600, HA-2620)
Circuit for waveform generator using three op amps.
Harris Application Note 510 (2 pg.)

11 **"HA-909 Operational Amplifier"**
(HA-909, HA-911)
Discusses applications as a unity gain breadboard op amp, servo preamplifier, high-Q bandpass filter, Wien bridge oscillator, and phase-delay filters.
Harris Application Note 501 (2 pg.)

12 **"HA-909 Operational Amplifiers Performance Tailoring"**
(HA-909, HA-911)
Discusses how to optimize HA-909's offset, power dissipation, bandwidth, large signal bandwidth, slew rate, transient response, and stability with reactive loads.
Harris Application Note 502 (3 pg.)

13 **"Automatic Phase Margin Testing"**
(HA-2600)
How to test op amps using an HA-2600 comparator, the 8405A vector voltmeter and a sweep generator.
Harris Application Note 504 (2 pg.)

14 **"A High Impedance Hysteresis Circuit"**
(HA-2520, HA-2620)
Describes HA-2520/HA-2620 used as a hysteresis amplifier and covers output voltage limiting.
Harris Application Note 505 (2 pg.)

15 **"Equivalent Input Noise Measurements on High Gain Monolithic Operational Amplifiers"**
(HA-709, HA-909, HA-2520, HA-2600)
Broadband noise versus bandwidth measurements for HA-709,909, 2520, and 2600 op amps.
Harris Application Note 506 (2 pg.)

16 **"The 8007 - A High Performance FET-Input Operational Amplifier'**
(8007)
Circuit description, applications as log and antilog amplifiers, photocell amplifier, peak detector, sample and hold circuits, high impedance buffer, and Wien Bridge oscillator.
Intersil Application Bulletin A005 (6 pg.)

Bold face indicates additional data is provided, see the Product Index.

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Amplifiers, Operational (cont)

1 **"The 8043 - A Low Cost Dual FET-Input Operational Amplifier"**
(8043)
Summary of circuit characteristics. Applications as automatic offset suppression circuit, staircase generator, sample and hold circuit, and instrumentation amplifier.
Intersil Application Bulletin A008 (6 pg.)

2 **"Ultra Low Bias Current Operational Amplifier"**
(ICH8500, ICH8500A)
Brief discussion of ICH8500 and ICH8500A circuit characteristics. Describes applications as pico ammeter, sample and hold circuit, and gated integrator.
Intersil Application Bulletin H001 (4 pg.)

3 **"The MC1556 Operational Amplifier and Its Applications"**
(MC1456, MC1556)
Gives characteristics and describes operation. Discusses application as a voltage follower, high impedance bridge amplifier, and a logarithmic amplifier.
Motorola AN-522 (8 pg.)

4 **"Single Power Supply Operation of IC Operational Amplifiers"**
(MC1430, MC1431, MC1433, MC1530, MC1531, MC1533, MC1709, MC1709C)
Describes a split zener biasing technique that permits the use of these operational amplifiers from a single power supply. Discusses general circuit as well as specific ac and dc device considerations to minimize operating and design problems.
Motorola AN-403 (3 pg.)

5 **"The MC1539 Operational Amplifier and Its Applications"**
(MC1439, MC1539)
Discusses dc and ac operation and the performance of this amplifier. Describes a high frequency feed-forward scheme and application as a comparator, voltage follower, differential amplifier, and a summing amplifier.
Motorola AN-439 (22 pg.)

6 **"A Simple Technique for Extending Op Amp Power Bandwidth"**
(MC1433, MC1533)
Describes a method of reducing loop gain and using only as much compensation as needed to increase the power bandwidth. Cites the MC1533G as an example.
Motorola AN-459 (3 pg.)

7 **"Using Transient Response To Determine Operational Amplifier Stability"**
(MC1439, MC1539)
Describes a technique for evaluating the stability of any feedback amplifier configuration by analyzing its response to a step-function input. Includes a theoretical analysis and an example using the MC1539 operational amplifier.
Motorola AN-460 (9 pg.)

Amplifiers, Operational (cont)

8 **"The MC1535 Monolithic Dual Operational Amplifier"**
(MC1435, MC1535)
Gives complete ac and dc circuit analysis and discusses electrical characteristics. Discusses applications in a differential input/differential output circuit configuration, and as a signal level envelope detector. Describes an input compensation scheme for fast slew rate.
Motorola AN-411 (9 pg.)

9 **"Getting More Value Out Of An Integrated Operational Amplifier Data Sheet"**
(MC1439, MC1539)
Describes operational amplifier open loop characteristics and significance to overall circuit operation. Discusses loop gain stability and bandwidth, also reviews offset voltage and current and resultant drift effects for closed loop operation. Uses MC1439/1539 as examples.
Motorola AN-273A (9 pg.)

10 **"The MC1533 Monolithic Operational Amplifier"**
(MC1433, MC1533)
Analyses function of each stage of the circuit. Discusses methods for frequency compensating, and dc biasing. Describes application as a follower, twin tee filter and oscillator, voltage regulator, and a high input impedance voltmeter.
Motorola AN-248 (11 pg.)

11 **"The MC1530, MC1531 Integrated Operational Amplifiers"**
(MC1430, MC1431, MC1530, MC1531)
Describes the function of each stage in the circuit, methods of frequency compensating and dc biasing. Discusses application as a summing circuit, integrator, dc comparator, and a transfer function simulator.
Motorola AN-204A (13 pg.)

12 **"Analysis and Design of the Op/Amp Current Source"**
Develops expressions for the transfer function and output impedances of voltage controlled op amp current source using both ideal and non-ideal models. Discusses effects of parameter and temperature variations on performance.
Motorola AN-587 (7 pg.)

13 **"An Applications Guide for Operational Amplifiers"**
(LH101, LH201, LM101, LM201, LM301)
Discusses applications of operational amplifiers, grouping them in five categories: simple amplifiers, operational circuits, transducer amplifiers, wave shapers and generators, and power supplies.
National Linear Applications AN-20 12 pg.)

14 **"A Simplified Test Set for Operational Amplifier Characterization"**
(LM101, LM201, LM301, LM709)
Gives a functional description of set that allows quantitative characterization of the dc operational amplifier parameters for the LM101 and LM709. Discusses the circuit, includes construction information, and gives a layout for the tester circuit boards.
National Linear Applications AN-24 (12 pg.)

LINEAR

Amplifiers, Operational (cont)

1 **"IC Op Amp Beats FETs on Input Current"**
(LM108, LM208, LM308)
Describes LM108 operation and performance. Applications: sample and hold circuit, integrator, sine wave oscillator, capacitance multiplier, instrumentation amplifier, logarithmic converter, transducer amplifier, current source and voltage comparator. Discusses PC board construction.
National Linear Applications AN-29 (20 pg.)

2 **"Logarithmic Converters"**
(LM101A, LM102, LM108)
Describes log generators, anti-log generators, cube generators, and multiplier/dividers, using the LM101A and LM108 op amps.
National Linear Applications AN-30 (4 pg.)

3 **"Op Amp Circuit Collection"**
(LM101A, LM102, LM107, LM108)
Gives schematics only for some 90 circuits using one or more of the following operational amplifiers: LM101A, LM102, LM107, LM108. Includes basic, signal generation and signal processing circuits.
National Linear Applications AN-31 (20 pg.)

4 **"New Design Techniques for FET Op Amps"**
(LH0022, LH0022C, LH0042C, LH0052, LH0052C)
Gives parameters for LH0022, LH0042 and LH0052 operational amplifiers. Discusses rationale for FETs in these devices, describes the circuits. Describes application as voltage followers, integrators, sample/hold amplifiers, comparators, instrumentation and charge amplifiers.
National Linear Applications AN-63 (12 pg.)

5 **"Micropower Circuits Using the LM4250 Programmable Op Amp"**
(LM4250, LM4250C)
Describes LM4250 circuit and bias current setting procedure. Applications: 500 nano-watt amplifier, micro-power comparator meter amplifier, pulse generator, instrumentation amplifier, and a 5V regulator for CMOS logic circuits.
National Linear Applications AN-71 (8 pg.)

6 **"The LM3900 -- A New Current-Differencing Quad of ± Input Amplifiers"**
(LM3900)
Describes Norton "current mirror" circuit. Emphasizes the amplifiers' application in circuits for single power supply systems. Discusses use in ac and dc amplifiers, voltage regulators, RC active filters, waveform generators, phase locked loops, and voltage controlled oscillators.
Also covers designing digital and switching circuits, and special applications, including tachometers, squaring amplifiers, positive feedback oscillators, line operated audio amplifiers, and power circuits.
National Linear Applications AN-72 (39 pg.)

Amplifiers, Operational (cont)

7 **"Applications For A High Speed FET Input Op Amp"**
(LH0062, LH0062C)
Describes circuit, performance, compensation techniques for LH0062. Discusses applications in high speed sample and hold circuit, high speed peak detector, programmable integrator, and wide band ac voltmeter. Covers heat sinking, guarding, and bootstrapping.
National Linear Applications AN-75 (4 pg.)

8 **"Feedforward Compensation Speeds Op Amp"**
(LM101A, LM201A, LM301A)
Compares standard frequency compensation with feedforward frequency compensation of LM101A. Charts open loop response for both compensation networks. Shows fast integrator circuit.
National Linear Applications LB-2 (2 pg.)

9 **"Fast Compensation Extends Power Bandwidth"**
(LM101A, LM201A, LM301A)
Describes frequency compensation technique that extends power bandwidth of LM101A for non-inverting gains of unity to ten and also reduces gain error at moderate frequencies.
National Linear Applications LB-4 (2 pg.)

10 **"Precision AC/DC Converters"**
(LM101A, LM201A, LM301A)
Describes the use of the LM101A in a circuit for eliminating diode threshold potential, use as a precision clamp, as a fast half wave rectifier, and precision AC to DC converter.
National Linear Applications LB-8 (2 pg.)

11 **"Universal Balancing Techniques"**
Describes offset voltage adjustment: for inverting amplifiers using less than 10 K source resistance or using any type of feedback element, for non-inverting amplifiers, for voltage followers, and for differential amplifiers.
National Linear Applications LB-9 (2 pg.)

12 **"Speed Up the LM108 With Feedforward Compensation"**
(LM108, LM208 LM308)
Describes simple feedforward network for use with LM108 to achieve a factor of five improvement in speed.
National Linear Applications LB-14 (2 pg.)

13 **"Easily Tuned Sine Wave Oscillators"**
(LM101A, LM111, LM201A, LM211, LM301A, LM311)
Describes a circuit using the LM101A and LM111 that provides both a sine and square wave output for frequencies for below 20 Hz to above 20KHz. Also describes low distortion sine wave oscillator using two LM101As.
National Linear Applications LB-16 (2 pg.)

14 **"LM118 Op Amp Slews 70 V/μS"**
(LM118, LM218, LM318)
Describes this operational amplifier with 15 MHz bandwidth. Covers a compensation scheme to approximately double bandwidth and slew rate, and one for minimum settling time.
National Linear Applications LB-17 (2 pg.)

Bold face indicates additional data is provided, see the Product Index.

LINEAR

Amplifiers, Operational (cont)

1 **"Predicting Op Amp Slew Rate Limited Response"**
Discusses slew rate limiting and gives curves for sine wave and step voltage response.
National Linear Applications LB-19 (2 pg.)

2 **"Low Power Operational LH0001 Amplifier"**
(LH0001)
Operation of circuit offering 0.2 mv typical offset voltage at 25°C and quiescent supply currents in 100 μA range.
National Linear Applications Handbook, AN-10 (4 pg.)

3 **"Monolithic Operational Amplifiers - The Universal Linear Component"**
(LM101, LM102)
Applications of the LM101 and, in some cases, the LM102, include free-running multivibrator, level shifting amplifier, voltage comparator, servo preamplifier, and computing circuits. Frequency compensation techniques are discussed in detail.
National Linear Applications Handbook, AN-4 (10 pg.)

4 **"Drift Compensation Techniques for Integrated DC Amplifiers"**
Op amp bias current and offset voltage compensation are discussed. Current compensation techniques for high impedance levels and methods to achieve chopper- stabilized drift performance at low impedance levels are covered.
National Linear Applications Handbook, AN-3 (4 pg.)

5 **"True RMS Detector"**
Describes circuit using operational amplifiers that provide dc output equal to rms value of input with 2% accuracy for a 20 V_{P-P} input signal from 50Hz to 100kHz.
National Linear Brief-25 (2 pg.)

6 **"Instrumentational Amplifiers"**
(LM114, LM118)
Discusses general purpose instrumentation amplifier, using LM114 matched transistors ahead of an LM118 op amp that is optimized for wide bandwidth.
National Linear Brief-21 (2 pg.)

7 **"Low Drift Amplifiers"**
(LM121, LM725, LM741, LM308)
Discusses problems causing circuit drift in amplifiers and recommends solutions. Includes discussion of thermal and electrical shielding, resistor choice, circuit layout, and offset balancing.
National Linear Brief-22 (2 pg.)

8 **"Versatile IC Preamp Makes Thermocouple Amplifier With Cold Junction Compensation"**
See listing under Pre-amplifiers. (National)

9 **"IC Preamp Challenges Choppers On Drift"**
See listing under Pre-amplifiers. (National)

Amplifiers, Operational (cont)

10 **"Noise Specs Confusing?"**
Explanation of terms and factors contributing to noise; calculation of noise figure and signal to noise ratio. Gives points on selecting low noise amplifiers.
National AN-104 (8 pg.)

11 **"Use the LM158/LM358 Dual, Single Supply OP Amp"**
(LM158, LM258, LM358)
Proposes using this dual op amp with a single supply in place of the MC1458/MC1558 with a split supply.
National AN-116 (4 pg.)

12 **"Simple Precision Millivolt Reference Uses No Zeners"**
(OP-05)
Describes −3.5 mv to 3.5 mv reference built with instrumentation op amp and a potentiometer.
Precision Monolithics Application Note AN-10 (1 pg.)

13 **"The monoOP-07 Ultra-Low Offset Voltage Op Amp—A Bipolar Op Amp That Challenges Choppers, Eliminates Nulling"**
(OP-07)
Describes circuit design, compares performance to other devices. Covers application in a voltage reference, a high accuracy buffer, a D/A test system, a composite summing amplifier, an absolute value circuit, an analog computer building block, and as a thermocouple amplifier.
Precision Monolithics Application Note AN-13 (12 pg.)

14 **"Minimization of Noise in Operational Amplifier Applications"**
(OP-07)
Describes internal and external sources of noise. Helps to locate noise sources by frequency. Gives examples of noise calculation using the OP-07 as an example.
Precision Monolithics AN-15 (11 pg.)

15 **"Applications of the RCA CA3048 Integrated Circuit Amplifier Array"**
(CA3048)
Discusses operating parameters for this 4-amplifier array and covers applications, including Hartley and Colpitts oscillators, an astable multivibrator, four-channel linear mixer, and a gain-controlled amplifier.
RCA SSD-202B Linear Application Note Databook, ICAN-4072 (8 pg.)

16 **"Applications of the CA3080 and CA3080A High-Performance Operational Transconductance Amplifiers"**
(CA3080, CA3080A)
This device has additional control terminal for flexibility. Circuit operation is discussed. Applications covered: communications and industrial systems, modulators, multiplexers, sample and hold circuits, gain control circuits, and micropower comparators. Appendix discusses current mirrors.
RCA SSD-202B Linear Application Note Databook, ICAN-6668 (16 pg.)

LINEAR

Amplifiers, Operational (cont)

1 **"Application of the RCA CA3015 and CA3016 Integrated-Circuit Operational Amplifiers"**
(CA3015, CA3016)
Describes operating characteristics at +12 v. Applications covered are: 50-dB amplifier; twin-T bandpass amplifier; 20-dB, 10-MHz bandpass amplifier; and voltage follower.
RCA SSD-202 Linear Application Notes Databook, ICAN-5213 (6 pg.)

2 **"Application of RCA CA3033 and CA3033A High Performance Integrated-Circuit Operational Amplifiers"**
(CA3033, CA3033A)
Describes the basic circuit and operation. Covers application as a 250 mw. power amplifier and shows use in a DVM as a multivibrator, staircase generator, and comparator.
RCA SSD-202 Linear Application Notes Databook, ICAN-5641 (8 pg.)

3 **"Measurement of Burst (Popcorn) Noise In Linear Integrated Circuits"**
Discusses "pass-fail" criteria and describes a test set up for measuring burst noise. The setup includes a high gain amplifier-filter, a bipolar comparator, and a counter-latch-timer control circuit.
RCA SSD-202 Linear Application Notes Databook, ICAN 6732 (8 pg.)

4 **"Application of the RCA CA3008 and CA3010 Integrated-Circuit Operational Amplifiers"**
(CA3008, CA3010)
Describes operating characteristics of two op amps and their application in video amplifiers, frequency-shaping amplifiers, comparators, integrators, differentiators, scaling adders. Also covers the addition of a power output stage and/or input emitter followers.
RCA SSD-202 Linear Application Notes Databook ICAN-5015 (15 pg.)

5 **"Fast Slewing Operational Amplifier"**
(NE531, SE531)
Includes a schematic for the NE/SE531 and discusses applications in sample and hold circuits, active filters, precision rectifiers, voltage controlled amplifiers, and high speed inverters.
Signetics Applications Handbook (6 pg.)

6 **"L144 Programmable Micro-Power Triple Op Amp"**
(L144)
Describes device function, elements of programming, effects of slew rate limiting. Applications discussed include instrumentation amplifier, tone detectors, triple-amplifier active filters, and a micropower double-ended limit detector.
Siliconix Application Note AN73-6 (6 pg.)

Amplifiers, Power

7 **"The MC1554 One-Watt Monolithic Integrated Circuit Power Amplifier"**
(MC1554)
Describes the circuit, including dc characteristics, frequency response, and distortion. Shows how to calculate package power dissipation using the curves on the data sheet. Describes application, as one watt non-inverting, inverting, pulse power, and three-watt differential output amplifiers.
Motorola AN-401 (7 pg.)

8 **"LM380 Power Audio Amplifier"**
See listing under Consumer, Audio. (National)

9 **"LM377, LM378, LM379 Dual Two, Four and Six Watt Power Amplifiers"**
Discusses operation, choice and use of these circuits in audio applications. Covers distortion and heat dissipation. Also covers use in a bridge configuration, plus use as a Wein bridge power oscillator, motor drive, power comparator, relay and lamp driver.
National AN-125 (11 pg.)

10 **"Application of the RCA CA3020 and CA3020A Integrated Circuit Multi-Purpose, Wide-Band Power Amplifiers"**
(CA3020, CA3020A)
Circuit description and operation. Both circuits operate from single supply voltage as low as +3 v, offer voltage gains over 60 dB with a 3 dB bandwidth of 8 MHz. Discussion of audio, broadband and video amplifier, video line driver, motor controller and servo amp applications.
RCA SSD-202 Linear Application Notes Databook, ICAN-5766 (8 pg.)

Amplifiers, RF

11 **"An Integrated Circuit AGC IF Amplifier"**
(μA757)
Describes circuit and performance of μA757, which is recommended for applications in military and industrial equipment, also speech compressor amplifiers.
Fairchild Semiconductor Application Note 204 (4 pg.)

12 **"A High Gain Integrated Circuit RF-IF Amplifier With Wide Range AGC"**
(MC1590G)
Describes operation and Y parameters of the MC1590G. Applications include mixers plus IF, video, single and two-stage RF amplifiers.
Motorola AN-513 (10 pg.)

13 **"An Integrated Circuit RF-IF Amplifier"**
(MC1550)
Discusses MC1550 ac and dc operation, noise figure, and Y-parameters for calculating optimum power and voltage gain. Describes application as a tuned IF amplifier, oscillator, video-audio amplifier, and as a modulator.
Motorola AN-247A (16 pg.)

Bold face indicates additional data is provided, see the Product Index.

LINEAR

Amplifiers, RF (cont)

1 **"A Complete Monolithic AM/FM/SSB IF Strip"**
See listing under Consumer, AM/FM (National)

2 **"Applications of the LM173/LM273/LM373"**
(LM173, LM273, LM373)
Discusses FM, AM, and SSB operation of this multi-mode IF amplifier/detector.
National Linear Applications LB-13 (2 pg.)

3 **"Tuned Circuit Design Using Monolithic RF/IF Amplifiers"**
(LM171, LM703)
Discusses operating parameters for the LM171 and LM703 in emitter-coupled and cascode configurations. Brief description of 10.7 MHz emitter-coupled stage and 100 MHz cascode amplifier.
National Linear Applications Handbook, AN-6 (6 pg.)

4 **"Logarithmic IF Strips Using Monolithic Integrated Circuits"**
(SL521)
Describes operation of this log amplifier in successive detection type IF strips with center frequencies from 10 to 100 MHz. Covers broadband and narrow band circuits and describes in detail a 60 MHz wide-range logarithmic amplifier.
Plessey Semiconductor Technical Communication (3 pg.)

5 **"Application of the RCA-CA3002 Integrated-Circuit IF Amplifier"**
(CA3002)
Describes circuit, operating modes, characteristics, and application as an envelope detector, product detector, and a Schmitt trigger.
RCA SSD-202 Linear Application Notes Databook, ICAN-5036 (9 pg.)

6 **"Principal Features and Applications of the RCA-CA3040 Integrated-Circuit Wideband Amplifier"**
(CA3040)
Discusses bias modes, characteristics and ratings, stability, mounting, connections, and typical wideband amplifier circuits.
RCA SSD-202 Linear Application Notes Databook, ICAN-5977 (11 pg.)

8 **"Application of the RCA-CA3028A and CA3028B Integrated-Circuit RF Amplifiers in the HF and VHF Ranges"**
(CA3028A, CA3028B)
Describes circuits and operating modes. Covers use as an RF amp, autodyne converter, IF amp, and limiter.
RCA SSD-202 Linear Application Notes Databook, ICAN-5337 (10 pg.)

9 **"Application of the RCA CA3021, CA3022, and CA3023 Integrated-Circuit Wideband Amplifiers"**
(CA3021, CA3022, CA3023)
Describes circuit and operating characteristics. Covers video, 10 MHz IF, 455 KHz IF, 28 MHz two-stage limiter, and 500 kHz limiting amplifier applications.
RCA SSD-202 Linear Application Notes Databook, ICAN-5338 (12 pg.)

Amplifiers, RF (cont)

10 **"Application of the RCA CA3004, CA3005, and CA3006 Integrated-Circuit RF Amplifiers"**
(CA3004, CA3005, CA3006)
Discusses operating modes, Y parameters, noise performance, video amp capabilities, gain control, cross modulation and modulation distortion. Covers application as single-ended RF amplifier, tuned IF amplifier, mixer, suppressed-carrier modulator and product detector.
RCA SSD-202 Linear Application Notes Databook ICAN-5022 (26 pg.)

Amplifiers, Sense

11 **"Semiconductors for Plated-Wire Memories"**
See listing under (Digital) Interface

12 **"The MC1541, A Gated Dual-Channel Sense Amplifier For Core Memories"**
(MC1441, MC1541)
Discusses circuit operation, design considerations, interface problems, and applications.
Motorola AN-474 (10 pg.)

13 **"An Integrated Sense Amplifier For Core Memories"**
(MC1440, MC1540)
Discusses core memories and design considerations for a sense amplifier. Establishes performance and environmental specs for amplifier design, analyzes design of MC1540, and discusses measured performance.
Motorola AN-245A (7 pg.)

14 **"Dual Sense Amplifier"**
(N8T25)
Provides 8T25 description and covers applications in MOS memory systems.
Signetics Applications Handbook (4 pg.)

15 **"High-Speed Dual Differential Comparator/Sense Amp"**
See listing under Comparators. (Signetics)

Amplifiers, Video

16 **"Gated Video Amplifier Applications—The MC1545"**
(MC1445, MC1545)
Reviews basic operation and discusses applications, including several modulators, gated multivibrators, gated oscillators and FSK systems. Also discusses AGC, single supply operation, and temperature compensation of the active gate.
Motorola AN-491 (15 pg.)

17 **"An IC Wideband Video Amplifier With AGC"**
(MC1550)
Describes uses of the MC1550, including a single stage amplifier with 28 dB gain and 22 MHz bandwidth also as a 79 dB video amplifier with 10 MHz bandwidth. Gives AGC properties.
Motorola AN-299 (5 pg.)

LINEAR

Amplifiers, Video (cont)

1 **"Using the MC1545, A Monolithic Gated Video Amplifier"**
(MC1445, MC1545)
Describes ac and dc operation and discusses applications as a video switch, amplitude modulator, balanced modulator, pulse amplifier, frequency shift keyer and wideband differential amplifier.
Motorola AN-475 (7 pg.)

2 **"A Wide Band Monolithic Video Amplifier"**
(MC1552G, MC1553G)
Describes basic operation of the MC1552G and MC1553G, and the characteristics obtained as a function of the devices' operating modes. Applications: pulse amplifier, summing/scaling amplifier, oscillator, and tuned amplifier.
Motorola AN-404 (13 pg.)

3 **"Television Video IF Amplifier Using Integrated Circuits"**
See listing under Consumer, TV. (Motorola)

4 **"Application of the RCA-CA3001 Integrated-Circuit Video Amplifier"**
(CA3001)
Describes circuit and operating characteristics. Covers cascaded stages and use as a Schmitt trigger.
RCA SSD-202 Linear Application Notes Databook, ICAN-5038 (9 pg.)

5 **"The SG1401 Video Amplifier"**
(SG1401)
Discussion of fixed and variable gain. The high frequency stability is discussed to aid in optimizing the various configurations for this device.
Silicon General Linear IC Product Guide (2 pg.)

Arrays

6 **"Application of the RCA CA3018 Integrated Circuit Transistor Array"**
(CA3018)
Array of two isolated silicon epitaxial transistors plus two transistors with emitter-base common connections, suited for closely matched device requirements or interconnections with non-integrable components. Applications covered include IF-RF, video, agc, audio and dc amplifiers.
RCA SSD-202 Linear Application Note Databook, ICAN-5296 (5 pg.)

7 **"Application of the RCA-CA3019 Integrated-Circuit Diode Array"**
(CA3019)
Describes circuit configuration, operating characteristics and applications, including balanced modulator, high-speed gates, balanced mixer, and a ring modulator.
RCA SSD-202 Linear Application Notes Databook, ICAN-5299 (6 pg.)

8 **"Designing With An IC Transistor Array Containing Matched Super-Beta Transistors"**
(CA3095)
Describes CA3095 IC array. Applications: low frequency amplifier, low noise video amplifier, long-delay monostable multivibrator, low-input-bias current comparator, analog timer for long delays, high-input impedance dc-voltmeter circuit, and tape-head preamplifier.
RCA SSD-202 Linear Application Notes Datebook, ICAN-6222 (9 pg.)

Arrays (cont)

9 **"Monolithic Darlington Arrays Reduce Interface Cost and Complexity"**
(ULN-2001A, ULN-2002A, ULN-2003A)
Discusses packaging and heat dissipation of these 50v, 100-350 ma units. Covers parallel operation, input currents and control of up to 125 watts.
Sprague Electric Microcircuit Application Report MAR 75-2 (8 pg.)

Communications

10 **"A Monolithic Microtransmitter"**
(LP2000)
Describes operation of the rf power generation, rf amplification, molulation and regulator portions of this IC suitable for HF to VHF, am/pulse modulation. Applications: 27 MHz AM transmitter, 72 MHz telemetery transmitter.
Lithic Systems Application Note LAN-102 (3 pg.)

11 **"Communication System Transmission Losses"**
Derives equations for computing insertion losses for components in a communication system. Gives computer generated tables, series resistance and reactance plus parallel resistance and reactance for various system impedances.
Motorola AN-710 (5 pg.)

12 **"A Unique Monolithic AGC/Squelch Amplifier"**
(LM170, LM270, LM370)
Describes operation of LM170. Applications: agc circuits with peak or with transistor detectors, squelch preamplifier with hysteresis, voice-operated-relay controls, Wein bridge oscillators, decade tunable oscillators, and a modulated 455 kHz signal generator.
National Linear Applications AN-51 (12 pg.)

13 **"SL600 Series - Integrated Circuits for Radio Communications"**
(SL600 Series)
Describes circuits and applications for the following: RF/IF amplifiers; limiting RF amplifier/detector; AGC generators; AF amplifier, VOGAD side tone amplifier; AM detector, AGC amplifier and SSB demodulator; multimode detector; microphone/headphone amplifier; double balanced modulators; and a square log device. Describes synchrodyne, superhet, SSB and multimode receivers; SSB and AM transmitters; SSB transceiver; a multi-mode transceiver and a Morse keyer.
Plessey Semiconductor Applications Manual (92 pg.)

14 **"Applications of CMOS Integrated Circuits and Communications Equipment"**
See listing under (Digital) CMOS. (Solid State Scientific)

15 **Modems**
See listings under (Digital) Data Transmission

Bold face indicates additional data is provided, see the Product Index.

LINEAR

Comparators

1 **"A New High-Speed Comparator - the Am685"**
(685)
Circuit design of wideband device with under 10 ns propagation delay for application in A to D converters, data acquisition system, and optical isolators.
Advanced Micro Devices Data Book, Catalog (8 pg.)

2 **"Varying Comparator Hysteresis without Shifting Initial Trip Point"**
Describes adding a positive feedback circuit to introduce precise variable hysteresis into the usual comparator switching action.
Burr-Brown Application Note AN-62 (1 pg.)

3 **"The μA760 -- A High Speed Monolithic Voltage Comparator"**
(μA760)
Gives a functional description and cites typical performance characteristics. Discusses applications, including level detectors and line receivers, zero crossing detectors, high speed A/D converters, pulse width modulators, and fast peak detectors.
Fairchild Application Note 311 (8 pg.)

4 **"The μA750 Dual Comparator Subsystem"**
(μA750)
Discusses the circuit, design considerations and applications, including use in a combined heater/air conditioner control, a malfunction indicator, an analog status indicator and display, and a minimum frequency detector.
Fairchild Application Note 315 (7 pg.)

5 **"Voltage Comparator Applications Using the μA734"**
(μA734)
Discusses application of this comparator as a wide range phase meter, VCO, pulse width discriminator, free running oscillator, and sine wave frequency divider with phase adjustment.
Fairchild Applications Note 323 (3 pg.)

6 **"Radiation Testing of Linear Microcircuits"**
Includes the 702. See listing under (Linear) General. (Fairchild)

7 **"The Operation and Use of a Fast Integrated Circuit Comparator"**
(μA710, μA711)
Describes circuits of uA710 comparator and μA711 dual comparator. Discusses dc accuracy and response time of both. Discusses applications in line receivers, double-ended limit detectors, multivibrators, switching regulators, and switching power amplifiers. Appendices cover accuracy as a function of component matching, and test methods.
Fairchild Application Note 116 (14 pg.)

8 **"A High Speed Dual Differential Comparator -- the MC1514"**
(MC1414, MC1514)
Describes circuit operation and applications, including level and limit detectors, multivibrators, line receivers, sense amplifiers, zero crossing pulse generator and a peak voltage detector.
Motorola AN-547 (13 pg.)

Comparators (cont)

9 **"Precision IC Comparator Runs from 5V Logic Supply"**
(LM111, LM211, LM311)
Describes the LM111 circuit. Applications: photodiode level detector, zero crossing detectors, digital interface circuits, multivibrators, oscillators, and a frequency doubler. Includes application hints.
National Linear Applications AN-41 (6 pg.)

10 **"LM139/LM239/LM339 A Quad of Independently Functioning Comparators"**
(LM139, LM239, LM339)
Describes LM139 circuit. Applications: comparators with hysteresis, limit comparators with lamp drivers, zero crossing detectors, oscillators, MOS clock drivers, wide range VCO, AND/NAND gates, OR/NOR gates, multivibrators, time delay generators, pulse width modulator, temperature alarm, tape reader and peak detector.
National Linear Applications AN-74 (16 pg.)

11 **"Fast Voltage Comparators with Low Input Current"**
(LM102, LM106, LM202, LM206, LM302, LM306)
Describes use of LM102 to buffer the input of the LM106 comparator. Applications: comparators for fast A/D converters, for zero crossing detectors, and for ac coupled signals.
National Linear Applications LB-6 (2 pg.)

12 **"An IC Voltage Comparator For High Impedance Circuitry"**
(LM111, LM211, LM311)
Describes LM111 circuit and comparison to LM106/LM710. Applications: zero crossing detector driving an analog switch, detector for a magnetic transducer, comparator for a low level photodiode, and driving a ground-referred load.
National Linear Applications LB-12 (2 pg.)

13 **"Specifying Selected Op Amps and Comparators"**
Discusses the most common parameters that are tested on operational amplifiers and comparators and the relative difficulty of testing on high speed equipment. Gives a guideline to tightened specifications.
National Linear Applications LB-26 (2 pg.)

14 **"Comparing the High Speed Comparators"**
(LM160, LM161, LM260, LM261, LM360, LM361)
Compares LM360 to μA760 and LM261 to NE529. Covers application as a peak detector for tape and disk file channels and in a high-speed 3-bit A/D converter.
National AN-87 (6 pg.)

15 **"Interfacing Precision Monolithics Digital-toAnalog Converters with CMOS Logic"**
(DAC-100, DAC-01)
Analyzes input circuits of these DACs and CMOS interfaces. Describes a complete 10-bit DAC and an 8 bit A/D.
Precision Monolithics Applications Note AN-14 (4 pg.)

LINEAR

Comparators (cont)

1 **"High Speed Dual Differential Comparator/Sense Amp"**
(NE521, NE522, SE521, SE522)
Discusses applications of the 521/522 comparators as level detectors, line receivers, sense amplifiers, peak detectors, double ended limit detectors, A/D converters, and oscillators.
Signetics Applications Handbook (5 pg.)

2 **"A Simple Comparator Using the HA2620"**
See listing under Amplifiers, Operational (Harris)

Consumer, AM/FM

3 **"A Fully Integrated High Quality AM/FM Stereo Receiver"**
(μA706, μA720, μA739, μA753, μA758, μA3075)
Describes receiver using ICs with a comparison to discrete design.
Fairchild Application Note 328/1 (6 pg.)

4 **"Integrated Circuits For FM Receivers"**
(μA703, μA753, μA758, μA3075)
Describes ICs capable of performing all basic functions of an FM stereo receiver, except the front end. Discusses 753 IF block, CA3075 2nd end IF block, 758 stereo multiplex decoder, 706 audio power amplifier.
Fairchild Application Note 318 (7 pg.)

5 **"The μA758, A Phase Locked Loop FM Stereo Multiplex Decoder"**
(μA758)
Gives functional description of this device, including input buffer/amplifier and bias supply, demodulator, stereo switch and lamp driver, VCO, frequency dividers, and pilot phase and amplitude detectors. Discusses operating characteristics, testing and alignment.
Fairchild Application Note 319 (11 pg.)

6 **"The A732 and μA767 Integrated Circuit Stereo Multiplex Decoders"**
(μA732, μA767)
Discusses stereo demodulation, stereo/monaural switching, and interstation audio mute switching sections of these devices. Describes performance characteristics, external components required, alignment and user options.
Fairchild Application Note 286 (8 pg.)

7 **"The μA720 — An AM Radio IC"**
(μA720)
Describes RF amplifier, oscillator, converter mixer, IF amplifier, AGC detector, and regulator of this IC. Discusses applications in automobile and table radios.
Fairchild Application Note 325 (7 pg.)

8 **"2 Watt Sound System"**
(ITT3701)
Describes the use of this FM Detector/Amplifier in FM and TV sound systems.
ITT Semiconductor 3701 Application Note (15 pg.)

Consumer, AM/FM (cont)

9 **"Integrated Circuit IF Amplifiers For AM/FM and FM Radios"**
(MC1350, MC1355, MC1357, MFC4010, MFC6010)
Discusses the use of ICs in four IF amplifiers: a high performance FM, a quadrature detector FM, A COMPOSITE AM/FM, and an economy model FM receiver.
Motorola AN-543 (14 pg.)

10 **"A Complete Monolithic IF Strip for AM/AGC Applications"**
(LM172, LM272)
Circuit operation of LM172/LM272. Covers application in superheterodyne and low frequency T.R.F. receivers.
National Linear Applications Handbook, AN-15 (6 pg.)

11 **"Scanning Logic for RF Scanner-Receivers Using CMOS Integrated Circuits"**
See listing under CMOS (Motorola)

12 **"A Complete Monolithic AM/FM/SSB IF Strip"**
(LM273, LM373, LM274, LM374)
Discusses LM273/LM373, AND LM274/LM374 IF amplifier/detectors. Includes description of FM, SSB, and AM detection. Applications include: FM slope detector, double conversion IF strip, and coherent phase locked receiver. Also includes application hints.
National Linear Applications AN-54 (8 pg.)

13 **"LM1800 (LM1310, LM1310E) Phase Locked Loop FM Stereo Demodulator"**
(LM1310, LM1310E, LM1800)
Describes this demodulator and discusses typical performance.
National AN-81 (11 pg.)

14 **"Low Cost IC Stereo Receiver"**
(LM1800, LM1820, LM3089)
Describes the complete circuit and performance of an AM/FM/Stereo receiver.
National AN-147 (4 pg.)

15 **"FM Remote Speaker System"**
Describes an FM transmitter which couples to its companion receiver thru the power lines. The system transmits speech or music and is suitable for home use as well as some factory applications.
National AN-146 (4 pg.)

16 **"An IC for AM Radio Applications"**
(CA3088)
Describes CA3088E and application as a basic subsystem in AM broadcast receivers, as a 10.7 MHz IF amp, and as a general-purpose amplifier array.
RCA SSD-202 Linear Application Notes Databook, ican-6022 (4 pg.)

17 **"Integrated Circuits For FM Broadcast Receivers"**
(CA3005, CA3011, CA3012, CA3013, CA3014)
Discusses circuits for FM tuner, IF amplifier, limiter, and detector applications.
RCA SSD-202 Linear Application Notes Databook, ICAN-5269 (7 pg.)

Bold face indicates additional data is provided, see the Product Index.

LINEAR

Consumer, AM/FM (cont)

1 **"Integrated-Circuit Frequency-Modulation IF Amplifiers"**
(CA3012, CA3028)
Describes CA3012 and CA3028 differential amplifiers and application in IF-Amplifier strips.
RCA SSD-202 Linear Application Notes Databook, ICAN-5380 (7 pg.)

2 **"Application of the CA3089E FM-IF Subsystem"**
(CA3089)
Discusses stability considerations and following circuits: quadrature-detector, audio and AFC, mute, tuning meter and rf-agc, if amplifier/detector system and stereo decoder. Also covers operation at frequencies other than 10.7 MHz.
RCA Application Note, ICAN-6257 (8 pg.)

3 **"Integrated-Circuit Stereo Decoder Using the CA3090AQ Stereo Multiplex Demodulator"**
(CA3090AQ)
Gives circuit description. Describes the LC oscillator, reactance, stereo defeat, dc coupled flip-flop, preamplifier and phase splitter circuits.
RCA Application Note, ICAN-6259 (10 pg.)

4 **"A Demonstration Integrated Circuit FM Stereo Receiver"**
(ULN-2136, ULN-2209, ULN-2277, ULN-2244)
Describes the design and performance of a receiver using these ICs.
Sprague Electric Microcircuit Application Report MAR 73-4 (10 pg.)

5 **"Monolithic Integrated Circuits For Stereo Processing"**
(ULN-2120, ULN-2122)
Discusses use of the ULN-2120/22 to perform various functions in FM stereo receivers ranging from those with automatic mute and stereo mono-switching to those with no muting and manually activated switching.
Sprague Electric Engineering Bulletin 27109.1 (8 pg.)

Consumer Audio

6 **"MOS Circuit for Electronic Organs"**
(S2193, S2470, S5255, S5256)
Describes the use of ICs for various electronic organ circuits
American Microsystems AP74-10 (7 pg.)

7 **"Applications of the μA739 and μA749 Dual Preamplifier Integrated Circuits In Home Entertainment Equipment"**
(μA739, μA749)
Describes circuit operation. Discusses d-c and a-c considerations, compensation and noise performance. Covers applications as a stereo tape amplifier, a high fidelity phonograph preamplifier, and a TV remote control amplifier.
Fairchild Application Note 171 (7 pg.)

Consumer Audio (cont)

8 **"A High Output Power, (5 Watt), Low Distortion, IC Audio Amplifier"**
(μA706)
Describes circuit, functions, design considerations of the μA706. Discusses applications as an audio amplifier with the speaker load connected to ground, with the speaker load between supply and output, and discusses use in an FM stereo receiver.
Fairchild Application Note 317 (6 pg.)

9 **"Designing a Basic Organ System Using the MK50240"**
(MK50240)
Describes an organ system using the MK50240 Top Octave Generator for each octave.
Mostek (3 pg.)

10 **"LM380 Power Audio Amplifier"**
(LM380)
Describes the circuit and general operating characteristics. Applications: phono amplifier, bridge amplifier, and intercom.
National Linear Applications AN-69 (7 pg.)

11 **"Application of the RCA-CA3007 Integrated- Circuit Audio Amplifier"**
(CA3007)
Describes circuit. Covers application as dual- supply audio driver in a direct-coupled audio amp, and as single-supply audio driver in a capacitor- coupled audio amp.
RCA SSD-202 Linear Application Notes Databook, ICAN-5037 (4 PG.)

12 **"The ULN-2280 Amplifier"**
(ULN-2280)
Describes this single power amplifier circuit and discusses applications as a low-cost phonograph amplifier, amplifier with tone controls, common mode amplifier, full bridge amplifier, and in a mono FM receiver.
Sprague Electric Microcircuit Application Report MAR 73-2 (8 pg.)

13 **"Low-Cost-Dual Class B Driver"**
(ULN-2277, ULN-2278)
Describes the ULN-2277/78 ICs and describes use in dual 2-watt and dual 15-watt amplifiers.
Sprague Electric Microcircuit Application Report MAR 73-5 (3 pg.)

Consumer, Medical

14 **"A Personalized Heart-Rate Monitor With Digital Readout"**
(MC1776, MC14013, MC14040, MC14572)
Describes digital heart-rate monitor using the MC1776 op amp and CMOS digital ICs.
Motorola AN-714 (4 pg.)

Consumer, TV

15 **"The μA780, μA781 AND μA746 Integrated Circuit Color TV Chroma Processing System"**
(μA780, μA781, μA746)
Describes operation of μA780 chroma sub-carrier regenerator and μA781 chroma IF amplifier. Discusses their application along with the μA746 chroma demodulator as a complete IC chroma processing system for NTSC color TV receivers.
Fairchild Application Note 210 (10 pg.)

LINEAR

Consumer, TV (cont)

1 **"The μA746 Color TV Chroma Demodulator"**
(μA746)
Reviews NTSC color system, the requirements and the operation of a chroma demodulator. Describes circuit and function of this demodulator which contains two doubly-balanced synchronous detectors and a decoder matrix.
Fairchild Application Note 276 (5 pg.)

2 **"2 Watt Sound System"**
See listing under Consumer, AM/FM (ITT Semiconductor)

3 **"Television Video IF Amplifier Using Integrated Circuits"**
(MC1330, MC1350, MC1352, MC1353)
Discusses requirements of the video IF section of a TV receiver. Describes MC1350/2/3 amplifier and MC1330 detector circuits. Includes design for a practical TV IF amplifier and detector.
Motorola AN-545 (11 pg.)

4 **"Hybrid Modules For CATV Line Extender and Trunk Amplifiers"**
(MHW560, MHW561, MHW562)
Covers circuit, packaging, and thermal considerations of MHW560/1/and 2 hybrid modules.
Motorola AN-563 (5 pg.)

5 **"A Synthetic Spectrum Tuning System for TV"**
Describes a tuning system which generates a complete spectrum of TV channel markers to achieve precise tuning on any channel.
Motorola AN-739 (12 pg.)

6 **"Television Horizontal APC/AFC Loops: The Last 10 Percent"**
Discusses some of the common problems that may be encountered in the design of Horizontal APC/AFC loops and methods to avoid or overcome them.
Motorola Application Note AN-727 (15 pg.)

7 **"A Disassociated Intercarrier Television Video IF Amplifier"**
(MC1331)
Discusses a video IF system using the MC1331 low level multiplier detector.
Motorola AN-751 (9 pg.)

8 **"A Medium Cost PLL Varactor Tuning System Utilizing Off-the-Shelf Logic"**
Describes a frequency domain tuning scheme for varactor TV tuners.
Motorola AN-729 (14 pg.)

9 **"A Phase-Locked Loop Tuning System for Television"**
Describes a frequency domain tuning system using direct digital count down of the local oscillator.
Motorola AN-744 (10 pg.)

Consumer, TV (cont)

10 **"Application of the RCA-CA3044 and CA3044V1 Integrated Circuits In Automatic-Fine-Tuning Systems"**
(CA3044)
Describes circuits, operating characteristics and dynamic performance of this wide-band amplifier for AFC applications.
RCA SSD-202 Linear Application Notes Databook, ICAN-5831 (5 pg.)

11 **"Feedback-Type Volume-Control Circuits for RCA-CA3041 and CA3042 Integrated Circuits"**
(CA3041, CA3042)
Describes several types of volume controls for television receivers using these ICs, with a detailed discussion of feedback control.
RCA SSD-202 Linear Application Notes Databook, ICAN-5841 (4 pg.)

12 **"A Single IC for the Complete PIX-IF-System in TV Receivers"**
(CA3068)
Gives a detailed description of the circuit functions of the CA3068 and its use in color and b/w TV receivers.
RCA SSD-202 Linear Application Notes Databook, ICAN-6303 (17 pg.)

13 **"A Flexible Integrated-Circuit Color Demodulator for Color Television"**
(CA3067)
Describes circuit operation of the CA3067, including its output amplifiers, demodulator, demodulator preamp, and tint control amplifier. Describes use of this circuit in a red-green-blue system.
RCA SSD-202 Linear Application Notes Databook, ICAN-6724 (8 pg.)

14 **"Application of the CA3126Q Chroma-Processing IC Using Sample-And-Hold Circuit Techniques"**
(CA3126Q)
Detailed circuit description of this device, which requires only one adjustment; a trimmer capacitor to tune the crystal filter. Discusses performance data, the phase detector, sample and hold circuits, the VCO loop, first chroma amplifier and ACC servo loop, and the second chroma amplifier.
RCA SSD-202 Linear Application Notes Databook, ICAN-6247 (8 pg.)

15 **"Description and Application of the RCA-CA3120E Integrated-Circuit TV-Signal Processor"**
(CA3120)
Describes the operation and application of this device which includes TV video noise processor, agc and sync separator circuits.
RCA SSD-202 Linear Application Notes Databook, ICAN-6302 (9 pg.)

Bold face indicates additional data is provided, see the Product Index.

LINEAR

Consumer, TV (cont)

1 **"An Approach to a Unified Chroma System"**
Describes design approach that will eventually allow fabrication of a complete single-chip chroma system.
Sprague Electric TP 74-3 (9 pg.)

Converters

2 **"Beckman Model 845 Digital-to-Analog Converter"**
(845)
Discusses basic D/A converter performance including interface and transfer characteristics, then covers the performance of the 845 series.
Beckman Instruments (9 pg.)

3 **"Sample and Hold, Or High-Speed A/D Converters, How Do You Decide?"**
Uses 64-channel digital data-acquisition system as an example to discuss tradeoffs between converters. Covers dependency of sampling rate on input bandwidths, evaluation of system error budgets, and determination of the maximum system aperture.
Burr-Brown Application Note AN-56 (4 pg.)

4 **"D/A Converter Differential Linearity Error -- It Really Shows Up"**
Discusses differential linearity, the difference in analog output for a change between two successive digital input codes. Gives graphs of two examples with the same linearity specification.
Burr-Brown-Research Application Note AN-58 (2 pg.)

5 **"Don't Forget D/A Converter Tempco "**
Discusses offset, gain and linearity drift with temperature.
Burr-Brown Application Note AN-59 (3 pg.)

6 **"Principles of Data Acquisition and Conversion"**
Discusses basic principles of analog to digital systems including sampling rate, aperture error, accuracy, resolution, throughput, and codes.
Burr-Brown AN-79 (5 pg.)

7 **"Applications of the μA9650 4-Bit High Speed Precision Current Source"**
(9650)
Describes electrical characteristics, input circuit design considerations, basic biasing. Covers applications, including 8, 10, and 12-bit D/A and A/D converters, sample and hold circuits, servo or tracking converters, and voltage-to frequency converters.
Fairchild Application Note 324 (15 pg.)

8 **"Counter Type A to D Converter"**
(HI1080)
Circuit details of an A to D converter employing a unidirectional digital counter and the HI-1080 eight-bit D to A converter to generate a ramp voltage.
Harris Application Note 512 (3 pg.)

LINEAR—Converters (cont)

9 **"Digital-to-Analog Converter Applications"**
(HI1080, HI1085)
Operating modes and applications of HI-1080 converter, which features resistor ladder network and switching devices on same chip. Discusses cascaded D to A converter as well as up-down counter and successive approximation A to D converters.
Harris Application Note 511 (7 pg.)

10 **"Digital To Analog Converter Circuits Using the 8018A"**
(8018A, 8019A, 8020A)
Discusses D/A converters, both in general and their electrical specifications. Describes circuit operation for 8018A and covers its expansion to 8 and 12 bit units. Also discusses generating reference currents using zeners, pnp transistors or high-gain operational amplifiers as references. Describes system interface requirements.
Intersil Application Bulletin A010 (8 pg.)

11 **"Voltage Transients (Glitches)"**
(MN3008)
Discusses D/A converter analog voltage spikes appearing in the output following a change of input code.
Micro Networks AN-101 (2 pg.)

12 **"Truncation of A/D Converters"**
Describes how to reduce or to program the number of bits converted.
Micro Networks AN-102 (2 pg.)

13 **"When Should a Sample Hold Amplifier Be Used?"**
Covers the use of sample-hold amplifiers with A/D converters. Discusses use with dynamically changing signals and the droop rate of the sample-hold circuit.
Micro Networks AN-103 (2 pg.)

14 **"MN312 Connections for Bipolar Output"**
(MN312)
Shows use of an external op amp to convert a unipolar output to bipolar.
Micro Networks AN-104 (2 pg.)

15 **"Serial to Parallel Conversion"**
(MN502, MN5200, MN5210)
Covers timing considerations in the conversion of A/D converter output from serial to parallel form.
Micro Networks AN-106 (2 pg.)

16 **"Analog-To-Digital Cyclic Converter"**
(MC1456)
Discusses circuits and operation of medium speed-medium accuracy converter that uses successive approximation technique in which unknown analog input voltage is successively compared to reference voltage to determine each bit of digital output. A comparison of gray and binary code operation and an error analysis are provided.
Motorola AN-557 (10 pg.)

17 **"A Single Ramp Analog-To-Digital Converter"**
Discusses an A/D converter which incorporates a calibration cycle to insure 12 bit accuracy. Briefly covers errors encountered in the converter described.
Motorola AN-559 (9 pg.)

LINEAR

Converters (cont)

1 **"Generate Custom Waveforms Digitally"**
(MC1406, MC1458, MC74193)
Describes method using a read only memory and off-the shelf ICs, including MC74193 TTL up-down counter, MC1406L D/A converter, and MC1458CP, which acts as output buffer and polarity switch. Applications include standard as well as non-standard waveforms.
Motorola AN-589 (5 pg.)

2 **"High Speed Digital-To-Analog And Analog-To-Digital Techniques"**
Gives overview that includes voltage and current output D/As; parallel (flash), tracking, successive approximation, and parallel ripple A/Ds as well as nonsynchronous and synchronous VTF A/D, Glossary of terms.
Motorola AN-702 (14 pg.)

3 **"Analog-To-Digital Conversion Techniques"**
Discusses open-loop and feedback techniques: frequency, pulse width, cascade, ramp, counter, successive approximation, multiple comparison subranging, nonlinear conversion, double and triple ramp conversion.
Motorola AN-471 (21 pg.)

4 **"Successive Approximation A/D Conversion"**
(MC1408, MC14559)
Describes advances in successive approximation techniques with emphasis on SARs (Successive Approximation Registers.) Shows both a normal and a high speed A/D using these methods.
Motorola Application Note AN-716 (8 pg.)

5 **"Binary D/A Converters Can Provide BCD-Coded Conversion"**
See listing under (Digital) Converters (Motorola)

6 **"Binary-to-BCD and BCD-to-Binary Conversion with Complex IC Functions"**
See listing under (Digital) Converters (Motorola)

7 **"Applications of the MC1405/MC14435 in Digital Meters"**
See listing under Instrumentation (Motorola)

8 **"Logarithmic Converters"**
See listing under Amplifiers, Operational. (National)

9 **"Low Cost, High Speed Analog-to-Digital Conversion with the DAC-08"**
(DAC-08)
Discusses the succesive approximation technique to A/D and describes three designs with conversion times of 1, 2 and 4 μ sec.
Precision Monolithics Application Note AN-16 (8 pg.)

Converters (cont)

10 **"A Low Cost, Easy-to-Build Successive Approximation Analog-to Digital Converter"**
(DAC-100, CMP-01)
General discussion of feedback A/D converters. Operation of A/D converter capable of 8-bit conversions in 6 us. The system is expandable to 10-bit resolution. It uses aimDAC100, monoCMP-01, and a successive approximation register.
Precision Monolithics Application Notes AN-11 (8 pg.)

11 **"A Low Cost, High-Performance Tracking A/D Converter"**
(DAC-100, CMP-01)
Basic operation of 8-bit tracking converter that uses aimDAC100 series 10-bit D/A converter, monoCMP-01 series comparator, and 4-bit MSI up/down counters.
Precision Monolithics Application Notes AN-6 (8 pg.)

12 **"DAC-08 Applications Collection"**
(DAC-08)
Discusses the dual output, and high compliance. Covers use in a CRT display driver, bridge transducer control system, A/D converter, waveform generator, digital addition/subtraction with analog output, digital attenuator and microprocessor controlled A/D converter.
Precision Monolithics AN-17 (12 pg.)

13 **"Digital-to-Analog Conversion Using the RCA-CD4007A COS/MOS IC"**
(CD4007A)
Discusses resistance networks for DAC's and a voltage-follower amp for single-supply operation. Describes a 9-bit COS/MOS DAC.
RCA SSD-202 Linear Application Notes Databook, ICAN-6080 (6 pg.)

14 **"Function and Application of 3 1/2 Digit A/D Converter Set"**
(LD110, LD111)
Describes the operation of the LD110 digital processor and the LD111 analog processor. Various DVM circuits are shown including circuits for ratio, current, ac voltage and frequency measurements. A detailed error analysis is provided.
Siliconix Application Note AN74-1 (12 pg.)

Drivers

15 **"PIN Diode Drivers"**
See listing under Switches. (National)

16 **"Driver Circuits for the JFET Analog Switch"**
See listing under Switches. (Siliconix)

17 **"Monolithic Memory Driver"**
(SN75324)
Describes this monolithic memory driver and illustrates its use in addressing and driving a magnetic memory. Notes on circuit-board precautions and proper operation are provided.
Texas Instruments Application Report CA-107 (6 pg.)

Bold face indicates additional data is provided, see the Product Index.

LINEAR

Followers

1 **"A Fast Integrated Voltage Follower with Low Input Current"**
(LM102)
Circuit description. Use of the LM102 for analog commutator, sample and hold, ac amplifier and active filter applications.
National Linear Applications Handbook, AN-5 (11 pg.)

2 **"The LM110 -- An Improved IC Voltage Follower"**
(LM110, LM210, LM310)
Compares LM102 and LM110 circuits. Shows diagrams of LM110 as a high pass active filter, high Q notch filter, bandpass filter, and low drift sample and hold circuit.
National Linear Applications LB-11 (2 pg.)

3 **"Monolithic Operation Amplifiers - The Universal Linear Component"**
See Amplifiers, Operational (National)

4 **"Applications for a New Ultra-High Speed Buffer'**
(LH0033, LH0033C)
Describes LH0033 fast voltage follower/buffer,
Applications; high speed dual limit comparator for MOS logic, instrumentation shield/line driver, high speed sample and hold circuit, 4.5 MHz notch filter, high input impedance AC coupled amplifier, output buffer.
National Linear Applications AN-48 (4 pg.)

General

5 **"Radiation Testing of Linear Microcircuits"**
(μA702, μA709, μA710, μA711)
Describes tested performance of μA702 and μA709 operational amplifiers and μ A710 and μA711 comparators after having been irradiated with fast neutrons of energies greater than 0.01 MeV.
Fairchild Application Note 195 (13 pg.)

6 **"Solid State Gas/Smoke Detector Systems"**
Describes semiconductor and ionization chamber systems with some discussion of the use of these with CMOS ICs.
Motorola Application Note AN-735 (9 pg.)

7 **"CMOS Linear Applications"**
See listing under (Digital) CMOS National

8 **"MOS Analog Function Generator"**
Describes using MOS devices to construct an Analog Function Generator. The coding is stored in ROM.
National MOS Brief 3 (2 pg.)
National MOS Brief 4 (5 pg.)

9 **"Surface Acoustic Wave Technology"**
Presents surface acoustic wave fundamentals and use in delay lines, pulse compression filters, bandpass filters, oscillators and discriminators.
Plessey Semiconductor (10 pg.)

Industrial Control

10 **"Electronic Controller with an Equilibrium Sustaining Mode"**
(3500 series)
Discusses a controller formed with two operational amplifiers in a pulse width modulation circuit with feedback. The feedback operates from a heater through the medium being heated to sense amplifiers.
Burr-Brown Application Note AN-63 (2 pg.)

11 **"The Control Engineer's Guide to IC Applications"**
For digital ICs discusses types of logic, selection of package type, and designing ICs into circuits. For linear ICs covers cost factors, basic types, such as operational amplifiers and voltage regulators, and some circuit functions, such as limit detection.
Motorola AN-552 (21 pg.)

12 **"Variable Speed Control System For Induction Motors"**
(MC673, MC688)
Describes control scheme implemented with discrete components and IC logic coupled by an LED and a photo transistor. Gives example of a circuit used to drive a Class F, 60 Hz, permanent-split, capacitor induction motor with a 13 oz. in. load rating.
Motorola AN-575A (5 pg.)

13 **"A ROM-Digital Approach to PWM-Type Speed Control of AC Motors"**
Describes a pulse width modulation scheme to control motor speed. Shows a CMOS-ROM system to provide variable frequency drive for 1, 2 or 3 phase motors.
Motorola Application Note AN-733 (12 pg.)

14 **"Temperature Measurement Method Based on Matched Transistor Pair Requires No Reference"**
(monoMAT-01, monoOP-10)
Discusses properties of matched transistor pairs, then describes temperature measuring systems built with a matched pair, constant current sources, and a differential amplifier (monoOP-10)
Precision Monolithics Application Notes, AN-12 (6 pg.)

Instrumentation

15 **"Monolithic Thermal Converter Permits Wideband RMS AC Measurement"**
Describes (4131) monolithic thermal converter with a matched pair of npn transistors and diffused resistors. Discusses application as rms to dc converter and rms-voltage regulation.
Burr-Brown AN-76 (6 pg.)

16 **"Application Notes AN-205"**
(FX205)
Describes use of the FX205 psuedo sinewave generator as a tone generator, tone-burst generator, a divide by eight sinewave source and an fsk generator.
Consumer Microcircuits of America AN-205 (16 pg.)

LINEAR

Instrumentation (cont)

1 **"A Digital Voltmeter Using the AY-5-3507"**
(AY5-3507)
Gives schematics for the analog section, reference voltage generator, clock oscillator, and display circuitry required in addition to this logic IC to build a 3½ digit voltmeter.
General Instrument Microelectronics (5 pg.)

2 **"Everything You Always Wanted To Know About the 8038"**
(8038)
Includes a detailed schematic and a series of questions and answers about using this function generator, which produces sine, square, triangular, sawtooth and pulse waveforms.
Intersil Application Bulletin A013 (4 pg.)

3 **"A Precision Waveform Generator and Voltage Controlled Oscillator"**
(8038)
Discusses the 8038 circuit and operation. Covers external adjustments, power-supply connections, frequency modulation, sweeping, and use in phase locked loops.
Intersil Application Bulletin A012 (8 pg.)

4 **"A Synchronously Gated N-Decade Sweep Oscillator"**
(MC838P, MC856P, MC3061P)
Describes prototype oscillator that can be swept over five decades. Discusses options that allow preselection of any one, two or five frequency decades between 10 Hz and 10 MHz, whether sequential or not.
Motorola AN-540 (13 pg.)

5 **"Applications of MC1405/MC14435 in Digital Meters"**
(MC1405, MC14435)
Provides a detailed applications reference for this two chip, dual slope A/D converter system.
Motorola AN-748 (18 pg.)

6 **"A 3½ Digit DVM Using an Integrated Circuit Dual Ramp System"**
(MC1405, MC14435)
Describes a complete digital voltmeter based on the MC1405/14435 device pair. Includes input buffers and autopolarity.
Motorola AN-746 (6 pg.)

7 **"Generate Custom Waveforms Digitally"**
See listing under Converters. (Motorola)

8 **"A Fully Differential Input Voltage Amplifier (Instrumentation Amplifier)"**
(LM3900)
Describes operation of instrumentation amplifier built with LM3900. Also shows how a transducer bridge amplifier system can be developed with LM3900.
National Linear Applications LB-20 (2 pg.)

Instrumentation (cont)

9 **"Precise Tri-Wave Generation"**
(LM118, LM119)
Describes triangle-wave generator consisting of the LM118 integrator and two LM119 comparators. Discusses applications including
VCO, regulator and operational amplifier testing.
National Semiconductor Linear Brief-23 (2 pg.)

10 **"Solid State Altimeter for Transponder Applications"**
(LX3702)
Describes a solid state altimeter using a pressure transducer. The unit provides an an altitude transmission code for use with transponders, plus digital readout.
National Transducer Handbook AN-109 (8 PG.)

11 **"Wide Range Function Generator"**
Constructing a function generator for sine waves as well as square and triangular waveforms that operates below 10 Hz up to 1 MHz, with usable output to approximately 2 MHz. Design technique; circuit design, and construction directions.
National AN-115 (4 pg.)

12 **"Opto-Electronic Fault Indicator for Logic Circuits"**
Proposes use of visible-light-emitting-diodes (VLEDHs) as logic indicators. Discusses VLED characteristics, applications and typical circuits.
Texas Instruments Application Report CA-153 (4 pg.)

13 **"EPN2100 Thermal Printer"**
(EPN2100)
Detailed discussion of this solid state thermal printer and its interface requirements.
Texas Instruments Application Report CA-163 (6 pg.)

14 **"EPN2500 Thermal Printer"**
(EPN2500, SN74492, SN74495, TMS2502)
Discusses this thermal printer and its interface requirements. Includes a description of the SN75495 Row Driver and the SN75492 Digit Driver to interface the printhead to MOSFET logic circuits, and the TMS2502 character generator for providing alphanumeric characters.
Texas Instruments Application Report CA-175 (10 pg.)

Modulators

15 **"MC1596 Balanced Modulator"**
(MC1496, MC1596)
Describes device operation and applications, including modulators and demodulators for AM, SSB, and suppressed carrier AM; frequency doublers; and HF/VHF double balanced mixers.
Motorola AN-531 (12 pg.)

Multipliers

16 **"AD530 Complete Monolithic Multiplier, Divider, Square Rooter"**
(AD530)
Describes the device, its circuit, external connections and adjustments. Applications include use in a precision rectifier, a phase sensitive demodulator, an automatic level control, a voltage controlled filter, a voltage controlled oscillator, an amplitude modulator and a frequency discriminator.
Analog Devices Technical Bulletin (11 pg.)

Bold face indicates additional data is provided, see the Product Index.

LINEAR

Multipliers (cont)

1 **"Analog Modules Multiply User's Options"**
Discusses various types of multipliers, logarithmic converters, dividers and square rooters, peak detectors and comparing circuits. Applications: electron beam welder, 3-mode carriage control, position control, fog visiometer, optical measuring system, and lab pressure standard.
Burr-Brown Application Note AN-55 (6 pg.)

2 **"A Primer on Analog Multiplier Specifications"**
Discusses dc and dynamic performance specifications, including output and input offset, gain error, linearity, small signal and full power frequency response, output slewing rate, and settling time.
Burr-Brown Application Note AN-51 (6 pg.)

3 **"Using IC Multipliers"**
Covers the use as a divider, square root generator, polynomial generator, sine generator, voltage tuned filter. Cites some applications where other ICs should be chosen.
Burr-Brown Application Note AN-73 AN-73 (4 pg.)

4 **"Analog Shpaing"**
(4301)
Describes the use of the 4301 multifunction circuit which has the transfer function XY/Z. Includes rms to dc conversion, exponentiation, trigonometric functions, vector computation, and use as a log amp.
Burr-Brown AN-70 (5 pg.)

5 **"A Precision Four Quadrant Multiplier"**
(8013)
Describes the 8013 circuit, operation, and use in multiplication, division, squaring, square root, and variable gain.
Intersil Application Bulletin A011 (5 pg.)

6 **"Analysis and Basic Operation of the MC1595"**
(MC1495, MC1595)
Gives equations for the analysis of this linear four-quadrant multiplier and discusses characteristic performance. Covers multiplication, division, mean squares, square roots, roots and powers.
Motorola AN-489 (14 pg.)

7 **"Wideband Amplifier/Multiplier"**
(SG1402)
Operation and applications of the SG1402. Describes use as a single-ended variable gain amplifier, a modulator, and a demodulator.
Silicon General Linear IC Product Guide (4 pg.)

Phase Locked Loops

8 **"Precision PLL Systems Using the XR2207 and the XR2208"**
(XR2207, **XR2208**)
Defines phase locked loop parameters and describes this two-chip PLL system. Includes circuit interconnections for both single supply and split-supply operation. Also gives PLL design equations.
Exar Integrated Systems TB-1002 (6 pg.)

Phase Locked Loops (cont)

9 **"The μA758, a Phase-Locked Loop FM Stereo Multiplex Decoder"**
See listing under Consumer, AM/FM. (Fairchild)

10 **"Introduction to the Phase Locked Loop"**
(HA-2820)
General discussion of phase locked loops. Describes applications including a band-pass filter, FM receivers, data modems and synchronizers, a motor speed control, and a frequency synthesizer. Discusses features of HA-2800 and 2820 PLL.
Harris Application Note 601 (7 pg.)

11 **"A General Analysis of the Phase Locked Loop"**
Discusses a linear model, stability considerations and steady state response for phase locked loops.
Harris Application Note 602 (8 pg.)

12 **"The HA-2820/2825 Low Frequency Phase Locked Loop"**
(HA-2820, HA-2825)
Explains circuitry of these phase locked loops in 0.1 Hz to 3 MHz operation. Discusses methods for obtaining parameters of a linear model from device's performance curves. External connections are illustrated with an FM demodulator circuit.
Harris Application Note 605 (7 pg.)

13 **"A Frequency Synthesizer For Aircraft Automatic Direction Finding Systems"**
(MC4016, MC4044, MC1658)
Describes a phase locked loop frequency synthesizer, which includes a MC4016 programmable decade counter, a MC4044 phase detector, and a MC1658 voltage controlled multivibrator.
Motorola AN-594 (10 pg.)

14 **"A New Generation Of Integrated Avionic Synthesizers"**
Discusses several different types of servo phase locked loop systems and describes a synthesizer for avionic equipment.
Motorola AN-553 (9 pg.)

15 **"MTTL and MECL Avionics Digital Frequency Synthesizer"**
Describes phase detector, emitter coupled oscillator, prescaler, programmable counter and gives phase locked loop analysis, for a 118 MHz to 136 MHz synthesizer.
Motorola AN-532A (10 pg.)

16 **"Phase-Locked Loop Design Fundamentals"**
(MC4016, MC4024, MC4044, MC4316, MC4324, MC4344)
Outlines fundamental design concepts for phase locked loops implemented with ICs. Gives equations using Laplace Transforms needed to evaluate the basic loop performance and briefly describes a design using MC4000 series devices.
Motorola AN-535 (11 pg.)

LINEAR

Phase Locked Loops (cont)

1 **"An ADF Frequency Synthesizer Utilizing Phase-Lock-Loop ICs"**
(MC1648, MC3062, MC4016, MC4018, MC4044, MC7400)
Describes circuit for a synthesizer suitable for the local oscillator function in aircraft Automatic Direction Finder equipment. Covers programming, trouble shooting, power supply requirements, performance, circuit modifications, and circuit construction.
Motorola AN-564 (9 pg.)

2 **"A Medium Cost PLL Varactor Tuning System Utilizing Off-the-Shelf Logic"**
See listing under Consumer, TV (Motorola)

3 **"A Phase-Locked Loop Tuning System for Television"**
See listing under Consumer, TV (Motorola)

4 **"The Phase Locked Loop IC as a Communication System Building Block"**
(LM565, LM1596)
Discusses basic phase locked loop operation, design considerations, noise performance and describes the LM565 circuit. Applications; IRIG channel demodulator, FSK demodulator, and weather satellite picture demodulator.
National Linear Applications AN-46 (12 pg.)

5 **"SL650 Phase-Locked Loop Applications"**
(SL650, SL651)
Describes the circuit and application of this device that can operate to 0.5 MHz. Applications: Modulators-AM, FM, FSK, PAM, SCAM, tone burst, phase shift, delta, PWM; Waveform Generators-sine, triangle, mark/space ratio, staircase; Demodulators; Modem Systems, and a Digital Voltmeter.
Plessey Semiconductor SL650 Applications (32 pg.)

6 **"Low-Power Digital Frequency Synthesizers Utilizing COS/MOS ICs"**
(**CD4000 Series**)
Reviews digital phase-locked loops. Describes their implementation with CMOS for use in FM receiver synthesizers, both heterodyne and prescaling types.
RCA SSD-203, COS/MOS Digital Databook, ICAN-6716 (15 pg.)

7 **"The RCA COS/MOS Phase-Locked-Loop — A Versatile Building Block for Micro-Power Digital and Analog Applications"**
(**CD4046A**)
Discusses fundamentals of phase-locked-loops. Presents a detailed description of the CD4046A. Describes applications, including FM demodulators, frequency synthesizers, split-phase data synchronizers and decoders, and lock detection.
RCA SSD-203 COS/MOS Digital Databook, ICAN-6101 (8 pg.)

Phase Locked Loops (cont)

8 **"Phase Locked Loop Applications"**
(NE560, NE561, NE562, NE565, SE565, NE566, SE566, NE567, SE567)
Includes a glossary of phase locked loop terminology, a discussion of phase locked loop operation, and an analysis of the building blocks, including general comments about usage in applications such as demodulators and filters.
Discusses the general loop setup, including center frequency selection, capture range, and the choice of input level. Describes measurement techniques. Gives a detailed description of monolithic phase locked loops, including schematic diagrams, and discusses interfacing. Covers expansion of loop capability, including a discussion of extending the operating frequency to 60 MHz.
Applications covered: FM IF amplifier/demodulator with muting, FM demodulator, translation loop for precise FM, FSK demodulators, analog light-coupled isolators, phase modulators, dual tone decoders, a Touch-Tone decoder, ramp generators, sawtooth and pulse generators, single tone burst generators.
RF-FM generators, precision power inverter, aircraft VHF Omnidirectional Range (VOR) receiver, FSK data converter for a cassette recorder, self-resetting digital clock, tape recorder flutter meter, and a phase locked loop fluid flowmeter.
Signetics Applications Handbook (64 pg.)

Photosensitive devices

9 **"Application of Reticon Photodiode Arrays in Electron and X-Ray Detectors"**
(RL Series)
Describes the use of self-scanning photodiode arrays for detecting soft X-rays (1 to 10A) and electrons in the 10 to 100 KeV range.
Reticon Application Note 101 (4 pg.)

Power Control

10 **"A Monolithic Zero-Crossing AC Trigger (Trigac) For Thyristor Power Controls"**
(μA742)
Describes the μA742 zero-crossing ac trigger, which minimizes radio frequency interference generation. Discusses the circuit and operation of this device. Covers application with an SCR in a half wave circuit, full wave circuits, isolated system connections, and multi-phase power systems.
Fairchild Application Note 208 (5 pg.)

11 **"Servo Motor Drive Amplifiers"**
Discusses design of transformerless, AC servo amps using power Darlington transistors and IC op amps. Describes two power amplifiers, one using a 28 v power supply, the other, high voltage transistors. Also covers four op amp preamps and 90° phase shifters.
Motorola AN-590 (7 pg.)

12 **"Pulse Width Modulation For Small DC Motor Control"**
(MC1458, MC1709, MC14010, MC14011)
Discusses several circuits, using discrete, operational amplifier and IC devices, for developing pulse width modulation drive signals. Describes how these signals can control the speed of small motors, primarly permanent magnet types.
Motorola AN-705 (4 pg.)

Bold face indicates additional data is provided, see the Product Index.

LINEAR

Power Control (cont)

1 **"Power Control Using the Zero Voltage switch"**
(MFC8070)
Discusses zero voltage detector, pulse gate, input control, and charging circuit sections of the MFC8070. Describes application in a temperature controller that incorporates CMOS logic and optical couplers.
Motorola AN-597 (7 pg.)

2 **"A 20 KHz, 1 KW Line Operated Inverter"**
Describes application in 208-volt, line-operated, computer main-frame power supply. The output capability of the inverter is 5 v at 200 amp.
Motorola AN-588 (6 pg.)

3 **"Phase Control of AC Power with the SL440"**
(SL440)
Describes the operation of the SL440 power control circuit, and supply requirements. Applications include use with inductive loads, three phase systems, lighting, heating, motor and power supply control.
Plessey Semiconductor (38 pg.)

4 **"Power Switching Using Solid-State Relay"**
(CA3059)
Discusses advantages of triac over electro-mechanical relays. Covers basic parameters, such as surge in-rush currents, transient-voltages, suppression networks, turn-off considerations, and various modes of triac gating.
Also discusses ac power control by various circuit designs for ON/OFF control, zero-voltage switching, and line-voltage isolation.
RCA SSD-206 Thyristor, Rectifier Databook, AN-6141 (5 pg.)

5 **"Triac Power Controls For Three-Phase Systems"**
(CA3059)
Describes basic approach to designing triac control circuits for use in the switching of three-phase power. Outlines basic design rules and describes CA3059 zero-voltage switch. Discusses methods of isolation of dc logic circuitry. Covers recommended condigurations for power control circuits.
RCA SSD-206 Thyristor, Rectifier Databook, AN-6054 (6 pg.)

6 **"Solid-State Approaches To Cooking Range-Control"**
(CA3059, **CA3080**, CA3079, **CD4013A, CD4015A)**
Discusses application of ICs to cooking range control, both top burner and oven/broiler controls. Covers low-resistance sensors, zero-voltage switching and central processor control.
RCA SSD-206 Thyristor, Rectifier Databook AN-6096 (8 pg.)

7 **"Some Applications of a Programmable Power Switch/Amplifier"**
(CA3094)
Brief circuit description of CA3094. Device delivers three watts average power, 10 watts peak power to external load. Applications include Class A power amplifiers and driver amplifiers for complementary transistors, wideband power multivibrators, oscillators, comparators, voltage regulators, analog timers, and motor-speed controllers.
RCA SSD-202 Linear Application Notes Databook ICAN-6048 (12 pg.)

Power Control (cont)

8 **"Features and Applications of RCA IC Zero- Voltage Switches"**
See listing under Switches. (RCA.)

9 **"A Monolithic Amplifier-Detector SCR Firing Circuit"**
(ULN-2300)
Describes the operation of the ULN-2300 linear differential amplifier with integral SCR. Covers response, impedance characteristics and closed loop characteristics, open loop gain vs. temperature, and describes use as a sensitive control, as a drive amplifier in a typical control system and as a control for counters, relays, motors.
Sprague Electric TP69-4 (12 pg.)

10 **"Applications of High-Voltage/High-Current Monolithic Interface Circuits"**
(060, UHP-400 Series UHP-500 Series
Application of Series 060 Dual Darlington Switch and Series 400/500 Power Drivers in aircraft lamp drive circuit, solenoid printer, and 4-phase bipolar stepping motor.
Sprague Electric TP 72-4 (5 pg.)

11 **"Programmable Trigger Circuit for Triac Phase Control"**
The circuit uses an operational amplifier and external components. Provides notes on operation and a circuit description. Applications: motor control, temperature control, switching rate control, and frequency controlled lighting.
Texas Instruments Application Report CA-137 (7 pg.)

Power Converters

12 **"+5 To −15 Volts DC Converter"**
(LM311)
Describes use of the LM311 comparator for this voltage conversion.
National Linear Applications LB-18 (2 pg.)

13 **"Switched Mode Power Supplies- Highlighting a 5-V, 40-A Inverter Design"**
Discusses advantages of various approaches to regulator circuits. Describes in detail an 80% efficient 5v, 40a inverter which includes CMOS logic and an opto-electronic coupler.
Motorola AN-737 (16 pg.)

Power Transistor IC

14 **"Fast IC Power Transistor with Thermal Protection"**
(LM195)
Circuit design of the LM195 IC power transistor, a three terminal device with safe area protection plus current and thermal limiting. Applications: 6 amp variable output switching regulator, 1 amp positive and negative voltage regulators, time delay circuit, and optically controlled switch, power amplifier and voltage follower.
National AN-110 (6 pg.)

LINEAR

Preamplifiers

1 **"Applications of the µA739 and µA749 Dual Preamplifier Integrated Circuits In Home Entertainment Equipment"**
See listing under Consumer, Audio. (Fairchild)

2 **"IC Preamp Challenges Choppers On Drift"**
(LM108A, LM121)
Describes circuit of the LM121 preamplifier and discusses offset balancing, achieving of low drift, and typical operating performance. Also covers effects of the associated operational amplifier citing the LM108A as an example
National AN-79 (8 pg.)

3 **"Versatile IC Preamp Makes Thermocouple Amplifier With Cold Junction Compensation"**
(LM321, LM308A)
Discusses use of LM321 preamp with LM308A operational amplifier to form a precision, low-drift operational amplifier that also acts as a cold junction compensator.
National Linear Brief-24 (2 pg.)

4 **"LM381 Low Noise Dual Preamplifier"**
(LM381)
Describes the circuit. Discusses application as various tape amplifiers, phono preamplifier, and an audio mixer.
National Linear Applications AN-64 (12 pg.)

5 **"LM381A Dual Preamplifier for Ultra-Low Noise Applications"**
(LM381)
Gives detailed description of circuit operation of LM381A.
National Linear Applications AN-70 (4 pg.)

Regulators

6 **"More Voltage Regulator Applications Using the µA723"**
(µA723)
Describes foldback current limiting in positive and negative regulators, negative shunt regulation, and other techniques applicable to use of this device.
Fairchild Application Note 276 (4 pg.)

7 **"The µA7800 Series, Three-Terminal Positive Voltage Regulators"**
(µA7800)
Discusses the circuit and operation of this 3-lead, 15-watt regulator series. Discusses variable output voltage, high output current negative voltage regulation and use as an audio amplifier.
Fairchild Application Note 312 (6 pg.)

Regulators (cont)

8 **"The Voltage Regulator Applications Handbook"**
(µA104, µA105, µA109, µA723, µA7600, µA7800, µA78L00, µA78M00, µA79E00)
Gives specifications and parameters for various IC regulators and includes a selection guide. It devotes two chapters to each major regulator family, the first chapter describes design and electrical characterisitcs, the second discusses electrical and thermal considerations which are useful as application guidelines.
Includes appendices covering switching regulator and power supply design and a guide to the selection and operation of suitable power transistors. Applications of 7800 and 78M00 include fixed output, current and dual polarity regulators.
The 79EOO applications include use as a high current negative voltage regulator. The 723 is discussed in 150 mA maximum, positive shunt regulators with high line rejection or high input voltage, floating positive regulators, medium/high output current negative regulators, and several other applications.
The 104, 105, and 109 applications include high current, switching and floating regulators.
Fairchild Voltage Regulator Applications Handbook (96 pg.)

9 **"Development, Analysis, and Basic Operation of the MC1560-61 Monolithic Voltage Regulators"**
(MC1460, MC1461, MC1560, MC1561)
Discusses the basic operation of these regulators, gives data sheet parameters, and identifies problems in specifying a monolithic voltage regulator. Also covers basic circuit configurations and typical performance.
Motorola AN-500 (8 pg.)

10 **"Shutdown Techniques For the MC1560/61/69 Monolithic Voltage Regulators"**
(MC1460, MC1461, MC1469, MC1560, MC1561, MC1569)
Discusses the ways the MC1560 shutdown control can be used, including logic control, short circuit detection, over voltage detection, junction temperature control, and thermal feedback. Also covers current foldback and methods of restarting automatically from the shutdown state.
Motorola AN-499 (7 pg.)

11 **"Voltage and Current Boost Techniques Using the MC1560-61"**
(MC1460, MC1461, MC1560, MC1561)
Discusses stability requirements for these current boosted regulators. Describes internal and external compensation techniques, gives heatsink design information, provides typical circuits, and covers a voltage boost circuit.
Motorola AN-498 (11 pg.)

12 **"Designing Digitally-Controlled Power Supplies"**
(MC1406, MC1408, MC1466, MC1723)
Discusses two approaches to designing power supplies, one using the MC1723 voltage regulator, the other using the MC1466 floating regulator with optoelectonic isolation. Also discusses BCD-to-binary converter and memory options.
Motorola AN-703 (8 pg.)

Bold face indicates additional data is provided, see the Product Index.

LINEAR

Regulators (cont)

1 **"A Monolithic High-Power Series Voltage Regulator"**
(MC1560, MC1561)
Describes a regulator capable of delivering 1/2 ampere of current. Discusses ac reference shifting circuit, voltage and current reference generation, tracking current sources and biasing its lateral p-n-p current sources.
Motorola AN-473 (7 pg.)

2 **"A New Approach to Switching Regulators"**
Describes a 24 volt 3 ampere switching mode supply which operates at 20 kHz from a 120 volt AC line with 70% efficiency. Briefly discusses load-line shaping to reduce power losses and to reduce noise.
Motorola AN-719 (11 pg.)

3 **"LM340 Series Three Terminal Positive Regulators"**
(LM340)
Describes this 1 ampere regulator circuit. Applications: constant current source, high current regulator with short circuit current limit, 5 v regulator for TTL, adjustable output voltage regulators, tracking dual regulator, and high voltage regulators.
National AN-103 (12 pg.)

4 **"Designs for Negative Voltage Regulators"**
(LM104, LM204, LM304)
Describes the LM104 and covers pitfalls that cause unexpected failures as well as protection schemes. Includes discussions of high current regulators, symmetrical power supplies, high voltage regulators, switching and high current switching regulators, and driven switching regulators.
National Linear Applications AN-21 (16 pg.)

5 **"The LM105 -- An Improved Positive Regulator"**
(LM105, LM205, LM305)
Describes the circuit of this regulator, power limitations, using booster transistors, foldback current limiting, and dominant failure mechanisms.
National Linear Applications AN-23 (8 pg.)

6 **"IC Provides On-Card Regulation for Logic Circuits"**
(LM109)
Discusses design of regulators in general and describes the LM109. Covers application as a fixed 5V regulator, adjustable-output regulator, current regulator and high stability regulator.
National Linear Applications AN-42 (6 pg.)

7 **"1.2 Volt Reference"**
(LM113)
Describes the LM113 temperature compensated shunt regulator diode. Applications: low voltage regulator circuits, bias current source for a differential amplifier, and an electronic thermometer circuit.
National Linear Applications AN-56 (4 pg.)

Regulators (cont)

8 **"Worst Case Power Dissipation in Linear Regulators"**
(LM100, LM104, LM200, LM204, LM300, LM304)
Discusses problems of excessive dissipation in regulators and suggests solutions using LM100 and LM104.
National Linear Applications LB-3 (2 pg.)

9 **"Tracking Voltage Regulators"**
(LM104, LM105, LM204, LM205, LM304, LM305)
Describes adjusting several regulator voltages with one potentiometer, tracking positive and negative regulators using the LM104 as an amplifier, and tracking regulators with different output voltages.
National Linear Applications LB-7 (2 pg.)

10 **"IC Regulators Simplify Power Supply Design"**
(LM104, LM105, LM204, LM205, LM304, LM305)
Describes use of LM104 and LM105, IN 0.2 and 2A regulator circuits. Provides circuit construction hints.
National Linear Applications LB-10 (2 pg.)

11 **"High Stabiltiy Regulators"**
(LM108A, LM109, LM208A, LM209, LM308A, LM309)
Describes design and gives schematics for high stability positive and negative regulators using LM109 and LM108A.
National Linear Applications LB-15 (2 pg.)

12 **"New Uses for the LM100 Regulator"**
(LM100)
Applications include shunt regulator, switching regulator with overload shutoff, temperature controller, power amplifier, SSB transmitter, light-intensity regulator, and photomultiplier tube supply.
National Linear Applications Handbook, AN-8 (12 pg.)

13 **"A Versatile, Monolithic Voltage Regulator"**
(LM100)
Circuit operation. Applications for the LM100 between 2 v to 30 v (up to 2 amps with two external transistors) are discussed. Includes high power, switchback current limiting, negative voltage, temperature compensating, and switching regulators.
National Linear Applications Handbook, AN-1 (11 pg.)

14 **"Designing Switching Regulators"**
(LM100)
LM100 applications discussed include high current, driven switching, current limiting, negative and high voltage regulators, as well as switching and linear regulator combinations.
National Linear Applications Handbook, AN-2 (12 pg.)

15 **"LM125/LM126/LM127 Precision Dual Tracking Regulators"**
(LM125, LM126, LM127)
Circuit description, operation and applications, including current boosting, are discussed along with charts depicting external current limiting characteristics and a discussion of foldback current limiting. Electronic turn-off of the output without removing the input voltage is also described.
National Applications Report AN82 (15 pg.)

LINEAR

Regulators (cont)

1 **"The 4195 Regulator"**
(RC4195, RM4195)
Describes application as a ±15 v, 100 ma regulator; a ±2.5 a regulator; a ±15 to ±50 v unit, or a complementary ±3 to ±27 v device.
Raytheon Semiconductor Application Note (9 pg.)

2 **"Applications of the CA3085 Series Monolithic IC Voltage Regulators"**
(CA3085)
Circuit description of positive regulators with output currents up to 100 milliamperes from −55°C to +125°C.
Applications include high-current and constant-current regulators; switching, dual-tracking and high-voltage regulators. Use as a general purpose amplifier, and various methods of current limiting are mentioned.
RCA SSD-202 Linear Application Notes Databook, ICAN-6157 (11 pg.)

3 **"Dual-Polarity Tracking Regulators"**
(SG1501, SG1501A, SG1502, SG1568)
Operating parameters and circuit configurations for the 1501, 1501A, 1502 and 1568 regulators. Voltage adjustments are described, including the use as -12, 6 v power source for 710 and 711 comparators.
Silicon General Linear IC Product Guide (4 pg.)

4 **"723/823 Voltage Regulators"**
(723, 823)
Discusses characteristic device parameters, bias limitations, improvement of ripple rejection, external voltage sensing, thermal effects, protection, limiting and increasing the output current. Applications: switching regulator, tracking regulator, current sinking power supplies, precision current source, light intensity control, phase shift oscillator.
Teledyne Semiconductor Linear Application Note 2 (17 pg.)

Switches

5 **"Applications of the μA742 TRIGAC -- A Zero Crossing AC Trigger"**
(μA742)
Describes this TRIGAC circuit. Includes a discussion of the transfer characteristics and performance plus operation from ac and dc supplies. Applications: 110 V ac single threshold control; single phase, 110 V ac dual threshold control with hysteresis; 110 V ac dual threshold control with time proportioning; with time proportioning for Y or Δ loads; operating with transformer isolation between control circuit and ac line; output pulse amplifier with transformer; output pulse inverter; period extender for time proportioning; initial cycle delay; sensor failure detection circuit; time delay "relay" circuit; 208 V ac dual threshold control 110 V ac, 400 Hz dual threshold control with single TRIGAC for Y loads.
Also includes a section listing parts and component location diagrams for these applications and discusses operation with a fixed dc supply. Covers use of the TRIGAC with nonresistive loads, discusses thyristor cells, and full wave output power switches for use with the device.
Fairchild (30 pg.)

Switches (cont)

6 **"The IH5009 Series of Low Cost Analog Switches"**
(IH5009 Series)
Describes circuit parameters, logic compatibility, and virtual ground switching applications including 4-channel multiplexer, gain ranging circuit, gain programmable amplifier and 16-channel multiplexer.
Intersil Application Bulletin A004 (8 pg.)

7 **"A New CMOS Analog Gate Technology"**
General discussion of "latch up". Describes "floating body" process, which eliminates this problem.
Intersil Application Note A006 (2 pg.)

8 **"Understanding and Applying the Analog Switch"**
(IH5001, IH5009, IH5025, IH5040)
Compares parameters of analog switches. Applications of several switch families are discussed, including 3-channel differential multiplexer, gain programmable amplifier, gain ranging circuit, sample and hold circuit.
Intersil Application Bulletin A003 (16 pg.)

9 **"The MISER - A Monolithic Integrated Stored Energy Regulator"**
(LP1000)
Describes the operation of this 3 terminal, low voltage, threshold detector and switch. Emphasizes capacitor charging circuits with slow charge, rapid discharge characteristics. Applications: LED flasher, tone generator, relaxation oscillator.
Lithic Systems Application Ntoe LAN-101 (3 pg.)

10 **"High-Speed MOS Commutators"**
(MM451, MM453, MH454)
Discusses the lowered threshold voltages in commutators, on and off resistances, switching speed, noise and high-frequency noise control.
National Linear Applications AN-28 (8 pg.)

11 **"Applications of MOS Analog Switches"**
(LH0014, LH0019)
Discusses basic commutation circuits and describes the use of the LH0014 and LH0019 in linear amplifier applications, including reset functions and chopper circuits. Covers use of MOS switches as suppressed carrier double-sideband modulators and double-sideband demodulators. Also describes a circuit for a phase-locked loop AM-FM detector without tuned circuits.
National Linear Applications, also Interface Handbook AN-38 (8 pg.)

12 **"Analog-Signal Commutation"**
(MM450, MM451, MM454, MM550, MM551, MM552)
Describes dc characteristics involved in MOS IC switching of analog signals when the signal input range varies between ±10 v.
National Linear Applications and also Interface Handbooks, AN-33 (6 pg.)

13 **"High Speed Analog Switches"**
(AM1000, AM1001, AM1002)
Discusses time domain multiplexing, current mode multiplexing, the switching characteristics of the AM1000 J-FET switches, and drive circuits.
National Interface Handbook, AN-53 (6 pg.)

Bold face indicates additional data is provided, see the Product Index.

LINEAR

Switches (cont)

1 **"PIN Diode Drivers"**
(DH0035, DH0035C)
Describes PIN diode switching requirements and application of DH0035 as a driver. Includes discussion of anode ground and cathode ground designs and of repetition rate considerations.
National Linear Applications, also Interface Handbook AN-49 (6 pg.)

2 **"Applications of the RCA-CA3062 IC Photo-Detector and Power Amplifier in Switching Circuits"**
(CA3062)
Describes circuit operation and application in a latched memory circuit, a light activated triac control, a triac control with automatic shut off and alarm, and a triac intrusion alarm system.
RCA SSD-202 Linear Application Notes Databook ICAN-6538 (6 pg.)

3 **"Features and Applications of RCA IC Zero-Voltage Switches"**
(CA3058, CA3059, CA3079)
Discusses zero-voltage switch operation in general. Operation primarily with thyristors in ac power control and switching applications, including electric heating, oven/broiler control, machine control, light control and industrial systems.
RCA SSD-202 Linear Application Notes Databook, ICAN-6182 (28 pg.)

4 **"Some Applications of a Programmable Power Switch/Amplifier"**
See listing under Power Control. (RCA)

5 **"CMOS Analog Switches-A Powerful Design Tool"**
Describes CMOS switch construction, characteristics and operating precautions. Applications include: a four channel switch to multiplex a scope input, a low pass filter with digitally controlled frequency response, an amplifier with programmable inputs and gain, a sample and hold circuit, a latching switch, high frequency switching and multiplexer systems.
Siliconix Application Note AN75-1 (16 pg.)

6 **"Switching High-Frequency Signals with FET Integrated Circuits"**
(DG133, DG171, **DG181, DG200)**
Discussion of DG133/171/181/200 as rf switches. Gives equivalent circuits, "Off" isolation and "On" performance data. Applications: control of video monitor and switching between two video cameras.
Siliconix Application Note AN73-3 (16 pg.)

7 **"Driver Circuits for the JFET Analog Switch"**
Discussion and comparison of resistor-coupled diode charge transfer, space transistor charge transfer, and switched resistor driver circuits for JFET switches.
Siliconix Application Note AN73-5 (12 pg.)

Switches (cont)

8 **"FETs as Analog Switches"**
General discussion of FET operation; detailed discussion of factors affecting switch performance, including specific load problems and applicable driver circuits.
Siliconix Application Note AN72-2 (12 pg.)

9 **"Analog Switches in Sample and Hold Circuits"**
Covers the effects of FET analog switch current handling capability on settling time and the effects of offset characteristics on sample and hold system accuracy. Describes inverting and non-inverting sample and hold circuits.
Siliconix Application Note AN74-2 (4 pg.)

10 **"Driving the JFET Switch"**
(DG126, **DG139)**
Circuit operation of the DG126L and DG139L series driver-switches.
Siliconix Application Note AN69-1 (4 pg.)

11 **"D129/132 Quad Decode Driver"**
(D129, D132)
Describes basic level shifting uses including MOS switch, gas tube and lamp drive applications.
Siliconix Application Tip (4 pg.)

12 **"Designing with Monolithic FET Switches"**
Describes MOSFET and JFET switch operation, plus driver considerations.
Siliconix Technical Article TA73-2 (4 pg.)

13 **"Modes of Actuation for Type ULN-3006 'Hall Effect' Switches"**
(ULN-3006)
Describes magnetic operation of this non-contact, switching device.
Sprague Electric Application Note 27404.1 (4 pg.)

14 **"Suggested Output Loads for Type ULN-3006 'Hall Effect' Switches"**
(ULN-3006)
Diagrams connections to use the open collector output to drive transistors, thyristors, TTL and MOS circuits.
Sprague Electric Application Note 27404.2 (2 pg.)

Thermal Considerations

15 **"Thermal Evaluation of Integrated Circuits"**
Describes four methods for thermal evaluation, including reverse biasing substrate diodes.
Fairchild Application Note 205 (8 pg.)

16 **"Transient Thermal Resistance -- General Data and Its Use"**
Discusses transient thermal resistance and its use and describes methods using various degrees of approximations to determine the junction temperature rise of a device. Also covers the concept of a duty cycle family of curves to simplify calculation of junction temperature rise under a repetitive pulse train.
Motorola AN-569 (15 pg.)

LINEAR

Thermal Considerations (cont)

1 **"Mounting Techniques For Metal Packaged Power Semiconductors"**
Discusses preparation of mounting surfaces, using thermal compounds, and fastening techniques. Gives typical interface thermal resistance for a number of packages.
Motorola AN-599 (5 pg.)

2 **"Mounting Procedure For, And Thermal Aspects Of, Thermopad Plastic Power Devices"**
Covers various methods of mounting and heat-sinking Motorola case number 77, 90, and 199 plastic power devices. Also discusses thermal resistance considerations, lead forming, and circuit board cleaning.
Motorola AN-290B (9 pg.)

3 **"Micropower Thermometer"**
See listing under Transducers. (National)

4 **"Thermal Resistance of Integrated Circuit Packages"**
Describes method of measuring package thermal resistance while package is immersed in constant-temperature, circulating oil bath that acts as an infinite heat sink.
Sprague Electric TP 72-7 (5 pg.)

5 **"Thermal Design for Plastic Integrated Circuits"**
(ULN-2277)
Discussion of chip power dissipation -- using amplifier as an example -- heat dissipation, ULN-2277 dual 2-watt audio power heat sinks, heat sink finishes, and forced air cooling.
Sprague Electric TP 74-1 (7 pg.)

6 **"New Heat Sinking Techniques for Hermetic DIPs"**
Describes use of stamped and extruded heat sinks and method of reversing IC die and bonding chip directly to Kovar base.
Sprague Electric TP 74-4 (4 pg.)

Timers

7 **"Single-Chip Frequency Synthesizer Employing the XR2240"**
(XR2240)
Describes use of this timer/counter as a single-chip frequency synthesizer: $f_o = f_r (m/n+1)$ where $f_o < 200kHz$. Describes generating 100 Hz synchronized to 60 Hz line.
Exar Integrated Systems TB-1003 (3 pg.)

8 **"Versatile Timer Operates From Microseconds to Hours"**
(LM122)
Describes the LM122 circuit and its operation. Includes discussion of pin functions, timing errors and noisy environments. Discusses use as various timers, as a pulse width detector, a comparator, an oscillator, a two-terminal time delay switch, and a frequency to voltage converter.
National AN-97 (12 pg.)

Timers (cont)

9 **"Timers"**
(NE555, NE556, SE555, SE556)
Describes monostable operation of timers and discusses application as a missing pulse detector, frequency divider, pulse width modulator, pulse position modulator, test sequencer, and a tone burst generator. Circuits are shown for a touch control, burglar alarm, photographic timer, speed warning device, switching regulator, washer timer and an automobile burglar alarm.
Signetics Applications Handbook (13 pg.)

Transducers

10 **"Micropower Thermometer"**
(LX5600)
Describes use of the LX5600 as a thermometer whose output is a current proportional to temperature and can drive a meter for direct readout.
National Linear Brief-27 or Transducer Handbook TB-11 (2 pg.)

11 **"Pressure Transducers as Accelerometers"**
(LX1700G)
Discusses uses of accelerometers and describes scheme of converting LX series pressure transducers to cover ranges from fractions to thousands of g's.
National Transducer Handbook AN-96 (4 pg.)

12 **"LX Series Pressure Transducers: Design and Applications Information"**
(LX1600A, LX1601A, LX1602A)
Describes hybrid transducer circuit and applications, including pressure to frequency converter, latching altitude detector, digital readout barometer and altimeter.
National AN-94 (8 pg.)

13 **"Pressure Transducer Load Cell"**
(LX1700G)
Describes use of LX1700G pressure transducer to measure weight.
National Transducer Handbook AN-95 (4 pg.)

14 **"The LX1602A Pressure Transducer and Altimeter Applications"**
(LX1602A)
Describes how to use this transducer along with additional electronics to build an altimeter that operates over a range of −1,000 feet to +50,000 feet.
National AN-91 (3 pg.)

15 **"Transducers in Fluid Flow Applications"**
(LX1602A)
Discusses application of LX1602A in pressure vessel, open flow and closed flow applications.
National Transducer Handbook AN-93 (8 pg.)

16 **"Transducer Sensor Diaphram 15 Million Cycle Life Test"**
Findings in the continuing test of National's transducer sensing elements—a silicon membrane approx. 1 mil thick.
National Transducer Brief 3 (1 pg.)

Bold face indicates additional data is provided on the page noted.

LINEAR

Transducers (cont)

1 **"Use of the SK1007 Pressure Transducer Kit in Vault Alarm Systems"**
Describes application of this multi-level switch kit with a pressure transducer in vault alarm systems.
National Transducer Brief 7 (2 pg.)

2 **"Transducer Fluid Filled Option"**
Describes the "Fluid-Filled" methods of protecting transducers from hostile environments. Rates the resistance of silicone rubber to some common fluids.
National Transducer Brief 8 (2 pg.)

3 **"Installation Ideas for Pressure Transducers"**
(LX1600, LX1700, LX1400, LX1701AR, LX3700)
Provides suggestions for mounting National transducers for various applications. Includes diagrams and typical mounting configurations.
National Transducer Handbook AN-92 (4 pg.)

4 **"Zeroing Transducer Output Voltage"**
(LX1600 Series)
Shows how to set the supply voltages to provide an output starting at Ov.
National Transducer Handbook TB-2 (2 pg.)

5 **"Externally Zeroing Transducer Output Voltage"**
(LX1603G, LX1604G)
Describes how to use external components to zero the transducer output voltage. Tables compare output of the LX1603G and LX1604G devices.
National Transducer Handbook TB-5 (2 pgs.)

6 **"Automatic Zeroing Circuit"**
Diagrams an auto-zeroing system and describes its operation. Lists specifications and sensitivity.
National Transducer Handbook TB-12 (1 pg.)

7 **"Pressure to Current Converter (3 Wire)"**
(LX Series)
Describes the use of any LX series pressure transducer to obtain a pressure to current translator.
National Transducer Handbook TB-4 (2 pg.)

8 **"Current Sourcing and Sinking"**
(LX Series)
Offers a method that utilizes any LX()02() 0 to 15 psi transducer that sinks a standard 4 to 20 mA output (1:5 range) for a 3 to 15 psi pressure input (ratio 1:5 range)
National Transducer Handbook TB-15 (1 pg.)

9 **"Pressure to Frequency Converter"**
Shows how to take advantage of the hybrid construction of a pressure transducer and how to construct a self-contained voltage controlled oscillator.
National Transducer Handbook TB-13 (1 pg.)

Transducers (cont)

10 **"The Multi-Level Switch Kit, Part No. SK1007"**
Details the use of any LX series pressure transducer to produce a high level analog output as well as three independent switch points.
National Transducer Handbook TB-1 (2 pgs.)

11 **"Flow Velocity Measurement by Analog Shaping"**
(LX Series)
Discusses using an LX series pressure transducer to determine a fluid's flow velocity by extracting the square root of the transducer's analog voltage output.
National Transducer Handbook TB-20 (1 pg.)

12 **"Latching Altitude Detector"**
(LX1602A)
Uses the LX1602A absolute pressure transducer to construct an altitude detector that latches on when a given pressure is exceeded.
National Transducer Handbook TB-17 (1 pg.)

13 **"Solid State Barometers"**
(LX3700 Series)
Describes how to use thermostatically controlled pressure transducers as barometers with readout in inches of mercury, TORR or millibars.
National Transducer Handbook TB-21 (2 pg.)

14 **"Thermometer Using Pressure Transducers"**
(LX3700 Series)
Describes how to use a pressure transducer, to construct a constant volume gas, or "hot bulb", thermometer as an alternative to conventional electronic thermometers.
National Transducer Handbook TB-18 (2 pg.)

15 **"Acoustic Applications of Pressure Transducers"**
(LX Series)
Describes use of an LX series transducer as a microphone and sound pressure level meter, and the advantages over ordinary cardiod types.
National Transducer Handbook TB-19 (2 pg.)

16 **"Pressurized-Cable Fault Detection and Location"**
(LX1603A)
Describes the use of transducers in pressurized-cable control systems as early warning and break location alarms.
National Transdicer Handbook AN-121 (3 pg.)

17 **"Medical Applications"**
Describes the use of Pressure Transducers for protecting electronic equipment and operators; constructing blood pressure monitoring systems, respirators, kidney dialysis machines and other medical related applications.
National Transducer Handbook AN-122 (3 pg.)

LINEAR, MEMORY

Transducers (cont)

1 **"Automotive Applications"**
Describes the use of pressure transducers in automotive electronics for fuel metering, ignition management and other applications.
National Transducer Handbook AN-120 (4 pg.)

2 **"Calibrating the LX5600"**
(LX5600)
Discusses the accuracy of the LX5600 temperature transducer as well as three types of error—offset, slope and linearity.
National Transducer Handbook TB-9 (1 pg.)

3 **"IC Transducers Simplify Temperature Control Circuits"**
(LX5600)
Describes the advantages of this temperature transducer device in on/off temperature control appications. Also discusses construction of a temperature controller.
National Transducer Handbook TB-10 (3 pg.)

4 **"A New Interfacing Concept; The Monolithic Temperature Transducer"**
(LX5600, LX5700)
Covers alternate methods of powering the LX5600, load isolation and an unusual active thermal shield (the shield tracks the surface temperature of the sensor.) Describes use as a thermal transducer, temperature to frequency converter, and a temperature controller with rate-of-change sensing. Discusses use of differential temperature measurements for liquid or moving air dectection (including wind) and for position sensing (using a heat source as a position reference.)
National AN-132 (10 pg.)

5 **"Manual Control With Load Cells"**
Advocates the use of pressure transducers in force actuated controls for a better man-machine interface.
National Transducer Handbook TB-16 (1 pg.)

MEMORY

Analog

6 **"Principles of Analog Discrete-Time Signal Processing Devices"**
(SAD, SAM, SAP, TAD)
Describes a family of devices that effectively sample and store analog signals, quantizing time but retaining analog signal values. Different readout sequences result in processing the stored signals. Covers use as fixed and variable time delay, filters, correlation, convolution, time base modification, and video time base correction.
Reticon Application Note 102 (17 pg.)

7 **"Applications of Reticon TAD-12 Tapped Analog Delay"**
(TAD-12)
Describes the use of this clock controlled analog delay line in low pass and bandpass filter applications. Includes mathematical discussion of second order filter design. Briefly covers correlation and pattern recognition.
Reticon Application Note 103 (9 pg.)

Interface

CAMs

8 **"Content Addressable Memory Element (CAM)"**
(N8220)
Discussion of CAMs; logic diagram, functional description of 8220; applications including information retrieval, learning memory, masked searches, and search for maximum or minimum values.
Signetics Applications Handbook (8 pg.)

Character Generators

9 **"A CRT Display System Using NMOS Memories"**
(MC6565, MCM6570, MCM6571)
Discusses basic crt operation, character formation and describes the 8K-bit MCM6570 character generators. Describes a 128-character system in detail, including counter and retrace control, memory select, and address register sections.
Motorola AN-706A (15 pg.)

10 **"American and European Fonts In Standard Character Generators"**
(MM4240, MM5240, MM4241, MM5241)
Depicts the standard 64 character subsets for these devices.
National MOS Handbook AN-57 (6 pg.)

11 **"The Systems Approach to Character Generators"**
See listing under ROMs. (National)

12 **"Digital Display Generators"**
Using TTL compatible MOS ROMs to generate displays. Gives circuit diagrams and a sample readout.
National MOS Brief 8 (2 pg.)

13 **"7 X 9 Display Character Generator"**
Uses three MOS ROMs and some TTL logic to create a font of 64 7X 9 dot-type characters. A circuit diagram and a suggested character forms are provided.
National MOS Brief 13 (2 pg.)

Interface

14 **"The Recovery of Recorded Digital Information in Drum, Disk and Tape Systems"**
Reviews methods for converting the analog signal obtained from a magnetic recording into digital format.
Motorola Application Note AN-711 (10 pg.)

15 **"Applying Modern Clock Drivers to MOS Memories"**
(DS0025, DS0026)
Covers use of 0025/26 drivers in MOS memory systems. Information includes selection of packages and heat sinks, power dissipation, rise and fall time, power supply decoupling, system clock line ringing and crosstalk, input coupling techniques, and sample calculations.
National MOS Handbook AN-76 (12 pg.)

Bold face indicates additional data is provided on the page noted.

MEMORY

Interface (cont)

1 **"Interfacing Circuits for MOS Dynamic Random Access Memories"**
Discusses interfacing methods employing level shifters (TTL to MOS levels) with boosters, level shifters (MOS to TTL levels), and sense amplifiers.
Nortec Applications Note No. 25 Rev. A (3 pg.)

2 **"Charge Pump Driver for 7001 RAMs"**
(SN75450B)
Defines a method for driving the charge storage pump input of a 7001 RAM. Provides a description of the basic storage pump RAM cell and the charge pump circuit diagram. Gives performance curves.
Texas Instruments Application Report CA-178 (6 pg.)

3 **"High Speed TTL Interfacing for 7001 Static RAMs"**
(SN75261, SN75365)
Illustrates interface techniques for driving the 7001 RAM chip-select input, and sensing the memory output.
Texas Instruments Application Report CA-179 (8 pg.)

Microprogramming

4 **"Tri-State Logic in High-Speed Memories of Microprogrammed Computers"**
See listing under (Digital) TTL, General. (National)

5 **"Design of Microprogrammable Systems"**
Discusses building a simple system using read only storage (ROS). Gives example of the arithmetic unit of a System 360, reviews terminology, covers ROS addressing techniques and microinstruction word encoding, and writeable control storage.
Signetics Application Handbook pg. 5-24 (14 pg.)

6 **"Microprogramming and System Applications for Read Only Storage"**
Discusses fundamentals and advantages of microprogramming and applications of ROS in table look up, pattern generation, program storage, and microprogrammable devices (acting as control memories to control function of logic networks.)
Signetics Applications Handbook pg. 5-38 (7 pg.)

7 **"Cache Type Scratchpad Approach Improves CPU Throughput"**
Presents diagram with 4K by 32 main memory, ALU with 32 x 2 scratchpad, 32 x 12 CAM, and microprogrammed control.
Signetics Applications Handbook pg. 5-45 (2 pg.)

8 **"Economic Advantages of Microprogramming"**
Describes advantages, costs, and savings of microprogramming.
Signetics Applications Handbook pg. 5-19 (5 pg.)

PROMs

9 **"HPROM-0512 Bipolar PROM"**
(HPROM0512)
Covers basic programming considerations, automatic and custom programming of this 64-word by 8-bit memory.
Harris Application Note 202 (8 pg.)

10 **"Programming the HPROM-0512 In An Expanded Configuration"**
(HPROM0512)
Describes normal and expanded bit/word programming with sample calculations for a 256-word system. Describes programming expanded ROMs installed in a logic system.
Harris Application Note 203 (4 pg.)

11 **"Designing with Intel PROMs and ROMs"**
(1302, 1602A, 1702A, 3301A, 3404A, 3322, 3324A, 3601, 3604, 3622, 3624)
Describes technologies used to build PROMs, nichrome problems and advantages of polysilicon. Covers operation and use of Intels ROMs, PROMs and U. V. erasable PROMs.
Intel Application Note AP-6 (18 pg.)

12 **"Use of Bipolar ROM and PROMs"**
See listing under ROMs (Monolithic Memories)

13 **"ROM in Sequential & Combinatorial Logic"**
(6300, 6330)
Discusses combinatorial and sequential logic functions. Covers use of PROMs as synchronous counters, multiphase clock generators, character generators, octal decoders, parity generators, multiplexers, D/A converters, scalers, and 4-bit comparators.
Monolithic Memories Application Note 102 (8 pg.)

14 **"Programming the MCM5003/5004 Programmable Read Only Memory"**
(MCM5003, MCM5004)
Discusses programming methods for this 64 x 8 bit memory, describes circuit and operation. Describes a simple programmer using five ICs and a more sophisticated version using 25 ICs offering automatic sequencing.
Motorola AN-550 (12 pg.)

RAMs

15 **"AMS7001 Basic Storage Module High Speed Memories"**
(AMS7001)
Discusses AMS7001 storage module operation, backplane wiring, addressing scheme, and power requirements.
Advanced Memory Systems Application Note 35 (18 pg.)

16 **"Using the TM-200 Semiconductor Memory Card"**
(AMS7001)
Describes this memory card using the AMS7001 RAM. Includes detailed diagrams.
Advanced Memory Systems Application Note 36 (22 pg.)

MEMORY—

RAMs (cont)

1 **"The Am9338 Multiple Port Memory"**
(9338)
Describes applications for this 8-word by 1-bit three-address memory, including the working store for high-speed, three address computers; first in, first out (asynchronous buffer) memory; and direct address/indirect address memory.
Advanced Micro Devices Data Book, Catalog (4 pg.)

2 **"Designing with 1103 Memories"**
(**S1103**)
Discusses 1103 RAM timing requirements, voltage limits and the effects of noise on refresh time.
American Microsystems AP75-9 (5 pg.)

3 **"Dynamic RAMs are Easy and Economical"**
(**S4006**)
Compares 1024 bit dynamic RAMs with static ones. Describes how to apply and to test the S4006.
American Microsystems AP75-8 (14 pg.)

4 **"Testing Dynamic RAMs"**
(S146, **S1103**)
Describes test procedures used for the AMI 1103 series RAMs.
American Microsystems AP75-11 (8 pg.)

5 **"Application of First-In First-Out Memories"**
(Am2812, Am2813, Am2841, 3341)
Describes the function of a first-in first-out memory, methods of constructing FIFO buffers and the operation of the above P-channel MOS devices. Discusses storage and control, expansion methods, interfacing, and applications in an N-bit shift register and as a key encoder on key matrix.
Advanced Micro Devices Data Book, (9 pg.)

6 **"Micro Power Operation of Static RAMs"**
(1212, 1217, 1218, 1220, 1221)
Covers the operation of these NMOS memories in a pulsed power mode with the resultant power savings.
EMM Applications Note APL-N-200 (4 pg.)

7 **"93400 TTL Random Access Memories For High-Speed Applications"**
(7481, 7489)
Summarizes the uses for the 7481/93403 (general purpose); 7489/93407, 93433, and 93435 (highest speed); and 93400 (lower-cost, medium-to high speed). Discusses application in memory systems.
Fairchild Application Note 219 (9 pg.)

8 **"TTL/MSI 9334 8-Bit Addressable Latch"**
(9334)
Describes operation and applications, including 16 and 32-bit addressable latches, 16-word by 4-bit memory, demultiplexer and decoder, 8-bit A/D converter and a 16-bit serial-to parallel converter.
Fairchild Application Note 220 (8 pg.)

RAMs (cont)

9 **"Understanding the FIFO"**
(**3351**) Covers 3351 FIFO operation, cascading, plus use in data rate buffering, parallel operation, and burst operation.
Fairchild APP 332 (8 pg.)

10 **"Designing High Speed, Low Cost Memory Systems with the Intel 2105"**
(2105, 3210, 3211, 3207A)
Describes the 2105 operation, driving and sensing the unit plus power supply, voltage distribution, and decoupling considerations.
Intel Application Note (23 pg.)

11 **"Memory System Design with the Intel 2107B 4K RAM"**
(2107B, 3210, 3225)
Describes the operation and performance of the 2107B and memory systems considerations such as drivers, buffers, timing, layout, decoupling, debugging and power calculations.
Intel Application Note AP-10 (36 pg.)

12 **"Designing Non-Volatile Memory Systems with Intel's 5101 RAM"**
(5101)
Describes internal circuits and operation of the RAM. Outlines circuit techniques for battery supported non-volatile operation. Describes use of the device with the MCS-40 microcomputer.
Intel Application Note AP-12 (28 pg.)

13 **"Which Way for 4K - 16, 18 OR 22 PIN?"**
Describes trade-offs in building 16, 18 and 22 pin 4K RAMs.
Intel Application Brief AP-11 (9 pg.)

14 **"Designing with Intel's Static MOS RAMs"**
(2101, 2102A, 2111, 2112, **5101**)
Outlines internal operation of these static RAMs. Describes how they are used and covers design considerations.
Intel Application Note AP-8 (19 pg.)

15 **"Designing Memory Systems With the Intel 2107A 4K RAM"**
(**2107A**)
Describes the application of this 4096x1 RAM. Includes driving, sensing and power considerations.
Intel Application Note AP4 (16 pg.)

16 **"Design and Application of Intel's 2416 16K Charge Coupled Device"**
(2416)
Describes the internal organization and operation of this 16, 384x1 device. Covers application in memory systems including driver and control circuits as well as use on a megabit storage card.
Intel Application Note AP-14 (39 pg.)

17 **"CMOS RAMs"**
(IM6508, IM6523, IM6524)
Provides a block diagram and describes the operation and interface requirements for these 256x1 and 1024x1 CMOS RAMs.
Intersil Application Bulletin M002 (8 pg.)

Bold face indicates additional data is provided, see the Product Index.

MEMORY—

RAMs (cont)

1 **"12/16K Memory System for the MK5065 Microprocessor"**
See listing under Microprocessors Systems (Mostek)

2 **"Considerations for Designing a High Density, Low Power Memory System"**
(MK4200)
Describes a 16Kx8 memory array using the MK4200 4K RAM and CMOS logic.
Mostek (3 pg.)

3 **"MK4096 Application Information"**
(MK4096)
Describes the MK4096 operation, shows details necessary for system design, describes interface with PDP-11 processor.
Mostek (8 pg.)

4 **"The Design of an N-Channel 16K x 16 Bit Memory System for the PDP-11"**
(MCM6605, MC3450, MC3452, MC3459, MC3460)
Briefly describes operation of the MCM6605 NMOS RAM, the details the design of a PDP-11 add-on mainframe memory using this device. The interface ICs and system performance are also discussed.
Motorola AN-740 (15 pg.)

5 **"Semiconductor for Plated Wire Memories"**
See listing under (Digital) Interface. (Motorola)

6 **"MTTL Designer's Note—The MC4004/MC4005, A 16-Bit Random Access Memory"**
(MC4004, MC4005)
Discusses operation of this memory including typical read-write sequences, plus typical dc and switching characteristics as a function of temperature, power supply, and output load. Also gives examples of high-speed, non-destructive readout memory systems using this 16-bit memory as the basic cell.
Motorola AN-464 (10 pg.)

7 **"A High Speed FIFO Memory Using the MECL MC10143 Register File"**
See listing under (Digital) High Speed Logic (Motorola)

8 **"A Non-volatile Microprocessor Memory Using 4K N-channel MOS RAMs"**
(MCM6605, MC6800)
Describes the design of a 9192-byte non-volatile memory using the MCM6605 4K x 1 RAM and CMOS control logic to reduce the power requirement in the standby mode.
Motorola Application Note AN-732A (17 pg.)

9 **"Using Tri State ™ Logic For 'Rubber Band' Memories"**
Describes the construction and use of scratch/pad memories to store data at a rapid rate and then release it as required. They serve as buffers between systems operating at differenct clock rates.
National Applications Report AN68 (4 pg.)

RAMs (cont)

10 **"MOS Scratch Pad/Content Addressable Memory System"**
Describes a 64-bit Scratch Pad/Content Addressable Memory using MOS devices. Includes circuit diagrams and discusses circuit operations.
National MOS Brief 11 (2 pg.)

11 **"A Method of Implementing Stacks With Existing Minicomputer Memory"**
Gives detailed description of a controller for a stack of programmable size up to 256 words for a 16-bit minicomputer with less than 16 k of memory. Tells how stack size can be increased to 4096 words by adding ten ICs.
National AN-60 (4 pg.)

12 **"Designing Memory Systems Using the MM5262"**
(MM4262, MM5262)
Provides a detailed description of this 2048x1 PMOS dynamic RAM, operating instructions, and a diagram of a 16K x 10 memory using the device.
National AN-144 (14 pg.)

13 **"A Simple Power Saving Technique for the MM5262 2k RAM"**
(MM5262)
Describes method for decoding the clocks of unselected chips in a memory array to save power. Discusses application in 8k x 16 memory.
National MOS Handbook AN-86 (4 pg.)

14 **"Memory Systems Built with the Nortec 6002"**
(6002)
Describes circuits for the bit driver/sense amplifier required to interface the 6002 with TTL. Discusses external support circuit parameters and internal circuit operations that affect system performance.
Nortec Applications Note No. 28 (4 pg.)

15 **"Memory Systems Built with the Nortec 6002"**
(6002)
Describes use of this 1024-bit RAM in building a general purpose memory module with 425,984 bit capacity.
Nortec Applications Note No. 30 (14 pg.)

16 **"Printed Circuit Layout Considerations for Dynamic Memory Arrays"**
Gives P.C. layout guidelines for MOS dynamic memories (also applicable to standard TTL circuits.)
Nortec Applications Note No. 31 (2 pg.)

MEMORY

RAMs (cont)

1 **"Designing Memory Systems with the Nortec 6003 RAM"**
(6003)
Describes operation of this 2048-bit RAM, including a discussion of memory timing, refresh control, array control signals, device output sensing, and array driver circuits.
Nortec Applications Note No. 32 (9 pg.)

2 **"Applications Information for the RCA MW7001ID RAM"**
(MW7001I)
Discusses operation of the RAM's charge pump, input loading and recommended interface circuits.
RCA ICAN-6401 (5 pg.)

3 **"Memory Systems Characteristics and Applications for the CD4061A"**
(CD4061A)
Describes basic device operation, application in memory systems, and testing including construction of an all CMOS memory tester.
RCA ICAN-6445

4 **"1024-Bit Static Memory"**
(2602)
Discusses support circuitry for the 2602 RAM. Also covers power requirements, chip select gating, write operations, waveforms, and the basic memory cell.
Signetics Applications Handbook (4 pg.)

5 **"A High Speed Read-While-Write RAM"**
(N82S21)
Describes operation of the 82S21. Covers use as buffer register in an accumulator section, and in a 32 word by 2 byte memory with byte parity maintained.
Signetics Applications Handbook pg.5-15 (4 pg.)

6 **"256 Bit Bipolar Random Access Storage Applications"**
(N82S06, N82S07)
General discussion of the use of Bipolar memory including peripheral, terminal and main memory applications, memory protection, memory maps and virtual memory. Briefly describes use of 82S06/7 in 256 x 8 and 16394 x 1 memories.
Signetics Applications Handbook (6 pg.)

7 **"Driving the TMS4030 RAM using the SN75363 or SN75322"**
(SN75322, SN7536, TMS4030)
Driving the TMS4030 chip enable clock with these ICs, switching speeds versus system size, general performance characteristics and performance comparisons are provided.
Texas Instruments Application Report CA-181 (7 pg.)

ROMs

8 **"Designing with Intel PROMs and ROMs"**
See listing under PROMs (Intel)

ROMs (cont)

9 **"ROM in Sequential and Combinatorial Logic"**
See listing under PROMs (Monolithic Memories)

10 **"Applications of the 93434 Read Only Memory"**
(93434, 7488)
Describes features of this 32 x 8 memory. Discusses applications in memory systems and use as a decoder, and as a character generator for a 5 x 8 dot matrix.
Fairchild Application Note 168/1 (6 pg.)

11 **"Monolithic Diode Matrices"**
Describes programming and use of diode matrices. Applications: teletypewriter coding matrix, decimal decode for displays, nines complement-BCD, shift register matrices, and ROMs.
Harris Application Note 206 (16 pg.)

12 **"Use of Bipolar ROM And PROMs"**
(6225, 6240, 6260, 6300, 6335)
Describes applications including code converters, emulators, transducer error correctors, submarine identifiers, paper tape interpreters.
Also BCD adders, mutipliers, character generators, binary dividers, vector generators, voice synthesizers, microprogrammed timing generators, and sequence controllers.
Monolithic Memories Application Note 110 (10 pg.)

13 **"MCS2026-002"**
(MCS2026-002)
Describes connections to use this demonstrator version of the 16K (2048x8) dynamic ROM, which can be used as an adder, counter, encoder, decoder or shift register.
MOS Technology Application Note MCS2026-002 (8 pg.)

14 **"Code Conversion With Semiconductor Read Only Memories"**
(MCM4000)
Describes methods for converting data from binary to BCD and vice versa, from the Hollerith to the common 8-bit codes, and from one 8-bit code to another.
Motorola AN-506 (13 pg.)

15 **"Replacing Sequential Logic with ROMs"**
Describes design methods for using ROMs to replace sequential logic, that is to replace designs that would require random or combinational logic with feedback loops.
Motorola Application Note AN-722 (19 pg.)

16 **"Saving ROMs in High-Resolution Dot-Matrix Displays and Printers"**
(MM5232, MM5240, MM5241, DM8596, MM8597)
Describes two-stage, column-generation approach called "intermediate coding" that saves more than 25% of ROM capacity when several ROMs are needed to store a font.
National MOS Handbook AN-85 (8 pg.)

Bold face indicates additional data is provided, see the Product Index.

MEMORY

ROMs (cont)

1 **"The Application of ROMs"**
(MM5203, MM5230, MM5232, MM5240)
Describes applications of read only memories in table look up, code conversion and generation, character generation, random logic generation, and microprogramming.
National AN-61 (12 pg.)

2 **"Custom ROM Programming"**
Gives forms for submitting truth tables for various National read only memories.
National MOS Handbook AN-100 (8 pg.)

3 **"The Systems Approach to Character Generators"**
(MM5240, MM5241)
Discusses use of MM5240 and MM5241 ROMS in character generation. Includes discussion of CRT raster scan displays, refresh memory modulation, control logic, bipolar compatibility, printing applications, and raster scan systems.
National MOS Handbook AN-40 (12 pg.)

4 **"Trig Function Generators"**
Instead of simply cascading ROM to increase resolution and accuracy of the look-up tables, this note describes interpolation techniques to increase trig function accuracy with less memory.
National MOS Handbook, MOS Brief 10 (2 pg.)

5 **"MOS Goes Bipolar"**
See listing under Shift Registers (National)

6 **"Read-Only Memory"**
(2526)
Discusses input and output circuits of the 2526 static 5,184-bit ROM. Covers address dedoding, timing, memory organization, and organization for use as a character generator.
Signetics Appliatiions Handbook (4 pg.)

7 **"Fast Multipliers Using TTL Read Only Memories"**
(SN74182, SN74H183, SN74283, SN74284, SN74285)
Reviews fundamental algorithm of binary multiplication. Shows use of ROMs for multiplication, two's complement multiplication, and truncated multiplications.
Texas Instruments Application Report CA-172 (11 pg.)

Shift Registers

8 **"A Random Pattern Generator for Testing Digital Delay Elements"**
Describes the use of a linear feedback shift register for digital testing.
Advanced Micro Devices Data Book (3 pg.)

9 **"Applications of Dynamic Shift Registers"**
(1402A, 1403A, 1404A, 1405A, Am2802, Am2803, Am2804, Am2805, Am2806, Am2807, Am2808)
Discusses dynamic shift register storage in general, clock timing, circuits for clock drivers, interfacing with TTL, and recirculating registers.
Advanced Micro Devices Data Book, (7 pg.)

Shift Registers (cont)

10 **"Schottky TTL MSI Registers"**
(AM25S07, AM25S08, AM25S09, SN54S174, SN54S175, SN54S194, SN54S195, SN74S174, SN74S175, SN74S194, SN74S195)
Describes these 4 and 6-bit registers, their operation and applications. Contains logic diagrams and function tables. Applications covered include: longer words, use with dynamic shift registers, selective bus storage, use as a LIFO memory, psuedo random feedback, unique counting codes, permutation of inputs, and use in arithmetic.
Advanced Micro Devices Application Note (16 pg.)

11 **"The MSI 9328 Dual 8-Bit Shift Register"**
(9328)
Describes operation of this device and discusses applications, including variable-length shift registers, serial memories, counters.
Fairchild Application Note 182 (7 pg.)

12 **"9338 Eight-Bit Multiple Port Register"**
(9338)
Describes the features of this device, the TTL/MSI equivalent andparallel serial expansion capabilities. Covers use as three address arithmetic unit with eight registers, and use in a first-in first-out memory.
Fairchild Application Note 294 (6 pg.)

13 **"Design and Application of Intel's 2416 16K Charge Coupled Device"**
See listing under RAMs (Intel)

14 **"Using Shift Registers as Pulse Delay Networks"**
See listing under (Digital) High Speed Logic (Motorola)

15 **"The MC7491A Eight-Bit Serial Shift Register and the MC7495 Four-Bit Shift Register"**
(MC5491A, MC5495, MC7491A, MC7495)
Describes operation of these devices and discusses application as shift counters, delay lines, buffers, serial-parallel converters, parallel-serial converters, ring counters, and parallel arithmetic units. Also describes use in a teletypewriter-computer interface system.
Motorola AN-530A (9 pg.)

16 **"The MC4012, An MTTL 4-Bit Shift Register"**
(MC4012)
Discusses circuit operation and applications, including serial to parallel conversion, divide-by-N counting, programmable frequency division, and programmable burst generation.
Motorola AN-505 (11 pg.)

17 **"The Logical Design of Shift Counters"**
See listing under (Digital) Counters. (Motorola)

MEMORY, MICROPROCESSORS

Shift Registers (cont)

1 **"Programmable Divider Applications"**
(DM7520, DM8520)
Describes basic operation of DM7520/DM8520 divider. Covers optimum speed operation, programming, operating mode connections, applications as a speed controller for a two phase synchronous motor, and as a pseudo-random bit generator.
National AN-17 (8 pg.)

2 **"New MOS Clock Driver For MOS Shift Register"**
(MH0007)
Describes NH0007 circuit, turn-on characteristics, turn-off speed, power dissipation, and discusses application as a two-phase MOS clock system.
National AN-18 (8 pg.)

3 **"Low Power MOS Clock-Modulated Memory Systems"**
(MM400, MM402, MM406, MM451, MM482)
Presents several memory techniques to save power. Tabulates and compares methods for relative power utilization.
National AN-19 (7 pg.)

4 **"Design Considerations of MOS Dynamic Shift Registers With Tri-State Outputs"**
(MM4012, MM4013, MM5012, MM5013)
Describes operation of MOS shift registers with Tri-State push-pull outputs. Includes discussion of the dynamic characteristics and maximum clock frequency.
National AN-65 (4 pg.)

5 **"MOS Analog Function Generator"**
Describes the use of shift registers as delay lines. Shows methods to increase the clock rates and describes treating a long loop as several short ones to improve access.
National MOS Brief 4 (2 pg.)

6 **"MOS Delay Lines"**
(MM506)
Describes the characteristics of static and dynamic shift registers used in delay line. Discusses application as series/parallel delay lines and as substitutes for magnetic drum memories. Also covers specialized clocking techniques, such as two-speed clocking.
National AN-25 (8 pg.)

7 **"Low Frequency Operation With Dynamic Shift Registers"**
Discusses operation of two forms of dynamic shift registers: ratioless and ratio. Recommends techniques, such as keeping clock amplitudes high, to design added margin into systems. Discusses temperature considerations, packaging.
National MOS Handbook AN-55 (4 pg.)

8 **"Mask Programming Specializes MOS Shift Register Designs"**
(MM4007, MM4019, MM5007, MM5019)
Describes customizing MOS shift register bit lengths by programming a metalization mask used to manufacture these devices. Dual registers from 20 to 256 bits, and single registers from 40 to 512 bits are available. Describes single register tapped output options.
National MOS Handbook, MOS Brief 14 (2 pg.)

Shift Registers (cont)

9 **"Double-Clocking Cuts Standard Registers to Non-Standard Sizes"**
Describes a method of double-clocking for N data input periods to make the register appear shortened by N bits. When this is achieved, the clock rate resumes normal frequency.
National MOS Handbook, MOS Brief 16 (2 pg.)

10 **"MOS Goes Bipolar"**
Shows what voltages are required to combine MOS Shift Registers and Read Only Memories with bipolar devices. Presents interface diagrams.
National MOS Brief 12 (2 pg.)

11 **"Static Shift Register Operating Curves"**
How to use the minimum/maximum clock pulse width operating curves included in National's static shift register data sheets.
National MOS Brief 15 (2 pg.)

12 **"High Voltage Shift Registers Move Displays"**
(MM5081)
Describes use of the MM5081 high voltage shift register for driving gas discharge or lamp displays, ie. moving messages or moving graphics.
National AN-44 (14 PG.)

13 **"COS/MOS MSI Counter and Register Design and Applications"**
See listing under (Digital) CMOS (RCA)

14 **"Shift Registers and I/O Buffer Registers"**
(N8200, N8201, N8202, N8203, N8270, N8271, N8275, N8276, S8200, S8201, S8202, S8203, S8270, S8271, S8275, S8276)
Discussion of devices and applications, including ring counter, variable 4-bit modulo N counter, error correcting code generator, and bi-directional shift register.
Signetics Applications Handbook (16 pg.)

15 **"HiNIL 375 Universal Shift Register"**
See listing under (Digital) HNIL/HTL (Teledyne Semiconductor)

16 **"8-Bit Position Scaler"**
See listing under (Digital) Scaler. (Signetics)

MICROPROCESSORS

Applications

17 **"Disc Controller Design Uses New Bipolar Microcomputer LSI Components"**
(3000)
Describes the design of a 2310/5440 moving head disk controller using the 3000 series bipolar microprocessor devices. Detailed diagram.
Intel Application Note AP-7 (10 pg.)

18 **"M6800 Microprocessor Application Manual"**
(M6800)
Describes the use of the 6800 family of parts. Gives details of practical applications including the development of hardware and software, design of a point of sale terminal and interfaces to peripherals.
Motorola $25.00 (716 pg.)

Bold face indicates additional data is provided, see the Product Index.

MICROPROCESSORS

Applications (cont)

1 **"Data Handling with the IMP-8"**
(IMP-8, IMP-16)
Covers basic concepts for transferring data from a memory to peripherals.
National AN-117 (4 pg.)

2 **"Microprocessor Mates with MOS/LSI Keyboard Encoder"**
(IMP-16)
Shows how to interface a keyboard to the IMP-16 microprocessor for text editing.
National AN-128 (6 pg.)

3 **"The IMP-16 in Communication Applications**
(IMP-16)
Discusses communication processor functions, requirements for communications microprocessors and system considerations. Gives programming examples including status monitoring, data transmission, message routing, interrupt handling and error control.
National AN-134 (6 pg.)

4 **"The IMP-8C as a Data Concentrator"**
(IMP-8C)
Describes the use of this microprocessor in data concentrator applications. Covers use with a full duplex modem, and the terminal controller interface.
National AN-113 (6 pg.)

5 **"Multiple Microprocessors in Instrument Systems"**
(IMP-8, IMP-16)
Discusses systems built with central microcomputers plus peripheral microprocessors to distribute intelligence. Illustrates concepts with a data acquisition and setpoint control system.
National AN-106 (8 pg.)

General

6 **"A Non-volatile Microprocessor Memory Using 4K N-channel MOS RAMs"**
See listing under (Memory) RAMs (Motorola)

7 **"Microprocessors - An Introduction"**
Shows system components, defines terms and describes operation of an elementary computer system.
National AN-114 (4 pg.)

8 **"Timesharing Users Manual"**
(IMP-8, IMP-16)
Gives user information to assemble IMP-8 or IMP-16 programs using Tymshare, Inc. services, or IMP-16 programs using the General Electric Computer Timesharing facility.
National (35 pg.)

9 **"Microprocessors—Why They Evolved and What They Are"**
Offers background material and describes common microprocessor terms.
National Imp Brief 1 (2 pg.)

General (cont)

10 **"An Introduction to Microprocessors and RCA COSMAC COS/MOS Microprocessor"**
(CDP1800)
Gives a general description of microprocessor operation with some specific description of the COSMAC (CDP1800)
RCA ICAN-6416 (8 pg.)

Program Control

11 **"IMP-16 Interrupts"**
(IMP-16)
Describes various type of interrupts, including and overview of interrupt structure, example of interrupt request and service, multilevel and control panel interrupts.
National AN-107 (23 pg.)

12 **"IMP-8 Utilities Reference Manual"**
(IMP-8)
Provides information on the IMP-8 debugging program, loader programs, the standard teletype and I/O package, and the paper tape-punch package.
National (57 pg.)

13 **"Increasing the Number of Control Flags and Jump Conditions in the IMP-16C"**
(IMP-16C)
Describes simple and economical method of increasing the number of testable jump conditions and the number of control flags on the IMP-16C microprocessor.
National AN-101 (4 pg.)

Programming

14 **"S6800 Software Data Book"**
(S6800)
Description of instruction set.
American Microsystems (15 pg.)

15 **"S6800 Assembly Language Programming Manual"**
(S6800)
Extensive material on programming and use of the instruction set.
American Microsystems $15.00 (244 pg.)

16 **"Intellec 8/Mod 80 Microcomputer Development System Reference Manual"**
(8080)
Discusses the design concepts and the use of the components of this system which can simplify the development of systems using the 8080 microprocessor.
Intel. Available with system. (152 pg.)

17 **"Intellec 8/Mod 8 Microcomputer System Operator's Manual"**
(8008)
Describes how to operate and run programs on the INTELLEC 8 computer, which is a system development tool for 8008 microcomputer users.
Intel. Available with system. (145 pg.)

18 **"Interp/80 User's Manual"**
(8080)
Describes the use of a FORTRAN IV program called INTERP/80. The program provides software simulation of the 8080 CPU along with execution monitoring commands to aid program development for the MCS-80.
Intel $2.00 (32 pg.)

MICROPROCESSORS

Programming (cont)

1 **"Series 3000 Cross Microprogramming System CROMIS Reference Specification"**
(3000)
Describes the CROMIS microprogramming system for the 3000 series computing elements. It supports the user who wants to generate microcode.
Intel $5.00 (77 pg.)

2 **"8008 and 8080 PL/M Programming Manual"**
(8008, **8080)**
Tutorial introduction to PL/M language as it applies to these processors.
Intel. Price not available (70 pg.)

3 **"8080 Assembly Language Programming Manual"**
(8080)
Discusses the assembly language format and tells how to write assembly language programs for the 8080 microprocessor.
Intel $5.00 (85 pg.)

4 **"8008 PL/M Compiler Operators Manual"**
(8008)
Describes operation of the 8008 PL/M cross compiler.
Intel. Price not available (42 pg.)

5 **"8080 PL/M Compiler Operators Manual"**
(8080)
Discusses the two distinct programs that must be executed consecutively to perform a compilation of a PL/M source program.
Intel. Price not available (45 pg.)

6 **"IM6100 CMOS Microprocessor Basic 4K Software"**
(IM6100)
Describes use of the Digital Equipment Corp. PDP-8 software.
Intersil Application Bulletin M003 (7 pg.)

7 **"F8 Programmer's Guide"**
(F8)
Describes how to write programs for the F8 microprocessor system which cause the system to function as a discrete logic element.
Mostek $5.95 (304 pg.)

8 **"ROM Based Subroutine Calls with the IM6100"**
(IM6100)
Describes two methods for returning to the proper program location after executing a subroutine.
Intersil Application Bulletin M008 (6 pg.)

9 **"M6800 Evaluation Module Users Guide"**
(M6800)
Provides general information, installation instructions, preparation and operating procedures for the M6800 evaluation module.
Motorola $5.00 (150 pg.)

10 **"A Microprogram Development System"**
(IMP-16)
Describes the application of microprogramming to LSI processors and the advantages of a microprogram development system for hardware and software.
National AN-123 (6 pg.)

Programming (cont)

11 **"IMP-4 Programming Techniques"**
Discusses subtle considerations for programming the IMP-4 including subroutines, using the address register, decimal add and multi-precision arithmetic.
National AN-136 (6 pg.)

12 **"IMP-8 Assembler Manual"**
(IMP-8)
Presents preliminary information on the use of IMP-8 assembler language.
National (60 pg.)

13 **"IMP-8 Programming Manual"**
(IMP-8)
Provides information for the programming of the IMP-8 family of microprocessors and microcomputers.
National (111 pg.)

14 **"IMP-16 Assembler Program Description Manual"**
(IMP-16)
Describes the internal structure of the IMP-16 Assembler. It covers the general organization, functions required for conversion to operate on a different machine, and a detailed subroutine and data description.
National (105 pg.)

15 **"IMP-16 Microsymbolic Assembler"**
(IMP-16)
The microsymbolic assembler is a collection of routines that make it possible to write microprograms for the IMP-16 in symbolic language. This manual describes the statements, character set and basic programming elements.
National (21 pg.)

16 **"Installation of IMP-16 Assembler on System 360/370 Operator Manual"**
(IMP-16)
Provides information for installing the IMP-16 assembler and punch programs on an IBM 360/370 computer.
National (18 pg.)

17 **"Program Development Guide for the COSMAC Microprocessor"**
(COSMAC)
This manual reviews the system architecture, describes two levels of COSMAC assembly language and describes the COSMAC software development package.
RCA MPM-102 $10.00 (97 pg.)

18 **"IMP-16 Programming Techniques"**
(IMP-16)
Discusses several aspects of the instruction set to enable programmer to code more efficiently. Includes discussion of subroutines, subroute parameter passing, recursive subroutines, as well as sample programs.
National AN-111 (6 pg.)

Systems

19 **"S6800 Microprocessor Hardware Book"**
(S6800)
Provides System description and data sheets.
American Microsystems (72 pg.)

Bold face indicates additional data is provided, see the Product Index.

MICROPROCESSORS—

Systems (cont)

1 **"S6800 Hardware Reference Manual"**
(S6800)
Detailed descriptions of the system operation.
American Microsystems $15.00 (225 pg.)

2 **"F8 Microprocessor Application Manual"**
(F8)
Covers details concerning bit manipulation, RAM expansion, extension of the I/O ports, subroutines and boot strap loaders.
Fairchild Semiconductor

3 **"Central Processor Designs Using the Intel Series 3000 Computing Elements"**
(3000)
Gives a systematic procedure for designing central processors using the series 3000 devices. (Microprogram control unit and central processing element.)
Intel Application Note AP-13 (57 pg.)

4 **"Intellec 8/Mod 80 Operators Manual"**
(Intellec 8)
Describes how to operate and run programs on the Intellec 8 computer, a design development tool 8080 microcomputer users.
Intel (available with system) (143 pg.)

5 **"M6800 System Reference and Data Sheet Handbook"**
Describes the family of parts including data sheets.
Motorola. (68 pg.)

6 **"Static Memory Systems for the IM6100"**
(IM6100)
Describes CMOS, nonvolatile CMOS and NMOS memory systems for the IM6100.
Intersil Application Bulletin M004 (14 pg.)

7 **"Teletype Interface for the IM6100 CMOS Microprocessor"**
(IM6100)
Describes a teletype interface using the IM6100 and a UART.
Intersil Application Bulletin M005 (10 pg.)

8 **"IM6100 Operator Console"**
(IM6100)
Describes the 6900-CONTRL console for the prototyping system.
Intersil Application Bulletin M006 (17 pg.)

9 **"IM6100 CMOS Mciroprocessor Memory Extension"**
(IM6100)
Discusses a memory extension controller to increase the memory from 4096 to 32,768 words.
Intersil Application Bulletin M007 (6 pg.)

10 **"12/12K Memory System for the MK5065 Microprocessor"**
(MK4096, MK5065)
Describes a complete 12Kx8 or 16Kx8 memory system for use with the MK5065 microprocessor.
Mostek (6 pg.)

Systems (cont)

11 **"F8 Preliminary Data Book"**
(F8)
Describes the timing, signal sequences, and chip interactions as well as provides detailed system information.
Mostek (125 pg.)

12 **"Device Operation and System Implementation of the Asynchronous Communications Interface Adapter (MC6850)"**
See listing uncer Digital-Data Transmission (Motorola)

13 **"GCP/P Product Description"**
(GCP/P)
Delineates the system, gives a functional description of the CROM and RALU devices, and presents the general purpose macroinstruction set. Appendices cover a microprogram to implement the IMP-16 instructionssetaandttheuuseoofttheRALUstatus flag.
National (61 pg.)

14 **"IMP-4 Technical Description"**
(IMP-4)
Describes the general purpose instruction set, gives functional and system descriptions, describes the development system and shows specific programming examples.
National (77 pg.)

15 **"Designing with the IMP Chip Set"**
(IMP-16)
Describes some of the major considerations in the implementation of 4 to 32 bit systems using the IMP series of devices. A 16 bit system is covered in detail.
National AN-141 (10 pg.)

16 **"IMP-4A Base Memory Architecture"**
(IMP-4A)
Describes a memory that taxes the capabilities of the IMP-4A microprocessor system.
National AN-137 (4 pg.)

17 **"IMP-8C Application Manual"**
(IMP-8)
Describes the IMP-8C's operational features, functional and logic operation, and input/output interfacing in sufficient detail to permit the user to adapt the card to various applications.
National (119 pg.)

18 **"IMP-8C/200 Microprocessor, IMP-8P Microcomputer Product Description"**
(IMP-8)
Describes the IMP-8C microprocessor card and the IMP-8P prototyping tool (microcomputer) as systems.
National (10 pg.)

19 **"IMP-16C Peripheral Interfacing Simplified"**
(IMP-16C)
Explores techniques for interfacing peripheral devices to the microprocessor.
National AN-124 (4 pg.)

MICROPROCESSORS

Systems (cont)

1 **"IMP-16L Product Description"**
Describes the features of the IMP-16L general microcomputer system.
National (8 pg.)

2 **"PACE Technical Description"**
(PACE)
Defines and explains how to use the hardware and software items that support the PACE system.
National (96 pg.)

3 **"Applications of LSI Processors"**
(IMP-16)
Describes system architecture and operation of IMP-16C, 16-bit parallel processor with self-contained memory. Describes applications in a data communication link analyzer, in point-of-sales and in retailing systems.
National AN-98 (8 pg.)

4 **"POWR I/O CROM Technical Description"**
(IMP-16)
Describes the instruction repertoire and use of this unit which expands the variety of memory and input/output operations of the IMP-16.
National (22 pg.)

5 **"Using a Microprocessor Beyond Apparant Speed"**
(IMP-16)
Covers the concept of cycle stealing, a technique in which a peripheral device communicates directly with memory or another peripheral device while the CPU is doing work other than using the data and address buses.
National AN-142 (6 pg.)

6 **"User Manual for the COSMAC Microprocessor"**
(COSMAC)
Describes the COSMAC microprocessor architecture and its instructions with examples of each instruction. Illustrates methods of adding external memory and describes machine coding techniques.
RCA MPM-101 $5.00 (65 pg.)

Timing

7 **"Clock-Hold Schemes For the IMP Microprocessor Family"**
(IMP-8C, IMP-16C)
Presents scheme to extend the clock-hold function for additional periods of the main system clock, using the DM8570 shift register.
National AN-105 (4 pg.)

Bold face indicates additional data is provided on the page noted.

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ABBREVIATIONS OF COMPANY NAMES

AD	Analog Devices
AMD	Advanced Micro Devices
AMI	American Microsystems, Inc.
AMS	Advanced Memory Systems
Analogic	Analogic Corp.
Beckman	Beckman Instruments, Helipot Division
Burr-Brown	Burr-Brown Research
Cermetek	Cermetek
CMA	Consumer Microcircuits of America
Collins	Collins Radio
Datel	Datel Systems
DDC	ILC Data Devices Corp.
EA	Electronic Arrays
EMM/Semi	EMM Semi, Div. of Electronic Memories & Magnetics
Exar	Exar Integrated Systems
Fairchild	Fairchild Semiconductor
Ferranti	Ferranti Electric
GI	General Instrument
Harris	Harris Semiconductor
Hitachi	Hitachi America, Ltd.
Hughes	Hughes Aircraft Co., MOS Divison
Hybrid Sys.	Hybrid Systems
IMI	International Microcircuits, Inc.
Intech	Intech
Intel	Intel
Interdesign	Interdesign
Intersil	Intersil
IPI	Integrated Photomatrix, Inc.
ITT	ITT Semiconductors
Lithic Sys.	Lithic Systems
Litronix	Litronix
LSI Comp.	LSI Computer Systems
Micro Net	Micro Networks
Micropac	Micropac Industries
Micro Power	Micro Power Systems
Mitsubishi	Mitsubishi International
MMI	Monolithic Memories, Inc.
MOS	MOS Technology
Mostek	Mostek
Motorola	Motorola Semiconductor
National	National Semiconductor
NCR	National Cash Register, Microelectronics Div.
NEC	NEC Microcomputers
Nippon	Nippon Electric Co.
Nitron	Nitron
Nortec	Nortec Electronics
NPC	Nucleonic Products Co.
OKI	OKI Electronics of America, Inc.
Panasonic	Panasonic, Matsushita Electric Corp.
Plessey	Plessey Semiconductors
PMC	Power Monolithics Co.
PMI	Precision Monolithics, Inc.
Ragen	Ragen Semiconductor
Raytheon	Raytheon Semiconductor
RCA	RCA Solid State Division
Reticon	Reticon
Rockwell	Rockwell International, Microelectronic Div.
Sanken	Sanken Electric
SGS	SGS-ATES Semiconductor
Signetics	Signetics
Silicon G	Silicon General
Siliconix	Siliconix
SMC	SMC Microsystems Corp.
Solitron	Solitron Devices
Sprague	Sprague Electric Company
SSS	Solid State Scientific
SW	Stewart-Warner Microcircuits
Synertek	Synertek
Teledyne C	Teledyne Crystalonics
Teledyne P	Teledyne Philbrick
Teledyne S	Teledyne Semiconductor
TI	Texas Instruments
TMX	TMX, Inc.
Toshiba	Toshiba
TRW	TRW
Transitron	Transitron Electronics
Western	Western Digital

MILITARY PARTS DIRECTORY

This section is divided into three parts: a table of those manufacturers willing to perform MIL-STD-883 screening, a two way military to commercial cross reference index, and the Qualified Parts List broken down into functions. It not only shows what devices are on the list and which manufacturers supply them, but also it decodes the military numbers into familiar terms.

how to use the military parts directory

The next page contains a table showing the manufacturers who have advised that they want to screen devices to MIL-STD-883 and/or perform other environmental screening. The table also indicates which companies are currently qualified to supply one or more devices on the QPL list. Such achievement is apt to indicate that these companies are well equipped to perform 883 testing. The following page provides convenient cross references between M38510 numbers and their commercial equivalents; all these devices are listed in the latest QPL.

The heart of this section is the functional QPL parts list. It is based on the latest Defense Electronics Supply Center Qualified Products List (QPL-38510-XX) at the time of publication. The revision and date of this list are indicated at the bottom of each page. Like the Master Selection Guide, the devices are classified my major functions; within each function the devices are arranged in alphanumeric order, which automatically groups CMOS together, 5400 Series together, etc.

A complete military part number includes a three letter suffix signifying the device class and packaging. The definitions of these letters are given in the Part Number Guide under "JAN Nomenclature." All the devices listed here meet class B and C requirements, a few devices (CMOS) meet class A specifications. The package styles and lead finishes that each manufacturer is qualified to supply can be determined by consulting the official QPL or by contacting the individual manufacturers. Once you have found the names of the companies you need to contact, you can reach them by using the information in the Manufacturers and Distributors Directory.

MANUFACTURER	MIL-M-38510 QPL				MIL-STD-883 SCREENING			OTHER SCREENING	
	Linear	TTL	Other Bipolar	CMOS	Class A	Class B	Class C	Military	Industrial
Advanced Memory Systems						X	X	X	X
Advanced Micro Devices	X	X			X	X	X	X	X
American Microsystems, Inc.						X	X	X	X
Analog Devices						X	X		
Beckman Instruments					X	X	X	X	X
Burr-Brown Research						X	X	X	X
Collins Radio					X	X	X	X	X
Electronic Arrays						X	X	X	X
EMM/Semi					X	X	X	X	X
Exar Integrated Systems					X	X	X	X	X
Fairchild Semiconductor	X	X	DTL		X	X	X	X	X
General Instrument						X	X		X
Harris Semiconductor			PROM		X	X	X	X	X
Hybrid Systems					X	X	X	X	X
Intel						X	X	X	X
International Microcircuits								X	X
Intersil					X	X	X	X	X
ITT Semiconductor		X	DTL		X	X	X	X	X
Micro Networks						X	X	X	X
Micropac					X	X	X		
Monolithic Memories					X	X	X	X	X
Motorola Semiconductor	X	X			X	X	X	X	X
National Semiconductor	X	X		X	X	X	X	X	X
NEC Microcomputers						X	X		
Nitron						X	X	X	X
Nortec						X	X	X	X
Plessey Semiconductor					X	X	X		
Precision Monolithics					X	X	X	X	X
Ragen Semiconductor					X	X	X	X	X
Raytheon Semiconductor					X	X	X	X	X
RCA Solid State				X	X	X	X	X	X
Signetics		X			X	X	X	X	X
Silicon General					X	X	X	X	X
Siliconix					X	X	X	X	X
Solid State Scientific						X	X	X	X
Sprague Electric						X	X		
Teledyne Philbrick					X	X	X	X	X
Teledyne Semiconductor						X	X	X	X
Texas Instruments	X	X			X	X	X	X	X
Transitron					X	X	X	X	X

Explanation:

The "MIL-M-38510" section indicates the IC manufacturers currently providing Q.P.L. ICs. More detailed information on the specific devices is given in the Qualified Products lists which follow.

The "MIL-STD-883 Screening" section lists those manufacturers who are both set up and actively want to screen devices to the levels indicated.

"Other Screening" shows those who report that they want business calling for special military and industrial environment screening procedures.

Based on QPL-38510-21, 29 October 1975.

Cross Reference Military to Commercial

Device	M38510/
HPROM0512	20101
101A	10103
108A	10104
4000	05201
4001	05202
4002	05203
4006	05701
4007	05301
4009	05501
4010	05502
4011	05001
4012	05002
4013	05101
4014	05702
4015	05703
4017	05601
4018	05602
4019	05302
4020	05603
4021	05704
4022	05604
4023	05003
4024	05605
4025	05204
4027	05102
4031	05705
4049	05503
4050	05504
54H00	02304
54H01	02306
54H04	02305
54H10	02303
54H101	02205
54H103	02206
54H20	02302
54H22	02307
54H30	02301
54H40	02401
54H50	04001
54H51	04002
54H53	04003
54H54	04004
54H55	04005
54H72	02201
54H73	02202
54H74	02203
54H76	02204
54L00	02004
54L02	02701
54L03	02006
54L04	02005
54L10	02003
54L20	02002
54L30	02001
54L71	02101
54L72	02102
54L73	02103
54L74	02105
54L78	02104
54S00	07001
5400	00104
5401	00107
5402	00401
5403	00109
5404	00105
5405	00108
5406	00801
5407	00803
5408	01601
5409	01602
5410	00103
54107	00203
5412	00106
54121	01201
54122	01202
54123	01203
54145	01005
54150	01401
54153	01403

Device	M38510/
5416	00802
54160	01303
54161	01306
54162	01305
54163	01304
54164	00903
5417	00804
54174	01701
54175	01702
54180	01901
54181	01101
54182	01102
54194	00905
54195	00906
5420	00102
5423	00402
5425	00403
5426	00805
5427	00404
5430	00101
5437	00302
5438	00303
5440	00301
5442	01001
5443	01002
5444	01003
5445	01004
5446	01006
5447	01007
5448	01008
5449	01009
5450	00501
5451	00502
5453	00503
5454	00504
5470	00206
5472	00201
5473	00202
5474	00205
5475	01501
5476	00204
5477	01502
5479	00207
5482	00601
5483	00602
5485	15001
5486	00701
5490	01307
5492	01301
5493	01302
5495	00901
5496	00902
55107	10401
55108	10402
55113	10405
55114	10403
55115	10404
710	10301
723	10201
741	10101
747	10102
930	03001
9304	00603
9309	01404
9312	01402
9322	01405
935	03002
936	03003
946	03004
962	03005

Cross Reference Commercial to Military

Device	M38510/
00101	5430
00102	5420
00103	5410
00104	5400
00105	5404
00106	5412
00107	5401
00108	5405
00109	5403
00201	5472
00202	5473
00203	54107
00204	5476
00205	5474
00206	5470
00207	5479
00301	5440
00302	5437
00303	5438
00401	5402
00402	5423
00403	5425
00404	5427
00501	5450
00502	5451
00503	5453
00504	5454
00601	5482
00602	5483
00603	9304
00701	5486
00801	5406
00802	5416
00803	5407
00804	5417
00805	5426
00901	5495
00902	5496
00903	54164
00905	54149
00906	54195
01001	5442
01002	5443
01003	5444
01004	5445
01005	54145
01006	5446
01007	5447
01008	5448
01009	5449
01101	54181
01102	54182
01201	54121
01202	54122
01203	54123
01301	5492
01302	5493
01303	54160
01304	54163
01305	54162
01306	54161
01307	5490
01401	54150
01402	9312
01403	54153
01404	9309
01405	9322
01501	5475
01502	5477
01601	5408
01602	5409
01701	54174
01702	54175
01901	54180
02001	54L30
02002	54L20
02003	54L10
02004	54L00
02005	54L04
02006	54L03
02101	54L71

Device	M38510/
02102	54L72
02103	54L73
02104	54L78
02105	54L74
02201	54H72
02202	54H73
02203	54H74
02204	54H76
02205	54H101
02206	54H103
02301	54H30
02302	54H20
02303	54H10
02304	54H00
02305	54H04
02306	54H01
02307	54H22
02401	54H40
02701	54L02
03001	930
03002	935
03003	936
03004	946
03005	962
04001	54H50
04002	54H51
04003	54H53
04004	54H54
04005	54H55
05001	4011
05002	4012
05003	4023
05101	4013
05102	4027
05201	4000
05202	4001
05203	4002
05204	4025
05301	4007
05302	4019
05501	4009
05502	4010
05503	4049
05504	4050
05601	4017
05602	4018
05603	4020
05604	4022
05605	4024
05701	4006
05702	4014
05703	4015
05704	4021
05705	4031
07001	54S00
10101	741
10102	747
10103	101A
10104	108A
10201	723
10301	710
10401	55107
10402	55108
10403	55114
10404	55115
10405	55113
15001	5485
20101	HPROM0512

Based on QPL-38510-21, 29 October 1975.

DIGITAL

Arithmetic Functions

Device	M38510/	Description	Source
9304	00603	Dual Full Adder	Motorola
5482	00601	2-Bit Binary Full Adder	ITT, Motorola
5483	00602	4-Bit Binary Full Adder (Look-Ahead Carry)	ITT, Signetics, TI
5485	15001	4-Bit Magnitude Comparator	Signetics
54181	01101	High-Speed Arithmetic Logic	AMD, Motorola, TI
54182	01102	Look-Ahead Carry Generator	Signetics

Buffers, Inverters

Device	M38510/	Description	Source
935	03002	Hex Inverter	ITT
936	03003	Hex Inverter	ITT
4007	05301	Dual Complementary Pair plus Inverter	RCA
4009	05501	Hex Buffer/Converter, Inverting	RCA
4010	05502	Hex Buffer/Converter, Non-Inverting	National, RCA
4049	05503	Hex Buffer/Converter, Inverting	National, RCA
4050	05504	Hex Buffer/Converter, Non-Inverting	RCA
5404	00105	Hex Inverter	Fairchild, ITT, Motorola, National, Signetics, TI
5405	00108	Hex Inverter with Open Collector Output	Fairchild, ITT, Motorola, National, Signetics, TI
5437	00302	Quadruple 2-Input NAND Buffer	ITT, Motorola, Signetics, TI
5438	00303	Quadruple 2-Input NAND Buffer with Open Collector Outputs	Fairchild, Motorola, Signetics, TI
5440	00301	Dual 4-Input NAND Buffer	Fairchild, ITT, Motorola, Signetics, TI
54H04	02305	Hex Inverter	Fairchild, Motorola, Signetics, TI
54H40	02401	Dual 4-Input NAND Buffer	Motorola, Signetics, TI

Counters

Device	M38510/	Description	Source
54L04	02005	Hex Inverter	National
4017	05601	Decade Counter/Divider, Decoded Output	RCA
4018	05602	Presettable Divide-by-N Counter	RCA
4020	05603	14-Bit Binary Counter	RCA
4022	05604	Divide-by-8 Counter/divider, Decoded Output	RCA
4024	05605	7-Bit Binary Counter	RCA
5490	01307	Decade Counter, Ripple	ITT, Motorola, Signetics
5492	01301	Divide-By-Twelve Counter (Divide-By-Two and Divide-By-Six)	ITT, Motorola
5493	01302	4-Bit Binary Counter	ITT, Motorola, Signetics
54160	01303	Synchronous Decade Counter	Signetics
54161	01306	Synchronous 4-Bit Binary Counter	Signetics
54162	01305	Fully Synchronous Decade Counter	Signetics
54163	01304	Fully Synchronous 4-Bit Binary Counter	Signetics

Decoders

Device	M38510/	Description	Source
5442	01001	BCD-To-Decimal Decoder	ITT, Motorola, Signetics
5443	01002	Excess 3-To-Decimal Decoder	Motorola, Signetics
5444	01003	Excess 3-Gray-To-Decimal Decoder	Motorola, Signetics
5446	01006	BCD to Seven Segment Decoder/Driver	Signetics, TI
5447	01007	BCD to Seven Segment Decoder/Driver	Signetics
5448	01008	BCD to Seven Segment Decoder/Driver with 30 V Output	Motorola

Drivers

Device	M38510/	Description	Source
5406	00801	Hex Inverter Buffer/Driver with Open Collector High Voltage Output	Fairchild, ITT, Motorola, TI
5407	00803	Hex Buffer/Driver with Open Collector High Voltage Output	Fairchild, ITT, Motorola, TI
5416	00802	Hex Inverter Buffer/Driver with Open Collector High Voltage Output	Fairchild, ITT, Motorola, TI

Drivers (cont)

Device	M38510/	Description	Source
5417	00804	Hex Buffer/Driver with Open Collector High Voltage Output	Fairchild, ITT, Motorola, TI

Flip-Flops

Device	M38510/	Description	Source
4013	05101	Dual "D" Flip-Flop with Set/Reset	National, RCA
4027	05102	Dual J-K Master-Slave Flip-Flop	RCA
5470	00206	Positive Edge-Triggered J-K Flip-Flop	Fairchild, ITT, Motorola, Signetics, TI
5472	00201	J-K Master Slave Flip-Flop (AND Inputs)	ITT, Motorola, National, Signetics, TI
5473	00202	Dual J-K Master Slave Flip-Flop	ITT, Motorola, National, Signetics, TI
5474	00205	Dual D-Type Edge-Triggered Flip-Flop	Fairchild, ITT, National, Signetics, TI
5476	00204	Dual J-K Master Slave Flip-Flop with Preset and Clear	ITT, National, Signetics, TI
5479	00207	Dual D-Type Flip-Flop	Motorola
54107	00203	Dual J-K Master Slave Flip-Flop	Motorola, National, Signetics, TI
54174	01701	Hex D-Type Flip-Flop	Signetics
54175	01702	Quad D-Type Flip-Flop	Signetics
54H72	02201	J-K Master-Slave Flip-Flop (AND Inputs)	Motorola, Signetics
54H73	02202	Dual J-K Master-Slave Flip-Flop	Signetics, Motorola
54H74	02203	Dual D-Type Edge-Triggered Flip-Flop	Signetics
54H76	02204	Dual J-K Flip-Flop	TI
54H101	02205	J-K Negative Edge-Triggered Flip-Flop (AND-OR Inputs)	Motorola, Signetics
54H103	02206	Dual J-K Negative Edge Triggered Flip-Flop	Motorola, Signetics
54L71	02101	J-K Master-Slave Flip-Flop (AND-OR Inputs)	National
54L72	02102	J-K Master-Slave Flip Flop (AND Inputs)	National
54L73	02103	Dual J-K Master-Slave Flip-Flop	National
54L74	02105	Dual D-Type Edge-Triggered Flip-Flop	National
54L78	02104	Dual J-K Master-Slave Flip-Flop	National

Based on QPL-38510-18, 29 October 1975.

Gates, AND/NAND

Device	M38510/	Description	Source
930	03001	Expandable Dual 4-Input NAND Gate	Fairchild ITT
946	03004	Quad 2-Input NAND Gate	Fairchild ITT
962	03005	Triple 3-Input NAND Gate	Fairchild ITT
4011	05001	Quad 2-Input NAND Gate	National RCA
4012	05002	Dual 4-Input NAND Gate	National RCA
4023	05003	Triple 3-Input NAND Gate	National RCA
5400	00104	Quadruple 2-Input NAND Gate	Fairchild ITT Motorola National Signetics TI
5401	00107	Quadruple 2-Input NAND Gate with Open Collector Output	Fairchild ITT Motorola National Signetics TI
5403	00109	Quadruple 2-Input NAND Gate with Open Collector Output	Fairchild ITT Motorola National Signetics TI
5408	01601	Quadruple 2-Input AND Gate	Fairchild Motorola Signetics
5409	01602	Quad 2-Input AND Gate with Open Collector Output	Fairchild Motorola Signetics
5410	00103	Triple 3-Input NAND Gate	Fairchild ITT Motorola National Signetics TI
5412	00106	Triple 3-Input NAND Gate with Open Collector Output	TI
5420	00102	Dual 4-Input NAND Gate	Fairchild ITT Motorola National Signetics TI
5426	00805	Quad 2-Input NAND Gate with Open Collector Output	Signetics
5430	00101	8-Input Nand Gate	Fairchild ITT Motorola National Signetics TI
54H00	02304	Quadruple 2-Input NAND Gate	Fairchild Motorola Signetics TI

Gates, AND/NAND (cont)

Device	M38510/	Description	Source
54H01	02306	Quadruple 2-Input NAND Gate with Open Collector Output	Motorola Signetics TI
54H10	02303	Triple 3-Input NAND Gate	Fairchild Motorola Signetics TI
54H20	02302	Dual 4-Input NAND Gate	Fairchild Motorola Signetics TI
54H22	02307	Dual 4-Input NAND Gate with Open Collector Output	Motorola Signetics
54H30	02301	8-Input NAND Gate	Fairchild ITT Motorola Signetics TI
54L00	02004	Quadruple 2-Input NAND Gate	National
54L03	02006	Quadruple 2-Input NAND Gate with Open Collector Output	National
54L10	02003	Triple 3-Input NAND Gate	National
54L20	02002	Dual 4-Input NAND Gate	National
54L30	02001	8-Input NAND Gate	National
54S00	07001	Quadruple 2-Input NAND Gate	Signetics

Gates, AND-OR/AND-OR-Invert

Device	M38510/	Description	Source
4019	05302	Quad AND-OR Select Gate	RCA
5450	00501	Expandable Dual 2-Wide 2-Input AND-OR-Invert Gate	ITT Motorola National Signetics TI
5451	00502	Expandable Dual 2-Wide 2-Input AND-OR-Invert Gate	ITT Motorola National Signetics TI
5453	00503	Expandable 4-Wide 2-Input AND-OR- Invert Gate	ITT Motorola National Signetics TI
5454	00504	4-Wide 2-Input AND-OR-Invert Gate	ITT Motorola National Signetics TI
54H50	04001	Expandable Dual 2-Wide 2-Input AND-OR- Invert Gate	Signetics TI
54H51	04002	Dual 2-Wide 2-Input AND-OR-Invert Gate	Signetics TI
54H53	04003	Expandable 2-2-2-3 Input AND-OR-Invert Gate	Signetics
54H54	04004	2-2-2-3 Input AND-OR-Invert Gate	Signetics
54H55	04005	Expandable 2-Wide 4-Input AND-OR-Invert Gate	Signetics

Gates, Exclusive OR/NOR

Device	M38510/	Description	Source
5486	00701	Quad 2-Input Exclusive OR Gate	Fairchild ITT Motorola Signetics TI

Gates, OR/NOR

4000	05201	Dual 3-Input NOR Gate plus Inverter	RCA
4001	05202	Quad 2-Input NOR Gate	National RCA
4002	05203	Dual 4-Input NOR Gate	National RCA
4025	05204	Triple 3-Input NOR Gate	RCA
5402	00401	Quadruple 2-Input NOR Gate	Fairchild ITT Motorola National Signetics TI
5423	00402	Expandable Dual 4-Input NOR Gate with Strobe	Motorola TI
5425	00403	Dual 4-Input NOR Gate with Strobe	Motorola TI
5427	00404	Triple 3-Input NOR Gate	Fairchild Motorola TI
54L02	02701	Quadruple 2-Input NOR Gate	National

Latches

5475	01501	Quad Bistable Latch, Complementary Output	Motorola Signetics
5477	01502	Quad Bistable Latch	Motorola Signetics

Multiplexers

9309	01404	Dual 4-Input Multiplexer	AMD ITT Motorola Signetics
9312	01402	8-Channel Data Selector/Multiplexer	AMD ITT Motorola
9322	01405	Quadruple 2-Input Data Selector/Multiplexer (Non--Inverting)	AMD ITT Motorola Signetics
54150	01401	16-Channel Data Selector/Multiplexer	Signetics TI
54153	01403	Dual 4-Channel Data Selector/Multiplexer	Motorola Signetics

Multivibrators

54121	01201	Monostable Multivibrator	ITT Signetics
54122	01202	Retriggerable Monostable Multivibrator with Clear	Motorola
54123	01203	Dual Retriggerable Monostable Multivibrator with Clear	AMD Motorola Signetics

Based on QPL-38510-18, 29 October 1975.

Miscellaneous

Device	M38510/	Description	Source
54180	01901	9-Bit Odd/Even Parity Generator/Checker	Signetics

INTERFACE

Line Drivers and Receivers

55113	10405	Dual Differential Line Driver, Three-State	TI
55114	10403	Dual Differential Line Driver	AMD Fairchild
55115	10404	Dual Differential Line Receiver	AMD Fairchild TI

LINEAR

Amplifiers

101A	10103	Operational Amplifier	AMD
108A	10104	Operational Amplifier	AMD Fairchild National
741	10101	Operational Amplifier	AMD Fairchild Motorola
747	10102	Dual Operational Amplifier	Fairchild National

Comparators

710	10301	Voltage Comparator	Fairchild

Voltage Regulators

723	10201	Voltage Regulator	Fairchild

MEMORY

PROM

Device	M38510/	Description	Source
HPROM0512	20101	512-Bit Programmable Read Only Memory	Harris

Shift Registers

4006	05701	18-Bit Static Shift Register	RCA
4014	05702	8-Bit Static Shift Register (Synchronous)	RCA
4015	05703	Dual 4-Bit Static Shift Register	RCA
4021	05704	8-Bit Static Shift Register (Asynchronous)	RCA
4031	05705	64-Bit Static Shift Register	RCA
5495	00901	4-Bit Parallel Access Shift Register	Signetics
5496	00902	5-Bit Shift Register	ITT Signetics
54164	00903	8-Bit Serial-In Parallel-Out Shift Register	Signetics
54194	00905	4-Bit Universal Shift Register Signetics	Signetics
54195	00906	4-Bit Parrallel Access Shift Register	Signetics

Based on QPL-38510-18, 29 October 1975.

Last page of this section. The next page is 197.

INTRODUCTION TO DIGITAL

The Master Selection Guide provides sufficient information to make initial product selections, to lead you to a group of device numbers and manufacturers' names. It enables you to find the products which are most appropriate to fulfill your major requirements and then provides data for many of the more important products.

All devices that appear in this section, both in the initial selection guide and in the data pages, are included in the Part Number and Product Indexes. These index listings lead to the page and the line on that page where each device appears.

The first two pages of the digital section present comparisons of the performance of the major digital families to help you choose between families. These are followed by lists of the devices in each family arranged into functional groups (arithmetic, buffers/inverters, etc.). Within each group you can readily determine all of the various circuits available, surveying the entire IC industry so that you know all your options. The initial selection lists are followed by the device data pages which have been provided for you by the manufacturers. When such data is in the book, the page numbers are given with the initial selection listings.

Some digital circuits — calculator, watch chips, and electronic organ circuits — are not listed by model number, but the manufacturers are listed in Industrial/Consumer section. Digital circuits which do not fall into one of the major logic families are listed at the end of the selection information under the heading Digital-Other Devices.

This section is not complicated by reference to package styles; the package style suffixes are usually deleted. For more information on each companies' suffixes, see the Part Number Guide. Throughout the Master Selection Guide, each full military temperature range (−55°C to 125°C) device is indicated by a dagger (†) before the manufacturer's name. Manufacturers' names are normally spelled out; however, a few are abbreviated and the abbreviations are explained on page 200.

Page Number Index — Digital Devices

Detailed Product Information provided by:

The manufacturers listed above are providing detailed information on their latest and most significant products. They have made this investment to help you. Some chose not to.
If you want to see more data in future editions, tell the manufacturers through their salesmen and distributors.

WHICH DIGITAL FAMILY?

Edited from material published in Fairchild Progress magazine, Peter Alfke, author.

With several digital families available, the logical question is — which are the best ICs for my particular application?

To answer the question, you need to evaluate the pros and cons of the various logic families. These tradeoffs are listed in Tables I-IV. You will need to establish your speed requirements. Since speeds are characterized by the clock rate of registers and counters, this discussion is divided into four groups based on clock rates.

Very High Speed	Clock Rate	> 100 MHz	ECL
High Speed	Clock Rate	30 to 100 MHz	ECL, S-TTL
Medium Speed	Clock Rate	5 to 50 MHz	LS-TTL, TTL
Low Speed	Clock Rate	< 5 MHz	LS-TTL, CMOS

VERY HIGH SPEED SYSTEMS — Clock Rate > 100 MHz

There is only one reasonable IC logic family for use in very high speed systems — Emitter Coupled Logic, ECL. Originally, this technology presented considerable electrical problems such as voltage and temperature sensitivity and fast edge rates that caused reflection and cross-talk problems. In recent years, however, ECL development has become more user-oriented and there is better compatibility between circuit characteristics and interconnection techniques.

The modern popular ECL line is the 10,000 Series, manufactured in uncompensated, in voltage-compensated, or in both voltage and temperature-compensated forms. The latter form of compensation assures that significant parameters such as logic levels, noise margins and speed remain constant over a wide range of temperature and power supply voltage. These 10K and 95K logic circuits have deliberately slowed-down edge rates to make them easier to use and they can also drive terminated transmission lines whenever required by the interconnection length.

HIGH SPEED SYSTEMS — Clock Rate 30 to 100 MHz (Table II)

Here, you have a choice between ECL and Schottky TTL. H-TTL is really obsolete since it consumes more power than Schottky TTL, has similar interconnection problems and offers only half the speed. Also, it is not significantly faster than the best Low Power Schottky TTL. So, this narrows down your choice to ECL and Schottky TTL.

MEDIUM SPEED SYSTEMS — Clock Rate 5 to 50 MHz (Table III)

Standard TTL has been the obvious choice for medium speed systems for many years. Many designs will increasingly use Low Power Schottky TTL as it becomes more available, multiple sourced, and as the price premium decreases. You can mix standard and LS-TTL to solve most fan-out problems.

SLOW SPEED SYSTEMS — Clock Rate < 5 MHz (Table IV)

If you design slow speed systems you are faced with the largest number of attractive alternatives. Traditionally, TTL and DTL has been used. Now you can save power, cost and avoid heat and reliability problems by changing to LS-TTL, without affecting the logic design and perhaps not even changing the PC board layout.

If the system speed permits, you can switch to CMOS and save even more power and simplify the power supply, but now you must cope with a family of different logic elements and a hodgepodge of MSI elements, far less systems oriented than the better TTL circuits. Also you will notice wide parameter differences between the "same" products from different vendors.

The greatest challenge, however, is to examine the traditional hard-wired system design and decide whether or not it can be implemented with a microprocessor. If the requirements are both complicated and slow enough, this approach might save manufacturing cost, design time, and service time, as well as improve reliability, provide additional flexibility, and perhaps allow additional features at no extra cost.

MOS (p-channel, n-channel, either metal or silicon gate, also silicon on sapphire) does not compete directly with LS-TTL and CMOS. The MOS logic elements (gates and flip-flops) are very small but the input and output buffers are so large and relatively slow that MOS cannot be cost/performance competitive at MSI complexity (below 200 gates). MOS is therefore meaningful only in LSI circuits, where it has proven to be not only competitive, but dominating. These areas are:

- LSI memories, RAMs, ROMs, and shift registers of 500 to 4096 bits at clock rates below 5 MHz.
- Specialized, inherently slow LSI functions produced in very large volume (calculators, clocks, some instrument circuits like DVMs).
- Custom LSI circuits where the manufacturing volume is high enough or the weight/space saving valuable enough to absorb the development cost.
- Microprocessors, where a very carefully designed, standard circuit performs specialized tasks through ROM-stored programming.

SUMMARY

The proliferation of digital circuits and technologies gives you a new degree of freedom, but it also challenges your judgement and imagination. You are faced with an almost overwhelming number of competing technologies, each with its strong and weak points. The basic component speed requirement and the available power will quickly narrow your choice down to two or three different logic families; the tables presented here will make your final decision easier.

You should not forget, however, that the component speed requirement is also affected by your choice of architecture. A parallel approach requires more, but slower components, while a serial architecture requires fewer but faster components. The vesatility of modern MSI circuits makes it easy to explore these alternatives. It is very important to choose the IC logic family at an early stage in the system design, since the full cost, speed and reliability advantages can only be gained by designing in accordance with the device features, taking advantage of their logic and organization.

TABLE I: COMPARISON OF ELECTRICAL CHARACTERISTICS

	CMOS 5 V SUPPLY	CMOS 10 V SUPPLY	74LS LOW POWER SCHOTTKY	9LS LOW POWER SCHOTTKY	STANDARD TTL	SCHOTTKY TTL	10K ECL
PROPAGATION DELAY	35 ns	25 ns	10 ns	5 ns	10 ns	3 ns	2 ns
FLIP-FLOP TOGGLE FREQUENCY	5 MHz	10 MHz	40 MHz	80 MHz	35 MHz	100 MHz	200 MHz
QUIESCENT POWER[1]	10 nW	10 nW	2 mW	2 mW	10 mW	25 mW	25 mW
NOISE IMMUNITY	2 V	4 V	0.8 V	0.8 V	1 V	0.9 V	0.2 V
FAN OUT (within family)	> 50[2]	> 50[2]	20	20	10	10	> 50

[1]Note the change from nanowatts to milliwatts.
[2]Or as determined by allowable propagation delay.

TABLE II. COMPARISON OF DIGITAL LOGIC FAMILY CHARACTERISTICS FOR HIGH SPEED SYSTEMS (CLOCK RATE 30 TO 100 MHz)

10K AND 95K SERIES ECL	SCHOTTKY TTL
Advantages	**Disadvantages**
Short delays allow propagation through more logic levels in a clock cycle. Compatibility with even faster families currently in development makes future system upgrading easy.	Component delays are about twice as long as with ECL and will not be improved in the foreseeable future.
Low output impedance drives all types of interconnections including terminated transmission lines.	Outputs are not capable of driving terminated transmission lines without causing severe fan-out compromises.
High output drive capability and complementary outputs accommodate differential transmission over tested pairs.	
Slow edge rate minimizes reflection problems.	Has the fastest output transitions of any logic family, causing reflection problems even with relatively short interconnection lengths, and causing cross-talk problems.
Complementary outputs on many elements add design flexibility.	
Wired-OR capability simplifies logic design.	
Compensated circuits simplify power supply and temperature regulation.	Generates fast power supply load changes, requires good decoupling.
High input impedance minimizes loading, allows high fan-out.	Input thresholds and output low levels are slightly offset from conventional TTL, causing some loss of noise immunity.
Disadvantages	**Advantages**
Unfamiliar type of circuitry, logic, nomenclature, and pinouts.	Compatible with popular TTL, same supply voltage, almost identical signal levels, same SSI and MSI logic, nomenclature, pinouts. Ideal to speed up critical paths in standard TTL systems.
Not level-compatible with TTL and CMOS, requires additional interface elements.	
Requires external pull-down resistors on all used outputs.	Outputs require no pull-up (or down) resistors.
Has less absolute noise margin.	Large signal swing and large absolute noise immunity cause less problems with temperature or supply voltage variations and gradients, resistive drops along supply lines, and outside noise.
Higher ground current requires heavier distribution busses.	
Has one less logic pin per package due to double ground.	
Has higher power consumption at low frequencies than equivalent S-TTL circuits.	Has lower system power consumption at moderate speed.

TABLE III. COMPARISON OF DIGITAL LOGIC FAMILY CHARACTERISTICS FOR MEDIUM SPEED SYSTEMS (CLOCK RATE 5 TO 50 MHz)

STANDARD TTL	LOW POWER SCHOTTKY TTL
Advantages	**Disadvantages**
Large number of SSI and MSI functions.	Fewer device types available, but this is changing rapidly.
Low prices.	Presently higher priced than standard TTL.
Available from many suppliers.	Presently available from only a few suppliers.
Disadvantages	**Advantages**
High power consumption (10 mW per gate, 200 to 500 mW per MSI package.)	Saves 75% of the power of equivalent standard TTL.
Large, heavy, expensive, hot power supply and regulator.	Smaller, lighter, cheaper, cooler power supply and regulator.
Heat density problems when using predominantly MSI.	No heat density problem. Cooler, therefore more reliable.
	May eliminate the need for fans and filters.
Not fully compatible with most CMOS and MOS.	Compatible with CMOS and MOS.
	Generates less noise than standard TTL.

TABLE IV. COMPARISON OF DIGITAL LOGIC FAMILY CHARACTERISTICS FOR LOW SPEED SYSTEMS (CLOCK RATE 5 MHz)

STANDARD OR LOW POWER SCHOTTKY TTL	CMOS
Advantages	**Disadvantages**
Well designed, system-oriented MSI.	Some of the original CMOS circuits are poorly defined and not systems oriented.
Adequate speed, tight tolerances.	Low speed, delays depend on supply voltage and capacitive loading.
Low impedance outputs give good immunity against capacitively coupled noise.	Poor current noise immunity (capacitively coupled noise.)
Familiar functions, logic, pinouts.	New functions, logic pinouts.
Standard TTL available from many suppliers, low cost.	Large parameter variations between different vendors.
Disadvantages	**Advantages**
Relatively high static consumption and heat generation.	Extremely low static power consumption, very little heat generated at moderate speed.
Tight power supply voltage requirements (5 V ±5% commercial, ±10% military grade).	Very wide range of supply voltages (theoretically 3 . . . 20 V, practically 5 . . . 12 V).
Not well-suited for portable battery operation.	Ideally suited for battery operation.
More expensive power supply.	Low cost power supply. Less cost, weight, heat, size than for any other family.
Lower voltage noise immunity.	High voltage noise immunity, an advantage with inductively coupled noise.
LS-TTL available from only a few suppliers.	Available from many suppliers.

ABBREVIATIONS OF COMPANY NAMES

AD	Analog Devices
AMD	Advanced Micro Devices
AMI	American Microsystems, Inc.
AMS	Advanced Memory Systems
Analogic	Analogic Corp.
Beckman	Beckman Instruments, Helipot Division
Burr-Brown	Burr-Brown Research
Cermetek	Cermetek
CMA	Consumer Microcircuits of America
Collins	Collins Radio
Datel	Datel Systems
DDC	ILC Data Devices Corp.
EA	Electronic Arrays
EMM/Semi	EMM Semi, Div. of Electronic Memories & Magnetics
Exar	Exar Integrated Systems
Fairchild	Fairchild Semiconductor
Ferranti	Ferranti Electric
GI	General Instrument
Harris	Harris Semiconductor
Hitachi	Hitachi America, Ltd.
Hughes	Hughes Aircraft Co., MOS Divison
Hybrid Sys.	Hybrid Systems
IMI	International Microcircuits, Inc.
Intech	Intech
Intel	Intel
Interdesign	Interdesign
Intersil	Intersil
IPI	Integrated Photomatrix, Inc.
ITT	ITT Semiconductors
Lithic Sys.	Lithic Systems
Litronix	Litronix
LSI Comp.	LSI Computer Systems
Micro Net	Micro Networks
Micropac	Micropac Industries
Micro Power	Micro Power Systems
Mitsubishi	Mitsubishi International
MMI	Monolithic Memories, Inc.
MOS	MOS Technology
Mostek	Mostek
Motorola	Motorola Semiconductor
National	National Semiconductor
NCR	National Cash Register, Microelectronics Div.
NEC	NEC Microcomputers
Nippon	Nippon Electric Co.
Nitron	Nitron
Nortec	Nortec Electronics
NPC	Nucleonic Products Co.
OKI	OKI Electronics of America, Inc.
Panasonic	Panasonic, Matsushita Electric Corp.
Plessey	Plessey Semiconductors
PMC	Power Monolithics Co.
PMI	Precision Monolithics, Inc.
Ragen	Ragen Semiconductor
Raytheon	Raytheon Semiconductor
RCA	RCA Solid State Division
Reticon	Reticon
Rockwell	Rockwell International, Microelectronic Div.
Sanken	Sanken Electric
SGS	SGS-ATES Semiconductor
Signetics	Signetics
Silicon G	Silicon General
Siliconix	Siliconix
SMC	SMC Microsystems Corp.
Solitron	Solitron Devices
Sprague	Sprague Electric Company
SSS	Solid State Scientific
SW	Stewart-Warner Microcircuits
Synertek	Synertek
Teledyne C	Teledyne Crystalonics
Teledyne P	Teledyne Philbrick
Teledyne S	Teledyne Semiconductor
TI	Texas Instruments
TMX	TMX, Inc.
Toshiba	Toshiba
TRW	TRW
Transitron	Transitron Electronics
Western	Western Digital

DIGITAL—CMOS

Arithmetic Functions

Function	Device	Source
2 x 2 Bit (Parallel) Binary Multiplier	MC14554A	† Motorola
	MC14554C	Motorola
4-Bit Full Adder	F4008C	Fairchild
	F4008M	† Fairchild
	F40283C	Fairchild
	F40283M	† Fairchild
	HD4008A-2	† Harris
	HD4008A-9	Harris
	HD54C83 see page 266	**† Harris**
	HD74C83 see page 266	**Harris**
	MC14008A	† Motorola
	MC14008C	Motorola
	MM54C83	† National
	MM74C83	National
	CD4008A/B see page 375	**† RCA**
	CD4008A/BE see page 375	**RCA**
	HBF4008AE	SGS
	SCL4008A	† SSS
	SCL4008AE	SSS
	CM4008A	† Solitron
	CM4008AE	Solitron
	TF4008A	† TI
	TP4008A	TI
	TC4008	Toshiba
Triple Serial Adder (Positive Logic) With Internal Carry	MC14032A	† Motorola
	MC14032C	Motorola
	CD4032A see page 375	**† RCA**
	CD4032AE see page 375	**RCA**
	CM4032A	† Solitron
	CM4032AE	Solitron
	TC4032	Toshiba
Triple Serial Adder (Negative Logic) With Internal Carry	MC14038A	† Motorola
	MC14038C	Motorola
	CD4038A see page 375	**† RCA**
	CD4038AE see page 375	**RCA**
	CM4038A	† Solitron
	CM4038AE	Solitron
	TC4038	Toshiba
4-Bit Arithmetic Array	**CD4057A** see page 375	**† RCA**
4-Bit Arithmetic Logic Unit	MC14581A	† Motorola
	MC14581C	Motorola
	CD40181A/B see page 375	**† RCA**
	CD40181A/BE see page 375	**RCA**
	SCL4581A	† SSS
	SCL4581AE	SSS
	TF4581A	† TI
	TP4581A	TI

Arithmetic Functions (cont)

Function	Device	Source
Look-Ahead Carry Block	F4582C	Fairchild
	F4582M	† Fairchild
	MC14582A	† Motorola
	MC14582C	Motorola
	CD40182A/B see page 375	**† RCA**
	CD40182A/BE see page 375	**RCA**
	SCL4582A	SSS
	TF4582A	† TI
	TP4582A	TI
4-Bit Magnitude Comparator	F40085C	Fairchild
	F40085M	† Fairchild
	HD54C85 see page 266	**† Harris**
	HD74C85 see page 266	**Harris**
	MC14585A	† Motorola
	MC14585C	Motorola
	MM54C85	† National
	MM74C85	National
	CD4063A/B see page 375	**† RCA**
	CD4063A/BE see page 375	**RCA**
	SCL4585A	† SSS
	SCL4585AE	SSS
	TC4585	Toshiba
NBCD Adder (Natural Binary Coded Decimal)	MC14560A	† Motorola
	MC14560C	Motorola
Nines Complementer	MC14561A	† Motorola
	MC14561C	Motorola
Data Path Switch	F4704C	Fairchild
	F4704M	† Fairchild
Arithmetic Logic Register Stack	F4705C	Fairchild
	F4705M	† Fairchild
Data Access Register (for memory address arithmetic)	F4707C	Fairchild
	F4707M	† Fairchild

Buffers/Inverters

Function	Device	Source
Quad Low Impedance Buffer	SCL4441A	† SSS
	SCL4441AE	SSS
Hex Buffer/Converter (Non-Inverting)	CD4010C	National
	CD4010M	† National
	CD4010A/B see page 375	**† RCA**
	CD4010A/BE see page 375	**RCA**
	HBF4010AE	SGS
	SCL4010A	† SSS
	SCL4010AE	SSS
	CM4010A	† Solitron
	CM4010AE	Solitron
	TF4010A/B	† TI
	TP4010A/B	TI
	TC4010	Toshiba

Buffers/Inverters (cont)

Function	Device	Source
Hex Buffer/Converter (Non-Inverting) - Improved	F4050C	Fairchild
	F4050M	† Fairchild
	MEM4050D	GI
	MEM4050P	GI
	HD4050A-2	† Harris
	HD4050A-9	Harris
	MC14050A	† Motorola
	MC14050C	Motorola
	CD4050C	National
	CD4050M	National
	CD4050A/B see page 375	**† RCA**
	CD4050A/BE see page 375	**RCA**
	HBF4050AE	SGS
	SCL4050A	† SSS
	SCL4050AE	SSS
	CM4050A	† Solitron
	CM4050AE	Solitron
	SW4050AE	SW
	CD4050	Teledyne S
	TF4050A/B	† TI
	TP4050A/B	TI
	TC4050	Toshiba
Hex Buffer, Open Drain (Active pull down)	HD54C906	† Harris
	HD74C906	Harris
	MM54C906	† National
	MM74C906	National
Hex Buffer, Open Drain (Active pull up)	HD54C907	† Harris
	HD74C907	Harris
	MM54C907	† National
	MM74C907	National
Hex Buffer Three-State	F40097C	Fairchild
	F40097M	† Fairchild
	HD70C95	Harris
	HD70C97	Harris
	HD80C95	Harris
	HD80C97	Harris
	MC14503	Motorola
	MM70C95	† National
	MM70C97	† National
	MM80C95	National
	MM80C97	National
Hex Buffer/Converter (Inverting)	CD4009C	National
	CD4009M	† National
	CD4009A/B see page 375	**† RCA**
	CD4009A/BE see page 375	**RCA**
	HBF4009AE	SGS
	SCL4009A	† SSS
	SCL4009AE	SSS
	CM4009A	† Solitron
	CM4009AE	Solitron
	TF4009A/B	† TI
	TP4009A/B	TI
	TC4009	Toshiba
Hex Buffer/Converter (Inverting) - Improved	F4049C	Fairchild
	F4049M	† Fairchild
	(continued)	

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL

Master Selection Guide

DIGITAL—CMOS (cont)

Function	Device	Source	Line
Buffers/Inverters (cont)			
Hex Buffer/Converter (Inverting) - Improved (continued)			
	MEM4049D	† GI	
	MEM4049P	GI	
	HD4049A-2	† Harris	
	HD4049A-9	Harris	
	MC14049A	† Motorola	
	MC14049C	Motorola	
	CD4049C	National	
	CD4049M	† National	
	CD4049A/B **see page 375**	**† RCA**	
	CD4049A/BE **see page 375**	**RCA**	10
	HBF4049AE	SGS	
	SCL4049A	† SSS	
	SCL4049AE	SSS	
	CM4049A	† Solitron	
	CM4049AE	Solitron	
	SW4049AE	SW	
	CD4049	Teledyne S	
	TF4049A/B	† TI	
	TP4049A/B	TI	
	TC4049	Toshiba	20
Hex Inverter			
	F4069C	Fairchild	
	F4069M	† Fairchild	
	HD54C04	† Harris	
	HD74C04	Harris	
	MC14069BA	† Motorola	
	MC14069BC	Motorola	
	MC14572A	† Motorola	
	MC14572C	Motorola	
	CD4069BC	National	
	MM54C04	† National	30
	CD4069BM	† National	
	CD4069A/B **see page 375**	**† RCA**	
	CD4069A/BE **see page 375**	**RCA**	
	SCL4069	SSS	
	SCL4069A	† SSS	
	SCL4069AE	SSS	
	SCL4449A	† SSS	
	SCL4449AE	SSS	
	CM4069A/B	† Solitron	
	CM4069A/BE	Solitron	40
	MM54C04	† Teledyne S	
	MM74C04	Teledyne S	
	TF4315A	† TI	
	TP4315A	TI	
	TC4069	Toshiba	
	TC7404	Toshiba	
Hex Inverter Three-State			
	F40098C	Fairchild	
	F40098M	† Fairchild	
	HD80C96	Harris	
	HD80C98	Harris	50
	MM80C96	National	
	MM80C98	National	
Hex Inverter/Buffer Three-State Strobed			
	MC14502A	† Motorola	
	MC14502C	Motorola	
	CD4502A/B **see page 375**	**† RCA**	
	(continued)		

Function	Device	Source	Line
Buffers/Inverters (cont)			
Hex Inverter/Buffer Three-State Strobed (continued)			
	CD4502A/BE **see page 375**	**RCA**	
	SCL4502A	† SSS	
	SCL4502AE	SSS	
Hex CMOS Compatible Buffer			
	DS1630	† National	
	DS3630	National	60
Dual Complementary Pair plus Inverter			
	F4007C	Fairchild	
	F4007M	† Fairchild	
	MEM4007D	† GI	
	MEM4007P	GI	
	HD4007A-2	† Harris	
	HD4007A-9	Harris	
	MC14007A	† Motorola	
	MC14007C	Motorola	
	CD4007C	National	
	CD4007M	† National	70
	CD4007A **see page 375**	**† RCA**	
	CD4007AE **see page 375**	**RCA**	
	HBF4007AE	SGS	
	SCL4007A	† SSS	
	SCL4007AE	SSS	
	CM4007A	† Solitron	
	CM4007AE	Solitron	
	TF4007A	† TI	
	TP4007A	TI	
	TC4007	Toshiba	80
Quad True/Complement Buffer			
	F4041C	Fairchild	
	F4041M	† Fairchild	
	CD4041A/B **see page 375**	**† RCA**	
	CD4041A/BE **see page 375**	**RCA**	
	SCL4041A	† SSS	
	SCL4041AE	SSS	
	CM4041A	† Solitron	
	CM4041AE	Solitron	
Counters, Binary			
Divide by 2, 8 or 16 Counters			
	MM54C93	† National	
	MM74C93	National	90
7-Stage Binary Counter			
	F4024C	Fairchild	
	F4024M	† Fairchild	
	HD4024A-2	† Harris	
	HD4024A-9	Harris	
	MC14024A	† Motorola	
	MC14024C	Motorola	
	CD4024C	National	
	CD4024M	† National	
	CD4024A **see page 375**	**† RCA**	
	CD4024AE **see page 375**	**RCA**	100
	HBF4024AE	SGS	
	SCL4024A	† SSS	
	SCL4024AE	SSS	
	CM4024A	† Solitron	
	CM4024AE	Solitron	
	(continued)		

Function	Device	Source	Line
Counters, Binary (cont)			
7-Stage Binary Counter (continued)			
	SW4024AE	SW	
	TF4024A	† TI	
	TP4024A	TI	
	TC4024	Toshiba	
8-Stage Synchronous Binary Counter			
	SCL4404A	† SSS	110
	SCL4404AE	SSS	
12-Stage Binary Counter			
	F4040C	Fairchild	
	F4040M	† Fairchild	
	HD4040A-2	† Harris	
	HD4040A-9	Harris	
	MC14040A	† Motorola	
	MC14040C	Motorola	
	CD4040C	National	
	CD4040M	† National	
	CD4040A **see page 375**	**† RCA**	120
	CD4040AE **see page 375**	**RCA**	
	CDS4040	† RCA	
	CDS4040E	RCA	
	SCL4040A	† SSS	
	SCL4040AE	SSS	
	CM4040A	† Solitron	
	CM4040AE	Solitron	
	TF4040A	† TI	
	TP4040A	TI	
	TC4040	Toshiba	130
14-Stage Binary Counter			
	F4020C	Fairchild	
	F4020M	† Fairchild	
	HD4020A-2 **see page 266**	**† Harris**	
	HD4020A-9 **see page 266**	**Harris**	
	MC14020A	† Motorola	
	MC14020C	Motorola	
	CD4020C	National	
	CD4020M	† National	
	CD4020A **see page 375**	**† RCA**	
	CD4020AE **see page 375**	**RCA**	140
	CDS4020	† RCA	
	CDS4020E	RCA	
	HBF4020AE	SGS	
	SCL4020A	† SSS	
	SCL4020AE	SSS	
	CM4020A	† Solitron	
	CM4020AE	Solitron	
	SW4020AE	SW	
	TF4020A	† TI	
	TP4020A	TI	150
	TC4020	Toshiba	
14-Stage Binary Counter and Oscillator			
	CD4060A **see page 375**	**† RCA**	
	CD4060AE **see page 375**	**RCA**	
	CDS4060	† RCA	
	CDS4060E	RCA	
	SCL4060A	† SSS	
	(continued)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—CMOS (cont)

Counters, Binary (cont)

14-Stage Binary Counter and Oscillator (continued)

Device	Source
SCL4060AE	SSS

Presettable Synchronous Binary Counter, Asynchronous Clear

Device	Source
F40161C	Fairchild
F40161M	† Fairchild
HD54C161 see page 266	**† Harris**
HD74C161 see page 266	**Harris**
MC14161BA	† Motorola
MC14161BC	Motorola
MM54C161	† National
MM74C161	National
MM54C161	† Teledyne S
MM74C161	Teledyne S
TF4361A	† TI
TP4361A	TI

Presettable Fully Synchronous Binary Counter, Synchronous Clear

Device	Source
F40163C	Fairchild
F40163M	† Fairchild
HD54C163	† Harris
HD74C163	Harris
MC14163BA	† Motorola
MC14163BC	Motorola
MM54C163	† National
MM74C163	National
MM54C163	† Teledyne S
MM74C163	Teledyne S
TF4363A	† TI
TP4363A	TI

Dual Synchronous Binary Counter

Device	Source
F4520C	Fairchild
F4520M	† Fairchild
HD14520-2	† Harris
HD14520-9	Harris
MC14520A	† Motorola
MC14520C	Motorola
CD4520C	National
CD4520M	† National
CD4520A/B see page 375	**† RCA**
CD4520A/BE see page 375	**RCA**
CDS4520	† RCA
CDS4520	RCA
SCL4520A	† SSS
SCL4520AE	SSS
CM4520B	† Solitron
CM4520BE	Solitron
TF4520A	† TI
TP4520A	TI
TC4520	Toshiba

Presettable Binary Up/Down Counter

Device	Source
F40193C	Fairchild
F40193M	† Fairchild
F4516C	Fairchild
F4516M	† Fairchild
HD14516-2	† Harris
HD14516-9	Harris
HD54C193 see page 266	**† Harris**
HD74C193 see page 266	**Harris**
MC14516A (continued)	† Motorola

Counters, Binary (cont)

Presettable Binary Up/Down Counter (continued)

Device	Source
MC14516C	Motorola
CD40193C	National
CD40193M	† National
CD4516C	National
CD4516M	† National
MM54C193	† National
MM74C193	National
CD40193A/B see page 375	**† RCA**
CD40193A/BE see page 375	**RCA**
CD4516A/B see page 375	**† RCA**
CD4516A/BE see page 375	**RCA**
SCL4516A	† SSS
SCL4516AE	SSS
MM54C193	† Teledyne S
MM74C193	Teledyne S
TC4516	Toshiba

Presettable 8-bit Binary Down Counter

Device	Source
CD40103A/B see page 375	**† RCA**
CD40103A/BE see page 375	**RCA**

Programmable Binary Divide-by-N 4-Bit Counter

Device	Source
F4526C	Fairchild
F4526M	† Fairchild
MC14526A	† Motorola
MC14526C	Motorola
TF4526A	† TI
TP4526A	TI

Counters, Decade

Presettable Decade Counter (Sets to 0 or 9, divides by 2, 5 or 10)

Device	Source
MM54C90	† National
MM74C90	National

Presettable Synchronous Decade Counter, Asynchronous Clear

Device	Source
F40160C	Fairchild
F40160M	† Fairchild
HD54C160 see page 266	**† Harris**
HD74C160 see page 266	**Harris**
MC14160BA	† Motorola
MC14160BC	Motorola
MM54C160	† National
MM74C160	National
MM54C160	† Teledyne S
MM74C160	Teledyne S
TF4360A	† TI
TP4360A	TI

Presettable Fully Synchronous Decade Counter, Synchronous Clear

Device	Source
F40162C	Fairchild
F40162M	† Fairchild
HD54C162 see page 266	**† Harris**
HD74C162 see page 266	**Harris**
MC14162BA	† Motorola
MC14162BC	Motorola
MM54C162	† National
MM74C162	National
MM54C162 (continued)	† Teledyne S

Counters, Decade (cont)

Presettable Fully Synchronous Decade Counter, Synchronous Clear (continued)

Device	Source
MM74C162	Teledyne S
TF4362A	† TI
TP4362A	TI

Dual Synchronous Decade Counter

Device	Source
F4518C	Fairchild
F4518M	† Fairchild
HD14518-2	† Harris
HD14518-9	Harris
MC14518A	† Motorola
MC14518C	Motorola
CD4518C	National
CD4518M	† National
CD4518A/B see page 375	**† RCA**
CD4518A/BE see page 375	**RCA**
CDS4518	† RCA
CDS4518E	RCA
SCL4518A	† SSS
SCL4518AE	SSS
CM4518B	† Solitron
CM4518BE	Solitron
TF4518	† TI
TP4518	TI
TC4518	Toshiba

Decade Counter/Divider, Decoded Output

Device	Source
F4017C	Fairchild
F4017M	† Fairchild
HD4017A-2	† Harris
HD4017A-9	Harris
MC14017A	† Motorola
MC14017C	Motorola
CD4017C	National
CD4017M	† National
CD4017A see page 375	**† RCA**
CD4017AE see page 375	**RCA**
CDS4017	† RCA
CDS4017E	RCA
HBF4017AE	SGS
SCL4017A	† SSS
SCL4017AE	SSS
CM4017A	† Solitron
CM4017AE	Solitron
SW4017AE	SW
TF4017A	† TI
TP4017A	TI
TC4017	Toshiba

Presettable Decade Up/Down Counter

Device	Source
F40192C	Fairchild
F40192M	† Fairchild
F4510C	Fairchild
F4510M	† Fairchild
HD14510-2	† Harris
HD14510-9	Harris
HD54C192 see page 266	**† Harris**
HD74C192 see page 266	**Harris**
MC14510A	† Motorola
MC14510C	Motorola
CD40192BC (continued)	National

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—CMOS (cont)

Counters, Decade (cont)

Function	Device	Source
Presettable Decade Up/Down Counter (continued)	CD40192BM	† National
	CD4510C	National
	CD4510M	† National
	MM54C192	† National
	MM74C192	National
	CD40192A/B see page 375	† **RCA**
	CD40192A/BE see page 375	**RCA**
	CD4510A/B see page 375	† **RCA**
	CD4510A/BE see page 375	**RCA**
	SCL4510A	† SSS
	SCL4510AE	SSS
	MM54C192	† Teledyne S
	MM74C192	Teledyne S
	TC4510	Toshiba
Presettable 2-Decade Down Counter	**CD40102A/B** see page 375	† **RCA**
	CD40102A/BE see page 375	**RCA**
Programmable Decade Divide-By-N 4-Bit Counter	F4522C	Fairchild
	F4522M	† Fairchild
	MC14522A	† Motorola
	MC14522C	Motorola
	TF4522A	† TI
	TP4522A	TI
4-Decade Divide-by-N Counter	**CD4059A** see page 375	† **RCA**
Decade Counter/Divider — 7 Segment Display Output and Display Enable	HD4026A-2	† Harris
	HD4026A-9	Harris
	CD4026A see page 375	† **RCA**
	CD4026AE see page 375	**RCA**
	SCL4026A	† SSS
	SCL4026AE	SSS
	SCL4426A	† SSS
	SCL4426AE	SSS
	CM4026A	† Solitron
	CM4026AE	Solitron
Decade Counter/Divider — 7 Segment Display Output and Ripple Blanking	**CD4033A** see page 375	† **RCA**
	CD4033AE see page 375	**RCA**
	HBF4033AE	SGS
	SCL4033A	† SSS
	SCL4033AE	SSS
	SCL4433A	† SSS
	SCL4433AE	SSS
	CM4033A	† Solitron
	CM4033AE	Solitron
3-1/2 Digit Counter to BCD Driver	CM4102A	† Solitron
	CM4102AE	Solitron
3 Decade Counter, Multiplexed Ouput	F4553C	Fairchild
	F4553M	† Fairchild
	MC14553A (continued)	† Motorola

Counters, Decade (cont)

Function	Device	Source
3 Decade Counter, Multiplexed Ouput (continued)	MC14553C	Motorola
4 Decade Counter	TC5001	Toshiba
4 Decade Counter, Multiplexed Output	HD54C925	† Harris
	HD54C926	† Harris
	HD74C925	Harris
	HD74C926	Harris
	MM54C925	† National
	MM74C925	National
	MM54C926	† National
	MM74C926	National
4 Digit Counter, Multiplexed Output, Second digit counts to 6 (Maximum count 9599.)	HD54C927	† Harris
	HD74C927	Harris
	MM54C927	† National
	MM74C927	National
4 Digit Counter, Multiplexed Output, left digit counts to 2 (Maximum count 1999.)	HD54C928	† Harris
	HD74C928	Harris
	MM54C928	† National
	MM74C928	National
5 Decade Counter, Multiplexed Ouput	MC14534A	† Motorola
	MC14534C	Motorola
7 Decade Counter, Multiplexer, Display Driver, 2-6 v Supply	ICM7208	Intersil

Counters, Miscellaneous

Function	Device	Source
Presettable Up/Down Binary or Decade Counter	F4029C	Fairchild
	F4029M	† Fairchild
	HD4029A-2 see page 266	† **Harris**
	HD4029A-9 see page 266	**Harris**
	CD4029C	National
	CD4029M	† National
	CD4029A see page 375	† **RCA**
	CD4029AE see page 375	**RCA**
	HBF4029AE	SGS
	SCL4029A	† SSS
	SCL4029AE	SSS
	CM4029A	† Solitron
	CM4029AE	Solitron
	SW4029AE	SW
	TF4029A/B	† TI
	TP4029A/B	TI
	TC4029	Toshiba
Divide-By-8-Counter/Divider, Decoded Output	F4022C	Fairchild
	F4022M	† Fairchild
	HD4022A-2 see page 266	† **Harris**
	HD4022A-9 see page 266	**Harris**
	MC14022A	† Motorola
	MC14022C	Motorola
	CD4022C	National
	CD4022M	† National
	CD4022A see page 375	† **RCA**
	CD4022AE see page 375 (continued)	**RCA**

Counters, Miscellaneous (cont)

Function	Device	Source
Divide-By-8-Counter/Divider, Decoded Output (continued)	N4022	Signetics
	HBF4022AE	SGS
	SCL4022A	† SSS
	SCL4022AE	SSS
	CM4022A	† Solitron
	CM4022AE	Solitron
	TF4022A	† TI
	TP4022A	TI
	TC4022	Toshiba
Divide-by-60-Counter, BCD Output (Industrial Time Base Generator)	MC14566A	† Motorola
	MC14566C	Motorola
Presettable Divide-by-N Counter	F4018C	Fairchild
	F4018M	† Fairchild
	HD4018A-2 see page 266	† **Harris**
	HD4018A-9 see page 266	**Harris**
	CD4018A see page 375	† **RCA**
	CD4018AE see page 375	**RCA**
	CD4018C	National
	CD4018M	† National
	HBF4018AE	SGS
	SCL4018A	† SSS
	SCL4018AE	SSS
	CM4018A	† Solitron
	CM4018AE	Solitron
	TF4018A/B	† TI
	TP4018A/B	TI
	TC4018	Toshiba

Decoders

Function	Device	Source
BCD-to-Decimal Decoder	F4028C	Fairchild
	F4028M	† Fairchild
	HD4028A-2 see page 266	† **Harris**
	HD4028A-9 see page 266	**Harris**
	HD54C42 see page 266	† **Harris**
	HD74C42 see page 266	**Harris**
	MC14028A	† Motorola
	MC14028C	Motorola
	CD4028C	National
	MM54C42	† National
	CD4028M	† National
	MM74C42	National
	CD4028A see page 375	† **RCA**
	CD4028AE see page 375	**RCA**
	HBF4028AE	SGS
	SCL4028A	† SSS
	SCL4028AE	SSS
	CM4028A	† Solitron
	CM4028AE	Solitron
	SW4028AE (continued)	SW

† Military Temperature Range (—55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—CMOS (cont)

Decoders (cont)

Function	Device	Source
BCD-to-Decimal Decoder (continued)	MM54C42	† Teledyne S
	MM74C42	Teledyne S
	TF4028A	† TI
	TP4028A	TI
	TC4028	Toshiba
BCD-to-7-Segment Decoder	HD54C48	† Harris
	HD74C48	Harris
	MC14558A	† Motorola
	MC14558C	Motorola
	MM54C48	† National
	MM74C48	National
	MM54C48	† Teledyne S
	MM74C48	Teledyne S
	TC5002	Toshiba
4-Bit Latch/4-to-16-Line Decoder (High)	F4514C	Fairchild
	F4514M	† Fairchild
	MC14514A	† Motorola
	MC14514C	Motorola
	CD4514A/B see page 375	**† RCA**
	CD4514A/BE see page 375	**RCA**
	SCL4514A	† SSS
	CM4514B	† Solitron
	CM4514BE	Solitron
	TC4514	Toshiba
4-Bit Latch/4-to-16-Line Decoder (Low)	F4515C	Fairchild
	F4515M	† Fairchild
	MC14515A	† Motorola
	MC14515C	Motorola
	CD4515A/B see page 375	**† RCA**
	CD4515A/BE see page 375	**RCA**
	SCL4515A	† SSS
	CM4515B	† Solitron
	CM4515BE	Solitron
	TC4515	Toshiba
Dual Binary to 1 of 4 Decoder/Demultiplexer (High)	F4555C	Fairchild
	F4555M	† Fairchild
	MC14555A	† Motorola
	MC14555C	Motorola
	CD4555A/B see page 375	**† RCA**
	CD4555A/BE see page 375	**RCA**
	SCL4555A	SSS
Dual Binary to 1 of 4 Decoder/Demultiplexer (Low)	F4556C	Fairchild
	F4556M	† Fairchild
	MC14556A	† Motorola
	MC14556C	Motorola
	CD4556A/B see page 375	**† RCA**
	CD4556A/BE see page 375	**RCA**
	SCL4556A	SSS
4-Line-to-16-Line Decoder/De-Multiplexer	**HD54C154** see page 266 (continued)	**† Harris**

Decoders (cont)

Function	Device	Source
4-Line-to-16-Line Decoder/De-Multiplexer (continued)	**HD74C154** see page 266	**Harris**
	MM54C154	† National
	MM74C154	National
	MM54C154	† Teledyne S
	MM74C154	Teledyne S
1 of 8 Strobed Decoder	SCL4428AE	SSS
	SCL4428A	† SSS

Drivers

Function	Device	Source
BCD-to-7-Segment Latch/Decoder/Driver	F4511C	Fairchild
	F4511M	† Fairchild
	HD14511-2	† Harris
	HD14511-9	Harris
	MC14511A	† Motorola
	MC14511C	Motorola
	CD4511C	National
	CD4511M	† National
	CD4511A/B see page 375	**† RCA**
	CD4511A/BE see page 375	**RCA**
	SCL4511A	† SSS
	SCL4511AE	SSS
	CM4511B	† Solitron
	CM4511BE	Solitron
BCD-to-7-Segment Latch/Decoder/Driver (for liquid Crystal Displays)	HD14543-2	† Harris
	HD14543-9	Harris
	MC14543A	† Motorola
	MC14543C	Motorola
	SCL4543	SSS
BCD-to-7-Segment Liquid Crystal Decoder/Driver with "Display Frequency Output"	**CD4055A/B** see page 375	**† RCA**
	CD4055A/BE see page 375	**RCA**
BCD-to-7-Segment Liquid Crystal Decoder/Driver with Strobed-Latch Function	**CD4056A/B** see page 375	**† RCA**
	CD4056A/BE see page 375	**RCA**
4-Line Liquid Crystal Display Driver	**CD4054A/B** see page 375	**† RCA**
	CD4054A/BE see page 375	**RCA**
3½-Digit Liquid Crystal Display Driver	CM4117A	† Solitron
4-Digit Liquid Crystal Display Driver	5201	Intel
	5204	Intel
	5202	Intel
	5015	Nortec
	SCL5424	SSS
	SCL5441	SSS
8-Digit LED Display Driver	SCL5440A	† SSS
Dual High Voltage Driver, Source 250 ma	HD54C908	† Harris
	HD74C908	Harris
	MM74C908	National
	MM74C918	National

Drivers (cont)

Dual and Quad Line Drivers— See Miscellaneous

Flip-Flops

Function	Device	Source
Dual "D" Flip-Flop	F4013C	Fairchild
	F4013M	† Fairchild
	MEM4013D	† GI
	MEM4013P	GI
	HD4013A-2	† Harris
	HD4013A-9	Harris
	HD54C74	† Harris
	HD74C74	Harris
	MC14013A	† Motorola
	MC14013C	Motorola
	CD4013C	National
	CD4013M	† National
	MM54C74	† National
	MM74C74	National
	CD4013A/B see page 375	**† RCA**
	CD4013A/BE see page 375	**RCA**
	HBF4013AE	SGS
	SCL4013A	† SSS
	SCL4013AE	SSS
	CM4013A	† Solitron
	CM4013AE	Solitron
	SW4013AE	SW
	MM54C74	† Teledyne S
	MM74C74	Teledyne S
	TF4013A/B	† TI
	TP4013A/B	TI
	TC4013	Toshiba
Quad "D" Flip-Flop	F40175C	Fairchild
	F40175M	† Fairchild
	HD54C175	† Harris
	HD74C175	Harris
	MC14175BA	† Motorola
	MC14175BC	Motorola
	MM54C175	† National
	MM74C175	National
Quad "D" Flip-Flop Three-State	F4076C	Fairchild
	F4076M	† Fairchild
	HD54C173	† Harris
	HD74C173	Harris
	MC14076A	† Motorola
	MC14076C	Motorola
	MM54C173	† National
	MM74C173	National
	CD4076BC	National
	CD4076BM	† National
	CD4076A/B see page 375	**† RCA**
	CD4076A/BE see page 375	**RCA**
	SCL4076AE	SSS
	SCL4076A	† SSS
	CM4076A/B	† Solitron
	CM4076A/BE	Solitron
	MM54C173	† Teledyne S
	MM74C173	Teledyne S

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

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DIGITAL—CMOS (cont)

Flip-Flops (cont)

Function	Device	Source
Hex "D" Flip-Flop	F40174C	Fairchild
	F40174M	† Fairchild
	HD54C174	† Harris
	HD74C174	Harris
	MC14174BA	† Motorola
	MC14174BC	Motorola
	MM54C174	† National
	MM74C174	National
	TF4370A	† TI
	TP4370A	TI
Dual "J-K" Flip-Flop	F4027C	Fairchild
	F4027M	† Fairchild
	HD4027A-2	† Harris
	HD4027A-9	Harris
	HD54C76	† Harris
	HD74C76	Harris
	MC14027A	† Motorola
	MC14027C	Motorola
	CD4027C	National
	CD4027M	† National
	MM54C76	† National
	MM74C76	National
	CD4027A/B see page 375	**† RCA**
	CD4027A/BE see page 375	**RCA**
	HBF4027AE	SGS
	SCL4027A	† SSS
	SCL4027AE	SSS
	CM4027A	† Solitron
	CM4027AE	Solitron
	SW4027AE	SW
	MM54C76	† Teledyne S
	MM74C76	Teledyne S
	TF4027A	† TI
	TP4027A	TI
	TC4027	Toshiba
	TC7476	Toshiba
Dual "J-K" Flip-Flop W/O Preset	HD54C73	† Harris
	HD74C73	Harris
	HD54C107	† Harris
	HD74C107	Harris
	MM54C73	† National
	MM74C73	National
	MM54C107	† National
	MM74C107	National
	MM54C73	† Teledyne S
	MM74C73	Teledyne S
	MM54C107	† Teledyne S
	MM74C107	Teledyne S
AND Gated "J-K" Flip-Flop	**CD4095A/B** see page 375	**† RCA**
	CD4095A/BE see page 375	**RCA**
	CD4096A/B see page 375	**† RCA**
	CD4096A/BE see page 375	**RCA**

Gates, AND/NAND

Function	Device	Source
Dual 4-Input AND Gate	F4082C	Fairchild
	F4082M	† Fairchild
	MC14082BA	† Motorola
	MC14082BC	Motorola
	CD4082A/B see page 375	**† RCA**
	CD4082A/BE see page 375	**RCA**
	SCL4082A	SSS
	SCL4082AE	† SSS
	TC4082	Toshiba
Triple 3-Input AND Gate	F4073C	Fairchild
	F4073M	† Fairchild
	MC14073BA	† Motorola
	MC14073BC	Motorola
	CD4073A/B see page 375	**† RCA**
	CD4073A/BE see page 375	**RCA**
	SCL4073A	† SSS
	SCL4073AE	SSS
	CM4073A/B	† Solitron
	CM4073A/BE	Solitron
	TF4073B	† TI
	TP4073B	TI
	TC4073	Toshiba
Quad 2-Input AND Gate	F4081C	Fairchild
	F4081M	† Fairchild
	HD54C08	† Harris
	HD74C08	Harris
	MC14081A/BA	Motorola †
	MC14081C/CB	Motorola
	MM54C08	† National
	MM74C08	National
	CD4081A/B see page 375	**† RCA**
	CD4081A/BE see page 375	**RCA**
	SCL4081A	† SSS
	SCL4081AE	SSS
	CM4081A/B	† Solitron
	CM4081A/BE	Solitron
	TF4081B	† TI
	TP4081B	TI
	TC4081	Toshiba
8-Input NAND Gate	F4068C	Fairchild
	F4068M	† Fairchild
	HD54C30	† Harris
	HD74C30	Harris
	MC14068BA	† Motorola
	MC14068BC	Motorola
	MC14501A	† Motorola
	MC14501C	Motorola
	MM54C30	† National
	MM74C30	National
	CD4068A/B see page 375	**† RCA**
	CD4068A/BE see page 375 (continued)	**RCA**

Gates, AND/NAND (cont)

Function	Device	Source
8-Input NAND Gate (continued)	SCL4412A	† SSS
	SCL4412AE	SSS
	CM4068A/B	† Solitron
	CM4068A/BE	Solitron
	TC4068	Toshiba
Dual 4-Input NAND Gate	F4012C	Fairchild
	F4012M	† Fairchild
	HD4012A-2	† Harris
	HD4012A-9	Harris
	HD54C20	† Harris
	HD74C20	Harris
	MC14012A/BA	Motorola †
	MC14012C/BC	Motorola
	CD4012C	National
	CD4012M	† National
	MM54C20	† National
	MM74C20	National
	CD4012A/B see page 375	**† RCA**
	CD4012A/BE see page 375	**RCA**
	HBF4012AE	SGS
	SCL4012A	† SSS
	SCL4012AE	SSS
	CM4012A	† Solitron
	CM4012AE	Solitron
	SW4012AE	SW
	MM54C20	† Teledyne S
	MM74C20	Teledyne S
	TF4012A/B	† TI
	TP4012A/B	TI
	TC4012	Toshiba
	TC7420	Toshiba
Dual 2-Input NAND Gate (Driver)	**CD40107A/B** see page 375	**† RCA**
	CD40107A/BE see page 375	**RCA**
Dual 4-Input Expandable NAND Gate	SCL4412A	† SSS
	SCL4412AE	SSS
Triple 3-Input NAND Gate	F4023C	Fairchild
	F4023M	† Fairchild
	HD4023A-2	† Harris
	HD4023A-9	Harris
	HD54C10	† Harris
	HD74C10	Harris
	MC14023A/BA	Motorola †
	MC14023C/BC	Motorola
	CD4023C	National
	CD4023M	† National
	MM54C10	† National
	MM74C10	National
	CD4023A/B see page 375	**† RCA**
	CD4023A/BE see page 375	**RCA**
	HBF4023AE	SGS
	SCL4023A	† SSS
	SCL4023AE	SSS
	CM4023A (continued)	† Solitron

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—CMOS (cont)

Gates, AND/NAND (cont)

Function	Device	Source
Triple 3-Input NAND Gate (continued)		
	CM4023AE	Solitron
	SW4023AE	SW
	MM54C10	† Teledyne S
	MM74C10	Teledyne S
	TF4023A/B	† TI
	TP4023A/B	TI
	TC4023	Toshiba
	TC7410	Toshiba
Quad 2-Input NAND Gate		
	F4011C	Fairchild
	F4011M	† Fairchild
	MEM4011D	† GI
	MEM4011P	GI
	HD4011A-2	† Harris
	HD4011A-9	Harris
	HD54C00	† Harris
	HD74C00	Harris
	MC14011A/BA	Motorola †
	MC14011C/BC	Motorola
	CD4011C	National
	CD4011M	† National
	MM54C00	† National
	MM74C00	National
	CD4011A/B see page 375	**† RCA**
	CD4011A/BE see page 375	**RCA**
	HBF4011AE	SGS
	SCL4011A	† SSS
	SCL4011AE	SSS
	CM4011A	† Solitron
	CM4011AE	Solitron
	SW4011AE	SW
	MM54C00	† Teledyne S
	MM74C00	Teledyne S
	TF4011A/B	† TI
	TP4011A/B	TI
	TF4311A	† TI
	TP4311A	TI
	TC4011	Toshiba
	TC7400	Toshiba

Gates, AND-OR/AND-OR-Invert

Function	Device	Source
Triple AND-OR Bi-Phase Pairs		
	CD4037A see page 375	**† RCA**
	CD4037AE see page 375	**RCA**
	CM4037A	† Solitron
	CM4037AE	Solitron
Quad AND-OR Select Gate		
	F4019C	Fairchild
	F4019M	† Fairchild
	F4519C	Fairchild
	F4519M	† Fairchild
	HD14519-2	† Harris
	HD14519-9	Harris
	HD4019A-2 see page 266	**† Harris**
	HD4019A-9 see page 266	**Harris**
	MC14519A (continued)	† Motorola

Gates, AND-OR/AND-OR-Invert (cont)

Function	Device	Source
Quad AND-OR Select Gate (continued)		
	MC14519C	Motorola
	CD4019C	National
	CD4019M	† National
	CD4019A see page 375	**† RCA**
	CD4019AE see page 375	**RCA**
	HBF4019AE	SGS
	SCL4019A	† SSS
	SCL4019AE	SSS
	CM4019A	† Solitron
	CM4019AE	Solitron
	SW4019AE	SW
	TF4019A	† TI
	TP4019A	TI
	TC4019	Toshiba
Quad AND-OR Select Gate, Three-State		
	CD40257A/B see page 375	**† RCA**
	CD40257A/BE see page 375	**RCA**
Dual 2-Wide 2-Input AND-OR-Invert Gate		
	F4085C	Fairchild
	F4085M	Fairchild
	MC14506A	† Motorola
	MC14506C	Motorola
	CD4085A/B see page 375	**† RCA**
	CD4085A/BE see page 375	**RCA**
4 Wide 2-Input Expandable AND-OR-Invert Gate		
	F4086C	Fairchild
	F4086M	† Fairchild
	CD4086A/B see page 375	**† RCA**
	CD4086A/BE see page 375	**RCA**
Quad 4-2-2-1-Input AND-OR-Invert Gate		
	TF4302A	TI
	TP4302A	TI
Quad 2-4-4-1-Input AND-OR-Invert Gate		
	TF4303A	TI
	TP4303A	TI

Gates, Exclusive OR/NOR

Function	Device	Source
Quad Exclusive OR Gate		
	F4030C	Fairchild
	F4030M	† Fairchild
	F4070C	Fairchild
	F4070M	† Fairchild
	HD4030A-2 see page 266	**† Harris**
	HD4030A-9 see page 266	**Harris**
	HD54C86	† Harris
	HD74C86	Harris
	MC14507A	† Motorola
	MC14507C	Motorola
	CD4030C	National
	CD4030M	† National
	CD4070BC	National
	CD4070BM	† National
	MM54C86	† National
	MM74C86 (continued)	National

Gates, Exclusive OR/NOR (cont)

Function	Device	Source
Quad Exclusive OR Gate (continued)		
	CD4030A see page 375	**† RCA**
	CD4030AE see page 375	**RCA**
	CD4070A/B see page 375	**† RCA**
	CD4070A/BE see page 375	**RCA**
	HBF4030AE	SGS
	SCL4030A	† SSS
	SCL4030AE	SSS
	SCL4070A	† SSS
	SCL4070AE	SSS
	CM4030A	† Solitron
	CM4030AE	Solitron
	CM4070A/B	† Solitron
	CM4070A/BE	Solitron
	SW4030AE	SW
	MM54C86	† Teledyne S
	MM74C86	Teledyne S
	TF4030A/B	† TI
	TP4030A/B	TI
	TF4507	† TI
	TP4507	TI
	TF4519A	† TI
	TP4519A	TI
	TC4030	Toshiba
Quad Exclusive NOR Gate		
	F4077C	Fairchild
	F4077M	† Fairchild
	F4519C	Fairchild
	F4519M	† Fairchild
	HD14519-2	† Harris
	HD14519-9	Harris
	MC14519A	† Motorola
	MC14519C	Motorola
	CD4077A/B see page 375	**† RCA**
	CD4077A/BE see page 375	**RCA**
	CM4077A/B	† Solitron
	CM4077A/BE	Solitron

Gates, OR/NOR

Function	Device	Source
Dual 4-Input OR Gate		
	F4072C	Fairchild
	F4072M	† Fairchild
	MC14072BA	† Motorola
	MC14072BC	Motorola
	CD4072A/B see page 375	**† RCA**
	CD4072A/BE see page 375	**RCA**
	SCL4072A	† SSS
	SCL4072AE	SSS
	TC4072	Toshiba
triple 3-Input OR Gate		
	F4075C	Fairchild
	F4075M	† Fairchild
	MC14075BA	† Motorola
	MC14075BC	Motorola
	CD4075A/B see page 375 (continued)	**† RCA**

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—CMOS (cont)

Gates, OR/NOR (cont)

Function	Device	Source
Triple 3-Input OR Gate (continued)		
	CD4075A/BE see page 375	**RCA**
	SCL4075A	† SSS
	SCL4075AE	SSS
	TC4075	Toshiba
quad 2-Input OR Gate	F4071C	Fairchild
	F4071M	† Fairchild
	HD54C32	† Harris
	HD74C32	Harris
	MC14071A/BA	Motorola †
	MC14071C/BC	Motorola
	MM54C32	† National
	MM74C32	National
	CD4071A/B see page 375	**† RCA**
	CD4071A/BE see page 375	**RCA**
	SCL4071A	† SSS
	SCL4071AE	SSS
	CM4071A/B	† Solitron
	CM4071A/BE	Solitron
	TF4071B	† TI
	TP4071B	TI
	TC4071	Toshiba
8- Input NOR Gate	F4078C	Fairchild
	F4078M	† Fairchild
	MC14078BA	† Motorola
	MC14078BC	Motorola
	CD4078A/B see page 375	**† RCA**
	CD4078A/BE see page 375	**RCA**
	SCL4402A	† SSS
	SCL4402AE	SSS
	CM4078A/B	† Solitron
	CM4078A/BE	Solitron
	TC4078	Toshiba
Dual 3-Input NOR Gate plus Inverter	HD4000A-2	† Harris
	HD4000A-9	Harris
	MC14000A	† Motorola
	MC14000C	Motorola
	CD4000A/B see page 375	**† RCA**
	CD4000A/BE see page 375	**RCA**
	SCL4000A	† SSS
	SCL4000AE	SSS
	CM4000A	Solitron
	CM4000AE	Solitron
	TF4000A/B	† TI
	TP4000A/B	TI
Dual 4-Input NOR Gate	F4002C	Fairchild
	F4002M	† Fairchild
	HD4002A-2	† Harris
	HD4002A-9	Harris
	MC14002A/BA	Motorola †
	MC14002C/BC	Motorola
	CD4002C	National
	CD4002M (continued)	† National

Gates, OR/NOR (cont)

Function	Device	Source
Dual 4-Input NOR Gate (continued)		
	CD4002A/B see page 375	**† RCA**
	CD4002A/BE see page 375	**RCA**
	HBF4002AE	SGS
	SCL4002A	† SSS
	SCL4002AE	SSS
	CM4002A	† Solitron
	CM4002AE	Solitron
	SW4002AE	SW
	TF4002A/B	† TI
	TP4002A/B	TI
	TC4002	Toshiba
Dual 4-Input Expandable NOR Gate	SCL4402A	† SSS
	SCL4402AE	SSS
Triple 3-Input NOR Gate	F4025C	Fairchild
	F4025M	† Fairchild
	HD4025A-2	† Harris
	HD4025A-9	Harris
	MC14025A/BA	Motorola †
	MC14025C/BC	Motorola
	CD4025C	National
	CD4025M	† National
	CD4025A/B see page 375	**† RCA**
	CD4025A/BE see page 375	**RCA**
	HBF4025AE	SGS
	SCL4025A	SSS
	SCL4025AE	SSS
	CM4025A	Solitron
	CM4025AE	Solitron
	SW4025AE	SW
	TF4025A/B	† TI
	TP4025A/B	TI
	TC4025	Toshiba
Quad 2-Input NOR Gate	F4001C	Fairchild
	F4001M	† Fairchild
	MEM4001D	† GI
	MEM4001P	GI
	HD4001A-2	† Harris
	HD4001A-9	Harris
	HD54C02	† Harris
	HD74C02	Harris
	MC14001A/BA	Motorola †
	MC14001C/BC	Motorola
	CD4001C	National
	CD4001M	† National
	MM54C02	† National
	MM74C02	National
	CD4001A/B see page 375	**† RCA**
	CD4001A/BE see page 375	**RCA**
	HBF4001AE	SGS
	SCL4001A	† SSS
	SCL4001AE	SSS
	CM4001A	† Solitron
	CM4001AE	Solitron
	SW4001AE (continued)	SW

Gates, OR/NOR (cont)

Function	Device	Source
Quad 2-Input NOR Gate (continued)	MM54C02	† Teledyne S
	MM74C02	Teledyne S
	TF4001A/B	† TI
	TP4001A/B	TI
	TF4301A	† TI
	TP4301A	TI
	TC4001	Toshiba

Gates, Miscellaneous

Function	Device	Source
8-Input Expandable Multifunction Gate	CD4048C	National
	CD4048M	† National
	CD4048A see page 375	**† RCA**
	CD4048AE see page 375	**RCA**
	SCL4402A	† SSS
	SCL4402AE	SSS
	CM4048A	† Solitron
	CM4048AE	Solitron
Triple Gate (dual 4-input NAND and 2-input OR/NOR)	MC14501A	† Motorola
	MC14501C	Motorola
Hex Function Gate	MC14572A	† Motorola
	MC14572C	Motorola
Dual 5-Input Majority Logic Gate	MC14530A	† Motorola
	MC14530C	Motorola

Latches

Function	Device	Source
8-Bit AND Gated Addressable Latch	F4724C	Fairchild
	F4724M	† Fairchild
	CD4099A/B see page 375	**† RCA**
	CD4099A/BE see page 375	**RCA**
Quad Clocked "D" Latch	F4042C	Fairchild
	F4042M	† Fairchild
	HD4042A-2	† Harris
	MC14042A	† Motorola
	MC14042C	Motorola
	CD4042C	National
	CD4042M	† National
	CD4042A/B see page 375	**† RCA**
	CD4042A/BE see page 375	**RCA**
	HBF4042AE	SGS
	N4042B	Signetics
	SCL4042A	† SSS
	SCL4042AE	SSS
	CM4042A	† Solitron
	CM4042AE	Solitron
	TF4042A/B	† TI
	TP4042A/B	TI
	TC4042	Toshiba
Quad NAND R/S Latch	F4044C	Fairchild
	F4044M	† Fairchild
	HD4044A-2	† Harris
	HD4044A-9	Harris
	MC14044BA (continued)	† Motorola

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—CMOS (cont)

Latches (cont)

Function	Device	Source
Quad NAND R/S Latch (continued)		
	MC14044BC	Motorola
	CD4044C	National
	CD4044M	† National
	CD4044A/B see page 375	**† RCA**
	CD4044A/BE see page 375	**RCA**
	SCL4044A	† SSS
	SCL4044AE	SSS
	CM4044A	† Solitron
	TF4044A/B	† TI
	TP4044A/B	TI
	TC4044	Toshiba
Quad NAND Latch		
	TF4376B	† TI
	TP4376B	TI
Quad NOR R/S Latch		
	F4043C	Fairchild
	F4043M	† Fairchild
	HD4043A-2	† Harris
	HD4043A-9	Harris
	MC14043BA	† Motorola
	MC14043BC	Motorola
	CD4043C	National
	CD4043M	† National
	CD4043A/B see page 375	**† RCA**
	CD4043A/BE see page 375	**RCA**
	SCL4043A	† SSS
	SCL4043AE	SSS
	CM4043A	† Solitron
	CM4043AE	Solitron
	TF4043A/B	† TI
	TP4043A/B	TI
	TC4043	Toshiba
Quad NOR Latch		
	TF4377B	† TI
	TP4377B	TI
Dual 4-Bit Latch		
	MC14508A	† Motorola
	MC14508C	Motorola
	CD4508A/B see page 375	**† RCA**
	CD4508A/BE see page 375	**RCA**
	CM4508B	† Solitron
	CM4508BE	Solitron
	TC4508	Toshiba
Dual 4-Bit Addressable Latch		
	F4723	Fairchild

Memories

For additional information see Master Selection Guide - Memory Sections.

Function	Device	Source
16-Bit FIFO (4x4)		
	CD40105B see page 375	**† RCA**
	CD40105BE see page 375	**RCA**
64-Bit FIFO (16x4)		
	F4703C	Fairchild
	F4703M	† Fairchild
64-Bit Program Stack (16x4 FIFO)		
	F4706C	Fairchild
	F4706M	† Fairchild

Memories (cont)

Function	Device	Source
16-Bit Multiport Register File (4x4 Read While Write RAM)		
	MC14580A	† Motorola
	MC14580C	Motorola
	CD40108A/B see page 375	**† RCA**
	CD40108A/BE see page 375	**RCA**
	SCL4580	SSS
64-Bit CAM (8x8 Content Addressable Memory)		
	SCM5533	† SSS
32-Bit RAM (Direct Word Line Addressing)		
	CD4039A see page 375	**† RCA**
	CD4039AE see page 375	**RCA**
	CM4039A	† Solitron
	CM4039AE	Solitron
32-Bit RAM (Binary Addressing)		
	CD4036A see page 375	**† RCA**
	CD4036AE see page 375	**RCA**
	CM4036A	† Solitron
	CM4036AE	† Solitron
64-Bit RAM (64x1)		
	MCM14505A	† Motorola
	MCM14505C	Motorola
64-Bit RAM (16x4)		
	F4725C	Fairchild
	F4725M	† Fairchild
	HD54/74C89 see page 266	**† Harris**
	MM54C89	† National
	MM74C89	National
	SCL5589	† SSS
	MM54C89	† Teledyne S
	MM74C89	Teledyne S
64-Bit RAM (16x4 clocked RAM, three state output register)		
	F4710	Fairchild
256-Bit RAM (256x1)		
	F4720	Fairchild
	HD54/74C200 see page 266	**† Harris**
	IM6523	† Intersil
	MCM14537A	† Motorola
	MCM14537C	Motorola
	MM54C200	† National
	MM74C200	National
	CD4061A see page 375	**† RCA**
	CD40061AE see page 375	**RCA**
	CD40061	RCA
	SCM5520S	† SSS
	MM54C200	† Teledyne S
	MM74C200	Teledyne S
	TC4061	Toshiba
256-Bit RAM (64x4)		
	MCM14552A	† Motorola
	MCM14552C	Motorola
	MM54C910	† National
	MM74C910	National
	SCM5555D	SSS
512-Bit RAM (512x1)		
	S2222 see page 706	**AMI**
	S2222A see page 706 (continued)	**AMI**

Memories (cont)

Function	Device	Source
512-Bit RAM (512x1) (continued)		
	2222	Nortec
	2222A	Nortec
	N2222	Signetics
	S2222	† Signetics
1,024-Bit RAM (256x4)		
	S5101 see page 716	**AMI**
	F4721	Fairchild
	5101 see page 960	**Intel**
	M5101-4	† Intel
	MWS5040 see page 786	**RCA**
	MWS5540 see page 786	**RCA**
	MW7040	RCA
	SCM5501S	† SSS
1,024-Bit RAM (1,024x1)		
	IM6508C	Intersil
	IM6508M	† Intersil
	IM6518C	Intersil
	IM6518M	Intersil
	MWS5001 see page 785	**RCA**
	MWS5501 see page 786	**RCA**
	MWS5002 see page 786	**RCA**
	MWS5502 see page 786	**RCA**
	MW7001I	RCA
	SCM5502S	† SSS
	SY5101	Synertek
	TC5006	Toshiba
1,024-Bit ROM (256x4)		
	MCM14524A	† Motorola
	MCM14524C	Motorola
	TC5007	Toshiba

Multiplexers, Digital

See also Interface—Analog Switches

Function	Device	Source
Quad 2-Input Multiplexer		
	F4519C	Fairchild
	F4519M	† Fairchild
	HD14519-2	† Harris
	HD14519-9	Harris
	HD54C157	† Harris
	HD74C157	Harris
	MC14519A	† Motorola
	MC14519C	Motorola
	MM54C157	† National
	MM74C157	National
	MM54C157	† Teledyne S
	MM74C157	Teledyne S
	TF4519A	† TI
	TP4519A	TI
Dual 4-Channel Digital Multiplexer		
	F4539C	Fairchild
	F4539M	† Fairchild
	MC14539A	† Motorola
	MC14539C	Motorola
	TC4539	Toshiba

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—CMOS (cont)

Multiplexers, Digital (cont)

Function	Device	Source
8-Channel Data Selector		
	F4512C	Fairchild
	F4512M	† Fairchild
	HD14512-2	† Harris
	HD14512-9	Harris
	MC14512A	† Motorola
	MC14512C	Motorola
	SCL4512A	† SSS
	SCL4512AE	SSS
	TF4512	† TI
	TP4512	TI
	TC4512	Toshiba
8-Channel Digital Multiplexer		
	HD54C151 see page 266	**† Harris**
	HD74C151 see page 266	**Harris**
	MM54C151	† National
	MM74C151	National
	MM54C151	† Teledyne S
	MM74C151	Teledyne S
Dual 8-Channel Digital Multiplexer		
	TF4321A	† TI
	TP4321A	TI
16-Channel Digital Multiplexer		
	TF4320A	† TI
	TP4320A	TI

Multivibrators

Function	Device	Source
Monostable/Astable Multivibrator		
	F4047C	Fairchild
	F4047M	† Fairchild
	CD4047A see page 375	**† RCA**
	CD4047AE see page 375	**RCA**
	CM4047A	† Solitron
	CM4047AE	Solitron
	TC4047	Toshiba
Dual Monostable Multivibrator		
	F4528C	Fairchild
	F4528M	† Fairchild
	HD14528-2	† Harris
	HD14528-9	Harris
	HD54C221	† Harris
	HD74C221	Harris
	MC14528A	† Motorola
	MC14528C	Motorola
	MM54C221	† National
	MM74C221	National
	CD4098A/B see page 375	**† RCA**
	CD4098A/BE see page 375	**RCA**
	SCL4528A	† SSS
	SCL4528AE	SSS
	TC4528	Toshiba

Oscillators/Dividers

Function	Device	Source
Oscillator/Divider (Programmable Timer)		
	MC14541A	† Motorola
	MC14541C	Motorola
Clock Generator, Oscillator to 10MHz, 8:1 divider, for microprocessors		
	ICM7209	† Intersil

Oscillators/Dividers (cont)

Function	Device	Source
Oscillator/2^3 Divider (2-5v supplies)		
	7209	Intersil
Oscillator/2^9 Divider		
	5801	Intel
	5016	Nortec
Oscillator/2^{11} to 2^{19} Divider		
	MC14451	Motorola
Oscillator/2^{13} and 2^{15} Divider (2-5v supplies)		
	7038A	Intersil
Oscillator/2^{13} and 2^{17} Divider (Also 2^{17}x10, 2-5v supplies)		
	7213	Intersil
Oscillator/2^{16} Divider/Buffer		
	MC14450	Motorola
	SCL5411	SSS
Oscillator/2^{21} Divider/Buffer		
	CD4045A see page 375	**† RCA**
	CD4045AE see page 375	**RCA**
	HBF4045AE	SGS
	SCL4445A	† SSS
	SCL4445AE	SSS
	CM4045A	† Solitron
	CM4045AE	Solitron
Oscillator/2^{22} Divider (with 1 second and 1 minute pulses using 4.193 MHz crystal, 2-5v supplies)		
	7213	Intersil
Oscillator/2^{23} Divider		
	SCL5419	SSS
Oscillator/2^{24} Divider		
	HD14521-2	† Harris
	HD14521-9	Harris
	MC14521A	† Motorola
	MC14521C	Motorola
Frequency Divider (9-Stage)		
	SCL5425A	SSS
	SCL5427A	SSS
	SCL5437A	SSS
Divider, divide by 5/6		
	RED5/6	LSI Comp
Divider, divide by 6		
	D6	LSI Comp
Divider, divide by 50/60		
	RED50/60	LSI Comp
Divider, divide by 60		
	D60	LSI Comp
Divider, divide by 3000/3600		
	RED3000/3600	LSI Comp
Divider, divide by 3600		
	D3600	LSI Comp

Shift Registers

Function	Device	Source
4-Bit Parallel In/Parallel Out Shift Register		
	F4035C	Fairchild
	F4035M	† Fairchild
	HD4035A-2 see page 266	**† Harris**
	HD4035A-9 see page 266	**Harris**
	MC14035A	† Motorola
	MC14035C	Motorola
	CD4035C	National
	CD4035M	† National
	CD4035A see page 375	**† RCA**
	CD4035AE see page 375	**RCA**
	HBF4035AE	SGS
	SCL4035A	† SSS
	SCL4035AE	SSS
	CM4035A	† Solitron
	CM4035AE	Solitron
	TF4035A/B (continued)	† TI

Shift Registers (cont)

Function	Device	Source
4-Bit Parallel In/Parallel Out Shift Register (continued)		
	TP4035A/B	TI
	TC4035	Toshiba
4-Bit Parallel Shift Register		
	F40195C	Fairchild
	F40195M	† Fairchild
	HD54/74C195 see page 266	**† Harris**
	MM54C195	† National
	MM74C195	National
	MM54C195	† Teledyne S
	MM74C195	Teledyne S
4-Bit Bidirectional Shift Register		
	F40194C	Fairchild
	F40194M	† Fairchild
	HD54/74C95 see page 266	**† Harris**
	MC14194BA	† Motorola
	MC14194BC	Motorola
	MM54C95	National
	MM74C95	† National
	CD40194A/B see page 375	**† RCA**
	CD40194A/BE see page 375	**RCA**
	MM54C95	† Teledyne S
	MM74C95	Teledyne S
4-Bit Bidirectional Shift Register, Three-State		
	CD40104A/B see page 375	**† RCA**
	CD40104A/BE see page 375	**RCA**
Dual 4-Bit Serial In/Parallel Out Shift Register		
	F4015C	Fairchild
	F4015M	† Fairchild
	HD4015A-2 see page 266	**† Harris**
	HD4015A-9 see page 266	**Harris**
	MC14015A	† Motorola
	MC14015C	Motorola
	CD4015C	National
	CD4015M	† National
	CD4015A see page 375	**† RCA**
	CD4015AE see page 375	**RCA**
	HBF4015AE	SGS
	SCL4015A	† SSS
	SCL4015AE	SSS
	CM4015A	† Solitron
	CM4015AE	Solitron
	SW4015AE	SW
	TF4015A/B	† TI
	TP4015A/B	TI
	TC4015	Toshiba
8-Bit Sychronous Parallel In/Serial Out Shift Register		
	F4014C	Fairchild
	F4014M	† Fairchild
	HD4014A-2 see page 266	**† Harris**
	HD4014A-9 see page 266	**Harris**
	MC14014A	† Motorola
	MC14014C (continued)	Motorola

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—CMOS (cont)

Shift Registers (cont)

Function	Device	Source
8-Bit Sychronous Parallel In/Serial Out Shift Register (continued)	CD4014C	National
	CD4014M	† National
	CD4014A see page 375	**† RCA**
	CD4014AE see page 375	**RCA**
	HBF4014AE	SGS
	SCL4014A	† SSS
	SCL4014AE	SSS
	CM4014A	† Solitron
	CM4014AE	Solitron
	TF4014A/B	† TI
	TP4014A/B	TI
	TC4014	Toshiba
8-Bit (Asynchronous parallel or synchronous serial operation) Parallel In/Serial Out Shift Register	F4021C	Fairchild
	F4021M	† Fairchild
	HD4021A-2 see page 266	**† Harris**
	HD4021A-9 see page 266	**Harris**
	MC14021A	† Motorola
	MC14021C	Motorola
	CD4021C	National
	CD4021M	† National
	CD4021A see page 375	**† RCA**
	CD4021AE see page 375	**RCA**
	SCL4021A	† SSS
	SCL4021AE	SSS
	CM4021A	† Solitron
	CM4021AE	Solitron
	SW4021AE	SW
	TF4021A/B	† TI
	TP4021A/B	TI
	TC4021	Toshiba
8-Bit Serial In/Parallel Out Shift Register	**HD54/74C164** see page 266	† Harris Harris
	MM54C164	† National
	MM74C164	National
	MM54C164	† Teledyne S
	MM74C164	Teledyne S
8-Bit Parallel In/Serial Out Shift Register	**HD54/74C165** see page 266	**† Harris**
	MM54C165	† National
	MM74C165	National
8-Bit Bidirectional Parallel/Serial Input/Output Bus Register	F4034C	Fairchild
	F4034M	† Fairchild
	MC14034A	† Motorola
	MC14034C	Motorola
	SCL4034A	† SSS
	SCL4034AE	SSS
	CM4034A	† Solitron
	CM4034AE	Solitron
	CD4034A see page 375	**† RCA**
	CD4034AE see page 375 (continued)	**RCA**

Shift Registers (cont)

Function	Device	Source
8-Bit Bidirectional Parallel/Serial Input/Output Bus Register (continued)	TC4034	Toshiba
8-Bit Bus Register, Shift and Store	**CD4094A/B** see page 375	**† RCA**
	CD4094A/BE see page 375	**RCA**
18-Bit Static Shift Register	F4006C	Fairchild
	F4006M	† Fairchild
	HD4006A-2	† Harris
	HD4006A-9	Harris
	MC14006A	† Motorola
	MC14006C	Motorola
	CD4006C	National
	CD4006M	† National
	CD4006A see page 375	**† RCA**
	CD4006AE see page 375	**RCA**
	M5612	† Ragen
	SCL4006A	† SSS
	SCL4006AE	SSS
	CM4006A	† Solitron
	CM4006AE	Solitron
32-Bit Bidirectional Serial In/Serial Out Shift Register	**CD40100A/B** see page 375	**† RCA**
	CD40100A/BE see page 375	**RCA**
64-Bit Static Shift Register	F4031C	Fairchild
	F4031M	† Fairchild
	MC14557A	† Motorola
	MC14557C	Motorola
	CD4031C	National
	CD4031M	† National
	CD4031A see page 375	**† RCA**
	CD4031AE see page 375	**RCA**
Dual 64-Bit Static Shift Register	MC14517A	† Motorola
	MC14517C	Motorola
	SCL4517	SSS
128-Bit Static Shift Register	MC14562A	† Motorola
	MC14562C	Motorola
200 Bit Dynamic Shift Register	**CD4062A** see page 375	**† RCA**
	CD4062AE see page 375	**RCA**
Quad 64-Bit Static Shift Register, Separate Clock	F4731	Fairchild
64-Bit Variable Length Shift Register	MC14557A	† Motorola
	MC14557C	Motorola
96-Bit Variable Length Elastic Shift Register	MS618	† Ragen
128-Bit Static Shift Register, W/Control Logic	MS625	† Ragen
250-Bit Variable Length Dynamic Shift Register	SC370	Siliconix

Translators

Function	Device	Source
Quad Voltage Up Level Translator	F4104C	Fairchild
	F4104M	† Fairchild
	MEM4900D (continued)	† GI

Translators (cont)

Function	Device	Source
Quad Voltage Up Level Translator (continued)	MEM4900P	GI
	CM4104A	† Solitron
	CM4104AE	Solitron
Quad Level Shifter (low to high voltage)	**CD40109A/B** see page 375	**† RCA**
	CD40109A/BE see page 375	**RCA**
Hex TTL Buffer (Inverting) (CMOS To TTL)	HD54C901	† Harris
	HD74C901	Harris
	MM54C901	† National
	MM74C901	National
Hex TTL Buffer (Non-Inverting) (CMOS To TTL)	HD54C902	† Harris
	HD74C902	Harris
	MM54C902	† National
	MM74C902	National
Hex PMOS Buffer (Inverting) (PMOS To CMOS or TTL)	HD54C903	† Harris
	HD74C903	Harris
	MM54C903	† National
	MM74C903	National
Hex PMOS Buffer (Non-Inverting) (PMOS To CMOS or TTL)	HD54C904	† Harris
	HD74C904	Harris
	MM54C904	† National
	MM74C904	National
HNIL/HTL is Suitable for Translation/input protection. See HNIL/HTL section		

Miscellaneous

Function	Device	Source
Phase-Locked Loop	F4046C	Fairchild
	F4046M	† Fairchild
	MC14046A	† Motorola
	MC14046C	Motorola
	CD4046A see page 375	**† RCA**
	CD4046AE see page 375	**RCA**
	SCL4046A	† SSS
	SCL4046AE	SSS
	SCL4446	SSS
CMOS Transistor Array (See also 4007 Dual Complementary Pair and Inverter-listed under Buffers/Inverters)	CA3600E	† RCA
Hex Contact Bounce Eliminator	MC14490	Motorola
	MC14490E	† Motorola
8-Bit Priority Encoder	F4532C	Fairchild
	F4532M	† Fairchild
	MC14532A	† Motorola
	MC14532C	Motorola
	CD4532A/B see page 375	**† RCA**
	CD4532A/BE see page 375	**RCA**
	TC4532	Toshiba
Binary Rate Multiplier	**CD4089A/B** see page 375	**† RCA**
	CD4089A/BE see page 375	**RCA**

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—CMOS (cont)

Miscellaneous (cont)

Function	Device	Source
BCD Rate Multiplier		
	HD14527-2	† Harris
	HD14527-9	Harris
	MC14527A	† Motorola
	MC14527C	Motorola
	CD4527A/B see page 375	**† RCA**
	CD4527A/BE see page 375	**RCA**
	SCL4527A	† SSS
	SCL4527AE	SSS
Bit Rate Generator		
	F4702C	Fairchild
	F4702M	† Fairchild
	MC14411	Motorola
Dual Differential Line Driver		
	HD88C30	Harris
	MM78C30	† National
	MM88C30	National
Quad Single Ended Line Driver		
	HD88C29	Harris
	MM78C29	† National
	MM88C29	National
Dual Line Receiver		
	MM78C20	† National
	MM88C20	National
Successive Approximation Register		
	HD54C905	† Harris
	HD74C905	Harris
	MC14559A	† Motorola
	MC14559C	Motorola
	MM54C905	† National
	MM74C905	National
Successive Approximation Register, Cascadable		
	MC14549A	† Motorola
	MC14549C	Motorola
Digital Logic (for 3½ digit A/D Systems)		
	MC14435	Motorola
	MC14435E	† Motorola
9-Bit Parity Generator and Checker		
	CD40101A/B see page 375	**† RCA**
	CD40101A/BE see page 375	**RCA**
12-Bit Parity Tree		
	F4531C	Fairchild
	F4531M	† Fairchild
	MC14531A	† Motorola
	MC14531C	Motorola
	SCL4531A	SSS
	TF4531A	† TI
	TP4531A	TI
Dual Schmitt Trigger		
	MC14583A	† Motorola
	MC14583C	Motorola
	TC4583	Toshiba
Quad Schmitt Trigger		
	HD54C909	† Harris
	HD74C909	Harris
	MM54C909	† National
	MM74C909	National
Hex Schmitt Trigger		
	F40014C	Fairchild
	F40014M	† Fairchild
	HD54C14	† Harris
	HD54C914	† Harris
	HD74C14	Harris
	HD74C914	Harris
	CD40106BC	National
	CD40106BM (continued)	† National

Miscellaneous (cont)

Function	Device	Source
Hex Schmitt Trigger (continued)		
	MM54C14	† National
	MM54C914	† National
	MM74C14	National
	MM74C914	National
	TF4304A	† TI
	TP4304A	TI
Quad 2-Input NAND Schmitt Trigger		
	CD4093A/B see page 375	**† RCA**
	CD4093A/BE see page 375	**RCA**
Binary to Pulse Converter		
	MC14408	Motorola
	MC14409	Motorola
Modem (0-600 bps)		
	MC14412	Motorola
Tone Encoder (4x4 input, 2 Outputs)		
	MC14410	Motorola
2 of 8 Keyboard to Binary Encoder		
	MC14419	Motorola
Programmable Timer		
	MC14536A	† Motorola
	MC14536C	Motorola
	MC14541A	† Motorola
	MC14541C	Motorola
Quad Precision Timer/Driver (Inputs cause outputs to switch state for 100 clock pulses)		
	MC14415	Motorola
	MC14415E	† Motorola
Standaridized CMOS Array, to build custom circuits by changing final metalization		
	MasterMOS	IMI
	MonochipM	Interdesign
Low voltage CMOS devices (Counters, Display Drivers, Counter-Timers) not usually mixed with 5-20v CMOS logic are listed under Digital-Special		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—ECL

ECL-10000 Series

The ECL-10000, 95000, 100K and III - Series are presented as separate groups in that sequence.

Arithmetic Functions

Function	Device	Source
Dual High Speed Adder/Subtractor	F10180	Fairchild
	F10580	† Fairchild
	HD10180	Hitachi
	MC10180	Motorola
	10180	Signetics
	MC10580	† Motorola
	SN10180	TI
2-Bit Arithmetic Logic Unit/Function Generator	MC10182	Motorola
4-Bit Arithmetic Logic Unit/Function Generator	F10181	Fairchild
	F10581	† Fairchild
	HD10181	Hitachi
	MC10181	Motorola
	MC10581	† Motorola
	10181	Signetics
	SN10181	TI
2-Bit Multiplier, High Speed	MC10287	Motorola
4x2-Bit Multiplier	MC10183	Motorola
Look-Ahead Carry Circuit	F10179	Fairchild
	F10579	† Fairchild
	HD10179	Hitachi
	MC10179	Motorola
	MC10579	† Motorola
	10179	Signetics
	SN10179	TI
5-Bit Comparator	F10166	Fairchild
	F10566	† Fairchild
	MC10166	Motorola

Buffers

Function	Device	Source
Hex Buffer	10188	Signetics
Hex Inverter	10189	Signetics
Hex Inverter/Buffer	MC10195	Motorola
	10195	Signetics

Counters, Binary

Function	Device	Source
4-Bit Binary Counter	F10016C	Fairchild
	F10016M	† Fairchild
	MC10178	Motorola
	10178	Signetics
4-Bit Universal Binary Counter	F10136	Fairchild
	HD10136	Hitachi
	MC10136	Motorola
	MC10536	† Motorola
	SP10136	Plessey
	10136	Signetics
	SN10136	TI

Counters, Decade

Function	Device	Source
Bi-Quinary Counter	MC10138	Motorola
	10138	Signetics

Counters, Decade (cont)

Function	Device	Source
Decade Counter	F10010C	Fairchild
	F10010M	† Fairchild
Universal Decade Counter	F10137	Fairchild
	MC10137	Motorola
	MC10537	† Motorola
	SP10137	Plessey
	10137	Signetics
	SN10137	TI

Decoders

Function	Device	Source
Binary to 1-8 Decoder (High)	F10162	Fairchild
	F10562	† Fairchild
	HD10162	Hitachi
	MC10162	Motorola
	MC10562	† Motorola
	SP10162	Plessey
	10162	Signetics
	SN10162	TI
Binary to 1-8 Decoder (Low)	F10161	Fairchild
	F10561	† Fairchild
	HD10161	Hitachi
	MC10161	Motorola
	MC10561	† Motorola
	SP10161	Plessey
	10161	Signetics
	SN10161	TI
Dual Binary to 1-4 Decoder (High)	F10172	Fairchild
	F10572	† Fairchild
	MC10172	Motorola
	MC10572	† Motorola
	SP10172	Plessey
	10172	Signetics
	SN10172	TI
Dual Binary to 1-4 Decoder (Low)	F10171	Fairchild
	F10571	† Fairchild
	MC10171	Motorola
	MC10571	† Motorola
	SP10171	Plessey
	10171	Signetics
	SN10171	TI

Drivers

Function	Device	Source
Dual TTL/MST Bus Driver	MC10128	Motorola
	10128	Signetics
Triple 4-3-3 Input Bus Driver	F10123	Fairchild
	F10523	† Fairchild
	MC10123	Motorola
	MC10523	† Motorola
	10123	Signetics
	SN10123	TI
Quad Bus Driver	F10192	Fairchild
	10192	Signetics

Flip-Flops

Function	Device	Source
Dual "D" Master-Slave Flip-Flop	F10131	Fairchild
	F10231	Fairchild
	F10531	† Fairchild
	F10631	† Fairchild
	(continued)	

Flip-Flops (cont)

Function	Device	Source
Dual "D" Master-Slave Flip-Flop (continued)	HD10131	Hitachi
	MC10131	Motorola
	MC10231	Motorola
	MC10531	† Motorola
	MC10631	† Motorola
	SP10131	Plessey
	10131	Signetics
	10231	Signetics
	SN10131	TI
	SN10231	TI
Quad "D" Master-Slave Flip-Flop (with Common Reset)	SN10304	TI
Hex "D" Master-Slave Flip-Flop	F10176	Fairchild
	F10576	† Fairchild
	MC10176	Motorola
	MC10576	† Motorola
	10176	Signetics
	SN10176	TI
Hex "D" Master-Slave Flip-Flop (With Common Reset)	F10186	Fairchild
	F10586	† Fairchild
	MC10186	Motorola
	10186	Signetics
Dual "J-$\overline{K}$" Master-Slave Flip-Flop	SN10302	TI
Dual "J-$\overline{K}$" Master-Slave Flip-Flop	F10135	Fairchild
	F10535	† Fairchild
	MC10135	Motorola
	MC10535	† Motorola
	10135	Signetics
	SN10135	TI

Gates, AND/NAND

Function	Device	Source
Hex AND Gate	MC10197	Motorola
Dual 4-Input AND/NAND Gate	10108	Signetics
	SN10108	TI
Quad 2-Input Gate (3 AND, 1 AND/NAND)	F10104	Fairchild
	F10509	† Fairchild
	HD10104	Hitachi
	MC10104	Motorola
	MC10504	† Motorola
	10104	Signetics
	SN10104	TI

Gates, Exclusive OR/NOR

Function	Device	Source
Quad Exclusive OR Gate	F10113	Fairchild
	F10513	† Fairchild
	MC10113	Motorola
	10113	Signetics
	SN10113	TI
Triple 2-Input Exclusive OR/NOR Gate	F10507	† Fairchild
	HD10107	Hitachi
	F10107	Fairchild
	MC10107	Motorola
	MC10507	† Motorola
	SP10107	Plessey
	10107	Signetics
	SN10107	TI

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—ECL (cont)

Function	Device	Source
Gates, OR/NOR		
(Sequence OR, NOR, OR/NOR, Combinations)		
Dual 3-Input 3-Output OR Gate (Line Driver)	F10110	Fairchild
	F10210	Fairchild
	F10510	† Fairchild
	F10610	† Fairchild
	HD10110	Hitachi
	MC10110	Motorola
	MC10210	Motorola
	SP10110	Plessey
	10110	Signetics
	10210	Signetics
	SN10110	TI
	SN10210	TI
Dual 3-Input 3-Output NOR Gate (Line Driver)	F10111	Fairchild
	F10211	Fairchild
	F10511	† Fairchild
	F10611	† Fairchild
	HD10111	Hitachi
	MC10111	Motorola
	MC10211	Motorola
	DM10111	National
	SP10111	Plessey
	10111	Signetics
	10211	Signetics
	SN10111	TI
	SN10211	TI
Triple 4-3-3 Input NOR Gate	F10106	Fairchild
	F10506	† Fairchild
	HD10106	Hitachi
	MC10106	Motorola
	MC10506	† Motorola
	DM10106	National
	SP10106	Plessey
	10106	Signetics
	SN10106	TI
Quad 3-Input NOR Gate (One Input Common)	F10100	Fairchild
	MC10100	Motorola
	SP10100	Plessey
	10100	Signetics
	SN10100	TI
Dual 3-Input 3-Output (1 OR, 2 NOR) Gate (Line Driver)	F10212	Fairchild
	MC10212	Motorola
	DM10112	National
	SP10112	Plessey
	10112	Signetics
	10212	Signetics
	SN10112	TI
	SN10212	TI
Dual 4-5 Input OR/NOR Gate	F10109	Fairchild
	F10509	† Fairchild
	HD10109	Hitachi
	MC10109	Motorola
	MC10509	† Motorola
	DM10109	National
	SP10109	Plessey
	10109	Signetics
	SN10109	TI
Gates, OR/NOR (cont)		
Triple 2-3-2 Input OR/NOR Gate	F10105	Fairchild
	F10505	† Fairchild
	HD10105	Hitachi
	MC10105	Motorola
	MC10505	† Motorola
	DM10105	National
	SP10105	Plessey
	10105	Signetics
	SN10105	TI
Quad 2-Input OR/NOR Gate (One Input Common)	F10101	Fairchild
	F10501	† Fairchild
	HD10101	Hitachi
	MC10101	Motorola
	MC10501	† Motorola
	SP10101	Plessey
	10101	Signetics
	SN10101	TI
Quad 2-Input Gate (3 OR, 1 OR/NOR)	F10103	Fairchild
	F10503	† Fairchild
	MC10103	Motorola
	SP10103	Plessey
	10103	Signetics
	SN10103	TI
Quad 2-Input Gate (3 NOR, 1 OR/NOR)	F10102	Fairchild
	F10502	† Fairchild
	HD10102	Hitachi
	MC10102	Motorola
	MC10502	† Motorola
	SP10102	Plessey
	10102	Signetics
	SN10102	TI
Gates, OR-AND/OR-AND-Invert		
4-Wide 4-3-3-3 Input OR-AND Gate	F10119	Fairchild
	F10519	† Fairchild
	HD10119	Hitachi
	MC10119	Motorola
	MC10519	† Motorola
	MC10519	Motorola
	DM10119	National
	SP10119	Plessey
	10119	Signetics
	SN10119	TI
Dual 2-Wide 3-Input OR-AND Gate	F10118	Fairchild
	F10518	† Fairchild
	HD10118	Hitachi
	MC10118	Motorola
	MC10518	† Motorola
	DM10118	National
	SP10118	Plessey
	10118	Signetics
	SN10118	TI
4-Wide 3-Input OR-AND/OR-AND-Invert Gate	F10121	Fairchild
	F10521	† Fairchild
	HD10121	Hitachi
	MC10121	Motorola
	MC10521	† Motorola
	DM10121	National
	10121 (continued)	Signetics
Gates, OR-AND/OR-AND-Invert (cont)		
4-Wide 3-Input OR-AND/OR-AND-Invert Gate (continued)	SN10121	TI
Dual 2-Wide 2-3 Input OR-AND/OR-AND-Inverter Gate	F10117	Fairchild
	F10517	† Fairchild
	HD10117	Hitachi
	MC10117	Motorola
	MC10517	† Motorola
	DM10117	National
	SP10117	Plessey
	10117	Signetics
	SN10117	TI
Latches		
Dual "D" Clocked Latch	F10130	Fairchild
	F10530	† Fairchild
	HD10130	Hitachi
	MC10130	Motorola
	MC10530	† Motorola
	SP10130	Plessey
	10130	Signetics
	SN10130	TI
Quad "D" Latch, Gated Output; Active High Enable	F10133	Fairchild
	F10533	† Fairchild
	HD10133	Hitachi
	MC10133	Motorola
	MC10533	† Motorola
	10133	Signetics
	SN10133	TI
Quad "D" Latch, Gated Output, Active Low Enable	F10153	Fairchild
	F10553	† Fairchild
	MC10153	Motorola
	SN10153	TI
Quad Latch, Common Clock, Separate Output Enable	F10168	Fairchild
	F10568	† Fairchild
	MC10168	Motorola
	SN10168	TI
Quint Latch	F10175	Fairchild
	F10575	† Fairchild
	HD10175	Hitachi
	MC10175	Motorola
	MC10575	† Motorola
	10175	Signetics
	SN10175	TI
Dual 2 to 1 Multiplexer-Latch, Common Reset	F10132	Fairchild
	F10532	† Fairchild
	HD10132	Hitachi
	MC10132	Motorola
	10132	Signetics
	SN10132	TI
Dual 2 to 1 Multiplexer-Latch	F10134	Fairchild
	F10534	† Fairchild
	HD10134	Hitachi
	MC10134	Motorola
	10134	Signetics
	SN10134	TI
Quad 2-Input Multiplexer-Latch	F10173	Fairchild
	F10573	† Fairchild
	MC10173 (continued)	Motorola

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—ECL (cont)

Latches (cont)

Function	Device	Source
Quad 2-Input Multiplexer-Latch (continued)		
	10173	Signetics
	SN10173	TI

Memories

Function	Device	Source
For additional information, see Master Selection Guide—Memory sections		
RAM (8x2) Simultaneous Read-Write	MCM10143	Motorola
RAM (16x4)	F10145AC	Fairchild
	F10545AM	† Fairchild
	HD10145	Hitachi
	MCM10145	Motorola
	10145	Signetics
	SN10145	TI
RAM (64x 1)	MCM10142	Motorola
	SN10142	TI
RAM (64x1) 50 Ohm Drive	HD10148	Hitachi
	MCM10148	Motorola
	10148	Signetics
	SN10148	TI
RAM (64x1) 90 Ohm Drive	MCM10140	Motorola
	10140	Signetics
	SN10140	TI
RAM (64x1) Read-while-Write	10151	Signetics
RAM (128x1)	F10405C	Fairchild
	MCM10147	Motorola
	SN10147	TI
RAM (256x1)	F10410C	Fairchild
	MCM10144	Motorola
	10144	Signetics
	RC10144	Raytheon
	RI10144	Raytheon
	SN10144	TI
RAM (1024x1)	F10415C	Fairchild
	10146	Signetics
PROM (32x8)	**10139** **see page 831**	**Signetics**
	SN10139	TI
PROM (256x4)	F10416	Fairchild
	10149	MMI
	MCM10149	Motorola
	10149	Signetics

Multiplexers

Function	Device	Source
8 to 1 Multiplexer	F10164	Fairchild
	F10564	† Fairchild
	HD10164	Hitachi
	MC10164	Motorola
	MC10564	† Motorola
	10164	Signetics
	SN10164	TI
Dual 4 to 1 Multiplexer	F10174	Fairchild
	F10574	† Fairchild
	HD10174	Hitachi
	MC10174	Motorola
	10174	Signetics
	SN10174	TI
	MC10574	† Motorola

Multiplexers (cont)

Function	Device	Source
Quad 2 to 1 Multiplexer (Non-inverting)	F10158	Fairchild
	F10558	† Fairchild
	MC10158	Motorola
	10158	Signetics
	SN10158	TI
Quad 2 to 1 Multiplexer (Inverting With Enable)	F10159	Fairchild
	F10559	† Fairchild
	MC10159	Motorola
	10159	Signetics
	SN10159	TI

Shift Registers

Function	Device	Source
4-Bit Shift Register	F10000C	Fairchild
	F10000M	† Fairchild
4-Bit Universal Shift Register	F10141	Fairchild
	MC10141	Motorola
	MC10541	† Motorola
	10141	Signetics
	SN10141	TI
4-Bit Universal Shift Register, with Reset	SN10303	TI

Translators

Function	Device	Source
Dual ECL to MOS Translator	10127	Signetics
Dual ECL to MOS/TTL Translator	MC75358	Motorola
	MC75368	Motorola
	SN75358	TI
Triple ECL to NMOS Translator	MC10177	Motorola
	SN10177	TI
Quintuple ECL to MST Translator	SN10184	TI
Hex ECL to MST Translator	MC10191	Motorola
	10191	Signetics
Quad ECL to TTL Translator (Differential Input)	F10125	Fairchild
	F10525	† Fairchild
	HD10125	Hitachi
	MC10125	Motorola
	MC10525	† Motorola
	10125	Signetics
	SN10125	TI
Quad Differential Receiver/MST to ECL Translator	MC10190	Motorola
	10190	Signetics
Hex MST to ECL Translator	SN10185	TI
Quad TTL to ECL OR/NOR Translator	F10124	Fairchild
	F10524	† Fairchild
	HD10124	Hitachi
	MC10124	Motorola
	MC10524	† Motorola
	DM10124	National
	SP10124	Plessey
	10124	Signetics
	SN10124	TI

Miscellaneous

Function	Device	Source
Triple Differential Line Receiver	F10114	Fairchild
	F10116	Fairchild
	F10514	† Fairchild
	F10516	† Fairchild
	(continued)	

Miscellaneous (cont)

Function	Device	Source
Triple Differential Line Receiver (continued)	HD10116	Hitachi
	MC10114	Motorola
	MC10116	Motorola
	MC10216	Motorola
	MC10516	† Motorola
	MC10514	† Motorola
	MC10616	† Motorola
	DM10116	National
	10114	Signetics
	10116	Signetics
	10216	Signetics
	SN10114	TI
	SN10116	TI
	SN10216	TI
Quad Differential Line Receiver	F10115	Fairchild
	F10515	† Fairchild
	MC10115	Motorola
	MC10515	† Motorola
	DM10115	National
	SP10115	Plessey
	10115	Signetics
	SN10115	TI
Quad Bus Receiver	MC10129	Motorola
	10129	Signetics
Dual Simultaneous Bus Transceiver	MC10194	Motorola
8-Input Priority Encoder	F10165	Fairchild
	F10565	† Fairchild
	HD10165	Hitachi
	MC10165	Motorola
	10165	Signetics
9-Bit Parity Circuit (2 Carry Inputs)	F10170	Fairchild
	F10570	† Fairchild
	MC10170	Motorola
	10170	Signetics
12-Bit Parity Generator/Checker	F10160	Fairchild
	F10560	† Fairchild
	HD10160	Hitachi
	MC10160	Motorola
	MC10560	† Motorola
	10160	Signetics
	SN10160	TI
Error Detection/Correction Circuit	MC10163	Motorola
	MC10193	Motorola
Active Terminator	F10014	Fairchild

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL

Master Selection Guide

DIGITAL—ECL (cont)

Function	Device	Source	Line
ECL-95000 Series			
Counters			
Binary Counter	F95016	Fairchild	
Decade Counter	F95010	Fairchild	
Flip-Flops			
"J-K" Flip-Flop	F95029	Fairchild	
Dual "D" Master-Slave Flip Flop	F95231	Fairchild	
Gates, Exclusive OR/NOR			
Triple 2-Input Exclusive OR/NOR Gate	F95107	Fairchild	
Gates, OR/NOR			
(Sequence OR, NOR, OR/NOR,)			
Dual 3-Input 3-Output OR Gate (Line Driver)	F95110	Fairchild	
Dual 3-Input 3-Output NOR Gate (Line Driver)	F95111	Fairchild	
Triple 4-3-3 Input NOR Gate	F95106	Fairchild	
Quad 2-Input NOR (With Enable)	F95004	Fairchild	10
Dual 4-5 Input OR/NOR Gate	F95109	Fairchild	
Dual 4-Input OR/NOR Gate (With Enable)	F95002	Fairchild	
Triple 2-3-2 Input OR/NOR Gate	F95105	Fairchild	
Triple 2-Input OR/NOR Gate (With Enable)	F95003	Fairchild	
Quad 2-Input Gate (3 OR, 1 OR/NOR)	F95103	Fairchild	
Quad 2-Input Gate (3 NOR, 1 OR/NOR)	F95102	Fairchild	
Quad 2-Input OR/NOR Gate (One Input Common)	F95101	Fairchild	
Latches			
Dual "D" Clocked Latch	F95130	Fairchild	
Memories			
For additional information, See Master Selection Guide—Memory sections			
RAM, Scratch pad (4x4)	F95401C	Fairchild	20
RAM (16x4)	F95400C	Fairchild	
RAM (256x1)	F95410C	Fairchild	
RAM (1024x1)	F95415C	Fairchild	
Shift Registers			
4-Bit Shift Register	F95000	Fairchild	

Function	Device	Source	Line
Translators			
Quad TTL to ECL OR/NOR Translator	F95124	Fairchild	
Miscellaneous			
Triple Differential Line Receiver	F95116	Fairchild	
Quad Differential Line Receiver	F95115	Fairchild	

Function	Device	Source	Line
ECL—100K Series			
Arithmetic Functions			
4-Bit Binary/Decade Arithmetic Logic Unit	F100181	Fairchild	
Counters			
Multipurpose Counting Register	F100136	Fairchild	
Decoders			
Universal Decoder	F100170	Fairchild	30
Drivers			
Quad Driver	F100131	Fairchild	
Hex Bus Driver	F100151	Fairchild	
Gates, AND-OR-Invert			
Triple AND-OR-Invert Gate	F100117	Fairchild	
5-Wide AND-OR-Invert Gate	F100118	Fairchild	
Gates, Exclusive OR/NOR			
Quintuple Exclusive OR/NOR Gate	F100107	Fairchild	
Gates, OR/NOR			
Triple 5-Input OR/NOR Gate	F100101	Fairchild	
Quintuple 2-Input OR/NOR Gate	F100102	Fairchild	
Latches			
Triple D Latch	F100130	Fairchild	
Hex D Latch	F100150	Fairchild	
Memories			
RAM (16x4 Register File)	F100145	Fairchild	40
RAM (1024x1)	F100415	Fairchild	
Multiplexers			
16-Input Multiplexer	F100164	Fairchild	
Triple 4-Input Multiplexer	F100171	Fairchild	
Quad 2-Input Multiplexer with Latch	F100155	Fairchild	
Shift Registers			
8-Bit Universal Shift Register	F100141	Fairchild	
8-Bit Shift Matrix	F100158	Fairchild	
Miscellaneous			
Quintuple Line Receiver	F100114	Fairchild	
Dual 9-Bit Parity Generator/Checker	F100160	Fairchild	
Universal Priority Encoder	F100165	Fairchild	

† Military Temperature Range (—55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—ECL (cont)

Function	Device	Source
ECL-III Series		
Counters		
Binary Counter	MC1654	Motorola
Divide by 4 Counter (1 GHz)	11C05C	Fairchild
	11C05M	Fairchild
	MC1697	Motorola
	MC1699	Motorola
Divide by 4 Prescaler (1 GHz)	MC1697	Motorola
Bi-Quinary Counter	MC1678	Motorola
Decade Counter (1 GHz)	MC1696	Motorola
Flip-Flops		
Master-Slave "D" Flip-Flop	11C70	Fairchild
	MC1670	Motorola
	SP1670	Plessey
	SP1671	Plessey
Master-Slave "D" Flip-Flop (UHF Prescaler)	11C06	Fairchild
	MC1690	Motorola
	SP1690	Plessey
Dual Master-Slave "D" Flip-Flop	MC1605	Motorola
Dual, Clocked "R-S" Flip-Flop	MC1666	Motorola
	SP1666	Plessey
	SP1667	Plessey
Gates, Exclusive OR/NOR		
Triple 2-Input Exclusive OR GATE	MC1672	Motorola
	SP1672	Plessey
	SP1673	Plessey
Triple 2-Input Exclusive NOR Gate	MC1674	Motorola
	SP1674	Plessey
	SP1675	Plessey
Gates, OR/NOR		
Quad 2-Input OR Gate	MC1664	Motorola
	SP1664	Plessey
	SP1665	Plessey
Quad 2-Input NOR Gate	MC1662	Motorola
	SP1662	Plessey
	SP1663	Plessey
Dual 4-Input OR/NOR Gate	MC1660	Motorola
	SP1660	Plessey
	SP1661	Plessey
Dual 4-5 Input OR/NOR Gate	11C01	Fairchild
	MC1603	Motorola
	MC1688	Motorola
Triple 2-2-3-Input OR/NOR Gate	MC1602	Motorola
Quad 2-Input OR/NOR Gate	MC1601	Motorola
Latches		
Dual Clocked Latch	MC1668	Motorola
	SP1668	Plessey
	SP1669	Plessey

Function	Device	Source
Multivibrators		
Voltage Controlled Multivibrator	11C58	Fairchild
	MC1658	Motorola
	SP1658	Plessey
Shift Registers		
4-Bit Shift Register	MC1694	Motorola
Miscellaneous		
Dual Analog/Digital Comparator	MC1650	Motorola
	MC1651	Motorola
	SP1650	Plessey
	SP1651	Plessey
Triple Line Receiver	MC1604	Motorola
Quad Line Receiver	MC1692	Motorola
	SP1692	Plessey
Voltage Controlled Oscillator	MC1648	Motorola
	SP1648	Plessey

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—Industrial/Consumer Circuits

Calculator

Function	Part	Source
Calculating Circuits	**S9414** **S9651** **see page 254**	**AMI**
		Exetron
		EA
		GI
		Hitachi
		Hughes
		Intel
		ITT
		Litronix
		MOS
		Mostek
		National
		NEC
		Nitron
		Nortec
		OKI
		Panasonic
		Rockwell
		Signetics
		Synertek
		TI
		Western

Electronic Organ

Function	Part	Source
Delay Circuits		Reticon
Frequency Dividers	**S2193** **S2470** **see page 254**	**AMI**
		GI
		ITT
		Lithic Sys
		Motorola
		Mostek
		National
		NPC
		SGS
Tone Generators	**see page 255**	
	S1424A	**AMI**
	S2555	**AMI**
	S2556	**AMI**
	S2566	**AMI**
	S2567	**AMI**
	S8890	**AMI**
	S9660	**AMI**
		GI
		ITT
		Lithic Sys
		Motorola
		Mostek
		National
		Nitron
		NPC

Timekeeping

Function	Part	Source
Appliance Timers		AMI
		Motorola
		National

Timekeeping (cont)

Function	Part	Source
Clocks		AMI
		EA
		Fairchild
		GI
		Hitachi
		IMI
		Intersil
		ITT
		Litronix
		Mostek
		Motorola
		National
		Nortec
		OKI
		RCA
		Signetics
		Synertek
		SSS
		Sprague
Clock Radio Circuits		Fairchild
		Mostek
		National
Watch, Digital	**S1998A** **see page 260**	**AMI**
		Harris
		Hitachi
		ITT
		Hughes
		Intel
		IMI
		Intersil
		Litronix
		Micro Pwr
		Mostek
		Motorola
		National
		Nortec
		Panasonic
		RCA
		Rockwell
		Ragen
		Siliconix
		SSS
		Sprague
		Synertek
Watch, Analog (Hands)		Hughes
		Hitachi
		Intersil
		ITT
		Micro Pwr
		Motorola
		Panasonic
		SSS
		Synertek

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—HNIL/HTL

Function	Device	Source
Arithmetic Functions		
4-Bit Comparator	343A/C	Teledyne S
	343B/M	† Teledyne S
Buffers/Inverters		
See also: Gates, Miscellaneous		
Hex Inverter	MC680	Motorola
	MC690	Motorola
	H118	SGS
	332A/C	Teledyne S
	332B/M	† Teledyne S
Hex Inverter, Open Collector	MC681	Motorola
	MC689	Motorola
	H112	SGS
Hex Inverter, Strobed	ITT335-1	† ITT
	ITT335-5	ITT
	MC677	Motorola
	H119	SGS
	335A/C	Teledyne S
	335B/M	† Teledyne S
Hex Inverter, Strobed, Open Collector	ITT334-1	† ITT
	ITT334-5	ITT
	MC678	Motorola
	H115	SGS
	334A/C	Teledyne S
	334B/M	† Teledyne S
Counters		
Binary Counter	ITT372-1	† ITT
	ITT372-5	ITT
	MC685	Motorola
	H156	SGS
	372A/C	Teledyne S
	372B/M	† Teledyne S
Binary Up/Down Counter	374A/C	Teledyne S
	374B/M	† Teledyne S
Decade Counter	ITT371-1	† ITT
	ITT371-5	ITT
	MC684	Motorola
	H157	SGS
	371A/C	Teledyne S
	371B/M	† Teledyne S
Decade Up/Down Counter	373A/C	Teledyne S
	373B/M	† Teledyne S
Decoders/Drivers		
BCD to Seven Segment Decoder/Driver	383A/C	Teledyne S
	383B/M	† Teledyne S
BCD to Decimal Decoder, Open Collector	ITT381-1	† ITT
	ITT381-5	ITT
	381A/C	Teledyne S
	381B/M	† Teledyne S
BCD to Seven Segment Driver, Gas Discharge Driver	384A/C	Teledyne S
	384B/M	† Teledyne S
BCD to Decimal Decoder/Lamp Driver, Open Collector	ITT380-1	† ITT
	ITT380-5	ITT
	(continued)	
Decoders/Drivers (cont)		
BCD to Decimal Decoder/Lamp Driver, Open Collector (continued)	380A/C	Teledyne S
	380B/M	† Teledyne S
BCD to Decimal Decoder/Driver (for Gas Discharge Display Tubes)	MC676	Motorola
	H158	SGS
	382A/C	Teledyne S
	382B/M	† Teledyne S
Dual Power AND Driver, Open Collector and Open Emitter	MC699	Motorola
Dual 4-Input AND Driver, Expandable	H109	SGS
Dual 4-Input NAND Line Driver, Expandable	MC662	Motorola
Dual 5-Input Power NAND Driver	301A/C	Teledyne S
	301B/M	† Teledyne S
Dual 4-Input NAND Lamp/Relay Driver, Open Collector (to 30 v)	MC679	Motorola
Quad 2-Input Power NAND Driver, Open Collector	302A/C	Teledyne S
	302B/M	† Teledyne S
Flip-Flops		
Quad D Flip-Flop	ITT370-1	† ITT
	ITT370-5	ITT
	370A/C	Teledyne S
	370B/M	† Teledyne S
Master-Slave R-S Flip-Flop	MC664	Motorola
Master/Slave J-K or Set-Reset Flip-Flop	ITT311-1	† ITT
	ITT311-5	ITT
	311A/C	Teledyne S
	311B/M	† Teledyne S
Dual "J-K" Flip-Flop with Preset	H110	SGS
Dual "J-K" Flip-Flop with Preset and Clear	H111	SGS
Dual "J-K" Flip-Flop with Reset	MC663	Motorola
Dual "J-K" or Set-Reset Flip-Flop	ITT312-1	† ITT
	ITT312-5	ITT
	MC688	Motorola
	312A/C	Teledyne S
	312B/M	† Teledyne S
	313A/C	Teledyne S
	313B/M	† Teledyne S
Gates, AND/NAND		
Dual 2-Input AND Interface Buffer	391	Teledyne S
Dual 4-Input AND Interface Buffer	390	Teledyne S
Dual 4-Input NAND Gate	MC660	Motorola
	MC661	Motorola
Dual 2-Input NAND Interface Buffer	392	Teledyne S
Dual 4-Input NAND Interface Buffer	395	Teledyne S
Dual 4-Input NAND Gate, Expandable	H104	SGS
	H124	SGS
Dual 5-Input NAND Gate	ITT301-1	† ITT
	ITT301-5	ITT
	ITT 322-1	† ITT
	ITT 322-5	ITT
	301A/C	Teledyne S
	301B/M	† Teledyne S
	322A/C	Teledyne S
	322B/M	† Teledyne S
Gates, AND/NAND (cont)		
Triple 3-Input NAND Gate	MC670	Motorola
	MC671	Motorola
	H103	SGS
Quad 2-Input NAND Gate	ITT303-1	† ITT
	ITT303-5	ITT
	ITT321-1	† ITT
	ITT321-5	ITT
	ITT324-1	† ITT
	ITT324-5	ITT
	MC668	Motorola
	MC672	Motorola
	H102	SGS
	H122	SGS
	303A/C	Teledyne S
	303B/M	† Teledyne S
	321A/C	Teledyne S
	321B/M	† Teledyne S
	324A/C	Teledyne S
	324B/M	† Teledyne S
Quad 2-Input NAND Gate, Open Collector	ITT302-1	† ITT
	ITT302-5	ITT
	ITT323-1	† ITT
	ITT323-5	ITT
	302A/C	Teledyne S
	302B/M	† Teledyne S
	323A/C	Teledyne S
	323B/M	† Teledyne S
Quad 2,2,3,3-Input NAND Gate	ITT325-1	† ITT
	ITT325-5	ITT
	ITT326-1	† ITT
	ITT326-5	ITT
	325A/C	Teledyne S
	325B/M	† Teledyne S
	326A/C	Teledyne S
	326B/M	Teledyne S
Gates, OR/NOR		
Dual 2-Input OR Interface Buffer	393	Teledyne S
Dual 2-Input NOR Interface Buffer	394	Teledyne S
Quad 2-Input NOR Gate	306A/C	Teledyne S
	306B/M	† Teledyne S
Quad 2-Input NOR Gate, Open Collector	307A/C	Teledyne S
	307B/M	† Teledyne S
Gates, AND-OR-Invert		
Expandable AND-OR-Invert	344A/C	Teledyne S
	344B/M	† Teledyne S
Dual 2-Wide, 2-Input AND-OR-Invert Gate	MC673	Motorola
	MC674	Motorola
	341A/C	Teledyne S
	341B/M	† Teledyne S
Dual 2-Wide, 2-Input AND-OR-Invert Gate, Expandable	H105	SGS
Gates, Exclusive OR		
Quad 2-Input Exclusive OR Gate	MC683	Motorola

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—HNIL/HTL (cont)

Function	Device	Source
Gates, Miscellaneous		
Hex Inverter/Gate (Quad Inverter, Dual NAND Gate)	ITT333-1	† ITT
	ITT333-5	ITT
	333A/C	Teledyne S
	333B/M	† Teledyne S
Hex Inverter/Gate (Quad Inverter, Dual NAND Gate) Open Collector	ITT332-1	† ITT
	ITT332-5	ITT
	332A/C	Teledyne S
	332B/M	† Teledyne S
Dual 4-Input Gate Expander (for 600 Series)	MC669	Motorola
Dual 5-Input Gate Expander (for 300 Series)	331A/C	Teledyne S
	331B/M	† Teledyne S
	CA3094	† RCA
	CA3094A	† RCA
	CA3094B	† RCA
Latches		
Quad Latch	MC682	Motorola
Multiplexers		
8-Bit Multiplexer	350A/C	Teledyne S
	350B/M	† Teledyne S
Dual 4-Bit Multiplexer	351A/C	Teledyne S
	351B/M	† Teledyne S
Multivibrators		
Monostable Multivibrator	H117	SGS
Dual Monostable Multivibrator	ITT342-1	ITT
	ITT342-5	ITT
	MC667	Motorola
	342A/C	Teledyne S
	342B/M	† Teledyne S
Dual Retriggerable Monostable Multivibrator	347A/C	Teledyne S
	347B/M	† Teledyne S
Shift Registers		
4-Bit Parallel In Parallel Out Shift Register	MC686	Motorola
	375A/C	Teledyne S
	375B/M	† Teledyne S
Translators		
Dual Low to High Interface (TTL to HNIL)	362A/C	Teledyne S
	362B/M	† Teledyne S
Triple Low to High Translator (TTL to HTL)	MC666	Motorola
Quad Low to High Interface (TTL to HNIL)	H114	SGS
	363A/C	Teledyne S
	363B/M	† Teledyne S
Dual High to Low Interface (HNIL to DTL, TTL)	361A/C	Teledyne S
	361B/M	† Teledyne S
Dual Interface Element, (Line Driver, Receiver, ECL to TTL, MOS to TTL)	MC696	Motorola
Triple High to Low Translator (HTL to TTL)	MC665	Motorola
Quad High to Low Converter (Open Collector)	H113	SGS
Translators (cont)		
Hex Inverter/Interface (Low to High: TTL, CMOS to HTL, CMOS)	MC691	Motorola
Miscellaneous		
Dual Pulse Stretcher	MC675	Motorola
	349A/C	Teledyne S
	349B/M	† Teledyne S
Quad Schmitt Trigger/Line Receiver	367A/C	Teledyne S
	367B/M	† Teledyne S
Quad Schmitt Trigger/Line Receiver, Open Collector	368A/C	Teledyne S
	368B/M	† Teledyne S

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL

Function	Device	Source
Arithmetic Functions		
Gated Full Adder		
	5480	† Fairchild
	7480	Fairchild
	ITT5480	† ITT
	ITT7480	ITT
	MC5480	† Motorola
	MC7480	Motorola
	N7480	Signetics
	N8268	Signetics
	S5480	† Signetics
	S8268	† Signetics
	SW7480	SW
	SN5480	† TI
	SN7480	TI
2-Bit Binary Full Adder		
	5482	† Fairchild
	7482	Fairchild
	ZN5482	† Ferranti
	ZN7482	Ferranti
	HD2513	Hitachi
	ITT5482	† ITT
	ITT7482	ITT
	SW7482	SW
	SN5482	† TI
	SN7482	TI
4-Bit Binary Full Adder,		
	5483	† Fairchild
	7483	Fairchild
	54283	† Fairchild
	74283	Fairchild
	ZN5483A	† Ferranti
	ZN7483A	Ferranti
	HD2535	Hitachi
	ITT5483	† ITT
	ITT7483	ITT
	MC5483	† Motorola
	MC7483	Motorola
	DM5483	† National
	DM7483	National
	5483	† Raytheon
	7483	Raytheon
	54283	† Raytheon
	74283	Raytheon
	N7483	Signetics
	S5483	† Signetics
	SW7483	SW
	SN5483A	† TI
	SN7483A	TI
	SN54283	† TI
	SN74283	TI
4-Bit Full Adder with Output Latch		
	AM2506C	AMD
	AM2506M	AMD
NBCD Adder (Natural Binary Coded Decimal)		
	MC54456	† Motorola
	MC74456	Motorola
Dual Full Adder		
	9304C	AMD
	9304M	† AMD
	9304C	Fairchild
	9304M	† Fairchild
	ITT9304-1	† ITT
	ITT9304-5	ITT
	MC8304	Motorola
	(continued)	
Arithmetic Functions (cont)		
Dual Full Adder (continued)		
	MC9304	† Motorola
	RC9304	Raytheon
	RM9304	† Raytheon
Binary (4x2) Multiplier		
	9344C	Fairchild
	9344M	† Fairchild
TWO's Complement Multiplier (4x2)		
	AM2505C	AMD
	AM2505M	† AMD
	RC2505	Raytheon
	RM2505	† Raytheon
4-Bit-by-4-Bit Parallel Binary Multiplier (used with 54/74285)		
	54284	† MMI
	74284	MMI
	DM54284	† National
	SN74284	TI
4-Bit-by-4-Bit Parallel Binary Multiplier (used with 54/74284)		
	54285	† MMI
	74285	MMI
	SN54285	† TI
	SN74285	TI
4-Bit Multiplier, Three-State (two ICs to a set 7875A and 7875B)		
	DM7875	† National
	DM8875	National
4-Bit ALU with Lookahead Carry		
	9340C	AMD
	9340M	† AMD
	9340C	Fairchild
	9340M	† Fairchild
Arithmetic Logic Element		
	MC7260	Motorola
	MC8260	† Motorola
	RC8260	Raytheon
	RM8260	† Raytheon
	N8260	Signetics
	S8260	† Signetics
Fast Carry Extender (for 8260)		
	MC7261	Motorola
	MC8261	† Motorola
	RC8261	Raytheon
	RM8261	† Raytheon
	N8261	Signetics
	S8261	† Signetics
High Speed Arithmetic Logic Unit/Function Generator		
	9341C	AMD
	9341M	† AMD
	AM2506C	AMD
	AM2506M	† AMD
	SN54181	† AMD
	SN74181	AMD
	7341C	Fairchild
	9341C	Fairchild
	9341M	† Fairchild
	54181	† Fairchild
	74181	† Fairchild
	ZN54181	† Ferranti
	ZN74181	Ferranti
	HD2547	Hitachi
	MC54181	Motorola
	MC74181	Motorola
	DM54181	† National
	DM74181	National
	54181	† Raytheon
	74181	Raytheon
	RC9341	Raytheon
	RM9341	† Raytheon
	(continued)	
Arithmetic Functions (cont)		
High Speed Arithmetic Logic Unit/Function Generator (continued)		
	N74181	Signetics
	S54181	† Signetics
	SW7481	SW
	SN54181	† TI
	SN74181	TI
Look-Ahead Carry Generator		
	9342C	AMD
	9342M	† AMD
	SN54182	† AMD
	SN74182	AMD
	9342C	Fairchild
	9342M	† Fairchild
	54182	† Fairchild
	74182	Fairchild
	HD2562	Hitachi
	ITT54182	† ITT
	ITT74182	ITT
	MC54182	† Motorola
	MC74182	Motorola
	DM54182	† National
	DM74182	National
	RC9342	Raytheon
	RM9342	† Raytheon
	54182	† Raytheon
	74182	Raytheon
	N74182	Signetics
	S54182	† Signetics
	SW74182	SW
	SN54182	† TI
	SN74182	TI
4-Bit Magnitude Comparator		
	DM7200	† National
	DM8200	National
	N8269	Signetics
	S8269	† Signetics
4-Bit Magnitude Comparator, Separate A=B Output, Expandable		
	9324C	AMD
	9324M	† AMD
	5485	† Fairchild
	7485	Fairchild
	9324C	Fairchild
	9324M	† Fairchild
	ZN5485	† Ferranti
	ZN7485	Ferranti
	HD7485	Hitachi
	MC8324	Motorola
	MC9324	† Motorola
	DM5485	† National
	DM7485	National
	N7485	Signetics
	S5485	† Signetics
	SW7485	SW
	SN5485	† TI
	SN7485	TI
	7485	TRW
Dual 4-Bit Magnitude Comparator		
	MC4022	Motorola
Dual 4-Bit Magnitude Comparator Open Collector		
	MC4021	Motorola
6-Bit Identity Comparator		
	DM7160	† National
	DM8160	National
10-Bit Identity Comparator		
	DM7130	† National
	DM8130	National

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL (cont)

Arithmetic Functions (cont)

Function	Device	Source	Line
6-Bit, Unified Bus Comparator, Active Pull Up			
	DM7131	† National	
	DM8131	National	
6-Bit Unified Bus Comparator, Open Collector			
	DM7136	† National	
	DM8136	National	

Buffers/Inverters

Function	Device	Source	Line
Quad Gated Buffer, Three-State			
	54125	† Fairchild	
	74125	Fairchild	
	HD74125	Hitachi	
	DM7093	† National	
	DM8093	National	
	DM54125	† National	10
	DM74125	National	
	N74125	Signetics	
	S54125	† Signetics	
	SN54125	† TI	
	SN54425	† TI	
	SN74125	TI	
	SN74425	TI	
Quad Gated Buffer, Three-State (Inverted Control)			
	54126	† Fairchild	
	74126	Fairchild	
	HD74126	Hitachi	20
	DM7094	† National	
	DM8094	National	
	DM54126	† National	
	DM74126	National	
	N74126	Signetics	
	S54126	† Signetics	
	SN54126	† TI	
	SN74126	TI	
	SN54426	† TI	
	SN74426	TI	30
Hex Buffer, Three-State			
	DM7095	† National	
	DM7097	† National	
	DM8095	National	
	DM8097	National	
	DM54365	† National	
	DM74365	National	
	DM54367	† National	
	DM74367	National	
	N8T95	Signetics	
	N8T97	Signetics	40
	SN54365	† TI	
	SN54367	† TI	
	SN74365	TI	
	SN74367	TI	
Hex Inverter			
	5404	† Fairchild	
	7404	Fairchild	
	9016C	Fairchild	
	9016M	† Fairchild	
	ZN5404	† Ferranti	
	ZN7404	Ferranti	50
	HD2522	Hitachi	
	HD7404	Hitachi	
	ITT5404	† ITT	
	ITT7404	ITT	
	ITT9012	† ITT	
	ITT9016-1	† ITT	
	ITT9016-5 (continued)	ITT	

Buffers/Inverters (cont)

Function	Device	Source	Line
Hex Inverter (continued)			
	MC5404	† Motorola	
	MC7404	Motorola	
	DM5404	† National	60
	DM7404	National	
	5404	† Raytheon	
	7404	Raytheon	
	N7404	Signetics	
	S5404	† Signetics	
	SW7404	SW	
	SN5404	† TI	
	TD3404	Toshiba	
	SN7404	TI	
	7404	TRW	70
Hex Inverter, Three-State			
	DM7096	† National	
	DM7098	† National	
	DM8096	National	
	DM8098	National	
	DM54366	† National	
	DM75366	National	
	DM54368	† National	
	DM74368	National	
	N8T96	Signetics	
	SN54366	† TI	80
	SN54368	† TI	
	SN74366	TI	
	SN74368	TI	
Hex Inverter, Open Collector			
	5405	† Fairchild	
	7405	Fairchild	
	9017C	Fairchild	
	9017M	† Fairchild	
	ZN5405	Ferranti	
	ZN7405	Ferranti	
	HD2523	Hitachi	90
	HD7405	Hitachi	
	ITT5405	† ITT	
	ITT7405	ITT	
	MC5405	† Motorola	
	MC7405	Motorola	
	DM5405	† National	
	DM7405	National	
	5405	† Raytheon	
	7405	Raytheon	
	N7405	Signetics	100
	S5405	† Signetics	
	SW7405	SW	
	SN5405	† TI	
	SN7405	TI	
	TD3405	Toshiba	
	7405	TRW	

Counters, Binary, Count-Up

Function	Device	Source	Line
Binary Counter, Ripple			
	5493	† Fairchild	
	7493	Fairchild	
	9305C	Fairchild	
	9305M	† Fairchild	110
	9356C	Fairchild	
	74293	Fairchild	
	ZN5493	† Ferranti	
	ZN7493 (continued)	Ferranti	

Counters, Binary, Count-Up (cont)

Function	Device	Source	Line
Binary Counter, Ripple (continued)			
	HD2520	Hitachi	
	HD7493	Hitachi	
	ITT5493	† ITT	
	ITT7493	ITT	
	MC5493	† Motorola	
	MC7493	Motorola	120
	DM5493	† National	
	DM7493	National	
	N7493	Signetics	
	S5493	† Signetics	
	SW7493	SW	
	SN5493A	† TI	
	SN7493A	TI	
	SN54293	† TI	
	SN74293	TI	
	TD3493	Toshiba	130
	7493	TRW	
	74293	TRW	
Dual 4-Bit Binary Counter, Ripple (Dual 54/7493A)			
	SN54393	† TI	
	SN74393	TI	
Binary (Divide-By-2 and Divide-By-8) Counter/Latch, Ripple, Preset Input			
	54177	† Fairchild	
	54197	Fairchild	
	74177	Fairchild	
	74197	Fairchild	
	ZN54197	† Ferranti	
	ZN74197	Ferranti	140
	HD2573	Hitachi	
	MC7281	Motorola	
	MC8281	Motorola	
	MC54177	† Motorola	
	MC74177	Motorola	
	DM7281	† National	
	DM7291	† National	
	DM8281	National	
	DM8291	National	
	DM54197	† National	150
	DM74197	National	
	DM54177	† National	
	DM74177	National	
	RC8281	Raytheon	
	RC8291	Raytheon	
	RM8281	† Raytheon	
	RM8291	† Raytheon	
	N8281	Signetics	
	N8291	Signetics	
	N74177	Signetics	160
	S54177	† Signetics	
	S8281	† Signetics	
	S8291	† Signetics	
	SN54177	† TI	
	SN54197	† TI	
	SN74177	TI	
	SN74197	TI	
Dual Binary Counter, Synchronous			
	MC54453	† Motorola	
	MC74453	Motorola	
Binary Counter, Synchronous, Preset Input (Synchronous Clear)			
	SN54163	† AMD	170
	SN74163	AMD	
	54163	† Fairchild	
	74163 (continued)	Fairchild	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (cont)

Counters, Binary, Count-Up (cont)

Function	Device	Source	Line
Binary Counter, Synchronous, Preset Input (Synchronous Clear) (continued)			
	ZN54163	† Ferranti	
	ZN74163	Ferranti	
	HD74163	Hitachi	
	ITT54163	† ITT	
	ITT74163	ITT	
	DM54163	† National	
	DM74163	National	
	54163	† Raytheon	
	74163	Raytheon	
	N74163	Signetics	10
	S54163	Signetics	
	SN54163	† TI	
	SN74163	TI	
	74163	TRW	
Binary Counter, Synchronous, Preset Input (Asynchronous Clear)			
	SN54161	† AMD	
	SN74161	AMD	
	9316C	AMD	
	9316M	† AMD	
	9316C	Fairchild	
	9316M	† Fairchild	20
	54161	† Fairchild	
	74161	Fairchild	
	ZN54161	† Ferranti	
	ZN74161	Ferranti	
	HD74161	Hitachi	
	ITT9316	ITT	
	ITT54161	† ITT	
	ITT74161	ITT	
	MC8316	Motorola	
	MC9316	† Motorola	30
	DM54161	† National	
	DM74161	National	
	RC9316	Raytheon	
	RM9316	† Raytheon	
	54161	† Raytheon	
	74161	Raytheon	
	N74161	Signetics	
	S54161	† Signetics	
	SN29316	TI	
	SN39316	† TI	40
	SN54161	† TI	
	SN74161	TI	
	74161	TRW	
Binary Counter, Synchronous, Preset, Input Low-Power			
	N8293	Signetics	
	S8293	† Signetics	
Binary Counter, Synchronous (both conventional and three state outputs) Preset Input			
	DM7556	† National	
	DM8556	National	

Counters, Binary, Count-Up/Down

Function	Device	Source	Line
Binary Up/Down Counter, Synchronous with mode control			
	N8284	AMD	
	S8284	† AMD	
	AM2501C	AMD	50
	AM2501M	† AMD	
	RC8284	Raytheon	
	RM8284	† Raytheon	
	N8284	Signetics	
	S8284	† Signetics	

Counters, Binary, Count-Up/Down (cont)

Function	Device	Source	Line
Binary Up/Down Counter, Synchronous Preset Input with Mode Control			
	SN54191	† AMD	
	SN74191	AMD	
	54191	† Fairchild	
	74191	Fairchild	
	ZN54191	† Ferranti	60
	ZN74191	Ferranti	
	HD74191	Hitachi	
	ITT54191	† ITT	
	ITT74191	ITT	
	DM54191	† National	
	DM74191	National	
	54191	† Raytheon	
	74191	Raytheon	
	SN54191	† TI	
	SN74191	TI	70
Binary Up/Down Counter, Synchronous, Preset Input (2 Clocks)			
	9366C	AMD	
	9366M	† AMD	
	SN54193	† AMD	
	SN74193	AMD	
	9366C	Fairchild	
	9366M	† Fairchild	
	54193	† Fairchild	
	74193	Fairchild	
	ZN54193	† Ferranti	
	ZN74193	Ferranti	80
	HD2542	Hitachi	
	ITT54193	† ITT	
	ITT74193	ITT	
	MC54193	† Motorola	
	MC74193	Motorola	
	DM7563	† National	
	DM8563	National	
	DM54193	† National	
	DM74193	National	
	RC9366	Raytheon	90
	MR9366	† Raytheon	
	54193	† Raytheon	
	74193	Raytheon	
	N74193	Signetics	
	S54193	† Signetics	
	SW74193	SW	
	SN54193	† TI	
	SN74193	TI	
	TD34193	Toshiba	
Dual Binary Up/Down Counter, Synchronous, Preset Input			
	MC54455	† Motorola	100
	MC74455	Motorola	

Counters, Decade, Count Up

Function	Device	Source	Line
Decade Counter, Ripple			
	9350C	Fairchild	
	9350M	† Fairchild	
	5490	† Fairchild	
	7490	Fairchild	
	74290	Fairchild	
	ZN5490	† Ferranti	
	ZN7490	Ferranti	
	HD2519	Hitachi	
	HD7490	Hitachi	110
	ITT5490	† ITT	
	ITT7490 (continued)	ITT	

Counters, Decade, Count Up (cont)

Function	Device	Source	Line
Decade Counter, Ripple (continued)			
	MC5490	† Motorola	
	MC7490	Motorola	
	DM5490	† National	
	DM7490	National	
	N7490	Signetics	
	S5490	† Signetics	
	SW7490	SW	
	SN54290	† TI	120
	SN5490A	† TI	
	SN74290	TI	
	SN7490A	TI	
	TD3490	Toshiba	
	7490	TRW	
	74290	TRW	
Dual Decade Counter, Ripple (Dual 54/7490A)			
	SN54390	† TI	
	SN54490	† TI	
	SN74390	TI	
	SN74490	TI	130
Decade (Divide-By-2 and Divide-By-5) Counter/Latch, Ripple, Preset Input			
	54176	† Fairchild	
	74176	Fairchild	
	54196	† Fairchild	
	74196	Fairchild	
	MC7280	† Motorola	
	MC54176	† Motorola	
	MC74176	Motorola	
	DM7280	† National	
	DM7290	† National	
	DM8280	National	140
	DM8290	National	
	DM54176	† National	
	DM54196	† National	
	DM74176	National	
	DM74196	National	
	RC8280	Raytheon	
	RC8290	Raytheon	
	RM8280	† Raytheon	
	RM8290	† Raytheon	
	N8280	Signetics	150
	N8290	Signetics	
	N74176	Signetics	
	S8280	† Signetics	
	S8290	† Signetics	
	S54176	† Signetics	
	SN54176	† TI	
	SN54196	† TI	
	SN74176	TI	
	SN74196	TI	
Dual Decade Counter, Synchronous			
	MC54452	† Motorola	160
	MC74452	Motorola	
Decade Counter, Synchronous, Preset Input (Asynchronous Clear)			
	9310C	AMD	
	9310M	† AMD	
	SN54160	† AMD	
	SN74160	AMD	
	9310C	Fairchild	
	9310M	† Fairchild	
	54160	† Fairchild	
	74160	Fairchild	
	HD74160	Hitachi	170
	ITT54160 (continued)	† ITT	

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL (cont)

Counters, Decade, Count Up (cont)

Function	Device	Source
Decade Counter, Synchronous, Preset Input (Asynchronous Clear) (continued)	ITT74160	ITT
	MC8310	Motorola
	MC9310	Motorola
	DM54160	† National
	DM74160	National
	54160	† Raytheon
	74160	Raytheon
	RC9310	Raytheon
	RM9310	† Raytheon
	N74160	Signetics
	S54160	† Signetics
	SN29310	TI
	SN39310	TI
	SN54160	† TI
	SN74160	TI
	74160	TRW
Decade Counter, Synchronous, Preset Input (Asynchronous Clear)	SN54162	† AMD
	SN74162	AMD
	54162	† Fairchild
	74162	Fairchild
	HD74162	Hitachi
	ITT54162	† ITT
	ITT74162	ITT
	DM54162	† National
	DM74162	National
	54162	† Raytheon
	74162	Raytheon
	N74162	Signetics
	S54162	† Signetics
	SN54162	† TI
	SN74162	TI
	74162	TRW
Decade Counter, Synchronous, Preset Input Low-Power	N8292	Signetics
	S8292	† Signetics
Decade Counter, Synchronous (both conventional and three state outputs), Preset Inputs	DM7555	† National
	DM8555	National

Counters, Decade, Count Up/Down

Function	Device	Source
Decade Up/Down Counter, Synchronous	N8285	AMD
	S8285	† AMD
	RC8285	Raytheon
	RM8285	† Raytheon
	N8285	Signetics
	S8285	† Signetics
Decade Up/Down Counter, Synchronous, Preset with Mode Control	SN54190	† AMD
	SN74190	AMD
	9306C	AMD
	9306M	† AMD
	9360C	Fairchild
	9360M	† Fairchild
	54190	† Fairchild
	74190	Fairchild
	HD74190	Hitachi
	ITT54190	† ITT
	ITT74190	ITT
	DM54190	† National
	DM74190	National
	54190	† Raytheon
(continued)		

Counters, Decade, Count Up/Down (cont)

Function	Device	Source
Decade Up/Down Counter, Synchronous, Preset with Mode Control (continued)	74190	Raytheon
	SN54190	† TI
	SN74190	TI
Decade Up/Down Counter, Synchronous, Preset Input (2 clocks)	9360C	AMD
	9360M	† AMD
	SN54192	† AMD
	SN74192	AMD
	54192	† Fairchild
	74192	Fairchild
	ZN54192	† Ferranti
	ZN74192	Ferranti
	HD2541	Hitachi
	ITT54192	† ITT
	ITT74192	ITT
	MC54192	† Motorola
	MC74192	Motorola
	DM7560	† National
	DM8560	National
	DM54192	† National
	DM74192	National
	54192	† Raytheon
	74192	Raytheon
	RC9360	Raytheon
	RM9360	† Raytheon
	N74192	† Signetics
	S74192	Signetics
	SN54192	† TI
	SN74192	TI
	TD34192	Toshiba
Dual Decade Up/Down Counter, Synchronous, Preset Input	MC54454	Motorola
	MC74454	Motorola
Four Decade Counter/Latch/Display Driver (Synchronous up/down count, BCD and segment drives)	ZN1040	Ferranti

Counters, Miscellaneous

Function	Device	Source
4-Bit Universal Counter	MC4023	Motorola
Divide-By-12 Counter (Divide-By-Two and Divide-By-6), Ripple	5492	† Fairchild
	7492	Fairchild
	ZN5492	† Ferranti
	ZN7492	Ferranti
	HD2521	Hitachi
	HD7492	Hitachi
	ITT5492	† ITT
	ITT7492	ITT
	MC5492	† Motorola
	MC7492	Motorola
	DM5492	† National
	DM7492	National
	N7492	Signetics
	S5492	† Signetics
	SW7492	SW
	SN5492A	† TI
	SN7492A	TI
	TD3492	Toshiba
	7492	TRW
Divide-By-12 (Divide by 2 and 6) Counter, Preset Input	DM7288	† National
	DM8288	National
	N8288	Signetics
	S8288	† Signetics

Counters, Miscellaneous (cont)

Function	Device	Source
Programmable Modulo-N Binary Counter	MC4018	Motorola
	MC4019	Motorola
	MC4318	† Motorola
	MC4319	† Motorola
Programmable Modulo-N Decade Counter	MC4016	Motorola
	MC4017	Motorola
	MC4316	† Motorola
	MC4317	† Motorola
Binary Counter/Latch, Three-State	DM7554	† National
	DM8554	National
Decade Counter/Latch, Three-State	DM7552	† National
	DM8552	National
Programmable Modulo-N Divider (Divide by 2 to 15, Cascadable)	DM7520	† National
	DM8520	National
4-Bit Variable Modulo Counter (2 and 4, 5, 6, 7, 8, or 10, 12, 14, 16)	9305C	Fairchild
	9305M	† Fairchild
Decade Counter/Latch/7 Segment Decoder	MC4050	Motorola
	MC4051	Motorola
	MC4350	† Motorola
Decade Counter/Latch/Decoder (Nixie Driver)	SN74142	TI
Decade Counter/Latch LED/Lamp Driver (High Current Output)	SN54144	† TI
	SN74144	TI
Decade Counter/Latch, LED/Lamp Driver (Constant Current Output)	SN54143	† TI
	SN74143	TI

Decoders

Function	Device	Source
Excess 3-To-Decimal (1 of 10) Decoder	5443	† Fairchild
	7443	Fairchild
	HD2537	Hitachi
	HD7443	Hitachi
	ITT5443	† ITT
	ITT7443	ITT
	MC5443	† Motorola
	MC7443	Motorola
	5443	† Raytheon
	7443	Raytheon
	N7443	Signetics
	S5443	† Signetics
	SW7443	SW
	SN5443A	† TI
	SN7443A	TI
Excess 3 Gray-To-Decimal (1 of 10) Decoder	5444	† Fairchild
	7444	Fairchild
	HD2538	Hitachi
	HD7444	Hitachi
	ITT5444	† ITT
	ITT7444	ITT
	MC5444	† Motorola
	MC7444	Motorola
	5444	† Raytheon
	7444	Raytheon
	S5444	† Signetics
	N7444	Signetics
	SW7444	SW
	SN5444A	† TI
	SN7444A	TI

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (cont)

Decoders (cont)

Function	Device	Source
BCD-To-Decimal (1 of 10) Decoder		
	9301M	† AMD
	9301C	AMD
	5442	† Fairchild
	7442	Fairchild
	9301C	Fairchild
	9301M	† Fairchild
	9302C	Fairchild
	9302M	† Fairchild
	ZN5442	† Ferranti
	ZN7442	Ferranti
	HD2536	Hitachi
	HD7442	Hitachi
	ITT5441	† ITT
	ITT7441	ITT
	ITT5442	† ITT
	ITT7442	ITT
	ITT9301-1	† ITT
	ITT9301-5	ITT
	MC5442	† Motorola
	MC7442	Motorola
	MC8301	Motorola
	MC9301	† Motorola
	DM5442	† National
	DM7442	National
	DM8301	National
	DM9301	† National
	5442	† Raytheon
	7442	Raytheon
	RC8251	Raytheon
	RC8252	Raytheon
	RM8251	† Raytheon
	RM8252	† Raytheon
	N7442	Signetics
	N8251	Signetics
	N8252	Signetics
	S5442	† Signetics
	S8251	† Signetics
	S8252	† Signetics
	SW7442	SW
	SN29301	TI
	SN39301	† TI
	SN5442A	† TI
	SN7442A	TI
	TD3441	Toshiba
	TD3442	Toshiba
BCD-to-Binary and Binary-To-BCD Converter, Open Collector		
	MC4001	Motorola
BCD-To-Decimal Decoder/Driver, Open Collector, 15v		
	54145	† Fairchild
	74145	Fairchild
	93145C	Fairchild
	93145M	† Fairchild
	HD2555	† Hitachi
	ITT54145	† ITT
	ITT74145	ITT
	MC54145	† Motorola
	MC74145	Motorola
	DM54145	† National
	DM74145	National
	54145	† Raytheon
	74145	Raytheon
	N74145	Signetics
	(continued)	

Decoders (cont)

Function	Device	Source
BCD-To-Decimal Decoder/Driver, Open Collector, 15v (continued)		
	S54145	† Signetics
	SW74145	SW
	SN54145	† TI
	SN74145	TI
	74145	TRW
BCD-To-Decimal/Decoder Driver, Open Collector to 30v Output		
	5445	† Fairchild
	7445	Fairchild
	HD2531	Hitachi
	ITT5445	† ITT
	ITT7445	ITT
	MC5445	† Motorola
	MC7445	Motorola
	DM5445	† National
	DM7445	National
	5445	† Raytheon
	7445	Raytheon
	N7445	Signetics
	S5445	† Signetics
	SW7445	SW
	SN5445	† TI
	SN7445	TI
	7445	TRW
Dual 1-of-4 Decoder/Demultiplexer (Independent Address)		
	9321C	AMD
	9321M	† AMD
	9321C	Fairchild
	9321M	† Fairchild
Dual Binary to One-Of-Four Line Gated Decoder		
	MC4007	Motorola
	MC4307	† Motorola
Demultiplexer, (2-Lines In - 2 of 4 Out) Three-State		
	DM7230	† National
	DM8230	National
Dual 2-Line To 4-Line Decoder/Demultiplexer, Totem Pole Output (or 3-Line to 8-Line Decoder/Demultiplexer)		
	54155	† Fairchild
	74155	Fairchild
	ZN54155	† Ferranti
	ZN74155	Ferranti
	HD75155	Hitachi
	ITT54155	† ITT
	ITT74155	ITT
	MC54155	† Motorola
	MC74155	Motorola
	DM54155	† National
	DM74155	National
	54155	† Raytheon
	74155	Raytheon
	N74155	Signetics
	S54155	† Signetics
	SW74155	SW
	SN54155	† TI
	SN74155	TI
	74155	TRW
Dual 2-Line to 4-Line Decoder/Demultiplexer, Open Collector (or 3-Line to 8-Line Decoder/Demultiplexer)		
	54156	† Fairchild
	74156	Fairchild
	HD74156	Hitachi
	ITT54156	† ITT
	ITT74156	ITT
	MC54156	† Motorola
	MC74156	Motorola
	DM54156	† National
	DM74156	National
	(continued)	

Decoders (cont)

Function	Device	Source
Dual 2-Line to 4-Line Decoder/Demultiplexer, Open Collector (or 3-Line to 8-Line Decoder/Demultiplexer) (continued)		
	54156	† Raytheon
	74156	Raytheon
	N74156	Signetics
	S54156	† Signetics
	SW74156	SW
	SN54156	† TI
	SN74156	TI
	74156	TRW
Dual 2-Line to 4-Line Decoder/Demultiplexer (or 3-Line to 8-Line Decoder/Demultiplexer) Three-State		
	54255	† Raytheon
	74255	Raytheon
Binary To Octal (1 of 8) Decoder		
	9301	Fairchild
	9301M	† Fairchild
	MC4006	Motorola
	MC4306	† Motorola
	MC7250	Motorola
	MC8250	† Motorola
	RC8250	Raytheon
	RM8250	† Raytheon
	N8250	Signetics
	S8250	† Signetics
Binary to Octal Decoder, Non-Inverting		
	MC4048	Motorola
Binary to Octal Decoder, Inverting/Non-Inverting, Open Collector		
	MC4038	Motorola
1-Line to 8-Line Demultiplexer		
	DM7223	† National
	DM8223	National
Binary to 2-of-8 Decoder, Open Collector		
	MC4040	Motorola
4-Line to 16-Line Decoder/Demultiplexer		
	9311C	AMD
	9311M	† AMD
	SN54154	† AMD
	SN74154	AMD
	9311C	Fairchild
	9311M	† Fairchild
	54154	† Fairchild
	74154	Fairchild
	ZN54154	† Ferranti
	ZN74154	Ferranti
	HD2580	Hitachi
	ITT9311-1	† ITT
	ITT9311-5	ITT
	ITT54154	† ITT
	ITT74154	ITT
	MC8311	Motorola
	MC9311	† Motorola
	DM54154	† National
	DM74154	National
	RC9311	Raytheon
	RM9311	† Raytheon
	54154	† Raytheon
	74154	Raytheon
	N74154	Signetics
	S54154	† Signetics
	SW74154	SW
	SN29311	TI
	SN39311	† TI
	SN54154	† TI
	SN74154	TI
	74154	TRW

† Military Temperature Range (—55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL (cont)

Decoders (cont)

Function	Device	Source
4-Line To 16-Line Decoder/Demultiplexer, Open Collector Output	54159	† Raytheon
	74159	Raytheon
	SN54159	† TI
	SN74159	TI

Drivers

Function	Device	Source
Quad Predriver, Open Collector	MC4042	Motorola
Quad Driver, Common Enable Active Pull-Up (sinks to 120ma)	IM5001	Intersil
	IM5001M	† Intersil
	IM5011	Intersil
	IM5011M	† Intersil
Quad 2-Input AND Buffer, Open Collector, to 15v Output (High voltage 54/74109)	ITT54131	† ITT
	ITT74131	ITT
	DS7819	† National
	DS8819	National
Hex Buffer/Driver, Open Collector High Voltage Output, to 15v	5417	† Fairchild
	7417	Fairchild
	HD7417	Hitachi
	ITT5417	† ITT
	ITT7417	ITT
	MC5417	† Motorola
	MC7417	Motorola
	DM5417	† National
	DM7417	National
	N7417	Signetics
	S5417	† Signetics
	SW7417	SW
	SN5417	† TI
	SN7417	TI
	TD3417	Toshiba
	7417	TRW
Hex Buffer/Driver, Open Collector High Voltage Output, to 30v	5407	† Fairchild
	7407	Fairchild
	HD7407	Hitachi
	ITT5407	† ITT
	ITT7407	ITT
	MC5407	† Motorola
	MC7407	Motorola
	DM5407	† National
	DM7407	National
	N7407	Signetics
	S5407	† Signetics
	SW7407	SW
	SN5407	† TI
	SN7407	TI
	TD3407	Toshiba
	7407	TRW
Hex Inverter Buffer/Driver Open Collector High Voltage Output, to 15v	5416	† Fairchild
	7416	Fairchild
	HD7416	Hitachi
	ITT5416	† ITT
	ITT7416	ITT
	MC5416	† Motorola
	MC7416	Motorola
	DM5416	† National
	DM7416	National
	DM7812	† National
	DS8812	National
	(continued)	

Drivers (cont)

Function	Device	Source
Hex Inverter Buffer/Driver Open Collector High Voltage Output, to 15v (continued)	N7416	Signetics
	S5416	† Signetics
	SW7416	SW
	SN5416	† TI
	SN7416	TI
	TD3416	Toshiba
	7416	TRW
Hex Inverter Buffer/Driver, Open Collector High Voltage Output, to 30v.	5406	† Fairchild
	7406	Fairchild
	HD7406	Hitachi
	ITT5406	† ITT
	ITT7406	ITT
	MC5406	† Motorola
	MC7406	Motorola
	DM5406	† National
	DM7406	National
	N7406	Signetics
	S5406	† Signetics
	SW7406	SW
	SN5406	† TI
	SN7406	TI
	TD3406	Toshiba
	7406	TRW
Hex High Voltage Interface Driver, Open Collector, to 35v	HD235	† Harris
	HD535	Harris
Quad 2-Input AND Buffer, Open Collector, to 30v Output	ITT54130	† ITT
	ITT74130	ITT
Quad 2-Input NAND Buffer, Open Collector, to 15v Output	5426	† Fairchild
	7426	Fairchild
	HD2560	Hitachi
	HD7426	Hitachi
	ITT5426	† ITT
	ITT7426	ITT
	MC5426	† Motorola
	MC7426	Motorola
	DM5426	† National
	DM7426	National
	DS7810	† National
	DS7811	† National
	DS8810	National
	DS8811	National
	N7426	Signetics
	S5426	† Signetics
	SW7426	SW
	SN5426	† TI
	SN7426	TI
	TD3426	Toshiba
	7426	TRW
Quad 2-Input NAND Buffer, Open Collector, to 30v Output	N8T80	Signetics
	S8T80	† Signetics
Quad 2-Input OR Buffer, Open Collector, to 15v Output	ITT54139	† ITT
	ITT74139	ITT
Quad 2-Input OR Buffer, Open Collector, to 30 v Output	ITT54138	† ITT
	ITT74138	ITT
4-Input NAND High Voltage, High Current Driver (40 to 50v, sinks 150 to 500 ma)	SH2001C	Fairchild
	SH2001M	† Fairchild
	SH2002C	Fairchild
	(continued)	

Drivers (cont)

Function	Device	Source
4-Input NAND High Voltage, High Current Driver (40 to 50v, sinks 150 to 500 ma) (continued)	SH2002M	† Fairchild
	SH2200C	Fairchild
	SH2200M	† Fairchild
Dual 4-Input AND Power Driver Open Collector (to 100v, sinks 250 ma)	UHP-420	Sprague
	UHP-520	Sprague
Dual AND-OR Power Driver, Open Collector (to 100v, sinks 250ma)	UHP-451	Sprague
	UHP-459	Sprague
	UHP-551	Sprague
	UHP-559	Sprague
Quad 2-Input AND Power Driver, Open Collector (to 100v, sinks 250 ma)	UHC/D-400	† Sprague
	UHC/D-406	† Sprague
	UHC/D-500	† Sprague
	UHC/D-506	† Sprague
	UHP-400	Sprague
	UHP-406	Sprague
	UHP-500	Sprague
	UHP-506	Sprague
Quad 2-Input NAND Power Driver, Open Collector (to 100v, sinks 250 ma)	UHC/D-407	† Sprague
	UHC/D-408	† Sprague
	UHC/D-507	† Sprague
	UHC/D-508	† Sprague
	UHP-407	Sprague
	UHP-408	Sprague
	UHP-507	Sprague
	UHP-508	Sprague
Quad 2-Input NAND Bus Driver, Open Collector, 80 ma	96101	Fairchild
Quad 2-Input OR Power Driver, Open Collector (to 100v, sinks 250 ma)	UHC/D-402	† Sprague
	UHC/D-403	† Sprague
	UHC/D-502	† Sprague
	UHC/D-503	† Sprague
	UHP-402	Sprague
	UHP-403	Sprague
	UHP-502	Sprague
	UHP-503	Sprague
Quad 2-Input NOR Power Driver, Open Collector (to 100v, sinks 250 ma)	UHC/D-432	† Sprague
	UHC/D-433	† Sprague
	UHC/D-532	† Sprague
	UHC/D-533	† Sprague
	UHP-432	Sprague
	UHP-433	Sprague
	UHP-532	Sprague
	UHP-533	Sprague
Quad 2-Input NOR 75-Ohm/50-Ohm Line Driver	SN54128	† TI
	SN74128	TI
Hex Interface Inverter, Open Collector, to 50v or to 50 ma)	HD234	† Harris
	HD334	† Harris
	HD534	Harris
Quad Bus Driver, Three-State	RC8T09	Raytheon
	RM8T09	† Raytheon
	N8T09	Signetics
	S8T09	† Signetics
Hex Bus Driver, Gated Enable, Three-State	DM54365	† National
	DM74365	National
	SN54365	† TI
	SN74365	TI

† Military Temperature Range (—55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (cont)

Function	Device	Source
Drivers (cont)		
Hex Bus Driver, Gated Enable, Inverted Three-State Output		
	DM54366	† National
	DM74366	National
	SN54366	† TI
	SN74366	TI
Hex Bus Driver, 2-Line and 4-Line Enable, Three-State		
	DM54367	† National
	DM74367	National
	SN54367	† TI
	SN74367	TI
Hex Bus Driver, 2-Line and 4-Line Enable, Inverted Three-State Output		
	DM54368	† National
	DM74368	National
	SN54368	† TI
	SN74368	TI
Flip-Flops		
J-K Master-Slave Flip-Flop		
	9000C	Fairchild
	9000M	† Fairchild
	9001C	Fairchild
	9001M	† Fairchild
	54104	† Fairchild
	54105	† Fairchild
	74104	Fairchild
	74105	Fairchild
	ITT54104	† ITT
	ITT54105	† ITT
	ITT74104	ITT
	ITT74105	ITT
	SW74104	SW
AND Gated J-K Master-Slave Flip-Flop with Preset and Clear		
	5472	† Fairchild
	7472	Fairchild
	ZN5472	† Ferranti
	ZN7472	Ferranti
	HD2529	Hitachi
	HD7472	Hitachi
	ITT5472	† ITT
	ITT7472	ITT
	MC5472	† Motorola
	MC7472	Motorola
	DM5472	† National
	DM7472	National
	N7472	Signetics
	S5472	† Signetics
	SW7472	SW
	SN5472	† TI
	SN7472	TI
	TD3472	Toshiba
	7472	TRW
AND-Gated J-K Master-Slave Flip-Flop with Data Lockout		
	SN54110	† TI
	SN74110	TI
AND Gated, Edge Triggered J-K Flip-Flop with Preset and Clear		
	5470	† Fairchild
	7470	Fairchild
	ZN5470	† Ferranti
	ZN7470	Ferranti
	HD2539	Hitachi
	ITT5470	† ITT
	ITT7470	ITT
	MC5470	† Motorola
	MC7470	Motorola
	DM5470 (continued)	† National
Flip-Flops (cont)		
AND Gated, Edge Triggered J-K Flip-Flop with Preset and Clear (continued)		
	DM7470	National
	N7470	Signetics
	N8270	Signetics
	S5470	† Signetics
	S8270	† Signetics
	SW7470	SW
	SN5470	† TI
	SN7470	TI
Dual J-$\overline{K}$ Positive-Edge Triggered Flip-Flop Preset and Clear		
	9024C	Fairchild
	9024M	† Fairchild
	74109	Fairchild
	ITT9024-1	† ITT
	ITT9024-5	ITT
	ITT54109	† ITT
	ITT74109	ITT
	DM54109	† National
	DM74109	National
	N74109	Signetics
	S54109	† Signetics
	SN54109	† TI
	SN74109	TI
Dual J-K Master-Slave Flip-Flop		
	9020C	Fairchild
	9020M	† Fairchild
	ITT9020-1	† ITT
	ITT9020-5	ITT
Dual J-K Master-Slave Flip-Flop with Clear		
	5473	† Fairchild
	7473	Fairchild
	54107	† Fairchild
	74107	Fairchild
	ZN5473	† Ferranti
	ZN7473	Ferranti
	ZN54107	† Ferranti
	ZN74107	Ferranti
	HD2515	Hitachi
	HD2530	Hitachi
	HD74107	Hitachi
	ITT5473	† ITT
	ITT7473	ITT
	ITT54107	† ITT
	ITT74107	ITT
	MC5473	† Motorola
	MC7473	Motorola
	MC54107	† Motorola
	MC74107	Motorola
	DM5473	† National
	DM7473	National
	DM54107	† National
	DM74107	National
	N7473	Signetics
	N74107	Signetics
	S5473	† Signetics
	S54107	† Signetics
	SW7473	SW
	SN5473	† TI
	SN7473	† TI
	SN54107	† TI
	SN74107	TI
	TD3473	Toshiba
	TD34107	Toshiba
Flip-Flops (cont)		
Dual J-K Master-Slave Flip-Flop with Preset and Clear		
	5476	† Fairchild
	7476	Fairchild
	9022C	Fairchild
	9022M	† Fairchild
	ZN5476	† Ferranti
	ZN7476	Ferranti
	HD2516	Hitachi
	ITT5476	† ITT
	ITT7476	ITT
	ITT9022-1	ITT
	ITT9022-5	ITT
	MC5476	† Motorola
	MC7476	Motorola
	DM5476	† National
	DM7476	National
	N7476	Signetics
	S5476	† Signetics
	SW7476	SW
	SN5476	† TI
	SN7476	TI
	TD3476	Toshiba
	7476	TRW
Dual J-K Master-Slave Flip-Flop with Data Lockout		
	SN54111	† TI
	SN74111	TI
	74111	TRW
Dual Gated Master-Slave J-K/D Flip-Flop		
	DM7512	† National
	DM8512	National
Quad J-$\overline{K}$ Edge Triggered Flip-Flop with Clear		
	SN54376	† TI
	SN74376	TI
Quad J-$\overline{K}$ Edge-Triggered Flip-Flop with Preset and Clear		
	SN74276	TI
Dual D-Type Flip-Flop		
	MC5479	† Motorola
	MC7479	Motorola
Dual D-Type Positive Edge-Triggered Flip-Flop with Preset and Clear		
	5474	† Fairchild
	7474	Fairchild
	ZN5474	† Ferranti
	ZN7474	Ferranti
	HD2510	Hitachi
	HD7474	Hitachi
	ITT5474	† ITT
	ITT7474	ITT
	DM5474	† National
	DM7474	National
	5474	† Raytheon
	7474	Raytheon
	N7474	Signetics
	S5474	† Signetics
	SW7474	SW
	SN5474	† TI
	SN7474	TI
	TD3474	Toshiba
	7474	TRW
Dual Gated D Flip-Flop		
	DM7511	† National
	DM8511	National
Quad Gated D Flip-Flop		
	DM7613	† National
	DM8613	National
Quad D-Type Flip-Flop, Common Clock		
	MC4015	Motorola
	RL4015	Raytheon

† Military Temperature Range (—55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

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Flip-Flops (cont)

Function	Device	Source
Quad D-Type Flip-Flop, Three-State		
	DM54173	† National
	DM74173	National
	DM7551	† National
	DM8551	National
	RC8T10	Raytheon
	RM8T10	† Raytheon
	N8T10	Signetics
	S8T10	† Signetics
	SN54173	† TI
	SN74173	TI
Quad D-Type Edge-Triggered Flip-Flop with Clear, Complementary Output		
	SN54175	† AMD
	SN74175	AMD
	54175	† Fairchild
	74175	Fairchild
	ZN54175	† Ferranti
	ZN74175	Ferranti
	HD74175	Hitachi
	DM54175	† National
	DM74175	National
	54175	† Raytheon
	74175	Raytheon
	N74175	Signetics
	S54175	† Signetics
	SW74175	SW
	SN54175	† TI
	SN74175	TI
Quad I/O Register, Three-State (two terminals per flip-flop can be used as input or output)		
	DM7542	† National
	DM8542	National
Quad, Selectable Input, Edge-Triggered Flip-Flop		
	54298	† Fairchild.
	74298	Fairchild
	SN54298	† TI
	SN74298	TI
Hex D-Type, Edge-Triggered Flip-Flop with Clear		
	SN54174	† AMD
	SN74174	AMD
	54174	† Fairchild
	74174	Fairchild
	93174C	Fairchild
	ZN54174	† Ferranti
	ZN74174	Ferranti
	HD74174	Hitachi
	DM54174	† National
	DM74174	National
	54174	† Raytheon
	74174	Raytheon
	N74174	Signetics
	S54174	† Signetics
	SW74174	SW
	SN54174	† TI
	SN74174	TI
Octal D-Type, Edge-Triggered Flip-Flop, with Clear		
	SN74273	TI

Gates, AND/NAND

Function	Device	Source
Dual 4-Input AND Gate		
	5421	† Fairchild
	7421	Fairchild
	ITT5421	† ITT
	ITT7421	ITT
	5421	† Raytheon
	7421 (continued)	Raytheon

Gates, AND/NAND (cont)

Function	Device	Source
Dual 4-Input AND Gate (continued)		
	N7421	Signetics
	S5421	† Signetics
	TD3421	Toshiba
Triple 3-Input AND Gate		
	5411	† Fairchild
	7411	Fairchild
	ITT5411	† ITT
	ITT7411	ITT
	DM5411	† National
	DM7411	National
	5411	† Raytheon
	7411	Raytheon
	N7411	Signetics
	S5411	† Signetics
Triple 3-Input AND Gate, Open Collector		
	5415	† Raytheon
	7415	Raytheon
Quad 2-Input AND Gate		
	5408	† Fairchild
	7408	Fairchild
	ZN5408	† Ferranti
	ZN7408	Ferranti
	HD2550	Hitachi
	ITT5408	† ITT
	ITT7408	ITT
	MC5408	† Motorola
	MC7408	Motorola
	DM5408	† National
	DM7408	National
	5408	† Raytheon
	7408	Raytheon
	N7408	Signetics
	S5408	† Signetics
	SW7408	SW
	SN5408	† TI
	SN7408	TI
	TD3408	Toshiba
	7408	TRW
Quad 2-Input AND Gate, Open Collector		
	5409	† Fairchild
	7409	Fairchild
	ZN5409	Ferranti
	ZN7409	Ferranti
	HD2551	Hitachi
	ITT5409	† ITT
	ITT7409	ITT
	MC5409	† Motorola
	MC7409	Motorola
	DM5409	† National
	DM7409	National
	5409	† Raytheon
	7409	Raytheon
	N7409	Signetics
	S5409	† Signetics
	SW7409	SW
	SN5409	† TI
	SN7409	TI
	TD3409	Toshiba
	7409	TRW
8-Input NAND Gate		
	5430	† Fairchild
	7430	Fairchild
	9007C	Fairchild
	9007M (continued)	† Fairchild

Gates, AND/NAND (cont)

Function	Device	Source
8-Input NAND Gate (continued)		
	ZN5430	† Ferranti
	ZN7430	Ferranti
	HD2508	Hitachi
	HD7430	Hitachi
	ITT5430	† ITT
	ITT7430	ITT
	MC5430	† Motorola
	MC7430	Motorola
	DM5430	† National
	DM7430	National
	N7430	Signetics
	S5430	† Signetics
	SW7430	SW
	SN5430	† TI
	SN7430	TI
	TD3430	Toshiba
	7430	TRW
Dual 4-Input NAND Gate		
	5420	† Fairchild
	7420	Fairchild
	9004C	Fairchild
	9004M	† Fairchild
	ZN7420	Ferranti
	ZN5420	† Ferranti
	HD2504	Hitachi
	HD7420	Hitachi
	ITT5420	† ITT
	ITT7420	ITT
	ITT9004-1	ITT
	ITT9004-5	† ITT
	MC5420	† Motorola
	MC7420	Motorola
	DM5420	† National
	DM7420	National
	DM9004C	National
	5420	† Raytheon
	7420	Raytheon
	N7420	Signetics
	S5420	† Signetics
	SW7420	SW
	SN5420	† TI
	SN7420	TI
	TD3420	Toshiba
	7420	TRW
Dual 4-Input NAND Buffer		
	5440	† Fairchild
	7440	Fairchild
	9009C	Fairchild
	9009M	† Fairchild
	ZN5440	† Ferranti
	ZN7440	Ferranti
	HD2501	Hitachi
	HD7440	Hitachi
	ITT5440	† ITT
	ITT7440	ITT
	ITT9009-1	† ITT
	ITT9009-5	ITT
	MC5440	† Motorola
	MC7440	Motorola
	DM5440	† National
	DM7440	National
	DM9009C (continued)	National

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

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Gates, AND/NAND (cont)

Function	Device	Source	Line
Dual 4-Input NAND Buffer (continued)			
	N7440	Signetics	
	S5440	† Signetics	
	SW7440	SW	
	SN5440	† TI	
	SN7440	TI	
	TD3440	Toshiba	
	7440	TRW	
Dual 4-Input NAND Gate, Open Collector			
	5422	† Fairchild	
	7422	Fairchild	
	HD7422	Hitachi	10
	5422	† Raytheon	
	7422	Raytheon	
	SN5422	† TI	
	SN7422	TI	
Dual 5-Input NAND Gate			
	DM7092	† National	
	DM8092	National	
Triple 3-Input NAND Gate			
	5410	† Fairchild	
	7410	Fairchild	
	9003C	Fairchild	
	9003M	† Fairchild	20
	ZN5410	† Ferranti	
	ZN7410	Ferranti	
	HD2507	Hitachi	
	HD7410	Hitachi	
	ITT5410	† ITT	
	ITT7410	ITT	
	ITT9003-1	† ITT	
	ITT9003-5	ITT	
	MC5410	† Motorola	
	MC7410	Motorola	30
	DM5410	† National	
	DM7410	National	
	DM9003C	National	
	5410	† Raytheon	
	7410	Raytheon	
	N7410	Signetics	
	S5410	† Signetics	
	SW7410	SW	
	SN5410	† TI	
	SN7410	TI	40
	TD3410	Toshiba	
	7410	TRW	
Triple 3-Input NAND Gate, Open Collector			
	5412	† Fairchild	
	7412	Fairchild	
	ZN5412	† Ferranti	
	ZN7412	Ferranti	
	HD7412	Hitachi	
	ITT5412	† ITT	
	ITT7412	ITT	
	5412	† Raytheon	50
	7412	Raytheon	
	N7412	Signetics	
	S5412	† Signetics	
	SN5412	† TI	
	SN7412	TI	
	7412	TRW	
Quad 2-Input NAND Gate			
	5400	† Fairchild	
	7400	Fairchild	
	9002C (continued)	Fairchild	
Quad 2-Input NAND Gate (continued)			
	9002M	† Fairchild	60
	ZN5400	† Ferranti	
	ZN7400	Ferranti	
	HD2503	Hitachi	
	HD7400	Hitachi	
	ITT5400	† ITT	
	ITT7400	ITT	
	ITT9002-1	† ITT	
	ITT9002-5	ITT	
	MC5400	† Motorola	
	MC7400	Motorola	70
	DM5400	† National	
	DM7400	National	
	DM9002C	National	
	5400	† Raytheon	
	7400	Raytheon	
	N7400	Signetics	
	S5400	† Signetics	
	SW7400	SW	
	SN5400	† TI	
	SN7400	TI	80
	TD3400	Toshiba	
	7400	TRW	
Quad 2-Input NAND Buffer			
	5437	† Fairchild	
	7437	Fairchild	
	ZN5437	† Ferranti	
	ZN7437	Ferranti	
	HD2552	Hitachi	
	ITT5437	† ITT	
	ITT7437	ITT	
	MC5437	† Motorola	90
	MC7437	Motorola	
	DM5437	† National	
	DM7091	† National	
	DM7437	National	
	DM8091	National	
	N7437	Signetics	
	S5437	† Signetics	
	SW7437	SW	
	SN5437	† TI	
	SN7437	TI	100
	TD3437	Toshiba	
	7437	TRW	
Quad 2-Input NAND Gate, Open Collector			
	5401	† Fairchild	
	5403	† Fairchild	
	7401	Fairchild	
	7403	Fairchild	
	9012C	Fairchild	
	9012M	† Fairchild	
	ZN5401	† Ferranti	
	ZN7401	Ferranti	110
	HD2509	Hitachi	
	HD2528	Hitachi	
	HD7403	Hitachi	
	ITT5401	† ITT	
	ITT5403	† ITT	
	ITT7401	ITT	
	ITT7403	ITT	
	MC5401	† Motorola	
	MC5403 (continued)	† Motorola	
Quad 2-Input NAND Gate, Open Collector (continued)			
	MC7401	Motorola	120
	MC7403	Motorola	
	DM5401	† National	
	DM5403	† National	
	DM7401	National	
	DM7403	National	
	DM9012C	National	
	5401	† Raytheon	
	7401	Raytheon	
	5403	† Raytheon	
	7403	Raytheon	130
	S5401	† Signetics	
	S5403	† Signetics	
	S7401	Signetics	
	S7403	Signetics	
	SW7401	SW	
	SW7403	SW	
	SN5401	† TI	
	SN5403	† TI	
	SN7401	TI	
	SN7403	TI	140
	TD3401	Toshiba	
	TD3403	Toshiba	
	7401	TRW	
	7403	TRW	
Quad 2-Input NAND Buffer, Open Collector			
	5438	† Fairchild	
	7438	Fairchild	
	7439	Fairchild	
	ZN5438	† Ferranti	
	ZN7438	Ferranti	
	HD2544	Hitachi	150
	ITT5438	† ITT	
	ITT7438	ITT	
	MC5438	† Motorola	
	MC7438	Motorola	
	DM5438	† National	
	DM7438	National	
	N7438	Signetics	
	N7439	Signetics	
	S5438	† Signetics	
	S5439	† Signetics	160
	SW7438	SW	
	SN5438	† TI	
	SN7438	TI	
	TD3438	Toshiba	
	7438	TRW	

Gates, AND-OR-Invert

Function	Device	Source	Line
2-2-2-3-Input AND-OR-Invert Gate, Expandable			
	9008C	Fairchild	
	9008M	† Fairchild	
	ITT9008-1	† ITT	
	ITT9008-5	ITT	
	DM9008C	National	170
4-Wide 2-Input AND-OR-Invert Gate			
	5454	† Fairchild	
	7454	Fairchild	
	ZN5454	† Ferranti	
	ZN7454	Ferranti	
	HD2514	Hitachi	
	HD7454 (continued)	Hitachi	

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL (cont)

Function	Device	Source	Line
Gates, AND-OR-Invert (cont)			
4-Wide 2-Input AND-OR-Invert Gate (continued)			
	ITT5454	† ITT	
	ITT7454	ITT	
	MC5454	† Motorola	
	MC7454	Motorola	
	DM5454	† National	
	DM7454	National	
	N7454	Signetics	
	S5454	† Signetics	
	SW7454	SW	
	SN5454	† TI	10
	SN7454	TI	
	7454	TRW	
4-Wide 2-Input AND-OR-Invert Gate, Expandable			
	5453	† Fairchild	
	7453	Fairchild	
	ZN5453	† Ferranti	
	ZN7453	Ferranti	
	HD2512	Hitachi	
	HD2578	Hitachi	
	HD7453	Hitachi	
	ITT5453	† ITT	20
	ITT7453	ITT	
	MC5453	† Motorola	
	MC7453	Motorola	
	DM5453	† National	
	DM7453	National	
	N7453	Signetics	
	S5453	† Signetics	
	SW7453	SW	
	SN5453	† TI	
	SN7453	TI	30
	7453	TRW	
Dual 2-Wide 2-Input AND-OR-Invert Gate			
	5451	† Fairchild	
	7451	Fairchild	
	ZN7451	Ferranti	
	ZN5451	† Ferranti	
	HD2505	Hitachi	
	HD7451	Hitachi	
	ITT5451	† ITT	
	ITT7451	ITT	
	MC5451	† Motorola	40
	MC7451	Motorola	
	DM5451	† National	
	DM7451	National	
	N7451	Signetics	
	S5451	† Signetics	
	SW7451	SW	
	SN5451	† TI	
	SN7451	TI	
	TD3451	Toshiba	
	7451	TRW	50
Dual 2-Wide 2-Input AND-OR-Invert Gate (one gate is expandable)			
	5450	† Fairchild	
	7450	Fairchild	
	5460	† Fairchild	
	7460	Fairchild	
	9005C	Fairchild	
	9005M	† Fairchild	
	ZN5450	† Ferranti	
	ZN7450	Ferranti	
	HD2506 (continued)	Hitachi	

Function	Device	Source	Line
Gates, AND-OR-Invert (cont)			
Dual 2-Wide 2-Input AND-OR-Invert Gate (one gate is expandable) (continued)			
	HD7450	Hitachi	60
	ITT5450	† ITT	
	ITT7450	ITT	
	ITT9005-1	† ITT	
	ITT9005-5	ITT	
	MC5450	† Motorola	
	MC7450	Motorola	
	DM5450	† National	
	DM7450	National	
	DM9005C	National	
	N7450	Signetics	70
	S5450	† Signetics	
	SW7450	SW	
	SN5450	† TI	
	SN7450	TI	
	TD3450	Toshiba	
	7450	TRW	
Dual 4-Input Expander (for 54/7423, 54/7450, 54/7453)			
	5460	† Fairchild	
	7460	Fairchild	
	ZN5460	† Ferranti	
	ZN7460	Ferranti	80
	HD2502	Hitachi	
	HD7460	Hitachi	
	ITT5460	† ITT	
	ITT7460	ITT	
	MC5460	† Motorola	
	MC7460	Motorola	
	DM5460	† National	
	DM7460	National	
	N7460	Signetics	
	S5460	† Signetics	90
	SW7460	SW	
	SN5460	† TI	
	SN7460	TI	
	TD3460	Toshiba	
	7460	TRW	
Dual 4-Input Extender (for 9005, 9008)			
	9006C	Fairchild	
	9006M	† Fairchild	
	DM9006C	National	
Gates, Exclusive OR/NOR			
Quad 2-Input Exclusive-OR Gate			
	5486	† Fairchild	
	7486	Fairchild	100
	ZN5486	† Ferranti	
	ZN7486	Ferranti	
	HD2526	Hitachi	
	HD7486	Hitachi	
	ITT5486	† ITT	
	ITT7486	ITT	
	MC5486	† Motorola	
	MC7241	Motorola	
	MC7486	Motorola	
	MC8241	† Motorola	110
	DM5486	National	
	DM7486	National	
	5486	† Raytheon	
	7486	Raytheon	
	RC8241	Raytheon	
	RM8241 (continued)	† Raytheon	

Function	Device	Source	Line
Gates, Exclusive OR/NOR (cont)			
Quad 2-Input Exclusive-OR Gate (continued)			
	N7486	Signetics	
	N8241	Signetics	
	S5486	† Signetics	
	S8241	† Signetics	120
	SW7486	SW	
	SN5486	† TI	
	SN7486	TI	
	7486	TRW	
Quad 2-Input Exclusive OR Gate (two of the outputs are complemented)			
	9014C	Fairchild	
	9014M	† Fairchild	
Quad 2-Input Exclusive-OR Gate, Open Collector			
	HD74136	Hitachi	
	54136	† Raytheon	
	74136	Raytheon	
	SN54136	† TI	130
	SN74136	TI	
	74136	TRW	
Quad Exclusive NOR Gate, Open Collector			
	9386C	Fairchild	
	9386M	† Fairchild	
	MC7242	Motorola	
	MC8242	† Motorola	
	RC8242	Raytheon	
	RM8242	† Raytheon	
	N8242	Signetics	
	S8242	† Signetics	140
Gates, OR/NOR			
(Sequence OR, NOR, OR/NOR,)			
Quad 2-Input OR Gate			
	5432	† Fairchild	
	7432	Fairchild	
	ZN5432	† Ferranti	
	ZN7432	Ferranti	
	HD7432	Hitachi	
	ITT5432	† ITT	
	ITT7432	ITT	
	DM5432	† National	
	DM7432	National	150
	N7432	Signetics	
	S5432	† Signetics	
	SW7432	SW	
	SN5432	† TI	
	SN7432	TI	
2-2-2-4 Input NOR Gate			
	9015C	Fairchild	
	9015M	† Fairchild	
Dual 4-Input NOR Gate, with Strobe			
	5425	† Fairchild	
	7425	Fairchild	
	ZN5425	† Ferranti	160
	ZN7425	Ferranti	
	ITT5425	† ITT	
	ITT7425	ITT	
	DM5425	† National	
	DM7425	National	
	SW7425	SW	
	SN5425	† TI	
	SN7425	TI	
Dual 4-Input NOR Gate, with Strobe, Expandable (see 54/7460 Expander)			
	5423	† Fairchild	
	7423	Fairchild	170
	DM5423 (continued)	† National	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

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Gates, OR/NOR (cont)

Function	Device	Source
Dual 4-Input NOR Gate, with Strobe, Expandable (see 54/7460 Expander) (continued)		
	DM7423	National
	SW7423	SW
	SN5423	† TI
	SN7423	TI
Triple 3-Input NOR Gate		
	5427	† Fairchild
	7427	Fairchild
	ZN5427	† Ferranti
	ZN7427	Ferranti
	HD7427	Hitachi
	DM5427	† National
	DM7427	National
	SW7427	SW
	SN5427	† TI
	SN7427	TI
Quad 2-Input NOR Gate (54/7428 devices are also buffers)		
	5402	† Fairchild
	7402	Fairchild
	ZN5428	† Ferranti
	ZN7428	Ferranti
	HD2511	Hitachi
	HD7402	Hitachi
	ITT5402	† ITT
	ITT7402	ITT
	ITT5428	† ITT
	ITT7428	ITT
	MC5402	† Motorola
	MC7402	Motorola
	DM5402	† National
	DM7402	National
	N7402	Signetics
	S5402	† Signetics
	SW7402	SW
	SN5402	† TI
	SN5428	† TI
	SN7402	TI
	SN7428	TI
	7402	TRW
Quad 2-Input NOR Buffer, Open Collector		
	ITT5433	† ITT
	ITT7433	ITT
	SN5433	† TI
	SN7433	TI

Gates, Miscellaneous

Function	Device	Source
Quad Inverter and Dual 2-Input NAND Gate		
	DM7090	† National
	DM8090	National
Dual Majority Logic Gate		
	MC4062	Motorola

Latches

Function	Device	Source
8-Bit Addressable Latch, with Clear		
	9334C	AMD
	9334M	† AMD
	SN54259	† AMD
	SN74259	AMD
	9334C	Fairchild
	9334M	† Fairchild
	DM8334	National
	DM9334	† National
	SN54259	† TI
	SN74259	TI

Latches (cont)

Function	Device	Source
8-Bit Latch, Three-State (input and output through the same leads)		
	DM7553	† National
	DM8553	National
Dual 4-Bit Latch		
	MC54100	† Motorola
	MC74100	Motorola
	N74100	Signetics
	S54100	† Signetics
	SW74100	SW
	SN54100	† TI
	SN74100	TI
Dual 4-Bit Latch with Clear		
	9308C	AMD
	9308M	† AMD
	9308C	Fairchild
	9308M	† Fairchild
	54116	† Fairchild
	74116	Fairchild
	ITT9308-1	† ITT
	ITT9308-5	ITT
	MC8308	Motorola
	MC9308	† Motorola
	RM9308	† Raytheon
	RC9308	Raytheon
	SN29308	TI
	SN39308	† TI
	SN54116	† TI
	SN74116	TI
Quad Multifunction Latch		
	9314C	AMD
	9314M	† AMD
	9314C	Fairchild
	9314M	† Fairchild
	MC8314	Motorola
	MC9314	† Motorola
Quad Bistable Latch, Single Output		
	5477	† Fairchild
	7477	Fairchild
	MC5477	† Motorola
	MC7477	Motorola
	N7477	Signetics
	S5477	† Signetics
	SN5477	† TI
	SN7477	TI
Quad Bistable Latch, Complementary Outputs		
	5475	† Fairchild
	7475	Fairchild
	ZN5475	† Ferranti
	ZN7475	Ferranti
	HD2517	Hitachi
	HD7475	Hitachi
	ITT5475	† ITT
	ITT7475	ITT
	MC5475	† Motorola
	MC7475	Motorola
	DM5475	† National
	DM7475	National
	N7575	Signetics
	S5475	† Signetics
	SW7475	SW
	SN5475	† TI
	SN7475	TI
	TD3475	Toshiba
	7475	TRW

Latches (cont)

Function	Device	Source
Quad Set-Reset Latch		
	54279	† Fairchild
	74279	Fairchild
	S54279	† Signetics
	N74279	Signetics
	SN54279	† TI
	SN74279	TI
Hex Set-Reset Latch (Common Reset)		
	ZN54118	† Ferranti
	ZN54119	† Ferranti
	ZN74118	Ferranti
	ZN74119	Ferranti
	ITT54118	† ITT
	ITT74118	ITT

Memories

For additional information on these and larger TTL compatable memories, see the Master Selection Guide—Memory section

Function	Device	Source
8-Bit (4x2) Content Addressable Memory		
	N8220	Signetics
	N8222	Signetics
	S8222	† Signetics
8-Bit Multiport Register (RAM with simultaneous Read/Write)		
	9338C	AMD
	9338M	† AMD
	9338C	Fairchild
	9338M	† Fairchild
16-Bit Active Element Memory		
	93407C	Fairchild
	93407M	† Fairchild
	93433C	Fairchild
	93433M	† Fairchild
	HM2501	Hitachi
	MC4004	Motorola
	MC4005	Motorola
	MC4304	† Motorola
	MC4305	† Motorola
	5481	† Raytheon
	7481	Raytheon
	SN5481A	† TI
	SN7481A	TI
	7481	TRW
16-Bit Active Element Memory, Gated Write		
	SN5484A	† TI
	SN7484A	TI
16-Bit (4x4) Register File, Simultaneous Read/Write		
	54170	† Fairchild
	74170	Fairchild
	ZN54170	† Ferranti
	ZN74170	Ferranti
	HD2540	Hitachi
	DM74170	National
	54170	† Raytheon
	74170	Raytheon
	N74170	Signetics
	S54170	† Signetics
	SN54170	† TI
	SN74170	TI
16-Bit (8x2) Multiport Register File, Simultaneous Read/Write, Three-State		
	N74172	Signetics
	SN74172	TI
16-Bit (4x4) Content Addressable Memory		
	3104	Intel
64-Bit (16x4) RAM with output register		
	9410C	Fairchild
	9410M	† Fairchild

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL (cont)

Function	Device	Source
Multiplexers		
Quad 2-Input Multiplexer, Non-Inverting		
	9322C	AMD
	9322M	† AMD
	SN54157	† AMD
	SN74157	AMD
	9322C	Fairchild
	9322M	† Fairchild
	54157	† Fairchild
	74157	Fairchild
	ZN54157	† Ferranti
	ZN74157	Ferranti
	HD74157	Hitachi
	ITT9322-1	ITT
	ITT9322-5	ITT
	ITT74157	ITT
	ITT54157	† ITT
	MC9322	† Motorola
	MC8322	Motorola
	MC54157	† Motorola
	MC74157	Motorola
	DM8322	National
	DM9322	† National
	DM54157	† National
	DM74157	National
	RC8233	Raytheon
	RM8233	† Raytheon
	RC9322	Raytheon
	RM9322	† Raytheon
	54157	† Raytheon
	74157	Raytheon
	N8233	Signetics
	S8233	† Signetics
	N74157	Signetics
	S54157	† Signetics
	SW74157	SW
	SN54157	† TI
	SN74157	TI
Quad 2-Input Multiplexer, (Three-State 54/74157)		
	DM7123	National
	DM8123	† National
Quad 2-Input Multiplexer with Storage		
	54298	† Fairchild
	74298	Fairchild
	SN54298	† TI
	SN74298	TI
Quad 2-Input, Multiplexer (for adder, register input)		
	MC7266	Motorola
	MC8266	† Motorola
	RC8266	Raytheon
	RM8266	† Raytheon
	N8266	Signetics
	S8266	† Signetics
Quad 2-Input, Multiplexer, Open Collector (for adder, register input)		
	MC7267	Motorola
	MC8267	† Motorola
	RC8267	Raytheon
	RM8267	† Raytheon
	N8267	Signetics
	S8267	† Signetics
Quad 2-Input Multiplexer, Inverting		
	54158	† Raytheon
	74158	Raytheon
	N74158	Signetics
	S54158	† Signetics
Multiplexers (cont)		
Quad 2-Input Multiplexer, Inverting, Open Collector		
	RC8234	Raytheon
	RM8234	† Raytheon
	N8234	Signetics
	S8234	† Signetics
Quad 2-Input Multiplexer, Conditional Complementing, Open Collector		
	N8235	Signetics
	S8235	† Signetics
Quad 3-Input Multiplexer, Conditional Complementing		
	RC8263	Raytheon
	RM8263	† Raytheon
	N8263	Signetics
	S8263	† Signetics
Quad 3-Input Multiplexer, Open Collector, Conditional Complementing, Output Enable		
	RC8264	Raytheon
	RM8264	† Raytheon
	N8264	Signetics
	S8264	Signetics
Dual 4-Input Multiplexer		
	SN54153	† AMD
	SN74153	AMD
	54153	† Fairchild
	74153	Fairchild
	ZN54153	† Ferranti
	ZN74153	Ferranti
	HD2564	Hitachi
	ITT54153	† ITT
	ITT74153	ITT
	MC4000	Motorola
	MC4300	† Motorola
	MC54153	† Motorola
	MC74153	Motorola
	DM54153	† National
	DM74153	National
	54153	† Raytheon
	74153	Raytheon
	N74153	Signetics
	S54153	† Signetics
	SW74153	SW
	SN54153	† TI
	SN74153	TI
	74153	TRW
Dual 4-Input Multiplexer (Three-State 54/74153)		
	DM7214	† National
	DM8214	National
Dual 4-Input Multiplexer, Complementary Output		
	9309C	AMD
	9309M	† AMD
	9309C	Fairchild
	9309M	† Fairchild
	ITT9309-1	† ITT
	ITT9309-5	ITT
	MC8309	Motorola
	MC9309	† Motorola
	DM8309	National
	DM9309	National
	N9309	Signetics
	S9309	† Signetics
	SN29309	TI
	SN39309	† TI
8-Input Multiplexer, Inverted Output		
	54152	† Fairchild
	74152	Fairchild
	MC54152	† Motorola
	MC74152	Motorola
	DM7210 (continued)	† National
Multiplexers (cont)		
8-Input Multiplexer, Inverted Output (continued)		
	DM7211	† National
	DM8210	National
	DM8211	National
	54152	† Raytheon
	74152	Raytheon
	S54152	† Signetics
	SN54152A	† TI
	74152	TRW
8-Input Multiplexer, Complementary Output		
	9312C	AMD
	9312M	† AMD
	9312C	Fairchild
	9312M	† Fairchild
	ITT9312-1	† ITT
	ITT9312-5	ITT
	MC8312	Motorola
	MC9312	† Motorola
	DM8312	National
	DM9312	† National
	RC8230	Raytheon
	RC8232	Raytheon
	RC9312	Raytheon
	RM8230	† Raytheon
	RM8232	† Raytheon
	RM9312	† Raytheon
	N8230	Signetics
	N8232	Signetics
	S8230	† Signetics
	S8232	† Signetics
	SN29312	TI
	SN39312	† TI
8-Input Multiplexer, Complementary Output, Strobe		
	54151	† Fairchild
	74151	Fairchild
	ZN54151	† Ferranti
	ZN74151	Ferranti
	HD2549	Hitachi
	HD2571	Hitachi
	HD74151	Hitachi
	ITT54151	† ITT
	ITT74151	ITT
	MC54151	† Motorola
	MC74151	Motorola
	DM54151A	† National
	DM74151A	National
	54151	† Raytheon
	74151	Raytheon
	N74151	Signetics
	S54151	† Signetics
	SW74151	SW
	SN54151A	† TI
	SN74151A	TI
	74151	TRW
8-Input Multiplxer, Complementary Output (Three-State 54/74151)		
	DM7121	† National
	DM8121	National
8-Input Multiplexer, Complementary Output, Open Collector		
	9313C	Fairchild
	9313M	† Fairchild
	RC8231	Raytheon
	RM8231	† Raytheon
	N8231	Signetics
	S8231	† Signetics

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

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Multiplexers (cont)

Function	Device	Source
8-Input Multiplexer, Three-State Strobe		
	DM54251	† National
	DM74251	National
	SN54251	† TI
	SN74251	TI
Dual 8-Input Multiplexer (two 8-to-1 sections)		
	SN74351	TI
16-Input Multiplexer, Inverted Output, Strobe		
	54150	† Fairchild
	74150	Fairchild
	ZN54150	† Ferranti
	ZN74150	Ferranti
	HD2548	Hitachi
	HD74150	Hitachi
	ITT54150	† ITT
	ITT74150	ITT
	MC54150	† Motorola
	MC74150	Motorola
	DM54150	† National
	DM74150	National
	54150	† Raytheon
	74150	Raytheon
	N74150	Signetics
	S54150	† Signetics
	SW74150	SW
	SN54150	† TI
	SN74150	TI
	74150	TRW
16-Input Multiplexer (Three-State 54/74150)		
	DM7219	† National
	DM8219	National

Multivibrators

Function	Device	Source
Monostable Multivibrator, Schmitt Trigger Input		
	54121	† Fairchild
	74121	Fairchild
	ZN54121	† Ferranti
	ZN74121	Ferranti
	HD2543	Hitachi
	HD74121	Hitachi
	ITT54121	† ITT
	ITT74121	ITT
	MC54121	† Motorola
	MC74121	Motorola
	DM54121	† National
	DM74121	National
	N74121	Signetics
	S54121	† Signetics
	SW74121	SW
	SN54121	† TI
	SN74121	TI
	TD34121	Toshiba
	74121	TRW
Retriggerable Monostable Multivibrator		
	9601C	AMD
	9601M	† AMD
	9601C	Fairchild
	9601M	† Fairchild
	ITT9601-1	ITT
	ITT9601-5	† ITT
	MC8601	Motorola
	MC9601	† Motorola
	DM8601	National
	DM9601 (continued)	† National

Multivibrators (cont)

Function	Device	Source
Retriggerable Monostable Multivibrator (continued)		
	RF8601	Raytheon
	RF9601	† Raytheon
	RC8T22	Raytheon
	RM8T22	† Raytheon
	N8T22	Signetics
	SW9601	SW
	SN29601	TI
Retriggerable Monostable Multivibrator, with Reset		
	9600C	AMD
	9600M	† AMD
	AM2600C	AMD
	AM2600M	† AMD
	9600C	Fairchild
	9600M	† Fairchild
Retriggerable Monostable Multivibrator with Clear		
	54122	† Fairchild
	74122	Fairchild
	ZN54122	† Ferranti
	ZN74122	Ferranti
	ITT54122	† ITT
	ITT74122	ITT
	N74122	Signetics
	SW74122	SW
	SN54122	† TI
	SN74122	TI
Bidirectional Monostable Multivibrator (Low Level Input)		
	RC8T20	Raytheon
	RM8T20	† Raytheon
	N8T20	Signetics
	S8T20	† Signetics
Dual Monostable Multivibrator, Schmitt-Trigger Input (Dual 54/74121)		
	SN54221	† AMD
	SN74221	AMD
	SN54221	† TI
	SN74221	TI
Dual Retriggerable Monostable Multivibrator with Reset (OR Triggered)		
	9602C	AMD
	9602M	† AMD
	96L02C	Fairchild
	96L02M	† Fairchild
	9602M	† AMD
	AM2602C	AMD
	AM2602M	† AMD
	9602C	Fairchild
	9602M	† Fairchild
	ITT9602-1	† ITT
	ITT9602-5	ITT
	MC8602	Motorola
	MC9602	† Motorola
	DM8602	National
	DM9602	† National
	RF8602	Raytheon
	RF9602	† Raytheon
	N9602	Signetics
	S9602	† Signetics
	SW9602	SW
Dual Retriggerable Monostable Multivibrator with Clear (AND Triggered)		
	AM26123C	AMD
	AM26123M	† AMD
	SN54123	† AMD
	SN74123	AMD
	54123	† Fairchild
	74123	Fairchild
	ZN54123 (continued)	† Ferranti

Multivibrators (cont)

Function	Device	Source
Dual Retriggerable Monostable Multivibrator with Clear (AND Triggered) (continued)		
	ZN74123	Ferranti
	HD2561	Hitachi
	DM54123	† National
	DM74123	National
	54123	† Raytheon
	74123	Raytheon
	N74123	Signetics
	S54123	† Signetics
	SW74123	SW
	SN54123	† TI
	SN74123	TI
	74123	TRW
Dual Monostable Multivibrator (Double-Edge)		
	DM7853	† National
	DM8853	National
Dual Voltage-Controlled Multivibrator		
	11C24C	Fairchild
	MC4024	Motorola
	MC4324	† Motorola
Universal Pulse Generator		
	ITT54124	† ITT
	ITT74124	ITT

Shift Registers

Function	Device	Source
4-Bit Parallel Input, Parallel Output Shift Register		
	9300C	AMD
	9300M	† AMD
	SN54195	† AMD
	SN74195	AMD
	9300C	Fairchild
	9300M	† Fairchild
	54195	† Fairchild
	74195	Fairchild
	ITT9300-1	† ITT
	ITT9300-5	ITT
	ITT54195	† ITT
	ITT74195	ITT
	MC8300	Motorola
	MC9300	† Motorola
	MC54195	† Motorola
	MC74195	Motorola
	DM8300	National
	DM9300	† National
	DM54195	† National
	DM74195	National
	RC9300	Raytheon
	RM9300	† Raytheon
	54195	† Raytheon
	74195	Raytheon
	N9300	Signetics
	N74195	Signetics
	S9300	† Signetics
	S54195	† Signetics
	SN29300	TI
	SN39300	† TI
	SN54195	† TI
	SN74195	TI
4-Bit Parallel-In, Parallel Out, Right/Left Shift Register		
	5495	† Fairchild
	7495	Fairchild
	ZN5495A	† Ferranti
	ZN7495A	Ferranti
	HD2534 (continued)	Hitachi

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL (cont)

Shift Registers (cont)

Function	Device	Source
4-Bit Parallel-In, Parallel Out, Right/Left Shift Register (continued)		
	ITT5495	† ITT
	ITT7495	ITT
	MC4012	Motorola
	MC5495	† Motorola
	MC7495	Motorola
	DM5495	† National
	DM7495	National
	N7495	Signetics
	S5495	† Signetics
	SW7495	SW
	SN5495A	† TI
	SN7495A	TI
	TD3495	Toshiba
4-Bit Universal Bidirectional Shift Register		
	SN54194	† AMD
	SN74194	AMD
	54194	† Fairchild
	74194	Fairchild
	ZN54194	† Ferranti
	ZN74194	Ferranti
	HD74194	Hitachi
	ITT54194	† ITT
	ITT74194	ITT
	DM54194	† National
	DM74194	National
	54194	† Raytheon
	74194	Raytheon
	N74194	Signetics
	S54194	† Signetics
	SN54194	† TI
	SN74194	TI
4-Bit, Parallel-In, Serial-Out, Shift Register		
	5494	† Fairchild
	7494	Fairchild
	ZN5494	† Ferranti
	ZN7494	Ferranti
	HD2533	Hitachi
	ITT5494	† ITT
	ITT7494	ITT
	MC5494	† Motorola
	MC7494	Motorola
	N7494	Signetics
	S5494	† Signetics
	SW7494	SW
	SN5494	† TI
	SN7494	TI
4-Bit Parallel-In, Serial-Out, Shift Register, (with load, shift, hold control)		
	54178	† Fairchild
	74178	Fairchild
	MC7270	Motorola
	MC8270	† Motorola
	RC8270	Raytheon
	RM8270	† Raytheon
	S8270	† Signetics
	N8270	Signetics
	SN54178	† TI
	SN74178	TI
4-Bit Parallel-In, Serial-Out, Shift Register, with Reset, Complementary Output for last bit		
	54179	† Fairchild
	74179	Fairchild
	MC7271	Motorola
	MC8271	† Motorola
	RC8271 (continued)	Raytheon
4-Bit Parallel-In, Serial-Out, Shift Register, with Reset, Complementary Output for last bit (continued)		
	RM8271	† Raytheon
	N8271	Signetics
	S8271	† Signetics
	SN54179	† TI
	SN74179	TI
5-Bit Parallel-In, Parallel-Out, Shift Register		
	5496	† Fairchild
	7496	Fairchild
	ZN5496	† Ferranti
	ZN7496	Ferranti
	HD2546	Hitachi
	HD7496	Hitachi
	ITT5496	† ITT
	ITT7496	ITT
	MC5496	† Motorola
	MC7496	Motorola
	DM5496	† National
	DM7496	National
	N7496	Signetics
	S5496	† Signetics
	SW7496	SW
	SN5496	† TI
	SN7496	TI
	7496	TRW
8-Bit Parallel-In, Parallel-Out, Unidirectional Shift Register		
	54199	† Fairchild
	74199	Fairchild
	HDP4199	Hitachi
	DM54199	† National
	DM74199	National
	54199	† Raytheon
	74199	Raytheon
	N74199	Signetics
	S54199	† Signetics
	SN54199	† TI
	SN74199	TI
8-Bit Parallel-In, Parallel Out, Right/Left Shift Register		
	54198	† Fairchild
	74198	Fairchild
	HD74198	Hitachi
	DM54198	† National
	DM74198	National
	54198	† Raytheon
	74198	Raytheon
	N74198	Signetics
	S54198	† Signetics
	SN54198	† TI
	SN74198	TI
8-Bit Universal Shift Register, Three-State		
	DM7546	† National
	DM8546	National
8-Bit Parallel-In, Serial-Out Shift Register, Complementary Output		
	54165	† Fairchild
	74165	Fairchild
	ZN54165	† Ferranti
	ZN74165	Ferranti
	DM54165	† National
	DM74165	National
	54165	† Raytheon
	74165	Raytheon
	N74165	Signetics
	S54165	† Signetics
	SN54165 (continued)	† TI
8-Bit Parallel-In, Serial-Out Shift Register, Complementary Output (continued)		
	SN74165	TI
8-Bit Parallel-In, Serial Out Shift Register with Clear		
	54166	† Fairchild
	74166	Fairchild
	ZN54166	† Ferranti
	ZN74166	Ferranti
	HD74166	Hitachi
	DM54166	† National
	DM74166	National
	54166	† Raytheon
	74166	Raytheon
	N74166	Signetics
	S54166	† Signetics
	SN54166	† TI
	SN74166	TI
8-Bit Gated Serial-In, Parallel-Out Shift Register		
	54164	† AMD
	74164	AMD
	54164	† Fairchild
	74164	Fairchild
	ZN54164	† Ferranti
	HD74164	Hitachi
	ZN74164	Ferranti
	ITT54164	† ITT
	ITT74164	ITT
	MC54164	† Motorola
	MC74164	Motorola
	DM7570	† National
	DM8570	National
	DM54164	† National
	DM74164	National
	54164	† Raytheon
	74164	Raytheon
	N74164	Signetics
	S54164	† Signetics
	SN54164	† TI
	SN74164	TI
	TD3503	Toshiba
8-Bit Serial-In, Serial-Out Shift Register		
	5491	† Fairchild
	7491	Fairchild
	ZN5491	† Ferranti
	ZN7491	Ferranti
	HD2524	Hitachi
	ITT5491A	† ITT
	ITT7491A	ITT
	MC5491	† Motorola
	MC7491	Motorola
	DM5491A	† National
	DM7491A	National
	N7491	Signetics
	N8276	Signetics
	S5491	† Signetics
	SW7491	SW
	SN5491A	† TI
	SN7491A	TI
	TD3491	Toshiba
10-Bit Parallel-In, Parallel Out Buffer Register, with Reset (clocked flip-flops)		
	RC8202	Raytheon
	RM8202	† Raytheon
	N8202	Signetics
	S8202	† Signetics

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

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Shift Registers (cont)

Function	Device	Source
10-Bit Parallel-In, Parallel-Out Buffer Register, with Reset, Inverting Output (clocked flip-flops)	RC8203	Raytheon
	RM8203	† Raytheon
	N8203	Signetics
	S8203	† Signetics
10-Bit Parallel-In, Serial-Out Shift Register	RC8274	Raytheon
	RM8274	† Raytheon
	N8274	Signetics
	S8274	Signetics
10-Bit Serial-In, Parallel-Out Shift Register	RC8273	Raytheon
	RM8273	† Raytheon
	N8273	Signetics
	S8273	† Signetics
Dual 5-Bit Parallel-In, Parallel Out Buffer Register, (clocked flip-flops)	RC8200	Raytheon
	RM8200	† Raytheon
	N8200	Signetics
	S8200	† Signetics
Dual 5-Bit Parallel-In, Parallel-Out, Buffer Register, Inverting Output (clocked flip-flops)	RC8201	Raytheon
	RM8201	† Raytheon
	N8201	Signetics
	S8201	† Signetics
Dual 8-Bit Serial In, Serial Out, Shift Register	9328C	AMD
	9328M	† AMD
	9328C	Fairchild
	9328M	† Fairchild
	ITT9328-1	† ITT
	ITT9328-5	ITT
	MC8328	Motorola
	MC9328	† Motorola
	RC8277	Raytheon
	RM8277	† Raytheon
	N8277	Signetics

Translators

Function	Device	Source
Hex DTL to TTL Inverter	9109C	Fairchild
	9109M	† Fairchild
Hex TTL to DTL Inverter	9112C	Fairchild
	9112M	† Fairchild
Dual MOS to TTL Level Converter	9625C	Fairchild
	9625M	† Fairchild
Dual MOS-to-TTL Level Translator, Three-State	MC54468	† Motorola
	MC74468	Motorola
7-Unit MOS to TTL Level Converter	SN75270	TI
Dual 2-Input NAND Gate, High Voltage to TTL Interface, to 30v Input	N8T18	Signetics
	S8T18	† Signetics
Dual TTL to MOS Voltage Translator	D130A	† Siliconix
	D130B	Siliconix
	D139A	† Siliconix
	D139B	Siliconix
Dual 2-Input NAND TTL to MOS Voltage Translator	9624C	Fairchild
	9624M	† Fairchild
	DH0034	† National
	DH0034C	National
	DS7800	† National
	DS8800	National
	SN55180	† TI
	(continued)	

Translators (cont)

Function	Device	Source
Dual 2-Input NAND TTL to MOS Voltage Translator (continued)	SN75180	TI
Hex TTL to MOS Voltage Translator	DS7812	† National
	DS8812	National
	DS78L12	† National
	DS88L12	National
	D123A	† Siliconix
	D123B	Siliconix
	D125A	† Siliconix
	D125B	Siliconix
Quad 2-Input NAND TTL to MOS Voltage Translators	DS7810	† National
	DS8810	National
	DS7811	† National
	DS8811	National
Quad 2-Input AND TTL to MOS Voltage Translators	DS7819	† National
	DS8819	National
Dual ECL to MOS Driver (also ECL to TTL)	MC75358	Motorola
	MC75368	Motorola
	SN75368	TI
Quad TTL to CMOS Inverter/Driver, Three-State	ITT75367	ITT
For other translators, see Interface-Sense Amplifiers		

Miscellaneous

Function	Device	Source
Programmable Logic Array (mask programmed)	5775	† MMI
	6775	MMI
	5776	† MMI
	6776	MMI
	DM7575	† National
	DM7576	† National
	DM8575	National
	DM8576	National
Programmable Logic Arrays, Field Programmable	IM5200	Intersil
	5870	† MMI
	6870	MMI
	5871	† MMI
	6871	MMI
	82S100	Signetics
	82S101	Signetics
8-Bit Successive Approximation Register	AM2502C	AMD
	AM2502M	† AMD
	AM2503C	AMD
	AM2503M	† AMD
	DM2502	† National
	DM2502C	National
	DM2503	† National
	DM2503C	National
12-Bit Successive Approximation Register	AM2504C	AMD
	AM2504M	† AMD
	DM2504	† National
	DM2504C	National
8-Bit Position Scaler (The output is shifted with respect to the input up to 8 positions as determined by a 3-bit selector code.)	RC8243	Raytheon
	RM8243	† Raytheon
	N8243	Signetics
	S8243	† Signetics
6-Bit Synchronous Binary Rate Multiplier	5497	† Fairchild
	7497	Fairchild
	SN5497	† TI
	(continued)	

Miscellaneous (cont)

Function	Device	Source
6-Bit Synchronous Binary Rate Multiplier (continued)	SN7497	TI
Synchronous Decade Rate Multiplier	SN54167	† TI
	SN74167	TI
4-Bit Priority Register, Cascadable	SN54278	† TI
	SN74278	TI
8-Input Priority Encoder	9318C	AMD
	9318M	† AMD
	9318C	Fairchild
	9318M	† Fairchild
	HD74148	Hitachi
	MC8318	Motorola
	MC9318	† Motorola
	DM54148	† National
	DM74148	National
	N74148	Signetics
	S54148	† Signetics
	SN29318	TI
	SN39318	† TI
	SN54148	† TI
	SN74148	TI
10-Input Priority Encoder	HD74147	Hitachi
	DM54147	† National
	DM74147	National
	N74147	Signetics
	S54147	† Signetics
	SN54147	† TI
	SN74147	TI
8-Bit Parity Tree	MC4008	Motorola
	MC4308	† Motorola
	MC54408	† Motorola
	MC74408	Motorola
Dual 4-Bit Parity Tree	MC4010	Motorola
	MC4310	† Motorola
9-Bit Parity Generator/Checker	DM7220	† National
	DM8220	National
	RC8262	Raytheon
	RM8262	† Raytheon
	N8262	Signetics
	S8262	† Signetics
9-Bit Odd/Even Parity Generator/Checker	54180	† Fairchild
	74180	Fairchild
	ZN54180	† Ferranti
	ZN74180	Ferranti
	HD2525	Hitachi
	HD74180	Hitachi
	ITT54180	† ITT
	ITT74180	ITT
	MC54180	† Motorola
	MC74180	Motorola
	DM54180	† National
	DM74180	National
	54180	† Raytheon
	74180	Raytheon
	RC8262	Raytheon
	RM8262	† Raytheon
	N8262	Signetics
	S8262	† Signetics
	S54180	† Signetics
	(continued)	

† Military Temperature Range (—55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

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DIGITAL—TTL (cont)

Function	Device	Source
Miscellaneous (cont)		
9-Bit Odd/Even Parity Generator/Checker (continued)		
	N74180	Signetics
	SW74180	SW
	SN54180	† TI
	SN74180	TI
	74180	TRW
12-Input Odd/Even Parity Checker/Generator		
	9348C	Fairchild
	9348M	† Fairchild
Cyclic Redundancy Checker		
	9401C	Fairchild
	9401M	† Fairchild
4-Bit Universal Presettable Polynomial Generator		
	MC8504	Motorola
Polynomial Generator		
	MC8506	Motorola
Single Error Hamming Code Detector and Generator		
	MC4041	Motorola
BCD-To-Binary/Binary-To-BCD Number Converter		
	MC4001	Motorola
BCD-To-Binary Converter		
	ZN54184	† Ferranti
	ZN74184	Ferranti
	DM54184	† National
	DM74184	National
	SN54184	† TI
	SN74184	TI
BCD-to-Binary Converter (Three-State 54/74184)		
	DM8898	National
Binary-To-BCD Converter		
	DM54185A	† National
	DM74185A	National
	SN54185A	† TI
	SN74185A	TI
Binary-to-BCD Converter		
	DM8899	National
Dual Pulse Synchronizer/Driver		
	SN54120	† TI
	SN74120	TI
Quad Power Strobe (V_{cc} strobe or digit driver)		
	HD6600-2	† Harris
	HD6600-5	Harris
	HD6605-2	† Harris
	HD6605-5	† Harris
Phase-Frequency Detector		
	11C44C	Fairchild
	MC4044	Motorola
	MC4344	† Motorola
Contact Bounce Eliminator		
	DM7544	† National
	DM8544	National
Quad Complementary-Output Elements (for symmetrical generation of complementary outputs)		
	SN54265	† TI
	SN74265	TI
Dual Zero Crossing Detector		
	N8T363	Signetics
	S8T363	† Signetics
MOS Dynamic Memory Refresh Logic Circuit		
	MC8505	Motorola
Dual 4-Input NAND Schmitt-Trigger		
	5413	† Fairchild
	7413	Fairchild
	ZN5413	† Ferranti
	ZN7413	Ferranti
	HD2545	Hitachi
	ITT5413	† ITT
	ITT7413	ITT
	DM5413	† National
	DM7413	National
	N7413	Signetics
	S5413	† Signetics
	SW7413	SW
	SN5413	† TI
	SN7413	TI
	(continued)	

Function	Device	Source
Miscellaneous (cont)		
Dual 4-Input NAND Schmitt-Trigger (continued)		
	7413	TRW
Quad 2-Input NAND Schmitt Trigger		
	54132	† Fairchild
	74132	Fairchild
	HD74132	Hitachi
	ITT54137	† ITT
	ITT74137	ITT
	DM54132	† National
	DM74132	National
	N74132	Signetics
	S54132	† Signetics
	SN54132	† TI
	SN74132	TI
Quad 2-Input NOR Schmitt Trigger		
	N74232	Signetics
	S54232	† Signetics
Hex Schmitt Trigger, Inverting		
	5414	† Fairchild
	7414	Fairchild
	HD7414	Hitachi
	ITT54135	† ITT
	ITT74135	ITT
	DM5414	† National
	DM7414	National
	N7414	Signetics
	S5414	† Signetics
	SN5414	† TI
	SN7414	TI
Decade Sequencer (sequential 1 of 10 decoder)		
	9319C	Fairchild
	9319M	† Fairchild
	9320C	Fairchild
	9320M	† Fairchild
Bus Transfer Switch (transmit-receive connections to 4 bus terminals)		
	MC54460	† Motorola
	MC74460	Motorola

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

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Function	Device	Source	Line
Arithmetic Functions			
Dual Full Adder			
	54H183	† Fairchild	
	74H183	Fairchild	
	SN54H183	† TI	
	SN74H183	TI	
Arithmetic Logic Unit/Function Generator			
	54R181	† Raytheon	
	74R181	Raytheon	
Look ahead Carry Generator			
	54R182	† Raytheon	
	74R182	Raytheon	
Buffers/Inverters			
Hex Inverter			
	54H04	† Fairchild	
	74H04	Fairchild	10
	HD2563	Hitachi	
	ITT54H04	† ITT	
	ITT74H04	ITT	
	MC3008	Motorola	
	MC3108	† Motorola	
	DM54H04	† National	
	DM74H04	National	
	54H04	† Raytheon	
	54R04	† Raytheon	
	74H04	Raytheon	20
	74R04	Raytheon	
	S54H04	† Signetics	
	N74H04	Signetics	
	SN54H04	† TI	
	SN74H04	TI	
Hex Inverter, Open Collector			
	54H05	† Fairchild	
	74H05	Fairchild	
	ITT54H05	† ITT	
	ITT74H05	ITT	
	MC3009	Motorola	30
	MC3109	† Motorola	
	DM54H05	† National	
	DM74H05	National	
	54H05	† Raytheon	
	54R05	† Raytheon	
	74H05	Raytheon	
	74R05	Raytheon	
	S54H05	† Signetics	
	N74H05	Signetics	
	SN54H05	† TI	40
	SN74H05	TI	
Drivers			
Dual 3-Input 3-Output AND Series Terminated Line Driver			
	MC3028	Motorola	
	MC3128	† Motorola	
Dual 3-Input 3-Output NAND Series Terminated Line Driver			
	MC3029	Motorola	
	MC3129	† Motorola	
Flip-Flops			
J-K Master Slave Flip-Flop, AND-OR Input			
	54H71	† Fairchild	
	74H71	Fairchild	
	MC3054	Motorola	
	MC3154	† Motorola	
	DM54H71	† National	50
	DM74H71	National	
	(continued)		
Flip-Flops (cont)			
J-K Master Slave Flip-Flop, AND-OR Input (continued)			
	S54H71	† Signetics	
	N74H71	Signetics	
	SN54H71	† TI	
	SN74H71	TI	
J-K Master-Slave Flip-Flop, AND Input with Preset and Clear			
	54H72	† Fairchild	
	74H72	Fairchild	
	ITT54H72	† ITT	
	ITT74H72	ITT	
	MC3050	Motorola	60
	MC3051	Motorola	
	MC3055	Motorola	
	MC3150	† Motorola	
	MC3151	† Motorola	
	MC3155	† Motorola	
	DM54H72	† National	
	DM74H72	National	
	S54H72	† Signetics	
	N74H72	Signetics	
	SN54H72	† TI	70
	SN74H72	TI	
Dual J-K Master-Slave Flip-Flop with clear			
	54H73	† Fairchild	
	74H73	Fairchild	
	ITT54H73	† ITT	
	ITT74H73	ITT	
	MC3061	Motorola	
	MC3062	Motorola	
	MC3063	Motorola	
	MC3161	† Motorola	
	MC3162	† Motorola	80
	MC3163	† Motorola	
	DM54H73	† National	
	DM74H73	National	
	S54H73	† Signetics	
	N74H73	Signetics	
	SN54H73	† TI	
	SN74H73	TI	
Dual J-K Master-Slave Flip-Flop with Preset and Clear			
	54H76	† Fairchild	
	74H76	Fairchild	
	ITT54H76	† ITT	90
	ITT74H76	ITT	
	DM54H76	† National	
	DM74H76	National	
	N74H76	Signetics	
	S54H76	† Signetics	
	SN54H76	† TI	
	SN74H76	TI	
Dual J-K Master-Slave Flip-Flop, Preset, Common Clear, Common Clock			
	54H78	† Fairchild	
	74H78	Fairchild	
	DM54H78	† National	100
	DM74H78	National	
	SN54H78	† TI	
	SN74H78	TI	
J-K Negative Edge-Triggered Flip-Flop, AND Input			
	54H102	† Fairchild	
	74H102	Fairchild	
	S54H102	† Signetics	
	N74H102	Signetics	
	SN54H102	† TI	
	SN74H102	TI	
Flip-Flops (cont)			
J-K Negative Edge-Triggered Flip-Flop, AND-OR Input			
	54H101	† Fairchild	110
	74H101	Fairchild	
	S54H101	† Signetics	
	N74H101	Signetics	
	SN54H101	† TI	
	SN74H101	TI	
Dual J-K Negative Edge- Triggered Flip-Flop, with Clear			
	54H103	† Fairchild	
	74H103	Fairchild	
	DM54H103	† National	
	DM74H103	National	
	S54H103	† Signetics	120
	N74H103	Signetics	
	SN54H103	† TI	
	SN74H103	TI	
Dual J-K Negative Edge- Triggered Flip-Flop, with Preset and Clear			
	54H106	† Fairchild	
	74H106	Fairchild	
	DM54H106	† National	
	DM74H106	National	
	54R112	† Raytheon	
	74R112	Raytheon	
	S54H106	† Signetics	130
	N74H106	Signetics	
	SN54H106	† TI	
	SN74H106	TI	
Dual J-K Negative Edge- Triggered Flip-Flop, Preset, Common Clear, Common Clock			
	54H108	† Fairchild	
	74H108	Fairchild	
	DM54H108	† National	
	DM74H108	National	
	54R114	† Raytheon	
	74R114	Raytheon	
	S54H108	† Signetics	140
	N74H108	Signetics	
	SN54H108	† TI	
	SN74H108	TI	
Dual J-K Negative Edge-Triggered Flip-Flop, Separate Preset and Clock, (no Clear)			
	54R113	† Raytheon	
	74R113	Raytheon	
AND Input $J\overline{J}$-$K\overline{K}$ Flip-Flop			
	MC3052	Motorola	
	MC3152	† Motorola	
D Type Double Edge-Triggered Master-Slave Flip-Flop			
	MC3053	Motorola	
	MC3153	† Motorola	
Dual D Flip-Flop			
	54H74	† Fairchild	150
	74H74	Fairchild	
	ITT54H74	† ITT	
	ITT74H74	ITT	
	MC3060	Motorola	
	MC3160	† Motorola	
	MC54H74	† Motorola	
	MC74H74	Motorola	
	DM74H74	† National	
	DM74H74	National	
	54H74	† Raytheon	160
	54R74	† Raytheon	
	74H74	Raytheon	
	74R74	Raytheon	
	S54H74	† Signetics	
	N74H74	Signetics	
	SN54H74	† TI	
	SN74H74	TI	

† Military Temperature Range (—55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL - High Speed (cont)

Gates, AND/NAND

Function	Device	Source
Dual 4-Input AND Gate	54H21	† Fairchild
	74H21	Fairchild
	ITT54H21	† ITT
	ITT74H21	ITT
	MC3011	Motorola
	MC3111	† Motorola
	DM54H21	† National
	DM74H21	National
	S54H21	† Signetics
	N74H21	Signetics
	SN74H21	† TI
	SN74H21	TI
Dual 4-Input AND Power Gate	MC3026	Motorola
	MC3126	† Motorola
Triple 3-Input AND Gate	54H11	† Fairchild
	74H11	Fairchild
	ITT54H11	† ITT
	ITT74H11	ITT
	MC3006	Motorola
	MC3106	† Motorola
	DM54H11	† National
	DM74H11	National
	54H11	† Raytheon
	54R11	† Raytheon
	74H11	Raytheon
	74R11	Raytheon
	S54H11	† Signetics
	N74H11	Signetics
	SN54H11	† TI
	SN74H11	TI
Triple 3-Input AND Gate Open Collector	54H15	† Fairchild
	74H15	Fairchild
	54H15	† Raytheon
	54R15	† Raytheon
	74H15	Raytheon
	74R15	Raytheon
	SN54H15	† TI
	SN74H15	TI
Quad 2-Input AND Gate	54H08	† Fairchild
	74H08	Fairchild
	MC3001	Motorola
	MC3101	† Motorola
	DM54H08	† National
	DM74H08	National
	S54H08	† Signetics
	N74H08	Signetics
Quad 2-Input AND Gate (Open Collector)	54H09	† Fairchild
	74H09	Fairchild
8-Input NAND Gate	54H30	† Fairchild
	74H30	Fairchild
	ITT54H30	† ITT
	ITT74H30	ITT
	MC3015	Motorola
	MC3016	Motorola
	MC3115	† Motorola
	MC3116	† Motorola
	DM54H30	† National
	DM74H30 (continued)	National

Gates, AND/NAND (cont)

Function	Device	Source
8-Input NAND Gate (continued)	S54H30	† Signetics
	N74H30	Signetics
	SN54H30	† TI
	SN74H30	TI
Dual 4-Input NAND Gate	54H20	† Fairchild
	74H20	Fairchild
	ITT54H20	† ITT
	ITT74H20	ITT
	MC3010	Motorola
	MC3110	† Motorola
	DM54H20	† National
	DM74H20	National
	54H20	† Raytheon
	54R20	† Raytheon
	74H20	Raytheon
	74R20	Raytheon
	S54H20	† Signetics
	N74H20	Signetics
	SN54H20	† TI
	SN74H20	TI
Dual 4-Input NAND Gate, Open Collector	54H22	† Fairchild
	74H22	Fairchild
	MC3012	Motorola
	MC3112	† Motorola
	DM54H22	† National
	DM74H22	National
	54H22	† Raytheon
	54R22	† Raytheon
	74H22	Raytheon
	74R22	Raytheon
	S54H22	† Signetics
	N74H22	Signetics
	SN54H22	† TI
	SN74H22	TI
Dual 4-Input NAND Buffer	54H40	† Fairchild
	74H40	Fairchild
	ITT54H40	† ITT
	ITT74H40	ITT
	MC3024	Motorola
	MC3025	Motorola
	MC3124	† Motorola
	MC3125	† Motorola
	DM54H40	† National
	DM74H40	National
	54H40	† Raytheon
	54R40	† Raytheon
	74H40	Raytheon
	74R40	Raytheon
	S54H40	† Signetics
	N74H40	Signetics
	SN54H40	† TI
	SN74H40	TI
Triple 3-Input NAND Gate	54H10	† Fairchild
	74H10	Fairchild
	ITT54H10	† ITT
	ITT74H10	ITT
	MC3005	Motorola
	MC3015	† Motorola
	DM54H10 (continued)	† National

Gates, AND/NAND (cont)

Function	Device	Source
Triple 3-Input NAND Gate (continued)	DM74H10	National
	54H10	† Raytheon
	54R10	† Raytheon
	74H10	Raytheon
	74R10	Raytheon
	S54H10	† Signetics
	N74H10	Signetics
	SN54H10	† TI
	SN74H10	TI
Triple 3-Input NAND Gate, Open Collector	MC3007	Motorola
	MC3107	† Motorola
Quad 2-Input NAND Gate	54H00	† Fairchild
	74H00	Fairchild
	ITT54H00	† ITT
	ITT74H00	ITT
	MC3000	Motorola
	MC3100	† Motorola
	DM54H00	† National
	DM74H00	National
	54H00	† Raytheon
	54R00	† Raytheon
	74H00	Raytheon
	74R00	Raytheon
	S54H00	† Signetics
	N74H00	Signetics
	SN54H00	† TI
	SN74H00	TI
Quad 2-Input NAND Gate, Open Collector	54H01	† Fairchild
	74H01	Fairchild
	ITT54H01	† ITT
	ITT74H01	ITT
	MC3004	Motorola
	MC3104	† Motorola
	DM54H01	† National
	DM74H01	National
	54H01	† Raytheon
	74H01	Raytheon
	54R03	† Raytheon
	74R03	Raytheon
	S54H01	† Signetics
	N74H01	Signetics
	SN54H01	† TI
	SN74H01	TI

Gates, AND-OR/AND-OR-Invert

Function	Device	Source
2-2-2-3-Input AND-OR Gate, Expandable	54H52	† Fairchild
	74H52	Fairchild
	MC3031	Motorola
	MC3131	† Motorola
	DM54H52	† National
	DM74H52	National
	S54H52	† Signetics
	N74H52	Signetics
	SN54H52	† TI
	SN74H52	TI
2-2-2-3-Input AND-OR-Invert Gate	54H54	† Fairchild
	74H54	Fairchild
	ITT54H54	† ITT
	ITT74H54 (continued)	ITT

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL - High Speed (cont)

Function	Device	Source	Line
Gates, AND-OR/AND-OR-Invert (cont)			
2-2-2-3-Input AND-OR-Invert Gate (continued)	MC3033	Motorola	
	MC3133	† Motorola	
	DM54H54	† National	
	DM74H54	National	
	S54H54	† Signetics	
	N74H54	Signetics	
	SN54H54	† TI	
	SN74H54	TI	
2-2-2-3-Input AND-OR-Invert Gate, Expandable	54H53	† Fairchild	
	74H53	Fairchild	10
	ITT54H53	† ITT	
	ITT74H53	ITT	
	MC3032	Motorola	
	MC3132	† Motorola	
	DM54H53	† National	
	DM74H53	National	
	S54H53	† Signetics	
	N74H53	Signetics	
	SN54H53	† TI	
	SN74H53	TI	20
2-2-3-4-Input AND-OR-Invert Gate	54R64	† Raytheon	
	74R64	Raytheon	
2-2-3-4-Input AND-OR-Invert Gate, Open Collector	54R65	† Raytheon	
	74R65	Raytheon	
2-Wide 4-Input AND-OR-Invert Gate, Expandable	54H55	† Fairchild	
	74H55	Fairchild	
	MC3034	Motorola	
	MC3134	† Motorola	
	DM54H55	† National	
	DM74H55	National	30
	S54H55	† Signetics	
	N74H55	Signetics	
	SN54H55	† TI	
	SN74H55	TI	
Dual 2-Wide 2-Input AND-OR-Invert Gate	54H51	† Fairchild	
	74H51	Fairchild	
	ITT54H51	† ITT	
	ITT74H51	ITT	
	MC3023	Motorola	
	MC3123	† Motorola	40
	DM54H51	† National	
	DM74H51	National	
	S54H51	† Signetics	
	N74H51	Signetics	
	SN54H51	† TI	
	SN74H51	TI	
Dual 2-Wide 2-Input AND-OR-Invert Gate, Expandable	54H50	† Fairchild	
	74H50	Fairchild	
	ITT54H50	† ITT	
	ITT74H50	ITT	50
	MC3020	Motorola	
	MC3120	† Motorola	
	DM54H50	† National	
	DM74H50	National	
	S54H50	† Signetics	
	N74H50	Signetics	
	SN54H50	† TI	
	SN74H50	TI	
Gates, Exclusive, OR/NOR			
Quad 2-Input Exclusive OR Gate	MC3021	Motorola	
	MC3121	† Motorola	60
Quad 2-Input Exclusive NOR Gate	MC3022	Motorola	
	MC3122	† Motorola	
Gates, OR/NOR			
Quad 2-Input OR Gate	MC3003	Motorola	
	MC3103	† Motorola	
Quad 2-Input NOR Gate	MC3002	Motorola	
	MC3102	† Motorola	
	54R02	† Raytheon	
	74R02	Raytheon	
Miscellaneous			
4-Bit True/Complement Zero/One Element	54H87	† Fairchild	
	74H87	Fairchild	70
	SN54H87	† TI	
	SN74H87	TI	
Dual 4-Input Expander (for H50, H53, H55)	54H60	† Fairchild	
	74H60	Fairchild	
	ITT54H60	† ITT	
	ITT74H60	ITT	
	MC3030	Motorola	
	MC3130	† Motorola	
	DM54H60	† National	
	DM74H60	National	80
	S54H60	† Signetics	
	N74H60	Signetics	
	SN54H60	† TI	
	SN74H60	TI	
Triple 3-Input Expander (for H52)	54H61	† Fairchild	
	74H61	Fairchild	
	MC3019	Motorola	
	MC3119	† Motorola	
	DM54H61	National	
	S54H61	† Signetics	90
	N74H61	Signetics	
	SN54H61	† TI	
	SN74H61	TI	
3-2-2-3-Input AND-OR Expander (for H50, H53, H55)	54H62	† Fairchild	
	74H62	Fairchild	
	MC3018	Motorola	
	MC3118	† Motorola	
	DM54H62	† National	
	DM74H62	National	
	S54H62	† Signetics	100
	N74H62	Signetics	
	SN54H62	† TI	
	SN74H62	TI	

† Military Temperature Range (—55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

Master Selection Guide — DIGITAL

DIGITAL—TTL - Low Power Schottky

Arithmetic Functions

4-Bit Binary Full Adder, Look-ahead Carry

Device	Source
9LS83C	Fairchild
9LS83M	† Fairchild
9LS283C	Fairchild
9LS283M	† Fairchild
54LS83	† Fairchild
74LS83	Fairchild
54LS283	† Fairchild
74LS283	Fairchild
54LS83A see page 282	**† Raytheon**
54LS283 see page 282	**† Raytheon**
N74LS83	Signetics
S54LS83	† Signetics
N74LS283 see page 384	**Signetics**
S54LS283 see page 384	**† Signetics**
SN54LS83A	† TI
SN74LS83A	TI
SN54LS283	† TI
SN74LS283	TI

4-Bit ALU and 16-Word two-port Stack

Device	Source
AM2901C	AMD
AM2901M	† AMD

Arithmetic Logic Unit

Device	Source
AM25LS381C	AMD
AM25LS381M	AMD †
SN54LS381	† AMD
SN74LS381	AMD

Arithmetic Logic Unit/Function Generator

Device	Source
AM25LS181C	AMD
AM25LS181M	AMD †
SN54LS181	† AMD
SN74LS181	AMD
9LS181C	Fairchild
9LS181M	† Fairchild
54LS181	† Fairchild
74LS181	Fairchild
54LS181 see page 282	**† Raytheon**
N74LS181 see page 384	**Signetics**
S54LS181 see page 384	**† Signetics**
SN54LS181	† TI
SN74LS181	TI

Register/Arithmetic Logic Unit

Device	Source
AM25LS281C	AMD
AM25LS281M	AMD †
SN54LS281	† AMD
SN74LS281	AMD

Quad Serial Adder/Subtractor

Device	Source
AM25LS15C	AMD
AM25LS15M	† AMD

2-Bit-by-4 Bit Parallel Binary Mulitplier, Serial Output

Device	Source
N74LS261 see page 384	**Signetics**
S54LS261 see page 384	**† Signetics**
SN54LS261	† TI
SN74LS261	TI

Arithmetic Functions (cont)

8-Bit-by-1-Bit Serial/Parallel Multiplier

Device	Source
AM25LS14C	AMD
AM25LS14M	† AMD

4-Bit Magnitude Comparator

Device	Source
N74LS85 see page 384	**Signetics**
S74LS85	†
SN54LS85	† TI
SN74LS85	TI

Buffers/Inverters

Quad Buffer, Three-State

Device	Source
54LS125	† Fairchild
74LS125	Fairchild
54LS126	† Fairchild
74LS126	Fairchild
SN54LS125	† TI
SN54LS126	† TI
SN74LS125	TI
SN74LS126	TI

Hex Buffer, Three-State

Device	Source
54LS365	† Fairchild
74LS365	Fairchild
54LS367	† Fairchild
74LS367	Fairchild
SN54LS365	† TI
SN74LS365	TI
SN54LS367	† TI
SN74LS367	TI

Hex Inverter

Device	Source
9LS04C	Fairchild
9LS04M	† Fairchild
54LS04	† Fairchild
74LS04	Fairchild
DM54LS04	† National
DM74LS04	National
54LS04 see page 282	**† Raytheon**
N74LS04 see page 384	**Signetics**
S54LS04 see page 384	**† Signetics**
SN54LS04	† TI
SN74LS04	TI

Hex Inverter, Open Collector

Device	Source
9LS05C	Fairchild
9LS05M	† Fairchild
54LS05	† Fairchild
74LS05	Fairchild
DM54LS05	† National
DM74LS05	National
54LS05 see page 282	**† Raytheon**
N74LS05 see page 384	**Signetics**
S54LS05 see page 384	**† Signetics**
SN54LS05	† TI
SN74LS05	TI

Hex Inverter, Three-State

Device	Source
54LS366	† Fairchild
74LS366	Fairchild
54LS368	† Fairchild
74LS368	Fairchild
SN54LS366	† TI
SN74LS366 (continued)	TI

Buffers/Inverters (cont)

Hex Inverter, Three-State (continued)

Device	Source
SN54LS368	† TI
SN74LS368	TI

Counters, Binary

4-Bit Binary Counter

Device	Source
9LS93C	Fairchild
9LS93M	† Fairchild
54LS93	† Fairchild
74LS93	Fairchild
54LS293	† Fairchild
74LS293	Fairchild
N74LS93 see page 384	**Signetics**
S54LS93 see page 384	**† Signetics**
N54LS293	Signetics
S74LS293	† Signetics
SN54LS93	† TI
SN54LS293	† TI
SN74LS93	TI
SN74LS293	TI

4-Bit Binary Counter, Synchronous

Device	Source
AM25LS163C	AMD
AM25LS163M	AMD †
SN54LS163	† AMD
SN74LS163	AMD
9LS163C	Fairchild
9LS163M	† Fairchild
54LS163	† Fairchild
74LS163	Fairchild
54LS163 see page 282	**† Raytheon**
N74LS163 see page 384	**Signetics**
S54LS163 see page 384	**† Signetics**
SN54LS163	† TI
SN74LS163	TI

4-Bit Binary Counter, Synchronous, Direct Clear

Device	Source
AM25LS161C	AMD
AM25LS161M	AMD †
SN54LS161	† AMD
SN74LS161	AMD
9LS161C	Fairchild
9LS161M	† Fairchild
54LS161	† Fairchild
74LS161	Fairchild
54LS161 see page 282	**† Raytheon**
N74LS161 see page 384	**Signetics**
S54LS161 see page 384	**† Signetics**
SN54LS161	† TI
SN74LS161	TI

Binary (Divide-by-2 and Divide-by-8) Counter/Latch, Preset Input

Device	Source
9LS197C	Fairchild
9LS197M	† Fairchild
54LS197	† Fairchild
74LS197	Fairchild
54LS197 see page 282	**† Raytheon**
S54LS197 see page 384 (continued)	**† Signetics**

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL - Low Power Schottky (cont)

Counters, Binary (cont)

Function	Device	Source
Binary (Divide-by-2 and Divide-by-8) Counter/ Latch, Preset Input (continued)	**N74LS197** see page 384	**Signetics**
	SN54LS197	† TI
	SN74LS197	TI
Binary Up/Down Counter, Synchronous, Preset Input	AM25LS193C	AMD
	AM25LS193M	AMD †
	SN54LS193	† AMD
	SN74LS193	AMD
	9LS193C	Fairchild
	9LS193M	† Fairchild
	54LS193	† Fairchild
	74LS193	Fairchild
	54LS193 see page 282	**† Raytheon**
	N74LS193 see page 384	**Signetics**
	S54LS193 see page 384	**Signetics**
	SN54LS193	† TI
	SN74LS193	TI
Binary Up/Down Counter, Synchronous, Preset Input, Mode Control	AM25LS191C	AMD
	AM25LS191M	AMD †
	SN54LS191	† AMD
	SN74LS191	AMD
	9LS191C	Fairchild
	9LS191M	† Fairchild
	54LS191	† Fairchild
	74LS191	Fairchild
	54LS191 see page 282	**† Raytheon**
	N74LS191 see page 384	**Signetics**
	S54LS191 see page 384	**† Signetics**
	SN54LS191	† TI
	SN74LS191	TI
Binary Up/Down Counter, Synchronous, Preset Input, Mode Control Look-ahead Carry	SN54LS169	† TI
	SN74LS169	TI

Counters, Decade

Function	Device	Source
Decade Counter, Synchronous	AM25LS160C	AMD
	AM25LS160M	AMD †
	SN54LS160	† AMD
	SN74LS160	AMD
	9LS160C	Fairchild
	9LS160M	† Fairchild
	54LS160	† Fairchild
	74LS160	Fairchild
	54LS160 see page 282	**† Raytheon**
	N74LS160 see page 384	**Signetics**
	S54LS160 see page 384	**† Signetics**
	SN54LS160	† TI
	SN74LS160	TI

Counters, Decade (cont)

Function	Device	Source
Decade Counter, Synchronous, Direct Clear	AM25LS162C	AMD
	AM25LS162M	AMD †
	SN54LS162	† AMD
	SN74LS162	AMD
	9LS162C	Fairchild
	9LS162M	† Fairchild
	54LS162	† Fairchild
	74LS162	Fairchild
	54LS162 see page 282	**† Raytheon**
	N74LS162 see page 384	**Signetics**
	S54LS162 see page 384	**† Signetics**
	SN54LS162	† TI
	SN74LS162	TI
Decade Counter (Divide-by-2 and by 5)	9LS90C	Fairchild
	9LS90M	† Fairchild
	54LS90	† Fairchild
	74LS90	Fairchild
	54LS290	† Fairchild
	74LS290	Fairchild
	N74LS90 see page 384	**Signetics**
	S54LS90 see page 384	**† Signetics**
	N74LS290 see page 384	**Signetics**
	S54LS290 see page 384	**† Signetics**
	SN54LS90	† TI
	SN74LS90	TI
	SN54LS290	† TI
	SN74LS290	TI
Decade Up/Down Counter, Synchronous, Preset Input	AM25LS192C	AMD
	AM25LS192M	AMD †
	SN54LS192	† AMD
	SN74LS192	AMD
	9LS192C	Fairchild
	9LS192M	† Fairchild
	54LS192	† Fairchild
	74LS192	Fairchild
	54LS192 see page 282	**† Raytheon**
	S54LS192 see page 384	**† Signetics**
	N74LS192 see page 384	**Signetics**
	S74LS192	† Signetics
	SN54LS192	† TI
	SN74LS192	TI
Decade Up/Down Counter, Synchronous, Preset Input Mode Control	AM25LS190C	AMD
	AM25LS190M	AMD †
	SN54LS190	† AMD
	SN74LS190	AMD
	9LS190C	Fairchild
	9LS190M	† Fairchild
	54LS190	† Fairchild
	74LS190 (continued)	Fairchild

Counters, Decade (cont)

Function	Device	Source
Decade Up/Down Counter, Synchronous, Preset Input Mode Control (continued)	**54LS190** see page 282	**† Raytheon**
	N74LS190 see page 384	**Signetics**
	S54LS190 see page 384	**† Signetics**
	SN54LS190	† TI
	SN74LS190	TI
Decade Up/Down Counter, Counter, Synchronous, Preset Input, Mode Control, Look-ahead Carry	SN54LS168	† TI
	SN74LS168	TI
Decade (Divide-by-2 and Divide-by-5) Counter/ Latch, Preset Input	9LS196C	Fairchild
	9LS196M	† Fairchild
	54LS196	† Fairchild
	74LS196	Fairchild
	54LS196 see page 282	**† Raytheon**
	N74LS196 see page 384	**† Signetics**
	S54LS196 see page 384	**Signetics**
	SN54LS196	† TI
	SN74LS196	TI

Counters, Miscellaneous

Function	Device	Source
Divide-by-Twelve Counter (Divide-by-2 and by 6)	54LS92	† Fairchild
	74LS92	Fairchild
	N74LS92 see page 384	**Signetics**
	S54LS92 see page 384	**† Signetics**
	SN54LS92	† TI
	SN74LS92	TI

Decoders/Drivers

Function	Device	Source
BCD to 7-Segment Decoder/ Driver	SN54LS47	† TI
	SN54LS48	† TI
	SN54LS49	† TI
	SN54LS247	† TI
	SN54LS248	† TI
	SN54LS249	† TI
	SN74LS47	TI
	SN74LS48	TI
	SN74LS49	TI
	SN74LS247	TI
	SN74LS248	TI
	SN74LS249	TI
3-Line to 8-Line Decoder/Demultiplexer	AM25LS138C	AMD
	AM25LS138M	AMD †
	SN54LS138	† AMD
	SN74LS138	AMD
	9LS138C	Fairchild
	9LS138M	† Fairchild
	54LS138	† Fairchild
	74LS138	Fairchild
	54LS138 see page 282	**† Raytheon**
	N74LS138 see page 384 (continued)	**Signetics**

† Military Temperature Range (—55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL - Low Power Schottky (cont)

Decoders/Drivers (cont)

Function	Device	Source
3-Line to 8-Line Decoder/Demultiplexer (continued)	**S54LS138** see page 384	**† Signetics**
	SN54LS138	† TI
	SN74LS138	TI
3-Line to 8-Line Decoder/ Demultiplexer, Three-State	**54LS255** see page 282	**† Raytheon**
	N74LS255	Signetics
	S54LS255	† Signetics
BCD to 10-Line Decoder (one-of-ten)	9LS42C	Fairchild
	9LS42M	† Fairchild
	54LS42	† Fairchild
	74LS42	Fairchild
	N74LS42 see page 384	**Signetics**
	S54LS42 see page 384	**† Signetics**
	SN54LS42	† TI
	SN74LS42	TI
BCD-to-Decimal Decoder/Driver, Open Collector to 15 v	**N74LS145** see page 384	**Signetics**
	S54LS145 see page 384	**† Signetics**
	SN54LS145	† TI
	SN74LS145	TI
Dual 2-Line to 4-Line Decoder/Demultiplexer	AM25LS139C	AMD
	AM25LS139M	AMD †
	SN54LS139	† AMD
	SN74LS139	AMD
	9LS139C	Fairchild
	9LS139M	† Fairchild
	54LS139	† Fairchild
	74LS139	Fairchild
	54LS139 see page 282	**† Raytheon**
	N74LS139 see page 384	**Signetics**
	S54LS139 see page 384	**† Signetics**
	SN54LS139	† TI
	SN74LS139	TI
Dual 2-Line to -4-Line Decoder/Demultiplexer, Common Address (or 3-Line to 8-Line Decoder/Demultiplexer)	9LS155C	Fairchild
	9LS155M	† Fairchild
	54LS155	† Fairchild
	74LS155	Fairchild
	54LS155 see page 282	**† Raytheon**
	N74LS155 see page 384	**Signetics**
	S54LS155 see page 384	**† Signetics**
	SN54LS155	† TI
	SN74LS155	TI
Dual 2-Line to 4-Line Decoder/Demultiplexer, Common Address, (or 3-Line to 8-Line Decoder/Demultiplexer) Open Collector	9LS156C	Fairchild
	9LS156M	† Fairchild
	54LS156	† Fairchild
	74LS156	Fairchild
	54LS156 see page 282 (continued)	**† Raytheon**

Decoders/Drivers (cont)

Function	Device	Source
Dual 2-Line to 4-Line Decoder/Demultiplexer, Common Address, (or 3-Line to 8-Line (continued)	SN54LS156	† TI
	SN74LS156	TI

Flip-Flops

Function	Device	Source
Dual "J-K" Flip-Flop with Clear	DM54LS107	† National
	DM74LS107	National
	54LS107 see page 282	**† Raytheon**
	N74LS107 see page 384	**Signetics**
	S54LS107 see page 384	**† Signetics**
	SN54LS107	† TI
	SN74LS107	TI
Dual "J-K" Flip-Flop with Preset and Clear	DM54LS76	† National
	DM74LS76	National
	54LS76 see page 282	**† Raytheon**
	N74LS76 see page 384	**Signetics**
	S54LS76 see page 384	**† Signetics**
	SN54LS76	† TI
	SN74LS76	TI
Dual "J-$\overline{K}$" Flip-Flop with Preset, Common Clock and Common Clear	DM54LS78	† National
	DM74LS78	National
	54LS78 see page 282	**Raytheon**
	N74LS78 see page 384	**Signetics**
	S54LS78 see page 384	**† Signetics**
	SN54LS78	† TI
	SN74LS78	TI
Dual "J-$\overline{K}$" Flip-Flop with Preset and Clear	9LS109C	Fairchild
	9LS109M	† Fairchild
	54LS109	† Fairchild
	74LS109	Fairchild
	DM54LS109	† National
	DM74LS109	National
	54LS109 see page 282	**† Raytheon**
	S54LS109 see page 384	**† Signetics**
	N74LS109 see page 384	**Signetics**
	SN54LS109	† TI
	SN74LS109	TI
Dual "J-K" Negative Edge-Triggered Flip-Flop with Clear	9LS73C	Fairchild
	9LS73M	† Fairchild
	54LS73	† Fairchild
	74LS73	Fairchild
	DM54LS73	† National
	DM74LS73	National
	54LS73 see page 282	**† Raytheon**
	N74LS73 see page 384 (continued)	**Signetics**

Flip-Flops (cont)

Function	Device	Source
Dual "J-K" Negative Edge-Triggered Flip-Flop with Clear (continued)	**S54LS73** see page 384	**† Signetics**
	SN54LS73	† TI
	SN74LS73	TI
Dual "J-K" Negative Edge-TriggeredFlip-Flop with Preset	9LS113C	Fairchild
	9LS113M	† Fairchild
	54LS113	† Fairchild
	74LS113	Fairchild
	DM54LS113	† National
	DM74LS113	National
	54LS113 see page 282	**† Raytheon**
	N74LS113 see page 384	**Signetics**
	S54LS113 see page 384	**† Signetics**
	SN54LS113	† TI
	SN74LS113	TI
Dual "J-K" Negative Edge-Triggered Flip-Flop with Preset and Clear	9LS112C	Fairchild
	9LS112M	† Fairchild
	54LS112	† Fairchild
	74LS112	Fairchild
	DM54LS112	† National
	DM74LS112	National
	54LS112 see page 282	**† Raytheon**
	N74LS112 see page 384	**Signetics**
	S54LS112 see page 384	**Signetics**
	SN54LS112	† TI
	SN74LS112	TI
Dual "J-K" Negative Edge-Triggered Flip-Flop with Preset Common Clock and Common Clear	9LS114C	Fairchild
	9LS114M	† Fairchild
	54LS114	† Fairchild
	74LS114	Fairchild
	DM54LS114	† National
	DM74LS114	National
	54LS114 see page 282	**† Raytheon**
	N74LS114 see page 384	**Signetics**
	S54LS114 see page 384	**† Signetics**
	SN54LS114	† TI
	SN74LS114	TI
Dual D-Type Positive Edge-Triggered Flip-Flop with Preset and Clear	9LS74C	Fairchild
	9LS74M	† Fairchild
	9LS74M	† Raytheon
	54LS74	† Fairchild
	74LS74	Fairchild
	DM54LS74	† National
	DM74LS74	National
	54LS74 see page 282	**† Raytheon**
	N74LS74 see page 384	**Signetics**
	S54LS74 see page 384 (continued)	**† Signetics**

† Military Temperature Range (—55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL - Low Power Schottky (cont)

Flip-Flops (cont)

Function	Device	Source
Dual D-Type Positive Edge-Triggered Flip-Flop with Preset and Clear (continued)		
	SN54LS74	† TI
	SN74LS74	TI
Quad D-Type Flip-Flop with Clear		
	AM25LS175C	AMD
	AM25LS175M	AMD †
	SN54LS175	† AMD
	SN74LS175	AMD
	9LS175C	Fairchild
	9LS175M	† Fairchild
	54LS175	† Fairchild
	74LS175	Fairchild
	DM54LS175	† National
	DM74LS175	National
	54LS175	† Raytheon
	N74LS175 **see page 282**	**Signetics**
	S54LS175 **see page 384**	**† Signetics**
	SN54LS175	† TI
	SN74LS175	TI
Quad D-Type Flip-Flip with Common Clock Enable		
	AM25LS08C	AMD
	AM25LS08M	† AMD
	SN54LS379	† AMD
	SN74LS379	AMD
	54LS298	† Fairchild
	74LS298	Fairchild
Quad D-Type Flip-Flop with Multiplexed Dual Inputs		
	AM25LS209C	AMD
	AM25LS209M	AMD †
	SN54LS399	† AMD
	SM74LS399	AMD
	9LS298C	AMD
	9LS298M	† AMD
	9LS298C	Fairchild
	9LS298M	† Fairchild
	SN54LS298	† TI
	SN74LS298	TI
	SN54LS399	† TI
	SN74LS399	TI
Hex D-Type Flip-Flop with Clear		
	AM25LS174C	AMD
	AM25LS174M	AMD †
	SN54LS174	† AMD
	SN74LS174	AMD
	9LS174C	Fairchild
	9LS174M	† Fairchild
	54LS174	† Fairchild
	74LS174	Fairchild
	DM54LS174	† National
	DM74LS174	National
	54LS174 **see page 282**	**† Raytheon**
	N74LS174 **see page 384**	**Signetics**
	S54LS174 **see page 384**	**† Signetics**
	SN54LS174	† TI
	SN74LS174	TI
Hex D-Type Flip-Flop with Common Enable		
	AM25LS07C	AMD
	AM25LS07M	† AMD
	SN54LS378	† AMD
	SN74LS378 (continued)	AMD

Flip-Flops (cont)

Function	Device	Source
Hex D-Type Flip-Flop with Common Enable (continued)		
	SN54LS378	† TI
	SN74LS378	TI
Octal D-Type Flip-Flop with Clear		
	SN54LS273	† TI
	SN74LS273	TI
Octal D-Type Flip-Flop with Enable		
	SN54LS377	† TI
	SN74LS377	TI

Gates, AND/NAND

Function	Device	Source
Dual 4-Input AND Gate		
	9LS21C	Fairchild
	9LS21M	† Fairchild
	54LS21	† Fairchild
	74LS21	Fairchild
	54LS21	† Raytheon
	S54LS21 **see page 384**	**† Signetics**
	N74LS21 **see page 384**	**Signetics**
	SN74LS21	TI
	SN54LS21	† TI
Triple 3-Input AND Gate		
	9LS11C	Fairchild
	9LS11M	† Fairchild
	54LS11	† Fairchild
	74LS11	Fairchild
	54LS11 **see page 282**	**† Raytheon**
	N74LS11 **see page 384**	**Signetics**
	S54LS11 **see page 384**	**† Signetics**
	SN54LS11	TI
	SN74LS11	† TI
Triple 3-Input AND Gate, Open Collector		
	9LS15C	Fairchild
	9LS15M	† Fairchild
	54LS15	† Fairchild
	74LS15	Fairchild
	54LS15 **see page 282**	**† Raytheon**
	N74LS15 **see page 384**	**Signetics**
	S54LS15 **see page 384**	**† Signetics**
	SN54LS15	† TI
	SN74LS15	TI
Quad 2-Input AND Gate		
	9LS08C	Fairchild
	9LS08M	† Fairchild
	54LS08	† Fairchild
	74LS08	Fairchild
	54LS08 **see page 282**	**† Raytheon**
	N74LS08 **see page 384**	**Signetics**
	S54LS08 **see page 384**	**† Signetics**
	SN54LS08	† TI
	SN74LS08	TI
Quad 2-Input AND Gate, Open Collector		
	9LS09C	Fairchild
	9LS09M	† Fairchild
	54LS09 (continued)	† Fairchild

Gates, AND/NAND (cont)

Function	Device	Source
Quad 2-Input AND Gate, Open Collector (continued)		
	74LS09	Fairchild
	54LS09 **see page 282**	**† Raytheon**
	N74LS09 **see page 384**	**Signetics**
	S54LS09 **see page 384**	**† Signetics**
	SN54LS09	† TI
	SN74LS09	† TI
8-Input NAND Gate		
	9LS30C	Fairchild
	9LS30M	† Fairchild
	54LS30	† Fairchild
	74LS30	Fairchild
	DM54LS30	† National
	DM74LS30	National
	54LS30 **see page 282**	**† Raytheon**
	N74LS30 **see page 384**	**Signetics**
	S54LS30 **see page 384**	**† Signetics**
	SN54LS30	† TI
	SN74LS30	TI
13-Input NAND Gate		
	54LS133	† Fairchild
	74LS133	Fairchild
Dual 4-Input NAND Gate		
	9LS20C	Fairchild
	9LS20M	† Fairchild
	54LS20	† Fairchild
	74LS20	Fairchild
	DM54LS20	† National
	DM74LS20	National
	54LS20 **see page 282**	**† Raytheon**
	N74LS20 **see page 384**	**Signetics**
	S54LS20 **see page 384**	**† Signetics**
	SN54LS20	† TI
	SN74LS20	TI
Dual 4-Input NAND Buffer		
	9LS40C	Fairchild
	9LS40M	† Fairchild
	54LS40	† Fairchild
	74LS40	Fairchild
	54LS40 **see page 282**	**† Raytheon**
	N74LS40 **see page 384**	**Signetics**
	S54LS40 **see page 384**	**Signetics**
	SN54LS40	† TI
	SN74LS40	TI
Dual 4-Input NAND Gate, Open Collector		
	9LS22C	Fairchild
	9LS22M	† Fairchild
	54LS22	† Fairchild
	74LS22	Fairchild
	DM54LS22	† National
	DM74LS22	National
	54LS22 **see page 282** (continued)	**† Raytheon**

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL - Low Power Schottky (cont)

Gates, AND/NAND (cont)

Dual 4-Input NAND Gate, Open Collector (continued)

Device	Source	Line
S54LS22 see page 384	**† Signetics**	
N74LS22 see page 384	**Signetics**	
SN54LS22	† TI	
SN74LS22	TI	

Triple 3-Input NAND Gate

Device	Source	Line
9LS10C	Fairchild	
9LS10M	† Fairchild	
54LS10	† Fairchild	
74LS10	Fairchild	
DM54LS10	† National	
DM74LS10	National	10
54LS10 see page 282	**† Raytheon**	
N74LS10 see page 384	**Signetics**	
S54LS10 see page 384	**† Signetics**	
SN54LS10	† TI	
SN74LS10	TI	

Triple 3-Input NAND Gate, Open Collector

Device	Source	Line
DM54LS12	† National	
DM74LS12	National	
54LS12 see page 282	**† Raytheon**	
N74LS12 see page 384	**Signetics**	
S54LS12 see page 384	**† Signetics**	20
SN54LS12	† TI	
SN74LS12	TI	

Quad 2-Input NAND Gate

Device	Source	Line
9LS00C	Fairchild	
9LS00M	† Fairchild	
54LS00	† Fairchild	
74LS00	Fairchild	
DM54LS00	† National	
DM74LS00	National	
54LS00 see page 282	**† Raytheon**	
N74LS00 see page 384	**Signetics**	30
S54LS00 see page 384	**† Signetics**	
SN54LS00	† TI	
SN74LS00	TI	

Quad 2-Input NAND Buffer

Device	Source	Line
9LS37C	Fairchild	
9LS37M	† Fairchild	
54LS37	† Fairchild	
74LS37	Fairchild	
54LS37 see page 282	**† Raytheon**	
N74LS37 see page 384	**Signetics**	
S54LS37 see page 384	**† Signetics**	40
SN54LS37	† TI	
SN74LS37	TI	

Quad 2-Input NAND Gate, Open Collector

Device	Source	Line
9LS03C	Fairchild	
9LS03M	† Fairchild	
9LS38C (continued)	Fairchild	

Gates, AND/NAND (cont)

Quad 2-Input NAND Gate, Open Collector (continued)

Device	Source	Line
9LS38M	† Fairchild	
54LS03	† Fairchild	
74LS03	Fairchild	
DM54LS01	† National	
DM74LS01	National	50
DM54LS03	† National	
DM74LS03	National	
54LS01 see page 282	**† Raytheon**	
54LS03 see page 282	**† Raytheon**	
54LS38 see page 282	**† Raytheon**	
N74LS01 see page 384	**Signetics**	
N74LS03 see page 384	**Signetics**	
N74LS38 see page 384	**Signetics**	
S54LS01 see page 384	**† Signetics**	
S54LS03 see page 384	**† Signetics**	60
S54LS38 see page 384	**† Signetics**	
SN54LS01	† TI	
SN74LS01	TI	
SN54LS03	† TI	
SN74LS03	TI	
SN54LS38	† TI	
SN74LS38	TI	

Quad 2-Input NAND Buffer, Open Collector

Device	Source	Line
9LS38C	Fairchild	
9LS38M	† Fairchild	
54LS38	† Fairchild	70
74LS38	Fairchild	
N74LS38 see page 384	**Signetics**	
S54LS38 see page 384	**† Signetics**	
SN54LS38	† TI	
SN74LS38	TI	

Quad 2-Input NAND Buffer, Open Collector, to 15 V

Device	Source	Line
54LS26	† Fairchild	
74LS26	Fairchild	
DM54LS26	† National	
DM74LS26	National	
54LS26 see page 282	**† Raytheon**	80
N74LS26 see page 384	**Signetics**	
S54LS26 see page 384	**† Signetics**	
SN54LS26	† TI	
SN74LS26	TI	

Gates, AND-OR-Invert

2-Wide, 4-Input AND-OR-Invert Gate

Device	Source	Line
9LS55C	Fairchild	
9LS55M	† Fairchild	
54LS55	† Fairchild	
74LS55 (continued)	Fairchild	

Gates, AND-OR-Invert (cont)

2-Wide, 4-Input AND-OR-Invert Gate (continued)

Device	Source	Line
DM54LS55	† National	
DM74LS55	National	90
54LS55 see page 282	**† Raytheon**	
N74LS55 see page 384	**Signetics**	
S54LS55 see page 384	**† Signetics**	
SN54LS55	† TI	
SN74LS55	TI	

4-Wide, 2-3-3-2-Input AND-OR-Invert Gate

Device	Source	Line
9LS54C	Fairchild	
9LS54M	† Fairchild	
54LS54	† Fairchild	
74LS54	Fairchild	
DM54LS54	† National	100
DM74LS54	National	
54LS54 see page 282	**† Raytheon**	
N74LS54 see page 384	**Signetics**	
S54LS54 see page 384	**† Signetics**	
SN54LS54	† TI	
SN74LS54	TI	

Dual 2-Wide 2/3-Input AND-OR-Invert Gate

Device	Source	Line
9LS51C	Fairchild	
9LS51M	† Fairchild	
54LS51	† Fairchild	
74LS51	Fairchild	110
DM54LS51	† National	
DM74LS51	National	
54LS51 see page 282	**† Raytheon**	
N74LS51 see page 384	**Signetics**	
S54LS51 see page 384	**† Signetics**	
SN54LS51	† TI	
SN74LS51	TI	

Gates, Exclusive OR/NOR

Quad 2-Input Exclusive OR Gate

Device	Source	Line
9LS86C	Fairchild	
9LS86M	† Fairchild	
54LS86	† Fairchild	120
74LS86	Fairchild	
54LS86 see page 282	**† Raytheon**	
54LS386 see page 282	**† Raytheon**	
N74LS86 see page 384	**Signetics**	
S54LS86 see page 384	**† Signetics**	
N74LS386 see page 384	**Signetics**	
S54LS386 see page 384	**† Signetics**	
SN54LS86	† TI	
SN74LS86	TI	
SN54LS386 (continued)	† TI	130

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL - Low Power Schottky (cont)

Function	Device	Source
Gates, Exclusive OR/NOR (cont)		
Quad 2-Input Exclusive OR Gate (continued)		
	SN74LS386	TI
Quad 2-Input Exclusive OR Gate, Open Collector		
	9LS136C	Fairchild
	9LS136M	† Fairchild
	54LS136	† Fairchild
	74LS136	Fairchild
	54LS136 see page 282	**† Raytheon**
	N74LS136 see page 384	**Signetics**
	S54LS136 see page 384	**† Signetics**
	SN54LS136	† TI
	SN74LS136	TI
Quad 2-Input Exclusive NOR Gate, Open Collector		
	9LS266C	Fairchild
	9LS266M	† Fairchild
	54LS266	† Fairchild
	74LS266	Fairchild
	54LS266 see page 282	**† Raytheon**
	N74LS266 see page 384	**Signetics**
	S54LS266 see page 384	**† Signetics**
	SN54LS266	† TI
	SN74LS266	TI
Gates, OR/NOR		
Quad 2-Input OR Gate		
	9LS32C	Fairchild
	9LS32M	† Fairchild
	54LS32	† Fairchild
	74LS32	Fairchild
	54LS32 see page 282	**† Raytheon**
	N74LS32 see page 384	**Signetics**
	S54LS32 see page 384	**† Signetics**
	SN54LS32	† TI
	SN74LS32	TI
Dual 5-Input NOR Gate		
	54LS260	† Fairchild
	74LS260	Fairchild
	N74LS260A see page 384	**Signetics**
	S54LS260A see page 384	**† Signetics**
Triple 3-Input NOR Gate		
	9LS27C	Fairchild
	9LS27M	† Fairchild
	54LS27	† Fairchild
	74LS27	Fairchild
	DM54LS27	† National
	DM74LS27	National
	54LS27 see page 282	**† Raytheon**
	N74LS27 see page 384	**Signetics**
	S54LS27 see page 384	**† Signetics**
	SN54LS27 (continued)	† TI

Function	Device	Source
Gates, OR/NOR (cont)		
Triple 3-Input NOR Gate (continued)		
	SN74LS27	TI
Quad 2-Input NOR Gate		
	9LS02C	Fairchild
	9LS02M	† Fairchild
	54LS02	† Fairchild
	74LS02	Fairchild
	DM54LS02	† National
	DM74LS02	National
	54LS02 see page 282	**† Raytheon**
	N74LS02 see page 384	**Signetics**
	S54LS02 see page 384	**† Signetics**
	SN54LS02	† TI
	SN74LS02	TI
Quad 2-Input NOR Buffer		
	54LS28 see page 282	**† Raytheon**
	N74LS28 see page 384	**Signetics**
	S54LS28 see page 384	**† Signetics**
	SN54LS28	† TI
	SN74LS28	TI
Quad 2-Input NOR Buffer, Open Collector		
	54LS33 see page 282	**† Raytheon**
	N74LS33 see page 384	**Signetics**
	S54LS33 see page 384	**† Signetics**
	SN54LS33	† TI
	SN74LS33	TI
Latches		
8-Bit Addressable Latch		
	54LS259	† Fairchild
	74LS259	Fairchild
	SN54LS259	† TI
	SN74LS259	TI
Dual 4-Bit Addressable Latch		
	54LS255	† Fairchild
	74LS255	Fairchild
Quad Bistable Latch, Complementary Output		
	N74LS75 see page 384	**Signetics**
	S54LS75 see page 384	**† Signetics**
	SN54LS75	† TI
	SN74LS75	TI
	SN54LS375	† TI
	SN74LS375	TI
Quad Bistable Latch		
	SN54LS77	TI
Quad $\overline{S}$-$\overline{R}$ Latch		
	9LS279C	Fairchild
	9LS279M	† Fairchild
	54LS279	† Fairchild
	74LS279	Fairchild
	SN54LS279	† TI
	SN74LS279	TI

Function	Device	Source
Memories		
16-Bit (4 x 4)Register File Simultaneous Read/Write		
	9LS170C	Fairchild
	9LS170M	† Fairchild
	54LS170	† Fairchild
	74LS170	Fairchild
	N74LS170 see page 384	**Signetics**
	S54LS170 see page 384	**† Signetics**
	SN54LS170	† TI
	SN74LS170	TI
16-Bit (4 x 4) Register File, Simultaneous Read/Write, Three-State		
	9LS670C	Fairchild
	9LS670M	† Fairchild
	54LS670	† Fairchild
	74LS670	Fairchild
	54LS670	† Raytheon
	N74LS670 see page 384	**Signetics**
	S54LS670 see page 384	**† Signetics**
	SN54LS670	† TI
	SN74LS670	TI
Multiplexers		
Quad 2-Input Multiplexer, Non-Inverting		
	AM25LS157C	AMD
	AM25LS157M	AMD †
	SN54LS157	† AMD
	SN74LS157	AMD
	9LS157C	Fairchild
	9LS157M	† Fairchild
	54LS157	† Fairchild
	74LS157	Fairchild
	54LS157 see page 282	**† Raytheon**
	N74LS157 see page 384	**Signetics**
	S54LS157 see page 384	**Signetics**
	SN54LS157	† TI
	SN74LS157	TI
Quad 2-Input Multiplexer, Non-Inverting, Three-State		
	AM25LS257C	AMD
	AM25LS257M	AMD †
	SN54LS257	† AMD
	SN74LS257	AMD
	9LS257C	Fairchild
	9LS257M	† Fairchild
	54LS257	† Fairchild
	74LS257	Fairchild
	54LS257 see page 282	**† Raytheon**
	N74LS257 see page 384	**Signetics**
	S54LS257 see page 384	**† Signetics**
	SN54LS257	† TI
	SN74LS257	TI
Quad 2-Input Multiplexer, Inverting		
	AM25LS158C	AMD
	AM25LS158M	AMD †
	SN54LS158 (continued)	† AMD

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL - Low Power Schottky (cont)

Multiplexers (cont)

Quad 2-Input Multiplexer, Inverting (continued)

Device	Source
SN74LS158	AMD
9LS158C	Fairchild
9LS158M	† Fairchild
54LS158	† Fairchild
74LS158	Fairchild
54LS158 see page 282	† Raytheon
N74LS158 see page 384	Signetics
S54LS158 see page 384	† Signetics
SN54LS158	† TI
SN74LS158	TI

Quad 2-Input Multiplexer, Inverting Three State

Device	Source
AM25LS258C	AMD
AM25LS258M	AMD †
SN54LS258	† AMD
SN74LS258	AMD
9LS258C	Fairchild
9LS258M	† Fairchild
54LS258	† Fairchild
74LS258	Fairchild
54LS258 see page 282	† Raytheon
N74LS258 see page 384	Signetics
S54LS258 see page 384	† Signetics
SN54LS258	† TI
SN74LS258	TI

Quad 2-Input Multiplexer with Storage

Device	Source
9LS298C	AMD
9LS298M	† AMD
AM25LS09C	AMD
AM25LS09M	† AMD
SN54LS399	† AMD
SN74LS399	AMD
9LS298C	Fairchild
9LS298M	† Fairchild
54LS298	† Fairchild
74LS298	Fairchild
SN54LS298	† TI
SN74LS298	TI
SN54LS399	† TI
SN74LS399	TI

Dual 4-Input Multiplexer

Device	Source
AM25LS153C	AMD
AM25LS153M	AMD †
SN54LS153	† AMD
SN74LS153	AMD
9LS153C	Fairchild
9LS153M	† Fairchild
54LS153	† Fairchild
74LS153	Fairchild
54LS153 see page 282	† Raytheon
S54LS153 see page 384	† Signetics
N74LS153 see page 384	Signetics
SN54LS153	† TI
SN74LS153	TI

Dual 4-Input Multiplexer, Inverting

Device	Source
SN54LS352	† TI
SN74LS352	TI

Dual 4-Input Multiplexer, Three-State

Device	Source
AM25LS253C	AMD
AM25LS253M	AMD †
SN54LS253	† AMD
SN74LS253	AMD
9LS253C	Fairchild
9LS253M	† Fairchild
54LS253	† Fairchild
74LS253	Fairchild
DM54LS253	† National
DM74LS253	National
SN54LS253	† National
SN74LS253	National
54LS253 see page 282	† Raytheon
N74LS253 see page 384	Signetics
S54LS253 see page 384	† Signetics
SN54LS253	† TI
SN74DC253	TI

8-Input Data Selector/Multiplexer, Single Output

Device	Source
9LS152C	Fairchild
9LS152M	† Fairchild
54LS152	† Fairchild
74LS152	Fairchild
54LS152 see page 282	† Raytheon
SN54LS152	† TI
SN74LS152	TI

8-Input Multiplexer, Strobe, Complementary Output

Device	Source
AM25LS151C	AMD
AM25LS151M	AMD †
SN54LS151	† AMD
SN74LS151	AMD
9LS151C	Fairchild
9LS151M	† Fairchild
54LS151	† Fairchild
74LS151	Fairchild
DM54LS151	† National
DM74LS151	National
54LS151 see page 282	† Raytheon
N74LS151 see page 384	Signetics
S54LS151 see page 384	† Signetics
SN54LS151	† TI
SN74LS151	TI

8-Input Multiplexer, Strobe, Complementary Output, Three-State

Device	Source
AM25LS251C	AMD
AM25LS251M	AMD †
SN54LS251	† AMD
SN74LS251	AMD
9LS251C	Fairchild
9LS251M	† Fairchild
54LS251	† Fairchild
74LS251	Fairchild
54LS251 see page 282	† Raytheon
S54LS251 see page 384	† Signetics

(continued)

8-Input Multiplexer, Strobe, Complementary Output, Three-State (continued)

Device	Source
N74LS251 see page 384	Signetics
SN54LS251	† TI
SN74LS251	TI

Multivibrators

Retriggerable Monostable Multivibrator with Clear

Device	Source
SN54LS122	† TI
SN74LS122	TI

Dual Monostable Multivibrator with Schmitt-Trigger Inputs

Device	Source
N74LS221 see page 384	Signetics
S54LS221 see page 384	† Signetics
SN54LS221	TI
SN74LS221	TI

Dual Retriggerable Monostable Multivibrator with Clear

Device	Source
AM25LS123C	AMD
AM25LS123M	AMD †
SN54LS123	† AMD
SN74LS123	AMD
96L02C	Fairchild
96L02M	† Fairchild
SN54LS123	† TI
SN74LS123	TI

Shift Registers

4-Bit Parallel In, Parallel Out Shift Register

Device	Source
AM25LS195C	AMD
AM25LS195M	AMD †
SN54LS195A	† AMD
SN74LS195A	AMD
9LS195C	Fairchild
9LS195M	† Fairchild
54LS195	† Fairchild
74LS195	Fairchild
54LS195A see page 282	† Raytheon
N74LS195A see page 384	Signetics
S54LS195A see page 384	† Signetics
SN74LS195A	TI

4-Bit Parallel In, Parallel Out Right/Left Shift Register

Device	Source
9LS95C	Fairchild
9LS95M	† Fairchild
54LS95	† Fairchild
74LS95	Fairchild
54LS95B see page 282	† Raytheon
N74LS95B see page 384	Signetics
S54LS95B see page 384	† Signetics
SN54LS95B	† TI
SN74LS95B	TI

4-Bit Parallel In, Parallel Out Cascadable Shift Register, Three-State

Device	Source
SN54LS395	† TI
SN74LS395	TI

4-Bit Parallel In, Parallel Out, Right/Left Shift Register, Three-State

Device	Source
9LS295C	Fairchild
9LS295M	† Fairchild
54LS295	† Fairchild
74LS295	Fairchild

(continued)

† Military Temperature Range (—55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL - Low Power Schottky (cont)

Shift Registers (cont)

Function	Device	Source
4-Bit Parallel In, Parallel Out, Right/Left Shift Register, Three-State (continued)		
	54LS295A see page 282	**† Raytheon**
	N74LS295	Signetics
	S54LS295	† Signetics
	SN54LS295A	† TI
	SN74LS295A	TI
4-Bit Bidirectional Universal Shift Register		
	AM25LS194AC	AMD
	AM25LS194AM	AMD †
	SN54LS194A	† AMD
	SN74LS194A	AMD
	9LS194C	Fairchild
	9LS194M	† Fairchild
	54LS194	† Fairchild
	74LS194	Fairchild
	54LS194A see page 282	**† Raytheon**
	N74LS194A see page 384	**Signetics**
	S54LS194A see page 384	**Signetics**
	SN54LS194A	† TI
	SN74LS194A	TI
5-Bit Parallel Out Shift Register		
	N74LS96 see page 384	**Signetics**
	S54LS96 see page 384	**† Signetics**
	SN54LS96	† TI
	SN74LS96	TI
8-Bit Gated Serial In, Parallel Out Shift Register		
	AM25LS164C	AMD
	AM25LS164M	AMD †
	SN54LS164	† AMD
	SN74LS164	AMD
	9LS164C	Fairchild
	9LS164M	† Fairchild
	54LS164	† Fairchild
	74LS164	Fairchild
	N74LS164 see page 384	**Signetics**
	S54LS164 see page 384	**† Signetics**
	SN54LS164	† TI
	SN74LS164	TI
8-Bit Serial In, Serial Out Shift Register		
	SN54LS91	† TI
	SN74LS91	TI
8-Bit Bidirectional Shift Register		
	AM25LS22C	AMD
	AM25LS22M	† AMD
	AM25LS23C	AMD
	AM25LS23M	† AMD
	AM25LS299C	AMD
	AM25LS299M	AMD †
	SN54LS299	† AMD
	SN74LS299	AMD

Miscellaneous

Function	Device	Source
Voltage Controlled Oscillator (or Crystal Controlled)		
	SN54LS324	† TI
	SN74LS324	TI

Miscellaneous (cont)

Function	Device	Source
Dual Voltage Controlled Oscillator (or Crystal Controlled)		
	SN54LS124	† TI
	SN74LS124	TI
Hex Current Sensing Interface Gate		
	SN54LS63	† TI
	SN74LS63	TI
-Bit Parity Generator/Checker		
	SN54LS280	† TI
	SN74LS280	TI
Dual 4-Input NAND Gate, Schmitt Trigger		
	N74LS13 see page 384	**Signetics**
	S54LS13 see page 384	**† Signetics**
	SN54LS13	† TI
	SN74LS13	TI
Quad 2-Input NAND Gate, Schmitt Trigger		
	9LS132C	Fairchild
	9LS132M	† Fairchild
	54LS132	† Fairchild
	74LS132	Fairchild
	N74LS132 see page 384	**Signetics**
	S54LS132 see page 384	**† Signetics**
	SN54LS132	† TI
	SN74LS132	TI
Hex Schmitt Trigger Inverting		
	9LS14C	Fairchild
	9LS14M	Fairchild
	54LS14	† Fairchild
	74LS14	Fairchild
	N74LS14 see page 384	**Signetics**
	S54LS14 see page 384	**† Signetics**
	SN54LS14	† TI
	SN74LS14	TI
Microprogram Sequences		
	AM2909C	AMD
	AM2909M	† AMD

† Military Temperature Range (—55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL - Schottky

Arithmetic Functions

Function	Device	Source
4-Bit Binary Adder		
	SN54S283	† TI
	SN74S283	TI
4-Bit BCD Adder		
	N82S83	Signetics
4-Bit BCD Arithmetic Unit (Add, Subtract, Compare)		
	N82S82	Signetics
Arithmetic and Logic Shift Matrix, Bit and Byte Masking		
	9404C	Fairchild
	9404M	† Fairchild
Arithmetic Logic Unit/Function Generator (16 Function)		
	SN54S181	† AMD
	SN74S181	AMD
	54S181	† Fairchild
	74S181	Fairchild
	93S41C	Fairchild
	93S41M	† Fairchild
	HD74S181	Hitachi
	N74S181	Signetics
	SN54S181	† TI
	SN74S181	TI
Arithmetic Logic/Function Generator (8 Function)		
	SN54S381	† TI
	SN74S381	TI
Accumulator, 4-Bit Parallel Binary (ALU, Shift; Expandable)		
	SN54S281	† TI
	SN74S281	TI
Carry Look-ahead Unit (for 54/74S181, 54/74S281, 74S381)		
	54S182	† Fairchild
	74S182	Fairchild
	93S42C	Fairchild
	93S42M	† Fairchild
	N74S182	Signetics
	SN54S182	† TI
	SN74S182	TI
4-Bit Microcontroller (ALU, Shift and Registers; Expandable Section of a CPU)		
	9405C	Fairchild
	9405M	† Fairchild
	5701	† MMI
	6701	MMI
2's Complement Multiplier (4-Bit x 2-Bit)		
	AM25S05C	AMD
	AM25S05M	† AMD
	93S43C	Fairchild
	93S43M	† Fairchild
4-By-4-Bit Binary Multiplier, Three-State		
	SN74S274	TI
7-Bit Slice Wallace Tree (to build multipliers)		
	SN54S275	† TI
	SN74S275	TI
4-Bit Magnitude Comparator		
	SN54S85	† TI
	SN74S85	TI
6-Bit Identity Comparator		
	93S46C	Fairchild
	93S46M	† Fairchild
6-Bit Identity Comparator, Open Collector		
	93S47C	Fairchild
	93S47M	† Fairchild

Buffers/Inverters

Function	Device	Source
Hex Buffer, Three-State		
	N8T95	Signetics
	N8T96	Signetics
	N8T97	Signetics
	N8T98	Signetics
Octal (Dual Quad), Buffer (Driver), Hysteresis, Three-State		
	SN74S241	TI
Hex Inverter		
	54S04	† Fairchild
	74S04	Fairchild
	(continued)	

Buffers/Inverters (cont)

Function	Device	Source
Hex Inverter (continued)		
	9S04AC	Fairchild
	9S04AM	† Fairchild
	HD74S04	Hitachi
	DM74S04	National
	N74S04	Signetics
	N8T93	Signetics
	SN54S04	† TI
	SN74S04	TI
Hex Inverter, Open Collector		
	54S05	† Fairchild
	74S05	Fairchild
	9S05AC	Fairchild
	9S05AM	† Fairchild
	HD74S05	Hitachi
	DM74S05	National
	N74S05	Signetics
	N8T94	Signetics
	SN54S05	† TI
	SN74S05	TI
Octal (Dual Quad) Inverter (Driver) Hysteresis, Three State		
	SN74S240	TI

Counters, Binary

Function	Device	Source
4-Bit Binary Synchronous Counter		
	SN54S161	† AMD
	SN74S161	AMD
	93S16C	AMD
	93S16M	† AMD
	93S16C	Fairchild
	93S16M	† Fairchild
	SN54S163	† TI
	SN74S163	TI
4-Bit Binary Up/Down Counter, Synchronous		
	SN54S169	† TI
	SN74S169	TI
4-Bit Universal Shift Register, Binary Up/Down Counter, Synchronous		
	SN74S291	TI
Binary Counter (Divide by 2, 4, 8, 16) Asynchronous Preset Input		
	N74S197	Signetics
	N82S91	Signetics
	SN54S197	† TI
	SN74S197	TI

Counters, Decade

Function	Device	Source
Decade Synchronous Counter		
	SN54S160	† AMD
	SN74S160	AMD
	93S10C	AMD
	93S10M	† AMD
	93S10C	Fairchild
	93S10M	† Fairchild
	SN54S162	† TI
	SN74S162	TI
Decade Up/Down Counter, Synchronous		
	SN54S168	† TI
	SN74S168	TI
Decade Counter (Divide by 2 and Divide by 5), Asynchronous Preset Input		
	N74S196	Signetics
	N82S90	Signetics
	SN54S196	† TI
	SN74S196	TI

Counters, Miscellaneous

Function	Device	Source
Variable Modulo Counter (Divide by 2, 4, 5, 6, 8, 10, 12, 14, 16)		
	93S05C	Fairchild
	93S05M	† Fairchild

Decoders, Drivers

Function	Device	Source
3-Line to 8-Line Decoder		
	N82S50	Signetics
3-Line to 8-Line Decoder/Demultiplexer		
	SN54S138	† AMD
	SN74S138	AMD
	54S138	† Fairchild
	74S138	Fairchild
	3205	Intel
	N74S138	† Signetics
	SN54S138	† TI
	SN74S138	TI
3-Line to 8-Line Decoder/Demultiplexer with Input Latches		
	93S137C	Fairchild
	93S137M	† Fairchild
Dual 2-Line to 4-Line Decoder/Demultiplexer		
	93S21C	AMD
	93S21M	† AMD
	SN54S139	† AMD
	SN74S139	AMD
	54S139	† Fairchild
	74S139	Fairchild
	N74S139	Signetics
	SN54S139	† TI
	SN74S139	TI
BCD-to-Decimal Decoder		
	N82S52	Signetics
Dual 4-Input Positive NAND 50 Ohm Line Driver		
	54S140	† Fairchild
	74S140	† Fairchild
	HD74S140	Hitachi
	DM74S140	National
	N74S140	Signetics
	SN54S140	† TI
	SN74S140	TI

Flip-Flops

Function	Device	Source
Dual "J-K" Negative Edge-Triggered Flip-Flop with Individual Clock, Asynchronous Preset and Clear		
	54S112	† Fairchild
	74S112	Fairchild
	HD74S112	Hitachi
	DM74S112	National
	N74S112	Signetics
	SN54S112	† TI
	SN74S112	TI
Dual "J-K" Negative Edge-Triggered Flip-Flop with Individual Preset and Clock		
	54S113	† Fairchild
	74S113	Fairchild
	HD74S113	Hitachi
	DM74S113	National
	N74S113	Signetics
	SN54S113	† TI
	SN74S113	TI
Negative Edge-Triggered Flip-Flop with Common Clock and Common Clear		
	54S114	† Fairchild
	74S114	Fairchild
	HD74S114	Hitachi
	DM74S114	National
	N74S114	Signetics
	SN54S114	† TI
	SN74S114	TI

† Military Temperature Range (—55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL - Schottky (cont)

Flip-Flops (cont)

Function	Device	Source
Dual "J-K" Edge-Triggered Flip-Flop with Set and Clear	54S109	† Fairchild
	74S109	Fairchild
Dual D-Type Edge-Triggered Flip-Flop with Preset and Clear	54S74	† Fairchild
	74S74	Fairchild
	HD74S74	Hitachi
	DM74S74	National
	N74S74	Signetics
	SN54S74	† TI
	SN74S74	TI
Quad D-Type Flip-Flop, Standard TTL and Three-State Outputs	AM25S18C	AMD
	AM25S18M	† AMD
Quad D-Type Edge-Triggered Flip-Flop with Clear and Complementary Output	SN54S175	† AMD
	SN74S175	AMD
	54S175	† Fairchild
	74S175	Fairchild
	HD74S175	Hitachi
	N74S175	Signetics
	SN74S175	TI
	SN54S175	† TI
Quad D-Type Edge-Triggered Flip-Flop with Common Clock Enable	AM25S08C	AMD
	AM25S08M	† AMD
Quad Selectable Input D-Type Edge-Triggered Flip-Flop	AM25S09C	AMD
	AM25S09M	† AMD
Hex D-Type Edge-Triggered Flip-Flop with Clear	SN54S174	† AMD
	SN74S174	AMD
	54S174	† Fairchild
	74S174	Fairchild
	HD74S174	Hitachi
	N74S174	Signetics
	SN54S174	† TI
	SN74S174	TI
Hex D-Type Edge-Triggered Flip-Flop with Common Clock Enable	AM25S07C	AMD
	AM25S07M	† AMD
Octal D-Type Edge-Triggered Flip-Flop, Three-State	SN74S374	TI

Gates, AND/NAND

Function	Device	Source
Triple 3-Input AND Gate	54S11	† Fairchild
	74S11	Fairchild
	HD74S11	Hitachi
	DM74S11	National
	N74S11	Signetics
	S54S11	† Signetics
	SN54S11	† TI
	SN74S11	TI
Triple 3-Input AND Gate, Open Collector	54S15	† Fairchild
	74S15	Fairchild
	HD74S15	Hitachi
	DM74S15	National
	N74S15	Signetics
	S54S15	† Signetics
	SN54S15	† TI
	SN74S15	TI
Quad 2-Input AND Gate	54S08	† Fairchild
	74S08	Fairchild
	SN54S08	† TI
	(continued)	

Gates, AND/NAND (cont)

Function	Device	Source
Quad 2-Input AND Gate (continued)	SN74S08	TI
Quad 2-Input AND Gate, Open Collector	54S09	† Fairchild
	74S09	Fairchild
	SN54S09	† TI
	SN74S09	TI
2-2-3-3 Input AND Gate	9S41C	Fairchild
	9S41M	† Fairchild
8-Input NAND Gate	54S30	† Fairchild
	74S30	Fairchild
	DM74S30	National
	SN54S30	† TI
	SN74S30	TI
12-Input NAND Gate, Three-State	54S134	† Fairchild
	74S134	Fairchild
	HD74S134	Hitachi
	DM74S134	National
	N74S134	Signetics
	SN54S134	† TI
	SN74S134	TI
13-Input NAND Gate	54S133	† Fairchild
	HD74S133	Hitachi
	74S133	Fairchild
	DM74S133	National
	N74S133	Signetics
	SN54S133	† TI
	SN74S133	TI
Dual 4-Input NAND Gate	54S20	† Fairchild
	74S20	Fairchild
	ZN54S20	† Ferranti
	ZN74S20	Ferranti
	HD74S20	Hitachi
	DM74S20	National
	N74S20	Signetics
	SN54S20	† TI
	SN74S20	TI
Dual 4-Input NAND Buffer	54S40	† Fairchild
	74S40	Fairchild
	HD74S40	Hitachi
	DM74S40	National
	N74S40	Signetics
	SN54S40	† TI
	SN74S40	TI
Dual 4-Input NAND Gate, Open Collector	54S22	† Fairchild
	74S22	Fairchild
	ZN54S22	† Ferranti
	ZN74S22	Ferranti
	HD74S22	Hitachi
	DM74S22	National
	N74S22	Signetics
	SN54S22	† TI
	SN74S22	TI
Triple 3-Input NAND Gate	54S10	† Fairchild
	74S10	Fairchild
	HD74S10	Hitachi
	DM74S10	National
	N74S10	Signetics
	SN54S10	† TI
	SN74S10	TI

Gates, AND/NAND (cont)

Function	Device	Source
Quad 2-Input NAND Gate	54S00	† Fairchild
	74S00	† Fairchild
	ZN54S00	† Ferranti
	ZN74S00	Ferranti
	HD74S00	Hitachi
	DM74S00	National
	N74S00	Signetics
	SN54S00	† TI
	SN74S00	TI
Quad 2-Input NAND Gate (Buffer)	SN54S37	† TI
	SN74S37	TI
Quad 2-Input NAND Gate, Open Collector	54S03	† Fairchild
	74S03	Fairchild
	ZN54S03	† Ferranti
	ZN74S03	Ferranti
	HD74S03	Hitachi
	DM74S03	National
	N74S03	Signetics
	SN54S03	† TI
	SN74S03	TI
Quad 2-Input NAND Gate, (Buffer), Open Collector	SN54S38	† TI
	SN74S38	TI

Gates, AND-OR/AND-OR-Invert

Function	Device	Source
Dual 2-4 Input AND-OR Gate	9S42C	Fairchild
	9S42M	Fairchild
4-2-3-2 Input AND-OR-Invert Gate	54S64	† Fairchild
	74S64	† Fairchild
	HD74S64	Hitachi
	DM74S64	National
	N74S64	† Signetics
	SN54S64	TI
	SN74S64	TI
4-2-3-2 Input AND-OR-Invert Gate, Open Collector	54S65	† Fairchild
	74S65	† Fairchild
	HD74S65	Hitachi
	DM74S65	National
	SN54S65	† TI
	SN74S65	TI
4-2-3-2 Input AND-OR-Invert Dual 2-Wide 2-Input AND-OR-Invert Gate	54S51	† Fairchild
	74S51	Fairchild
	SN54S51	† TI
	SN74S51	TI

Gates, Exclusive OR/NOR

Function	Device	Source
Quad 2-Input Exclusive-OR Gate	54S86	† Fairchild
	74S86	Fairchild
	HD74S86	Hitachi
	DM74S86	National
	N82S41	Signetics
	S54S86	† Signetics
	SN54S86	† TI
	SN74S86	TI
Quad 2-Input Exclusive-OR Gate, Open Collector	DM74S136	National
Quad 2-Input Exclusive NOR Gate, Open Collector	N82S42	Signetics

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—TTL - Schottky (cont)

Gates, Exclusive OR/NOR (cont)

Function	Device	Source
Quad Exclusive OR/NOR Gate	54S135	† Fairchild
	74S135	Fairchild
	HD74S135	Hitachi
	DM74S135	National
	N74S135	Signetics
	SN54S135	† TI
	SN74S135	TI

Gates, OR/NOR

Function	Device	Source
Quad 2-Input OR Gate	54S32	† Fairchild
	74S32	Fairchild
	SN54S32	† TI
	SN74S32	TI
Dual 5-Input NOR Gate	SN54S260	† TI
	SN74S260	TI
Quad 2-Input NOR Gate	54S02	† Fairchild
	74S02	Fairchild
	DM74S02	National
	SN54S02	† TI
	SN74S02	TI

Latches

Function	Device	Source
6-Bit Latch (Independent 2 and 4-Bit)	3404	Intel
8-Bit Latch, Transparent D-Type, Three-State	SN54S412	† TI
	SN74S373	TI
	SN74S412	TI

Memories

Function	Device	Source
16-Bit (8 x 2) Multiple Port Register File, Simultaneous Read/Write, Three-State	N74S172	Signetics
32-Bit (8 x 4) Multiport RAM	**N82S12**	**Signetics**
	see page 804, 806, 810,	
	N82S112	**Signetics**
	see page 804, 806, 810,	
64-Bit (16 x 4) Bipolar Read/Write RAM, Three-State	AM27S03C	AMD
	AM27S03M	† AMD
	SN54S189	† AMD
	SN74S189	AMD
	93405C	Fairchild
	93405M	† Fairchild
	SN54S189	† TI
	SN74S189	TI
64-Bit (16 x 4) Bipolar Read/Write RAM, Open Collector	AM27S02C	AMD
	AM27S02M	† AMD
	SN54S289	† AMD
	SN74S289	AMD
	93404C	Fairchild
	93404M	† Fairchild
	3101A	Intel
	SN54S289	† TI
	SN74S289	TI
64-Bit (32 x 2) Bipolar Write-While-Read RAM	DM86S21	National
	N82S21	**Signetics**
	see page 804, 806, 812,	
64-Bit (16x4) First In/First Out Memory Asynchronous, Three-State	9403C	Fairchild
	9403M	† Fairchild

Memories (cont)

Function	Device	Source
80-Bit (16 x 5) First-In/First-Out Memory, Asynchronous, Three-State	SN74S225	TI

Multiplexers

Function	Device	Source
Quad 2-Input Digital Multiplexer (Suitable for Driving Adders, Registers)	N82S33	Signetics
	N82S66	Signetics
Quad 2-Input Multiplexer, Non-Inverting	SN54S157	† AMD
	SN74S157	AMD
	93S22C	AMD
	93S22M	† AMD
	54S157	† Fairchild
	74S157	Fairchild
	DM74S157	National
	N74S157	Signetics
	N82S33	Signetics
	SN54S157	† TI
	SN74S157	TI
Quad 2-Input Multiplexer, Non-Inverting, Three-State	SN54S257	† AMD
	SN74S257	AMD
	54S257	† Fairchild
	74S257	Fairchild
	S54S257	† Signetics
	N74S257	Signetics
	SN54S257	† TI
	SN74S257	TI
Quad 2-Input Multiplexer, Inverting	SN54S158	† AMD
	SN74S158	AMD
	54S158	† Fairchild
	74S158	Fairchild
	DM74S158	National
	N74S158	Signetics
	N82S66	Signetics
	SN54S158	† TI
	SN74S158	TI
Quad 2-Input Multiplexer, Inverting, Open Collector	N82S34	Signetics
	N82S67	Signetics
Quad 2-Input Multiplexer, Inverting, Three/State	SN54S258	† AMD
	SN74S258	AMD
	54S258	† Fairchild
	74S258	Fairchild
	S54S258	† Signetics
	N74S258	Signetics
	SN54S258	† TI
	SN74S258	TI
Dual 4-Input Multiplexer	SN54S153	† AMD
	SN74S153	AMD
	54S153	† Fairchild
	74S153	Fairchild
	DM74S153	National
	N74S153	Signetics
	SN54S153	† TI
	SN74S153	TI
Dual 4-Input Multiplexer Three-State	SN54S253	† AMD
	SN74S253	AMD
	54S253	† Fairchild
	74S253	Fairchild
	N74S253	Signetics

Multiplexers (cont)

Function	Device	Source
8-Input Multiplexer	N82S30	Signetics
	N82S31	Signetics
	N82S32	Signetics
8-Input Multiplexer, Strobe, Complementary Output	SN54S151	† AMD
	SN74S151	AMD
	54S151	† Fairchild
	74S151	Fairchild
	93S12C	Fairchild
	93S12M	† Fairchild
	HD74S151	Hitachi
	DM74S151	National
	N74S151	Signetics
	SN54S151	† TI
	SN74S151	TI
8-Input Multiplexer, Complementary Three-State Output	SN54S251	† AMD
	SN74S251	AMD
	54S251	† Fairchild
	74S251	Fairchild
	HD74S251	Hitachi
	N74S251	Signetics
	SN54S251	† TI
	SN74S251	TI

Multivibrators

Function	Device	Source
Dual Retriggerable, Resettable Monostable Multivibrator	AM26S02C	AMD
	AM26S02M	† AMD
	96S02C	Fairchild
	96S02M	† Fairchild

Shift Registers

Function	Device	Source
4-Bit Shifter, Three-State (Shifts 0, 1, 2, or 3 Bits Under 2-Line Select Control)	AM25S10C	AMD
	AM25S10M	† AMD
4-Bit Parallel-In, Parallel-Out Shift Register	SN54S195	† AMD
	SN74S195	AMD
	93S00C	Fairchild
	93S00M	† Fairchild
	54S195	Fairchild
	74S195	Fairchild
	N74S179	Signetics
	N74S178	Signetics
	N74S195	Signetics
	N82S70	Signetics
	N82S71	Signetics
	SN54S195	† TI
	SN74S195	TI
4-Bit Bidirectional Universal Shift Register	SN54S194	† AMD
	SN74S194	AMD
	54S194	† Fairchild
	74S194	Fairchild
	DM74S194	† National
	N74S194	Signetics
	SN54S194	† TI
	SN74S194	TI
4-Bit Universal Shift Register, Binary Up/Down Counter, Synchronous	SN74S291	TI
8-Bit Universal Shift/Storage Register, Three-State	SN74S299	TI

† Military Temperature Range (—55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL - Schottky (cont)

Function	Device	Source
Miscellaneous		
9-Bit Parity Generator and Checker		
	82S62C	AMD
	82S62M	† AMD
	93S62C	Fairchild
	93S62M	† Fairchild
	DM74S280	National
	N74S280	Signetics
	N82S62	Signetics
	SN54S280	† TI
	SN74S280	TI
12-Bit Parity Generator and Checker		
	93S48C	AMD
	93S48M	† AMD
Voltage Comparator (Analog Input-Digital Output)		
	686C	AMD
	686M	† AMD
Dual Voltage Controlled Oscillator (Also can be crystal controlled)		
	SN54S124	† TI
	SN74S124	TI
Quad 2-Input NAND Schmitt Trigger		
	54S132	† Fairchild
	74S132	Fairchild
	SN54S132	† TI
	SN74S132	TI
4-Bit Parallel Universal Bus Transceiver, Storage, Three-State		
	SN54S226	† TI
	SN74S226	TI
4-Bit Parallel Bus Transceiver, Open Collector Drivers		
	AM26S10C	AMD
	AM26S10M	† AMD
	AM26S11C	AMD
	AM26S11M	† AMD
	AM26S12AC	AMD
	AM26S12C	AMD
	AM26S12AM	† AMD
	AM26S12M	† AMD
4-Bit Parallel Bus Transceiver, Inverting Three-State		
	N8T26	AMD
	S8T26	† AMD
	N8T26	Signetics
4-Bit Parallel Bus Transceiver, Non-inverting, Three-State		
	N8T28	Signetics

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

DIGITAL—Special

Other Digital Devices

Function	Device	Source
Baud Rate Generator/Programmable Divider (ROM controlled divider; supply −12,5v)		
	MM5307	National
	COM5016T	SMC
	COM5016	SMC
Custom Arrays (Digital and Linear circuits customized in final metalization)		
	XR-IIL-CHIP see page 645	**Exar**
	XR-CHIP	Exar
	ULA	Ferranti
	MONOCHIP	Interdesign
	MASTERMOS	
	XC160	Motorola
	XC400	Motorola
	ECL-ARRAY	Plessey
	IIL-ARRAY	Plessey
	RTL-ARRAY	Plessey
Calculators: See Digital-Industrial/Consumer for manufacturers		
Counter, Decade, 1 GHz and above		
	MC1696	Motorola
Counter, 4 Decade (Counts and stores, BCD Output, 0.5 MHz; supply −12,5v)		
	AY5-4057	GI
Counter/Display Decoder, 4 Decade (7 segment and BCD outputs, 0.25 MHz; supply 5v)		
	MK5002	Mostek
	MK5005	Mostek
	MK5007	Mostek
Counter, 5 Decade (includes storage, multiplexed BCD output, 0.6 MHz, supply −12,5v)		
	3815	Fairchild
Quad Counter (two 2-decade up/down counters, 1 MHz; supply −12, ±5 v)		
	M003T1	SGS
	M003T2	† SGS
Counter/Display Driver, 1 Decade (7 segment output, 1 MHz; supply −13, −17v)		
	MEM1056	GI
Counter/Display Driver, 1 Decade (7 segment and BCD Output, 1 MHz; supply −13, −17v)		
	MEM1056BCD	GI
Counter/Display Driver, 1 Decade Up/Down, (7 segment and BCD Output, 0.5 MHz; supply −12, −27v)		
	MCS1003	† MOS
Counter/Display Driver, 4 Decade (7 segment Output, 0.4 MHz; supply −12,5v; BCD and serial output versions available)		
	AY5-4007	GI
Counter/Display Driver, 6 Decade Up/Down (7 segment and BCD output, 1 MHz, presettable compare register, latched output, LED drive, supply 12-18v)		
	MK50395	Mostek
Counter/Display Driver, 7 Decade (7 segment output, supply 2-6v)		
	ICM7208	Intersil
Counter Time-Base (Oscillator, programmable divider, 10^1 to 10^8, $2x10^4$, $6x10^7$, $6x10^8$ and $36x10^8$; supply 5v)		
	MK5009	Mostek

Other Digital Devices (cont)

Function	Device	Source
Elapsed Time Counter (0.01 seconds to 1 hour, supply 2-5v)		
	7205	Intersil
Elapsed Time Counter (0.01 seconds to 24 hours, supply 2-5v)		
	7045	Intersil
Programmable Diode Matrix, 5x5		
	HM-074	† Harris
	HM-075	† Harris
	HM-076	† Harris
Programmable Diode Matrix, 5x8		
	HM-010	† Harris
	HM-012	† Harris
	HM-013	† Harris
Programmable Diode Matrix, 8x5		
	HM-080	† Harris
	HM-081	† Harris
	HM-084	† Harris
Programmable Diode Matrix, 4x10		
	HM-090	† Harris
	HM-091	† Harris
	HM-093	† Harris
	HM-0110	Harris
Programmable Diode Matrix, 10x4		
	HM-050	† Harris
	HM-051	† Harris
	HM-055	† Harris
	HM-0104	Harris
Programmable Diode Matrix, 6x8		
	HM-030	† Harris
	HM-031	† Harris
	HM-034	† Harris
	HM-0168	Harris
Programmable Diode Matrix, 8x6		
	HM-040	† Harris
	HM-041	† Harris
	HM-044	† Harris
	HM-0186	Harris
Digital Filters (Four arrays: Multiplier, Input/Output, Storage and Timing, supply −12, −28v)		
	351-8006	† Collins
Divider, divide by 1/2, 1/525, supply −12v		
	MN115	Panasonic
Divider, divide by 1/2, 1/625, supply −12v		
	MN116	Panasonic
Programmable Divider (any module from 3 to 262, 145, supply −12,5)		
	3816	Fairchild
Dividers, 250 MHz to 1 GHz (Listed Device is one of several related units offering this performance.)		
	11C05C	Fairchild
	11C06C	Fairchild
	11C90C	Fairchild
	95H90M (continued)	† Fairchild

Other Digital Devices (cont)

Function	Device	Source
Dividers, 250 MHz to 1 GHz (Listed Device is one of several related units offering this performance.) (continued)		
	MC1690	Motorola
	SP8602	† Plessey
	SP8630	† Plessey
	SP8635	† Plessey
	SP8640	† Plessey
	SP8650	† Plessey
Dividers, 1 GHz and above (Listed device is one of several related units offering this performance)		
	MC1699	Motorola
	MC1697	Motorola
	SP8665	Plessey
	SP8667	Plessey
DVM Counter/Display Driver (for 3½ and 4½ digit DVMs; supply −14, −24v)		
	S1907A see page 254	**AMI**
DVM Logic, 3½ Decade (for dual ramp integration DVM BCD or 7 Segment Output; supply −15v)		
	AY5-3507	GI
DVM Logic, 3½ Decade (ramp integration, supply −7.5, −15)		
	AY5-3500	GI
DVM Logic, 4 Digits (supply −17v)		
	MN6032	Panasonic
DVM Logic, 4½ Digit, (dual slope integration, supply −15,5)		
	MM5330	National
DVM Logic, 4½ Decade (Multiplexed BCD output; supply −12,5v)		
	3814C	Fairchild
Electronic Organ Circuits: See Digital-Industrial/Consumer for manufacturers		
Flip-Flop, D-Type (750 MHz, ECL or TTL supplies)		
	11C06C	Fairchild
Flip-Flop, D-Type Master-Slave (ECL or TTL supplies)		
	11C70C	Fairchild
Gate, Dual OR/NOR (5/4-Input, 700ns delay, ECL or TTL supplies)		
	11C01C	Fairchild
Hall Effect Switch (senses magnetic field)		
	DN830	Panasonic
	DN831	Panasonic
	DN834	Panasonic
	DN837	Panasonic
	ULN-3006	Sprague
	ULN-3008	Sprague
	ULN-3100	Sprague
	ULS-3006	Sprague
Multiplexer Decoder, 4-Decades (they are stored, then multiplexed to provide 10 line decoded outputs; supply −12,5v)		
	M004T1	SGS
	M004T2	† SGS

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—Special (cont)

Other Digital Devices (cont)

Function	Device	Source
Programmable Logic Array (64x20 bit storage accessible through 15 or 16 independent inputs; supply −12,5v)	CRC3506	Collins
	CRC3507	Collins
Pulse Group Encoder (2141) and Decoder (2151) for pulse width code systems (25^5 codes programmed by RC networks)	TMX2141	TMX
	TMX2151	TMX
Quad Serial Summer (Adds and subtracts serial words, used with other ICs to solve differential equations; supply −12,5v)	CRC9504	Collins
R-Adder (Adds and subtracts serial words, see Quad Serial Summer above)	CRC9503	Collins
Schmitt Trigger, Complementary Open Collector Output; supply 2.2 to 6v	ULN-3303	Sprague
Schmitt Trigger, Programmable	CA3098	† RCA
	CA3099	† RCA
Schmitt Trigger, Zener Clamped Output; supply 2.2 to 6v	ULN-3304	Sprague
Schmitt Trigger, Dual, Complementary Open Collector Outputs; supply 2.2 to 6v	ULN-3305	Sprague
Schmitt Trigger, Dual, one Open Collector Output, one Zener Clamped Output; supply 2.2 to 6v	ULN-3306	Sprague
Schmitt Trigger, Dual, Low voltage; 3.5v	SN76811	TI
T.V. Camera Sync. Generator; supply −12,5v	3262A	Fairchild
	3262B	Fairchild
	MM4320	National
	MM5320	† National
TV Camera Sync. Generator, supply −15, −21v	MN6060	Panasonic
T.V. Camera Sync. Generator; supply 5v	ZNA103E	Ferranti
T.V. Color Bar Generator	MM5332	National
Watch Circuits: See Digital-Industrial/Consumer for manufacturers.		

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

Calculator Circuits

Part No.	Digits	Output	Memory	%	Const. Factor	Sq. Root	Add Mode	Kbd Type	Micro. Prog.	Intl. Clock	Process	Page
S9414	12	Disp.	1	Yes	Yes	No	Yes	Bus.	Yes	Yes	P-SiGate	254
S9651 (1)	10 (2)	Disp.	1	No	Yes	Yes	No	Alg.	Yes	Yes	P-SiGate	254
9209	8-12	Disp.	1	(3)	(3)	(3)	(3)	Prog.	Yes	Yes	P-SiGate	917

(1) Other features (Not listed above) - Pi (π). Change sign, Square Root, Reciprocal, Square, Register exchange, Memory exchange - Scientific notation or floating input and output.

(2) Scientific notation - 8-Digit mantissa, 2-Digit exponent

(3) Number of digits, features, and keyboard are all microprogrammable.

Consumer Circuits

Series	Description	Digits	Power Supply (V)	Process	Packaging: Chip	Packaging: PC Board	Packaging: DIP
Watch Circuits							
S1406	Two-function LCD Watch (Same as S1400, pinouts are mirror image of S1400)	3½	+1.5	CMOS	S1409	S1407	S1408
S1410	Four-function LCD Watch (Hrs/Min/Sec or Date)	3½	+1.5	CMOS	S1411	S1412	S1413 (1)
S1424A	Five-function LCD Watch (Hrs/Min or Sec or Month/Date with alternating time/date mode and voltage tripler display options)	3½	+1.5	CMOS	S1424A	S1426A	S1427A
					Page 255		

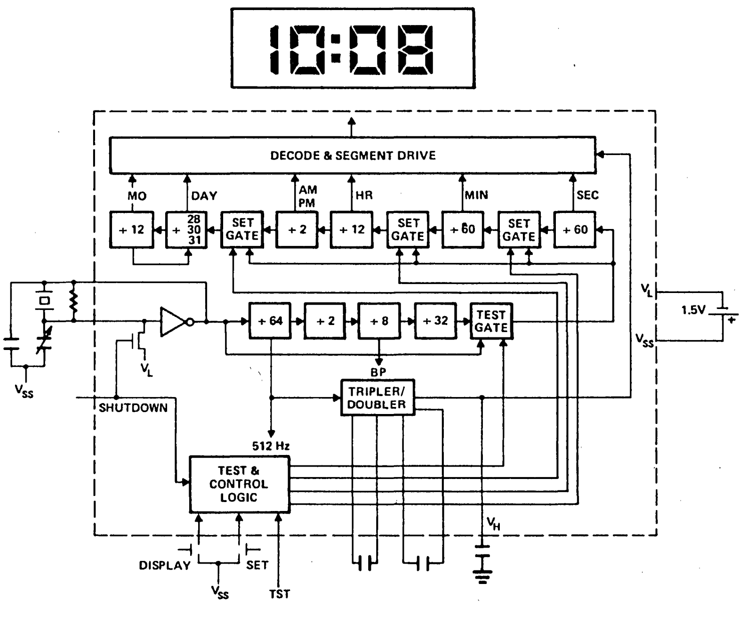
Part No.	Description	Power Supply (V)	I/O	Power Dissip. (mW)	Data Rate (MHz)	Process	Page
Clock and DVM Circuits							
S1856	LED/LCD Auto Clk. (3½ digits)	+6 to +16	MOS	70	0.256	$P-I^2$	254
S1907A	DVM Counter/Displ. Driver	+9, -9	MOS	50	0.5	$P-I^2$	254
S1998A	50/60 Hz Line Clk. (4 digits)	+8 to +29	MOS	300	50×10^{-3}	$P-I^2$	260
Organ Circuits							
S2193	7 Stage Frequency Divider	-14, -28	MOS	300	0.1	$P-I^2$	254
S2470	6 Stage Frequency Divider	-10, -27	MOS	350	0.1	HI V_T	254
S2555	7 Out Frequency Synthesizer	-15, -27	MOS	400	2.1	HI V_T	254
S2556	6 Out Frequency Synthesizer	-15, -27	MOS	400	2.1	HI V_T	254
S2566	Rhythm Generator	-15, -27	MOS	300	0.1	HI V_T	254
S2567	Rhythm Generator	-15, -27	MOS	400	0.1	HI V_T	254
S50240/41/42	Top Octave Synthesizer	-14	MOS	360	2.5	$P-I^2$	254
S8890	Rhythm Generator	+12	MOS	400	0.01	$P-I^2$	254
S9660	Rhythm Generator	+12	MOS	400	0.008	$P-I^2$	254

(1) 48-lead DIP, similar to 3M

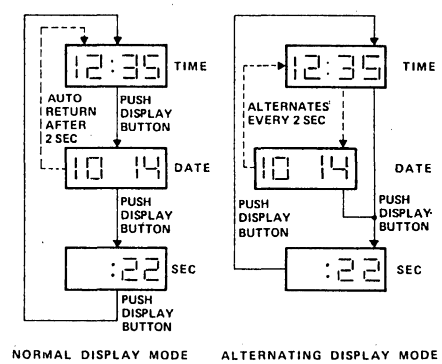
AMI
AMERICAN MICROSYSTEMS, INC.

S1424A
S1426A
S1427A

5-FUNCTION LCD WATCH CIRCUIT



BLOCK DIAGRAM



DISPLAY OPERATING MODES

PACKAGE OPTIONS

S1424A	–	CHIP ONLY
S1426A	–	PC BOARD
S1427A	–	40 DIP

FEATURES

- Drives Standard 3½ Digit Display
- 12 Month Calendar Memory
- One Push Button Controls Display
- Uses Single 1.5V Battery
- Displays Time, Month-Date, or Seconds
- Additional Alternating Time/Date Display Mode
- Voltage Doubler or Tripler LCD Drive Options

FUNCTIONAL DESCRIPTION

The AMI S1424A is a single chip, silicon gate CMOS watch circuit designed to drive a 3½ digit, field effect, liquid crystal display. Hour and minutes or seconds can be displayed continuously. Month and date are displayed on interrogation. A continuous display alternating between time and date is also selectable (see operating modes above).

Only two single pole single throw switches are required to accomplish all display and setting functions. The circuit provides a full calendar function which needs to be reset only once every four years.

For a complete data sheet contact your nearest AMI Sales Office.

Display Operation is illustrated on page one. Operation in either the normal or alternating display mode is selected by the Set button during setting of the watch. When operating in the normal mode, the display initially shows hours and minutes. The absence of a colon distinguishes the Month-Date display from the Hour-Minute and Seconds display. The Seconds display is obvious as only the last two digits are used and the display is incrementing once per second.

All display and setting operations are controlled by two inputs. the Display input and the Set input. In Normal Operation only the Display input is used. Both inputs have an internal pulldown to - V_L so that a single pole, single throw contact may be used.

DATE DISPLAY

The date is displayed in the normal operating mode by pushing the display button until the readout changes to Month-Date (1/2 sec. max.). The circuit will readout Month-Date for 2 to 3 seconds and return to Hours-Minutes automatically. If readout of Month-Date in excess of 2 seconds is desired, the display button is held in the depressed condition for the required time period. Upon release of the display button, the readout will return to Hour-Minute.

TESTING

A test input (TST) is furnished to facilitate high speed testing of the circuit. An internal pulldown to V_L allows this pin to float during normal operation.

SECONDS DISPLAY

In the normal operating mode the display button is pushed twice within two seconds to change from an Hour-Minutes readout to Seconds. The first press of the display button changes the readout to Month-Date. Pressing the display button again while Month-Date is being displayed causes the readout to change from Month-Date to Seconds. Once Seconds appears, the display button is released and Seconds will be shown continuously. Pressing the display button a third time will return the readout to Hours-Minutes. This scheme allows all information to be viewed using one push button input and Seconds to be viewed without continually pressing a button. Seconds display in the alternating display mode is described below.

ALTERNATING TIME/DATE DISPLAY

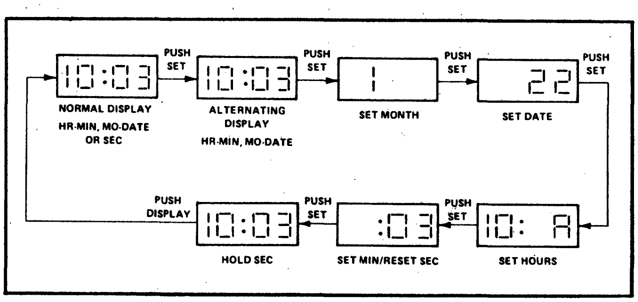
In the alternating display mode, the watch will alternately display Hours-Minutes then Month-Date for two seconds intervals. Pushing the display button will call up seconds. Another push restores the alternating Time/Date display.

SHUTDOWN

A shutdown input (SD) is provided to reduce power consumption of the watch module during storage. When this input is connected to V_{SS} the oscillator is stopped and all other node voltages within the CMOS chip are held constant.

SETTING OPERATION

Five setting states and two normal operating states are included in the setting sequence. Each state is uniquely identified by the display as shown below. Hours, minutes, and seconds are distinguished from month and date by the colon. In the hours set mode the fourth digit is either an A or P to indicate AM or PM.



Only the set input is required to select the desired setting state. Connecting the Set input repeatedly to V_{SS} causes the circuit to advance through its set and run states at the rate of one state per Set switch closure. When the display is in the desired setting state the display button is used to set the displayed quantity. Connecting the display input to V_{SS} causes the selected quantity (month, date, hours or minutes) to be advanced at the rate of one unit per second. In all seting states, timekeeping is not interrupted nor is any counter advanced until the display button is depressed. In all setting states except minutes, only the quantity being displayed can be changed and that change cannot happen until the display button is depressed. In the set minutes state, seconds are reset to zero and held when minutes are advanced. After minutes are set and the display is returned to the run mode, the colon is held on. Seconds counting is resumed from zero by pressing the display button.

SETTING OPERATION

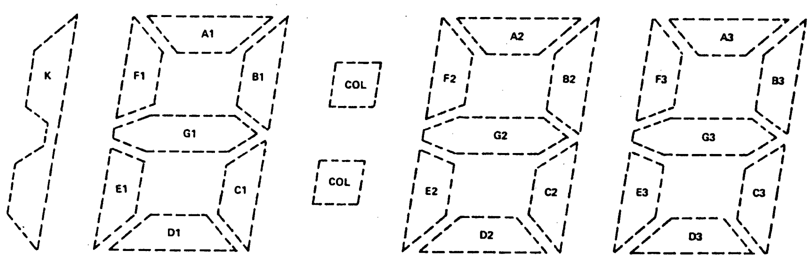
Detailed Procedure

To set the watch, use the following procedure (it is assumed the watch is in the Normal Operating state):

1. Depress the Set button. Circuit will advance to the alternating Time/Date operating mode.
2. Depress the Set button until the display shows Month (shown in left most digits). Release the Set button.
3. Depress the Display button to advance Month to the proper value. Release the Display button.
4. Depress the Set button until the display shows Date (in right most digits). Release the Set button.
5. Depress the Display button to advance Date to the proper value. Release the Display button.
6. Depress the Set button until the display shows Hours (shown in left most digits), and A or P (shown in right most digit. Release the Set button.
7. Depress the Display button to advance Hours to the proper value. Release the Display button.
8. Depress the Set button until the display shows minutes (shown in right most digits) and colon. Release the Set button.
9. Depress the Display button to advance minutes to approximately one minute past the present time. Release the Display button. Depressing the Display button also resets the seconds counter to zero and hold.
10. Depress Set button until the display shows hours and minutes. Release the Set button.
11. When time reaches the start of the minute set in step 9 (showing on display), depress the Display button. The seconds counter is then started and the watch is in normal operation.

FUNCTIONAL DESCRIPTION OF INPUTS/OUTPUTS

SET	- Setting Sequence Advance Button	TST	- High Speed Test Control Input
DISPLAY	- Date, Seconds Display/Counter Advance Button	BP	- 32 Hz Backplane Driver
		CAP 2, CAP 3	- Voltage Tripler Capacitor Connection
SD	- Oscillator Shutdown Control	CAP 1, 512	- Voltage Doubler/Tripler Capacitor Connection
V_L	- Divider Voltage Supply (- 1.5V)		
V_H	- LCD Driver Voltage Supply (- 4.5V)	OSC_{IN}	- Gate of Oscillator Inverter
V_{SS}	- Most Positive Voltage Supply	OSC_{OUT}	- Output of Oscillator Inverter
		256 Hz	- 256 Hz Upconverter Output*



DISPLAY CONNECTION

*Available by special order only after April 1, 1976.

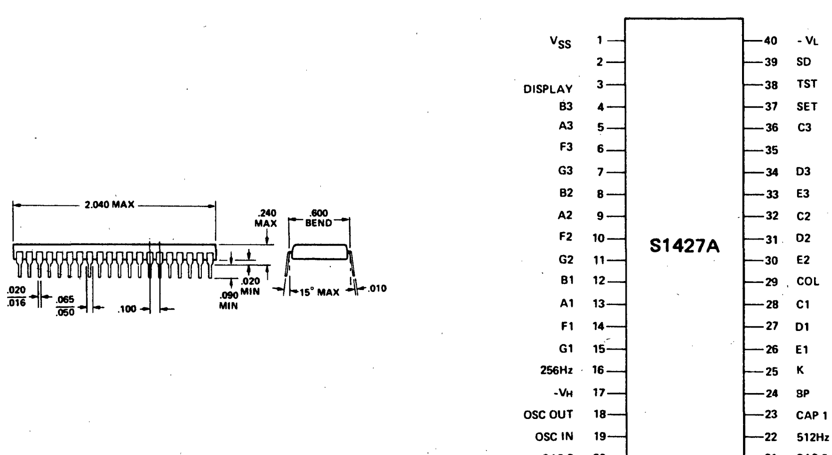
ABSOLUTE MAXIMUM RATINGS

Storage chip temperature	- 55°C to + 150°C	Negative Voltage (on TST, 256 Hz, OSC_{OUT}, OSC_{IN}, 512Hz, DISPLAY, SET, SD)	V_L - 0.3V
Operating ambient temperature	- 10°C to + 70°C		
Positive Voltage on any pin	+ 0.3V	Negative Voltage on all other pins	V_H - 0.3V

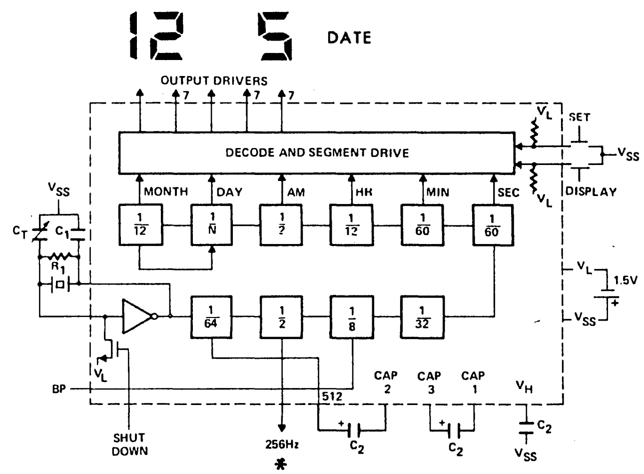
SPECIFICATIONS

(T_A = 25°C, V_L = 1.5 ± 5%, V_H = - 2.9V to - 4.6V, V_{SS} = 0V, FREQ = 32768 Hz)

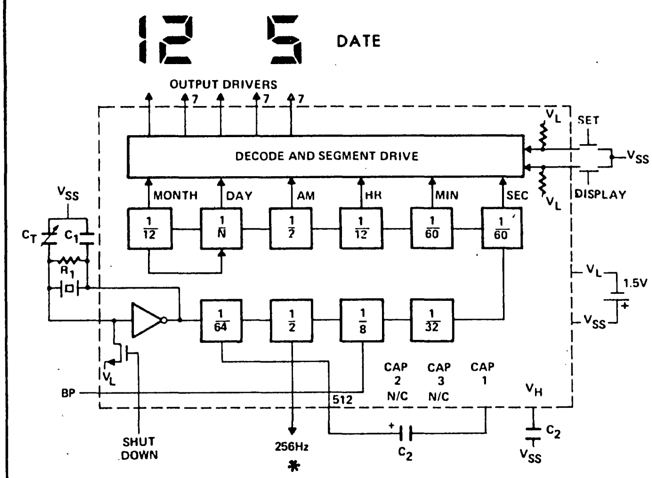
SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS	CONDITIONS
V_S	Starting Voltage	-1.45	-1.1		Volts	
R(SEG)	Segment Resistance Both States		20		Kohm	I_O = 10 μA
R(BP)	Back Plate Resistance Both States		6	12	Kohm	I_O = 10 μA to V_H or V_{SS}
R(Pulse)	256 Hz Pulse Resistance to V_L			400	ohm	I_O = 10 μA
PW(256)	Pulse Width		15.2		μs	
R_H(512)	512 Hz on Resistance to V_{SS}		5	17	Kohm	I_O = 10 μA
R_L(512)	512 Hz on Resistance to V_L			13	Kohm	I_O = 10 μA
PW(512)	Pulse Width		976		μs	
I_L	- V_L Supply Current			6.0	μA	
I_H	- V_H Supply Current-			1.0	μA	Outputs open ckt
V_H	Display Drive Voltage		4.5	12.0	Volts	C_2 = .05 μF
I_{IN}	Input Current					
	(Display Set)			1.0	μA	Input connected to V_{SS}
	(Shutdown)			0.5	μA	Input connected to V_{SS}
$R_{IN_{OSC\ IN}}$	Resistance to V_L		250		KΩ	During Shutdown



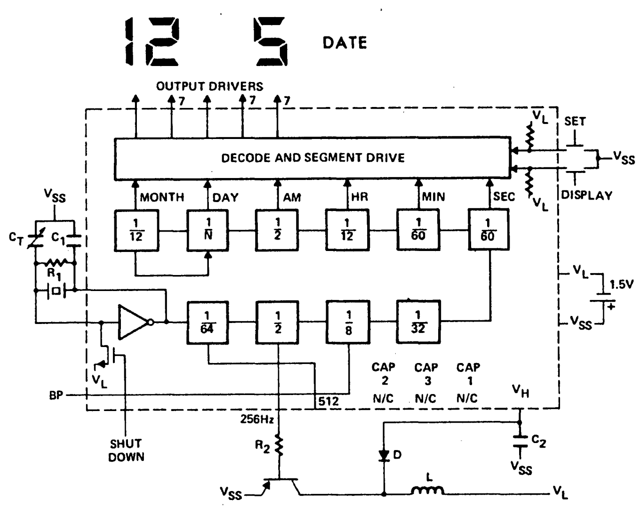
S1427A PIN/PACKAGE CONFIGURATION



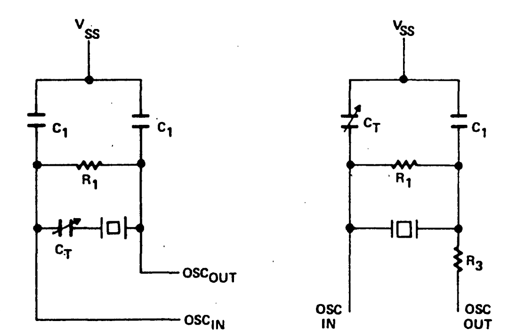
VOLTAGE TRIPLER CONNECTION



VOLTAGE DOUBLER CONNECTION



COIL UPCONVERTER CONNECTION*



TUNING CIRCUITS

C_1	33 pF	R_2	10K ohms
C_T	5 - 50 pF	R_3	100-300 Kohms
C_2	.05μF	XTAL	32.768 kHz
R_1	20 Mohms	D	IN914

EXTERNAL COMPONENT LIST

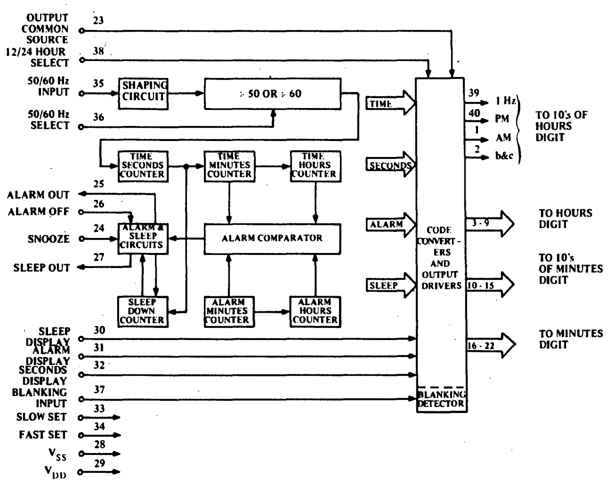
*Available on special order only after April 1, 1976.

S1998A/B

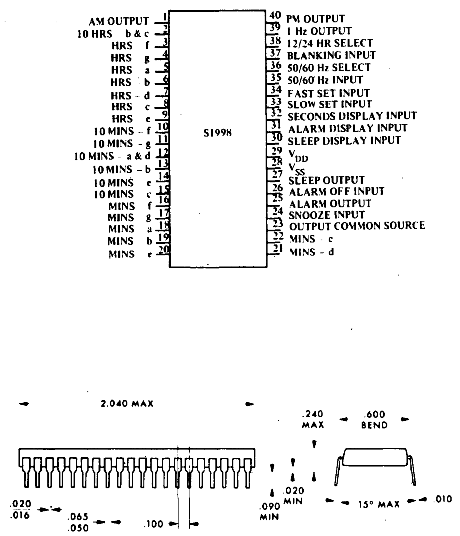
DIGITAL ALARM CLOCK

AMERICAN MICROSYSTEMS, INC.

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- 50 or 60 Hz inputs
- Direct LED/LCD/Fluorescent drive
- 8 ma LED output current/segment
- AM/PM or 24 hour outputs
- Power Failure indication
- Elapsed time counter capability
- 1 Hz output blanking
- Presettable 59 minute count-down timer
- Alarm with snooze feature and unlimited snooze repeat
- One-button sleep set capability
- Clock input noise rejection circuitry
- Pin compatible with S1998, MM5316, EA5316, FCI3817
- Alternate to MM5384, MK50380

FUNCTIONAL DESCRIPTION

The S1998/B is an improved version of the industry-standard S1998 digital alarm clock radio circuit. The S1998A can be directly substituted for the S1998 in high current, low voltage display applications. (e.g. – LED displays) where the common source line is connected to V_{SS}. For higher voltage displays such as fluorescent or gas discharge, the S1998B should be selected. The circuit interfaces directly with both solid-state and fluorescent/gas discharge displays. The time-keeping function will operate from either a 50 Hz or 60 Hz input, and the display output may be in either 12 hour or 24-hour format.

Clock input noise rejection circuitry eliminates the need for externally filtering the line frequency input. Reset-to-zero circuitry is included for timer/elapsed time applications, and the blanking control allows use of several circuits in parallel with a single display (multiple event timing). The sleep set input can be modified through use of an external diode (Figure 9) to allow one button sleep counter setting.

TYPICAL APPLICATIONS

Alarm Clock, Clock Radio, Industrial Timer, Stop Watch, Photography Timers, Desk Clocks, Appliance Timers, Aircraft Elapsed Time Meters.

FUNCTIONAL DESCRIPTION

A block diagram of the S1998 digital alarm clock is shown on page 1. The various display modes provided by this clock are listed in Table 1. The functions of the setting controls are listed in Table 2. The following discussions are based on the Block Diagram.

50 or 60 Hz Input (pin 35): A shaping circuit is provided to square the 50 or 60 Hz input. This circuit allows use of a filtered sinewave input. A simple RC filter should be used to remove possible line-voltage transients that could either cause the clock to gain time or damage the device. The input should swing between V_{SS} and V_{DD}. The shaper output drives a counter chain which performs the timekeeping function.

50 or 60 Hz Select Input (pin 36): A programmable prescale counter divides the input line frequency by either 50 or 60 to obtain a 1-pps time base. This counter is programmed to divide by 60 simply by leaving pin 36 unconnected; pull-down to V_{DD} is provided by an internal 2.5 MΩ resistor: Operation at 50 Hz is programmed by connecting pin 36 to V_{SS}.

Display Mode Select Inputs (pins 30 thru 32): In the absence of any of these three inputs, the display drivers present time-of-day information to the appropriate display digits. Internal 2.5 MΩ pull-down resistors allow use of simple SPST switches to select the display mode. If more than one mode is selected, the priorities are as noted in Table 1. Alternate display modes are selected by applying V_{SS} to the appropriate pin. As shown in the Block Diagram the code converters receive time, seconds, alarm and sleep information from appropriate points in the clock circuitry. The display mode select inputs control the gating of the desired data to the code converter inputs and ultimately (via output drivers) to the display digits.

Time Setting Inputs (pins 33 and 34): Both fast and slow setting inputs are provided. These inputs are applied either singly or in combination to obtain the control functions listed in Table 2. Again, internal 2.5 MΩ pull-down resistors are provided; application of V_{SS} to these pins effects the control functions. Note that the control functions proper are dependent on the selected display mode. For example, a hold-time control function is obtained by selecting seconds display and actuating the slow set input. As another example, for elapsed time or timer applications, the clock time may be reset to 00:00:00, in the 24-hour format (12:00:00 AM in the 12-hour format), by selecting seconds display and actuating both slow and fast set inputs.

Blanking Control Input (pin 37): Connecting this Schmitt trigger input to V_{DD} places all display drivers in a non-conducting, high-impedance state, thereby inhibiting the display. See Figure 4. Conversely, V_{SS} applied to this input enables the display.

Output Common Source Connection (pin 23): All display output drivers are open-drain devices with all sources common to pin 23 (Figure 4). When using fluorescent tube displays, V_{SS} or a display brightness control voltage is permanently connected to this pin. Since the brightness of a fluorescent tube display is dependent on the anode (segment) voltage, applying a variable voltage to pin 23 results in a display brightness control. This control is shown in Figure 6. However, when using liquid crystal displays, the lifetime of the display device is optimized when AC drive voltages are provided. The common source connection of the S1998 output drivers facilitates generating AC drive voltages. An interface circuit for driving liquid crystal display is shown in Figure 7.

When using low current LED displays the S1998 is connected as shown in Figure 9, to provide direct drive to the display. The 28V supply insures low output on resistance. The resistor provides a voltage drop across output drivers which limits internal power dissipation to less than 1000 mW.

12 or 24 Hour Select Input (pin 38): By leaving this pin unconnected, the outputs for the most-significant display digit (10's of hours) are programmed to provide a 12-hour display format. An internal 2.5 MΩ pull-down resistor is again provided. Connecting this pin to V_{SS} programs the 24-hour display format. Also, the output connections (pins 1, 2 and 40) are different for each format. Figure 5 illustrates these differences. In addition to displaying 10's of hours, this digit provides an AM/PM indication (12-hour format only) and the power failure indication. In the 12-hour format, AM indication is provided by segment "f"; PM indication by segment "e." The power failure indication consists of a flashing of the AM or PM indicator at a 1-Hz rate. A fast or slow set input resets an internal power failure latch and returns the display to normal. In the 24-hour format, the power failure indication consists of flashing segments "a", "d", "e", "g" of the HR x 10 digit.

FUNCTIONAL DESCRIPTION (Con't.)

Alarm Operation and Output (pin 25): The alarm comparator (Figure 1) senses coincidence between the alarm counter (the alarm setting) and the time counters (real time). The comparator output is used to set a latch in the alarm and sleep circuits. The latch output enables the alarm output driver (Figure 4), the S1998 output that is used to control the external alarm sound generator. The alarm latch remains set for 59 minutes during which the alarm will sound if the latch output is not temporarily inhibited by another latch set by the snooze alarm input (pin 24) or reset by the alarm off input (pin 26).

Snooze Alarm Input (pin 24): Momentarily connecting pin 24 to V_{SS} inhibits the alarm output for between 8 and 9 minutes, after which the alarm will again be sounded. This input is pulled-down to V_{DD} by an internal 2.5 MΩ resistor. The snooze alarm feature may be repeatedly used during the period in which the alarm latch remains set.

Alarm Off Input (pin 26): Momentarily connecting pin 26 to V_{SS} resets the alarm latch and thereby silences the alarm. This input is also returned to V_{DD} by an internal 2.5 MΩ resistor. The momentary alarm off input also readies the alarm latch for the next comparator output, and the alarm will automatically sound again in 24 hours (or at a new alarm setting). If it is desired to silence the alarm for a day or more, the alarm off input should remain at V_{SS}.

Sleep Timer and Output (pin 27): The sleep output at pin 27 can be used to turn off a radio after a desired time interval of up to 59 minutes. The time interval is chosen by selecting the sleep display mode (Table 1) and setting the desired time interval (Table 2). This automatically results in a current-source output via pin 27, which can be used to turn on a radio (or other appliance). When the sleep counter, which counts downwards, reaches 00 minutes, a latch is reset and the sleep output current drive is removed, thereby turning off the radio. This turn-off may also be manually controlled (at any time in the countdown) by a momentary V_{SS} connection to the snooze input (pin 24). The output circuitry is the same as the other outputs (Figure 4).

TABLE 1. S1998 Display Modes

*SELECTED DISPLAY MODE	DIGIT NO. 1	DIGIT NO. 2	DIGIT NO. 3	DIGIT NO. 4
Time Display	10's of Hours & AM/PM	Hours	10's of Minutes	Minutes
Seconds Display	Blanked	Minutes	10's of Seconds	Seconds
Alarm Display	10's of Hours & AM/PM	Hours	10's of Minutes	Minutes
Sleep Display	Blanked	Blanked	10's of Minutes	Minutes

*If more than one display mode input is applied, the display priorities are in the order of Sleep (overrides all others), Alarm, Seconds, Time (no other mode selected).

TABLE 2. S1998 Setting Control Functions

SELECTED DISPLAY MODE	CONTROL INPUT	CONTROL FUNCTION
*Time	Slow	Minutes Advance at 2 Hz Rate
	Fast	Minutes Advance at 60 Hz Rate
	Both	Minutes Advance at 60 Hz Rate
Alarm	Slow	Alarm Minutes Advance at 2 Hz Rate
	Fast	Alarm Minutes Advance at 60 Hz Rate
	Both	Alarm Resets to 12:00 AM (12-hour format)
	Both	Alarm Resets to 12:00 (24-hour format)
Seconds	Slow	Input to Entire Time Counter is Inhibited (Hold)
	Fast	Seconds and 10's of Seconds Reset to Zero Without a Carry to Minutes
	Both	Time Resets to 12:00:00 AM (12-hour format)
	Both	Time Resets to 00:00:00 (24-hour format)
Sleep	Slow	Subtracts Count at 2 Hz
	Fast	Subtracts Count at 60 Hz
	Both	Subtracts Count at 60 Hz

*When setting time sleep minutes will decrement at rate of time counter, until the sleep counter reaches 00 minutes (sleep counter will not recycle).

ABSOLUTE MAXIMUM RATINGS

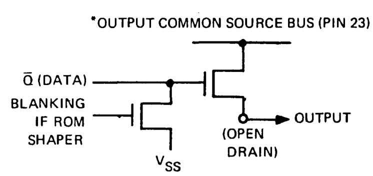
Positive Voltage on any Pin	V_{SS} + 0.3V	Storage and Operating Chip Temperature	−55°C to + 150°C
Negative Voltage on any Pin	V_{SS} − 30V	Operating Ambient Temperature	0°C to + 70°C

STATIC CHARACTERISTICS

(T_A = 25°C, V_{SS} = +26V, V_{DD} = GROUND)

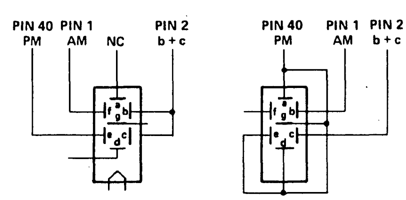
	Min.	Typ.	Max.	Units	Conditions
I_{SS} Power Supply Current:		2	5	mA	V_{SS} = +8V no output
		3	10	mA	V_{SS} = +26V loads
50/60 Hz Input:					
Frequency	DC	50 or 60	10K	Hz	
Voltage					
V_{IH} Logical High Level	V_{SS} −1		V_{SS}	V	Internal 2.5 MΩ on all inputs
V_{IL} Logical Low Level	V_{DD}		V_{DD} +1	V	except CLOCK
Power Failure Detect Voltage:	+8.5		+13.5	V	(V_{SS} Voltage
Output Currents:					V_{SS} = +21 to +26V, V_{DD} = 0V
1Hz Display					
I_{OH} Logical High Level	24			mA	V_{OH} = V_{SS} −4V
I_{OL} Logical Low Level			1	μA	V_{OL} = V_{DD}
10's of Hours (b & c), 10's of Minutes (a &d)					
I_{OH} Logical High Level	16			mA	V_{OH} = V_{SS} −4V
I_{OL} Logical Low Level			1	μA	V_{OL} = V_{DD}
All Other Display					
I_{OH} Logical High Level	8			mA	V_{OH} = V_{SS} −4V
I_{OL} Logical Low Level			1	μA	V_{OL} = V_{DD}
I_{OH} Alarm, Sleep	500			μA	V_{OH} = V_{SS} −2V

FIGURE 4. OUTPUT CIRCUITS



*ALARM & SLEEP OUTPUT SOURCES ARE CONNECTED TO V_{SS}. BLANKING IS NOT APPLIED TO THESE OUTPUTS.

FIGURE 5. WIRING TEN'S OF-HOURS DIGIT



A. 12-HOUR DISPLAY FORMAT B. 24-HOUR DISPLAY FORMAT

FIGURE 6. TUBE DISPLAY CLOCK

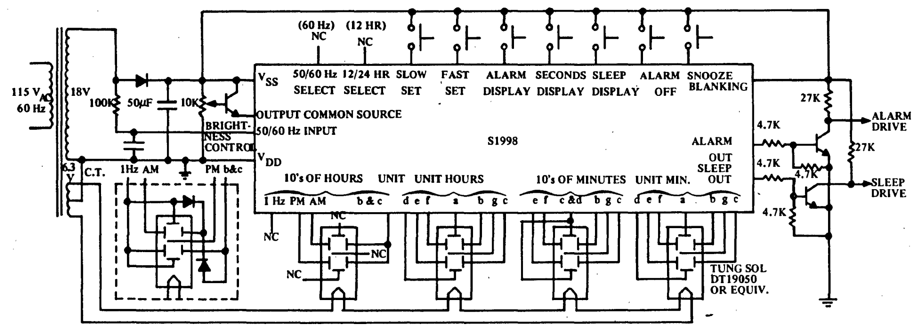


FIGURE 7 LCD DISPLAY CLOCK

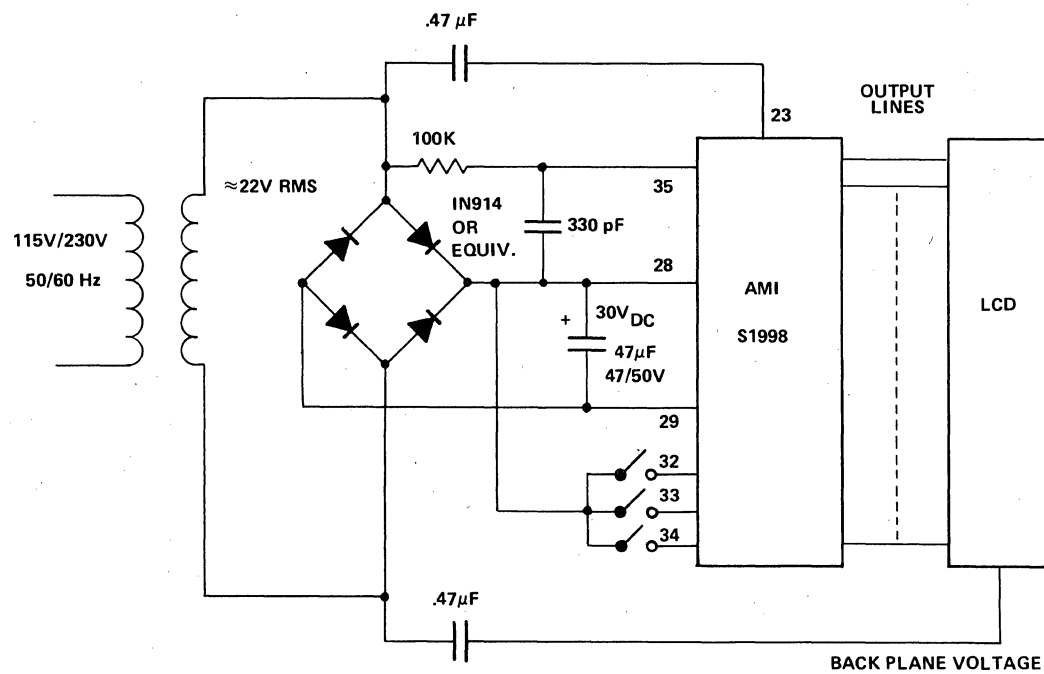


FIGURE 8. GAS DISCHARGE CLOCK (with "keep alive" voltage regulator)

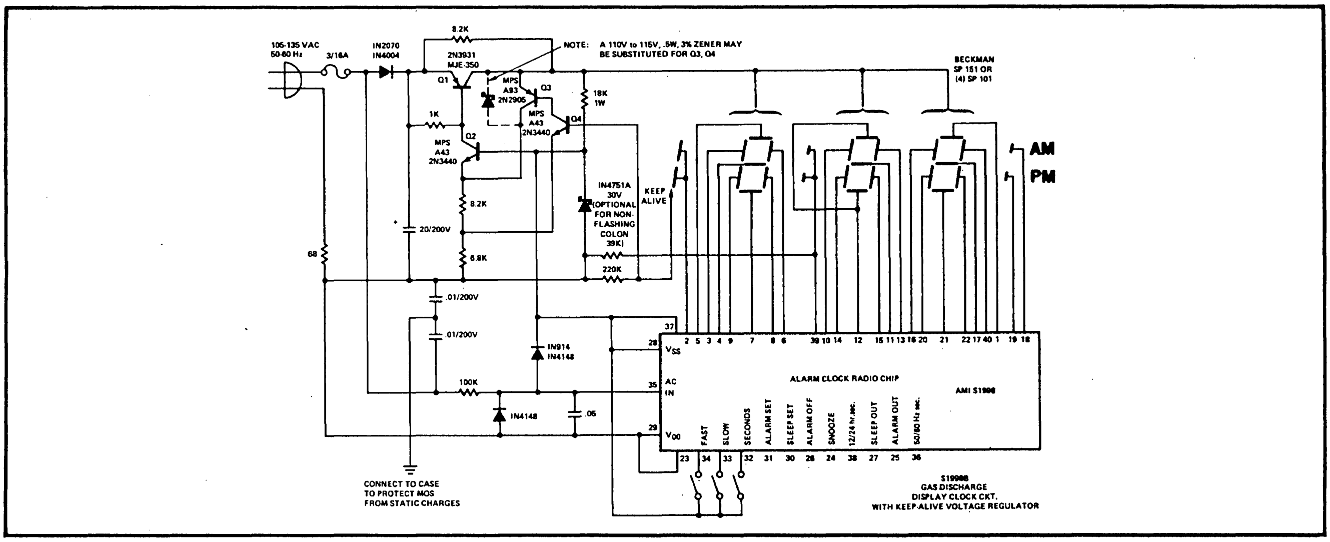
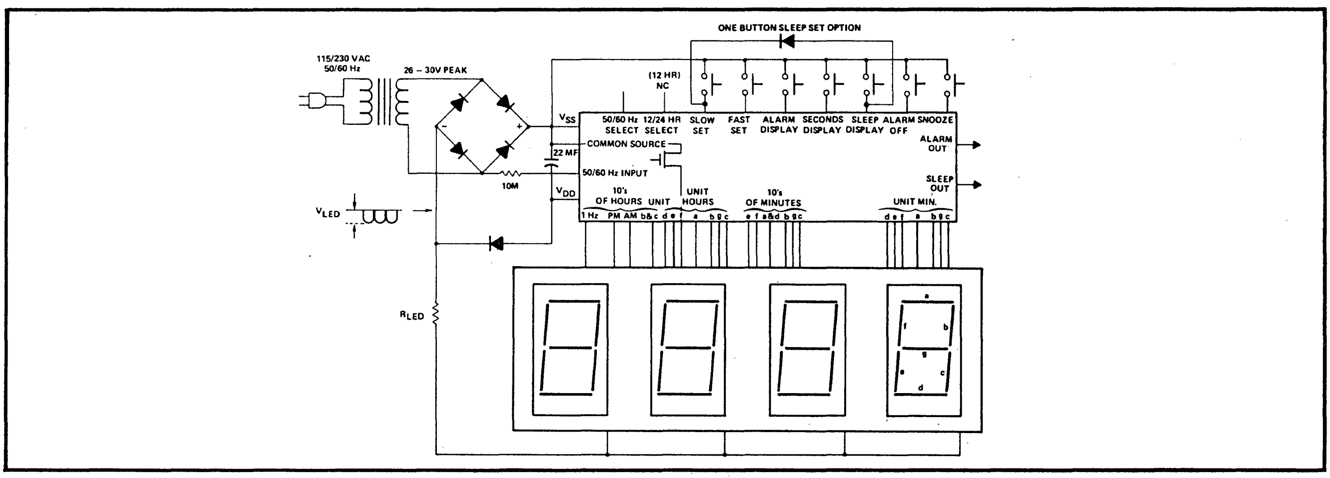


FIGURE 9. LED CLOCK (Common Cathode Design)



OPERATING CONDITIONS

Common Source (Pin 23):	Connect to V_{SS} (Pin 28)
LED Voltage Supply:	Full Wave Rectified Sine Wave (Pulsating)
(V_{LED}) LED Power Supply Voltage Peak:	30 Volts Max.
LED Segment Voltage:	–20 Volts DC Min.
	–30 Volts DC Max.
Temperature:	65 Degrees C Max.
R_{LED}: (1)	To be determined

DEVICE CHARACTERISTICS

S1998A Segment Current:(2)	(22 Segments on) 8.0 mA Min. at V_{LED} = 22 Volts peak
Power Dissipation:	1000 Milliwatts Max. @ 40°C and –30V
Output on resistance	300 ohms at V_{DD} = 20V

NOTES:
1. (R_{LED}) resistor connected between LED cathodes and LED full wave rectified voltage supply. R_{LED} limits power on chip to 1000 mW.
2. S1998B current is limited to 2.8 ma.

HARRIS SEMICONDUCTOR
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HARRIS is BIG in CMOS

All three major series...54C/74C, 4000, and 14500

Total availability in CMOS... more than 100 circuit-types, with more being added. Count on Harris to produce and deliver—any volume — at competitive prices.

Harris now offers commercial devices in both CERDIP and Epoxy 410-B,, rated for −40°C to 85°C. And high-rel versions—CERDIP and Flat-Pack for −55°C to 125°C. All devices available in chip form as well.

Immediate delivery of both families from these major distributors, Schweber, Hamilton/Avnet, R. V. Weatherford and Harvey Electronics.

In the following pages we feature complex MSI from both 54C/74C and 4000 Series, representative of our capability in CMOS.

FUNCTIONAL INDEX

Description	Device No.	Package Code	Page No.
ARITHMETIC FUNCTIONS			
4-Bit Full Adder	HD-4008A		-
4-Bit Binary Full Adder	HD-74C83*	1W, 9L	274
4-Bit Magnitude Comparator	HD-74C85*	1W, 9L	275
COUNTERS			
Decade Counter/Divider	HD-4017A		-
Presettable Divide-by-"N" Counter	HD-4018A	1U, 9V	269
14-Stage Binary/Ripple Counter	HD-4020A	1W, 9L	270
Divide-by-8 Counter/Divider with 8 Decoded Outputs	HD-4022A	1W, 9L	271
7-Stage Binary/Ripple Counter	HD-4024A		-
Presettable Up/Down Counter	HD-4029A	1W, 9L	272
12-Bit Binary Counter	HD-4040A		-
Synchronous Decade	HD-74C160*	1W, 9L	277
Synchronous Binary	HD-74C161*	1W, 9L	277
Fully Synchronous Decade	HD-74C162*	1W, 9L	277
Synchronous Up/Down Decade	HD-74C192*	1W, 9L	278
Synchronous Up/Down Binary	HD-74C193*	1W, 9L	278
4-Bit Counter/7-Segment Output	HD-74C925*		-
BCD Up/Down Counter	HD-14510		-
Binary Up/Down Counter	HD-14516		-
Dual BCD Up Counter	HD-14518		-
Dual Binary Up Counter	HD-14520		-
GATES/BUFFERS			
Dual 3-Input NOR Gate	HD-4000A		-
Quad 2-Input NOR Gate	HD-4001A		-
Dual 4-Input NOR Gate	HD-4002A		-
Dual Complementary Pair with Inverter	HD-4007A		-
Quad 2-Input NAND Gate	HD-4011A		-
Dual 4-Input NAND Gate	HD-4012A		-
Quad AND/OR Select	HD-4019A	1W, 9L	270
Triple 3-Input NAND	HD-4023A		-
Triple 3-Input NOR	HD-4024A		-
Quad 2-Input Exclusive OR	HD-4030A	1U, 9V	273
Hex Buffer/Converter, Inverting	HD-4049A		-
Hex Buffer/Converter, Non-Inverting	HD-4050A		-
Quad 2 Input NAND	HD-74C00*		-
Quad 2 Input NOR	HD-74C02*		-
Hex Inverter	HD-74C04*		-
Quad 2 Input AND	HD-74C08*		-
Triple 3 Input AND	HD-74C10*		-
Dual 4 Input NAND	HD-74C20*		-
8 Input NAND	HD-74C30*		-
Quad 2 Input OR	HD-74C32*		-
Quad 2 Input Exclusive OR	HD-74C86*		-
Three State Hex Buffer	HD-80C95**		-
Three State Hex Inverting Buffer	HD-80C96**		-
Three State Hex Buffer	HD-80C97**		-
Three State Hex Inverting Buffer	HD-80C98**		-
Hex Buffer/Converter, Inverting	HD-74C901*		-
Hex Buffer/Converter, Non-Inverting	HD-74C902*		-
Hex Inverting PMOS Buffer	HD-74C903*		-
Hex Open Drain N-Channel Buffer	HD 74C906*		-
Hex Open Drain P-Channel Buffer	HD-74C907*		-
4-Bit AND/OR Selector	HD-14519		-

*All Listed 74C Devices Are Also Available As 54C.

Description	Device No.	Package Code	Page No.
DECODERS/MULTIPLEXERS			
BCD to Decimal Decoder	HD-4028A	1W, 9L	271
Single 8-Channel Multiplexer	HD-4051A		-
Differential 4-Channel Multiplexer	HD-4052A		-
Triple 2-Channel Multiplexer	HD-4053A		-
Quad Bilateral Switch	HD-4066A		-
BCD to Decimal Decoder	HD-74C42*	1W, 9L	274
BCD to 7-Segment Decoder	HD-74C48*		-
8-Channel Digital Multiplexer	HD-74C151*	1W, 9L	276
4-Line to 16-Line Decoder/Demultiplexer	HD-74C154*	1U, 9V	276
Quad 2-Input Multiplexer	HD-74C157*		-
8-Channel Data Selector	HD-14512		-
Dual 4-Channel Analog Data Selector	HD-14529		-
FLIP-FLOPS			
Dual "D" with Set/Reset	HD-4013A		-
Dual J-K with Set/Reset	HD-4027A		-
Quad Clocked "D" Latch	HD-4042A		-
Quad Three State NOR Reset/Set Latch	HD-4043A		-
Quad Three State NAND Reset/Set Latch	HD-4044A		-
Dual "J-K" Master/Slave	HD-74C73		-
Dual "D" with Set/Reset	HD-74C74		-
Dual "J-K" Master/Slave Preset	HD-74C76		-
Dual "J-K"	HD-74C107		-
Quad "D" Three States (Quad Latch)	HD-74C173		-
Hex "D"	HD-74C174		-
Quad "D"	HD-74C175		-
SHIFT REGISTERS			
18-Stage Static	HD-4006A		-
8 Stage Synchronous Parallel Input/Serial Output	HD-4014A	1W, 9L	268
Dual 4 Stage with Serial Input/Parallel Output	HD-4015A	1W, 9L	269
8 Stage Asynchronous Parallel Input/Serial Output	HD-4021A	1W, 9L	270
4 Stage with J-K Input and True/Complement Output	HD-4035A	1U, 9V	273
4 Bit Right-Shift Left-Shift	HD-74C95*	1U, 9V	276
8 Bit Serial-In Parallel Out	HD-74C164*	1U, 9V	277
8 Stage Synchronous Parallel Input/Serial Output	HD-74C165*	1W, 9L	278
4-Bit Parallel-In Parallel-Out	HD-74C195*	1W, 9L	279
12-Bit Successive Approximation Register	HD-74C905*		-
SPECIAL FUNCTION			
Hex Schmitt Trigger	HD-74C14*		-
Quad Single-Ended Line Driver	HD-88C29		-
Dual Differential Line Driver	HD-88C30		-
64 Bit Three State RAM	HD-74C89*	1W, 9L	275
256 Bit Three State RAM	HD-74C00*	1U, 9V	279
Dual Monostable Multivibrator	HD-74C221*	1W, 9L	280
Hi-Voltage Driver	HD-74C908*		-
Quad Comparator	HD-74C909*		-
16-Key Keyboard Encoder	HD-74C922*		-
20-Key Keyboard Encoder	HD-74C923*		-
BCD to 7-Segment Latch/Decoder/Driver	HD-14511		-
BCD Rate Multiplier	HD-14527		-
Dual One Shot	HD-14528		-

**All Listed 80C Devices Are Also Available As 70C.

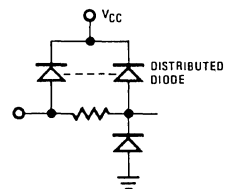
Family Features

These circuits employ complementary MOS (CMOS) to achieve low power dissipation, high noise immunity and wide power supply voltage ranges with symmetric rise and fall times. Features such as these make the 4000 and 54C/74C families ideal for use in digital systems.

The 4000 series is popular because of the wide range of logic functions and readily abundant supply.

The 54C/74C series is ideal for "worse case" noise immunity design. Function and pin out compatibility with 54/74 TTL devices minimizes design time for those designers already familiar with that logic family.

- Wide Supply Voltage Range 3.0V to 15V
- Guaranteed Noise Margin 1.0V
- High Noise Immunity 0.45 V_{CC} Typ.
- Low Power 10nW Typ. for Gates; 10 μW Typ. for MSI Circuits
- All inputs are protected from damage due to static discharge by diode clamps to V_{CC} and GND unless otherwise noted.



CMOS Product Code

Harris CMOS Products are designated by "PRODUCT CODE". When ordering, please refer to products by the full code. Harris Products will always begin with "H". Specific device numbers will always be isolated by hyphens.

4000 SERIES

EXAMPLE:
- HARRIS LOGO (LETTER – H)
- FAMILY DESIGNATION (LETTERS)
- PACKAGE TYPE (NUMBERS)
- SPECIFIC DEVICE TYPE NUMBERS & LETTERS
- TEMPERATURE RANGE (NUMBERS)

H D 1 - 4001A 2

FAMILY (LETTERS)	PACKAGE (NUMBERS)	TEMPERATURE RANGE
D – DIGITAL	1 – DUAL IN-LINE CERAMIC	2 – -55°C to +125°C
	9 – FLAT PACKAGE	9 – -40°C to +85°C

54C/74C SERIES

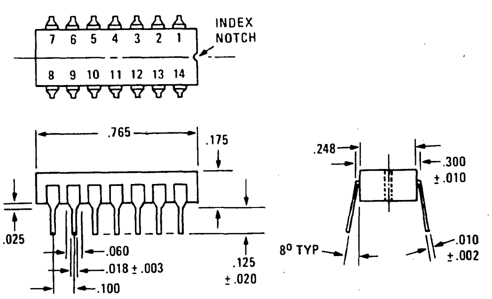
EXAMPLE:
- HARRIS LOGO (LETTER – H)
- FAMILY DESIGNATION (LETTERS)
- PACKAGE TYPE (NUMBERS)
- TEMPERATURE RANGE (NUMBERS)
- SPECIFIC DEVICE TYPE NUMBERS

H D 9 - 74C10

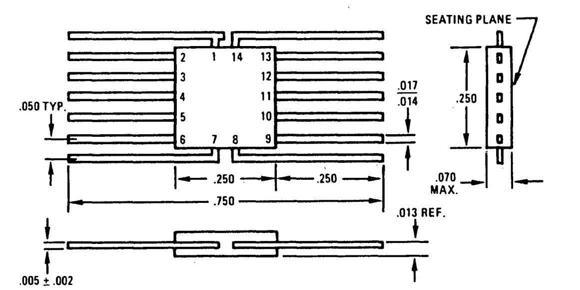
FAMILY (LETTERS)	PACKAGE (NUMBERS)	TEMPERATURE RANGE
D – DIGITAL	1 – DUAL IN-LINE CERAMIC	54C – -55°C to +125°C
	9 – FLAT PACKAGE	74C – 0°C to +70°C

Packaging Code

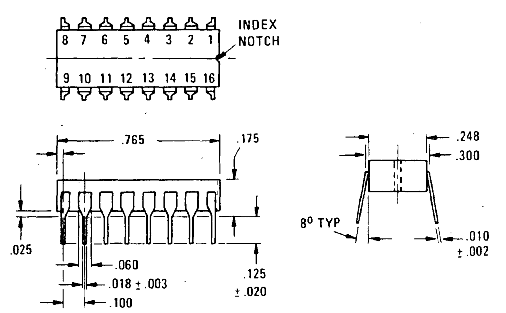
Code 1U 14 LEAD CERAMIC D.I.P. (CERDIP) *



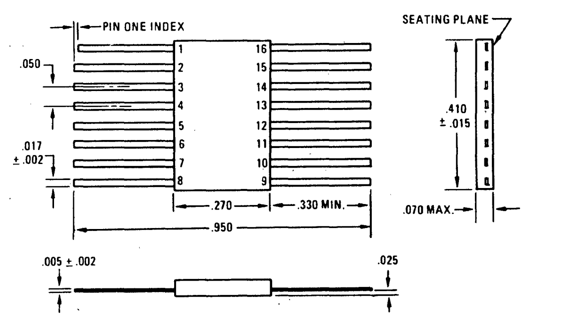
Code 9V TO-86 (METAL BOTTOM) BRAZED SEAL FLAT PACK *



Code 1W 16 LEAD CERAMIC D.I.P. (CERDIP) *



Code 9L 16 LEAD BRAZED SEAL FLAT PACK *



HARRIS SEMICONDUCTOR
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HD-4000A Series

ABSOLUTE MAXIMUM RATINGS

Power Supply Voltage Range, $V_{DD} - V_{SS}$		-0.5VDC to +15VDC
Voltage at any Pin		V_{SS} -0.3VDC $\leq V_{pin} \leq V_{DD}$ +0.3VDC
Storage Temperature Range		-65°C to +150°C
Power Dissipation per Package		200mW
Operating Temperature Range:	HD-4000A-2	-55°C to +125°C
	HD-4000A-9	-40°C to +85°C

HD-4014A *8-Stage Static Shift Register*

Description

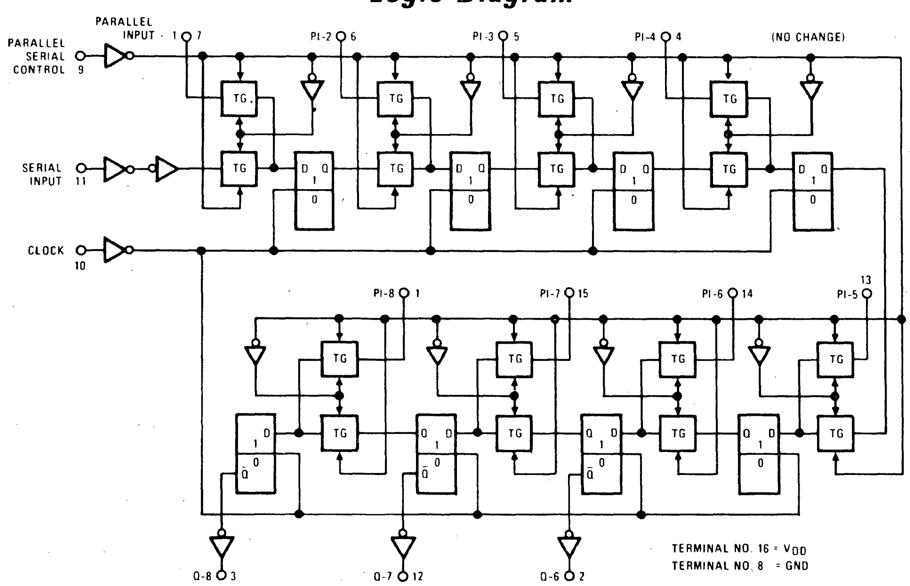
- CLOCK RATE 5MHz (TYP.) $V_{DD}-V_{SS}$ = 10V

The HD-4014 is an 8 stage shift register with parallel or serial data input and serial data output capabilities.

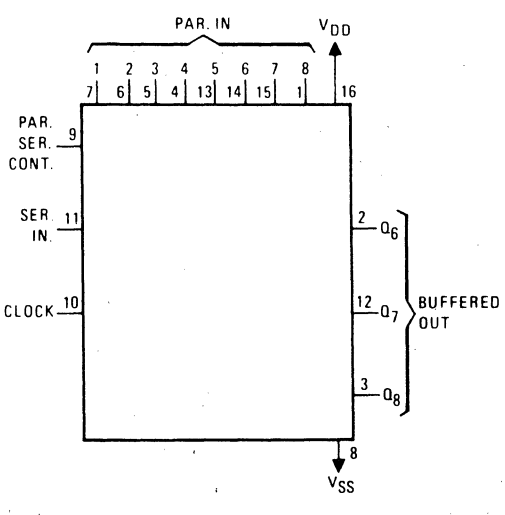
The state of the parallel/serial input determines the data entry mode. With a high on the parallel/serial control, input data is loaded from the parallel inputs synchronous with the positive going clock input. A low on the parallel/serial input enables serial data entry synchronous with the positive going clock.

Parallel operation of two or more HD-4014's allows bit expansion beyond eight bits.

Logic Diagram



Connection Diagram



Truth Table

C_L▲	SER. IN	PAR. SER. CONTROL	PI-1	PI-n	Q_1 (INTER-NAL)	Q_n
↑	X	1	0	0	0	0
↑	X	1	1	0	1	0
↑	X	1	0	1	0	1
↑	X	1	1	1	1	1
↑	0	0	X	X	0	Q_{n-1}
↑	1	0	X	X	1	Q_{n-1}
↓	X	X	X	X	Q_1	Q_n (NO CHANGE)

X = DON'T CARE CASE ▲= LEVEL CHANGE

HD-4015A *Dual 4-Stage Static Shift Register*

Description

- CLOCK RATE 5 MHz (TYP.) $V_{DD} - V_{SS} = 10V$

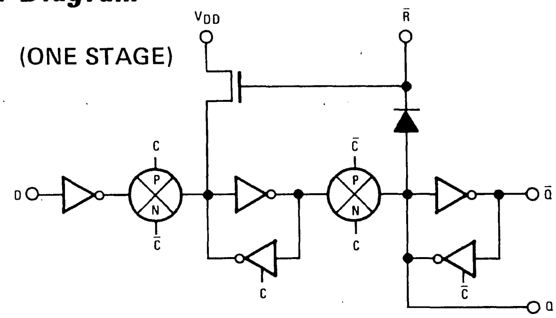
The HD-4015 is a dual 4 stage static shift register. Both four bit segments are capable of independent operation. With an independent serial "Data", "Clock", and "Reset", input and "Q" output available from each stage.

Resetting either four bit segment occurs when its respective reset line is held at a high level. Data shifting occurs on the positive-going clock transition.

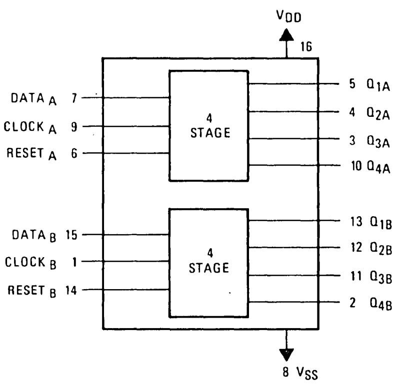
The shift register function provided by the HD-4015 can easily be expanded in multiples of four stages by paralleling additional units as required.

Circuit Diagram

(ONE STAGE)



Connections

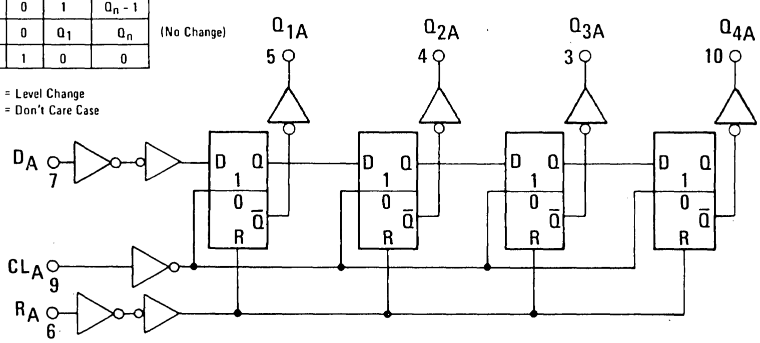


Block Diagram

CL▲	D	R	Q_1	Q_n	
_/‾	0	0	0	Q_{n-1}	
_/‾	1	0	1	Q_{n-1}	
‾_	X	0	Q_1	Q_n	(No Change)
X	X	1	0	0	

▲ = Level Change
X = Don't Care Case

(FOUR BITS)



HD-4018A *Presettable Divide-By-'N' Counter*

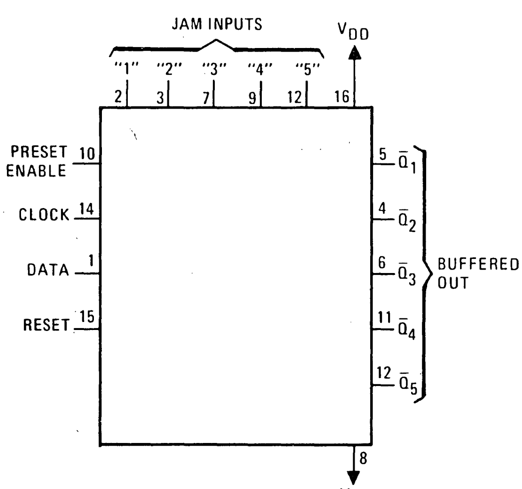
Description

The HD-4018 is a 5-bit Johnson counter incorporating reset and load capabilities. Fixed and programmable frequency division can be implemented by hard wiring or gating feedback to the data input. Divide by 10, 8, 6, 4, and 2 result from feedback of Q_5, Q_4, Q_3, Q_2 and Q_1 to the data input. Proper gating of feedback results in division by 9, 7, 5, or 3.

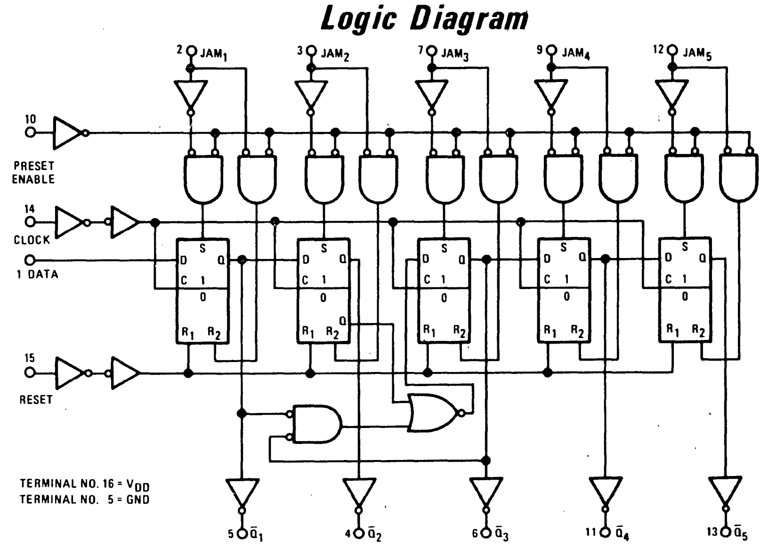
Division by numbers greater than 10 can be performed by using two or more HD-4018's.

Application of a "high" to the reset input clears the counter to the "zero" state. When the preset enable input is held high, data applied to the Jam inputs is loaded into the counter asynchronously with the clock. The counter increments synchronously with the positive-going clock transition.

Connections



Logic Diagram



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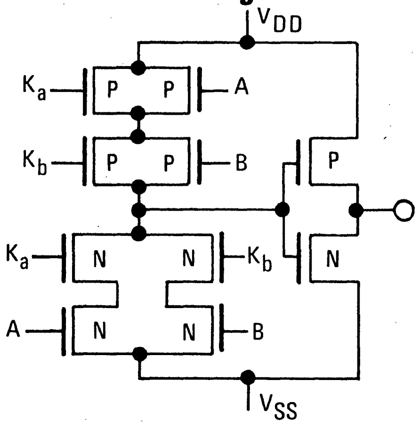
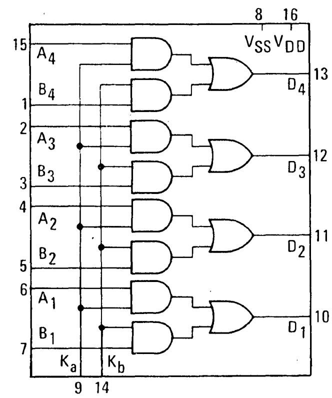
HD-4019A *Quad AND-OR Select Gate*

Circuit Diagram



Connections



Truth Table

CONTROL		OUTPUT
K_a	K_b	D_1
0	0	0
0	1	B_1
1	0	A_1
1	1	$A_1 + B_1$

LOGIC "1" → V_{DD}

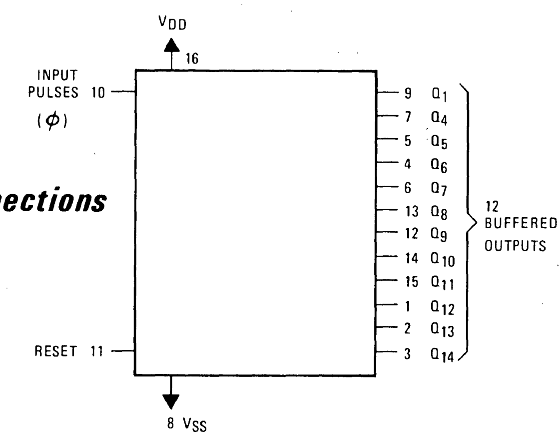
LOGIC "0" → V_{SS}

HD-4020A *14-Stage Ripple-Carry Binary Counter/Divider*

Description

The HD-4020 is a 14 stage ripple-carry binary counter/divider. Buffered outputs are available from stage 1, and stages 4 through 14. The counter increments on the negative going edge of the input pulse. Resetting of the counter to the "zero" state occurs when a "high" is applied to the reset input.

Connections



HD-4021A *8-Stage Static Shift Register*

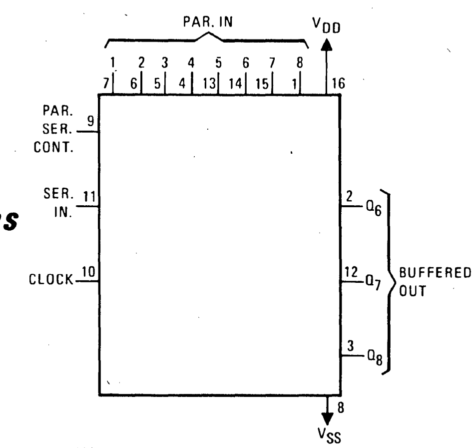
Description

The HD-4021 is an 8-stage parallel or serial input/serial output shift register. Inputs are provided for clock, parallel/serial control, serial data, and parallel data (8 inputs). "Q" outputs for the sixth, seventh, and eighth stages are also available.

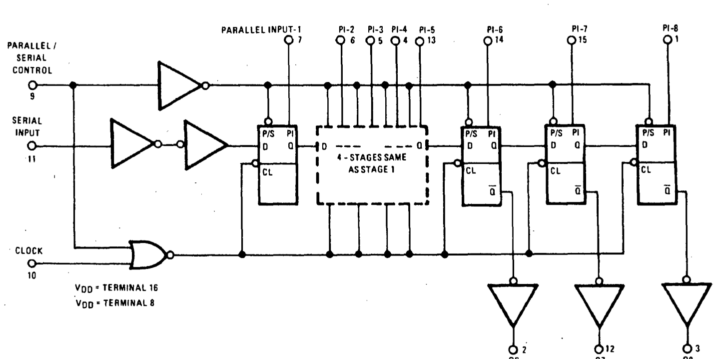
With the parallel/serial control high data is jammed into the register via the parallel input lines. With the parallel/serial input low data is shifted synchronously during the positive going clock.

The HD-4021 register function can be easily expanded in multiples of eight stages by paralleling additional units as required.

Connections



Logic Diagram



Truth Table

C_L▲	SERIAL INPUT	PARALLEL/ SERIAL CONTROL	PI-1	PI-n	Q_1 (INTERNAL)	Q_n	
X	X	1	0	0	0	0	
X	X	1	0	1	0	1	
X	X	1	1	0	1	0	
X	X	1	1	1	1	1	
⌐ (rising)	0	0	X	X	0	Q_{n-1}	
⌐ (rising)	1	0	X	X	1	Q_{n-1}	
⌐ (falling)	X	0	X	X	Q_1	Q_n	NO CHANGE

▲= LEVEL CHANGE X = DON'T CARE CASE

HD-4022A *Divide-By-8 Counter/Divider with 8 Decoded Outputs*

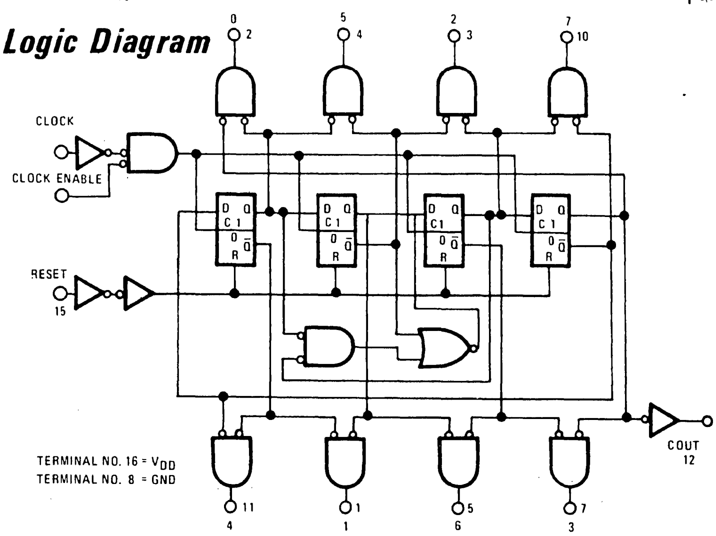
Description

The HD-4022 is a 4-stage Johnson counter with decoded outputs. The counter outputs internally drive the inputs of a one of eight decoder, with the decoder outputs available at the package pins. Buffered clock and reset pins are provided for maximization of circuit noise immunity and reduction of input capacitance. A clock enable pin is also available. The counter advances on the positive going clock signal if clock enable is low.

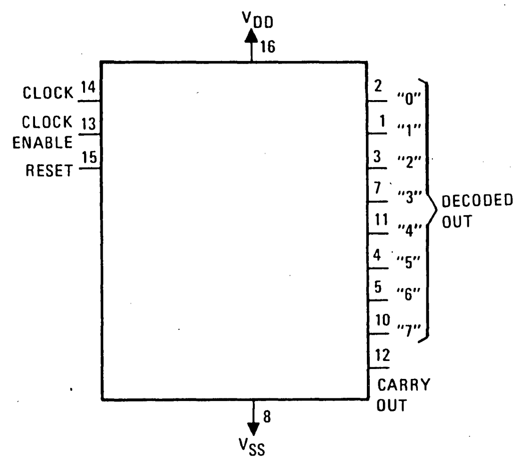
The Johnson counter configuration permits high speed spike-free operation with all counter stages clocking in parallel.

The normal state of an undecoded output is low, going high for one complete clock cycle when decoded. The carry-out signal goes high every 8 clock cycles, and can be used as a ripply carry input if two or more counters are used in parallel.

Logic Diagram



Connections

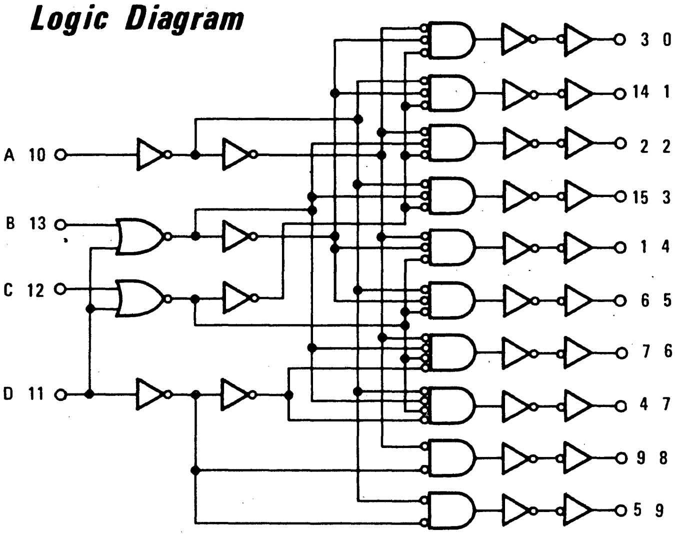


HD-4028A *BCD-to-Decimal Decoder*

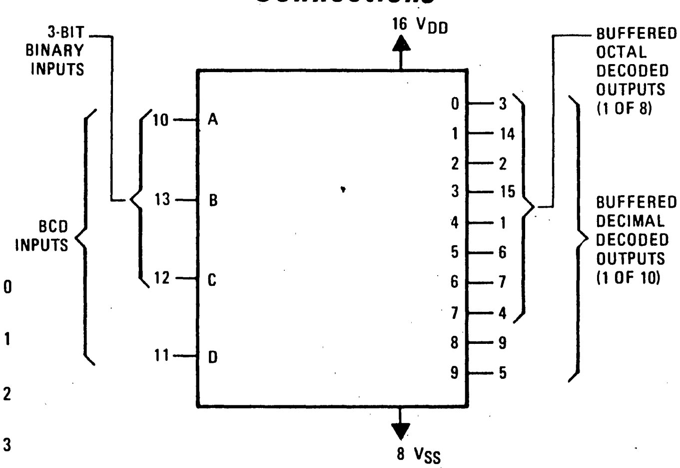
Description

The HD-4028 is a BCD - decimal decoder or binary to octal decoder. Application of BCD at inputs A, B, C, and D will result in 1 of 10 outputs being decoded as defined in the truth table. Octal code will be decoded at outputs 0 to 7 with a 3-bit binary code applied to inputs A, B, and C and input D held "low". An output, when decoded, will be "high" with all other outputs "low".

Logic Diagram



Connections



Truth Table

D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	1	0	1	0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	0	0	0	0	0	0
0	1	0	0	0	0	0	0	1	0	0	0	0	0
0	1	0	1	0	0	0	0	0	1	0	0	0	0
0	1	1	0	0	0	0	0	0	0	1	0	0	0
0	1	1	1	0	0	0	0	0	0	0	1	0	0
1	0	0	0	0	0	0	0	0	0	0	0	1	0
1	0	0	1	0	0	0	0	0	0	0	0	0	1

Where: 1 = High Level
0 = Low Level

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HD-4029A *Presettable Up/Down Counter*

Description

The HD-4029 is a four stage counter capable of counting up or down in either binary or BCD decade modes. Levels preset on the Jam inputs are loaded into the counter asynchronously with the clock when the Preset Enable input is "high". "Look ahead" carry capabilities are provided to facilitate high speed operation where two or more HD-4029's are used in parallel.

The counter toggles one count on the positive going clock input when the carry input and preset enable inputs are "low". If either carry input or preset enable are "high" clocking is inhibited.

The carry out signal is normally high, going low for one clock cycle under the following conditions providing the Carry Input signal is low:

The counter has reached its maximum count in the "Up" mode.

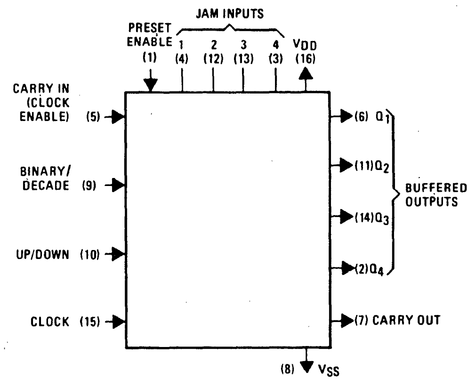
The counter has reached its minimum count in the "Down" mode.

The carry input signal functions as a clock enable permitting the counter to toggle only when "low". If the carry input is not used it must be tied to V_{SS}.

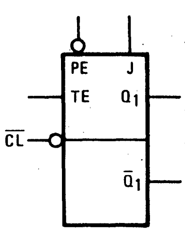
Operating modes for the HD-4029 are selected as follows:

Binary/Decade input "high"	Binary Counter
Binary/Decade input "low"	Decade Counter
Up/Down input "high"	"Up" Counter
Up/Down Input "low"	"Down" Counter

Connection Diagram

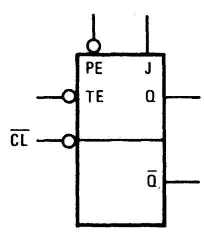


Truth Tables



CLOCK	TE	PE	J	Q	Q̄
X	X	0	0	0	1
↓	1	1	X	Q̄	Q
X	X	0	1	1	Q
↓	0	1	X	Q	Q̄ NC
↑	X	1	X	Q	Q̄ NC

NC – No Change
TE – Toggle Enable
X – Don't Care

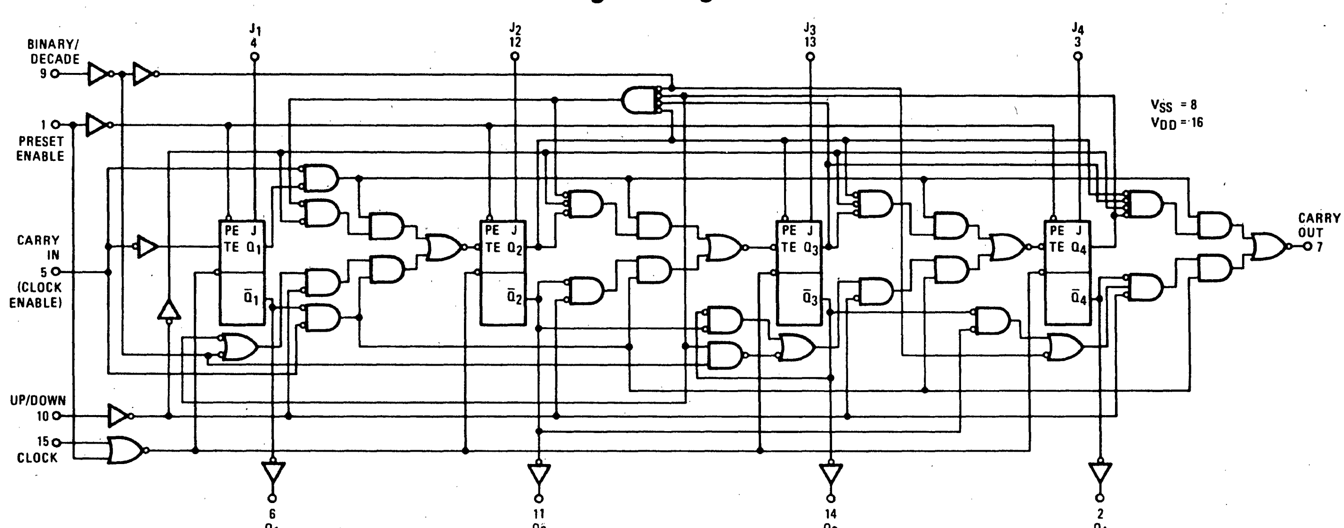


CLOCK	TE	PE	J	Q	Q̄
X	X	0	0	0	1
↓	0	1	X	Q̄	Q
X	X	0	1	1	0
↓	1	1	X	Q	Q̄ NC
↑	X	1	X	Q	Q̄ NC

NC – No Change
TE – Toggle Enable
X – Don't Care

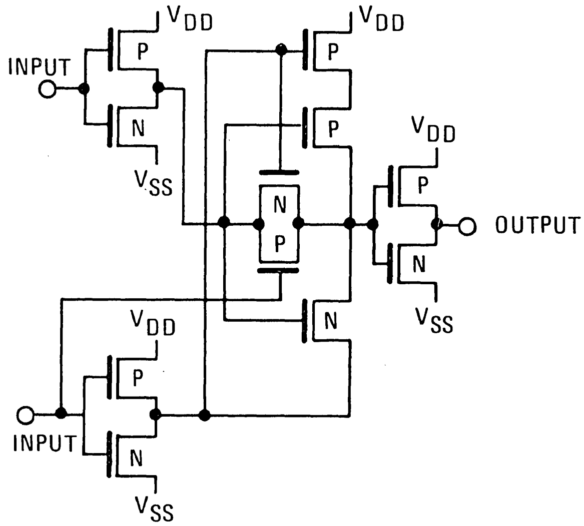
CONTROL INPUT	LOGIC LEVEL	ACTION
BIN/DEC (B/D)	1 0	BINARY COUNT DECADE COUNT
UP/DOWN (U/D)	1 0	UP COUNT DOWN COUNT
PRESET ENABLE (PE)	1 0	JAM IN NO JAM
CARRY IN (CI) (CLOCK ENABLE)	1 0	NO COUNTER ADVANCE AT POS CLOCK TRANSITION ADVANCE COUNTER AT POS CLOCK TRANSITION

Logic Diagrams

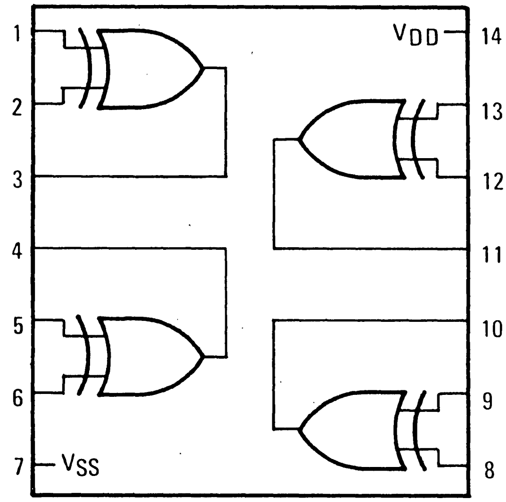


HD-4030A *Quad Exclusive "OR" Gate*

Circuit Diagram



Connections



Truth Table

INPUTS		OUTPUT
0	0	0
0	1	1
1	0	1
1	1	0

LOGIC "1" → V_{DD}

LOGIC "0" → V_{SS}

HD-4035A *4 Stage with J-K Input and True/Complement Output Shift Register*

Description

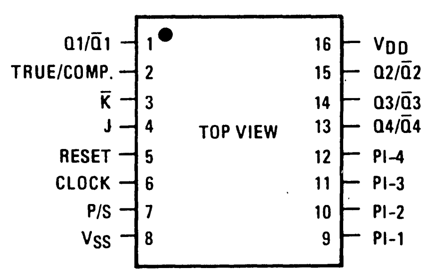
The HD-4035 is a four stage shift register capable of parallel input, serial input via J-K̄ inputs and parallel output.

Data entry mode is controlled by the parallel/serial input. With P/S high, data is entered via the parallel inputs on the positive clock transition. Serial data is entered on the positive going clock with P/S low.

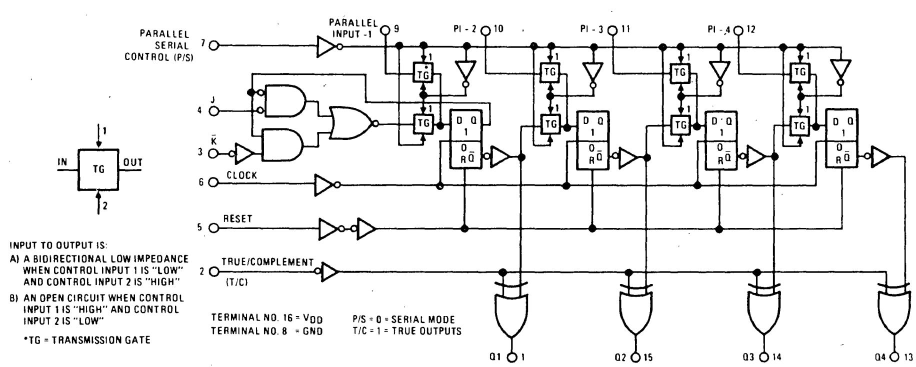
The True/complement input, when high, results in display of the true contents of the register at the outputs. When T/C is low, the complement of the register data is displayed.

The reset input, when high, asynchronously resets all four flip-flop stage.

Connection Diagrams



Circuit Diagram



Truth Table

CL	$t_n - 1$ (INPUTS)				t_n (OUTPUTS)
	J	K̄	R	$Q_n - 1$	Q_n
↑	0	X	0	0	0
↑	1	X	0	0	1
↑	X	0	0	1	0
↑	1	0	0	$Q_n - 1$	$\overline{Q_n - 1}$ TOGGLE MODE
↑	X	1	0	1	1
↓	X	X	0	$Q_n - 1$	$Q_n - 1$
X	X	X	1	X	0

HD-54C/74C Series

ABSOLUTE MAXIMUM RATINGS

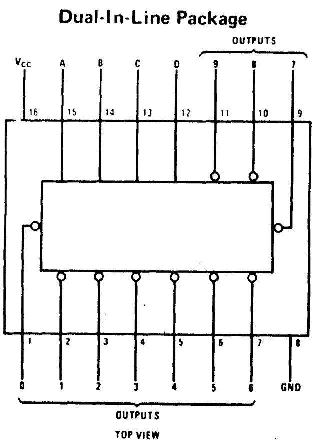
Voltage at Any Pin	-0.3V to V_{CC} + 0.3V	Storage Temperature Range	-65°C to +150°C
Operating Temperature Range		Maximum V_{CC} Voltage	16V
54C	-55°C to +125°C	Package Dissipation	500mW
74C	-40°C to +85°C	Lead Temperature (Soldering, 10 Seconds)	300°C

HD-54C42/HD-74C42 *BCD to Decimal Decoder*

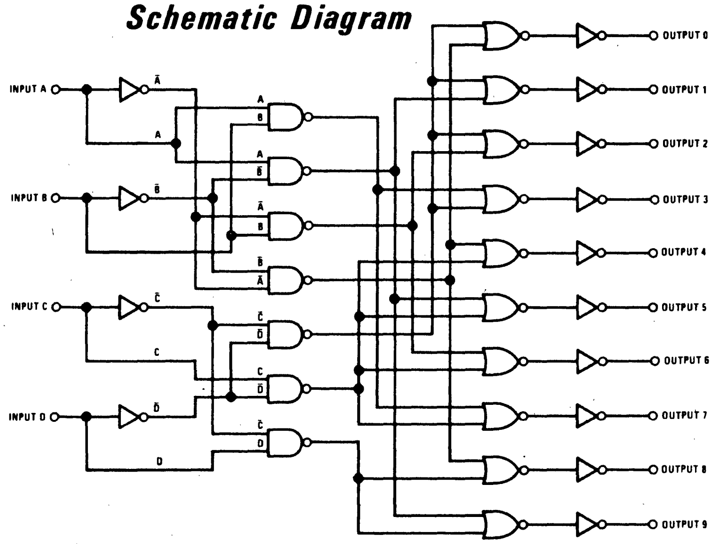
Description

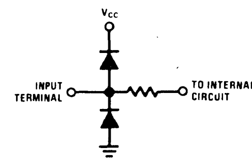
The HD-54C42/HD-74C42 one-of-ten decoder is a monolithic complementary MOS (CMOS) integrated circuit constructed with N and P-channel enhancement transistors. This decoder produces a logical "0" at the output corresponding to a four bit binary input from zero to nine and a logical "1" at the other outputs. For binary inputs from ten to fifteen all outputs are logical "1".

Connection Diagram



Schematic Diagram





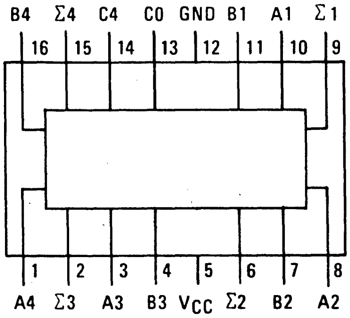
INPUT PROTECTION FOR ALL INPUTS

HD-54C83/HD-74C83 *4-Bit Binary Full Adder*

Description

The HD-54C83/HD-74C83 4-bit binary full adder is a monolithic complementary MOS (CMOS) integrated circuit constructed with N and P-channel enhancement transistors. This full adder performs the addition of two 4-bit binary numbers. The sum (Σ) outputs are provided for each bit and the resultant carry (C4) is obtained from the fourth bit. The adders are designed so that logic levels of the input and output, including the carry, are in their true form. Thus the end-around carry is accomplished without the need for level inversion.

Connection Diagram



NOTE:
Input conditions at A3, A2, B2 and C0 are used to determine outputs $\Sigma 1$ and $\Sigma 2$ and the value of the internal carry C2. The values at C2, A3, B3, A4 and B4 are then used to determine outputs $\Sigma 3$, $\Sigma 4$ and C4.

Truth Table

INPUT				OUTPUT WHEN C0 = L / WHEN C2 = L			OUTPUT WHEN C0 = H / WHEN C2 = H		
A1 / A3	B1 / B3	A2 / A4	B2 / B4	Σ1 / Σ3	Σ2 / Σ4	C2 / C4	Σ1 / Σ3	Σ2 / Σ4	C2 / C4
L	L	L	L	L	L	L	H	L	L
H	L	L	L	H	L	L	L	H	L
L	H	L	L	H	L	L	L	H	L
H	H	L	L	L	H	L	H	H	L
L	L	H	L	L	H	L	H	H	L
H	L	H	L	H	H	L	L	L	H
L	H	H	L	H	H	L	L	L	H
H	H	H	L	L	L	H	H	L	H
L	L	L	H	L	H	L	H	H	L
H	L	L	H	H	H	L	L	L	H
L	H	L	H	H	H	L	L	L	H
H	H	L	H	L	L	H	H	L	H
L	L	H	H	L	L	H	H	L	H
H	L	H	H	H	L	H	L	H	H
L	H	H	H	H	L	H	L	H	H
H	H	H	L	H	H	H	H	H	H

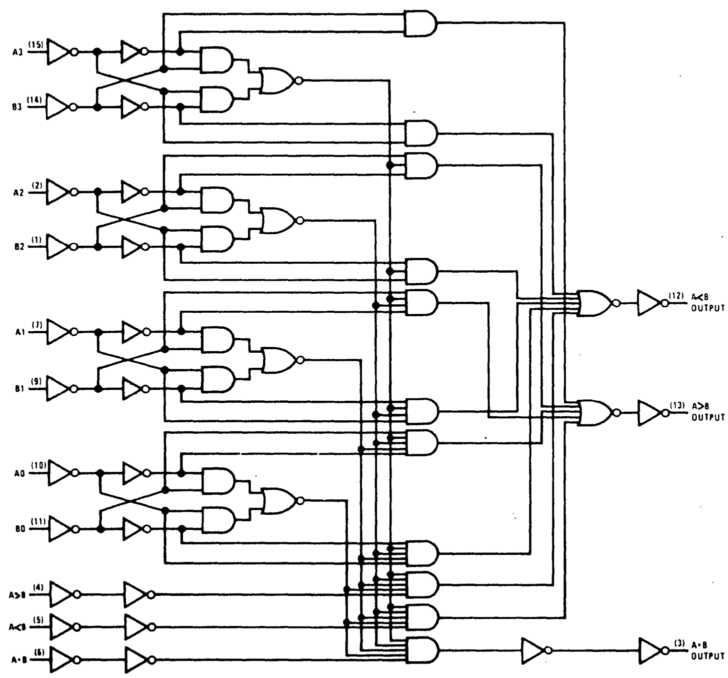
H = High Level L = Low Level

HD-54C85/HD-74C85 *4-Bit Magnitude Comparator*

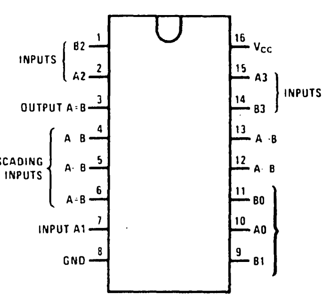
Description

The HD-54C85/HD-74C85 is a four-bit magnitude comparator which will perform comparison of straight binary or BCD codes. The circuit consists of eight comparing inputs (A0, A1, A2, A3, B0, B1, B2, B3), three cascading inputs (A>B, A<B and A = B), and three outputs (A>B, A<B and A = B). This device compares two four-bit words (A and B) and determines whether they are "greater than," "less than," or "equal to" each other by a high level on the appropriate output. For words greater than four-bits, units can be cascaded by connecting the outputs (A>B, A<B and A = B) of the least-significant stage to the cascade inputs (A<B, A<B and A = B) of the next-significant stage. In addition, the least significant stage must have a high level voltage ($V_{IN(1)}$) applied to the A = B input and low level voltages ($V_{IN(0)}$) applied to A>B and A<B inputs.

Logic Diagram



Connection Diagram



TOP VIEW

HD-54C89/HD-74C89 *64-Bit Three-State Random Access Read/Write Memory*

Description

The HD-54C89/HD-74C89 is a 16 word by 4-bit random access read/write memory. Inputs to the memory consist of four address lines, four data input lines, a write enable line and a memory enable line. The four binary address inputs are decoded internally to select each of the 16 possible word locations. An internal address register, latches the address information on the positive to negative transition of the memory enable input. The four three state data output lines working in conjunction with the memory enable input provides for easy memory expansion.

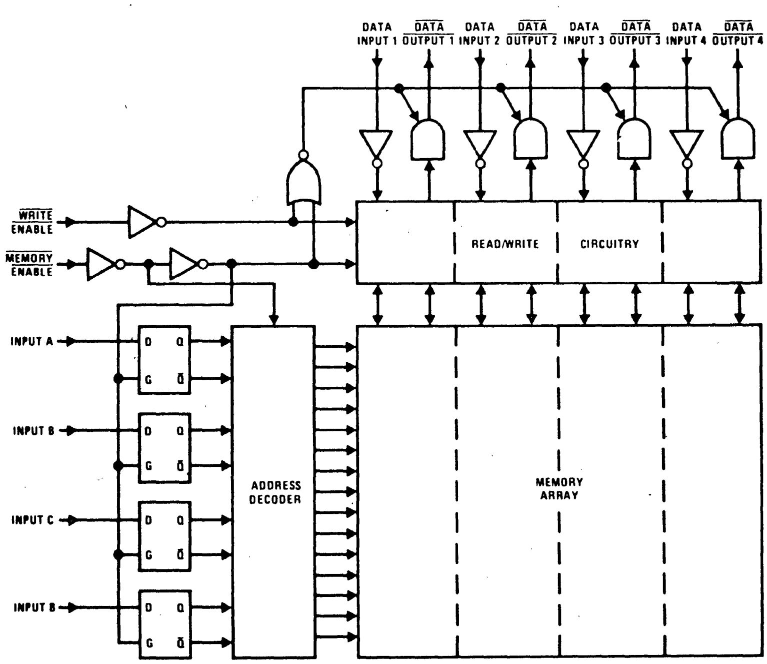
ADDRESS OPERATION: Address inputs must be stable t_{SA} prior to the positive to negative transition of memory enable. It is thus not necessary to hold address information stable for more than t_{HA} after the memory is enabled (positive to negative transition of memory enable.)

WRITE OPERATION: Information present at the data inputs is written into the memory at the selected address by bringing write enable and memory enable low.

READ OPERATION: The complement of the information which was written into the memory is nondestructively read out at the four outputs. This is accomplished by selecting the desired address and bringing memory enable low and write enable high.

When the device is writing or disabled the output assumes a three state (HI-Z) condition.

Circuit Diagram



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HD-54C95/HD-74C95 *4-Bit Right-Shift, Left-Shift Register*

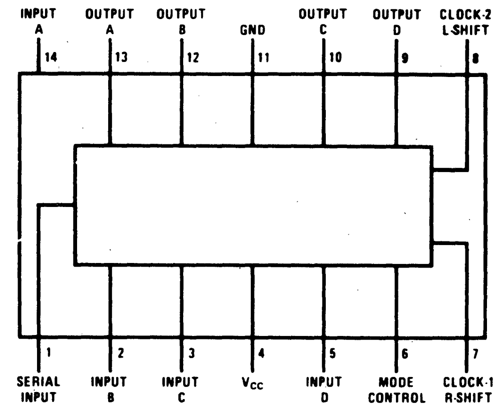
Description

This four-bit shift register is a monolithic complementary MOS (CMOS) integrated circuit composed of four D flip flops. This register will perform right-shift or left-shift operations dependent upon the logical input level to the mode control. A number of these registers may be connected in series to form an N-bit right-shift or left-shift register.

When a logical "0" level is applied to the mode control input, the output of each flip-flop is coupled to the D input of the succeeding flip-flop. Right-shift operation is performed by clocking at the clock 1 input, and serial data entered at the serial input, clock 2 and parallel inputs A through D are inhibited. With a logical "1" level applied to the mode control, outputs to succeeding stages are decoupled and parallel loading is possible, or with external interconnection, shift-left operation can be accomplished by connecting the output of each flip-flop to the parallel input of the previous flip-flop and serial data is entered at input D.

Connection Diagram

Dual-In-Line Package



TOP VIEW

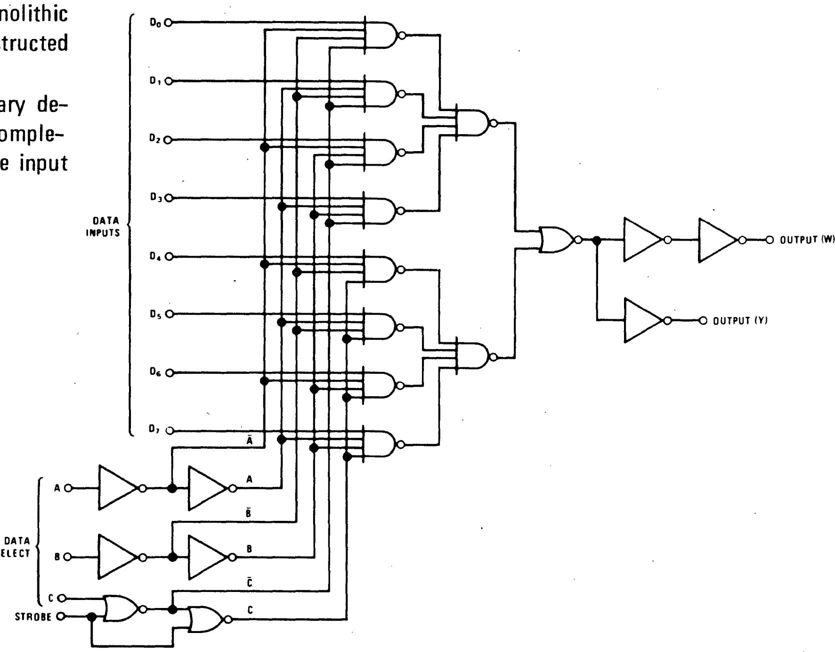
HD-54C151/HD-74C151 *8 Channel Digital Multiplexer*

Description

The HD-54C151/HD-74C151 multiplexer is a monolithic complementary MOS (CMOS) integrated circuit constructed with N- and P- channel enhancement transistors.

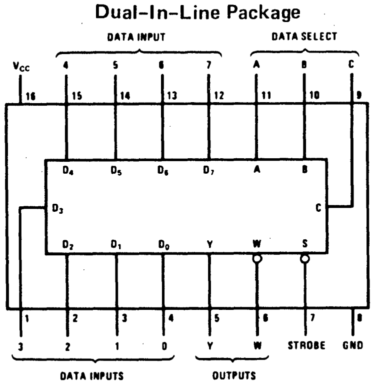
This data selector/multiplexer contains on-chip binary decoding. Two outputs provide true (output Y) and complement (output W) data. A logical "1" on the strobe input forces W to a logical "1" and Y to a logical "0"

Logic Diagrams



Connection Diagrams

Dual-In-Line Package



TOP VIEW

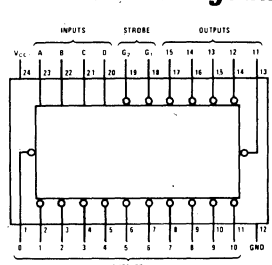
HD-54C154/HD-74C154 *4-Line to 16-Line Decoder/Demultiplexer*

Description

The HD-54C154/HD-74C154 one of sixteen decoder is a monolithic complementary MOS (CMOS) integrated circuit constructed with N and P-channel enhancement transistors. The device is provided with two strobe inputs, both of which must be in the logical "0" state for normal operation. If either strobe input is in the logical "1" state, all 16 outputs will go to the logical "1" state.

To use the product as a demultiplexer, one of the strobe inputs serves as a data input terminal, while the other strobe input must be maintained in the logical "0" state. The information will then be transmitted to the selected output as determined by the four-line input address.

Connection Diagram



TOP VIEW

Truth Table

INPUTS						OUTPUTS															
G1	G2	D	C	B	A	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	L	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H
L	L	L	H	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H
L	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H
L	L	H	L	L	L	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H
L	L	H	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H
L	L	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H
L	L	H	H	L	L	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H
L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H
L	L	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H
L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L
L	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	L	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

X = "Don't Care" Condition

HD-54C160/HD-74C160 *Decade Counter with Asynchronous Clear*
HD-54C161/HD-74C161 *Binary Counter with Asynchronous Clear*
HD-54C162/HD-74C162 *Decade Counter with Synchronous Clear*

Description

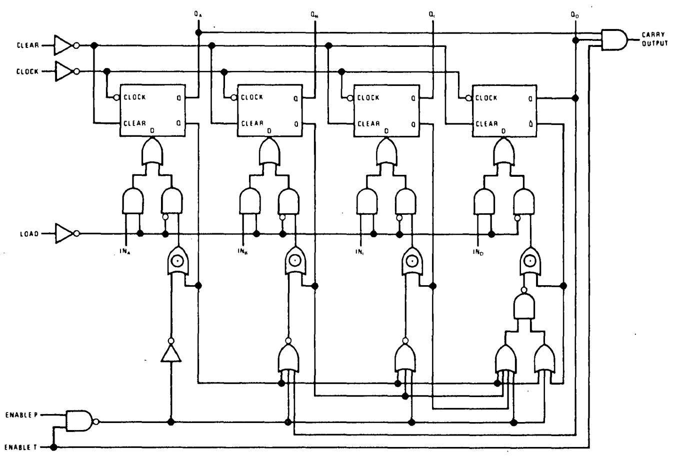
These (synchronous presettable up) counters are monolithic complementary MOS (CMOS) integrated circuits constructed with N and P-channel enhancement mode transistors. They feature an internal carry lookahead for fast counting schemes and for cascading packages without additional gating.

A low level at the load input disables counting and causes the outputs to agree with the data input after the next positive clock edge. The clear function for the C162 is synchronous and a low level at the clear input sets all our outputs low after the next positive clock edge. The clear function for the C160 and C161 is asynchronous and a low level at the clear input sets all four outputs low regardless of the state of the clock.

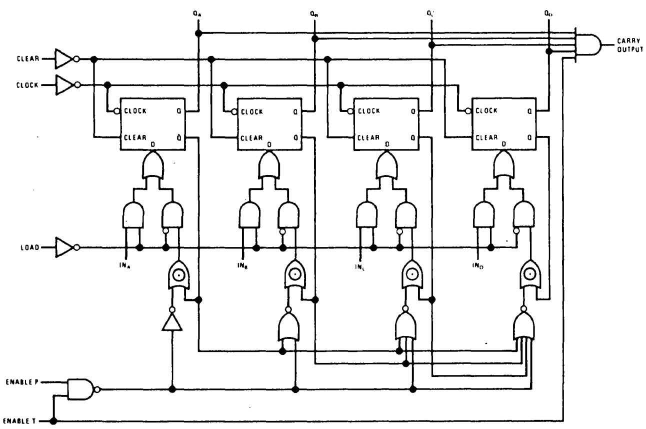
Counting is enabled when both count enable inputs are high. Input T is fed forward to also enable the carry out. The carry output is a positive pulse with a duration approximately equal to the positive protion of Q_A and can be used to enable successive cascaded stages. Logic transitions at the enable P or T inputs can occur when the clock is high or low.

Logic Diagrams

C160/C162; Clear is Synchronous for the C162



C161; Clear is Asynchronous



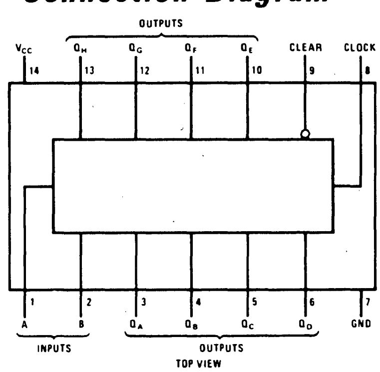
HD-54C164/HD-74C164 *8-Bit Parallel-Out Serial Shift Register*

Decription

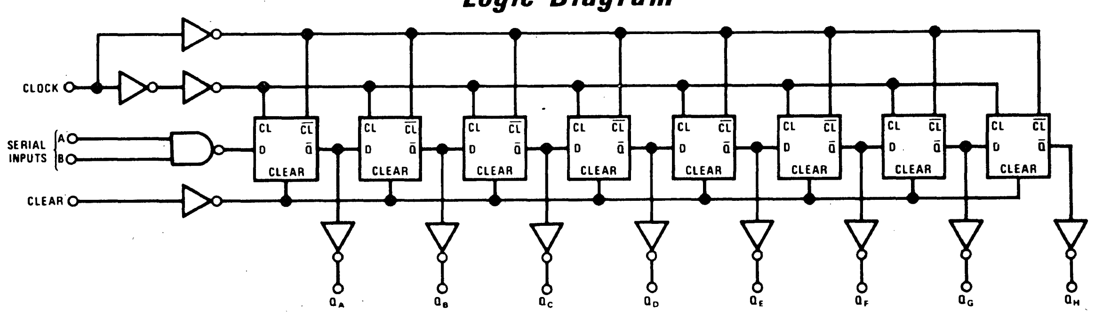
The HD-54C164/HD-74C164 shift registers are a monolithic complementary MOS (CMOS) integrated circuit constructed with N- and P- channel enhancement transistors. These 8-bit shift registers have gated serial inputs and clear. Each register bit is a D-type master/slave flip-flop. A high-level input enables the other input which will then determine the state of the flip-flop.

Data is serially shifted in and out of the 8-bit register during the positive going transition of clock pulse. Clear is independent of the clock and accomplished by a low level at the clear input. All inputs are protected against electrostatic effects.

Connection Diagram



Logic Diagram



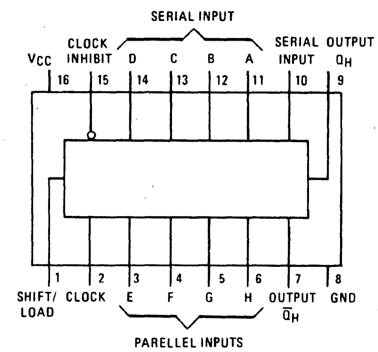
HD-54C165/HD-74C165 *Parallel-Load 8-Bit Shift Register*

Description

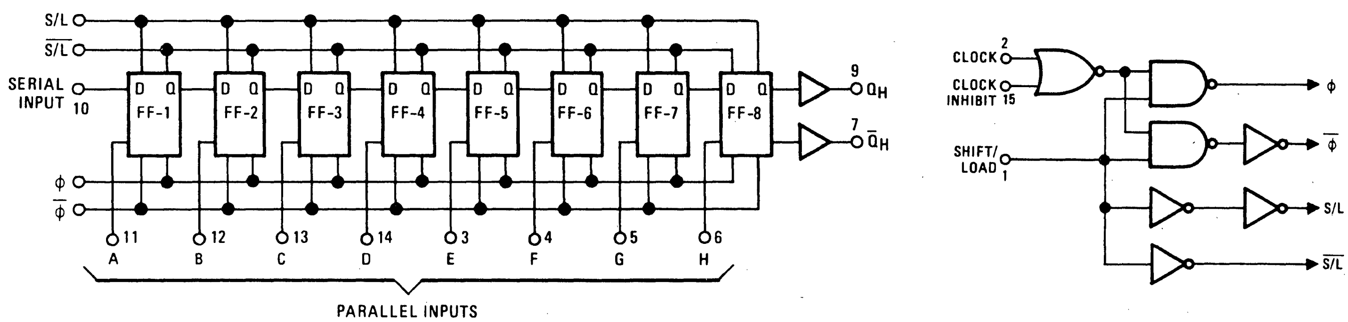
The HD54C165/HD74C165 is an 8-bit serial shift register which shifts data from Q_A to Q_H when clocked. Parrallel inputs to each stage are enabled by a low level at the shift/load input. Also included is a gated clock input and a complementary output from the eight-bit.

Clocking is accomplished through a 2-input NOR-gate permitting one input to be used as a clock-inhibit function. Holding either of the clock inputs high inhibits clocking, and holding either clock input low with the shift/load input high enables the other clock input. Data transfer occurs on the positive edge of the clock. The clock inhibit input should be changed to a high level only while the clock input is high. Parallel loading is inhibited as long as the shift/load input is high. When taken low, data at the parallel inputs is loaded directly into the register independent of the state of the clock.

Connection Diagram



Block Diagram



HD-54C192/HD-74C192 *Synchronous 4-Bit Up/Down Decade Counter*

HD-54C193/HD-74C193 *Synchronous 4-Bit Up/Down Binary Counter*

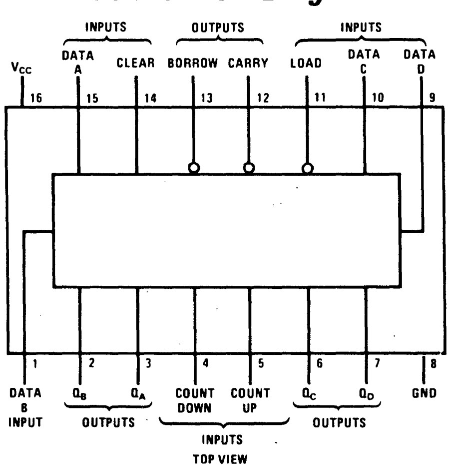
Description

These up/down counters are monolithic complementary MOS (CMOS) integrated circuits. The HD-54C192 and HD-74C192 are BCD counters. While the HD-54C193 and HD-74C193 are binary counters.

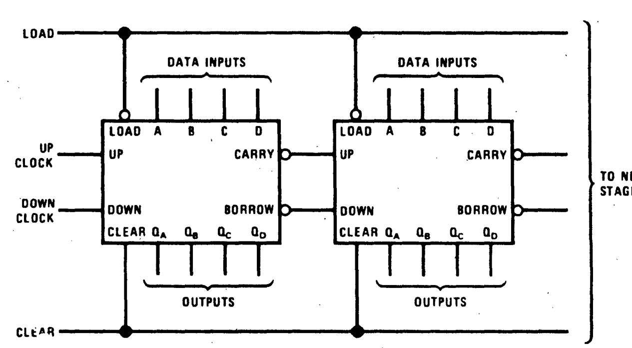
Counting up and counting down is performed by two count inputs, one being held high while the other is clocked. The outputs change on the positive going transition of this clock.

These counters feature preset inputs that are set when load is a logical "0" and a clear which forces all outputs to "0" when it is at logical "1". The counters also have carry and borrow outputs so that they can be cascaded using no external circuitry.

Connection Diagram



Functional Diagram



HD-54C195/HD-74C195 *4-Bit Registers*

Description

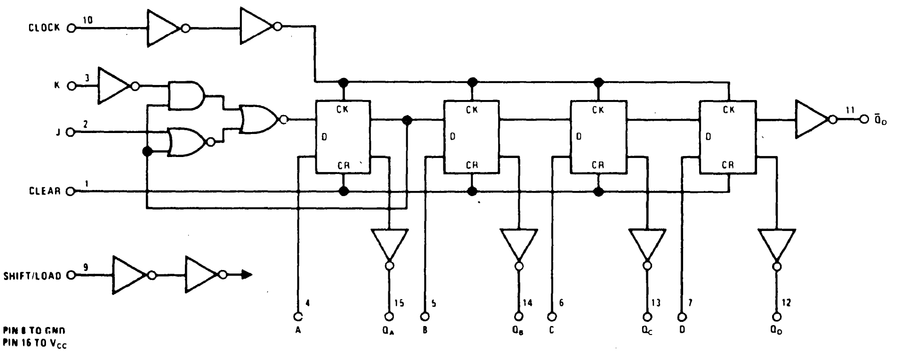
The HD-54C195/HD-74C195 CMOS 4-bit registers feature parallel inputs, parallel outputs, J-K serial inputs, shift/load control input and a direct overriding clear. The following two modes of operation are possible.

Parallel Load
Shift in direction Q_A towards Q_D

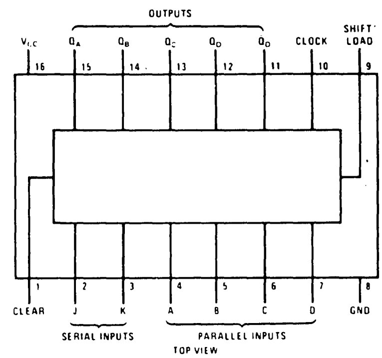
Parallel loading is accomplished by applying the four bits of data and taking the shift/load control input low. The data is loaded into the associated flip-flops and appears at the outputs after the positive transition of the clock input. During parallel loading, serial data flow is inhibited.

Serial shifting is accomplished synchronously when the shift/load control input is high. Serial data for this mode is entered at the J-$\overline{K}$ inputs. These inputs allow the first stage to perform as a J-$\overline{K}$, D or T-type flip-flop as shown in the truth table.

Circuit Diagram



Connection Diagram



Advanced Information HD-54C200/HD-74C200

256-Bit Three-State Random Access Read/Write Memory

Description

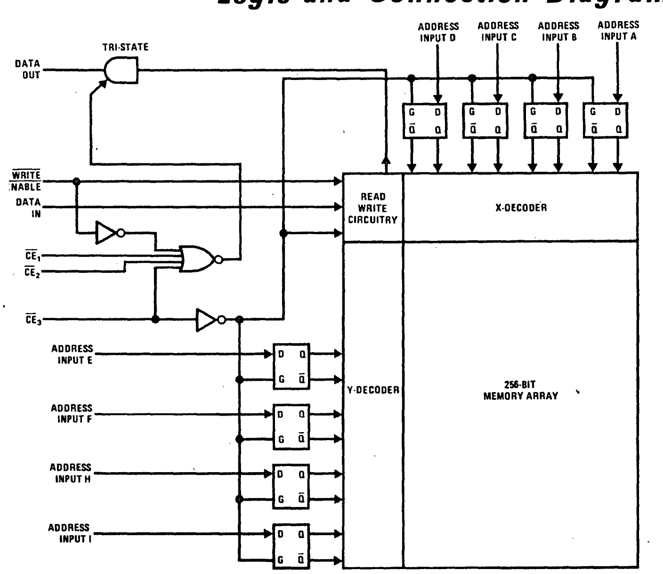
The HD-54C200/HD-74C200 is a 256-bit random access read/write memory. Inputs consist of eight address lines, a data input line, a write enable line, and three chip enables. The eight binary address inputs are decoded internally to select each of the 256 locations. An internal address register, latches and address information on the positive to negative edge of $\overline{CE}_3$ or $\overline{CE}_2$ inputs. The three state data output line working in conjunction with $\overline{CE}_1$ or $\overline{CE}_2$ inputs provides for easy memory expansion.

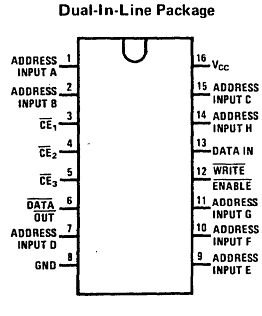
ADDRESS OPERATION: Address inputs must be stable t_{SA} prior to the positive to negative transition of $\overline{CE}_3$ or $\overline{CE}_2$. It is thus not necessary to hold address information stable for more than t_{HA} after the memory is enabled (positive to negative transition).

READ OPERATION: The data is read out by selecting the proper address and bringing $\overline{CE}_1$, $\overline{CE}_2$ or $\overline{CE}_3$ low and write enable high. Holding $\overline{CE}_1$ or $\overline{CE}_2$ at a high level forces the output into three state. When used in bus organized systems, $\overline{CE}_1$, or $\overline{CE}_2$, a three state control, provides for fast access times by not disabling the chip.

WRITE OPERATION: Data is written into the memory with $\overline{CE}_2$ and $\overline{CE}_3$ low and write enable low. The state of $\overline{CE}_1$ has no effect on the write cycle. The output assumes three state with write enable low.

Logic and Connection Diagrams





HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HD-54C221/HD-74C221 *Dual Monostable Multivibrator*

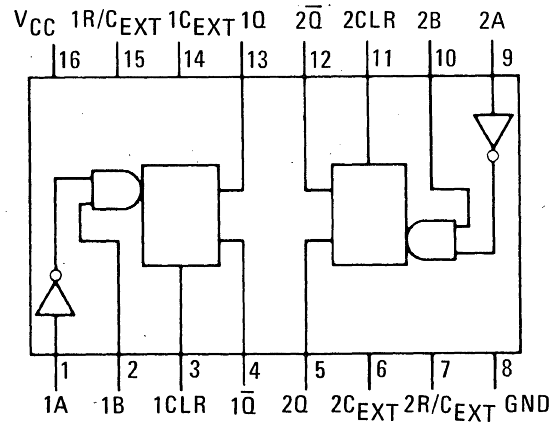
Description

The HD54C221/HD74C221 dual monostable multivibrators is monolithic complementary MOS integrated circuit. Each multivibrator features a negative-transition-triggered input and a positive-transition-triggered input either of which can be used as an inhibit input, and a clear input.

Once fired, the output pulses are independent of further transitions of the A and B inputs and are a function of the external timing components C_{EXT} and R_{EXT}. The pulse width is stable over a wide range of temperature and V_{CC}. Pulse stability will be limited by the accuracy of external timing components. The R_{EXT} ranges from 10k to 100k. Throughout these ranges the pulse width is approximately defined by the relationship $t_{W(OUT)} \approx C_{EXT} R_{EXT}$.

Connection Diagram

DUAL-IN-LINE PACKAGE



Truth Table

INPUTS			OUTPUTS	
CLEAR	A	B	Q	$\overline{Q}$
L	X	X	L	H
X	H	X	L	H
X	X	L	L	H
H	L	↑	⊓	⊔
H	↓	H	⊓	⊔

H = High Level

L = Low Level

↑ = Transition from Low to High

↓ = Transition from High to Low

⊓ = One High Level Pulse

⊔ = One Low Level Pulse

X = Irrelevant

LOW-POWER SCHOTTKY

54LS

DESCRIPTION

The Raytheon 54LS Low-Power Schottky TTL family utilizes Schottky-barrier diode clamping, shallow diffusions and small geometries to achieve speeds comparable to 5400 at one-fifth the power and 54H at one-tenth the power. It is completely compatible with most of the popular TTL and DTL logic families and is equivalent in performance to the Fairchild 9LS series.

FEATURES

High Speed, Low Power

- **5 ns typical gate propagation delay time**
- **2 mW typical gate power dissipation at 50% duty cycle = speed-power product of 10 pJ**

Ease of System Design

- **Switching times virtually insensitive to power supply, temperature variations**
- **Low noise generation**
- **High fan-out**
- **Schottky-diode-clamped inputs minimize high-speed termination effects**
- **Low output impedance gives low noise susceptibility, high capacitance drive capability**
- **Power dissipation remains relatively low at operating frequencies up to 30 mHz**
- **Smaller, lower-cost power supplies and cooling equipment**

ABSOLUTE MAXIMUM RATINGS

Supply voltage, V_{CC} (see Note 1) .... 7 V
Input voltage (see Notes 1 and 2) .... 5.5 V
Interemitter voltage (see Note 3) .... 5.5 V
Output voltage (see Notes 1 and 4) .... 7 V
Operating free-air temperature range: 54LS −55°C to 125°C
Storage temperature range .... −65°C to 150°C

NOTES:
1. Voltage values, except interemitter voltage, are with respect to network ground terminal.
2. Except 54LS74, 109, 181,196, 197. For 54LS74, 109, 181, 196, 197, rating is 5.5 V.
3. This is the voltage between two emitters of a multiple-emitter transistor.
4. This is the maximum voltage which should be applied to any open-collector output when it is in the off state.

Raytheon cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Raytheon product. No other circuit patent licenses are implied.

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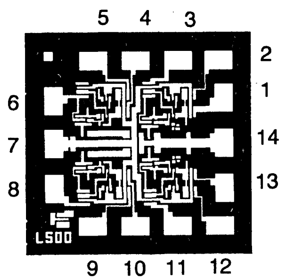
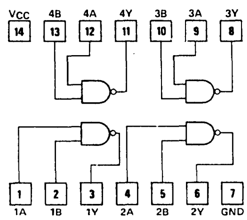
Positive-NAND Gates, Hex Inverters

PIN-OUT AND LOGIC DIAGRAMS

54LS00
QUADRUPLE 2-INPUT NAND GATE

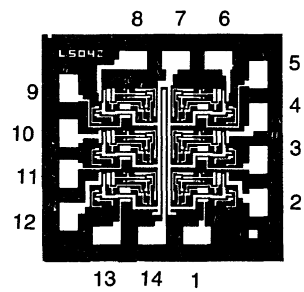


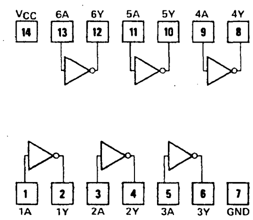


Positive logic: $Y = \overline{AB}$

Die Size .047 x .048

54LS04
HEX INVERTER

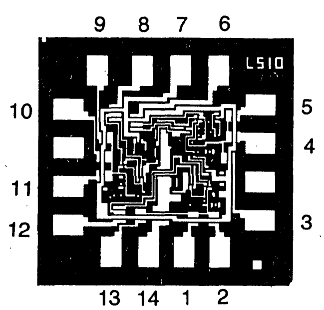


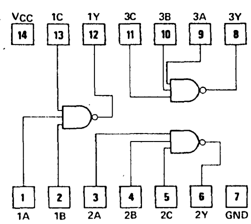


positive logic: $Y = \overline{A}$

Die Size .048 x .051

54LS10
TRIPLE 3-INPUT NAND GATE

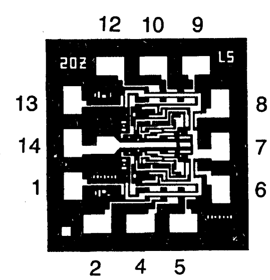


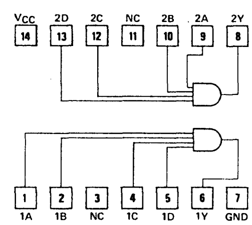


positive logic: $Y = \overline{ABC}$

Die Size .052 x .054

54LS20
DUAL 4-INPUT NAND GATE



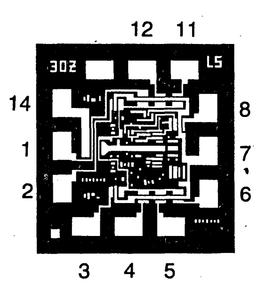


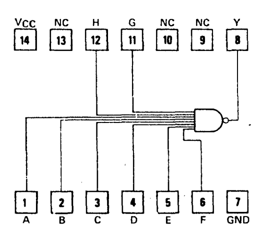
positive logic: $Y = \overline{ABCD}$

Die Size .042 x .044

NC — No internal connection

54LS30
8-INPUT NAND GATE





positive logic: $Y = \overline{ABCDEFGH}$

Die Size .042 x .044

Positive-NAND Gates, Hex Inverters

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
Normalized fan-out from each output, N	High logic level			20	
	Low logic level			20	
Operating free-air temperature, T_A		−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC}=MIN,	I_I=−18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC}=MIN,	I_{OH}=−400 μA	V_{IL}=0.7 V	2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC}=MIN,	V_{IH}=2 V	I_{OL}=4 mA		0.25	0.4	V
				I_{OL}=8 mA		0.3	0.45	V
I_I	Input current at maximum input voltage	V_{CC}=MAX,	V_I=7.0 V				0.1	mA
I_{IH}	High-level input current	V_{CC}=MAX,	V_I=2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC}=MAX,	V_I=0.4 V				−0.36	mA
I_{OS}	Short-circuit output current§	V_{CC}=MAX			−15		−100	mA
I_{CCH}	Supply current, outputs high (average per gate)	V_{CC}=MAX,	All inputs at 0 V	LS00,04,10,20		0.2	0.4	mA
				LS30		0.35	0.5	
I_{CCL}	Supply current, outputs low (average per gate)	V_{CC} = MAX,	All inputs at 4.5 V			0.6	1.1	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC}=5 V, T_A=25°C.
§Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

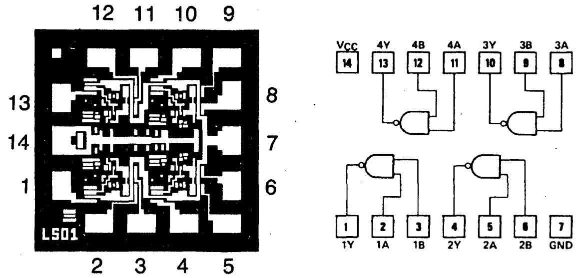
Parameter	Test Conditions		Min	Typ	Max	Unit
Propagation delay time, low-to-high-level output	C_L = 15 pF, R_L = 2 kΩ	LS00,04,10, 20	3.0	5.0	10	ns
		LS30	4.0	7.0	12	
t_{PHL} Propagation delay time high-to-low-level output	See Fig. A on page 373	LS00,04,10,	3.0	5.0	10	ns
		LS20	4.0	8.0	12	
		LS30	6.0	13	20	

54LS01 54LS03 54LS05 54LS12 54LS22

Positive-NAND Gates, Hex Inverters With Open-Collector Outputs

PIN-OUT AND LOGIC DIAGRAMS

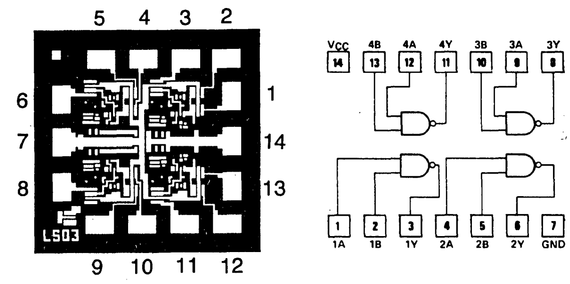
54LS01
QUADRUPLE 2-INPUT NAND GATE



positive logic: Y = $\overline{AB}$

Die Size .047 x .048

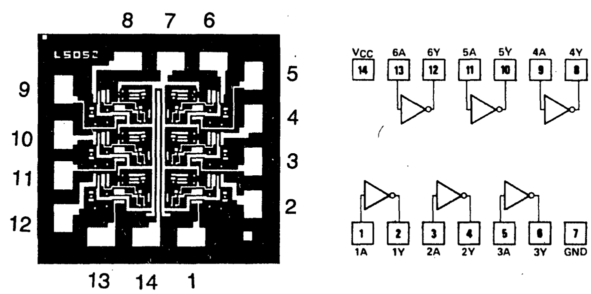
54LS03
QUADRUPLE 2-INPUT NAND GATE



positive logic: Y = $\overline{AB}$

Die Size .047 x .048

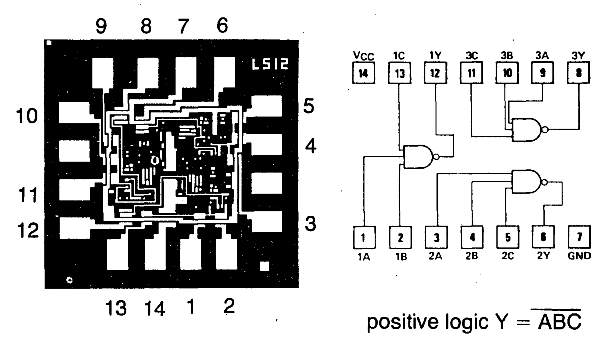
54LS05
HEX INVERTER



positive logic: Y = $\overline{A}$

Die Size .048 x .051

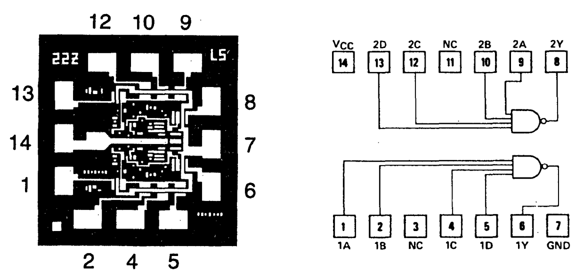
54LS12
TRIPLE 3-INPUT NAND GATE



positive logic Y = $\overline{ABC}$

Die Size .052 x .054

54LS22
DUAL 4-INPUT NAND GATE



positive logic: Y = $\overline{ABCD}$

Die Size .042 x .044

NC—No internal connection

Positive-NAND Gates, Hex Inverters With Open-Collector Outputs

54LS01 54LS03 54LS05 54LS12 54LS22

DIGITAL

Raytheon Semiconductor

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC} (See Note 1)	4.5	5	5.5	V
High-level output voltage, V_{OH}			5.5	V
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

NOTE 1: Voltage values are with respect to network ground terminal.

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA				−1.5	V
I_{OH}	High-level output current	V_{CC} = MIN,	V_{OH} = 5.5 V	V_{IL} = 0.7 V			100	μA
V_{OL}	Low-level output voltage	V_{CC} = MIN,	V_{IH} = 2 V	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7.0 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.36	mA
I_{CCH}	Supply current, outputs high (average per gate)	V_{CC} = MAX,	All inputs at 0 V			0.2	0.4	mA
I_{CCL}	Supply current, outputs low (average per gate)	V_{CC} = MAX,	All inputs at 4.5 V			0.6	1.1	mA

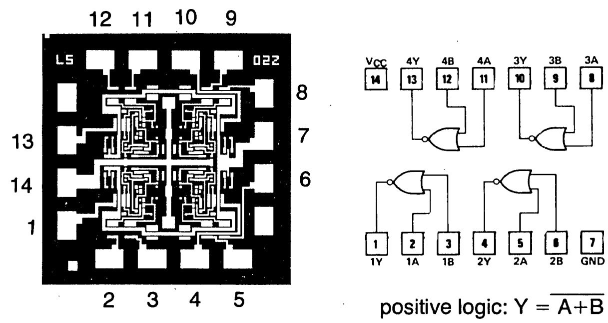
†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter	Test Conditions		Min	Typ	Max	Unit
t_{PLH} Propagation delay time, low-to-high-level output	C_L = 15 pF, R_L = 2 kΩ, See Fig. B on page 373	All Types	7.0	14	22	ns
t_{PHL} Propagation delay time, high-to-low-level output		All Types	4.0	10	18	ns

PIN-OUT AND LOGIC DIAGRAMS

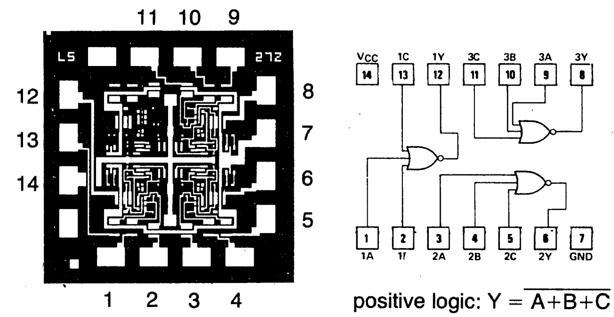
54LS02
QUADRUPLE 2-INPUT NOR GATE



positive logic: $Y = \overline{A+B}$

Die Size .053 x .053

54LS27
TRIPLE 3-INPUT NOR GATE



positive logic: $Y = \overline{A+B+C}$

Die Size .053 x .053

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
Normalized fan-out from each output, N	High logic level			20	
	Low logic level			20	
Operating free-air temperature, T_A		−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	$I_I = -18$ mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN,	$I_{OH} = -400$ μA	$V_{IL} = 0.7$ V	2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN,	$V_{IH} = 2$ V	$I_{OL} = 4$ mA		0.25	0.4	V
				$I_{OL} = 8$ mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	$V_I = 7$ V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	$V_I = 2.7$ V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	$V_I = 0.4$ V				−0.36	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−15		−100	mA
I_{CCH}	Supply current, outputs high (Total)	V_{CC} = MAX,	All inputs at 0 V	LS02		1.6	3.2	mA
				LS27		2.0	4.0	
I_{CCL}	Supply current, outputs low (Total)	V_{CC} = MAX,	All inputs at 5 V	LS02		2.8	5.4	mA
				LS027		3.4	6.8	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
‡All typical values are at $V_{CC} = 5$ V, $T_A = 25°C$.
§Not more than one output should be shorted at a time.

Switching Characteristics, $V_{CC} = 5$ V, $T_A = 25°C$

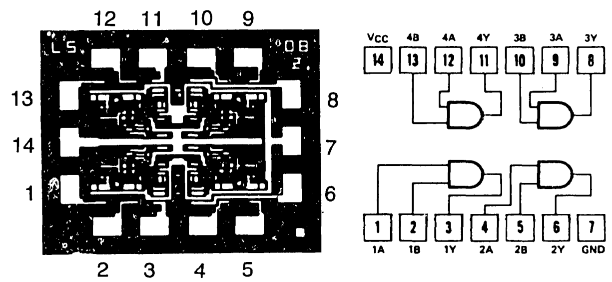
Parameter		Test Conditions	Min	Typ	Max	Unit
t_{PLH}	Propagation delay time, low-to-high-level output	$C_L = 15$ pF, $R_L = 2$ kΩ,	3.0	6.0	10	ns
t_{PHL}	Propagation delay time, high-to-low-level output	See Fig. A on page 373	3.0	5.0	10	ns

Positive-AND Gates

54LS08 54LS11 54LS21

PIN-OUT AND LOGIC DIAGRAMS

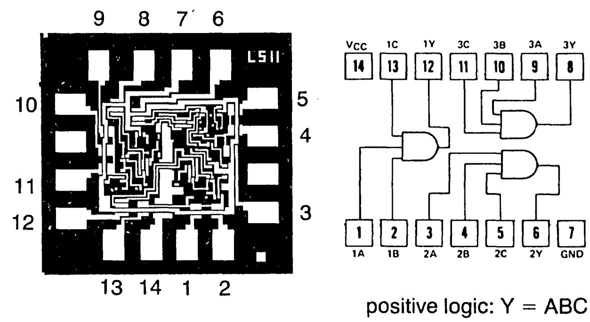
54LS08
QUADRUPLE 2-INPUT AND GATES



positive logic: Y = AB

Die Size .045 x .056

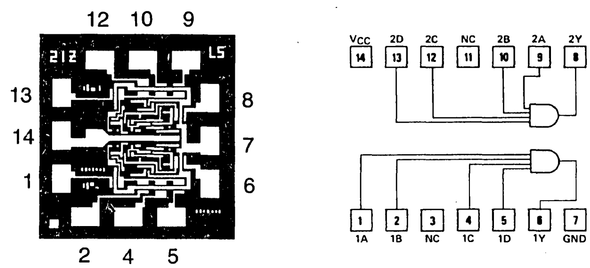
54LS11
TRIPLE 3-INPUT AND GATES



positive logic: Y = ABC

Die Size .052 x .054

54LS21
DUAL 4-INPUT AND GATES



positive logic: Y = ABCD

Die Size .042 x .044

NC—No internal connection

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
Normalized fan-out from each output, N	High logic level			20	
	Low logic level			20	
Operating free-air temperature, T_A		−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN,	I_{OH} = −400 μA	V_{IH} = 2.0 V	2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN,	V_{IL} = V_{IL}MAX	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7.0 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.36	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−15		−100	mA
I_{CCH}	Supply current, outputs high (average per gate)	V_{CC} = MAX,	All inputs at 4.5 V			0.6	1.2	mA
I_{CCL}	Supply current, outputs low (average per gate)	V_{CC} = MAX,	All inputs at 0 V			1.1	2.2	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

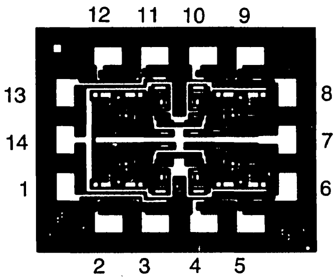
Parameter	Test Conditions		Min	Typ	Max	Unit
t_{PLH} Propagation delay time, low-to-high-level output	C_L = 15 pF	LS08, 11	4.0	8.5	13	ns
	R_L = 2 kΩ	LS21	5.0	10	15	
t_{PHL} Propagation delay time, high-to-low-level output	See Fig. A on page 373	LS08, 11	3.0	7.5	11	ns
		LS21	4.0	8.0	12	

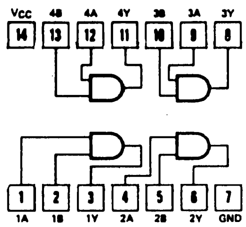
Positive-AND Gates With Open-Collector Outputs

54LS09 54LS15

PIN-OUT AND LOGIC DIAGRAMS

54LS09
QUADRUPLE 2-INPUT AND GATES

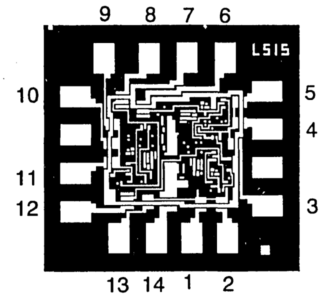


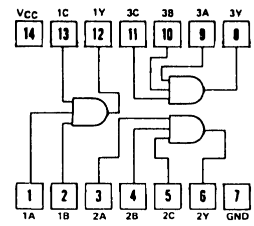


positive logic: Y = AB

Die Size .045 x .056

54LS15
TRIPLE 3-INPUT AND GATES





positive logic: Y = ABC

Die Size .052 x .054

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC} (See Note 1)	4.5	5	5.5	V
High-level output voltage, V_{OH}			5.5	V
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

NOTE 1: Voltage values are with respect to network ground terminal.

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	$I_I = -18$ mA				−1.5	V
I_{OH}	High-level output current	V_{CC} = MIN,	$V_{OH} = 5.5$ V	$V_{IH} = 2.0$ V			100	μA
V_{OL}	Low-level output voltage	V_{CC} = MIN,	$V_{IL} = V_{IL}$ MAX	$I_{OL} = 4$ mA		0.25	0.4	V
				$I_{OL} = 8$ mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	$V_I = 7.0$ V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	$V_I = 2.7$ V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	$V_I = 0.4$ V				−0.36	mA
I_{CCH}	Supply current, outputs high (average per gate)	V_{CC} = MAX,	All inputs at 4.5 V			0.6	1.2	mA
I_{CCL}	Supply current, outputs low (average per gate)	V_{CC} = MAX,	All inputs at 0 V			1.1	2.2	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at $V_{CC} = 5$ V, $T_A = 25°C$.

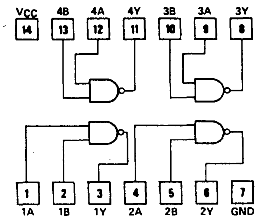
Switching Characteristics, $V_{CC} = 5$ V, $T_A = 25°C$

Parameter	Test Conditions		Min	Typ	Max	Unit
t_{PLH} Propagation delay time, low-to-high-level output	$C_L = 15$ pF, $R_L = 2$ kΩ	All Types	7.0	13	20	ns
t_{PHL} Propagation delay time, high-to-low-level output	See Fig. B on page 373	All Types	5.0	10	15	ns

54LS26

Quadruple 2-Input High-Voltage Positive-NAND Gate

PIN-OUT AND LOGIC DIAGRAM
(OPEN-COLLECTOR OUTPUTS)



positive logic: $Y = \overline{AB}$

For chip layout, see 54LS03

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC} (See Note 1)	4.5	5	5.5	V
High-level output voltage, V_{OH}			15	V
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

NOTE 1: Voltage values are with respect to network ground terminal.

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	$I_I = -18$ mA				−1.5	V
I_{OH}	High-level output current	V_{CC} = MIN,	$V_{IL} = V_{IL}$ max	$V_{OH} = 12$ V			50	μA
				$V_{OH} = 15$ V			1	mA
V_{OL}	Low-level output voltage	V_{CC} = MIN,	$V_{IH} = 2$ V	$I_{OL} = 4$ mA		0.25	0.4	V
				$I_{OL} = 8$ mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	$V_I = 7$ V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	$V_I = 2.7$ V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	$V_I = 0.4$ V				−0.36	mA
I_{CCH}	Supply current, outputs high	V_{CC} = MAX,	All inputs at 0 V			0.8	1.6	mA
I_{CCL}	Supply current, outputs low	V_{CC} = MAX,	All inputs at 4.5 V			2.4	4.4	mA

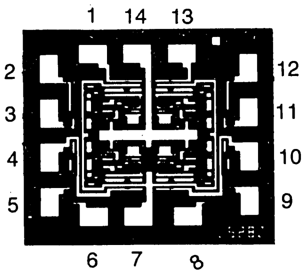
†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.

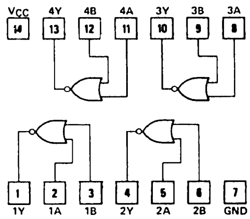
Switching Characteristics, V_{CC} = 5 V, T_A = 25°C.

Parameter		Test Conditions	Min	Typ	Max	Unit
t_{PLH}	Propagation delay time, low-to-high-level output	C_L=15 pF, R_L=2 kΩ	7.0	14	22	ns
t_{PHL}	Propagation delay time, high-to-low-level output	See Fig. B on page 373	4.0	10	18	ns

PIN-OUT AND LOGIC DIAGRAMS

54LS28
QUADRUPLE 2-INPUT NOR BUFFER

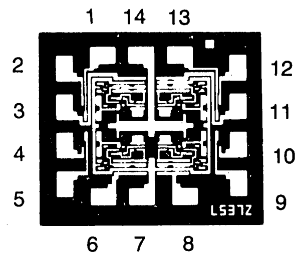


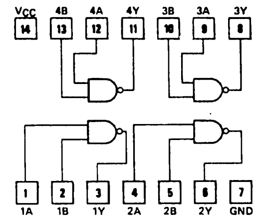


positive logic: $Y = \overline{A+B}$

Die Size .045 x .052

54LS37
QUADRUPLE 2-INPUT NAND BUFFER

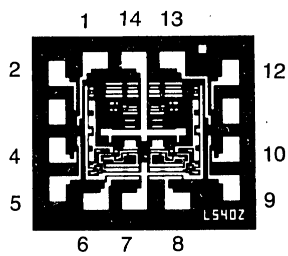


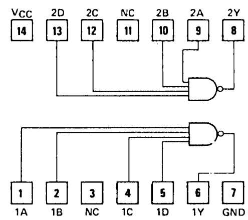


positive logic: $Y = \overline{AB}$

Die Size .045 x .052

54LS40
DUAL 4-INPUT NAND BUFFER





positive logic: $Y = \overline{ABCD}$

Die Size .045 x .052

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
Normalized fan-out from each output, N	High logic level			60	
	Low logic level			60	
Operating free-air temperature, T_A		−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN,	I_{OH} = −1.2 mA	V_{IL} = 0.7 V	2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN,	V_{IH} = 2 V	I_{OL} = 12 mA		0.25	0.4	V
				I_{OL} = 22 mA		0.35	0.5	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.36	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−30		−100	mA
I_{CCH}	Supply current, outputs high (average per gate)	V_{CC} = MAX,	All inputs at 0 V	LS28		0.45	0.9	mA
				LS37,40		0.23	0.5	
I_{CCL}	Supply current, outputs low (average per gate)	V_{CC} = MAX,	All inputs at 5 V	LS28		1.7	3.45	mA
				LS37,40		1.5	3.0	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

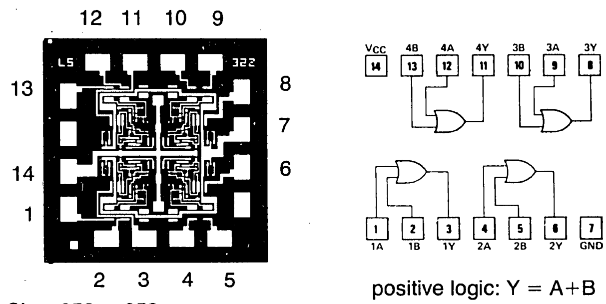
Parameter		Test Conditions	Min	Typ	Max	Unit
t_{PLH}	Propagation delay time, low-to-high-level output	C_L = 45 pF, R_L = 667Ω	4.0	6	12	ns
t_{PHL}	Propagation delay time, high-to-low-level output	See Fig. A on page 373	4.0	7	14	ns

Quadruple 2-Input Positive-OR Gate

54LS32

PIN-OUT AND LOGIC DIAGRAM

QUADRUPLE 2-INPUT OR GATE



Die Size .053 x .053

positive logic: Y = A+B

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
Normalized fan-out from each output, N	High logic level			20	
	Low logic level			20	
Operating free-air temperature, T_A		−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN,	I_{OH} = −400 μA	V_{IL} = 0.7 V	2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN,	V_{IH} = 2 V	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I= 0.4 V				−0.36	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−15		−100	mA
I_{CCH}	Supply current, outputs high (Total)	V_{CC} = MAX,	All inputs at 5 V			3.1	6.2	mA
I_{CCL}	Supply current, outputs low (Total)	V_{CC} = MAX,	All inputs at 0 V			4.9	9.8	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
‡All typical values are at V_{CC} = 5 V, T_A= 25°C.
§Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C.

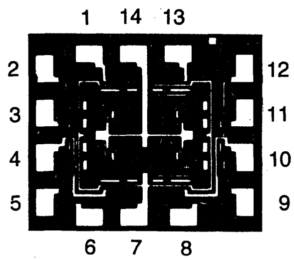
Parameter		Test Conditions	Min	Typ	Max	Unit
t_{PLH}	Propagation delay time, low-to-high-level output	C_L = 15 pF, R_L = 2 kΩ,	3.0	7.0	11	ns
t_{PHL}	Propagation delay time, high-to-low-level output	See Fig. A on Page 373	3.0	7.0	11	ns

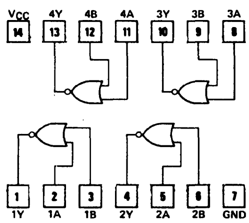
54LS33 54LS38

NOR, NAND Buffers With Open-Collector Outputs

PIN-OUT AND LOGIC DIAGRAMS

54LS33
QUADRUPLE 2-INPUT NOR BUFFER

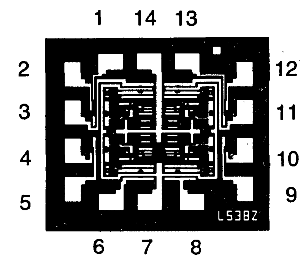


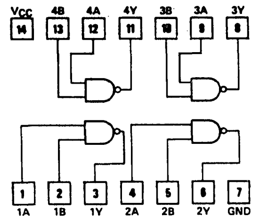


Die Size .045 x .052

positive logic: $Y = \overline{A+B}$

54LS38
QUADRUPLE 2-INPUT NAND BUFFER





Die Size .045 x .052

positive logic: $Y = \overline{AB}$

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC} (see Note 1)	4.5	5	5.5	V
High-level output voltage, V_{OH}			5.5	V
Low-level output current, I_{OL}			22	mA
Operating free-air temperature, T_A	−55		125	°C

NOTE 1: Voltage values are with respect to network ground terminal.

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	$I_I = -18$ mA				−1.5	V
I_{OH}	High-level output current	V_{CC} = MIN,	$V_{IL} = V_{IL}$max	$V_{OH} = 5.5$ V			250	μA
V_{OL}	Low-level output voltage	V_{CC} = MIN,	$V_{IH} = 2$ V	$I_{OL} = 12$ mA		0.25	0.4	V
				$I_{OL} = 22$ mA		0.35	0.5	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	$V_I = 7$ V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	$V_I = 2.7$ V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	$V_I = 0.4$ V				−0.36	mA
I_{CCH}	Supply current, outputs high (Total)	V_{CC} = MAX,	All inputs at 0 V	LS33		1.8	3.6	mA
				LS38		0.9	2.0	
I_{CCL}	Supply current, outputs low (Total)	V_{CC} = MAX,	All inputs at 4.5 V	LS33		6.9	13.8	mA
				LS38		6.0	12.0	

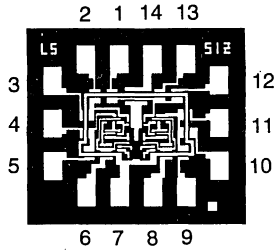
†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
‡All typical values are at $V_{CC} = 5$ V, $T_A = 25$°C.

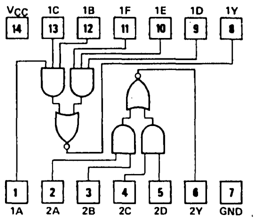
Switching Characteristics, $V_{CC} = 5$ V, $T_A = 25$°C

Parameter		Test Conditions	Min	Typ	Max	Unit
t_{PLH}	Propagation delay time, low-to-high-level output	$C_L = 45$ pF, $R_L = 667\Omega$	7.0	17	25	ns
t_{PHL}	Propagation delay time, high-to-low-level output	See Fig. B on page 373	4.0	9	16	ns

PIN-OUT AND LOGIC DIAGRAMS

54LS51
DUAL 2-WIDE AOI GATE





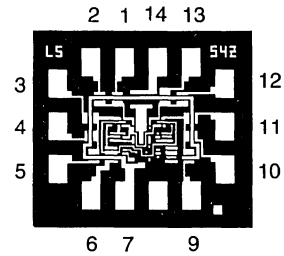
positive logic:

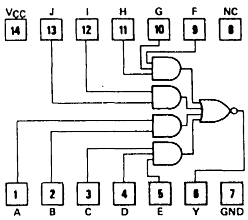
$1Y = \overline{(1A \cdot 1B \cdot 1C) + (1D \cdot 1E \cdot 1F)}$

$2Y = \overline{(2A \cdot 2B) + (2C \cdot 2D)}$

Die Size .041 x .046

54LS54
4-WIDE 2-3-3-2-INPUT AOI GATE



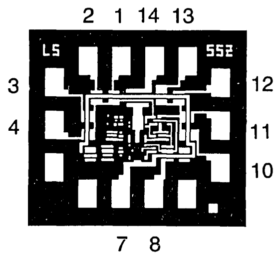


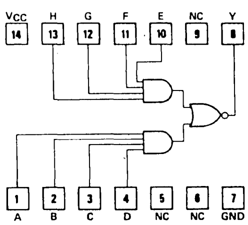
positive logic:

$Y = \overline{(AB) + (CDE) + (FGH) + (IJ)}$

Die Size .041 x .046

54LS55
2-WIDE 4-INPUT AOI GATE





positive logic:

$Y = \overline{(ABCD) + (EFGH)}$

Die Size .041 x .046

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
Normalized fan-out from each output, N	High logic level			20	
	Low logic level			20	
Operating free-air temperature, T_A		−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	$I_I = -18$ mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN,	$I_{OH} = -400\ \mu A$	V_{IL} = 0.7 V	2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN,	V_{IH} = 2 V	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.36	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−15		−100	mA
I_{CCH}	Supply current, output high (Total)	V_{CC} = MAX,	See Note 1	LS51		0.8	1.6	mA
				LS54		0.8	1.6	
				LS55		0.4	0.8	
I_{CCL}	Supply current, output low (Total)	V_{CC} = MAX,	See Note 2	LS51		1.4	2.8	mA
				LS54		1.0	2.0	
				LS55		0.7	1.3	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

NOTES:
1. I_{CCH} is measured with all inputs grounded, and the outputs open.
2. I_{CCL} is measured with all inputs of one gate at 5 V, the remaining inputs grounded, and the outputs open.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C.

Parameter		Test Conditions	Min	Typ	Max	Unit
t_{PLH}	Propagation delay time, low-to-high-level output	C_L = 15 pF, R_L = 2 kΩ,	3.0	8.0	13	ns
t_{PHL}	Propagation delay time, high-to-low-level output	See Fig. A on page 373	3.0	8.0	13	ns

Dual J-K Negative-Edge-Triggered Flip-Flops

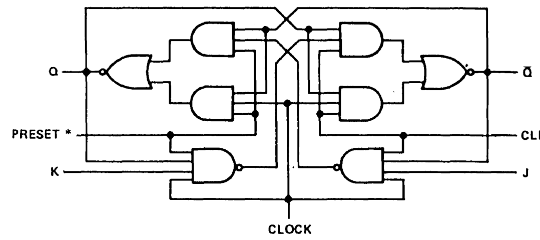
54LS73 54LS76 54LS107 54LS112 54LS113

•Pin-for-Pin and functional equivalents to 5473, 5476, 54107, 54S112, 54S113

DESCRIPTION

These monolithic dual J-K flip-flops feature individual J, K, clock, and asynchronous preset and clear inputs to each flip-flop. The preset or clear inputs, when low, set or reset the outputs regardless of the levels at the other inputs. When preset and clear inputs are inactive (high), a high level at the clock input enables the J and K inputs and data will be accepted. The logic levels at the J and K inputs may be allowed to change when the clock pulse is high and the bistable will perform according to the function table as long as minimum setup and hold times are observed. Input data is transferred to the outputs on the negative-going edge of the clock pulse.

LOGIC DIAGRAM (½)



*	PRESET	CLEAR
LS73		X
LS76	X	X
LS107		X
LS112	X	X
LS113	X	

54LS73, 54LS107 FUNCTION TABLE (EACH FLIP-FLOP)

INPUTS				OUTPUTS	
CLEAR	CLOCK	J	K	Q	$\bar{Q}$
L	X	X	X	L	H
H	↓	L	L	Q_0	$\bar{Q}_0$
H	↓	H	L	H	L
H	↓	L	H	L	H
H	↓	H	H	TOGGLE	
H	H	X	X	Q_0	$\bar{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↓ = transition from high to low level
Q_0 = the level of Q before the indicated input conditions were established.
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.

54LS76, 54LS112 FUNCTION TABLE (EACH FLIP-FLOP)

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	K	Q	$\bar{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↓	L	L	Q_0	$\bar{Q}_0$
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	TOGGLE	
H	H	H	X	X	Q_0	$\bar{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.
*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

54LS113 FUNCTION TABLE (EACH FLIP-FLOP)

INPUTS				OUTPUTS	
PRESET	CLOCK	J	K	Q	$\bar{Q}$
L	X	X	X	H	L
H	↓	L	L	Q_0	$\bar{Q}_0$
H	↓	H	L	H	L
H	↓	L	H	L	H
H	↓	H	H	TOGGLE	
H	H	X	X	Q_0	$\bar{Q}_0$

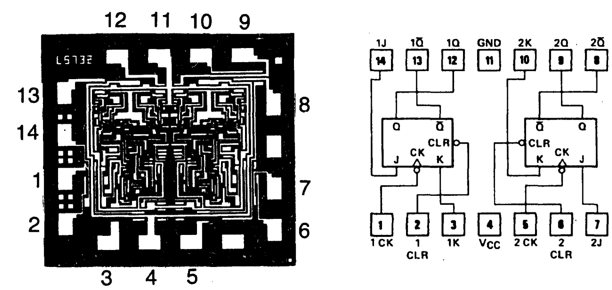
H = high level (steady state)
L = low level (steady state)
X = irrelevant
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
TOGGLE: Each output changes to the complement of its previous level of each ↓ clock transition.

54LS73 54LS76 54LS107 54LS112 54LS113

Dual J-K Negative-Edge-Triggered Flip-Flops

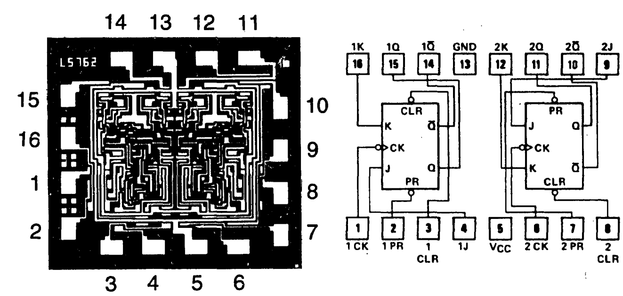
PIN-OUT DIAGRAMS

54LS73



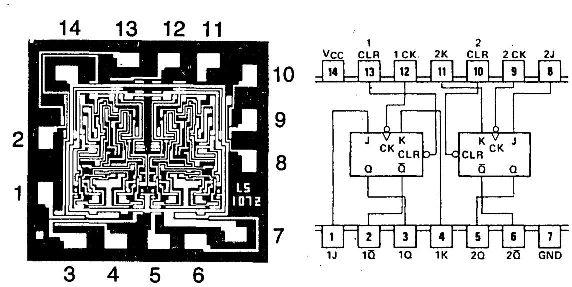
Die Size .060 x .066

54LS76



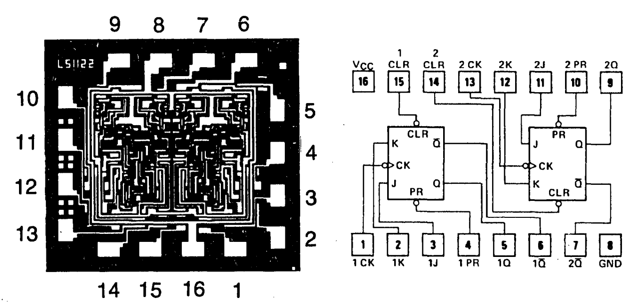
Die Size .060 x .066

54LS107



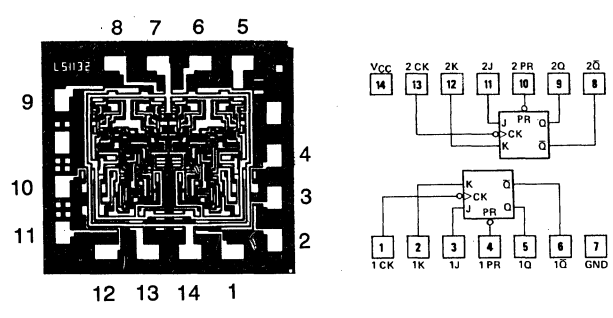
Die Size .060 x .066

54LS112



Die Size .060 x .066

54LS113



Die Size .060 x .066

Dual J-K Negative-Edge-Triggered Flip-Flops

54LS73 54LS76 54LS107 54LS112 54LS113

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
Normalized fan-out from each output, N	High logic level			20	
	Low logic level			20	
Clock frequency, f_{clock}		0		35	MHz
Width of clock pulse, $t_{w(clock)}$ (High)		15			ns
Width of preset pulse, $t_{w(preset)}$ (Low)		15			ns
Width of clear pulse, $t_{w(clear)}$ (Low)		15			ns
Input setup time, t_{setup}		15			ns
Input hold time, t_{hold}		0			ns
Operating free-air temperature, T_A		−55		125	°C

t_{setup} is the minimum time required for the correct logic level to be present at the J or K input prior to the falling edge of the clock in order to be recognized and transferred to the outputs.
t_{hold} is the minimum time required for the logic level to be maintained at the J or K input after the falling edge of the clock in order to insure recognition. These devices require no hold time.

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter			Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage					2			V
V_{IL}	Low-level input voltage							0.7	V
V_I	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, $V_{IL} = V_{IL}$max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN,	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
			$V_{IL} = V_{IL}$max		I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	J or K	V_{CC} = MAX,	V_I = 7 V				0.1	mA
		Clock						0.4	
		Preset or Clear						0.3	
I_{IH}	High-level input current	J or K	V_{CC} = MAX,	V_I = 2.7 V				20	μA
		Clock						80	
		Preset or Clear						60	
I_{IL}	Low-level input current	J or K	V_{CC} = MAX,	V_I = 0.4 V				−0.36	mA
		Clock						−0.72	
		Preset or Clear						−0.8	
I_{OS}	Short-circuit output current§		V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 1			4	8	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE 1:
I_{CC} is measured with outputs open, with clock, J, K, and clear grounded and preset at 4.5 V; then with clock, J, K, and preset grounded and clear at 4.5 V.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter		Test Conditions	Min	Typ	Max	Unit
f_{max}	Maximum clock frequency	C_L = 15 pF, R_L = 2 kΩ, See Fig. A on page 373	35	50		MHz
t_{PLH}	Propagation delay time, low-to-high-level output from clear or preset			9	16	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear or preset			11	20	ns
t_{PLH}	Propagation delay time, low-to-high-level output from clock			9	16	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock			11	20	ns

54LS74

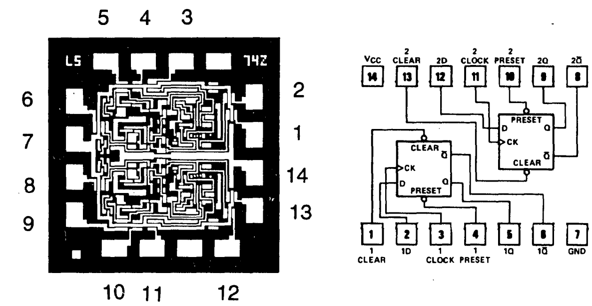
Dual D-Type Positive-Edge-Triggered Flip-Flop

DESCRIPTION

This monolithic dual edge-triggered D-type flip-flop features individual D, clock, preset, and clear inputs.

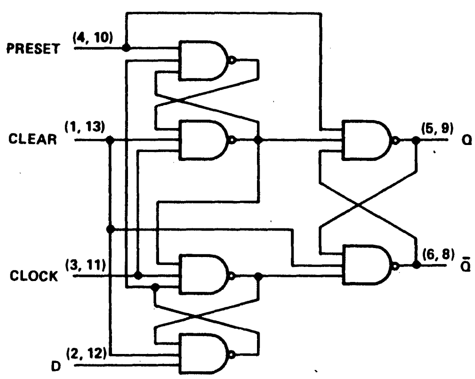
Preset and clear inputs are active-low and operate independently of the clock input. When preset and clear are inactive (high), information at the D input is transferred to the Q output on the positive-going edge of the clock pulse. Clock triggering occurs at a voltage level of the clock pulse and is not directly related to the transition time of the positive-going pulse. When the clock input is at either the high or low level, the D-input signal has no effect at the output.

PIN-OUT DIAGRAM



Die Size .055 x .056

LOGIC DIAGRAM (½)



FUNCTION TABLE (EACH FLIP-FLOP)

INPUTS				OUTPUTS	
PRESET	CLEAR	CLOCK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H*	H*
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q_0	$\overline{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↑ = transition from low to high level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
Normalized fan-out from each output, N	High logic level			20	
	Low logic level			20	
Clock frequency, f_{clock}		0		30	MHz
Width of clock pulse, $t_{w(clock)}$ (High)		17			ns
Width of preset pulse, $t_{w(preset)}$ (Low)		15			ns
Width of clear pulse, $t_{w(clear)}$ (Low)		15			ns
Input setup time, t_{setup}	High-level data	10			ns
	Low-level data	10			
Input hold time, t_{hold}		0			ns
Operating free-air temperature, T_A		−55		125	°C

t_{setup} is the minimum time required for the correct logic level to be present at the D input prior to the rising edge of the clock in order to be recognized and transferred to the outputs.
t_{hold} is the minimum time required for the logic level to be maintained at the D input after the rising edge of the clock in order to insure recognition. This device requires no hold time.

Dual D-Type Positive-Edge-Triggered Flip-Flop

54LS74

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter			Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage					2			V
V_{IL}	Low-level input voltage							0.7	V
V_I	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL} max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL}max	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
					I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	D input	V_{CC} = MAX,	V_I = 5.5 V				0.1	mA
		Clock or preset						0.2	
		Clear						0.3	
I_{IH}	High-level input current	D input	V_{CC} = MAX,	V_I = 2.7 V				20	μA
		Clock or preset						40	
		Clear						60	
I_{IL}	Low-level input current	D input	V_{CC} = MAX,	V_I = 0.4 V				−0.4	mA
		Clock or preset						−0.8	
		Clear						−1.2	
I_{OS}	Short-circuit output current§		V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 1			4	8	mA

For condition shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE 1:
I_{CC} is measured with outputs open with D, clock, and preset grounded; then with D, clock, and clear grounded.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter			Test Conditions	Min	Typ	Max	Unit
f_{max}	Maximum clock frequency		C_L = 15 pF, R_L = 2 kΩ, See Fig. A on page 373	30	45		MHz
t_{PLH}	Propagation delay time, low-to-high-level output from clear or preset				10	15	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear or preset	CK Low			18	24	ns
		CK High			26	35	
t_{PLH}	Propagation delay time, low-to-high-level output from clock				12	18	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock				14	22	ns

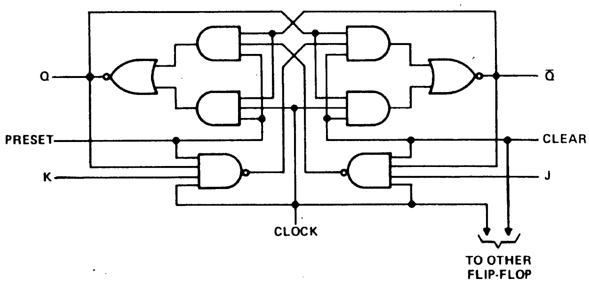
Dual J-K Negative-Edge-Triggered Flip-Flops

54LS78 54LS114

DESCRIPTION

These monolithic dual J-K edge-triggered flip-flops feature individual J, K, and preset inputs plus common clock and common clear inputs. The preset or clear inputs, when low, set or reset the outputs regardless of the levels at the other inputs. When preset and clear inputs are inactive (high), a high level at the clock input enables the J and K inputs and data will be accepted. The logic levels at the J and K inputs may be allowed to change when the clock pulse is high and the bistable will perform according to the function table as long as minimum setup and hold times are observed. Input data is transferred to the outputs on the negative-going edge of the clock pulse.

LOGIC DIAGRAM (½)

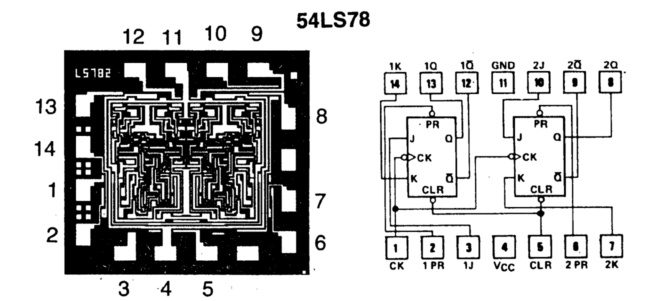


FUNCTION TABLE (EACH FLIP-FLOP)

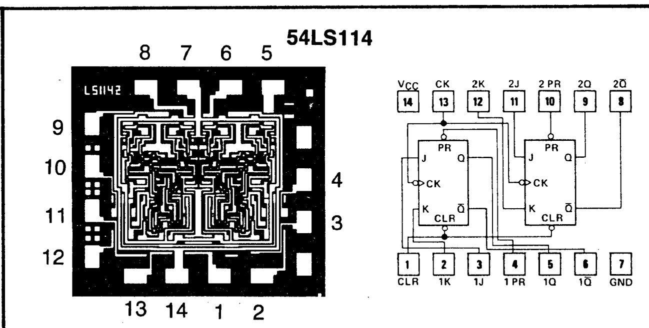
INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	K	Q	$\bar{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↓	L	L	Q_0	$\bar{Q}_0$
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	TOGGLE	
H	H	H	X	X	Q_0	$\bar{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.
*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

PIN-OUT DIAGRAMS



Die Size .060 x .066



Die Size .060 x .066

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
Normalized fan-out from each output, N	High logic level			20	
	Low logic level			20	
Clock frequency, f_{clock}		0		35	MHz
Width of clock pulse, $t_{w(clock)}$ (High)		15			ns
Width of preset pulse, $t_{w(preset)}$ (Low)		15			ns
Width of clear pulse, $t_{w(clear)}$ (Low)		15			ns
Input setup time, t_{setup}		15			ns
Input hold time, t_{hold}		0			ns
Operating free-air temperature, T_A		−55		125	°C

t_{setup} is the minimum time required for the correct logic level to be present at the J or K input prior to the falling edge of the clock in order to be recognized and transferred to the outputs.
t_{hold} is the minimum time required for the logic level to be maintained at the J or K input after the falling edge of the clock in order to insure recognition. These devices require no hold time.

Dual J-K Negative-Edge-Triggered Flip-Flops

54LS78 54LS114

DIGITAL

Raytheon Semiconductor

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter			Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage					2			V
V_{IL}	Low-level input voltage							0.7	V
V_I	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{CC} = V_{IL}max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN,	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
			V_{IL} = V_{IL}max		I_{OL}=8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	J or K	V_{CC} = MAX,	V_I = 7 V				0.1	mA
		Preset						0.3	
		Clear						0.6	
		Clock						0.8	
I_{IH}	High-level input current	J or K	V_{CC} = MAX,	V_I = 2.7 V				20	μA
		Preset						60	
		Clear						120	
		Clock						160	
I_{IL}	Low-level input current	J or K	V_{CC} = MAX,	V_I = 0.4 V				−0.36	mA
		Preset						−0.8	
		Clear						−1.6	
		Clock						−1.44	
I_{OS}	Short-circuit output current§		V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 1			4	8	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

NOTE 1:
I_{CC} is measured with outputs open, with clock, J, K, and clear grounded and preset at 4.5 V; then with clock, J, K, and preset grounded and clear at 4.5 V.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C.

Parameter		Test Conditions	Min	Typ	Max	Unit
f_{max}	Maximum clock frequency	C_L = 15 pF, R_L = 2 kΩ, See Fig. A on page 373	35	50		MHz
t_{PLH}	Propagation delay time, low-to-high-level output from clear or preset			9	16	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear or preset			11	20	ns
t_{PLH}	Propagation delay time, low-to-high-level output from clock			9	16	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock			11	20	ns

4-Bit Binary Full Adders With Fast Carry

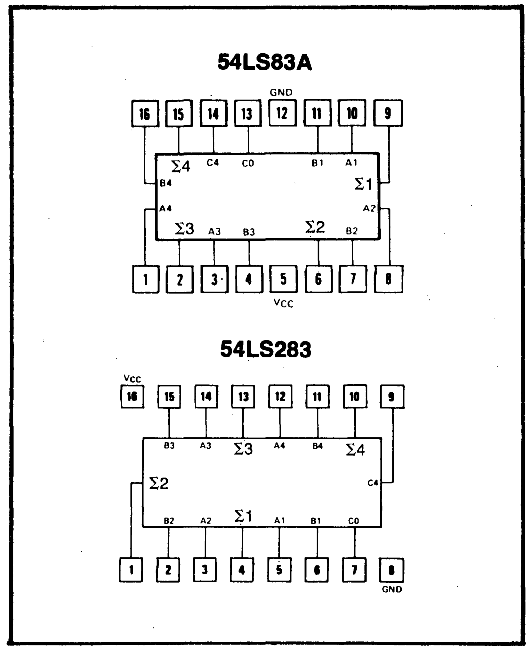
DESCRIPTION

These improved full adders perform the addition of two 4-bit binary numbers. The sum (Σ) outputs are provided for each bit and the resultant carry (C4) is obtained from the fourth bit. These adders feature full internal look ahead across all four bits generating the carry term in ten nanoseconds typically. This provides the system designer with partial look-ahead performance at the economy and reduced package count of a ripple-carry implementation.

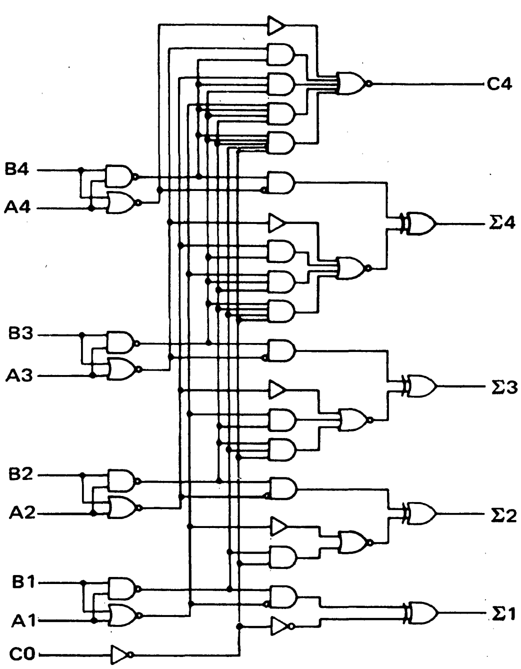
The adder logic, including the carry, is implemented in its true form meaning that the end-around carry can be accomplished without the need for logic or level inversion.

The 54LS83A and the 54LS283 are identical in performance; only the pin-out is different. They are designed to replace the 5483A and the 54283 respectively. The 54LS283 is recommended for new designs; V_{CC} and ground on corner pins simplify board layout.

PIN-OUT DIAGRAMS



LOGIC DIAGRAM



FUNCTION TABLE

INPUT				OUTPUT					
				WHEN C0 = L		WHEN C2 = L	WHEN C0 = H		WHEN C2 = H
A1 / A3	B1 / B3	A2 / A4	B2 / B4	Σ1 / Σ3	Σ2 / Σ4	C2 / C4	Σ1 / Σ3	Σ2 / Σ4	C2 / C4
L	L	L	L	L	L	L	H	L	L
H	L	L	L	H	L	L	L	H	L
L	H	L	L	H	L	L	L	H	L
H	H	L	L	L	H	L	H	H	L
L	L	H	L	L	H	L	H	H	L
H	L	H	L	H	H	L	L	L	H
L	H	H	L	H	H	L	L	L	H
H	H	H	L	L	L	H	H	L	H
L	L	L	H	L	H	L	H	H	L
H	L	L	H	H	H	L	L	L	H
L	H	L	H	H	H	L	L	L	H
H	H	L	H	L	L	H	H	L	H
L	L	H	H	L	L	H	H	L	H
H	L	H	H	H	L	H	L	H	H
L	H	H	H	H	L	H	L	H	H
H	H	H	H	L	H	H	H	H	H

H = high level, L = low level

NOTE: Input conditions at A1, B1, A2, B2, and C0 are used to determine outputs Σ1 and Σ2 and the value of the internal carry C2. The values at C2, A3, B3, A4, and B4 are then used to determine outputs Σ3, Σ4, and C4.

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−400	μA
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter			Test Conditions†		Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage		V_{CC} = MIN, I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL}max, I_{OH} = −400 μA		2.5	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	Any A or B	V_{CC} = MAX, V_I = 7 V				0.2	mA
		C0					0.1	
I_{IH}	High-level input current	Any A or B	V_{CC} = MAX, V_I = 2.7 V				40	μA
		C0					20	
I_{IL}	Low-level input current	Any A or B	V_{CC} = MAX, V_I = 0.4 V				−0.8	mA
		C0					−0.4	
I_{OS}	Short-circuit output current§		V_{CC} = MAX		−15		−100	mA
I_{CC}	Supply current		V_{CC} = MAX, Outputs open	All inputs grounded		22	39	mA
				All B low, other inputs at 4.5 V		19	34	
				All inputs at 4.5 V		19	34	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Only one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

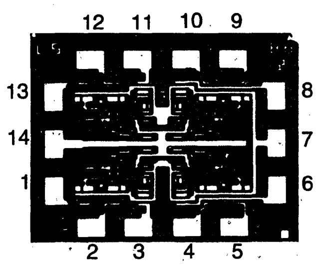
Parameter¶	From (Input)	To (Output)	Test Conditions	Min	Typ	Max	Unit
t_{PLH}	C0	Any Σ	C_L = 15 pF, R_L = 2 kΩ, See Fig. A on page 373			24	ns
t_{PHL}						24	
t_{PLH}	A_i or B_i	Σ_i				24	ns
t_{PHL}						24	
t_{PLH}	C0	C4				17	ns
t_{PHL}						17	
t_{PLH}	A_i or B_i	C4				17	ns
t_{PHL}						17	

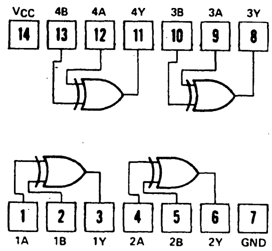
¶t_{PLH} ≡ Propagation delay time, low-to-high-level output
t_{PHL} ≡ Propagation delay time, high-to-low-level output

54LS86 54LS386 Quadruple 2-Input Exclusive-OR Gates

PIN-OUT AND LOGIC DIAGRAMS

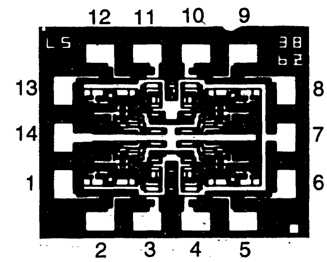
54LS86

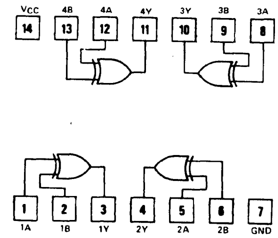




Die Size .045 x .056 positive logic: $Y = A \oplus B = \bar{A}B + A\bar{B}$

54LS386





Die Size .045 x .056 positive logic: $Y = A \oplus B = \bar{A}B + A\bar{B}$

54LS86 and 54LS386 are electrically identical. The 54LS386 is a pin-for-pin replacement for the 54L386.

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−400	μA
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	$I_I = -18$ mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, $V_{IL} = V_{IL}$max,	$V_{IH} = 2$ V, $I_{OH} = -400$ μA		2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, $V_{IL} = V_{IL}$max,	$V_{IH} = 2$ V,	$I_{OL} = 4$ mA		0.25	0.4	V
				$I_{OL} = 8$ mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	$V_I = 7$ V				0.2	mA
I_{IH}	High-level input current	V_{CC} = MAX,	$V_I = 2.7$ V				40	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	$V_I = 0.4$ V				−0.6	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current	V_{CC} = MAX,	See Note 2			6.1	10	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
‡All typical values are at $V_{CC} = 5$ V, $T_A = 25°C$.
§Not more than one output should be shorted at a time.
NOTE 2:
I_{CC} is measured with the inputs grounded and the outputs open.

Switching Characteristics, $V_{CC} = 5$ V, $T_A = 25°C$.

Parameter¶	From (input)	Test Conditions		Min	Typ	Max	Unit
t_{PLH}	A or B	Other input low	$C_L = 15$ pF,				ns
t_{PHL}			$R_L = 2$ kΩ,				
t_{PLH}	A or B	Other input high	See Fig. A				ns
t_{PHL}			on page 373				

¶t_{PLH} ≡ propagation delay time, low-to-high-level output
¶t_{PHL} ≡ propagation delay time, high-to-low-level output

Tenative data, subject to change without notice

4-Bit Bi-Directional, Parallel-Access Shift Register

54LS95B

DESCRIPTION

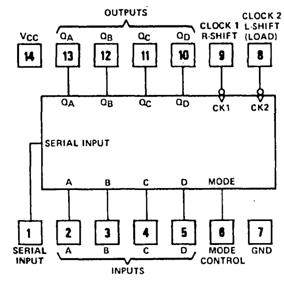
This 4-bit register features parallel and serial inputs, parallel outputs, mode control, and two clock inputs. The register has three modes of operation:

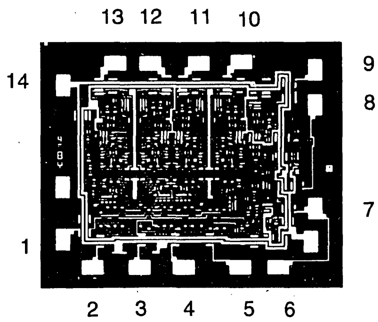
Parallel (broadside) load
Shift right (the direction Q_A toward Q_D)
Shift left (the direction Q_D toward Q_A)

Parallel loading is accomplished by applying the four bits of data and taking the mode control input high. The data is loaded into the associated flip-flops and appears at the outputs after the high-to-low transition of the clock-2 input. During loading, the entry of serial data is inhibited.

Shift right is accomplished on the high-to-low transition of clock 1 when the mode control is low; shift left is accomplished on the high-to-low transition of clock 2 when the mode control is high by connecting the output of each flip-flop to the parallel input of the previous flip-flop (Q_D to input C, etc.) and serial data is entered at input D. The clock input may be applied commonly to clock 1 and clock 2 if both modes can be clocked from the same source. Changes at the mode control input should normally be made while both clock inputs are low; however, conditions described in the last three lines of the function table will also ensure that register contents are protected.

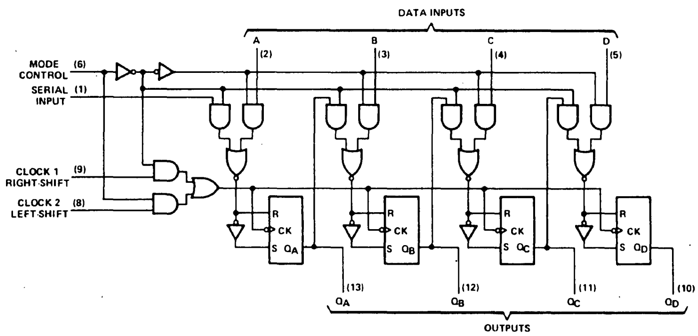
PIN-OUT DIAGRAM





Die Size .067 x .082

LOGIC DIAGRAM



FUNCTION TABLE

INPUTS								OUTPUTS			
MODE CONTROL	CLOCKS 2 (L)	CLOCKS 1 (R)	SERIAL	PARALLEL A	PARALLEL B	PARALLEL C	PARALLEL D	Q_A	Q_B	Q_C	Q_D
H	H	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
H	↓	X	X	a	b	c	d	a	b	c	d
H	↓	X	X	Q_B†	Q_C†	Q_D†	d	Q_{Bn}	Q_{Cn}	Q_{Dn}	d
L	L	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
L	X	↓	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}
L	X	↓	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}
↑	L	L	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↓	L	L	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↓	L	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↑	H	L	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↑	H	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}

†Shifting left requires external connection of Q_B to A, Q_C to B, and Q_D to C. Serial data is entered at input D.

H = high level (steady state), L = low level (steady state), X = irrelevant (any input, including transitions)

↓ = transition from high to low level, ↑ = transition from low to high level

a, b, c, d = the level of steady-state input at input, A, B, C, or D, respectively.

Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established.

Q_{An}, Q_{Bn}, Q_{Cn}, Q_{Dn} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the most-recent ↓ transition of the clock.

54LS95B

4-Bit Bi-Directional, Parallel-Access Shift Register

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−400	μA
Low-level output current, I_{OL}			8	mA
Clock frequency, f_{clock}	0			MHz
Width of clock pulse, $t_{w(clock)}$ (see Figure 1)	25			ns
Setup time, high-level or low-level data, t_{setup} (see Figure 1)	0			ns
Hold time, high-level or low-level data, t_{hold} (see Figure 1)	20			ns
Time to enable clock 1, $t_{enable\ 1}$ (see Figure 2)	20			ns
Time to enable clock 2, $t_{enable\ 2}$ (see Figure 2)	20			ns
Time to inhibit clock 1, $t_{inhibit\ 1}$ (see Figure 2)	10			ns
Time to inhibit clock 2, $t_{inhibit\ 2}$ (see Figure 2)	10			ns
Operating free-air temperature, T_A	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

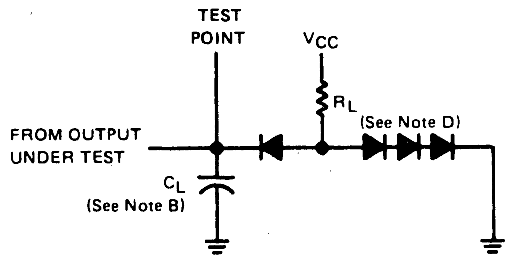
Parameter			Test Conditions†		Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA			−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL} max,	V_{IH} = 2 V, I_{OH} = −400 μA	2.5	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IH} = 2V, V_{IL} = V_{IL} max	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	Clock inputs	V_{CC} = MAX,	V_I = 7 V			0.2	mA
		Other inputs					0.1	
I_{IH}	High-level input current	Clock inputs	V_{CC} = MAX,	V_I = 2.7 V			40	μA
		Other inputs					20	
I_{IL}	Low-level input current	Clock inputs	V_{CC} = MAX,	V_I = 0.4V			−0.8	mA
		Other inputs					−0.4	
I_{OS}	Short-circuit output current§		V_{CC} = MAX		−15		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 1		13	21	mA

†For conditions shown as MIN or MAX, use the appropiate value specified under recommended operating conditions.
‡All typical values are at V_{cc} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE: 1
I_{CC} is measured with all outputs and serial input open; A, B, C, and D inputs grounded; mode control at 4.5 V; and a momentary 3 V, then ground, applied to both clock inputs.

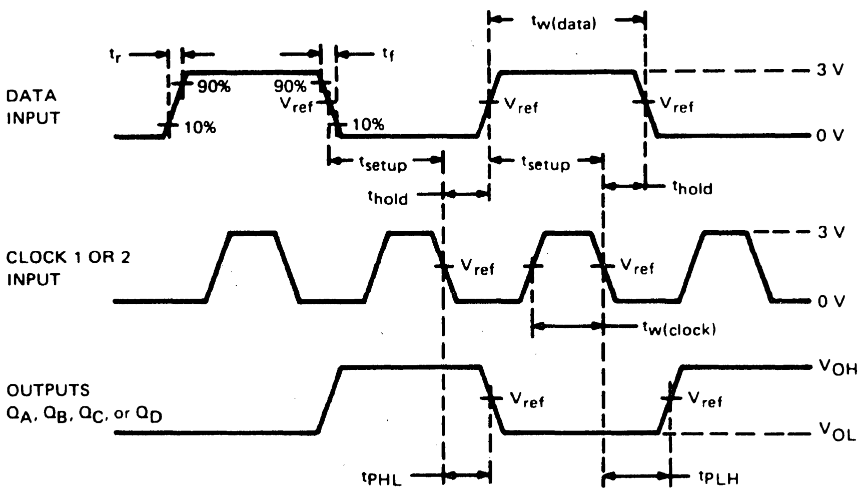
Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter		Test Conditions		Min	Typ	Max	Unit
f_{max}	Maximum clock frequency	C_L = 15 pF,	R_L = 2 kΩ	20	30		MHz
t_{PLH}	Propagation delay time, low-to-high-level output from clock	See Figure 1			27	35	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock				30	40	ns

PARAMETER MEASUREMENT INFORMATION

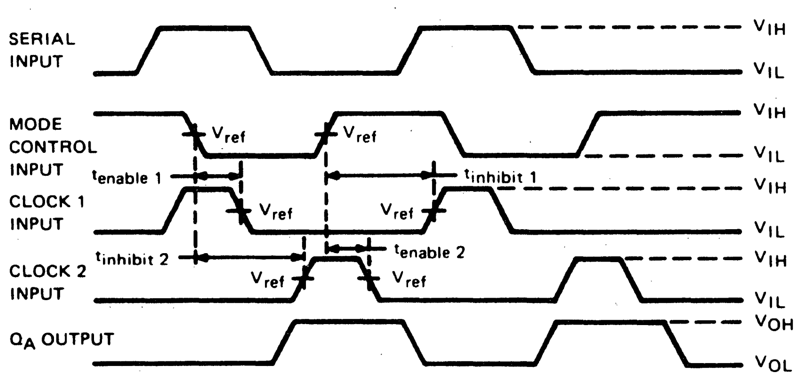


LOAD CIRCUIT



NOTES: A. Input pulses are supplied by a generator having the following characteristics: $t_r \leqslant 10$ ns, $t_f \leqslant 10$ ns, and $Z_{out} \approx 50\ \Omega$. For the data pulse generator, PRR = 500 kHz; for the clock pulse generator, PRR = 1 MHz. When testing f_{max}, vary PRR. $t_{w(data)} \geqslant 20$ ns, $t_{w(clock)} \geqslant 15$ ns.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N916 or 1N3064.
D. V_{ref} = 1.3 V.

VOLTAGE WAVEFORMS
FIGURE 1—SWITCHING TIMES



NOTES: A. Input A is at a low level.
B. V_{ref} = 1.3 V.

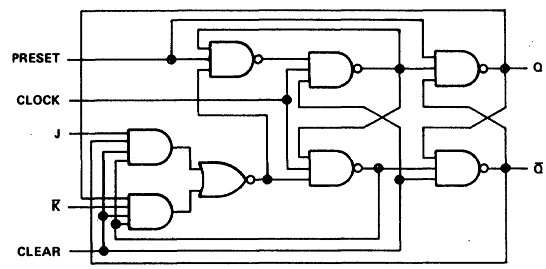
VOLTAGE WAVEFORMS
FIGURE 2—CLOCK ENABLE/INHIBIT TIMES

DESCRIPTION

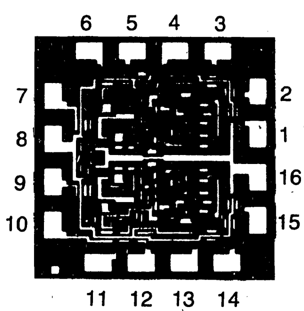
This monolithic dual J-$\bar{K}$ edge-triggered flip-flop features individual J, $\bar{K}$, clock, preset, and clear inputs. A low level at preset or clear sets or resets the outputs regardless of the levels of the other inputs. When preset and clear are inactive (high), data at the J and $\bar{K}$ inputs meeting the setup time requirements are transferred to the outputs on the positive-going edge of the clock pulse. Clock triggering occurs at a voltage level of the clock pulse and is not directly related to the transition time of the positive-going pulse. Following the hold time interval, data at the J and $\bar{K}$ inputs may be changed without affecting the levels at the outputs.

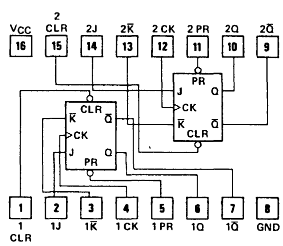
The J and $\bar{K}$ data inputs simplify hardware design as a D-type flip-flop can be implemented by simply tying the J and $\bar{K}$ inputs together.

LOGIC DIAGRAM (½)



PIN-OUT DIAGRAM





positive logic: see function table

Die Size .055 x .056

FUNCTION TABLE (EACH FLIP-FLOP)

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	$\bar{K}$	Q	$\bar{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↑	L	L	L	H
H	H	↑	H	L	TOGGLE	
H	H	↑	L	H	Q_0	$\bar{Q}_0$
H	H	↑	H	H	H	L
H	H	L	X	X	Q_0	$\bar{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↑ = transition from low to high level
Q_0 = the level of Q before the indicated steady-state input conditions were established
TOGGLE: each output changes to the complement of its previous level on each ↑ clock transition.
*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
Normalized fan-out from each output, N	High logic level			20	
	Low logic level			20	
Clock frequency, f_{clock}		0		30	MHz
Width of clock pulse, $t_{w(clock)}$ (High)		17			ns
Width of preset pulse, $t_{w(preset)}$ (Low)		15			ns
Width of clear pulse, $t_{w(clear)}$ (Low)		15			ns
Input setup time, t_{setup}		15			ns
Input hold time, t_{hold}		0			ns
Operating free-air temperature, T_A		−55		125	°C

t_{setup} is the minimum time required for the correct logic level to be present at the J or $\bar{K}$ input prior to the rising edge of the clock in order to be recognized and transferred to the outputs.
t_{hold} is the minimum time required for the logic level to be maintained at the J or $\bar{K}$ input after the clock transition in order to insure recognition. This device requires no hold time.

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter			Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage					2			V
V_{IL}	Low-level input voltage							0.7	V
V_I	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL} max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL}max	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
					I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	J or $\overline{K}$	V_{CC} = MAX,	V_I = 5.5 V				0.1	mA
		Clock or preset						0.2	
		Clear						0.4	
I_{IH}	High-level input current	J or $\overline{K}$	V_{CC} = MAX,	V_I = 2.7 V				20	μA
		Clock or preset						40	
		Clear						80	
I_{IL}	Low-level input current	J or $\overline{K}$	V_{CC} = MAX,	V_I = 0.4 V				−0.4	mA
		Clock or preset						−0.8	
		Clear						−1.6	
I_{OS}	Short-circuit output current§		V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 1			4	8	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE 2:
I_{CC} is measured with outputs open, clock grounded, and J, $\overline{K}$, preset, and clear at 4.5 V.

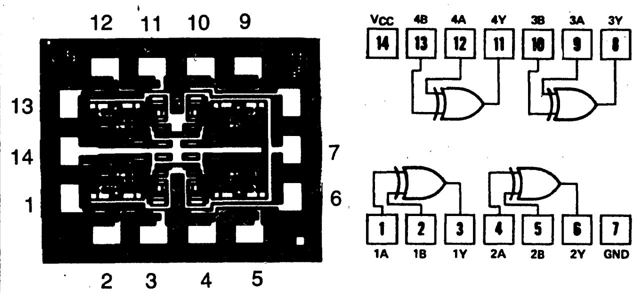
Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter			Test Conditions	Min	Typ	Max	Unit
f_{max}	Maximum clock frequency		C_L = 15 pF, R_L = 2 kΩ, See Fig. A on page 373	30	45		MHz
t_{PLH}	Propagation delay time, low-to-high-level output from clear or preset				10	15	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear or preset	CK Low			12	18	ns
		CK High			16	24	
t_{PLH}	Propagation delay time, low-to-high-level output from clock				12	18	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock				14	22	ns

54LS136 54LS266 Quadruple 2-Input Exclusive-OR, -NOR Gates With Open-Collector Outputs

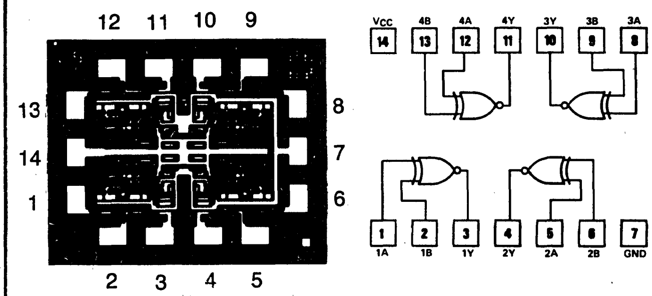
PIN-OUT AND LOGIC DIAGRAMS

54LS136
QUADRUPLE 2-INPUT EXCLUSIVE-OR WITH OPEN-COLLECTOR OUTPUTS



Die Size .045 x .056 positive logic: $Y = A \oplus B = \overline{A}B + A\overline{B}$

54LS266
QUADRUPLE 2-INPUT EXCLUSIVE-NOR WITH OPEN COLLECTOR OUTPUTS



Die Size .045 x .056 positive logic: $Y = \overline{A \oplus B} = AB + \overline{A}\overline{B}$

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output voltage, V_{OH}			5.5	V
Low-level output current, I_{OL}			18	mA
Operating free-air temperature, T_A	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

	Parameter	Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	$I_I = -18$ mA				−1.5	V
I_{OH}	High-level output current	V_{CC} = MIN, $V_{IL} = V_{IL}$max,	$V_{IH} = 2$ V, $V_{OH} = 5.5$ V				100	μA
V_{OL}	Low-level output voltage	V_{CC} = MIN, $V_{IL} = V_{IL}$max	$V_{IH} = 2$ V	$I_{OL} = 4$ mA		0.25	0.4	V
				$I_{OL} = 8$ mA		0.3	0.45	V
I_I	Input current at maximum input voltage	V_{CC} = MAX,	$V_I = 7$ V				0.2	mA
I_{IH}	High-level input current	V_{CC} = MAX,	$V_I = 2.7$ V				40	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	$V_I = 0.4$ V				−0.6	mA
I_{CC}	Supply current (LS266)	V_{CC} = MAX,	See Note 1			8	13	mA
I_{CC}	Supply current (LS136)					6.1	10	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
‡All typical values are at $V_{CC} = 5$ V, $T_A = 25°C$.
NOTE 1
I_{CC} is measured with one input of each gate at 4.5 V, the other inputs grounded, and the outputs open.

Switching Characteristics, $V_{CC} = 5$ V, $T_A = 25°C$.

Parameter*	From	Test Conditions		Min	Typ	Max	Unit
t_{PLH}	A or B	Other input low	$C_L = 15$ pF, $R_L = 2$ kΩ, See Fig. A on page 373			23	ns
t_{PHL}						23	
t_{PLH}	A or B	Other input high				23	ns
t_{PHL}						23	

* t_{PLH} ≡ propagation delay time, low-to-high level output. t_{PHL} ≡ propagation delay time, high-to-low-level output.

FEATURES

- 54LS138: 3-Line-to-8-Line Decoder
  1-of-8 Demultiplexer
- 54LS139: Dual 2-Line-to-4-Line Decoder
  Dual 1-of-4 Demultiplexer
- 54LS138 is expandable to a 5-lines-to-32-lines decoder using 4 54LS138's and one inverter.

DESCRIPTION

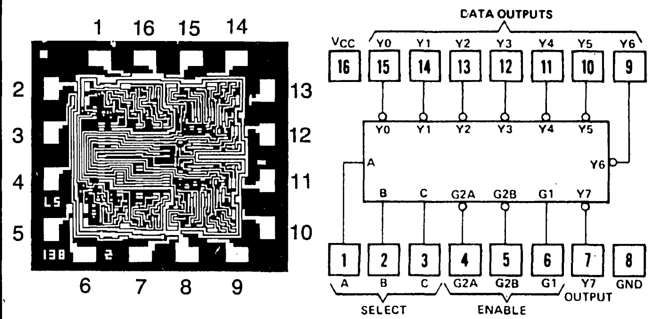
The 54LS138 decodes one-of-eight lines dependent on the conditions at the three binary select inputs and the three enable inputs. Two active-low and one active-high enable inputs reduce the need for external gates or inverters when expanding. A 24-line decoder can be implemented without external inverters and a 32-line decoder requires only one inverter. An enable input can be used as a data input for demultiplexing applications.

The 54LS139 comprises two individual two-line-to-four-line decoders in a single package. The active-low enable input can be used as a data line in demultiplexing applications.

These circuits are designed to be used in high-performance memory-decoding and data-routing applications requiring very short delay times.

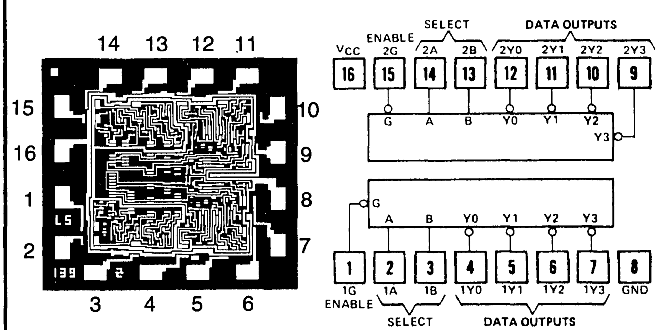
PIN-OUT DIAGRAMS

54LS138



Die Size .063 x .069

54LS139



Die Size .063 x .069

54LS138
FUNCTION TABLE

INPUTS					OUTPUTS							
ENABLE		SELECT										
G1	G2*	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	H	H	H	H	H	L	H	H	H	H
H	L	H	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	H	L	H	H
H	L	H	H	L	H	H	H	H	H	H	L	H
H	L	H	H	H	H	H	H	H	H	H	H	L

*G2 = G2A + G2B
H = high level, L = low level, X = irrelevant

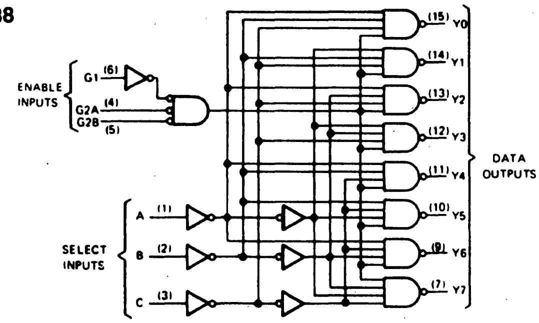
54LS139
FUNCTION TABLE (½)

INPUTS			OUTPUTS			
ENABLE	SELECT					
G	B	A	Y0	Y1	Y2	Y3
H	X	X	H	H	H	H
L	L	L	L	H	H	H
L	L	H	H	L	H	H
L	H	L	H	H	L	H
L	H	H	H	H	H	L

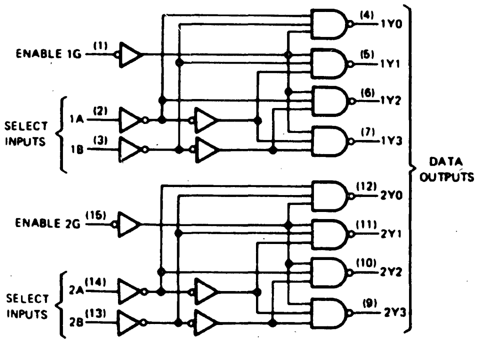
H = high level, L = low level, X = irrelevant

LOGIC DIAGRAMS

54LS138



54LS139



Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−400	μA
Low-level output current, I_{OL}			18	mA
Operating free-air temperature, T_A	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†		Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage			2			V
V_{IL}	Low-level input voltage					0.7	V
V_I	Input clamp voltage	V_{CC} = MIN, I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL}max, I_{OH} = −400 μA		2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL}max	I_{OL} = 4 mA		0.25	0.4	V
			I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX, V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX, V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX, V_I = 0.4 V				−0.36	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX		−6		−100	mA
I_{CC}	Supply current	V_{CC} = MAX, Outputs enabled and open	'LS138		6.3	10	mA
			'LS139		6.8	11	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter¶	From (Input)	To (Output)	Levels of Delay	Test Conditions	54LS138 Min	54LS138 Typ	54LS138 Max	54LS139 Min	54LS139 Typ	54LS139 Max	Unit
t_{PLH}	Binary Select	Any	2	C_L = 15 pF, R_L = 2 kΩ, See Fig. A on page 373		11	16		12	17	ns
t_{PHL}						14	20		12	17	ns
t_{PLH}			3			16	24		15	22	ns
t_{PHL}						19	27		17	25	ns
t_{PLH}	Enable	Any	2			11	15		11	15	ns
t_{PHL}						16	24		11	16	ns
t_{PLH}			3			14	18				ns
t_{PHL}						22	28				ns

¶t_{PLH} ∫ propagation delay time, low-to-high level output; t_{PHL} ∫ propagation delay time, high-to-low-level output.

8-Line-To-1-Line Multiplexers

54LS151 54LS152

FEATURES

- Select one of eight data sources
- Perform parallel-to-serial conversion
- 54LS151 has complementary outputs; 54LS152 has inverting output only
- 54LS151 has strobe input

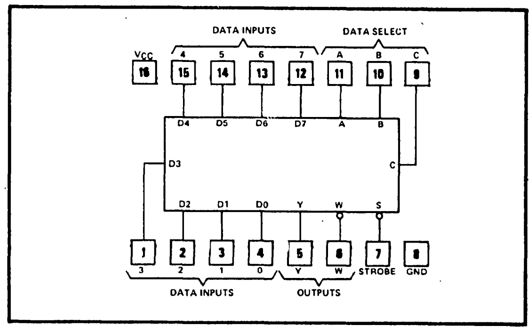
DESCRIPTION

These monolithic data selectors/multiplexers contain full on-chip binary decoding to select one-of-eight data sources. The 54LS151 has a strobe input which must be at a low logic level to enable the device. A high level at the strobe forces the W output high, and the Y output low.

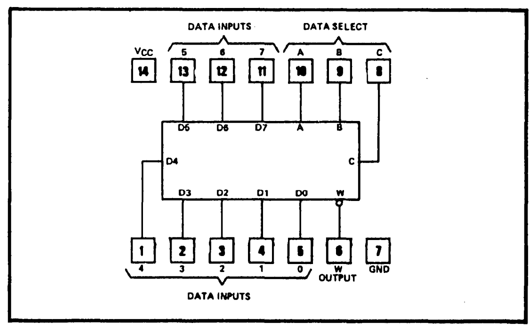
The 54LS151 features complementary W and Y outputs whereas the 54LS152 has an inverted (W) output only.

PIN-OUT DIAGRAMS

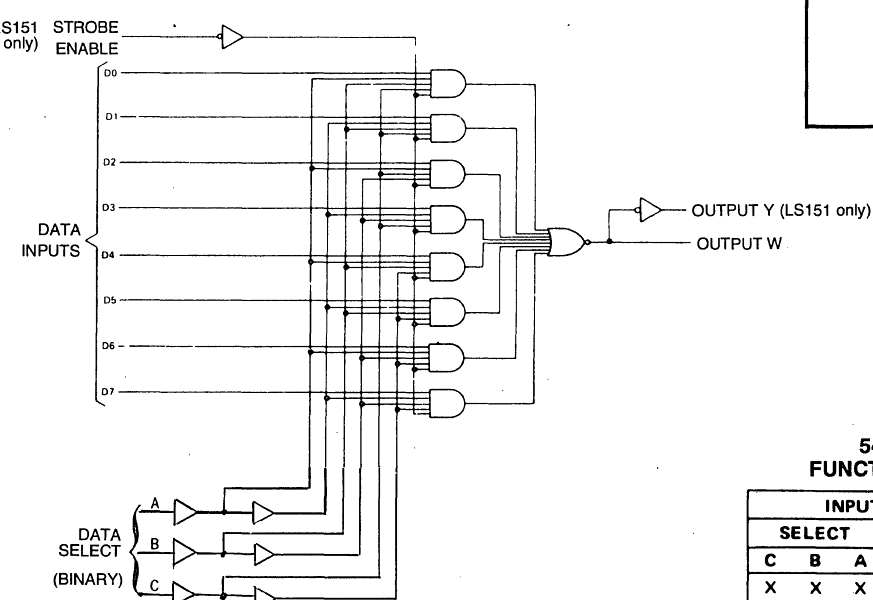
54LS151



54LS152



LOGIC DIAGRAM



54LS151 FUNCTION TABLE

INPUTS				OUTPUTS	
SELECT			STROBE	Y	W
C	B	A	S		
X	X	X	H	L	H
L	L	L	L	D0	$\overline{D0}$
L	L	H	L	D1	$\overline{D1}$
L	H	L	L	D2	$\overline{D2}$
L	H	H	L	D3	$\overline{D3}$
H	L	L	L	D4	$\overline{D4}$
H	L	H	L	D5	$\overline{D5}$
H	H	L	L	D6	$\overline{D6}$
H	H	H	L	D7	$\overline{D7}$

H = high level, L = low level, X = irrelevant
D0, D1 . . . D7 = the level of the D respective input

54LS152 FUNCTION TABLE

SELECT INPUTS			OUTPUT
C	B	A	W
L	L	L	$\overline{D0}$
L	L	H	$\overline{D1}$
L	H	L	$\overline{D2}$
L	H	H	$\overline{D3}$
H	L	L	$\overline{D4}$
H	L	H	$\overline{D5}$
H	H	L	$\overline{D6}$
H	H	H	$\overline{D7}$

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−400	μA
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IL} = V_{IL}max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN,	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
		V_{IL} = V_{IL}max		I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.4	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current	V_{CC} = MAX,	Outputs open,	54LS151		6.0	10	mA
		All inputs at 4.5 V		54LS152		5.6	9	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter¶	From (Input)	To (Output)	Test Conditions	Min	Typ	Max *	Unit
t_{PLH}	A, B, or C (4 levels)	Y (54LS151 only)	C_L = 15 pF, R_L = 2 kΩ, See Fig. A on page 373			43	ns
t_{PHL}						30	
t_{PLH}	A, B, or C (3 levels)	W				23	ns
t_{PHL}						32	
t_{PLH}	Strobe	Y (54LS151 only)				42	ns
t_{PHL}						32	
t_{PLH}	Strobe	W (54LS151 only)				24	ns
t_{PHL}						30	
t_{PLH}	Any D	Y (54LS151 only)				32	ns
t_{PHL}						26	
t_{PLH}	Any D	W				21	ns
t_{PHL}						20	

¶t_{PLH} ≡ Propagation delay time, low-to-high-level output
t_{PHL} ≡ Propagation delay time, high-to-low-level output

*Tentative data, subject to change without notice.

Dual 4-Line-To-1-Line Multiplexer

54LS153

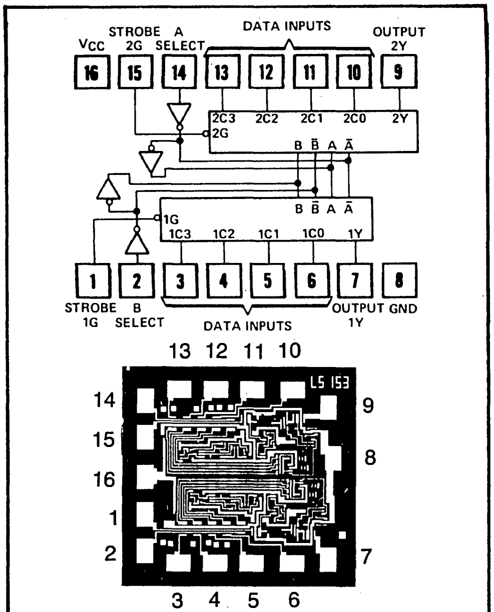
FEATURES

- **Permits multiplexing from N lines to 1 line**
- **Performs parallel-to-serial conversion**
- **Strobe (Enable) line provided for cascading (N lines to n lines)**
- **Non-inverting**

DESCRIPTION

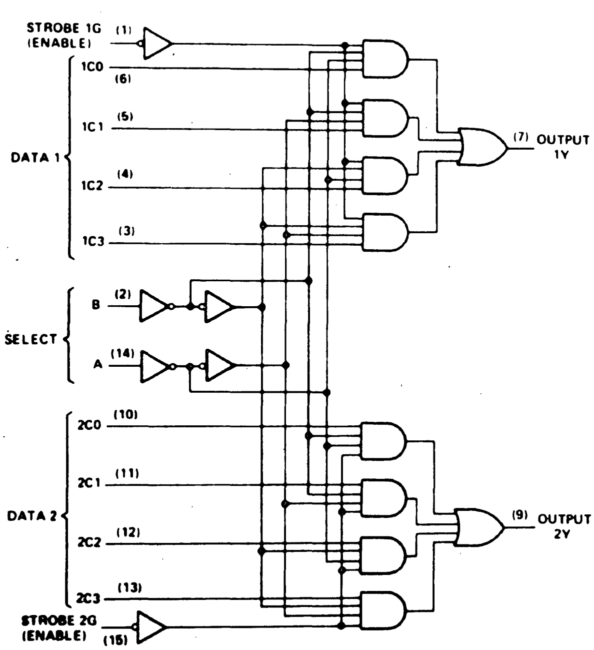
The 54LS153 is a high speed Dual 4-Line-to-1-Line Multiplexer with common select inputs and separate strobe (enable) inputs for each half. Each half can select one bit of four and present it at the output in non-inverted form.

PIN-OUT DIAGRAM



Die Size .057 x .061

LOGIC DIAGRAM



FUNCTION TABLE

SELECT INPUTS		DATA INPUTS				STROBE	OUTPUT
B	A	C0	C1	C2	C3	G	Y
X	X	X	X	X	X	H	L
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

Select inputs A and B are common to both sections.
H = high level, L = low level, X = irrelevant

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−400	μA
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	$I_I = -18$ mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, $V_{IL} = V_{IL}$max,	$V_{IH} = 2$ V, $I_{OH} = -400$ μA		2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, $V_{IL} = V_{IL}$max	$V_{IH} = 2$ V,	$I_{OL} = 4$ mA		0.25	0.4	V
				$I_{OL} = 8$ mA		0.3		
I_I	Input current at maximum input voltage	V_{CC} = MAX,	$V_I = 7.0$ V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	$V_I = 2.7$ V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	$V_I = 0.4$ V				−0.36	mA
I_{OS}	Short-circuit output current §	V_{CC} = MAX			−6		−100	mA
I_{CCL}	Supply current, output low	V_{CC} = MAX,	See Note 1			6.2	10	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at $V_{CC} = 5$ V, $T_A = 25°C$.
§Not more than one output should be shorted at a time.
NOTE: 1
I_{CCL} is measured with the outputs open and all inputs grounded.

Switching Characteristics, $V_{CC} = 5$ V, $T_A = 25°C$

Parameter¶	From (Input)	To (Output)	Test Conditions	Min	Typ	Max	Unit
t_{PLH}	Data	Y	$C_L = 15$ pF, $R_L = 2$ kΩ, See Fig. A on page 373		7	13	ns
t_{PHL}	Data	Y			12	19	ns
t_{PLH}	Select	Y			16	24	ns
t_{PHL}	Select	Y			20	29	ns
t_{PLH}	Strobe	Y			13	20	ns
t_{PHL}	Strobe	Y			17	24	ns

¶t_{PLH} ≡ propagation delay time, low-to-high-level output
t_{PHL} ≡ propagation delay time, high-to-low-level output

Dual 2-Line-To-4-Line Decoders/Demultiplexers

54LS155 54LS156

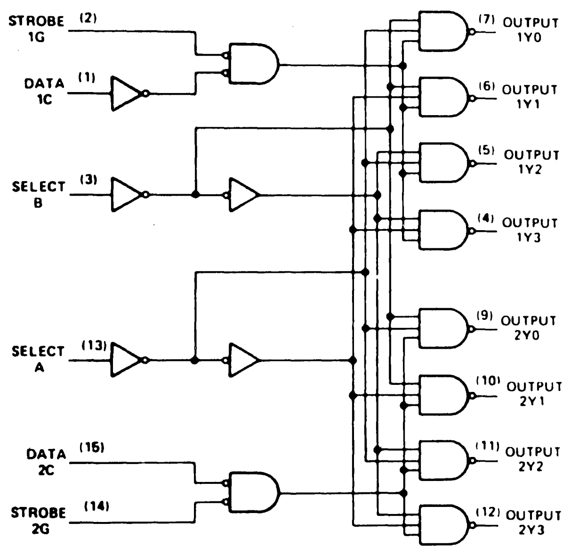
FEATURES

- 54LS156 has open-collector outputs
- Applications:
  Dual 2-Line-to-4-Line Decoder
  Dual 1-Line-to-4-Line Demultiplexer
  3-Line-to-8-Line Decoder
  1-Line-to-8-Line Demultiplexer

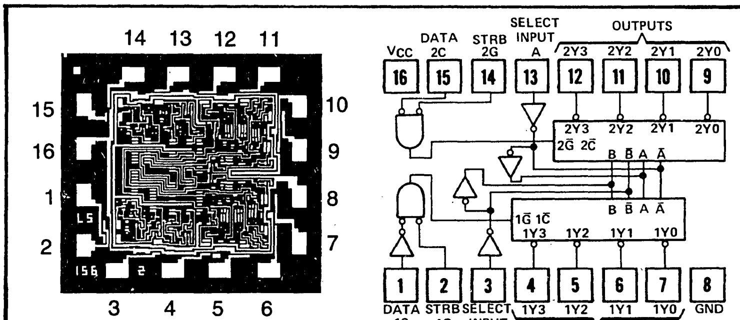
DESCRIPTION

These circuits feature dual 1-line-to-4-line demultiplexers with individual strobes and common binary-address inputs in a single 16-pin package. When both sections are enabled by the strobes, the common binary-address inputs sequentially select and route associated input data to the appropriate output of each section. The individual strobes permit activating or inhibiting each of the 4-bit sections as desired. Data applied to input 1C is inverted at its outputs and data applied at 2C is not inverted through its outputs. The inverter following the 1C data input permits use as a 3-to-8-line decoder or 1-to-8-line demultiplexer without external gating. Input clamping diodes are provided on all of these circuits to minimize transmission-line effects and simplify system design.

LOGIC DIAGRAM



PIN-OUT DIAGRAM



Die Size .063 x .069 (both types)

FUNCTION TABLES 2-LINE-TO-4-LINE DECODER OR 1-LINE-TO-4-LINE DEMULTIPLEXER

INPUTS				OUTPUTS			
SELECT		STROBE	DATA				
B	A	1G	1C	1Y0	1Y1	1Y2	1Y3
X	X	H	X	H	H	H	H
L	L	L	H	L	H	H	H
L	H	L	H	H	L	H	H
H	L	L	H	H	H	L	H
H	H	L	H	H	H	H	L
X	X	X	L	H	H	H	H

INPUTS				OUTPUTS			
SELECT		STROBE	DATA				
B	A	2G	2C	2Y0	2Y1	2Y2	2Y3
X	X	H	X	H	H	H	H
L	L	L	L	L	H	H	H
L	H	L	L	H	L	H	H
H	L	L	L	H	H	L	H
H	H	L	L	H	H	H	L
X	X	X	H	H	H	H	H

FUNCTION TABLE 3-LINE-TO-8-LINE DECODER OR 1-LINE-TO-8-LINE DEMULTIPLEXER

INPUTS				OUTPUTS							
SELECT			STROBE OR DATA	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
C†	B	A	G‡	2Y0	2Y1	2Y2	2Y3	1Y0	1Y1	1Y2	1Y3
X	X	X	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H
L	H	L	L	H	H	L	H	H	H	H	H
L	H	H	L	H	H	H	L	H	H	H	H
H	L	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	L	H	H
H	H	L	L	H	H	H	H	H	H	L	H
H	H	H	L	H	H	H	H	H	H	H	L

†C = inputs 1C and 2C connected together
‡G = inputs 1G and 2G connected together
H = high level, L = low level, X = irrelevant

54LS155 54LS156 Dual 2-Line-To-4-Line Decoders/Demultiplexers

Recommended Operating Conditions

	54LS155 Min	54LS155 Nom	54LS155 Max	Unit	54LS156 Min	54LS156 Nom	54LS156 Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V	4.5	5	5.5	V
High-level output current, I_{OH}; or output voltage, V_{OH}			−400	μA			5.5	V
Low-level output, I_{OL}			8	mA			8	mA
Operating free-air temperature, T_A	−55		125	°C	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†		54LS155 Min	54LS155 Typ‡	54LS155 Max	54LS156 Min	54LS156 Typ‡	54LS156 Max	Unit
V_{IH}	High-level input voltage			2			2			V
V_{IL}	Low-level input voltage					0.7			0.7	V
V_I	Input clamp voltage	V_{CC} = MIN, $I_I = -18$ mA				−1.5			−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, $V_{IH} = 2$ V, $V_{IL} = V_{IL}$max, $I_{OH} = -400$ μA		2.5	3.4					V
I_{OH}	High-level output current	V_{CC} = MIN, $V_{IH} = 2$ V, $V_{IL} = V_{IL}$max, $V_{OH} = 5.5$ V							100	μA
V_{OL}	Low-level output voltage	V_{CC} = MIN, $V_{IH} = 2$ V, $V_{IL} = V_{IL}$ max	$I_{OL} = 4$ mA		0.25	0.4		0.25	0.4	V
			$I_{OL} = 8$ mA		0.3	0.45		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX, $V_I = 7$ V				0.1			0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX, $V_I = 2.7$ V				20			20	μA
I_{IL}	Low-level input current	V_{CC} = MAX, $V_I = 0.4$ V				−0.36			−0.36	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX		−6		−100				mA
I_{CC}	Supply current	V_{CC} = MAX, See Note 1			6.1	10		6.1	10	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at $V_{CC} = 5$ V, $T_A = 25°C$.
§Not more than one output should be shorted at a time.
NOTE 1:
I_{CC} is measured with outputs open, A, B, and 1C inputs at 4.5 V, and 2C, 1G, and 2G inputs grounded.

Switching Characteristics, $V_{CC} = 5$ V, $T_A = 25°C$

Parameter¶	From (Input)	To (Output)	Levels of Logic	Test Conditions	54LS155 Min	54LS155 Typ	54LS155 Max	54LS156 Min	54LS156 Typ	54LS156 Max	Unit
t_{PLH}	2C, 1G, or 2G	Y	2	$C_L = 15$ pF, $R_L = 2$ kΩ, See Figs. A & B on page 373		11	15		22	30	ns
t_{PHL}	2C, 1G, or 2G	Y	2			13	20		16	24	ns
t_{PLH}	A or B	Y	3			14	18		27	37	ns
t_{PHL}	A or B	Y	3			18	27		22	30	ns
t_{PLH}	1C	Y	3			13	18		25	34	ns
t_{PHL}	1C	Y	3			16	24		23	31	ns

¶t_{PLH} ≡ propagation delay time, low-to-high-level output
t_{PHL} ≡ propagation delay time, high-to-low-level output

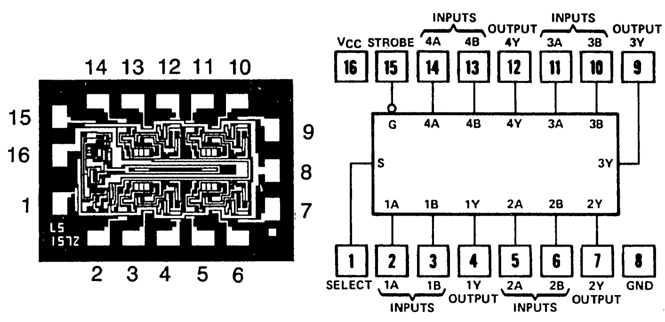
Quadruple 2-Line-To-1-Line Multiplexers 54LS157 54LS158

DESCRIPTION

These data selectors/multiplexers select a 4-bit word from one of two sources and present it at the four outputs. The 54LS157 presents true data; the 54LS158 presents inverted data.

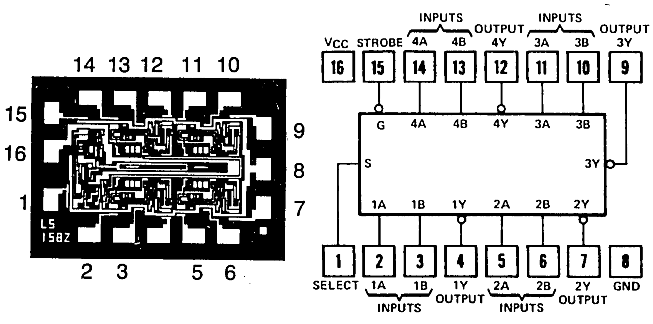
PIN-OUT DIAGRAMS

54LS157



Die Size .047 x .066

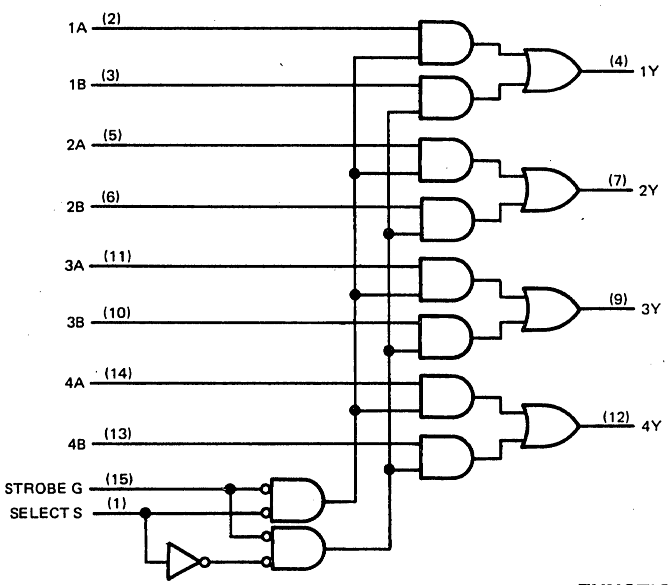
54LS158



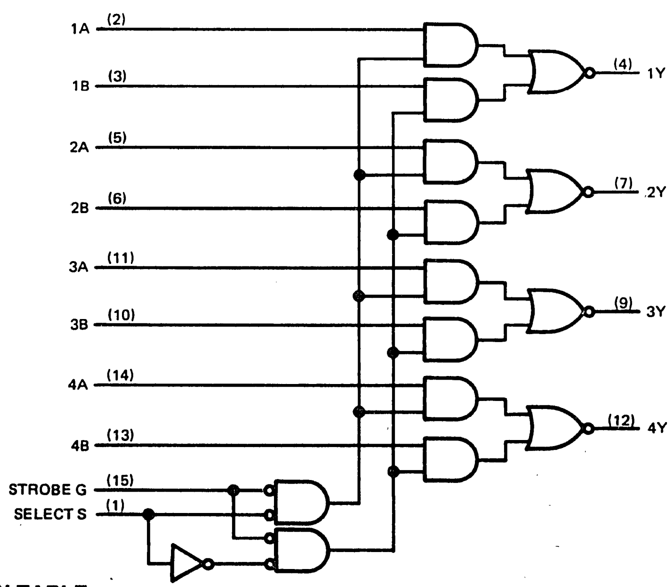
Die Size .047 x .066

LOGIC DIAGRAMS

54LS157



54LS158



FUNCTION TABLE

INPUTS				OUTPUT Y	
STROBE	SELECT	A	B	54LS157	54LS158
H	X	X	X	L	H
L	L	L	X	L	H
L	L	H	X	H	L
L	H	X	L	L	H
L	H	X	H	H	L

H = high level, L = low level, X = irrelevant
Low level at S selects A inputs
High level at S selects B inputs
Strobe is active low

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−400	μA
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

	Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage					2			V
V_{IL}	Low-level input voltage							0.7	V
V_I	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IL} = MAX,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IL} = MAX	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
					I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	S or G input	V_{CC} = MAX,	V_I = 7 V				0.2	mA
		A or B input						0.1	
I_{IH}	High-level input current	S or G input	V_{CC} = MAX,	V_I = 2.7 V				40	μA
		A or B input						20	
I_{IL}	Low-level input current	S or G input	V_{CC} = MAX,	V_I = 0.4 V				−0.8	mA
		A or B input						−0.4	
I_{OS}	Short-circuit output current§		V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 1	'LS157		9.7	16	mA
					'LS158		4.8	8	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time and duration of the short-circuit test should not exceed one second.
NOTE: 1
I_{CC} is measured with 4.5 V applied to all inputs and all outputs open.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter¶	From (Input)	Test Conditions	54LS157 Min	54LS157 Typ	54LS157 Max	54LS158 Min	54LS158 Typ	54LS158 Max	Unit
t_{PLH}	Data	C_L = 15 pF, R_L = 2 kΩ, See Fig. A on page 373		5	10		7	13	ns
t_{PHL}				7	14		5	10	
t_{PLH}	Strobe			13	23		8	18	ns
t_{PHL}				8	16		12	22	
t_{PLH}	Select			10	20		11	20	ns
t_{PHL}				11	20		10	20	

¶t_{PLH} ≡ propagation delay time, low-to-high-level output
t_{PHL} ≡ propagation delay time, high-to-low-level output

Synchronous BCD Decade Counters — 54LS160 54LS162
Synchronous 4-Bit Binary Counters — 54LS161 54LS163

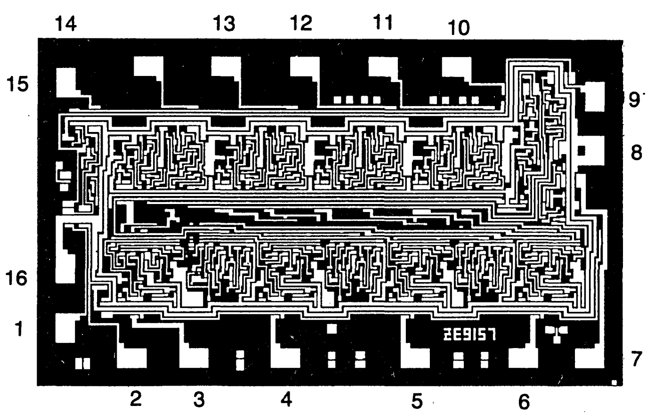
FEATURES
- 54LS160, 161: Synchronous with direct clear
- 54LS162, 163: Fully synchronous
- Synchronous counting and loading
- Expandable to N-Bit synchronous counter
- Edge-triggered operation

DESCRIPTION
These synchronous, presettable counters feature an internal carry look-ahead for application in high-speed counting designs. The 54LS160 and 54LS162 are decade counters and the 54LS161 and 54LS163 are 4-bit binary counters. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple clock) counters. A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveform.

These counters are fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable inputs. The clear function for the 54LS160 and 54LS161 is asynchronous and a low level at the clear input sets all four of the flip-flop outputs low regardless of the levels of clock, load, or enable inputs. The clear function for the 54LS162 and 54LS163 is synchronous and a low level at the clear input sets all four of the flip-flop outputs low after the next clock pulse, regardless of the levels of the enable inputs. This synchronous clear allows the count length to be modified easily as decoding the maximum count desired can be accomplished with one external NAND gate. The gate output is connected to the clear input to synchronously clear the counter to 0000 (LLLL).

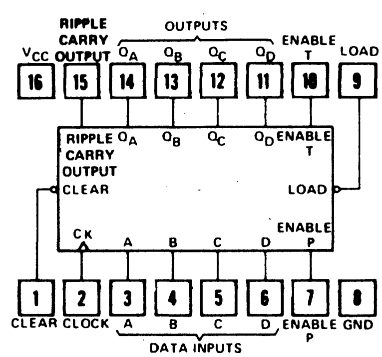
The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Instrumental in accomplishing this function are two count-enable inputs and a ripple carry output. Both count-enable inputs (P and T) must be high to count, and input T is fed forward to enable the ripple carry output. The ripple carry output thus enabled will produce a high-level output pulse with a duration approximately equal to the high-level portion of the Q_A output. This high-level overflow ripple carry pulse can be used to enable successive cascaded stages.

These counters feature a fully independent clock circuit. Changes made to control inputs (enable P or T, load or clear) that will modify the operating mode have no effect until clocking occurs. The function of the counter (whether enabled, disabled, loading, or counting) will be dictated solely by the conditions meeting the stable setup and hold times.



Die Size .070 x .118 — all 4 types

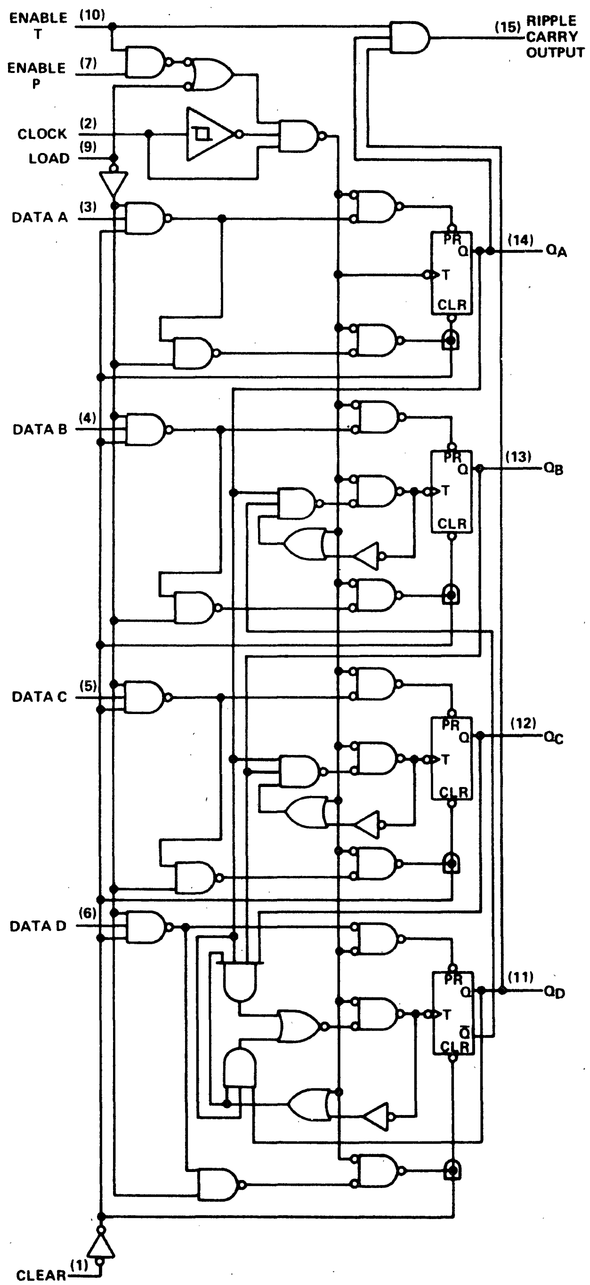
PIN-OUT DIAGRAM



LOGIC DIAGRAMS

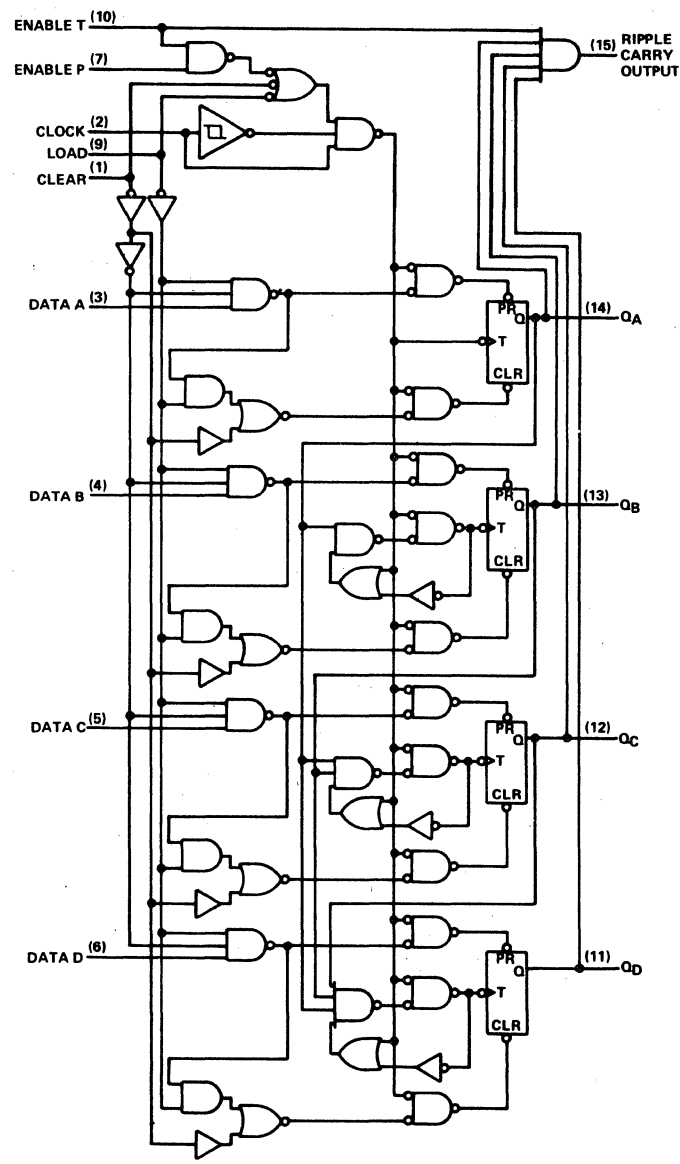
54LS160 Synchronous Decade Counter

The 54LS162 synchronous decade counter is similar, however the clear is synchronous as shown for the 54LS163 binary counter below.



54LS163 SYNCHRONOUS BINARY COUNTER

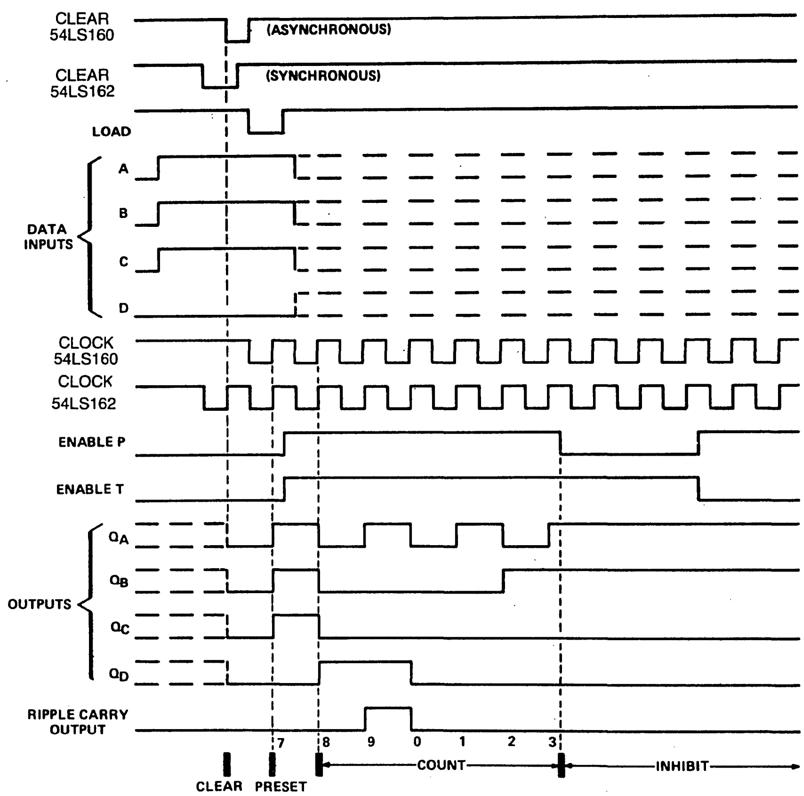
The 54LS161 synchronous binary counter is similar, however the clear is asynchronous as shown for the 54LS160 decade counter below.



Synchronous BCD Decade Counters — 54LS160 54LS162

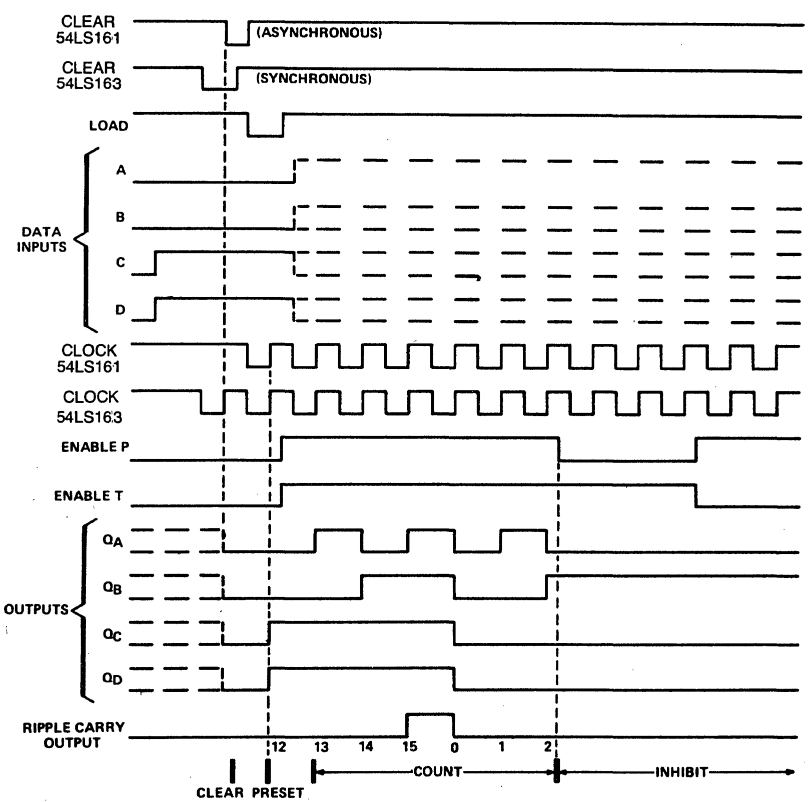
Synchronous 4-Bit Binary Counters — 54LS161 54LS163

TYPICAL CLEAR, PRESET, COUNT, AND INHIBIT SEQUENCES



54LS160, 54LS162

Illustrated below is the following sequence:
1. Clear outputs to zero
2. Preset to BCD seven
3. Count to eight, nine, zero, one, two, and three
4. Inhibit



54LS161, 54LS163

Illustrated below is the following sequence:
1. Clear outputs to zero
2. Preset to binary twelve
3. Count to thirteen; fourteen fifteen, zero, one, and two
4. Inhibit

54LS160 54LS162 Synchronous BCD Decade Counters
54LS161 54LS163 Synchronous 4-Bit Binary Counters

Recommended Operating Conditions

Parameter		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
High-level output current, I_{OH}				−400	μA
Low-level output current, I_{OL}				4	mA
Clock frequency, f_{clock}		0		25	MHz
Width of clock pulse, $t_{w(clock)}$		25			ns
Width of clear pulse, $t_{w(clear)}$		20			ns
Setup time, t_{setup}(see Figures 1 and 2)	Data inputs A, B, C, D	0			ns
	Enable P or T	20			
	Load	20			
	Clear◇	20			
Hold time, t_{hold}	Data inputs A, B, C, D	25¶			ns
	Other inputs	10¶			
Operating free-air temperature, T_A		−55		125	°C

◇This applies only for 54LS162 and 54LS163, which have synchronous clear inputs.
¶The minimum hold time is as specified or as long as the clock input takes to rise from 0.8 V to 2 V, whichever is longer.

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter			Test Conditions†		Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage		V_{CC} = MIN, I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL}max, I_{OH} = −400 μA		2.5	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL}max,	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	Data or enable P	V_{CC} = MAX, V_I = 7 V				0.1	mA
		Load, clock, or enable T					0.2	
		Clear (LS160, LS161)					0.1	
		Clear (LS162, LS163)					0.2	
I_{IH}	High-level input current	Data or enable P	V_{CC} = MAX, V_I = 2.7 V				20	μA
		Load, clock, or enable T					40	
		Clear (LS160, LS161)					20	
		Clear (LS162, LS163)					40	
I_{IL}	Low-level input current	Data or enable P	V_{CC} = MAX, V_I = 0.4 V				−0.4	mA
		Load, clock, or enable T					−0.8	
		Clear (LS160, LS161)					−0.4	
		Clear (LS162, LS163)					−0.8	
I_{OS}	Short-circuit output current§		V_{CC} = MAX		−15		−100	mA
I_{CCH}	Supply current, all outputs high		V_{CC} = MAX, See Note 1			18	31	mA
I_{CCL}	Supply current, all outputs low		V_{CC} = MAX, See Note 2			19	32	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

NOTES:
1. I_{CCH} is measured with the load input high, then again with the load input low, with all other inputs high and all outputs open.
2. I_{CCL} is measured with the clock input high, then again with the clock input low, with all other inputs low and all outputs open.

Switching Characteristics, $V_{CC} = 5$ V, $T_A = 25°C$

Parameter¶	From (Input)	To (Output)	Test Conditions	Min	Typ	Max*	Unit
f_{MAX}				25	32		MHz
t_{PLH}	Clock	Ripple carry	$C_L = 15$ pF, $R_L = 2$ kΩ, See Figures 1 and 2 and Notes 3 and 4		23	35	ns
t_{PHL}					23	35	
t_{PLH}	Clock (load input high)	Any Q			16	24	ns
t_{PHL}					18	27	
t_{PLH}	Clock (load input low)	Any Q			17	25	ns
t_{PHL}					19	29	
t_{PLH}	Enable T	Ripple carry			15	23	ns
t_{PHL}					15	23	
t_{PHL}	Clear	Any Q			26	38	ns

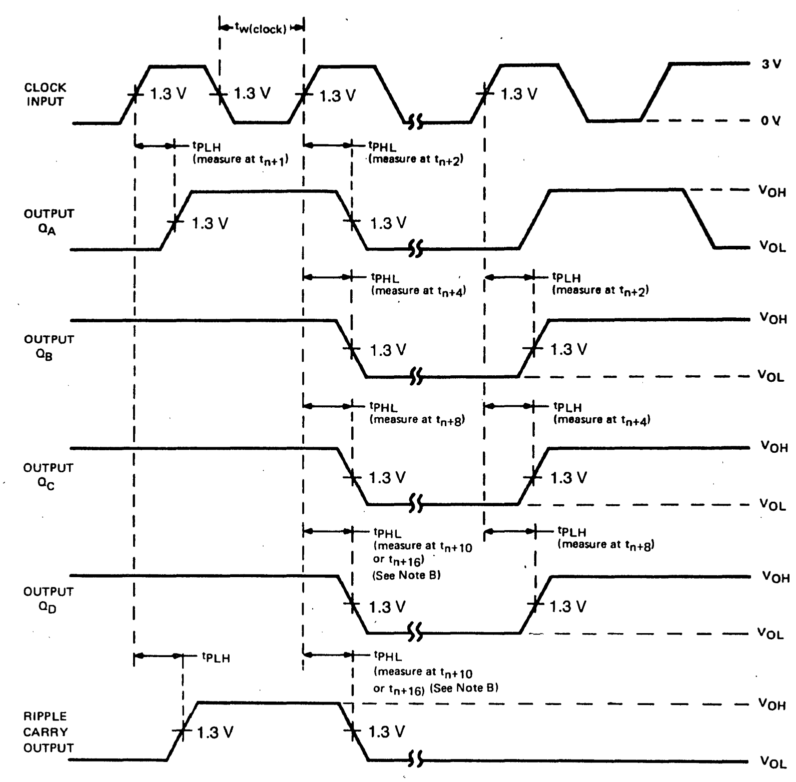
¶f_{max} ≡ Maximum clock frequency
t_{PLH} ≡ propagation delay time, low-to-high-level output.
t_{PHL} ≡ propagation delay time, high-to-low-level output.

*Tentative date, subject to change without notice

NOTES:
3. Load circuit is shown on page
4. Propagation delay for clearing is measured from the clear input for the 'LS160 and 'LS161 or from the clock input transition for the 'LS162 and 'LS163.

FIGURE 1

PARAMETER MEASUREMENT INFORMATION

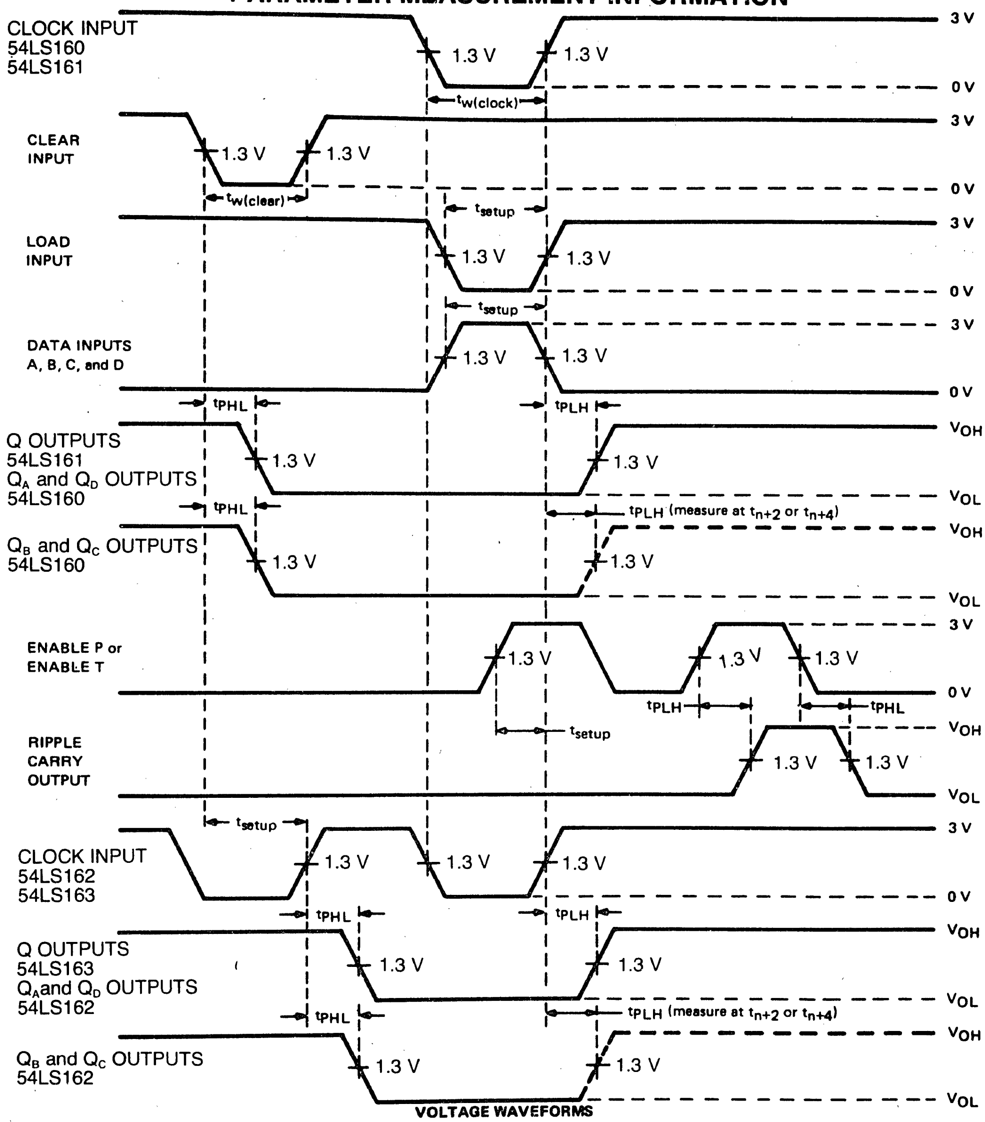


VOLTAGE WAVEFORMS

NOTES:
A. The input pulses are supplied by a generator having the following characteristics: PRR ≤ 1 MHz, duty cycle ≤ 50%, $Z_{out} \approx 50$ Ω: $t_r \leq 15$ ns, $t_f \leq 6$ ns. Vary PRR to measure f_{max}.
B. Outputs Q_d and carry are tested at t_{n+10} 54LS160, 54LS162, and at t_{n+16} for 54LS161, 54LS163 where t_n is the bit time when all outputs are low.

FIGURE 2

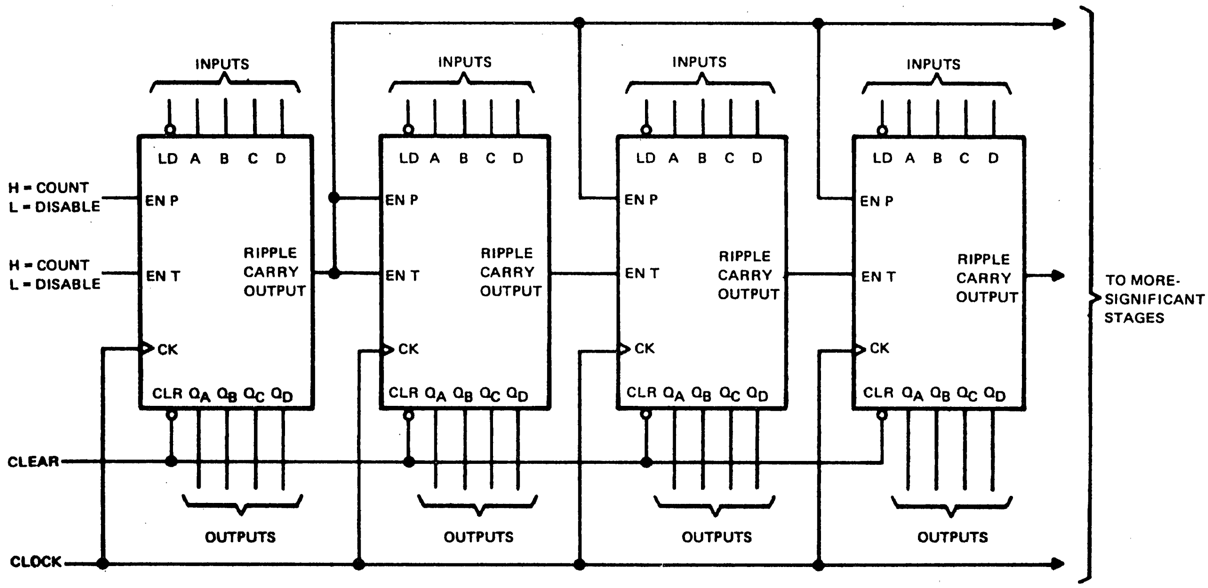
PARAMETER MEASUREMENT INFORMATION



NOTES:
A. The input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, duty cycle ≤ 50%, $Z_{out} \approx 50\ \Omega$; $t_r \leq 15$ ns, $t_f \leq 6$ ns.
B. Enable P and enable T setup times are measured at $t_n=0$

N-BIT SYNCHRONOUS COUNTERS

This application demonstrates how the look-ahead carry circuit can be used to implement a high-speed n-bit counter. The 54LS160 or 54LS162 will count in BCD and the 54LS163 will count in binary. Virtually any count mode (modulo-N, N_1-to N_2, N_1-to-maximum) can be used with this fast look-ahead ciruit.



54LS174 Hex D-Type Flip-Flops With Clear

54LS175 Quadruple D-Type Flip-Flops With Clear

FEATURES

- Positive edge-triggered common clock
- Asynchronous common reset
- Clock-to-output delays of 14 ns

DESCRIPTION

The 54LS174 is a six-bit register with single-rail outputs and the 54LS175 is a four-bit register with complementary outputs. Both consist of D-type flip-flops with a buffered common clock and an asynchronous, active-Low buffered clear.

Information at the D inputs meeting the setup time requirements is transferred to the Q outputs on the positive-going edge of the clock pulse. Clock triggering occurs at a particular voltage level and is not directly related to the transition time of the positive-going pulse. When the clock input is at either the high or low level, the D input signal has no effect at the output.

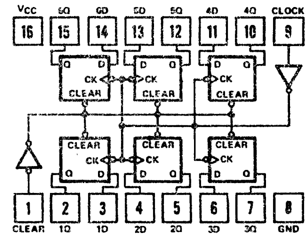
FUNCTION TABLE (EACH FLIP-FLOP)

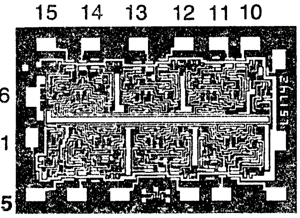
INPUTS			OUTPUTS	
CLEAR	CLOCK	D	Q	$\bar{Q}$†
L	X	X	L	H
H	↑	H	H	L
H	↑	L	L	H
H	L	X	Q_0	$\bar{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↑ = transition from low to high level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
† = 54LS175 only

PIN-OUT DIAGRAMS

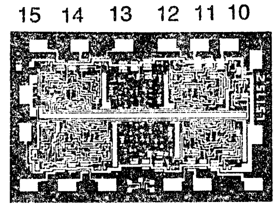
54LS174

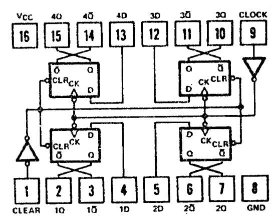




Die Size .056 x .085
(both types)

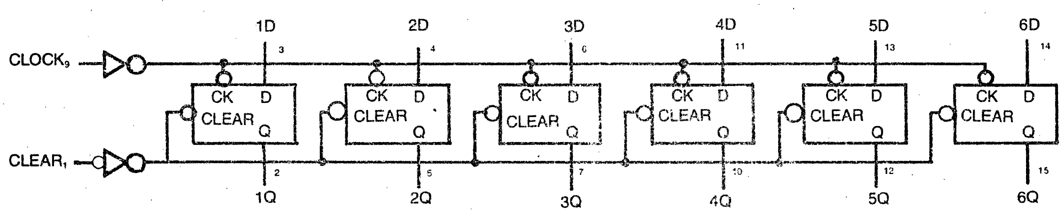
54LS175



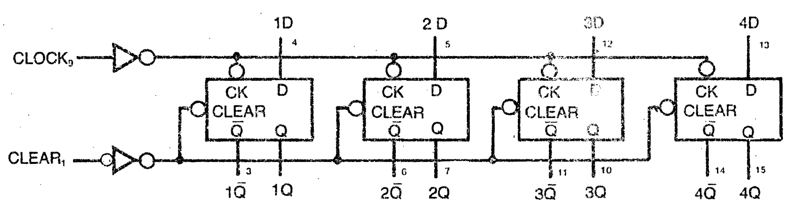


LOGIC DIAGRAMS

54LS174



54LS175



Hex D-Type Flip-Flops With Clear — 54LS174
Quadruple D-Type Flip-Flops With Clear — 54LS175

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
High-level output current, I_{OH}				−400	μA
Low-level output current, I_{OL}				8	mA
Clock frequency, f_{clock}		0		35	MHz
Width of clock pulse, t_w (Low)		15			ns
Width of clear pulse, t_w (Low)		20			ns
Setup time	Data input, t_{setup}	10			ns
	Clear recovery, t_{rec}	12			ns
Data hold time, t_{hold}		5			ns
Operating free-air temperature, T_A		−55		125	°C

t_{setup} is the minimum time required for the correct logic level to be present at the data input prior to the rising edge of the clock in order to be recognized and transferred to the output.
t_{hold} is the minimum time required for the logic level to be maintained at the data input after the rising edge of the clock in order to insure recognition.
t_{rec} is the minimum time required between the end of the clear pulse and the rising edge of the clock in order to transfer High data to the Q output.

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter			Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage					2			V
V_{IL}	Low-level input voltage							0.7	V
V_I	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL}max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.5		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL}max	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
					I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage		V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current		V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	Clock, Clear	V_{CC} = MAX,	V_I = 0.4 V				−0.4	mA
		Other inputs						−0.36	
I_{OS}	Short-circuit output current§		V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 1	'LS174		45 6	26	mA
					'LS175		11	18	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

NOTE 1: With all outputs open and 4.5 V applied to all data and clear inputs, I_{CC} is measured after a momentary ground, then 4.5 V, is applied to clock.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter		Test Conditions	Min	Typ	Max	Unit
f_{max}	Maximum clock frequency	C_L = 15 pF, R_L = 2 kΩ, See Fig. A on page 373	35	45		MHz
t_{PLH}	Propagation delay time, low-to-high level output clear (54LS175 only)			19	24	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear			23	31	ns
t_{PLH}	Propagation delay time, low-to-high-level output from clock			14	20	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock			14	22	ns

4-Bit Arithmetic Logic Unit

FEATURES

- **Provides 16 arithmetic operations**
- **Provides 16 logic operations**
- **Full look-ahead for high-speed arithmetic operation on long words**

DESCRIPTION

The '54LS181 is an arithmetic logic unit (ALU)/function generator which has a complexity of 75 equivalent gates on a monolithic chip. This circuit performs 16 binary arithmetic operations on two 4-bit words as shown in Tables 1 and 2. These operations are selected by the four function-select lines (S0, S1, S2, S3) and include addition, subtraction, decrement, and straight transfer. When performing arithmetic manipulations, the internal carries must be enabled by applying a low-level voltage to the mode control input (M). A full carry look-ahead scheme is made available in these devices for fast, simultaneous carry generation by means of two cascade-outputs (pins 15 and 17) for the four bits in the package. When used in conjunction with the 54182, full carry look-ahead circuits, high-speed arithmetic operations can be performed.

If high speed is not of importance, a ripple-carry input (C_n) and a ripple-carry output (C_{n+4}) are available. However, the ripple-carry delay has also been minimized so that arithmetic manipulations for small word lengths can be performed without external circuitry.

The 54LS181 will accommodate active-high or active-low data if the pin designations are interpreted as follows:

Subtraction is accomplished by 1's complement addition where the 1's complement of the subtrahend is generated internally. The resultant output is A-B-1 which requires an end-around or forced carry to provide A-B.

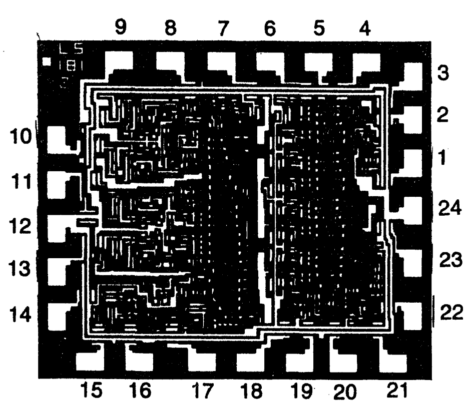
The 54LS181 can also be utilized as a comparator. The A = B output is internally decoded from the function outputs (F0,F1,F2,F3) so that when two words of equal magnitude are applied at the A and B inputs, it will assume a high level to indicate equality (A = B). The ALU should be in the subtract mode with C_n = H when performing this comparison. The A = B output is open-collector so that it can be wire-AND connected to give a comparison for more than four bits. The carry output (C_{n+4}) can also be used to supply relative magnitude information. Again, the ALU should be placed in the subtract mode by placing the function select inputs S3, S2, S1, S0 at L,H,H,L, respectively.

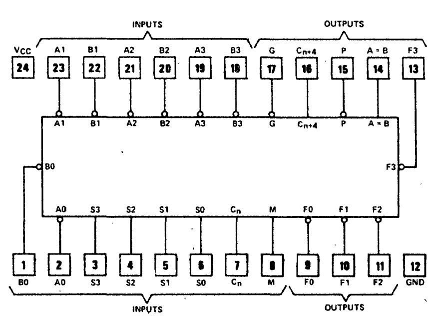
INPUT $\bar{C}_n$	OUTPUT $\bar{C}_{n+4}$	ACTIVE-HIGH DATA (FIGURE 1)	ACTIVE-LOW DATA (FIGURE 2)
H	H	$A \leq B$	$A \geq B$
H	L	$A > B$	$A < B$
L	H	$A < B$	$A > B$
L	L	$A \geq B$	$A \leq B$

These circuits have been designed to not only incorporate all of the designer's requirements for arithmetic operations, but also to provide 16 possible functions of two Boolean variables without the use of external circuitry. These logic functions are selected by use of the four function-select inputs (S0,S1,S2,S3) with the mode-control input (M) at a high level to disable the internal carry. The 16 logic functions are detailed in Tables 1 and 2 and include exclusive-OR, NAND, AND, NOR, and OR functions.

PIN NUMBER	2	1	23	22	21	20	19	18	9	10	11	13	7	16	15	17
Active-low data (Table 1)	A_0	B_0	A_1	B_1	A_2	B_2	A_3	B_3	F_0	F_1	F_2	F_3	$\bar{C}_n$	$\bar{C}_{n+4}$	X	Y
Active-low data (Table 2)	$\bar{A}_0$	$\bar{B}_0$	$\bar{A}_1$	$\bar{B}_1$	$\bar{A}_2$	$\bar{B}_2$	$\bar{A}_3$	$\bar{B}_3$	$\bar{F}_0$	$\bar{F}_1$	$\bar{F}_2$	$\bar{F}_3$	C_n	C_{n+4}	$\bar{P}$	$\bar{G}$

PIN-OUT DIAGRAM





Die Size .074 x .085

ALU SIGNAL DESIGNATIONS

The SN54LS181 and SN74LS181 can be used with the signal designations of either Figure 1 or Figure 2.

The logic functions and arithmetic operations obtained with signal designations as in Figure 1 are given in Table 1; those obtained with the signal designations of Figure 2 are given in Table 2.

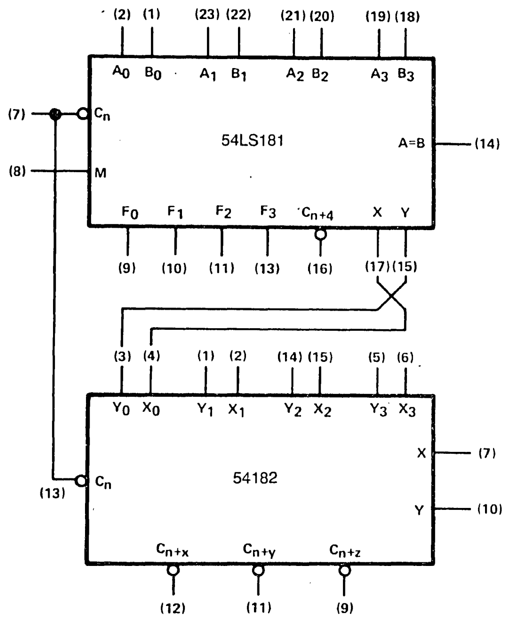


FIGURE 1
(FOR TABLE 1)

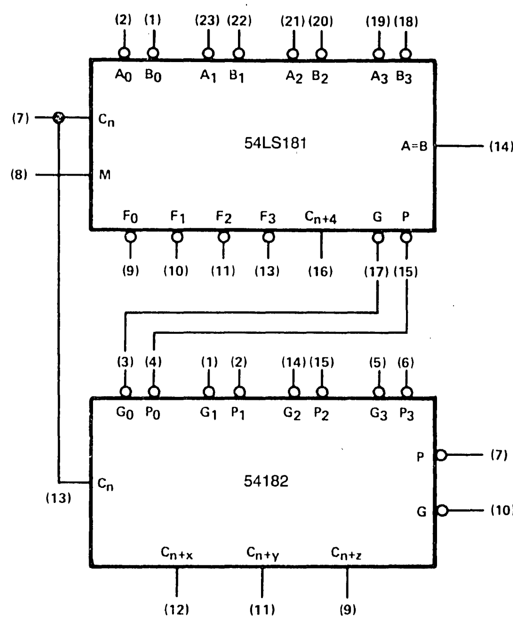


FIGURE 2
(FOR TABLE 2)

TABLE 1

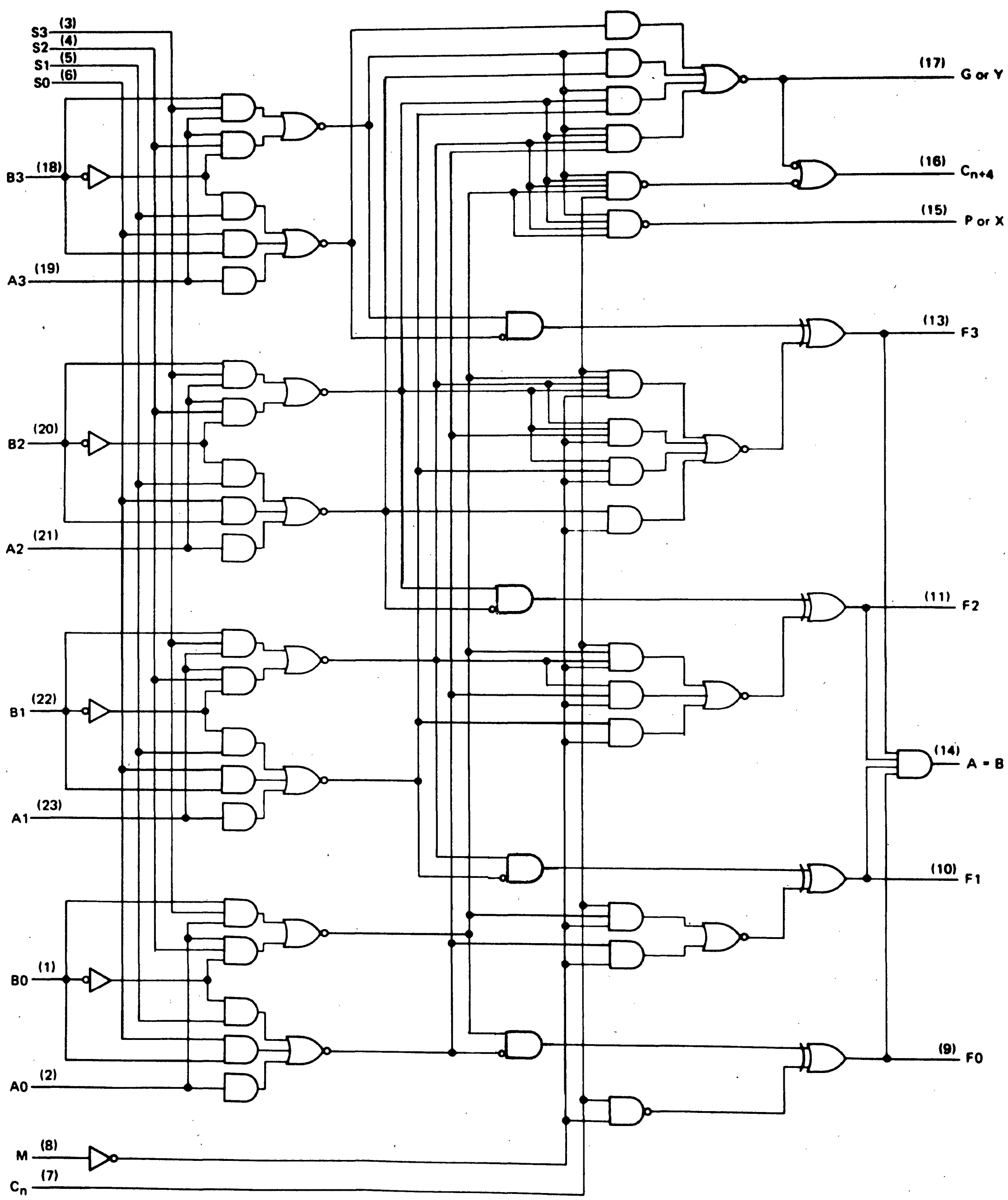
SELECTION S_3 S_2 S_1 S_0	ACTIVE-HIGH DATA: M = H LOGIC FUNCTIONS	M = L; ARITHMETIC OPERATIONS: C_n = 0 = H (no carry)	C_n = 1 = H (with carry)
L L L L	$F = \overline{A}$	F = A	F = A PLUS 1
L L L H	$F = \overline{A + B}$	F = A + B	F = (A + B) PLUS 1
L L H L	$F = \overline{A}B$	$F = A + \overline{B}$	$F = (A + \overline{B})$ PLUS 1
L L H H	F = 0	F = MINUS 1 (2's COMPL)	F = ZERO
L H L L	$F = \overline{AB}$	$F = A$ PLUS $A\overline{B}$	$F = A$ PLUS $A\overline{B}$ PLUS 1
L H L H	$F = \overline{B}$	$F = (A + B)$ PLUS $A\overline{B}$	$F = (A + B)$ PLUS $A\overline{B}$ PLUS 1
L H H L	$F = A \oplus B$	F = A MINUS B MINUS 1	F = A MINUS B
L H H H	$F = A\overline{B}$	$F = A\overline{B}$ MINUS 1	$F = A\overline{B}$
H L L L	$F = \overline{A} + B$	F = A PLUS AB	F = A PLUS AB PLUS 1
H L L H	$F = \overline{A \oplus B}$	F = A PLUS B	F = A PLUS B PLUS 1
H L H L	F = B	$F = (A + \overline{B})$ PLUS AB	$F = (A + \overline{B})$ PLUS AB PLUS 1
H L H H	F = AB	F = AB MINUS 1	F = AB
H H L L	F = 1	F = A PLUS A*	F = A PLUS A PLUS 1
H H L H	$F = A + \overline{B}$	F = (A + B) PLUS A	F = (A + B) PLUS A PLUS 1
H H H L	F = A + B	$F = (A + \overline{B})$ PLUS A	$F = (A + \overline{B})$ PLUS A PLUS 1
H H H H	F = A	F = A MINUS 1	F = A

*Each bit is shifted to the next more significant position.

TABLE 2

SELECTION S_3 S_2 S_1 S_0	ACTIVE-LOW DATA: M = H LOGIC FUNCTIONS	M = L; ARITHMETIC OPERATIONS: C_n = 0 = L (no carry)	C_n = 1 = H (with carry)
L L L L	$F = \overline{A}$	F = A MINUS 1	F = A
L L L H	$F = \overline{AB}$	F = AB MINUS 1	F = AB
L L H L	$F = \overline{A} + B$	$F = A\overline{B}$ MINUS 1	$F = A\overline{B}$
L L H H	F = 1	F = MINUS 1 (2's COMP)	F = ZERO
L H L L	$F = \overline{A + B}$	$F = A$ PLUS $(A + \overline{B})$	$F = A$ PLUS $(A + \overline{B})$ PLUS 1
L H L H	$F = \overline{B}$	$F = AB$ PLUS $(A + \overline{B})$	$F = AB$ PLUS $(A + \overline{B})$ PLUS 1
L H H L	$F = \overline{A \oplus B}$	F = A MINUS B MINUS 1	F = A MINUS B
L H H H	$F = A + \overline{B}$	$F = A + \overline{B}$	$F = (A + \overline{B})$ PLUS 1
H L L L	$F = \overline{A}B$	F = A PLUS (A + B)	F = A PLUS (A + B) PLUS 1
H L L H	$F = A \oplus B$	F = A PLUS B	F = A PLUS B PLUS 1
H L H L	F = B	$F = A\overline{B}$ PLUS $(A + B)$	$F = A\overline{B}$ PLUS $(A + B)$ PLUS 1
H L H H	F = A + B	F = A + B	F = (A + B) PLUS 1
H H L L	F = 0	F = A PLUS A*	F = A PLUS A PLUS 1
H H L H	$F = A\overline{B}$	F = AB PLUS A	F = AB PLUS A PLUS 1
H H H L	F = AB	$F = A\overline{B}$ PLUS A	$F = A\overline{B}$ PLUS A PLUS 1
H H H H	F = A	F = A	F = A PLUS 1

LOGIC DIAGRAM



Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH} (All outputs except A = B)			−400	μA
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter			Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage					2			V
V_{IL}	Low-level input voltage							0.7	V
V_I	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage, any output except A = B		V_{CC} = MIN, V_{IL} = V_{IL}max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.4		V
I_{OH}	High-level output current, A = B output only		V_{CC} = MIN, V_{IL} = V_{IL}max,	V_{IH} = 2 V, V_{OH} = 5.5 V				100	μA
V_{OL}	Low-level output voltage	All outputs	V_{CC} = MIN, V_{IL} = V_{IL}max	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
					I_{OL} = 8 mA		0.35	0.6	
		Output G			I_{OL} = 16 mA		0.47	0.7	
I_I	Input current at max. input voltage	Mode input	V_{CC} = MAX,	V_I = 5.5 V				0.1	mA
		Any A or B input						0.3	
		Any S input						0.4	
		Carry input						0.5	
I_{IH}	High-level input current	Mode input	V_{CC} = MAX,	V_I = 2.7 V				20	μA
		Any A or B						60	
		Any S input						80	
		Carry input						100	
I_{IL}	Low-level input current	Mode input	V_{CC} = MAX,	V_I = 0.4 V				−0.36	mA
		Any A or B input						−1.08	
		Any S input						−1.44	
		Carry input						−2	
I_{OS}	Short-circuit output current, any output except A = B§		V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 1	Condition A		20	32	mA
					Condition B		21	35	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

NOTE 1:
With outputs open, I_{CC} is measured for the following conditions:
A. S0 through S3, M, and A inputs are at 4.5 V, all other inputs are grounded.
B. S0 through S3 and M are at 4.5 V, all other inputs are grounded.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C, (C_L = 15 pF, R_L = 2 kΩ, see Fig A on page 373)

Parameter¶	From (Input)	To (Output)	Test Conditions	Min	Typ	Max	Unit
t_{PLH}	C_n	C_{n+4}			14	24	ns
t_{PHL}					13	20	
t_{PLH}	Any A or B	C_{n+4}	M = 0 V, S0 = S3 = 4.5 V,		24	35	ns
t_{PHL}			S1 = S2 = 0 V ($\overline{SUM}$ mode)		17	30	
t_{PLH}	Any A or B	C_{n+4}	M = 0 V, S0 = S3 = 0 V		24	38	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		25	38	
t_{PLH}	C_n	Any F	M = 0 V		12	24	ns
t_{PHL}			($\overline{SUM}$ or $\overline{DIFF}$ mode)		12	20	
t_{PLH}	Any A or B	G	M = 0 V, S0 = S3 = 4.5 V,		12	29	ns
t_{PHL}			S1 = S2 = 0 V ($\overline{SUM}$ mode)		15	23	
t_{PLH}	Any A or B	G	M = 0 V, S0 = S3 = 0 V,		20	30	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		17	26	
t_{PLH}	Any A or B	P	M = 0 V, S0 = S3 = 4.5 V,		14	28	ns
t_{PHL}			S1 = S2 = 0 V, ($\overline{SUM}$ mode)		20	30	
t_{PLH}	Any A or B	P	M = 0 V, S0 = S3 = 0 V,		20	30	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		22	33	
t_{PLH}	A_i or B_i	F_i	M = 0 V, S0 = S3 = 4.5 V,		15	30	ns
t_{PHL}			S1 = S2 = 0 V ($\overline{SUM}$ mode)		13	20	
t_{PLH}	A_i or B_i	F_i	M = 0 V, S0 = S3 = 0 V,		21	32	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		15	23	
t_{PLH}	A_i or B_i	F_i	M = 4.5 V (logic mode)		17	30	ns
t_{PHL}					15	29	
t_{PLH}	Any A or B	A = B	M = 0 V, S0 = S3 = 0 V,		33	50	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		29	45	

¶t_{PLH} ≡ propagation delay time, low-to-high-level output
t_{PHL} ≡ propagation delay time, high-to-low-level output

PARAMETER MEASUREMENT INFORMATION

$\overline{\text{SUM}}$ MODE TEST TABLE

FUNCTION INPUTS: S0 = S3 = 4.5 V, S1 = S2 = M = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT APPLY 4.5 V	OTHER INPUT SAME BIT APPLY GND	OTHER DATA INPUTS APPLY 4.5 V	OTHER DATA INPUTS APPLY GND	OUTPUT UNDER TEST	OUTPUT WAVEFORM
t_{PLH}, t_{PHL}	A_i	B_i	None	Remaining A and B	C_n	F_i	In-Phase
t_{PLH}, t_{PHL}	B_i	A_i	None	Remaining A and B	C_n	F_i	In-Phase
t_{PLH}, t_{PHL}	A_i	B_i	None	None	Remaining A and B, C_n	P	In-Phase
t_{PLH}, t_{PHL}	B_i	A_i	None	None	Remaining A and B, C_n	P	In-Phase
t_{PLH}, t_{PHL}	A_i	None	B_i	Remaining B	Remaining A, C_n	G	In-Phase
t_{PLH}, t_{PHL}	B_i	None	A_i	Remaining B	Remaining A, C_n	G	In-Phase
t_{PLH}, t_{PHL}	C_n	None	None	All A	All B	Any F or C_{n+4}	In-Phase
t_{PLH}, t_{PHL}	A_i	None	B_i	Remaining B	Remaining A, C_n	C_{n+4}	Out-of-Phase
t_{PLH}, t_{PHL}	B_i	None	A_i	Remaining B	Remaining A, C_n	C_{n+4}	Out-of-Phase

$\overline{\text{DIFF}}$ MODE TEST TABLE

FUNCTION INPUTS: S1 = S2 = 4.5 V, S0 = S3 = M = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT APPLY 4.5 V	OTHER INPUT SAME BIT APPLY GND	OTHER DATA INPUTS APPLY 4.5 V	OTHER DATA INPUTS APPLY GND	OUTPUT UNDER TEST	OUTPUT WAVEFORM
t_{PLH}, t_{PHL}	A_i	None	B_i	Remaining A	Remaining B, C_n	F_i	In-Phase
t_{PLH}, t_{PHL}	B_i	A_i	None	Remaining A	Remaining B, C_n	F_i	Out-of-Phase
t_{PLH}, t_{PHL}	A_i	None	B_i	None	Remaining A and B, C_n	P	In-Phase
t_{PLH}, t_{PHL}	B_i	A_i	None	None	Remaining A and B, C_n	P	Out-of-Phase
t_{PLH}, t_{PHL}	A_i	B_i	None	None	Remaining A and B, C_n	G	In-Phase
t_{PLH}, t_{PHL}	B_i	None	A_i	None	Remaining A and B, C_n	G	Out-of-Phase
t_{PLH}, t_{PHL}	A_i	None	B_i	Remaining A	Remaining B, C_n	A = B	In-Phase
t_{PLH}, t_{PHL}	B_i	A_i	None	Remaining A	Remaining B, C_n	A = B	Out-of Phase
t_{PLH}, t_{PHL}	C_n	None	None	All A and B	None	C_{n+4} or any F	In-Phase
t_{PLH}, t_{PHL}	A_i	B_i	None	None	Remaining A, B, C_n	C_{n+4}	Out-of-Phase
t_{PLH}, t_{PHL}	B_i	None	A_i	None	Remaining A, B, C_n	C_{n+4}	In -Phase

LOGIC MODE TEST TABLE

FUNCTION INPUTS: S1 = S2 = M = 4.5 V, S0 = S3 = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT APPLY 4.5 V	OTHER INPUT SAME BIT APPLY GND	OTHER DATA INPUTS APPLY 4.5 V	OTHER DATA INPUTS APPLY GND	OUTPUT UNDER TEST	OUTPUT WAVEFORM
t_{PLH}, t_{PHL}	A_i	B_i	None	None	Remaining A and B, C_n	F_i	Out-of-Phase
t_{PLH}, t_{PHL}	B_i	A_i	None	None	Remaining A and B, C_n	F_i	Out-of-Phase

54LS190 Synchronous BCD Decade Up/Down Counter
54LS191 Synchronous 4-Bit Binary Up/Down Counter

FEATURES
- **Single up/down count mode control line**
- **Asynchronous parallel load**
- **Count enable, parallel load control inputs**
- **Cascadable**

DESCRIPTION
The 54LS190 and 54LS191 are synchronous, reversible up/down counters having a complexity of 58 equivalent gates. The 54LS191 is a 4-bit binary counter and the 54LS190 is a BCD counter. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes normally associated with asynchronous (ripple clock) counters.

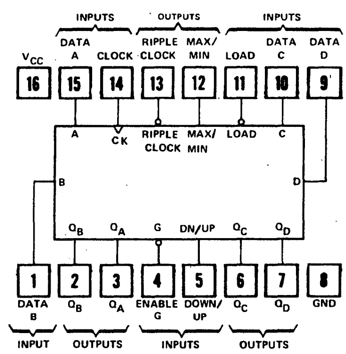
The outputs of the four master-slave flip-flops are triggered on a low-to-high-level transition of the clock input if the enable input is low. A high at the enable input inhibits counting. Level changes at the enable and down/up inputs should be made only when the clock input is high. The direction of the count is determined by the level of the down/up input. When low, the counter counts up and when high, it counts down.

These counters are fully programmable; that is, the outputs may be preset to either level by placing a low on the load input and entering the desired data at the data inputs. The output will change to agree with the data inputs independently of the level of the clock input. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

The clock, down/up, and load inputs are buffered to lower the drive requirement which significantly reduces the number of clock drivers, etc., required for long parallel words.

Two outputs have been made available to perform the cascading function: ripple clock and maximum/minimum count. The latter output produces a high-level output pulse with a duration approximately equal to one complete cycle of the clock when the counter overflows or underflows. The ripple clock output produces a low-level output pulse equal in width to the low-level portion of the clock input when an overflow or underflow condition exists. The counters can be easily cascaded by feeding the ripple clock output to the enable input of the succeeding counter if parallel clocking is used, or to the clock input if parallel enabling is used. The maximum/minimum count output can be used to accomplish look-ahead for high-speed operation.

PIN-OUT DIAGRAM



LOW INPUT TO LOAD SETS $Q_A = A$, $Q_B = B$, $Q_C = C$, $Q_D = D$

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−400	μA
Low-level output current, I_{OL}			8	mA
Input clock frequency, f_{clock}	0		20	MHz
Width of clock input pulse, $t_{w(clock)}$	25			ns
Width of load input pulse, $t_{w(load)}$	35			ns
Data setup time, t_{setup} (See Figures 1 and 2)	20			ns
Enable to clock setup time, t_{setup}	20			ns
Data hold time, t_{hold}	0			ns
Operating free-air temperature, T_A	−55		125	°C

Synchronous BCD Decade Up/Down Counter — 54LS190

Synchronous 4-Bit Binary Up/Down Counter — 54LS191

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter			Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage					2			V
V_{IL}	Low-level input voltage							0.7	V
V_I	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL}max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL}max	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
					I_{OL} = 8 mA		0.3	0.45	
I_I	High-level input current at maximum input voltage	Enable	V_{CC} = MAX,	V_I = 7 V				0.3	mA
		Others						0.1	
I_{IH}	High-level input current	Enable	V_{CC} = MAX,	V_I = 2.7 V				60	μA
		Others						20	
I_{IL}	Low-level input current	Enable	V_{CC} = MAX,	V_I = 0.4 V				−1.08	mA
		Others						−0.4	
I_{OS}	Short-circuit output current§		V_{CC} = MAX,			−15		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 1			20	35	mA

†For conditions shown as MAX or MIN, use appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE 1:
I_{CC} is measured with all inputs grounded and all outputs open.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

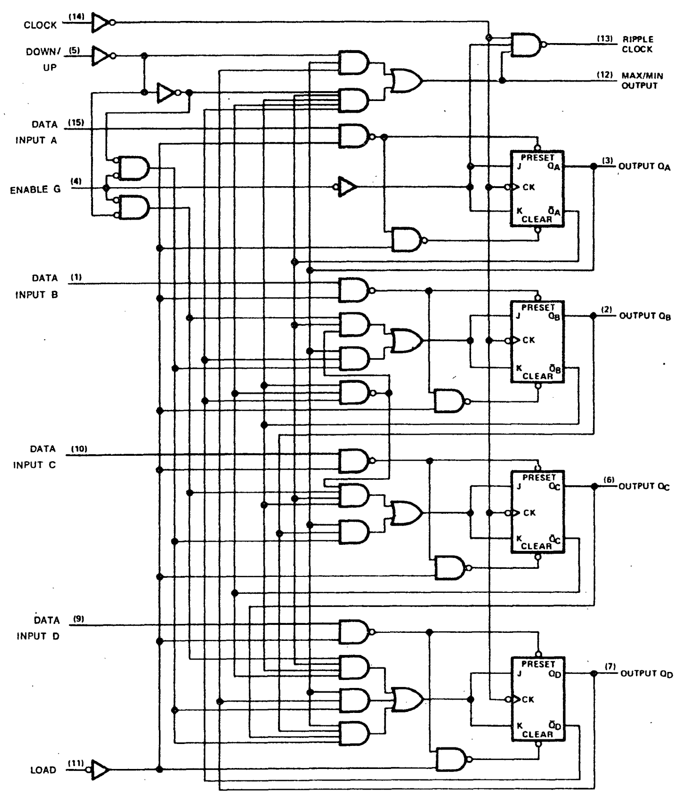
Parameter¶	From (Input)	To (Output)	Test Conditions	Min	Typ	Max	Unit
f_{max}			C_L = 15 pF, R_L = 2 kΩ, See Figures 1 and 3 thru 7	20	25		MHz
t_{PLH}	Load	Q_A, G_B, Q_C, Q_D			22	33	ns
t_{PHL}					33	50	
t_{PLH}	Data A, B, C, D	Q_A, Q_B, Q_C, Q_D			14	22	ns
t_{PHL}					35	50	
t_{PLH}	Clock	Ripple Clock			13	20	ns
t_{PHL}					16	24	
t_{PLH}	Clock	Q_A, Q_B, Q_C, Q_D			16	24	ns
t_{PHL}					24	36	
t_{PLH}	Clock	Max/Min			28	42	ns
t_{PHL}					37	52	
t_{PLH}	Down/Up	Ripple Clock			30	45	ns
t_{PHL}					30	45	
t_{PLH}	Down/Up	Max/Min			21	33	ns
t_{PHL}					22	33	
t_{PLH}	Enable	Ripple Clock			21	33	ns
t_{PHL}					22	33	

¶f_{max} ≡ maximum clock frequency
t_{PLH} ≡ propagation delay time, low-to-high-level output
t_{PHL} ≡ propagation delay time, high-to-low-level output

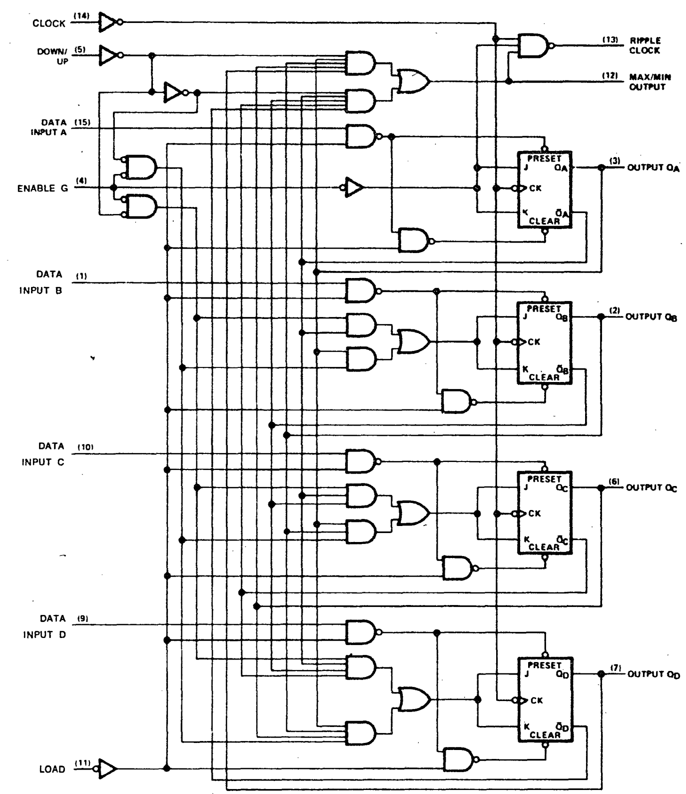
Tentative data, subject to change without notice.

LOGIC DIAGRAMS

54LS190



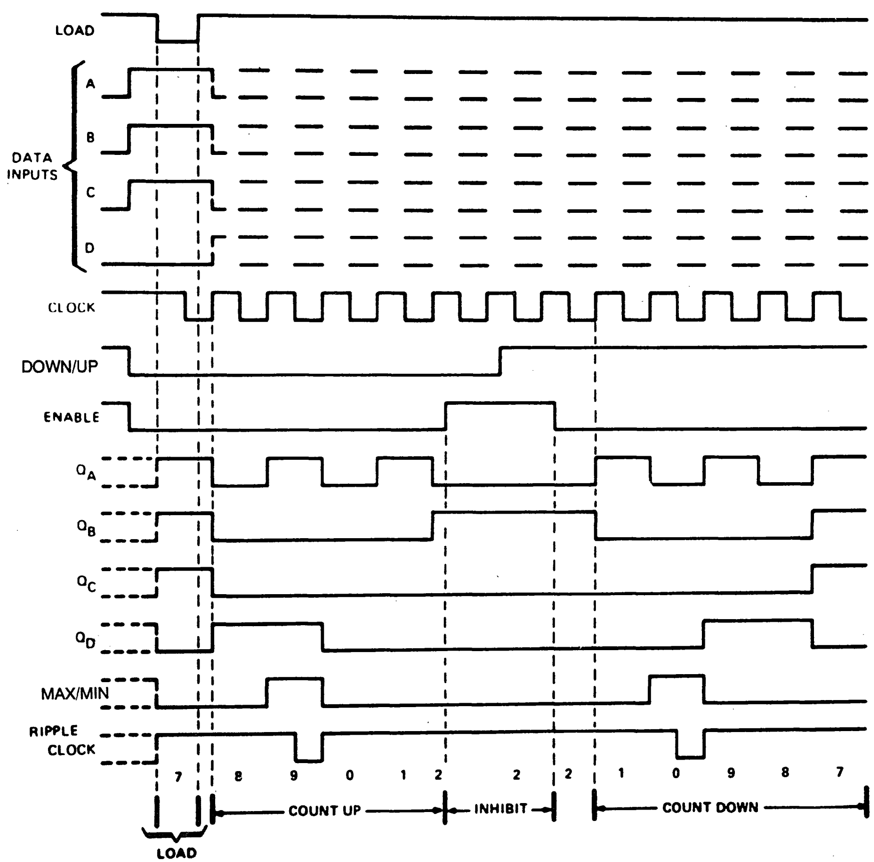
54LS191



54LS190 TYPICAL LOAD, COUNT AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

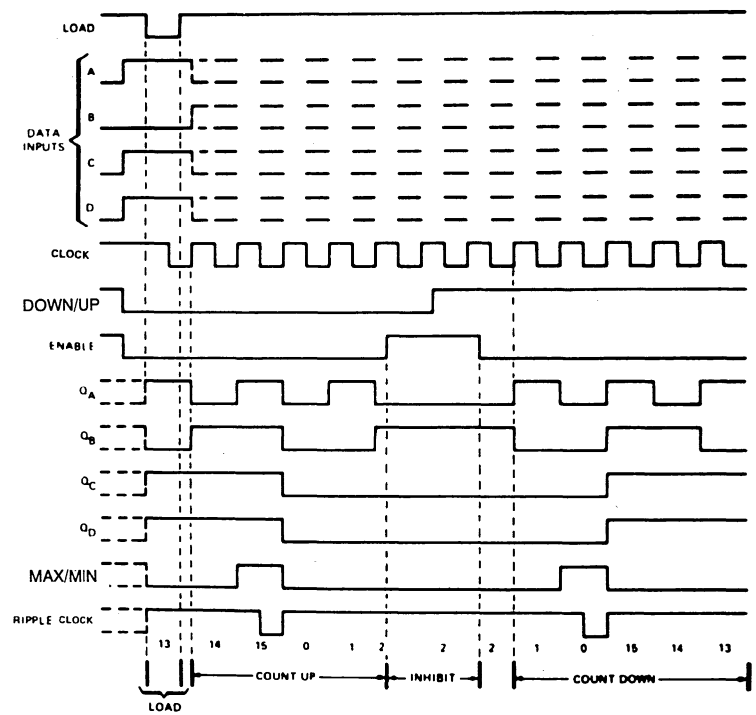
1. Load (preset) to BCD seven.
2. Count up to eight, nine (maximum), zero, one, and two.
3. Inhibit.
4. Count down to one, zero (minimum), nine, eight, and seven.



54LS191 TYPICAL LOAD, COUNT AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

1. Load (preset) to binary thirteen.
2. Count up to fourteen, fifteen (maximum), zero, one, and two.
3. Inhibit.
4. Count down to one, zero (minimum), fifteen, fourteen, and thirteen.



PARAMETER MEASUREMENT INFORMATION

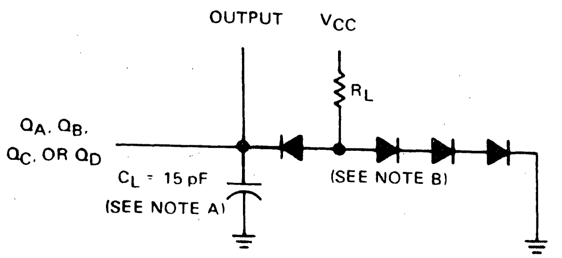


FIGURE 1—LOAD CIRCUIT FOR SWITCHING TIME MEASUREMENT

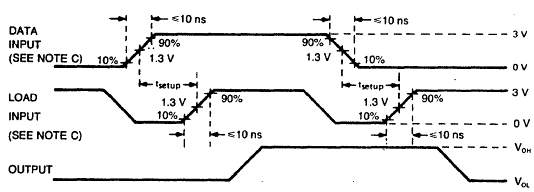
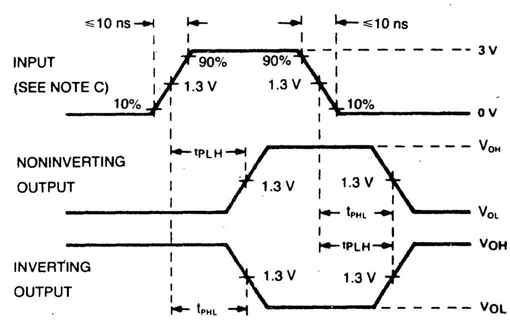


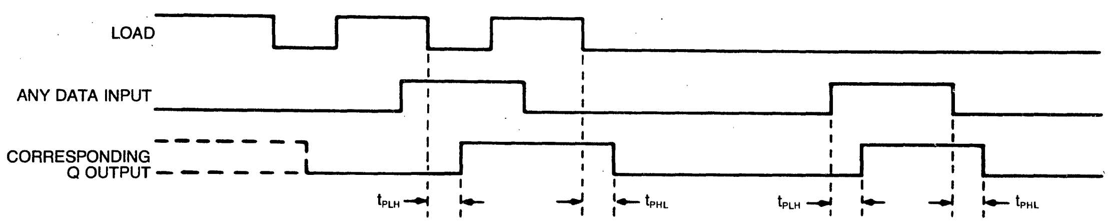
FIGURE 2—DATA SETUP TIME VOLTAGE WAVEFORMS



See waveform sequences in figures 4 through 7 for propagation times from a specific input to a specific output. For simplification, pulse rise times, reference levels, etc., have not been shown in figures 4 through 7.

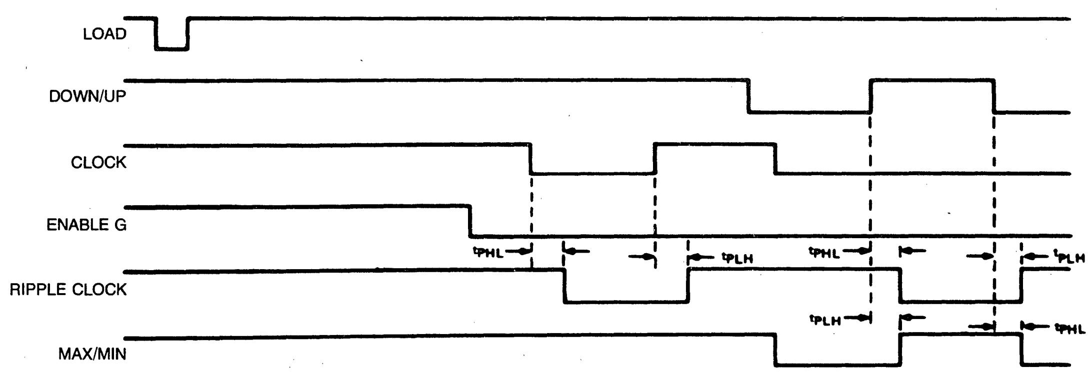
FIGURE 3—GENERAL VOLTAGE WAVEFORMS FOR PROPAGATION TIMES

NOTES:
A. C_L includes probe and jig capacitance.
B. All diodes are 1N3064
C. The input pulses are supplied by generators having the following characteristics: Z_{out} = 50 Ω, duty cycle ≤ 50%, PRR ≤ 1 MHz.



NOTE E: Conditions on other inputs are irrelevant.

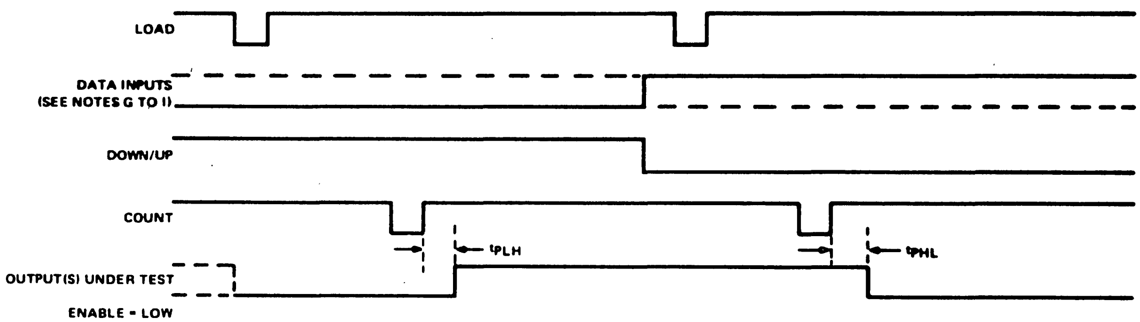
FIGURE 4 — LOAD TO OUTPUT AND DATA TO OUTPUT



NOTE F: All data inputs are low.

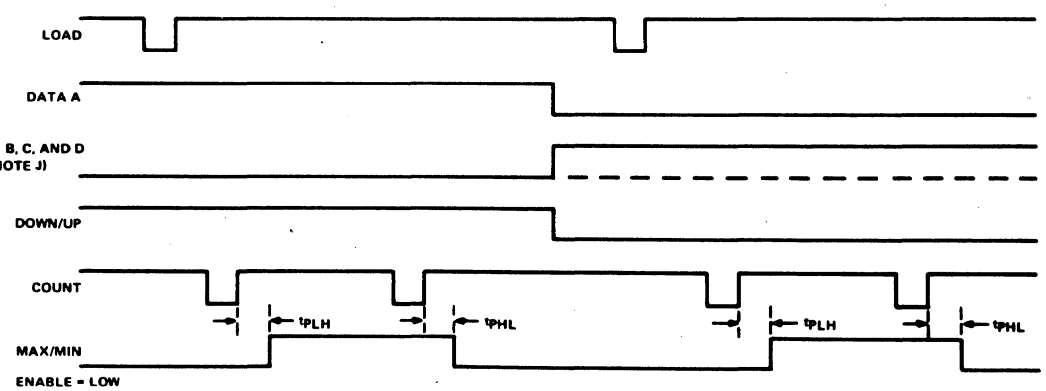
FIGURE 5 — ENABLE TO RIPPLE CLOCK, CLOCK TO RIPPLE CLOCK, DOWN/UP TO MAX/MIN

PARAMETER MEASUREMENT INFORMATION (Continued)



NOTES:
G. to test Q_A, Q_B, and Q_C outputs of 54LS190: Data inputs A, B, and C are shown by the solid line. Data input D is shown by the dashed line.
H. To test Q_D output of 54LS190: Data inputs A and D are shown by the solid line. Data inputs B and C are held at the low logic level.
I. To test Q_A, Q_B, Q_C, and Q_D outputs of 54LS191: All four data inputs are shown by the solid line.

FIGURE 6—CLOCK TO OUTPUT



NOTE J:
Data inputs B and C are shown by the dashed line for the 54LS190 and the solid line for the 54LS191: Data input D is shown by the solid line for both devices.

FIGURE 7—CLOCK TO MAX/MIN

54LS192 Synchronous BCD Decade Up/Down Counter

54LS193 Synchronous 4-Bit Binary Up/Down Counter

FEATURES

- **Separate clock inputs for count-up, count-down**
- **Asynchronous parallel load and clear**
- **Cascadable**

DESCRIPTION

These monolithic circuits are synchronous reversible (up/down) counters having a complexity of 55 equivalent gates. The 54LS192 is a BCD counter and the 54LS193 is a 4-bit binary counter. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincidently with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple-clock) counters.

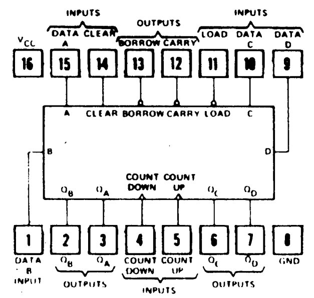
The outputs of the four master-slave flip-flops are triggered by a low-to-high-level transition of either count (clock) input. The direction of counting is determined by which count inputs is pulsed while the other count input is high.

All four counters are fully programmable; that is, each output may be preset to either level by entering the desired data at the data inputs while the load input is low. The output will change to agree with the data inputs independently of the count pulses. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

A clear input has been provided which forces all outputs to the low level when a high level is applied. The clear function is independent of the count and load inputs. The clear, count, and load inputs are buffered to lower the drive requirements. This reduces the number of clock drivers, etc., required for long words.

These counters were designed to be cascaded without the need for external circuitry. Both borrow and carry outputs are available to cascade both the up-and down-counting functions. The borrow output produces a pulse equal in width to the count-down input when the counter underflows. Similarly, the carry output produces a pulse equal in width to the count-down input when an overflow condition exists. The counters can then be easily cascaded by feeding the borrow and carry outputs to the count-down and count-up inputs respectively of the succeeding counter.

PIN-OUT DIAGRAM



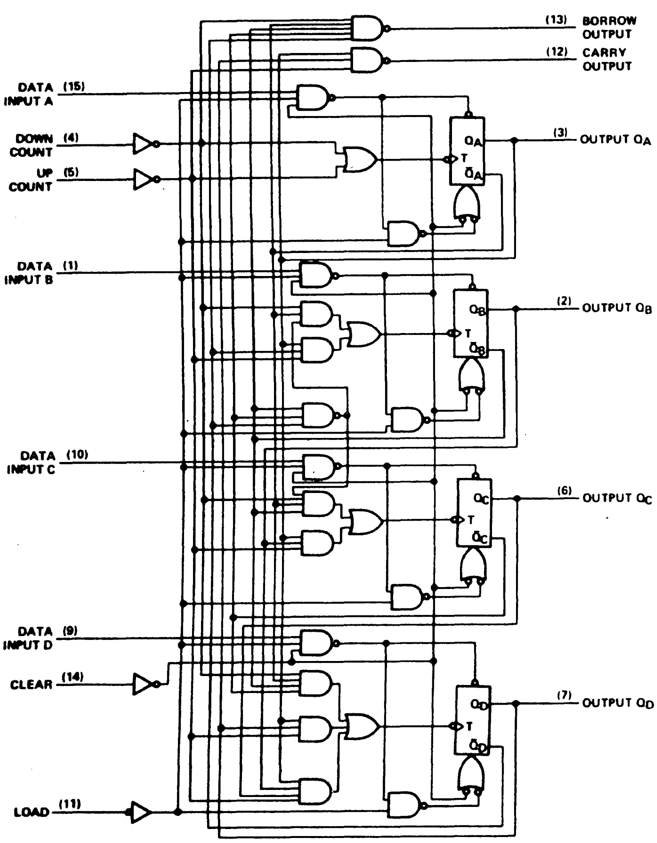
Low input to load sets $Q_A = A$, $Q_B = B$, $Q_C = C$, and $Q_D = D$

Synchronous BCD Decade Up/Down Counter — 54LS192

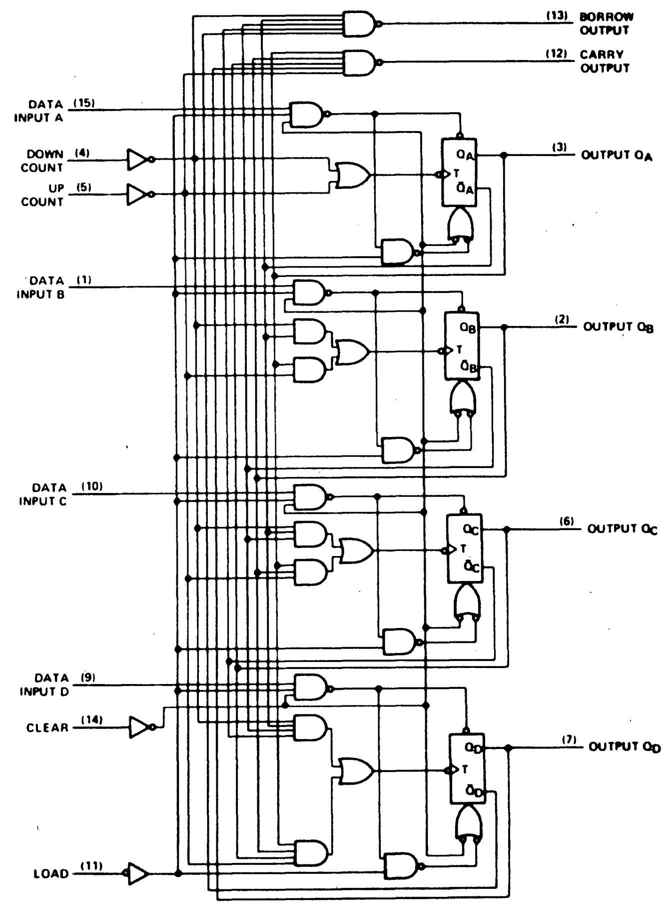
Synchronous 4-Bit Binary Up/Down Counter — 54LS193

LOGIC DIAGRAMS

54LS192



54LS193



Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−400	μA
Low-level output current, I_{OL}			18	mA
Count frequency, f_{count}	0		25	MHz
Width of any input pulse, t_w	20			ns
Data setup time, t_{setup} (see Figure 1)	20			ns
Data hold time, t_{hold}	0			ns
Operating free-air temperature range, T_A	−55		125	°C

54LS192 Synchronous BCD Decade Up/Down Counter
54LS193 Synchronous 4-Bit Binary Up/Down Counter

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	$I_I = -18$			−1.5	V	
V_{OH}	High-level output voltage	V_{CC} = MIN, $V_{IL} = V_{IL}$max,	V_{IH} = 2 V, $I_{OH} = -400\ \mu A$		2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN,	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
		$V_{IL} = V_{IL}$max		I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.4	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current	V_{CC} = MAX,	See Note 1			19	34	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE 1:
I_{CC} is measured with all outputs open, clear and load inputs grounded, and all other inputs at 4.5 V.

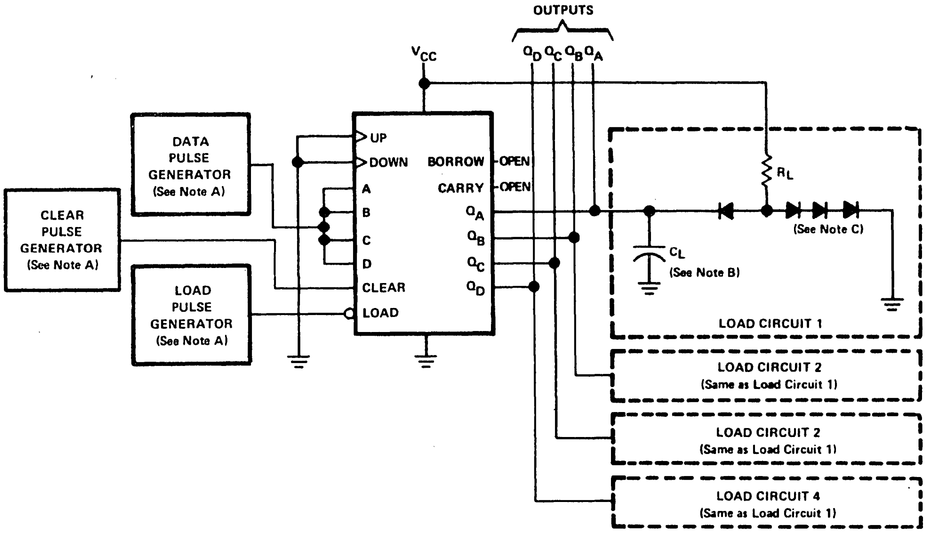
Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter¶	From (Input)	To (Output)	Test Conditions	Min	Typ	Max	Unit
f_{max}			C_L = 15 pF, R_L = 2 kΩ, See Figures 1 and 2	25	32		MHz
t_{PLH}	Count-up	Carry			17	26	ns
t_{PHL}					16	24	
t_{PLH}	Count-down	Borrow			16	24	ns
t_{PHL}					16	24	
t_{PLH}	Either Count	Q			25	38	ns
t_{PHL}					31	47	
t_{PLH}	Load	Q			27	40	ns
t_{PHL}					29	40	
t_{PHL}	Clear	Q			22	35	ns

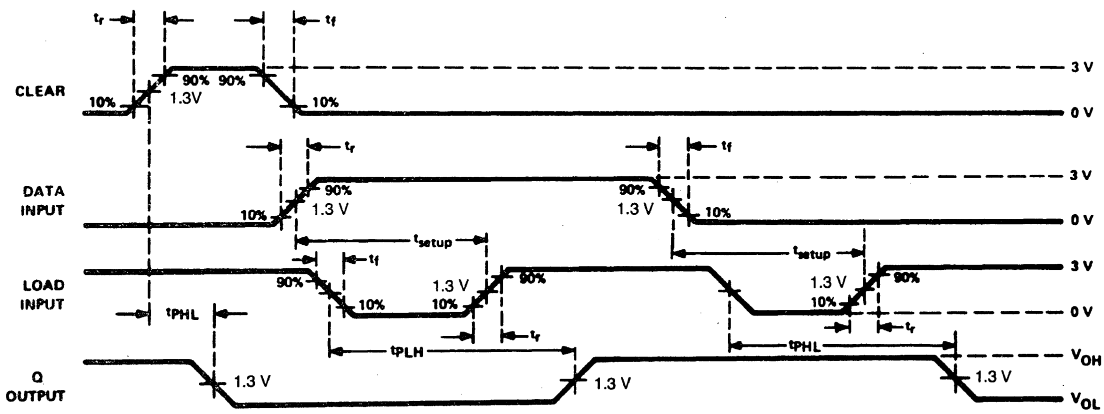
¶f_{max} ≡ maximum clock frequency
t_{PLH} ≡ propagation delay time, low-to-high-level output
t_{PHL} ≡ propagation delay time, high-to-low-level output

Tentative data, subject to change without notice

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT

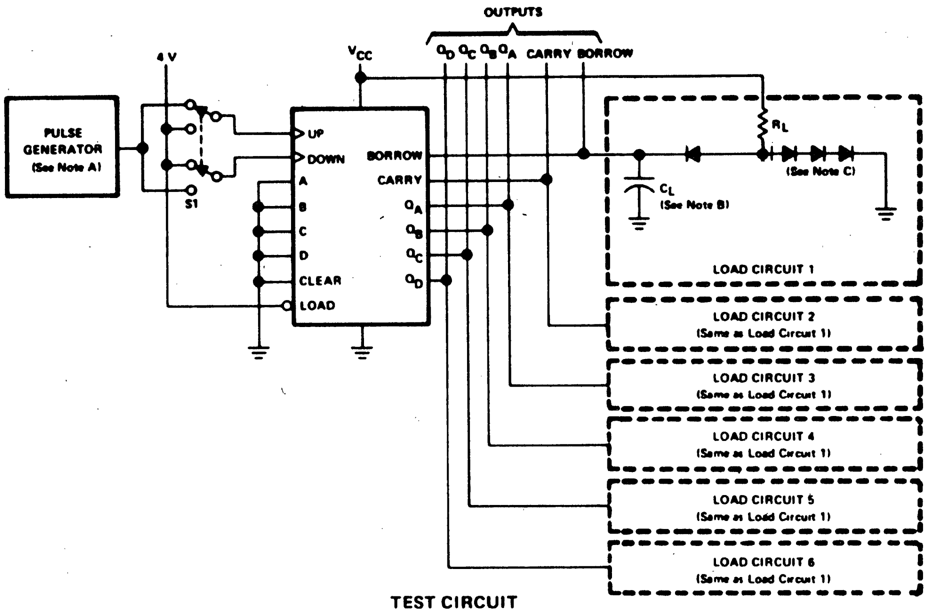


VOLTAGE WAVEFORMS

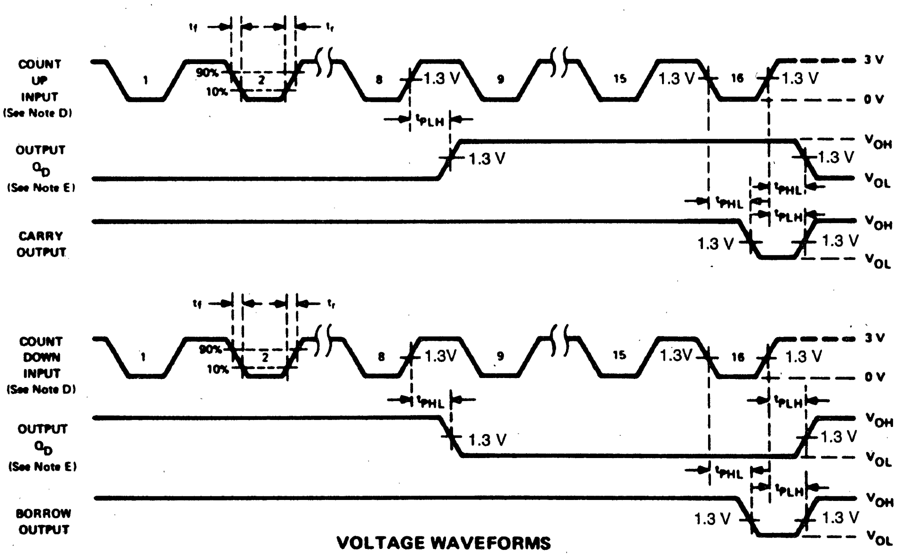
NOTES:
A. The pulse generators have the following characteristics: $Z_{out} \approx 50\ \Omega$ and for the data pulse generator PRR $\leq$500 kHz, duty cycle = 50%; for the load pulse generator PRR is two times data PRR, duty cycle =50%.
B. C_L includes probe and jig capacitance.
C. Diodes are 1N3064.
D. t_r and $t_f \leq 7$ ns.

FIGURE 1 — CLEAR, SETUP, AND LOAD TIMES

PARAMETER MEASUREMENT INFORMATION (Continued)



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:
A. The pulse generator has the following characteristics: PRR ≤ 1 MHz, $Z_{out} \approx 50\ \Omega$, duty cycle = 50 %.
B. C_L includes probe and jig capacitance.
C. Diodes are 1N3064.
D. Count-up and count-down pulse shown is for the 54LS193 binary counter. Count cycle for 54LS192 decade counter is 1 through 10.
E. Waveforms for outputs Q_A, Q_B, and Q_C are omitted to simplify the drawing.
F. t_r and t_f ≤ 7 ns.

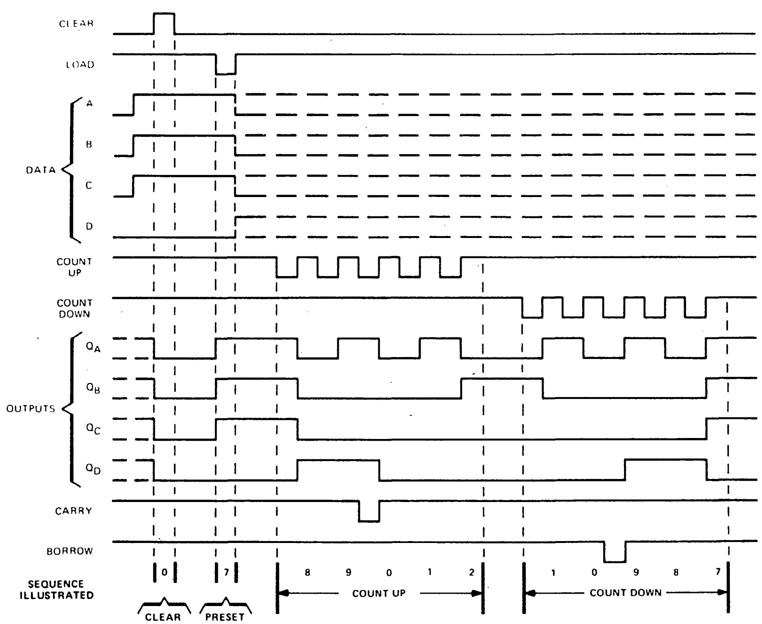
FIGURE 2—PROPAGATION DELAY TIMES

TYPICAL CLEAR, LOAD, AND COUNT SEQUENCES

54LS192

Illustrated below is the following sequence:

1. Clear outputs to zero.
2. Load (preset) to BCD seven.
3. Count up to eight, nine, carry, zero, one, and two.
4. Count down to one, zero, borrow, nine, eight, and seven.

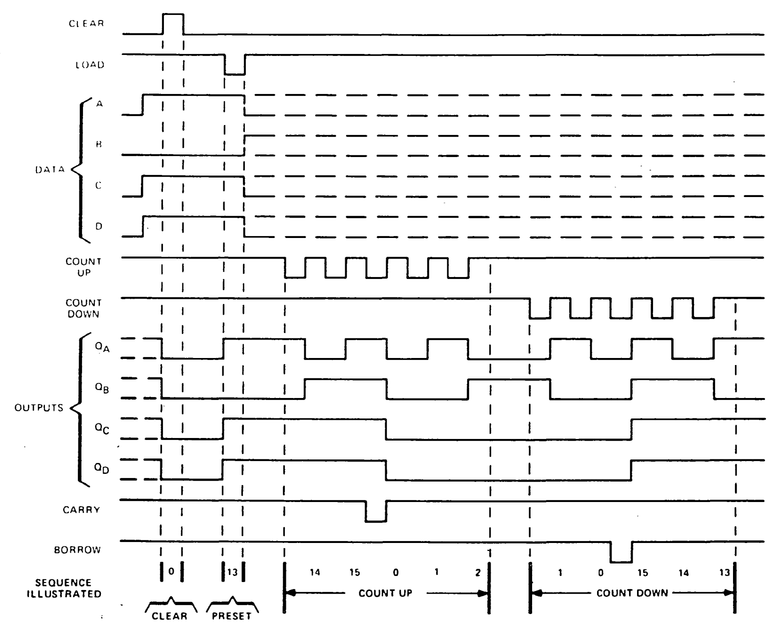


NOTES: A. Clear overrides load, data, and count inputs.
B. When counting up, count-down input must be high; when counting down, count-up input must be high.

54LS193

Illustrated below is the following sequence:

1. Clear outputs to zero.
2. Load (preset) to binary thirteen.
3. Count up to fourteen, fifteen, carry, zero, one, and two.
4. Count down to one, zero, borrow, fifteen, fourteen, and thirteen.



NOTES: A. Clear overrides load, data, and count inputs.
B. When counting up, count-down input must be high; when counting down, count-up input must be high.

4-Bit Universal Shift Register

DESCRIPTION

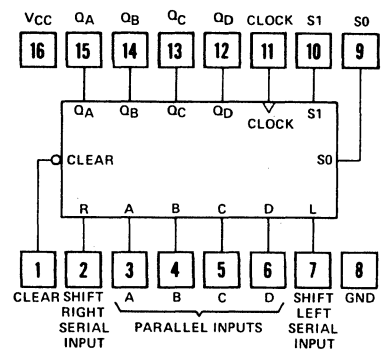
This bidirectional shift register is designed to incorporate virtually all of the features a system designer may want in a shift register. The circuit contains 46 equivalent gates and features parallel inputs, parallel outputs, right-shift and left-shift inputs, operating-mode-control inputs, and a direct overriding clear line. The register has four distinct modes of operation, namely:

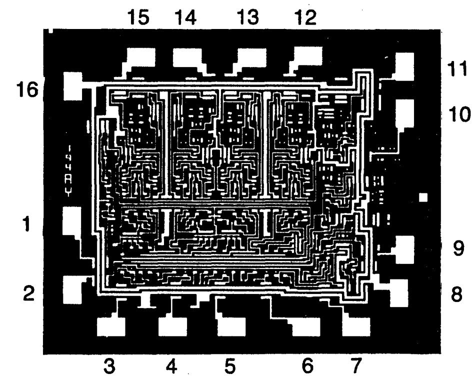
- Parallel (broadside) load
- Shift right (in the direction Q_A toward Q_D)
- Shift left (in the direction Q_D toward Q_A)
- Inhibit clock (do nothing)

Synchronous parallel loading is accomplished by applying the four bits of data and taking both mode control inputs, S0 and S1, high. The data are loaded into the associated flip-flops and appear at the outputs after the positive transition of the clock input. During loading, serial data flow is inhibited.

Shift right is accomplished synchronously with the rising edge of the clock pulse when S0 is high and S1 is low. Serial data for this mode is entered at the shift-right data input. When S0 is low and S1 is high, data shifts left synchronously and new data is entered at the shift-left serial input. Clocking of the flip-flop is inhibited when both mode control inputs are low.

PIN-OUT DIAGRAM





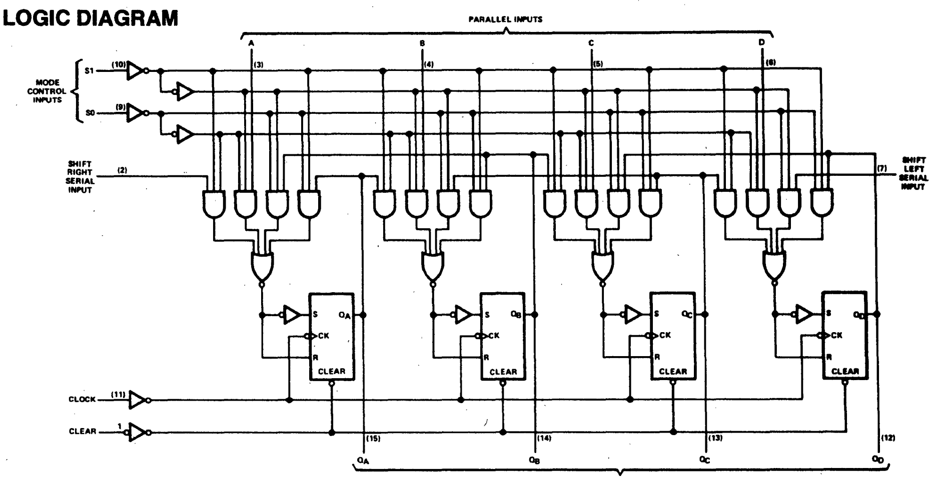
Die Size .067 x .082

FUNCTION TABLE

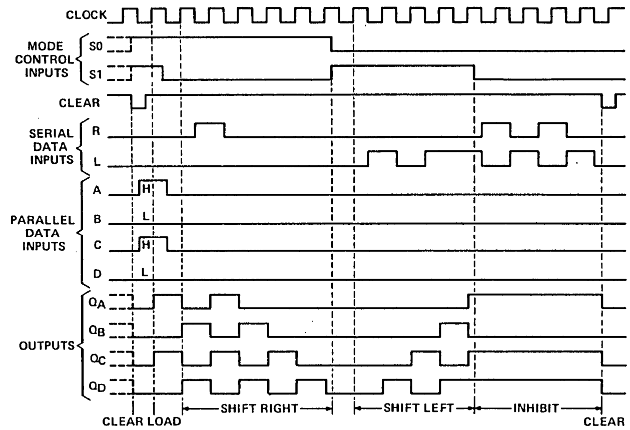
INPUTS										OUTPUTS			
CLEAR	MODE		CLOCK	SERIAL		PARALLEL				Q_A	Q_B	Q_C	Q_D
	S1	S0		LEFT	RIGHT	A	B	C	D				
L	X	X	X	X	X	X	X	X	X	L	L	L	L
H	X	X	L	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
H	H	H	↑	X	X	a	b	c	d	a	b	c	d
H	L	H	↑	X	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}
H	L	H	↑	X	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}
H	H	L	↑	H	X	X	X	X	X	Q_{Bn}	Q_{Cn}	Q_{Dn}	H
H	H	L	↑	L	X	X	X	X	X	Q_{Bn}	Q_{Cn}	Q_{Dn}	L
H	L	L	X	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}

H = high level (steady state)
L = low level (steady state)
X = irrelevant (any input, including transitions)
↑ = transition from low to high level
a, b, c, d = the level of steady-state input at inputs A, B, C, or D, respectively.
Q_{A0}, Q_{B0}, Q_{C0}, $2Q_{D0}$ = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established.
Q_{An}, Q_{Bn}, Q_{Cn}, Q_{Dn} = the level of Q_A, Q_B, Q_C, respectively, before the most-recent ↑ transition of the clock.

LOGIC DIAGRAM



TYPICAL TIMING SEQUENCES



Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
High-level output current, I_{OH}				−400	μA
Low-level output current, I_{OL}				8	mA
Clock frequency, f_{clock}		0			MHz
Width of clock or clear pulse, t_w		30			ns
Setup time, t_{setup}	Mode control	30			ns
	Serial and parallel data	16			ns
	Clear inactive-state	18			ns
Hold time at any input, t_{hold}		0			ns
Operating free-air temperature, T_A		−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

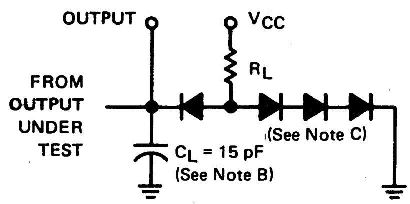
Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IL} = V_{IL}max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.5		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IL} = V_{IL}max	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.4	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current	V_{CC} = MAX,	See Note 1			15	23	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE 1:
With all outputs open, inputs A through D grounded, and 4.5 V applied to S0, S1, clear, and the serial inputs, I_{CC} is tested with a momentary GND, then 4.5 V, applied to clock.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C.

Parameter		Test Conditions	Min	Typ	Max	Unit
f_{max}	Maximum clock frequency	C_L = 15 pF,	30	40		MHz
t_{PHL}	Propagation delay time, high-to-low-level output from clear	R_L = 2 kΩ,		24	30	ns
t_{PLH}	Propagation delay time, low-to-high-level output from clock	See Figure 1		11	18	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock			15	22	ns

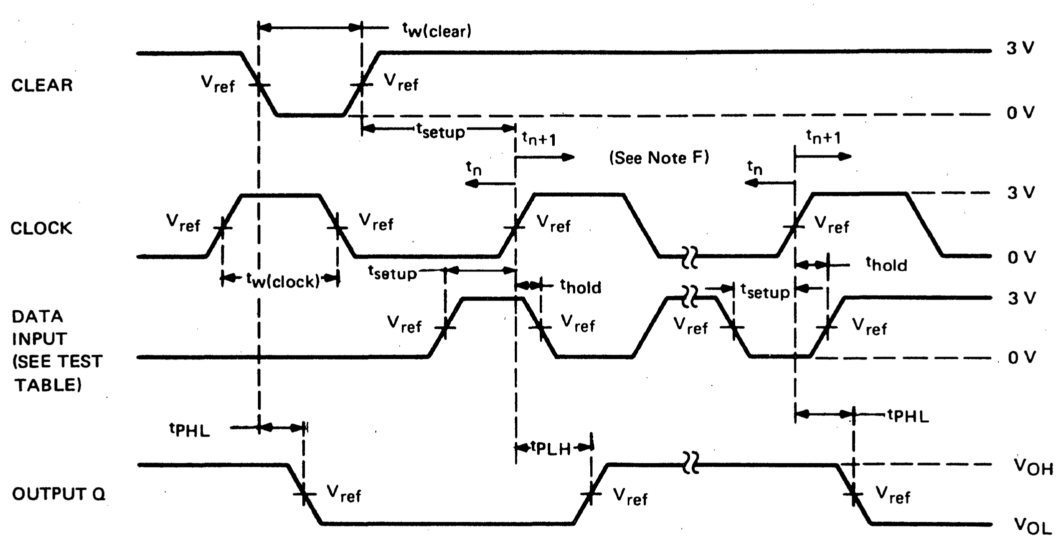
PARAMETER MEASUREMENT INFORMATION



LOAD FOR OUTPUT UNDER TEST

TEST TABLE FOR SYNCHRONOUS INPUTS

DATA INPUT FOR TEST	S1	S0	OUTPUT TESTED (SEE NOTE E)
A	4.5 V	4.5 V	Q_A at t_{n+1}
B	4.5 V	4.5 V	Q_B at t_{n+1}
C	4.5 V	4.5 V	Q_C at t_{n+1}
D	4.5 V	4.5 V	Q_D at t_{n+1}
L Serial Input	4.5 V	0 V	Q_A at t_{n+4}
R Serial Input	0 V	4.5 V	Q_D at t_{n+4}



VOLTAGE WAVEFORMS

NOTES:
A. The clock pulse generator has the following characteristics: $Z_{out} \approx 50\ \Omega$ and PRR ≤ 1 MHz, $t_r \leq 15$ ns and $t_f \leq 6$ ns. When testing f_{max}, vary PRR.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N3064 or 1N916.
D. A clear pulse is applied prior to each test.
E. V_{ref} = 1.3 V.
F. Proplagation delay times (t_{PLH} and t_{PHL}) are measured at t_{n+1}. Proper shifting of data is verified at t_{n+4} with a functional test.
G. t_n = bit time before clocking transition.
t_{n+1} = bit time after one clocking transition.
t_{n+4} = bit time after four clocking transitions.

FIGURE 1

4-Bit Parallel-Access Shift Register

54LS195A

DESCRIPTION

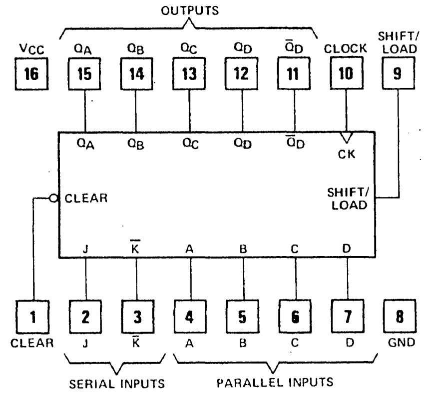
This 4-bit register features parallel inputs, parallel outputs, J-$\overline{K}$ serial inputs, shift/load control input, and a direct overriding clear. All inputs are buffered to lower the input drive requirements. The register has two modes of operation:

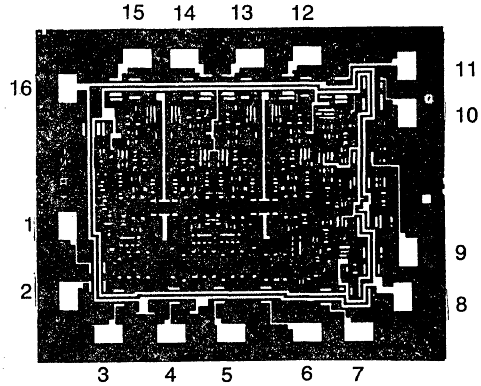
Parallel (broadside) load
Shift (in the direction Q_A toward Q_D)

Parallel loading is accomplished by applying the four bits of data and taking the shift/load control input low. The data is loaded into the associated flip-flop and appears at the outputs after the positive transition of the clock input. During loading, serial data flow is inhibited.

Shifting is accomplished synchronously when the shift/load control input is high. Serial data for this mode is entered at the J-$\overline{K}$ inputs. These inputs permit the first stage to perform as a J-$\overline{K}$, D-, or T-type flip-flop as shown in the function table.

PIN-OUT DIAGRAM





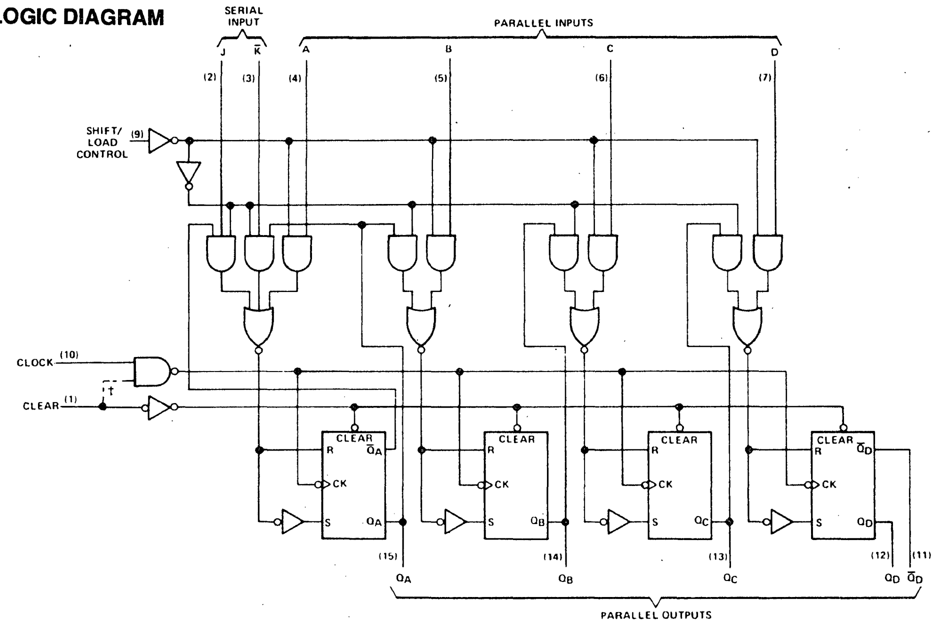
Die Size .067 x .082

FUNCTION TABLE

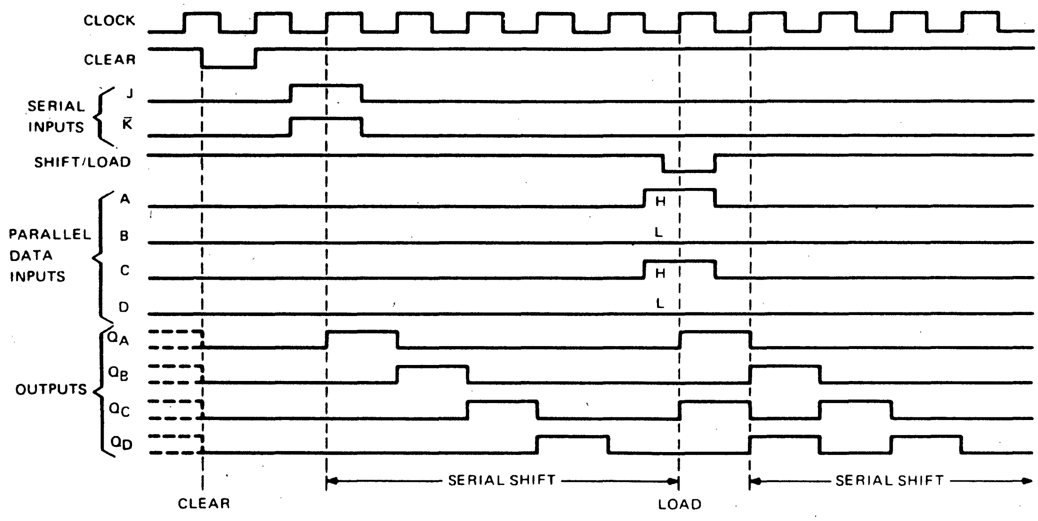
INPUTS									OUTPUTS				
CLEAR	SHIFT/ LOAD	CLOCK	SERIAL J	SERIAL $\overline{K}$	PARALLEL A	B	C	D	Q_A	Q_B	Q_C	Q_D	$\overline{Q}_D$
L	X	X	X	X	X	X	X	X	L	L	L	L	H
H	L	↑	X	X	a	b	c	d	a	b	c	d	$\overline{d}$
H	H	L	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}	$\overline{Q}_{D0}$
H	H	↑	L	H	X	X	X	X	Q_{A0}	Q_{A0}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	L	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	H	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	H	L	X	X	X	X	$\overline{Q}_{An}$	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$

H = high level (steady state)
L = low level (steady state)
X = irrelevant (any input, including transitions)
↑ = transition from low to high level
a, b, c, d = the level of steady-state input at A, B, C, or D, respectively.
Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established.
Q_{An}, Q_{Bn}, Q_{Cn} = the level of Q_A, Q_B, or Q_C, respectively, before the most- recent transition of the clock.

LOGIC DIAGRAM



TYPICAL TIMING SEQUENCES



Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
High-level output current, I_{OH}				−400	μA
Low-level output current, I_{OL}				8	mA
Clock frequency, f_{clock}		0			MHz
Width of clock pulse, $t_{w(clock)}$		18			ns
Width of clear input pulse, $t_{w(clear)}$		20			ns
Setup time, t_{setup} (see Figure 1)	Shift/load	25			ns
	Serial and parallel data	15			ns
	Clear inactive-state	25			ns
Shift/load release time, $t_{release}$ (see Figure 1)				0	ns
Serial and parallel data hold time, t_{hold} (see Figure 1)		0			ns
Operating free-air temperature, T_A		−55		125	°C

Switching Characteristics, $V_{CC} = 5$ V, $T_A = 25°C$.

	Parameter	Test Conditions	Min	Typ	Max	Unit
f_{max}	Maximum clock frequency	$C_L = 15$ pF, $R_L = 2$ kΩ, See Figure 1	30	40		MHz
t_{PHL}	Propagation delay time, high-to-low-level output from clear			27	35	ns
t_{PLH}	Propagation delay time, low-to-high-level output from clock			10	17	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock			13	20	ns

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

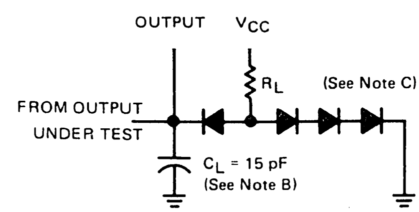
Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IL} = V_{IL}max,	V_{IH} = 2 V, I_{OH} = −400 μA		2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IL} = V_{IL}max	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.4	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current	V_{CC} = MAX,	See Note 1			14	21	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

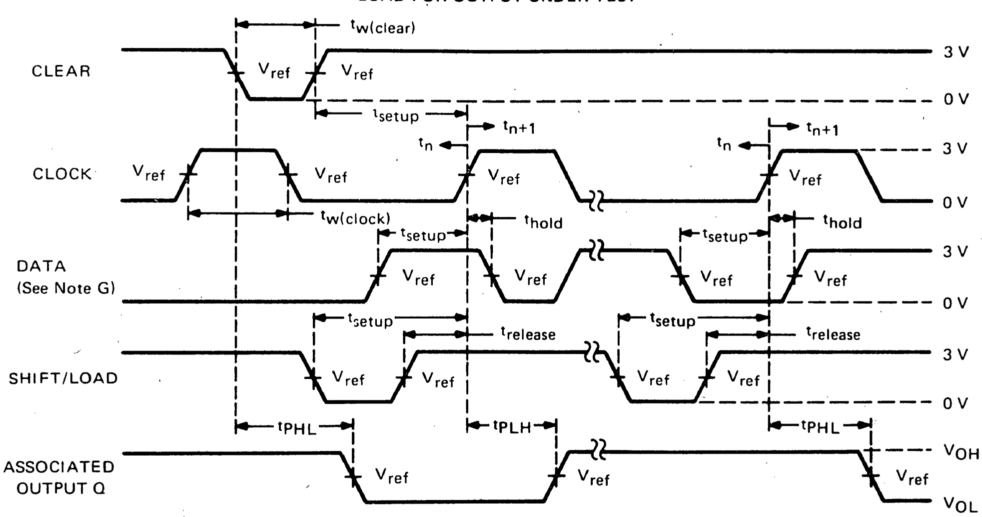
NOTE 1:
With all outputs open, shift/load grounded and 4.5 V applied to the J, $\bar{K}$, and data inputs, I_{CC} is measured by applying a momentary ground, followed by 4.5 V, to clear and then applying a momentary ground, followed by 4.5 V, to clock.

PARAMETER MEASUREMENT INFORMATION

FIGURE 1



LOAD FOR OUTPUT UNDER TEST



VOLTAGE WAVEFORMS

NOTES:
A. The clock pulse generator has the following characteristics: $Z_{out} \approx 50\ \Omega$ and PRR ≤ MHz, $t_r \le 15$ ns and $t_f \le 6$ ns. When testing f_{max}, vary the clock PRR.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N3064.
D. A clear pulse is applied prior to each test.
E. V_{ref} − 1.3 V.
F. Propagation delay times (t_{PLH} and t_{PHL}) are measured at t_{n+1}. Proper shifting of data is verified at t_{n+4} with a functional test.
G. J and $\bar{K}$ inputs are tested the same as data A, B, C, and D inputs except that shift/load input remains high.
H. t_n = bit time before clocking transition.
t_{n+1} = bit time after one clocking transition. t_{n+4} = bit time after four clocking transitions.

54LS196 Presettable BCD Decade Ripple Counter
54LS197 Presettable 4-Bit Binary Ripple Counter

FEATURES
- **BCD, bi-quinary, binary counting modes**
- **Asynchronous clear**
- **Fully programmable**
- **May be used as 4-Bit latches**

DESCRIPTION
These high-speed monolithic counters consist of four d-c coupled, master-slave flip-flops which are internally interconnected to provide either a divide-by-two and a divide-by-five counter (54LS196) or a divide-by-two and a divide-by-eight counter (54LS197). These four counters are fully programmable; that is, the outputs may be preset to any state by placing a low on the count/load input and entering the desired data at the data inputs. The outputs will change to agree with the data inputs independent of the state of the clocks.

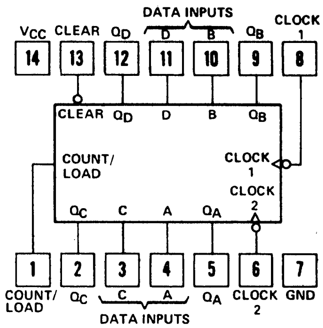
During the count operation, transfer of information to the outputs occurs on the negative-going edge of the clock pulse. These counters feature a direct clear which when taken low sets all outputs low regardless of the states of the clocks.

These counters may also be used as 4-bit latches by using the count/load input as the strobe and entering data at the data inputs. The outputs will directly follow the data inputs when the count/load is low, but will remain unchanged when the count/load is high and the clock inputs are inactive.

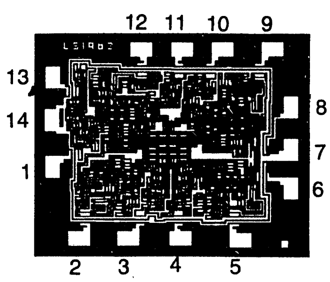
TYPICAL COUNT CONFIGURATIONS 54LS196
The output of flip-flop A is not internally connected to the succeeding flip-flops; therefore, the count may be operated in three independent modes:

1. When used as a binary-coded-decimal decade counter, the clock-2 input must be externally connected to the Q_A output. The clock-1 input receives the incoming count, and a count sequence is obtained in accordance with the BCD count sequence function table shown at the right.
2. If a symmetrical divide-by-ten count is desired for frequency synthesizers (or other applications requiring division of a binary count by a power of ten), the Q_D output must be externally connected to the clock-1 input. The input count is then applied at the clock-2 input and a divide-by-ten square wave is obtained at output Q_A in accordance with the bi-quinary function table.
3. For operation as a divide-by-two counter and a divide-by-five counter, no external interconnections are required. Flip-flop A is used as a binary element for the divide-by-two function. The clock-2 input is used to obtain binary divide-by-five operation at the Q_B, Q_C, and Q_D outputs. In this mode, the two counters operate independently; however, all four flip-flops are loaded and cleared simultaneously.

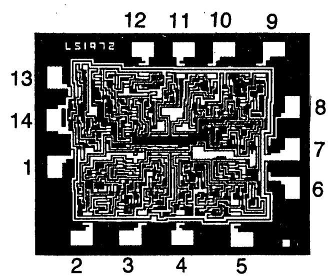
PIN-OUT DIAGRAM



54LS196



54LS197



Die Size .062 x .074

54LS196 FUNCTION TABLES

DECADE (BCD)
(See Note A)

COUNT	OUTPUTS			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

BI-QUINARY (5-2)
(See Note B)

COUNT	OUTPUTS			
	Q_A	Q_D	Q_C	Q_B
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	H	L	L	L
6	H	L	L	H
7	H	L	H	L
8	H	L	H	H
9	H	H	L	L

H = high level, L = low level
NOTES: A. Output Q_A connected to clock-2 input.
B. Output Q_D connected to clock-1 input.

Presettable BCD Decade Ripple Counter — 54LS196

Presettable 4-Bit Binary Ripple Counter — 54LS197

54LS197

The output of flip-flop A is not internally connected to the succeeding flip-flops, therefore the counter may be operated in two independent modes:

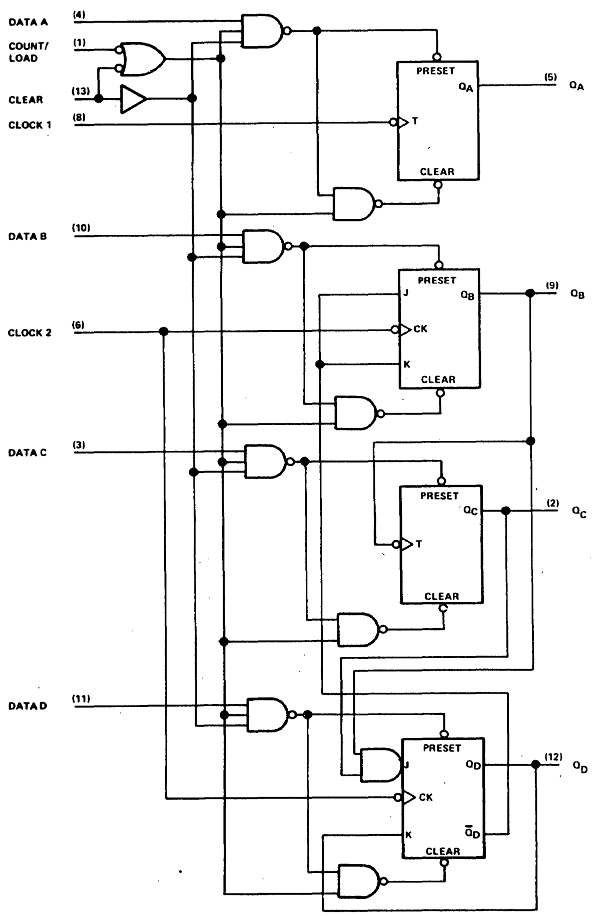
1. When used as a high-speed 4-bit ripple-through counter, output Q_A must be externally connected to the clock-2 input. The input count pulses are applied to the clock-1 input. Simultaneous divisions by 2, 4, 8, and 16 are performed at the Q_A, Q_B, Q_C, Q_D output as shown in the function table at right.
2. When used as a 3-bit ripple-through counter, the input count pulses are applied to the clock-2 input. Simultaneous frequency divisions by 2, 4, and 8 are available at the Q_B, Q_C, and Q_D outputs. Independent use of flip-flop A is available if the load and clear functions coincide with those of the 3-bit ripple-through counter.

54LS197 FUNCTION TABLE
(See Note A)

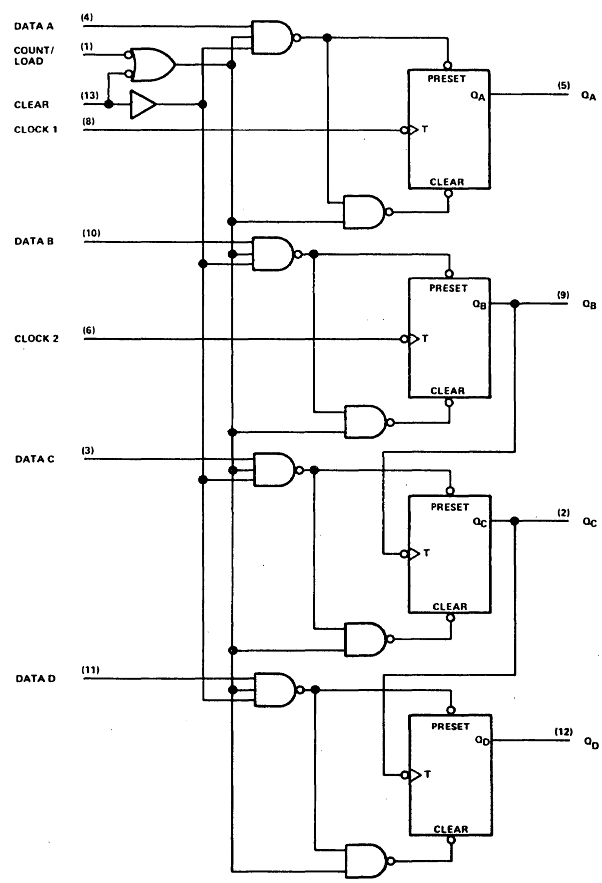
COUNT	OUTPUTS			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H
10	H	L	H	L
11	H	L	H	H
12	H	H	L	L
13	H	H	L	H
14	H	H	H	L
15	H	H	H	H

H = high level, L = low level
NOTE A: Output Q_A connected to clock-2 input.

LOGIC DIAGRAM 54LS196



LOGIC DIAGRAM 54LS197



Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter			Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage					2			V
V_{IL}	Low-level input voltage							0.7	V
V_I	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL}max,	V_{IH} = 2 V, I_{OH} = −400 μA			2.5	3.4	V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IL} = V_{IL}max	V_{IH} = 2 V,	I_{OL} = 4 mA¶		0.25	0.4	V
I_I	Input current at maximum input voltage	Data, count /load	V_{CC} = MAX,	V_I = 5.5 V				0.1	mA
		Clear, clock 1						0.2	
		Clock 2 of 'LS196						0.4	
		Clock 2 of 'LS197						0.2	
I_{IH}	High-level input current	Data, count /load	V_{CC} = MAX,	V_I = 2.7 V				20	μA
		Clear, clock 1						40	
		Clock 2 of 'LS196						80	
		Clock 2 of 'LS197						40	
I_{IL}	Low-level input current	Data, count /load	V_{CC} = MAX,	V_I = 0.4 V				−0.36	mA
		Clear						−0.72	
		Clock 1						−2.4	
		Clock 2 of 'LS196						−2.8	
		Clock 2 of 'LS197						−1.3	
I_{OS}	Short-circuit output current§		V_{CC} = MAX			−6		−100	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 2			12	20	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
¶Q_A outputs are tested at specified I_{OL} plus the limit value of I_{IL} for the clock-2 input. This permits driving the clock-2 input while maintaining full fan-out capability.

NOTE 2:
I_{CC} is measured with all inputs grounded and all outputs open.

Presettable BCD Decade Ripple Counter — 54LS196

Presettable 4-Bit Binary Ripple Counter — 54LS197

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage, V_{CC}		4.5	5	5.5	V
High-level output current, I_{OH}				−400	μA
Low-level output current, I_{OL}				4	mA
Count frequency	Clock-1 input	0			MHz
	Clock-2 input	0			
Pulse width, t_w	Clock-1 input	20			ns
	Clock-2 input	30			
	Clear	15			
	Load	20			
Input hold time, t_{hold}	High-level data	$t_{w\ (load)}$			ns
	Low-level data	$t_{w\ (load)}$			
Input setup time, t_{setup}	High-level data	10			ns
	Low-level data	15			
Count enable time, t_{enable} (See Note 1)		20			ns
Operating free-air temperature, T_A		−55		125	°C

NOTE 1:
Count enable time is the interval immediately preceding the negative-going edge of the clock pulse during which interval the count/load and clear inputs must both be high to ensure counting.

Switching Characteristics, $V_{CC} = 5$ V, $T_A = 25°C$

Parameter	From (Input)	To (Output)	Test Conditions†	54LS196 Min	54LS196 Typ	54LS196 Max	54LS197 Min	54LS197 Typ	54LS197 Max	Unit
f_{max}	Clock 1	Q_A	$C_L = 15$ pF, $R_L = 2$ kΩ, See Fig. A on page 373	45	70		45	60		MHz
t_{PLH}	Clock 1	Q_A			8	12		8	12	ns
t_{PHL}					12	16		12	16	
t_{PLH}	Clock 2	Q_B			11	15		10	15	ns
t_{PHL}					14	19		13	18	
t_{PLH}	Clock 2	Q_C			22	34		22	34	ns
t_{PHL}					29	40		26	34	
t_{PLH}	Clock 2	Q_D			11	18		34	50	ns
t_{PHL}					16	20		40	55	
t_{PLH}	A, B, C, D	Q_A, Q_B, Q_C, Q_D			12	18		21	18	ns
t_{PHL}					21	34		21	34	
t_{PLH}	Load	Any			20	30		20	30	ns
t_{PHL}					31	45		31	45	
t_{PHL}	Clear	Any			32	45		32	45	ns

°f_{max} ≡ maximum input count frequency.
t_{PLH} ≡ propagation delay time, low-to-high-level output, t_{PHL} ≡ propagation delay time, high-to-low-level output.

54LS251

8-Line-To-1-Line Multiplexer With Three-State Outputs

FEATURES

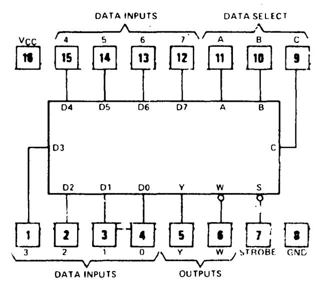
- **Selects one of eight data sources**
- **Performs parallel-to-serial conversion**
- **Complementary 3-state outputs**

DESCRIPTION

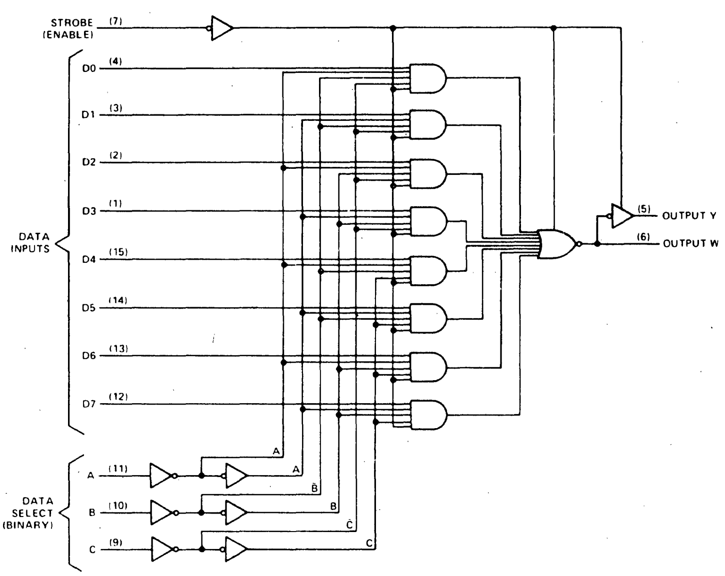
This monolithic data selector/multiplexer contains full on-chip binary decoding to select one-of-eight data sources and features a strobe-controlled three-state output. The strobe must be at a low logic level to enable this device. The three-state outputs permit a number of outputs to be connected to a common bus. When the strobe input is high, both outputs are in a high-impedance state in which both the upper and lower transistors of each totem-pole output are off, and the output neither drives nor loads the bus significantly. When the strobe is low, the outputs are activated and operate as standard TTL totem-pole outputs.

To minimize the possibility that two outputs will attempt to take a common bus to opposite logic levels, the output control circuitry is designed so that the average output disable time is shorter than the average output enable time.

PIN-OUT DIAGRAM



LOGIC DIAGRAMS



FUNCTION TABLE

INPUTS				OUTPUTS	
SELECT			STROBE		
C	B	A	S	Y	W
X	X	X	H	Z	Z
L	L	L	L	D0	$\overline{D0}$
L	L	H	L	D1	$\overline{D1}$
L	H	L	L	D2	$\overline{D2}$
L	H	H	L	D3	$\overline{D3}$
H	L	L	L	D4	$\overline{D4}$
H	L	H	L	D5	$\overline{D5}$
H	H	L	L	D6	$\overline{D6}$
H	H	H	L	D7	$\overline{D7}$

H = high logic level, L = low logic level
X = irrelevant, Z = high impedance (off)
D0, D1 . . . D7 = the level of the respective D input

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−1	mA
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

8-Line-To-1-Line Multiplexer With Three-State Outputs

54LS251

DIGITAL

Raytheon Semiconductor

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IL} = MAX,	V_{IH} = 2 V, I_{OH} = MAX		2.5	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN,	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
		V_{IL} = MAX,		I_{OL} = 8 mA		0.3	0.45	
$I_{O(off)}$	Off-state (high-impedance-state) output current	V_{CC} = MAX,		V_O = 2.7V			20	μA
		V_{IH} = 2 V		V_O = 0.4 V			−20	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.4	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current	V_{CC} = MAX,		Condition A		6.1	10	mA
		See Note 1		Condition B		7.1	12	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE 1:
I_{CC} is measured with the outputs open and all data and select inputs at 4.5 V under the following conditions:
A. Strobe grounded.
B. Strobe at 4.5 V.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C.

Parameter¶	From (Input)	To (Output)	Test Conditions	Min	Typ	Max	Unit
t_{PLH}	A, B, or C (4 levels)	Y	C_L = 15 pF, R_L = 2 kΩ, See Fig. C on page 373		29	45	ns
t_{PHL}					28	45	
t_{PLH}	A, B, or C (3 levels)	W			20	33	ns
t_{PHL}					21	33	
t_{PLH}	Any D	Y			17	28	ns
t_{PHL}					18	28	
t_{PLH}	Any D	W			10	15	ns
t_{PHL}					9	15	
t_{ZH}	Strobe	Y			17	27	ns
t_{ZL}					26	40	
t_{ZH}	Strobe	W			17	27	ns
t_{ZL}					24	40	
t_{HZ}	Strobe	Y	C_L = 5 pF, R_L = 2 kΩ, See Fig. C on page 373		30	45	ns
t_{LZ}					15	25	
t_{HZ}	Strobe	W			30	45	ns
t_{LZ}					15	25	

¶t_{PLH} ≡ Propagation delay time, low-to-high-level output.
t_{PHL} ≡ Propagation delay time, high-to-low-level output.
t_{ZH} ≡ Output enable time to high level.
t_{ZL} ≡ Output enable time to low level.
t_{HZ} ≡ Output disable time from high level.
t_{LZ} ≡ Output disable time from low level.

Tentative data,subject to change without notice

54LS253 Dual 4-Line-To-1-Line Multiplexer With Three-State Outputs

FEATURES

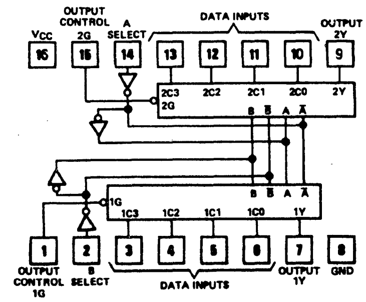
- Three-state version of 54LS153
- Non-inverting
- Permits multiplexing from N lines to 1 line
- Performs parallel-to-serial conversion

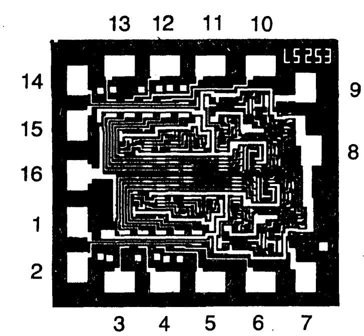
DESCRIPTION

The 54LS253 is a high-speed dual 4-line-to-1-line multiplexer with common select inputs and separate output control inputs for each half. Each half can select one bit of four and present it at the output in non-inverted form.

The three-state outputs can interface with and drive data lines of bus-organized systems. With all but one of the common outputs disabled (at a high-impedance state) the low-impedance of the single enabled output will drive the bus line to a high or low logic level.

PIN-OUT DIAGRAM





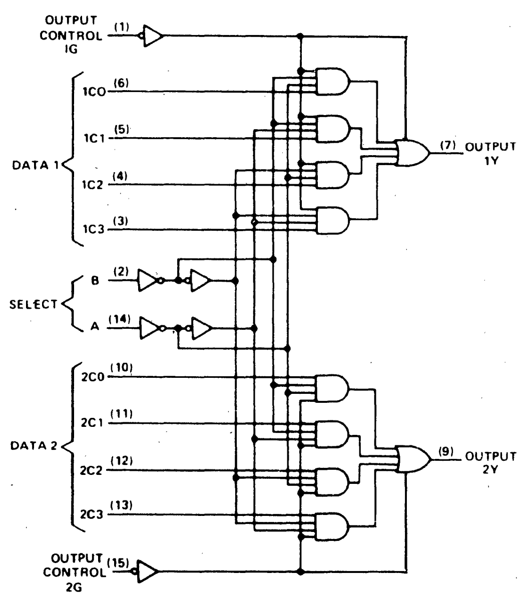
Die Size .057 x .061

FUNCTION TABLE

SELECT INPUTS		DATA INPUTS				OUTPUT CONTROL	OUTPUT
B	A	C0	C1	C2	C3	G	Y
X	X	X	X	X	X	H	Z
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

Address inputs A and B are common to both sections.
H = high level, L = low level, X = irrelevant, Z = high impedance (off)

LOGIC DIAGRAM



Dual 4-Line-To-1-Line Multiplexer With Three-State Outputs

54LS253

DIGITAL

Raytheon Semiconductor

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−1	mA
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	$I_I = -18$ mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, $V_{IL} = V_{IL}$max,	V_{IH} = 2 V, I_{OH} = MAX		2.4	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, $V_{IL} = V_{IL}$max	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	
$I_{O(off)}$	Off-State (high-impedance state) output current	V_{CC} = MAX, V_{IH} = 2 V		V_O = 2.7 V			20	µA
				V_O = 0.4 V			−20	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	µA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.36	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−6		−100	mA
I_{CC}	Supply current	V_{CC} = MAX,	See Note 1	Condition A		7	12	mA
				Condition B		8.5	14	

§For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_a = 25°C.
§Not more than one output should be shorted at a time.
NOTE: 1
I_{CC} is measured with the outputs open under the following conditions:
A. All inputs grounded.
B. Output control at 4.5 V, all inputs grounded.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter¶	From (Input)	To (Output)	Test Conditions	Min	Typ	Max	Unit
t_{PLH}	Data	Y	C_L = 15 pF, R_L = 2 kΩ, See Fig. C on page 373		7	12	ns
t_{PHL}					12	17	
t_{PLH}	Select	Y			18	25	ns
t_{PHL}					18	27	
t_{ZH}	Output Control	Y			10	16	ns
t_{ZL}					13	18	
t_{HZ}	Output Control	Y	C_L = 5 pF, R_L = 2 kΩ, See Fig. C on page 373		7	15	ns
t_{LZ}					12	19	

¶t_{PLH} ≡ Propagation delay time, low-to-high-level output
t_{PHL} ≡ Propagation delay time, high-to-low-level output
t_{ZH} ≡ Output enable time to high level
t_{ZL} ≡ Output enable time to low level
t_{HZ} ≡ Output disable time from highlevel
t_{LZ} ≡ Output disable time from low level

Dual 2-Line-To-4-Line Decoder/Demultiplexer With Three-State Outputs

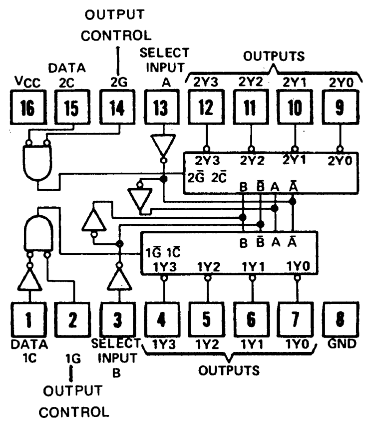
FEATURES

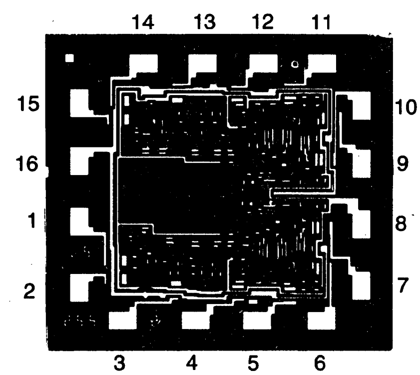
- Three-state version of 54LS155
- Applications:
  Dual 2-Line-to-4-Line Decoder
  Dual 1-Line-to-4-Line Demultiplexer
  3-Line-to-8-Line Decoder
  1-Line-to-8-Line Demultiplexer

DESCRIPTION

The 54LS255 features dual 1-line-to-4-line demultiplexers with individual strobes and common binary-address inputs in a single 16-pin package. When both sections are enabled by the output controls, the common binary-address inputs sequentially select and route associated input data to the appropriate output of each section. The individual controls permit activating or inhibiting each of the 4-bit sections as desired. Data applied to input 1C is inverted at its outputs and data applied at 2C is not inverted through its outputs. The inverter following the 1C data input permits use as a 3-to-8-line decoder or 1-to-8-line demultiplexer without external gating. Input clamping diodes are provided on all of these circuits to minimize transmission-line effects and simplify system design.

PIN-OUT DIAGRAM





Die Size .063 x .069

FUNCTION TABLE
3-LINE-TO-8-LINE DECODER OR 1-LINE-TO-8-LINE DEMULTIPLEXER

INPUTS				OUTPUTS			
SELECT		CONTROL	DATA				
B	A	1G	1C	1Y0	1Y1	1Y2	1Y3
X	X	H	X	z	z	z	z
L	L	L	H	L	H	H	H
L	H	L	H	H	L	H	H
H	L	L	H	H	H	L	H
H	H	L	H	H	H	H	L
X	X	X	L	H	H	H	H

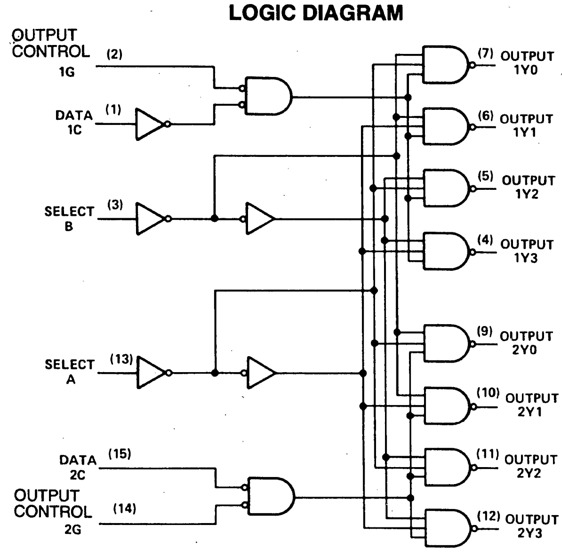
INPUTS				OUTPUTS			
SELECT		CONTROL	DATA				
B	A	2G	2C	2Y0	2Y1	2Y2	2Y3
X	X	H	X	z	z	z	z
L	L	L	L	L	H	H	H
L	H	L	L	H	L	H	H
H	L	L	L	H	H	L	H
H	H	L	L	H	H	H	L
X	X	X	H	H	H	H	H

FUNCTION TABLES
2-LINE-TO-4-LINE DECODER OR 1-LINE-TO-4-LINE DEMULTIPLEXER

INPUTS				OUTPUTS							
SELECT			CONTROL OR DATA	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
C†	B	A	G‡	2Y0	2Y1	2Y2	2Y3	1Y0	1Y1	1Y2	1Y3
X	X	X	H	z	z	z	z	z	z	z	z
L	L	L	L	L	H	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H
L	H	L	L	H	H	L	H	H	H	H	H
L	H	H	L	H	H	H	L	H	H	H	H
H	L	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	L	H	H
H	H	L	L	H	H	H	H	H	H	L	H
H	H	H	L	H	H	H	H	H	H	H	L

†C = inputs 1C and 2C connected together
‡G = inputs 1G and 2G connected together
H = high level, L = low level, X = irrelevant, Z = high impedance (off)

LOGIC DIAGRAM



Dual 2-Line-To-4-Line Decoder/Demultiplexer With Three-State Outputs

54LS255

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−1	mA
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IL} = V_{IL}max,	V_{IH} = 2 V, I_{OH} = MAX		2.4	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IL} = V_{IL}max	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	V
$I_{O(off)}$	Off-State (high-impedance state) output current	V_{CC} = MAX, V_{IH} = 2 V		V_O = 2.7 V			20	μA
				V_O = 0.4 V			−20	μA
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.36	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−6		−100	mA
I_{CC}	Supply current	V_{CC} = MAX,	See Note 1	Condition A		6	10	mA
				Condition B		11	17	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

NOTE 1:
I_{CC} is measured with the outputs open under the following conditions:
A. A, B, and 1C inputs at 4.5 V, and 2C, 1G, and 2G inputs grounded.
B. Same as Condition A except inputs 1G and 2G at 4.5 V.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C

Parameter¶	From (Input)	To (Output)	Test Conditions	Min	Typ	Max	Unit
t_{PLH}	A, B, 1C or 2C	Y	C_L = 15 pF, R_L = 2 kΩ, See Fig. C on page 373		13	18	ns
t_{PHL}					16	22	
t_{PLH}	A or B (3 levels)	Y			16	22	ns
t_{PHL}					20	26	
t_{ZH}	Output Control	Y			10	15	ns
t_{ZL}					12	18	
t_{HZ}	Output Control	Y	C_L = 5 pF, R_L = 2 kΩ, See Fig. C on page 373		9	15	ns
t_{LZ}					15	20	

¶t_{PLH} ≡ Propagation delay time, low-to-high-level output
t_{PHL} ≡ Propagation delay time, high-to-low-level output
t_{ZH} ≡ Output enable time to high level
t_{ZL} ≡ Output enable time to low level
t_{HZ} ≡ Output disable time from high level
t_{LZ} ≡ Output disable time from low level

54LS257 54LS258 Quadruple 2-Line-To-1-Line Multiplexers With Three-State Outputs

DESCRIPTION

These data selectors/multiplexers select a 4-bit word from one of two sources and present it at the four outputs. The 54LS257 presents true data; the 54LS258 presents inverted data. With Output Control HIGH, the outputs are forced to a high impedance state.

FUNCTION TABLE

INPUTS				OUTPUT Y	
OUTPUT CONTROL	SELECT	A	B	54LS257	54LS258
H	X	X	X	Z	Z
L	L	L	X	L	H
L	L	H	X	H	L
L	H	X	L	L	H
L	H	X	H	H	L

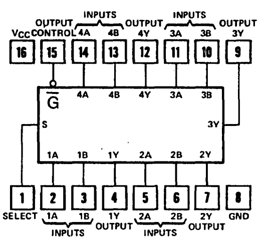
H = high level, L = low level, X = irrelevant, Z = high impedance (off)

Low level at S selects A inputs.

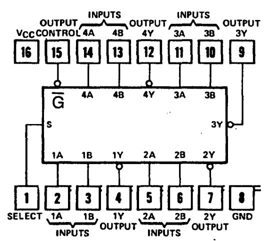
High level at S selects B inputs.

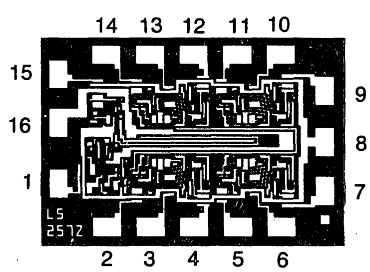
PIN-OUT DIAGRAMS

54LS257

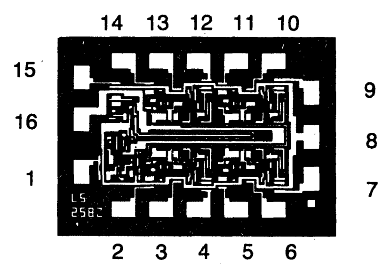


54LS258





Die Size .047 x .066



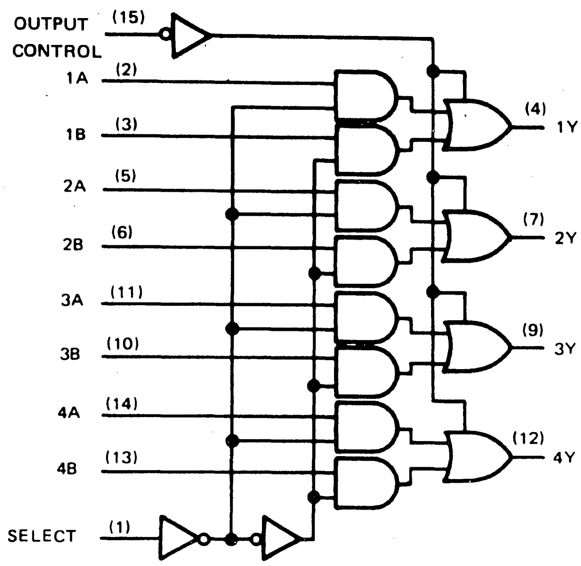
Die Size .047 x .066

Quadruple 2-Line-To-1-Line Multiplexers With Three-State Outputs

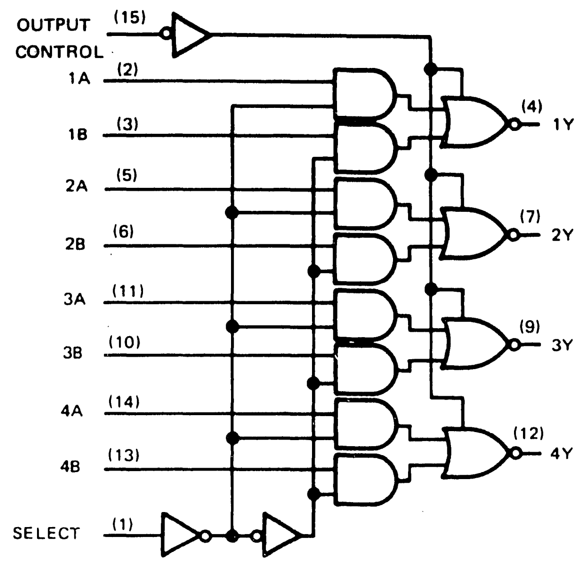
54LS257 54LS258

LOGIC DIAGRAMS

54LS257



54LS258



Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−1	mA
Low-level output current, I_{OL}			8	mA
Operating free-air temperature, T_A	−55		125	°C

54LS257 54LS258 Quadruple 2-Line-To-1-Line Multiplexers With Three-State Outputs

Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter			Test Conditions†		Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage		V_{CC} = MIN, I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL}max, I_{OH} = MAX		2.4	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL}max	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	V
I_{OZH}	Off-state output current, high-level voltage applied		V_{CC} = MAX, V_{IH} = 2 V, V_O = 2.4 V				20	μA
I_{OZL}	Off-state output current, low-level voltage applied		V_{CC} = MAX, V_{IH} = 2 V, V_O = 0.4 V				−20	μA
I_I	Input current at maximum input voltage	S input	V_{CC} = MAX, V_I = 7 V				0.2	mA
		Any other					0.1	
I_{IH}	High-level input current	S input	V_{CC} = MAX, V_I = 2.7 V				40	μA
		Any other					20	
I_{IL}	Low-level input current	S input	V_{CC} = MAX, V_I = 0.4 V				−0.8	mA
		Any other					−0.4	
I_{OS}	Short-circuit output current§		V_{CC} = MAX		−15		−100	mA
I_{CC}	Supply current	All outputs high	V_{CC} = MAX, See Note 1	54LS257		5.9	10	mA
		All outputs low				9.2	16	
		All outputs off				10	17	
		All outputs high		54LS258		4.1	7	
		All outputs low				6.2	11	
		All outputs off				7.0	12	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC}=5 V, T_A=25°C.
§Not more than one output should be shorted at a time and duration of the short-circuit test should not exceed one second.
NOTE: 1
I_{CC} is measured with all outputs open and all possible inputs grounded while achieving the stated output conditions.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C, R_L = 2 kΩ

Parameter¶	From (Input)	To (Output)	Test Conditions	54LS257 Min	54LS257 Typ	54LS257 Max	54LS258 Min	54LS258 Typ	54LS258 Max	Unit
t_{PLH}	Data	Any	C_L = pF, See Fig C on page 373		6	12		8	14	ns
t_{PHL}					7	12		5	12	
t_{PLH}	Select	Any			12	18		12	18	ns
t_{PHL}					12	18		10	18	
t_{ZH}	Output Control	Any			10	18		10	18	ns
t_{ZH}					10	16		11	18	
t_{HZ}	Output Control	Any	C_L = 5 pF, See Fig C		10	15		9	15	ns
t_{LZ}					10	18		8	15	

¶t_{PLH} ≡ propagation delay time, low-to-high-level output
t_{PHL} ≡ propagation delay time, high-to-low-level output
t_{ZH} ≡ output enable time to high level
t_{ZL} ≡ output enable time to low level
t_{HZ} ≡ output disable time from high level
t_{LZ} ≡ output disable time from low level

4-Bit Bi-Directional Shift Register With Three-State Outputs

54LS295A

FEATURES

- **Three-state version of 54LS95B parallel-access shift register**

DESCRIPTION

This 4-bit register features parallel inputs, parallel outputs, and clock, serial, mode, and output control inputs. The register has three modes of operation:

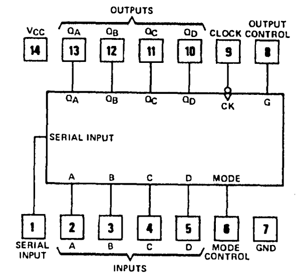
Parallel (broadside) load
Shift right (the direction Q_A toward Q_D)
Shift left (the direction Q_D toward Q_A)

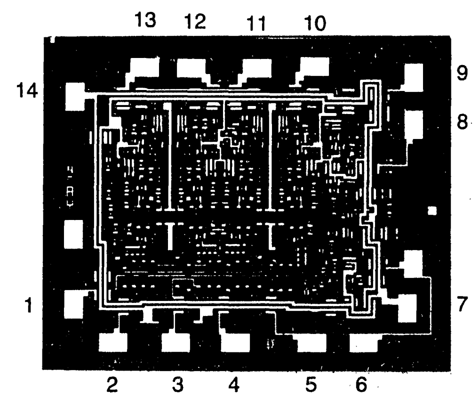
Parallel loading is accomplished by applying the four bits of data and taking the mode control input high. The data is loaded into the associated flip-flops and appears at the outputs after the high-to-low transition of the clock input. During parallel loading, the entry of serial data is inhibited.

Shift right is accomplished when the mode control is low; shift left is accomplished when the mode control is high by connecting the output of each flip-flop to the parallel input of the previous flip-flop (Q_D to input C, etc.) and serial data is entered at input D.

When the output is high, the normal logic levels of the four out-puts are available for driving the loads or bus lines. The outputs are disabled independently from the level of the clock by a low logic level at the output control input. The outputs then present a high impedance and neither load nor drive the bus line; however, sequential operation of the register is not affected.

PINOUT DIAGRAM





Die Size .067 x .082

FUNCTION TABLE

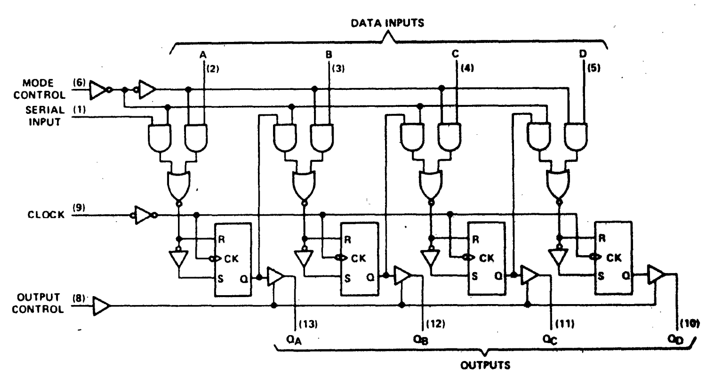
INPUTS							OUTPUTS			
MODE CONTROL	CLOCK	SERIAL	PARALLEL A	B	C	D	Q_A	Q_B	Q_C	Q_D
H	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
H	↓	X	a	b	c	d	a	b	c	d
H	↓	X	Q_B†	Q_C†	Q_D†	d	Q_{Bn}	Q_{Cn}	Q_{Dn}	d
L	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
L	↓	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}
L	↓	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}

When the output control is low, the outputs are disabled to the high-impedance state; however, sequential operation of the registers is not affected.

†Shifting left requires external connection of Q_B to A, Q_C to B, and Q_D to C. Serial data is entered at input D.

H = high level (steady state), L = low level (steady state), X = irrelevant (any input, including transitions)
↓ = transition from high to low level.
a, b, c, d = the level of steady-state input at inputs A, B, C, or D, respectively.
Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established.
Q_{An}, Q_{Bn}, Q_{Cn}, Q_{Dn} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the most-recent transition of the clock.

LOGIC DIAGRAM



4-Bit Bi-Directional Shift Register With Three-State Outputs

Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply voltage, V_{CC}	4.5	5	5.5	V
High-level output current, I_{OH}			−1	mA
Low-level output current, I_{OL}			8	mA
Clock frequency, f_{clock}	0		30	MHz
Width of clock pulse, $t_{w(clock)}$	20			ns
Setup time, high-level or low-level data, t_{setup}	10			ns
Hold time, high-level or low-level data, t_{hold}	10			ns
Operating free-air temperature, T_A	−55		125	°C

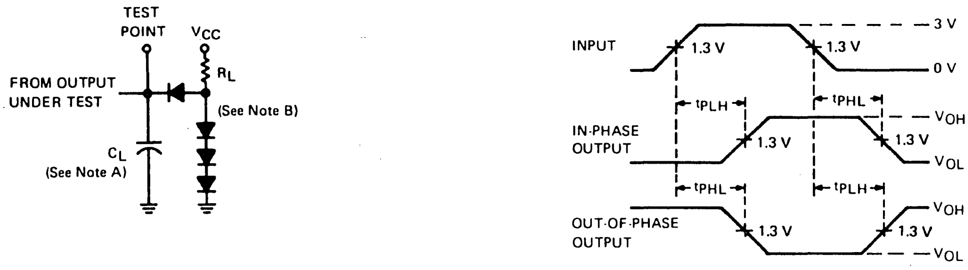
Electrical Characteristics Over Recommended Operating Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions†			Min	Typ‡	Max	Unit
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.7	V
V_I	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IL} = V_{IL}max,	V_{IH} = 2 V, I_{OH} = MAX		2.4	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IL} = V_{IL}max	V_{IH} = 2 V,	I_{OL} = 4 mA		0.25	0.4	V
				I_{OL} = 8 mA		0.3	0.45	
I_{OZH}	Off-state output current, high-level voltage applied	V_{CC} = MAX, V_O = 2.7 V	V_{IL} = V_{IL}max,				20	μA
I_{OZL}	Off-state output current, low-level voltage applied	V_{CC} = MAX, V_O = 0.4 V	V_{IH} = 2 V,				−20	μA
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V				0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V				−0.4	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−15		−100	mA
I_{CC}	Supply current	V_{CC} = MAX,	See Note 1	Condition A		14	23	mA
				Condition B		15	25	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE: 1
I_{CC} is measured with the outputs open, the serial input and mode control at 4.5 V, and the data inputs grounded under the following conditions:
A. Output control at 4.5 V and a momentary 3 V, then ground, applied to clock input.
B. Output control and clock input grounded.

Switching Characteristics, V_{CC} = 5 V, T_A = 25°C.

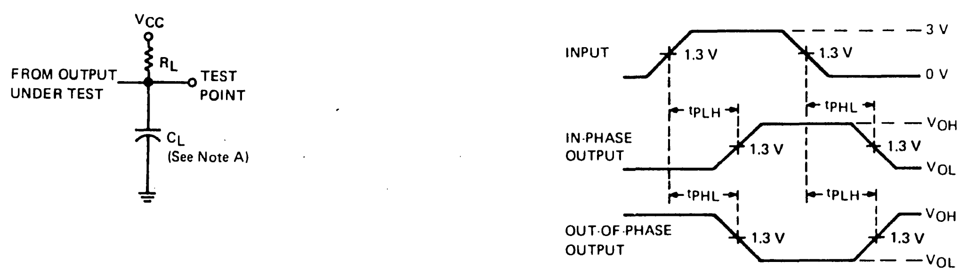
Parameter		Test Conditions	Min	Typ	Max	Unit
f_{max}	Maximum clock frequency	C_L = 15 pF, R_L = 2 kΩ, See Fig. C on page 373	30	40		MHz
t_{PLH}	Propagation delay time, low-to-high-level output			27	35	ns
t_{PHL}	Propagation delay time, high-to-low-level output			35	45	ns
t_{ZH}	Output enable time to high level			10	18	ns
t_{ZL}	Output enable time to low level			10	18	ns
t_{HZ}	Output disable time from high level	C_L = 5 pF, R_L = 2 kΩ, See Fig. C on page 373		19	28	ns
t_{LZ}	Output disable time from low level			24	32	ns



LOAD CIRCUIT

VOLTAGE WAVEFORMS

FIGURE A – FOR TOTEM-POLE OUTPUTS



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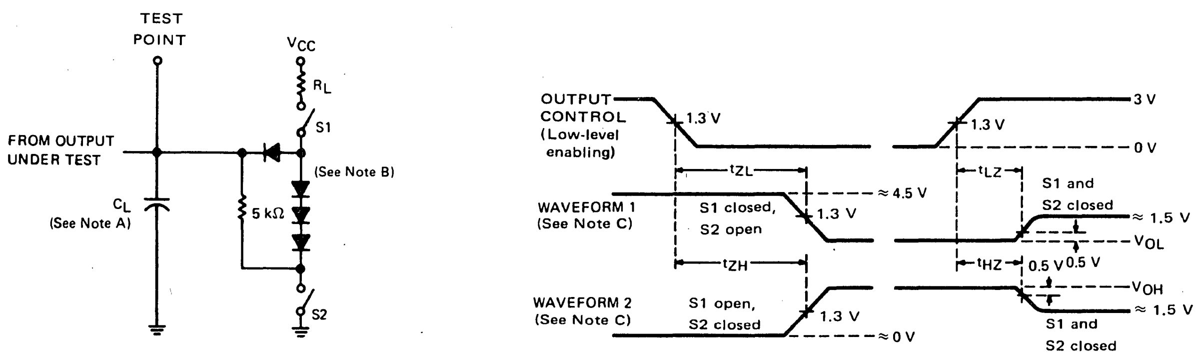
VOLTAGE WAVEFORMS

FIGURE B – FOR OPEN-COLLECTOR OUTPUTS



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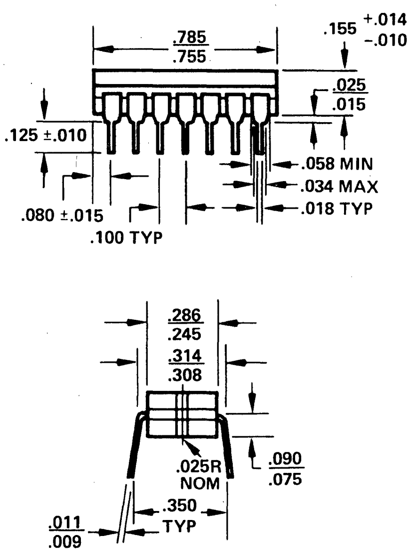
VOLTAGE WAVEFORMS

FIGURE C – FOR THREE-STATE OUTPUTS

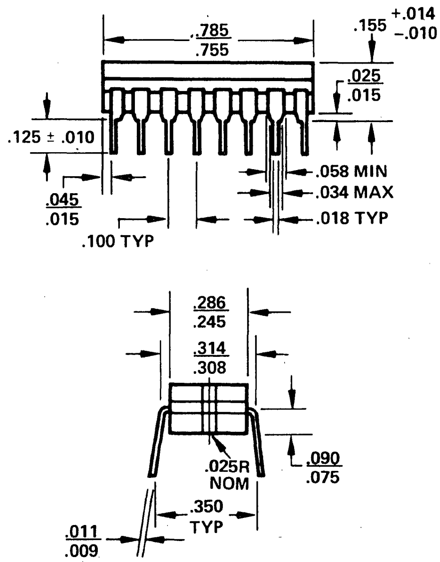
NOTES:
- A. C_L includes probe and jig capacitance.
- B. All diodes are 1N3064.
- C. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
- D. In the examples above, the phase relationships between inputs and outputs have been chosen arbitrarily.
- E. All input pulses are supplied by generators having the following characteristics: $t_r \leqslant 15$ ns, $t_f \leqslant 6$ ns, PRR $\leqslant$ 1 MHz, $Z_{out} \approx 50\ \Omega$, and $t_w = 100$ ns.

Packages
Ordering Information

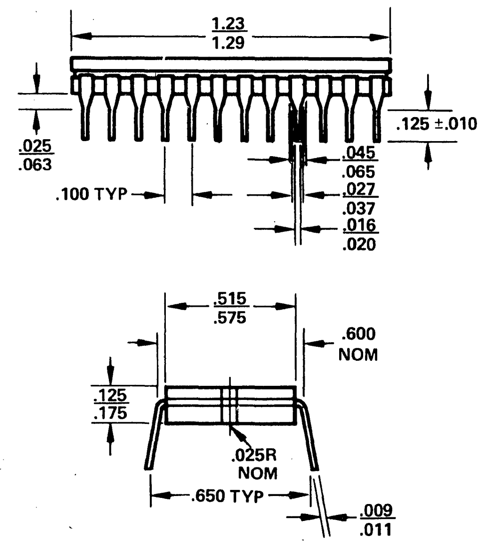
14-PIN CERDIP



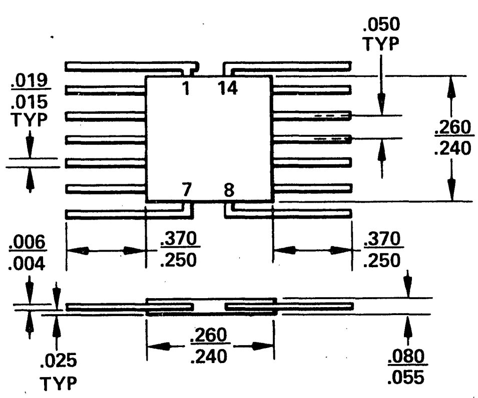
16-PIN J CIRDIP



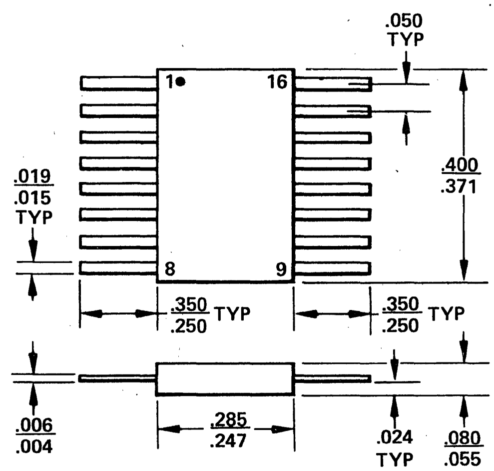
24-PIN J CERDIP



14 PIN W CERPAK



16 PIN W CERPAK



NOTES:
1. All dimensions in inches.
2. Leads are bright tin-plated.
3. Pin 1 orientation is by a notch in the pin 1 end of the J packages, by a tab on pin 1 of the 14 pin W package, and by a dot on the 16-pin W.

ORDERING INFORMATION

54 LS153 J

TEMPERATURE RANGE — "54" = −55°C to 125°C

FUNCTION — LS153

PACKAGE CODE — J
"J" — Ceramic DIP
"W" — Ceramic Flatpack
"CH" — Gold-backed chip, visually inspected to MIL-STD-883, method 2010.2, and packaged in waffle pack.

RCA CD4000A-Series and CD4000B-Series Types COS/MOS Digital Integrated Circuits

Ratings, Operating Conditions, Static Characteristics Common To All Types

MAXIMUM RATINGS, *Absolute-Maximum Values:*

STORAGE-TEMPERATURE RANGE (T_{stg}) .... −65 to +150°C

OPERATING-TEMPERATURE RANGE (T_A):

PACKAGE TYPES D, F, K, H .... −55 to +125°C

PACKAGE TYPES E, Y .... −40 to +85°C

DC SUPPLY-VOLTAGE RANGE, (V_{DD})
(Voltages referenced to V_{SS} Terminal):

STANDARD "A"-SERIES TYPES .... −0.5 to +15 V

HIGH-VOLTAGE "B"-SERIES TYPES .... −0.5 to +20 V

POWER DISSIPATION PER PACKAGE (P_D):

FOR T_A= −40 to +60°C (PACKAGE TYPES E, Y) .... 500 mW

FOR T_A= +60 to +85°C (PACKAGE TYPES E, Y) .... Derate Linearly at 12 mW/°C to 200 mW

FOR T_A= −55 to +100°C (PACKAGE TYPES D, F, K) .... 500 mW

FOR T_A= +100 to +125°C (PACKAGE TYPES D, F, K)...... Derate Linearly at 12 mW/°C to 200 mW

DEVICE DISSIPATION PER OUTPUT TRANSISTOR

FOR T_A = FULL PACKAGE-TEMPERATURE RANGE (ALL PACKAGE TYPES) .... 100 mW

INPUT VOLTAGE RANGE, ALL INPUTS .... −0.5 to V_{DD} +0.5 V

LEAD TEMPERATURE (DURING SOLDERING):

At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10 s max. .... +265°C

ELECTRICAL CHARACTERISTICS, Full-Temperature Range: T_A = −55°C to +125°C

CD4000A Standard Series

See pages 376 to 381

Conditions V_{DD} V	V_{IN} V	Output Voltage (At Indicated V_{IN} and V_{DD}) Low-Level (V_{OL}) Max. V — Output Inverted	Low-Level (V_{OL}) Max. V — Output Non-Inverted	High-Level (V_{OH}) Min. V — Output Inverted	High-Level (V_{OH}) Min. V — Output Non-Inverted	Maximum Input Current (I_{IL}, I_{IH}) µA
5	0	–	0.05	4.95	–	–
10	0	–	0.05	9.95	–	–
5	5	0.05	–	–	4.95	–
10	10	0.05	–	–	9.95	–
15	–	–	–	–	–	±1

Conditions V_{DD} V	V_{IN} V	Noise Immunity (At I_O = 10 µA and Indicated V_{IN} and V_{DD}) (V_O) Min. V — Output Inverted	(V_O) Min. V — Output Non-Inverted	(V_O) Max. V — Output Inverted	(V_O) Max. V — Output Non-Inverted	Minimum Noise Margin (V_{NM}) V
5	1.5	4.5	–	–	0.5	1
10	2	9	–	–	1	1
5	3.5	–	4.5	0.5	–	1
10	8	–	9	1	–	1
15	–	–	–	–	–	–

CD4000B High-Voltage Series

See pages 380 to 383

Conditions V_{DD} V	V_{IN} V	Output Voltage (At Indicated V_{IN} and V_{DD}) Low-Level (V_{OL}) Max. V — Output Inverted	Low-Level (V_{OL}) Max. V — Output Non-Inverted	High-Level (V_{OH}) Min. V — Output Inverted	High-Level (V_{OH}) Min. V — Output Non-Inverted	Maximum Input Current (I_{IL}, I_{IH}) µA
5	0	–	0.05	4.95	–	–
10	0	–	0.05	9.95	–	–
15	0	–	0.05	14.95	–	–
5	5	0.05	–	–	4.95	–
10	10	0.05	–	–	9.95	–
15	15	0.05	–	–	14.95	–
20	–	–	–	–	–	±1

Conditions V_{DD} V	V_{IN} V	Noise Immunity (At I_O = 10 µA and Indicated V_{IN} and V_{DD}) (V_O) Min. V — Output Inverted	(V_O) Min. V — Output Non-Inverted	(V_O) Max. V — Output Inverted	(V_O) Max. V — Output Non-Inverted	Minimum Noise Margin (V_{NM}) V
5	1.5	4.5	–	–	0.5	1
10	2	9	–	–	1	1
15	2.5	13.5	–	–	1.5	1
5	3.5	–	4.5	0.5	–	1
10	8	–	9	1	–	1
15	12.5	–	13.5	1.5	–	1
20	–	–	–	–	–	–

CD4000A Standard Series, Static Electrical Characteristics

COS/MOS "A" Series Type	Conditions	Static, $T_A = 25^oC$																
		Max. Quiescent Device Current						Min. Output Drive Current										Max. "ON" Resistance
		D,F,K,T Packages			E,Y Packages			D,F,K,T Packages					E,Y Packages					All Packages
		(I_L) µA			(I_L) µA			N Channel (Sink) (I_DN) mA			P-Channel (Source) (I_DP) mA		N-Channel (Sink) (I_DN) mA			P-Channel (Source) (I_DP) mA		(R_{ON}) Ω
	V_{DD}(V)	5	10	15	5	10	15	5	5	10	5	10	5	5	10	5	10	R_L = 10 kΩ
	V_O(V)							0.4	0.5	0.5	4.5	9.5	0.4	0.5	0.5	4.5	9.5	
CD4000		0.05	0.1	50	0.5	5	50	0.4	–	0.9	–0.5▲	–0.5	0.3	–	0.6	–0.3▲	–0.25	–
CD4001		0.05	0.1	50	0.5	5	50	0.4		0.9	–0.5▲	–0.5	0.3	–	0.6	–0.3▲	–0.25	–
CD4002		0.05	0.1	50	0.5	5	50	0.4	–	0.9	–0.5▲	–0.5	0.3	–	0.6	–0.3▲	–0.25	–
CD4006		0.5	1	500	5	10	500	–	0.125	0.25	–0.1	–0.2	–	0.06	0.125	–0.05	–0.1	–
CD4007		0.05	0.1	50	0.5	1	50	0.6	–	1.3	–1.4▲	–1.1	0.3	–	1.0	–1.1▲	–0.55	–
CD4008		5	10	500	50	100	500	–	0.25	0.75	–0.25	–0.75	–	0.13	0.5	–0.13	–0.5	–
CD4009		0.3	0.5	50	3	5	50	3	–	8	–1.25▲	–0.6	3	–	8	–1.25▲	–0.6	–
CD4010		0.3	0.5	50	3	5	50	3	–	8	–1.25▲	–0.6	3	–	8	–1.25▲	–0.6	–
CD4011		0.05	0.1	50	0.5	5	50		0.25	0.5	0.25	–0.6	–	0.12	0.25	–0.12	–0.3	–
CD4012		0.05	0.1	50	0.5	5	50	–	0.12	0.25	–0.25	–0.6	–	0.06	0.13	–0.12	–0.3	–
CD4013		1	2	500	10	20	500	–	0.5	1	–0.25	–0.65	–	0.3	0.6	–0.14	–0.33	–
CD4014		5	10	500	50	100	500	–	0.12	0.25	–0.08	–0.20	–	0.06	0.1	–0.05	–0.1	–
CD4015		5	10	500	50	100	500	–	0.12	0.25	–0.08	–0.20	–	0.06	0.1	–0.05	–0.1	–
CD4016		–	0.5	50	–	0.5	50	–	–	–	–	–	–	–	–	–	–	2000 at V_{DD}=10V 850 at V_{DD}=15V
CD4017		5	10	500	50	100	500	–	0.05	0.1	–0.03	–0.1	–	0.025	0.07	–0.015	–0.07	–
CD4018		5	10	500	50	100	500	–	0.15	0.35	–0.15	–0.35	–	0.08	0.25	–0.08	–0.25	–
CD4019		5	10	500	50	100	500	–	0.45	0.75	–0.25	–0.7	–	0.30	0.65	–0.12	–0.5	–
CD4020		15	25	500	50	100	500	–	0.075	0.15	–0.09	–0.20	–	0.08	0.10	–0.06	–0.15	–
CD4021		5	10	500	50	100	500	–	0.12	0.25	–0.08	–0.20	–	0.06	0.1	–0.05	–0.1	–
CD4022		5	10	500	50	100	500	–	0.05	0.1	–0.03	–0.1	–	0.025	0.05	–0.015	–0.05	–
CD4023		0.05	0.1	50	0.5	5	50	–	0.25	0.5	–0.25	–0.6	–	0.12	0.25	–0.12	–0.3	–
CD4024		5	10	500	50	100	500	–	0.25	0.5	–0.15	–0.35	–	0.12	0.25	–0.12	–0.25	–
CD4025		0.05	0.1	50	0.5	5	50	0.4	–	0.9	–0.5▲	–0.5	0.3	–	0.6	–0.3▲	–0.25	–
CD4026		5	10	500	50	100	500	–	0.12	0.25	–0.14	–0.3	–	0.06	0.12	–0.07	–0.15	–
CD4027		1	2	500	10	20	500	–	0.5	1	–0.25	–0.65	–	0.3	0.6	–0.14	–0.33	–
CD4028		5	10	500	50	100	500	–	0.6	1.2	–0.45	–0.95	–	0.3	0.6	–0.22	–0.48	–
CD4029		5	10	500	50	100	500	–	0.4	0.6	–0.12	–0.2	–	0.2	0.3	–0.06	–0.1	–
CD4030		0.5	1	50	5	10	50	–	0.6	1.2	–0.3	–0.65	–	0.3	0.6	–0.15	–0.32	–
CD4031		10	25	500	50	100	500	–	0.09	0.2	–0.09	–0.2	–	0.045	0.1	–0.045	–0.1	–
CD4032		5	10	500	50	100	500	–	0.5	0.7	–0.15	–0.55	–	0.2	0.5	–0.1	–0.27	–
CD4033		5	10	500	50	100	500	–	0.12	0.25	–0.14	–0.3	–	0.06	0.12	–0.07	–0.15	–
CD4034		5	10	500	–	–	500	–	0.1	0.25	–0.05	–0.125	–	–	–	–	–	–
CD4035		5	10	500	50	100	500	–	0.5	1.25	–0.25	–0.65	–	0.35	0.85	–0.18	–0.45	–
CD4036		5	10	500	–	–	500	–	0.03	0.075	–0.03	–0.075	–	–	–	–	–	–
CD4037		5	10	500	50	100	500	–	0.7	1.1	–0.55	–0.75	–	0.35	0.55	–0.3	–0.4	–
CD4038		5	10	500	50	100	500	–	0.5	0.7	–0.15	–0.55	–	0.2	0.5	–0.1	–0.27	–
CD4039		5	10	500	–	–	500	–	0.03	0.075	–0.03	–0.075	–	–	–	–	–	–
CD4040		15	25	500	50	100	500	–	0.145	0.4	–0.1	–0.25	–	0.08	0.2	–0.06	–0.15	–
CD4041		1	2	50	10	20	50	1.6	–	5	–1.4	–4	0.8	–	2.5	–0.7	–2	–
CD4042		1	2	500	10	20	500	–	0.4	1	–0.35	–0.9	–	0.2	0.5	–0.175	–0.45	–
CD4043		1	2	500	10	20	500	–	0.2	0.5	–0.175	–0.4	–	0.1	0.25	–0.09	–0.2	–
CD4044		1	2	500	10	20	500	–	0.2	0.5	–0.175	–0.4	–	0.1	0.25	–0.09	–0.2	–
CD4045		15	25	500	50	100	500	–	3.5	5.5	–2.5	–4.5	–	1.8	2.8	–1.3	–2.3	–
CD4046		15	60	500	15	60	500	–	0.43	1.3	–0.3	–0.9	–	0.43	1.3	–0.3	–0.9	–
CD4047		5	10	500	50	100	500	–	0.4	1	–0.4	–1	–	0.28	0.7	–0.28	–0.7	–
CD4048		1	2	500	10	20	500	1.6⌀	–	4.5	–1.6	–4.5	1.6⌀	–	4.5	–1.6	–3.15	–
CD4049		0.3	0.5	50	3	5	50	3	–	8	–0.5	–1.25	3	–	8	–0.5	–1.25	–
CD4050		0.3	0.5	50	3	5	50	3	–	8	–0.5	–1.25	3	–	8	–0.5	–1.25	–

▲ V_O = 2.5 V ⌀ V_{DD} = 4.5 V

CD4000A Standard Series, Dynamic Electrical Characteristics

COS/MOS "A" Series Type	Conditions	Dynamic, $T_A = 25^oC$; $C_L = 15$ pF Unless Otherwise Specified; $C_I = 5$ pF t_r, $t_f = 20$ ns — Max. Propagation Delay				Max. Transition Time				Max. Clock Input Frequency			
		D,F,K,T Packages (t_{PHL},t_{PLH}) ns		E,Y Packages (t_{PHL},t_{PLH}) ns		D,F,K,T Packages (t_{THL},t_{TLH}) ns		E,Y Packages (t_{THL},t_{TLH}) ns		D,F,K,T Packages (f_{CL}) MHz		E,Y Packages (f_{CL}) MHz	
	V_{DD}(V)	5	10	5	10	5	10	5	10	5	10	5	10
	V_O(V)												
CD4000		50,95	40,45	80,120	55,65	125,175	70,75	200,300	115,125	–	–	–	–
CD4001		50,95	40,45	80,120	55,65	125,175	70,75	200,300	115,125	–	–	–	–
CD4002		50,95	40,45	80,120	55,65	125,175	70,75	200,300	115,125				
CD4006		400	200	500	250	400	200	500	250	1	2.5	0.6	2
CD4007		60	40	75	50	75	40	100	50	–	–	–	–
CD4008		1300	500	2000	650	2200	900	2900	1100	–	–	–	–
CD4009		55,80	30,55	70,100	40,70	45,125	40,100	60,160	50,120	–	–	–	–
CD4010		55,80	30,55	70,100	40,70	45,125	40,100	60,160	50,120	–	–	–	–
CD4011		75	40	100	50	100,125	60,75	125,150	75,100	–	–	–	–
CD4012		75,150	40,75	100,200	50,100	100,375	60,200	125,500	75,250	–	–	–	–
CD4013		300	110	350	125	125	70	150	75	2.5	7	1	5
CD4014		750	225	1000	300	300	125	400	150	1	3	0.6	2.5
CD4015		750	225	1000	300	300	125	400	150	1	3	0.6	2.5
CD4016		–	20•	–	20•	–	–	–	–	–	–	–	–
CD4017		1200	400	1600	500	900	350	1200	450	1	3	0.6	2
CD4018		1200	400	1600	500	900	350	1200	450	1	1	0.6	2
CD4019		225	100	300	125	200	65	275	80	–	–	–	–
CD4020		600	225	650	250	600	300	650	350	1.5	4	1	3
CD4021		750	225	1000	300	300	125	400	150	1	3	0.6	2.5
CD4022		1200	400	1600	800	900	250	1200	500	1	3	0.6	2
CD4023		75	40	100	50	100,125	60,75	125,150	75,100	–	–	–	–
CD4024		350	150	400	150	225	150	250	150	1.5	4	1	3
CD4025		50,95	40,45	80,120	55,65	125,175	70,75	200,300	115,125	–	–	–	–
CD4026		1700	500	2200	700	900	350	1200	450	1.5	3	1	2
CD4027		300	110	400	150	125	70	250	140	1.5	4.5	1	3
CD4028		480	180	700	290	150	75	300	150	–	–	–	–
CD4029		650	230	1300	460	200	100	400	200	1.5	3	1	2
CD4030		200	100	300	150	150	75	300	150	–	–	–	–
CD4031		800	400	1600	800	150	60	300	120	0.8	2	0.4	1.0
CD4032		2200	500	2400	600	375	150	425	200	1.5	3	1	2
CD4033		1700	500	2200	700	900	350	1200	450	1.5	3	1	2
CD4034		1200	480	–	–	750	300	–	–	1.5	3	–	–
CD4035		500	200	700	300	200	100	300	150	1.5	3	1	2
CD4036		1000	400	1000	400	400	200	400	200	–	–	–	–
CD4037		500,450	150,180	700,650	200,250	80,150	30,120	120,200	40,180	–	–	–	–
CD4038		2200	500	2400	600	375	150	425	200	1.5	3	1	2
CD4039		1000	400	1000	400	400	200	400	200	–	–	–	–
CD4040		900	450	950	475	300	150	350	175	1	3.5	0.9	3.25
CD4041		100,100	45,40	125,125	65,60	60,55	40,40	80,75	50,50	–	–	–	–
CD4042		300	125	400	200	200	100	300	150	–	–	–	–
CD4043		350	175	400	200	200	100	250	125	–	–	–	–
CD4044		350	175	400	200	200	100	250	125	–	–	–	–
CD4045		4.4□	2.4□	5.5□	3.3□	800	650	900	750	4.4	8.5	3.5	6.5
CD4046		–	–	–	–	–	–	–	–	–	–	–	–
CD4047		1200	600	1600	800	125	75	150	100	–	–	–	–
CD4048		1300	400	1600	500	140,250	50,60	170,300	65,75	–	–	–	–
CD4049		55,80	30,55	110,140	55,85	45,100	40,60	45,100	40,60	–	–	–	–
CD4050		55,80	30,55	110,140	55,85	45,100	40,60	45,100	40,60	–	–	–	–

• Typical □ μs

CD4000A Standard Series, Static Electrical Characteristics

COS/MOS "A" Series Type	Conditions	Static, $T_A = 25^oC$ — Max. Quiescent Device Current — D,F,K,T Packages (I_L) μA			E,Y Packages (I_L) μA			Min. Output Drive Current — D,F,K,T Packages — N-Channel (Sink)(I_DN) mA			P-Channel (Source)(I_DP) mA		E,Y Packages — N-Channel (Sink)(I_DN) mA			P-Channel (Source)(I_DP) mA		Max. "ON" Resistance — All Packages (R_{ON}) Ω
	V_{DD}(V)	5	10	15	5	10	15	5	5	10	5	10	5	5	10	5	10	R_L = 10 kΩ
	V_O(V)							0.4	0.5	0.5	4.5	9.5	0.4	0.5	0.5	4.5	9.5	
CD4051		5	10	500	50	100	500	–	–	–	–	–	–	–	–	–	–	2500 at V_{DD}=5V 400 at V_{DD}=10V 280 at V_{DD}=15V
CD4052		5	10	500	50	100	500	–	–	–	–	–	–	–	–	–	–	
CD4053		5	10	500	50	100	500	–	–	–	–	–	–	–	–	–	–	
CD4054		–	10	20	–	10	20	–	–	0.9	–	0.45	–	–	0.6	–	–0.3	–
CD4055		–	10	20	–	10	20	–	–	0.9	–	0.45	–	–	0.6	–	–0.3	–
CD4056		–	10	20	–	10	20	–	–	0.9	–	0.45	–	–	0.6	–	–0.3	–
CD4057		5	10	500	–	–	500	–	0.09	0.05	0.02	0.05	–	–	–	–	–	–
CD4059		10	25	500	50	100	500	2	–	4	–0.4	–0.9	2	–	4	–0.4	–0.9	–
CD4060		15	25	500	50	100	500	–	0.18	0.36	–0.125	–0.25	–	0.18	0.36	–0.125	–0.25	–
CD4061		5	10	500	–	–	500	1.6*	–	3.5	–0.4	–0.9	–	–	–	–	–	–
CD4062		12	25	500	–	–	500	1.3	–	4	–0.25	–0.7	–	–	–	–	–	–
CD4063		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4066		–	0.5	50	–	5	50		–	–	–	–	–	–	–	–	–	Note 1
CD4067		5	10	500	50	100	500		–	–	–	–	–	–	–	–	–	Note 2
CD4068		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4069		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4070		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4071		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4072		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4073		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4075		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4076		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4077		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4078		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4081		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4082		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4085		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4086		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4089		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4093		0.5	1	50	5	10	50	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4094		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	
CD4095		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4096		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4097		5	10	500	50	100	500		–	–	–	–	–	–	–	–	–	2500 at V_{DD}=5V 400 at V_{DD}=10V 280 at V_{DD}=15V
CD4098		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4099		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4502		0.5	1	50	5	10	50	3.2	–	7.2	–0.4	–0.9	3.2	–	7.2	–0.4	–0.9	–
CD4508		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4510		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4511		5	10	500	50	100	500	0.4	–	0.9	20‡	20ǂ	0.4	–	0.9	–20‡	–20ǂ	–
CD4514		5	10	500	–	–	500	0.4	–	0.9	–0.2	–0.5	0.4	–	0.9	–0.2	–0.5	–
CD4515		5	10	500	–	–	500	0.4	–	0.9	–0.2	–0.5	0.4	–	0.9	–0.2	–0.5	–
CD4516		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4518		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4520		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–

Note 1: 5000 at V_{DD} = 5 V, 500 at V_{DD} = 10 V, 280 at V_{DD} = 15 V

Note 2: 2500 at V_{DD} = 5 V, 400 at V_{DD} = 10 V, 280 at V_{DD} = 15 V

ǂ V_O = 8.6 V

‡ V_O = 3.4 V

* V_{DD} = 4.5 V

CD4000A Standard Series, Dynamic Electrical Characteristics

COS/MOS "A" Series Type	Conditions	Dynamic, T_A = 25°C; C_L = 15 pF Unless Otherwise Specified; C_I = 5 pF t_r, t_f = 20 ns											
		Max. Propagation Delay				Max. Transition Time				Max. Clock Input Frequency			
		D,F,K,T Packages		E,Y Packages		D,F,K,T Packages		E,Y Packages		D,F,K,T Packages		E,Y Packages	
		(t_{PHL},t_{PLH}) ns		(t_{PHL},t_{PLH}) ns		(t_{THL},t_{TLH}) ns		(t_{THL},t_{TLH}) ns		(f_{CL}) MHz		(f_{CL}) MHz	
	V_{DD}(V)	5	10	5	10	5	10	5	10	5	10	5	10
	V_O(V)												
CD4051		325●	135●	325●	135●	–	–	–	–	–	–	–	–
CD4052		325●	135●	325●	135●	–	–	–	–	–	–	–	–
CD4053		325●	135●	325●	135●	–	–	–	–	–	–	–	–
CD4054		900	600	1200	800	80	60	110	80	–	–	–	–
CD4055		900	600	1200	800	80	60	110	80	–	–	–	–
CD4056		900	600	1200	800	80	60	110	80	–	–	–	–
CD4057		3900	720	–	–	2775	1275	–	–	–	–	–	–
CD4059		360	180	360	180	70,200	40,100	70,200	40,100	–	–	–	–
CD4060		900	450	950	475	300	150	350	175	1	3	0.9	2.75
CD4061		750	380	–	–	100,60	75,40	–	–	1/1200	1/500	–	–
CD4062		1500	600	–	–	400,200	200,100	–	–	1.25	2.5	–	–
CD4063		1250	500	1250	500	200	100	200	100	–	–	–	–
CD4066		–	35●	–	35●	–	–	–	–	–	–	–	–
CD4067		325●	135●	325●	135●	–	–	–	–	–	–	–	–
CD4068		650,500	260,200	650,500	260,200	200	100	200	100	–	–	–	–
CD4069		125	80	125	80	200	100	200	100	–	–	–	–
CD4070		175●	75●	175●	75●	200	100	200	100	–	–	–	–
CD4071		500,350	200,140	500,350	200,140	200	100	200	100	–	–	–	–
CD4072		500,350	200,140	500,350	200,140	200	100	200	100	–	–	–	–
CD4073		320,420	130,170	320,420	130,170	200	100	200	100	–	–	–	–
CD4075		500,350	200,140	500,350	200,140	200	100	200	100	–	–	–	–
CD4076		600	250	600	250	200	100	200	100	–	–	–	–
CD4077		175●	75●	175●	75●	200	100	200	100	–	–	–	–
CD4078		400,850	160,340	400,850	160,340	200	100	200	100	–	–	–	–
CD4081		320,420	130,170	320,420	130,170	200	100	200	100	–	–	–	–
CD4082		320,420	130,170	320,420	130,170	200	100	200	100	–	–	–	–
CD4085		450,620	180,250	450,620	180,250	200	100	200	100	–	–	–	–
CD4086		450,700	180,280	450,700	180,250	200	100	200	100	–	–	–	–
CD4089		180●	90●	180●	90●	200	100	200	100	2●	5●	2●	5
CD4093		600	300	600	300	200	100	200	100	–	–	–	–
CD4094		840	390	840	390	200	100	200	100	2.5	5	2.5	5
CD4095		500	200	500	200	200	100	200	200	3.5	8	3.5	8
CD4096		500	200	500	200	200	100	100	100	3.5	8	3.5	8
CD4097		325●	135●	325●	135●	–	–	–	–	–	–	–	–
CD4098		350●	125●	350●	125●	200	100	200	100	–	–	–	–
CD4099		220●	90●	220●	90●	200	100	200	100	–	–	–	–
CD4502		135,295●	55,130●	135,295●	55,130●	40,100●	20,50●	40,100●	20,50●	–	–	–	–
CD4508		220	90	220	90	200	100	200	100	–	–	–	–
CD4510		315●	130●	315●	130●	200	100	200	100	1.5	3	1.5	3
CD4511		720,640●	290,250●	720,640●	290,250●	125,40●	75,30●	125,40●	75,30●	–	–	–	–
CD4514		1100	450	1100	450	200,400	100,200	200,400	100,200	–	–	–	–
CD4515		1100	450	1100	450	200,400	100,200	200,400	100,200	–	–	–	–
CD4516		315●	130●	315●	130●	200	100	200	100	1.5	3	1.5	3
CD4518		560	230	560	230	200	100	200	100	1.5	3	1.5	3
CD4520		560	230	560	230	200	100	200	100	1.5	3	1.5	3

Note: C_L = 50 pF for type CD4063 and for types CD4067 through CD40257.

** V_{DD} = 12 V, V_{CC} = 5 V, V_{SS} = 0

● Typical value

CD4000A Standard Series, Static Electrical Characteristics

COS/MOS "A" Series Type	Static, T_A = 25°C																	
	Conditions	Max. Quiescent Device Current						Min. Output Drive Current										Max. "ON" Resistance
		D,F,K,T Packages			E,Y Packages			D,F,K,T Packages					E,Y Packages					All Packages
		(I_L) µA			(I_L) µA			N-Channel (Sink)(I_DN) mA			P-Channel (Source)(I_DP) mA		N-Channel (Sink)(I_DN) mA			P-Channel (Source)(I_DP) mA		(R_{ON}) Ω
	V_{DD}(V)	5	10	15	5	10	15	5	5	10	5	10	5	5	10	5	10	R_L = 10 kΩ
	V_O(V)							0.4	0.5	0.5	4.5	9.5	0.4	0.5	0.5	4.5	9.5	
CD4527		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4532		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4555		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD4556		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40100		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40101		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40102		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40103		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40104		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40107		0.5	1	50	5	10	50	12.8	–	28.8	–	–	12.8	–	28.8	–	–	–
CD40108		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40109		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40181		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40182		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40192		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40193		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40194		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	–
CD40257		5	10	500	50	100	500	0.4	–	0.9	–0.4	–0.9	0.4	–	0.9	–0.4	–0.9	

CD4000B High-Voltage Series, Static Electrical Characteristics

COS/MOS "B" Series Type	Static, T_A = 25°C																
	Conditions	Max. Quiescent Device Current								Min. Output Drive Current							Max. "ON" Resistance
		D,F,K,T Packages				E,Y Packages				All Packages							All Packages
		(I_L) µA				(I_L) µA				N-Channel (Sink)(I_DN) mA			P-Channel (Source)(I_DP) mA				R_{ON} Ω
	V_{DD}(V)	5	10	15	20	5	10	15	20	5	10	15	5	5	10	15	R_L = 10 KΩ
	V_O(V)									0.4	0.5	1.5	2.5	4.6	9.5	13.5	
CD4000		0.5	1	2	50	5	10	20	50	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4001		0.5	1	2	50	5	10	20	50	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4002		0.5	1	2	50	5	10	20	50	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4008		5	10	20	500	50	100	200	500	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4009		0.5	1	2	50	5	10	20	50	1.6	3.6	12	–0.8	–0.2	–0.45	–1.5	–
CD4010		0.5	1	2	50	5	10	20	50	1.6	3.6	12	–0.8	–0.2	–0.45	–1.5	–
CD4011		0.5	1	2	50	5	10	20	50	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4012		0.5	1	2	50	5	10	20	50	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4013		5	10	20	500	50	100	200	500	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4016		0.5	1	2	50	5	10	20	50	0.4	0.9	3	–1.6	–0.4	–0.9	–3	2000 at V_{DD}=10 V 850 at V_{DD}=15 V
CD4023		0.5	1	2	50	5	10	20	50	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4025		0.5	1	2	50	5	10	20	50	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4027		5	10	20	500	50	100	200	500	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4041		0.5	1	2	50	5	10	20	50	1.6	3.6	12	–6.4	–1.6	–3.6	–12	–
CD4042		5	10	20	500	50	100	200	500	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4043		5	10	20	500	50	100	200	500	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4044		5	10	20	500	50	100	200	500	0.4	0.9	3	–1.6	–0.4	–0.9	–3	–
CD4049		0.5	1	2	50	5	10	20	50	3.2	7.2	32	–1.6	–0.4	–0.9	–3	–
CD4050		0.5	1	2	50	5	10	20	50	3.2	7.2	32	–1.6	–0.4	–0.9	–3	–

CD4000A Standard Series, Dynamic Electrical Characteristics

COS/MOS "A" Series Type	Conditions	Max. Propagation Delay (t_{PHL}, t_{PLH}) ns, D,F,K,T Packages		Max. Propagation Delay (t_{PHL}, t_{PLH}) ns, E,Y Packages		Max. Transition Time (t_{THL}, t_{TLH}) ns, D,F,K,T Packages		Max. Transition Time (t_{THL}, t_{TLH}) ns, E,Y Packages		Max. Clock Input Frequency (f_{CL}) MHz, D,F,K,T Packages		Max. Clock Input Frequency (f_{CL}) MHz, E,Y Packages	
	Dynamic, T_A = 25°C; C_L = 15 pF Unless Otherwise Specified; C_I = 5 pF t_r, t_f = 20 ns												
	V_{DD}(V)	5	10	5	10	5	10	5	10	5	10	5	10
	V_O(V)												
CD4527		180•	90	180•	90	200	100	200	100	–	–	–	–
CD4532		440	220	440	220	200	100	200	100	–	–	–	–
CD4555		440	190	440	190	200	100	200	100	–	–	–	–
CD4556		440	190	190	190	200	100	200	100	–	–	–	–
CD40100		350•	125•	350•	125•	200	100	200	100	3•	6•	3•	6•
CD40101		350•	125•	350•	125•	200	100	200	100	–	–	–	–
CD40102		250•	100•	250•	100•	200	100	200	100	2•	5•	2•	5•
CD40103		250•	100•	250•	100•	200	100	200	100	2•	5•	2•	5•
CD40104		350•	125•	350•	125•	200	100	100	100	3•	6•	3•	6•
CD40107		100,100•	40,60•	100,100•	40,60•	40,40•	20,35•	40,40•	20,35•	–	–	–	–
CD40108		350•	125•	350•	125•	200	100	200	100	–	–	–	–
CD40109		←	350	150•**	→	200	100	200	100	–	–	–	–
CD40181		715•	250•	715•	250•	200	100	200	100				
CD40182		345•	140•	345•	140•	200	100	200	100	–	–	–	–
CD40192		775•	310•	775•	310•	200	100	200	100	3•	6•	3•	6•
CD40193		775•	310•	775•	310•	200	100	200	100	3•	6•	3•	6•
CD40194		350•	125•	350•	125•	200	100	200	100	3•	6•	3•	6•
CD40257		150•	75•	150•	75•	200	100	200	100				

Note: C_L = 50 pF for type CD4063 and for types CD4067 through CD40257.

• Typical value

CD4000B High-Voltage Series, Dynamic Electrical Characteristics

COS/MOS "B" Series Type	Conditions	Max. Propagation Delay (t_{PHL}, t_{PLH}) ns			Max. Transition Time (t_{THL}, t_{TLH}) ns			Max. Clock Input Frequency (f_{CL}) MHz		
	Dynamic, T_A = 25°C; C_L = 50 pF; C_I = 5 pF; t_r,t_f = 20 ns — All Packages									
	V_{DD}(V)	5	10	15	5	10	15	5	10	15
	V_O(V)									
CD4000		75•	35•	25•	200	100	80	–	–	–
CD4001		75•	35•	25•	200	100	80	–	–	–
CD4002		75•	35•	25•	200	100	80	–	–	–
CD4008		400•	160•	115•	200	100	80	–	–	–
CD4009		30,80•	15,40•	10,30•	40,100•	20,50•	15,40•	–	–	–
CD4010		40,80•	20,40•	15,30•	40,100•	20,50•	15,40•	–	–	–
CD4011		75•	35•	25•	200	100	80	–	–	–
CD4012		75•	35•	25•	200	100	80	–	–	–
CD4013		175•	75•	50•	200	100	80	7•	16•	24•
CD4016			40•	–	–	–	..	–	–	–
CD4023		75•	35•	25•	200	100	80	–	–	–
CD4025		75•	35•	25•	200	100	80	–	–	–
CD4027		175•	75•	50•	200	100	80	7•	16•	24•
CD4041		75•	35•	25•	75•	35•	25•	–	–	–
CD4042		220•	90•	60•	200	100	80	–	–	–
CD4043		220•	90•	60•	200	100	80	–	–	–
CD4044		220•	90•	60•	200	100	80	–	–	–
CD4049		30,80•	15,40•	10,30•	40,100•	20,50•	15,40•	–	–	–
CD4050		40,80•	20,40•	15,30•	40,100•	20,50•	15,40•	–	–	–

• Typical value

DIGITAL

RCA Solid State

CD4000B High-Voltage Series, Static Electrical Characteristics

COS/MOS "B" Series Type	Static, $T_A = 25^oC$ Conditions	Max. Quiescent Device Current D,F,K,T Packages (I_L) μA				Max. Quiescent Device Current E,Y Packages (I_L) μA				Min. Output Drive Current All Packages N-Channel (Sink)(I_DN) mA			Min. Output Drive Current All Packages P-Channel (Source)(I_DP) mA				Max. "ON" Resistance All Packages R_{ON} Ω
	V_{DD}(V)	5	10	15	20	5	10	15	20	5	10	15	5	5	10	15	R_L = 10 KΩ
CD4051		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4052		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4053		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4054		5	10	20	500	50	100	200	500	0.4	0.9	3	−0.8	−0.2	−0.45	−1.5	2500 at V_{DD}=5 V
CD4055		5	10	20	500	50	100	200	500	0.4	0.9	3	−0.8	−0.2	−0.45	−1.5	400 at V_{DD}=10 V
CD4056		5	10	20	500	50	100	200	500	0.4	0.9	3	−0.8	−0.2	−0.45	−1.5	280 at V_{DD}=15 V
CD4063		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.45	−1.5	–
CD4067		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.45	−1.5	2500 at V_{DD}=5 V 400 at V_{DD}=10 V 280 at V_{DD}=15 V
CD4068		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.45	−1.5	–
CD4069		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4070		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4071		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4072		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4073		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4075		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4076		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4077		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4078		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4081		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4082		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4085		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4086		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4089		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4093		0.5	1	2	50	5	10	20	50	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4094		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4095		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4096		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4097		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	2500 at V_{DD}=5 V 400 at V_{DD}=10 V 280 at V_{DD}=15 V
CD4098		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4099		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4502		0.5	1	2	50	5	10	20	50	3.2	7.2	32	−1.6	−0.4	−0.9	−3	–
CD4508		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4510		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4511		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−20‡	−20‡	−3	–
CD4514		5	10	20	500	50	100	200	500	0.4	0.9	3	−0.8	−0.2	−0.45	−1.5	–
CD4515		5	10	20	500	50	100	200	500	0.4	0.9	3	−0.8	−0.2	−0.45	−1.5	–
CD4516		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4518		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4520		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4527		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4532		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4555		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD4556		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40100		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40101		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40102		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40103		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40104		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40105		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40107		0.5	1	2	50	5	10	20	50	12.8	28.8	96	Open Drain				–
CD40108		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40109		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40181		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40182		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40192		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40193		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40194		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–
CD40257		5	10	20	500	50	100	200	500	0.4	0.9	3	−1.6	−0.4	−0.9	−3	–

‡ V_O = 8.6 V   ‡ V_O = 3.4 V

CD4000B High-Voltage Series, Dynamic Electrical Characteristics

COS/MOS "B" Series Type	Dynamic, $T_A = 25^oC$; $C_L = 50$ pF; $C_I = 5$ pF; $t_r, t_f = 20$ ns									
	Conditions	Max. Propagation Delay			Max. Transition Time			Max. Clock Input Frequency		
		All Packages								
		(t_{PHL}, t_{PLH}) ns			(t_{THL}, t_{TLH}) ns			(f_{CL}) MHz		
	V_{DD}(V)	5	10	15	5	10	15	5	10	15
	V_O(V)									
CD4051		325•	135•	95•	–	–	–	–	–	–
CD4052		325•	135•	95•	–	–	–	–	–	–
CD4053		325•	135•	95•	–	–	–	–	–	–
CD4054		–	800	500	–	200	150	–	–	–
CD4055			1300	750	–	200	150	–	–	–
CD4056			1300	750	–	200	150	–	–	–
CD4063		1250	500	350	200	100	80	–	–	–
CD4067		325•	135•	95•	–	–	–	–	–	–
CD4068		650,500	260,200	200,150	200	100	80	–	–	–
CD4069		125	80	60	200	100	80	–	–	–
CD4070		175	75	50	200	100	80	–	–	–
CD4071		500,350	200,140	150,110	200	100	80	–	–	–
CD4072		500,350	200,140	150,110	200	100	80	–	–	–
CD4073		320,420	130,170	100,130	200	100	80	–	–	–
CD4075		500,350	200,140	150,110	200	100	80	–	–	–
CD4076		600	250	180	200	100	80	–	–	–
CD4077		175•	75•	50•	200	100	80	–	–	–
CD4078		400,850	160,340	120,240	200	100	80	–	–	–
CD4081		320,420	130,170	100,130	200	100	80	–	–	–
CD4082		320,420	130,170	100,130	200	100	80	–	–	–
CD4085		450,620	180,250	130,180	200	100	80	–	–	–
CD4086		450,700	180,280	120,200	200	100	80	–	–	–
CD4089		220•	90•	60•	200	100	80	2•	5•	7.5•
CD4093		600	300	240	200	100	80	–	–	–
CD4094		840	390	270	200	100	80	2.5	5	6
CD4095		500	200	150	200	100	80	3.5	8	12
CD4096		500	200	150	200	100	80	3.5	8	12
CD4097		325•	135•	95•	–	–	–	–	–	–
CD4098		350•	125•	90•	200	100	80	–	–	–
CD4099		220•	90•	60•	200	100	80	–	–	–
CD4502		135,295•	55,130•	40,95•	40,100•	20,50•	15,40•	–	–	–
CD4508		220•	90•	60•	200	100	80	–	–	–
CD4510		315•	130•	100•	200	100	80	1.5	3	4
CD4511		720,640•	290,250•	200,180•	125,40•	75,30•	65,25•	–	–	–
CD4514		1100	450	300	200,400	100,200	80,160	–	–	–
CD4515		1100	450	300	200,400	100,200	80,160	–	–	–
CD4516		315•	130•	100•	200,400	100,200	80,160	1.5	3	4
CD4518		560	230	160	200	100	80	–	–	–
CD4520		560	230	160	200	100	80	–	–	–
CD4527		220•	90•	60•	200	100	80	3•	7•	10•
CD4532		440	220	170	200	100	80	–	–	–
CD4555		440	190	140	200	100	80	–	–	–
CD4556		440	190	140	200	100	80	–	–	–
CD40100		350•	125•	90•	200	100	80	3•	6•	9•
CD40101		350•	125•	90•	200	100	80	–	–	–
CD40102		250•	100•	75•	200	100	80	2•	5•	7.5•
CD40103		250•	100•	75•	200	100	80	2•	5•	7.5•
CD40104		350•	125•	90•	200	100	80	3•	6•	9•
CD40105		6000•	3000•	2000•	200	100	80	3•	6•	9•
CD40107		100,100•	40,60•	30,45•	40,40•	20,35•	15,30•	–	–	–
CD40108		350•	125•	90•	200	100	80	–	–	–
CD40109		← 350,150 •** →			200	100	80	–	–	–
CD40181		715•	250•	180•	200	100	80	–	–	–
CD40182		345•	140•	110•	200	100	80	–	–	–
CD40192		775•	310•	235•	200	100	80	3•	6•	9•
CD40193		775•	310•	235•	200	100	80	3•	6•	9•
CD40194		350•	125•	90•	200	100	80	3•	6•	9•
CD40257		150•	75•	50•	200	100	80	–	–	–

• Typical

•* $V_{DD} = 12$ V, V_{CC} 5 V, $V_{SS} = 0$

TABLE OF CONTENTS

INTRODUCTION TO SIGNETICS LS

FEATURES OF LOW POWER SCHOTTKY TTL

Low Power, High Speed Operation

- 9.5ns typical gate propagation delay time (avg.)
- 2mw per gate power dissipation at 50% duty cycle — speed-power product = 19 picojoules typ.
- 45 MHz typical J-K Flip-Flop maximum clock frequency (D.C. coupled)

54/74 TTL performance at one fifth the power makes it possible to reduce size and cost of power supplies and eliminate cooling fans in 7400 type system designs. Manufacturing costs can be reduced by up to $.10 per package by using Signetics Low Power Schottky in place of 54/74. The speed-power characteristics of Low Power Schottky are also such that many systems previously designed with a combination of 54/74 and 54L/74L can be immediately upgraded with 54LS/74LS resulting in little or no increase in power and possible reduction in component cost.

Fully Compatible with Other TTL Families

- Fan out of 5 7400 (2.5 5400) inputs or 4 74S/74H (2 54S/54H) loads.
- Low input current (.36 mA max) zero level input current.
- Pin, function speed compatible with 54/74.

Low Power Schottky has sufficient drive capability to interface with other TTL families in most applications without the need for buffer circuits. Thus it is possible to upgrade designs to Low Power Schottky as functions become available, using 5400/7400 functions where 54LS/74LS functions aren't yet available. The low input currents of Low Power Schottky make it an ideal interface between TTL compatible MOS devices and other systems.

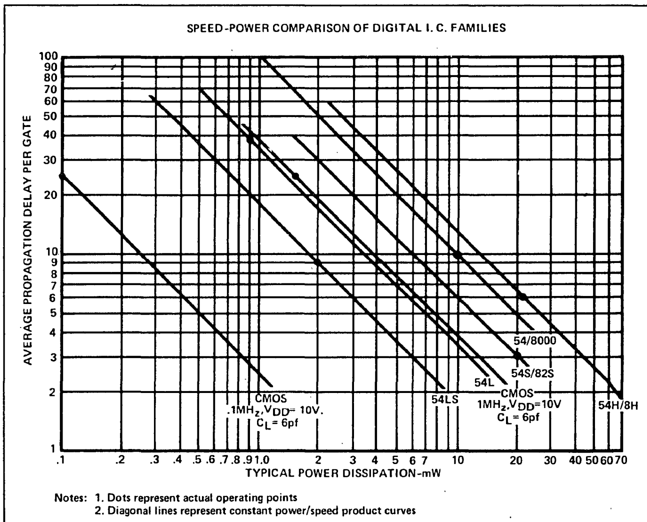


Figure 1

The high output current capability of 54LS/74LS Low Power Schottky enables it to drive a wide range of capacitive loads with minimum affect on device performance. This low impedance output characteristic also enables Low Power Schottky to drive reasonably long lines (up to 36 inches) without the need for terminated, controlled impedance lines.

ADVANTAGES OF LOW POWER SCHOTTKY

Circuit Density

74LS is fabricated using a thin epitaxial process to reduce parasitic capacitance. Low internal currents permit design of transistor geometries and metal widths to be the smallest allowable using state of the art mask and fabrication techniques. Further circuit density improvements are made by the use of ion implanted resistors. Greater than five times reduction in resistor geometries is made possible by this technique. A comparison of 5400/7400 geometries versus 54LS/74LS geometries is shown in Figure 2. These techniques result in Low Power Schottky die areas being 60 to 75 percent the area of the equivalent 5400/7400 function. For example, the die size of the 54LS/74LS181 4-bit ALU is:

72 mils by 84 mils or 6048 square mils versus 90 mils by 92 mils, or 8280 square mils for the 54181/74181, or 75 percent of the area.

Future Trends

High circuit density, high speed and low power make Signetics Low Power Schottky a natural choice for high performance bipolar LSI designs such as microprocessors and large custom logic blocks. An example of an LSI product that has been developed by Signetics is a custom logic chip containing 270 equivalent logic gates on a 140x160 mil chip containing 1,590 components. This design resulted in a 40% improvement in performance, 80% reduction in power and 2:1 reduction in manufacturing cost. (see Table 1)

Table 1
COMPARISON OF TTL LSI VS. STANDARD TTL

	LSI	STD
Packages	1	26
Equivalent Gates	270	270
Power Dissipation	.65 watts	2.7 watts
Power/Gate	2.4 mW typ.	10.0 mW typ.
Speed	7ns/gate typ.	12ns /gate typ.

Thermal Considerations

TTL technology has now reached the level where maximum circuit complexity is often limited by package power capabilities. When standard TTL circuit designs are done with Low Power Schottky, circuit complexities can increase by a factor of five greater than standard designs without exceeding package power limitations as shown by Table 1.

Low Power Schottky's reduced power can also have a significant impact on component reliability in a system. For example, if we compare the reliability of a typical MSI function in a system with an operating ambient temperature of 55°C a four times improvement in component failure rate can result from the lower junction temperature of a Low Power Schottky function versus a standard 5400/7400 function. The Table 3 below and Figure 3 show a specific example of this improvement.

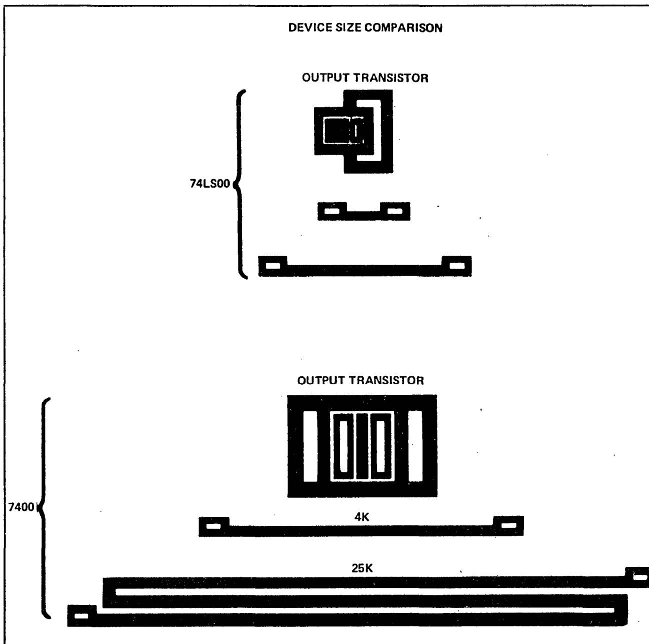


Figure 2

Table 2

	Military	Commercial
Maximum junction temperature	175°C	150°C
Maximum ambient temperature	125°C	70°C
Allowable thermal rise ambient to junction	50°C	80°C
Maximum allowable power dissipation	330 mw plastic[1] 500 mw Cerdip[2]	500 mw plastic[1] 800 mw Cerdip[2]
Maximum numbers of 5400 gates (at 10 mw/gate)	33 plastic 50 Cerdip	50 plastic 80 Cerdip
Maximum number of 54LS gates (at 2 mw/gate)	165 Plastic 250 Cerdip	250 Plastic 400 Cerdip

() ja for plastic = 160° C/watt (16 pin)   2 () ja for Cerdip = 100° C/watt (16 pin)

Table 3

	Standard 54/74	54/74LS
Device Power	250mW	50 mW
Thermal impedance	150°C/watt	160°C/watt
Thermal rise	40°C	8°C
Junction temperature	95°C	63°C
Reliability factor*	22.5	5

*The reliability factor = $\frac{\text{Failure rate at operating junction temperature}}{\text{Failure rate at 25°C junction temperature}}$

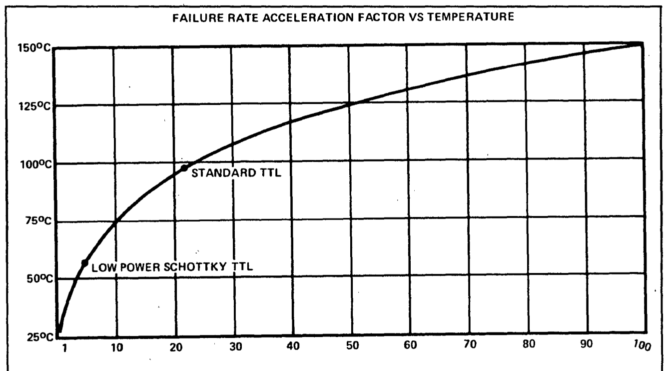


Figure 3

COST REDUCTION

In comparing the cost of designing a system with a particular logic family, the project engineer should compare the total cost including reductions in manufacturing cost which may offset higher prices of a particular family. With low power logic, the cost savings associated with smaller, lower cost power supplies can be significant. As an example, a comparison will be made for the same system, using 54/74 logic, 54/74LS logic, CMOS logic and 54/74L. For purposes of comparison, a controller will be used. It consists of 500 packages, 200 quad NAND gates, 150 dual type D flip-flops and 150 presettable decade counters. It will be assumed that half of the system will operate at 200 kHz and half at 1 MHz. The CMOS system will operate at V_{DD} = 10 Volts with 15 pf. capacitance on each output. The part types used are shown in table 4.

Table 4

DEVICE	QUANTITY	54/74LS TYPE	STD TYPE	CMOS TYPE
Quad NAND Gate	200	54/74LS00	54/7400	4011
Dual D Flip-Flop	150	54/74LS74	54/7474	4013
Presettable Counter	150	54/74LS196	8280	4018

Table 5
DEVICE POWER REQUIREMENTS — Per Package (mW)

	54/74LS	STD TTL	CMOS	54/74L
Quad NAND Gate	8mW	40mW	Static-.05μWatt 200kHz-2.4mW 1MHz-10mW	4mW
Dual D Flip-Flop	20mW	85mW	Static-.2μWatt 200kHz-1.2mW 1MHz-4mW	10mW
Presettable Counter	60mW	185mW	Static-10μWatts 200kHz-1.2mW 1MHz-7mW	30mW

Table 6
SYSTEM POWER CONSUMPTION

		54/74LS	STD TTL	CMOS	54/74L
Gates	Static	1.6watts	8watts	.01mW	.8watts
	Dynamic	1.6watts	8watts	1.3watts	.8watts
Flip-Flops	Static	3watts	12.8watts	.03mW	1.5watts
	Dynamic	3watts	12.8watts	.4watts	1.5watts
Counters	Static	3watts	27.8watts	1.5watts	4.5watts
	Dynamic	9watts	27.8watts	.4watts	4.5watts
Total	Static	13.6watts	48.6watts	1.5mW	6.8watts
	Dynamic	13.6watts	48.6watts	2.1watts	6.8watts
Cost of Power	Static	$13.60	$48.60	0	$6.80
	Dynamic	$13.60	$48.60	$2.10	$6.80
Cost of Power Per Package		$.027	$.097	$.004	$.014

*Assume Power Costs $1.00 Per Watt.

Although standard TTL is the lowest priced logic available today, and probably will be for some time to come, Signetics Low Power Schottky is the *most cost effective* form of logic to design your system with. Low Power Schottky prices are rapidly approaching 7400 as shown by Figure 4. Over the production life of your system, Low Power Schottky will result in the lowest overall manufacturing cost. If you are presently using low power TTL in your design you can affect an immediate cost reduction by replacing it with Low Power Schottky. Similarly, before designing a system with CMOS for lowest power supply costs, compare prices with Low Power Schottky. The difference in price may well offset the power supply savings. You also don't have the easy upgradability with CMOS.

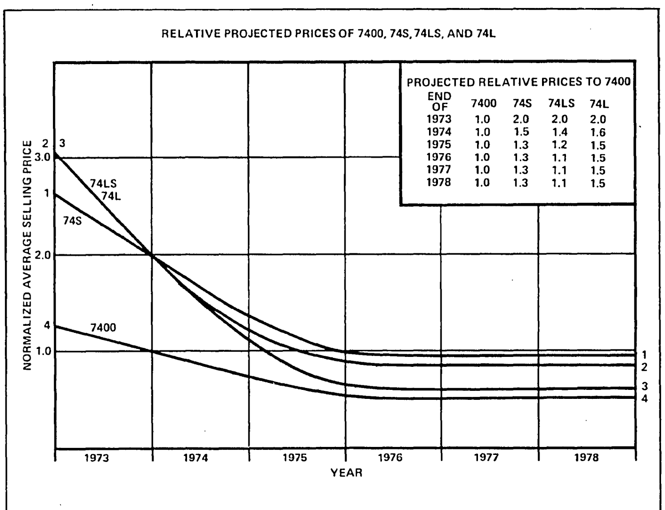


Figure 4

UPGRADING A SYSTEM TO LOW POWER SCHOTTKY

To verify that 54/74LS can be plugged directly into a 54/74 system design, an experiment was conducted using an actual operating system. The system used for the experiment was a communications adapter that is designed to plug into a mini-computer frame. The board contains 103 TTL packages of which two thirds were MSI. All of the 7400 gates and flip-flops were replaced with equivalent 74LS types. System operation was not affected by the use of 74LS in place of 7400 in these sockets. In fact, in addition to the five to one reduction in power requirements for the devices replaced, the system power supply noise was reduced 25% from 80 millivolts to 60 millivolts as shown by Figure 5.

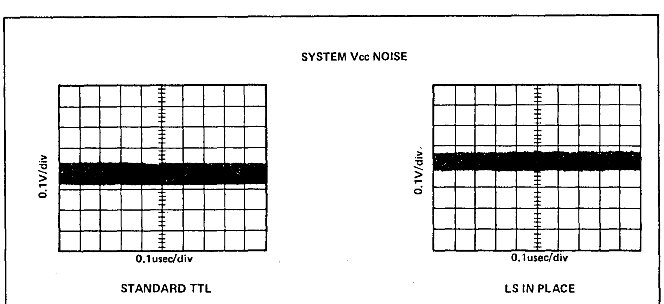


Figure 5

Based on results from this experiment and the characteristic data shown in the section on electrical characteristics, it is concluded that by observing a few simple guidelines, any system can be easily upgraded from 7400 to 74LS resulting in significant reduction in power consumption, system cooling requirements, and improved component reliability in the system.

DESIGN RULES FOR UPGRADING 54/74 SYSTEM TO 54/74LS

1. Check fan out requirements at each output node where a 54/74LS device may have to drive a 54/7400 device. Do not exceed 5 7400 loads or 2.5 5400 loads.
2. Check system set up and hold times for sequential functions to assure that data is available at the correct time for Low Power Schottky functions. These specifications are sometimes slightly different for 54/74LS types than they are for the corresponding 54/74 type.
3. Use standard 54/74 where it is necessary to drive heavy capacitive loads greater than 100pf—150pf.

Three benefits can be derived from the ability to upgrade 5400/7400 designs to 54/74LS.

1. The ability to immediately eliminate thermal heating problems in systems where it has been necessary to put a lot of logic in a small package such as terminals, point of sale systems, etc. A substantial reduction in heat generation can be affected by simply plugging in 54/74LS.
2. Redesign system to reduce power supply cost.
3. Upgrade system capability by adding plug in logic boards without having to redesign the power supply.

DESIGN RULES FOR UPGRADING 54/74L SYSTEM TO 54/74LS

1. Check power supply capability. 54/74LS SSI functions consume approximately twice the power of 54/74 SSI. However, a great many systems are a mix of 54/74L and standard 54/74. In these systems total power can often be reduced by replacing both the standard 54/74 and the 54L/74L with 54/74LS.
2. Check loading rules. The loading rules for 54/74L are almost identical to 54/74LS (See Tables 8 & 9). Generally, the only areas of concern are inputs from non-TTL elements such as linear devices, MOS, memories, CMOS or other devices with limited drive capability.
3. Check system timing. 54/74LS logic is much faster than 54/74L. Therefore, the designer should verify that no race conditions will be created which could affect system operation.

BENEFITS FROM REPLACING 54/74L WITH 54/74LS

1. Cost reduction — 54/74LS is less expensive than 54/74L. The cost difference will become even more significant in the future. (See Figure 4).
2. Availability — 54/74L is an obsolete logic family. Future availability of these devices could be a problem as IC manufacturers phase out production.
3. Inventory — By placing both 54/74 and 54/74L with 54/74LS, the total number of different devices to be tested and stored can be reduced.

CIRCUIT DESIGN

The standard gate circuit for the Signetics 54/74LS00 is shown in Figure 6. The threshold level is set at 1.5V at 25°C by the three base emitter diodes up from ground minus the input diode. This threshold provides a zero level noise immunity of 1.5—0.3 = 1.2V at 25°C by substracting the low output level of the driving gate. At 125°C the noise immunity becomes 1.05—0.20 = .85V which is the worst case zero level. The worst case "one" level noise immunity is V_{OH}—V_{THRESH} or 2.80—1.70 = 1.10V at −55°C. This circuit allows the guarantee of 0.8V for low level input voltage over the −55° to +125°C temperature range including open collector inverters specified at 100 micro amps high level output current. The combination of high threshold and fast turn-on speed is achieved with "kicker" transistor Q_2 which supplies an initial current surge during turn-on. D_3 also helps turn-on by supplying a quick discharge path of the ISO transistor Q_6. The active pull down circuit consisting of Q_4, R_6, and R_7, provides a good V_{in} vs V_{out} characteristic for best noise immunity. The ISO resistor R_3 is low at 120 ohms. The ISO current is typically 30mA which makes it near the capability of standard 7400 in charging highly capacitive bus lines. The base drive to the output transistor Q_5 is at least 0.3mA. With a typical beta of 40 the output sink current will generally be more than 12 mA through a collector resistance of 20 ohm.

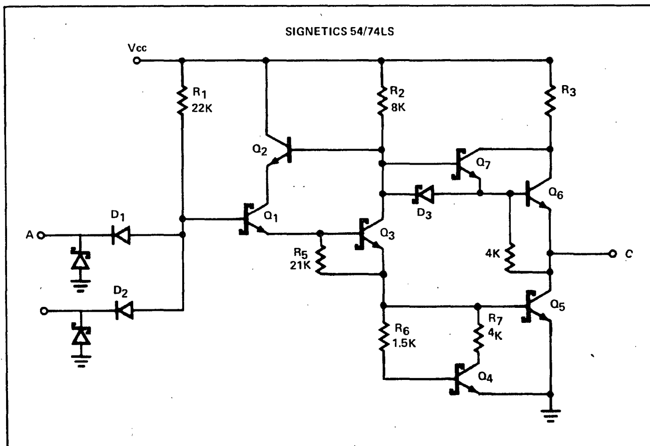


Figure 6

D.C. CHARACTERISTICS

Low Power Schottky has basically the same input and output voltage levels as standard TTL. Input current requirements are reduced to 0.36mA for logic "0" state and $-20\mu a$ for logic "1" state. Output currents are also reduced to 4mA/8mA for 54/74LS in logic "0" state and $400\mu A$ for logic "1" state. Table 7 shows the d.c. characteristics for both 54/74LS and 54/74.

Table 7

PARAMETER		54LS	74LS	54	74	UNIT
V_{IH}	High level input voltage	2 (min)	2 (min)	2 (min)	2 (min)	V
V_{IL}	Low level input voltage	0.8 (max)	0.8 (max)	0.8 (max)	0.8 (max)	V
V_{OH}	High level output voltage	2.5 (min)	2.7 (min)	2.4 (min)	2.4 (min)	V
V_{OL}	Low level output voltage	0.4 (max)	0.5 (max)	0.4 (max)	0.4 (max)	V
I_{IH}	High level input current	20 (max)	20 (max)	40 (max)	40 (max)	μA
I_{IL}	Low level input current	−0.36 (max)	−0.36 (max)	−1.6 (max)	−1.6 (max)	mA
I_{OH}	High level output current	−400 (min)	−400 (min)	−400 (min)	−400 (min)	μA
I_{OL}	Low level output current	4 (min)	8 (min)	16 (min)	16 (min)	mA

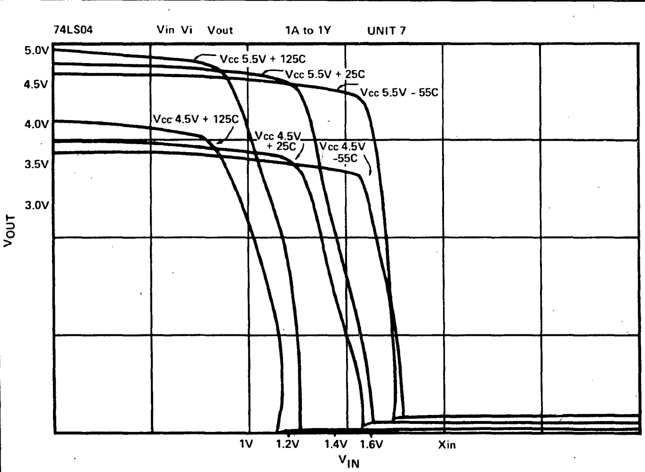


Figure 7

DC NOISE MARGIN

54/74LS devices have slightly higher minimum logic "1" input voltage while maintaining the same maximum logic "1" output voltage, therefore noise margin for 54/74LS in the logic "1" state is improved over that of 54/74. Noise margin in logic "0" state remains the same except for 74LS devices, which have a maximum of 0.5V output, instead of 0.4V, thus have a reduction of 100mv in logic "0" state. Table 10 shows the noise margin for both families.

Table 8 D.C. NOISE MARGIN (VOLTS)

	54	74	54LS	74LS
Logic "1"	0.4	0.4	0.7	0.5
Logic "0"	0.4	0.4	0.4	*0.3

*74LS NOISE MARGIN IS 0.4V at 4ma out (11 loads)

UNUSED INPUTS OF POSITIVE AND/NAND GATES

For optimum switching times and minimum noise susceptibility, unused inputs of AND or NAND gates should be maintained at a voltage greater than 2.7V, but not exceed the absolute maximum rating of 5.5V. This eliminates the distributed capacitance associated with the floating input, bond wire, and package lead, and ensures that no degradation will occur in the propagation delay times.

Possible ways of handling unused inputs are:

1. Connect unused inputs to an independent supply voltage. Preferably this voltage should be between 2.7V and 3.5V.
2. Connect unused inputs to a used input if maximum fan-out of the driving output will not be exceeded. Each additional input presents a full load to the driving output at a high level voltage but adds no loading at a low level voltage.
3. Connect unused inputs to V_{CC} through a 1K ohm resistor so that if a transient which exceeds the 5.5V maximum rating should occur, the impedance will be high enough to protect the input. One to 25 unused inputs may be connected to each 1K ohm resistor.
4. Connect unused inputs to the output of an inverter that has its input grounded.

LINE DRIVING AND RECEIVING

The Low Power Schottky displays similar line driving and receiving capability as the standard TTL logic. Low Power Schottky is slightly more sensitive to the transmission line effect when driving longer lines due to the low output impedance of the circuit. Figures 15 through 22 show the driving and receiving capability of the LS and standard TTL over 12 and 36 inch lines. Even though the LS is more sensitive to transmission line effects, the point to be noted is that the LS output of the receiver display has a much cleaner waveform than the standard logic. The ringing effect of the standard logic is almost negligible in the LS. Test configuration is shown as follows with $V_{CC} = 5.0V$, $T_A = 25°C$, and $C_L = 15pf$.

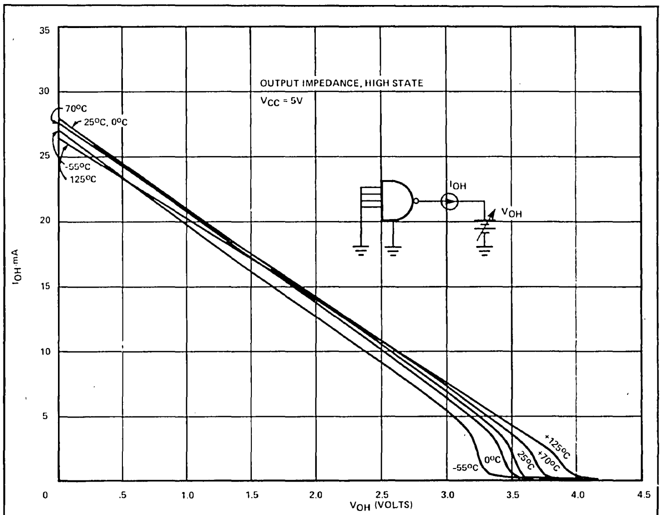


Figure 8

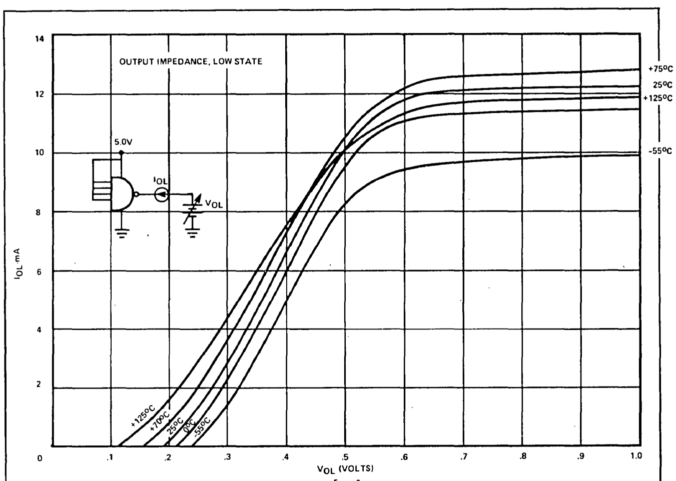


Figure 9

A.C. CHARACTERISTICS

Fig. 10 to 14 illustrate the propagation delays, rise and fall times, and AC over temperature. The LS devices display similar transfer characteristics as standard TTL and meet all the worst case conditions. Propagtion delays are similar on turn off and faster on turn on. Edge speed is generally slower in LS than standard, thus creates less cross-talk, V_{CC} noise, etc.

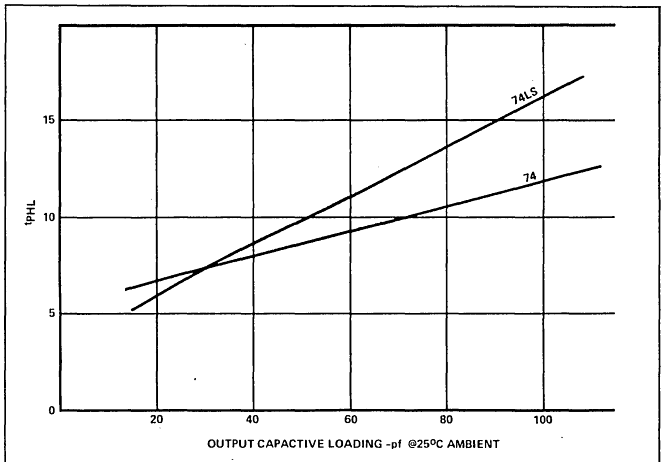


Figure 10

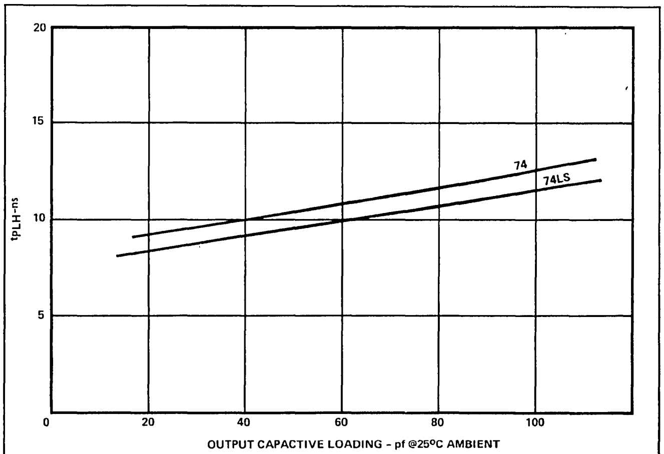


Figure 11

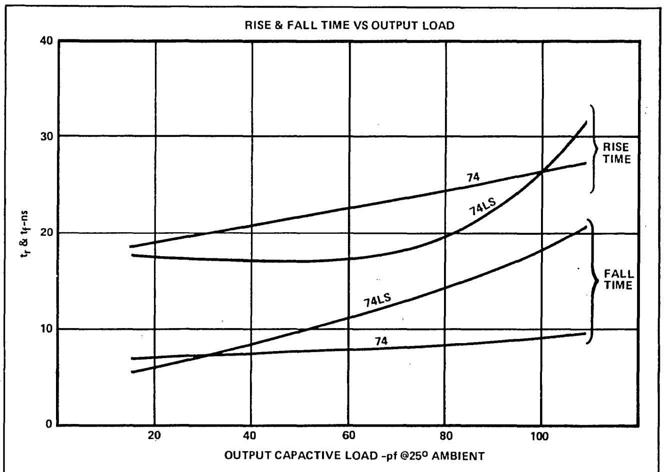


Figure 12

DIGITAL

Signetics

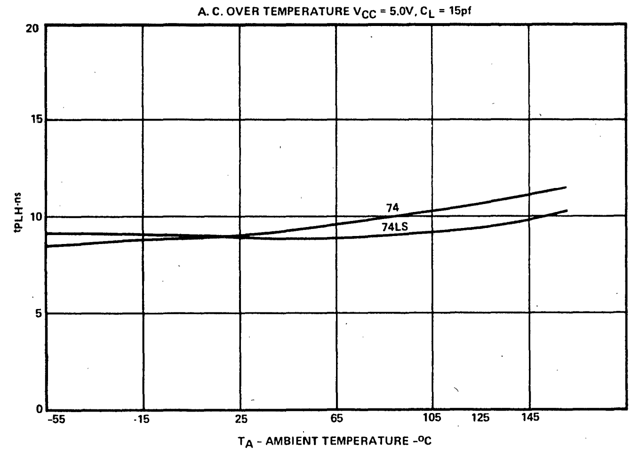


Figure 13

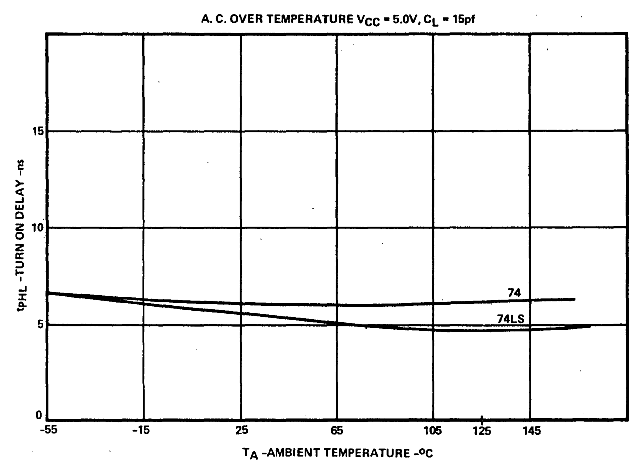


Figure 14

TABLE 9
FANOUT (0°—70°C) LOGIC 1/LOGIC 0
DRIVING GATES

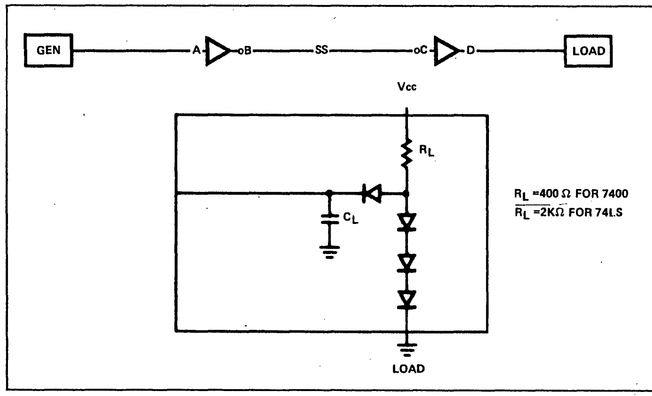
	74	74L	74LS
74	10/10	5/2	10/5
74L	40/89	20/20	40/44
74LS	20/44	10/10	20/22

DRIVEN GATES

TABLE 10
FANOUT (−55°C TO +125°C) LOGIC 1/LOGIC 0
DRIVING GATES

	54	54L	54LS
54	10/10	2/1	10/2
54L	40/89	10/11	40/22
54LS	20/44	5/5	20/11

DRIVEN GATES



DESIGN GUIDELINES

Fanout Capabilities

Low Power Schottky has high fan-out capabilities both in the logic "0" and logic "1" state. Within the family Low Power Schottky can fan-out to 22 in logic "0" state and 20 in logic "1" state.

Fan-out capability is calculated by dividing the output current of the driving gate by the input current of the driven gate. For example, if a 74 gate is driving another 74 gate, the fan-out capability would be:

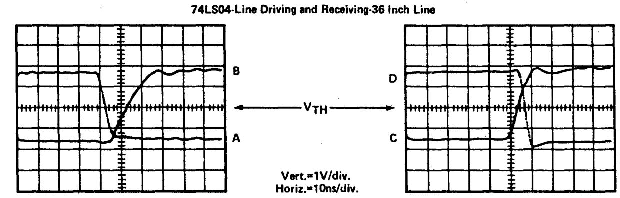
$$F.O. = \frac{16ma}{1.6ma} = 10 \text{ for logic "0" state}$$

and

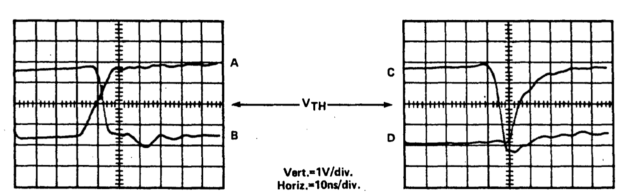
$$F.O. = \frac{400\mu a}{40\mu a} = 10 \text{ for logic "1" state}$$

Referring to Table 7 for current requirements, we can calculate the fan-out for 54/74LS and 54/74 families. Tables 8 and 9 show the fan-out capabilities between these two families.

74LS04-Line Driving and Receiving-36 Inch Line

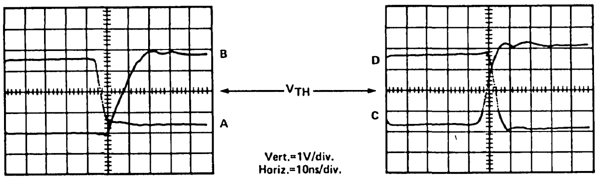


Input Pulse-Negative Going
Total Propagation Delay=14ns+Line Delay
Figure 15



Input Pulse-Positive Going
Total Propagation Delay=15ns+Line Delay
Figure 16

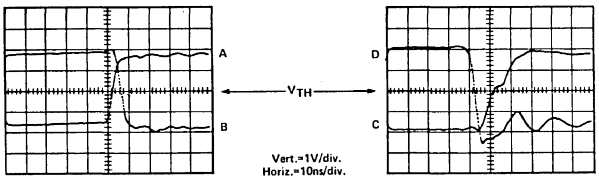
7404-Line Driving and Receiving-36 Inch Line



7404A 7404B

Input Pulse-Negative Going
Total Propagation Delay=15.5ns+Line Delay

Figure 17

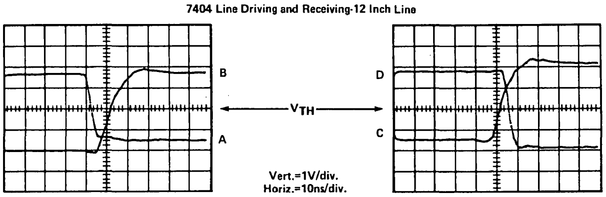


7404C 7404D

Input Pulse-Positive Going
Total Propagation Delay=15ns+Line Delay

Figure 18

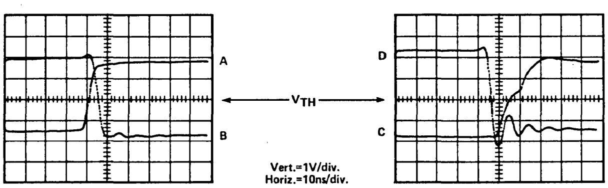
7404 Line Driving and Receiving-12 Inch Line



7404E 7404F

Input Pulse-Negative Going
Total Propagation Delay from A to D-13.5ns+Line Delay

Figure 19

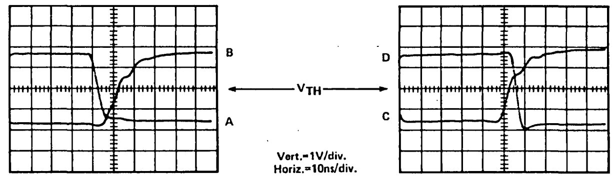


7404G 7404H

Input Pulse-Positive Going
Total Propagation Delay from A to D-12.5ns Line Delay

Figure 20

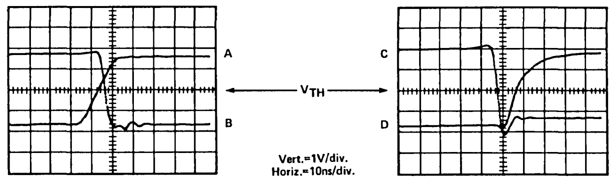
74LS04-Line Driving and Receiving-12 Inch Line



74LS04E 74LS04F

Input Pulse-Negative Going
Total Propagation Delay=13ns+Line Delay

Figure 21

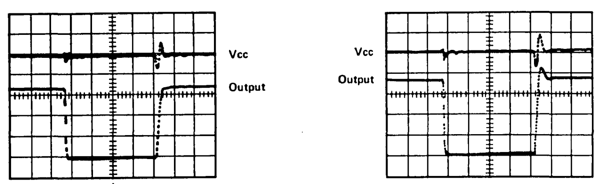


74LS04G 74LS04H

Input Pulse-Positive Going
Total Propagation Delay=13ns+Line Delay

Figure 22

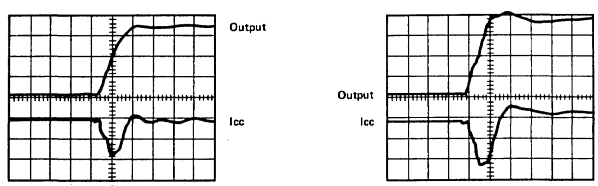
74LS04 7404



C_L = 25pf Vcc = 0.5V/div. Output = 1.0V/div.

17

Figure 23



C_L = 25pf Output = 1.0V/div. Icc = 4ma/div. t = 20ns/div.

18

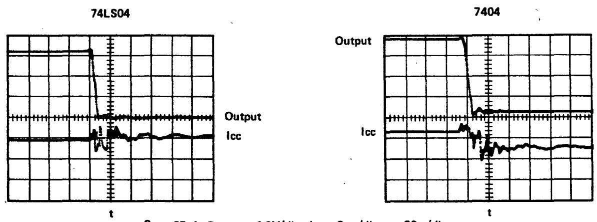
Figure 24

POWER SUPPLY CONSIDERATIONS

Decoupling

Current spiking and V_{CC} noise are generated internally within the circuits due to overlap in conduction of the upper and lower transistors in the totem pole outputs, the difference in Icch and Iccl and the changing of load capacitances. The power supply decoupling rules for standard TTL apply to Low Power Schottky also, i.e. 0.0lufd per synchronously driven gate and at least 0.1ufd per 20 gates regardless of synchronization.

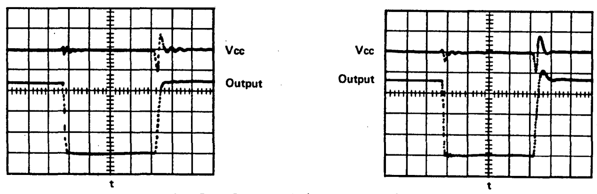
Figure 17 to 22 display the current spikes and V_{CC} noise generated by a 7404 and 74LS04 with two different capacitive loading @ V_{CC} = 5.0V and TA = 25°C. In both cases, the LS device generates less V_{CC} noise and smaller current spikes for 25 pf. and 50 pf. capacitive loading. This is because Low Power Schottky generally switches approximately 25% of the current as a standard TTL would, thus less current spiking and less V_{CC} noise generated.



C_L = 25pf Output = 1.0V/div. Icc = 2ma/div. t = 20ns/div.

19

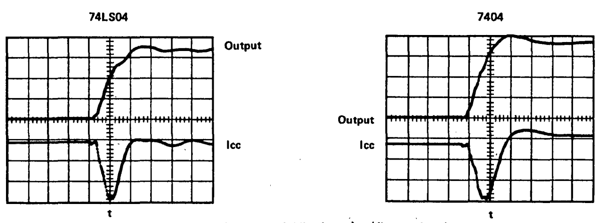
Figure 25



C_L = 50pf Output = 1.0V/div. Vcc = 0.5V/div.

20

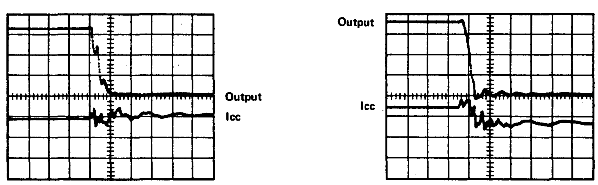
Figure 26



C_L = 50pf Output = 1.0Vdiv. Icc = 4ma/div. t = 20ns/div.

21

Figure 27



C_L = 50pf Output = 1.0V/div. Icc = 2ma/div. t = 20ns/div.

22

Figure 28

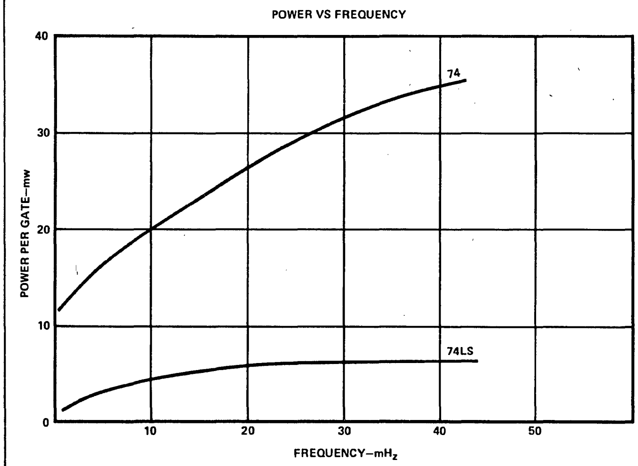


Figure 29

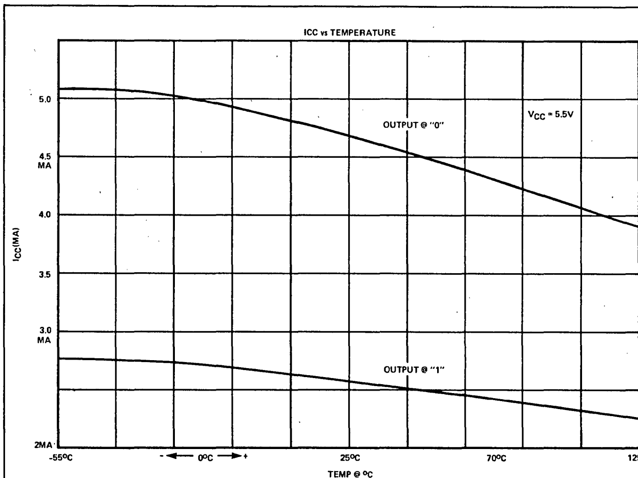


Figure 30

ON-BOARD REGULATION

In most digital systems, there is a large current requirement, and the current supplied usually comes from a main supply. TTL logic tends to generate current spikes during switching due to the overlap in conduction of both upper and lower transisters, thus creating V_{CC} noise. An on-board voltage regulator could be used not only to regulate the power supplied to the circuits on-board, but also would isolate the noise otherwise propagated to the rest of the system. Systems designed using this technique would not need tight regulation on the main power supply.

Most voltage regulator circuits can supply up to 1 Amp of current. For systems with large boards (150 or more IC's), two or three regulator circuits might be needed to supply enough current to standard TTL logic. However, for Low Power Schottky systems, one regulator per board should be sufficient. This represents approximately 1 cent per package of Low Power Schottky vs 5 cents per package for standard TTL for large boards.

ABSOLUTE MAXIMUM RATINGS

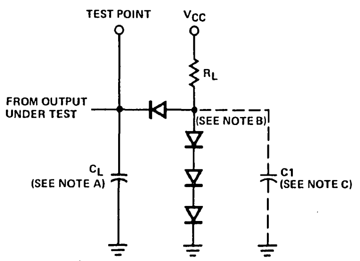
(Over Operating Free-Air Temperature Range Unless Otherwise Noted)

V_{CC}	Supply Voltage[1]	7V
V_{IN}	Input Voltage[1]	5.5V
	Intermitter Voltage[2]	5.5V
T_A	Operating Free-Air Temperature Range	
	Series 54 Circuits	−55 C to 125 C
	Series 74 Circuits	0 C to 70 C
	Storage Temperature Range	−65 C to 150 C

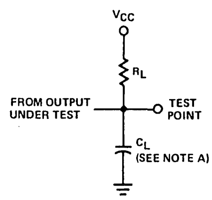
NOTES
1. Voltage values, except intermitter voltage, are with respect to network ground terminals.
2. This is the voltage between two emitters of a multiple-emitter transistor.
3. Output sink current tests one output at a time.

TEST CIRCUITS

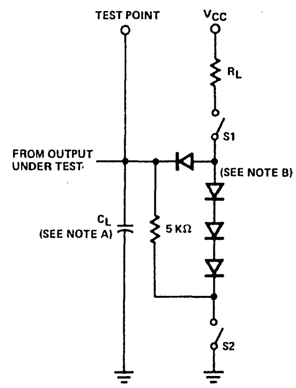
LOAD CIRCUIT FOR BI-STATE TOTEM-POLE OUTPUTS



LOAD CIRCUIT FOR OPEN-COLLECTOR OUTPUTS



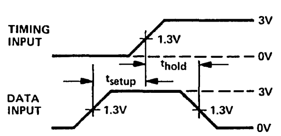
LOAD CIRCUIT FOR THREE-STATE OUTPUTS



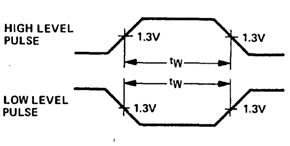
NOTES
A. C_L includes probe and jig capacitance.
B. All diodes are 1N916 or 1N3064.

WAVEFORMS

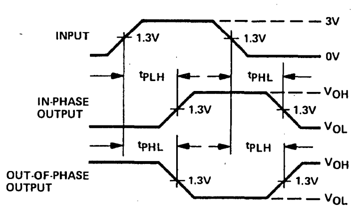
VOLTAGE WAVEFORMS SETUP AND HOLD TIMES



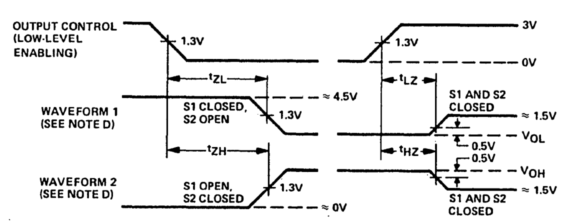
VOLTAGE WAVEFORMS PULSE WIDTHS



VOLTAGE WAVEFORMS PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS ENABLE AND DISABLE TIMES, THREE-STATE OUTPUTS



NOTES
C. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
D. In the examples above, the phase relationships between inputs and outputs have been chosen arbitrarily.
E. All input pulses are supplied by generators having the following characteristics: PRR ≤ 1MHz, Z_{out} ≈ 50Ω and t_r ≤ 15 ns, t_f ≤ 6 ns.

		INPUT VOLTAGE (V)									OUTPUT VOLTAGE (V)						INPUT CURRENT (mA)					
PARAMETER		V_{IL} LOW LEVEL			V_{IH} HIGH LEVEL			V_{IC} CLAMP VOLTAGE			V_{OL} LOW LEVEL			V_{OH} HIGH LEVEL			I_{IL} LOW LEVEL			$I_{IH}(\mu A)$ HIGH LEVEL		
TEST CONDITIONS								V_{CC}=MIN I_{IN}=18mA			V_{CC}=MIN V_{IN}=* I_{OL}=4mA@V_{OL}=0.4V I_{OL}=8mA@V_{OL}=0.5V			V_{CC}=MIN V_{IN}=* I_{OH}=-400μA			V_{CC}=MAX V_{IL}=4.V			V_{CC}=MAX V_{IH}=2.7V		
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
54/74LS00	54	54		0.7	2					-1.5	54/74		0.4	2.5	3.4				-0.36			20
	74	74		0.8							74		0.5	2.7	3.4							
54/74LS01	54			0.7	2					-1.5	54/74		0.4		N/A				-0.36			20
	74			0.8							74		0.5									
54/74LS02	54			0.7	2					-1.5	54/74		0.4	2.5	3.4				-0.36			20
	74			0.8							74		0.5	2.7	3.4							
54/74LS03	54			0.7	2					-1.5	54/74		0.4		N/A				-0.36			20
	74			0.8							74		0.5									
54/74LS04	54			0.7	2					-1.5	54/74		0.4	2.5	3.4				-0.36			20
	74			0.8							74		0.5	2.7	3.4							
54/74LS05	54			0.7	2					-1.5	54/74		0.4		N/A				-0.36			20
	74			0.8							74		0.5									
54/74LS08	54			0.7	2					-1.5	54/74	0.25	0.4	2.5	3.4				-0.36			20
	74			0.8							74	0.35	0.5	2.7	3.4							
54/74LS09	54			0.7	2					-1.5	54/74		0.4		N/A				-0.36			20
	74			0.8							74		0.5									
54/74LS10	54			0.7	2					-1.5	54/74		0.4	2.5	3.4				-0.36			20
	74			0.8							74			2.7	3.4							
54/74LS11	54			0.7	2					-1.5	54/74	0.25	0.4	2.5	3.4				-0.36			20
	74			0.8							74	0.35	0.5	2.7	3.4							
54/74LS12	54			0.7	2					-1.5	54/74	0.25	0.4						-0.36			20
	74			0.8							74	0.35	0.5									
															V_I=0.6V							
54/74LS13	54			See Data	Sheet					-1.5	54/74	0.25	0.4	2.5	3.4				-0.4			20
	74										74	0.35	0.5	2.7	3.4							
54/74LS14	54			See Data	Sheet					-1.5	54/74	0.25	0.4		V_I=0.6V				-0.4			20
	74										74	0.35	0.5	2.5	3.4							
														2.7	3.4							
54/74LS15	54			0.7	2					-1.5	54/74		0.4		N/A				-0.36			20
	74			0.8							74		0.5									
54/74LS20	54			0.7	2					-1.5	54/74		0.4	2.5	3.4				-0.36			20
	74			0.8							74		0.5	2.7	3.4							
54/74LS21	54			0.7	2					-1.5	54/74	0.25	0.4	2.5	3.4				-0.36			20
	74			0.8							74	0.35	0.5	2.7	3.4							
54/74LS22	54			0.7	2					-1.5	54/74		0.4		N/A				-0.36			20
	74			0.8							74		0.5									
54/74LS26	54			0.7	2					-1.5	54/74	0.25	0.4			-15			-0.36			20
	74			0.8							74	0.35	0.5									
54/74LS27	54			0.7	2					-1.5	54/74	0.25	0.4	2.5	3.4				-0.36			20
	74			0.8							74	0.35	0.5	2.7	3.4							
54/74LS28	54			0.7	2					-1.5	54/74	0.25	0.4	2.5	3.4				-0.36			20
	74			0.8							74	0.35	0.5	2.7	3.4							
54/74LS30	54			0.7	2					-1.5	54/74	I_{OL}+12mA	0.4	2.5		3.4			-0.36			20
	74			0.8							74⁄	I_{OL}=24mA	0.5	2.7		3.4						
54/74LS32	54			0.7	2					-1.5	54/74	0.25	0.4	2.5		3.4			-0.36			20
	74			0.8							74	0.35	0.5	2.7		3.4						
54/74LS33	54			0.7	2					-1.5	54/74		0.4		N/A				-0.36			20
	74			0.8							74		0.5									
54/74LS37	54			0.7	2					-1.5	54/74	I_{OL}=12mA	0.4	2.5		3.4			-0.36			20
	74			0.8							74	I_{OL}=24mA	0.5	2.7		3.4						
54/74LS38	54			0.7	2					-1.5	54/74		0.4		N/A				-0.36			20
	74			0.8							74		0.5									
54/74LS39	54			0.7	2					-1.5	54/74	0.25	0.4	2.5		3.4			-0.36			20
	74			0.8							74	0.35	0.5	2.7		3.4						
54/74LS40	54			0.7	2					-1.5	54/74		0.4	2.5		3.4			-0.36			20
	74			0.8							74		0.5	2.7		3.4						
54/74LS42	54			0.7	2					-1.5	54/74	0.25	0.4	2.5		3.5			-0.4			20
	74			0.8							74	0.35	0.5	2.7		3.5						

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		INPUT CURRENT (mA)			OUTPUT CURRENT (mA)			POWER SUPPLY CURRENT (mA)									OFF-STATE OUTPUT CURRENT (μA)					
PARAMETER		I_{IN}			I_{OS} SHORT CIRCUIT			I_{CCL} LOW LEVEL			I_{CCH} HIGH LEVEL			$I_{OH(\mu A)}$ LEAKAGE			I_{OZL} LOW LEVEL VOLTAGE SUPPLIED			I_{OZH} HIGH LEVEL VOLTAGE SUPPLIED		
TEST CONDITIONS		V_{CC}=MAX V_{IN}=7.0V						V_{CC}=MAX V_{IH}=4.5V V_{IL}=0.5V as appropriate						V_{CC}=MAX V_{IN}=* V_{OH}=5.5V			V_{CC}=MAX V_O=0.4V			V_{CC}=MAX V_O=2.7V		
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
54/74LS00	54 74	V_I=5.5V		0.1	-15		-100		2.4	4.4		0.8	1.6		N/A			N/A			N/A	
54/74LS01	54 74	V_I=5.5V		0.1		N/A			2.4	4.4		0.8	1.6			100		N/A			N/A	
54/74LS02	54 74	V_I=5.5V		0.1	-15		-100		2.8	5.4		1.6	3.2		N/A			N/A			N/A	
54/74LS03	54 74	V_I=5.5V		0.1		N/A			2.4	4.4		0.8	1.6			100		N/A			N/A	
54/74LS04	54 74	V_I=5.5V		0.1	-15		-100		3.6	6.6		1.2	2.4		N/A			N/A			N/A	
54/74LS05	54 74	V_I=5.5V		0.1		N/A			3.6	6.6		1.2	2.4			100		N/A			N/A	
54/74LS08	54 74	V_I=5.5V		0.1	-15		-100		6.8	8.8		2.4	4.8		N/A			N/A			N/A	
54/74LS09	54 74	V_I=5.5V		0.1		N/A			4.4	8.8		2.4	4.8			100		N/A			N/A	
54/74LS10	54 74	V_I=5.5V		0.1	-15		-100		1.8	3.3		0.6	1.2		N/A			N/A			N/A	
54/74LS11	54 74	V_I=5.5V		0.1	-15		-100		3.3	6.6		1.8	3.6		N/A			N/A			N/A	
54/74LS12	54 74	V_I=5.5V		0.1		N/A			1.8	3.3		0.7	1.4			100		N/A			N/A	
54/74LS13	54 74			0.1	-15		-100		4.1	7		2.9	6		N/A			N/A			N/A	
54/74LS14	54 74			0.1	-15		-100		4.1	7		8.6	16		N/A			N/A			N/A	
54/74LS15	54 74	V_I=5.5V		0.1		N/A			3.3	6.6		1.8	3.6			100		N/A			N/A	
54/74LS20	54 74			0.1	-15		-100		1.2	2.2		0.4	0.8		N/A			N/A			N/A	
54/74LS21	54 74			0.1	-15		-100		2.2	4.4		1.2	2.4		N/A			N/A			N/A	
54/74LS22	54 74			0.1		N/A			1.2	2.2		0.4	0.8			100		N/A			N/A	
54/74LS26	54 74			0.1	-15		-100		2.4	4.4		0.8	1.6	V_{IL}=0.7V V_{OH}=12V V_{OH}=15V		50 1MA		N/A			N/A	
54/74LS27	54 74	V_I=5.5V		0.1	-15		-100		3.4	6.8		2.0	4.0		N/A			N/A			N/A	
54/74LS28	54			0.1	-15		-100		6.9	13.8		1.8	3.6		N/A			N/A			N/A	
54/74LS30	54 74			0.1	-15		-100		0.6	1.1	0.35		0.5		N/A			N/A			N/A	
54/74LS32	54 74	V_I=5.5V		0.1	-15		-100		4.9	9.8		3.1	6.2		N/A			N/A			N/A	
54/74LS33	54 74			0.1		N/A			6.9	13.8		1.8	3.6			250		N/A			N/A	
54/74LS37	54 74			0.1	-15		-100		6.0	12.0		0.9	2.0		N/A			N/A			N/A	
54/74LS38	54 74			0.1		N/A			6.0	12.0		0.9	2.0			250		N/A			N/A	
54/74LS39	54 74			0.1	-15		-100		N/A			6.8 NOTE 1	11.0		N/A			N/A			N/A	
54/74LS40	54 74			0.1	-15		-100		3	6		0.45	1		N/A			N/A			N/A	
54/74LS42	54 74			1	-15		-100		N/A			7 NOTE 1	13		N/A			N/A			N/A	

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PARAMETER		INPUT VOLTAGE (V) V_{IL} LOW LEVEL	V_{IH} HIGH LEVEL	V_{IC} CLAMP VOLTAGE	OUTPUT VOLTAGE (V) V_{OL} LOW LEVEL			V_{OH} HIGH LEVEL			INPUT CURRENT (mA) I_{IL} LOW LEVEL		I_{IH} (μA) HIGH LEVEL	
TEST CONDITIONS				V_{CC}=MIN I_{IN}=18mA	V_{CC}=MIN V_{IN}=* I_{OL}=4mA@V_{OL}=0.4V I_{OL}=8mA@V_{OL}=0.5V			V_{CC}=MIN V_{IN}=* I_{OH}=−400μA			V_{CC}=MAX V_{IL}=4.V		V_{CC}=MAX V_{IH}=2.7V	
		MIN TYP MAX	MIN TYP MAX	MIN TYP MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN TYP	MAX	MIN TYP	MAX
54/74LS51	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4		-0.36		20
	74	0.8			74	0.35	0.5	2.7		3.4				
54/74LS54	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4		-0.36		20
	74	0.8			74	0.35	0.5	2.7		3.4				
54/74LS55	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4		-0.36		20
	74	0.8			74	0.35	0.5	2.7		3.4				
54/74LS73	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4	J/K Input	-0.36	J/K Input	20
	74	0.8			74	0.35	0.5	2.7		3.4	CLear	-0.8	Clear	60
											Clock	-0.72	Clock	80
54/74LS74	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4	D Input	-0.36	D Input	20
	74	0.8			74	0.35	0.5	2.7		3.4	Clk/Preset	-0.8	Clk/Preset	60
											Clear	-1.15	Clear	60
54/74LS75	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4	D Input	-0.4	D Input	20
	74	0.8			74	0.35	0.5	2.7		3.4	G Input	-1.6	G Input	80
54/74LS76	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4	J/K Input	-0.36	J/K Input	20
	74	0.8			74	0.35	0.5	2.7		3.4	Clock	-0.72	Clock	80
											Preset/Clr	-0.8	Preset/Clr	60
54/74LS78	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4	J/K Input	-0.36	J/K Input	20
	74	0.8			74	0.35	0.5	2.7		3.4	Preset	-0.8	Preset	60
											Clear	-1.6	Clear	120
											Clock	-1.44	Clock	160
54/74LS83	54	0.7	2	-1.5		0.2	0.4	2.4		3.4		-1.6	V_I=5.5V	40
	74	0.8												
54/74LS85	54	0.7	2	-1.5	54/74	0.25	0.4	2.4		3.4	A B,A B	-0.4	A B,A B	20
	74	0.8			74	0.35	0.5				Others	-1.2	Others	60
54/74LS86	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4		-0.6		40
	74	0.8			74	0.35	0.5	2.7		3.4				
54/74LS90	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4	Any Reset	-0.4	Any Reset	20
	74	0.8			74	0.35	0.5	2.7		3.4	A Input	-2.4	A Input	120
											B Input	-3.2	B Input	40
54/74LS92	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4	Any Reset	-0.4	Any Reset	20
	74	0.8			74	0.35	3.4	2.7		3.4	A Input	-2.4	A Input	120
											B Input	-3.2	B Input	40
54/74LS93	54	0.7	2	-1.5	54/74	0.25	0.4	2.5		3.4	Any Reset	-0.4	Any Reset	20
	74	0.8			74	0.35	0.5	2.7		3.4	A Input	2.4	A Input	120
											B Input	-1.6	B Input	40
54/74LS95B	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.5	Clock	-0.8	Clock	40
	74	0.8			74	0.35	0.5		2.7	3.5	Other	-0.4	Other	20
54/74LS96	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.5	Preset	-2.0		20
	74	0.8			74	0.35	0.5		2.7	3.5	Enable			
											Others	-0.4		
54/74LS107	54	0.7	2	-1.5	54/74		0.4		2.5	3.4	J/K Input	-0.36	J/K Input	20
	74	0.8			74		0.5		2.7	3.4	Clear	-0.8	Clear	60
											Clock	-0.72	Clock	80
54/74LS109	54	0.7	2	-1.5	54/74		0.4		2.5	3.4	J or K	-0.4	J or K	20
	74	0.8			74		0.5		2.7	3.4	Clk/Preset	-0.8	Clk/Preset	40
											Clear	-1.6	Clear	80
54/74LS112	54	0.7	2	-1.5	54/74		0.4		2.5	3.4	J/K Input	-0.36	J/K Input	20
	74	0.8			74		0.5		2.7	3.4	Clock	-0.72	Clock	80
											Preset/Clr	-0.08	Preset/Clr	60
54/74LS113	54	0.7	2	-1.5	54/74		0.4		2.5	3.4	J/K Input	-0.36	J/K Input	20
	74	0.8			74		0.5		2.7	3.4	Preset	-0.8	Preset	60
											Clock	-0.72	Clock	80
54/74LS114	54	0.7	2	-1.5	54/74		0.4		2.5	3.4	J/K Input	-0.36	J/K Input	20
	74	0.8			74		0.5		2.7	3.4	Preset	-0.8	Preset	60
											Clear	-1.6	Clear	120
											Clock	-1.44	Clock	160
54/74LS132	54	See Data	Sheet	-1.5	54/74	0.25	0.4		V_I=0.6V			-0.4		20

PARAMETER		INPUT CURRENT (mA) I_{IN}			OUTPUT CURRENT (mA) I_{OS} SHORT CIRCUIT			POWER SUPPLY CURRENT (mA) I_{CCL} LOW LEVEL			I_{CCH} HIGH LEVEL			$I_{OH(\mu A)}$ LEAKAGE			OFF-STATE OUTPUT CURRENT (μA) I_{OZL} LOW LEVEL VOLTAGE SUPPLIED			I_{OZH} HIGH LEVEL VOLTAGE SUPPLIED		
TEST CONDITIONS		V_{CC}=MAX V_{IN}=7.0V						V_{CC}=MAX V_{IH}=4.5V V_{IL}=0.5V as appropriate						V_{CC}=MAX V_{IN}=* V_{OH}=5.5V			V_{CC}=MAX V_O=0.4V			V_{CC}=MAX V_O=2.7V		
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
54/74LS51	54 74			0.1	-15		-100		1.4	2.8		0.8	1.6		N/A			N/A			N/A	
54/74LS54	54 74			0.1	-15		-100		1.0	2.0		0.8	1.6		N/A			N/A			N/A	
54/74LS55	54 74			0.1	-15		-100		0.7	1.3		0.4	0.8		N/A			N/A			N/A	
54/74LS73	54 74	V_I=5.5V J/K Input Clear Clock		 0.1 0.3 0.4	-15		-100		N/A			2.0 NOTE 2	4.0		N/A			N/A			N/A	
54/74LS74	54 74	D Input Clk Preset Clear		0.1 0.2 0.3	-15		-100		N/A			2.0 NOTE 2	4.0		N/A			N/A			N/A	
54/74LS75	54 74	D Input G Input		0.1 0.4	-15		-100		N/A			6.3 NOTE 1	12.0		N/A			N/A			N/A	
54/74LS76	54 74	V_I=5.5V J/K Input Clock Preset/Clr		 0.1 0.4 0.3	-15		-100		N/A			2.0 NOTE 2	4.0		N/A			N/A			N/A	
54/74LS78	54 74	V_I=5.5V J/K Input Preset Clear Clock		 0.1 0.3 0.6 0.8	-15		-100		N/A			2.0	4.0		N/A			N/A			N/A	
54/74LS83	54 74	V_I=5.5V		1	-15		-100		N/A			N/A			N/A			N/A			N/A	
54/74LS85	54 74	AB,AB Others		0.1 0.3	-15		-100		N/A			10.4 NOTE 3	20.0		N/A			N/A			N/A	
54/74LS86	54 74			0.2	-15		-100		N/A			6.1 NOTE 1	10.0		N/A			N/A			N/A	
54/74LS90	54 74	V_I=7V Any Reset V_I=5.5V A Input B Input		 0.1 0.4 0.8	-15		-100		N/A			9.0 NOTE 4	15.0		N/A			N/A			N/A	
54/74LS92.	54 74	V_I=7V Any Reset V_I=2.5V A Input B Input		 0.1 0.4 0.8	-15		-100		N/A			9.0 NOTE 4	15.0		N/A			N/A			N/A	
54/74LS93	54 74	V_I=7V Any Reset V_I=5.5 A or B Input		 0.1 0.4	-15		-100		N/A			9.0 NOTE 4	15.0		N/A			N/A			N/A	
54/74LS95B	54 74	V_I=7V Clock Other		 0.2 0.1	-15		-100		N/A			12.0 NOTE 6	20.0		N/A			N/A			N/A	
54/74LS96	54 74	V_I=7V		0.1	-15		-100		N/A			12.0 NOTE 6	20.0		N/A			N/A			N/A	
54/74LS107	54 74	J/K Input Clear Clock		0.1 0.3 0.4	-15		-100		N/A			2.0 NOTE 2	4.0		N/A			N/A			N/A	
54/74LS109	54 74	J or K Clk/preset Clear		0.1 0.2 0.4	-15		-100		N/A			2.0 NOTE 2	4.0		N/A			N/A			N/A	
54/74LS112	54 74	V_I=5.5 J/K Input		 0.1	-15		-100		N/A			2.0 NOTE 2	4.0		N/A			N/A			N/A	

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		INPUT VOLTAGE (V)			OUTPUT VOLTAGE (V)						INPUT CURRENT (mA)			
PARAMETER		V_{IL} LOW LEVEL	V_{IH} HIGH LEVEL	V_{IC} CLAMP VOLTAGE	V_{OL} LOW LEVEL			V_{OH} HIGH LEVEL			I_{IL} LOW LEVEL		$I_{IH}(\mu A)$ HIGH LEVEL	
TEST CONDITIONS				V_{CC}=MIN I_{IN}=18mA	V_{CC}=MIN V_{IN}=* I_{OL}=4mA@V_{OL}=0.4V I_{OL}=8mA@V_{OL}=0.5V			V_{CC}=MIN V_{IN}=* I_{OH}=-400μA			V_{CC}=MAX V_{IL}=4.V		V_{CC}=MAX V_{IH}=2.7V	
		MIN TYP MAX	MIN TYP MAX	MIN TYP MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN TYP	MAX	MIN TYP	MAX
	74				74	0.35	0.5		2.5	3.4				
									2.7	3.4				
54/74LS136	54	0.7	2	-1.5	54/74	0.25	0.4		N/A			-0.6		40
	74	0.8			74	0.35	0.5							
54/74LS138	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4		-0.36		20
	74	0.8			74	0.35	0.5		2.7	3.4				
54/74LS145	54	0.7	2	-1.5	54/74 I_{OL}=12MA		0.4		N/A			-0.4		20
	74	0.8			74 I_{OL}=24MA		0.5							
					74 I_{OL}=80MA		1.7							
54/74LS151	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4		-0.4		20
	74	0.8			74	0.35	0.5		2.7	3.4				
54/74LS153	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4		-0.36		20
	74	0.8			74	0.35	0.5		2.7	3.4				
54/74LS157	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4	S/G Inputs	-0.8	S/G	40
	74	0.8			74	0.35	0.5		2.7	3.4	A/B Inputs	-0.4	A/B	20
54/74LS158	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4	S/G Inputs	-0.8		40
	74	0.8			74	0.35	0.5		2.7	3.4	A/B Inputs	-0.4		20
54/74LS160	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4	D/EP	-0.4	D/EP	20
	74	0.8			74	0.35	0.5		2.7	3.4	LD, ET	-0.8	LD,CLK,ET	40
											CLR	-0.4	CLR	20
											CLK	-1.2		
54/74LS161	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4	D/EP	-0.4	D/EP	20
	74	0.8			74	0.35	0.5		2.7	3.4	LD, ET	-0.8	LD,CLK,ET	40
											CLR	-0.4	CLR	20
											CKT	-1.2		
54/74LS162	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4	D/EP	-0.4	D/EP	20
	74	0.8			74	0.35	0.5		2.7	3.4	LD, ET	-0.8	LDCLK,ET	40
											CLR	-0.8	CLR	40
											CLK	-1.2		
54/74LS163	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4	D/EP	-0.4	D/EP	20
	74	0.8			74	0.35	0.5		2.7	3.4	LD, ET	-0.8	LDCLK,ET	40
											CLR	-0.8	CLR	40
											CLK	-1.2		
54/74LS164	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.5		-0.4		20
	74	0.8			74	0.35	0.5		2.7	3.5				
54/74LS170	54	0.7	2	-1.5	54/74	0.25	0.4		N/A		Any D,R,W	-0.4	Any D,R,W	20
	74	0.8			74	0.35	0.5				G_R or G_W	-0.8	G_R or G_W	40
54/74LS174	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.5	Clock Input	-0.4		20
	74	0.8			74	0.35	0.5		2.7	3.5	Other Inputs	-0.36		
54/74LS175	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.5	Clock Input	-0.4		20
	74	0.8			74	0.35	0.5		2.7	3.5	Other Inputs	-0.36		
54/74LS181	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4	Mode Input	-0.36	Mode Input	20
	74	0.8			74	0.35	0.5		2.7	3.4	A/B Inputs	-1.08	A/B Inputs	60
											S Inputs	-1.44	S Inputs	80
											Carry Input	-2	Carry Input	100
54/74LS190	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4	Enable	-1.08	Enable	60
	74	0.8			74	0.35	0.5		2.7	3.4	Others	-0.4	Others	20
54/74LS191	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4	Enable	-1.08	Enable	60
	74	0.8			74	0.35	0.5		2.7	3.4	Others	-0.4	Others	20
54/74LS192	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4		-0.4		20
	74	0.8			74	0.35	0.5		2.7	3.4				
54/74LS193	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4		-0.4		20
	74	0.8			74	0.35	0.5		2.7	3.4				
54/74LS194A	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4		-0.4		20
	74	0.8			74	0.35	0.5		2.7	3.4				
54/74LS195A	54	0.7	2	-1.5	54/74	0.25	0.4		2.5	3.4	CLK	-0.44		20
	74	0.8			74	0.35	0.5		2.7	3.4	Others	-0.36		

PARAMETER	INPUT CURRENT (mA) I_{IN}		OUTPUT CURRENT (mA) I_{OS} SHORT CIRCUIT		POWER SUPPLY CURRENT (mA) I_{CCL} LOW LEVEL		I_{CCH} HIGH LEVEL		$I_{OH(\mu A)}$ LEAKAGE	OFF-STATE OUTPUT CURRENT (μA) I_{OZL} LOW LEVEL VOLTAGE SUPPLIED	I_{OZH} HIGH LEVEL VOLTAGE SUPPLIED
TEST CONDITIONS	V_{CC}=MAX V_{IN}=7.0V				V_{CC}=MAX V_{IH}=4.5V V_{IL}=0.5V as appropriate				V_{CC}=MAX V_{IN}=* V_{OH}=5.5V	V_{CC}=MAX V_O=0.4V	V_{CC}=MAX V_O=2.7V
	MIN TYP	MAX	MIN TYP	MAX	MIN TYP	MAX	MIN TYP	MAX	MIN TYP MAX	MIN TYP MAX	MIN TYP MAX
	Clock Reset/Clr	0.4 0.3									
54/74LS113 54 74	V_I=5.5 J/K Input Preset Clock	 0.1 0.3 0.4	-15	-100	N/A		2.0 NOTE 2	4.0	N/A	N/A	N/A
54/74LS114 54 74	V_I=5.5 J/K Input Preset Clear Clock	 0.1 0.3 0.6 0.8	-15	-100	N/A		2.0 NOTE 2	4.0	N/A	N/A	N/A
54/74LS132 54 74		0.1	-15	-100	8.2	14	5.9	11	N/A	N/A	N/A
54/74LS136 54 74		0.2	-15	-100	N/A		6.1 NOTE 8	10.0	N/A	N/A	N/A
54/74LS138 54 74		0.1	-15	-100	N/A		6.3 NOTE 1	10.0	N/A	N/A	N/A
54/74LS145 54 74		0.1	N/A		N/A		7.0 NOTE 1	13.0	250	N/A	N/A
54/74LS151 54 74		0.1	-15	-100	N/A		6.0 NOTE 8	10.0	N/A	N/A	N/A
54/74LS153 54 74		0.1	-15	-100	N/A		6.2	10.0	N/A	N/A	N/A
54/74LS157 54 74	S/G Inputs A/B Inputs	0.2 0.1	-15	-100	N/A		9.7 NOTE 8	16.0	N/A	N/A	N/A
54/74LS158 54 74	S/G Inputs A/B Inputs	0.2 0.1	-15	-100	N/A		4.8 NOTE 8	8.0	N/A	N/A	N/A
54/74LS160 54 74	D/EP LD,CLK,ET CLR	0.1 0.2 0.1	-15	-100	19	32	18	31	N/A	N/A	N/A
54/74LS161 54 74	D/EP LD,CLK,ET CLR	0.1 0.2 0.1	-15	-100	19	32	18 NOTE 10	31	N/A	N/A	N/A
54/74LS162	D/EP LD,CLK,ET CLR	0.1 0.2 0.2	-15	-100	19	32	18 NOTE 10	31	N/A	N/A	N/A
54/74LS163 54 74	D/EP LD,CLK,ET CLR	0.1 0.2 0.2	-15	-100	19	32	18 NOTE 10	31	N/A	N/A	N/A
54/74LS164 54 74		0.1	-15	-100	N/A		16.0	27.0	N/A	N/A	N/A
54/74LS170 54 74	Any D,R,W G_R or G_W	0.1 0.2	N/A		N/A		26.0 NOTE 12	40.0	20	N/A	N/A
54/74LS174 54 74		0.1	-15	-100	N/A		16.0 NOTE 7	26.0	N/A	N/A	N/A
54/74LS175 54 74		0.1	-15	-100	N/A		11.0 NOTE 7	18.0	N/A	N/A	N/A
54/74LS181 54 74	Mode Input A/B Inputs S Inputs	0.1 0.3 0.4 0.5	-15	-100	N/A		Cond.A 20.0 Cond.B 21.0 NOTE 13	32.0 35.0	A=B Output	100	N/A
54/74LS190 54 74	Enable Others	0.3 0.1	-15	-100	20.0 NOTE 1	35.0	N/A		N/A	N/A	N/A
54/74LS191 54 74	Enable Others	0.3 0.1	-15	-100	20.0 NOTE 1	35.0	N/A		N/A	N/A	N/A
54/74LS192 54 74		0.1	-15	-100	20.0 NOTE 14	34.0	N/A		N/A	N/A	N/A

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PARAMETER	INPUT VOLTAGE (V)									OUTPUT VOLTAGE (V)						INPUT CURRENT (mA)					
	V_{IL} LOW LEVEL			V_{IH} HIGH LEVEL			V_{IC} CLAMP VOLTAGE			V_{OL} LOW LEVEL			V_{OH} HIGH LEVEL			I_{IL} LOW LEVEL			$I_{IH}(\mu A)$ HIGH LEVEL		
TEST CONDITIONS							V_{CC}=MIN I_{IN}=18mA			V_{CC}=MIN V_{IN}=* I_{OL}=4mA@V_{OL}=0.4V I_{OL}=8mA@V_{OL}=0.5V			V_{CC}=MIN V_{IN}=* I_{OH}=-400μA			V_{CC}=MAX V_{IL}=4.V			V_{CC}=MAX V_{IH}=2.7V		
	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
54/74LS196 54			0.7	2					-1.5	54/74		0.4		2.5	3.4	Data, Count/Load		-0.36	Data, Count/Load		20
74			0.8							74		0.5		2.7	3.4	Clear		-0.72	Clear,Clock 1		40
																Clock 1		-2.4	Clock 2		80
																Clock 2		-2.8			
54/74LS197 54			0.7	2					-1.5	54/74	0.25	0.4		2.5	3.4	Data, Count/Load		-0.36	Data, Count/Load		20
74			0.8							74	0.35	0.5		2.7	3.4	Clear		-0.72	Clear, Clock 1		40
																Clock 1		-2.4	Clock 2		40
																Clock 2		-1.3			
54/74LS221	See Data Sheet for Electrical Characteristics																				
54/74LS251 54			0.7	2					-1.5	54/74	0.25	0.4		2.5	3.4			-0.4			20
74			0.8							74	0.35	0.5		2.7	3.4						
54/74LS253 54			0.7	2					-1.5	54/74	0.25	0.4		2.4	3.4			-0.36			20
74		-3	0.8							74	0.35	0.5		2.4	3.4						
54/74LS257 54			0.7	2					-1.5	54/74	0.25	0.4		2.4	3.4	S Input		-0.8	S Input		40
74			0.8							74	0.35	0.5		2.4	3.4	Others		-0.4	Others		20
54/74LS258 54			0.7	2					-1.5	54/74	0.25	0.4		2.4	3.4	S Input		-0.8	S Input		40
74			0.8							74	0.35	0.5		2.4	3.1	Others		-0.4	Others		20
54/74LS260 54			0.7	2					-1.5	54/74	0.25	0.4		2.5	3.4			0.36			20
74			0.8							74	0.35	0.5		2.7	3.4						
54/74LS261 54			0.7	2					-1.5	54/74	0.25	0.4	2.5		3.4	M_{01} M_1		-0.8	M_{01} M_1		40
74			0.8							74	0.35	0.5	2.7		3.4			-0.4			20
54/74LS266 54			0.7	2					-1.5	54/74	0.25	0.4		N/A				-0.6			40
74			0.8							74	0.35	0.5									
54/74LS283 54			0.7	2					-1.5	54/74	0.25	0.4	2.5		3.6	Any A or B		-0.8	Any A or B		40
74			0.8							74	0.35	0.5	2.4		5.6	CO		-0.4	CO		20
54/74LS290 54			0.7	2					-1.5	54/74	0.25	0.4	2.5		3.4	Any Reset		-0.4	Any Reset		20
74			0.8							74	0.35	0.5	2.7		3.4	A Input		-2.4	A Input		120
																B Input		-3.2	B Input		80
54/74LS293 54			0.7	2					-1.5	54/74	0.25	0.4	2.5		3.4	Any Reset		-0.4	Any Reset		20
74			0.8							74	0.35	0.5	2.7		3.4	A Input		-2.4	A Input		120
																B Input		-1.6	B Input		40
54/74LS295A 54			0.7	2					-1.5	54/74	0.25	0.4	2.4		3.4			-0.4			20
74			0.8							74	0.35	0.5	2.4		3.1						
54/74LS386 54			0.7	2					-1.5	54/74	0.25	0.4	2.5		3.4			-0.6			40
74			0.8							74	0.35	0.5	3.7		3.4						
54/74LS670 54			0.7	2					-1.5	54/74	0.25	0.4	2.4		3.4	Any D,R,W		-0.4	Any D,R,W		20
74			0.8							74	0.35	0.5	2.4		3.1	GW Input		-0.8	CW Input		40
																GR Input		-1.2	GR Input		60

	INPUT CURRENT (mA)	OUTPUT CURRENT (mA)	POWER SUPPLY CURRENT (mA)			OFF-STATE OUTPUT CURRENT (μA)	
PARAMETER	I_{IN}	I_{OS} SHORT CIRCUIT	I_{CCL} LOW LEVEL	I_{CCH} HIGH LEVEL	$I_{OH(\mu A)}$ LEAKAGE	I_{OZL} LOW LEVEL VOLTAGE SUPPLIED	I_{OZH} HIGH LEVEL VOLTAGE SUPPLIED
TEST CONDITIONS	V_{CC}=MAX V_{IN}=7.0V		V_{CC}=MAX V_{IH}=4.5V V_{IL}=0.5V as appropriate		V_{CC}=MAX V_{IN}=* V_{OH}=5.5V	V_{CC}=MAX V_O=0.4V	V_{CC}=MAX V_O=2.7V
	MIN TYP MAX	MIN TYP MAX	MIN TYP MAX	MIN TYP MAX	MIN TYP MAX	MIN TYP MAX	MIN TYP MAX
54/74LS193 54 74	0.1	-15 -100	20.0 34.0 NOTE 14	N/A	N/A	N/A	N/A
54/74LS194A 54 74	0.1	-15 -100	15.0 23.0 NOTE 15	N/A	N/A	N/A	N/A
54/74LS195A 54 74	V_I=5.5V 0.1	-15 -100	14.0 21.0 NOTE 16	N/A	N/A	N/A	N/A
54/74LS196 54 74	Data, Count/Load 0.1 Clear, Clock 1 0.2 Clear, Clock 2 0.4	-15 -100	16.0 27.0 NOTE 1	N/A	N/A	N/A	N/A
54/74LS197 54 74	V_I=5.5V Data, Count/Load 0.1 Clear, Clock 1 0.2 Clock 2 0.4	-15 -100	16.0 27.0 NOTE 1	N/A	N/A	N/A	N/A
54/74LS251 54 74		0.1 -15	-100 N/A	Cond A 6.1 10.0 Cond B 7.1 12.0 NOTE 17	N/A	V_{CC}=MAX -20	V_{CC}=MAX 20
54/74LS253 54 74	0.1	-15 -100	N/A	Cond A 7.0 12.0 Cond B 8.5 14.0 NOTE 18	N/A	V_{CC}=MAX -20	V_{CC}=MAX 20
54/74LS257 54 74	S Input 0.2 Others 0.1	-15 -100	N/A	Cond.A 9.2 16.0 Cond.B 5.9 10.0 Cond.C 10.0 17.0 NOTE 19	N/A	V_o=0.5V -50	V_o=2.4V -50
54/74LS258 54 74	S Input 0.2 Others 0.1	-15 -100	N/A	Cond.A 6.2 11.0 Cond.B 4.1 7.0 Cond.C 7.0 12.0 NOTE 19	N/A	V_o=0.5V -50	V_o=2.4V -50
54/74LS260 54 74	V_I=5.5V 0.1	-15 -100	2.6 5.2	1.4 2.7	N/A	N/A	N/A
54/74LS261 54 74	M_{01} M_1 0.2 V=5.5V 0.1	-15 -100	N/A	22.0 38.0 NOTE 1	N/A	N/A	N/A
54/74LS266 54 74	V_I=5.5V 0.2	N/A	N/A	8.0 13.0 NOTE 20	100	N/A	N/A
54/74LS283 54 74	Any A or B 0.2 CO 0.1	-15 -100	N/A	Cond.A 22.0 39.0 Cond.B&C 19.0 34.0 NOTE 21	N/A	N/A	N/A
54/74LS290 54 74	V_I=5.6V Any Reset 0.1 A Input 0.4 B Input 0.8	-15 -100	N/A	29.0 42.0 NOTE 4	N/A	N/A	N/A
54/74LS293 54 74	V_I=7.0 Any Reset 0.1 A Input 0.4 B Input 0.4	-15 -100	N/A	26.0 39.0 NOTE 4	N/A	N/A	N/A
54/74LS295A 54 74	0.1	-15 -100	N/A	Cond.A 14.0 23.0 Cond.B 15.0 25.0 NOTE 22	N/A	N/A	N/A
54/74LS386 54 74	0.2	-15 -100	N/A	6.1 10.0 NOTE 1	N/A	N/A	N/A
54/74LS670 54 74	Any D,R,W 0.1 GW Input 0.2 GR Input 0.3	-15 -100	N/A	30.0 50.0	N/A	V_{CC}=MAX -20	V_{CC}=MAX 20

ELECTRICAL CHARACTERISTICS NOTES

1. All inputs grounded, outputs open.
2. With all outputs open, I_{CC} is measured with Q and $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is grounded.
3. I_{CC} is measured with outputs open, A=B grounded, and all other inputs at 4.5V.
4. I_{CC} is measured with all outputs open, both R_O inputs grounded following momentary connection to 4.5V and all other inputs grounded.
5. I_{CC} is measured with all outputs and serial inputs open; A,B,C and D inputs grounded, mode control at 4.5V and a momentary 3V, then ground, applied to both clock inputs.
6. I_{CC} is measured with clear input grounded and all other inputs and outputs open.
7. I_{CC} is measured with outputs open and 4.5V applied to all data and clear inputs. The measurement is made after a momentary ground, then 4.5V is applied to the clock.
8. I_{CC} is measured with inputs at 4.5V, outputs open.
9. I_{CCL} is measured with clock input high, then again with the clock input low with all other inputs low and all outputs open.
10. I_{CCH} is measured with the load input high, then again with the load input low, with all other inputs high and all outputs open.
11. I_{CC} is measured with outputs open, serial inputs grounded, the clock input at 2.4V, and a momentary ground, then 4.5V applied to clear.
12. I_{CC} is measured under the following worst case conditions: 4.5V are applied to all data inputs and both enable inputs, all address inputs are grounded, and all outputs are open.
13. With outputs open, I_{CC} is measured for the following conditions:
    Condition A — S_0 through S_3, M and A inputs are at 4.5V, all other inputs grounded.
    Condition B — S_0 through S_3 and M are at 4.5V, all other inputs are grounded.
14. I_{CC} is measured with outputs open, clear and load inputs grounded, and all other inputs at 4.5V.
15. With all outputs open, inputs A through D grounded, and 4.5V applied to S0, S1, clear and the serial inputs, I_{CC} is tested with a momentary ground then 4.5V applied to the clock.
16. With all outputs open, shift/load grounded and 4.5V applied to the J,$\overline{K}$ and data inputs, I_{CC} is measured by applying a momentary ground, followed by 4.5V to clear, then applying a momentary ground followed by 4.5V to clock.
17. I_{CC} is measured with the outputs open and all data and select inputs at 4.5V under the following conditions:
    Condition A — Strobe grounded
    Condition B — Strobe grounded
18. I_{CC} is measured with the outputs open and all data and select inputs at 4.5V under the following conditions:
    Condition A — All inputs grounded.
    Condition B — Output control at 4.5V, all inputs grounded.
19. I_{CC} is measured with all outputs open and all possible inputs grounded while achieving the stated output conditions.
20. I_{CC} is measured with one input of each gate at 4.5V, the other inputs grounded, and the outputs open.
21. I_{CC} is measured with the outputs open under the following conditions:
    Condition A — All inputs grounded.
    Condition B — All B inputs low, other at 4.5V
    Condition C — All inputs at 4.5V.
22. I_{CC} is measured with the outputs open, the serial input and mode control at 4.5V, and the data inputs grounded under the following conditions:
    Condition A — Output control at 4.5V and a momentary 3v then ground applied to clock input.
    Condition B — Output control and clock input grounded.

QUAD 2-INPUT NAND BUFFER — 54/74LS37

54LS37-F,W • 74LS37-A,F

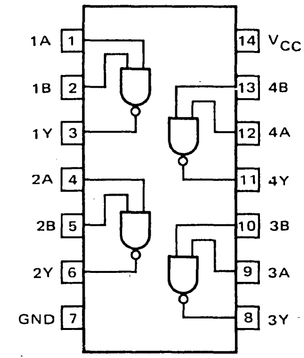
SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH} Propagation delay time, low-to-high-level output	C_L = 45pF, R_L = 667Ω		12	24	ns
t_{PHL} Propagation delay time, high-to-low-level output			12	24	ns

Load circuit and typical waveforms are shown at the front of book.

PIN CONFIGURATION

A,F,W PACKAGE



positive logic: Y=$\overline{AB}$

QUAD 2-INPUT NAND BUFFER W/OPEN COLLECTOR OUTPUTS — 54/74LS38

54LS38-F,W • 74LS38-A,F

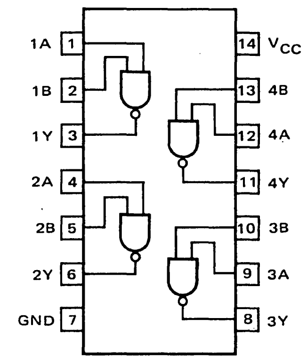
SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH} Propagation delay time, low-to-high-level output	C_L = 45pF, R_L = 667Ω		20	32	ns
t_{PHL} Propagation delay time, high-to-low-level output			18	28	ns

Load circuit and typical waveforms are shown at the front of book.

PIN CONFIGURATION

A,F,W PACKAGE



positive logic: Y=$\overline{AB}$

DUAL 4-INPUT NAND BUFFER — 54/74LS40

54LS40-F,W • 74LS40-A,F

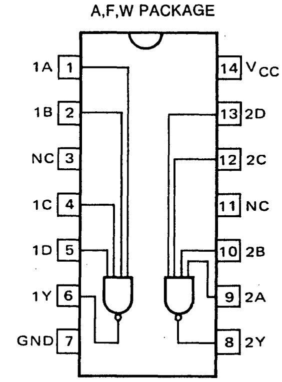
SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH} Propagation delay time, low-to-high-level output	C_L = 45pF, R_L = 667Ω		12	24	ns
t_{PHL} Propagation delay time, high-to-low-level output			12	24	ns

Load circuit and typical waveforms are shown at the front of book.

PIN CONFIGURATION

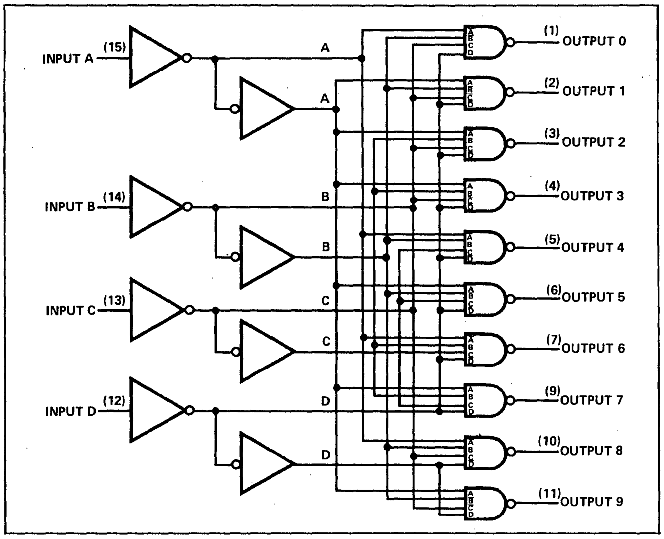
A,F,W PACKAGE



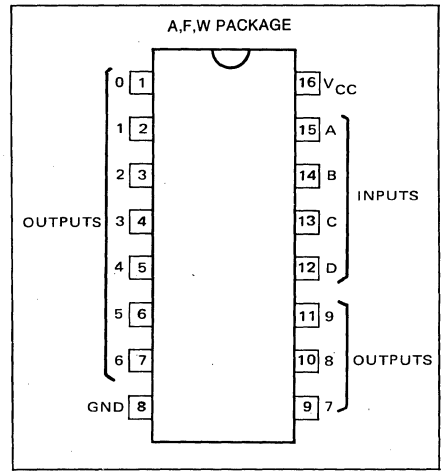
positive logic: Y=$\overline{ABCD}$

54LS42-F,W • 74LS42-A,F

FUNCTIONAL BLOCK DIAGRAM



PIN CONFIGURATION



FUNCTION TABLE

NO.	BCD INPUT				DECIMAL OUTPUT									
	D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	L	L	L	L	L	H	H	H	H	H	H	H	H	H
1	L	L	L	H	H	L	H	H	H	H	H	H	H	H
2	L	L	H	L	H	H	L	H	H	H	H	H	H	H
3	L	L	H	H	H	H	H	L	H	H	H	H	H	H
4	L	H	L	L	H	H	H	H	L	H	H	H	H	H
5	L	H	L	H	H	H	H	H	H	L	H	H	H	H
6	L	H	H	L	H	H	H	H	H	H	L	H	H	H
7	L	H	H	H	H	H	H	H	H	H	H	L	H	H
8	H	L	L	L	H	H	H	H	H	H	H	H	L	H
9	H	L	L	H	H	H	H	H	H	H	H	H	H	L
INVALID	H	L	H	L	H	H	H	H	H	H	H	H	H	H
	H	L	H	H	H	H	H	H	H	H	H	H	H	H
	H	H	L	L	H	H	H	H	H	H	H	H	H	H
	H	H	L	H	H	H	H	H	H	H	H	H	H	H
	H	H	H	L	H	H	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H	H	H	H	H	H	H

H = high level, L = low level

SWITCHING CHARACTERISTICS V_{CC}=5V, T_A=25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
t_{PHL}	Propagation delay time, high-to-low-level output from A,B,C, or D through 2 levels of logic	C_L = 15pF, R_L = 2kΩ		14	25	ns
t_{PHL}	Propagation delay time, high-to-low-level output from A,B,C, or D through 3 levels of logic			17	30	ns
t_{PHL}	Propagation delay time, low-to-high-level output from A,B,C, and D through 2 levels of logic			10	25	ns
t_{PLH}	Propagation delay time, low-to-high-level output from A,B,C, and D through 3 levels of logic			17	30	ns

Load circuit and waveforms shown at front of book (totem pole outputs)

DIGITAL

Signetics

DUAL 2-WIDE 2-INPUT AND-OR-INVERT GATE — 54/74LS51

54LS51-F,W • 74LS51-A,F

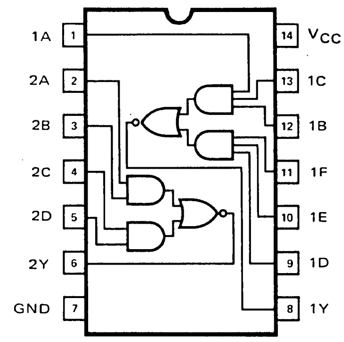
SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low-to-high-level output	C_L = 15pF, R_L = 2kΩ		9	15	ns
t_{PHL}	Propagation delay time, high-to-low-level output			9.5	15	ns

Load circuit and typical waveforms are shown at the front of book.

PIN CONFIGURATION

A,F,W PACKAGE



positive logic:

$1Y = \overline{(1A \cdot 1B \cdot 1C) + (1D \cdot 1E \cdot 1F)}$

$2Y = \overline{(2A \cdot 2B) + (2C \cdot 2D)}$

4-WIDE 2-INPUT AND-OR-INVERT GATE — 54/74LS54

54LS54-F,W • 74LS54-A,F

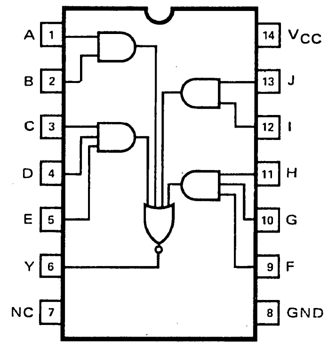
SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low-to-high-level output	C_L = 15pF, R_L = 2kΩ		7.0	20	ns
t_{PHL}	Propagation delay time, high-to-low-level output			11.5	20	ns

Load circuit and typical waveforms are shown at the front of book.

PIN CONFIGURATION

A,F,W PACKAGE



positive logic:

$Y = \overline{(AB) + (CDE) + (FGH) + (IJ)}$

NC—No internal connection

2-WIDE 4-INPUT AND-OR-INVERT GATE — 54/74LS55

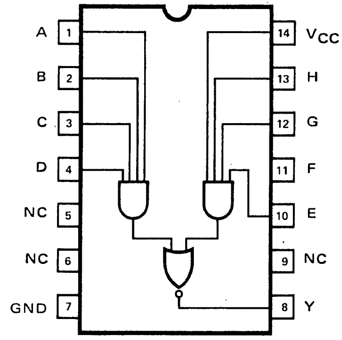
54LS55-F,W • 74LS55-A,F

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low-to-high-level output	C_L = 15pF, R_L = 2kΩ		7.0	20	ns
t_{PHL}	Propagation delay time, high-to-low-level output			11.5	20	ns

Load circuit and typical waveforms are shown at the front of book.

PIN CONFIGURATION



positive logic:

$Y = \overline{(ABCD) + (EFGH)}$

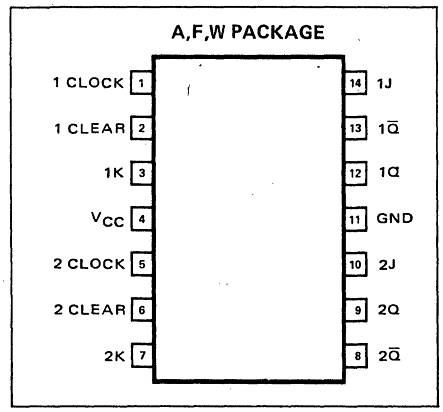
DUAL J-K MASTER-SLAVE FLIP-FLOP 54/74LS73

54LS73-F,W • 74LS73-A,F

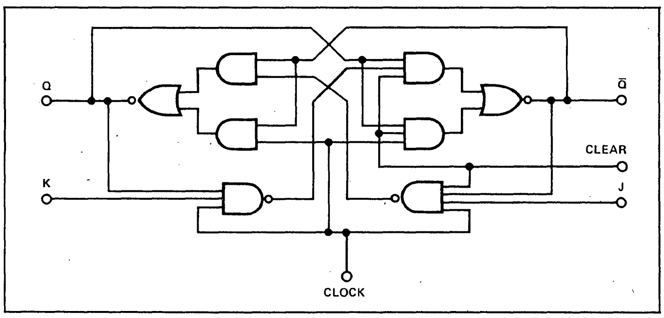
DESCRIPTION

This monolithic edge-triggered dual J-K flip-flop features individual J, K, clock, and clear inputs to each flip-flop. A low logic level at the clear input resets the Q output to a low level regardless of the levels at the other inputs. With clear inactive (high), a high level at the clock input enables the J and K inputs and data will be accepted. The logic levels at the J and K inputs may be allowed to change when the clock pulse is high and the bistable will perform according to the function table, as long as minimum setup and hold times are observed. Input data is transferred to the outputs on the negative-going edge of the clock pulse.

PIN CONFIGURATION



LOGIC DIAGRAM



FUNCTION TABLE (Each Flip-Flop)

INPUTS				OUTPUTS	
CLEAR	CLOCK	J	K	Q	$\bar{Q}$
L	X	X	X	L	H
H	↓	L	L	Q_0	$\bar{Q}_0$
H	↓	H	L	H	L
H	↓	L	H	L	H
H	↓	H	H	TOGGLE	
H	H	X	X	Q_0	$\bar{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↓ = transition from high to low level
Q_0 = the level of Q before the indicated input conditions were established.
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.

SWITCHING CHARACTERISTICS V_{CC}=5V, T_A=25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency	C_L = 15pF, R_L = 2kΩ	30	45		MHz
$t_{w(Clock)}$	Width of clock pulse (high)		20			ns
$t_{w(Clear)}$	Width of clear pulse (low)		25			ns
t_{Setup}	Input setup time		20			ns
t_{Hold}	Input hold time		0			ns
t_{PLH}	Propagation delay time, low-to-high-level output from clear or clock (as appropriate)			11	20	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear or clock (as appropriate)			15	30	ns

Load circuit and typical waveforms are shown at the front of book.

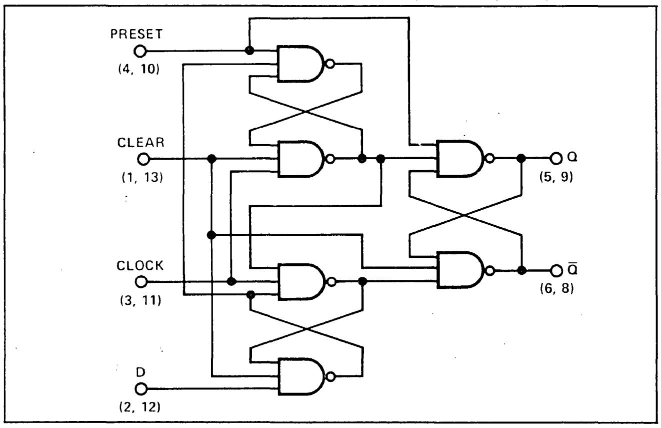
54LS74-F,W • 74LS74-A,F

DESCRIPTION

These monolithic dual edge-triggered D-type flip-flops feature individual D, clock, preset, and clear inputs.

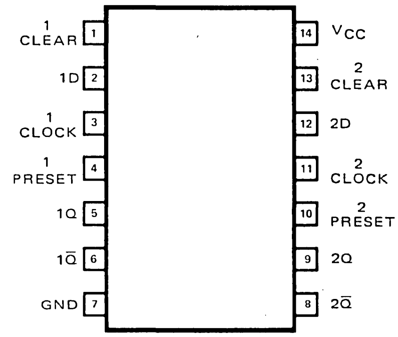
Preset and clear inputs are active-low and operate independently of the clock input. When preset and clear are inactive (high), information at the D input is transferred to the Q output on the positive-going edge of the clock pulse. Clock triggering occurs at a voltage level of the clock pulse and is not directly related to the transition time of the positive-going pulse. When the clock input is at either the high or low level, the D-input signal has no effect at the output.

FUNCTIONAL BLOCK DIAGRAM (Each Flip-Flop)



PIN CONFIGURATION

A,F,W PACKAGE



FUNCTION TABLE (Each Flip-Flop)

INPUTS				OUTPUTS	
PRESET	CLEAR	CLOCK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
H	L	X	X	H*	H*
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q_0	$\overline{Q}_0$

H = high level (steady state) L = low level (steady state)

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency		25	33		ns
$t_{w\ (Clock)}$	Width of clock pulse		25			ns
$t_{w\ (Preset)}$	Width of preset pulse		25			ns
$t_{w\ (Clear)}$	Width of clear pulse		25			ns
t_{Setup}	Input setup time					
	High level data		25			ns
	Low level data	C_L = 15pF, R_L = 2kΩ	20			ns
t_{Hold}	Input hold time		0			ns
t_{PLH}	Propagation delay time, low-to-high-level output from clear or preset			8	25	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear, preset or clock (whichever is applicable)			16	40	ns

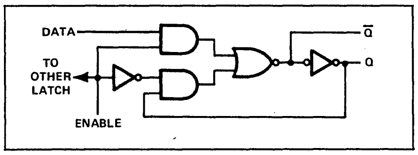
QUAD BISTABLE LATCH 54/74LS75

54LS75-F,W • 74LS75-B,F

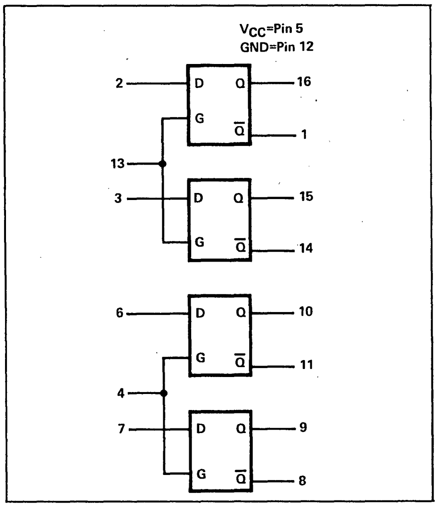
DESCRIPTION

This latch is ideally suited for use as temporary storage for binary information between processing units and input/output or indicator units. Information present at a data (D) input is transferred to the Q output when the enable (G) is high and the Q output will follow the data input as long as the enable remains high. When the enable goes low, the information (that was present at the data input at the time the transition occurred) is retained at the Q output until the enable is permitted to go high.

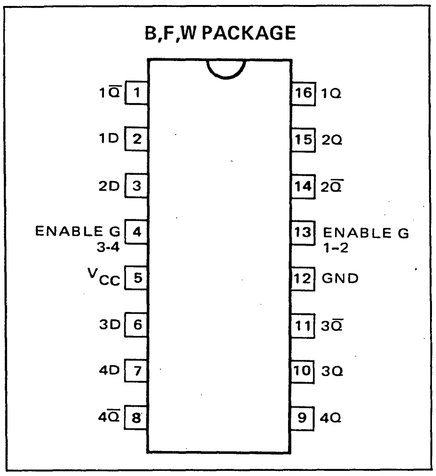
FLIP-FLOP LOGIC DIAGRAM



BLOCK DIAGRAM



PIN CONFIGURATION



SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_W	Width of enabling pulse				20			ns
t_{Setup}	Input setup time				20			ns
t_{Hold}	Input hold time				0			ns
Propagation delay time				$C_L = 15pF$, $R_L = 2k\Omega$				ns
t_{PLH}	Low to high	D	Q			15	27	ns
t_{PHL}	High to low					9	17	
t_{PLH}	Low to high	D	$\overline{Q}$			12	20	ns
t_{PHL}	High to low					7	15	
t_{PLH}	Low to high	G	Q			15	27	ns
t_{PHL}	High to low					14	25	
t_{PLH}	Low to high	G	$\overline{Q}$			16	30	ns
t_{PHL}	High to low					7	15	

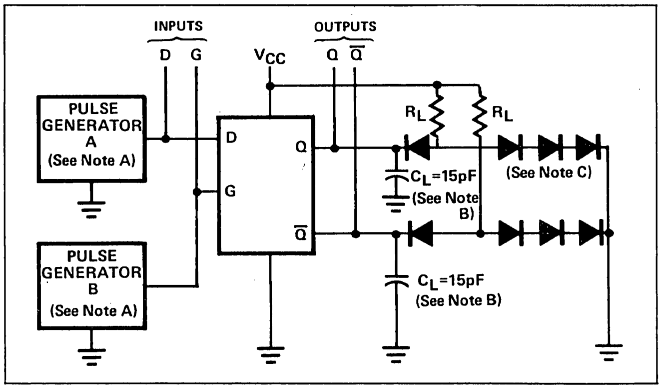
FUNCTION TABLE

(Each Latch)

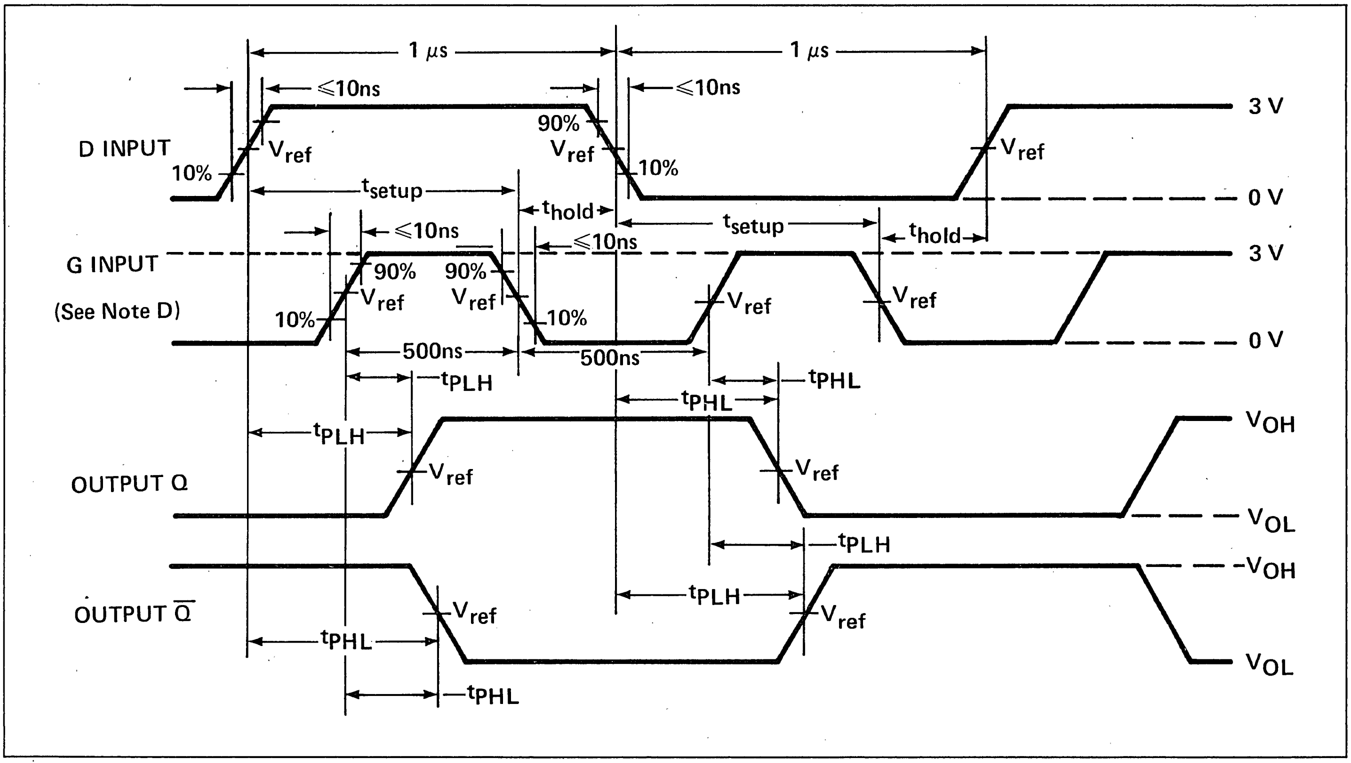
INPUTS		OUTPUTS	
D	G	Q	$\overline{Q}$
L	H	L	H
H	H	H	L
X	L	Q_0	$\overline{Q}_0$

H = high level, L = low level, X = irrelevant
Q_0 = the level of Q before the high-to-low transition of G

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:

A. The pulse generators have the following characteristics: Z_{out} = 50 Ω; for pulse generator A, PRR ≤ 500 kHz; for pulse generator B, PRR ≤ I MHz. Positions of D and G input pulses are varied with respect to each other to verify setup times.

B. C_L includes probe and jig capacitance.

C. All diodes are 1N3064.

D. When measuring propagation delay times from the D input, the corresponding G input must be held high.

E. V_{ref} = 1.3V.

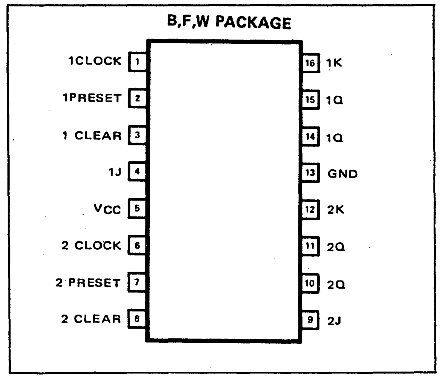
DUAL J-K MASTER-SLAVE FLIP-FLOP 54/74LS76

54LS76-F,W • 74LS76-B,F

DESCRIPTION

This monolithic dual J-K flip-flop features individual J, K, clock, and asynchronous preset and clear inputs to each flip-flop. The preset or clear inputs, when low, set or reset the outputs regardless of the levels at the other inputs. When preset and clear inputs are inactive (high), a high level at the clock input enables the J and K inputs and data will be accepted. The logic levels at the J and K inputs may be allowed to change when the clock pulse is high and the bistable will perform according to the function table as long as minimum setup and hold times are observed. Input data is transferred to the outputs on the negative-going edge of the clock pulse.

PIN CONFIGURATION

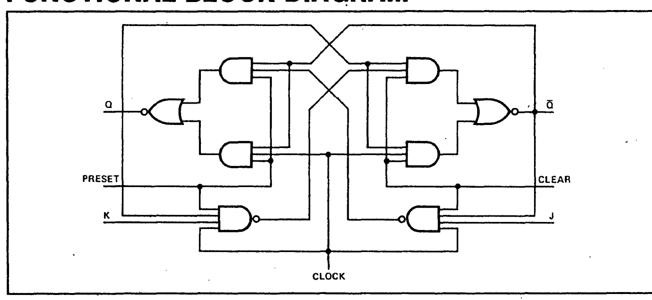


FUNCTION TABLE (Each Flip Flop)

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	K	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↓	L	L	Q_0	$\overline{Q}_0$
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	TOGGLE	
H	H	H	X	X	Q_0	$\overline{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.
*This configuration is nonstable, that is, it will not persist when preset and clear inputs return to their inactive (high) level.

FUNCTIONAL BLOCK DIAGRAM



SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency		30	45		MHz
$t_{w(Clock)}$	Width of clock Pulse		20			ns
$t_{w(Preset)}$	Width of preset pulse		25			ns
$t_{w(Clear)}$	Width of clear pulse		25			ns
t_{Setup}	Input setup time		20↓			ns
t_{Hold}	Input hold time	C_L = 15pF, R_L = 2kΩ	0↓			ns
t_{PLH}	Propagation delay time, low-to-high-level output from clear, preset or clock (as appropriate)			11	20	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear, preset or clock (as appropriate)			15	30	ns

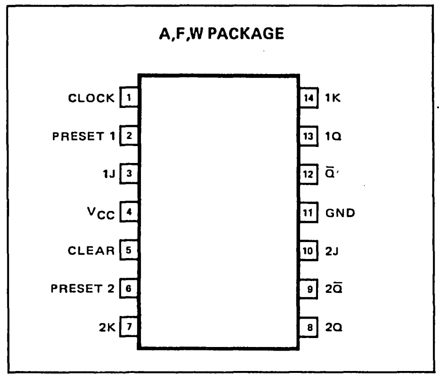
DUAL J-K NEGATIVE EDGE-TRIGGERED FLIP-FLOP — 54/74LS78

54LS78-F,W • 74LS78-A,F

DESCRIPTION

This monolithic dual J-K edge-triggered flip-flop features individual J, K, and preset inputs plus common clock and common clear inputs. The preset or clear inputs, when low, set or reset the outputs regardless of the levels at the other inputs. When preset and clear inputs are inactive (high), a high level at the clock input enables the J and K inputs and data will be accepted. The logic levels at the J and K inputs may be allowed to change when the clock pulse is high and the bistable will perform according to the function table as long as minimum setup and hold times are observed. Input data is transferred to the outputs on the negative-going edge of the clock pulse.

PIN CONFIGURATION

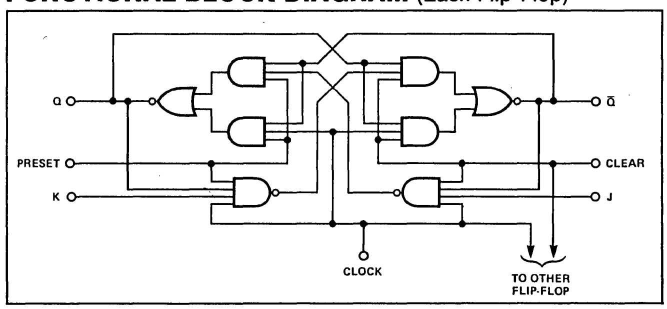


FUNCTION TABLE (Each Flip-Flop)

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	K	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↓	L	L	Q_0	$\overline{Q}_0$
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	TOGGLE	
H	H	H	X	X	Q_0	$\overline{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.
*This configuration is nonstable, that is, it will not persist when preset and clear inputs return to their inactive (high) level.

FUNCTIONAL BLOCK DIAGRAM (Each Flip-Flop)



SWITCHING CHARACTERISTICS $V_{CC} = 5V, T_A = 25°C$

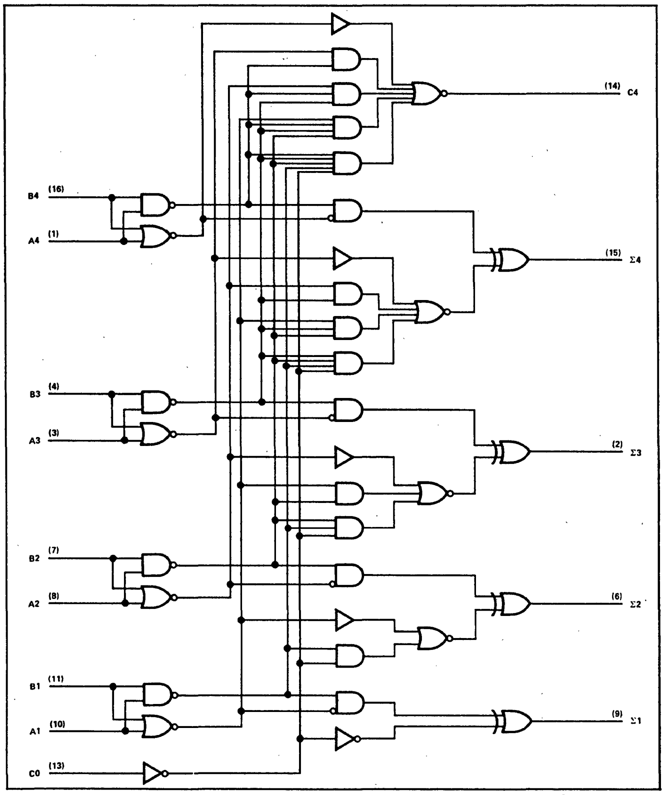
PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency	$C_L = 15pF, R_L = 2k\Omega$	30	45		MHz
$t_{w(Clock)}$	Width of clock pulse (high)		20			ns
$t_{w(Preset)}$	Width of preset pulse (low)		25			ns
$t_{w(Clear)}$	Width of clear pulse (low)		25			ns
t_{Setup}	Input setup time		20↓			ns
t_{Hold}	Input hold time		0↓			ns
t_{PLH}	Propagation delay time, low-to-high-level output from clear, preset or clock (as appropriate)			11	20	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear, preset or clock (as appropriate)			15	30	ns

Load circuit and waveforms are shown at the front of book.

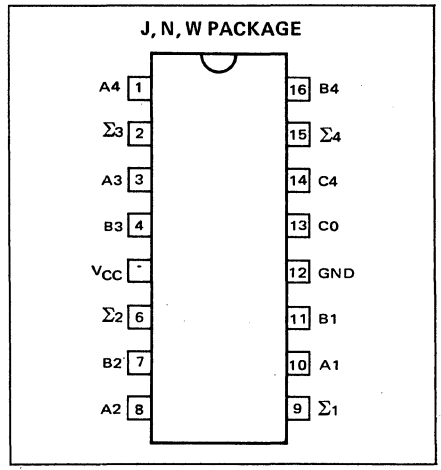
4-BIT BINARY FULL ADDER — 54/74LS83A

54LS83A-J,W • 74LS83A-J,N

BLOCK DIAGRAM



PIN CONFIGURATION



FUNCTION TABLE

INPUT				OUTPUT					
				WHEN CO = L			WHEN CO = H		
						WHEN C2 = L			WHEN C2 = H
A1 A3	B2 B3	A2 A4	B2 B4	Σ1 Σ3	Σ2 Σ4	C2 C4	Σ1 Σ3	Σ2 Σ4	C2 C4
L	L	L	L	L	L	L	H	L	L
H	L	L	L	H	L	L	L	H	L
L	H	L	L	H	L	L	L	H	L
H	H	L	L	L	H	L	H	H	L
L	L	H	L	L	H	L	H	H	L
H	L	H	L	H	H	L	L	L	H
L	H	H	L	H	H	L	L	L	H
H	H	H	L	L	L	H	H	L	H
L	L	L	H	L	H	L	H	H	L
H	L	L	H	H	H	L	L	L	H
L	H	L	H	H	H	L	L	L	H
H	H	L	H	L	L	H	H	L	H
L	L	H	H	L	L	H	H	L	H
H	L	H	H	H	L	H	L	H	H
L	H	H	H	H	L	H	L	H	H
H	H	H	H	L	H	H	H	H	H

H = high level, L = low level

NOTE: Input conditions at A1, B1, A, B2, and CO are used to determine outputs Σ1 and Σ2 and the value of the internal carry C2. The values at C2, A3, B3, A4, and B4, are then used to determine outputs Σ3, Σ4, and C4.

Load circuit and waveforms are shown at the front of book.

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER★	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	C0	Any Σ	$C_L = 15pF$, $R_L = 2k\Omega$		16	24	ns
t_{PHL}					15	24	
t_{PLH}	A_i or B_i	Σ_i			15	24	ns
t_{PHL}					15	24	
t_{PLH}	C0	C4			11	17	ns
t_{PHL}					11	17	
t_{PHL}	A_i or B_i	C4			11	17	ns
t_{PHL}					12	17	

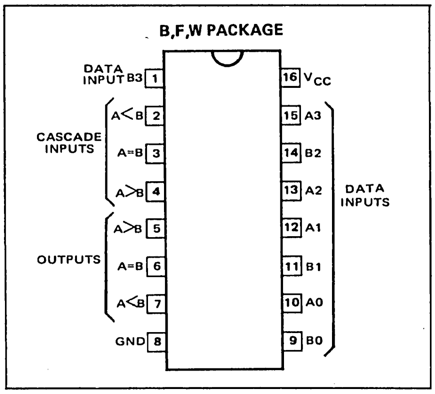
★t_{PLH} = Propagation delay time, low-to-high-level output
t_{PHL} = Propagation delay time, high-to-low-level output

54LS85-F,W • 74LS85-B,F

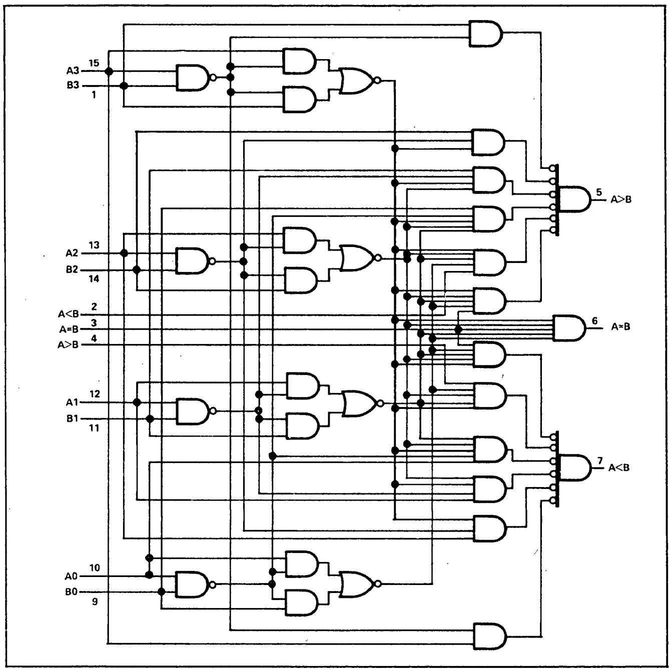
DESCRIPTION

This four-bit magnitude comparator performs comparison of straight binary and straight BCD (8-4-2-1) codes. Three fully decoded decisions about two 4-bit words (A, B) are made and are externally available at three outputs. These devices are fully expandable to any number of bits without external gates. Words of greater length may be compared by connecting comparators in cascade. The A > B, A < B and A = B outputs of a stage handling less-significant bits are connected to the corresponding A > B, A < B, and A = B inputs of the next stage handling more-significant bits. The stage handling the least-significant bits must have a high-level voltage applied to the A = B input. The cascading path is implemented with only a two-gate-level delay to reduce overall comparison times for long words. An alternate method of cascading which further reduces the comparison time is shown in the typical application data.

PIN CONFIGURATION



BLOCK DIAGRAM



FUNCTION TABLE

COMPARING INPUTS				CASCADING INPUTS			OUTPUTS		
A3, B3	A2, B2	A1, B1	A0, B0	A > B	A < B	A = B	A > B	A < B	A = B
A3 > B3	X	X	X	X	X	X	H	L	L
A3 < B3	X	X	X	X	X	X	L	H	L
A3 = B3	A2 > B2	X	X	X	X	X	H	L	L
A3 = B3	A2 < B2	X	X	X	X	X	L	H	L
A3 = B2	A2 = B2	A1 > B1	X	X	X	X	H	L	L
A3 = B3	A2 = B2	A1 < B1	X	X	X	X	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 > B0	X	X	X	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0 < B0	X	X	X	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	H	L	L	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	H	L	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	L	H	L	L	H
A3 = B3	A2 = B2	A1 = B1	A0 = B0	X	X	H	L	L	H
A3 = B3	A2 = B2	A1 = B1	A0 = B0	H	H	L	L	L	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	L	L	H	H	L

H = high level, L = low level, X = irrelevant

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER★	FROM INPUT	TO OUTPUT	NUMBER OF GATE LEVELS	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	Any A or B data input	A < B, A > B A = B	1 2 3 4	C_L = 15pF, R_L = 2kΩ		14 19 24 23	 36 40	ns
t_{PHL}	Any A or B data input	A < B, A > B A = B	1 2 3 4			11 15 20 20	 30 30	ns
t_{PLH}	A < B or A = B	A > B	1			14	22	ns
t_{PHL}	A < B or A = B	A > B	1			11	17	ns
t_{PLH}	A = B	A = B	2			13	20	ns
t_{PHL}	A = B	A = B	2			11	17	ns
t_{PLH}	A > B or A = B	A < B	1			14	22	ns
t_{PHL}	A > B or A = B	A < B	1			11	17	ns

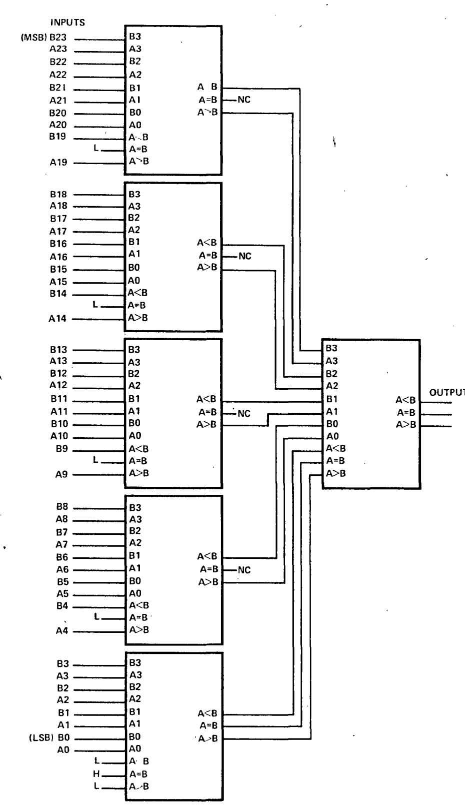
★t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
Load circuit and waveforms are shown at the front of the book.

TYPICAL APPLICATION DATA

COMPARISON OF TWO N-BIT WORDS

This application demonstrates how these magnitude comparators can be cascaded to compare longer words. The example illustrated shows the comparison of two 24-bit words; however, the design is expandable to n-bits. As an example, one comparator can be used with five of the 24-bit comparators illustrated to expand the word length to 120-bits. Typical comparison times for various word lengths using the 54/74LS85 are:

WORD LENGTH	NUMBER OF PKGS	
1-4 bits	1	24 ns
5-24 bits	2-6	48 ns
25-120 bits	8-31	72 ns



QUAD 2-INPUT EXCLUSIVE-OR GATE 54/74LS86

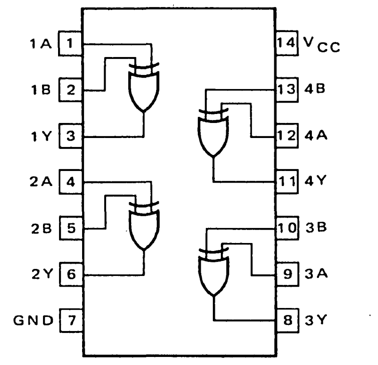
54LS86-F,W • 74LS86-A,F

SWITCHING CHARACTERISTICS $V_{CC} = 5V, T_A = 25°C$

PARAMETER★	FROM (INPUT)	TEST CONDITIONS		LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	A or B	Other input low	$C_L = 15pF$, $R_L = 2k\Omega$		12	23	ns
t_{PHL}					10	17	
t_{PLH}	A or B	Other input high			10	30	ns
t_{PHL}					18	22	

PIN CONFIGURATION

A,F,W PACKAGE



positive logic: $Y = A \oplus B = \overline{A}B + A\overline{B}$

FUNCTION TABLE

INPUTS A	B	OUTPUT Y
L	L	L
L	H	H
H	L	H
H	H	L

H = high level, L = low level

★t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
Load circuit and voltage waveforms are shown at front of book

DECADE COUNTER 54/74LS90

54LS90-F,W •74LS90-A,F

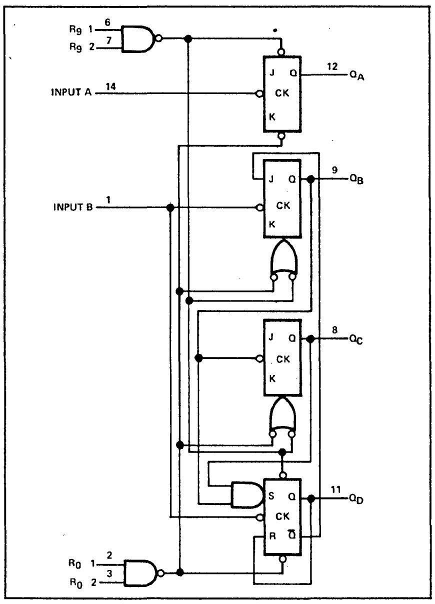
DESCRIPTION

This monolithic counter contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divide-by-five.

The 54/74LS90 also has a gated zero reset and gated set-to-nine inputs for use in BCD nine's complement applications.

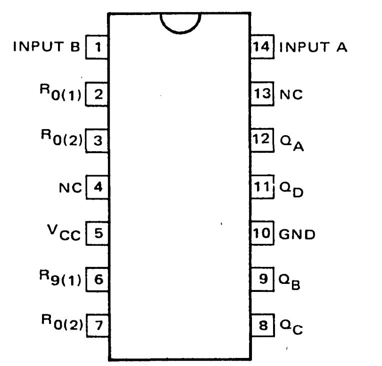
To use its maximum count length of this counter, the B input is connected to the Q_A output. The input count pulses are applied to input A and the outputs are as described in the function table. A symmetrical divide-by-ten count can be obtained by connecting the Q_D output to the A input and applying the input count to the B input which gives a divide-by-ten square wave at output Q_A.

BLOCK DIAGRAM



PIN CONFIGURATION

A,F,W PACKAGE



54LS90-F,W • 74LS90-A,F

BCD COUNT SEQUENCE (See Note A)

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

BI-QUINARY (5-2) (See Note B)

COUNT	OUTPUT			
	Q_A	Q_D	Q_C	Q_B
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	H	L	L	L
6	H	L	L	H
7	H	L	H	L
8	H	L	H	H
9	H	H	L	L

RESET/COUNT FUNCTION TABLE

RESET INPUTS				OUTPUT			
$R_{0(1)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	Q_D	Q_C	Q_B	Q_A
H	H	L	X	L	L	L	L
H	H	X	L	L	L	L	L
X	X	H	H	H	L	L	H
X	L	X	L	COUNT			
L	X	L	X	COUNT			
L	X	X	L	COUNT			
X	L	L	X	COUNT			

NOTES:
A. Output Q_A is connected to input B for BCD count.
B. Output Q_D is connected to input A for bi-quinary count.
C. Output Q_A is connected to input B.
D. H = high level, L = low level, X = irrelevant

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

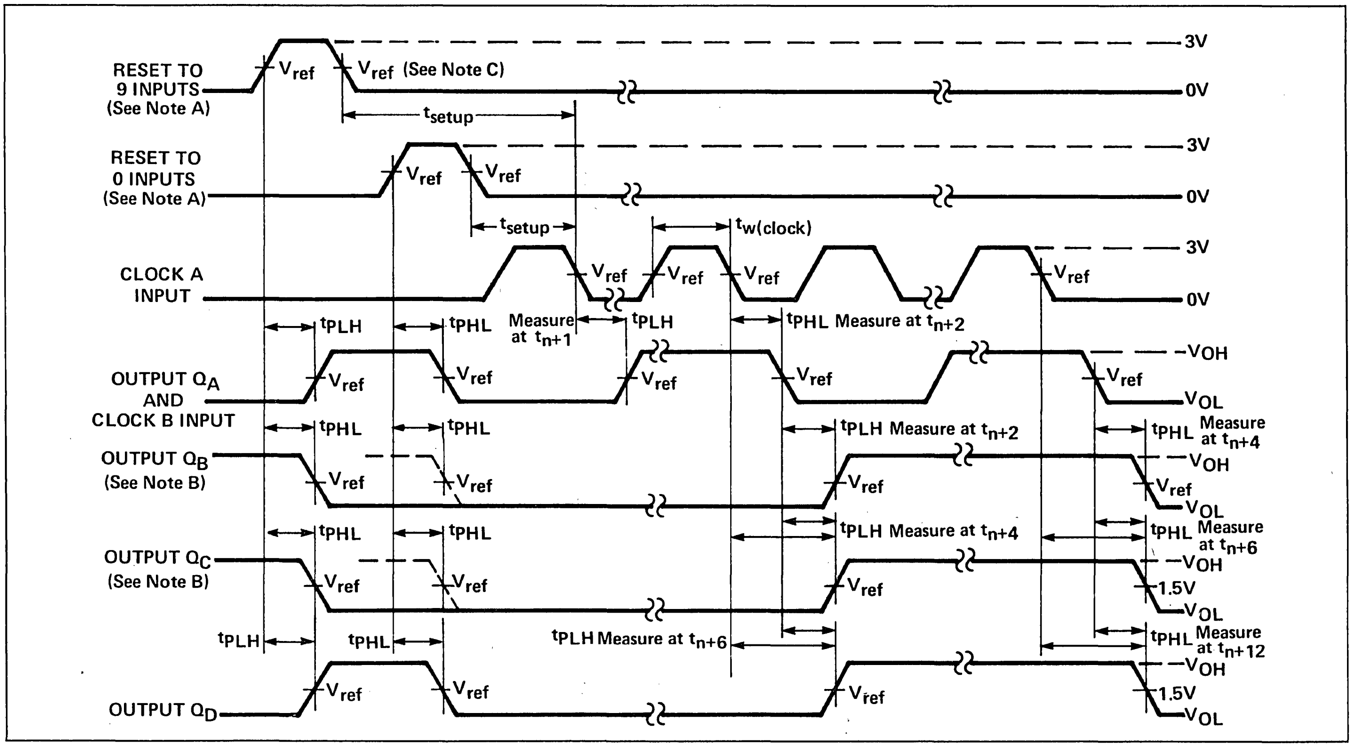
PARAMETER★	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Count}	A	Q_A		32	42		MHz
	B	Q_B		16			
t_w Pulse width	A	Q		15			ns
	B	Q		30			ns
	Reset	Q		15			ns
t_{Setup}	Reset inactive-state setup time			25			ns
t_{PLH}	A	Q_A	C_L = 15pF, R_L = 2kΩ See Figure 1		10	16	ns
t_{PHL}					12	18	
t_{PLH}	A	Q_D			32	48	ns
t_{PHL}					34	50	
t_{PLH}	B	Q_B			10	16	ns
t_{PHL}					14	21	
t_{PLH}	B	Q_C			21	32	ns
t_{PHL}					23	35	
t_{PLH}	B	Q_D			21	32	ns
t_{PHL}					23	35	
t_{PHL}	Set-to-0	Any			26	40	ns
t_{PLH}	Set-to-9	Q_A, Q_D			20	30	ns
t_{PHL}		Q_B, Q_C			26	40	

★f_{max} = maximum count frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

DIGITAL

Signetics

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

A. Each reset input is tested separately with the other reset at 4.5 V.
B. Reference waveforms are shown with dashed lines.
C. V_{ref} = 1.3 V.
Load circuit is shown at front of book (for totem pole outputs).

54LS92-F,W • 74LS92-A,F

DESCRIPTION

This monolithic counter contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three stage binary counter for which the count cycle length is divide-by-six.

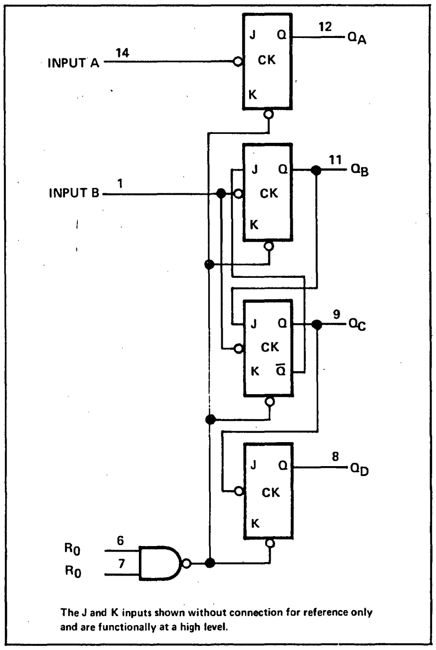
To use its maximum count length of this counter, the B input is connected to the Q_A output. The input count pulses are applied to input A and the outputs are as described in the function table.

COUNT SEQUENCE

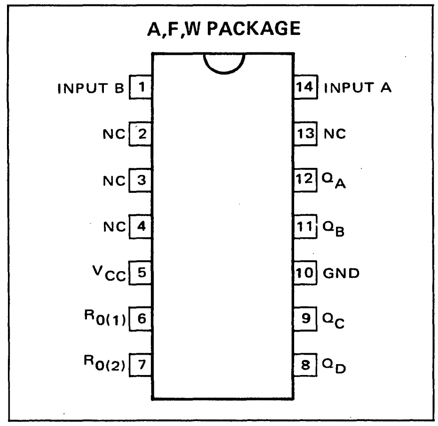
COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	H	L	L	L
7	H	L	L	H
8	H	L	H	L
9	H	L	H	H
10	H	H	L	L
11	H	H	L	H

Output Q_A is connected to Input B.

BLOCK DIAGRAM



PIN CONFIGURATION



RESET/COUNT FUNCTION TABLE

RESET INPUTS		OUTPUT			
$R_{0(1)}$	$R_{0(2)}$	Q_D	Q_C	Q_B	Q_A
H	H	L	L	L	L
L	X	COUNT			
X	L	COUNT			

SWITCHING CHARACTERISTICS $V_{CC} = 5V, T_A = 25°C$

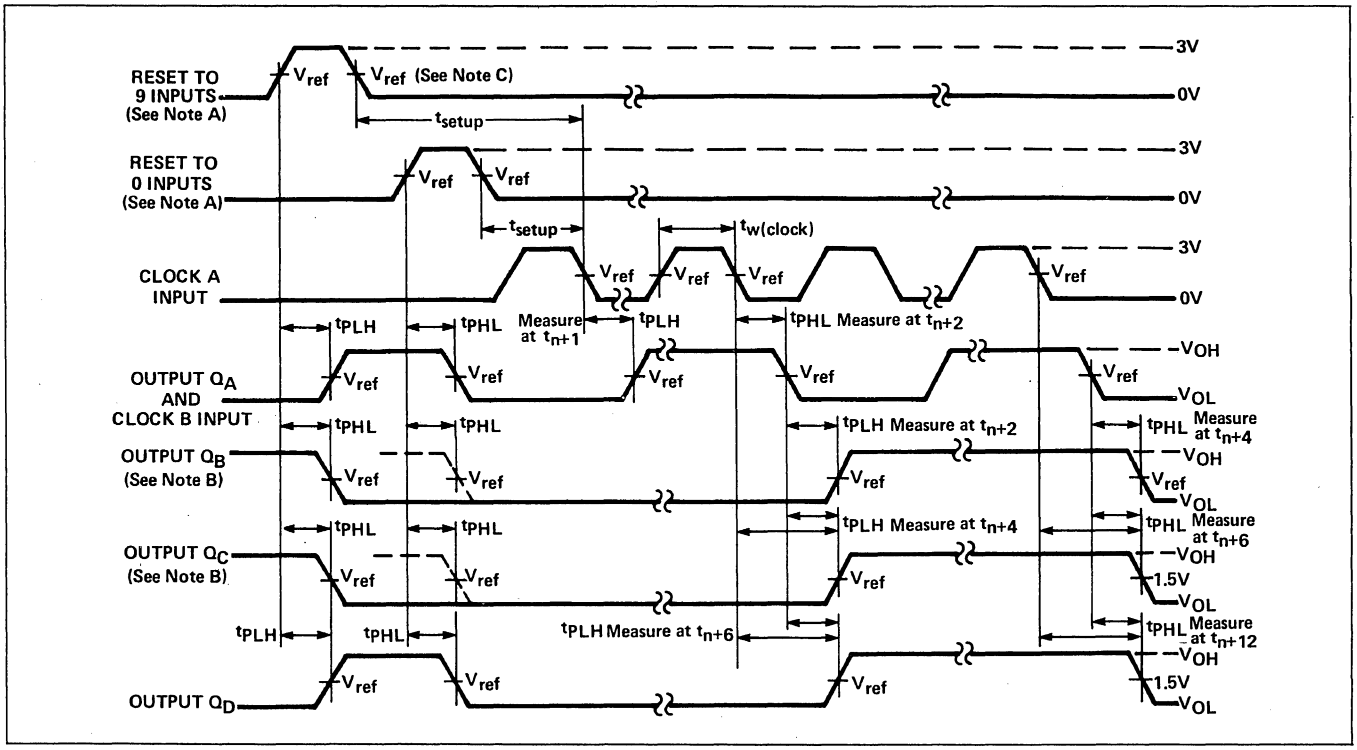
PARAMETER★	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{Count}	A	Q_A		32	42		MHz
	B	Q_B		16			
t_W Pulse width	A	Q		15			ns
	B	Q		30			ns
	Reset	Q		15			ns
t_{Setup}	Reset inactive-state setup time			25			ns
t_{PLH} t_{PHL}	A	Q_A	$C_L = 15pF, R_L = 2k\Omega$ See Figure 1		10 12	16 18	ns
t_{PLH} t_{PHL}	A	Q_D			32 34	48 50	ns
t_{PLH} t_{PHL}	B	Q_B			10 14	16 21	ns
t_{PLH} t_{PHL}	B	Q_C			10 14	16 21	ns
t_{PLH} t_{PHL}	B	Q_D			21 23	32 35	ns
t_{PHL}	Set-to-0	Any			26	40	ns
t_{PLH} t_{PHL}	Set-to-9	Q_A, Q_D Q_B, Q_C					ns

★t_{max} = maximum count frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

DIVIDE-BY-TWELVE COUNTER 54/74LS92

54LS92-F,W • 74LS92-A,F

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

NOTES:
A. Each reset input is tested separately with the other reset at 4.5 V.
B. Reference waveforms are shown with dashed lines.
C. V_{ref} = 1.3 V.
Load circuit is shown at front of book (for totem pole outputs).

4-BIT BINARY COUNTER 54/74LS93

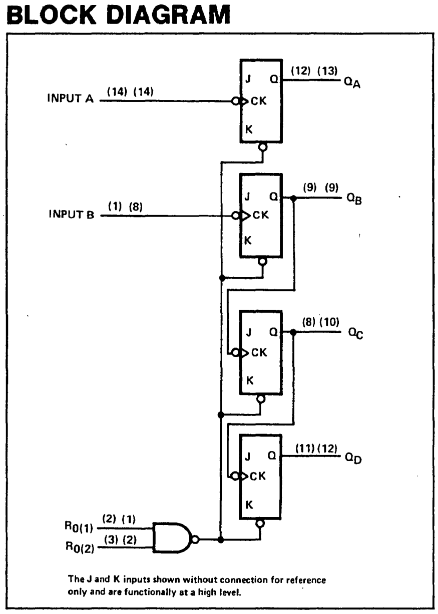
54LS93-F,W • 74LS93-A,F

DESCRIPTION

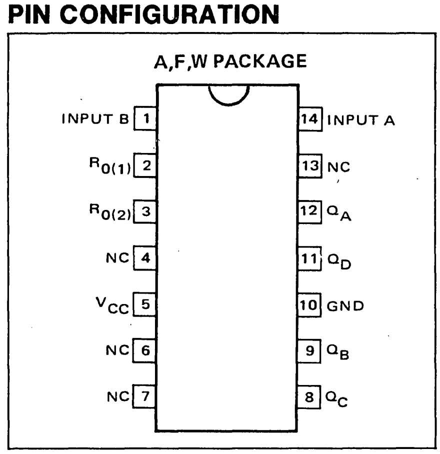
This monolithic counter contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three stage binary counter for which the count cycle length is divide-by-eight.

To use its maximum count length of this counter, the B input is connected to the Q_A output. The input count pulses are applied to input A and the outputs are as described in the function table.

BLOCK DIAGRAM



PIN CONFIGURATION



SWITCHING CHARACTERISTICS $V_{CC} = 5V, T_A = 25°C$

PARAMETER★	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{Count}	A	Q_A		32	42		MHz
	B	Q_B		16			
t_w Pulse width	A	Q		15			ns
	B	Q		30			ns
	Reset	Q		15			ns
t_{Setup}	Reset inactive-state-setup time			25			ns
t_{PLH}	A	Q_A			10	16	ns
t_{PHL}			$C_L = 15pF$, $R_L = 2k\Omega$		12	18	
t_{PLH}	A	Q_D	See Figure 1		46	70	ns
t_{PHL}					46	70	
t_{PLH}	B	Q_B			10	16	ns
t_{PHL}					14	21	
t_{PLH}	B	Q_C			21	32	ns
t_{PHL}					23	35	
t_{PLH}					34	51	ns
t_{PHL}	B	Q_D			34	51	
t_{PHL}	Set-to-0	Any			26	40	ns

★t_{max} = maximum count frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

COUNT SEQUENCE

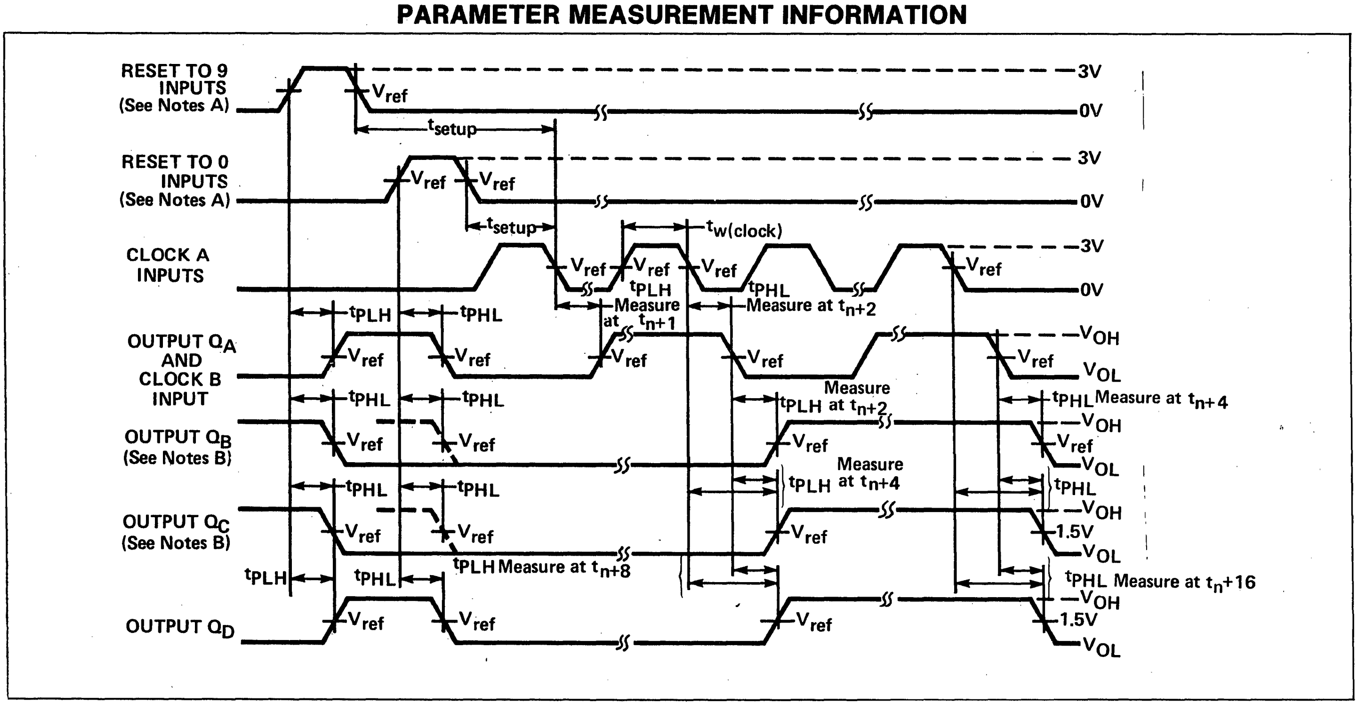
COUNT	OUTPUT Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H
10	H	L	H	L
11	H	L	H	H
12	H	H	L	L
13	H	H	L	H
14	H	H	H	L
15	H	H	H	H

Output Q_A Is Connected To Input B.

RESET/COUNT FUNCTION TABLE

RESET INPUTS $R_{0(1)}$	$R_{0(2)}$	OUTPUT Q_D	Q_C	Q_B	Q_A
H	H	L	L	L	L
L	X	COUNT			
X	L	COUNT			

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

NOTES:
A. Each reset input is tested separately with the other reset at 4.5 V.
B. Reference waveforms are shown with dashed lines.
C. V_{ref} = 1.8 V.
Load circuit shown at front of book (for totem pole outputs).

54LS95-F,W • 74LS95-A,F

DESCRIPTION

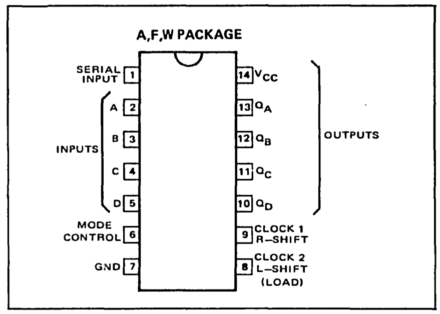
This 4-bit register features parallel and serial inputs, parallel outputs, mode control, and two clock inputs. The register has three modes of operation:

Parallel (broadside) load
Shift right (the direction Q_A toward Q_D)
Shift left (the direction Q_D toward Q_A)

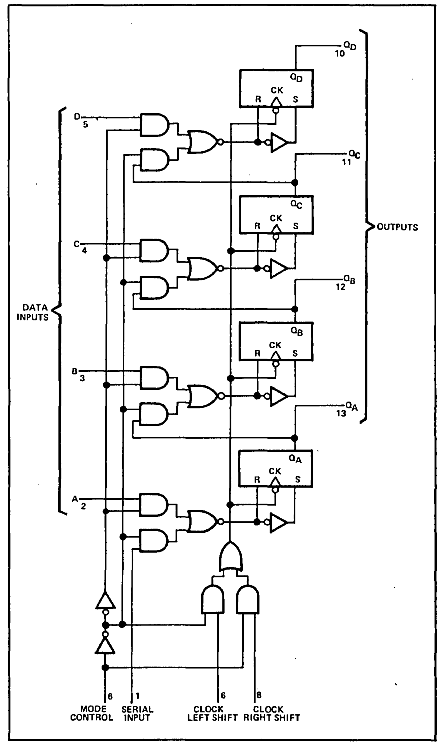
Parallel loading is accomplished by applying the four bits of data and taking the mode control input high. The data is loaded into the associated flip-flops and appears at the outputs after the high-to-low transition of the clock-2 input. During loading, the entry of serial data is inhibited.

Shift right is accomplished on the high-to-low transition of clock 1 when the mode control is low; shift left is accomplished on the high-to-low transition of clock 2 when the mode control is high by connecting the output of each flip-flop to the parallel input of the previous flip-flop (Q_D to input C, etc.) and serial data is entered at input D. The clock input may be applied commonly to clock 1 and clock 2 if both modes can be clocked from the same source. Changes at the mode control input should normally be made while both clock inputs are low; however, conditions described in the last three lines of the function table will also ensure that register contents are protected.

PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE

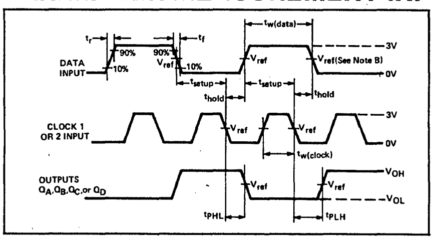
INPUTS								OUTPUTS			
MODE CONTROL	CLOCKS 2(L)	CLOCKS 1(R)	SERIAL	PARALLEL A	B	C	D	Q_A	Q_B	Q_C	Q_D
H	H	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
H	↓	X	X	a	b	c	d	a	b	c	d
H	↓	X	X	Q_B*	Q_C*	Q_D*	d	Q_{Bn}	Q_{Cn}	Q_{Dn}	d
L	L	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
L	X	↓	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}
L	X	↓	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}
↑	L	L	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↓	L	L	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↓	L	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↑	H	L	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↑	H	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}

*Shifting left requires external connection of Q_B to A, Q_C to B, and Q_D to C. Serial data is entered at input D.
H = high level (steady state), L = low level (steady state), X = irrelevant (any input, including transitions)
↓ = transition from high to low level, ↑ = transition from low to high level
a, b, c, d = the level of steady-state input at Inputs A, B, C, or D, respectively.
Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady state input conditions were established.
Q_{An}, Q_{Bn}, Q_{Cn}, Q_{Dn} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the most-recent ↓ transition of the clock.

SWITCHING CHARACTERISTICS $V_{CC} = 5V, T_A = 25°C$

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
$f_{(Clock)}$	Clock frequency	$C_L = 15pF, R_L = 2k\Omega$	25	36		MHz
$t_{w(Clock)}$	Width of clock pulse	See Figure 1	25			ns
t_{Setup}	Input setup time, high level or low level data	See Figure 1	20↓			ns
t_{Hold}	Input hold time, high level or low level data	See Figure 1	10↓			ns
$t_{Enable\ 1}$	Time to enable clock 1	See Figure 2	20↓			ns
$t_{Enable\ 2}$	Time to enable clock 2	See Figure 2	20↓			ns
$t_{Inhibit\ 1}$	Time to inhibit clock 1	See Figure 2	20↓			ns
$t_{Inhibit\ 2}$	Time to inhibit clock 2	See Figure 2	20↓			ns
t_{PLH}	Propagation delay time, low-to-high-level output from clock	See Figure 1		18	27	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock	See Figure 1		21	32	ns

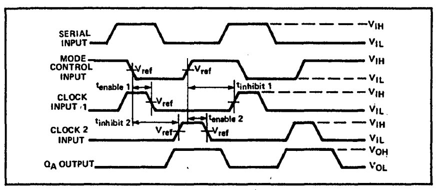
PARAMETER MEASUREMENT INFORMATION



NOTES:
A. When testing f_{Clock} vary PRR. $t_{w(Data)} \geq 20$ ns. $t_{w(Clock)} \geq 15$ ns.
B. $V_{ref} = 1.3v$

Load circuit shown at front of book (totem pole outputs).

VOLTAGE WAVEFORMS
FIGURE 1—SWITCHING TIMES



NOTES:
A. Input A is at a low level.
B. $V_{ref} = 1.3$ V.

VOLTAGE WAVEFORMS
FIGURE 2—CLOCK ENABLE/ INHIBIT TIMES

54LS96-F,W • 74LS96-B,F

DESCRIPTION

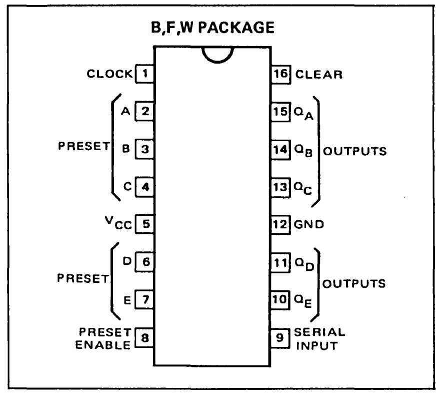
This shift register consists of five R-S master-slave flip-flops connected to perform parallel-to-serial or serial-to-parallel conversion of binary data. Since both inputs and outputs for all flip-flops are accessible, parallel-in/parallel-out or serial-in/serial-out operation may be performed.

All flip-flops are simultaneously set to a low output level by applying a low-level voltage to the clear input while the preset is inactive (low). Clearing is independent of the level of the clock input.

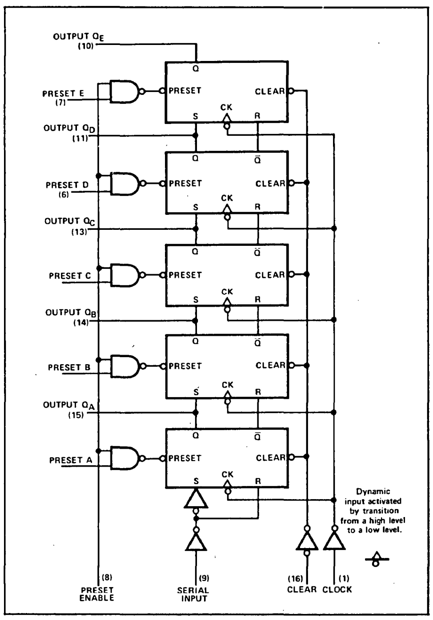
The register may be parallel loaded by using the clear input in conjunction with the preset inputs. After clearing all stages to low output levels, data to be loaded is applied to the individual preset inputs (A, B, C, D, and E) and a high-level load pulse is applied to the preset enable input. Presetting like clearing is independent of the level of the clock input.

Transfer of information to the outputs occurs on the positive-going edge of the clock pulse. The proper information must be set up at the R-S inputs of each flip-flop prior to the rising edge of the clock input waveform. The serial input provides this information to the first flip-flop, while the outputs of the subsequent flip-flops provide information for the remaining R-S inputs. The clear input must be high and the preset or preset enable inputs must be low when clocking occurs.

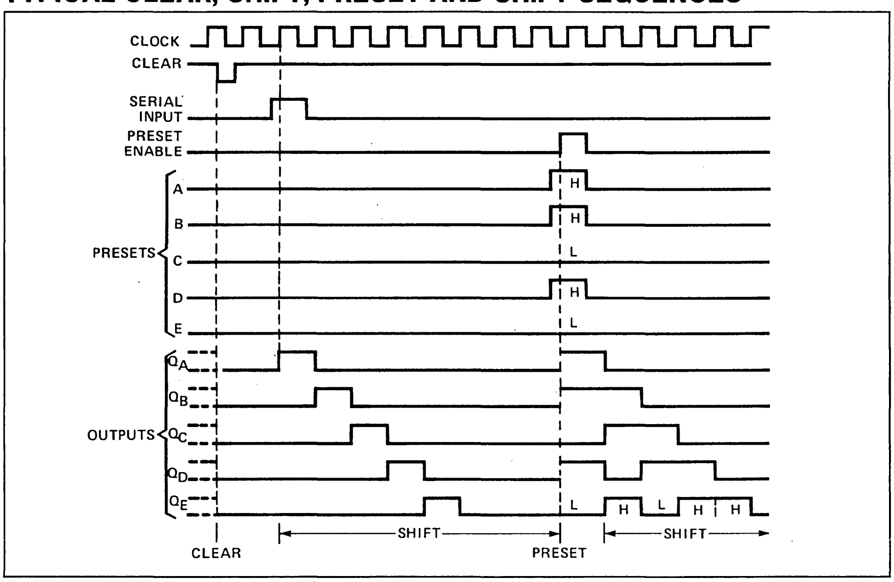
PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM



TYPICAL CLEAR, SHIFT, PRESET AND SHIFT SEQUENCES



FUNCTION TABLE

INPUTS									OUTPUTS				
		PRESET											
CLEAR	PRESET ENABLE	A	B	C	D	E	CLOCK	SERIAL	Q_A	Q_B	Q_C	Q_D	Q_E
L	L	X	X	X	X	X	X	X	L	L	L	L	L
L	X	L	L	L	L	L	X	X	L	L	L	L	L
H	H	H	H	H	H	H	X	X	H	H	H	H	H
H	H	L	L	L	L	L	L	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}	Q_{E0}
H	H	H	L	H	L	H	L	X	H	Q_{B0}	H	Q_{D0}	H
H	L	X	X	X	X	X	L	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}	Q_{E0}
H	L	X	X	X	X	X	↑	H	H	Q_{An}	Q_{Bn}	Q_{Cn}	Q_{Dn}
H	L	X	X	X	X	X	↑	L	L	Q_{An}	Q_{Bn}	Q_{Cn}	Q_{Dn}

H = high level (steady state), L = low level (steady state)
X = irrelevant (any input, including transitions)
↑ = transition from low to high level
Q_{A0}, Q_{B0}, etc = the level of Q_A, Q_B, etc, respectively before the indicated steady-state input conditions were established.
Q_{An}, Q_{Bn}, etc = the level of Q_A, Q_B, etc, respectively before the most recent ↑ transition of the clock.

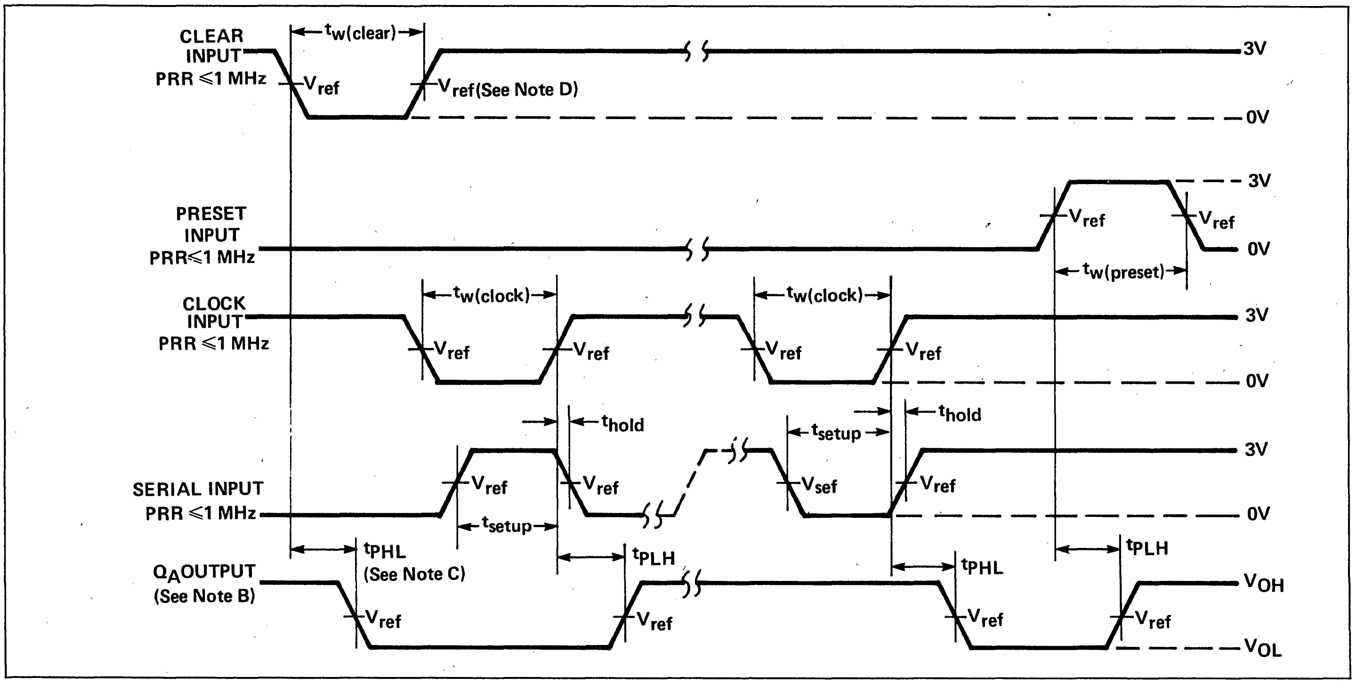
DIGITAL

Signetics

SWITCHING CHARACTERISTICS $V_{CC} = 5V, T_A = 25°C$

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency		10			MHz
$t_{w(Clock)}$	Width of clock input pulse		35			ns
t_w	Width of preset and clear input pulse		30			ns
t_{Setup}	Serial input setup time		30↑			ns
t_{Hold}	Serial input hold time	$C_L = 15pF, R_L = 2kΩ$	0↑			ns
t_{PLH}	Propagation delay time, low-to-high-level output from clock	See Figure 1		25	40	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock			25	40	ns
t_{PLH}	Propagation delay time, low-to-high-level output from preset or preset enable			28	35	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear				55	ns

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

NOTES:

A. Preset may be tested by applying a high-level voltage to the individual preset inputs and pulsing the preset enable or by applying a high-level voltage to the preset enable and pulsing the individual preset inputs.

B. Q_A output is illustrated. Relationship of serial input to other Q outputs is illustrated in the typical shift sequence.

C. Outputs are set to the high level prior to the measurement of t_{PHL} from the clear input.

D. $V_{ref} = 1.3$ V

Load circuit shown at front of book (totem pole outputs).

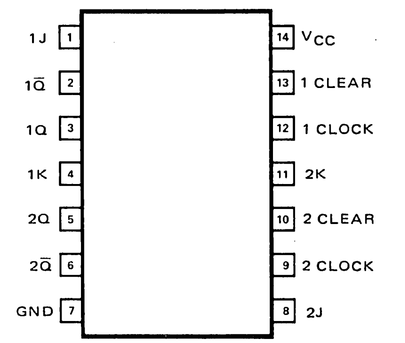
54LS107-F.W. • 74LS107-A,F

DESCRIPTION

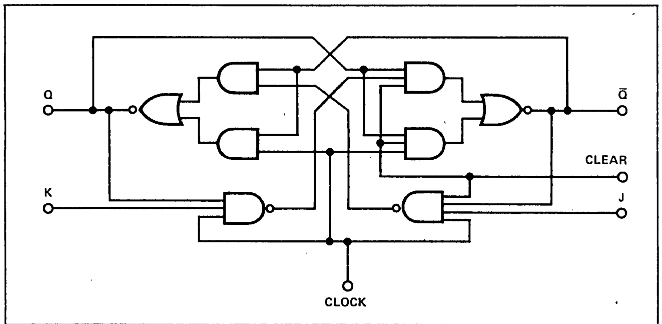
A low logic level at the clear input resets the Q output to a low level regardless of the levels at the other inputs. With clear inactive (high), a high level at the clock input enables the J and K inputs and data will be accepted. The logic levels at the J and K inputs may be allowed to change when the clock pulse is high and the bistable will perform according to the function table, as long as minimum setup and hold times are observed. Input data is transferred to the outputs on the negative-going edge of the clock pulse.

PIN CONFIGURATION

A,F,W PACKAGE



LOGIC DIAGRAM



FUNCTION TABLE (Each Flip-Flop)

INPUTS				OUTPUTS	
CLEAR	CLOCK	J	K	Q	$\bar{Q}$
L	X	X	X	L	H
H	↓	L	L	Q_0	$\bar{Q}_0$
H	↓	H	L	H	L
H	↓	L	H	L	H
H	↓	H	H	TOGGLE	
H	H	X	X	Q_0	$\bar{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↓ = transition from high to low level
Q_0 = the level of Q before the indicated input conditions were established.
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.

SWITCHING CHARACTERISTICS $V_{CC} = 5V, T_A = 25°C$

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency		30	45		MHz
$t_{w(Clock)}$	Width of clock pulse (high)		20			ns
$t_{w(Clear)}$	Width of clear pulse (low)					ns
t_{Setup}	Input setup time	$C_L = 15pF, R_L = 2k\Omega$	25			ns
			20↓			
t_{Hold}	Input hold time		0↓			ns
t_{PLH}	Propagation delay time, low-to-high-level output from clear or clock (as appropriate)			11	20	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear or clock (as appropriate)			15	30	ns

Load circuit and typical waveforms are shown at the front of book.

DUAL J-$\overline{K}$ POSITIVE EDGE-TRIGGERED FLIP-FLOP — 54/74LS109

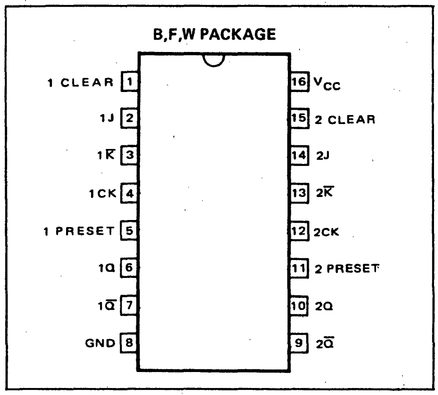
54LS109-F,W • 74LS109-B,F

DESCRIPTION

A low level at preset or clear sets or resets the outputs regardless of the levels of the other inputs. When preset and clear are inactive (high), data at the J and $\overline{K}$ inputs meeting the setup time requirements are transferred to the outputs on the positive-going edge of the clock pulse. Clock triggering occurs at a voltage level of the clock pulse and is not directly related to the transition time of the positive-going pulse. Following the hold time interval, data at the J and $\overline{K}$ inputs may be changed without affecting the levels at the outputs.

The J and $\overline{K}$ data inputs simplify hardware design as a D-type flip-flop can be implemented by simply tying the J and $\overline{K}$ inputs together.

PIN CONFIGURATION



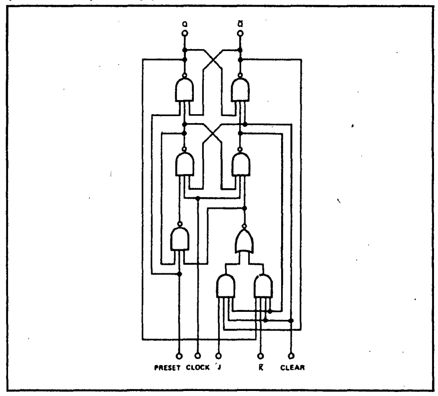
FUNCTION TABLE (Each Flip-Flop)

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	$\overline{K}$	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↑	L	L	L	H
H	H	↑	H	L	TOGGLE	
H	H	↑	L	H	Q_0	$\overline{Q}_0$
H	H	↑	H	H	H	L
H	H	L	X	X	Q_0	$\overline{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↑ = transition from low to high level
Q_0 = the level of Q before the indicated steady-state input conditions were established
TOGGLE: Each output changes to the complement of its previous elevel on each ↑ clock transition.
*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

FUNCTIONAL BLOCK DIAGRAM

(Each Flip-Flop)



SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency		25	33		MHz
$t_{w(Clock)}$	Width of clock pulse (high)		25			ns
$t_{w(Preset)}$	Width of preset pulse		25			ns
$t_{w(Clear)}$	Width of clear pulse		25			ns
t_{Setup}	Input setup time	$C_L = 15pF$, $R_L = 2k\Omega$	20↑			ns
t_{Hold}	Input hold time		5↑			ns
t_{PLH}	Propagation delay time, low-to-high-level output from clear, preset or clock (as appropriate)			8	25	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear, preset or clock (as appropriate)			16	40	ns

Load circuit and typical waveforms are shown at the front of this section.

DUAL J-K NEGATIVE EDGE-TRIGGERED FLIP-FLOP 54/74LS112

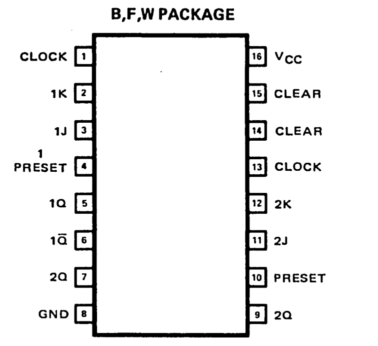
(Separate clock, preset and clear inputs)

54LS112-F,W • 74LS112-B,F

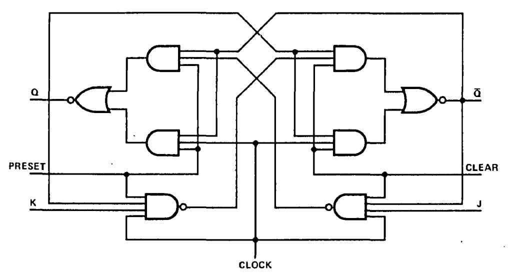
DESCRIPTION

The preset or clear inputs, when low, set or reset the outputs regardless of the levels at the other inputs. When preset and clear inputs are inactive (high), a high level at the clock input enables the J and K inputs and data will be accepted. The logic levels at the J and K inputs may be allowed to change when the clock pulse is high and the bistable will perform according to the function table as long as minimum setup and hold times are observed. Input data is transferred to the outputs on the negative-going edge of the clock pulse.

PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM



FUNCTIONAL TABLE (Each Flip-Flop)

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	K	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↓	L	L	Q_0	$\overline{Q}_0$
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	TOGGLE	
H	H	H	X	X	Q_0	$\overline{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.
*This configuration is nonstable, that is, it will not persist when preset and clear inputs return to their inactive (high) level.

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency	C_L = 15pF, R_L = 2kΩ	30	45		MHz
$t_{w(Clock)}$	Width of clock pulse		20			ns
$t_{w(Preset)}$	Width of preset pulse		25			ns
$t_{w(Clear)}$	Width of clear pulse		25			ns
t_{Setup}	Input setup time		20↓			ns
t_{Hold}	Input hold time		0↓			ns
t_{PLH}	Propagation delay time, low-to-high -level output from clear, preset or clock (as appropriate)			11	20	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear, preset or clock (as appropriate)			15	30	ns

Load circuit and typical waveforms are shown at the front of book.

DUAL J-K NEGATIVE EDGE-TRIGGERED FLIP-FLOP — 54/74LS113

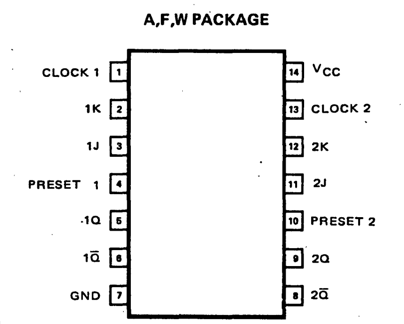
(Separate clock and preset inputs)

54LS113-F,W • 74LS113-A,F

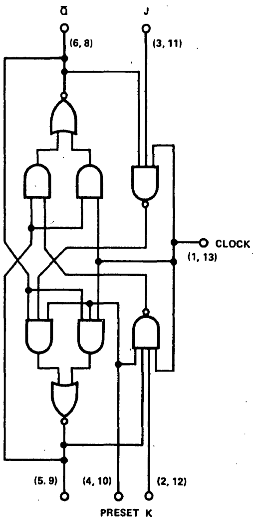
DESCRIPTION

A low level at the preset input sets the Q output high regardless of the levels at the other inputs. When preset is inactive (high), a high level at the clock input enables the J and K inputs and data will be accepted. The logic levels at the J and K inputs may be allowed to change when the clock pulse is high and the bistable will perform according to the function table as long as minimum setup and hold times are observed. Input data is transferred to the outputs on the negative-going edge of the clock pulse.

PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM (Each Flip-Flop)



FUNCTION TABLE (Each Flip-Flop)

INPUTS				OUTPUTS	
PRESET	CLOCK	J	K	Q	$\overline{Q}$
L	X	X	X	H	L
H	↓	L	L	Q_0	$\overline{Q}_0$
H	↓	H	L	H	L
H	↓	L	H	L	H
H	↓	H	H	TOGGLE	
H	H	X	X	Q_0	$\overline{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established
TOGGLE: Each output changes to the complement of its previous level of each ↓ clock transition.

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency	$C_L = 15pF$, $R_L = 2k\Omega$	30	45		MHz
$t_{w(Clock)}$	Width of clock pulse		20			ns
$t_{w(Preset)}$	Width of preset pulse		25			ns
t_{Setup}	Input setup time		20↓			ns
t_{Hold}	Input hold time		0↓			ns
t_{PLH}	Propagation delay time, low-to-high-level output from preset or clock (as appropriate)			11	20	ns
t_{PHL}	Propagation delay time, high-to-low-level output from preset or clock (as appropriate)			15	30	ns

Load circuit and waveforms are shown at the front of book.

DUAL J-K NEGATIVE EDGE-TRIGGERED FLIP-FLOP — 54/74LS114

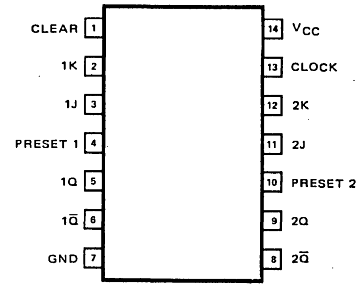
(Separate preset, common clock and clear)

54LS114-F,W • 74LS114-A,F

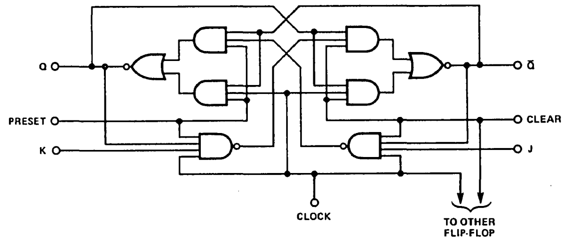
DESCRIPTION

The preset or clear inputs, when low, set or reset the outputs regardless of the levels at the other inputs. When preset and clear inputs are inactive (high), a high level at the clock input enables the J and K inputs and data will be accepted. The logic levels at the J and K inputs may be allowed to change when the clock pulse is high and the bistable will perform according to the function table as long as minimum setup and hold times are observed. Input data is transferred to the outputs on the negative-going edge of the clock pulse.

PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM (Each Flip-Flop)



FUNCTION TABLE (Each Flip-Flop)

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	K	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↓	L	L	Q_0	$\overline{Q_0}$
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	TOGGLE	
H	H	H	X	X	Q_0	$\overline{Q_0}$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established
TOGGLE: = Each output changes to the complement of its previous level on each ↓ clock transition.
*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
$f_{(Clock)}$	Clock frequency	C_L=15pF, R_L=2kΩ	30	45		MHz
$t_{w(Clock)}$	Width of clock pulse		20			ns
$t_{w(Preset)}$	Width of preset pulse		25			ns
$t_{w(Clear)}$	Width of clear pulse		20			ns
t_{Setup}	Input setup time		20↓			ns
f_{Hold}	Input hold time		0↓			ns
t_{PLH}	Propagation delay time, low-to-high-level output from clear, preset or clock (as appropriate)			11	20	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear, preset or clock (as appropriate)			15	30	ns

Load circuit and typical waveforms are shown at the front of this section.

QUAD 2-INPUT NAND SCHMITT TRIGGER 54/74LS132

54LS132-F,W • 74LS132-A,F

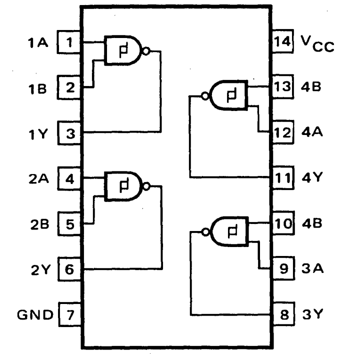
DESCRIPTION

Each circuit functions as a NAND gate, but because of the Schmitt action, it has different input threshold levels for positive- and negative-going signals. The hysteresis or backlash, which is the difference between the two threshold levels, is typically 800 millivolts.

These circuits are temperature compensated and can be triggered from the slowest of input ramps and still give clean, jitter-free output signals.

PIN CONFIGURATION

A,F,W PACKAGE

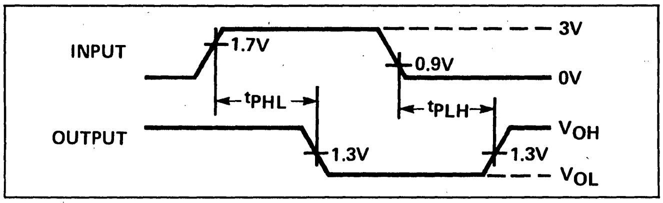


positive logic: $Y=\overline{AB}$

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER	TEST CONDITIONS	LIMITS			
		MIN	TYP	MAX	UNIT
t_{PLH} Propagation delay time, low-to-high-level output	C_L = 15pF, R_L = 2kΩ		15	22	ns
t_{PHL} Propagation delay time, high-to-low-level output			15	22	ns

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

NOTES:
A. The input waveform is supplied by a generator with the following characteristics: Z_{out} = 50 Ω and PRR ≤ 1 MHz, t_r ≤ 15 ns, t_f ≤ 6 ns.

Load circuit and waveforms are shown at the front of book.

QUAD EXCLUSIVE-OR GATE WITH OPEN COLLECTOR OUTPUTS 54/74LS136

54LS136 F,W • 74LS136 A,F

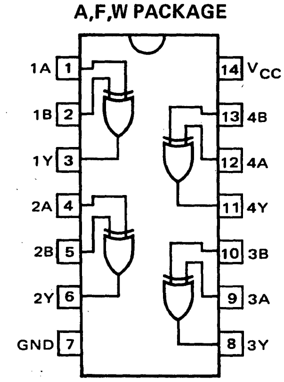
SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER★	FROM (INPUT)	TEST CONDITIONS		LIMITS			
				MIN	TYP	MAX	UNIT
t_{PLH}	A or B	Other input low	C_L = 15pF,		18	30	ns
t_{PHL}			R_L = 2kΩ		18	30	
t_{PLH}	A or B	Other input high			18	30	ns
t_{PHL}					18	30	

★t_{PLH} = propagation delay time, low-to-high level output
t_{PHL} = propagation delay time, high-to-low-level output
Load circuit and typical waveforms shown in front of book.

PIN CONFIGURATION

A,F,W PACKAGE



positive logic: $Y=A\oplus B=\overline{A}B+A\overline{B}$

FUNCTION TABLE

INPUTS		OUTPUT
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	L

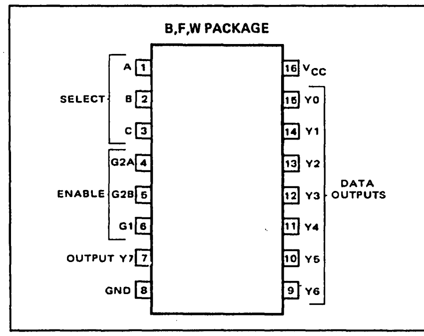
H = high level, L = low level

54LS138-F,W • 74LS138-B,F

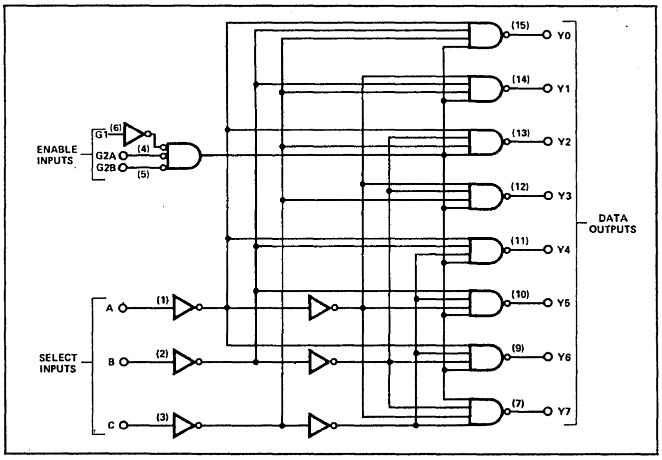
DESCRIPTION

The S54LS138 and N74LS138 decode one-of-eight lines dependent on the conditions at the three binary select inputs and the three enable inputs. Two active-low and one active-high enable inputs reduce the need for external gates or inverters when expanding. A 24-line decoder can be implemented without external inverters and a 32-line decoder requires only one inverter. An enable input can be used as a data input for demultiplexing applications. Typical delay time through the three-level address circuitry is 22 nanoseconds. Typical power dissipation is 32 milliwatts.

PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE

INPUTS					OUTPUTS							
ENABLE		SELECT										
G1	G2*	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	H	H	H	H	H	L	H	H	H	H
H	L	H	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	H	L	H	H
H	L	H	H	L	H	H	H	H	H	H	L	H
H	L	H	H	H	H	H	H	H	H	H	H	L

*G2 = G2A + G2B
H = high level, L = low level, X = irrelevant

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER[1]	FROM (INPUT)	TO (OUTPUT)	LEVELS OF DELAY	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	Binary Select	Any	2	C_L = 15pF, R_L = 2kΩ		14	20	ns
t_{PHL}						20	41	ns
t_{PLH}			3			18	27	ns
t_{PHL}						20	39	ns
t_{PLH}	Enable	Any	2			17	18	ns
t_{PHL}						15	32	ns
t_{PLH}			3			21	26	ns
t_{PHL}						19	28	ns

1 t_{PLH} = propagation delay time, low-to-high-level output; t_{PHL} = propagation delay time, high-to-low-level output.
Load circuit and typical waveforms are shown at the front of book.

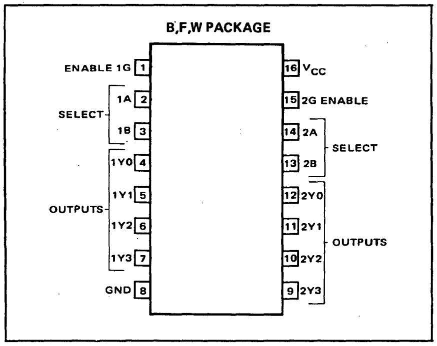
DUAL 2-TO-4 LINE DECODER/DEMULTIPLEXER 54/74LS139

54LS139-F,W • 74LS139-B,F

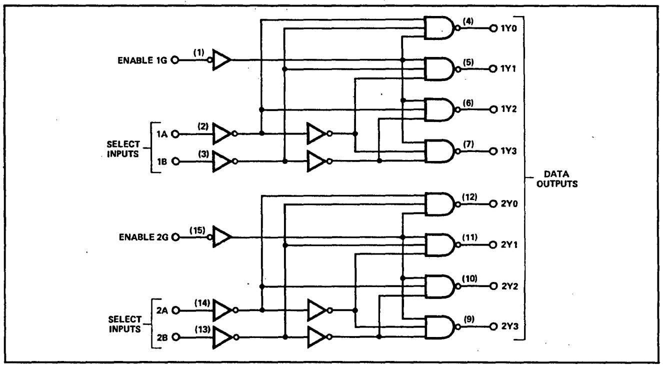
DESCRIPTION

The S54LS139 and N74LS139 comprise two individual two-line-to-four-line decoders in a single package. The active-low enable input can be used as a data line in demultiplexing applications. Typical total delay time is 22 nanoseconds through the three-gate-level address circuitry and power consumption is typically 34 milliwatts total.

PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE (Each Decoder/Demultiplexer)

INPUTS			OUTPUTS			
ENABLE	SELECT					
G	B	A	Y0	Y1	Y2	Y3
H	X	X	H	H	H	H
L	L	L	L	H	H	H
L	L	H	H	L	H	H
L	H	L	H	H	L	H
L	H	H	H	H	H	L

H=high level, L=low level, X=irrelevant

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER[1]	FROM (INPUT)	TO (OUTPUT)	LEVELS OF DELAY	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	Binary Select	Any	2	$C_L = 15pF$, $R_L = 2k\Omega$		13	20	ns
t_{PHL}						22	33	ns
t_{PLH}			3			18	29	ns
t_{PHL}						25	38	ns
t_{PLH}	Enable	Any	2			16	24	ns
t_{PHL}						21	32	ns

[1]t_{PLH} = propagation delay time, low-to-high-level output; t_{PHL} = propagation delay time, high-to-low-level output.
Load circuit and typical waveforms are shown at the front of book.

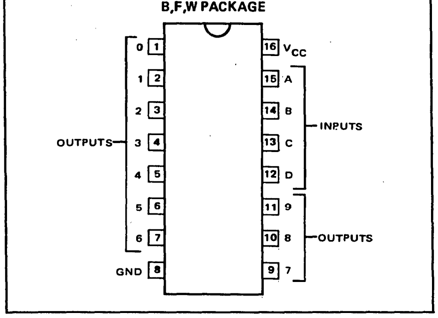
BCD-TO-DECIMAL DECODER/DRIVER 54/74LS145

54LS145-F,W • 74LS145-B,F

DESCRIPTION

This monilithic BCD-to-decimal decoder/driver consists of eight inverters and ten four-input NAND gates. The inverters are connected in pairs to make BCD input data available for decoding by the NAND gates. Full decoding of valid BCD input logic ensures that all outputs remain off for all invalid binary input conditions. This decoder features high-performance, n-p-n output transistors designed for use as indicator/relay drivers or as open-collector logic-circuit drivers. Each of the high-breakdown output transistors (15 volts) will sink up to 80 milliamperes of current. Each input is one standard load. Inputs and outputs are entirely compatible for use with TTL or DTL logic circuits, and the outputs are compatible for interfacing with most MOS integrated circuits. Power dissipation is typically 35 milliwatts.

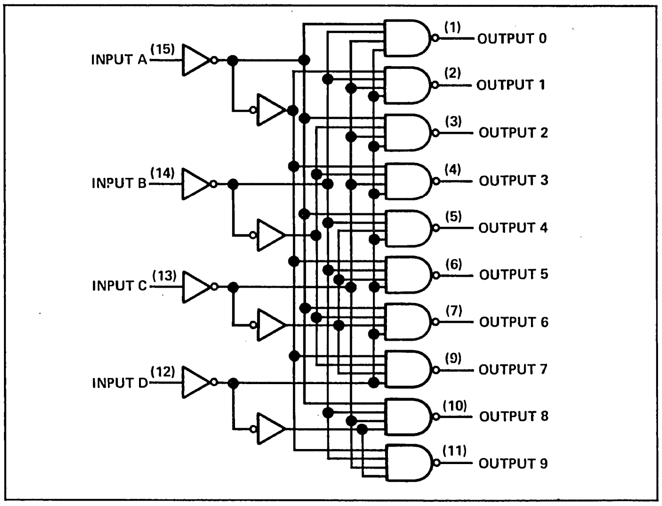
PIN CONFIGURATION



BCD-TO-DECIMAL DECODER/DRIVER 54/74LS145

54S145-F,W • 74LS145-B,F

FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE

NO.	INPUTS				OUTPUTS									
	D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	L	L	L	L	L	H	H	H	H	H	H	H	H	H
1	L	L	L	H	H	L	H	H	H	H	H	H	H	H
2	L	L	H	L	H	H	L	H	H	H	H	H	H	H
3	L	L	H	H	H	H	H	L	H	H	H	H	H	H
4	L	H	L	L	H	H	H	H	L	H	H	H	H	H
5	L	H	L	H	H	H	H	H	H	L	H	H	H	H
6	L	H	H	L	H	H	H	H	H	H	L	H	H	H
7	L	H	H	H	H	H	H	H	H	H	H	L	H	H
8	H	L	L	L	H	H	H	H	H	H	H	H	L	H
9	H	L	L	H	H	H	H	H	H	H	H	H	H	L
INVALID	H	L	H	L	H	H	H	H	H	H	H	H	H	H
	H	L	H	H	H	H	H	H	H	H	H	H	H	H
	H	H	L	L	H	H	H	H	H	H	H	H	H	H
	H	H	L	H	H	H	H	H	H	H	H	H	H	H
	H	H	H	L	H	H	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H	H	H	H	H	H	H

H = high level, (off), L = low level (on)

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

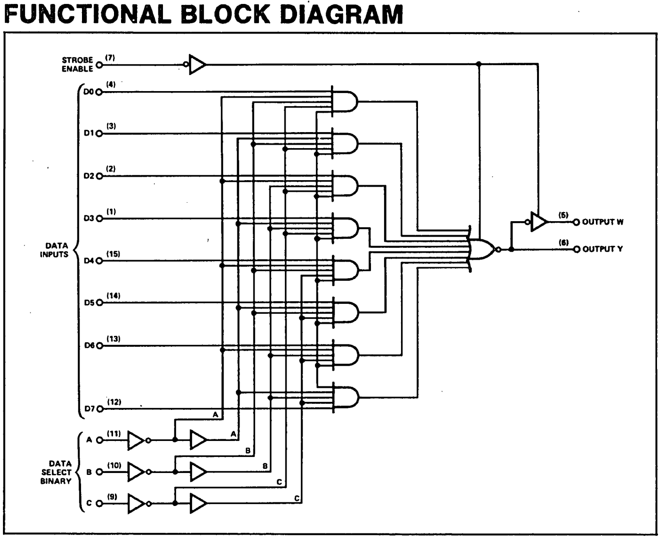
PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low-to-high-level output	C_L = 45pF, R_L = 665 Ω			50	ns
t_{PHL}	Propagation delay time, high-to-low-level output				50	ns

Load circuit and waveforms are shown at front of book.

8-LINE TO 1-LINE DATA SELECTOR/MULTIPLEXER 54/74LS151

54LS151-F,W • 74LS151-B,F

FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE

INPUTS				OUTPUTS	
SELECT			STROBE		
C	B	A	S	Y	W
X	X	X	H	L	H
L	L	L	L	D0	$\overline{D0}$
L	L	H	L	D1	$\overline{D1}$
L	H	L	L	D2	$\overline{D2}$
L	H	H	L	D3	$\overline{D3}$
H	L	L	L	D4	$\overline{D4}$
H	L	H	L	D5	$\overline{D5}$
H	H	L	L	D6	$\overline{D6}$
H	H	H	L	D7	$\overline{D7}$

H = high level, L = low level, X = irrelevant
$\overline{E0}$, $\overline{E1}$ . . . $\overline{E15}$ = the complement of the level of the respective E input
D0, D1 . . . D7 = the level of the D respective input

8-LINE TO 1-LINE DATA SELECTOR/MULTIPLEXER 54/74LS151

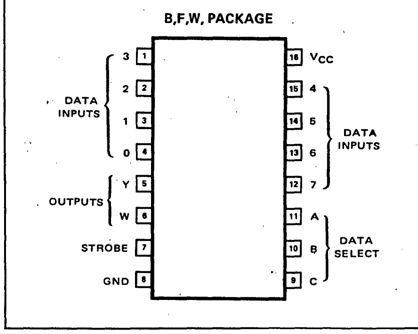
54LS151-F,W • 74LS151-B,F

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER[1]	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	A, B, or C	Y	$C_L = 15pF$, $R_L = 2k\Omega$		27	43	ns
t_{PHL}	(4 levels)				31	50	
t_{PLH}	A, B, or C	W			24	39	ns
t_{PHL}	(3 levels)				20	32	
t_{PLH}	Strobe	Y			23	37	ns
t_{PHL}					25	42	
t_{PLH}	Strobe	W			19	31	ns
t_{PHL}					16	26	
t_{PLH}	Any D	Y			16	26	ns
t_{PHL}					20	32	
t_{PLH}	Any D	W			13	21	ns
t_{PHL}					9	15	

[1] t_{PLH} = Propagation delay time, low-to-high-level output
t_{PHL} = Propagation delay time, high-to-low-level output
Load circuit and typical waveforms are shown at front of book.

PIN CONFIGURATION



DUAL 4-LINE TO 1-LINE MULTIPLEXER 54/74LS153

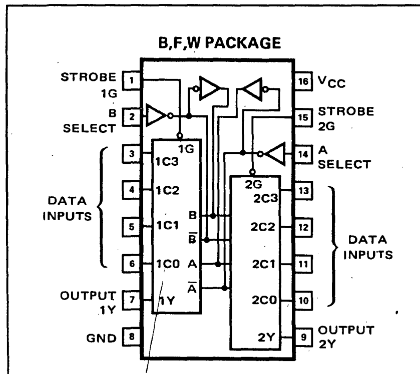
54LS153-F,W • 74LS153-B,F

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER[1]	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MIN	UNIT
t_{PLH}	Data	Y	$C_L = 15pF$, $R_L = 2k\Omega$		10	15	ns
t_{PHL}	Data	Y			17	26	ns
t_{PLH}	Select	Y			19	29	ns
t_{PHL}	Select	Y			25	38	ns
t_{PLH}	Strobe	Y			16	24	ns
t_{PHL}	Strobe	Y			21	32	ns

[1] t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
Load circuit and typical waveforms are shown at the front of book.

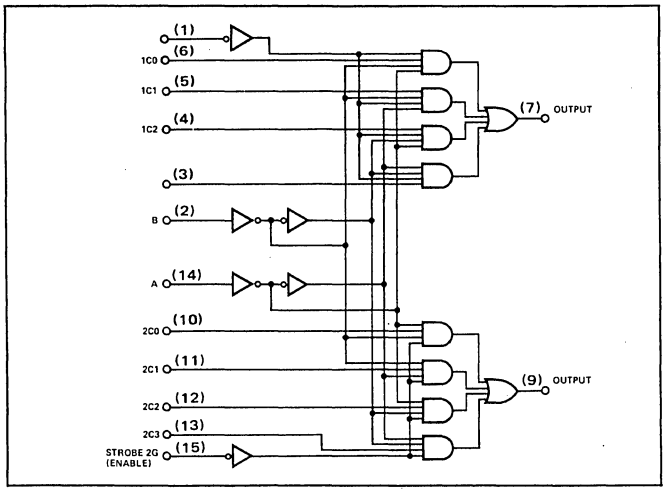
PIN CONFIGURATION



DUAL 4-LINE TO 1-LINE MULTIPLEXER 54/74LS153

54LS153-F,W • 74LS153-B,F

FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE

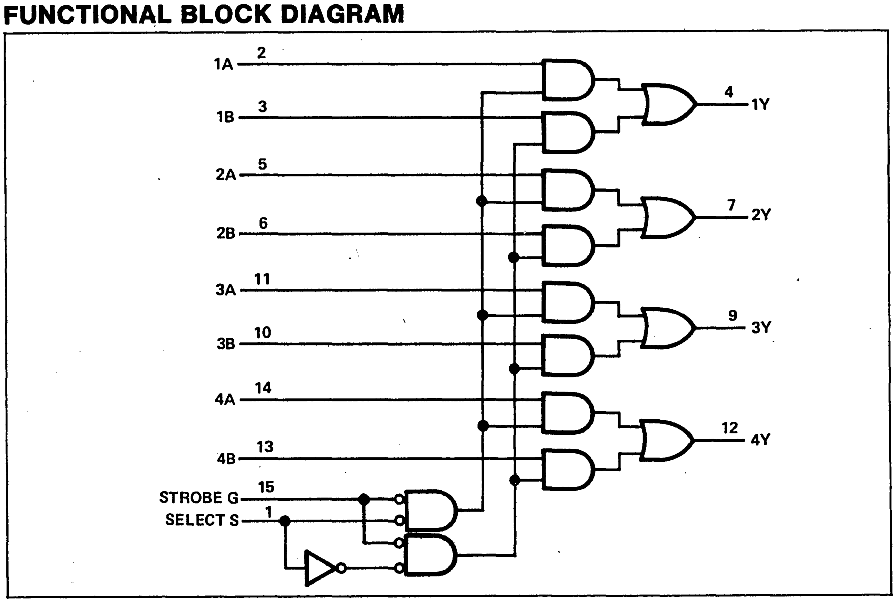
SELECT INPUTS		DATA INPUTS				STROBE	OUTPUT
B	A	C0	C1	C2	C3	G	Y
X	X	X	X	X	X	H	L
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

Select inputs A and B are common to both sections.
H = high level, L = low level, X = irrelevant

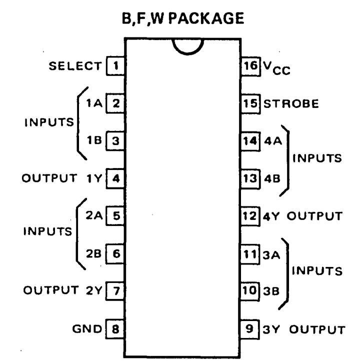
QUAD 2-LINE TO 1-LINE DATA SELECTOR/MULTIPLEXER (NON-INV.) 54/74LS157

54LS157-F,W • 74LS157-B,F

FUNCTIONAL BLOCK DIAGRAM



PIN CONFIGURATION



positive logic: low level at S selects A inputs
high level at S selects B inputs

FUNCTION TABLE

INPUTS				OUTPUT Y
STROBE	SELECT	A	B	
H	X	X	X	L
L	L	L	X	L
L	L	H	X	H
L	H	X	L	L
L	H	X	H	H

H = high level, L = low level, X = irrelevant

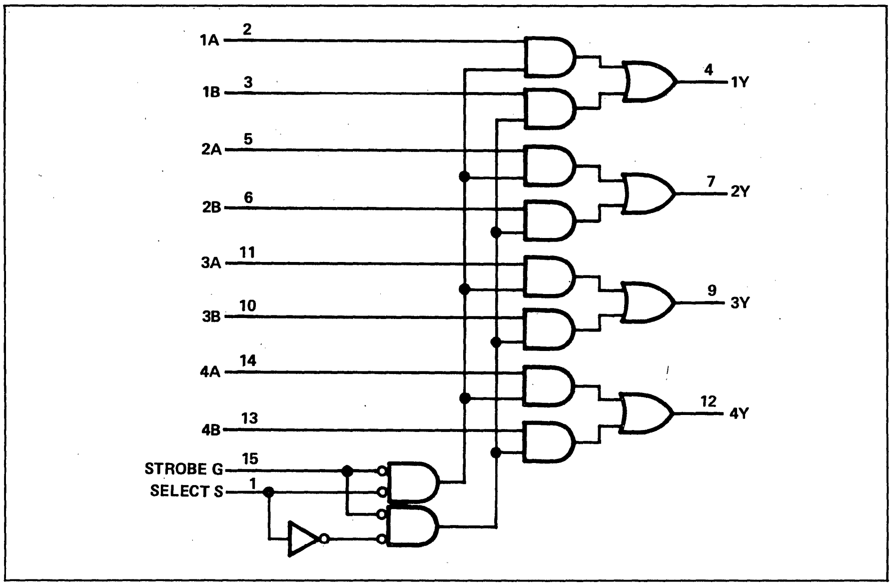
SWITCHING CHARACTERISTICS $V_{CC} = 5V, T_A = 25°C$

PARAMETER★	FROM (INPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	Data	$C_L = 15pF$, $R_L = 2k\Omega$,		9	14	ns
t_{PHL}				12	19	
t_{PLH}	Strobe			16	25	ns
t_{PHL}				17	27	
t_{PLH}	Select			16.5	26	ns
t_{PHL}				19	30	

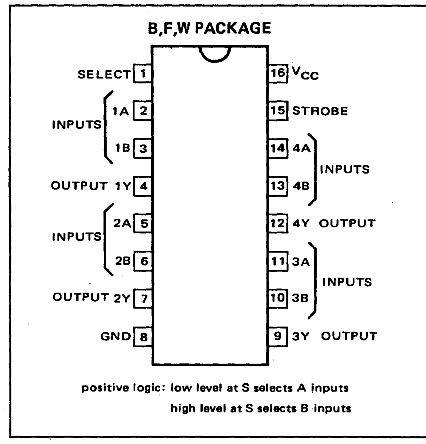
★t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
Load circuit and waveforms are shown in front of book.

54LS158-F,W • 74LS158-B,F

BLOCK DIAGRAM



PIN CONFIGURATION



SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER★	FROM (INPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	Data	$C_L = 15pF$, $R_L = 2k\Omega$		8	13	ns
t_{PHL}				8	13	
t_{PLH}	Strobe			14	25	ns
t_{PHL}				16	27	
t_{PLH}	Select			13	20	ns
t_{PHL}				16	24	

★t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
Load circuits and waveforms are shown at the front of the book.

FUNCTION TABLE

INPUTS				OUTPUT Y
STROBE	SELECT	A	B	
H	X	X	X	H
L	L	L	X	H
L	L	H	X	L
L	H	X	L	H
L	H	X	H	L

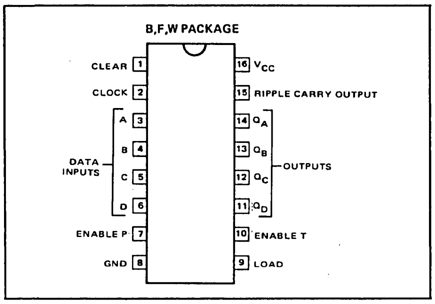
H = high level, L = low level, X = irrelevant

54LS160-F,W • 74LS160-B,F

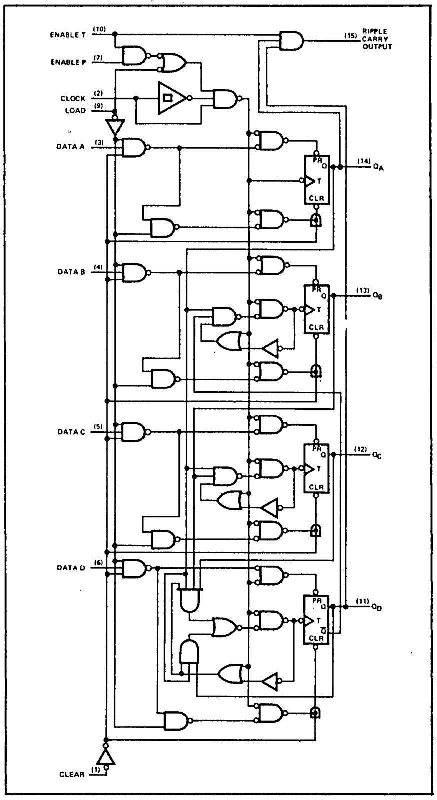
DESCRIPTION

This synchronous presettable decade counter features an internal carry look-ahead for applications in high-speed counting designs. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple clock) counters. A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveform.

PIN CONFIGURATION



BLOCK DIAGRAM



This counter is fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable inputs. The clear function for the 54/74LS160 is asynchronous and a low level at the clear input sets all four of the flip-flop outputs low regardless of the levels of clock, load or enable inputs.

The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Instrumental in accomplishing this function are two count-enable inputs and a ripple carry output. Both count-enable inputs (P and T) must be high to count, and input T is fed forward to enable the ripple carry output. The ripple carry output thus enabled will produce a high-level output pulse with a duration approximately equal to the high-level portion of the Q_A output. This high-level overflow ripple carry pulse can be used to enable successive cascaded stages. Transitions at the enable P or T inputs are allowed regardless of the level of the clock input.

The 54/74LS160 features a fully independent clock circuit. Changes made to control inputs (enable P or T, load or clear) that will modify the operating mode have no effect until clocking occurs. The function of the counter (whether enabled, disabled, loading or counting) will be dictated solely by the conditions meeting the stable setup and hold times.

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER★		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Clock}					25	32		MHz
$t_{w(Clock)}$	Width of clock pulse				25			ns
$t_{w(Clear)}$	Width of clear pulse			$C_L = 15pF$, $R_L = 2k\Omega$	20			ns
t_{Setup}	Input setup time	A,B,C,D	Q	See Figures	0↑			
		Enable Port	Q	1 and 2 and	20↑			
		Load	Q	Note 1	20↑			ns
t_{Hold}	Input hold time							ns
		A,B,C,D			25↑[2]			
		Others			10↑[2]			ns
t_{PLH} t_{PHL}		Clock	Ripple carry			23 23	35 35	ns
t_{PLH} t_{PHL}		Clock (load input high)	Any Q			16 18	24 27	ns
t_{PLH} t_{PHL}		Clock (load input low)	Any Q			17 19	25 29	ns
t_{PLH} t_{PHL}		Enable T	Ripple carry			15 15	23 23	ns
t_{PHL}		Clear	Any Q			26	38	ns

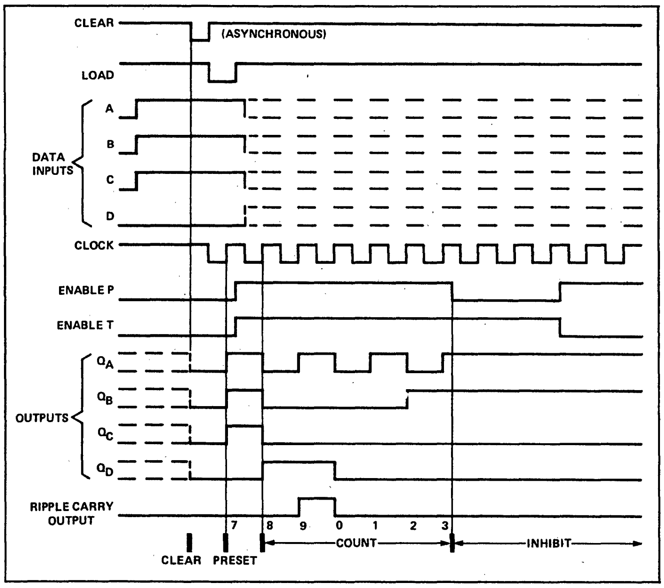
★f_{max} = Maximum clock frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

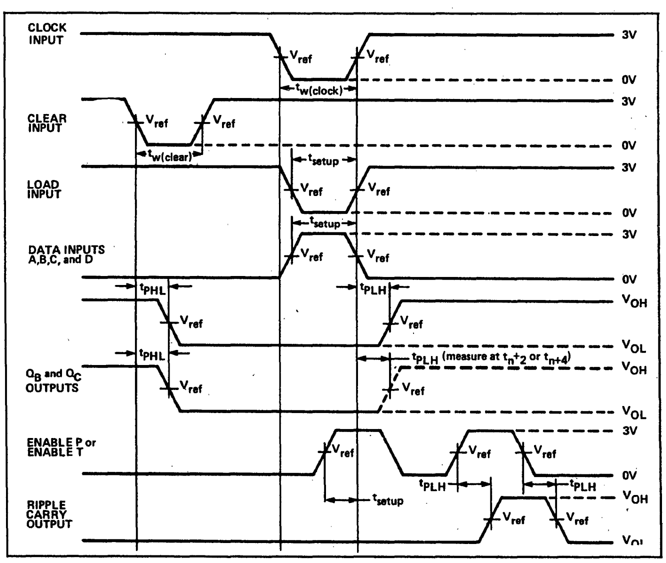
NOTES:
1. Propagation delay for clearing is measured from the clear input.
2. The minimum hold time is as specified or as long as the clock input takes to rise from 0.8V. to 2.0V., whichever is longer.

PARAMETER MEASUREMENT INFORMATION

TYPICAL CLEAR, PRESET, COUNT AND INHIBIT SEQUENCES

Illustrated below is the following sequence:
1. Clear outputs to zero
2. Preset to BCD seven
3. Count to eight, nine, zero, one, two, and three
4. Inhibit





VOLTAGE WAVEFORMS

NOTES:

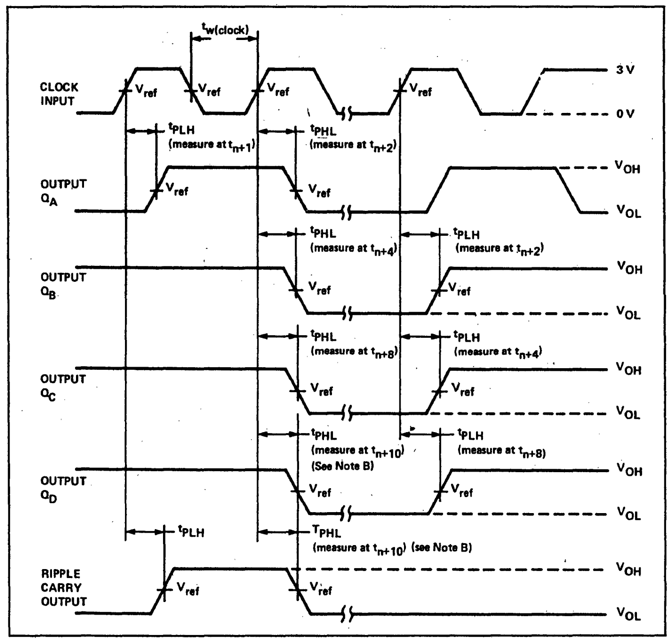
A. The input pulses are supplied by generators having the following characteristics. PRR ≤ 1MHz, duty cycle ≤ 50%, $Z_{out} \approx 50\Omega$, $t_r \leq 15ns$, $t_f \leq 6ns$.

B. Enable P and enable T setup times are measured at t_{N+0}

C. $V_{ref} = 1.3V$.

Load circuit is shown at front of book (totem pole outputs).

FIGURE 2—SWITCHING TIMES



VOLTAGE WAVEFORMS

NOTES:

A. The input pulses are supplied by a generator having the following characteristics: PRR ≤ 1MHz, duty cycle ≤ 50%, $Z_{out} \approx 50\Omega$ $t_r \leq 15ns$, $t_f \leq 6ns$.

B. Outputs Q_D and carry are tested at t_n+10, where t_n is the bit time when all outputs are low.

C. $V_{ref} = 1.3V$.

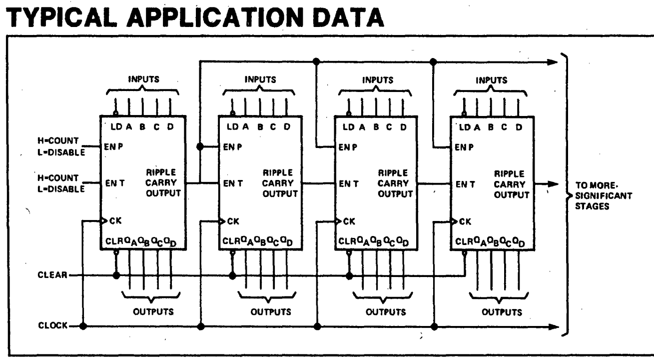
Load circuit is shown at front of book (totem pole outputs).

FIGURE 1—SWITCHING TIMES

N-BIT SYNCHRONOUS COUNTERS

This application demonstrates how the look-ahead carry circuit can be used to implement a high-speed n-bit counter. The 54/74LS160 will count in BCD. Virtually any count mode (modulo-N, N_1-toN_2, N_1-to-maximum) can be used with this fast look-ahead circuit.

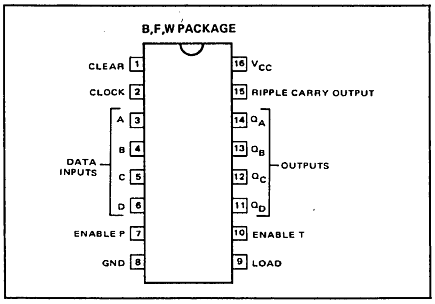
TYPICAL APPLICATION DATA



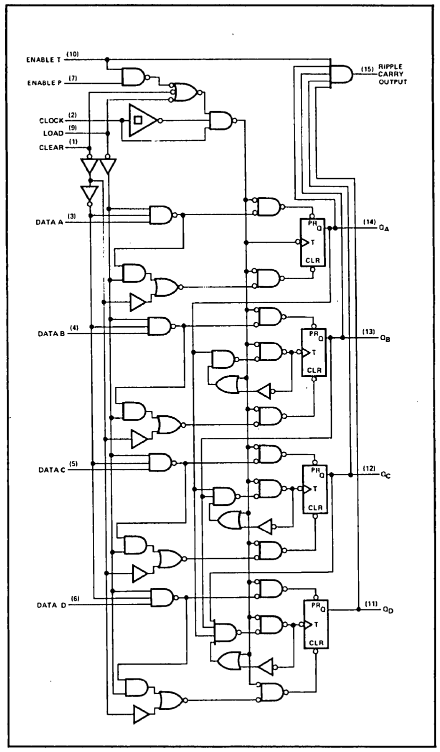
DESCRIPTION

This synchronous presettable binary counter features an internal carry look-ahead for applications in high-speed counting designs. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple clock) counters. A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveform.

PIN CONFIGURATION



BLOCK DIAGRAM



This counter is fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable inputs. The clear function for the 54/74LS161 is asynchronous and a low level at the clear input sets all four of the flip-flop outputs low regardless of the levels of clock, load or enable inputs.

The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Instrumental in accomplishing this function are two count-enable inputs and a ripple carry output. Both count-enable inputs (P and T) must be high to count, and input T is fed forward to enable the ripple carry output. The ripple carry output thus enabled will produce a high-level output pulse with a duration approximately equal to the high-level portion of the Q_A output. This high-level overflow ripple carry pulse can be used to enable successive cascaded stages. Transitions at the enable P or T inputs are allowed regardless of the level of the clock input.

The 54/74LS161 features a fully independent clock circuit. Changes made to control inputs (enable P or T, load or clear) that will modify the operating mode have no effect until clocking occurs. The function of the counter (whether enabled, disabled, loading or counting) will be dictated solely by the conditions meeting the stable setup and hold times.

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER★		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Clock}				$C_L = 15pF$,	25	32		MHz
$t_{w (Clock)}$	Width of clock pulse			$R_L = 2k\Omega$,	25			ns
$t_{w (Clear)}$	Width of clear pulse			See Figures	20			ns
t_{Setup}	Input setup time	A,B,C,D	Q	1 and 2 and	0↑			
		Enable P or T	Q	Note 1	20↑			
		Load	Q		20↑			ns
t_{Hold}	Input hold time	A,B,C,D			25↑[2]			ns
		Others			10↑[2]			ns
t_{PLH} t_{PHL}		Clock	Ripple carry			23 23	35 35	ns
t_{PLH} t_{PHL}		Clock (load input high)	Any Q			16 18	24 27	ns
t_{PLH} t_{PHL}		Clock (load input low)	Any Q			17 19	25 29	ns
t_{PLH} t_{PHL}		Enable T	Ripple carry			15 15	23 23	ns
t_{PHL}		Clear	Any Q			26	38	ns

★ f_{max} = Maximum clock frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

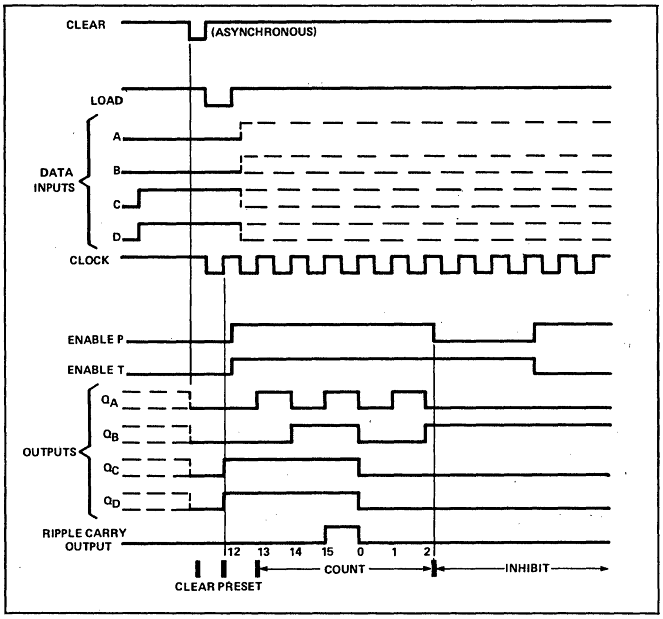
NOTES:
1. Propagation delay for clearing is measured from the clear input,
2. The minimum hold time is as specified or as long as the clock input takes to rise from 0.8V. to 2.0V., whichever is longer.

PARAMETER MEASUREMENT INFORMATION

TYPICAL CLEAR, PRESET, COUNT AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

1. Clear outputs to zero
2. Preset to binary twelve
3. Count to thirteen, fourteen, fifteen, zero, one, and two
4. Inhibit

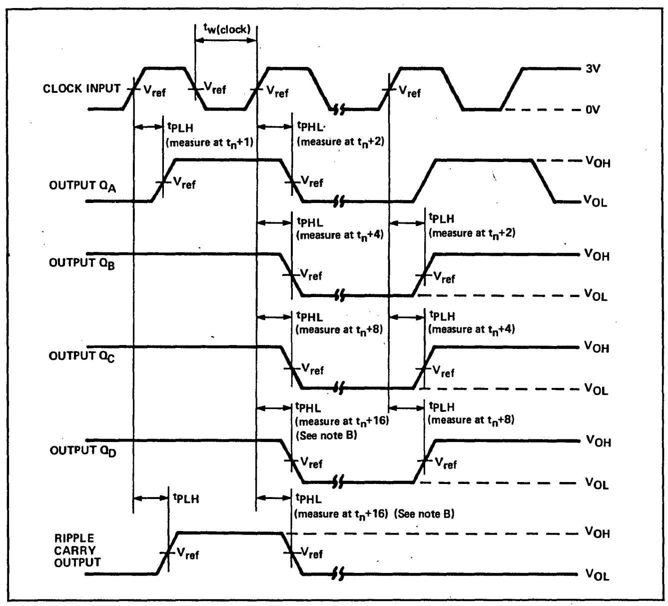


NOTES

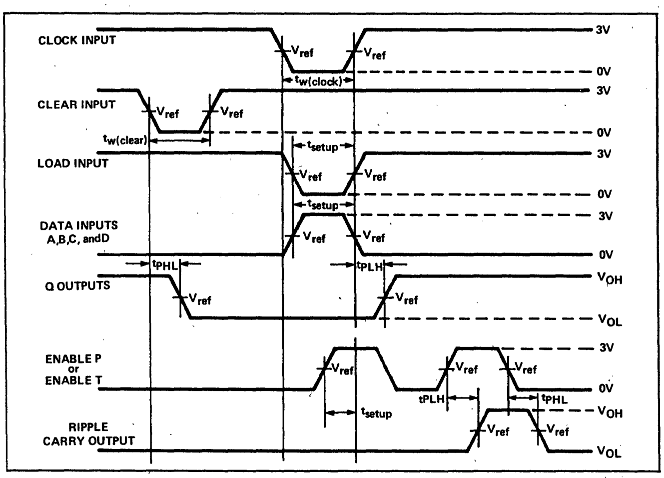
A. The input pulses are supplied by a generator having the following characteristics: PRR ≤ 1mHz, Duty Cycle ≤ 50%, $Z_{out} \approx 50\Omega$ $t_r \le 15ns$, $t_f \le 6ns$.

B. Outputs Q_D and carry are tested at t_{n+16}, where t_n is the bit time when all outputs are low.

C. V_{ref} = 1.3V.



VOLTAGE WAVEFORMS



VOLTAGE WAVEFORMS

NOTES

A. The input pulses are supplied by generators having the following characteristics: PRR≤1mHz, Duty cycle ≤ 50%, $Z_{out} \approx 50\Omega$, $t_r \le 15ns$, $t_f \le 6ns$.

B. Enable P and T setup times are measured at t_{n+o}.

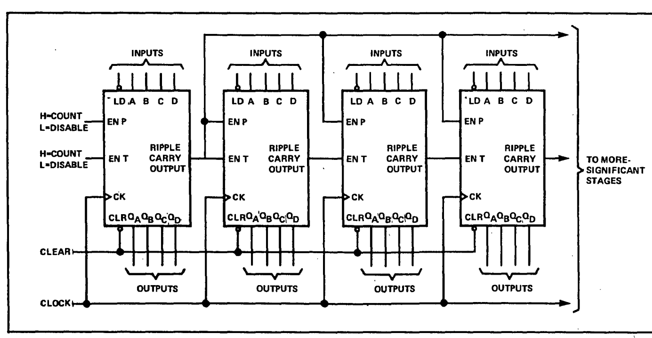
C. V_{ref} = 1.3V.

Load circuit is shown at front of book (totem pole outputs)

TYPICAL APPLICATION DATA

N-BIT SYNCHRONOUS COUNTERS

This application demonstrates how the look-ahead carry circuit can be used to implement a high-speed n-bit counter.The 54/74LS161 will count in binary. Virtually any count mode (modulo-N, N_1-toN_2, N_1-to-maximum) can be used with this fast look-ahead circuit.

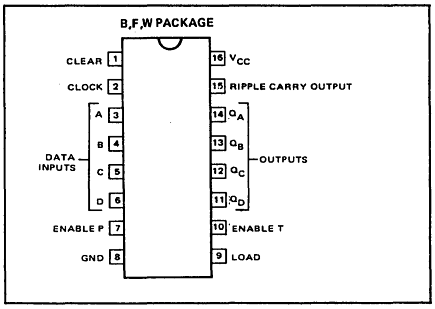


54LS162-F,W • 74LS162-B,F

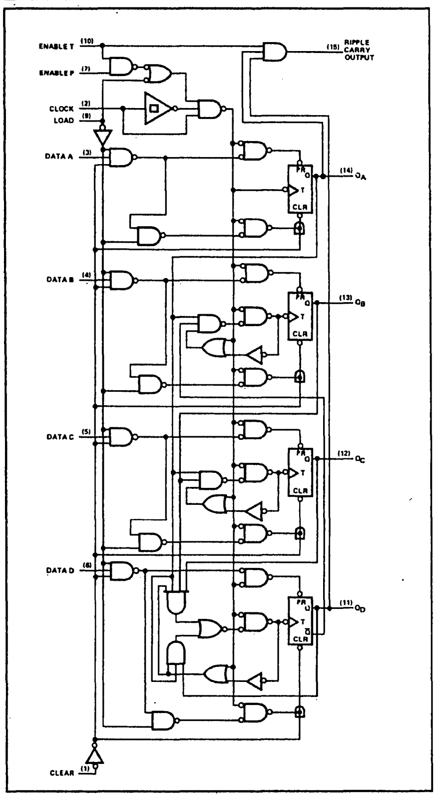
DESCRIPTION

This synchronous presettable decade counter features an internal carry look-ahead for applications in high-speed counting designs. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple clock) counters. A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveforms.

PIN CONFIGURATION



BLOCK DIAGRAM



This counter is fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable inputs. The clear function for the 54/74LS162 is synchronous and a low level at the clear input sets all four of the flip-flop outputs low after the next clock pulse, regardless of the levels of the enable inputs. This synchronous clear allows the count length to be modified easily as decoding the maximum count desired can be accomplished with one external NAND gate. The gate output is connected to the clear input to synchronously clear the counter to 0000 (LLLL).

The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Instrumental in accomplishing this function are two count-enable inputs and a ripple carry output. Both count-enable inputs (P and T) must be high to count, and input T is fed forward to enable the ripple carry output. The ripple carry output thus enabled will produce a high-level output pulse with a duration approximately equal to the high-level portion of the Q_A output. This high-level overflow ripple carry pulse can be used to enable successive cascaded stages. Transitions at the enable P or T inputs are allowed regardless of the level of the clock input.

The 54/74LS162 features a fully independent clock circuit. Changes made to control inputs (enable P or T, load or clear) that will modify the operating mode have no effect until clocking occurs. The function of the counter (whether enabled, disabled, loading or counting) will be dictated solely by the conditions meeting the stable set up and hold times.

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER★		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Clock}					25	32		MHz
$t_{w\ Clock}$	Width of Clock Pulse				25			ns
$t_{w\ (Clear)}$	Width of Clear Pulse				20			ns
t_{Setup}	Input Setup Time	A,B,C,D	Q		0↑			
		Enable P or T	Q		20↑			
		Load	Q		20↑			ns
		Clear	Q	C_L = 15pF, R_L = 2kΩ, See Figures 1 and 2 and Notes 1 and 2	20↑			
t_{Hold}	Input Hold Time	A,B,C,D			25↑[2]			ns
		Others			10↑[2]		ns	
t_{PLH} / t_{PHL}		Clock	Ripple carry			23 / 23	35 / 35	ns
t_{PLH} / t_{PHL}		Clock (load input high)	Any Q			16 / 18	24 / 27	ns
t_{PLH} / t_{PHL}		Clock (load input low)	Any Q			17 / 19	25 / 29	ns
t_{PLH} / t_{PHL}		Enable T	Ripple carry			15 / 15	23 / 23	ns
t_{PHL}		Clear	Any Q			26	38	ns

★ t_{max} = Maximum clock frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

NOTES:
1. Propagation delay for clearing is measured from the clock input transition.
2. The minimum hold time is as specified or as long as the clock input takes to rise from 0.8V to 2.0V., whichever is longer.

signetics

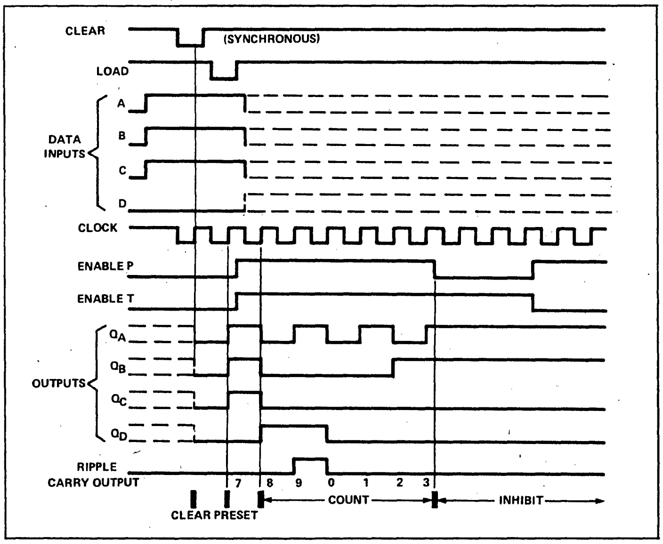
54LS162-F,W • 74LS162-B,F

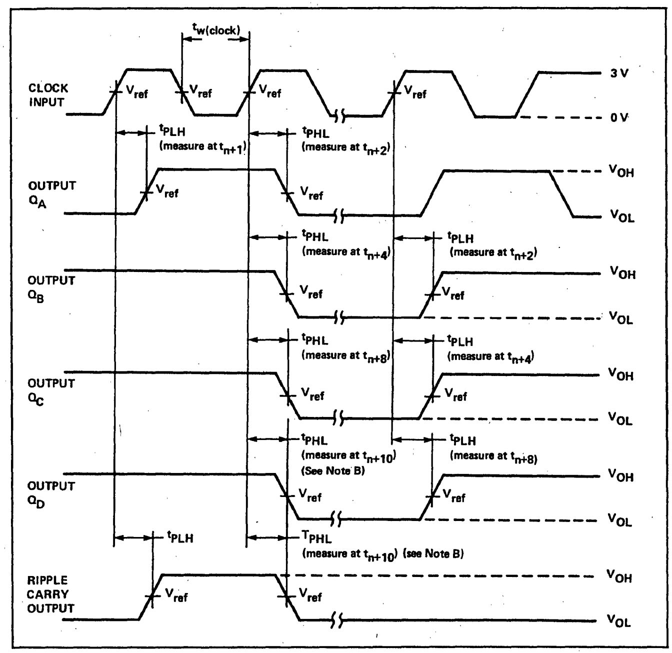
PARAMETER MEASUREMENT INFORMATION

TYPICAL CLEAR, PRESET, COUNT AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

1. Clear outputs to zero
2. Preset to BCD seven
3. Count to eight, nine, zero, one, two, and three
4. Inhibit





VOLTAGE WAVEFORMS

NOTES:

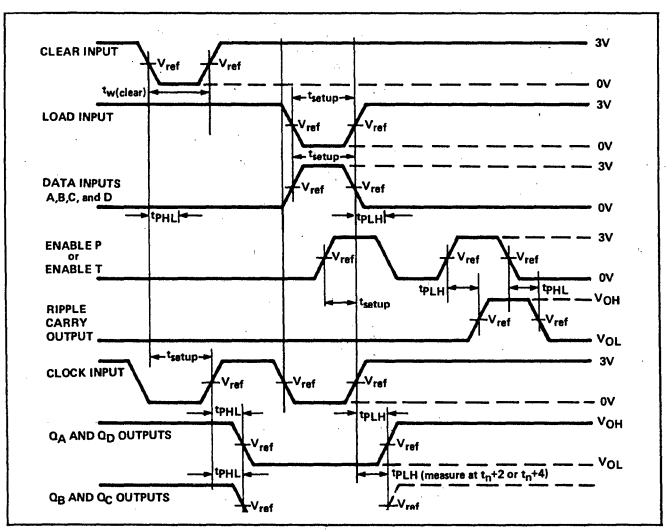
A. The input pulses are supplied by a generator having the following characteristics: PRR ≤ 1MHz, duty cycle ≤ 50%, $Z_{out} \approx 50\ \Omega$; $t_r \leq 15$ ns, $t_f \leq 6$ ns; vary PRR to measure f_{max}.

B. Outputs Q_D and carry are tested at t_{n+10} where t_n is the bit time when all outputs are low.

C. $V_{ref} = 1.5$ V.

Load Circuit information is shown at the front of the book.

FIGURE 1-SWITCHING TIMES



VOLTAGE WAVEFORMS

NOTES:

A. The input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, duty cycle ≤ 50%, $Z_{out} \approx 50\ \Omega$; $t_r < 15$ ns, $t_f \leq 6$ ns.

B. Enable P and enable T setup times are measured at t_{n+0}.

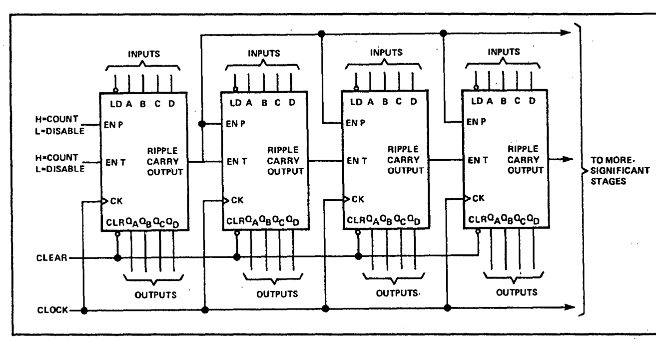
C. $V_{ref} = 1.3$ V.

FIGURE 2-SWITCHING TIMES

TYPICAL APPLICATION DATA

N-BIT SYNCHRONOUS COUNTERS

This application demonstrates how the look-ahead carry circuit can be used to implement a high-speed n-bit counter. The 54/74LS162 will count in BCD. Virtually any count mode (modulo-N, N_1-toN_2, N_1-to-maximum) can be used with this fast look-ahead circuit.

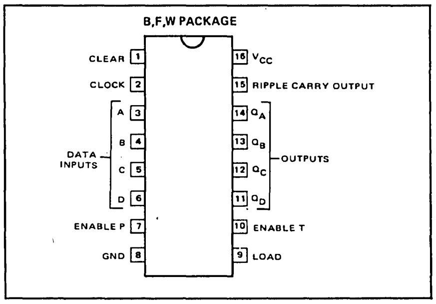


54LS163-F,W • 74LS163-B,F

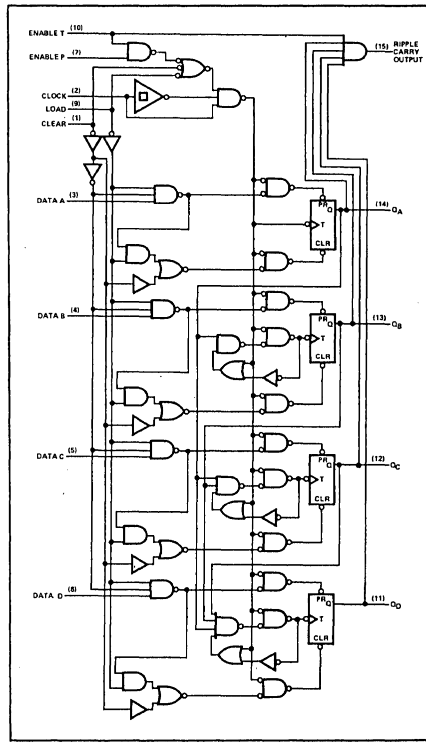
DESCRIPTION

This synchronous presettable binary counter features an internal carry look-ahead for applications in high-speed counting designs. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple clock) counters. A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveforms.

PIN CONFIGURATION



BLOCK DIAGRAM



This counter is fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable inputs. The clear function for the 54/74LS163 is synchronous and a low level at the clear input sets all four of the flip-flop outputs low after the next clock pulse, regardless of the levels of the enable inputs. This synchronous clear allows the count length to be modified easily as decoding the maximum count desired can be accomplished with one external NAND gate. The gate output is connected to the clear input to synchronously clear the counter to 0000 (LLLL).

The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Instrumental in accomplishing this function are two count-enable inputs and a ripple carry output. Both count-enable inputs (P and T) must be high to count, and input T is fed forward to enable the ripple carry output. The ripple carry output thus enabled will produce a high-level output pulse with a duration approximately equal to the high-level portion of the Q_A output. This high-level overflow ripple carry pulse can be used to enable successive cascaded stages. Transitions at the enable P or T inputs are allowed regardless of the level of the clock input.

The 54/74LS163 features a fully independent clock circuit. Changes made to control inputs (enable P or T, load or clear) that will modify the operating mode have no effect until clocking occurs. The function of the counter (whether enabled, disabled, loading or counting) will be dictated solely by the conditions meeting the stable setup and hold times.

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER★		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Clock}					25	32		MHz
$t_{w(Clock)}$	Width of clock pulse				25			ns
$t_{w(Clear)}$	Width of clear pulse				20			ns
t_{Setup}	Input setup time	A,B,C,D	Q		0↑			ns
		Enable Port	Q		20↑			ns
		Load	Q		20↑			ns
		Clear	Q		20↑			ns
t_{Hold}	Input hold time	A,B,C,D		$C_L = 15pF$, $R_L = 2k\Omega$, See Figures 1 and 2 and Note 1	25↑+			ns
		Others			10↑2		ns	
t_{PLH}		Clock	Ripple carry			23	35	ns
t_{PHL}						23	35	
t_{PLH}		Clock (load input high)	Any Q			16	24	ns
t_{PHL}						18	27	
t_{PLH}		Clock (load input low)	Any Q			17	25	ns
t_{PHL}						19	29	
t_{PLH}		Enable T	Ripple carry			15	23	ns
t_{PHL}						15	23	
t_{PHL}		Clear	Any Q			26	38	ns

★ f_{max} = Maximum clock frequency
t_{PLH} = propagation delay time, low-to-high-level output.
t_{PHL} = propagation delay time, high-to-low-level output

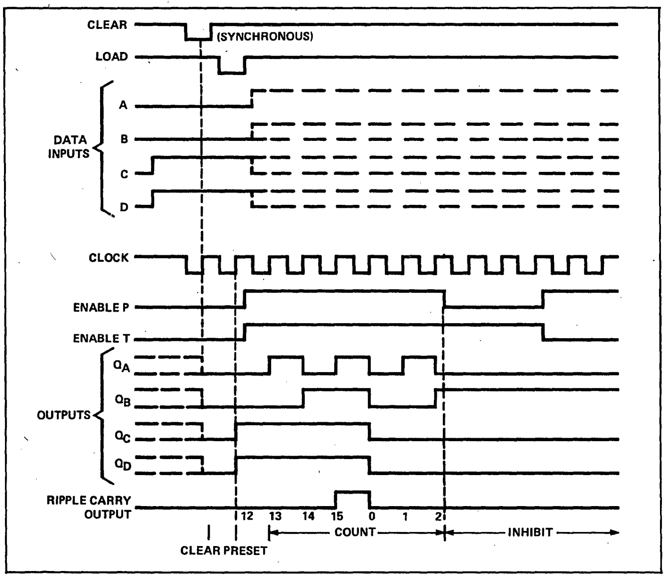
NOTES:
1. Propagation delay for clearing is measured from the clock input transition.
2. The minimum hold time is as specified or as long as the clock input takes to rise from 0.8V. to 2.0V., whichever is longer.

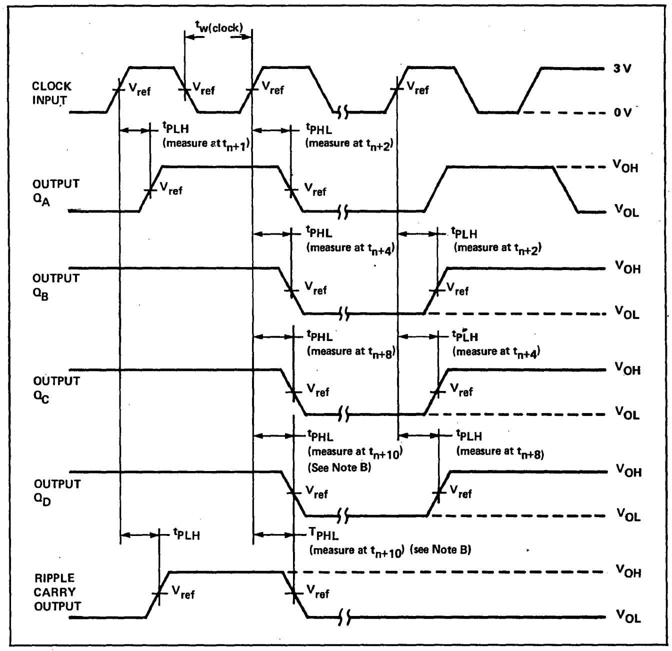
PARAMETER MEASUREMENT INFORMATION

TYPICAL CLEAR, PRESET, COUNT, AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

1. Clear outputs to zero
2. Preset to binary twelve
3. Count to thirteen, fourteen, fifteen, zero, one, and two
4. Inhibit

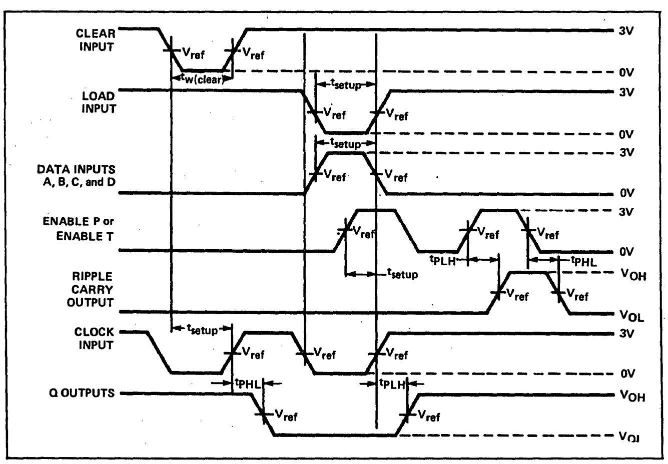




VOLTAGE WAVEFORMS

NOTES:
A. The input pulses are supplied by a generator having the following characteristics: PRR ≤ 1 MHz, duty cycle ≤ 50%, $Z_{out} \approx 50\ \Omega$; $t_r \leq 15$ ns, $t_f \leq 6$ ns. Vary PRR to measure f_{max}.
B. Outputs Q_D and carry are tested at t_{n+16} where t_n is the bit time when all outputs are low.
C. $V_{ref} = 1.3$ V.
Load circuit is shown at the front of the book.

FIGURE 1—SWITCHING TIMES



VOLTAGE WAVEFORMS

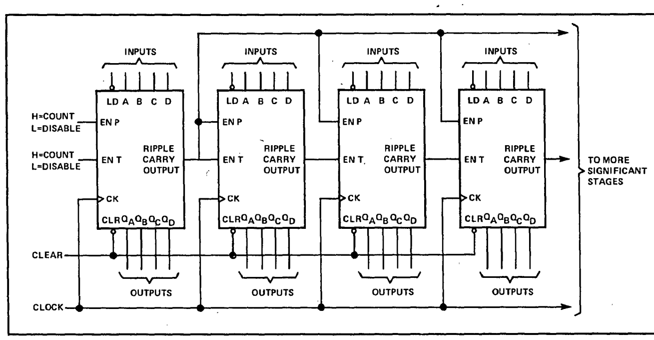
NOTES:
A. The input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, duty cycle ≤ 50%, $Z_{out} \approx 50\ \Omega$; '163, $t_r \leq 10$ ns, $t_f \leq 10$ ns; and for 'LS160 thru 'LS163, $t_r \leq 15$ ns, $t_f \leq 6$ ns.
B. Enable P and enable T setup times are measured at t_{n+0}.
C. $V_{ref} = 1.3$ V.

FIGURE 2—SWITCHING TIMES

TYPICAL APPLICATION DATA

N-BIT SYNCHRONOUS COUNTERS

This application demonstrates how the look-ahead carry circuit can be used to implement a high-speed n-bit counter. The 54/74LS163, will count in binary. Virtually any count mode (modulo-N, N_1-toN_2, N_1-to-maximum) can be used with this fast look-ahead circuit.

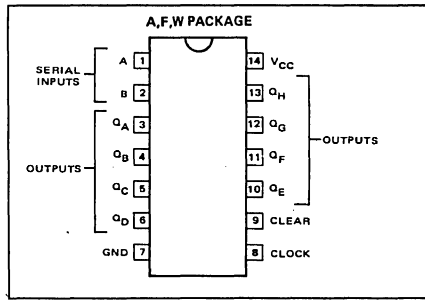


54LS164-F,W • 74LS164-A,F

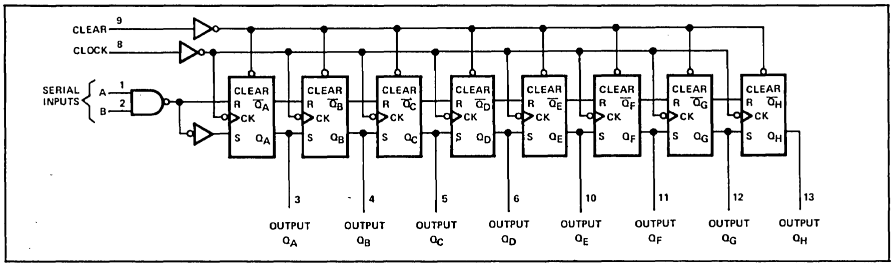
DESCRIPTION

This 8-bit shift register features gated serial inputs and an asynchronous clear. The gated serial inputs (A and B) permit complete control over incoming data as a low at either (or both) input(s) entry of the new data and resets the first flip-flop to the low level at the next clock pulse. A high-level input enables the other input which will then determine the state of the first flip-flop. Data at the serial inputs may be changed while the clock is high or low, but the only information meeting the setup requirements will be entered. Clocking occurs on the low-to-high level transition of the clock input. All inputs are diode-clamped to minimize transmission-line effects.

PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE

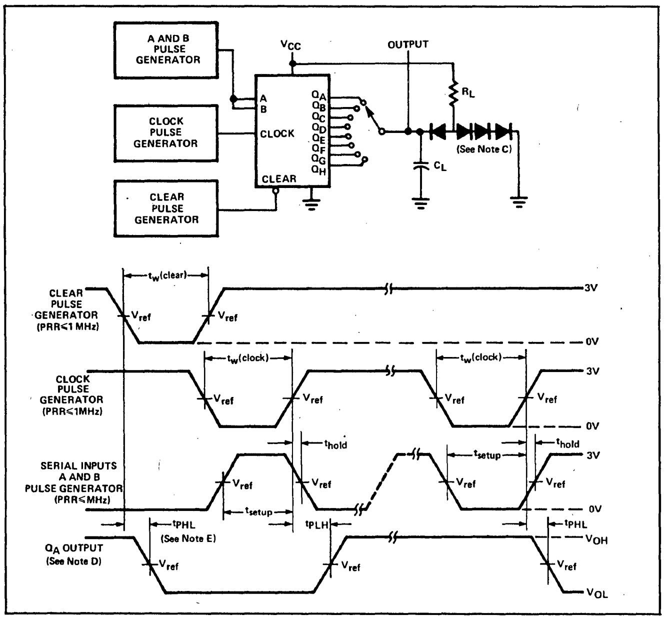
INPUTS				OUTPUTS		
CLEAR	CLOCK	A	B	Q_A	Q_B	Q_H
L	X	X	X	L	L	L
H	L	X	X	Q_{A0}	Q_{B0}	Q_{H0}
H	↑	H	H	H	Q_{An}	Q_{Gn}
H	↑	L	X	L	Q_{An}	Q_{Gn}
H	↑	X	L	L	Q_{An}	Q_{Gn}

H = high level (steady state), L = low level (steady state)
X = irrelevant (any input, including transitions)
↑ = transition from low to high level.
Q_{A0}, Q_{B0}, Q_{H0} = the level of Q_A, Q_B, or Q_H, respectively, before the indicated steady-state input conditions were established.
Q_{An}, Q_{Gn} = the level of Q_A or Q_G before the most-recent ↑ transition of the clock; indicates a one-bit shift.

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency	C_L = 15pF, R_L = 2kΩ, See Figure 1	25	36		MHz
t_W	Width of clock or clear input pulse		20			ns
t_{Setup}	Input setup time		15↑			ns
t_{Hold}	Input hold time		5↑			ns
t_{PHL}	Propagation delay time, high-to-low-level Q outputs from clear input			24	36	ns
t_{PLH}	Propagation delay time, low-to-high-level Q outputs from clock input			17	27	ns
t_{PHL}	Propagation delay time, high-to-low-level Q outputs from clock input			21	32	ns

PARAMETER MEASUREMENT INFORMATION

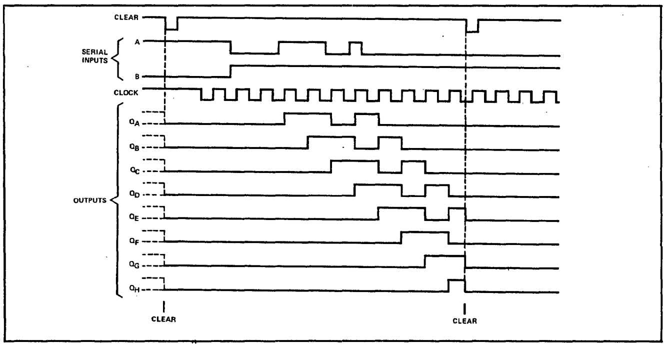


VOLTAGE WAVEFORMS

NOTES:

A. The pulse generators have the following characteristics: duty cycle ≤50%, $Z_{out} \approx 50\Omega$; $t_r \leq 15$ ns, $t_f \leq 6$ ns.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N3064 or 1N916.
D. Q_A output is illustrated. Relationship of serial input A and B data to other Q outputs is illustrated in the typical shift sequence.
E. Outputs are set to the high level prior to the measure of t_{PHL} from the clear input.
F. V_{ref} = 1.3V.

TYPICAL CLEAR, SHIFT, AND CLEAR SEQUENCES



54LS170-F,W • 74LS170-B,F

DESCRIPTION

The register file is organized as 4 words of 4 bits each and separate on-chip decoding is provided for addressing the four word locations to either write-in or retrieve data. This permits simultaneous writing into one location and reading from another word location.

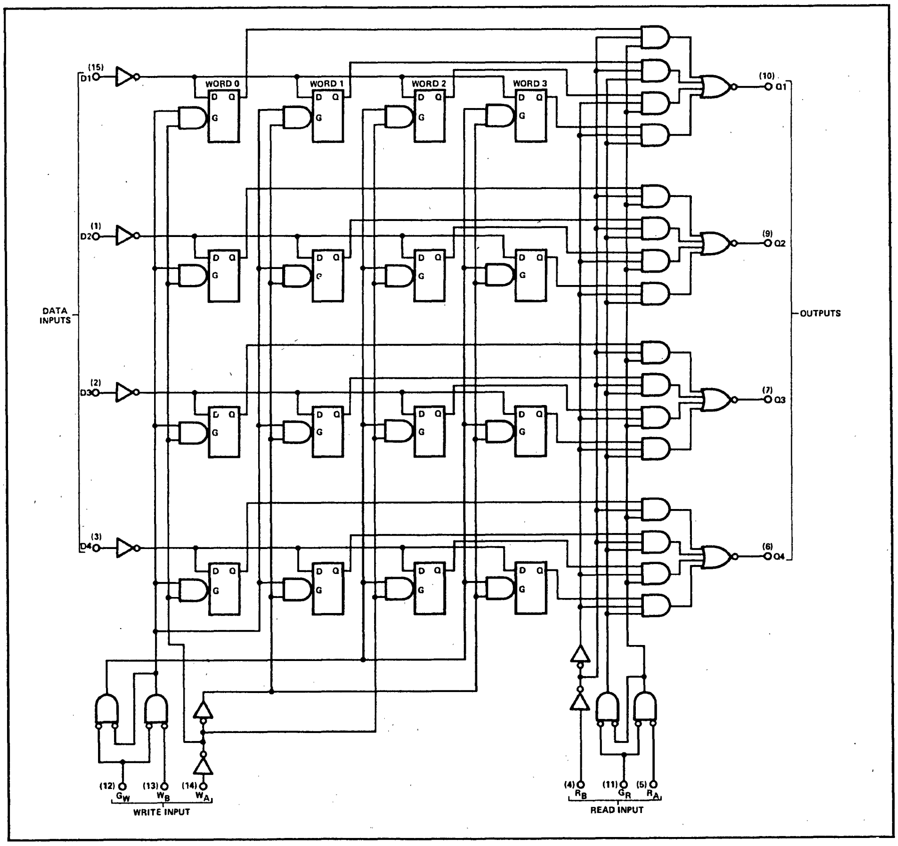
Four data inputs are available which are used to supply the 4-bit word to be stored. Location of the word is determined by the write-address inputs A and B in conjunction with a write-enable signal. Data applied at the inputs should be in its true form. That is, if a high-level signal is desired from the output, a high level is applied at the data input for that particular bit location. The latch inputs are arranged so that new data will be accepted only if both internal address gate inputs are high. When this condition exists, data at the D input is transferred to the latch output. When the write-enable input, G_W, is high, the data inputs are inhibited and their levels can cause no change in the information stored in the internal latches. When the read-enable input, G_R, is high, the data outputs are inhibited and remain high.

The individual address lines permit direct acquisition of data stored in any four of the latches. Four individual decoding gates are used to complete the address for reading a word. When the read address is made in conjunction with the read-enable signal, the word appears at the four outputs.

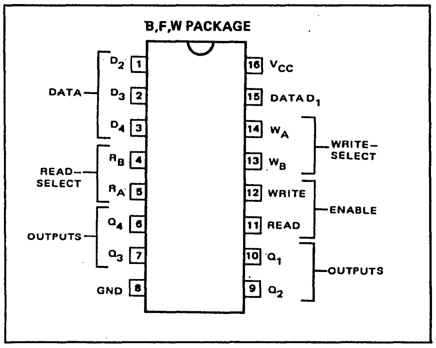
This arrangement—data-entry addressing separate from data read addressing and individual sense line—eliminates recovery times, permits simultaneous reading and writing, and is limited in speed only by the write time (30 nanoseconds typical) and the read time (25 nanoseconds typical). The register file has a nondestructive readout in that data is not lost when addressed.

All inputs except the read enable and write enable of the 54/74LS170 are buffered to lower the drive requirements to one Series 54LS/74LS standard load, respectively. Input-clamping diodes minimize switching transients to simplify system design. High-speed, double-ended AND-OR-INVERT gates are employed for the read-address function and drive high-sink-current, open-collector outputs. Up to 256 of these outputs may be wire-AND connected for increasing the capacity up to 1024 words. Any number of these registers may be paralleled to provide n-bit word length.

FUNCTIONAL BLOCK DIAGRAM



PIN CONFIGURATION



READ FUNCTION TABLE

(See Notes A and D)

READ INPUTS			OUTPUTS			
R_B	R_A	G_R	Q1	Q2	Q3	Q4
L	L	L	W0B1	W0B2	W0B3	W0B4
L	H	L	W1B1	W1B2	W1B3	W1B4
H	L	L	W2B1	W2B2	W2B3	W2B4
H	H	L	W3B1	W3B2	W3B3	W3B4
X	X	H	H	H	H	H

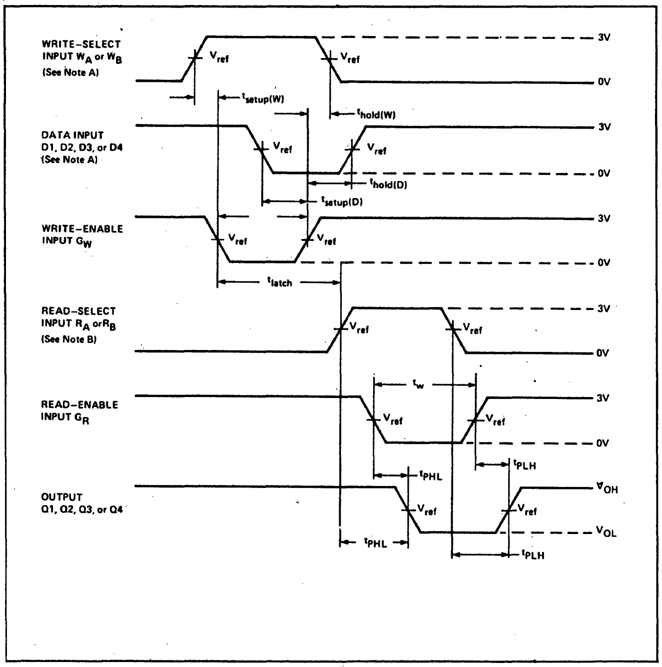
WRITE FUNCTION TABLE

(See Notes A, B, and C)

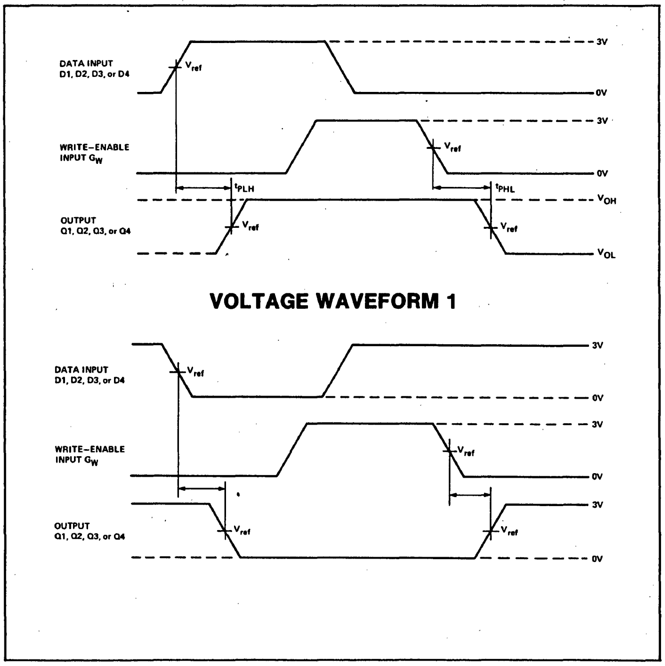
WRITE INPUTS			WORD			
W_B	W_A	G_W	0	1	2	3
L	L	L	Q=D	Q_0	Q_0	Q_0
L	H	L	Q_0	Q=D	Q_0	Q_0
H	L	L	Q_0	Q_0	Q=D	Q_0
H	H	L	Q_0	Q_0	Q_0	Q=D
X	X	H	Q_0	Q_0	Q_0	Q_0

NOTES:
A. H = high level, L = low level, X = irrelevant.
B. (Q = D) = The four selected internal flip-flop outputs will assume the states applied to the four external data inputs.
C. Q_0 = The level of Q before the indicated input conditions were established.
D. W0B1 = The first bit of word 0, etc.

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS
FIGURE 1



VOLTAGE WAVEFORM 2
FIGURE 2

NOTES:
A. High-level input pulses at the select and data inputs are illustrated in Figure 2; however, times associated with low-level pulses are measured from the same reference points.
B. When measuring delay times from a read-select input, the read-enable input is low. When measuring delay times from the read-enable input, both read-select inputs have been established at steady states.
C. In Figure 2, each select address is tested. Prior to the start of each of the above tests, both write and read address inputs are stabilized with $W_A = R_A$ and $W_B = R_B$. During the test G_R is low.
D. $V_{ref} = 1.3V$.
Load circuits are shown at the front of book (open collector outputs).

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER[1]		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_W	Width of write-enable or read-enable pulse			C_L = 15pF, R_L = 2kΩ,	25			ns
t_{Setup}	Input setup time (See fig. 2)							
		Data input	Write-enable		10			ns
		Write-select	Write-enable		15			ns
t_{Hold}	Input hold time (See notes 3 & fig. 2)							
		Data input	Write enable		15			ns
		Write select	Write enable		5			ns
t_{Latch}	Latch time for new data				25			
t_{PLH}		Read enable	Any Q	C_L = 15pF, R_L = 2kΩ See Figure 1		20	30	ns
t_{PHL}						20	30	
t_{PLH}		Read select	Any Q			25	40	ns
t_{PHL}						24	40	
t_{PLH}		Write-enable	Any Q	C_L = 15pF, R_L = 2kΩ See Figure 2		30	45	ns
t_{PHL}						26	40	
t_{PLH}		Data	Any Q			30	45	ns
t_{PHL}						22	35	

NOTE:
1. t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

HEX D-TYPE FLIP-FLOP WITH CLEAR — 54/74LS174

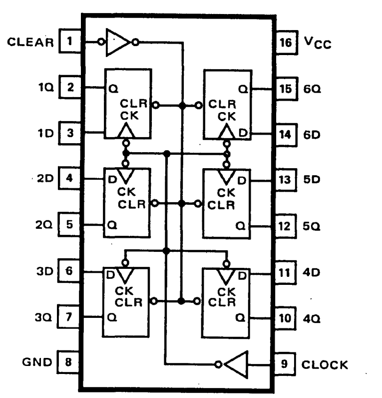
54LS174-B,F,W • 74LS174-B,F

DESCRIPTION

Information at the D inputs meeting the setup time requirements is transferred to the Q outputs on the positive-going edge of the clock pulse. Clock triggering occurs at a particular voltage level and is not directly related to the transition time of the positive-going pulse. When the clock input is at either the high or low level, the input signal has no effect at the output.

PIN CONFIGURATION

B,F,W PACKAGE



FUNCTION TABLE (Each Flip-Flop)

INPUTS			OUTPUTS
CLEAR	CLOCK	D	Q
L	X	X	L
H	↑	H	H
H	↑	L	L
H	L	X	Q_0

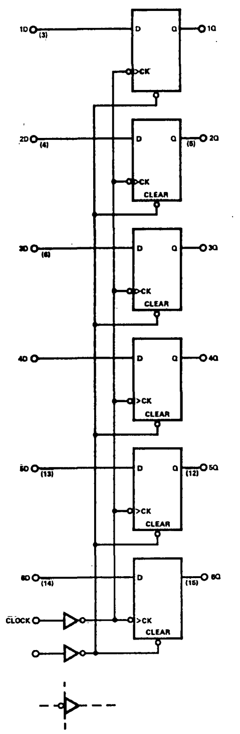
H = high level (steady state)
L = low level (steady state)
X = irrelevant
↑ = transition from low to high level
Q_0 = the level of Q before the indicated steady-state input conditions were established

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency		30	40		MHz
t_w	Width of clock or clear pulse		20			ns
t_{Setup}	Input setup time					
	Data input		20↑			ns
	Clear inactive-state		25↑			ns
t_{Hold}	Input hold time		5↑			ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear	$C_L = 15pF$, $R_L = 2k\Omega$		23	35	ns
t_{PLH}	Propagation delay time, low-to-high-level output from clock			20	30	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock			21	35	ns

Load circuit and typical waveforms are shown at the front of book.

FUNCTIONAL BLOCK DIAGRAM



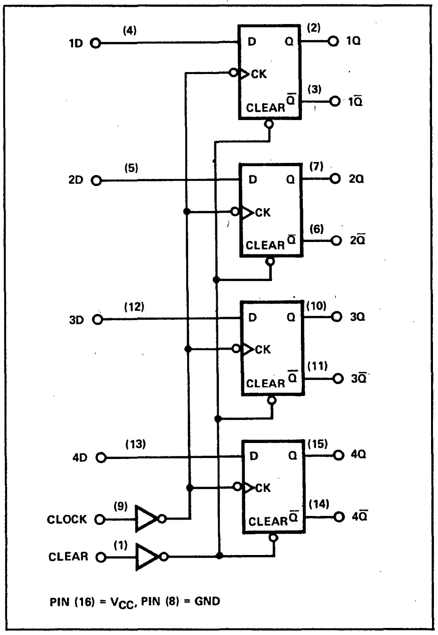
QUAD D-TYPE EDGE-TRIGGERED FLIP-FLOP 54/74LS175

54LS175-F,W • 74LS175-B,F

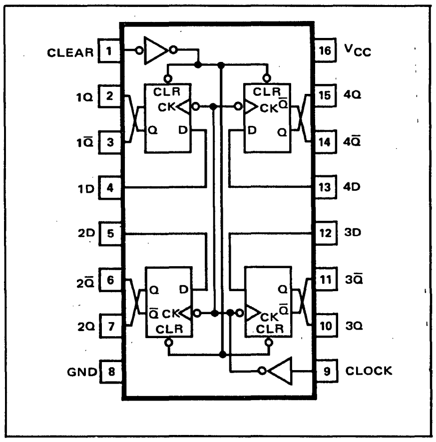
DESCRIPTION

Information at the D inputs meeting the setup time requirements is transferred to the Q outputs on the positive-going edge of the clock pulse. Clock triggering occurs at a particular voltage level and is not directly related to the transition time of the positive-going pulse. When the clock input is at either the high or low level, the D input signal has no effect at the output.

FUNCTIONAL BLOCK DIAGRAM



PIN CONFIGURATION



SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Clock}	Maximum clock frequency		30	40		MHz
t_w	Width of clock or clear pulse		20			ns
t_{Setup}	Input setup time					
	Data input		20			ns
	Clear inactive-state		25			ns
t_{Hold}	Input hold time		5			ns
t_{PLH}	Propagation delay time, low-to-high-level output from clear			16	25	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear	C_L = 15pF, R_L = 2kΩ		23	35	ns
t_{PLH}	Propagation delay time, low-to-high-level output from clock			20	30	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock			21	30	ns

Load circuit and typical waveforms are shown at the front of book.

FUNCTION TABLE (Each Flip-Flop)

INPUTS			OUTPUTS	
CLEAR	CLOCK	D	Q	$\overline{Q}$
L	X	X	L	H
H	↑	H	H	L
H	↑	L	L	H
H	L	X	Q_0	$\overline{Q_0}$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↑ = transition from low to high level
Q_0 = the level of Q before the indicated steady-state input conditions were established

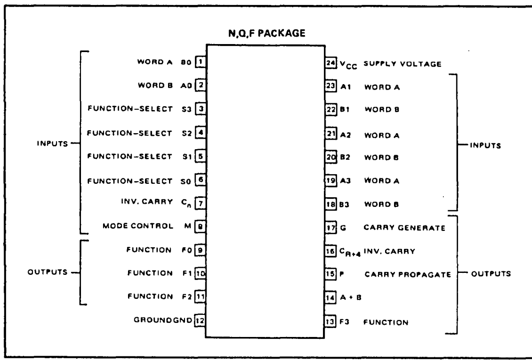
54LS181-Q,F • 74LS181-N,F

DESCRIPTION

The S54/N74LS181 arithmetic logic unit (ALU)/function generators have a complexity of 75 equivalent gates on a monolithic chip. These circuits perform 16 binary arithmetic operations on two 4-bit words as shown in Tables 1 and 2. These operations are selected by the four function-select lines (S0, S1, S2, S3) and include addition, subtraction, decrement, and straight transfer. When performing arithmetic manipulations, the internal carries must be enabled by applying a low-level voltage to the mode control input (M). A full carry look-ahead scheme is made available in these devices for fast, simultaneous carry generation by means of two cascade-outputs (pins 15 and 17) for the four bits in the package. When used in conjunction with the 182 full carry look-ahead circuit, high-speed arithmetic operations can be performed.

If high speed is not of importance, a ripple-carry input (C_n) and a ripple-carry output (C_{n+4}) are available. However, the ripple-carry delay has also been minimized so that arithmetic manipulations for small word lengths can be performed without external circuitry.

PIN CONFIGURATION



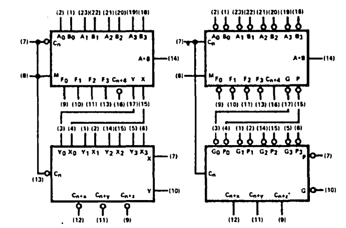


FIGURE 1 (FOR TABLE 1)

FIGURE 2 (FOR TABLE 2)

The S54/N74LS181 will accommodate active-high or active-low data if the pin designations are interpreted as follows: Subtraction is accomplished by 1's complement addition where the 1's complement of the subtrahend is generated internally. The resultant output is A—B—1 which requires an end-around or forced carry to provide A—B.

The S54/74LS181 can also be utilized as a comparator. The A = B output is internally decoded from the function outputs (F0, F1, F2, F3) so that when two words of equal magnitude are applied at the A and B inputs, it will assume a high level to indicate equality (A = B). The ALU should be in the subtract mode with C_n = H when performing this comparison. The A = B output is open-collector so that it can be wire-AND connected to give a comparison for more than four bits. The carry output (C_{n+4}) can also be used to supply relative magnitude information. Again, the ALU should be placed in the subtract mode by placing the function select inputs S3, S2, S1 S0 at L, H, H, L, respectively.

INPUT C_n	OUTPUT C_{n+4}	ACTIVE-HIGH DATA (FIGURE1)	ACTIVE-LOW DATA (FIGURE 2)
H	H	A≤B	A≥B
H	L	A>B	A<B
L	H	A<B	A>B
L	L	A≥B	A≤B

These circuits have been designed to not only incorporate all of the designer's requirements for arithmetic operations, but also to provide 16 possible functions of two Boolean variables without the use of external circuitry. These logic functions are selected by use of the four function-select inputs (S0, S1, S2, S3) with the mode-countrol input (M) at a high level to disable the internal carry. The 16 logic functions are detailed in Tables 1 and 2 and include exclusive-OR, NAND, AND, NOR, and OR functions.

ALU SIGNAL DESIGNATIONS

The S54/N74LS181 can be used with the signal designations of either Figure 1 or Figure 2.

The logic functions and arithmetic operations obtained with signal designations as in Figure 1 are given in Table 1; those obtained with the signal designations of Figure 2 are given in Table 2.

PIN NUMBER	2	1	23	22	21	20	19	18	9	10	11	13	7	16	15	17
Active-high data (Table 1)	A_0	B_0	A_1	B_1	A_2	B_2	A_3	B_3	F_0	F_1	F_2	F_3	$\overline{C}_n$	$\overline{C}_{n+4}$	X	Y
Active-low data (Table 11)	$\overline{A}_0$	$\overline{B}_0$	$\overline{A}_1$	$\overline{B}_1$	$\overline{A}_2$	$\overline{B}_2$	$\overline{A}_3$	$\overline{B}_3$	$\overline{F}_0$	$\overline{F}_1$	$\overline{F}_2$	$\overline{F}_3$	C_n	C_{n+4}	$\overline{P}$	$\overline{G}$

TABLE 1

SELECTION				ACTIVE-HIGH DATA		
				M=H LOGIC FUNCTIONS	M=L: ARITHMETIC OPERATIONS	
S3	S2	S1	S0		C_n=H (NO CARRY)	C_n=L (WITH CARRY)
L	L	L	L	F=$\overline{A}$	F=A	F=A PLUS 1
L	L	L	H	F=$\overline{A+B}$	F=A+B	F=(A+B) PLUS 1
L	L	H	L	F=$\overline{A}$B	F=A+$\overline{B}$	F=(A+$\overline{B}$) PLUS 1
L	L	H	H	F=0	F=MINUS 1 (2's COMPL)	F=ZERO
L	H	L	L	F=$\overline{AB}$	F=A PLUS A$\overline{B}$	F=A PLUS A$\overline{B}$ PLUS 1
L	H	L	H	F=$\overline{B}$	F=(A+B) PLUS A$\overline{B}$	F=(A-B) PLUS A$\overline{B}$ PLUS 1
L	H	H	L	F= A+ B	F=A MINUS B MINUS 1	F= A MINUS B
L	H	H	H	F=A$\overline{B}$	F=A$\overline{B}$ MINUS 1	F=A$\overline{B}$
H	L	L	L	F=$\overline{A}$+B	F=A PLUS AB	F=A PLUS AB PLUS 1
H	L	L	H	F=$\overline{A+B}$	F=A PLUS B	F=A PLUS B PLUS 1
H	L	H	L	F=B	F=(A+$\overline{B}$) PLUS AB	F=(A+$\overline{B}$) PLUS AB PLUS 1
H	L	H	H	F=AB	F=AB MINUS 1	F=AB
H	H	L	L	F=1	F=A PLUS A*	F=A PLUS A PLUS 1
H	H	L	H	F=A+$\overline{B}$	F=(A+B) PLUS A	F=(A+B) PLUS A PLUS 1
H	H	H	L	F=A+B	F=(A+B) PLUS A	F=(A+$\overline{B}$) PLUS A PLUS 1
H	H	H	H	F=A	F=A MINUS 1	F=A

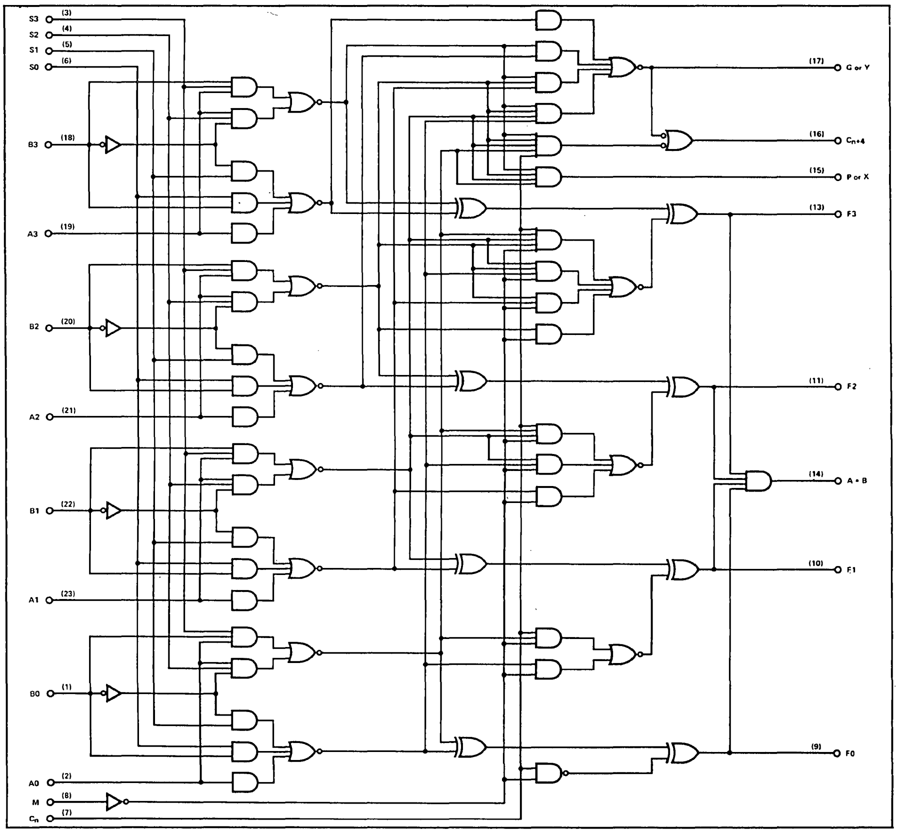
*Each bit is shifted to the next more significant position.

TABLE 2

SELECTION				ACTIVE-HIGH DATA		
				M=H LOGIC FUNCTIONS	M=L: ARITHMETIC OPERATIONS	
S3	S2	S1	S0		C_n=L (NO CARRY)	C_n=H (WITH CARRY)
L	L	L	L	F=$\overline{A}$	F=A MINUS 1	F=A
L	L	L	H	F=$\overline{AB}$	F=AB MINUS 1	F=AB
L	L	H	L	F=$\overline{A}$+B	F=A$\overline{B}$ MINUS 1	F=A$\overline{B}$
L	L	H	H	F=1	F=MINUS 1 (2's COMPL)	F=ZERO
L	H	L	L	F=$\overline{A+B}$	F=A PLUS (A+$\overline{B}$)	F=A PLUS (A+$\overline{B}$) PLUS 1
L	H	L	H	F=$\overline{B}$	F=AB PLUS (A+$\overline{B}$)	F=AB PLUS (A+$\overline{B}$) PLUS 1
L	H	H	L	F=$\overline{A + B}$	F=A MINUS B MINUS 1	F=A MINUS B
L	H	H	H	F=A+$\overline{B}$	F=A+$\overline{B}$	F=(A+$\overline{B}$) PLUS 1
H	L	L	L	F=$\overline{A}$B	F=A PLUS (A+B)	F=A PLUS (A+B) PLUS 1
H	L	L	H	F=A + B	F=A PLUS B	F=A PLUS B PLUS 1
H	L	H	L	F=B	F=A$\overline{B}$ PLUS (A+B)	F=A$\overline{B}$ PLUS (A+B) PLUS 1
H	L	H	H	F=A+B	F=A+B	F=(A+B) PLUS 1
H	H	L	L	F=0	F=A PLUS A*	F=A PLUS A PLUS 1
H	H	L	H	F=A$\overline{B}$	F=AB PLUS A	F=AB PLUS A PLUS 1
H	H	H	L	F=AB	F=A$\overline{B}$ PLUS A	F=A$\overline{B}$ PLUS A PLUS 1
H	H	H	H	F=A	F=A	F=A PLUS 1

54LS181-Q,F • 74LS181-N,F

FUNCTIONAL BLOCK DIAGRAM



SWITCHING CHARACTERISTICS V_{CC}=5V, T_A=25°C C_L=15pF, R_L=2kΩ

PARAMETER[1]	FROM (INPUT	TO (OUTPUT	TEST CONDITIONS	LIMITS			
				MIN	TYP	MAX	UNIT
t_{PLH} t_{PHL}	C_n	C_{n+4}			18 13	27 20	ns
t_{PLH} t_{PHL}	Any A or B	C_{n+4}	M=0V, S0=S3=4.5V, S1=S2=0V ($\overline{SUM}$ mode)		25 25	38 38	ns
t_{PLH} t_{PLH}	Any A or B	C_{n+4}	M=OV, SO=S3=OV S1=S2=4.5V ($\overline{DIFF}$ mode)		27 27	41 41	ns
t_{PLH} t_{PHL}	C_n	Any F	M=0V ($\overline{SUM}$ or $\overline{DIFF}$ mode)		17 13	26 20	ns
t_{PLH} t_{PHL}	Any A or B	G	M=0V, S0=S3=4.5V, S1=S2=0V ($\overline{SUM}$ mode)		19 15	29 23	ns
t_{PLH} t_{PHL}	Any A or B	G	M=0V, S0=S3=0V, S1=S2=4.5V ($\overline{DIFF}$ mode)		21 17	32 26	ns
t_{PLH} t_{PHL}	Any A or B	P	M=0V, S0=S3=4.5V, S1=S2=0V ($\overline{SUM}$ mode)		20 20	30 30	ns
t_{PLH} t_{PHL}	Any A or B	P	M=0V, S0=S3=0V, S1=S2=4.5V ($\overline{DIFF}$ mode)		20 22	30 33	ns
t_{PLH} t_{PHL}	A_i or B_i	F_i	M=0V, S0=S3=4.5V, S1=S2=0V ($\overline{SUM}$ mode)		21 13	32 20	ns
t_{PLH} t_{PHL}	A_i or B_i	F_i	M=0V, S0=S3=0V, S1=S2=4.5V $\overline{DIFF}$ mode)		21 15	32 23	ns
t_{PLH} t_{PHL}	A_i or B_i	F_i	M=4.5V (logic mode)		22 19	33 29	ns
t_{PLH} t_{PHL}	Any A or B	A=B	M=0V, S0=S3=0V, S1=S2=4.5V ($\overline{DIFF}$ mode)		33 41	50 62	ns

[1] t_{PLH}= propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
Load circuit and typical waveforms are shown at front of book

54LS190-F,W • 74LS190-B,F

DESCRIPTION

The 54/74LS190 is a synchronous, reversible up/down counter having a complexity of 58 equivalent gates. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes normally associated with asynchronous (ripple clock) counters.

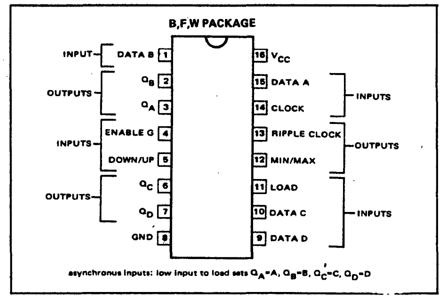
The outputs of the four master-slave flip-flops are triggered on a low-to-high-level transition of the clock input if the enable input is low. A high at the enable input inhibits counting. Level changes at either the enable input or the down/up input should be made only when the clock input is high. The direction of the count is determined by the level of the down/up input. When low, the counter counts up and when high, it counts down.

These counters are fully programmable; that is, the outputs may be preset to either level by placing a low on the load input and entering the desired data at the data inputs. The output will change to agree with the data inputs independently of the level of the clock input. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

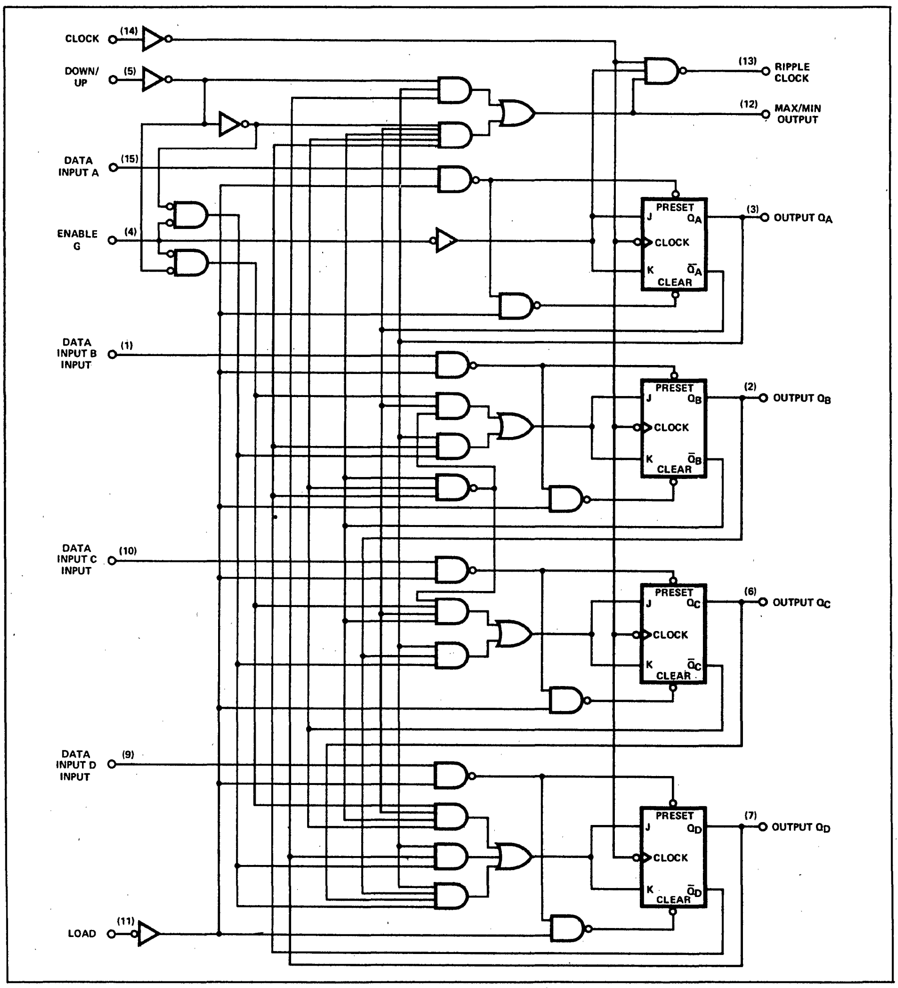
The clock, down/up, and load inputs are buffered to lower the drive requirement which significantly reduces the number of clock drivers, etc., required for long parallel words.

Two outputs have been made available to perform the cascading function: ripple clock and maximum/minimum count. The latter output produces a high-level output pulse with a duration approximately equal to one complete cycle of the clock when the counter overflows or underflows. The ripple clock output produces a low-level output pulse equal in width to the low-level portion of the clock input when an overflow or underflow condition exists. The counters can be easily cascaded by feeding the ripple clock output to the enable input of the succeeding counter if parallel clocking is used, or to the clock input if parallel enabling is used. The maximum/minimum count output can be used to accomplish look-ahead for high-speed operation.

PIN CONFIGURATION



BLOCK DIAGRAM



DIGITAL

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SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER★		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS			
					MIN	TYP	MAX	UNIT
f_{Clock}					20	25		MHz
$t_{w(Clock)}$	Width of clock input pulse				25			ns
$t_{w(Load)}$	Width of load input pulse				35			ns
t_{Setup}	Input setup time				20↑			ns
t_{Hold}	Input hold time				0↑			ns
t_{Enable}	Enable time to cycle				20↑			
t_{PLH}		Load	Q_A, Q_B, Q_C, Q_D			22	33	ns
t_{PHL}						33	50	
t_{PLH}		Data A,B,C,D	Q_A,Q_B,Q_C,Q_D			14	22	ns
t_{PHL}						35	50	
t_{PLH}		Clock	Ripple clock	C_L = 15pF, R_L = 2kΩ, See Figures 1 and 3 thru 7		13	20	ns
t_{PHL}						16	24	
t_{PLH}		Clock	Q_A,Q_B,Q_C,Q_D			16	24	ns
t_{PHL}						24	36	
t_{PLH}		Clock	Max/min			28	42	ns
t_{PHL}						37	52	
t_{PLH}		Down/up	Ripple clock			30	45	ns
t_{PHL}						30	45	
t_{PLH}		Down/up	Max/min			21	33	ns
t_{PHL}						22	33	
t_{PLH}		Enable	Ripple clock			21	33	ns
t_{PHL}		E				22	33	ns

★f_{max} = maximum clock frequency
t_{PLH} = propagation delay time, low-to-high level output
t_{PHL} = propagation delay time, high-to-low-level output

signetics

DIGITAL

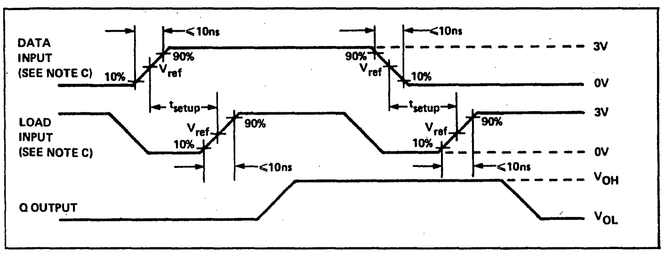
Signetics

PARAMETER MEASUREMENT INFORMATION

TYPICAL LOAD, COUNT, AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

1. Load (preset) to BCD seven.
2. Count up to eight, nine (maximum), zero, one, and two.
3. Inhibit.
4. Count down to one, zero (minimum), nine, eight, and seven.



VOLTAGE WAVEFORMS

FIGURE 1 — DATA SETUP TIME VOLTAGE WAVEFORMS

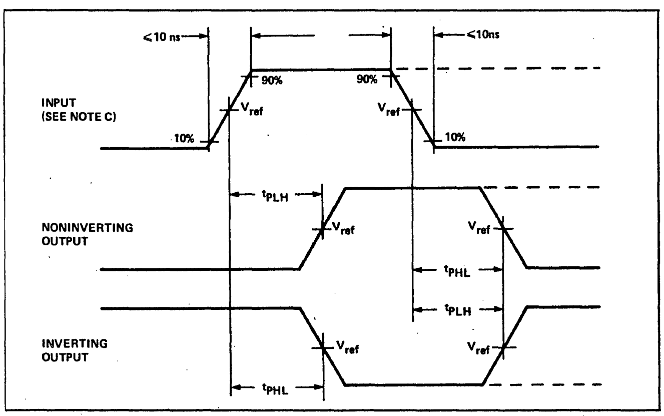
NOTES:

A. C_L includes probe and jig capacitance.

B. All diodes are 1N3064.

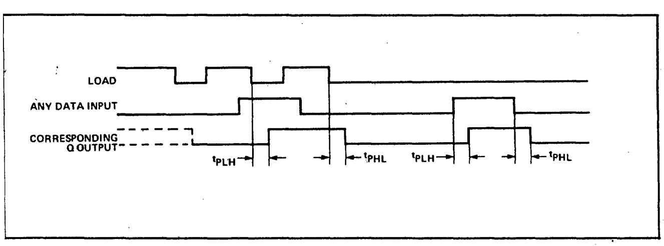
C. The input pulses are supplied by generators having the following characteristics: Z_{out} = 50 Ω, duty cycle ≤ 50%, PRR ≤ 1 MHz.

D. V_{ref} = 1.3V.



See waveform sequences in figures 3 through 6 for propagation times from a specific input to a specific output. For simplification, pulse rise times, reference levels, etc., have not been shown in figures 3 through 6.

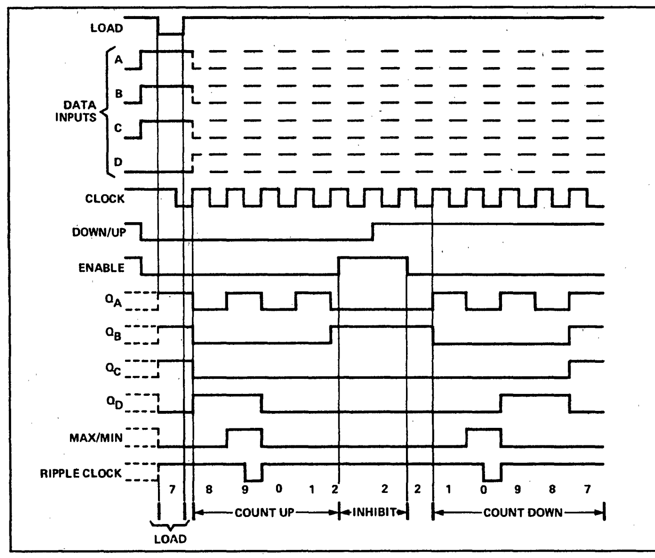
FIGURE 2 — GENERAL VOLTAGE WAVEFORMS FOR PROPAGATION TIMES

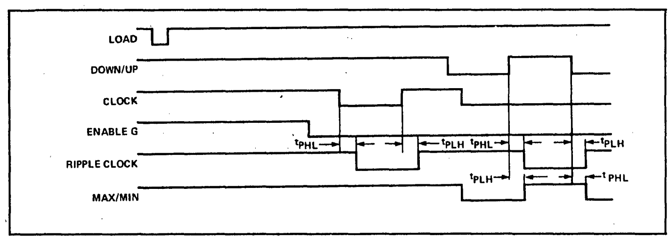


NOTE:

E. Conditions on other inputs are irrelevant.

FIGURE 3 — LOAD TO OUTPUT AND DATA TO OUTPUT

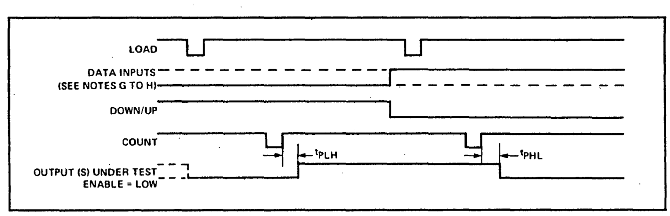




NOTE:

F. All data inputs are low.

FIGURE 4 — ENABLE TO RIPPLE CLOCK, CLOCK TO RIPPLE CLOCK, DOWN/UP TO RIPPLE CLOCK, AND DOWN/UP TO MAX/MIN

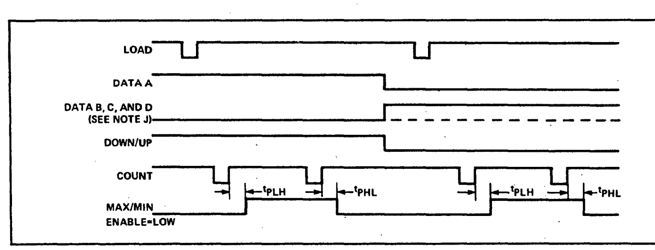


NOTES:

G. To test Q_A, Q_B, and Q_C outputs: Data inputs A, B, and C are shown by the solid line. Data input D is shown by the dashed line.

H. To test Q_D output: Data inputs A and D are shown by the solid line. Data inputs B and C are held at the low logic level.

FIGURE 5 — CLOCK TO OUTPUT



NOTE:

J. Data inputs B and C are shown by the dashed line. Data input D is shown by the solid line.

FIGURE 6 — CLOCK TO MAX/MIN

SYNCHRONOUS BINARY UP/DOWN COUNTER — 54/74LS191

54LS191-F.W • 74LS191-B.F

DESCRIPTION

The 54/74LS191 is a synchronous, reversible binary up/down counter having a complexity of 58 equivalent gates. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes normally associated with asynchronous (ripple clock) counters.

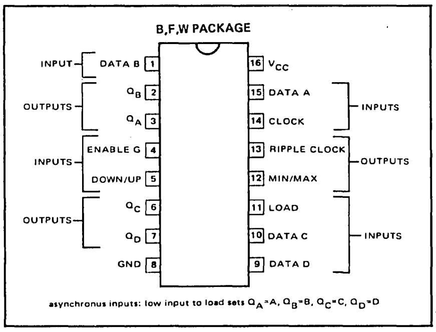
The outputs of the four master-slave flip-flops are triggered on a low-to-high-level transition of the clock input if the enable input is low. A high at the enable input inhibits counting. Level changes at either the enable input or the down/up input should be made only when the clock input is high. The direction of the count is determined by the level of the down/up input. When low, the counter counts up and when high, it counts down.

These counters are fully programmable; that is, the outputs may be preset to either level by placing a low on the load input and entering the desired data at the data inputs. The output will change to agree with the data inputs independently of the level of the clock input. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

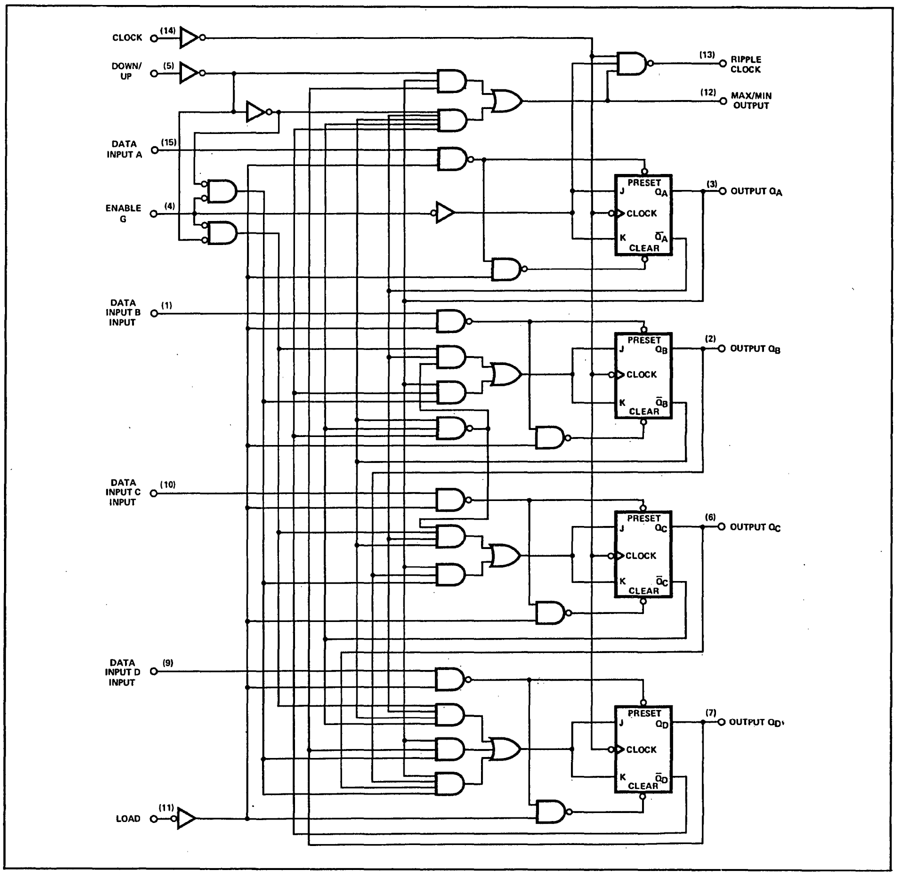
The clock, down/up, and load inputs are buffered to lower the drive requirement which significantly reduces the number of clock drivers, etc., required for long parallel words.

Two outputs have been made available to perform the cascading function: ripple clock and maximum/minimum count. The latter output produces a high-level output pulse with a duration approximately equal to one complete cycle of the clock when the counter overflows or underflows. The ripple clock output produces a low-level output pulse equal in width to the low-level portion of the clock input when an overflow or underflow condition exists. The counters can be easily cascaded by feeding the ripple clock output to the enable input of the succeeding counter if parallel clocking is used, or to the clock input if parallel enabling is used. The maximum/minimum count output can be used to accomplish look-ahead for high-speed operation.

PIN CONFIGURATION



BLOCK DIAGRAM



SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER★		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Clock}					20	25		MHz
$t_{w(Clock)}$	Width of clock input pulse				25			ns
$t_{(Load)}$	Width or load input pulse				35			ns
t_{setup}	Input setup time				20↑			ns
t_{Hold}	Input hold time				0↑			ns
t_{Enable}	Enable time to cycle				20↑			
t_{PLH}		Load	Q_A, Q_B, Q_Q, Q_D			22	33	ns
t_{PHL}						33	50	
t_{PLH}		Data A,B,C,D	Q_A, Q_B, Q_C, Q_D			14	22	ns
t_{PHL}						35	50	
t_{PLH}		Clock	Ripple clock	C_L = 15pF, R_L = 2kΩ,		13	20	ns
t_{PHL}				See Figures 1 and 3		16	24	
t_{PLH}		Clock	Q_A, Q_B, Q_C, Q_D	thru 7		16	24	ns
t_{PHL}						24	36	
t_{PLH}		Clock	Max/min			28	42	ns
t_{PHL}						37	52	
t_{PLH}		Down/up	Ripple clock			30	45	ns
t_{PHL}						30	45	
t_{PLH}		Down/up	Max/min			21	33	ns
t_{PHL}						22	33	
t_{PLH}		Enable	Ripple clock			21	32	ns
t_{PHL}		E				22	33	ns

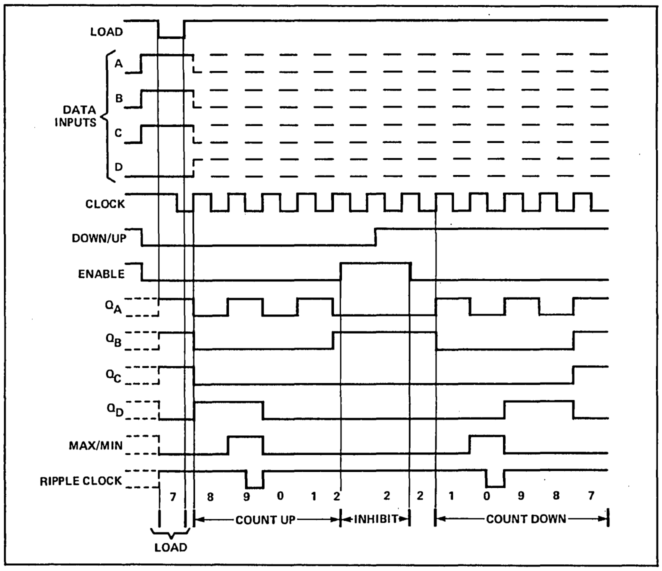
★f_{max} = maximum clock frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

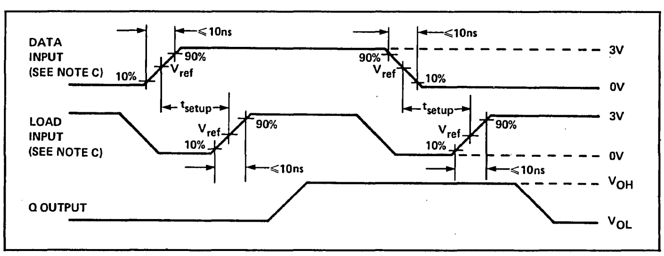
PARAMETER MEASUREMENT INFORMATION

TYPICAL LOAD, COUNT, AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

1. Load (preset) to binary thirteen.
2. Count up to fourteen, fifteen (maximum), zero, one, and two.
3. Inhibit.
4. Count down to one, zero (minimum), fifteen, fourteen, and thirteen.



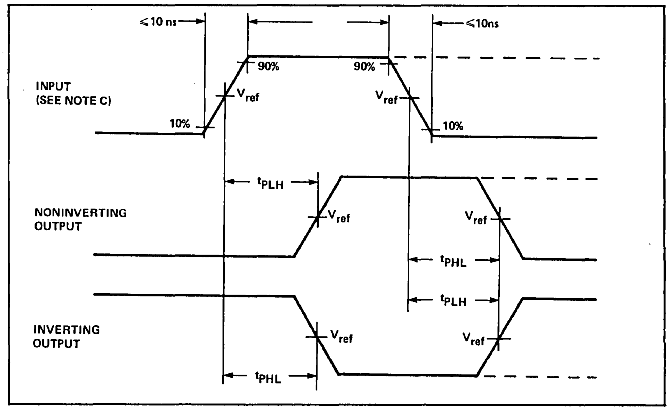


VOLTAGE WAVEFORMS

FIGURE 1 — DATA SETUP TIME VOLTAGE WAVEFORMS

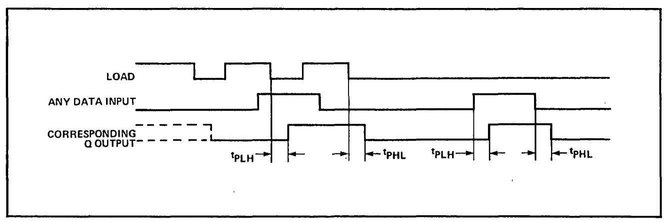
NOTES:

A. C_L includes probe and jig capacitance.
B. All diodes are 1N3064.
C. The input pulses are supplied by generators having the following characteristics: Z_{out} = 50 Ω, duty cycle ≤ 50%, PRR ≤ 1 MHz.
D. V_{ref} = 1.3 V.



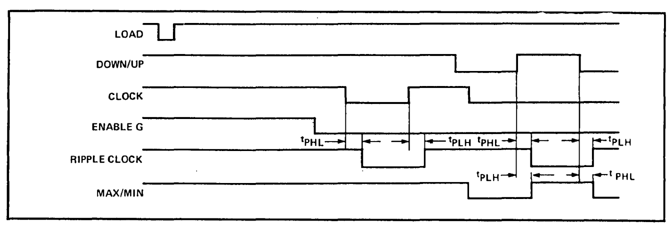
See waveform sequences in figures 4 through 7 for propagation times from a specific input to a specific output. For simplification, pulse rise times, reference levels, etc., have not been shown in figures 4 through 7.

FIGURE 2 — GENERAL VOLTAGE WAVEFORMS FOR PROPAGATION TIMES



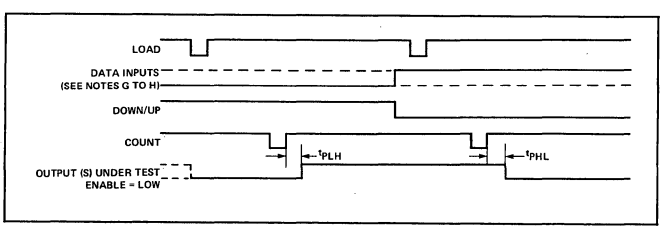
NOTE:
E. Conditions on other inputs are irrelevant.

FIGURE 3 — LOAD TO OUTPUT AND DATA TO OUTPUT



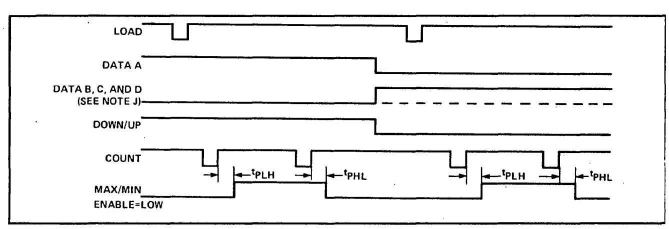
NOTE:
F. All data inputs are low.

FIGURE 4 — ENABLE TO RIPPLE CLOCK, CLOCK TO RIPPLE CLOCK, DOWN/UP TO RIPPLE CLOCK, AND DOWN/UP TO MAX/MIN



NOTE:
G. To test Q_A, Q_B, Q_C, and Q_D outputs: All four data inputs are shown by the solid line.

FIGURE 5 — CLOCK TO OUTPUT



NOTE:
H. Data inputs B and C are shown by the dashed line for the '190 and 'LS190 and the solid line for the '191 and 'LS191: Data input D is shown by the solid line for both devices.

FIGURE 6 — CLOCK TO MAX/MIN

SYNCHRONOUS DECADE UP/DOWN COUNTER 54/74LS192

54LS192-F,W • 74LS192-B,F

DESCRIPTION

This monolithic circuit is a synchronous reversible (up/down) counter having a complexity of 55 equivalent gates. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincidently with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple-clock) counters.

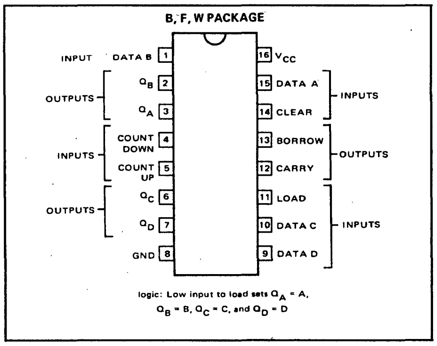
The outputs of the four master-slave flip-flops are triggered by a low-to-high-level transition of either count (clock) input. The direction of counting is determined by which count inputs is pulsed while the other count input is high.

All four counters are fully programmable; that is, each output may be preset to either level by entering the desired data at the data inputs while the load input is low. The output will change to agree with the data inputs independently of the count pulses. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

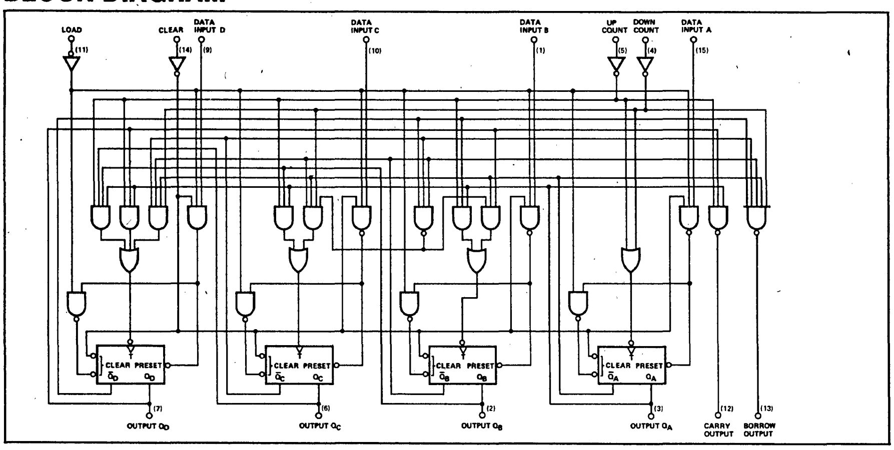
A clear input has been provided which forces all outputs to the low level when a high level is applied. The clear function is independent of the count and load inputs. The clear, count, and load inputs are buffered to lower the drive requirements. This reduces the number of clock drivers, etc., required for long words.

These counters were designed to be cascaded without the need for external circuitry. Both borrow and carry outputs are available to cascade both the up- and down-counting functions. The borrow output produces a pulse equal in width to the count-down input when the counter underflows. Similarly, the carry output produces a pulse equal in width to the count-down input when an overflow condition exists. The counters can then be easily cascaded by feeding the borrow and carry outputs to the count-down and count-up inputs respectively of the succeeding counter.

PIN CONFIGURATION



BLOCK DIAGRAM



TYPICAL CLEAR, LOAD, AND COUNT SEQUENCES

Illustrated below is the following sequence:

1. Clear outputs to zero.
2. Load (preset) to BCD seven.
3. Count up to eight, nine, carry, zero, one, and two.
4. Count down to one, zero, borrow, nine, eight, and seven.

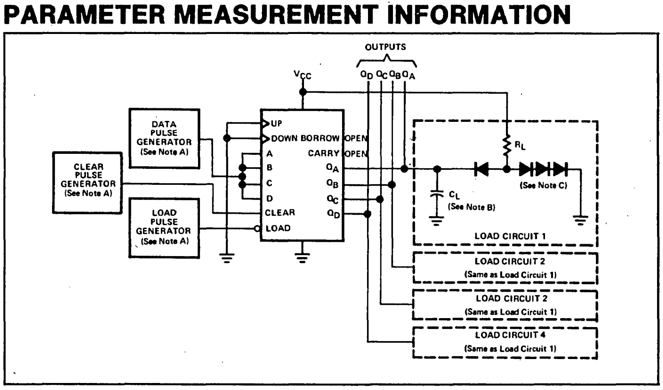
54LS192-F,W • 74LS192-B,F

SWITCHING CHARACTERISTICS $V_{CC} = 5V, T_A = 25°C$

PARAMETER★		FROM (INPUT	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Count}					25	32		MHz
t_w	Input pulse width				20			ns
t_{setup}	Input setup time				20↑			ns
t_{Hold}	Input hold time				0↑			ns
t_{PLH}		Count-up	Carry	C_L = 15pf,		17	26	ns
t_{PHL}		Count-up	Carry	R_L = 2kΩ,		16	24	ns
t_{PLH}		Count-down	Borrow	See Figures 1 and 2		16	24	ns
t_{PHL}		Count-down	Borrow			16	24	ns
t_{PLH}		Either count	Q			25	38	ns
t_{PHL}		Either count	Q			31	47	ns
t_{PLH}		Load	Q			27	40	ns
t_{PHL}		Load	Q			29	40	ns
t_{PHL}		Clear	Q			22	35	ns

★f_{max} = maximum clock frequency
t_{PLH} = propagation delay time, low-to-high level output
t_{PHL} = propagation delay time, high-to-low-level output

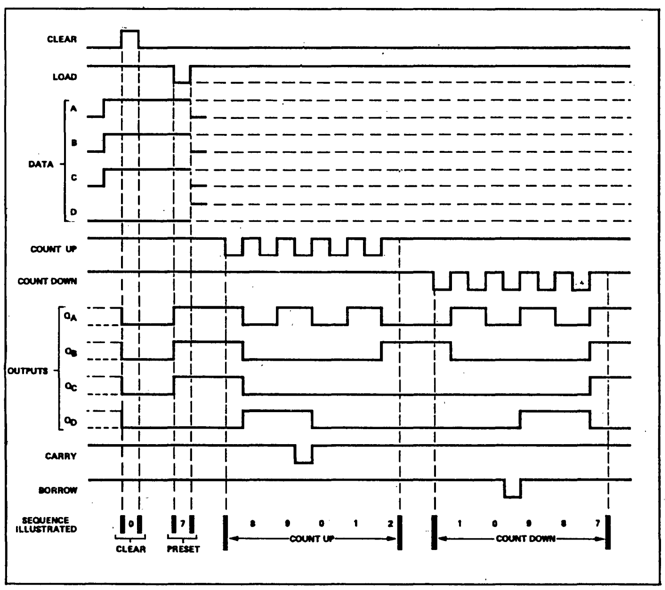
PARAMETER MEASUREMENT INFORMATION



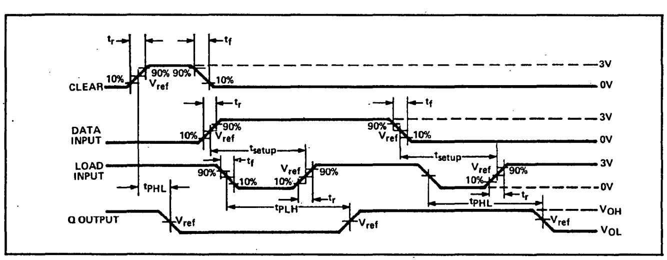
TEST CIRCUIT

NOTES:
A. The pulse generators have the following characteristics: $Z_{out} \approx 50\ \Omega$, and for the data pulse generator PRR ≤ 500 kHz, duty cycle = 50%; for the load pulse generator PRR is two times data PRR, duty cycle = 50%.
B. C_L includes probe and jig capacitance.
C. Diodes are 1N3064.
D. t_r and t_f ≤ 7 ns
E. V_{ref} is 1.3 volts

FIGURE 1—CLEAR, SETUP, AND LOAD TIMES



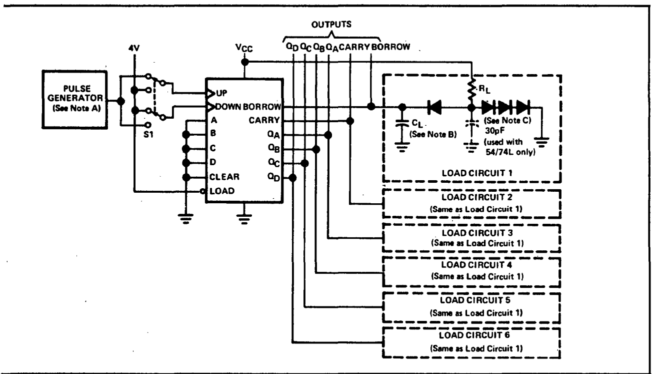
NOTES:
A. Clear overrides load, data, and count inputs.
B. When counting up, count-down input must be high; when counting down, count-up input must be high.



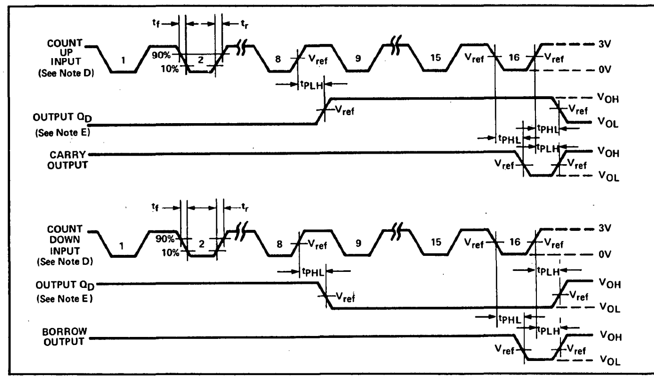
VOLTAGE WAVEFORMS

SYNCHRONOUS DECADE UP/DOWN COUNTER 54/74LS192

54LS192-F,W • 74LS192-B,F



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:
A. The pulse generator has the following characteristics: PRR ≤ 1 MHz, $Z_{out} \approx 50\ \Omega$, duty cycle = 50%.
B. C_L includes probe and jig capacitance.
C. Diodes are 1N3064
D. Count cycle is 1 through 10.
E. Waveforms for outputs Q_A, Q_B, and Q_C are omitted to simplify the drawing.
F. t_r and $t_f \leq 7$ ns
G. V_{ref} is 1.3 volts

FIGURE 2—PROPAGATION DELAY TIMES

SYNCHRONOUS 4-BIT BINARY UP/DOWN COUNTER 54/74LS193

54LS193-F,W • 74LS193-B,F

DESCRIPTION

This monolithic circuit is a synchronous reversible (up/down) counter having a complexity of 55 equivalent gates. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincidently with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple-clock) counters.

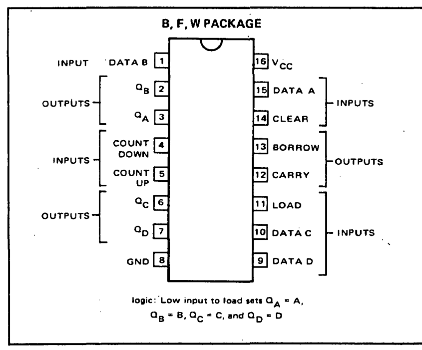
The outputs of the four master-slave flip-flops are triggered by a low-to-high-level transition of either count (clock) input. The direction of counting is determined by which count inputs is pulsed while the other count input is high.

All four counters are fully programmable; that is, each output may be preset to either level by entering the desired data at the data inputs while the load input is low. The output will change to agree with the data inputs independently of the count pulses. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

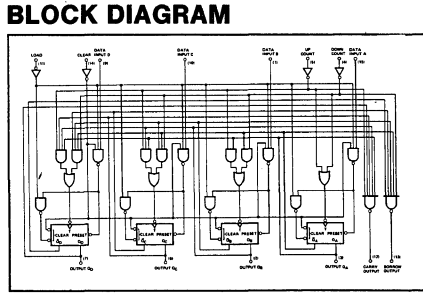
A clear input has been provided which forces all outputs to the low level when a high level is applied. The clear function is independent of the count and load inputs. The clear, count, and load inputs are buffered to lower the drive requirements. This reduces the number of clock drivers, etc., required for long words.

These counters were designed to be cascaded without the need for external circuitry. Both borrow and carry outputs are available to cascade both the up- and down-counting functions. The borrow output produces a pulse equal in width to the count-down input when the counter underflows. Similarly, the carry output produces a pulse equal in width to the count-down input when an overflow condition exists. The counters can then be easily cascaded by feeding the borrow and carry outputs to the count-down and count-up inputs respectively of the succeeding counter.

PIN CONFIGURATION



BLOCK DIAGRAM



SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

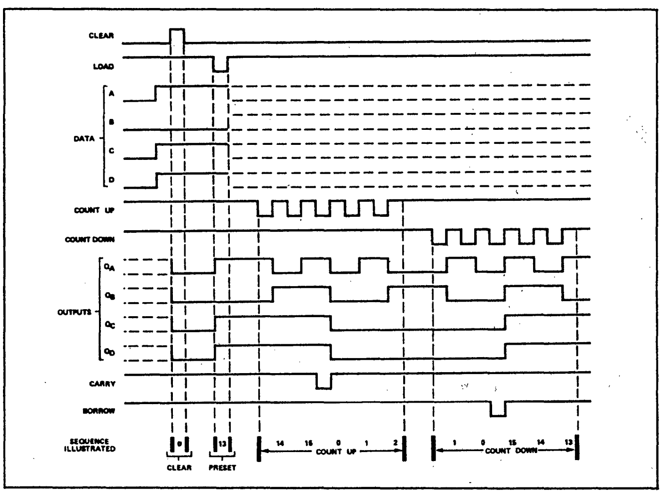
PARAMETER★		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS			
					MIN	TYP	MAX	UNIT
f_{Count}					25	32		MHz
t_w	Input pulse width				20			ns
t_{Set-up}	Input setup time				20↑			ns
t_{Hold}	Input hold time				0↑			ns
t_{PLH}		Count-up	Carry	$C_L = 15pF$, $R_L = 2k\Omega$, See Figures 1 and 2		17	26	ns
t_{PHL}						16	24	
t_{PLH}		Count-down	Borrow			16	24	ns
t_{PHL}						16	24	
t_{PLH}		Either count	Q			25	38	ns
t_{PHL}						31	47	
t_{PLH}		Load	Q			27	40	ns
t_{PHL}						29	40	
t_{PHL}		Clear	Q			22	35	ns

★ f_{max} = maximum clock frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

TYPICAL CLEAR, LOAD, AND COUNT SEQUENCES

Illustrated below is the following sequence:

1. Clear outputs to zero.
2. Load (preset) to binary thirteen.
3. Count up to fourteen, fifteen, carry, zero, one, and two.
4. Count down to one, zero, borrow, fifteen, fourteen, and thirteen.

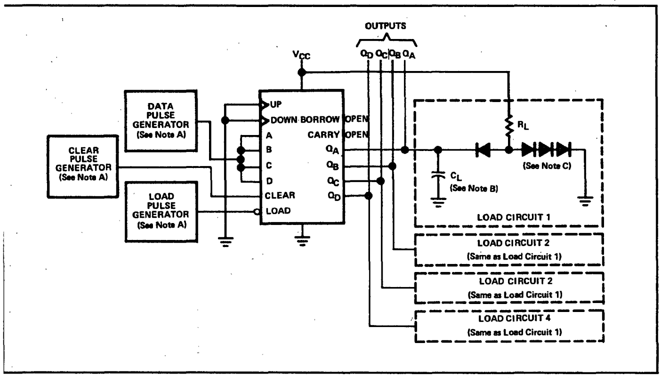


NOTES:

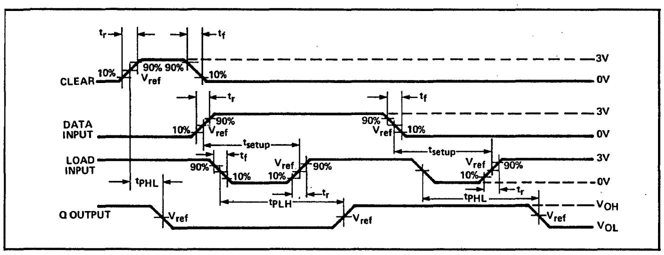
A. Clear overrides load, data, and count inputs.

B. When counting up, count-down input must be high; when counting down, count-up input must be high.

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:

A. The pulse generators have the following characteristics: $Z_{out} \approx 50\ \Omega$ and for the data pulse generator PRR ≤ 500 kHz, duty cycle = 50%; for the load pulse generator PRR is two times data PRR, duty cycle = 50%.

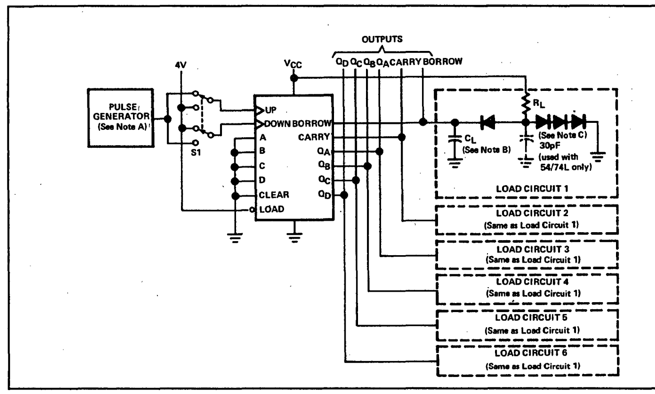
B. C_L includes probe and jig capacitance.

C. Diodes are 1N3064

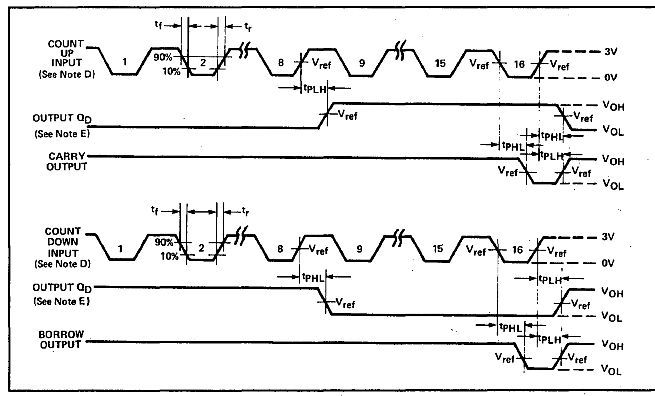
D. t_r and $t_f \leq 7$ ns

E. V_{ref} is 1.3 volts

FIGURE 1—CLEAR, SETUP, AND LOAD TIMES



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:

A. The pulse generator has the following characteristics: PRR ≤ 1 MHz, $Z_{out} \approx 50\ \Omega$, duty cycle = 50%.

B. C_L includes probe and jig capacitance.

C. Diodes are 1N3064

D. Waveforms for outputs Q_A, Q_B, and Q_C are omitted to simplify the drawing.

E. t_r and $t_f \leq 7$ ns

F. V_{ref} is 1.3 volts

FIGURE 2—PROPAGATION DELAY TIMES

54LS194A-F,W • 74LS194A-B,F

DESCRIPTION

This bidirectional shift register is designed to incorporate virtually all of the features a system designer may want in a shift register. The circuit contains 45 equivalent gates and features parallel inputs, parallel outputs, right-shift and left-shift serial inputs, operating-mode-control inputs, and a direct overriding clear line. The register has four distinct modes of operation, namely:

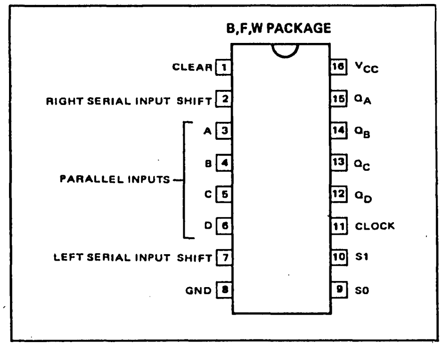
Parallel (broadside) load
Shift right (in the direction Q_A toward Q_D)
Shift left (in the direction Q_D toward Q_A)
Inhibit clock (do nothing)

Synchronous parallel loading is accomplished by applying the four bits of data and taking both mode control inputs, S0 and S1, high. The data are loaded into the associated flip-flops and appear at the outputs after the positive transistion of the clock input. During loading, serial data flow is inhibited.

Shift right is accomplished synchronously with the rising edge of the clock pulse when S0 is high and S1 is low. Serial data for this mode is entered at the shift-right data input. When S0 is low and S1 is high, data shifts left synchronously and new data is entered at the shift-left serial input.

Clocking of the flip-flop is inhibited when both mode control inputs are low. The mode controls of the S54194/N74194 should be changed only while the clock input is high.

PIN CONFIGURATION

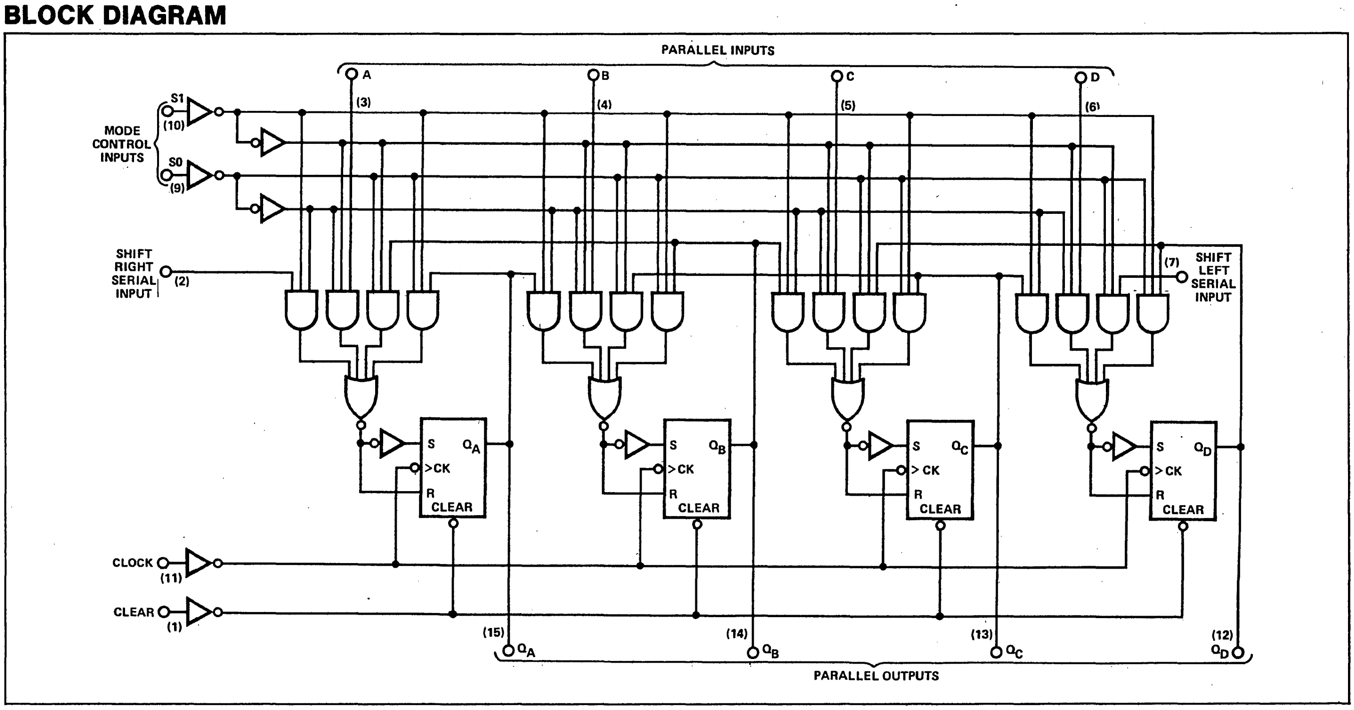


H = high level (steady state)
L = low level (steady state)
X = irrelevant (any input, including transitions)
↑ = transition from low to high level
a,b,c,d, = the level of steady state input at inputs A,B,C, or D, respectively
Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady state input conditions were established
Q_{An}, Q_{Bn}, Q_{Cn}, Q_{Dn} = the level of Q_A, Q_B, Q_C, respectively, before the most recent ↑ transition of the clock

FUNCTION TABLE

INPUTS										OUTPUTS			
	MODE			SERIAL		PARALLEL							
CLEAR	S1	S0	CLOCK	LEFT	RIGHT	A	B	C	D	Q_A	Q_B	Q_C	Q_D
L	X	X	X	X	X	X	X	X	X	L	L	L	L
H	X	X	L	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
H	H	H	↑	X	X	a	b	c	d	a	b	c	d
H	L	H	↑	X	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}
H	L	H	↑	X	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}
H	H	L	↑	H	X	X	X	X	X	Q_{Bn}	Q_{Cn}	Q_{Dn}	H
H	H	L	↑	L	X	X	X	X	X	Q_{Bn}	Q_{Cn}	Q_{Dn}	L
H	L	L	X	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}

BLOCK DIAGRAM

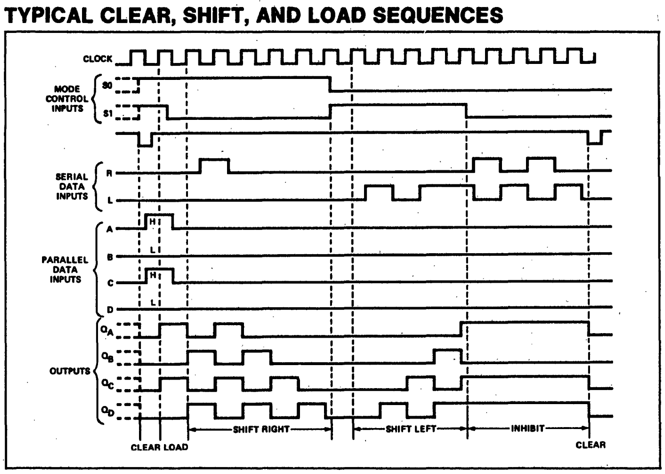


SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

	PARAMETER	TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency	C_L = 15pF, R_L = 2kΩ, See Figure 1	25	36		MHz
t_w	Width of clock or clear pulse		20			ns
t_{Setup}	Input setup time Mode control Serial & parallel data Clear inactive-state		 30↑ 20↑ 25↑			ns
t_{Hold}	Input hold time		0↑			ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear			19	30	ns
t_{PLH}	Propagation delay time, low-to-high-level output from clock			14	22	ns
t_{PHL}	Propagagation delay time, high-to-low-level output from clock			17	22	ns

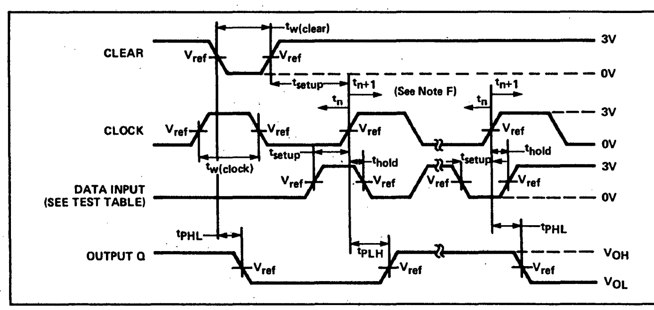
PARAMETER MEASUREMENT INFORMATION

TYPICAL CLEAR, SHIFT, AND LOAD SEQUENCES



TEST TABLE FOR SYNCHRONOUS INPUTS

DATA INPUT FOR TEST	S1	S0	OUTPUT TESTED (SEE NOTE E)
A	4.5V	4.5V	Q_A at t_{n+1}
B	4.5V	4.5V	Q_B at t_{n+1}
C	4.5V	4.5V	Q_C at t_{n+1}
D	4.5V	4.5V	Q_D at t_{n+1}
L Serial Input	4.5V	0V	Q_A at t_{n+4}
R Serial Input	0V	4.5V	Q_D at t_{n+4}



VOLTAGE WAVEFORMS

NOTES:

A. The clock pulse generator has the following characteristics: $Z_{out} \approx 50\ \Omega$ and PRR ≤ MHz, $t_r \le 15$ ns and $t_f \le 6$ ns. When testing f_{max}, vary PRR.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N3064 or 1N916.
D. A clear pulse is applied prior to each test.
E. V_{ref} = 1.3V.
F. Propagation delay times (t_{PLH} and t_{PHL}) are measured at t_n +1. Proper shifting of data is verified at t_n+4 with a functional test.
G. t_n = bit time before clocking transition.
t_n+1 = bit time after one clocking transition.
t_n+4 = bit time after four clocking transitions.

FIGURE 1—SWITCHING TIMES

54LS195A-F,W • 74LS195A-B,F

DESCRIPTION

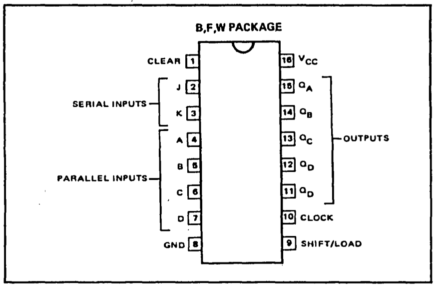
This 4-bit register features parallel inputs, parallel outputs, J-$\overline{K}$ serial inputs, shift/load control input, and a direct overriding clear. All inputs are buffered to lower the input drive requirements. The registers have two modes of operation:

Parallel (Broadside) Load
Shift (In direction Q_A toward Q_D)

Parallel loading is accomplished by applying the four bits of data and taking the shift/load control input low. The data is loaded into the associated flip-flop and appears at the outputs after the positive transition of the clock input. During loading, serial data flow is inhibited.

Shifting is accomplished synchronously when the shift/load control input is high. Serial data for this mode is entered at the J-$\overline{K}$ inputs. These inputs permit the first stage to perform as a J-$\overline{K}$, D-, or T-type flip-flop as shown in the function table.

PIN CONFIGURATION

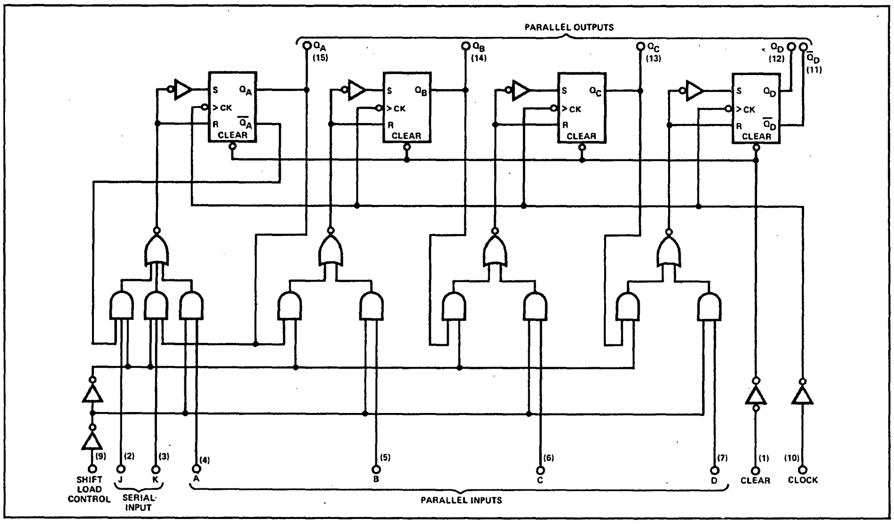


FUNCTION TABLE

INPUTS									OUTPUTS				
	SHIFT/		SERIAL		PARALLEL								
CLEAR	LOAD	CLOCK	J	$\overline{K}$	A	B	C	D	Q_A	Q_B	Q_C	Q_D	$\overline{Q}_D$
L	X	X	X	X	X	X	X	X	L	L	L	L	H
H	L	↑	X	X	a	b	c	d	a	b	c	d	$\overline{d}$
H	H	L	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}	$\overline{Q}_{D0}$
H	H	↑	L	H	X	X	X	X	Q_{A0}	Q_{A0}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	L	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	H	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	H	L	X	X	X	X	$\overline{Q}_{An}$	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$

H = high level (steady state)
L = low level (steady state)
X = irrelevant (any input, including transitions)
↑ = transition from low to high level
a,b,c,d = the level of steady-state input at A,B,C, or D, respectively
Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established
Q_{An}, Q_{Bn}, Q_{Cn} = the level of Q_A, Q_B, or Q_C, respectively, before the most recent transition of the clock

FUNCTIONAL BLOCK DIAGRAM



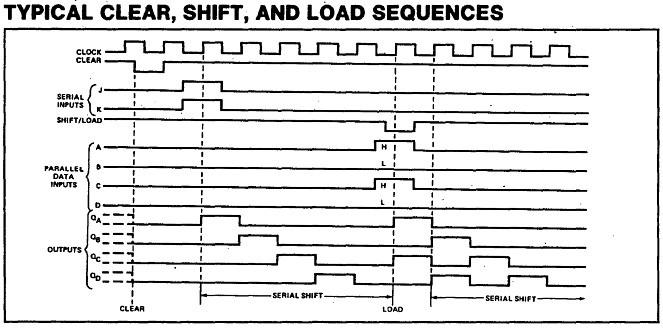
signetics

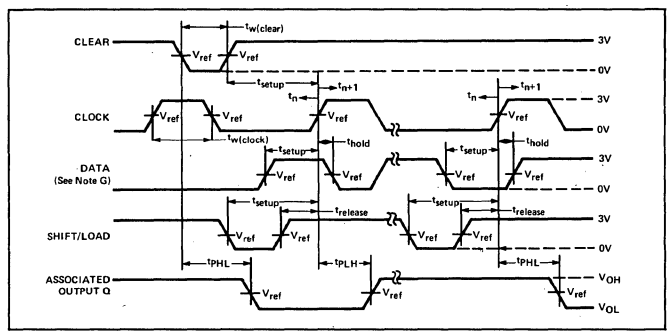
SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency	C_L = 15pF, R_L = 2kΩ,	20	28		MHz
$t_{w(Clock)}$	Width of clock input pulse		16			ns
$t_{w(Clear)}$	Width of clear input pulse		12			ns
t_{setup}	Input setup time					
	Shift/Load		25↑			
	Serial and parallel data		15↑			ns
	Clear inactive-state		25↑			
$t_{Release}$	Shift/load release time				10↑	ns
t_{Hold}	Serial and parallel data hold time		0↑			ns
t_{PHL}	Propagation delay time, high-to-low-level output from clear			31	47	ns
t_{PLH}	Propagation delay time, low-to-high-level output from clock			19	29	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock			23	35	ns

PARAMETER MEASUREMENT INFORMATION

TYPICAL CLEAR, SHIFT, AND LOAD SEQUENCES





VOLTAGE WAVEFORMS

NOTES:

A. The clock pulse generator has the following characteristics: $Z_{out} \approx 50\ \Omega$ and PRR ≤ 1 MHz
$t_r \leq 15$ ns and $t_f \leq 6$ ns. When testing f_{max}, vary the clock PRR.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N3064.
D. A clear pulse is applied prior to each test.
E. V_{ref} = 1.3V.
F. Propagation delay times (t_{PLH} and t_{PHL}) are measured at t_n+1. Proper shifting of data is verified at t_n+4 with a functional test.
G. J and $\overline{K}$ inputs are tested the same as data A, B, C, and D inputs except that shift/load input remains high.
H. t_n = bit time before clocking transition.
t_n+1 = bit time after one clocking transition.
t_n+4 = bit time after four clocking transitions.

FIGURE 1—SWITCHING TIMES

54LS196-F,W • 74LS196-A,F

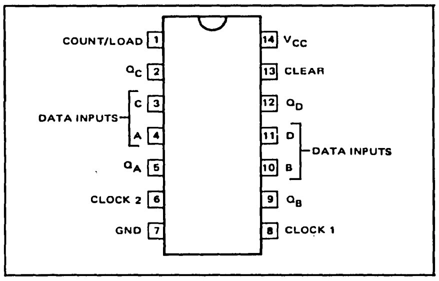
DESCRIPTION

This high-speed monolithic counter consists of four DC coupled, master-slave flip-flops which are internally interconnected to provide a divide-by-two and a divide-by-five counter S54/N74LS196. This counter is fully programmable; that is, the outputs may be preset to any state by placing a low on the count/load input and entering the desired data at the data inputs. The outputs will change to agree with the data inputs independent of the state of the clocks.

During the count operation, transfer of information to the outputs occurs on the negative-going edge of the clock pulse. This counter features a direct clear which when taken low sets all outputs low regardless of the states of the clocks.

This counter may also be used as a 4-bit latch by using the count/load input as the strobe and entering data at the data inputs. The outputs will directly follow the data inputs when the count/load is low, but will remain unchanged when the count/load is high and the clock inputs are inactive.

PIN CONFIGURATION



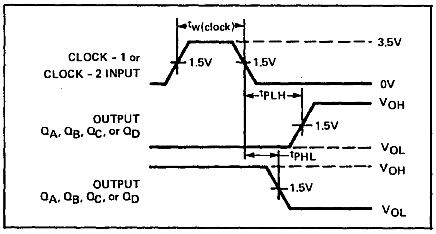
SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER[1]		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Clock}		Clock 1	Q_A		30	40		MHz
		Clock 2	Q_A		15			
t_w	Input pulse-width				20			
		Clock 1			30			ns
		Clock 2						
		Clear			15			
		Load			20			
t_{Hold}	Input hold time							
		High level			$t_{w(Load)}$↓			
		Low level			$t_{w(Load)}$↓			
t_{Setup}	Input setup time							
		High level			10↓			ns
		Low level			15↓			ns
t_{Enable} (Note 3)	Count enable time				20↓			ns
t_{PLH}		Clock 1	Q_A	$C_L = 15pF$		8	15	ns
t_{PHL}				$R_L = 2k\Omega$		13	20	
t_{PLH}		Clock 2	Q_B			16	24	ns
t_{PHL}						22	33	
t_{PLH}		Clock 2	Q_C			38	57	ns
t_{PHL}						41	62	
t_{PLH}		Clock 2	Q_D			12	18	ns
t_{PHL}						30	45	
t_{PLH}		A,B,C,D	Q_A, Q_B, Q_C, Q_D			20	30	ns
t_{PHL}						29	44	
t_{PLH}		Load	Any			27	41	ns
t_{PHL}						30	45	
t_{PHL}		Clear	Any			34	51	ns

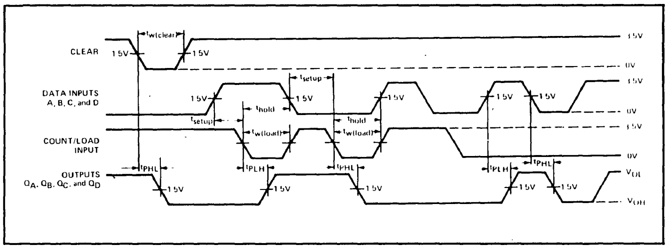
[1] f_{max} = maximum input count frequency
t_{PLH} = propagation delay time, low-to-high-level output, t_{PHL} = propagation delay time, high-to-low-level output.

NOTE:
3. Count enable time is the internal immediately preceding the negative – going edge of the clock pulse during which internal the count/load and clear inputs must be high to ensure counting.

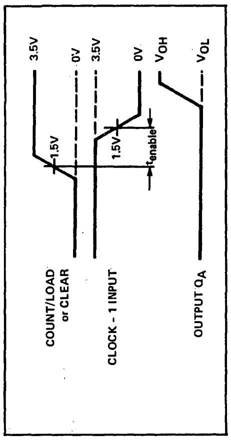
PARAMETER MEASUREMENT INFORMATION



CLOCK-MODE VOLTAGE WAVEFORMS



CLEAR AND LOAD VOLTAGE WAVEFORMS
FIGURE 1



CLOCK ENABLE TIME VOLTAGE WAVEFORMS

NOTES:
A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1 MHz, duty cycle ≤ 50%, t_r < 5 ns, and unless specified, t_f < 5 ns. When testing f_{max}, vary PRR.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N3064.
D. Unless otherwise specified, Q_A is connected to clock 2.

54LS197-F,W • 74LS197-A,F

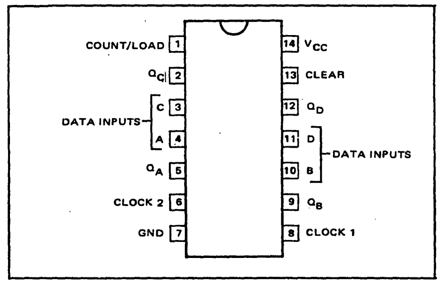
DESCRIPTION

This high-speed monolithic counter consists of four DC coupled, master-slave flip-flops which are internally interconnected to provide a divide-by-two and a divide-by-eight counter S54/N74LS197. These four counters are fully programmable; that is, the outputs may be preset to any state by placing a low on the count/load input and entering the desired data at the data inputs. The outputs will change to agree with the data inputs independent of the state of the clocks.

During the count operation, transfer of information to the outputs occurs on the negative-going edge of the clock pulse. These counters feature a direct clear which when taken low sets all outputs low regardless of the states of the clocks.

These counters may also be used as 4-bit latches by using the count/load input as the strobe and entering data at the data inputs. The outputs will directly follow the data inputs when the count/load is low, but will remain unchanged when the count/load is high and the clock inputs are inactive.

PIN CONFIGURATION

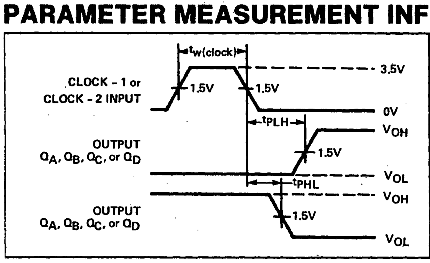


SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

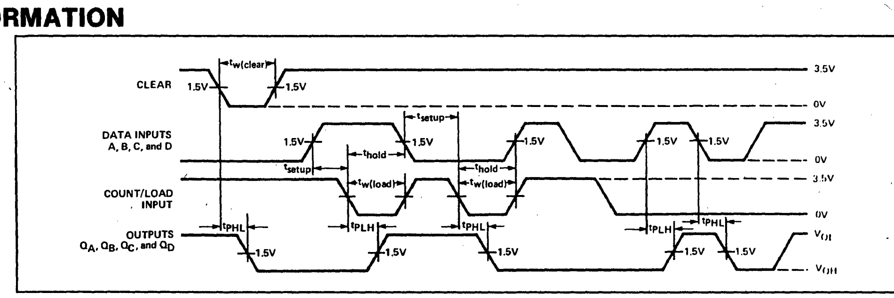
PARAMETER[1]	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Count}	Clock 1	Q_A	C_L = 15pF, R_L = 2kΩ	30	40		MHz
	Clock 2	Q_A		15			
t_{PLH}	Clock 1	Q_A			8	15	ns
t_{PHL}					14	21	
t_{PLH}	Clock 2	Q_B			12	19	ns
t_{PHL}					23	35	
t_{PLH}	Clock 2	Q_C			34	51	ns
t_{PHL}					42	63	
t_{PLH}	Clock 2	Q_D			55	78	ns
t_{PHL}					63	95	
t_{PLH}	A,B,C,D	Q_A, Q_B, Q_C, Q_D			18	27	ns
t_{PHL}					29	44	
t_{PLH}	Load	Any			26	39	ns
t_{PHL}					30	45	
t_{PHL}	Clear	Any			34	51	ns

[1] f_{max} = maximum input count frequency
t_{PLH} = propagation delay time, low-to-high-level output, t_{PHL} = propagation delay time, high-to-low-level output.

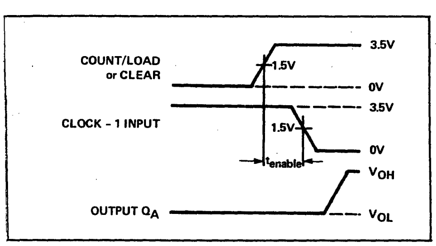
PARAMETER MEASUREMENT INFORMATION



CLOCK MODE



CLEAR AND LOAD



CLOCK ENABLE

DESCRIPTION

The 54/74LS221 is a monolithic dual multivibrator which features a negative-transition-triggered input either of which can be used as an inhibit input. Pulse triggering occurs at a particular voltage level and is not directly related to the transition time of the input pulse. Schmitt-trigger input circuitry (TTL hystersis) for B input allows jitter-free triggering from inputs with transition rates as slow as 1 volt/second, providing the circuit with excellent noise immunity of typically 1.2V. A high immunity to Vcc noise of typically 1.5V is also provided by internal latching circuitry.

Once fired, the outputs are independent of further transitions of the A and B inputs and are a function of the timing components, or the output pulse can be terminated by the overriding clear. Input pulses may be of any duration relative to the output pulse. Output pulse length may be varied from 35ns to 49s (54LS221) or 70s (74LS221) by choosing appropriate timing components. With R_{ext} = 2kΩ and C_{ext} = 0, an output pulse of typically 30ns is achieved which may be used as a d-c triggered reset signal. Output rise and fall times are TTL compatible and independent of pulse length. Typical triggering and clearing sequences are illustrated as a part of the switching characteristics waveforms.

Pulse width stability is achieved through internal compensation and is virtually independent of Vcc and temperature. In most applications, pulse stability will only be limited by the accuracy of external timing components.

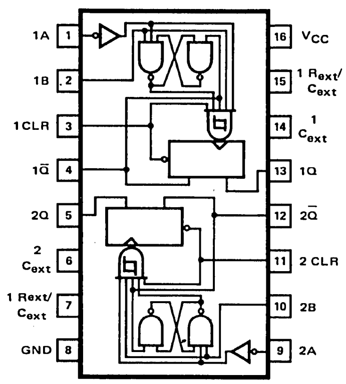
Jitter-free operation is maintained over the full temperature and Vcc ranges for more than six decades of timing capacitance (10pF to 10μF) and more than one decade of timing resistance (2kΩ to 70kΩ for the 54LS221, and 2kΩ to 100kΩ for the 74LS221). Throughout these ranges, pulse width is defined by the relationship: $t_{w(out)} = C_{ext}R_{ext}$. In 20.7 C_{ext}-R_{ext}. In circuits where pulse cutoff is not critical, timing capacitance up to 1000μF and timing resistance as low as 1.4k may be used. Also, the range of jitter-free output pulse widths is extended if Vcc is held to 5V and free-air temperature is 25°C. Duty cycles as high as 90% are achieved when using maximum recommended R_1. High duty cycles are available if a certain amount pulse width jitter is allowed. The variance in output pulse width from device to device is typically less than ±0.5% for given external timing components.

Pin assignments for this device are identical to those of the 54LS123/74LS123 so that the 54/74LS221 can be substituted for those products in systems not using the retrigger by merely changing the value of R_{ext} and/or C_{ext}.

54LS221-F,W • 74LS221-B,F

PIN CONFIGURATION

B,F,W PACKAGE



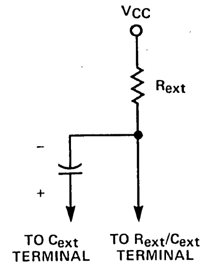
positive logic: Low input to clear reset Q low and Q̄ high regardless of d-c levels at A or B input.

FUNCTION TABLE
(EACH MONOSTABLE)

INPUTS			OUTPUTS	
CLEAR	A	B	Q	Q̄
L	X	X	L	H
X	H	X	L	H
X	X	L	L	H
H	L	↑		
H	↓	H		

Also see description and switching characteristics

H = high level (steady state)
L = low level (steady state)
↑ = transition from low to high level
↓ = transition from high to low level
= one high level pulse
= one low level pulse
X = irrelevant



TIMING COMPONENT CONNECTIONS

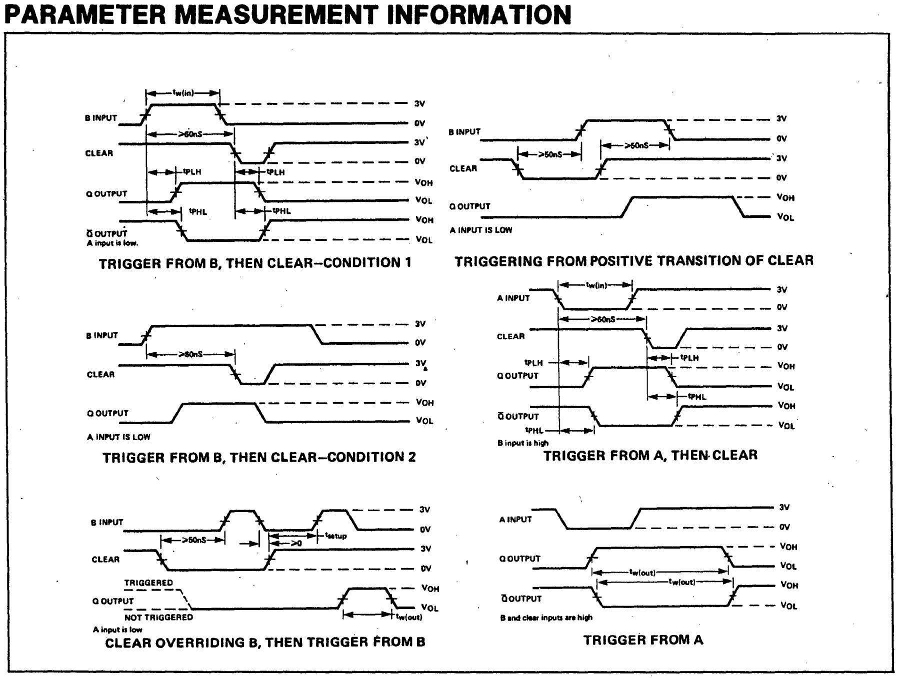
54LS221-F,W • 74LS221-B,F

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER*		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS		LIMITS MIN	TYP	MAX	UNIT
dv/dt	Rate of rise or fall of input pulse				C_{ext}=80pF, R_{ext}=2kΩ				
	Schmitt, B					1			V/s
	Logic input, A					1			V/μs
$t_{w(in)}$	A or B input pulse width					40			ns
$t_{w(out)}$		A or B	Q or $\overline{Q}$		C_{ext}=80pF, R_{ext}=2kΩ	70	120	150	
					C_{ext}=0, R_{ext}=2kΩ	20	47	70	ns
					C_{ext}=100pF, R_{ext}=10kΩ	600	670	750	
				C_L = 15pF,	C_{ext}=1μF, R_{ext}=10kΩ	6.0	6.7	7.5	ns
$t_{w(Clear)}$	Clear input pulse width			R_L = 2kΩ,		40			ns
t_{Setup}	Input setup time			See Figure 1		15↑			ns
R_{ext}	External timing resistance			and Note 3					
	54LS221					1.4		70	KΩ
	74LS221					1.4		100	KΩ
C_{ext}	External timing capacitance					0		1000	μF
	Output duty cycle								
	R_T=2kΩ							67	%
	R_T=MAX R_{ext}							90	%
t_{PLH}		A	Q				45	70	ns
		B	Q				35	55	
t_{PHL}		A	$\overline{Q}$				50	80	ns
		B	$\overline{Q}$				40	65	
t_{PHL}		Clear	Q					55	ns
t_{PLH}		Clear	$\overline{Q}$					65	ns

*t_{PLH} = Propagation delay time, low-to-high-level output
t_{PHL} = Propagation delay time, high-to-low-level output
$t_{w(out)}$ = Output pulse width

PARAMETER MEASUREMENT INFORMATION



NOTES:
A. Input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, Z_{out} ≈ 50 Ω; t_r ≤ 15 ns, t_f ≤ 6 ns.
B. All measurements are made between the 1.3V points of the indicated transitions

FIGURE 1—SWITCHING CHARACTERISTICS

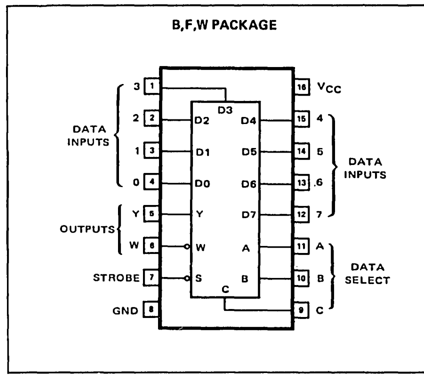
54LS251-F,W • 74LS251-B,F

DESCRIPTION

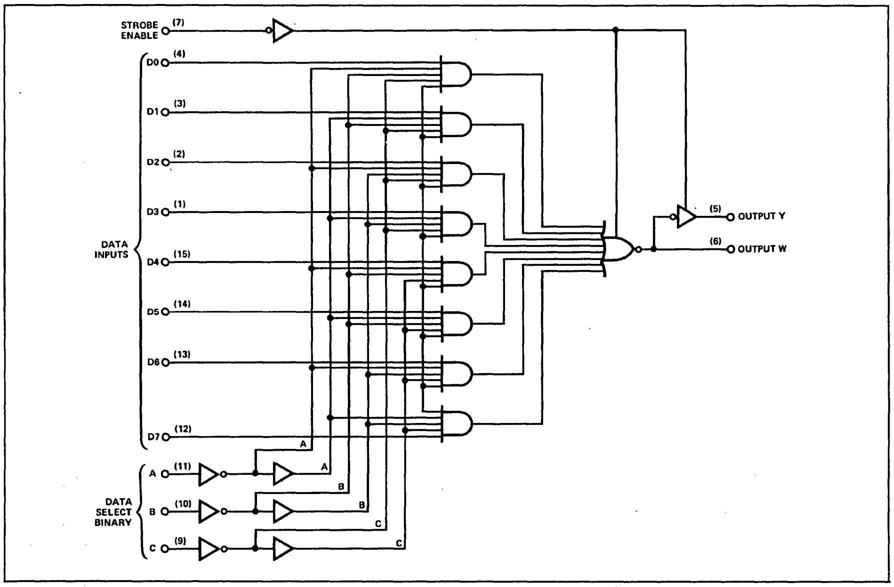
These monolithic data selectors/multiplexers contain full on-chip binary decoding to select one-of-eight data sources and feature a strobe-controlled three-state output. The strobe must be at a low logic level to enable these devices. The three-state outputs permit up to 49 54LS251 and 129 74LS251 outputs to be connected to a common bus. When the strobe input is high, both outputs are in a high-impedance state in which both the upper and lower transistors of each totem-pole output are off, and the output neither drives nor loads the bus significantly. When the strobe is low, the outputs are activated and operate as standard TTL totem-pole outputs.

To minimize the possibility that two outputs will attempt to take a common bus to opposite logic levels, the output control circuitry is designed so that the average output disable time is shorter than the average output enable time.

PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE

INPUTS				OUTPUTS	
SELECT			STROBE	Y	W
C	B	A	S		
X	X	X	H	Z	Z
L	L	L	L	D0	$\overline{D0}$
L	L	H	L	D1	$\overline{D1}$
L	H	L	L	D2	$\overline{D2}$
L	H	H	L	D3	$\overline{D3}$
H	L	L	L	D4	$\overline{D4}$
H	L	H	L	D5	$\overline{D5}$
H	H	L	L	D6	$\overline{D6}$
H	H	H	L	D7	$\overline{D7}$

H = high logic level, L = low logic level
X = irrelevant, Z = high impedance (off)
D0, D1 . . . D7 = the level of the respective D input

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER[1]	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	A,B, or C	Y	$C_L = 15pF$, $R_L = 2k\Omega$		29	45	ns
t_{PHL}	(4 levels)				28	45	
t_{PLH}	A, B, or C	W			20	33	ns
t_{PHL}	(3 levels)				21	33	
t_{PLH}	Any D	Y			17	28	ns
t_{PHL}					18	28	
t_{PLH}	Any D	W			10	15	ns
t_{PHL}					9	15	
t_{ZH}	Strobe	Y			17	45	ns
t_{ZL}					26	40	
t_{ZH}	Strobe	W			17	27	ns
t_{ZL}					24	40	
t_{HZ}	Strobe	Y	$C_L = 5pF$, $R_L = 2k\Omega$		30	45	ns
t_{LZ}					15	25	
t_{HZ}	Strobe	W			30	55	ns
t_{LZ}					15	25	

[1] t_{PLH} = Propagation delay time low-to-high-level output
t_{PHL} = Propagation delay time, high-to-low-level output
t_{ZH} = Output enable time to high level
t_{ZL} = Output enable time to low level
t_{HZ} = Output disable time from high level
t_{LZ} = Output disable time from low level
Load circuit and waveforms are shown at front of book.

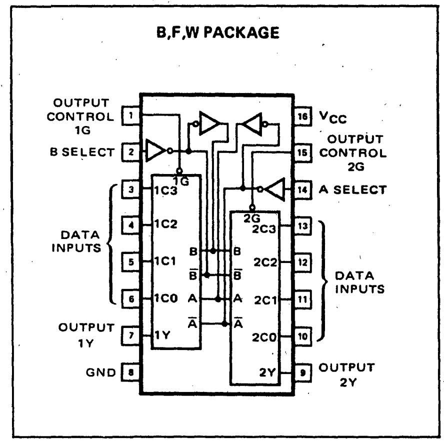
54LS253-F,W • 74LS253-B,F

DESCRIPTION

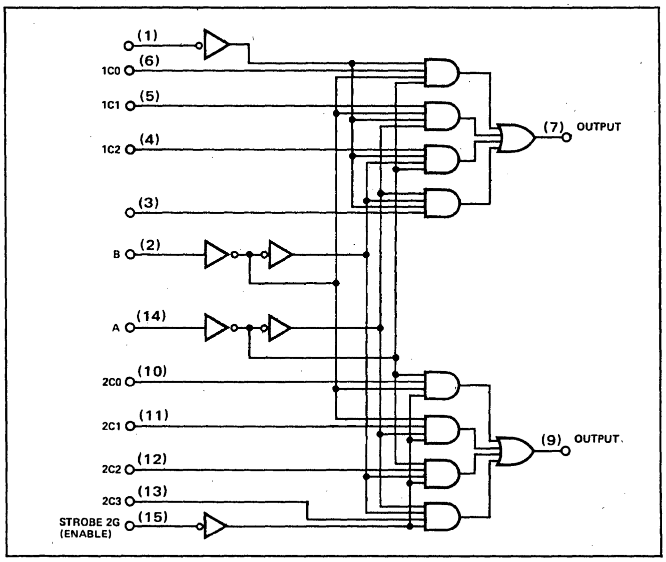
Each of these Schottky-clamped data selectors/multiplexers contains inverters and drivers to supply fully complementary, on-chip, binary decoding data selection to the AND-OR gates. Separate output control inputs are provided for each of the two four-line sections.

The three-state outputs can interface with and drive data lines of bus-organized systems. With all but one of the common outputs disabled (at a high-impedance state) the low-impedance of the single enabled output will drive the bus line to a high or low logic level.

PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE

SELECT INPUTS		DATA INPUTS				OUTPUT CONTROL	OUTPUT
B	A	C0	C1	C2	C3	G	Y
X	X	X	X	X	X	H	Z
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

Address inputs A and B are common to both sections.
H = high level. L = low level. X = irrelevant. Z = high impedance (off)

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER[1]	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	Data	Y	C_L = 15pF, R_L = 2kΩ		11	25	ns
t_{PHL}					13	20	
t_{PLH}	Select	Y			20	45	ns
t_{PHL}					21	32	
t_{ZH}	Output Control	Y			11	23	ns
t_{ZL}					15	23	
t_{HZ}	Output Control	Y	C_L = 5pF, R_L = 2kΩ		27	41	ns
t_{LZ}					12	27	

[1] t_{PLH} = Propagation delay time, low-to-high-level output
t_{PHL} = Propagation delay timne, high-to-low-level output
t_{ZH} = Output enable time to high level
t_{ZL} = Output enable time to low level
t_{HZ} = Output disable time from high level
t_{LZ} = Output disable time from low level
Load circuit and typical waveforms are shown at the front of book.

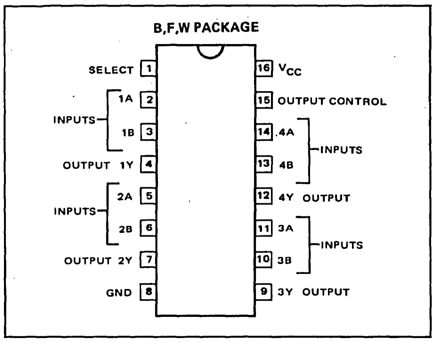
54LS257-F,W • 74LS257-B,F

DESCRIPTION

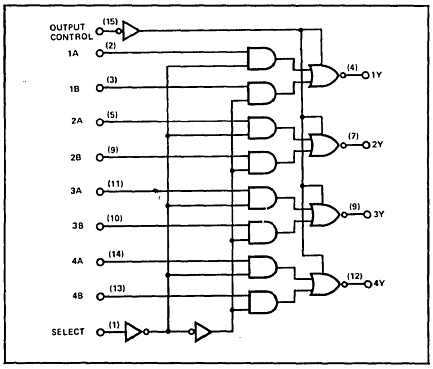
This Schottky-clamped high-performance multiplexer features three-state outputs that can interface directly with and drive data lines of bus-organized systems. With all but one of the common outputs disabled (at a high-impedance state) the low impedance of the single enabled output will drive the bus line to a high or low logic level. To minimize the possibility that two outputs will attempt to take a common bus to opposite logic levels, the output-enable circuitry is designed such that the output disable times are shorter than the output enable times.

This three-state output feature means that n-bit (paralleled) data selectors with up to 258 sources can be implemented for data buses. It also permits the use of standard TTL registers for data retention throughout the system.

PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE

INPUTS				OUTPUT Y	
OUTPUT CONTROL	SELECT	A	B	'LS257 'S257	'LS258 'S258
H	X	X	X	Z	Z
L	L	L	X	L	H
L	L	H	X	H	L
L	H	X	L	L	H
L	H	X	H	H	L

H = H = high level, L = low level, X = irrelevant, Z = high impedance (off)

SWITCHING CHARACTERISTICS $V_{CC} = 5V, T_A = 25°C$

PARAMETER★	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	Data	Any	$C_L = 15pF$		12	18	ns
t_{PHL}					12	18	
t_{PLH}	Select	Any			14	21	ns
t_{PHL}					14	21	
t_{ZH}	Output Control	Any			20	30	ns
t_{ZL}					20	30	
t_{HZ}	Output Control	Any	$C_L = 5pF$		14	30	ns
t_{LZ}					14	35	

★t_{PLH} = Propagation delay time, low-to-high-level output
t_{PHL} = Propagation delay time, high-to-low-level output
t_{ZH} = Output enable time to high level
t_{ZL} = Output enable time to low level
t_{HZ} = Output disable time from high level
t_{LZ} = Output disable time from low level

Load circuits and waveforms are shown at the front of the book.

QUAD 2-LINE TO 1-LINE DATA SELECTOR/MULTIPLEXER — 54/74LS258

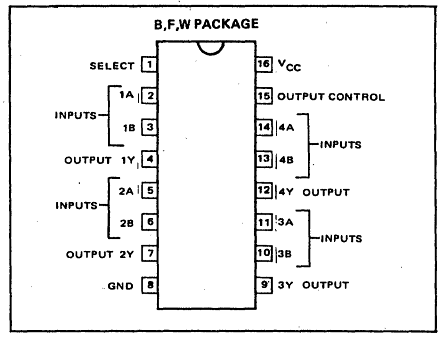
54LS258-F,W • 74LS258-B,F

DESCRIPTION

This Schottky-clamped high-performance multiplexer features three-state outputs that can interface directly with and drive data lines of bus-organized systems. With all but one of the common outputs disabled (at a high-impedance state) the low impedance of the single enabled output will drive the bus line to a high or low logic level. To minimize the possibility that two outputs will attempt to take a common bus to opposite logic levels, the output-enable circuitry is designed such that the output disable times are shorter than the output enable times.

This three-state output feature means that n-bit (paralleled) data selectors with up to 258 sources can be implemented for data buses. It also permits the use of standard TTL registers for data retention throughout the system.

PIN CONFIGURATION



SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER★	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH}	Data	Any	$C_L = 15pF$		12	18	ns
t_{PHL}					12	18	
t_{PLH}	Select	Any			14	21	ns
t_{PHL}					14	21	
t_{ZH}	Output Control	Any			20	30	ns
t_{ZL}					20	30	
t_{HZ}	Output Control	Any	$C_L = 5pF$		14	20	ns
T_{LZ}					14	21	

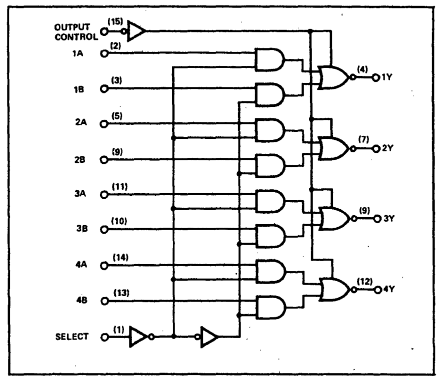
★t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
t_{ZH} = output enable time-to-high-level
t_{ZL} = output enable time-to-low-level
t_{HZ} = output disable time-from-high-level
t_{LZ} = output disable time-from-low-level
Load circuits and waveforms are shown at the front of the book.

FUNCTION TABLE

INPUTS				OUTPUT Y
OUTPUT CONTROL	SELECT	A	B	
H	X	X	X	Z
L	L	L	X	H
L	L	H	X	L
L	H	X	L	H
L	H	X	H	L

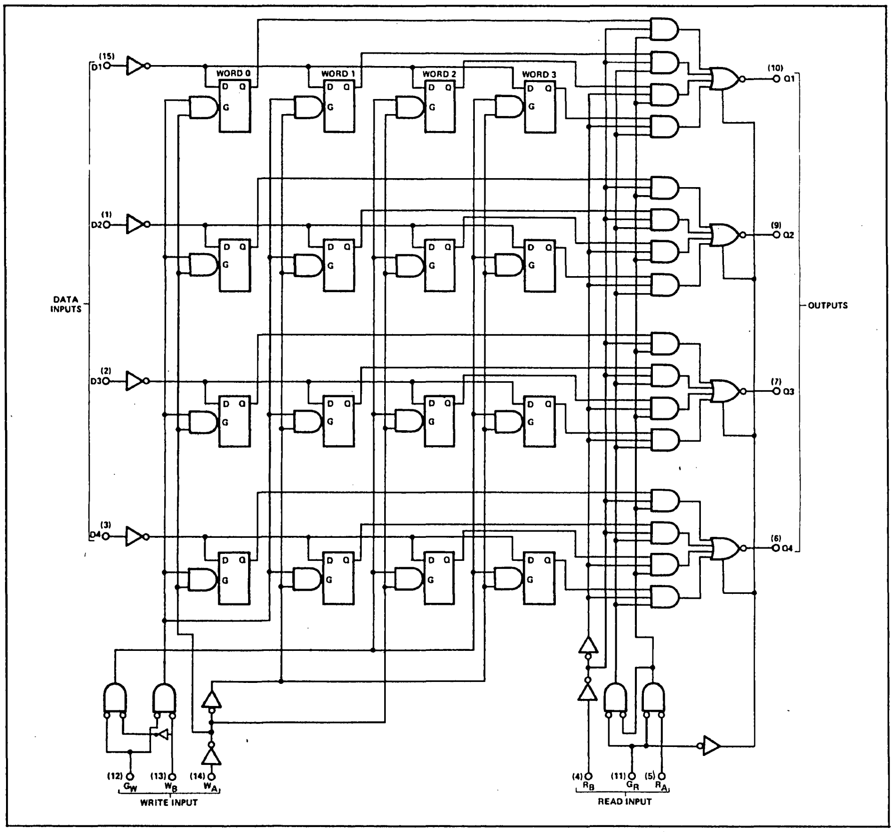
H = high level, L = low level, X = irrelevant, Z = high impedance (off)

BLOCK DIAGRAM

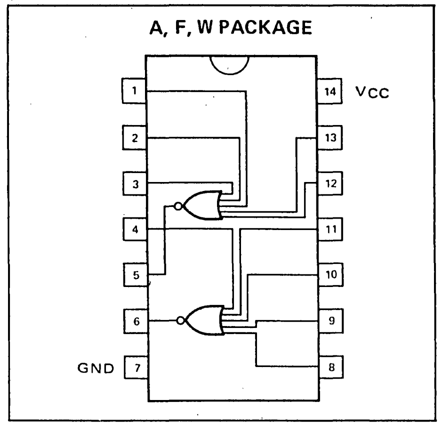


54LS260-F,W • 74LS260-A,F

BLOCK DIAGRAM



PIN CONFIGURATION



SWITCHING CHARACTERISTICS $V_{CC} = 5V, T_A = 25°C$

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low-to-high-level output	$C_L = 15pF, R_L = 2k\Omega$		10	15	ns
t_{PHL}	Propagation delay time, high-to-low-level output			10	15	ns

54LS261-F,W • 74LS261-B,F

DESCRIPTION

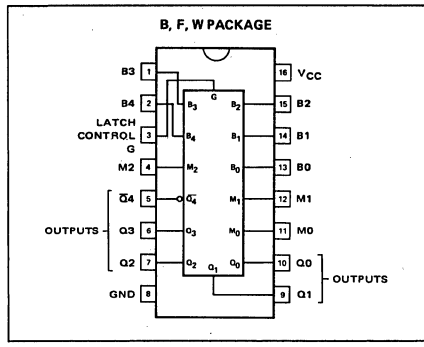
These low-power Schottky circuits are designed to be used in parallel multiplication applications. They perform binary multiplication in two's-complement form, two bits at a time.

The M inputs are for the multiplier bits and the B inputs are for the multiplicand. The Q outputs represent the partial product as a recoded base-4 number. This recoding effectively reduces the Wallace-tree hardware requirements by a factor of two.

The outputs represent partial products in one's-complement form generated as a result of multiplication. A simple rounding scheme using two additional gates is needed for each partial product to generate two's complement.

The leading (most significant) bit of the product is inverted for ease in extending the sign to square (left justify) the partial-product bits.

PIN CONFIGURATION

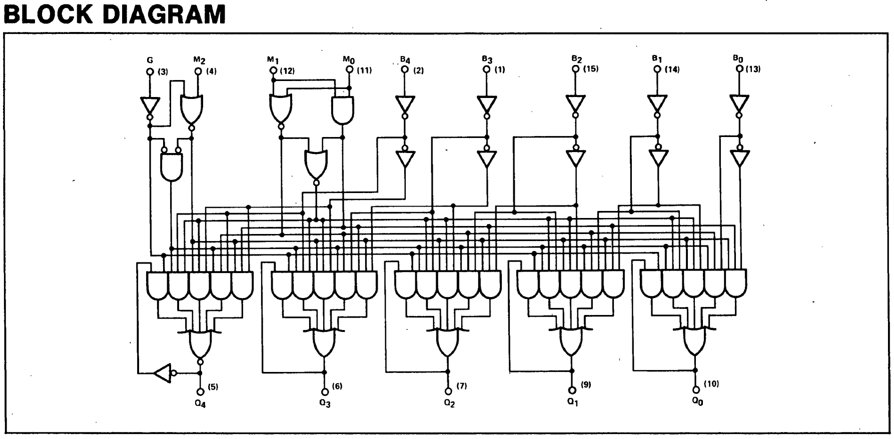


FUNCTION TABLE

INPUTS				OUTPUTS				
LATCH CONTROL G	MULTIPLIER							
	M2	M1	M0	$\overline{Q4}$	Q3	Q2	Q1	Q0
L	X	X	X	$\overline{Q4}_0$	$Q3_0$	$Q2_0$	$Q1_0$	$Q0_0$
H	L	L	L	H	L	L	L	L
H	L	L	H	$\overline{B4}$	B4	B3	B2	B1
H	L	H	L	$\overline{B4}$	B4	B3	B2	B1
H	L	H	H	$\overline{B4}$	B3	B2	B1	B0
H	H	L	L	B4	$\overline{B3}$	$\overline{B2}$	$\overline{B1}$	$\overline{B0}$
H	H	L	H	B4	$\overline{B4}$	$\overline{B3}$	$\overline{B2}$	$\overline{B1}$
H	H	H	L	B4	$\overline{B4}$	$\overline{B3}$	$\overline{B2}$	$\overline{B1}$
H	H	H	H	H	L	L	L	L

H = high level, L = low level, X = irrelevant
$\overline{Q4}_0 \ldots Q0_0$ = The logic level of the same output before the high-to-low- transition of G.
B4 . . .B0 = The logic level of the indicated multiplicand (b) input.

BLOCK DIAGRAM



54LS261-F,W • 74LS261-B,F

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

	PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_w	Width of enable pulse				25			ns
t_{setup}	Input setup time							
		Any M input	Q		17↓			ns
		Any B input	Q		15↓			ns
t_{Hold}	Input hold time							
		Any M input	Q		0↓			ns
		Any B input	Q		0↓			ns
t_{PLH}	Propagation delay time Low-to-high-level output	Enable G	Any Q	C_L = 15pF, R_L = 2kΩ		22	35	ns
t_{PHL}	Propagation delay time High-to-low-level output	Enable G	Any Q			20	30	ns
t_{PLH}	Propagation delay time Low-to-high-level output	Any M input	Any Q			25	40	ns
t_{PHL}	Propagation delay time High-to-low-level output	Any M input	Any Q			22	35	ns
t_{PLH}	Propagation delay time Low-to-high-level output	Any B input	Any Q			27	42	ns
t_{PHL}	Propagation delay time High-to-low-level output	Any B input	Any Q			24	37	ns

Load circuit and waveforms are shown at the front of book.

TYPICAL APPLICATION DATA

Multiplication of the numbers 26 (multiplicand) by 29 (multiplier) in decimal, binary, and 2-bit-at-a-time-binary is shown here:

```
DECIMAL        BINARY                 2-BIT-AT-A-TIME BINARY
               Sign                      Sign
               Bit                       Bit
B  26          011010                    011010
M  29          011101                    (+2)(-1)(+1)
  234          011010                    00000011010    3
   52         000000       6             111100110      Partial
  754        011010       Partial        0110100        Products
            011010        Products       01011110010
           011010                        Sign  Product
          000000                         Bit
          01011110010
          Sign   Product
          Bit
```

Two points should be noted in the 2-bit-at-a-time-binary example above. First, in positioning the partial products beneath each other for final addition, each partial product is shifted two places to the left of the partial products above it instead of one place as is done in regular multiplication. Second, the msb of the partial product (the sign bit) is extended to the sign-bit column of the final answer. A substantial reduction of multiplication time, cost, and power is obtained by implementing a parallel partial-product-generation scheme using a 2-bit-at-a-time algorithm, followed by a Wallace Tree summation.

Partial-product-generation rules of the algorithm are:

1. Examine two bits of multiplier M plus the next lower bit. For the first partial product (PP1) the next lower bit is zero.

```
2^15 2^14 2^13 2^12 2^11 2^10 2^9 2^8 2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0 0
 PP8       PP7       PP6       PP5      PP4     PP3     PP2     PP1
```

2. Generate partial product (PPi) as shown in the following table:
3. Weight the partial products by indexing each two places left relative to the next-less-significant product.
4. Extend the most-significant bit of the partial product to the sign-bit place value of the final product.

```
                 EXAMPLE OF ALGORITHM

M = 29 = 011101       Operator        B = 26 = 011010
                      Symbol
             010
        110           +1B             00000011010
    011               -1B             111100110
                      +2B             0110100
```

The summation of these partial products was shown in the 2-bit-at-a-time binary multiplication example above.

The 54/74LS261 generates partial products according to this algorithm with two exceptions:

1. The one's complement is generated for the cases requiring the two's complement. The two's complement can be obtained by adding one to the one's complement; this rounding can be done by using one NAND gate and one AND gate as shown in Figure B.
2. The most-significant bit is complemented to reduce the hardware required to extend the sign bit. This extension can be accomplished by adding a hard-wired logic 1 in bit position 2^{2i+15} of each partial product and also in bit position 2^{16} of the first partial product (PP1).

MULTIPLIER BITS FROM STEP 1			OPERATOR SYMBOL	TO OBTAIN PARTIAL PRODUCT
2^{2i-1}	2^{2i-2}	2^{2i-3}		
0	0	0	0	Replace multiplicand by zero
0	0	1	+1B	Copy multiplicand
0	1	0	+1B	Copy multiplicand
0	1	1	+2B	Shift multiplicand left one bit
1	0	0	−2B	Shift two's complement of multiplicand left one bit
1	0	1	−1B	Replace multiplicand by two's complement
1	1	0	−1B	Replace multiplicand by two's complement
1	1	1	0	Replace multiplicand by zero

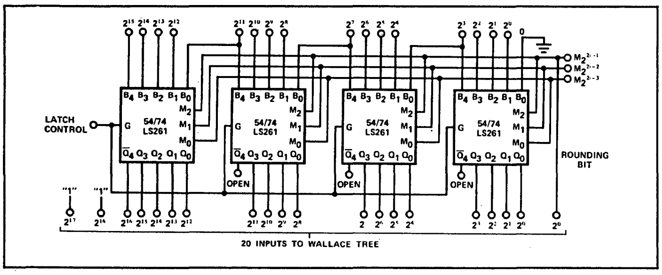


FIGURE A—FIRST PARTIAL PRODUCT, PP1

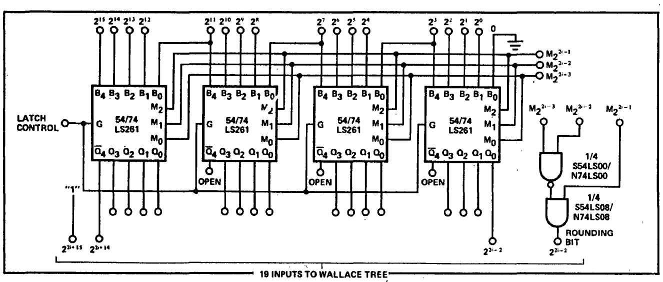


FIGURE B—OTHER PARTIAL PRODUCTS, PPi

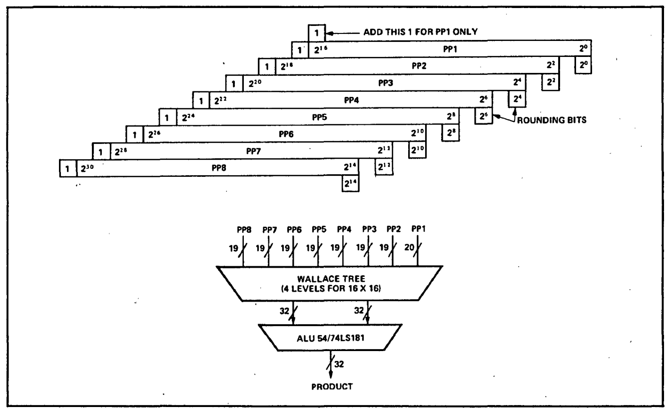


FIGURE C — MANIPULATION OF PARTIAL PRODUCTS FOR ENTRY INTO WALLACE TREE

In general, the 4 x 2 bit 54/74LS261 can be expanded for use in 4m x 2n bit multipliers. Partial-product generation uses m x n 54/74LS261s, m x n ÷ 16 54/74LS00s, and m x n ÷ 16 54/74LS08s. The size of the Wallace Tree and ALU requirements vary depending on the size of the problem. The count for the 16 x 16 bit multiplier is:

32	S54LS261/N74LS261
2	S54LS00/N74LS00
2	S54LS08/N74LS08
56	54H183/74H183*
7	S54LS181/N74LS181
2	S54LS182/N74LS182*

*Not currently available from Signetics.

QUAD 2-INPUT EXCLUSIVE-NOR GATE W/OPEN COLLECTOR OUTPUTS 54/74LS266

54LS266-F,W • 74LS266-A,F

DESCRIPTION

The 54/74LS266 is comprised of four independent 2-input exclusive-NOR gates with open-collector outputs. The open-collector outputs permit tying outputs together for multiple-bit comparisons.

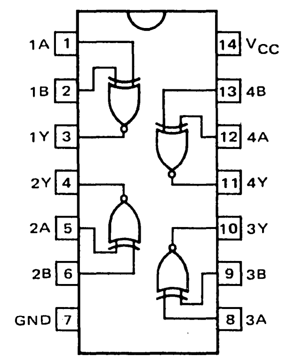
SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER★	FROM (INPUT)	TEST CONDITIONS		LIMITS MIN	TYP	MAX	UNIT
t_{PLH} t_{PHL}	A or B	Other input low	C_L = 15pF, R_L = 2kΩ		18 18	30 30	ns
t_{PLH} t_{PHL}	A or B	Other input high			18 18	30 30	ns

★t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
Load circuit and waveforms are shown at the front of the book.

PIN CONFIGURATION

A,F,W PACKAGE



positive logic: $Y=\overline{A \oplus B}=\bar{A}\bar{B}+AB$

FUNCTION TABLE

INPUTS A	B	OUTPUT Y
L	L	H
L	H	L
H	L	L
H	H	H

H = high level, L = low level

4-BIT BINARY ADDER 54/74LS283

54LS283-F,W • 74LS283-B,F

DESCRIPTION

This improved full adder performs the addition of two 4-bit binary numbers. The sum (Σ) outputs are provided for each bit and the resultant carry (C4) is obtained from the fourth bit. This adder features full internal look ahead across all four bits generating the carry term in ten nanoseconds typically. This provides the system designer with partial look-ahead performance at the economy and reduced package count of a ripple-carry implementation.

The adder logic, including the carry, is implemented in its true form meaning that the end-around carry can be accomplished without the need for logic or level inversion.

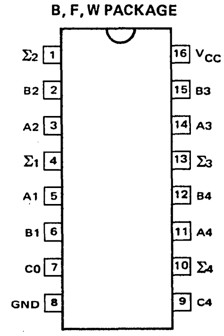
SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER★	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_{PLH} t_{PHL}	C0	Any Σ	C_L = 15pF, R_L = 2kΩ		16 15	24 24	ns
t_{PLH} t_{PHL}	A_i or B_i	Σ_i			15 15	24 24	ns
t_{PLH} t_{PHL}	C0	C4			11 11	17 22	ns
t_{PLH} t_{PHL}	A_i or B_i	C4			11 12	17 17	ns

★t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
Load circuit and waveforms are shown at the front of the book.

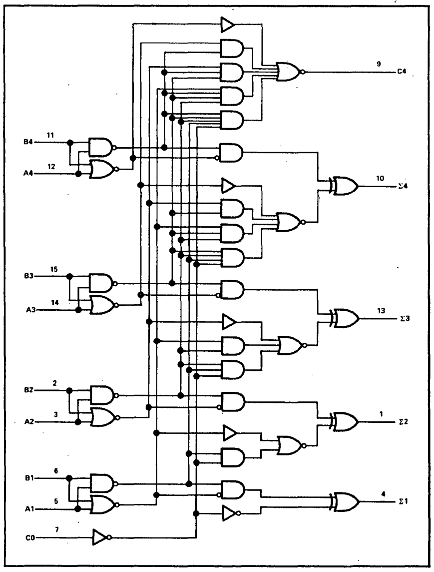
PIN CONFIGURATION

B, F, W PACKAGE



54LS283-F,W • 74LS283-B,F

FUNCTIONAL BLOCK DIAGRAM



FUNCTION TABLE

INPUT				OUTPUT					
				WHEN CO = L		WHEN C2 = L	WHEN CO = H		WHEN C2 = H
A1 A3	B2 B3	A2 A4	B2 B4	Σ1 Σ3	Σ2 Σ4	C2 C4	Σ1 Σ3	Σ2 Σ4	C2 C4
L	L	L	L	L	L	L	H	L	L
H	L	L	L	H	L	L	L	H	L
L	H	L	L	H	L	L	L	H	L
H	H	L	L	L	H	L	H	H	L
L	L	H	L	L	H	L	H	H	L
H	L	H	L	H	H	L	L	L	H
L	H	H	L	H	H	L	L	L	H
H	H	H	L	L	L	H	H	L	H
L	L	L	H	L	H	L	H	H	L
H	L	L	H	H	H	L	L	L	H
L	H	L	H	H	H	L	L	L	H
H	H	L	H	L	L	H	H	L	H
L	L	H	H	L	L	H	H	L	H
H	L	H	H	H	L	H	L	H	H
L	H	H	H	H	L	H	L	H	H
H	H	H	H	L	H	H	H	H	H

H = high level, L = low level

NOTE: Input conditions at A1, B1, A, B2, and CO are used to determine outputs Σ1 and Σ2 and the value of the internal carry C2. The values at C2, A3, B3, A4, and B4, are then used to determine outputs Σ3, Σ4, and C4.

54LS290-F,W • 74LS290-A,F

DESCRIPTION

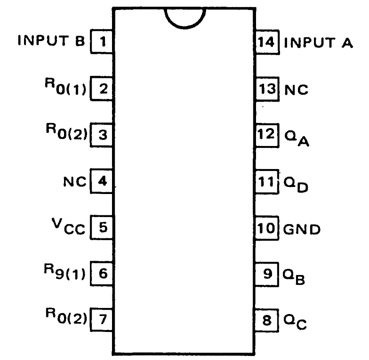
This monolithic counter contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divide-by-five.

The 54/74LS290 has a gated zero reset and has gated set-to-nine inputs for use in BCD nine's complement applications.

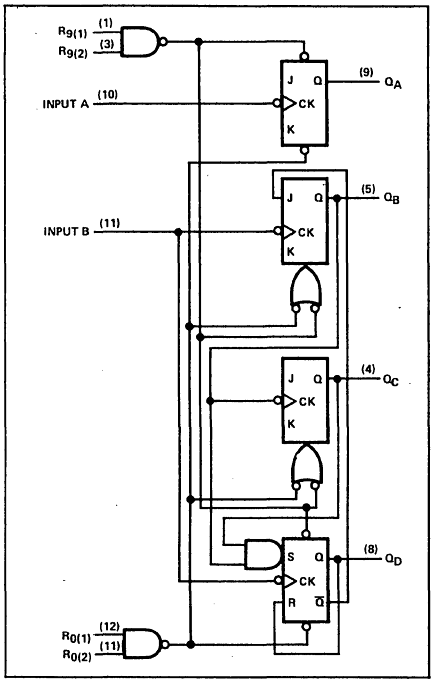
To use the maximum count length (decade or four-bit binary) of these counters, the B input is connected to the Q_A output. The input count pulses are applied to input A and the outputs are as described in the function table. A symmetrical divide-by-ten count can be obtained by connecting the Q_D output to the A input and applying the input count to the B input which gives a divide-by-ten square wave at output Q_A.

PIN CONFIGURATION

A,F,W PACKAGE



FUNCTIONAL BLOCK DIAGRAM



The J and K inputs shown without connection are for reference only and are functionally at a high level.

BCD COUNT SEQUENCE (See Note A)

COUNT	OUTPUT Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

BI-QUINARY (5-2) (See Note B)

COUNT	OUTPUT Q_A	Q_D	Q_C	Q_B
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	H	L	L	L
6	H	L	L	H
7	H	L	H	L
8	H	L	H	H
9	H	H	L	L

RESET/COUNT FUNCTION TABLE

RESET INPUTS $R_{0(1)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	OUTPUT Q_D	Q_C	Q_B	Q_A
H	H	L	X	L	L	L	L
H	H	X	L	L	L	L	L
X	X	H	H	H	L	L	H
X	L	X	L	COUNT			
L	X	L	X	COUNT			
L	X	X	L	COUNT			
X	L	L	X	COUNT			

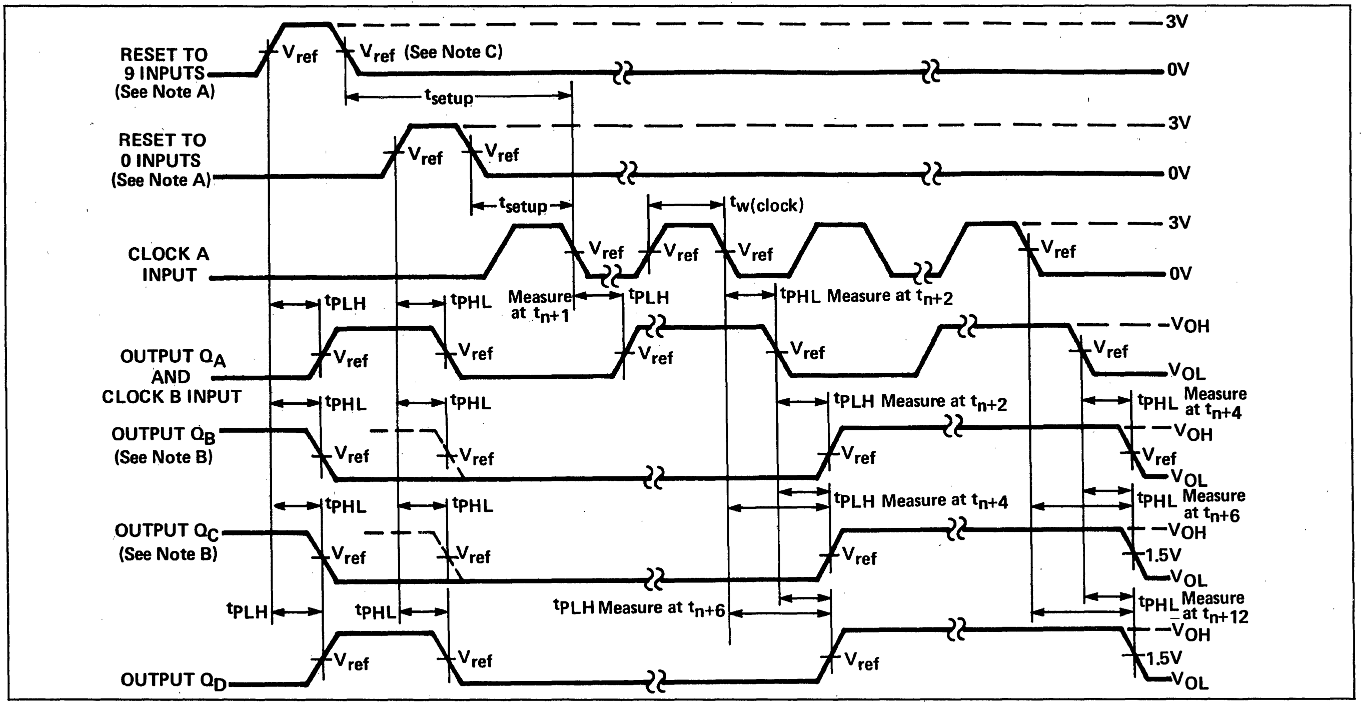
NOTES:
A. Output Q_A is connected to input B for BCD count.
B. Output Q_D is connected to input A for bi-quinary count.
C. Output Q_A is connected to input B.
D. H = high level, L = low level, X = irrelevant

SWITCHING CHARACTERISTICS $V_{CC} = 5V$, $T_A = 25°C$

PARAMETER★		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Count}		A	Q_A		32	42		MHz
		B	Q_B		16			
t_w	Input pulse width							
		A	Q		15			ns
		B	Q		30			ns
		Reset	Q		15			ns
t_{Setup}	Input setup time				25↓			ns
t_{PLH}		A	Q_A			10	16	ns
t_{PHL}						12	18	
t_{PLH}		A	Q_D	$C_L = 15pF$,		32	48	ns
t_{PHL}				$R_L = 400\Omega$		34	50	
t_{PLH}		B	Q_B			10	16	ns
t_{PHL}						14	21	
t_{PLH}		B	Q_C			21	32	ns
t_{PHL}						23	35	
t_{PLH}		B	Q_D			21	32	ns
t_{PHL}						23	35	
t_{PHL}		Set-to-0	Any			26	40	ns
t_{PLH}		Set-to-9	Q_A, Q_D			20	30	ns
t_{PHL}			Q_B, Q_C			26	40	

★f_{max} = maximum count frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

NOTES:
A. Input pulses are supplied by a generator having the following characteristics: $t_r \leq 15ns$, $t_f \leq 5ns$, PRR = 1 MHz, duty cycle = 50%, $Z_{out} \approx 50$ ohms.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N916 or 1N3064.
D. Each reset input is tested separately with the other reset at 4.5V.
E. Reference waveforms are shown with dashed lines.
F. V_{ref} = 1.3V.

DESCRIPTION

54LS293-F,W • 74LS293-A,F

This monolithic counter contains four master-slave flip-flops and a gated zero reset to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divide-by-eight.

To use the maximum count length (decade or four-bit binary) of this counter, the B input is connected to the Q_A output. The input count pulses are applied to input A and the outputs are as described in the function table.

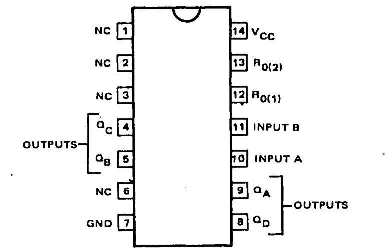
RESET/COUNT FUNCTION TABLE

RESET INPUTS		OUTPUT			
$R_{0(1)}$	$R_{0(2)}$	Q_D	Q_C	Q_B	Q_A
H	H	L	L	L	L
L	X	COUNT			
X	L	COUNT			

NOTES:
A. Output Q_A is connected to input B for BCD count.
B. Output Q_D is connected to input A for bi-quinary count.
C. Output Q_A is connected to input B.
D. H = high level, L = low level, X = irrelevant

PIN CONFIGURATION

A,F,W PACKAGE

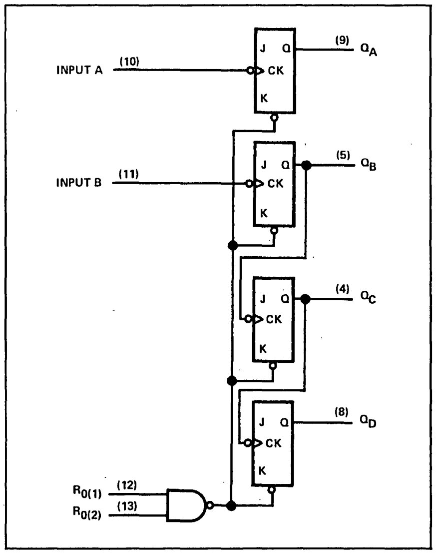


SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER★	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
f_{Count}	A	Q_A		32	42		MHz
	B	Q_B		16			
t_W Input pulse width	A	Q		15			ns
	B	Q		30			ns
	Reset	Q		15			ns
t_{Setup} Input setup time				25↓			ns
t_{PLH}	A	Q_A	C_L = 15pF,		10	16	ns
t_{PHL}			R_L = 400Ω		12	18	
t_{PLH}	A	Q_D			46	70	ns
t_{PHL}					46	70	
t_{PLH}	B	Q_B			10	16	ns
t_{PHL}					14	21	
t_{PLH}	B	Q_C			21	32	ns
t_{PHL}					23	35	
t_{PLH}	B	Q_D			34	51	ns
t_{PHL}					34	51	
t_{PHL}	Set-to-0	Any			26	40	ns

★f_{max} = maximum count frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

BLOCK DIAGRAM

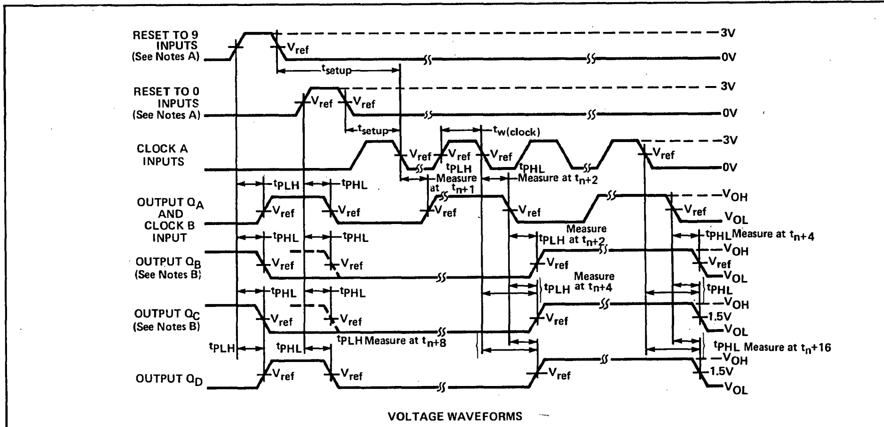


The J and K inputs shown without connection are for reference only and are functionally at a high level.

COUNT SEQUENCE
(See Note C)

COUNT	OUTPUT Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H
10	H	L	H	L
11	H	L	H	H
12	H	H	L	L
13	H	H	L	H
14	H	H	H	L
15	H	H	H	H

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

NOTES:
A. Input pulses are supplied by a generator having the following characteristics: $t_r \leq 15$ ns, $t_f \leq 5$ ns, PRR = 1 MHz, duty cycle = 50%, $Z_{out} \approx 50$ ohms.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N916 or 1N3064.
D. Each reset input is tested separately with the other reset at 4.5 V.
E. Reference waveforms are shown with dashed lines.
F. V_{ref} = 1.3 V.

4-BIT RIGHT-SHIFT LEFT-SHIFT REGISTER W/3-STATE OUTPUTS 54/74LS295A

54LS295A-F,W • 74LS295A-A,F

DESCRIPTION

These 4-bit registers feature parallel inputs, parallel outputs, and clock, serial, mode, and output control inputs. The registers have three modes of operation:

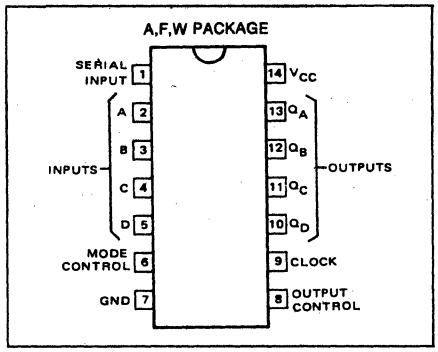
- Parallel (broadside) load
- Shift right (the direction Q_A toward Q_D)
- Shift left (the direction Q_D toward Q_A)

Parallel loading is accomplished by applying the four bits of data and taking the mode control input high. The data is loaded into the associated flip-flops and appears at the outputs after the high-to-low transition of the clock input. During parallel loading, the entry of serial data is inhibited.

Shift right is accomplished when the mode control is low; shift left is accomplished when the mode control is high by connecting the output of each flip-flop to the parallel input of the previous flip-flop (Q_D to input C, etc.) and serial data is entered at input D.

When the output control is high, the normal logic levels of the four outputs are available for driving the loads or bus lines. The outputs are disabled independently from the level of the clock by a low logic level at the output control input. The outputs then present a high impedance and neither load nor drive the bus line; however, sequential operation of the registers is not affected.

PIN CONFIGURATION



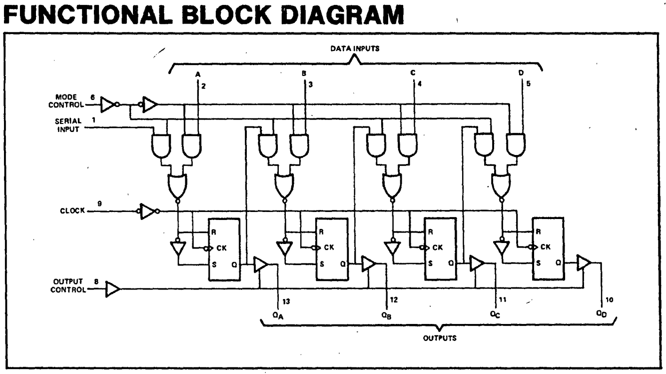
FUNCTION TABLE

INPUTS							OUTPUTS			
MODE CONTROL	CLOCK	SERIAL	PARALLEL A	PARALLEL B	PARALLEL C	PARALLEL D	Q_A	Q_B	Q_C	Q_D
H	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
H	↓	X	a	b	c	d	a	b	c	d
H	↓	X	Q_B†	Q_C†	Q_D†	d	Q_{Bn}	Q_{Cn}	Q_{Dn}	d
L	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
L	↓	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}
L	↓	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}

When the output control is low, the outputs are disabled to the high impedance state, however, sequential operation of the registers is not affected.

†Shifting left requires external connection of Q_B to A, Q_C to B, and Q_D to C. Serial data is entered at input D.
H = high level (steady state), L = low level (steady state), X = irrelevant (any input, including transitions)
↓ = transition from high to low level.
a, b, c, d = the level of steady state input at inputs A, B, C, or D, respectively.
Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_C, or Q_D, respectively, before the indicated steady state input conditions were established.
Q_{An}, Q_{Bn}, Q_{Cn}, Q_{Dn} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the most recent ↓ transition of the clock.

FUNCTIONAL BLOCK DIAGRAM



4-BIT RIGHT-SHIFT LEFT-SHIFT REGISTER W/3-STATE OUTPUTS 54/74LS295A

54LS295A-F,W • 74LS295A-A,F

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		TEST CONDITIONS	LIMITS			
			MIN	TYP	MAX	UNIT
f_{Clock}	Clock frequency		20	28		MHz
$t_{w(Clock)}$	Width of clock pulse		25			ns
t_{Setup}	Input setup time, high or low level		20↓			ns
t_{Hold}	Input hold time, high or low level		20↓			ns
t_{PLH}	Propagation delay time, low-to-high-level output	C_L = 15pF,		40	60	ns
t_{PHL}	Propagation delay time, high-to-low-level output	R_L = 2kΩ		47	70	ns
t_{ZH}	Output enable time to high level			15	25	ns
t_{ZL}	Output enable time to low level			21	30	ns
t_{HZ}	Output disable time from high level			39	60	ns
t_{LZ}	Output disable time from low level			32	50	ns

Load circuit and waveforms are shown at the front of the book.

QUAD 2-INPUTS EXCLUSIVE-OR GATE 54/74LS386

54LS386-F,W • 74LS386-A,F

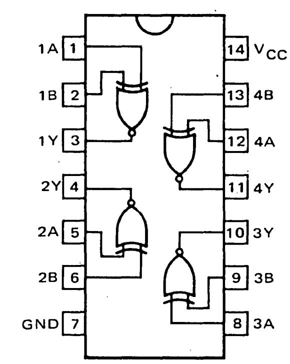
SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER★	FROM (INPUT)	TEST CONDITIONS		LIMITS			
				MIN	TYP	MAX	UNIT
t_{PLH} t_{PHL}	A or B	Other input low	C_L = 15pF, R_L = 2kΩ		10 10	23 17	ns
t_{PLH} t_{PHL}	A or B	Other input high			10 10	30 22	ns

★t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

PIN CONFIGURATION

A,F,W PACKAGE



positive logic: Y = A ⊕ B = $\bar{A}B + A\bar{B}$

FUNCTION TABLE
(EACH GATE)

INPUTS		OUTPUT
A	B	
L	L	L
L	H	H
H	L	H
H	H	L

H = high level
L = low level

4X4 REGISTER FILE WITH 3-STATE OUTPUTS — 54/74LS670

54LS670-F,W • 74LS670-B,F

DESCRIPTION

The S54LS670 and N74LS670 MSI 16-bit TTL register files incorporate the equivalent of 98 gates. The register file is organized as 4 words of 4 bits each and separate on-chip decoding is provided for addressing the four word locations to either write-in or retrieve data. This permits simultaneous writing into one location and reading from another word location.

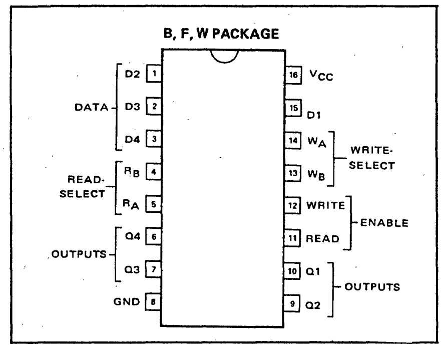
Four data inputs are available which are used to supply the 4-bit word to be stored. Location of the word is determined by the write-address inputs A and B in conjunction with a write-enable signal. Data applied at the inputs should be in its true form. That is, if a high-level signal is desired from the output, a high-level is applied at the data input for that particular bit location. The latch inputs are arranged so that new data will be accepted only if both internal address gate inputs are high. When this condition exists, data at the D input is transferred to the latch output. When the write-enable input, G_W, is high, the data inputs are inhibited and their levels can cause no change in the information stored in the internal latches. When the read-enable input, G_R, is high, the data outputs are inhibited and go into the high-impedance state.

The individual address lines permit direct acquisition of data stored in any four of the latches. Four individual decoding gates are used to complete the address for reading a word. When the read address is made in conjunction with the read-enable signal, the word appeaars at the four outputs.

This arrangement—data-entry addressing separate from data-read addressing and individual sense line—eliminates recovery times, permits simultaneous reading and writing, and is limited in speed only by the write time (27 nanoseconds typical). The register file has a nondestructive readout in that data is not lost when addressed.

All inputs except read enable and write enable are buffered to lower the drive requirements to one Series 54LS/74LS standard load, and input-clamping diodes minimize switching transients to simplify system design. High-speed, double-ended AND-OR-INVERT gates are employed for the read-address function and have high-sink-current, three-state outputs. Up to 128 of these outputs may be wire-AND connected for increasing the capacity up to 512 words. Any number of these registers may be paralleled to provide n-bit word length.

PIN CONFIGURATION



WRITE FUNCTION TABLE

(See Notes A, B and C)

WRITE INPUTS			WORD			
W_B	W_A	G_W	0	1	2	3
L	L	L	Q=D	Q_0	Q_0	Q_0
L	H	L	Q_0	Q=D	Q_0	Q_0
H	L	L	Q_0	Q_0	Q=D	Q_0
H	H	L	Q_0	Q_0	Q_0	Q=D
X	X	H	Q_0	Q_0	Q_0	Q_0

READ FUNCTION TABLE

(See Notes A and D)

READ INPUTS			OUTPUTS			
R_B	R_A	G_R	Q1	Q2	Q3	Q4
L	L	L	W0B1	W0B1	W0B3	W0B4
L	H	L	W1B1	W1B2	W1B3	W1B4
H	L	L	W2B1	W2B2	W2B3	W2B4
H	H	L	W3B1	W3B2	W3B3	W3B4
X	X	H	Z	Z	Z	Z

NOTES:

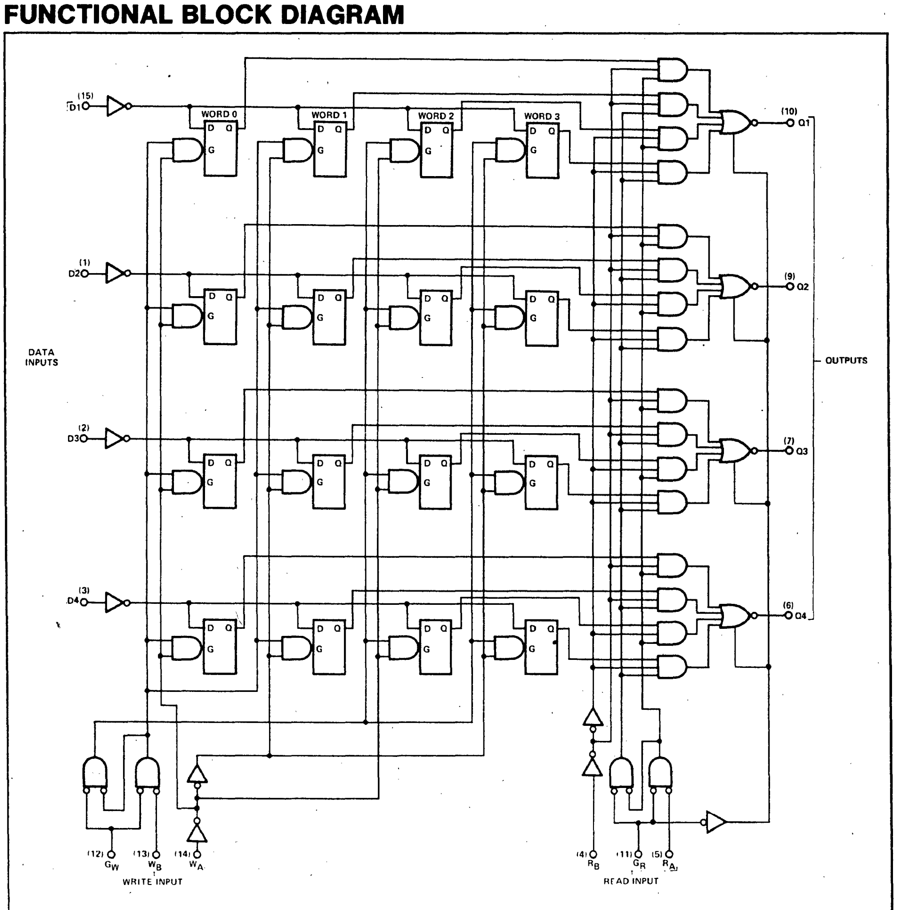
A. H = high level, L = low level, X = irrelevant, Z = high impedance (off).

B. (Q = D) = The four selected internal flip-flop outputs will assume the states applied to the four external data inputs.

C. Q_0 = the level of Q before the indicated input conditions were established.

D. W0B1 = The first bit of word 0, etc.

FUNCTIONAL BLOCK DIAGRAM



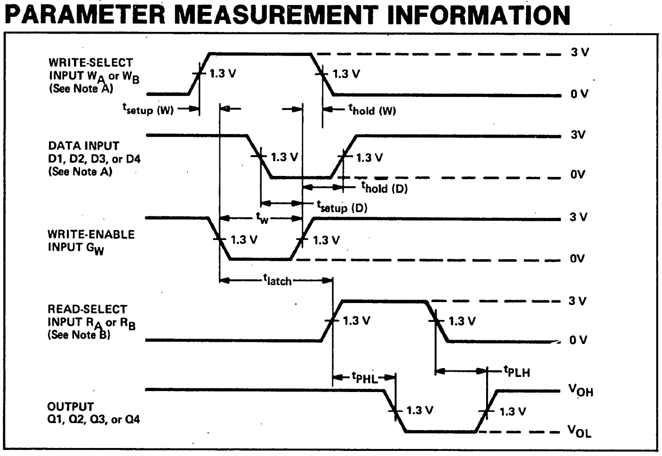
54LS670-F,W • 74LS670-B,F

SWITCHING CHARACTERISTICS V_{CC} = 5V, T_A = 25°C

PARAMETER		FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
t_W	Width of write-enable or read-enable pulse				25			ns
t_{Setup}	Input setup time (See fig. 2)	Data input Write-select	Write-enable Write-enable		10 15			ns
t_{Hold}	Input hold time (See note 2 & fig. 2)	Data input Write-select	Write-enable Write-enable		15 5			ns
t_{Latch}	Latch time for new data (Note 3)				25			ns
Propagation delay time								
t_{PHL} t_{PHL}	Low-to-high High-to-low	Read select	Any Q			23 25	40 45	ns
t_{PLH} t_{PHL}	Low-to-high High-to-low	Write enable	Any Q	C_L = 15pF, R_L = 2kΩ		26 28	45 50	ns
t_{PLH} t_{PHL}	Low-to-high High-to-low	Data	Any Q			25 23	45 40	ns
t_{ZH}	Output enable time to high level					15	35	ns
t_{ZL}	Output enable time to low level					22	40	
t_{HZ}	Output disable time from high level					30	50	ns
t_{LZ}	Output disable time from low level					16	35	

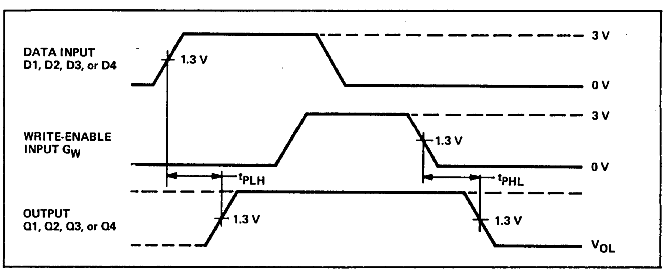
NOTES:
1. Voltage values are with respect to network ground terminal.
2. Write-select setup time will protect the data written into the previous address. If protection of data in the previous address is not required, $t_{Setup(w)}$ can be ignored as any address selection sustained for the final 30 ns of the write-enable pulse and during $t_{Hold(w)}$ will result in data being written into that location. Depending on the duration of the input conditions, one or a number of previous addresses may have been written into.
3. Latch time is the time allowed for the internal output of the latch to assume the state of new data. See Figure 2. This is important only when attempting to read from a location immediately after that location has received new data.

PARAMETER MEASUREMENT INFORMATION

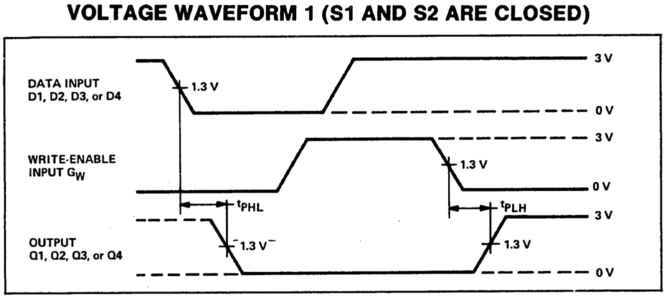


VOLTAGE WAVEFORMS (S1 AND S2 ARE CLOSED)

NOTES:
A. High-level input pulses at the select and data inputs are illustrated; however, times associated with low-level pulses are measured from the same reference points.
B. When measuring delay times from a read-select input, the read-enable input is low.
C. Input waveforms are supplied by generators having the following characteristics: PRR ≤ 2 MHz, Z_{out} ≈ 50 Ω, duty cycle ≤ 50%, t_r ≤ 15 ns, t_f ≤ 6 ns.



VOLTAGE WAVEFORM 1 (S1 AND S2 ARE CLOSED)



VOLTAGE WAVEFORM 2 (S1 AND S2 ARE CLOSED)

NOTES:
A. Each select address is tested. Prior to the start of each of the above tests both write and read address inputs are stabilized with $W_A = R_A$ and $W_B = R_B$. During the test G_R is low.
B. Input waveforms are supplied by generators having the following characteristics: PRR ≤ 1 MHz, Z_{out} ≈ 50 Ω, duty cycle ≤ 50%, t_r ≤ 15 ns, t_f ≤ 6 ns.
Load circuit is shown at front of book (for three state outputs).

signetics

INTRODUCTION TO INTERFACE

The Master Selection Guide provides sufficient information to make initial product selections, to lead you to a group of device numbers and manufacturers' names. It enables you to find the products which are most appropriate to fulfill your major requirements and then provides data for many of the more important products.

All devices that appear in this section, both in the initial selection guide and in the data pages, are included in the Part Number and Product Indexes. These index listings lead to the page and the line on that page where each device appears.

In the Interface Section the selection parameters differ drastically for each category; therefore, each has its own format. The analog to digital converter category has two formats: one for binary output devices and another for decimal units. Some of the products in this section, primarily analog to digital and digital to analog converters, are hybrids; the ones listed are those packaged to be compatible with IC's.

This section is not complicated by reference to package styles; the package style suffixes are usually deleted. For more information on each companies' suffixes, see the Part Number Guide. Throughout the Master Selection Guide, each full military temperature range (−55°C to 125°C) device is indicated by a dagger (†) before the manufacturer's name. Manufacturers' names are normally spelled out; however, a few are abbreviated and the abbreviations are explained on page 200.

The manufacturers listed above are providing detailed information on their latest and most significant products. They have made this investment to help you. Some chose not to.

If you want to see more data in future editions, tell the manufacturers through their salesmen and distributors.

INTERFACE—Analog Switches

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers						
SPST	CMOS	75	±11	±15,5	1109	DDC
					HI5040-2	† Harris
					HI5040-5	Harris
					IH5040C	Intersil
					IH5040M	† Intersil
	JFET	6	−5 to 4	±15,5	CAG10A	† Teledyne C
			−5 to 10	±15	CAG6	† Teledyne C
		10	−5 to 4	±15,5	CAG10C	† Teledyne C
			−5 to 10	±15	CAG6-10	† Teledyne C
		30	±5	±5,5	CAG10	† Teledyne C
			±8	−18,12	IH5001	Intersil
		50	±8	−18,12	IH5002	Intersil
			−10 to 4	±15,5	CAG10B	† Teledyne C
			−10 to 5	±15,5	CAG14	Teledyne C
		60	±10	±18,5	CAG30	† Teledyne C
2xSPST	CMOS	30	±11	±15,5	IH5048C	Intersil
					IH5048M	† Intersil
		50	±15	±15,5	HI5048-2	† Harris
					HI5048-5	Harris
		70	±11	±15	DG200A	† Intersil
			±15	±15	**AD7513S** see page 546	**† AD**
					HI200-2	† Harris
					DG200A see page 559, 560	**† Siliconix**
		75	±15	±15,5	1110	DDC
					HI5041-2	† Harris
					HI5041-5	Harris
					IH5041C	Intersil
					IH5041M	† Intersil
		80	±11	±15	DG200B	Intersil
			±15	±15	**AD7513J** see page 546	**AD**
					AD7513K see page 546	**AD**
					HI200-5	Harris
					DG200B see page 559, 560	**Siliconix**
					DG200C see page 559, 560	**Siliconix**
	JFET	6	−6 to 10	−18,15	CAG27	† Teledyne C
		10	−6 to 10	−18,15	CAG27-10	† Teledyne C
			−7.5 to 15	±15,5	**DG180A** see page 552, 554	**† Siliconix**
					DG180B see page 552, 554	**Siliconix**
			±10	−18,12	DG141A	† Intersil
					IH5005	† Intersil
					AM0141	† National
					AM0141C	National
					DG141A see page 551	**† Siliconix**
Switches with Drivers (cont)						
2xSPST	JFET	10	±10	−20,10,5	**DG180A** see page 552, 554	**† Siliconix**
					DG180B see page 552, 554	**Siliconix**
		15	±7.5	±15	DG151A	† Intersil
					AM0151	† National
					AM0151C	National
					DG151A see page 551	**† Siliconix**
			±8	−18,12	DG141B	Intersil
					DG441	Intersil
					DG141B see page 551	**Siliconix**
		20	±5.5	±15	DG151B	Intersil
					DG451A	Intersil
					DG151B see page 551	**Siliconix**
		30	−6 to 10	−18,15	CAG22	† Teledyne C
					CAG24	† Teledyne C
			−7.5 to 15	±15,5	DG181A	† Intersil
					IH181M	† Intersil
					DG181A see page 552, 554	**† Siliconix**
			±10	−18,12	DG133A	† Intersil
					IH5003	† Intersil
					IH5006	† Intersil
					AM0133	† National
					AM0133C	National
					DG133A see page 551	**† Siliconix**
			−12.5 to 10	−20,10,- 5	DG181A	† Intersil
					IH181M	† Intersil
					DG181A see page 552, 554	**† Siliconix**
			for D/A 0 to 20	−10	CDA2-1	† Teledyne C
			±10	−20	CDA2-3	† Teledyne C
		35	±8	−18,12	DG433A	† Intersil
		40	for D/A 0 to 20	−10	CDA2-2	† Teledyne C
			±10	−20	CDA2-4	† Teledyne C
		50	±7.5	±15	DG152A	† Intersil
					AM0152	† National
					AM0152C	National
					DG152A see page 551	**† Siliconix**
			−7.5 to 15	±15,5	DG181B	Intersil
					IH181C	Intersil
					DG181B see page 552, 554	**Siliconix**
			±8	−18,12	DG133B	Intersil
					DG133B see page 551	**Siliconix**
			±10	−18,15	CAG13	† Teledyne C
					CAG23	† Teledyne C
					CAG42 (continued)	† Teledyne C

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog Switches (cont)

Switches with Drivers (cont)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
2xSPST (continued)	JFET	50	±10	−18,15	CAG45A	† Teledyne C
					CAG48	Teledyne C
					CAG48A	† Teledyne C
			±10	−18,12	IH5004	Intersil
			−12.5 to 10	−20,10,- 5	DG181B	Intersil
					IH181C	Intersil
					DG181B see page 552, 554	Siliconix
		75	−10 to 15	±15,5	DG182A	† Intersil
					IH182M	† Intersil
					DG182A see page 552, 554	† Siliconix
			−15 to 10	−20,10,- 5	DG182A	† Intersil
					IH182M	† Intersil
					DG182A see page 552, 554	† Siliconix
		80	±8	−18,12	DG4344A	Intersil
			±10	−18,12	DG134A	† Intersil
					IH5007	Intersil
					AH0134	† National
					AH0134C	National
					DG134A see page 551	† Siliconix
		100	±5.5	±15	DG452	Intersil
					DG152B see page 551	Siliconix
			±8	−18,12	DG134B	Intersil
					DG134B see page 551	Siliconix
			−10 to 15	±15,5	DG182B	Intersil
					IH182C	Intersil
					DG182B see page 552, 554	Siliconix
			−15 to 10	−20,10,- 5	DG182B	Intersil
					IH182C	Intersil
					DG182B see page 552, 554	Siliconix
	PMOS	75-200	−5 to 10	±15,5	**DGM111A** see page 557, 558	† Siliconix
			±10	−20,10,5	**DGM111A** see page 557, 558	† Siliconix
		75-250	−5 to 10	±15,5	**DGM111B** see page 557, 558	Siliconix
			±10	−20,10,5	**DGM111B** see page 557, 558	Siliconix
		100-450	±10	−20,10,5	DG111	† Intersil
					DG112	† Intersil
4xSPST	CMOS	80	±15	±15	HI201-2	† Harris
		80*	±5		CDS4016	RCA
					CDS4016E	RCA
		100	±15	±15	HI201-5	Harris
					AD7510J see page 546	AD
					AD7510K see page 546 (continued)	AD
4xSPST (continued)	CMOS	100	±15	±15	**AD7510S** see page 546	† AD
					AD7510DIJ see page 546	AD
					AD7510DIK see page 546	AD
					AD7510DIS see page 546	† AD
					AD7511J	AD
					AD7511K	AD
					AD7511S see page 546	† AD
					AD7511D1J see page 546	AD
					AD7511D1K see page 546	AD
					AD7511D1S see page 546	† AD
		175	±15	±15	**DG201A** see page 559, 560	† Siliconix
		200	±15	±15	**DG201B** see page 559, 560	Siliconix
					DG201C see page 559, 560	Siliconix
		280	±7.5	±7.5	**AD7516K** see page 546	AD
					AD7516T see page 546	† AD
					F4066C	Fairchild
					F4066M	† Fairchild
					HD4066A-2	† Harris
					HD4066A-9	Harris
					CD4066C	National
					CD4066M	† National
					MC14066BA	† Motorola
					MC14066BC	Motorola
					CD4066A see page 375	† RCA
					CD4066AE see page 375	RCA
					HBF4066AE	SGS
					N4066A	Signetics
					SCL4066A	† SSS
					SCL4066AE	SSS
					CD4066	Teledyne C
					TC4066	Toshiba
		400	±7.5	±7.5	**AD7516J** see page 546	AD
					AD7516S see page 546	† AD
					MC14016A	† Motorola
					MC14016C	Motorola
					SCL4016A	† SSS
					SCL4016AE	SSS
					CM4016A	† Solitron
					CM4016AE	Solitron
					TF4016A/B	TI
					TP4016A/B	† TI
					TF4316A	TI
					TP4316A (continued)	† TI

† Military Temperature Range (−55°C to 125°C)

DT[1] means four terminals with a pair of normally open and normally closed contacts.

INTERFACE—Analog Switches (cont)

Switches with Drivers (cont)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
4xSPST (continued)	CMOS	400	±7.5	±7.5	TC4016	Toshiba
		800	±7.5	±7.5	F4016C F4016M	Fairchild † Fairchild
		850	±7.5	±7.5	MEM4016D MEM4016P CD4016C CD4016M **CD4016A/B** **see page 375** **CD4016A/BE** **see page 375** N4016 SCL4086A SCL4086AE CM4016A CM4016AE CM4116A CM4016AE SW4016AE	† GI GI National † National **† RCA** **RCA** Signetics † SSS SSS † Solitron Solitron † Solitron Solitron SW
			Inverted control ±7.5	±7.5	SCL4416A SCL4416AE	† SSS SSS
4xSPST Various Combinations of normally on/off	JFET	200	±10	±15,5	LF12201 LF13201 LF12202 LF13202 LF12331 LF13331 LF12332 LF13332 LF12333 LF13333	National National National National National National National National National National
		250	±10	±15,5	LF11201 LF11202 LF11331 LF11332 LF11333	† National † National † National † National † National
4xSPST	PMOS	100-450	±10	−20,10 −20,10,5	DG116 DG118	† Intersil † Intersil
		150-450	±10	−20,10,5	**DG172A** **see page 557, 558**	**† Siliconix**
		150-500	±10	−20,10,5	**DG172B** **see page 557, 558**	**Siliconix**
		200-600	±10	−20,10,5	AH0015 AH0015C **DG172C** **see page 557, 558**	† National National **Siliconix**
5xSPST Common output	PMOS	100-450	±10	−20,10	DG123 **DG123A** **see page 551**	† Intersil **† Siliconix**
			±10	−20,10,5	DG125 **DG125A** **see page 551**	† Intersil **† Siliconix**

Switches with Drivers (cont)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
5X SPST Common output	PMOS	125-500	±10	−20,10	DG123B **DG123B** **see page 551**	Intersil **Siliconix**
			±10	−20,10,5	DG125B **DG125B** **see page 551**	Intersil **Siliconix**
SPDT[1]	CMOS	30	±11	±15,5	IH5050C IH5050M	Intersil † Intersil
		50	±15	±15,5	HI5050-2 HI5050-5	† Harris Harris
		75	±15	±15,5	1111 HI5042-2 HI5042-5 IH5042C IH5042M	† DDC † Harris Harris Intersil † Intersil
	JFET	6	−5 to 10	±15	CAG7	† Teledyne S
		10	±10	−15,5	CDA23	† Teledyne S
			−5 to 10	±15	CAG7-10	† Teledyne S
			−7.5 to 15	±15,5	**DG186A** **see page 552, 554** **DG186B** **see page 552, 554**	**† Siliconix** **Siliconix**
			±10	−18,12	DG146A AH0146 AH0146C **DG146A** **see page 551**	† Intersil † National National **Siliconix**
			−12.5 to 10	−20,10,- 5	**DG186A** **see page 552, 554** **DG186B** **see page 552, 554**	**† Siliconix** **Siliconix**
		15	±7.5	±15	DG161A AH0161 AH0161C **DG161A** **see page 551**	† Intersil † National National **Siliconix**
			±8	−18,12	DG146B DG446A **DG146B** **see page 551**	Intersil Intersil **Siliconix**
		20	±5.5	±15	DG461A **DG161B** **see page 551**	Intersil **Siliconix**
		30	−7.5 to 15	±15,5	DG187A IH187M **DG187A** **see page 552, 554**	† Intersil † Intersil **† Siliconix**
			±10	−18,12	DG144A AH0144 AH0144C **DG144A** **see page 551**	† Intersil † National National **† Siliconix**
			−12.5 to 10	−20,10,- 5	DG187A IH287M **DG187A** **see page 552, 554**	† Intersil † Intersil **† Siliconix**

† Military Temperature Range (−55°C to 125°C) * — Typical Values
Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog Switches (cont)

Switches with Drivers (cont)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
SPDT[1]	JFET				DG444A	Intersil
		50	±7.5	±15	DG162A	† Intersil
					AH0162	† National
					AH0162C	National
					DG162A see page 551	† Siliconix
			−7.5 to 15	±5,5	DG187B	Intersil
					IH187C	Intersil
					DG187B see page 552, 554	Siliconix
			±8	−18,12	DG144B	Intersil
					DG144B see page 551	Siliconix
			−12.5 to 10	−20,10,-5	DG187B	Intersil
					IH187C	Intersil
					DG187B see page 552, 554	Siliconix
		75	−10,15	±15,5	DG188A	† Intersil
					IH188M	† Intersil
					DG188A see page 552, 554	† Siliconix
			−15,10	−20,10,5	DG188A	† Intersil
					IH188M	† Intersil
					DG188A see page 552, 554	† Siliconix
		80	±8	−18,12	DG443	Intersil
			±10	−18,12	DG143	† Intersil
					AH0143	† National
					AH0143C	National
					DG143A see page 551	† Siliconix
		100	±5.5	±15	**DG162B** see page 551	Siliconix
			±8	±15	DG462A	Intersil
			±10	±15	AH2114	† National
			±10	−18,12	**DG143B** see page 551	Siliconix
			−10 to 15	±15,5	DG188B	Intersil
					IH188C	Intersil
					DG188B see page 552, 554	Siliconix
			−15 to 10	−20,10,-5	DG188B	Intersil
					IH188C	Intersil
					DG188B see page 552, 554	Siliconix
		125	±10	±15	AH2114C	National
SPDT	JFET	50	±10	−15,5	CDA18	Teledyne C
SPDT (for D/A)	NPN-PNP	10	10	10	CDA4A	† Teledyne C
			−0 to −10	−15	CDA1-3	Teledyne C
			±10	±15	CDA6	Teledyne C
SPDT[1]	PMOS	75-200	−5 to 15	±15	**DG175A** see page 557, 558	† Siliconix

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
SPDT[1]	PMOS	75-200	±10	−20,10,5	**DG175A** see page 557, 558	† Siliconix
		75-250	−5 to 15	±15	**DG175B** see page 557, 558	Siliconix
			±10	−20,10,5	**DG175B** see page 557, 558	Siliconix
SPDT	PMOS	100-400	±10	−20,10	**SI3002A** see page 551	† Siliconix
					SI3002B see page 551	Siliconix
		200*	±10	−20,10	SH3002C	Fairchild
					SH3002M	† Fairchild
2xSPDT[1]	CMOS	30	±11	±15,5	IH5051C	Intersil
					IH5051M	† Intersil
		50	±15	±15,5	HI5051-2	† Harris
					HI5051-5	Harris
		75	±15	±15,5	1112	† DDC
					HI5043-2	† Harris
					HI5043-5	Harris
					IH5043C	Intersil
					IH5043M	† Intersil
2xSPDT	CMOS	100	±15	±15	**AD7512J** see page 546	AD
					AD7512K see page 546	AD
					AD7512S see page 546	† AD
					AD7512DIJ see page 546	AD
					AD7512DIK see page 546	AD
					AD7512DIS see page 546	† AD
2xSPDT[1]	JFET	10	−7.5 to 15	±15,5	**DG189A** see page 552, 554	† Siliconix
					DG189B see page 552, 554	Siliconix
			±12.5 to 15	−20,15,-5	**DG189A** see page 552, 554	† Siliconix
					DG189B see page 552, 554	Siliconix
		30	−7.5 to 15	±15,5	DG190A	† Intersil
					IH190M	† Intersil
					DG190A see page 552, 554	† Siliconix
			−12.5 to 15	−20,15,-5	DG190A	† Intersil
					IH190M	† Intersil
					DG190A see page 552, 554	† Siliconix
		50	−7.5 to 15	±15,5	**DG190B** see page 552, 554	Siliconix
			−12.5 to 15	−20,10,-5	**DG190B** see page 552, 554	Siliconix

† Military Temperature Range (−55°C to 125°C)

DT[1] means four terminals with a pair of normally open and normally closed contacts.

INTERFACE—Analog Switches (cont)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (cont)						
2xSPDT[1]	JFET	75	−10 to 15	±15,5	DG191A	† Intersil
					IH191M	† Intersil
					DG191A see page 552, 554	**† Siliconix**
			−15 to 10	−20,10,-5	DG191A	† Intersil
					IH191M	† Intersil
					DG191A see page 552, 554	**† Siliconix**
		100	−10 to 15	±15,5	DG191B	Intersil
					IH191C	Intersil
					DG191B see page 552, 554	**Siliconix**
2xSPDT[1]	JFET	100	−15 to 10	−20,10,-5	DG191B	Intersil
					IH191C	Intersil
					DG191B see page 552, 554	**Siliconix**
3xSPDT	CMOS	280	±7.5	±7.5	F4053C	Fairchild
					F4053M	† Fairchild
					HD4053A-2	† Harris
					HD4053A-9	Harris
					MEM4053D	† GI
					MEM4053P	GI
					MC14053BA	† Motorola
					MC14053BC	Motorola
					CD4053C	National
					CD4053M	† National
					CD4053A/B see page 375	**† RCA**
					CD4053A/BE see page 375	**RCA**
					SCL4053A	† SSS
					SCL4053AE	SSS
					CM4053A	† Solitron
					CM4053AE	Solitron
					TF4053A/B	† TI
					TF4053A/B	TI
					TC4053	Toshiba
	PMOS	200-800	±10	−20,10,5	**DG170A** see page 557, 558	**† Siliconix**
		250-850	±10	−20,10,5	**DG170B** see page 557, 558	**Siliconix**
					DG170C see page 557, 558	**Siliconix**
4xSPDT (for D/A)	CMOS	100	0.1	8	**AD7519J** see page 546	**AD**
	NMOS	—	—	8	DG515	Siliconix
	NPN	—	−10 to −3	±15	ULN-2140	Sprague
					ULN-2141	Sprague
					ULN-2142	Sprague
					ULS-2140	† Sprague
					ULS-2141	† Sprague
					ULS-2142	† Sprague
	NPN-PNP	7	0 to −10	−15	CDA11-512	Teledyne C
		10	0 to −10	−15	CDA11	Teledyne C

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (cont)						
4xSPDT (for D/A)	NPN	—	—	—	AD550	† AD
					AD555	AD
	PNP	—	—	—	3240	Teledyne P
10xSPDT (for D/A)	NMOS	—	—	8	DG516A	† Siliconix
					DG516B	**Siliconix**
					DG516C	**Siliconix**
DPST	CMOS	75	±15	±15,5	1113	† DDC
					HI5044-2	† Harris
					HI5044-5	Harris
					IH5044C	Intersil
					IH5044M	† Intersil
2xDPST	CMOS	30	±11	±15,5	IH4049C	Intersil
					IH4049M	† Intersil
		50	±15	±15,5	HI5049-2	† Harris
					HI5049-5	Harris
		75	±15	±15,5	1114	† DDC
					HI5045-2	† Harris
					HI5045-5	Harris
					IH5045C	Intersil
					IH5045M	† Intersil
2xDPST Three control input	CMOS	200	±15	±15,5	HI1800A-2	† Harris
					HI1800A-5	Harris
2xDPST	JFET	10	−7.5 to 15	±15,5	**DG183A** see page 552, 554	**† Siliconix**
					DG183B see page 552, 554	**Siliconix**
			±10	−18,12	DG140A	† Intersil
					AH0140	† National
					AH0140C	National
					DG140A see page 551	**† Siliconix**
			−12.5 to 10	−20,10,-	**DG183A** see page 552, 554	**† Siliconix**
					DG183B see page 552, 554	**† Siliconix**
		15	±7.5	±15	DG153A	† Intersil
					AH153	† National
					AH153C	National
					DG153A see page 551	**† Siliconix**
			±8	−18,12	DG440A	Intersil
					DG140B see page 551	**Siliconix**
			±10	−18,15	CS4R	Teledyne C
					CD4RA	† Teledyne C
		20	±5.5	±15	DG153B	Intersil
					DG453	Intersil
					DG153B see page 551	**Siliconix**
		30	−6 to 10	−18,15	CAG21	† Teledyne C
			−7.5 to 15	±15,5	DG184A	† Intersil
					IH184M	† Intersil
					DG184A see page 552, 554	**† Siliconix**

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog Switches (cont)

Switches with Drivers (cont)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
2xDPST	JFET	–18,12			DG129A AH0129 AH0129C **DG129A** **see page 551**	† Intersil † National National **† Siliconix**
			–12.5 to 10	–20,10,-5	DG184A IH184M **DG184A** **see page 552, 554**	† Intersil † Intersil **† Siliconix**
		35	±8	–18,12	DG429A	Intersil
		50	±7.5	±15	DG154A AH0154 AH0154C **DG154A** **see page 551**	† Intersil † National National **† Siliconix**
			±7.5 to 15	±15,5	DG184B IH184C **DG184B** **see page 552, 554**	Intersil Intersil **Siliconix**
			±8	–18,12	**DG129B** **see page 551**	**Siliconix**
			–12.5 to 15	–20,10,- 5	DG184B IH184C **DG184B** **see page 552, 554**	Intersil Intersil **Siliconix**
		75	–10 to 15	±15,5	DG185A IH185M **DG185A** **see page 552, 554**	† Intersil † Intersil **† Siliconix**
			–15 to 10	–20,10,- 5	DG185A IH185M **DG185A** **see page 552, 554**	Intersil † Intersil **† Siliconix**
		80	±8	–18,12	DG426A	Intersil
			±10	–18,12	DG126A AH0126 AH0126C **DG126A** **see page 551**	† Intersil † National National **† Siliconix**
		100	±5.5	±15	DG154B DG454A **DG154B** **see page 551**	Intersil Intersil **Siliconix**
			±8	–18,12	**DG126B** **see page 551**	**Siliconix**
			–10 to 15	±15,5	DG185B IH185C **DG185B** **see page 552, 554**	Intersil Intersil **Siliconix**
			–15 to 10	–20,10,- 5	DG185B IH185C **DG185B** **see page 552, 554**	Intersil Intersil **Siliconix**
2xDPST Common output	PMOS	100-450	±10	–20,10,5	**DGM122A** **see page 557, 558**	**† Siliconix**
		125-500	±10	–20,10,5	**DGM122B** **see page 557, 558**	**Siliconix**
		200-600	±10	–20,10,5	AH0019 AH0019C	† National National
3xDPST Common output	PMOS	100-450	±10	–20,10	DG120	† Intersil
			±10	–20,10,5	DG121	† Intersil
DPDT[1]	CMOS	50	±15	±15,5	HI5046A-2 HI5046A-5	† Harris Harris
		75	±15	±15,5	1115 HI5046-2 HI5046-5 IH5046C IH5046M	† DDC † Harris Harris Intersil † Intersil
	JFET	10	±10	–18,12	DG145A AH0145 AH0145C **DG145A** **see page 551**	† Intersil † National National **† Siliconix**
		15	±7.5	±15	DG163A AH0163 AH0163C **DG163A** **see page 551**	† Intersil † National National **† Siliconix**
			±8	–18,12	DG445A **DG145B** **see page 551**	Intersil **Siliconix**
		20	±5.5	±15	DG163B DG463A **DG163B** **see page 551**	Intersil Intersil **Siliconix**
		30	±10	–18,12	DG139A AH0139 AH0139C **DG139A** **see page 551**	† Intersil † National National **† Siliconix**
		35	±8	–18,12	DG439A	Intersil
		50	±7.5	±15	DG164A AH0164 AH0164C **DG164A** **see page 551**	† Intersil † National National **† Siliconix**
			±8	–18,12	**DG139B** **see page 551**	**Siliconix**
		80	±8	–18,12	DG442A	Intersil
			±10	–18,12	DG142A AH0142 AH0142C **DG142A** **see page 551**	† Intersil † National National **† Siliconix**
		100	±5.5	±15	DG164B DG464A **DG164B** **see page 551**	Intersil Intersil **Siliconix**

† Military Temperature Range (–55°C to 125°C)

DT[1] means four terminals with a pair of normally open and normally closed contacts.

INTERFACE—Analog Switches (cont)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (cont)						
DPDT[1]	JFET	100	±10	−18,12	**DG142B** see page **551**	Siliconix
DPDT	PMOS	150-450	±10	−20,10,5	**DG173A** see page **557, 558**	† Siliconix
		150-500	±10	−20,10,5	**DG173B** see page **557, 558**	Siliconix
		200-600	±10	−20,10,5	AH0014	† National
					AH0014C	National
		200-275	±10	−28,5,12	CRC9005	Collins
4PST	CMOS	50	±15	±15,5	HI5047A-2	† Harris
					HI5047A-5	Harris
		75	±15	±15,5	HI5047-2	† Harris
					HI5047-5	Harris
					1116	† DDC
					IH5047C	Intersil
					IH5047M	† Intersil
4PST (for D/A)	JFET	10	±10	±15,5	CDA28A	† Teledyne C
					CDA28B	Teledyne C
Switches without Drivers						
SPST	JFET	30	±10		AM1000	† National
		50	±15		AM1001	† National
		100	±0.2		IH5021C	Intersil
					IH5021M	† Intersil
					IH5023C	Intersil
					IH5023M	† Intersil
			0 to (Drive-4)		1105C-1	DDC
					1105M-1	† DDC
					IH5037C	Intersil
					IH5037M	† Intersil
			±10		AM1002	† National
		150	±0.2		1101C-1	DDC
					1101M-2	† DDC
					1101C-2	DDC
					1101M-2	† DDC
					IH5022C	Intersil
					IH5022M	† Intersil
					IH5024C	Intersil
					IH5024M	† Intersil
			0 to (Drive-4)		1105C-2	DDC
					1105M-2	† DDC
					IH5038C	Intersil
					IH5038M	† Intersil
2xSPST	JFET	100	±0.2		IH5017C	Intersil
					IH5017M	† Intersil
			0 to (Drive-4)		1106C-3	DDC
					1106M-3	† DDC
					IH5033	Intersil
					IH5033M	† Intersil
		150	±0.2		1102C-2	DDC
					1102M-1	† DDC
					IH5020C	Intersil
					IH5020M	† Intersil

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches without Drivers (cont)						
2xSPST	JFET	150	0 to (Drive-4)		1106C-2	DDC
					1106M-2	† DDC
					IH5036C	Intersil
					IH5036M	† Intersil
2xSPST Common output	JFET	100	±0.2		IH5019C	Intersil
					IH5019M	† Intersil
			0 to (Drive-4)		1106C-1	DDC
					1106M-1	† DDC
					IH5035C	Intersil
					IH5035M	† Intersil
		150	±0.2		1102C-1	DDC
					1102M-1	† DDC
					IH5018C	Intersil
					IH5018M	† Intersil
			0 to (Drive-4)		1106C-4	DDC
					1106M-4	† DDC
					IH5034C	Intersil
					IH5034M	† Intersil
3xSPST	JFET	100	±0.2		IH5015C	Intersil
					IH5051M	† Intersil
					AH5051C	National
			0 to (Drive-4)		1107C-1	DDC
					1107M-1	† DDC
					IH5031C	Intersil
					IH5031M	† Intersil
		150	±0.2		1103C-2	DDC
					1103M-2	† DDC
					IH5016C	Intersil
					IH5016M	† Intersil
					AH5016C	National
			0 to (Drive-4)		1107C-2	DDC
					1107M-2	† DDC
3xSPST Common output	JFET	100	±0.2		IH5013C	Intersil
					IH5013M	† Intersil
					AH5013C	National
			0 to (Drive-4)		1107C-3	DDC
					1107M-3	† DDC
					IH5029C	Intersil
					IH5029M	† Intersil
		150	±0.2		1103C-1	DDC
					1103M-1	† DDC
					IH5014C	Intersil
					IH5014M	† Intersil
					AH5014C	National
			0 to (Drive-4)		1107C-4	DDC
					1107M-4	† DDC
					IH5030C	Intersil
					IH5030M	† Intersil
3xSPST	PMOS	—			MM455	† Intersil
					MM555	Intersil
					MM455	† National
					MM555	National
					SI455	† Siliconix
					SI555	Siliconix
4xSPST	DMOS	45	±5		SD5001	Signetics

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog Switches (cont)

Switches without Drivers (cont)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
4xSPST	DMOS	45	±10		SD5000	Signetics
4xSPST Common output	DMOS	45	±5		SD5101	Signetics
			±10		SD5100	Signetics
4xSPST	JFET	100	±0.2		IH5011C	Intersil
					IH5011M	† Intersil
					AH5011C	National
					AM97C11C	National
					AM9711C	National
			0 to (Drive-4)		1108C-1	DDC
					1108M-1	† DDC
					IH5027C	Intersil
					IH5027M	† Intersil
		150	±0.2		1104C-2	DDC
					1104M-2	† DDC
					IH5012C	Intersil
					IH5012M	† Intersil
					AH5012C	National
					AM97C12C	National
					AM9712C	National
			0 to (Drive-4)		1108C-2	DDC
					1108M-2	† DDC
					IH5028C	Intersil
					IH5028M	† Intersil
		—			G125	† Intersil
					G126	† Intersil
					G127	† Intersil
					G128	† Intersil
					G1330	Intersil
					G1340	Intersil
					G125A	† Siliconix
					G125B	Siliconix
					G126A	† Siliconix
					G126B	Siliconix
					G127A	† Siliconix
					G127B	Siliconix
					G128A	† Siliconix
					G128B	Siliconix
4xSPST Common output	JFET	100	±0.2		IH5009C	Intersil
					IH5009M	† Intersil
					AH5009C	National
					AM97C09C	National
					AM9709C	National
			0 to (Drive-4)		1108C-3	DDC
					1108M-3	† DDC
					IH5025C	Intersil
					IH5025M	† Intersil
		150	±0.2		1104C-1	DDC
					1104M-1	† DDC
					IH5010C	Intersil
					IH5010M	† Intersil
					AH5010C	National
					AM97C10C	National
					AM9710C	National
			0 to (Drive-4)		1108C-4	DDC
					1108M-4	† DDC
					IH5026C	Intersil
					IH5026M	† Intersil

Switches without Drivers (cont)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
4xSPST Common output	JFET	—			G129	† Intersil
					G130	† Intersil
					G131	† Intersil
					G132	† Intersil
					G1350	Intersil
					G1360	Intersil
					G129A	† Siliconix
					G129B	Siliconix
					G130A	† Siliconix
					G130B	Siliconix
					G131A	† Siliconix
					G131B	Siliconix
					G132A	† Siliconix
					G132B	Siliconix
4xSPST Two outputs	JFET	—			G123	Intersil
4xSPST	PMOS	—			MM452	† Intersil
					MM552	Intersil
4xSPST Common output	PMOS	—			MM451	† Intersil
					MM551	Intersil
					MM451	† National
					MM551	National
4xSPST Two outputs	PMOS	—			G123A	† Siliconix
					G123B	Siliconix
5xSPST Common output	PMOS	—			G116C	Intersil
					G116M	† Intersil
					G114A	† Siliconix
					G114B	Siliconix
					G116A	† Siliconix
					G116B	Siliconix
5xSPST Common output plus output switch	PMOS	—			G117C	Intersil
					G117M	† Intersil
					G117A	† Siliconix
					G117B	Siliconix
6xSPST Common output	PMOS	—			AM2009	† National
					CRC9509	Collins
					AM2009C	National
					MM5504	† National
					MM4504	National
					G115	Intersil
					G118C	Intersil
					G118M	† Intersil
					G115A	† Siliconix
					G115B	Siliconix
					G118A	† Siliconix
					G118B	Siliconix
10xSPST					CRC9510	Collins
2xDPST Common output	PMOS	—			G122A	† Siliconix
					G122B	Siliconix
					MM450	† Intersil
					MM550	Intersil
					MM450	† National
					MM550	National
3xDPST Common output	PMOS	—			G119C	Intersil

† Military Temperature Range (−55°C to 125°C)

DT[1] means four terminals with a pair of normally open and normally closed contacts.

INTERFACE—Analog Switches (cont)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches without Drivers (cont)						
Common output					G119M	† Intersil
					G119A	† Siliconix
					G119B	Siliconix
Multiplexers						
4 channel differential	CMOS	270	±7.5	±7.5	HD14529-2	† Harris
					HD14529-9	Harris
					MC14529A	† Motorola
					MC14529C	Motorola
		280	±7.5	±7.5	F4052C	Fairchild
					F4052M	† Fairchild
					HD4052A-2	† Harris
					HD4052A-9	Harris
					HD4052-5	Harris
					MC14052BA	† Motorola
					MC14052BC	Motorola
					CD4052C	National
					CD4052M	† National
					CD4052A/B see page 375	**† RCA**
					CD4052A/BE see page 375	**RCA**
					SCL4052A	† SSS
					SCL4052AE	SSS
					CM4052A	† Solitron
					CM4052AE	Solitron
					TF4052A/B	† TI
					TP4052A/B	TI
					TC4052	Toshiba
		300	±15	±15	**AD7502J see page 548**	**AD**
					AD7502K see page 548	**AD**
					AD7502S see page 548	**† AD**
		400	±15	±15	HI1828A-2	† Harris
					HI1828A-5	Harris
					DG509A	† Intersil
					DG509A see page 561, 563	**† Siliconix**
		450	±15	±15	DG509B	Intersil
					DG509C	Intersil
					DG509B see page 561, 563	**Siliconix**
					DG509C see page 561, 563	**Siliconix**
		1500	±15	±15	HI509A-2	† Harris
		1800	±15	±15	HI509A-5	Harris
	JFET	300	±10	±15,5	LF11306	† National
					LF12306	National
					LF13306	National
	PMOS	175-600	±10	−20,10	DG511A	† Siliconix
		200-700	±10	−20,10	DG511B	Siliconix
4 Sequential Commutator	PMOS	200-600	±10	−24,12	MM454	† National
					MM554	National

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Multiplexers (cont)						
6 channel	JFET	60	±10	−18,2.8	CAM601	Teledyne C
					CAM601A	† Teledyne C
8 channel	CMOS	150	±8	±8	MS504	Ragen
		270	±7.5	±7.5	HD4529-2	† Harris
					HD4529-5	Harris
					MC14529A	† Motorola
					MC14529C	Motorola
		280	±7.5	±7.5	F4051C	Fairchild
					F4051M	† Fairchild
					HD4051A-2	† Harris
					HD4051A-9	Harris
					MEM4051D	† GI
					MEM4051P	GI
					MC14051BA	† Motorola
					MC14051BC	Motorola
					CD4051C	National
					CD4051M	† National
					CD4051A/B see page 375	**† RCA**
					CD4051A/BE see page 375	**RCA**
					SCL4051A	† SSS
					SCL4051AE	SSS
					CM4051A	† Solitron
					CM4051AE	Solitron
					TF4051A/B	† TI
					TP4051A/B	TI
					TC4051	Toshiba
		300	±15	±15	**AD7501J see page 548**	**AD**
					AD7501K see page 548	**AD**
					AD7501S see page 548	**† AD**
					AD7503J see page 548	**AD**
					AD7503K see page 548	**AD**
					AD7503S see page 548	**† AD**
		400	±15	±15,5	HI1818A-2	† Harris
					HI1818A-5	Harris
				±15	DG508A	† Intersil
					DG508A see page 561, 563	**† Siliconix**
		450	±15	±15	DG508B	Intersil
					DG508C	Intersil
					DG508B see page 561, 563	**Siliconix**
					DG508C see page 561, 563	**Siliconix**
		1500	±15	±15	MN4708	Analogic
					HI508A-2	† Harris
		1800	±15	±15	HI508A-5	Harris
	JFET	300	±10	±15,5	LF11305	† National
					LF12305	National
					LF13305	National

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog Switches (cont)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Multiplexers (cont)						
8 channel	PMOS	150-250	±5	−20,5	**DG501A** see page 552, 554	† Siliconix
					DG501B see page 552, 554	Siliconix
					DG501C see page 555, 556	Siliconix
		150-400	±5	−20,5	3705	Fairchild
					SI3705 see page 551	Siliconix
		150-800	±10	−20,10	DG503A	† Siliconix
					DG503B	Siliconix
		200-600	±5	−15,5	**DG501A** see page 552, 554	† Siliconix
		200-800	±5	−15,5	**DG501B** see page 552, 554	Siliconix
					DG501C see page 555, 556	Siliconix
		250-400	±5	−15,5	AM3705	† National
					AM3705	National
		450	−15	−20	3708	Fairchild
					ITT3708	ITT
8 channel differential	CMOS	400	±15	±15	**AD7507J** see page 548	AD
					AD7507K see page 548	AD
					HI507-2	† Harris
					HI507-5	Harris
					IH5070M	† Intersil
					DG507A see page 561, 563	† Siliconix
		450	±15	±15	**AD7507S** see page 548	† AD
					AD7507T see page 548	† AD
					IH5070C	Intersil
					DG507B see page 561, 563	Siliconix
					DG507C see page 561, 563	Siliconix
8 channel (DPST) with ring counter	PMOS	500 and 6800	±5,±4	−12,5	CRC2002	Collins
8 channel differential	CMOS	1500	±15	±15	1507M	† DDC
					HI507A-2	† Harris
		1800	±15	±15	MN4708D	Analogic
					1507C	DDC
					HI507A-5	Harris
					4551	Teledyne P
8 channel differential with storage/counter	PMOS	1000	0 to −10	−28	CRC2001	Collins
16 channel	CMOS	400	±15	±15	**AD7506S** see page 548	† AD
					AD7506T see page 548	† AD
					HI506-2	† Harris
					HI506-5 (continued)	Harris

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Multiplexers (cont)						
16 channel (continued)	CMOS	400	±15	±15	IH5060M	† Intersil
					DG506A see page 561, 563	† Siliconix
		450	±15	±15	**AD7506J** see page 548	AD
					AD7506K see page 548	AD
					IH5060C	Intersil
					DG506B see page 561, 563	Siliconix
					DG506C see page 561, 563	Siliconix
					AD7506	Siliconix
		1500	±15	±15	1506M	† DDC
					HI506A-2	† Harris
		1800	±15	±15	MN4716	Analogic
					1506C	DDC
					HI506A-5	Harris
					4552	Teledyne P
16 channel with storage counter	PMOS	1000	0 to −18	−28	CRC2001	Collins
Crosspoint					**RC4444** see page 659, 660	Raytheon
					RM4444 see page 659, 660	† Raytheon
					MC3416	Motorola
					SD5300	Signetics
Drivers						
2 channel					D112C	Intersil
					D112M	† Intersil
					D113C	Intersil
					D113M	† Intersil
					D120C	Intersil
					D120M	† Intersil
					D121C	Intersil
					D121M	† Intersil
					D130A	† Siliconix
					D130B	Siliconix
					D139A	† Siliconix
					D139B	Siliconix
					D139C	Siliconix
4 channel					D129	Intersil
					D129A	† Siliconix
					D129B	Siliconix
4 channel for DMOS					SD5200	Signetics
4 channel with Decoder					D132A	† Siliconix
					D132B	Siliconix
6 channel					D123C	Intersil
					D123M	† Intersil
					D125C	Intersil
					D125M	† Intersil
					D123A	† Siliconix
					D123B	Siliconix
					D125A	† Siliconix
					D125B	Siliconix
					CDR125A	† Teledyne S
					CDR125B	Teledyne S

† Military Temperature Range (−55°C to 125°C)

DT[1] means four terminals with a pair of normally open and normally closed contacts.

NTERFACE—Analog to Digital Converters

		Full Temperature Range								
No. of Bits	Code	Total Conversion Time µs	Linearity Error ±%FS	Total Error ±%FS	Input Voltage Range	Reference Voltage	Supply Voltage	Comments	Device	Source
A/D Converters - Binary Output										
8	Binary	6	0.2	0.4	0 to −10	Internal	±15,5	Successive Approx.	MN5123	Micro Net
		12	0.2	0.4	0 to −10	Internal	±15,5	Successive Approx.	MN502	Micro Net
					0 to −10	Internal	±12,5	Successive Approx.	MN508	Micro Net
					0 to −10	Internal	±15,5	Successive Approx.	MN510	Micro Net
				0.8	0 to −10	Internal	±12,5	Successive Approx.	MN508H	† Micro Net
					0 to −10	Internal	±15,5	Successive Approx.	MN502H	† Micro Net
									MN510H	† Micro Net
		40	0.2	—	—	External	−12.5	Successive Approx.	MM4356	† National
									MM5356	National
		100	0.2	0.8	0 to −10	Internal	12	Successive Approx.	MN5061	Micro Net
									MN5061H	† Micro Net
		1250	0.2	(0.5*)		20µa	±5	Integrating	8700	Teledyne S
		—	—	—	0 to −10	−10	−12,−28	Requires resistors, comparators	CRC9501	Collins
									CRC9502	Collins
	Complementary Binary 1.5		0.2	0.4	Various	Internal	±15,5	Successive Approx.	MN5100	Micro Net
									MN5100H	Micro Net
		12	0.2	0.4	0 to 10	Internal	±15,5	Successive Approx.	MN504	Micro Net
				0.8	0 to 10	Internal	±15,5	Successive Approx.	MN504H	† Micro Net
		100	0.2	0.8	0 to 10	Internal	12,5-12	Successive Approx.	MN5066	Micro Net
									MN5066H	† Micro Net
	Complementary Offset Binary	6	0.2	0.4	0 to −10	Internal	±15,5	Successive Approx.	MN5120	Micro Net
		12	0.2	0.4	5 to −5	Internal	±15,5	Successive Approx.	MN503	Micro Net
									MN511	Micro Net
					5 to −5	Internal	±12,5	Successive Approx.	MN509	Micro Net
					10 to −10	Internal	±15,5	Successive Approx.	MN507	Micro Net
				0.8	5 to −5	Internal	±15,5	Successive Approx.	MN503H	† Micro Net
									MN511H	† Micro Net
		100	0.2	0.8	5 to −5	Internal	12,5-12	Successive Approx.	MN5065	Micro Net
									MN5065H	† Micro Net
	Offset Binary	6	0.2	0.4	−5 to 5	Internal	±15,5	Successive Approx.	MN5121	Micro Net
					−10 to 10	Internal	±15,5	Successive Approx.	MN5122	Micro Net
		100	0.2	0.8	5 to −5	Internal	12	Successive Approx.	MN5060	Micro Net
									MN5060H	† Micro Net

† Military Temperature Range (−55°C to 125°C)

Note: The total error is the manufacturers specified value. If that isn't stated, the value shown in parentheses is calculated by summing the linearity error, the temperature error (temperature coefficients times the maximum temperature deviation from 25°C) plus 1/2 LSB quantizing error.

INTERFACE—Analog to Digital Converters (cont)

No. of Bits	Code	Full Temperature Range: Total Conversion Time µs	Full Temperature Range: Linearity Error ±%FS	Full Temperature Range: Total Error ±%FS	Input Voltage Range	Reference Voltage	Supply Voltage	Comments	Device	Source
A/D Converters - Binary Output (cont)										
8	Complementary Binary/Complementary Offset Binary	2.5	0.5	(0.37)	Various	Internal	±15,5	Successive Approx.	ADC82	Burr-Brown
	Binary/Complementary Binary	8	0.2	(0.67-1.6)	Various	Internal	±15,5	Successive Approx.	AD-02	PMI
10	Binary	16*	0.2	(0.4)	0 to 10	−10	5-15,15	Successive Approx., 8-bit resolution	**AD7570J** see page 543	**AD**
		20*	0.05	(0.15)	0 to 10	−10	5-15,15	Successive Approx.	**AD7570L** see page 543	**AD**
		5000	0.05	(0.18*)	10μa	20μa	±5	Integrating	8701	Teledyne S
	Complementary Binary/ Complementary Offset Binary	21	0.048	(0.29)	Various	Internal	±15,5	Successive Approx.	ADC80A-10	Burr-Brown
11	Binary	12	—	0.32	0 to 10	Internal	±15,5	Successive Approx.	876-U10	† Beckman
	Offset Binary	12	—	0.32	−5 to 5	Internal	±15,5	Successive Approx.	876-B5	† Beckman
					−10 to 10	Internal	±15,5	Successive Approx.	876-B10	† Beckman
12	Binary	13	0.0125	0.1	0 to −10	−10	±15,5	Successive Approx.	MN5213 MN5213H	Micro Net † Micro Net
				0.4	0 to −10	Internal	±15,5	Successive Approx.	MN5210 MN5210H	Micro Net † Micro Net
		15	—	0.02	10 or ±10		±15,5	Building Block	AD1000	National
		50	0.0125	0.1	0 to −10	−10	±15,5	Successive Approx.	MN5203 MN5203H	Micro Net † Micro Net
				0.4	0 to −10	Internal	±15,5	Successive Approx.	MN5200	Micro Net
		50	0.012	—	—		3 to 15	Bipolar or Unipolar	AD1210	National
		175	0.0125	0.4	0 to −10	Internal	±12,5-12	Successive Approx.	MN5250 MN5250H	Micro Net Micro Net
		20ms	0.0125	(0.11*)	10μa	20μa	±5	Integrating	8702	Teledyne S
			0.012	(0.44*)	±10		±15,5	Dual Slope, Analog and Digital Chips	LF11300 MM5863	National National
	Complementary Binary	13	0.0125	0.4	0 to 10	Internal	±15,5	Successive Approx.	MN5216 MN5216H	Micro Net † Micro Net
		50	0.0125	0.4	0 to 10	Internal	±15,5	Successive Approx.	MN5206 MN5206H	Micro Net † Micro Net
		175	0.0125	0.4	0 to 10	Internal	±12,5-12	Successive Approx.	MN5253 MN5253H	Micro Net † Micro Net
	Complementary Offset Binary	13	0.0125	0.1	−5 to +5	−10	±15,5	Successive Approx.	MN5214 MN5214H	Micro Net † Micro Net
					−10 to +10	−10	±15,5	Successive Approx.	MN5215 MN5215H	Micro Net † Micro Net

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog to Digital Converters (cont)

No. of Bits	Code	Full Temperature Range: Total Conversion Time µs	Full Temperature Range: Linearity Error ±%FS	Full Temperature Range: Total Error ±%FS	Input Voltage Range	Reference Voltage	Supply Voltage	Comments	Device	Source
A/D Converters - Binary Output (cont)										
12	Complementary Offset Binary	−5 to +5	Internal	±15,5	Successive Approx.				MN5211 MN5211H	Micro Net † Micro Net
					−10 to +10	Internal	±15,5	Successive Approx.	MN5212 MN5212H	Micro Net † Micro Net
		50	0.0125	0.1	−5 to +5	−10	±15,5	Successive Approx.	MN5204 MN5204H	Micro Net † Micro Net
					−10 to +10	−10	±15,5	Successive Approx.	MN5205 MN5205H	Micro Net † Micro Net
				0.4	−5 to +5	Internal	±15,5	Successive Approx.	MN5201 MN5201H	Micro Net † Micro Net
					−10 to +10	Internal	±15,5	Successive Approx.	MN5202 MN5202H	Micro Net † Micro Net
		175	0.0125	0.4	5 to −5	Internal	±12,5-12	Successive Approx.	MN5251 MN5251H	Micro Net † Micro Net
					10 to −10	Internal	±12,5-12	Successive Approx.	MN5252 MN5251H	Micro Net † Micro Net
12	Complementary Binary/Complementary Offset Binary	6	0.048	(0.19)	Various	Internal	±15,5	10 bit resolution	ADC85-10	Burr-Brown
				(0.24)	Various	Internal	±15,5	10 bit resolution	ADC85C-10	Burr-Brown
		8	0.0125	(0.21)	Various	Internal	±15,5	Successive Approx.	ADC-HY12	Datel
		10	0.012	(0.12)	Various	Internal	±15,5	12 bit resolution	ADC85-12	Burr-Brown
				(0.14)	Various	Internal	±15,5	12 bit resolution	ADC85C-12	Burr-Brown
		25	0.012	(0.22)	Successive Approx.	Various	Internal	±15,5	ADC80A-12	Burr-Brown
	Binary, Offset Binary, two's Complement	24*	0.1	(0.32)	−2.5 to +2.5 −5 to +5 −10 to +10	Internal	±15,5	Successive Approx.	AD124-09CW3	PMI
16	Binary	250 ms	—	—	−15 to 4	Internal	±15,5	Dual Slope, two device set	ICL7104 ICL8052	Intersil Intersil
	Any	—	—	—	—	Internal	±15,5	Building Block	ICL8052 ICL8053	Intersil Intersil

No. of Digits	Total Conversion Time ms	Input Voltage Range volts	Reference Voltage volts	Supply Voltage	Comments	Device	Source
A/D Converters - Digital Output							
2½	1000	±1.99	Internal	−15,5	V to f converter, LED Output	DM7700 DM8700	† National National
2½-4½		0 to 2	Internal	5 to 15	Ramp Type	MC1405 MC1505 MC14435 MC14435E	Motorola † Motorola Motorola † Motorola
3½	Adjustable	±2	±2 µa	±15	Dual Slope Multiplexed Output	MN2301	Analogic
	50	−15 to +4	Internal	±15,5	Dual Slope	ICL7101 ICL8052	Intersil Intersil
	80 ms ±0.2, ±2	+7	±12,5		Ramp Type Multiplex output	LD110 LD111	Siliconix Siliconix
		±0.2, ±2	+7	±12,5	Ramp Type Serial or multiplexed parallel BCD output	LD111 LD114	Siliconix Siliconix
	300	±0.2, ±2	Current	±14	Dual Slope	MC904	IPI
4½	166	−15 to +4	Internal	±15,5	Dual Slope	ICL7103	Intersil
	—	±10	Internal	±15,5	Dual Slope, separate analog and digital	LF1130 MM5330	National National

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Note: The total error is the manufacturers specified value. If that isn't stated, the value shown in parentheses is calculated by summing the linearity error, the temperature error (temperature coefficients times the maximum temperature deviation from 25°C) plus ½ LSB quantizing error.

ABBREVIATIONS OF COMPANY NAMES

AD	Analog Devices
AMD	Advanced Micro Devices
AMI	American Microsystems, Inc.
AMS	Advanced Memory Systems
Analogic	Analogic Corp.
Beckman	Beckman Instruments, Helipot Division
Burr-Brown	Burr-Brown Research
Cermetek	Cermetek
CMA	Consumer Microcircuits of America
Collins	Collins Radio
Datel	Datel Systems
DDC	ILC Data Devices Corp.
EA	Electronic Arrays
EMM/Semi	EMM Semi, Div. of Electronic Memories & Magnetics
Exar	Exar Integrated Systems
Fairchild	Fairchild Semiconductor
Ferranti	Ferranti Electric
GI	General Instrument
Harris	Harris Semiconductor
Hitachi	Hitachi America, Ltd.
Hughes	Hughes Aircraft Co., MOS Divison
Hybrid Sys.	Hybrid Systems
IMI	International Microcircuits, Inc.
Intech	Intech
Intel	Intel
Interdesign	Interdesign
Intersil	Intersil
IPI	Integrated Photomatrix, Inc.
ITT	ITT Semiconductors
Lithic Sys.	Lithic Systems
Litronix	Litronix
LSI Comp.	LSI Computer Systems
Micro Net	Micro Networks
Micropac	Micropac Industries
Micro Power	Micro Power Systems
Mitsubishi	Mitsubishi International
MMI	Monolithic Memories, Inc.
MOS	MOS Technology
Mostek	Mostek
Motorola	Motorola Semiconductor
National	National Semiconductor
NCR	National Cash Register, Microelectronics Div.
NEC	NEC Microcomputers
Nippon	Nippon Electric Co.
Nitron	Nitron
Nortec	Nortec Electronics
NPC	Nucleonic Products Co.
OKI	OKI Electronics of America, Inc.
Panasonic	Panasonic, Matsushita Electric Corp.
Plessey	Plessey Semiconductors
PMC	Power Monolithics Co.
PMI	Precision Monolithics, Inc.
Ragen	Ragen Semiconductor
Raytheon	Raytheon Semiconductor
RCA	RCA Solid State Division
Reticon	Reticon
Rockwell	Rockwell International, Microelectronic Div.
Sanken	Sanken Electric
SGS	SGS-ATES Semiconductor
Signetics	Signetics
Silicon G	Silicon General
Siliconix	Siliconix
SMC	SMC Microsystems Corp.
Solitron	Solitron Devices
Sprague	Sprague Electric Company
SSS	Solid State Scientific
SW	Stewart-Warner Microcircuits
Synertek	Synertek
Teledyne C	Teledyne Crystalonics
Teledyne P	Teledyne Philbrick
Teledyne S	Teledyne Semiconductor
TI	Texas Instruments
TMX	TMX, Inc.
Toshiba	Toshiba
TRW	TRW
Transitron	Transitron Electronics
Western	Western Digital

INTERFACE—Digital to Analog Converters

No. of Bits	Code	Full Temperature Range Settling Time (±½LSB) µs	Linearity Error ±%FS	Total Error ±%FS	Output Voltage	Reference Voltage	Supply Voltage	Comments	Device	Source
D/A Converters										
6	Binary	0.25*	0.78	(0.88*)	0 to −2 ma	2 ma	−15, 5	Multiplying, Current output. No output op amp	SSS1408A-6	PMI
		0.3*	0.78	(0.88*)	0 to −2 ma	2 ma	−15, 5	Multiplying, Current output. No output op amp	MC1408-6	Motorola
	Complementary Binary	0.3	0.78	(1.18)	2 to 0 ma	2 ma	−15, 5	Multiplying, Current output. No output op amp	MC1406	Motorola
				(1.68)	2 to 0 ma	2 ma	−15, 5	Multiplying, Current output. No output op amp	MC1506	† Motorola
		3	0.3	(0.7)	−5 to +5 −10 to +10	Internal	±(12-18)	Unipolar or Bipolar	DAC-01A	† PMI
			0.45	(1.17)	−5 to +5 −10 to +10	Internal	±(12-18)	Unipolar or Bipolar	DAC-01C	PMI
					0 to +10	Internal	±(12-18)	Unipolar	DAC-01H	PMI
				(1.25)	−5 to +5 −10 to +10	Internal	±(12-18)	Unipolar or Bipolar	DAC-01	† PMI
					0 to +10	Internal	±(12-18)	Unipolar	DAC-01F	† PMI
				(1.65)	−5 to +5 −10 to +10	Internal	±(12-18)	Unipolar or Bipolar	DAC-01B	† PMI
		23*	0.78	(1.58)	0 to −10 −5 to +5	Internal	±15, 5	Bipolar or Unipolar	MN301 MN301H	Micro Net Micro Net
7	Binary	0.25*	0.39	(0.49*)	0 to −2 ma	2 ma	−15, 5	Multiplying, Current output. No output op amp	SSS1408A-7	PMI
		0.3*	0.39	(0.49*)	0 to −2 ma	2 ma	−15, 5	Multiplying, Current output. No output op amp	MC1408-7	Motorola
	Binary/Complementary Binary	0.1*	0.39	(0.78)	2 ma	2 ma	±(5-18)	Multiplying, Complementary current output	DAC-08CZ	PMI
8	BCD	23	0.5	0.5				0 to −9.900 Internal ±15 Unipolar	MN3010 MN3010H	Micro Net † Micro Net
	Binary	0.25*	0.19	(0.29*)	0 to −2 ma	2 ma	−15, 5	Multiplying, Current output, No output op amp	SSS1408A-8	PMI
				(0.39*)	0 to −2 ma	2 ma	−15, 5	Multiplying, Current output, No output op amp	SSS1508A-8	† PMI
		0.3*	0.19	(0.29)	0 to −2 ma	2 ma	−15, 5	Multiplying, Current output. No output op amp	**AD559K** **see page 538** DAC-IC8BC MC1408-8	**AD** Datel Motorola
				(0.39)	0 to −2 ma	2 ma	−15, 5	Multiplying, Current output. No output op amp	**AD559S** **see page 538** DAC-IC8BM MC1508-8	**† AD** † Datel † Motorola
		10	—	0.2	+10, ±5y, 2 ma	Internal	±15	Unipolar or Bipolar	DA800	National
		1	0.2	0.4	0 to +3.984	Internal	±15	Unipolar	MN3008	Micro Net
				1.0	0 to +3.984	Internal	±15	Unipolar	MN3008H	† Micro Net

† Military Temperature Range (−55°C to 125°C) * Typical values

Note: Total Error is the manufacturer's specified value. Where that wasn't available, the value shown in parentheses is sum of the linearity error plus the temperature error (temperature coefficients times the maximum temperature deviation from 25°C).

INTERFACE—Digital to Analog Converters (cont)

No. of Bits	Code	Full Temperature Range: Settling Time (±½LSB) μs	Full Temperature Range: Linearity Error ±%FS	Full Temperature Range: Total Error ±%FS	Output Voltage	Reference Voltage	Supply Voltage	Comments	Device	Source
D/A Converters (cont)										
8	Binary	23	0.19	0.39	0 to 10	Internal	±15	Unipolar	MN3002	Micro Net
			0.2	—	0 to +10	Internal	15, 5	Unipolar, storage register	MN328	Micro Net
		27	0.19	(0.28)	0 to 5	Internal	±15	Unipolar	845-U5	Beckman
		52	0.19	(0.28)	0 to 10	Internal	±15	Unipolar	845-U10	Beckman
	Complementary Binary	0.1	0.2	0.39	0 to −9.961	+10	5, 15	Unipolar. No output op amp	MN306	Micro Net
				(0.59)	0 to −10	Internal	±5, 15	Unipolar. No output op amp	MN333	Micro Net
		0.225*	0.2	(0.47)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100CCT	PMI
				(0.56)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100CCQ	† PMI
			0.3	(0.84)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100DDT	PMI
				(1.02)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100DDQ	† PMI
		23	0.19	0.39	0 to −10	Internal	±15	Unipolar	MN3000	Micro Net
	Offset Binary	23	0.19	0.39	5 to −5 10 to −10	Internal Internal	±15 ±15	Bipolar Bipolar	MN3001 MN3006	Micro Net Micro Net
			0.2	—	−4.961 to +5	Internal	±15, 5	Bipolar, storage register	MN328B	Micro Net
		45	0.19	—	10 to −10	Internal	±15, 5	Bipolar	MN335 MN335H	Micro Net † Micro Net
		52	0.19	(0.28)	−5 to +5	Internal	±15	Bipolar	845-B5	Beckman
		102	0.19	(0.28)	−10 to +10	Internal	±15	Bipolar	845-B10	Beckman
	Binary/Complementary Binary	0.135	0.1	(0.29)	2 ma	2 ma	±(5-18)	Multiplying, Complementary current output	DAC-08AZ	† PMI
		0.1*	0.19	(0.36)	2 ma	2 ma	±(5-18)	Multiplying, Complementary current output	DAC-08EZ DAC-08Z	PMI † PMI
		3.0	0.2	(0.3)	4 ma	−10 to +10	3-10	Multiplying	DAC331-8	† Hybrid Sys
	Complementary Binary/Complementary Offset Binary	0.2	0.2	0.2	±2,4	Internal	±15	Unipolar or Bipolar	DAC90L DAC90T	Burr-Brown † Burr-Brown
	8 Bit plus Sign or 9 bit Binary	23	0.2	—	+½ Vref to −½ Vref	−13 to +13	±15	Multiplying type, Bipolar	MN380 MN380H	Micro Net † Micro Net
	Binary Ladder	1.5*						Switch/Ladder Network	HI1085	Harris
		3						Switch/Ladder Network	HI1080	† Harris
9	Complementary Binary	0.300	0.1	(0.19)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100AAQ	† PMI
				(0.28)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100BBQ	† PMI

† Military Temperature Range (−55°C to 125°C) * Typical values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Digital to Analog Converters (cont)

No. of Bits	Code	Full Temperature Range: Settling Time (±½LSB) µs	Linearity Error ±%FS	Total Error ±%FS	Output Voltage	Reference Voltage	Supply Voltage	Comments	Device	Source
D/A Converters (cont)										
9	Complementary Binary	0.300	0.1	(0.37*)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100BCT	PMI
				(0.46)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100BCQ	† PMI
				(0.82)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100BDQ	† PMI
9	9 Bits plus Sign Offset Binary	15	0.1	(0.3)	+Vref to −Vref	−13 to +13	±15,5	Multiplying, Bipolar	MN411	Micro Net
									MN411H	Micro Net
		45	0.1	(0.3)	+Vref to −Vref	−13 to +13	±15, 5	Multiplying type, Bipolar	MN410	Micro Net
									MN410H	† Micro Net
10	BCD	23	0.05	—	0 to −9.975	Internal	±5, 15	Unipolar	MN319	Micro Net
	Binary	23	0.05	0.4	0 to +10	Internal	±15	Unipolar	MN3005	Micro Net
									MN3005H	† Micro Net
		1.5*	—	—	0 to 5 or 10	Internal	±(12 to 18)	Monotonicity- various model, 8-10 bits	DAC-03	PMI
	Complementary Binary	0.1	0.05	—	0 to −10	Internal	±15, 5	Unipolar. No output op amp	MN325	Micro Net
		0.375	0.05	(0.14)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100AAQ	† PMI
				(0.23)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100ABQ	† PMI
				(0.32)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100ACT	PMI
				(0.41)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100ACQ	† PMI
				(0.77)	±5,10 or ±2.5,5	Internal	±(6-18)	Unipolar or Bipolar. No output amplifier	DAC-100ADQ	† PMI
		2*	0.05	(0.1)	−1 to 1 ma	Internal	±15	Bipolar current output	DAC345I-10-BP	Hybrid Sys
					0 to −2 ma	Internal	±15	Unipolar current output	DAC345I-10-UP	Hybrid Sys
		5*	0.05	(0.1*)	−5 to +5	Internal	±15	Bipolar	DAC346V-10-BP	Hybrid Sys
									DAC346V-10-BP	† Hybrid Sys
					0 to +10	Internal	±15	Unipolar	DAC346V-10-UP	Hybrid Sys
		23	0.05	0.4	0 to −10	Internal	±15	Unipolar	MN3003	Micro Net
									MN3003H	† Micro Net
	Offset Binary	23	0.05	0.4	−5 to +5	Internal	±15	Bipolar	MN3004	Micro Net
									MN3004H	† Micro Net
		45	0.05	0.4	−10 to +10	Internal	±15	Bipolar	MN3007	Micro Net
									MN3007H	† Micro Net
	Binary/Offset Binary/Complement	0.5*	0.05	(0.11)	1 ma	−10 to +10	5-15	Multiplying, 10 bit linearity	**AD7520L** **see page 541**	**AD**
				(0.17)	1 ma	−10 to +10	5-15	Multiplying, 10 bit linearity	**AD7520U** **see page 541**	**† AD**

† Military Temperature Range (−55°C to 125°C) * Typical values

Note: Total Error is the manufacturer's specified value. Where that wasn't available, the value shown in parentheses is sum of the linearity error plus the temperature error (temperature coefficients times the maximum temperature deviation from 25°C).

INTERFACE—Digital to Analog Converters (cont)

No. of Bits	Code	Full Temperature Range: Settling Time (±½LSB) µs	Full Temperature Range: Linearity Error ±%FS	Full Temperature Range: Total Error ±%FS	Output Voltage	Reference Voltage	Supply Voltage	Comments	Device	Source
D/A Converters (cont)										
10	Binary/Offset Binary/Complement	1 ma	−10 to +10	5-15	Multiplying, 9 bit linearity				**AD7520K** see page 541	AD
				(0.22)	1 ma	−10 to +10	5-15	Multiplying, 9 bit linearity	**AD7520T** see page 541	† AD
			0.2	(0.25)	1 ma	−10 to +10	5-15	Multiplying, 8 bit linearity	**AD7520J** see page 541	AD
				(0.32)	1 ma	−10 to +10	5-15	Multiplying, 8 Bit Linearity	**AD7520S** see page 541	† AD
		3.0	0.05	(0.15)	4 ma	− 10 to +10	3-10	Multiplying	DAC331-10	† Hybrid Sys
	Binary, Magnitude and Sign	1.5*	0.1	(0.37)	±5 or ±10	Internal	±(12-18)	Monotonicity-10 bits	DAC-02AC	PMI
					±5 or ±10	Internal	±(12-18)	Monotonicity-9 bits	DAC-02BC	PMI
			0.2	(0.47)	±5 or ±10	Internal	±(12-18)	Monotonicity-8 bits	DAC-02CC	PMI
			0.4	(1.08)	±5 or ±10	Internal	±(12-18)	Monotonicity-7 bits	DAC-02DD	PMI
	Two's or One's Complement	1.5*	0.1	(0.37)	−5 to +5 −10 to +10	Internal	±(12-18)	Monotonicity-10 bits	DAC-04AC	PMI
					−5 to +5 −10 to +10	Internal	±(12-18)	Monotonicity-9 bits	DAC-04BC	PMI
			0.2	(0.47)	−5 to +5 −10 to +10	Internal	±(12-18)	Monotonicity-8 bits	DAC-04CC	PMI
			0.4	(1.08)	−5 to +5 −10 to +10	Internal	±(12-18)	Monotonicity-7 bits	DAC-04DD	PMI
11	Binary	4.5	0.05	0.25	0 to 10	Internal	±15	Unipolar	848-U10	† Beckman
	Offset Binary	4.5	0.05	0.25	−5 to 5	Internal	±15	Bipolar	848-B5	† Beckman
		7.5	0.05	0.25	−10 to 10	Internal	±15	Bipolar	848-B10	† Beckman
	Offset Binary, 11 Bits plus sign	15	0.025	0.05	+Vref to −Vref	−10 to +10	±15, 5	Multiplying type, Bipolar No output op amp	MN413	Micro Net
									MN413H	† Micro Net
		45	0.025	0.05	+Vref to −Vref	−10 to +10	±15, 5	Multiplying type, Bipolar	MN412	Micro Net
									MN412H	† Micro Net
12	BCD	0.3/3*	0.025	(0.18)	Various	Internal	±15,5	Voltage and Current Outputs	DAC-HY12DC	Datel
			0.05	(0.14)	Various	Internal	±15,5	Voltage and Current Outputs	DAC85C/CCD	Burr-Brown
				(0.18)	Various	Internal	±15,5	Voltage and Current Outputs	DAC80/CCD	Burr-Brown
									DAC85/CCD	† Burr-Brown
									DAC-S-CCD	DDC
		0.5	0.05	—	0 to +0.999	Internal	±15	Unipolar. No output op amp	MN311	Micro Net
									MN311H	† Micro Net
		1.2	0.025	(0.11)	0 to −2 ma, −1 to +1 ma	Internal	−15,5-15	Multiplying	**AD563K/BCD** see page 540	AD

† Military Temperature Range (−55°C to 125°C) * Typical values

Bold face indicates additional data is provided on the page noted.

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INTERFACE—Digital to Analog Converters (cont)

No. of Bits	Code	Full Temperature Range: Settling Time (±½LSB) µs	Full Temperature Range: Linearity Error ±%FS	Full Temperature Range: Total Error ±%FS	Output Voltage	Reference Voltage	Supply Voltage	Comments	Device	Source
D/A Converters (cont)										
12	BCD	1.2	0.025	(0.12)	0 to −2 ma, −1 to +1 ma	Internal	−15,5-15	Multiplying	**AD563T/BCD** see page 540	† AD
				(0.32)	0 to −2 ma, −1 to +1 ma	Internal	−15,5-15	Multiplying	**AD563S/BCD** see page 540	† AD
			0.05	(0.18)	0 to −2 ma, −1 to +1	Internal	−15,5-15	Multiplying	**AD563J/BCD** see page 540	AD
		3.5	0.01	(0.1)	0 to −2 ma −1 to +1 ma	+10	−15,5-15	Unipolar or Bipolar, current output	**AD562SD/BCD** see page 539	† AD
									AN562ID/BCD	Analogic
									AN562SD/BCD	† Analogic
			0.05	(0.1)	0 to −2 ma −1 to +1 ma	+10	−15,5-15	Unipolar or Bipolar, current output	**AD562AD/BCD** see page 539	AD
									AD562KD/BCD see page 539	AD
									AN562AD/BCD	Analogic
									AN562KD/BCD	Analogic
		35	0.05	0.3	0 to −10/10	Internal	±15	Unipolar	MN3202	Micro Net
	Binary	0.5	0.0125	—	0 to +.99976	+15 supply	±15	Unipolar. No output op amp	MN312	Micro Net
									MN312H	† Micro Net
		3	0.0125	1.0	0 to −1.5 ma	+10	±15, 5	Unipolar, current output	MN366	Micro Net
			0.025	1.0	0 to −1.5 ma	+10	±15, 5	Unipolar, current output	MN366H	† Micro Net
		5	0.012	—	10,±10y 2 ma	Internal	±15,5	Unipolar or Bipolar	DAC1200	National
		4 ms	0.0125	—	Pulse width	Internal	±10	Microprocessor Controllable	ICL6202	Intersil
	Binary/Offset Binary/Complements	0.5*	0.05	(0.11)	Current	−10 to +10	5-15	Multiplying, 10 bit linearity	**AD7521L** see page 541	AD
					Current	−10 to +10	15,5-15	Multiplying, 10 bit linearity	**AD7522L** see page 542	AD
				(0.17)	Current	−10 to +10	5-15	Multiplying, 10 bit linearity	**AD7521U** see page 541	† AD
					Current	−10 to +10	15,5-15	Multiplying, 10 bit linearity	**AD7522U** see page 542	† AD
			0.1	(0.16)	Current	−10 to +10	5-15	Multiplying, 9 bit linearity	**AD7521K** see page 541	AD
					Current	−10 to +10	15,5-15	Multiplying, 9 bit linearity	**AD7522K** see page 542	AD
				(0.22)	Current	−10 to +10	5-15	Multiplying, 9 bit linearity	**AD7521T** see page 541	† AD

† Military Temperature Range (−55°C to 125°C) * Typical values

Note: Total Error is the manufacturer's specified value. Where that wasn't available, the value shown in parentheses is sum of the linearity error plus the temperature error (temperature coefficients times the maximum temperature deviation from 25°C).

INTERFACE—Digital to Analog Converters (cont)

No. of Bits	Code	Full Temperature Range: Settling Time (±½LSB) μs	Linearity Error ±%FS	Total Error ±%FS	Output Voltage	Reference Voltage	Supply Voltage	Comments	Device	Source
D/A Converters (cont)										
12	Binary/Offset	Current	−10 to [illegible]15		Multiplying, 9 bit linearity				**AD7522T** see page 542	† AD
			0.2	(0.25)	Current	−10 to +10	5-15	Multiplying, 8 bit linearity	**AD7521J** see page 541	AD
					Current	−10 to +10	15,5-15	Multiplying, 8 bit linearity	**AD7522J** see page 542	AD
				(0.32)	Current	−10 to +10	5-15	Multiplying, 8 bit linearity	**AD7521S** see page 541	† AD
					Current	−10 to +10	15,5-15	Multiplying, 8 bit linearity	**AD7522S** see page 542	† AD
		1.2*	0.006	(0.14)	−2/+1 ma	Internal	−15,5-15	Multiplying	AD7563K/BIN	AD
				(0.21)	−2/+1 ma	Internal	−15,5-15	Multiplying	**AD563T/BIN** see page 540	† AD
				(0.41)	−2/+1 ma	Internal	−15,5-15	Multiplying	**AD563S/BIN** see page 540	† AD
			0.012	(0.19)	−2/+1 ma	Internal	−15,5-15	Multiplying	**AD563J/BIN** see page 540	AD
		3.5	0.006	(0.11)	0 to −2 ma −1 to +1 ma	+10	−15,5-15	Unipolar or Bipolar	**AD562SD/BIN** see page 539 AN562SD/BIN	† AD † Analogic
			0.0125	(0.05)	0 to −2 ma −10 to +1 ma	+10	−15,5-15	Unipolar or Bipolar	**AD562KD/BIN** see page 539 AN562KD/BIN	AD Analogic
				(0.06)	0 to −2 ma −10 to +1 ma	+10	−15,5-15	Unipolar or Bipolar	**AD562AD/BIN** see page 539 AN562AD/BIN	AD Analogic
	Binary/Complementary Binary	35	0.0125	0.3	0 to −10/10	Internal	±15	Unipolar	MN3200	Micro Net
	Binary/Offset Binary	75	0.024	—	0 to 10 −10 to 10	Internal	±15	Unipolar or Bipolar	872-D1	† Beckman
			0.05	—	0 to 10 −10 to 10	Internal	±15	Unipolar or Bipolar	872-D2	† Beckman
	Complementary Binary	2*	0.0125	(0.1*)	0 to −2 ma	Internal	±15	Unipolar	DAC345I-12-UP	Hybrid Sys
		5*	0.0125	(0.1*)	0 to +10	Internal	±15	Unipolar	DAC346V-12-UP DAC346V-12-UP	Hybrid Sys † Hybrid Sys
		7	0.0125	0.1	0 to +9.9976	+10	±15, 5	Unipolar	MN362	Micro Net
			0.025	0.25	0 to +9.9976	+10	±15, 5	Unipolar	MN362H	Micro Net
		70	0.0125	0.5	0 to +10	Internal	±15	Unipolar	MN371 MN371H	Micro Net † Micro Net

† Military Temperature Range (−55°C to 125°C) * Typical values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Digital to Analog Converters (cont)

No. of Bits	Code	Full Temperature Range: Settling Time (±½LSB) μs	Full Temperature Range: Linearity Error ±%FS	Full Temperature Range: Total Error ±%FS	Output Voltage	Reference Voltage	Supply Voltage	Comments	Device	Source
D/A Converters (cont)										
12	Complementary Binary/Offset Binary	5*	0.0125	—	5/10/±2.5/±5/±10	Internal	±15	Unipolar or Bipolar	MN3850 MN3850H	Micro Net † Micro Net
	Complementary Offset Binary	1*	0.0125	(0.1*)	−1 to +1 ma	Internal	±15	Bipolar, current output	DAC345I-12-BP DAC345I-12-BP	Hybrid Sys † Hybrid Sys
		35	0.0125	0.3	±5/±10	Internal	±15	Bipolar	MN3201	Micro Net
	Complementary/Complementary Offset Binary	3/3*	0.012	(0.07)	Various V/I	Internal	±15 ,5	Unipolar or Bipolar	DAC85LD/CBI	Burr-Brown
				(0.1)	Various V/I	Internal	±15 ,5	Unipolar or Bipolar	DAC85C/CBI DAC-S-CBI	Burr-Brown DDC
				(0.13)	Various V/I	Internal	±15 ,5	Unipolar or Bipolar	DAC85/CBI	Burr-Brown
				(0.15)	Various V/I	Internal	±15 ,5	Unipolar or Bipolar	DAC80/CBI DAC-SC-CBI	Burr-Brown DDC
				(0.21)	Various V/I	Internal	±15	Unipolar or Bipolar	DAC-HY12BC	Datel
		5*	0.0125	—	10/±5/±10	Internal	±15 ,5	Unipolar or Bipolar	MN3860 MN3860H	Micro Net † Micro Net
	Offset Binary	3	0.0125	1.0	+.75 to −.75 ma	+10	±15, 5	Bipolar, current output	MN364	Micro Net
			0.025	1.0	+.75 to −.75 ma	+10	±15, 5	Bipolar, current output	MN364H	† Micro Net
		5*	0.0125	(0.1*)	−5 to +5	Internal	±15	Bipolar	DAC346V-12-BP DAC346V-12-BP	Hybrid Sys † Hybrid Sys
		7	0.0125	0.1	−10 to +9.9951	+10	±15, 5	Bipolar	MN360	Micro Net
			0.025	0.25	−10 to +9.9951	+10	±15, 5	Bipolar	MN360H	† Micro Net
		70	0.0125	0.5	−10 to +10	Internal	±15	Bipolar	MN370 MN370H	Micro Net † Micro Net
13	Binary	20	—	0.1	±10	±10	−25,±15	Multiplying	877-69CD2 877-69MD2	Beckman † Beckman
				0.25	±10	±10	−25,±15	Multiplying	877-69CD1 877-69MCD1	Beckman † Beckman
	Complementary Binary/Complementary Offset Binary	0.1/0.37	0.0125	0.0125	Various	Internal	±5,15		SDAC-12	DDC
			0.025	0.025	Various	Internal	±5,15		SDAC-11	DDC
			0.05	0.05	Various	Internal	±5,15		SDAC-10	DDC
16	BCD	35	0.005	0.3	−5,−10, 5,10	Internal	±15	Unipolar	MN3300	Micro Net
		100*	0.03	(0.004)	0 to −2 ma	Internal	±15,5	Unipolar	DAC70/CCD	Burr-Brown
			0.005	(0.006)	0 to −2 ma	Internal	±15,5	Unipolar	DAC70C/CCD	Burr-Brown
	Complementary Binary	100*	0.003	(0.004)	0 to −2 ma	Internal	±15,5	Unipolar	DAC70/CSB	Burr-Brown

† Military Temperature Range (−55°C to 125°C) * Typical values

Note: Total Error is the manufacturer's specified value. Where that wasn't available, the value shown in parentheses is sum of the linearity error plus the temperature error (temperature coefficients times the maximum temperature deviation from 25°C).

INTERFACE—Digital to Analog Converters (cont)

No. of Bits	Code	Full Temperature Range: Settling Time ($\pm 1/2$LSB) μs	Linearity Error ±%FS	Total Error ±%FS	Output Voltage	Reference Voltage	Supply Voltage	Comments	Device	Source
D/A Converters (cont)										
16	Complementary Binary	0 to −2 ma	Internal	±15,5	Unipolar				DAC70C/CSB	Burr-Brown
	Complementary Offset Binary	100*	0.003	(0.004)	±1 ma	Internal	±15,5	Bipolar	DAC70/COB	Burr-Brown
			0.005	(0.006)	±1 ma	Internal	±15,5	Bipolar	DAC70C/COB	Burr-Brown

† Military Temperature Range (−55°C to 125°C) * Typical values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Display Drivers

Function	Device	Source
Display Drivers		
BCD to 7-Segment LED Driver (Adjustable Current)	DS7858	† National
	DS8858	National
BCD to Seven-Segment LED Decoder/Driver, Constant Current	DS8857	National
	N8T54	Signetics
	N8T59	Signetics
BCD to Seven-Segment LED Latch/Decoder/Driver, with ripple blanking	F4734	Fairchild
BCD to Seven-Segment LED Decoder/Driver, Constant Current, with Latch	9368C	Fairchild
	9374C	Fairchild
	N8T71	Signetics
	N8T74	Signetics
	N8T75	Signetics
	N8T79	Signetics
BCD to Seven-Segment LCD Decoder/Driver	**CD4055A/B** see page 375	**† RCA**
	CD4055A/BE see page 375	**RCA**
BCD to Seven-Segment LCD Latch/Decoder/Driver	MC14543A	† Motorola
	MC14543C	Motorola
	CD4056A/B see page 375	**† RCA**
	CD4056A/BE see page 375	**RCA**
	SCL4543A	SSS
BCD to Seven-Segment Decoder/Driver, Active High, Resistive Pull-Up	5448	† Fairchild
	7448	Fairchild
	9307C	Fairchild
	9307M	† Fairchild
	ITT5448	† ITT
	ITT7448	ITT
	MC5448	† Motorola
	MC7448	Motorola
	MC8307	Motorola
	MC9307	† Motorola
	DM5448	† National
	DM7448	National
	DS7856	† National
	DS8856	National
	N7448	Signetics
	N8T05	Signetics
	S8T05	† Signetics
	SW7448	SW
	SN5448	† TI
	SN54248	† TI
	SN54LS48	† TI
	SN54LS248	† TI
	SN7448	TI
	SN74248	TI
	SN74LS48	TI
	SN74LS248	TI
Display Drivers (cont)		
BCD to Seven-Segment Decoder/Driver, Active High, Open Collector	5449	† Fairchild
	7449	Fairchild
	MC5449	† Motorola
	MC7449	Motorola
	N8T06	Signetics
	S8T06	† Signetics
	SN5449	† TI
	SN54249	† TI
	SN54LS49	† TI
	SN54LS249	† TI
	SN74249	TI
	SN74LS49	TI
	SN74LS249	TI
BCD to Seven-Segment Decoder/Driver with latch, Active Low, Open Collector	9370C	Fairchild
BCD to Seven-Segment Decoder/Driver Active Low, Open Collector	MC4039	Motorola
	N8T04	Signetics
	S8T04	† Signetics
BCD to Seven-Segment Decoder/Driver, Active Low, Open Collector, 15V Output	5447	† Fairchild
	7447	Fairchild
	9317BC	Fairchild
	9317BM	† Fairchild
	HD2532	Hitachi
	ITT5447	† ITT
	ITT7447	ITT
	MC5447	† Motorola
	MC7447	Motorola
	DM5447A	† National
	DM7447A	National
	N7447	Signetics
	SW7447	SW
	SW7447A*	SW
	383A/C	Teledyne S
	383B/M	† Teledyne S
	SN5447A	† TI
	SN54247	† TI
	SN54LS47	† TI
	SN54LS247	† TI
	SN7447A	TI
	SN74247	TI
	SN74LS47	TI
	SN74LS247	TI
BCD to Seven-Segment Decoder/Driver, Active Low, Open Collector, 30V Output	5446	† Fairchild
	7446	Fairchild
	9317CC	Fairchild
	9317CM	† Fairchild
	HD2553	Hitachi
	ITT5446	† ITT
	ITT7446	ITT
	MC5446	† Motorola
	MC7446	Motorola
	DM5446A	† National
	DM7446A (continued)	National
Display Drivers (cont)		
BCD to Seven-Segment Decoder/Driver, Active Low, Open Collector, 30V Output (continued)	N7446	Signetics
	SW7446	SW
	SW7446A	SW
	SN5446A	† TI
	SN54246	† TI
	SN7446A	TI
	SN74246	TI
BCD to Seven-Segment Decoder/Driver (For gas discharge displays)	384A/C	Teledyne S
	384B/M	† Teledyne S
BCD to Seven-Segment Decoder/Driver for lamps and relays	CD2500	RCA
	CD2501	RCA
	CD2502	RCA
	CD2503	RCA
BCD To Seven-Segment Latch/Decoder/Driver (CMOS with Bipolar Output)	MC14511A	† Motorola
	MC14511C	Motorola
	CD4511BC	National
	CD4511BM	† National
	CD4511A/B see page 375	**† RCA**
	CD4511A/BE see page 375	**RCA**
	SCL4511A	† SSS
	SCL4511AE	SSS
	CM4511B	† Solitron
	CM4511BE	Solitron
BCD To Seven-Segment Latch/Decoder/Driver, for Liquid Crystal Displays	MC14543A	† Motorola
	MC14543C	Motorola
BCD To Seven-Segment Latch/Decoder/Driver (Strobed Latch), for Liquid Crystal Displays	**CD4056A/B** see page 375	**† RCA**
	CD4056A/BE see page 375	**RCA**
BCD To Seven-Segment Decoder/Driver, for Liquid Crystal Displays	**CD4055A/B** see page 375	**† RCA**
	CD4055A/BE see page 375	**RCA**
3½ Digit Liquid Crystal Display Driver	CM4117A	† Solitron
	CM4117AE	Solitron
4-Digit Liquid Crystal Display Driver	SCL5424	SSS
	SCL5441	SSS
4-Segment Liquid Crystal Display Driver	**CD4054A/B** see page 375	**† RCA**
	CD4054A/BE see page 375	**RCA**
Hex High Voltage Indicator Driver Open Collector (to 55v)	HD-536	Harris
Hex TTL to LED Bulb Driver, with Latch	DS8859	National
	DS8869	National
7 Digit/Segment MOS to Fluorescent Display Driver	XR-2271	Exar

† Military Temperature Range (−55°C to 125°C) • — Typical Values

Major functions arranged alphabetically. See list at beginning of section.

INTERFACE—Display Drivers (cont)

Function	Device	Source
Display Drivers (cont)		
3-Digit Gas Discharge Display Anode Driver		
	MC3495	Motorola
	MC3496	Motorola
4-Digit Gas Discharge Display Anode Driver		
	UDN-6144A	Sprague
5-Digit Gas Discharge Display Anode Driver		
	UHD-490	† Sprague
	UHP-490	Sprague
6-Digit Gas Discharge Display Anode Driver		
	ITT512	ITT
	DS7891	† National
	DS8891	National
	UDN-6164A	Sprague
	UHD-491	† Sprague
	UHP-491	Sprague
	UHP-495	Sprague
	SN75481	TI
7-Digit Gas Discharge Display Anode Driver		
	MC34090	Motorola
	MC34094	Motorola
8-Digit Gas Discharge Display Anode Driver		
	DS7887	† National
	DS8887	National
	DS7897	† National
	DS8897	National
	UDN-6184A	Sprague
10-Digit Gas Discharge Display Anode Driver		
	ITT504	ITT
5-Segment Gas Discharge Display Cathode Driver		
	DVR-01	PMI
	UHP-480	Sprague
7-Segment Gas Discharge Display Cathode Driver		
	DS7885	† National
	DS8885	National
	UHP-481	Sprague
7-Segment Gas Discharge Display Cathode Driver, with BCD Decoder		
	DS7880	† National
	DS8880	National
	DS8884	National
	DM8880	Signetics
	SN75480	TI
8-Segment Gas Discharge Display Cathode Driver		
	ITT505	ITT
	MC3491	Motorola
	DS7889	† National
	DS8889	National
	UDN-7183A	Sprague
	UDN-7186A	Sprague
	ULN-7184A	Sprague
	UHP-482	Sprague
4-Digit CMOS to LED Cathode Driver Driver		
	DS8658	National
7-Segment CMOS to LED Driver		
	DS8651	National
	DS8659	National
6-Digit MOS to LED Cathode Driver		
	9664C	Fairchild
	75492C	Fairchild
	ITT492	ITT
	ITT500	ITT
	ITT502	ITT
	ITT506	ITT
	ITT510	ITT
	LS1060	Lithic Sys
	(continued)	
Display Drivers (cont)		
6-Digit MOS to LED Cathode Driver (continued)		
	LBC1060	Litronix
	MC75492	Motorola
	DS75492	National
	DS75494	National
	DS8870	National
	DS8892	National
	N583	Signetics
	SN75492	TI
	SN75494	TI
7-Digit MOS to LED Cathode Driver		
	ITT546A	ITT
	DS8844	National
	SN75497	TI
7-Digit MOS to LED Cathode Driver, with low battery indicator		
	DS8866	National
	DS8877	National
8-Digit MOS to LED Cathode Driver		
	HD2903	Hitachi
	ITT508	ITT
	ITT514	ITT
	ITT525	ITT
	LBC1050	Litronix
	DS8863	National
	DS8865	National
	DS8871	National
	DS8963	National
8-Digit LED Driver (for use with G.I. C550-554 Calculator Series)		
	ITT7103	ITT
9-Digit MOS to LED Cathode Driver		
	ITT526	ITT
	ITT548	ITT
	DS8855	National
	DS8973	National
	DS8974	National
	SN75498	TI
9-Digit MOS to LED Cathode Driver, with low battery indicator		
	DS8864	National
9-Digit MOS to LED Cathode Driver with shift register decoding		
	DS8874	National
	DS8876	National
	DS8879	National
12-Digit MOS to LED Cathode Driver (for National Calculators)		
	DS8868	National
	DS8873	National
4-Segment MOS to LED Anode Driver		
	75491C	Fairchild
	ITT491	ITT
	ITT501	ITT
	ITT503	ITT
	ITT507	ITT
	ITT517	ITT
	MC75491	Motorola
	DS7895	† National
	DS8895	† National
	DS75491	National
	DS75493	National
	SN75491	TI
	SN75493	TI
Display Drivers (cont)		
5-Segment MOS to LED Anode Driver		
	DS8861	National
8-Segment MOS to LED Anode Driver		
	HD2902	Hitachi
	ITT509	ITT
	LBC1070	Litronix
	LBC1071	Litronix
	MC676	Motorola
	DS8867	National
BCD-To-Decimal Decoder/Driver (Nixie Driver)		
	5441	† Fairchild
	7441	Fairchild
	HD2518	Hitachi
	MC5441	† Motorola
	MC676	Motorola
	MC7441	Motorola
	DM5441A	† National
	DM7441A	National
	H158	SGS
	N7441	Signetics
	382A/C	Teledyne S
	382B/M	† Teledyne S
BCD-To-Decimal Decoder/Driver with Blanking (for cold cathode indicator tubes)		
	74141	Fairchild
	HD2558	Hitachi
	ITT54141	† ITT
	ITT74141	ITT
	DM54141	† National
	DM74141	National
	N74141	Signetics
	SN74141	TI
BCD-To-Decimal Decoder/Driver (for lamps)		
	ITT380-1	† ITT
	ITT380-5	ITT
	380A/C	Teledyne S
	380B/M	† Teledyne S
	381A/C	Teledyne S
	381B/M	† Teledyne S

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

INTERFACE

Master Selection Guide

Interface—Error Checking Circuits, Encoder-Decoders

Function	Max. Serial Data Rate KHz	Supply Voltage	Device	Source
Error checking Circuits				
Programmable CRC (Cyclic Redundancy Character) Encoder-Decoder. Generates and checks up to 8 different polynomials of up to 16 terms each.	1	−12,5	S9544	AMI
CRCC Generator			9401C 9401M MC8500	Fairchild † Fairchild Motorola
Deskew-Queue Register			MC8520	Motorola
Error Detection/Correction Circuit (ECL)	—	−5.2	MC10163 MC10193	Motorola Motorola
ERROR Pattern Register			MC8501	Motorola
LRCC Data Register			MC8502	Motorola
Single Error Hamming Code Detector and Generator	—	5	MC4041	Motorola
Polynominal Generator			MC8506	Motorola
Universal Polynomial Generator			MC8503	Motorola
Universal Polynomial 4 Bit Generator			MC8504	Motorola

No. of Keys	No. of Output Bits	Code	Max. Clock Rate KHz	Comments	Supply Voltage	Device	Source
Keyboard Encoder-Decoders							
16	4	1 of 16		Strobe output, Key rollover output	5	HD-0165	Harris
				2 of 8 keyboard to binary encoder, one of four row inputs and column inputs (telephone key pads) give binary output, strobe.	5	MC14419	Motorola
28	8 plus Parity	Mask, Programmable	50	4 X 8 matrix, N Key rollover, 2 Levels. Independent or expander for MCS1007. Repeat.	−12,5	MCS1008	MOS
48	4 lines			Keyboard Buffer, 8 x 6 matrix, 2 key rollover, 4 line data bus output		S2299	AMI
64	8 Plus Parity	Mask, Programmable	50	Odd Parity, N Key rollover, 9 X 8 matrix, 4 levels Repeat.	−12,5	MCS1007	MOS
88	8 plus Parity	Mask, Programmable	100	Programmable parity, strobe width, strobe Delay. Two key rollover. 8 X 11 matrix, 3 levels.	−12,5	AY52376 KR2376	GI SMC
90	10	Mask, Programmable	50	Two units give 180 keys. 9 X 10 matrix, N key rollover, 4 levels. Repeat	−12,5	MCS1009	MOS
90	9	Mask, Programmable	200	Programmable strobe width. 9 X 10 matrix. N or two key rollover. 4 levels. Repeat.	−12,5	MM5740	National
	10	Mask, Programmable		90 Key, 4 Mode, N Key rollover	−12,5	AY53600 KR3600	GI SMC
99	10	Mask, Programmable	250	9 X 9 matrix. N key rollover, 4 levels. No repeat.	−12,5	EA2000 EA2007	EA EA
	10			99 Key, 4 Mode Encoder	−12,5	EA2030	EA

† Military Temperature Range (−55°C to 125°C)

Major functions arranged alphabetically. See list at beginning of this section.

INTERFACE—Line Circuits

Line Drivers—Single Ended

No. Per Device	Output	Party Line	Power Supply	Comments	Device	Source
2	±6v	No	±12	4 Input; RS232B, C; MIL188	N8T15	Signetics
	±8v	No	±12	RS232C; MIL188; CCITT V.24	75150C	Fairchild
					DS75150	National
					RC75150	Raytheon
					RM55150	† Raytheon
					SN75150	TI
	TTL	No	5, 12	130 Ohm Twisted Pair	9621C	AMD
					9621M	† AMD
					9621C	Fairchild
					9621M	† Fairchild
					RC9621	Raytheon
					RM9621	† Raytheon
	High Current	Yes	5	Emitter Follower Coax/Twisted Pair	8T13C	Fairchild
					8T13M	† Fairchild
					55121M	† Fairchild
					75121C	Fairchild
					MC8T13	Motorola
					DS55121	† National
					DS75121	National
					RC8T13	Raytheon
					RM8T13	† Raytheon
					N8T13	Signetics
					S8T13	† Signetics
					SN55121	† TI
					SN75121	TI
				Coax/Twisted Pair; IBM360, 370	8T23C	Fairchild
					75123C	Fairchild
					MC8T23	Motorola
					DS75123	National
					RC8T23	Raytheon
					RM8T23	† Raytheon
					N8T23	Signetics
					SN75123	TI
3	±6v	No	±12	RS232B/C, CCITT, MIL188	9616C	AMD
					9616C	Fairchild
					9616E	Fairchild
					9616M	† Fairchild
4	±6 to 9v	No	±9 to ±15	RS232C, CCITT V.24	MC1488	AMD
					XR1488	Exar
					HD1488	Harris
					ITT1488	ITT
					MC1488	Motorola
					DS1488	National
					RC1488	Raytheon
					MC1488	Signetics
					SG1488	Silicon G
					SN75188	TI
	TTL	No	5	Active Pull-up	AM2614C	AMD
					AM2614M	† AMD
		Yes	5	Three-State	RC8T09	Raytheon
					RM8T09	† Raytheon
					N8T09	Signetics
					S8T09	† Signetics
				4 Input AND, NAND; Three-State	DM7831	† AMD
					DM8831	AMD
					DS7831 (continued)	† National

† Military Temperature Range (−55°C to 125°C) * Typical values
Bold face indicates additional data is provided on the page noted.

INTERFACE—Line Circuits (cont)

No. Per Device	Output	Party Line	Power Supply	Comments	Device	Source
Line Drivers—Single Ended (cont)						
4	TTL	Yes		4 Input AND, NAND; Three-State (continued)	DS8831	National
				DS7831 w/o V_{cc} Clamp	DS7832	† National
					DS8832	National
Line-Drivers—Differential						
2	High-Current TTL	No	5	40 ma, Active Pull-up/Pull-down	9612C	Fairchild
					9612M	† Fairchild
				50 ma, Active Pull-up/Pull-down	9612EC	Fairchild
				40 ma, Open Collector/Active Pull-up	9614C	AMD
					9614M	† AMD
					9614C	Fairchild
					9614M	† Fairchild
					ITT9614-1	† ITT
					ITT9614-5	ITT
					SN55114	† TI
					SN75114	TI
		Yes	5	40 ma, Open Collector/Active Pull-up, Three State	SN55113	† TI
					SN75113	TI
		No	5	40 ma, 4 Input AND, NAND	DM7830	† AMD
					DM8830	AMD
					54S140	† Fairchild
					74S140	Fairchild
					HD74S140	Hitachi
					DM74S140	National
					DS7830	† National
					DS8830	National
					DM7830	† Signetics
					DM8830	Signetics
					N74S140	Signetics
					SN54S140	† TI
					SN55183	† TI
					SN74S140	TI
					SN75183	TI
		Yes	5	40 ma, 4 Input AND, NAND; Three State	DM7831	† AMD
					DM8831	AMD
					DS7831	† National
					DS8831	National
				DS7831 w/o V_{cc} Clamp	DM7832	† AMD
					DM8832	AMD
					DS7832	† National
					DS8832	National
	High-Current CMOS	No	3-15	CMOS 50 ma, 4-Input AND, NAND	MM78C30	† National
					MM88C30	National
	6 ma	Yes	±5	Twisted Pair; Level Shifting	SN55109	† AMD
					SN75109	AMD
					55109M	† Fairchild
					75109C	Fairchild
					ITT55109	† ITT
					ITT75109	ITT
					MC75109	Motorola
					DS55109	† National
					DS75109	National
					RC75109	Raytheon
					RM55109	† Raytheon
					SN55109	† TI
					SN75109	TI

† Military Temperature Range (−55°C to 125°C)   * Typical values

INTERFACE—Line Circuits (cont)

Line-Drivers—Differential (cont)

No. Per Device	Output	Party Line	Power Supply	Comments	Device	Source
2	12 ma	Yes	±5	Twisted Pair; Level Shifting	SN55110	† AMD
					SN75110	AMD
					55110M	† Fairchild
					75110C	Fairchild
					ITT55110	† ITT
					ITT75110	ITT
					MC75110	Motorola
					DS55110	† National
					DS75110	National
					RM55110	† Raytheon
					RC75110	Raytheon
					SN55110	† TI
					SN75110	TI
	24 ma	Yes	±5	Higher current 75110	SN75112	TI
	±20 ma	Yes	−6,5	Push-Pull Output	MC75113	Motorola
3	2 ma	Yes	5	Constant Current	HD245	† Harris
					HD545	Harris
4	11 ma	Yes	±5	Quad 75110	MC3453	Motorola
	High Current TTL	No	5	50 ohm lines	SN74128	TI
				75 ohm lines	SN54128	TI
		Yes	5	RS-422, Three-State	DS1688	† National
					DS3688	National
	High Current CMOS	No	3-15	CMOS, 25 ma	MM78C29	† National
					MM88C29	National

See also Drivers under digital logic families

Line Receivers—Single Ended

No. Per Device	Receiver Input Threshold	Common Mode Voltage	Supply Voltage	Comments	Device	Source
2	Ref ±0.1v		5	Ext. Reference Adjustable from 1.5 to 3.5 v	MC75140	Motorola
					SN75140	TI
				Ext. Ref. Adj. 1.5 to 3.5v with optional internal 2.5v Reference	SN55142	† TI
					SN75142	TI
	0.4 to 2.4	±15	5	Differential Input, Single Ended Data	AM2615C	AMD
					AM2615M	† AMD
	±2.0		5	RS232B	DS7822	† National
					DS8822	National
3	0.7 to 1.7		5	Hysteresis, IBM 360/370	8T24C	Fairchild
					75124C	Fairchild
					MC8T24	Motorola
					DS75124	National
					RC8T24	Raytheon
					RM8T24	† Raytheon
					N8T24	Signetics
					SN75124	TI
	0.75 to 2.25		5	Hysteresis, RS232C, CCITT V.24	9617C	AMD
					9617C	Fairchild
	0.8 to 2.0 v		5	Hysteresis, High-Speed	8T14C	Fairchild
					8T14M	† Fairchild
					55122M	† Fairchild
					75122C	Fairchild
					MC8T14	Motorola
					DS55122	† National
					DS75122	National
					RC8T14	Raytheon

(continued)

† Military Temperature Range (−55°C to 125°C) * Typical values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Line Circuits (cont)

No. Per Device	Receiver Input Threshold	Common Mode Voltage	Supply Voltage	Comments	Device	Source
Line Receivers—Single Ended (cont)						
3	0.8 to 2.0 v		5	Hysteresis, High-Speed (continued)	RM8T14 N8T14 S8T14 SN55122 SN75122	† Raytheon Signetics † Signetics † TI TI
4	±3/0.8 to 3		5 or 12	RS232C, Hysteresis, Fail Safe Option	75154 DS75154 SN75154 RM55154 RC75154	Fairchild National TI † Raytheon Raytheon
	0.75 to 1.5v		5	RS232C, Programmable Threshold, Hysteresis	1489 HD1489 ITT1489 MC1489 DS1489 RC1489 SG1489 SN75189	AMD Harris ITT Motorola National Raytheon Silicon G TI
	0.75 to 2.25		5	RS232C, Programmable Threshold, Hysteresis	1489A XR1489A ITT1489A HD1489A MC1489A DS1489A RC1489A SG1489A SN75189A	AMD Exar ITT Harris Motorola National Raytheon Silicon G TI
	0.97 to 2.65		5	Hysteresis, 120 Ohm System	DS7836	† National
	1.05 to 2.5		5	Hysteresis, 120 Ohm System	DS8836	National
	1.2 to 1.8		5	120 Ohm System, No Hysteresis, NOR Input	DS7640	† National
	1.3 to 1.7		5	120 Ohm System, No Hysteresis, NOR Input	DS8640	National
	1.5 to 2.0		5	Hysteresis, 2-Input	DS8640 N8T380	National Signetics
	5 to 7.5		15	Hysteresis, Interface to CMOS	367A 367M	Teledyne S † Teledyne S
				Hysteresis, Open Collector, Interface to CMOS	368A 368M	Teledyne S † Teledyne S
	5.5 to 8		12	Hysteresis, Interface to CMOS	367B 367C	Teledyne S † Teledyne S
				Hysteresis, Open Collector, Interface to CMOS	368B 368C	† Teledyne S † Teledyne S
6	0.97 to 2.65		5	Hysteresis, 120 Ohm System	DS7837	† National
	1.05 to 2.50		5	Hysteresis, 120 Ohm System	MC3437 DS8837 N8T37	Motorola National Signetics
Line Receivers—Differential						
2	±0.35/0.3 to 3		5	ADJ. RS232B, C, MIL-188	N8T16	Signetics
	±0.2/0.3	±10/15	5	Twisted Pair, ±15v CMV, Response Control	DS78LS20 DS88LS20	† National National
	±0.5/2	±0/15	5,12	±15 v CMV	9620M 9620M	† AMD † Fairchild

† Military Temperature Range (−55°C to 125°C) * Typical values

INTERFACE—Line Circuits (cont)

Line Receivers—Differential (cont)

No. Per Device	Receiver Input Threshold	Common Mode Voltage	Supply Voltage	Comments	Device	Source
2	±0.5/2	±0/12	5, 12	±12 v CMV	9620C	AMD
					9620C	Fairchild
	±0.5/1	±0/15	5	±15 v CMV, Response Control	9615C	AMD
					9615M	† AMD
					9615C	Fairchild
					9615M	† Fairchild
					ITT9615-1	† ITT
					ITT9615-5	ITT
					SN55115	† TI
					SN75115	TI
				Twisted Pair, ±15v CMV, Response Control	DM7820	† AMD
					DM8820	AMD
					DS7820	† National
					DS8820	National
					DM7820	† Signetics
					DM8820	Signetics
		±5/15	5	±15v CMV	9613C	Fairchild
					9613M	† Fairchild
		±3/15	5	Twisted Pair, ±3/15 v CMV, Response Control	DM7820A	† AMD
					DM8820A	AMD
					DS7820A	† National
					DS8820A	National
					DM7820A	† Signetics
					DM8820A	Signetics
					SN55182	† TI
					SN75182	TI
	±0.5/3	±25	±12	Adjusts RS232C/MIL-188, ±25 v CMV, Hysteresis	9627C	Fairchild
					9627M	† Fairchild
					SN75152	TI
	±2	±10	−10, 5	130 ohm Termination	9622C	Fairchild
					9622M	† Fairchild
					RC9622	Raytheon
					RM9622	† Raytheon
	±0.010	±3	±5	10 mv, MOS Sense Active Pull-up	55207M	† Fairchild
					75207C	Fairchild
					ITT75207	ITT
					DS75207	National
					SN75207	TI
				10 mv, MOS Sense, Three State	DS3604	National
				10 mv, MOS Sense, Open Collector	55208M	† Fairchild
					75208C	Fairchild
					ITT75208	ITT
					DS75208	National
					SN75208	TI
	±0.025	±3	±5	25 mv, Active Pull-up	55107AM	† Fairchild
					75107AC	Fairchild
					ITT55107A	† ITT
					ITT75107	ITT
					MC55107	† Motorola
					MC75107	Motorola
					DS55107A	† National
					DS75107A	National
					RC75107A	Raytheon
					RM55107A	† Raytheon
					SN55107A	† TI
					SN75107A	TI

† Military Temperature Range (−55°C to 125°C) * Typical values
Bold face indicates additional data is provided on the page noted.

INTERFACE—Line Circuits (cont)

No. Per Device	Receiver Input Threshold	Common Mode Voltage	Supply Voltage	Comments	Device	Source
Line Receivers—Differential (cont)						
2	±0.025	±3		25 mv, 3 State 55107	DS1603	† National
					DS3603	National
				25 mv, Open Collector	55108AM	Fairchild
					75108AC	Fairchild
					ITT55108A	† ITT
					ITT75108A	ITT
					MC55108	† Motorola
					MC75108	Motorola
					DS55108A	† National
					DS75108A	National
					RC75108A	Raytheon
					RM55108A	† Raytheon
					SN55108A	† TI
					SN75108A	TI
				55107A w/Diode Protected Input Stage	SN55107B	† AMD
					SN75107B	AMD
					55107BM	† Fairchild
					75107BC	Fairchild
					ITT55107B	† ITT
					ITT75107B	ITT
					DS55107	† National
					DS75107	National
					SN55107B	† TI
					SN75107B	TI
				55108A w/Diode Protected Input Stage	SN55108B	† AMD
					SN75108B	AMD
					55108BM	† Fairchild
					75108BC	Fairchild
					DS55108	† National
					DS75108	National
					SN55108B	† TI
3	±0.075		±5	100 ohm Twisted Pair, Shielded	HD248	† Harris
					HD548	Harris
	±1.5 ma		±5	100 ohm Twisted Pair, Shielded	HD246	† Harris
					HD249	† Harris
					HD546	Harris
					HD549	Harris
4	±0.025	±3	±5	Four 75107, Active Pull-up	MC3450	Motorola
					DS3650	National
				Four 75108, Open Collector	MC3452	Motorola
					DS3652	National
				3 State	DS3651	National
	±0.2	±15	5	50 mv Hysteresis	DS1689	† National
					DS3689	National
					DS1690	† National
					DS3690	National
					DS3651	National

See also Receivers-listed under ECL and HNIL/HTL Miscellaneous sections

† Military Temperature Range (−55°C to 125°C)   * Typical values

No. Per Device	Receiver Input Threshold	Device Output	Supply Voltage	Comments	Device	Source
2	MOS/TTL	MOS/ TTL	5	Transceiver/Port Controller	N8T30	Signetics
4	0.8 to 2.0	TTL	5	General Purpose Interface Bus, Open Collector, 100 ma Output	MC3440 MC3441 MC3443 DS7641 DS8641 DS8642 6605C	Motorola Motorola Motorola † National National National Teledyne S
				General Purpose Bus, Open Collector, 100 ma, for 50 ohm system	DS8642	National
	0.85 to 2.0	TTL	5	Three-State	N8T26	Signetics
	0.97 to 2.65	TTL	5	Open Collector, 1 v Hysteresis	DS7838	† National
	1.05 to 2.50	TTL	5	Open Collector, 1 v Hysteresis	MC3438 DS8838 N8T38	Motorola National Signetics
	1.0 to 2.45 v	TTL	5	Open Collector, Hysteresis	AM26S12AM AM26S12AC	† AMD AMD
	1.2 to 2.2 v	TTL	5	Open Collector, Hysteresis	AM26S12M AM26S12C	† AMD AMD
	1.5 to 3.2 v	TTL	5	Open Collector, 100 ma Output	SN55138	† TI
	1.6 to 2.4v	TTL	5	Open Collector, 100 ma Output	AM26S10M AM26S11M	† AMD † AMD
	1.75 to 2.25v	TTL	5	Open Collector, 100 ma Output	AM26S10C AM26S11C	AMD AMD
	1.8 to 2.9 v	TTL	5	Open Collector, 100 ma Output	SN75138	TI
	1.05 to 2.50	TTL	5	Three-State, T/R Disables, Hysteresis	DS7833 DS8833	† National National
				Inverting 7833/8833	DS7835 DS8835	† National National
				Three-State, NOR Gate Transmit Disable, Hysteresis	DS7839 DS8839	† National National
				Inverting 7839/8839	DS7834 DS8834 N8T34	† National National Signetics

Line Transceivers—Differential

No. Per Device	Receiver Input Threshold	Device Output	Supply Voltage	Comments	Device	Source
1	±0.5/±1v	TTL	5	Independent Three-State 55113 Driver and 55115 receiver	SN55116 SN75116	† TI TI
				Three-State 8 Pin, 40 ma,	SN55117 SN75117	† TI TI
				Same as 55116 with Three-State receiver	SN55118 SN75118	† TI TI
				Same as 55117 with Three-State receiver	SN55119 SN75119	† TI TI

INTERFACE—Memory and Peripheral Drivers

Function	Device	Source
Memory & Peripheral Drivers		
MOS Dynamic Memory, Address Refresh Logic Circuitry	MC8505	Motorola
Clock Generator/Oscillator, to 10 MHz, 8:1 Divider, for Microprocessors	ICM7209	† Intersil
MOS Clock Driver	MH0007	† National
	MH0012	† National
	MH0007C	National
	MH0012C	National
Dual MOS Clock Driver	0026	† AMD
	0026C	AMD
	0056	† AMD
	0056C	AMD
	SH013C	Fairchild
	SH013M	† Fairchild
	MC1585	Motorola
	MMH0026	† Motorola
	MMH0026C	Motorola
	MH0009	† National
	MH0009C	National
	MH0013	† National
	MH0013C	National
	DS0025	† National
	DS0025C	National
	DS0026	† National
	DS0026C	National
	DS0056	† National
	DS0056C	National
	SN75369	TI
Dual MOS Clock Driver (for PMOS Memories)	IM5013AC	Intersil
	IM5013AM	† Intersil
Quad MOS Clock Driver (for PMOS Memories)	IM5003AC	Intersil
	IM5003AM	† Intersil
4 Phase MOS Clock Driver	M002	SGS
Two Phase Oscillator/Clock Driver (for MOS systems)	DS7803	† National
	DS7807	† National
	DS8803	National
	DS8807	National
	DS8813	National
	DS8817	National
Quad NMOS Memory Driver	MC3459	Motorola
	MC3460	Motorola
	DS3644	National
	DS3674	National
Quad MOS Driver (for clock inputs 2416 CCD Memory)	5244	Intel
Quad Part Driver, for MM5270 RAM	DS1640	† National
	DS3640	National
	DS1670	† National
	DS3670	National
Dual MOS Clock Driver, bootstrapped for single supply systems	DS1642	† National
	DS3642	National
	DS1671	† National
	DS3671	National
	DS1672	† National
	DS3672	National
Memory & Peripheral Drivers (cont)		
Quad MOS Clock Driver, Decodes input address	DS3643	National
	DS3673	National
6-Bit MOS Refresh Counter/Driver	DS1676	† National
	DS3676	National
Quad TTL to NMOS Memory Driver (For 7001, etc.)	MC3466	Motorola
Quad TTL to NMOS Memory Driver (for 2105, 2107, etc.)	3225	Intel
TTL and NMOS Level Shifters (4) and High Voltage Clock Driver (1) for 2105, 2107, etc.	3210	Intel
Dual NAND TTL to MOS Driver (PMOS memory interface)	ITT75361A	ITT
	MC75361	Motorola
	DS75360	National
	DS75361	National
	DS75364	National
	MH8805	National
	SN75361A	TI
	SN75362	TI
Dual AND TTL to MOS Driver (NMOS Memory interface)	SN75322	TI
	SN75363	TI
Dual Channel TTL to MOS Memory Interface (for TMS4062, AMS6002, etc)	ITT75370	ITT
	SN75370	TI
Quad NAND TTL to MOS Driver (MOS memory interface-1103 clock driver)	9607	Fairchild
	3207A	Intel
	3207A-1	Intel
	ITT75365	ITT
	MC75365	Motorola
	DS75365	National
	3207A	Signetics
	3207A-1	Signetics
	SN75365	TI
Dual Channel ECL to MOS Driver (MOS memory interface; also ECL to TTL driver)	ITT75368	ITT
	MC75358	Motorola
	MC75368	Motorola
	SN75368	TI
ECL and NMOS Level Shifters (4) and High Voltage Clock Driver (1) for 2105, 2107, etc.	3211	Intel
Dual MOS Logic to MOS Memory Driver	SN75364	TI
Hex Latch/Driver, for MOS memories	DS1645	† National
	DS3645	National
	DS1675	† National
	DS3675	National
Quad MOS Memory I/O Register	DS1647	† National
	DS3647	National
	DS1677	† National
	DS3677	National
	DS16147	† National
	DS36147	National
	DS16177	† National
	DS36177	National
Quad Predriver, Open Collector, 50 ma Sink (for magnetic memories)	MC4042	Motorola
Dual Memory Driver, 400 ma Sink (for magnetic memories)	MC4043	Motorola
Memory Driver Dual, 400ma Sink/Source, Decode (for magnetic memories)	DS3629	National
	DS75324	National
	RC75324	Raytheon
	RM55324	† Raytheon
	(continued)	
Memory & Peripheral Drivers (cont)		
Memory Driver Dual, 400ma Sink/Source, Decode (for magnetic memories) (continued)	SN75324	TI
Memory Driver, Quad, 600ma Sink, Decode	55326M	† Fairchild
	75326C	Fairchild
	ITT75326	ITT
	SN55326	† TI
	SN75326	TI
Memory Driver, Quad, 600ma Source Decode	55327M	† Fairchild
	75327C	Fairchild
	ITT75327	ITT
	SN55327	† TI
	SN75327	TI
	SN55328	† TI
	SN75328	TI
Memory Driver, Dual, 600ma Sink/Source, Decode	55325M	† Fairchild
	75325C	Fairchild
	ITT55325	ITT
	ITT75325	ITT
	MC55325	† Motorola
	MC75325	Motorola
	DS55325	† National
	DS75325	National
	RM55325	† Raytheon
	RC75325	Raytheon
	SN55325	† TI
	SN75325	TI
Memory Decoder/Driver 8-Channel, (for core)	SN55329	† TI
Quad Multiplexer/Driver, for MOS systems	DS1648	† National
	DS3648	National
	DS1678	† National
	DS3678	National
Hex Inverter/MOS Driver, Three-State	DS1649	† National
	DS3649	National
	DS1679	† National
	DS3679	National
Hex Inverter/MOS Driver, disable causes logic 1 state	DS16149	† National
	DS36149	National
	DS16179	† National
	DS36179	National
Dual AND Driver, HNIL, 250 ma, Open Collector	391	Teledyne S
Dual Peripheral AND Driver	55450M	† Fairchild
	55451M	† Fairchild
	55460M	† Fairchild
	55461M	† Fairchild
	55470M	† Fairchild
	55471M	† Fairchild
	75450C	Fairchild
	75451C	Fairchild
	75460C	Fairchild
	75461C	Fairchild
	75470C	Fairchild
	75471C	Fairchild
	HD2574	Hitachi
	HD2575	Hitachi
	ITT55450	† ITT
	ITT55460	† ITT
	(continued)	

† Military Temperature Range (−55°C to 125°C)

INTERFACE—Memory and Peripheral Drivers (cont)

Memory & Peripheral Drivers (cont)

Function	Device	Source	Line
Dual Peripheral AND Driver (continued)			
	ITT75450	ITT	
	ITT75451	ITT	
	ITT75460	ITT	
	MC75450	Motorola	
	MC75451	Motorola	
	MC75461	Motorola	
	DS3611	National	
	DS55450	† National	
	DS75450	National	
	DS75460	National	10
	DS75451	National	
	DS75461	National	
	RC75450	Raytheon	
	RC75451	Raytheon	
	RM55450	† Raytheon	
	RM55451	† Raytheon	
	75450	Signetics	
	75450A	Signetics	
	75451	Signetics	
	75451A	Signetics	20
	SG55450	† Silicon G	
	SG55451	† Silicon G	
	SG55460	† Silicon G	
	SG55461	† Silicon G	
	SG75450	Silicon G	
	SG75451	Silicon G	
	SG75460	Silicon G	
	SG75461	Silicon G	
	75450	Teledyne S	
	75450B	Teledyne S	30
	75451	Teledyne S	
	75451B	Teledyne S	
	75460	Teledyne S	
	75461	Teledyne S	
	SN55450B	† TI	
	SN55451B	† TI	
	SN55460	† TI	
	SN55461	† TI	
	SN55470	† TI	
	SN55471	† TI	40
	SN75401	TI	
	SN75411	TI	
	SN75450B	TI	
	SN75451B	TI	
	SN75460	TI	
	SN75461	TI	
	SN75470	TI	
	SN75471	TI	
Dual Peripheral AND Driver, to 80v, 300 ma			
	DS1611	† National	
	DS3611	National	50
Dual Peripheral AND Driver, for CMOS			
	DS1631	† National	
	DS3631	National	
Dual 4-Input AND Power Driver Open Collector (to 100v, sinks 250 ma)			
	UHP-420	Sprague	
	UHP-520	Sprague	
Dual 4-Input AND Driver, HNIL, 250 ma Open Collector			
	390	Teledyne S	

Memory & Peripheral Drivers (cont)

Function	Device	Source	Line
Dual AND-OR Power Driver, Open Collector (to 100v, sinks 250 ma)			
	UHP-451	Sprague	
	UHP-459	Sprague	
	UHP-551	Sprague	
	UHP-559	Sprague	
4-Input AND Current Driver (45v, to 1.5A peak)			
	DH0006	† National	60
	DH0006C	National	
4-Input AND High Voltage— High Current Driver (45v, to 3A peak)			
	DH0008	† National	
	DH0008C	National	
Quad 2-Input AND Driver (to 0v, sinks 300 ma)			
	UDN-5706A	Sprague	
Quad 2-Input AND Power Driver, Open Collector (to 100v, sinks 250 ma)			
	UHC/D-400	† Sprague	
	UHC/D-406	† Sprague	
	UHC/D-500	Sprague	
	UHC/D-506	Sprague	
	UHP-400	Sprague	
	UHP-406	Sprague	70
	UHP-500	Sprague	
	UHP-506	Sprague	
Quad 2-Input NAND Driver (to 70v, sinks 300 ma)			
	UDN-5707A	Sprague	
Dual NAND Driver, HNIL, 250 ma, Open Collector			
	392	Teledyne S	
4-Input NAND High Voltage, High Current Driver (40 to 50v, sinks 150 to 500 ma)			
	SH2001C	Fairchild	
	SH2001M	† Fairchild	
	SH2002C	Fairchild	
	SH2002M	† Fairchild	
	SH2200C	Fairchild	
	SH2200M	† Fairchild	80
Dual Peripheral NAND Driver			
	55452M	† Fairchild	
	55462M	† Fairchild	
	55472M	† Fairchild	
	75452C	Fairchild	
	75462C	Fairchild	
	75472	Fairchild	
	HD2577	Hitachi	
	ITT75452	ITT	
	ITT75462	ITT	
	MC75452	Motorola	90
	MC75462	Motorola	
	DS3612	National	
	DS55452	† National	
	DS55462	† National	
	DS75452	National	
	DS75462	National	
	RC75452	Raytheon	
	RM55452	† Raytheon	
	75452	Signetics	
	SG55452	† Silicon G	100
	SG55462	† Silicon G	
	SG75452	Silicon G	
	SG75462	Silicon G	
	75452	Teledyne S	
	75452B	Teledyne S	
	75462	Teledyne S	
	SN75402	TI	
	SN75412	TI	
	SN55452B	† TI	
	SN75452B (continued)	TI	110

Memory & Peripheral Drivers (cont)

Function	Device	Source	Line
Dual Peripheral NAND Driver (continued)			
	SN55462	† TI	
	SN75462	TI	
	SN55472	† TI	
	SN75472	TI	
Dual 4-Input NAND Driver, HNIL, 250 ma, Open Collector			
	395	Teledyne S	
Dual Peripheral NAND Driver, to 80v, 300 ma			
	DS1612	† National	
	DS3612	National	
Dual Peripheral NAND Driver, for CMOS			
	DS1632	† National	
	DS3632	National	
4-Input NAND High Voltage, High Current Drivers (40v, 0.15 to 0.25A)			
	DH0011	† National	120
	DH0011C	National	
4-Input NAND High Voltage, High Current Driver (50, 70 or 100v, 0.25 to 0.5A)			
	DH0016C	National	
	DH0017C	National	
	DH0018C	National	
Quad 2-Input NAND Power Driver, Open Collector (to 100v, sinks 250 ma)			
	UHC/D-407	† Sprague	
	UHC/D-408	† Sprague	
	UHC/D-507	† Sprague	
	UHC/D-508	† Sprague	
	UHP-407	Sprague	
	UHP-408	Sprague	130
	UHP-507	Sprague	
	UHP-508	Sprague	
Relay Driver, to 65v, sinks 300 ma, OR Input for 48v telephone relays			
	DS1686	† National	
	DS1687	† National	
	DS3686	National	
	DS3687	National	
Dual OR Driver, HNIL, 250 ma, Open Collector			
	393	Teledyne S	
Dual Peripheral OR Driver			
	55453M	† Fairchild	
	55463M	† Fairchild	
	55473M	† Fairchild	140
	75463C	Fairchild	
	75469C	Fairchild	
	55453	† Hitachi	
	55463	Hitachi	
	75453	Hitachi	
	75463	Hitachi	
	ITT75453	ITT	
	ITT75463	ITT	
	MC75453	Motorola	
	MC75463	Motorola	150
	DS3613	National	
	DS55453	† National	
	DS55463	† National	
	DS75453	National	
	DS75463	National	
	RC75453	Raytheon	
	RM55453	† Raytheon	
	75453	Signetics	
	75453	Teledyne S	
	75453B	Teledyne S	160
	75463	Teledyne S	
	SN55453B	† TI	
	SN55463	† TI	
	SN55473 (continued)	† TI	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

INTERFACE—Memory and Peripheral Drivers (cont)

Memory & Peripheral Drivers (cont)

Function	Device	Source
Dual Peripheral OR Driver (continued)		
	SN75403	TI
	SN75413	TI
	SN75453B	TI
	SN75463	TI
	SN75473	TI
Dual Peripheral OR Driver, to 80v, 300 ma		
	DS1613	† National
	DS3613	National
Dual Peripheral OR Driver, for CMOS		
	DS1633	† National
	DS3633	National
Quad 2-Input OR Driver (to 70v, sinks 300 ma)		
	UDN-5703A	Sprague
Quad 2-Input OR Power Driver, Open Collector (to 100v, sinks 250 ma)		
	UHC/D-402	† Sprague
	UHC/D-403	† Sprague
	UHC/D-502	† Sprague
	UHC/D-503	† Sprague
	UHP-402	Sprague
	UHP-403	Sprague
	UHP-502	Sprague
	UHP-503	Sprague
Dual NOR Driver, HNIL, 250 ma, Open Collector		
	394	Teledyne S
Dual Peripheral NOR Driver		
	55454M	† Fairchild
	55464M	† Fairchild
	55474M	† Fairchild
	75454C	Fairchild
	75464C	Fairchild
	75474C	Fairchild
	HD2579	Hitachi
	ITT75454	ITT
	ITT75464	ITT
	MC75454	Motorola
	MC75464	Motorola
	DS3614	National
	DS55454	† National
	DS55464	† National
	DS75454	National
	DS75464	National
	RC75454	Raytheon
	RM55454	† Raytheon
	75454	Signetics
	SG55454	† Silicon G
	SG55464	† Silicon G
	SG75454	Silicon G
	SG75464	Silicon G
	75454	Teledyne S
	75454B	Teledyne S
	75464	Teledyne S
	SN55454B	† TI
	SN55464	† TI
	SN55474	† TI
	SN75404	TI
	SN75414	TI
	SN75454B	TI
	SN75464	TI
	SN75474	TI
Dual Peripheral NOR Driver, to 80v, 300 ma		
	DS1614	† National
	DS3614	National
Dual Peripheral NOR Driver, for CMOS		
	DS1634	† National
	DS3614	National
Quintuple High Voltage Interface (Outputs can accept high negative voltages in "off" state)		
	SP1404	Plessey
Quad 2-Input NOR Driver (to 70v, sinks 300 ma)		
	UDN-5733A	Sprague
Quad 2-Input NOR Power Driver, Open Collector (to 100v, sinks 250 ma)		
	UHC/D-432	† Sprague
	UHC/D-433	† Sprague
	UHC/D-532	† Sprague
	UHC/D-533	† Sprague
	UHP-432	Sprague
	UHP-433	Sprague
	UHP-532	Sprague
	UHP-533	Sprague
Quintuple Driver (to 5v, 200 ma) Open Collector		
	SP762B	Plessey
Quintuple Driver (to 12v, 150 ma) Open Collector		
	SP761B	Plessey
Quad Darlington Switch (to 50v, 1.5a)		
	ULN-2064A	Sprague
	ULN-2074A	Sprague
Hammer Driver (to 6A- pulsed output)		
	DH0028C	National
Hammer Driver, 7 Channel, CMOS, TTL Input		
	ITT556	ITT
Hammer Driver, 7 Channel, MOS, TTL Input		
	ITT552	ITT
Hammer Driver, 7 Channel, PMOS Input		
	ITT554	ITT
Printer Driver, 7 channel		
	FD1021	Hitachi
Printer Driver, 10 channel		
	FD1018	Hitachi
	ULN-2001A	Sprague
	ULN-2002A	Sprague
	ULN-2003A	Sprague
	ULN-2004A	Sprague
Printing Calculate Circuits		
	DS8654	National
	DS8655	National
	DS8656	National
	DS8692	National
	DS8693	National
	DS8694	National

† Military Temperature Range (−55°C to 125°C)

INTERFACE

Master Selection Guide

Interface—Sense Amplifiers

Function	Device	Source	Line
Sense Amplifiers			
One Channel Sense Amplifier (for core memories)			
	MC1440	Motorola	
	MC1540	Motorola	
Dual Channel Gated Sense Amplifier (for core memories)			
	MC1441	Motorola	
	MC1541	† Motorola	
	CA1541	† RCA	
Dual Core Memory Sense Amplifier, Separate Outputs			
	5524M	† Fairchild	
	5525M	† Fairchild	
	7524C	Fairchild	
	7525C	Fairchild	
	ITT5524	† ITT	10
	ITT5525	† ITT	
	ITT7524	ITT	
	ITT7525	ITT	
	MC5524	† Motorola	
	MC5525	† Motorola	
	MC7524	Motorola	
	MC7525	Motorola	
	DS5524	† National	
	DS5525	† National	
	DS7524	National	20
	DS7525	National	
	SN7524	Signetics	
	SN7525	Signetics	
	SG7524	Silicon G	
	SG7525	Silicon G	
	SN5524	† TI	
	SN5525	† TI	
	SN7524	TI	
	SN7525	TI	
Dual Core Memory Sense Amplifier, Complementary Output, Latch Capability			
	ITT5520	† ITT	30
	ITT5521	† ITT	
	ITT7520	ITT	
	ITT7521	ITT	
	DS5520	† National	
	DS5521	† National	
	DS7520	National	
	DS7521	National	
	SN7520	Signetics	
	SN7521	Signetics	
	SG7520	Silicon G	40
	SG7521	Silicon G	
	SN5520	† TI	
	SN5521	† TI	
	SN7520	TI	
	SN7521	TI	
Dual Core Memory Sense Amplifier, Single Open Collector Output			
	ITT5522	† ITT	
	ITT5523	† ITT	
	ITT7522	ITT	
	ITT7523	ITT	
	MC5522	† Motorola	50
	MC5523	† Motorola	
	MC7522	Motorola	
	MC7523	Motorola	
	DS5522	† National	
	DS5523	† National	
	DS7522 (continued)	National	
Sense Amplifiers (cont)			
Dual Core Memory Sense Amplifier, Single Open Collector Output (continued)			
	DS7523	National	
	SN7522	Signetics	
	SN7523	Signetics	
	SG7522	Silicon G	60
	SG7523	Silicon G	
	SN5522	† TI	
	SN5523	† TI	
	SN7522	TI	
	SN7523	TI	
Dual Core Memory Sense Amplifier, Output Register			
	SN7526	TI	
	SN7527	TI	
Dual Core Memory Sense Amplifier, Separate Outputs, Test Points			
	5528M	† Fairchild	
	5529M	† Fairchild	
	7528C	Fairchild	70
	7529C	Fairchild	
	ITT5528	† ITT	
	ITT5529	† ITT	
	ITT7528	ITT	
	ITT7529	ITT	
	MC5528	† Motorola	
	MC5529	† Motorola	
	MC7528	Motorola	
	MC7529	Motorola	
	DS5528	† National	80
	DS5529	† National	
	DS7528	National	
	DS7529	National	
	SG7528	Silicon G	
	SG7529	Silicon G	
	SN5528	† TI	
	SN5529	† TI	
	SN7528	TI	
	SN7529	TI	
Dual Core Memory Sense Amplifier, Separate Inverted Outputs			
	SN75234	AMD	90
	SN75235	AMD	
	55234M	† Fairchild	
	55235M	† Fairchild	
	75234C	Fairchild	
	75235C	Fairchild	
	ITT55234	† ITT	
	ITT75234	ITT	
	ITT55235	† ITT	
	ITT75235	ITT	
	SN55234	† TI	100
	SN55235	† TI	
	SN75234	TI	
	SN75235	TI	
Dual Core Memory Sense Amplifier, Separate Inverted Outputs, Test Points			
	55238M	† Fairchild	
	55239M	† Fairchild	
	75238C	Fairchild	
	75239C	Fairchild	
	SN55238	† TI	
	SN55239	† TI	
	SN75238	TI	110
	SN75239	TI	
Sense Amplifiers (cont)			
Dual Core Memory Sense Amplifier, Separate Open Collector Outputs			
	5534M	† Fairchild	
	5535M	† Fairchild	
	55232M	† Fairchild	
	55233M	† Fairchild	
	7534C	Fairchild	
	7535C	Fairchild	
	75232C	Fairchild	
	75233C	Fairchild	
	ITT5534	† ITT	120
	ITT5535	† ITT	
	ITT7534	ITT	
	ITT7535	ITT	
	MC5534	† Motorola	
	MC5535	† Motorola	
	MC7534	Motorola	
	MC7535	Motorola	
	DS5534	† National	
	DS5535	† National	
	DS7534	National	130
	DS7535	National	
	SG7534	Silicon G	
	SG7535	Silicon G	
	SN55232	† TI	
	SN55233	† TI	
	SN75232	TI	
Dual Core Memory Sense Amplifier, Separate Open Collector Outputs, Test Points			
	5538M	† Fairchild	
	5539M	† Fairchild	
	7538C	Fairchild	
	7539C	Fairchild	140
	ITT5538	† ITT	
	ITT7538	ITT	
	MC5538	† Motorola	
	MC5539	† Motorola	
	MC7538	Motorola	
	MC7539	Motorola	
	DS5538	† National	
	DS5539	† National	
	DS7538	National	
	DS7539	National	150
	SG7538	Silicon G	
	SG7539	Silicon G	
Dual Sense Amplifier/Data Register (for core memories)			
	ITT3671-1	† ITT	
	ITT3671-5	ITT	
	ITT55236	† ITT	
	ITT75236	ITT	
	ITT55237	† ITT	
	ITT75237	ITT	
	SN55236	† TI	
	SN55237	† TI	160
	SN75236	TI	
	SN75237	TI	
MOS to TTL Level Converter, High Speed, Three-State			
	MC4000	Motorola	
	MC4300	† Motorola	
Dual Sense Amplifier (for MOS memory or line receiver)			
	LM163	† AMD	
	LM363	AMD	
	LM363A (continued)	AMD	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

Interface—Sense Amplifiers (cont)

Function	Device	Source
Sense Amplifiers (cont)		
Dual Sense Amplifier (for MOS memory or line receiver) (continued)		
	75207	Fairchild
	75208	Fairchild
	DS1604	† National
	DS3604	National
	DS1603	† National
	DS3603	National
	DS75207	National
	DS75208	National
	75S207	Signetics
	75S208	Signetics
	SN75207	TI
	SN75208	TI
Dual Sense Amplifier (NMOS memories to ECL 10K)		
	MC3461	Motorola
	SN75261	TI
Dual MOS to TTL Level Converter, Latch, Three-State (Sense Amp)		
	MC54468	† Motorola
	MC74468	Motorola
	DS3625	National
	DS7802	† National
	DS7806	† National
	DS8802	National
	DS8806	National
	N8T25	Signetics
See also Digital—TTL (Translators)		
Quad Sense Amplifier, Three-State		
	MC3430	Motorola
	MC3431	Motorola
	MC3432	Motorola
	MC3433	Motorola
	DS3651	National
	DS3653	National
Hex MOS Sense Amplifier (MOS to TTL Converter) Three-State		
	DS1605	† National
	DS1606	† National
	DS1607	† National
	DS1608	† National
	DS3605	National
	DS3606	National
	DS3607	National
	DS3608	National
Hex MOS Sense Amplifier, Open Collector (for 1103)		
	3208A	Intel
Hex MOS Sense Amplifiers with Latches, Three-State		
	3408A	Intel
4-Channel AC Coupled Sense Amplifier (decoded input channel selection)		
	SN55244	† TI
	SN75244	TI
4-Input Sense Amplifier (for plated wire or thick thin film memories)		
	MC1444	Motorola
	MC1544	† Motorola

† Military Temperature Range (−55°C to 125°C)

INTERFACE—Serial Transmitters - Receivers

Function	Max. Serial Data Rate KHz	Supply Volts	Device	Source
Serial Transmitters-Receivers				
(ACIA) Asynchronous Communications Interface Adapter (Links 8-bit bidirectional data bus to serial asynchronous data communications, including to 6860	50	5	**S6850** **see page 895**	**AMI**
			MC6850	Motorola
Digital Modem (Modulation, demodulation and supervisory control, up to 600bps.)			**S6860** **see page 900**	**AMI**
			MC6860	Motorola
PSAR (Programmable Synchronous-Asynchronous Receiver) Synchronous/Asynchronous serial to parallel converter with programmable character length and programmable serial data rate.	640	−12,±5	MC2259	Motorola
			NC2259	Nitron
			PT1472B	Western
			PT1472B-01	Western
PSAT (Programmable Synchronous-Asynchonous Transmitter) Synchronous/Asynchronous parallel to serial converter that has programmable character length and programmable serial data rate.			MC2257	Motorola
			MC2260	Motorola
			NC2257	Nitron
			NC2260	Nitron
			PT1482B	Western
			PT1482B-01	Western
PSART (Programmable Synchronous-Asynchronous Receiver-Transmitter) Serial to parallel and parallel to serial converter that can operate in Full Duplex Mode.	50	5	8251	Intersil
	—	—	3843	Fairchild
UART (Universal Asynchronous Receiver-Transmitter) complete serial to parallel and parallel to serial interface.	1.2	−12,5	10371	Rockwell
	10	5	AY3-1014	GI
		−12,±5	**S1757** **see page 532**	**AMI**
	12.5	−12.5	**S1883** **see page 533**	**AMI**
	20	−12,5	AY6-1013 †	GI
			TR1602	Western
	30	−12,5	AY5-1013	GI
			TR1602-03	Western
	40	−12,5	AY5-1013A	GI
			MP1013A	Plessey
			TR1602-09	Western
	50	5	AY5-1014A	GI
		−12,5	TR1602-05	Western
	200	5	HM6402-2 †	Harris
			HM6402-9	Harris
			HM6403-2 †	Harris
			HM6403-9	Harris
			IM6402	Intersil
			IM6402M †	Intersil
			IM6403	Intersil
			IM6403M †	Intersil
		−12,5	TMS6011	TI
	400	5	HM6402A-2 †	Harris
			HM6402A-9	Harris
			HM6403A-2 †	Harris
			(continued)	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

INTERFACE—Serial Transmitters - Receivers (cont)

Function	Max. Serial Data Rate KHz	Supply Volts	Device	Source
Serial Transmitters-Receivers (cont)				
(continued)			HM6403A-9	Harris
		−12,5	COM2502 COM2017	SMC SMC
	600	−12,5	COM2502H COM2017H	SMC SMC
USRT (Universal Synchronous Receiver-Transmitter) Complete serial to parallel and parallel to serial interface.	250	−12,5	COM2601	SMC
	500	5	**S2350** **see page 905**	**AMI**
Asynchronous/synchronous receiver/transmitter to interface serial communications channel with a parallel digital system (i.e. microporcessors)		±12,±5	UR1671	Western

† Military Temperature Range (−55°C to 125°C)

Communications Circuits

Part No.	Description	Word Length (Bits)	Max. Clock Freq. (kHz)	Input/ Output	Power Supply (V)	Process	Page
S1757	Asynchronous Receiver/Transmitter	5, 6, 7, 8	160	MOS	-12, ±5	P-I^2	532
S1883	Asynchronous Receiver/Transmitter	5, 6, 7, 8	200	TTL	-12, ±5	P-I^2	533
S2350	Synchronous Receiver/Transmitter	5, 6, 7, 8	500	TTL	+5	N-SiGate	906
S6850	Asynchronous Receiver/Transmitter	7, 8	800	TTL	+5	N-SiGate	895

Complete Data Sheets on all Standard Products Available from Your Local AMI Sales Office Listed Inside the Front Cover.

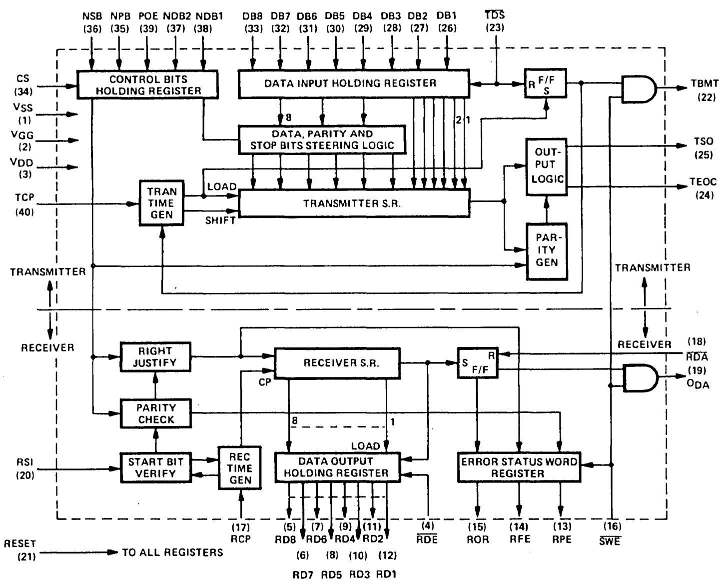
AMI®
AMERICAN MICROSYSTEMS, INC.

S1883

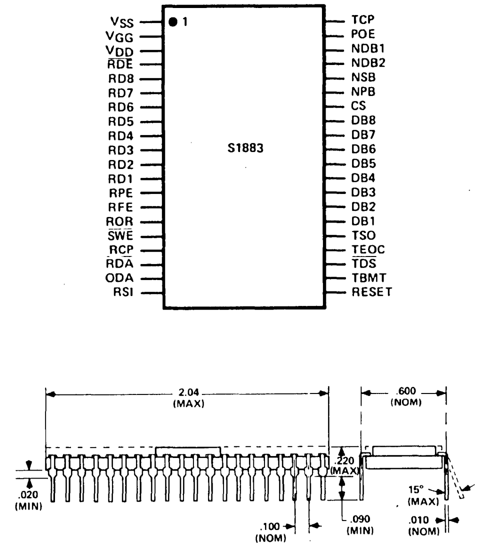
UART

INTERFACE

AMI



S1883 BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION
(Available in Pkgs. 3M, 1T - see Sec. 1)

FEATURES

- 12.5 K Baud Data Rates
- 5-8 Bit Word Length
- Parity Generation/Checking Odd, Even, None
- Framing and Overflow Error Detection
- 1, 1.5, or 2 Stop Bits
- Double Buffered Input/Output
- Independent Transmit/Receive Rates
- Start and Stop Bits Generated and Detected
- Interchangeable with TMS6011, COM2017, TR1602, AY-5-1013
- Tri-State Outputs

FUNCTIONAL DESCRIPTION

The S1883 Universal Asynchronous Receiver Transmitter (UART) is a single chip MOS/LSI device that totally replaces the asynchronous parallel to serial and serial to parallel conversion logic required to interface a word parallel controller or data terminal to a bit serial communication network.

For asynchronous data transmission with a non-contiguous data bit stream, the UART automatically inserts a START bit preceding each character and, under program control 1, 1.5, or 2 stop bits at the end of each character. To detect incoming characters in a noisy environment the UART employs a START bit detection network and allows errorless recovery of data with up to 42% distortion.

The UART will transmit or receive data characters of 5, 6, 7, or 8 bit length. Options allow the generation and checking of odd, even parity or no parity. The odd or even parity bit is automatically added to the character length for transmission. The parity bit is removed, checked and an error flag set if incorrectly received.

The data or baud rate at the receiver input and transmitter output are determined independently by external clock inputs. The clock inputs must be 16 times the data rate required at the serial input and output. The independent clocks allow for either half or full duplex operation.

The UART provides a buffer register in both the transmitter and receiver to allow a full character time for responding to a received data ready or transmit data request signal. The UART generates a MARK signal if the transmit register is not loaded with a data character and also indicates an overflow error if two characters are received without a RDA input.

TYPICAL APPLICATIONS

- Computer Peripherals
- Communication Concentrators
- Integrated Modems
- Industrial Data Transmission
- TTY Terminals
- Time Division Multiplexing

ABSOLUTE MAXIMUM RATINGS

Ambient Temperature Under Bias	0°C to +70°C
Storage Temperature	−65°C to +150°C
Positive Voltage on Any Pin with Respect to V_{SS}	+.3 Volt
Negative Voltage on Any Pin with Respect to V_{SS}	−20.0 Volt

NOTE: Stresses greater than those listed as Maximum Ratings may cause permanent damage to the device. Functional operation of the device at these or any other conditions above those indicated in the operation section of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

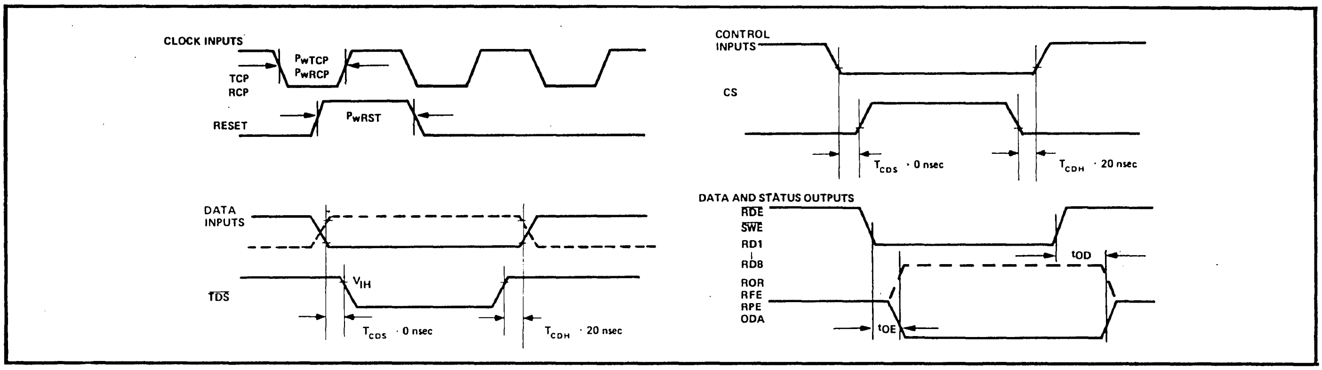
DC (STATIC) CHARACTERISTICS $T_A = 0° - +70°C$, $V_{SS} = +5$ Volt ±5%, $V_{GG} = -12$ Volt ±5%

Symbol	Parameter	Min	Max	Unit	Condition
V_{IH}	Input High Voltage	V_{SS} −1.0	V_{SS} +0.3	Volt	Internal Pull-up
V_{IL}	Input Low Voltage	V_{GG}	0.8	Volt	Resistor Provided
I_{LI}	Input Load Current		−1.2	mamp	V_{IN} = 0 Volt
V_{OH}	Output High Voltage	2.4		Volt	I_{OH} = - 100 uamp
V_{OL}	Output Low Voltage		.4	Volt	I_{OL} = 1.6 mamp
C_{IN}	Input Capacitance		20	pf	$V_{IN} = V_{SS}$
C_{OUT}	Output Capacitance		10	pf	$V_{OUT} = V_{SS}$
I_{SS}	V_{SS} Supply Current		30	mamp	$\overline{SWE} = \overline{RDE} = V_{IL}$
I_{GG}	V_{GG} Supply Current		40	mamp	ITTL Load

AC (DYNAMIC) CHARACTERISTICS $T_A = 0°C - +70°C$; $V_{SS} = +5$ Volt ±5%; $V_{GG} = -12$ Volt ±5%

Symbol	Parameter	Min	Max	Unit	Condition
TCP, RCP	Clock Frequency	DC	200	KHz	
Input Pulse Widths					
PWTCP	Transmit Clock	2.5		usec	C_L = 20pf
PWRCP	Receive Clock	2.5		usec	1 TTL Load
PWCS	Control Strobe	250		nsec	
PWTDS	Transmit Data Strobe	250		nsec	
PWRST	RESET	1.0		μsec	
PWSWE	Status Word Enable	500		nsec	
PWRDA	Reset Data Available	500		nsec	
PWRDE	Receive Data Enable	250		nsec	
Switching Characteristics					
t_{CDS}	Control Set Up Time	0		nsec	Figure 1
t_{CDH}	Control Hold Time	20		nsec	Figure 1
t_{OE}	Output Enable Time		500	nsec	
t_{OD}	Output Disable Time		500	nsec	

TIMING WAVEFORMS (Figure 1)



PIN DEFINITIONS

Pin	Label	Function
(1)	V_{SS}	+5 Volt ± 5%
(2)	V_{GG}	−12 Volt ± 5%
(3)	V_{DD}	Ground
(21)	RESET	The transmitter status outputs TBMT and TEOC are set to V_{OH} indicating the input transmitter buffer register is empty. The TSO output generates V_{OH} or MARK until a valid data character has been loaded into the transmitter and valid data transmission begins. The receiver status output ODA, is reset to the V_{OL} state.
(38)	NDB1	Number Data Bits/Character
(37)	NDB2	Number Data Bits/Character
(36)	NSB	Number Stop Bits The bit length of each data character and the number of stop bits added to each transmitted character are defined by these three inputs. The character word length does not include the parity bit and is common to both the transmitter and receiver if operating in the full duplex mode.

NSB	NDB2	NDB1	BITS/CHARACTER	STOP BITS
V_{IL}	V_{IL}	V_{IL}	5	1
V_{IL}	V_{IL}	V_{IH}	6	1
V_{IL}	V_{IH}	V_{IL}	7	1
V_{IL}	V_{IH}	V_{IH}	8	1
V_{IH}	V_{IL}	V_{IL}	5	1.5
V_{IH}	V_{IL}	V_{IH}	6	2
V_{IH}	V_{IH}	V_{IL}	7	2
V_{IH}	V_{IH}	V_{IH}	8	2

Pin	Label	Function
(35)	NPB	NO PARITY BIT. A V_{IH} eliminates the PARITY bit from being transmitted causing the STOP bit(s) to immediately follow the last data bit. The receiver assumes the bit(s) following the last data bit to be STOP bits. The RPE output is also forced to a V_{OL} condition.
(39)	POE	PARITY ODD/EVEN. If the NPB input is V_{IL}, the parity mode is ODD if POE is V_{IL} and EVEN if POE is V_{IH}. The parity mode is the same for both the transmitter and receiver.
(34)	CS	CONTROL STROBE. A V_{IH} loads POE, NDB1, NDB2, NPB, NSB into the CONTROL HOLDING REGISTER. To load the control inputs for static operation CS can be hard-wired to V_{IH}.
(26) (27) (28) (29) (30)	DB1 DB2 DB3 DB4 DB5	TRANSMITTER DATA BITS. Input data on DB1-DB8 are strobed into the DATA INPUT HOLDING REGISTER by $\overline{TDS}$. Input data is assumed right justified so DB1 is always the least significant bit and is the bit

INTERFACE
AMI

Pin	Label	Function
(31) (32) (33)	DB6 DB7 DB8	transmitted following the START bit. For data words less than eight bits, the unused bits are don't care inputs.
(23)	$\overline{TDS}$	TRANSMITTER DATA STROBE. A V_{IL} enters data on the DB1-DB8 inputs into the INPUT HOLDING REGISTER. If the transmitter is in the idle state with both TBMT and TEOC at V_{OH}, the START bit will be generated on the first negative transition of the input clock TCP following the return of $\overline{TDS}$ to a V_{IH} state.
(25)	TSO	TRANSMITTER SERIAL OUTPUT. Data entered on DB1-DB8 are serially transmitted on TSO. A START (SPACE) bit precedes each character. A PARITY bit, if selected, and the correct number of STOP bits follow the last valid data bit. The TSO output is V_{OH} (MARK) when a valid character is not being transmitted.
(22)	TBMT	TRANSMITTER BUFFER EMPTY. A V_{OH} indicates the character in the INPUT HOLDING REGISTER has been transferred into the transmitter and a new character may be loaded into the INPUT HOLDING REGISTER. One complete character time (START BIT, DATA BITS, PARITY BIT, AND STOP BIT(S)) is available to load the next character. If a $\overline{TDS}$ is not generated within the time allotted, the TSO output will go into an idle state of V_{OH} or a MARK condition. TBMT will remain in the tri state mode unless $\overline{SWE}$ is a U_{ZL}.
(24)	TEOC	TRANSMITTER END OF CHARACTER. A V_{OL} to V_{OH} transition indicates the transmission of the character and stop bits have been completed. The V_{OH} is maintained until the leading edge of the next START bit (MARK to SPACE transition) is generated.
(40)	TCP	TRANSMITTER CLOCK PULSE. The transmitter input clock must be 16 times faster than the desired baud rate at TSO.
(17)	RCP	RECEIVER CLOCK PULSE. The receiver input clock must be 16 times the baud rate of data received on RSI.
(20)	RSI	RECEIVER SERIAL INPUT. Serial input data is received on RSI at a baud rate 1/16th the rate of RCP. The V_{IH} to V_{IL} (MARK to SPACE) transition beginning each START bit synchronizes the receiver to the incoming data. Data is assumed to be received least significant bit first.
(12) (11) (10) (9) (8) (7) (6) (5)	RD1 RD2 RD3 RD4 RD5 RD6 RD7 RD8	RECEIVER DATA. Data outputs from the DATA OUTPUT HOLDING REGISTER are active only when $\overline{RDE}$ is a V_{IL}. The eight data outputs are in a tri-state mode if $\overline{RDE}$ is a V_{IH}. Data is presented at the outputs right justified with RDI the least significant bit. For data word lengths less than 8 bits the unused bits will appear as V_{OL}.
(4)	$\overline{RDE}$	RECEIVER DATA ENABLE. A V_{IL} enables data in the DATA OUTPUT HOLDING REGISTER to the RECEIVER DATA output pins. For an output configuration not requiring a tri-state condition for RD1-RD8 the RDE input can be tied directly to ground enabling the data outputs at all times.
(19)	ODA	OUTPUT DATA AVAILABLE. A V_{OH} indicates a complete character has been received and transferred to the DATA OUTPUT HOLDING REGISTER. The ODA output will be in the tri-state mode unless $\overline{SWE}$ is a V_{IL}. For contiguous data inputs on RSI data will remain in the holding register one character time before being lost.
(18)	$\overline{RDA}$	RESET DATA AVAILABLE. A V_{IL} resets the ODA to a V_{OL}. If ODA is not reset by $\overline{RDA}$ the ROR will be set when the next complete character is received and transferred to the DATA OUTPUT HOLDING REGISTER.
(15)	ROR	RECEIVER OVERRUN. A V_{OH} indicates a second character has been received and transferred to the DATA OUTPUT HOLDING REGISTER without an intervening $\overline{RDA}$. If the previously received character has not been unloaded from the register the next character will be loaded and the first character lost. ROR will remain in the tri-state mode unless $\overline{SWE}$ is a V_{IL}.
(14)	RFE	RECEIVER FRAMING ERROR. A V_{OH} indicates a correet STOP bit was not received following the START bit and correct number of data bits. RFE will remain in the tri-state mode unless $\overline{SWE}$ is a V_{IL}.

Pin	Label	Function
(13)	RPE	RECEIVER PARITY ERROR. A V_{OH} indicates the accumulated parity on the received character does not compare with the parity mode set by POE. RPE will remain in the tri-state mode unless $\overline{SWE}$ is a V_{IL}.
(16)	$\overline{SWE}$	STATUS WORD ENABLE. A V_{IL} enables the status outputs ODA, ROR, RFE, RPE and TBMT on the respective output lines. When $\overline{SWE}$ is V_{IH} all status outputs are in the tri-state mode. For output configurations not requiring a tri-state condition for the status outputs, $\overline{SWE}$ may be tied directly to ground.

APPLICATION DATA

Asynchronous data communications is typified by low data rates, non-contiguous data messages, and a MARK condition on the line between characters. As a result, each data character must be framed for recognition by START and STOP bits. The S1883 UART provides all the logic required to provide a complete full-duplex (transmit and receive simultaneously) asynchronous communication channel for baud rates up to 9600 bps. Included in the S1883 capabilities are; automatic START and STOP bit generation and detection; PARITY generation and detection on variable length characters; tri-state outputs for data and status for data bus configurations, double buffering for less critical timing, and a receiver allowing acceptance of data with up to 42% distortion.

RECEIVER OPERATION

Asynchronous communication line discipline dictates that each character, regardless of width, must be preceded by a START bit. The receiver input logic detects the V_{IH} to V_{IL} (MARK to SPACE) transition on the RSI line that is the leading edge of the START bit. For one half bit time after the leading edge, RSI is sampled for a V_{IL} to insure a proper START bit was present. The following data bits are then clocked into the receiver in the center of each bit period. If RSI returns to the V_{IH} condition before the mid-point of the START bit, the receiver returns to a search for a MARK to SPACE transition.

If at the time of transfer ODA has not been reset by a $\overline{RDA}$, indicating the previous character has not been read, the ROR error flag is set to V_{OH}. The previous data character and status will be lost as the new character is loaded. One full character time is available, assuming contiguous data input at RSI, after ODA is set to read the output character. The data is available at the outputs RD1-RD8 right justified with RD1 the least significant bit. For character widths less than 8 bits the unused outputs are forced to V_{OL}.

For data bus configurations the output data and status are tri-state lines enabled by $\overline{RDE}$ and $\overline{SWE}$ respectively. For polled systems $\overline{SWE}$ can be strobed for detection of ODA and error conditions prior to reading data. For interrupt driven systems $\overline{SWE}$ can be tied directly to ground and ODA used as a data ready interrupt input. A minimum of one character time is available to test the remaining error status bits and input the data character. Typically the same signal can be used for $\overline{RDE}$ and $\overline{RDA}$.

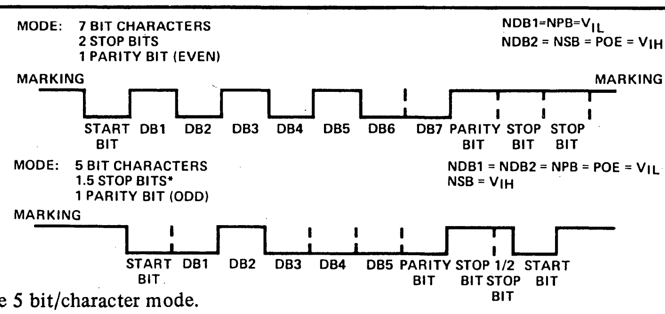
TRANSMITTER OPERATION

The transmit section of the S1883 is reset to a MARK condition with V_{OH} on TSO after receiving a pulse on RESET. Additionally, the transmitter is reset to a character request mode with TBMT and TEOC both at V_{OH}. If the character format is not static, the word length NDB1 and NDB2, parity mode NPB and POE, and number of stop bits NSB should be strobed into the UART with CS.

If both the DATA INPUT HOLDING REGISTER and the TRANSMITTER SHIFT REGISTER are empty the transmitter is in the idle state with TSO, TBMT and TEOC all at V_{OH}. The START bit for a data character loaded with a $\overline{TDS}$ pulse during the idle state is generated at the first negative transition of the TCP following the trailing edge of $\overline{TDS}$. TBMT goes to V_{OL} with the first $\overline{TDS}$. As soon as the character is transferred from the INPUT HOLDING REGISTER to the SHIFT REGISTER, TBMT returns to a V_{OH} and a second character can be loaded. Each character is transmitted with a START bit and 1, 1.5 or 2 stop bits controlled by the respective inputs.

The TEOC is set to V_{OH} after the generation of the last STOP bit indicating the complete character has been transmitted.

TYPICAL DATA FORMAT



*1.5 stop bits generated only in the 5 bit/character mode.

ANALOG DEVICES

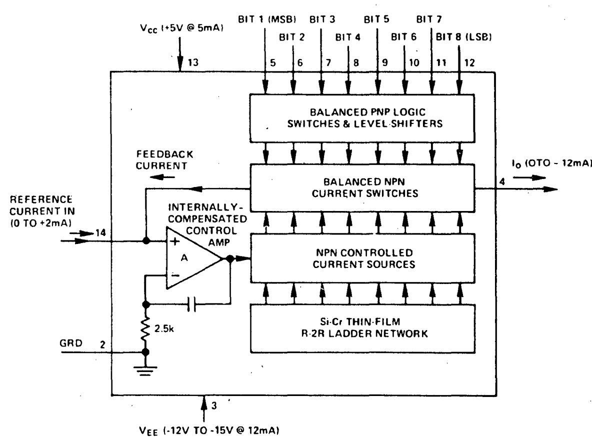
8 Bit Monolithic D/A Converter

AD559

PRELIMINARY TECHNICAL DATA

FEATURES

Replaces the Motorola 1408/1508 8-Bit DAC
Guaranteed Monotonicity Over Full Temperature Range
Single Chip Monolithic Construction
Hermetic 16 Pin Ceramic DIP
TTL/DTL and CMOS Compatibility
High Stability SiCr Thin Film Resistors
Low Cost



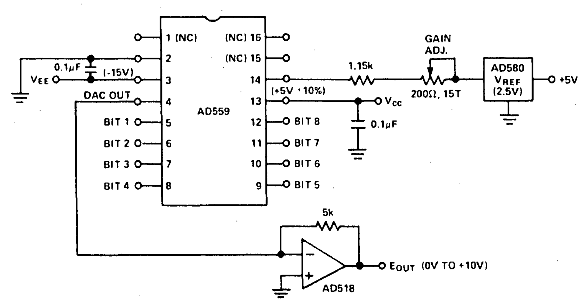
AD559 Block Diagram

PRODUCT DESCRIPTION

The AD559 is a low cost integrated circuit 8-bit digital-to-analog converter consisting of specially designed, precision bipolar switches, a control amplifier, and high stability silicon chromium thin-film resistors, all on a single monolithic chip. The single chip is mounted in a hermetically-sealed ceramic 16 lead dual in-line package.

A unique combination of advanced circuit design, and high stability SiCr thin film resistor processing provides the AD559 with true 8-bit accuracy at low I.C. costs. The maximum error at +25°C is limited to ½LSB (K version) and the gain temperature coefficient is limited to 20ppm/°C max. Monotonicity is guaranteed over the full operating temperature range of the devices.

The AD559 is recommended for all low cost, 8-bit DAC requirements and as a replacement for the Motorola 1408/1508 8-bit DAC, in most applications. The AD559K is specified for operation over the 0 to +70°C temperature range and the AD559S for operation over the full extended temperature range, -55 to +125°C.



Unipolar Output

ORDERING INFORMATION

MODEL	TEMP. RANGE (°C)	ACCURACY (LSB MAX)
AD559K/BIN	0 to +70	±½
AD559S/BIN	-55 to +125	±½

Route 1 Industrial Park; P.O. Box 280; Norwood, Mass. 02062
Tel: 617/329-4700 TWX: 710/394-6577
West Coast 213/595-1783 | Mid-West 312/894-3300 | Texas 214/231-5094

ANALOG DEVICES

Integrated Circuit 12-Bit D/A Converter

AD562

PRELIMINARY TECHNICAL DATA

FEATURES

Low Cost: $39 (100's, AD562K)
True 12-Bit Accuracy (±¼ LSB)
All Active Elements On Single LSI Linear Chip
Guaranteed Monotonicity Over Full Temperature Range
Hermetic 24-Pin DIP
TTL/DTL and CMOS Compatibility

PRODUCT DESCRIPTION

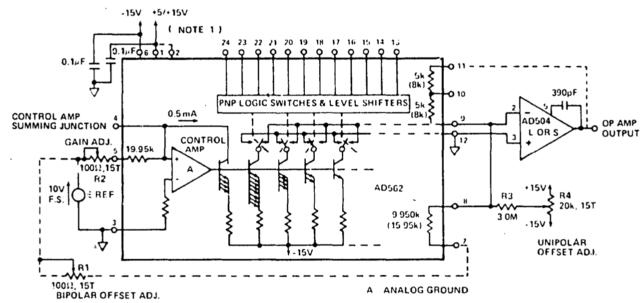
The AD562 is an integrated circuit 12-bit digital-to-analog converter consisting of a specially designed precision bipolar switch and control amplifier chip and a compatible high stability silicon chromium thin film resistor chip. The two IC chips are internally connected and mounted in a hermetically-sealed ceramic 24-lead dual-in-line package.

A unique combination of advanced circuit design, high stability SiCr thin film resistor processing, and laser trimming technology provides the AD562 with true 12-bit accuracy. The maximum error at +25°C is limited to ¼ LSB (K, A, and S versions) and the gain temperature coefficient is limited to 3ppm/°C max. Monotonicity is guaranteed over the full operating temperature range of the devices.

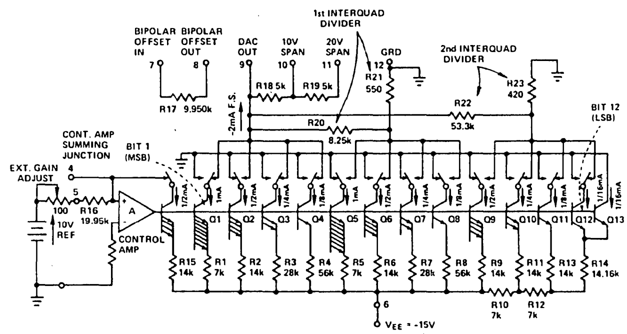
The AD562 is recommended for all high accuracy 12-bit D/A converter applications where true 12-bit performance is required and small size and low cost are primary considerations. The AD562 is also ideal for use in constructing A/D conversion systems and as a building block for higher resolution D/A systems. The AD562K is specified for operation over the 0 to +70°C temperature range, the AD562A for operation over the −25 to +85°C temperature range, and the AD562S for operation over the full extended temperature range of −55 to +125°C.

ORDERING INFORMATION

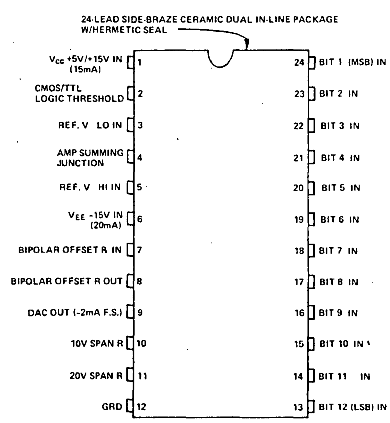
MODEL	TEMP. RANGE (°C)	ACCURACY (LSB MAX)	PRICE (100's) ($)
AD562K/BIN	0 to +70	±¼	$ 39.00
AD562K/BCD	0 to +70	±¼	$ 39.00
AD562A/BIN	-25 to +85	±¼	$ 49.00
AD562A/BCD	-25 to +85	±¼	$ 49.00
AD562S/BIN	-55 to +125	±¼	$100.00
AD562S/BCD	-55 to +125	±¼	$100.00



AD562 Functional Schematic



Ladder Network and Inter-Quad Divider Current Scaling



PIN CONFIGURATION TOP VIEW

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ANALOG DEVICES

Low Cost IC 12-Bit D/A Converter

AD563

PRELIMINARY TECHNICAL DATA

FEATURES

- Extremely Low Cost: $27 (100's, AD563J)
- True 12-Bit Accuracy: ±¼LSB max (AD563K, S, T)
- Guaranteed Differential Nonlinearity: ±½LSB max
- Positive True Logic
- Includes Internal Reference
- Guaranteed Monotonicity Over Full Temperature Range
- Low Overall Gain T.C.: 10ppm/°C max (AD563T)
  30ppm/°C max (AD563J)
- Hermetic 24 pin DIP
- TTL/DTL and CMOS Compatibility

PRODUCT DESCRIPTION

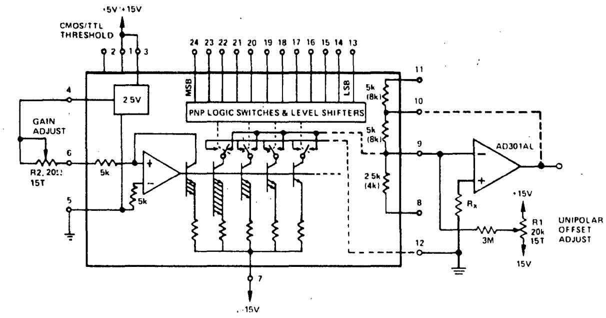
The AD563 is an integrated circuit 12-bit digital-to-analog converter consisting of a specially designed precision bipolar switch and control amplifier chip, a compatible high stability silicon chromium thin film resistor chip, and a low drift, voltage reference chip. The three I.C. chips are internally connected and mounted in a hermetically-sealed, ceramic 24 lead dual-in-line package to produce a self contained current output DAC.

A unique combination of advanced circuit design, high stability SiCr thin film resistor processing and laser trimming technology, provides the AD563 with true 12-bit accuracy. The maximum error at +25°C is limited to ¼LSB (K, S and T versions) with the gain temperature coefficient limited to 10ppm/°C max, including the effects of the internal reference. Monotonicity on all versions is guaranteed over the full operating temperature range.

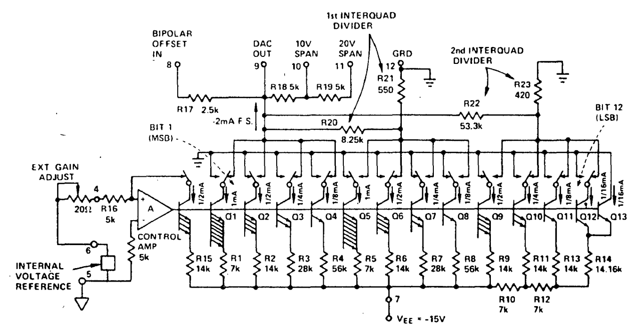
The AD563 is recommended for all high accuracy 12-bit D/A converter applications where true 12-bit performance is required, but low cost and small size are considerations. The AD563 is also ideal for use in constructing A/D conversion systems and as a building block for higher resolution D/A systems. The AD563J and K are specified for operation over the 0 to +70°C temperature range, the AD563S and T for operation over the military temperature range, -55°C to +125°C.

ORDERING INFORMATION

MODEL	TEMP. RANGE (°C)	ACCURACY (LSB MAX)	PRICE (100's) ($)
AD563J/BIN	0 to +70	±½	$ 27.00
AD563J/BCD	0 to +70	±½	$ 27.00
AD563K/BIN	0 to +70	±¼	$ 42.00
AD563K/BCD	0 to +70	±¼	$ 42.00
AD563S/BIN	-55 to +125	±¼	$110.00
AD563S/BCD	-55 to +125	±¼	$110.00
AD563T/BIN	-55 to +125	±¼	$140.00
AD563T/BCD	-55 to +125	±¼	$140.00



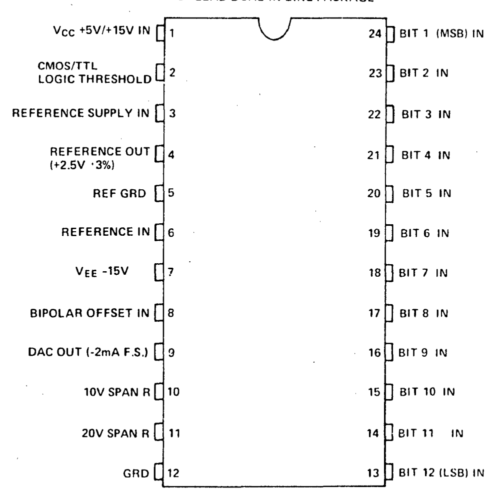
AD563 in Typical Unipolar Connection Scheme



Ladder Network and Inter-Quad Divider Current Scaling

PIN CONFIGURATION

24 LEAD DUAL IN-LINE PACKAGE



TOP VIEW

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ANALOG DEVICES

CMOS 10 & 12 Bit Monolithic Multiplying D/A Converters

AD7520, AD7521

FEATURES

AD7520:	**10 Bit Resolution**
AD7521:	**12 Bit Resolution**
Linearity:	**8, 9 and 10 Bit**
Nonlinearity Tempco:	**2 ppM of FSR/°C**
Low Power Dissipation:	**20 mW**
Current Settling Time:	**500 ns**
Feedthrough Error:	**1/2 LSB @ 100 kHz**
TTL/DTL/CMOS Compatible	

GENERAL DESCRIPTION

The AD7520 (AD7521) is a low cost, monolithic 10-bit (12-bit) multiplying digital-to-analog converter packaged in a 16-pin (18-pin) DIP. The devices use advanced CMOS and thin film technologies providing up to 10-bit accuracy with TTL/DTL/CMOS compatibility.

The AD7520 (AD7521) operates from +5V to +15V supply and dissipates only 20 mW, including the ladder network.

Typical AD7520 (AD7521) applications include: digital/analog multiplication, CRT character generation, programmable power supplies, digitally controlled gain circuits, etc.

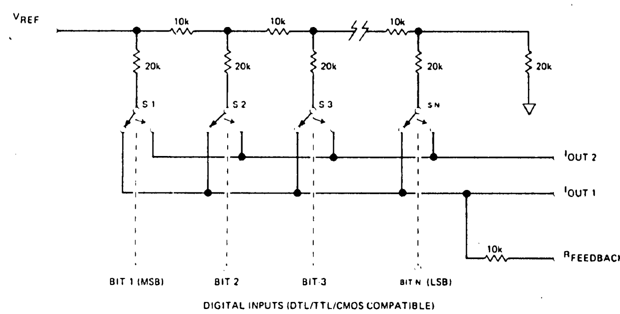
ORDERING INFORMATION

Nonlinearity	Temperature Range	
	0 to +75°C	−55°C to +125°C
0.2% (8-BIT)	AD7520JD AD7520JN AD7521JD AD7521JN	AD7520SD AD7521SD
0.1% (9-BIT)	AD7520KD AD7520KN AD7521KD AD7521KN	AD7520TD AD7521TD
0.05% (10-BIT)	AD7520LD AD7520LN AD7521LD AD7521LN	AD7520UD AD7521UD

PACKAGE IDENTIFICATION

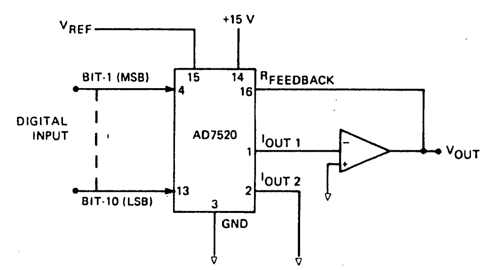
Suffix D: Ceramic DIP package
Suffix N: Plastic DIP package

FUNCTIONAL DIAGRAM



AD7520: N=10
AD7521: N=12
Logic: A switch is closed to I_{OUT} 1 for its digital input in a "HIGH" state.

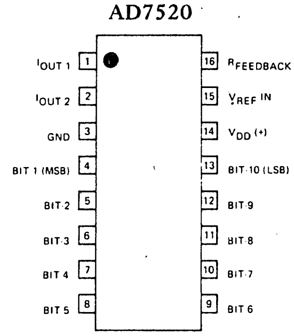
TYPICAL APPLICATION



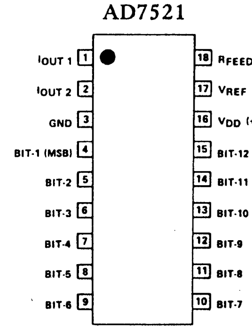
PIN CONFIGURATION

TOP VIEW

AD7520



AD7521



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ANALOG DEVICES

CMOS Monolithic 10-Bit, Buffered Multiplying D/A Converter

AD7522

FEATURES

10-Bit Resolution
8, 9, & 10-Bit Linearity
Microprocessor Compatible
Double Buffered Inputs
Serial or Parallel Loading
DTL/TTL/CMOS Direct Interface
Nonlinearity Tempco: 2ppM of FSR/°C
Gain Tempco: 10ppM of FSR/°C
Very Low Power Dissipation
Very Low Feedthrough

GENERAL DESCRIPTION

The AD7522 is a monolithic CMOS 10-bit multiplying D/A converter, with an input buffer and a holding register, allowing direct interface with microprocessors. Most applications require the addition of only an operational amplifier and a reference voltage.

The key to easy interface to a data bus is the AD7522's ability to load the input buffer in two bytes (an 8-bit and a 2-bit byte), and subsequently move this data to a holding register, where the digital word is converted into an analog current or voltage (with external operational amplifier). The input loading of either 8 or 10 bits can be done in a parallel or serial mode.

The AD7522 is packaged in a 28-pin DIP, and operates with a +15V main supply at 2mA max, and a logic supply of +5V for TTL interface, or +10 to +15V for CMOS interface.

A thin film on high density CMOS process, using silicon nitride passivation, ensures high reliability and excellent stability.

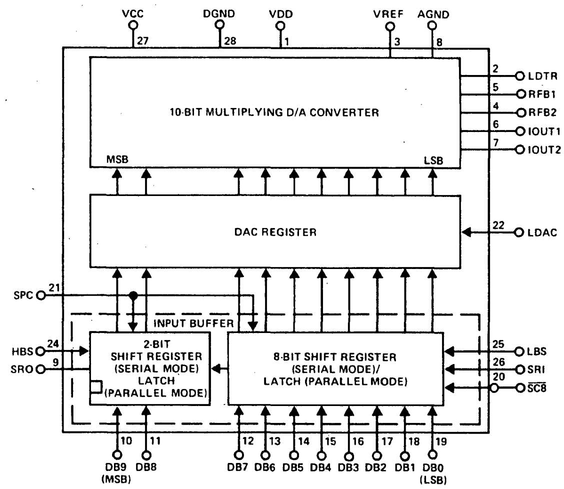
ORDERING INFORMATION

Nonlinearity	Temperature Range	
	0°C to +75°C	−55°C to +125°C
0.2% FSR (8-Bit)	AD7522JD AD7522JN	AD7522SD
0.1% FSR (9-Bit)	AD7522KD AD7522KN	AD7522TD
0.05% FSR (10-Bit)	AD7522LD AD7522LN	AD7522UD

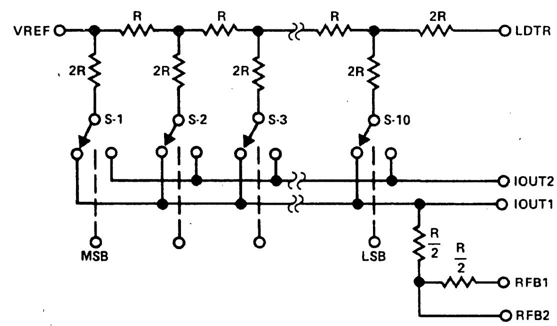
PACKAGE IDENTIFICATION

Suffix "D": Ceramic DIP Package
Suffix "N": Plastic DIP Package

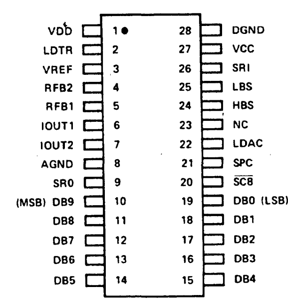
FUNCTIONAL DIAGRAM



D/A CONVERTER DIAGRAM



PIN CONFIGURATION



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Pin Function Description

PIN	MNEMONIC	DESCRIPTION
1	VDD	+15V (nominal) Main Supply.
2	LDTR	R-2R Ladder Termination Resistor. Normally grounded for unipolar operation or terminated at IOUT2 for bipolar operation.
3	VREF	Reference Voltage Input. Since the AD7522 is a multiplying DAC, VREF may vary over the range of ±10V.
4	RFB2	Rfeedback ÷ 2; gives full scale equal to VREF/2.
5	RFB1	Rfeedback, used for normal unity gain (at full scale) D/A conversion.
6	IOUT1	DAC Current OUT-1 Bus. Normally terminated at virtual ground of output amplifier.
7	IOUT2	DAC Current OUT-2 Bus, terminated at ground for unipolar operation, or virtual ground of op amp for bipolar operation.
8	AGND	Analog Ground. Back gate of DAC N-channel SPDT current steering switches.
9	SRO	Serial Output. An auxiliary output for recovering data in the input buffer.
10	DB9 (Note 1)	Data Bit 9. Most significant parallel data input.
11	DB8 (Note 1)	Data Bit 8.
12	DB7 (Note 1)	Data Bit 7.
13	DB6 (Note 1)	Data Bit 6.
14	DB5 (Note 1)	Data Bit 5.
15	DB4 (Note 1)	Data Bit 4.
16	DB3 (Note 1)	Data Bit 3.
17	DB2 (Note 1)	Data Bit 2.
18	DB1 (Note 1)	Data Bit 1.
19	DB0 (Note 1)	Data Bit 0. Least significant parallel data input.
20	$\overline{SC8}$	8-Bit Short Cycle Control. When in serial mode, if $\overline{SC8}$ is held to logic "0," the two least significant input latches in the input buffer are bypassed to provide proper serial loading of 8-bit serial words. If $\overline{SC8}$ is held to logic "1," the AD7522 will accept a 10-bit serial word. Data bits 0(LSB) and DB1 are in a parallel load mode when $\overline{SC8}$ = 0, and should be tied to a logic low state to prevent false data from being loaded.
21	SPC	Serial/Parallel Control. If SPC is a logic "0," the AD7522 will load parallel data appearing on DB0 through DB9 into the input buffer when the appropriate strobe inputs are exercised (see HBS and LBS). If SPC is a logic "1," the AD7522 will load serial data appearing on Pin 26 into the input buffers. Each serial data bit must be "strobed" into the buffer with the HBS and LBS.
22	LDAC	Load DAC: When LDAC is a logic "0," the AD7522 is in the "hold" mode, and digital activity in the input buffer is locked out. When LDAC is a logic "1," the AD7522 is in the "load" mode, and data in the input buffer loads the DAC register.
23	NC	No Connection.
24	HBS	High Byte Strobe. When in "parallel load" mode (SPC = 0), parallel data appearing on the DB9 (MSB) and DB8 data inputs will be "clocked" into the input buffer on the positive going edge of HBS. When in "serial load" mode (SPC = 1), serial data bits appearing at the serial input terminal, Pin 26, will be "clocked" into the input buffer on the positive going edges of HBS and LBS. (HBS and LBS must be clocked simultaneously when in "serial load" mode.)
25	LBS	Low Byte Strobe. When in "parallel load" mode (SPC = 0), parallel data appearing on the DB0 (LSB) through DB7 inputs will be "clocked" into the input buffer on the positive going edge of the LBS. When in "serial load" mode (SPC = 1), serial data bits appearing at the serial input terminal, Pin 26, will be "clocked" into the input buffer on the positive going edge of HBS and LBS. (HBS and LBS must be clocked simultaneously when in "serial load" mode.)
26	SRI	Serial Input.
27	VCC	Logic Supply. If +5V is applied, all digital inputs/outputs are TTL compatible. If +10V to +15V is applied, digital inputs/outputs are CMOS compatible.
28	DGND	Digital Ground.

Note 1: Logic "1" applied to a data bit steers that bit's current to the IOUT1 terminal.

ANALOG DEVICES

CMOS 10-Bit Monolithic A/D Converter

AD7570

FEATURES

8 and 10-Bit Resolution
20μsec Conversion Time
Microprocessor Compatibility
Very Low Power Dissipation
Parallel and Serial Outputs
Ratiometric Operation
TTL/DTL/CMOS Logic Compatibility
CMOS Monolithic Construction

GENERAL DESCRIPTION

The AD7570 is a monolithic CMOS 10-bit successive approximation A/D converter on a 120 by 135 mil chip, requiring only an external comparator, reference and passive clocking components. Ratiometric operation is inherent, since an extremely accurate multiplying DAC is used in the feedback loop.

The AD7570 parallel output data lines and Busy line utilize three-state logic to permit bussing with other A/D output and control lines or with other I/O interface circuitry. Two enables are available, one controls the two MSB's, the second controls the remaining 8 LSB's. This feature provides the control interface for most microprocessors which can accept only an 8-bit byte.

The AD7570 also provides a serial data output line to be used in conjunction with the serial synchronization line. The clock can be driven externally or, with the addition of a resistor and a capacitor, can run internally as high as 0.6 MHz allowing a total conversion time (8-bits) of typically 20μsec. An 8-bit short cycle control pin stops the clock after exercising 8 bits, normally used for the "J" version (8-bit resolution).

The AD7570 requires two power supplies, a +15V main supply and a +5V (for TTL/DTL logic) to +15V (for CMOS logic) supply for digital circuitry. Both analog and digital grounds are available.

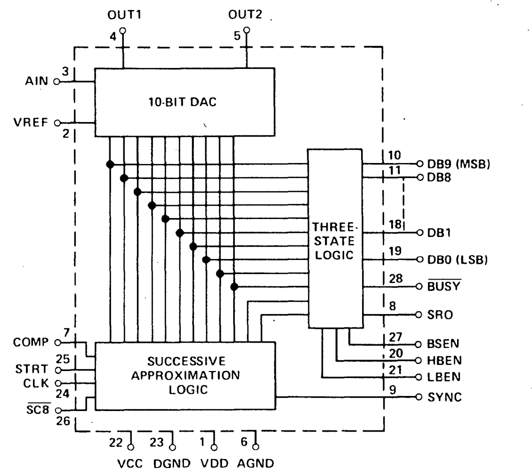
The AD7570 is a monolithic device using a proprietary CMOS process featuring a double layer metal interconnect, on-chip thin-film resistor network and silicon nitride passivation ensuring high reliability and excellent long term stability.

ORDERING INFORMATION

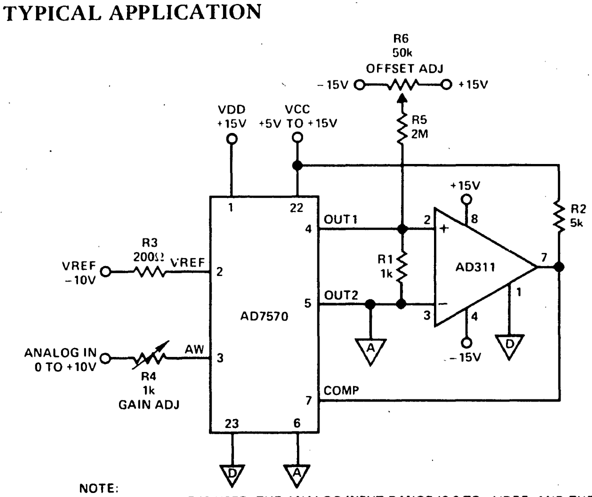
Resolution	Temperature Range
	0 to +75°C
8-Bit	AD7570J
10-Bit	AD7570L

Suffix D: Ceramic Package

FUNCTIONAL DIAGRAM

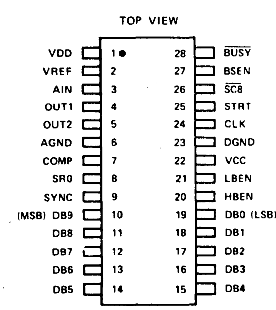


TYPICAL APPLICATION



NOTE:
IF POSITIVE VREF IS USED, THE ANALOG INPUT RANGE IS 0 TO -VREF, AND THE COMPARATOR'S (-) INPUT SHOULD BE CONNECTED TO OUT1 (PIN 4) OF THE AD7570.

PIN CONFIGURATION



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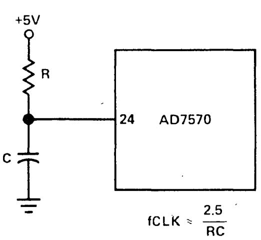
Pin Function Description

INPUT CONTROLS

1. Convert Start (pin 25 – STRT)
   When the start input goes to logical 1, the MSB data latch is set to logic 1 and all other data latches are set to logic 0. When the start input returns low, the conversion sequence begins. The start command must remain high for at least 500 nanoseconds. If a start command is reinitiated *during* conversion, the conversion sequence starts over.
2. High Byte Enable (pin 20 – HBEN)
   This is a three-state enable for the bit-9 (MSB) and bit 8. When the control is low, the output data lines for bits 9 and 8 are floating. When the control is high, digital data from the latches appears on the data lines.
3. Low Byte Enable (pin 21 – LBEN)
   Same as High Byte Enable pin, but controls bits 0 (LSB) through 7.
4. Busy Enable (pin 27 – BSEN)
   This is an interrogation input which requests the status of the converter, i.e., conversion in process or convert complete. The converter status is addressed by applying a logic 1 to the Busy Enable. (See Busy under Output Functions.)
5. Short Cycle 8-Bits (pin 26 – $\overline{SC8}$)
   With a logic 0 input, the conversion stops after 8 bits reducing the conversion time by 2 clock periods. This control should be exercised for proper operation of the "J" version. When a logic 1 is applied, a complete 10-bit conversion takes place ("L" version).
6. Clock(pin 24 – CLK)
   With an external RC connected, as shown in the Figure below, clock activity begins upon receipt of a Convert-Start command to the A/D, and ceases upon completion of conversion. An external clock (CMOS or TTL/DTL levels) can directly drive the clock terminals, if required.



Generating Internal Clock Frequency

7. VDD (pin 1)
   VDD is the positive supply for all analog circuitry plus some digital logic circuits that are not part of the TTL compatible input/output lines (back-gates to the P-channel devices). Nominal supply voltage is +15V.
8. VCC (pin 22)
   VCC is the logic power supply. If +5V is used, all control inputs/outputs (with the exception of comparator terminal) are DTL/TTL compatible. If +15V is applied, control inputs/outputs are CMOS compatible.

OUTPUT FUNCTIONS

1. Busy (pin 28 – $\overline{BUSY}$)
   The Busy line indicates whether conversion is complete or in process. Busy is a three-state output and floats until the Busy-Enable line is addressed with a logic 1. When addressed, Busy will indicate either a 1 (conversion complete) or a 0 (conversion in process).
2. Serial Output (pin 8 – SRO)
   Provides output data in serial format. Data is available only during conversion. When the A/D is not converting, the Serial Output line "floats." The Serial Sync (see next function) *must* be used, along with the Serial Output terminal to avoid misinterpreting data.
3. Serial Synchronization (pin 9 – SYNC)
   Provides 10 positive edges, which are synchronized to the Serial Output pin. Serial Sync is floating if conversion is not taking place.

Note that all digital inputs/outputs are TTL/DTL compatible when VCC is +5V, and CMOS compatible when VCC is +15V.

Table 1. Function Table

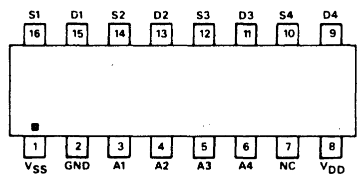
PIN NO.	MNEMONIC	FUNCTION
1	VDD	Positive Supply (+15V)
2	VREF	Voltage **REF**erence (±10V)
3	AIN	Analog **IN**put
4	OUT1	DAC Current **OUT**put 1
5	OUT2	DAC Current **OUT**put 2
6	AGND	Analog **G**rou**ND**
7	COMP	**COMP**arator
8	SRO	**S**e**R**ial **O**utput
9	SYNC	Serial **SYNC**hronization
10	DB9	Data Bit 9 (MSB)
11	DB8	Data Bit 8
12	DB7	Data Bit 7
13	DB6	Data Bit 6
14	DB5	Data Bit 5
15	DB4	Data Bit 4
16	DB3	Data Bit 3
17	DB2	Data Bit 2
18	DB1	Data Bit 1
19	DB0	Data Bit 0 (LSB)
20	HBEN	High Byte **EN**able
21	LBEN	Low Byte **EN**able
22	VCC	Logic Supply (+5V to +15V)
23	DGND	Digital **G**rou**ND**
24	CLK	**CL**oc**K**
25	STRT	**ST**a**RT**
26	$\overline{SC8}$	Short Cycle 8 Bits
27	BSEN	**B**u**S**y **EN**able
28	$\overline{BUSY}$	**BUSY**

ANALOG DEVICES

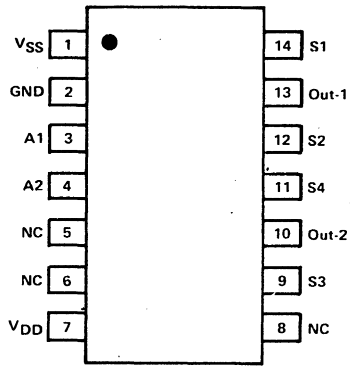
Monolithic Analog CMOS Switches

PIN CONFIGURATIONS (TOP VIEW)

AD7510DI
AD7511DI

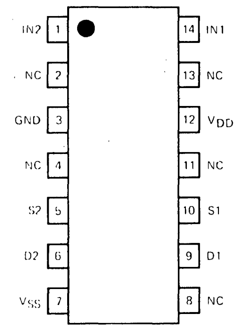


AD7512DI

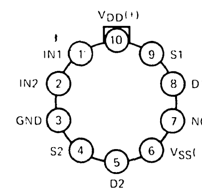


AD7513

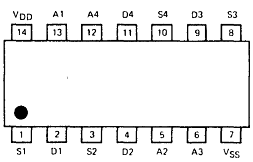
DIP



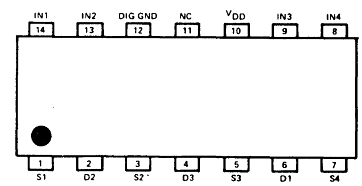
TO–100



AD7516



AD7519



PACKAGE INFORMATION

Suffix D – Ceramic DIP
Suffix N – Plastic DIP
Suffix H – TO-100

PERFORMANCE SELECTION TABLE ($T_A = +25°C$)

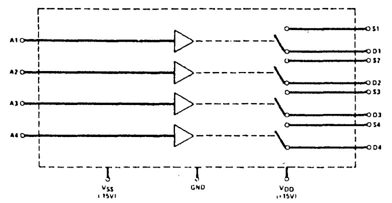
Parameter	Units	AD7510DI AD7510 Commercial	AD7511DI AD7511 Military	AD7512DI AD7512 Commercial	Military	AD7513 Commercial	AD7513 Military	AD7516 Commercial	AD7516 Military	AD7519 Commercial
R_{ON} (MAX)	ohms	100		100		80	70	400		100
I_D (I_s) (MAX)	nA	5	3	5	3	5	2	125[1]		––
I_{OUT} (MAX)	nA	–	–	15	9	––	––	––		––
t_{ON} (TYP)	µs	1µs		––		700		0.02		0.02
t_{OFF} (TYP)	µs	0.8µs		––		400		0.02		0.03
$t_{transition}$ (TYP)	µs	––		1.2		––		––		––
I_{DD}[2] (MAX)	mA	0.5	0.8	0.5	0.8	1	1	0.0005		0.001
I_{ss}[2] (MAX)	mA	0.1	0.8	0.1	0.8	1	1	0.0005		––
Nominal Pwr. Supply	V	±15V		±15V		±15V		($V_{DD}-V_{ss}$) = 15V		+8V

NOTES: [1] For ($V_{DD}-V_{SS}$) = 10V
[2] For all digital inputs high (worst case).

ANALOG DEVICES

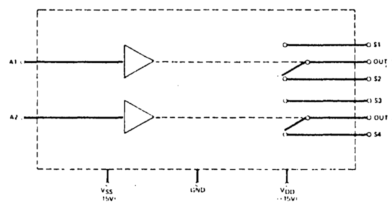
Monolithic Analog CMOS Switches

AD7510, AD7511
Quad SPST
Power Dissipation: 30μW
TTL/DTL/CMOS Direct Interface
"Break-Before-Make" Switching (AD7511)



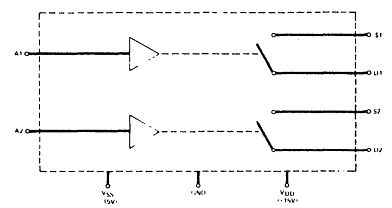
AD7510: Address "HIGH" closes switch
AD7511: Address "LOW" closes switch

AD7512
Dual SPDT
TTL/DTL/CMOS Direct Interface
Power Dissipation: 30μW



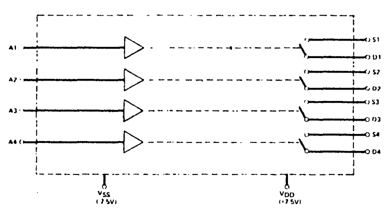
Address "HIGH" makes S-1 to OUT-1 and S-3 to OUT-2

AD7513
Dual SPST
TTL/DTL/CMOS Direct Interface



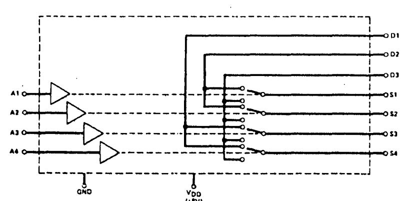
Address "LOW" Closes Switch

AD7516
Quad SPST
Switching Time: 20ns
Power Dissipation: 10μW
CMOS Compatible



Address "HIGH" Closes Switch

AD7519
Quad SPDT Current Switch
Switching Time: 20ns
Power Dissipation: 8μW
CMOS Compatible



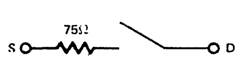
Address "HIGH" Steers Current to D3 buss

Indestructible Analog CMOS Switches

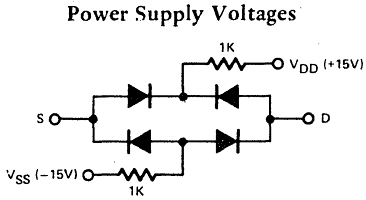
AD7510DI	Pin For Pin Spec For Spec With	AD7510	Latch Proof <u>and</u> Overvoltage Proof <u>without</u> Compromise!
AD7511DI		AD7511	
AD7512DI		AD7512	

EQUIVALENT CIRCUITS

Signals Within The Power Supply Voltages



Signals Beyond The Power Supply Voltages



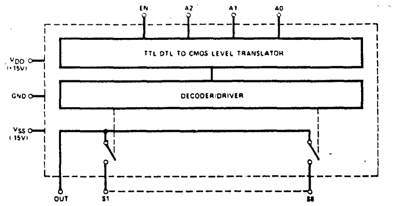
ANALOG DEVICES

Latchproof Monolithic CMOS Multiplexers

INTERFACE

Analog Devices

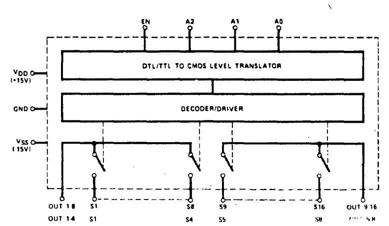
AD7501, AD7503
8-Channel MUX
TTL/DTL/CMOS Direct Interface
Output "Enable" Control
Power Dissipation: 30μW
AD7503 Replaces HI-1818



AD7501				
A_2	A_1	A_0	E_N	"ON"
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8
X	X	X	0	None

AD7503				
A_2	A_1	A_0	E_N	"ON"
0	0	0	0	1
0	0	1	0	2
0	1	0	0	3
0	1	1	0	4
1	0	0	0	5
1	0	1	0	6
1	1	0	0	7
1	1	1	0	8
X	X	X	1	None

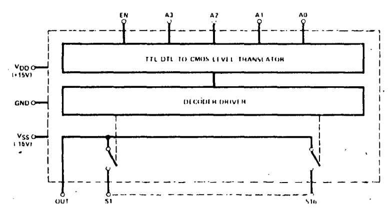
AD7502, AD7507
4- & 8-Channel Differential MUX
TTL/DTL/CMOS Direct Interface
Output "Enable" Control
AD7507 is superior plug-in replacement for DG-507



AD7502			
A_1	A_0	E_N	"ON"
0	0	1	1 & 5
0	1	1	2 & 6
1	0	1	3 & 7
1	1	1	4 & 8
X	X	0	None

AD7507				
A_2	A_1	A_0	E_N	"ON"
0	0	0	1	1 & 9
0	0	1	1	2 & 10
0	1	0	1	3 & 11
0	1	1	1	4 & 12
1	0	0	1	5 & 13
1	0	1	1	6 & 14
1	1	0	1	7 & 15
1	1	1	1	8 & 16
X	X	X	0	None

AD7506
16-Channel MUX
TTL/DTL/CMOS Direct Interface
Output "Enable" Control
Power Dissipation: 1.5mW
Superior replacement for DG-506



AD7506					
A_3	A_2	A_1	A_0	E_N	"ON"
0	0	0	0	1	1
0	0	0	1	1	2
0	0	1	0	1	3
0	0	1	1	1	4
0	1	0	0	1	5
0	1	0	1	1	6
0	1	1	0	1	7
0	1	1	1	1	8
1	0	0	0	1	9
1	0	0	1	1	10
1	0	1	0	1	11
1	0	1	1	1	12
1	1	0	0	1	13
1	1	0	1	1	14
1	1	1	0	1	15
1	1	1	1	1	16
X	X	X	X	0	None

PERFORMANCE SELECTION TABLE ($T_A = +25°C$)

Parameter	Units	AD7501 Commercial	AD7503 Military[1]	AD7502 Commercial	AD7502 Military	AD7506 Commercial	AD7506 Military	AD7507 Commercial	AD7507 Military
R_{ON} (MAX)	ohms	300		300		450	400	450	400
I_s (MAX)	nA	2	0.5	2	0.5	5	1	5	1
I_{OUT} (MAX)	nA	10	5	5	3	20	10	10	5
$t_{transition}$ (TYP)	μs	0.8		0.8		0.7		0.7	
I_{DD}[2] (MAX)	mA	0.5	0.8	0.5	0.8	1		1	
I_{SS}[2] (MAX)	mA	0.1	0.8	0.1	0.8	1		1	

NOTES: [1] "Commercial" and "Military" refer to operating temperature ranges.
[2] For all digital inputs high (worst case).

PRODUCT PROFILE

MOS/LSI

Siliconix offers a number of technologies in the MOS/LSI area, with a line of both standard and custom devices. Processing capability includes low V_{TH} in PMOS (metal gate), high-voltage CMOS (10 V – 30 V, metal gate) and low voltage CMOS (3 V – 15 V, metal gate). The most significant recent additions to our LSI product line are one-chip and two-chip (analog and digital) Integrated Circuits for A/D conversion.

FET Analog Switches

Siliconix's J-FET, MOS FET and Integrated Circuit technology has been utilized to produce an extensive family of Analog Switches. These Integrated Circuits are used in many high-reliability military and aerospace applications, such as the Mercury, Gemini, Apollo and Skylab manned space programs.

High performance multi-chip J-FET switches packaged with Integrated Circuit drivers offer low ON resistance, high OFF isolation, fast switching speed and excellent frequency response.

Since 1968, monolithic multi-channel PMOS switches with Integrated Drivers have been an integral part of the Siliconix Analog Switch family.

Most recent additions to the family have been CMOS switches and multiplexers of up to sixteen channels. These devices will switch analog voltages up to 30 Volts peak-to-peak.

Field Effect Transistors

Siliconix has maintained technical leadership in P- and N-Channel Junction FETs, and offers the most complete product line in the industry. FETs are characterized for such applications as low-drive d-c amplifiers, low-noise low-frequency amplifiers, high-frequency amplifiers (to 1 GHz), low gate current circuits (10^{-13} A), and analog switching (ON resistance as low as 2 Ω).

Both N- and P-Channel MOS FETs are also available, with applications aimed mainly at analog switching. P-Channel enhancement mode devices are offered with ON resistance ranging from 20 Ω to 1K Ω, and with breakdown voltages as high as 75 V. N-Channel MOS FETs are available in either enhancement or depletion mode structures. Depletion mode devices are also used in amplifiers with very low input currents (r_{DS} 10^{13} Ω).

High Reliability Devices

Siliconix capability in providing high-reliability devices to meet stringent military or aerospace applications is amply demonstrated by the company's qualification as a supplier for Mercury, Gemini, Apollo and the Viking 75 Mars orbiter/lander. Siliconix has a number of standard Hi-Rel screening options that can be applied to standard products. These options include MIL-STD-883 for microcircuits and MIL-STD-750 for discrete FETs. In addition, Siliconix offers certain JEDEC-registered FETs with JAN or JANTX processing, and has the capability of doing JANTXV processing. If other screening options are required to meet individual customer requirements, Siliconix can provide special additional inspections and controls to meet the most exacting demands.

The company has an in-house Scanning Electron Microscope facility and maintains many on-going product and process evaluation programs for standard products. Siliconix can supply SEM qualified products to meet individual customer requirements.

ANALOG SWITCH CONDENSED SPECIFICATIONS

Basic Part No. (Notes 1 & 2)	Switch Type	$r_{DS(on)}$ Max (Ω) (Note 3)	Analog Voltage Range (p-p V) (Note 3)	Switching Time (μsec) t_{ON}	t_{OFF}	Logic State for ON Switch	Logic Levels (V) V_{INL}	V_{INH}	Opt. Sup. Voltage (V) (+) Sup. V_1	(−) Sup. V_2	Logic Sup. V_L	Ref. Sup. V_R	Comments
					TWO CHANNEL SPST								
***DGM111**	PMOS	75-200	20	0.3	1.0	0	0.5	4.6	10	−20	5	—	
DG133	N-JFET	30	20	0.6	1.6	1	0.8	2.5	12	−18	—	0	See DG181
DG134	N-JFET	80	20	0.6	1.6	1	0.8	2.5	12	−18	—	0	See DG182
DG141	N-JFET	10	20	1.0	2.5	1	0.8	2.5	12	−18	—	0	See DG180
DG151	N-JFET	15	15	1.0	2.5	1	0.8	2.5	15	−15	—	0	See DG180
DG152	N-JFET	50	15	0.8	1.6	1	0.8	2.5	15	−15	—	0	See DG181
***DG180**	N-JFET	10	20	0.3	0.25	0	0.8	2.0	10	−20	5	0	Break-Before-Make
		10	15	0.3	0.25	0	0.8	2.0	15	−15	5	0	15 V Supplies
***DG181**	N-JFET	30	20	0.15	0.13	0	0.8	2.0	10	−20	5	0	Break-Before-Make
		30	15	0.15	0.13	0	0.8	2.0	15	−15	5	0	15 V Supplies
***DG182**	N-JFET	75	20	0.25	0.13	0	0.8	2.0	10	−20	5	0	Break-Before-Make
		75	20	0.25	0.13	0	0.8	2.0	15	−15	5	0	15 V Supplies
***DG200**	CMOS	70	30	1.0	0.5	0	0.8	2.4	15	−15	—	(Note 9)	
					FOUR CHANNEL SPST								
***DG172**	PMOS	150-450	20	0.3	0.75	0	0.8	2.0	10	−20	5	0	
***DG201**	CMOS	175	30	1.0	0.5	0	0.8	2.4	15	−15	—	(Note 9)	
					FIVE CHANNEL SPST								
DG123	PMOS	100-450	20	0.3	2.0	1	0.4	1 mA(6)	10	−20	—	0	
DG125	PMOS	100-450	20	0.3	2.0	0	0.5	4.6	10	−20	5	—	
					ONE CHANNEL SPDT								
DG143	N-JFET	80	20	0.8	1.6	(Note 4)	2.0	3.0	12	−18	—	0	See DG188
DG144	N-JFET	30	20	0.8	1.6	(Note 4)	2.0	3.0	12	−18	—	0	See DG187
DG146	N-JFET	10	20	1.0	2.5	(Note 4)	2.0	3.0	12	−18	—	0	See DG186
DG161	N-JFET	15	15	1.0	2.5	(Note 4)	2.0	3.0	15	−15	—	0	See DG186
DG162	N-JFET	50	15	0.8	1.6	(Note 4)	2.0	3.0	15	−15	—	0	See DG187
***DG175**	PMOS	75-200	20	0.2	0.5	(Note 5)	0.8	2.0	10	−20	5	0	
***DG186**	N-JFET	10	20	0.3	0.25	(Note 5)	0.8	2.0	10	−20	5	0	Break-Before-Make
	N-JFET	10	15	0.3	0.25	(Note 5)	0.8	2.0	15	−15	5	0	15 V Supplies
***DG187**	N-JFET	30	20	0.15	0.13	(Note 5)	0.8	2.0	10	−20	5	0	Break-Before-Make
	N-JFET	30	15	0.15	0.13	(Note 5)	0.8	2.0	15	−15	5	0	15 V Supplies
***DG188**	N-JFET	75	20	0.25	0.13	(Note 5)	0.8	2.0	10	−20	5	0	Break-Before-Make
	N-JFET	75	20	0.25	0.13	(Note 5)	0.8	2.0	15	−15	5	0	15 V Supplies
***SI3002**	PMOS	100-400	20	1.0	1.5	(Note 5)	0.8	2.0	10	−20	—	0	Same as HAD30021XX
					TWO CHANNEL SPDT								
***DG189**	N-JFET	10	20	0.3	0.25	(Note 5)	0.8	2.0	10	−20	5	0	Break-Before-Make
	N-JFET	10	15	0.3	0.25	(Note 5)	0.8	2.0	15	−15	5	0	15 V Supplies
***DG190**	N-JFET	30	20	0.15	0.13	(Note 5)	0.8	2.0	10	−20	5	0	Break-Before Make
	N-JFET	30	15	0.15	0.13	(Note 5)	0.8	2.0	15	−15	5	0	15 V Supplies
***DG191**	N-JFET	75	20	0.25	0.13	(Note 5)	0.8	2.0	10	−20	5	0	Break-Before-Make
	N-JFET	75	20	0.25	0.13	(Note 5)	0.8	2.0	15	−15	5	0	15 V Supplies
					THREE CHANNEL SPDT								
***DG170**	PMOS	200-800	20	0.3	0.4	(Note 5)	0.8	2.0	10	−20	5	0	
					TWO CHANNEL DPST								
***DGM122**	PMOS	100-450	20	0.3	2.0	1	0.4	1 mA(6)	10	−20	5	0	
DG126	N-JFET	80	20	0.6	1.6	1	0.8	2.5	12	−18	—	0	See DG185
DG129	N-JFET	30	20	0.6	1.6	1	0.8	2.5	12	−18	—	0	See DG184
DG140	N-JFET	10	20	1.0	2.5	1	0.8	2.5	12	−18	—	0	See DG183
DG153	N-JFET	15	15	1.0	2.5	1	0.8	2.5	15	−15	—	0	See DG183
DG154	N-JFET	50	15	0.6	1.6	1	0.8	2.5	15	−15	—	0	See DG185
***DG183**	N-JFET	10	20	0.3	0.25	1	0.8	2.0	10	−20	5	0	Break-Before-Make
	N-JFET	10	15	0.3	0.25	1	0.8	2.0	15	−15	5	0	15 V Supplies
***DG184**	N-JFET	30	20	0.15	0.13	1	0.8	2.0	10	−20	5	0	Break-Before-Make
	N-JFET	30	15	0.15	0.13	1	0.8	2.0	15	−15	5	0	15 V Supplies
***DG185**	N-JFET	75	20	0.25	0.13	1	0.8	2.0	10	−20	5	0	Break-Before-Make
	N-JFET	75	20	0.25	0.13	1	0.8	2.0	15	−15	5	0	15 V Supplies
					ONE CHANNEL DPDT								
DG139	N-JFET	30	20	0.8	1.6	(Note 4)	2.0	3.0	12	−18	—	0	See DG191
DG142	N-JFET	80	20	0.8	1.6	(Note 4)	2.0	3.0	12	−18	—	0	See DG190
DG145	N-JFET	10	20	1.0	2.5	(Note 4)	2.0	3.0	12	−18	—	0	See DG189
DG163	N-JFET	15	15	1.0	2.5	(Note 4)	2.0	3.0	15	−15	—	0	See DG189
DG164	N-JFET	50	15	0.8	1.6	(Note 4)	2.0	3.0	15	−15	—	0	See DG191
***DG173**	PMOS	150-450	20	0.2	0.7	(Note 5)	0.8	2.0	10	−20	5	0	2 Input "OR" Control
					EIGHT CHANNEL MUX + ENABLE								
***DG501**	PMOS	150-250	10	1.5	(Note 8)	(Note 7)	0.6	3.5	5	−20	—	0	Logic Pullup Resistors
***DG503**	PMOS	150-800	20	1.5	(Note 8)	(Note 7)	0.6	8.5	10	−20	—	0	
***DG508**	CMOS	400	30	1.0	(Note 8)	(Note 7)	0.8	2.4	15	−15	—	(Note 9)	
SI3705	PMOS	150-400	10	1.5	(Note 8)	(Note 7)	0.6	3.5	5	−20	—	0	See DG501/No Pullup Resistors
					SIXTEEN CHANNEL MUX + ENABLE								
***DG506**	CMOS	400	30	1.0	(Note 8)	(Note 7)	0.8	2.4	15	−15	—	(Note 9)	Break-Before-Make
					FOUR CHANNEL DIFFERENTIAL MUX								
***DG509**	CMOS	400	30	1.0	(Note 8)	(Note 7)	0.8	2.4	15	−15	—	(Note 9)	Break-Before-Make
***DG511**	PMOS	175-600	20	1.2	(Note 8)	(Note 7)	0.8	2.0	10	−20	—	0	Break-Before-Make
					EIGHT CHANNEL DIFFERENTIAL MUX + ENABLE								
***DG507**	CMOS	400	30	1.0	(Note 8)	(Note 7)	0.8	2.4	15	−15	—	(Note 9)	Break-Before-Make
					FOUR CHANNEL SPDT D/A CONVERTER SUMMING NODE SWITCHES								
***DG515**	NMOS	See Comments	—	120	170	(Note 5)	0.5	7.5	8.0	0	—	—	R_1 = 6.25 Ω, R_2 = 12.5 Ω, R_3 = 25 Ω, R_4 = 50Ω
					TEN CHANNEL SPDT D/A CONVERTER SUMMING NODE SWITCHES								
***DG516**	NMOS	See Comments	—	120	170	(Note 5)	0.5	7.5	8.0	0	—	—	R_1 = 100 Ω, R_2 = 200 Ω, R_3=400 Ω, R_4=800 Ω, R_5=1600 Ω, R_6 − 10 = 3200 Ω

NOTES:

(1) *Devices recommended for new designs are indicated in **bold face** type.

(2) The first suffix added to a basic part number indicates the device temperature range. The second suffix, the package type.

(3) Analog voltage range is a function of supply voltages. Where a FET switch is PMOS or CMOS, r_{DS} is also a function of Supply Voltage and Analog Voltage. Values shown are for temperature suffix A (see Note 2).

(4) Input reference voltage of 2.5 V is required (see data sheets).

(5) See data sheet for switch state of differential switches.

(6) Current Driven Device — I_{INH} = 1 mA

(7) For truth table see data sheet.

(8) The appropriate switching characteristic for multiplexers is $t_{TRANSITION}$, not t_{ON}, t_{OFF}.

(9) V_{REF} = 1.5 V is used when supply voltages $<\pm$15 V are used. Not needed when supply voltages of ±15 V are used.

INTERFACE

Siliconix

DG180-185 – Two-Channel SPST
DG183-185 – Two-Channel DPST
DG186-188 – One-Channel SPDT
DG189-191 – Two-Channel SPDT

Military (A Suffix) –55 to +125°C
Industrial (B Suffix) –20 to +85°C

FEATURES

- **Constant ON-Resistance over full Analog Range.**
- **Cross-Talk and Open Switch Isolation, > 80 dB at 1 MHz (75 Ohm Load).**
- **t_{off}, t_{on} Break-Before-Make Action.**
- **TTL, DTL, RTL, Direct Drive Compatibility.**

POWER SUPPLY	ANALOG RANGE	
	DG180,181,183,184,186,187, 189,190	DG182,185,188, 191
±15 V	-7.5V/+15V	-10V/+15V
10/-20V	-12V/+10V	-15V/+10V

ABSOLUTE MAXIMUM RATINGS

$V_{CC} - V_{EE}$	36 V
$V_{CC} - V_D$	33 V
$V_D - V_{EE}$ †	33 V
$V_D - V_S$	±22 V
$V_L - V_{EE}$	36 V
$V_L - V_{IN}$	8 V
$V_L - V_R$	8 V
$V_{IN} - V_R$	8 V
$V_R - V_{EE}$	27 V
$V_R - V_{IN}$	2 V
Current (Any Terminal)††	30 mA
Power Dissipation*	
Metal Can**	450 mW
Flat Package***	750 mW
14 Pin DIP****	825 mW
16 Pin DIP†††	900 mV

*All leads welded or soldered to PC board.
**Derate 6 mW/°C above 75°C.
***Derate 10 mW/°C above 75°C.
****Derate 11 mW/°C above 75°C.

†DG180, 83, 86, 89 – 30 V
††DG180, 83, 86, 89 – S or D Terminals– 200 mA
†††Derate 12 mV/°C above 75°C.

ELECTRICAL CHARACTERISTICS

All DC parameters are 100% tested at 25°C. Lots are sample-tested for AC parameters and high and low temperature limits to assure conformance with specifications.

TEST CONDITIONS, UNLESS NOTED: $V_{CC} = 15V$, $V_{EE} = -15V$, $V_L = 5V$, $V_R = 0$

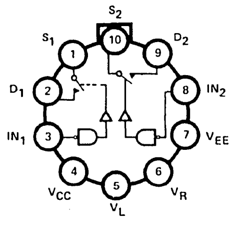
MAXIMUM LIMITS

Type (Temp. Suffix)↓	$r_{DS(on)}$ $-V_A$ MAX -10 mA	$I_{S(off)}/I_{D(off)}$		$I_{D(on)} + I_{S(on)}$ $V_D = V_S = -V_A$		t_{ON}	t_{OFF}	I_{CC} $V_{IN} = 0/V_{IN} = 5$	I_{EE} $V_{IN} = 0/V_{IN} = 5V$	I_L $V_{IN} = 0/V_{IN} = 5$
	Ω @ 25°C	nA @ 25°C	nA @ T MAX.	nA @ 25°C	nA @ T MAX.	ns @ 25°C	ns @ 25°C	mA @ 25°C	mA @ 25°C	mA @ 25°C
TWO-CHANNEL SPST										
DG180A	10	10	1000	–2	–200	300	250	1.5	–5	4.5
DG180B	15	15	300	–10	–200	350	300	1.5	–5	4.5
DG181A	30	1	100	–2	–200	150	130	1.5	–5	4.5
DG181B	50	5	100	–10	–200	180	150	1.5	–5	4.5
DG182A	75	1	100	–2	–200	250	130	1.5	–5	4.5
DG182B	100	5	100	–10	–200	300	150	1.5	–5	4.5
ONE-CHANNEL SPDT										
DG186A	10	10	1000	–2	–200	300	250	0.8	–3	3.2
DG186B	15	15	300	–10	–200	350	300	0.8	–3	3.2
DG187A	30	1	100	–2	–200	150	130	0.8	–3	3.2
DG187B	50	5	100	–10	–200	180	150	0.8	–3	3.2
DG188A	75	1	100	–2	–200	250	130	0.8	–3	3.2
DG188B	100	5	100	–10	–200	300	150	0.8	–3	3.2
TWO-CHANNEL SPDT										
DG189A	10	10	1000	–2	–200	300	250	1.5	–5	4.5
DG189B	15	15	300	–10	–200	350	300	1.5	–5	4.5
DG190A	30	1	100	–2	–200	150	130	1.5	–5	4.5
DG190B	50	5	100	–10	–200	180	150	1.5	–5	4.5
DG191A	75	1	100	–2	–200	250	130	1.5	–5	4.5
DG191B	100	5	100	–10	–200	300	150	1.5	–5	4.5
TWO-CHANNEL DPST										
DG183A	10	10	1000	–2	–200	300	250	3/0.1	–4	4.5
DG183B	15	15	300	–10	–200	350	300	3/0.1	–4	4.5
DG184A	30	1	100	–2	–200	150	130	3/0.1	–4	4.5
DG184B	50	5	100	–10	–200	180	150	3/0.1	–4	4.5
DG185A	75	1	100	–2	–200	250	130	3/0.1	–4	4.5
DG185B	100	5	100	–10	–200	300	150	3/0.1	–4	

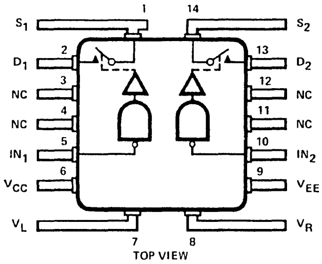
DG180-191	$V_{INH(MIN)}$ – 2.0V $V_{INL(MAX)}$ – 0.8V I_{INH} (V_{IN} = 5, T_{MIN}) – 10 μA	I_{INH} (V_{IN} = 5, T_{MAX}) – 20 μA I_{INL} (V_{IN} = 0, T_{MIN} to T_{MAX}) – –250 μA I_R (V_{IN} = 0/V_{IN} = 5, @ 25°C) = –2 mA

TWO-CHANNEL SPST (DG180-182)

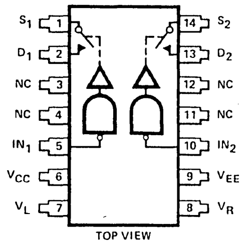
Metal Can Package



Flat Package



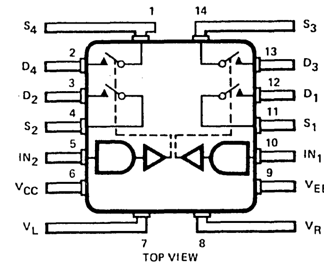
Dual-In-Line Package



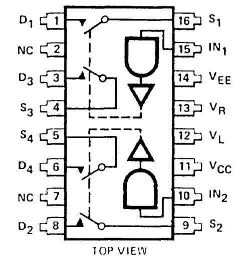
SWITCH STATES ARE FOR LOGIC "1" INPUT
(POSITIVE LOGIC)

TWO-CHANNEL DPST (DG183-185)

Flat Package



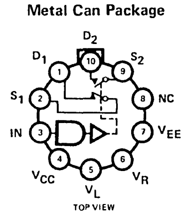
Dual-In-Line Package



SWITCH STATES ARE FOR LOGIC "0" INPUT
(POSITIVE LOGIC)

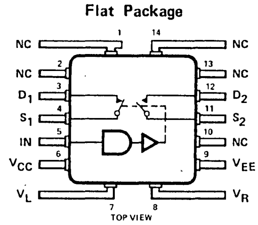
ONE-CHANNEL SPDT (DG186-188)

Metal Can Package

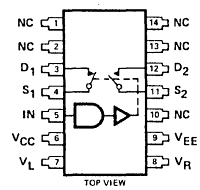


TO-100

Flat Package



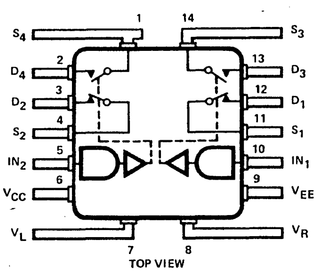
Dual-In-Line Package



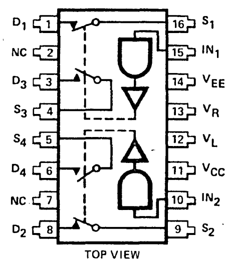
SWITCH STATES ARE FOR LOGIC "1" INPUT
(POSITIVE LOGIC)

TWO-CHANNEL SPDT (DG189-191)

Flat Package

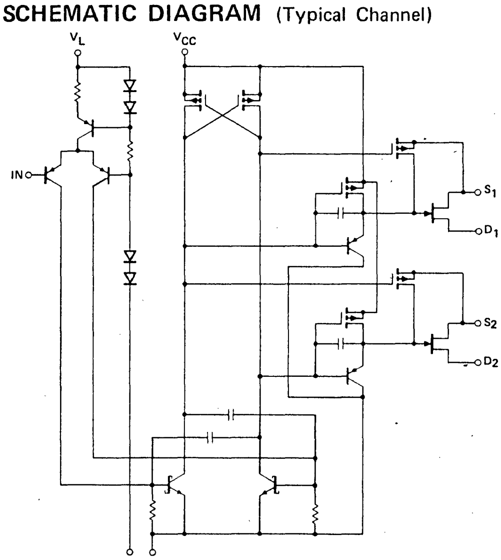


Dual-In-Line Package



SWITCH STATES ARE FOR LOGIC "1" INPUT
(POSITIVE LOGIC)

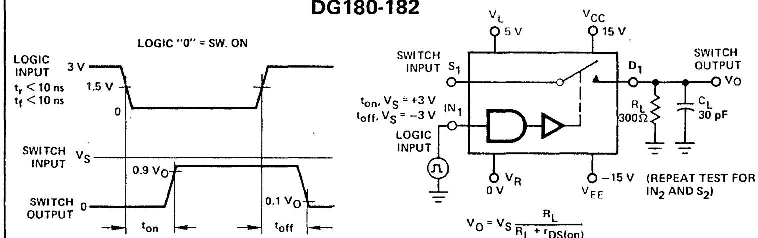
SCHEMATIC DIAGRAM (Typical Channel)



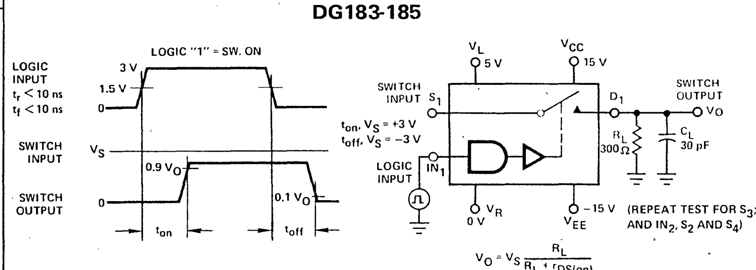
SWITCHING TIME TEST CIRCUIT

Switch output waveform shown for V_S = constant with logic input waveform as shown. Note that V_S may be + or – as per switching time test circuit. V_O is the steady state output with switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.

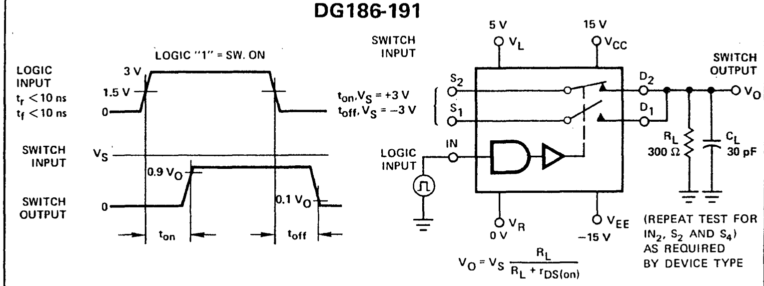
DG180-182



DG183-185



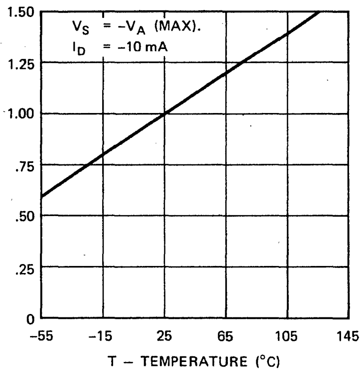
DG186-191



INTERFACE

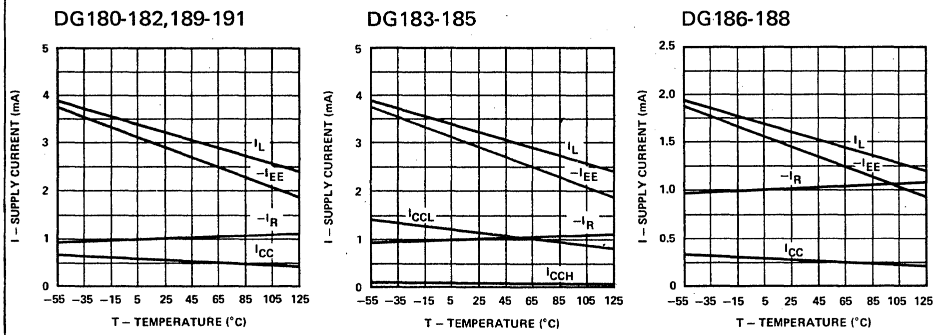
Siliconix

$r_{DS(on)}$ vs. Temperature

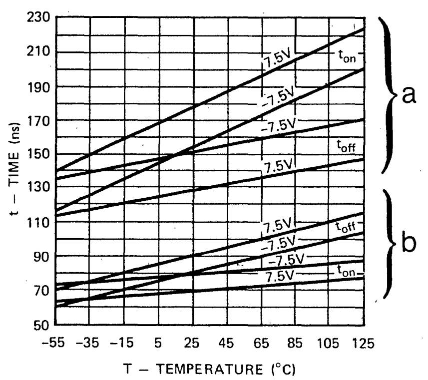


NORMALIZED CURVE

Supply Current vs. Temperature

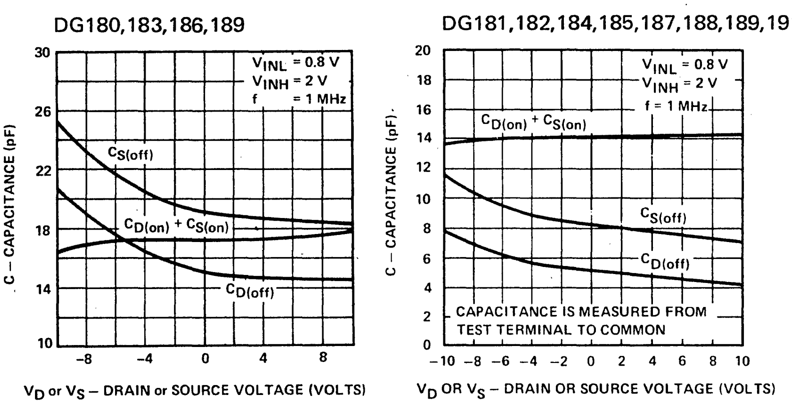


Switching Time vs. V_D and Temperature

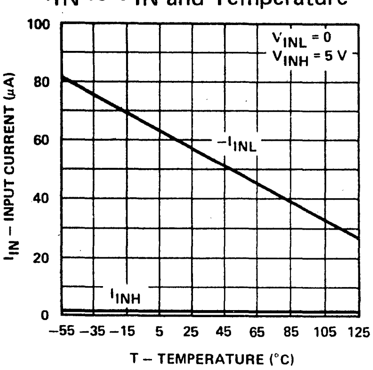


a-DG180,183,186,189
b-DG181,182,184,185,187,188,190,191

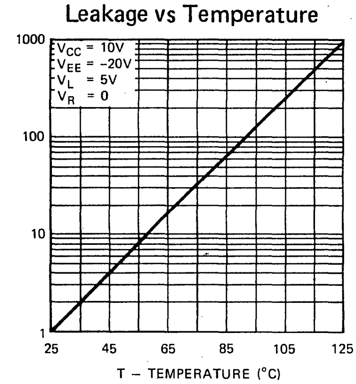
Capacitance vs. V_D or V_S



I_{IN} vs V_{IN} and Temperature

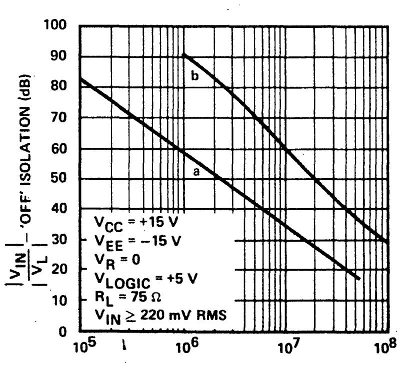


Leakage vs Temperature

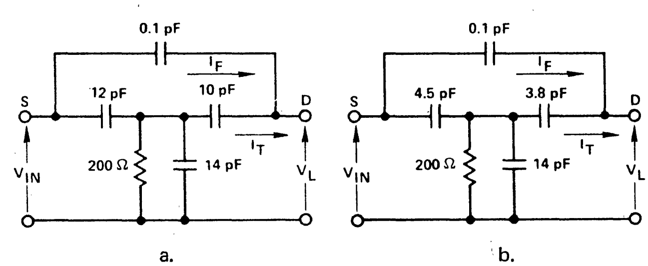


NORMALIZED CURVE

"OFF" Isolation vs. Frequency



Equivalent "OFF" Circuit



a-DG180,183,186,189 b-DG181,182,184,185,187,188,190,191

INTERFACE

Siliconix

DG501 8-CHANNEL MULTIPLEX SWITCH WITH DECODE

Military (A Suffix) −55 to +125°C
Industrial (B Suffix) −20 to +85°C
Commercial (C Suffix) 0 to +70°C

FEATURES

- **Break-Before Make Switching**
- **One-Out-Of-Eight Decoder on the Chip**
- **Pull-Up Resistors On Inputs For TTL Compatibility**
- **Output Enable Control**
- **±5V Analog Signal Range**
- **Voltage-Limiter Diodes Protect MOS Gates**
- **Zero Offset Voltage**

ABSOLUTE MAXIMUM RATINGS

$V_{SS} - V_{DD}$	−0.3, +30V
$V_{SS} - V_A, V_{En}$	−0.3, +30V
$V_{SS} - V_D$ or V_S	−0.3, +30V
$V_D - V_S$	±25V
$V_A, V_{En} - V_{DD}$	30V
V_D or $V_S - V_{DD}$	30V
Current (Any Terminal)	−20 mA
Power Dissipation*	
16 Pin DIP**	825 mW
16 Pin Plastic DIP***	470 mW

*Device mounted with all leads welded or soldered to PC board.
**Derate 11 mW/°C above 75°C.
***Derate 6.5 mW/°C above 25°C.

ELECTRICAL CHARACTERISTICS

All DC parameters are 100% tested at 25°C. Lots are sample-tested for AC parameters and high and low temperature limits to assure conformance with specifications.

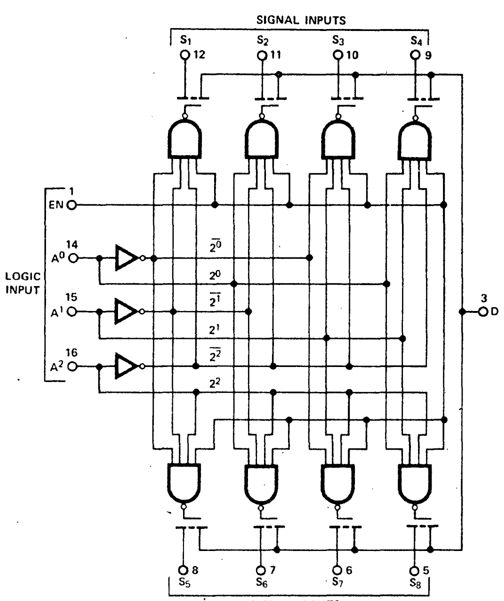
TEST CONDITIONS, UNLESS NOTED:
$V_{DD} = -20V$, $V_{SS} = 5V$, $V_{EN} = 3.5V$
$V_{AL} = 0.6V$, $V_{AH} = 3.5V$

MAXIMUM LIMITS

Type (Temp. Suffix)↓	$r_{DS(on)}$		$I_{S(off)}/I_{D(off)}$		$I_{D(on)} + I_{S(on)}$		$I_{INL(MAX)}$	$I_{INH(MIN)}$	t_{TRANS} [1]	I_{DD}	I_{SS}
	$V_S = -5V$; $V_{DD} = -20$, $I_S = -1$ mA	$V_{DD} = -15$, $I_S = -100$ μA	$V_S = -5$, $V_D = 5$/ $V_D = -5$, $V_S = 5$		$V_D = V_S = 5V$		$V_{AL} = 0$	$V_{AH} = 3.5$	Sw. time of MUX $V_{DD} = -20/-15$	$V_{En} = 0/3.5$ All $V_{ADD} = 0$	$V_{En} = 0/3.5$ All $V_{ADD} = 0$
	Ω @ 25°C	Ω @ 25°C	nA @ 25°C	nA @ T_{MAX}	nA @ 25°C	nA @ T_{MAX}	mA @ 25°C	μA @ 25°C	μS @ 25°C	mA @ 25°C	mA @ 25°C
DG501A	250	600	−1/−8	−1000/ −4000	8	4000	−1.2	−150	1.5/2.5	−6	8/7
DG501B (−20° to +85°C) DG501C (0 to +70°C)	250	800	−3/−10	−150/ −500	10	500	−1.2	−150	1.5/2.5	−6	8/7

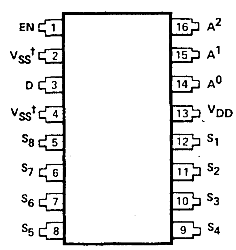
[1] NOTE: $V_{S1} = \pm1V$, $V_{S8} = \pm1V$, V_{S2-7} = gnd.

FUNCTIONAL DIAGRAM



PIN CONFIGURATION

Dual-In-Line Package



TOP VIEW

†Both V_{SS} lines are internally connected, either one or both may be used. V_{SS} common to substrate.

TRUTH TABLE

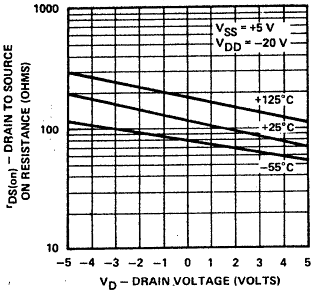
LOGIC INPUTS				CHANNEL
A^0	A^1	A^2	En	'ON'
L	L	L	H	S_1
H	L	L	H	S_2
L	H	L	H	S_3
H	H	L	H	S_4
L	L	H	H	S_5
H	L	H	H	S_6
L	H	H	H	S_7
H	H	H	H	S_8
X	X	X	L	OFF

INTERFACE

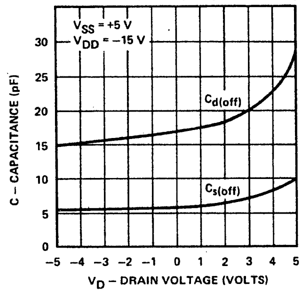
Siliconix

TYPICAL CHARACTERISTICS

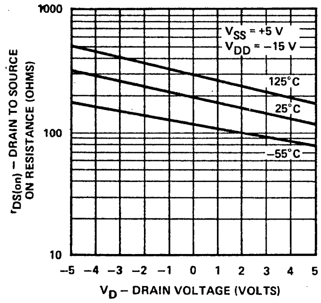
$r_{DS(on)}$ vs V_D



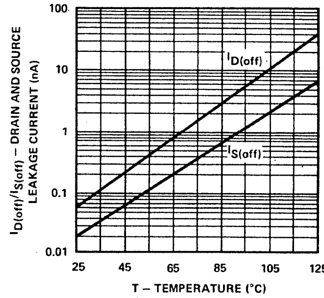
$C_{D(off)}$, $C_{S(off)}$ vs V_D



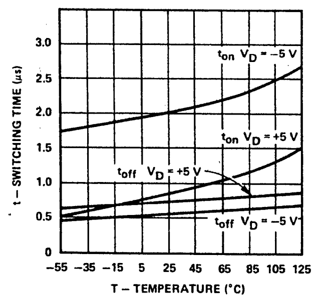
$r_{DS(on)}$ vs V_D



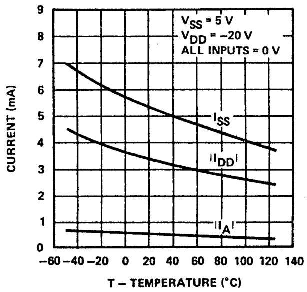
$I_{D(off)}/I_{S(off)}$ vs Temperature



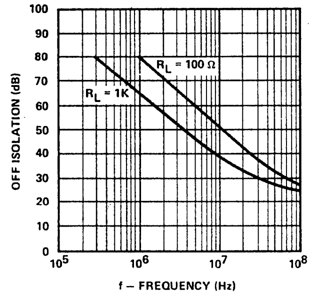
Switching Time vs Temperature

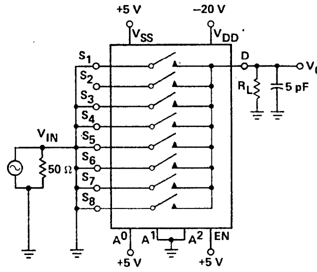


Supply Current vs Temperature



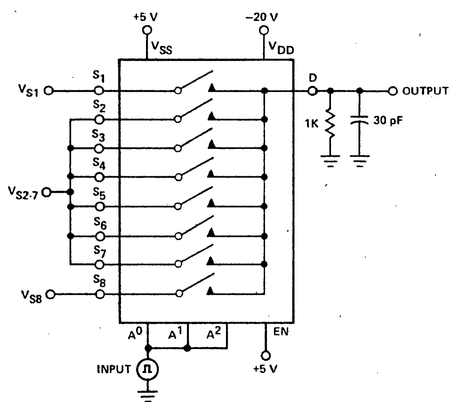
"OFF" Isolation vs R_L and Frequency

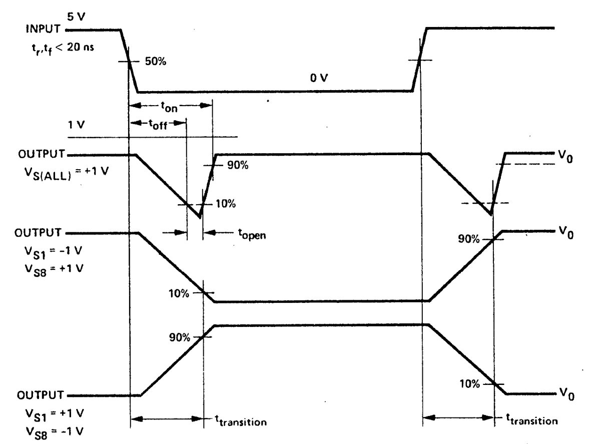




"OFF" ISOLATION = 20 LOG $\frac{|V_{OUT}|}{|V_{IN}|}$

SWITCHING TIME TEST CIRCUIT





DGM111 2-CHANNEL SPST MOS SWITCH WITH DRIVER
DGM122 2-CHANNEL DPST MOS SWITCH WITH DRIVER
DG170 3 x SPDT MOX SWITCH WITH DRIVER
DG172 4-CHANNEL MOS SWITCH WITH DRIVER
DG173 DPDT MOS SWITCH WITH DRIVER
DG175 SPDT MOS SWITCH WITH DRIVER

Military (A Suffix) −55 to +125°C
Industrial (B Suffix) −20 to +85°C
Commercial (C Suffix) 0 to +70°C

FEATURES

- P-Channel MOS FET Switches With Drivers
- Make-Before-Break Switch Function
- 20V Peak-to-Peak Signal Handling Capability
- TTL, DTL, RTL Direct Drive Compatibility — No Interface Components Required
- Voltage-Limiting Diodes Protect MOS Gates

ABSOLUTE MAXIMUM RATINGS

$V_{CC} - V_{EE}$ 36V
$V_{CC} - V_D$ 25V
$V_{CC} - V_D$ or V_S, DGM111 = . −0.5, 25V
$V_{CC} - V_S$ 25V
$V_S - V_{EE}$ 36V
$V_S - V_D$ . . . . ±25V
$V_D - V_{EE}$ 36V
$V_L - V_{EE}$ 30V
$V_L - V_{EE}$ DGM122 . . . . . . 25V
$V_L - V_{IN}$ . . . . ±6V
$V_L - V_{IN}$, DG170 . . . . . ±12V
$V_L - V_{IN}$, DGM122 . . . . . 6V
$V_L - V_R$, DG170-175 . . . . . ±6V
$V_R - V_{EE}$ 25V
$V_{IN} - V_R$, DG172-175 . . . . . ±6V
$V_{IN} - V_R$, DG170 . . . . . +18 −6V
$V_{IN} - V_R$, DGM122 . . . . . 2V
CURRENT ANY TERMINAL
DGM111, DGM122 . . . . . 30 mA
DG172-175 . . . . 20 mA
DG170 . . . . 12 mA
PEAK I_S, $I_{\bar{S}}$, I_D (DG170) . . . . 100 mA
(200µs pulse width, 100pps)
*POWER DISSIPATION
TO-100 METAL CAN 1 . . . 450 mW
FLAT PACKAGE 2 . . . . . 750 mW
14-PIN DIP 3 . . . . . . 825 mW
14-PIN PLASTIC DIP 4 . . . 470 mW
16-PIN DIP 3 . . . . . . 825 mW
16-PIN PLASTIC DIP 5 . . . 470 mW

*All leads welded or soldered to PC board.
1 Derate 6 mW/°C above 75°C
2 Derate 10 mW/°C above 75°C
3 Derate 11 mW/°C above 75°C
4 Derate 6.3 mW/°C above 25°C
5 Derate 6.5 mW/°C above +25°C

INTERFACE

Siliconix

ELECTRICAL CHARACTERISTICS

All DC parameters are 100% tested at 25°C. Lots are sample-tested for AC parameters and high and low temperature limits to assure conformance with specifications.

TEST CONDITIONS, UNLESS NOTED
$V_{CC} = 10V$, $V_{EE} = -20V$, $V_L^* = 5V$, $V_R = 0$
$^*V_L = 4.5V$ for DGM111, DGM122

MAXIMUM LIMITS

Type (Temp. Suffix)↓	$r_{DS(on)}$ $+V_A/-V_A$ −10 mA	$I_{S(off)}/I_{D(off)}$ $-V_A$			$I_{D(on)} + I_{S(on)}$ $V_D = V_C = +V_A$		I_{INL} T_{MIN} to T_{MAX} $V_{IN} = 0$	I_{INH} $V_{IN} = 5$		t_{ON}	t_{OFF}	I_{CC} $V_{IN} = 0/V_{IN} = 5$	$-I_{EE}$ $V_{IN} = 0/V_{IN} = 5$	I_L $V_{IN} = 0/V_{IN} = 5$	$-I_R$ $V_{IN} = 0/V_{IN} = 5$
	Ω @ 25°C	nA @ 25°C	nA @ 85°C	nA @ 125°C	nA @ 25°C	nA @ T_{MAX}	mA	µA @ 25°C	µA @ T_{MAX}	ns @ 25°C	ns @ 25°C	@ 25°C	@ 25°C	@ 25°C	@ 25°C
												(0.5V/4.1V)			
DGM111A	75/200	−1		−1000	1	1000	−0.7 (0.5V)	1 (4.1V)	10 (4.1V)	300	1000	3 mA/10 µA	4.5 mA/20 µA	1.5 mA/10 µA	—
DGM111B	75/250	−5	−100		5	100	−1	10	10	300	1000	3.5 mA/10 µA	5 mA/0.20 µA	2 mA/10 µA	—
												ONE CHANNEL ON/ALL OFF			
												($0.4V/I_{IN} = 100$ µA)			
DGM122A	100/450	−1/−3		−1000/−3000	3	3000	1µA ($V_{IN} = 0.3$)	†		0.3	2	10 µA/3 mA	20 µA/6 mA	10 µA/3 mA	15 µA/1.5 mA
DGM122B	125/500	−5/−10	−100/−300		10	300	10µA ($V_{IN} = 0.3$)	†		0.5	2	20 µA/3 mA	40 µA/6 mA	20 µA/3 mA	25 µA/1.5 mA
												ALL CHANNELS OFF/ONE ON			
DG170A	200/800	−1/−2		−1000/−2000	2	2000	−0.4	0.1	10	300	400	2 µA	8 mA/7 mA	7 mA/6 mA	0.8 mA
DG170B	250/850	−5/−10	−100/−200		10	200	−0.4	0.1	10	300	400	2.4 µA	10 mA/9 mA	9 mA/8 mA	1 mA
DG170C	250/850	−5/−10			10	200	−0.4	0.1	10	—	—	2.4 µA All channels on/all off	10 mA/9 mA All channels on/off	9 mA/8 mA All channels on/off	1 mA All channels on/all off
DG172A	150/450	−1/−4		−1000/−4000	4	4000	−0.5	0.1	10	300	750	3 mA/10 µA	5.1 mA/20 µA	5.7 mA/4.5 mA	3.6 mA/4.5 mA
DG172B	150/500	−5/−10	−100/−300		10	300	−1	0.1	10	500	1000	3 mA/10 µA	5.1 mA/20 µA	5.7 mA/4.5 mA	3.6 mA/4.5 mA
DG172C	200/600	−10			10		−1 @ 25°C	0.1		—	—	3 mA/10 µA One channel on/all off	5.1 mA/20 µA One channel on/all off	5.7 mA/4.5 mA One channel on/off	3.6 mA/4.5 mA One channel on/all off
DG173A	150/450	−1/−2		−1000/−2000	2	2000	−1	0.1	10	200	700	1 µA	3 mA	3 mA	1 mA/2 mA
DG173B	150/500	−5/−10	−100/−300		10	300	−1	0.1	10	200	800	1 µA	3 mA	3 mA	1 mA/2 mA
DG175A	75/200	−1		−1000	1	1000	−1	0.1	10	200	500	1 µA	3 mA	4 mA	1 mA/2 mA
DG175B	75/250	−5	−100		5	100	−1	0.1	10	200	500	1 µA	3 mA	4 mA	1 mA/2 mA

†DGM122-($V_{INH(MAX)}$) ($I_{IN} = 100$ µA, @ 25°C) 1.3V
DGM122A-$V_{INH(MAX)}$ ($I_N = 100$ µA, @ T_{MAX}) 1V

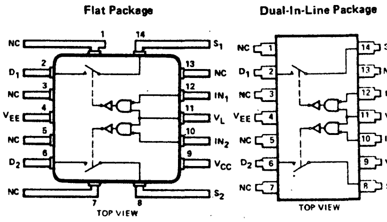
DGM111,DGM122,DG170-175
V_A($V_1 = 15$, $V_2 = -15$) . . . . . +15/−5V
V_A($V_1 = 10$, $V_2 = -20$) . . . +10/−10V

DGM111
$V_{INH(MIN)}$ 4.6V
$V_{INL(MAX)}$ 0.5V

DGM122
I_{INH} . . . . 100 µA
$V_{INL(MAX)}$ 0.4V

DG170-175
$V_{INH(MIN)}$ 2.0V
$V_{INL(MAX)}$ 0.8V

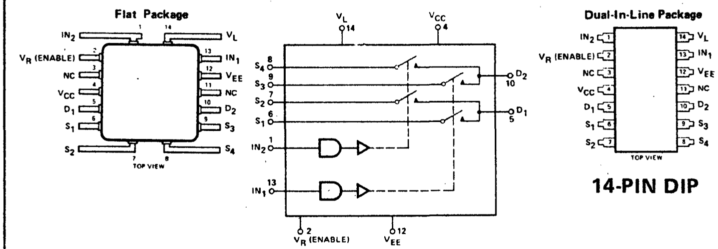
DGM111



14-PIN DIP

SWITCH STATES ARE FOR LOGIC "1" INPUTS

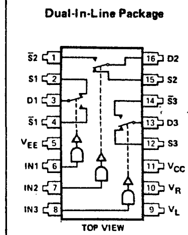
DGM122



14-PIN DIP

SWITCH STATES ARE FOR LOGIC "0" INPUT (POSITIVE LOGIC)

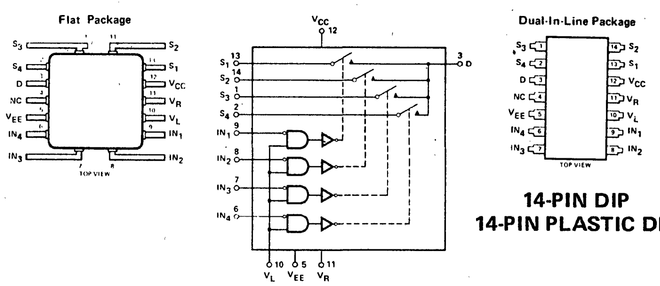
DG170



16-PIN DIP
16-PIN PLASTIC

SWITCH STATES ARE FOR LOGIC "1" INPUTS

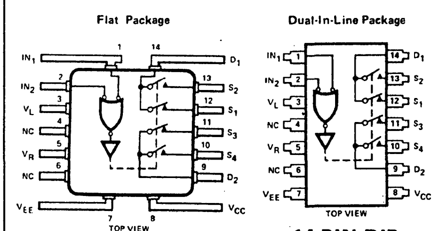
DG172



14-PIN DIP
14-PIN PLASTIC DIP

SWITCH STATES ARE FOR LOGIC "1" INPUTS

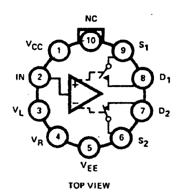
DG173



14-PIN DIP

SWITCH STATES ARE FOR LOGIC "1" INPUTS

DG175

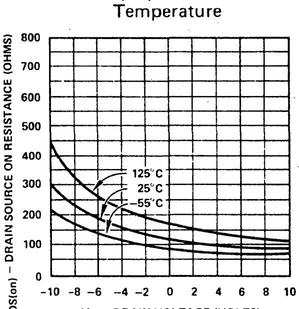


SWITCH STATES ARE FOR LOGIC "1" INPUTS

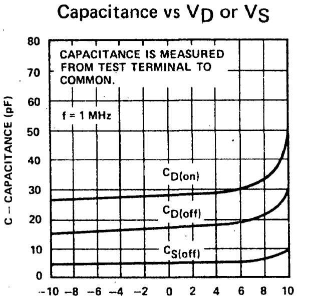
TYPICAL CHARACTERISTICS

Curves for the other devices in this grouping are similar to those of the DG172

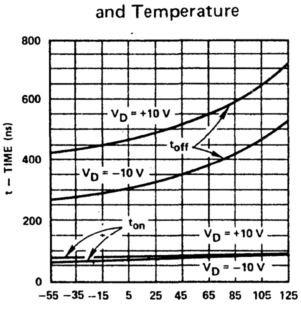
$r_{DS(on)}$ vs V_D and Temperature



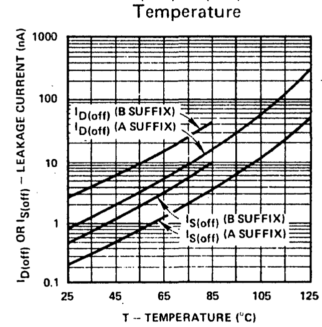
Capacitance vs V_D or V_S



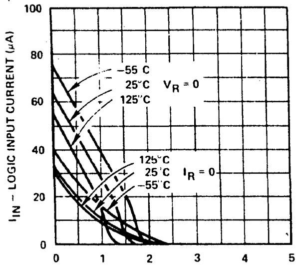
Switching Time vs V_D and Temperature



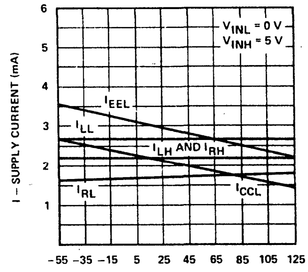
$I_{D(off)}/I_{S(off)}$ vs Temperature



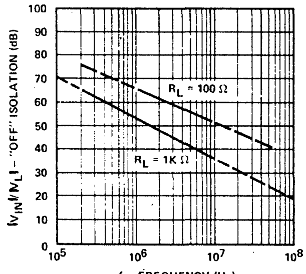
I_{IN} vs V_{IN} and Temperature

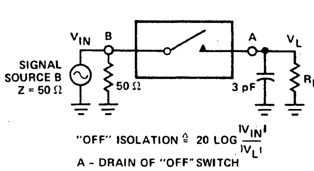


Supply Current vs Temperature



"OFF" Isolation vs R_L and Frequency





"OFF" ISOLATION ≜ 20 LOG $\frac{|V_{IN}|}{|V_L|}$

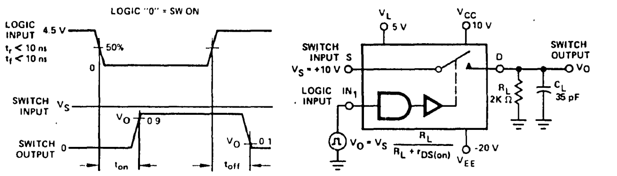
A - DRAIN OF "OFF" SWITCH

B - SOURCE OF "OFF" SWITCH

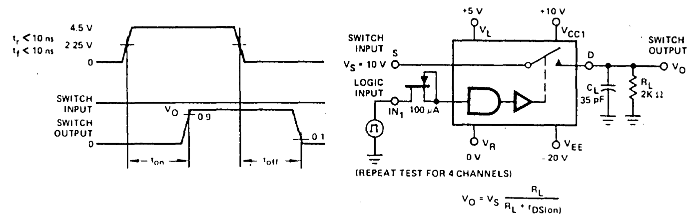
SWITCHING TIME TEST CIRCUIT

Switch output waveform shown for V_S = constant with logic input waveform as shown. Note that V_S may be + or – as per switching time test circuit. V_O is the steady state output with switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.

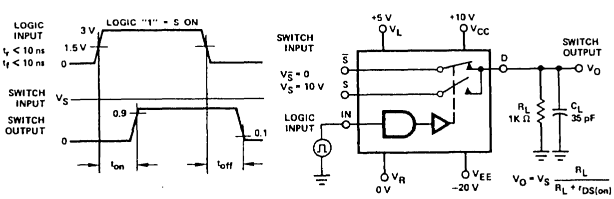
DGM111



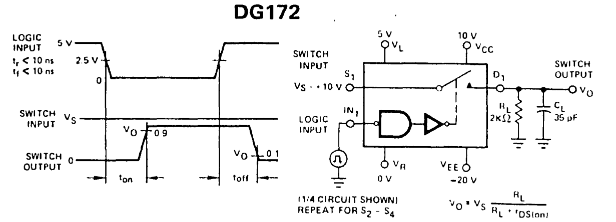
DGM122



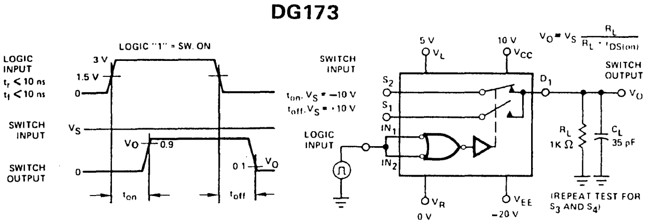
DG170



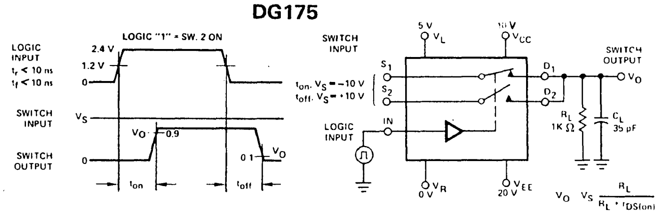
DG172



DG173



DG175



APPLICATION HINTS*

V_{CC} Positive Supply Voltage (V)	V_{EE} Negative Supply Voltage (V)	V_S Analog Signal Range (V)
10**	−20	−10 to +10
15	−15	−5 to +15
20	−10	0 to +20
+5	−15	−5 to +5
+5	−25	−15 to +5

*Application Hints are for DESIGN AID ONLY, not guaranteed and not subject to production testing.

**Electrical Characteristics are based on V_{CC} = +10V, V_{EE} = −20V only.

INTERFACE

Siliconix

DG200 DUAL SPST CMOS ANALOG TRANSMISSION GATE
DG201 DUAL SPST CMOS ANALOG TRANSMISSION GATE

Military (A Suffix) −55 to +125°C
Industrial (B Suffix) −20 to +85°C
Commercial (C Suffix) 0 to +70°C

Features

- **Impossible to Latch Up Under Any Circumstances**
- **±15V Analog Signal Range with ±15V Supplies**
- **r_{DS} <100 Ω Over Full Temperature and Signal Range — DG200**
  r_{DS} <250 Ω Over Full Temperature and Signal Range — DG201
- **Break-Before-Make Switching Action**
- **TTL, DTL, and CMOS Direct Control Interface Over the Military Temperature Range Without the Need for Interface Components**
- **All Terminals Are Protected Against Static Electricity**

ABSOLUTE MAXIMUM RATINGS

V_{IN} and V_{REF} to Ground	−0.3V, V_1
V_S or V_D to V_1	0, −32V
V_S or V_D to V_2	0, 32V
V_1 to Ground	16V
V_2 to Ground	−16V
Current, Any Terminal Except S or D	30 mA
Continuous Current, S or D	20 mA
Peak Current, S or D (pulsed at 1 msec, 10% duty cycle max) DG201	70 mA
Peak Current, S or D (pulsed at 1 msec, 10% duty cycle max) DG200	100 mA
Power Dissipation*	
Metal Can**	450 mW
Flat Package***	750 mW
14 Pin DIP****	825 mW
14 Pin Plastic DIP†	470 mW
16 Pin DIP****	825 mW
16 Pin Plastic DIP†	470 mW

*Device mounted with all leads welded or soldered to PC board.
**Derate 6 mW/°C above 75°C ****Derate 11 mW/°C above 75°C
***Derate 10 mW/°C above 75°C †Derate 6.5 mW/°C above 25°C

ELECTRICAL CHARACTERISTICS

All DC parameters are 100% tested at 25°C. Lots are sample-tested for AC parameters and high and low temperature limits to assure conformance with specifications.

Test conditions, unless noted:
V_1 = 15V, V_2 = −15V, Ground = 0, V_{REF} = Open

MAXIMUM LIMITS

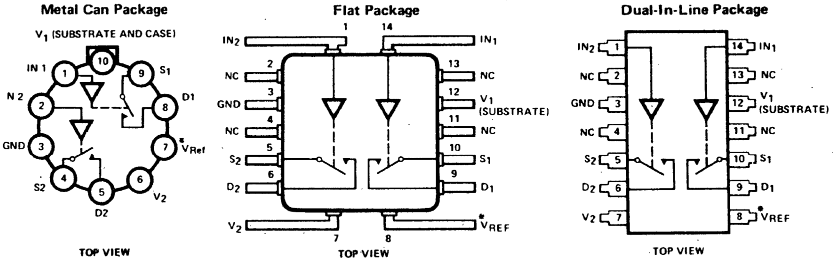
Type (Temp. Suffix)↓	$r_{DS(on)}$ V_D = −10V I_S = −1 mA		$I_{S(off)}/I_{D(off)}$ V_D = −15V V_S = +15V		$I_{S(off)}/I_{D(off)}$ V_D = 15V V_S = −15V		$I_{D(on)}$ $V_D = V_S$ = −15/ $V_D = V_S$ = 15		$I_{INL(MAX)}$ V_{IN} = 0		$I_{INH(MIN)}$ V_{IN} = 2.4/ V_{IN} = 15		t_{ON} See Test Circuit	t_{OFF} See Test Circuit	I_1/I_2 V_{IN} = 0	I_1 Standby/ I_2 Standby V_{IN} = 5
	Ω 25°C	Ω T_{MAX}	nA @ 25°C	nA @ T_{MAX}	nA @ 25°C	nA @ T_{MAX}	nA @ 25°C	nA @ T_{MAX}	µA @ 25°C	µA @ T_{MAX}	µA @ 25°C	µA @ T_{MAX}	µs @ 25°C	µs @ 25°C	mA @ 25°C	mA @ 25°C
															Both Channels ON	Both Channels OFF
DG200A	70	100	2/−2	1000/−1000	−2/2	−1000/1000	−2/2	−1000/1000	−1	−10	−1/1	−10/10	1	0.5	4/−4	2/−2
DG200B	80	100	5/−5	500/−500	−5/5	−500/500	−5/5	−500/500	−1	−10	−1/1	−10/10	1	0.5	4/−4	2/−2
															One Channel ON	Both Channels OFF
DG201A	175	250	1/−1	500/−500	−1/1	−500/500	−1/1	−500/500	−1	−10	−1/1	−10/10	1	0.5	4/−4	3/−3
DG201B	200	250	5/−5	250/−250	−5/5	−250/250	−5/5	−250/250	−1	−10	−1/1	−10/10	—	—	4/−4	3/−3
DG201C	200	250	5/−5	250/−250	−5/5	−250/250	−5/5	−250/250	−1	−10	−1/1	−10/10	—	—	4/−4	3/−3

POWER SUPPLIES — ANALOG RANGE

V_1 Positive Supply Voltage (V)	V_2 Negative Supply Voltage (V)	V_{REF} Reference Pin Connection (V)	V_{IN} Logic Input Voltage V_{INH} Min/ V_{INL} Max (V)	V_S or V_D** Analog Voltage Range (V)
+15*	−15	Open	2.4/0.8	−15 to +15
+12	−12	1.4V or 470K to V_1	2.4/0.8	−12 to +12
+10	−10	1.4V or 240K to V_1	2.4/0.8	−10 to +10

*Electrical Characteristics chart based on V_1 = +15V, V_2 = −15V, V_{REF} = Open
**The analog signal should not exceed the actual supply voltages appearing at pins V_1 and V_2.

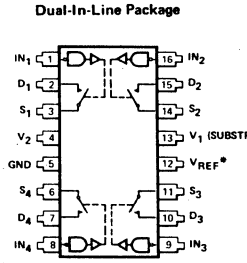
DG200 DUAL SPST



14-PIN DIP/14-PIN PLASTIC DIP

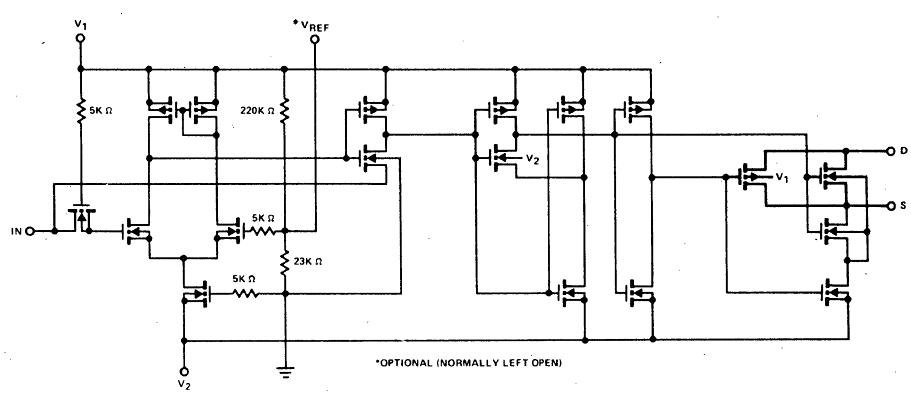
SWITCH STATES ARE FOR LOGIC "1" INPUT (POSITIVE LOGIC)

DG201 QUAD SPST



16-PIN DIP/16-PIN PLASTIC DIP SWITCH STATES ARE FOR LOGIC "1" INPUT (POS. LOGIC)

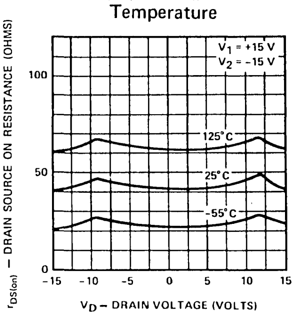
SCHEMATIC DIAGRAM (Typical Channel)



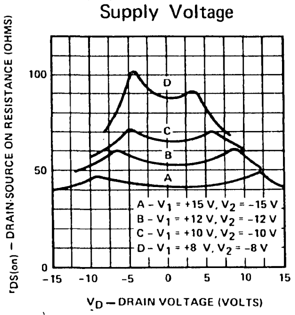
TYPICAL CHARACTERISTICS

DG200

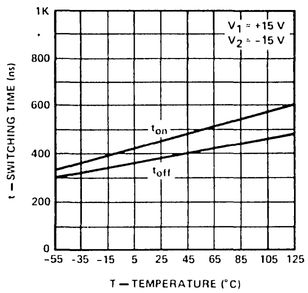
$r_{DS(on)}$ vs. V_D and Temperature



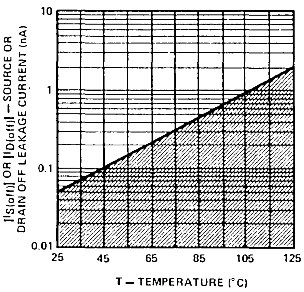
$r_{DS(on)}$ vs. V_D and Power Supply Voltage



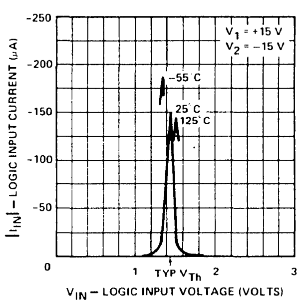
Switching Time vs Temperature



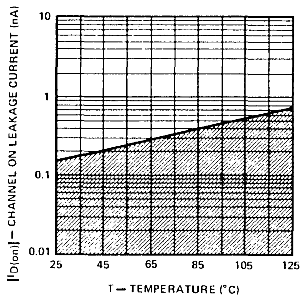
$I_{S(off)}$ or $I_{D(off)}$ vs Temperature*



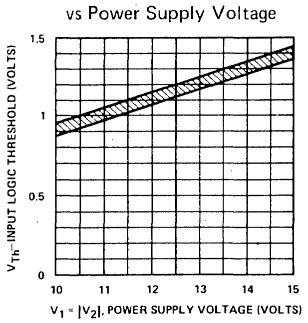
I_{IN} vs V_{IN}



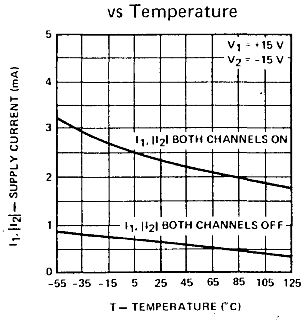
$I_{D(on)}$ vs Temperature*



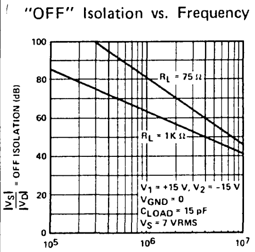
V_{Th} (Input Logic Threshold) vs Power Supply Voltage



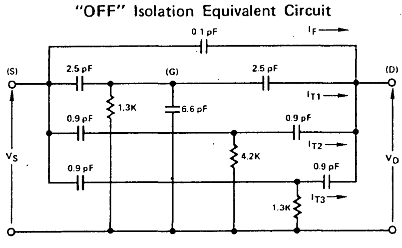
Supply Current vs Temperature



"OFF" Isolation vs. Frequency



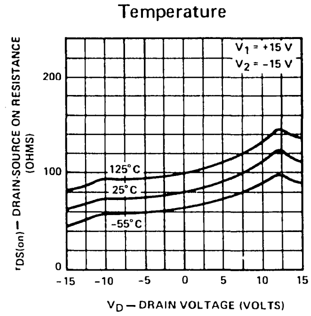
"OFF" Isolation Equivalent Circuit



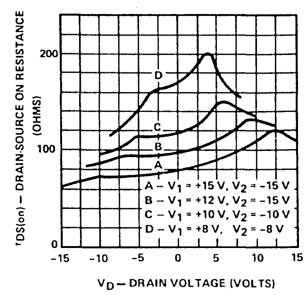
*The net leakage into the source or drain is the n-channel leakage minus the p-channel leakage. This difference can be positive, negative, or zero depending on the analog voltage and temperature, and will vary greatly from unit to unit.

DG201

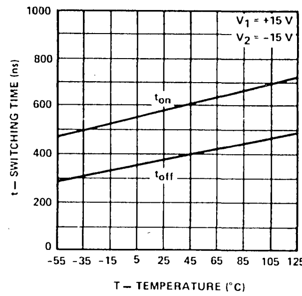
$r_{DS(on)}$ vs V_D and Temperature



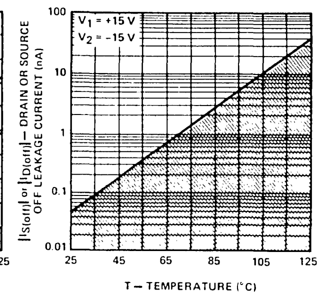
$r_{DS(on)}$ vs V_D and Power Supply Voltage



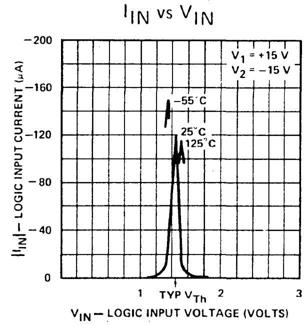
Switching Time vs Temperature



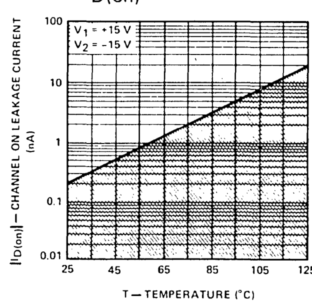
$I_{D(off)}$ or $I_{S(off)}$ vs Temperature*



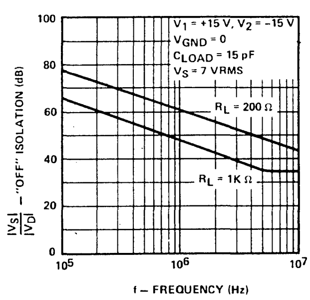
I_{IN} vs V_{IN}



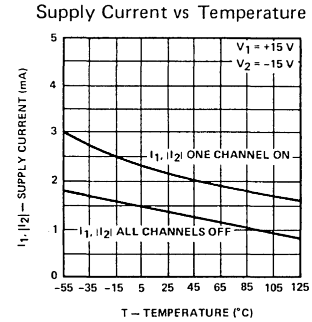
$I_{D(on)}$ vs Temperature*



OFF Isolation vs Frequency

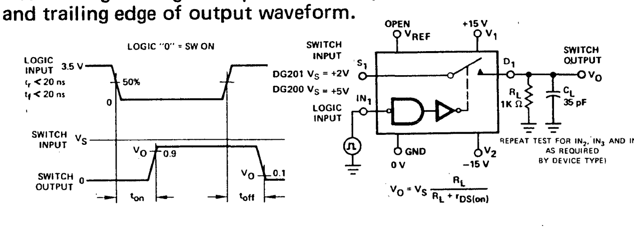


Supply Current vs Temperature



SWITCHING TIME TEST CIRCUIT

Switch output waveform shown for V_S = constant with logic input waveform as shown. Note that V_S may be + or – as per switching time test circuit. V_O is the steady state output with switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.



INTERFACE

Siliconix

DG506 16-CHANNEL ANALOG MULTIPLEXER
DG507 8-CHANNEL DIFFERENTIAL ANALOG MULTIPLEXER
DG508 8-CHANNEL ANALOG MULTIPLEXER
DG509 4-CHANNEL DIFFERENTIAL ANALOG MULTIPLEXER

Military (A Suffix) −55 to +125°C
Industrial (B Suffix) −20 to +85°C
Commercial (C Suffix) 0 to +70°C

FEATURES

- **Impossible to Latch Up Under Any Circumstances**
- **±15V Analog Signal Range with ±15V Supplies**
- **r_{ON} <500 Ohms Over Full Temperature and Signal Range**
- **Break-Before-Make Switching Action**
- **TTL, DTL, and CMOS Direct Control Interface Over Military Temperature Range Without Need For Interface Components**
- **Binary Inputs Select Channels**
- **Input (EN) Allows Output Line to be Common to Several Other Units**
- **36 mW Typical Standby Power**
- **All Terminals are Protecter' Against Static Electricity**

ABSOLUTE MAXIMUM RATINGS

V_{IN}(A, EN) to Ground . . . . −0.3V, V_1
V_S or V_D to V_1 . . . . 0, −32V
V_S or V_D to V_2 . . . . 0, 32V
V_1 to Ground 16V
V_2 to Ground . . . . −16V
Current (Any Terminal, Except S or D) . . . 30 mA
Continuous Current, S or D . . . . 20 mA
Peak Current, S or D
(Pulsed at 1 msec, 10% Duty Cycle Max) . 40 mA

Power Dissipation*
16 Pin DIP** . . . . 825 mW
16 Pin Plastic DIP*** . . . . 470 mW
28 Pin DIP† . . . . 1200 mW

*All leads soldered or welded to PC board.
**Derate 11 mW/°C above 75°C.
***Derate 6.3 mW/°C above 25°C.
†Derate 10 mV/°C above 70°C.

ELECTRICAL CHARACTERISTICS

All DC parameters are 100% tested at 25°C. Lots are sample-tested for AC parameters and high and low temperature limits to assure conformance with specifications.

Test conditions, unless noted:
V_1 = 15V, V_2 = −15V, Ground = 0, V_{REF} = Open

MAXIMUM LIMITS

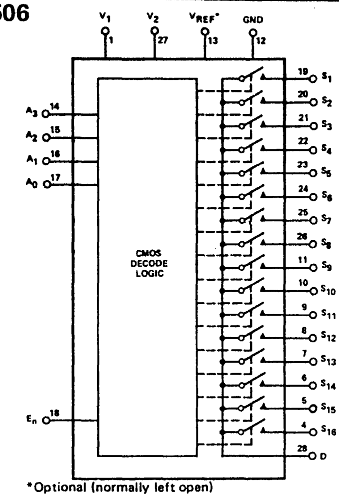
Type (Temp. Suffix)↓	$r_{DS(on)}$ V_D = −10 I_S = −200 μA		$I_{S(off)}/I_{D(off)}$ V_D = ∓10, V_S = ±10 + E_N = 0		$I_{D(on)}$ V_S = V_D = ±10V		$t_{on(EN)}$ See Fig. 2	$t_{off(EN)}$ See Fig. 2	t_{TRANS} Sw. time of Mux.	I_1 or $-I_2$ All V_A = 0 V_{EN} = 5/0V
	Ω @ 25°C	Ω @T_{MAX}	nA @ 25°C	nA @ T_{MAX}	nA @ 25°C	nA @ T_{MAX}	μs @ 25°C	μs @ 25°C	μs @ 25°C	mA @ 25°C
DG506A	400	500	±1/±10	±50/±500	±10	±500	1.5	1	1	10/2.5
DG506B,C	450	550	±5/±20	±50/±500	±20	±500	–	–	–	10/2.5
DG507A	400	500	±1/±5	±50/±250	±5	±250	1.5	1	1	10/2.5
DG507B,C	450	550	±5/±10	±50/±250	±10	±250	–	–	–	10/2.5
DG508A	400	500	±1/±10	±50/±500	±10	±500	1.5	1	1	8/2.4
DG508B,C	450	550	±5/±20	±50/±500	±20	±500	–	–	–	8/2.8
DG509A	400	500	±1/±10	±50/±250	±10	±250	1.5	1	1	8/2.4
DG509B,C	450	550	±5/±20	±50/±250	±20	±250	–	–	–	8/2.8

DG506-509

I_{AH} (V_{ADD} = 2.4, @ 25°C)	−10 μA	I_{AL} (V_{EN} = 2.4, All V_{ADD} = 0 @ 25°C)	−10
I_{AH} (V_{ADD} = 15, @ 25°C)	10 μA	I_{AL} (V_{EN} = 2.4, All V_{ADD} = 0 @ T_{MAX})	−30
I_{AH} (V_{ADD} = 2.4, @ T_{MAX})	−30 μA	I_{EN} (V_{EN} = 0, All V_{ADD} = 0 @ 25°C)	−10
I_{AH} (V_{ADD} = 15, @ T_{MAX})	30 μA	I_{EN}(V_{EN} = 0, All V_{ADD} = 0, @ T_{MAX})	−30

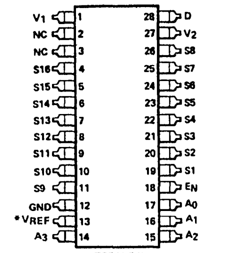
FUNCTIONAL DIAGRAM	PIN CONFIGURATIONS	DECODE TRUTH TABLE

DG506



*Optional (normally left open)

Dual In-Line Package

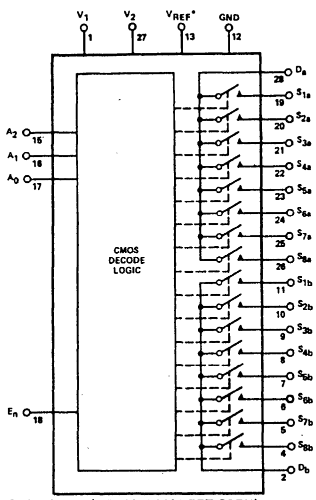


TOP VIEW
V_1 COMMON TO SUBSTRATE

A_3	A_2	A_1	A_0	E_n	ON SWITCH
X	X	X	X	0	NONE
0	0	0	0	1	1
0	0	0	1	1	2
0	0	1	0	1	3
0	0	1	1	1	4
0	1	0	0	1	5
0	1	0	1	1	6
0	1	1	0	1	7
0	1	1	1	1	8
1	0	0	0	1	9
1	0	0	1	1	10
1	0	1	0	1	11
1	0	1	1	1	12
1	1	0	0	1	13
1	1	0	1	1	14
1	1	1	0	1	15
1	1	1	1	1	16

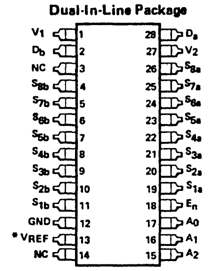
Logic "1" = $V_{AH} \geq 2.4$ V
Logic "0" = $V_{AL} \leq 0.8$ V

DG507



*OPTIONAL (NORMALLY LEFT OPEN)

Dual-In-Line Package

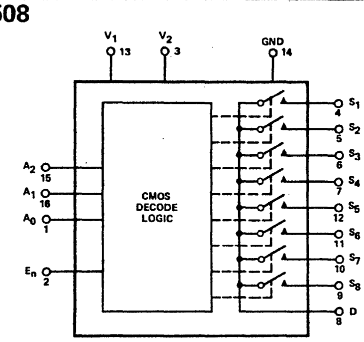


TOP VIEW
V_1 COMMON TO SUBSTRATE

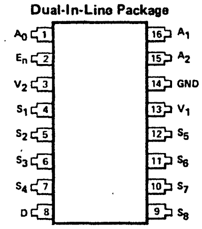
A_2	A_1	A_0	En	ON SWITCH PAIR
X	X	X	0	NONE
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

Logic "1" = $V_{AH} \geq 2.4$ V
Logic "0" = $V_{AL} \leq 0.8$ V

DG508



Dual-In-Line Package

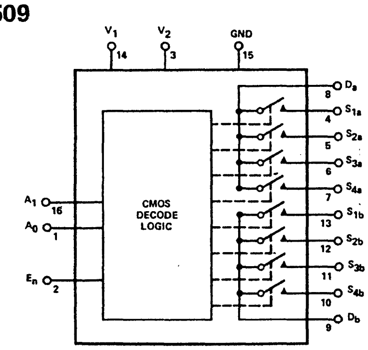


TOP VIEW
V_1 COMMON TO SUBSTRATE

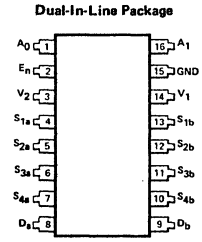
A_2	A_1	A_0	En	ON SWITCH
X	X	X	0	NONE
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

Logic "1" = $V_{AH} \geqslant 2.4$ V
Logic "0" = $V_{AL} \leqslant 0.8$ V

DG509



Dual-In-Line Package



TOP VIEW
V_1 COMMON TO SUBSTRATE

A_1	A_0	E_n	ON SWITCH PAIR
X	X	0	NONE
0	0	1	1
0	1	1	2
1	0	1	3
1	1	1	4

Logic "1" = $V_{AH} > 2.4$ V
Logic "0" = $V_{AL} < 0.8$ V

INTERFACE

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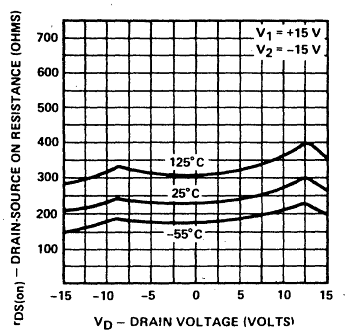
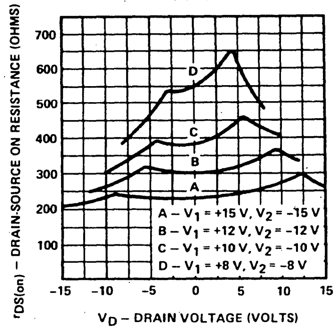
TYPICAL CHARACTERISTICS

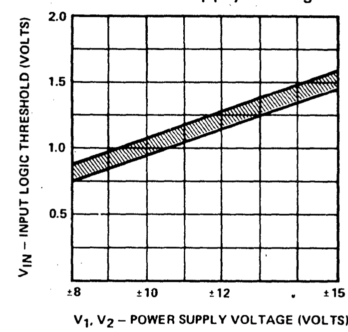
$r_{DS(on)}$ vs V_D and Temperature



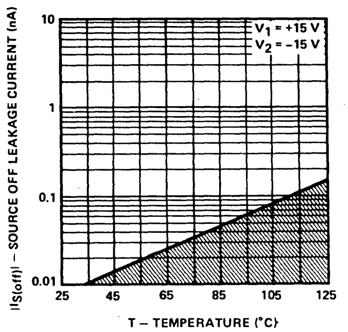
$r_{DS(on)}$ vs V_D and Power Supply Voltage



Logic Threshold vs Power Supply Voltage

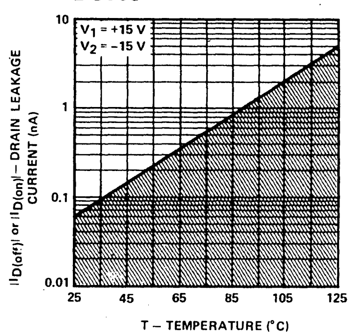


$I_{S(off)}$ vs Temperature*

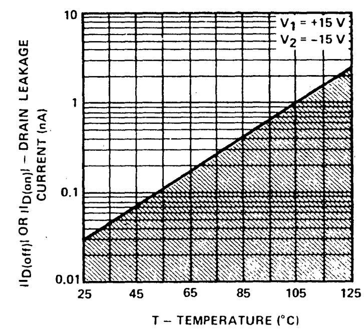


$I_{D(off)}$ and $I_{D(on)}$ vs Temperature*

DG506

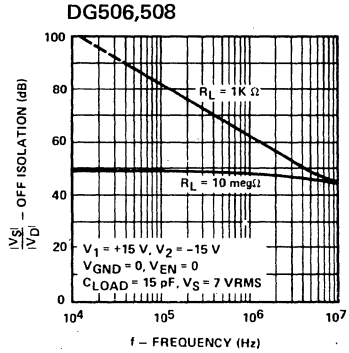


DG507,508,509

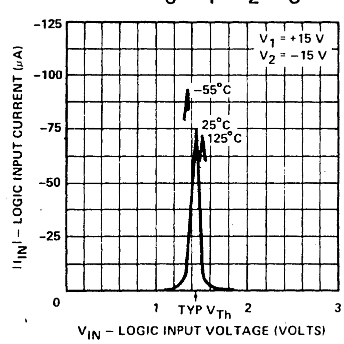


OFF Isolation vs Frequency

DG506,508

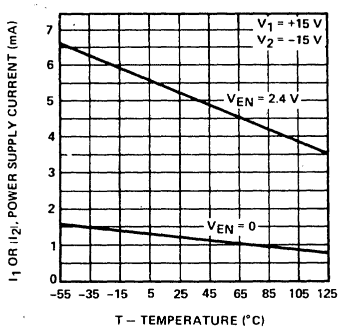


I_A vs V_A (Terminals A_0, A_1, A_2, A_3, EN)

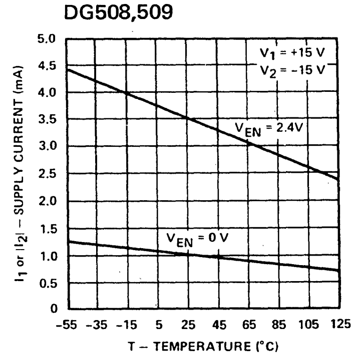


Power Supply Current vs Temperature

DG506,507



DG508,509



*The net leakage into the source or drain is the n-channel leakage minus the p-channel leakage. This difference can be positive, negative, or zero depending on the analog voltage and temperature, and will vary greatly from unit to unit.

DG506

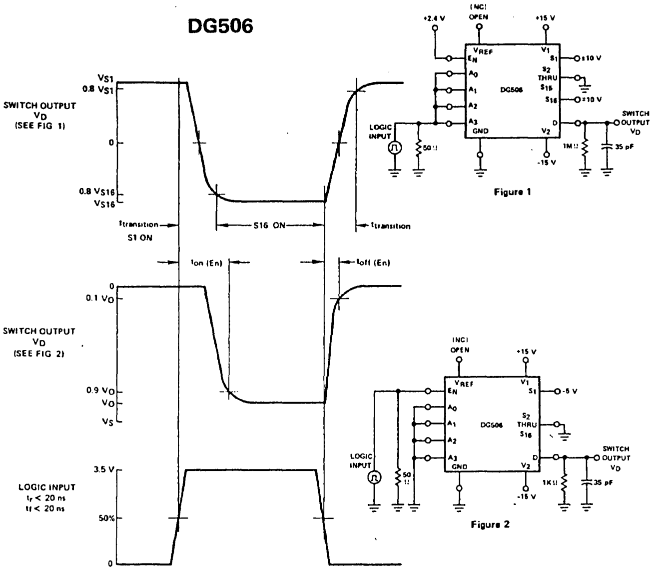


Figure 1

Figure 2

DG507

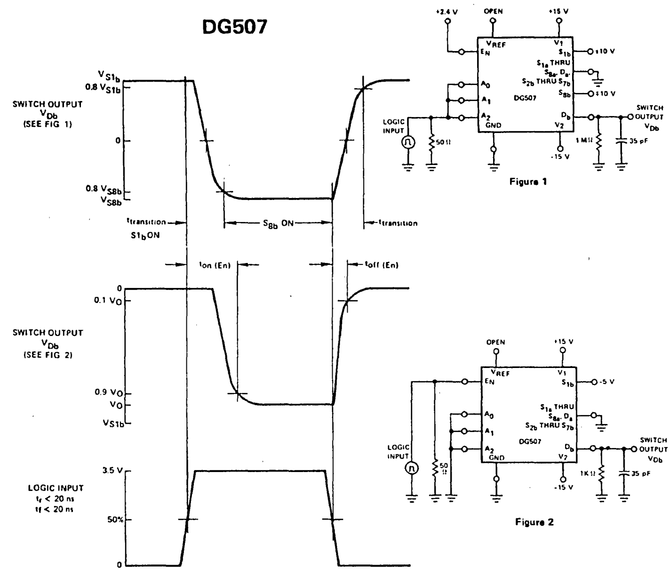


Figure 1

Figure 2

DG508

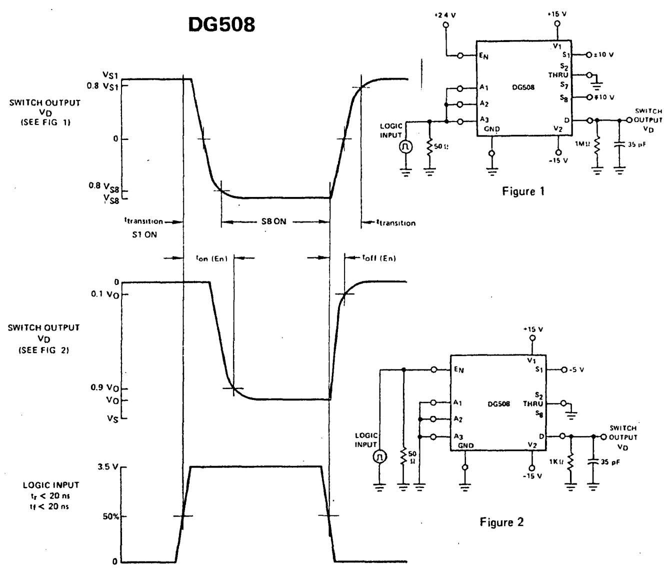


Figure 1

Figure 2

DG509

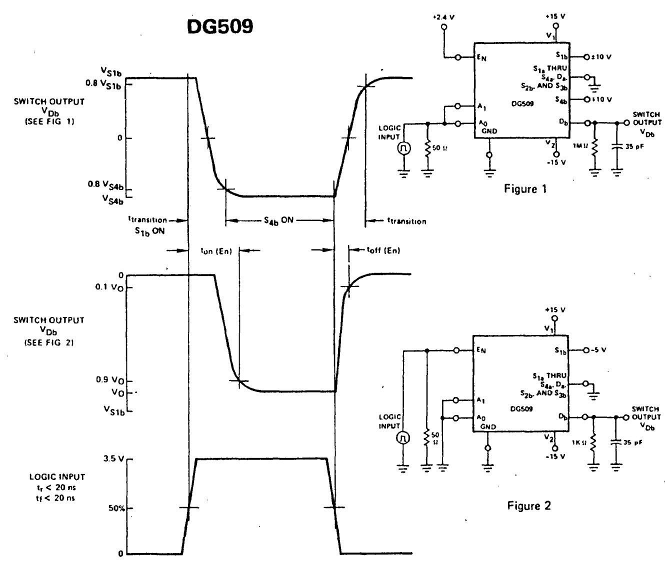


Figure 1

Figure 2

INTERFACE

Siliconix

INTRODUCTION TO LINEAR

The Master Selection Guide provides sufficient information to make initial product selections, to lead you to a group of device numbers and manufacturers' names. It enables you to find the products which are most appropriate to fulfill your major requirements and then provides data for many of the more important products.

All devices that appear in this section, both in the initial selection guide and in the data pages, are included in the Part Number and Product Indexes. These index listings lead to the page and the line on that page where each device appears.

In the Linear section over 925 operational amplifiers are covered. Since there are so many devices, the operational amplifier entries have been given special consideration. Separate lists are provided for those which have High Speed, High Voltage capability, Wide Bandwidth, etc. Under General Purpose, three amplifier types are listed; these are the ones that the high volume manufacturers indicate are the most widely used; however, quad amplifiers should also be considered when appropriate. If you have located a device in a specialized category, you can review its characteristics by finding it in the Part Number or Product Indexes and looking it up in the Operational Amplifier Characteristics Section and in the Data Section.

Following the special lists, the "Operational Amplifier-Characteristics" listings, categorize amplifiers by input parameters. They are arranged in order of increasing bias current, offset voltage, offset current and then voltage drift (with bias current first, the FET input devices tend to be at the beginning of the list). The other parameters listed do not affect the sequence in which the devices are presented. The column labeled "Comp" indicates the number of external components normally used for compensation; for example, "0" means no compensation is required.

Consumer circuits such as audio amplifiers, AM, FM, and TV circuits are not covered by model number but the manufacturers of these functions are listed under the heading Industrial/Consumer Circuits. Linear devices and unusual circuits which do not fit elsewhere are listed under the heading "Other Linear Devices."

The manufacturers listed above are providing detailed information on their latest and most significant products. They have made this investment to help you. Some chose not to.

If you want to see more data in future editions, tell the manufacturers through their salesmen and distributors.

LINEAR—Amplifiers

Function	Device	Source
Special Purpose		
AC Amplifier, Quad, Single Supply	CA3048	†RCA
Current Amplifier (unity gain, 100 ma Output)	LH0002	†National
	LH0002C	National
Current Amplifier (unity gain, 200 ma output)	3553	†Burr-Brown
Current Amplifier (unity gain, 300 ma output)	MC1438	Motorola
	MC1538	†Motorola
Current Amplifier (unity gain, 600 ma output)	1016C	DDC
	1016M	†DDC
	HA-2630	†Harris
	HA-2635	Harris
Differential Input/Differential Output Amplifier	μA730C	Fairchild
	μA730M	†Fairchild
	ITT730-1	ITT
	ITT730-5	ITT
Instrumentation, (Differential Input, Independent Gain Adjustment)	AD520J	AD
	AD520K	AD
	AD520S	†AD
	AD521J	AD
	AD521K	AD
	AD521S	†AD
	3660J	Burr-Brown
	3660K	Burr-Brown
	3660S	†Burr-Brown
	LH0036	†National
	LH0036C	National
	LH0037	†National
	LH0037C	National
Instrumentation, (Differential FET Input, Independent Gain Adjustment)	3670J	Burr-Brown
	3670K	Burr-Brown
	3670S	†Burr-Brown
Log/Antilog Amplifiers (Antilog)	1452	DDC
	8049C	Intersil
Log/Antilog Amplifiers, (Log)	4127	Burr-Brown
	1451	DDC
	8048C	Intersil
Microphone/Headphone Amplifier	SL630C	Plessey
Operational Transconductance Amplifier	CA3060	RCA
	CA3060	†RCA
	CA3060A	†RCA
	CA3060B	†RCA
	CA3080 **see page 666**	**RCA**
	CA3080A **see page 666**	**†RCA**
Power Amplifier/Switch (equivalent to an operational amplifier with uncommitted Darlington power output transitor), Programmable Gain	CA3094	†RCA
	CA3094A	†RCA
	CA3094B	†RCA
Preamplifier J.F.E.T. (to precede op amps and comparators)	HA-2000	†Harris
	HA-2005	Harris
Preamplifier, Precision (to precede operational amplifiers)	LM121	†National
	LM221	National
	LM321	National
Special Purpose (cont)		
Preamplifier, Temperature Controlled	μA727C	Fairchild
	μA727M	†Fairchild
Preamplifier with automatic level control, for tape recorders	TDA1054	SGS
	TA7055	Toshiba
Programmable Channel Op Amp (one of 4 input stages can be connected to single output)	1454C	DDC
	1454M	†DDC
	HA-2400	†Harris
	HA-2404	Harris
	HA-2405	Harris
Single-ended Input/Output Amplifier, Triple	CA3035	RCA
Two Wire Transmitter (Sends current signal over same two lines from which it is powered)	LH0045	†National
	LH0045C	National
Wideband Amplifier with low level video detection (7 to 150 MHz)	SL521A	Plessey
	SL521B	Plessey
	SL521C	Plessey
	SL613C	Plessey
Wideband Amplifier, logarithmic Limiting (4 to 85 MHz)	SL530C	Plessey
Wideband Amplifier, Triple	CA3035	†RCA

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

Linear—Arrays

Transistor Arrays

Function	Device	Source
Dual Transistors, Monolithic NPN Tightly Matched	AD810	† AD
	AD811	† AD
	AD812	† AD
	AD813	† AD
	AD814	† AD
	AD815	† AD
	AD816	† AD
	LM114	† National
	LM114A	† National
	LM115	† National
	LM115A	† National
	LM3018	† National
	LM194	† National
	LM394	National
	LM3018A	† National
	SL301	Plessey
	SL360	Plessey
	SL362	Plessey
	MAT-01	† PMI
Dual Transistors, Monolithic PNP, Tightly Matched	AD820	† AD
	AD821	† AD
	AD822	† AD
Dual Transistors, Monolithic NPN, Logarithmic Conformance	AD818	† AD
	MAT-01	† PMI
Dual Transistors, NPN, Matched plus a third transistor	SL303	Plessey
Dual Matched Transistor Pairs, NPN	SL354	Plessey
Darlington Pair and Two Matched NPN Transistors	µA3018M	† Fairchild
	µA3018AM	† Fairchild
	LA3018	† Lithic Sys
	LA3018A	† Lithic Sys
	LM3018	† National
	LM3018A	† National
	SFC2018	† NPC
	SL3018	† Plessey
	SL3018A	† Plessey
	SL3118	† Plessey
	SL3118A	† Plessey
	CA3018	† RCA
	CA3018A	† RCA
	CA3118	† RCA
	CA3118A	† RCA
	SG3818	Silicon G
	SG3818A	Silicon G
	TA7047	Toshiba
Dual Darlington (NPN)	µA3036M	† Fairchild
	SFC2036	† NPC
	SL305	Plessey
	CA3036	† RCA
Dual Darlington (NPN-PNP Quasi Complementary)	TDA1410	SGS
	TDA1420	SGS
Quad Darlington	ULN-2064A	Sprague
	ULN-2074A	Sprague
Four High Current NPN Transistors (Core Driver)	FQ 3724	Fairchild
	FQ 3725 (continued)	Fairchild

Transistor Arrays (cont)

Function	Device	Source
Four High Current NPN Transistors (Core Driver) (continued)	MHQ4001A	Motorola
	MHQ4002A	Motorola
	MHQ4013	Motorola
	MHQ4014	Motorola
	MPQ3303	Motorola
	MPQ3725	Motorola
	MPQ3725A	Motorola
	MPQ4003	Motorola
	MPQ4004	Motorola
	DH3725C	National
	DH6376C	National
	CA3138	† RCA
	CA3724G **see page 661**	**† RCA**
	CA3725G **see page 661**	**† RCA**
Four High Current PNP Transistors (Core Driver)	FQ 3467	Fairchild
	FQ 3468	Fairchild
	MHQ 3467	Motorola
	DH3467C	National
Differential Pair and Three NPN Transistors	µA3045M	† Fairchild
	µ3046C	Fairchild
	µ3086C	Fairchild
	LA3045	† Lithic Sys
	LA3046	† Lithic Sys
	LA3086	† Lithic Sys
	LM3045	† National
	LM3046	National
	LM3086	National
	LM3145	† National
	LM3145A	† National
	LM3146	National
	LM3146A	National
	SFC2046	† NPC
	SL3045	† Plessey
	SL3046	Plessey
	SL3086	Plessey
	SL3145	† Plessey
	SL3146	Plessey
	CA3045	† RCA
	CA3086	† RCA
	CA3046	† RCA
	CA3146	RCA
	CA3146A	RCA
	SG3821	Silicon G
	SG3886	Silicon G
	ULS-2045A	† Sprague
	ULN-2046A	Sprague
	ULN-2086A	Sprague
Three NPN and Two PNP Transistors	CA3096	† RCA
	CA3096A	† RCA
Five High Current NPN Transistors	SL3083	Plessey
	SL3183	Plessey
	CA3083	† RCA
	CA3183	RCA
	CA3183A	RCA

Transistor Arrays (cont)

Function	Device	Source
Five High Frequency NPN Transistors, ($f_t >$ GHz)	CA3127	RCA
Dual Darlington (NPN) AND TWO NPN Transistors	SG3823	Silicon G
Dual Differential Amplifiers (NPN), to 120 MHz	µA3026C	Fairchild
	µA3054M	† Fairchild
	LA3026	† Lithic Sys
	LM3026	† National
	LM3054	National
	SL3054	Plessey
	CA3026	† RCA
	CA3054	RCA
	SG3822	Silicon G
	ULN-2054A	Sprague
Dual Differential Amplifiers (NPN), biasing to above 100 MHz	NE510	Signetics
	NE511	Signetics
	SE510	† Signetics
	SE511	† Signetics
Dual Differential Amplifiers (NPN), to 500 MHz	LA3049	† Lithic Sys
	CA3049	† RCA
	CA3102	† RCA
Dual Differential Darlington Amplifiers (NPN) with Diode Bias String	SL3050	Plessey
	SL3051	Plessey
	CA3050	† RCA
	CA3051	RCA
One Darlington PNP Pair, and One Current Mirror Pair with Shared Diode, and Two PNP Transistors	CA3084	RCA
Seven NPN Transistors, Common Emitter	SL3081	Plessey
	CA3081	† RCA
	SG3081	Silicon G
	ULN-2081A	Sprague
Seven High Current NPN Transistors, Common Collector	SL3082	Plessey
	CA3082	† RCA
	SG3082	Silicon G
	ULN-2082A	Sprague
Seven High Current Darlingtons	ULN-2031A	Sprague
	ULN-2032A	Sprague
	ULN-2033A	Sprague
Seven High Current, High Voltage NPN Darlington Amplifiers, Open Collector	ULN-2001A	Sprague
	ULN-2002A	Sprague
	ULN-2003A	Sprague
	ULN-2004A	Sprague
Eight NPN Transistors (arranged 2x4 as a memory driver)	SN75303	TI
	SN75308	TI
Super Beta Differential Cascode Amplifier and Three NPN Transistors	**CA3095** **see page 667**	**† RCA**

Special Arrays

Function	Device	Source
CMOS (Three p-channel and three n-channel enhancement MOS Transistors Tested for linear operation)	CA3600	† RCA
Thyristor/Transistor Array (SCR, Programmable Unijunction Transistor, PNP/NPN Transistor Pair, NPN Transistor and Zener Diode)	CA3097	† RCA
Transistor/Diode Array (Three NPN Transistors Two Zener Diodes and One Diode)	SL3093	Plessey
	CA3093	RCA

† Military Temperature Range (—55°C to 125°C)

LINEAR—Comparators

Comparators—Single

Offset Voltage mv (25°C)	Bias Current (25°C)	Offset Current (25°C)	Response Time ns	Max. Differential Voltage	Gain	Fan Out	Supply Voltage	Device	Source
0.8	50nA	3nA	230	11	200K		+5 to ±18	CMP-02	† PMI
								CMP-02E	PMI
	600nA	25nA	150	11	200K*		+5 to ±18	CMP-01	† PMI
								CMP-01E	PMI
1.0	15μA	1μA	60	5	1400		−6,12	RM710A	Raytheon
2.0	10μA	1μA	6.5	6	NA		−5.2,6	685L	AMD
								685M	† AMD
			12	6	NA	5	−6,5	686M	† AMD
	20μA	3μA	40	5	40K*	10	−3 to −12,12	LM106	† AMD
								LM206	AMD
								LM106	† National
								LM206	National
								LM106	† Raytheon
								LM206	Raytheon
								SN52106	† TI
					1250	1	−6,12	μA710M	† Fairchild
								MC1710	† Motorola
								LM710	† National
								μA710	† Signetics
								SG710	† Silicon G
								710B	† Teledyne S
								SFC2710	† NPC
			60	5	1250	1	−6,12	RM710	† Raytheon
	75μA	3μA	80	5	12.5K		−6,12	SN52510	† TI
								SN52810	† TI
2.8	100nA	15nA	230	11	100K		±5 to ±10	CMP-02C	PMI
	900nA	80nA	150	11	100K		+5 to ±18	CMP-01C	PMI
3.0	5μA	2μA*	20	5	3K*	2	5, (−6,5 to ±15)	LM161	† National
								LM261	National
	10μA	1μA	12	6	NA	5	−6,5	686C	AMD
	50nA	10nA	200	10	35K		±5 to ±18	μA734M	† Fairchild
	100nA	10nA	165*	30	200K*	5	5,0 to ±15	SN52111	† TI
			200*	30	200K*	5	5,0 to ±15	AD111	† AD
								AD211	AD
								μA111M	† Fairchild
								HA-2111	† Harris
								HA-2211	Harris
								111	† Intersil
								211	Intersil
								MLM111	† Motorola
								MLM211	Motorola
								LM111	† National
								LM211	National
								SFC2111	† NPC
								SFC2211	NPC
								CA111G see page 661	**† RCA**
								CA211G see page 661	**RCA**
								LM111	† Raytheon
								LM211	Raytheon
								LM111	† Signetics
								LM211	Signetics
								SG111 (continued)	† Silicon G

† Military Temperature Range (−55°C to 125°C) * — Typical Values
Bold face indicates additional data is provided on the page noted.

LINEAR—Comparators (cont)

Offset Voltage mv (25°C)	Bias Current (25°C)	Offset Current (25°C)	Response Time ns	Max. Differential Voltage	Gain	Fan Out	Supply Voltage	Device	Source
Comparators—Single (cont)									
3.0 (continued)	100nA	10nA	200*	30	200K*	5	5,0 to ±15	SG211	Silicon G
								LM111	† Teledyne S
								LM211	Teledyne S
			250	30	200K*	5	5,0 to ±15	LM111	† AMD
								LM211	AMD
		20nA	250*	15	15K		5 to 15, ±5 to ±15	8001M	† Intersil
3.5	20µA	5µA	80	5	10K		−6,12	SN72510	TI
								SN72810	TI
4.0	2µA	0.5µA	26	5	5K*		5,(−6,5 to ±10)	SE527	† Signetics
	12µA	3µA	22	5	5K*		5,(−6,5 to ±10)	SE529	† Signetics
	50pA	25pA	200*	30	200K*	5	5,0 to ±15	LF111	† National
								LF211	National
5.0	10µA*	2µA*	20	5	3K*	2	(−6,5 to ±15)	LM361	National
	20µA	3µA	14*	5	3K*	4	±5	LM160	† National
								LM260	National
								LM360	National
	25µA	5µA	40	5	40K*	10	−3 to −12,12	LM306	National
								LM306	Raytheon
								SN72306	TI
			40K*	5	40*	10	−3 to −12,12	LM306	AMD
					1000	1	−6,12	µA710C	Fairchild
								MC1710C	Motorola
								LM710C	National
								RC710	Raytheon
								SG710	† Silicon G
								µA710	† Signetics
								710C	Teledyne S
	35µA	5µA	48	5	NA	10	±5	NE526	Signetics
								SE526	† Signetics
	75µA	10µA	40*	5	750		−6,12	SN52710	† TI
	100nA	25nA	200*	10	35K		±5 to ±10	µA734C	Fairchild
	250nA	50nA	250*	15	15K		5 to 15,±5 to±15	8001C	Intersil
6.0	2µA	0.75µA	26	5	5K*		5,(−6,5 to ±10)	NE527	Signetics
	20µA	5µA	22	5	5K*		5(−6,5 to ±10)	NE529	Signetics
	60µA	7.5µA	16*	5	5K*	2	±4.5 to ±6.5	µA760M	† Fairchild
								µA760C	Fairchild
	250nA	100nA	250	10	15K		±6 to ±18	AD351J	AD
								AD351K	AD
								AD351S	† AD
7.5	100µA	15µA	40*	5	700		−6,12	SN72710	TI
	250nA	50nA	165*	30	200K*	5	5,0 to ±15	SN72311	TI
			200*	30	200K*	5	5,0 to ±15	AD311	AD
								µA311C	Fairchild
								HA-2311	Harris
								311	Intersil
								MLM311	Motorola
								LM311	National
								SFC2311	NPC
								CA311G **see page 661**	**RCA**
								LM311	Raytheon
								LM311 (continued)	Signetics

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

LINEAR—Comparators (cont)

Offset Voltage mv (25°C)	Bias Current (25°C)	Offset Current (25°C)	Response Time ns	Max. Differential Voltage	Gain	Fan Out	Supply Voltage	Device	Source
Comparators—Single (cont)									
7.5 (continued)	250nA	50nA	200*	30	200K*	5	5,0 to ±15	SG311	Silicon G
								LM311	Teledyne S
			250	30	200K*	5	5,0 to ±15	LM311	AMD
10.0	150pA	75pA	200*	30	200K*	5	5,0 to ±15	LF311	National
Comparators—Dual									
1.5	15μA	1μA	40	5	1400	1	−6,12	RM711A	† Raytheon
2.0	10μA	1μA	8	6			−5.2,5	687AM	† AMD
			10	6			−5.2,5	687M	† AMD
	15μA	3μA	80	5	12.5K		−6,12	SN52514	† TI
								SN52820	† TI
	20μA	3μA	30*	5	1250	1	−6,12	LM1514	† National
			40	5	40K*	10	−3 to −12,12	SN52506	† TI
			40*	5	1250		−6,12	MC1514	† Motorola
								RM1514	† Raytheon
3.0	10μA	1μA	8	6			−5.2,5	687AL	AMD
			10	6			−5.2,5	687L	AMD
	100nA	10nA	200*	30	200K*	5	5,0 to ±15	LH2111	† National
								LH2211	National
								LH2111	† Signetics
								LH2211	Signetics
			250	30	200K*		5,0 to ±15	1500M	† AMD
								1500L	AMD
3.5	20μA	3μA	80	5	12.5K		−6,12	SN52811	† TI
		5μA	80	5	10K		−6,12	SN72514	TI
								SN72820	TI
	75μA	10μA	40*	5	700	1	−6,12	MC1711	† Motorola
					750	1	−6,12	μA711M	† Fairchild
								LM711	† National
								RM711	† Raytheon
								μA711	† Signetics
								711B	† Teledyne S
			60	5	750	1	−6,12	SG711	Silicon G
			80	5	750	1	−6,12	SN52711	† TI
4.0	500nA	75nA	80*	5	10K	2	5,0 to ±15	LM119	† National
								LM219	National
								LM119	† Signetics
								LM219	Signetics
5.0	25μA	5μA	28*	5	40*	10	−3 to −12,12	SN72506	TI
			30*	5	1000	1	−6,12	LM1414	National
			40*	5	1000		−6,12	MC1414	Motorola
								RC1414	Raytheon
	30μA	5μA	33*	5	10K		−6,12	SN75811	TI
	100μA	15μA	40*	5	700	1	−6,12	μA711C	Fairchild
								MC1711C	Motorola
								SFC2711	NPC
								LM711C	National
								RC711	Raytheon
								μA711C	Signetics
								SG711C	Silicon G
								SN72711 (continued)	TI

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Comparators (cont)

Offset Voltage mv (25°C)	Bias Current (25°C)	Offset Current (25°C)	Response Time ns	Max. Differential Voltage	Gain	Fan Out	Supply Voltage	Device	Source
Comparators—Dual (cont)									
5.0 (continued)	100μA	15μA	40*	5	700	1	−6,12	711C	Teledyne S
			65*	5	700	1	−6,12	HA17711	Hitachi
7.5	20μA	5μA	18	6	5K*	10	±5	NE521	Signetics
			25	6	5K*	10	±5	NE522	Signetics
	100μA	15μA	40*	5	700		−6,12	SN72720	TI
	250nA	50nA	200*	30	200K*	5	5,0 to ±15	LH2311	National
			250	30	200K*		5,0 to ±15	1500C	AMD
8.0	1μA	0.2μA	80*	5	8K	2	5,0 to ±15	LM319	National
								LM319	Signetics
10.0	2μA		150	10		10	5,±12	L132	Siliconix
Comparators—Quad									
2.0*	20μA	1μA*	55	5	1.2K*	10	±5	MC3430	Motorola
								MC3431	Motorola
			65	5	1.2K*	10	±5	MC3432	Motorola
								MC3433	Motorola
2.0	100nA	25nA	1300*	36	50K	2	2 to 36/±1 to ±18	LM139A	† National
								CA139AG see page 661	**† RCA**
					200K*	2	2 to 36/±1 to ±18	LM139A	† Teledyne S
	250nA	50nA	1300*	36	50K	2	2 to 36/±1 to ±18	**CA239AG see page 661**	**RCA**
								CA339AG see page 661	**RCA**
								LM239A	National
								LM339A	National
					200K*	2	2 to 36/±1 to ±18	LM239A	Teledyne S
								LM339A	Teledyne S
5.0	100nA	25nA	1300*	36	200K*	2	2 to 36/±1 to ±18	μA139M	† Fairchild
								LM139	† Raytheon
								LM139	† National
								CA139G see page 661	**† RCA**
								LM139	† Signetics
								LM139	† Teledyne S
								SN52139	† TI
	250nA	50nA	1300*	36	200K*	2	2 to 36/±1 to ±18	μA339C	Fairchild
								LM239	National
								LM339	National
								LM239	Raytheon
								LM339	Raytheon
								CA239G see page 661	**RCA**
								CA339G see page 661	**RCA**
								LM239	Signetics
								LM339	Signetics
								LM239	Teledyne S
								LM339	Teledyne S
								SN72339	TI
7.0	250nA	50nA	1300*	36	50K	2	2 to 36/±1 to ±18	LM2901	National
								LM2901	Raytheon
								LM2901 (continued)	Teledyne S

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

LINEAR—Comparators (cont)

Offset Voltage mv (25°C)	Bias Current (25°C)	Offset Current (25°C)	Response Time ns	Max. Differential Voltage	Gain	Fan Out	Supply Voltage	Device	Source
Comparators—Quad (cont)									
7.0 (continued)	250nA	50nA	1300*	36	50K	2	2 to 36/±1 to ±18	LM2901	TI
9.0	300nA	70nA	1300*	36			2 to36/±1 to ±18	μA775C	Fairchild
20	500nA	3nA*	2000*	V_{cc}	2K	1	2 to 28	MC3302 μA3302C RC3302 3302 3302	Motorola Fairchild Raytheon Teledyne S TI
		100nA	1300*	V_{CC}	2K	2	5 to ±15	LM3302	National

Special purpose comparators (Alarm Circuits; Comparators, Programmable; Level Detectors; Voltage Sensors, etc.) are listed under LINEAR—Other Devices

† Military Temperature Range (−55°C to 125°C) * — Typical Values
Bold face indicates additional data is provided on the page noted.

LINEAR—Followers

Bias Current na 25°C	Offset Voltage mv 25°C	Voltage Drift μv/°C	Unity Gain Bandwidth min	Slew Rate v/μs	Output v @ ma	Supply Range	Comments	Device	Source
Followers									
0.15	20	25*	100*	1000	9 @ 90	±5 to ±20	Fast Follower	LH0033C	National
0.1	10	25*	100*	1000	9 @ 90	±5 to ±20	Fast Follower	LH0033	† National
0.2	25	300*	200*	2000	10 @ 200	±5 to ±20	Very Fast Follower	LH0063	† National
	50	300*	200*	2000	10 @ 200	±5 to ±20	Very Fast Follower	LH0063C	National
2.0*	50	300*	300*	2000	10 @ 200	±5 to ±20	Gain 0.94 into 50 ohm	3553 LH0063C	† Burr-Brown National
3	4.0	6*	12*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	SG210	Silicon G
			20*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	LM210 MLM210 LM210	AMD Motorola National
							Dual 210 Follower	LH2210	National
		10*	20*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	110 210	† Intersil Intersil
		12*	12*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	SG110	† Silicon G
			20*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	LM110 μA110M MLM110 LM110 SN52110	† AMD † Fairchild † Motorola † National † TI
							Dual 110 Follower	LH2110	† National
7	7.5	10*	12*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	SG310	Silicon G
			20*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	LM310 μA310C 310 MLM310 LM310	AMD Fairchild Intersil Motorola National
							Dual 310 Follower	LH2310	National
10	5.0	6*	8*	10*	10 @ 1	±15	Follower	SG102	† Silicon G
			10*	10*	10 @ 1.25	±12 to ±18	Follower	LM102	† National
			—	—	10 @ 1.25	±15	Follower	μA102M 102	† Fairchild † Intersil
15	10.0	15*	8*	10*	10 @ 1	±15	Follower	SG202	Silicon G
			10*	10*	10 @ 1.25	±12 to ±18	Follower	LM202	National
			—	—	10 @ 1.25	±15	Follower	202	Intersil
30	15.0	20*	8*	10*	10 @ 1	±15	Follower	SG302	Silicon G
			10*	10*	10 @ 1.25	±12 to ±18	Follower	LM302	National
			—	—	10 @ 1.25	±15	Follower	μA302C 302	Fairchild Intersil

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

LINEAR—Industrial/Consumer Circuits

Function	Source
Alarm	
Intrusion Detectors	Lithic Sys
	National
	Signetics
Smoke/Fire	Intersil
	Lithic Sys
	National
	Signetics
Sound Actuated	Interdesign
	Lithic Sys
Audio	
Preamplifiers	Exar
	Fairchild
	Hitachi
	Interdesign
	ITT
	Lithic Sys
	Mitsubishi
	Motorola
	National
	Nippon
	NPC
	Panasonic
	Plessey
	RCA
	SGS
	Signetics
	Sprague
	Toshiba
Power Amplifiers	Beckman
	Fairchild
	Hitachi
	ITT
	Lithic Sys
	Mitsubishi
	Motorola
	National
	Nippon
	NPC
	Panasonic
	Plessey
	RCA
	Sanken
	SGS
	Sprague
	Toshiba
Quadraphonic Decoders	Hitachi
	IMI
	Motorola
	Nippon
	Panasonic
	RCA
	Signetics
	Toshiba
Noise Processors	Signetics
Automotive IC's	
Antiskid	AMI
	IMI
	ITT
	Motorola
	National
	Raytheon
	(continued)
Automotive IC's (cont)	
Antiskid (continued)	Signetics
	SSS
	Sprague
Ignition	AMI
	Fairchild
	Interdesign
	IMI
	ITT
	Motorola
	National
	Nippon
	OKI
	Raytheon
	Signetics
	Sprague
Position Sensing	Fairchild
	IMI
	National
	NPC
	Raytheon
	Signetics
Seatbelt	Fairchild
	IMI
	ITT
	National
	OKI
	Signetics
	SSS
	Sprague
	SW
Tachometer	Fairchild
	IMI
	ITT
	Motorola
	National
	NPC
	OKI
	Panasonic
	Raytheon
	Sanken
	Signetics
	SW
Voltage Regulators	Beckman
	Fairchild
	Hitachi
	ITT
	Motorola
	National
	Nippon
	NPC
	OKI
	Raytheon
	RCA
	Signetics
Light Bulb Fault	Raytheon
Camera	
Flash Control	National
	Sprague
Shutter Control	ITT
	National
	Sprague
Electrical	
Ground Fault Indicators	Fairchild
	Interdesign
	ITT
	Motorola
	National
	Raytheon
	Signetics
Motor Speed Controls	NPC
	Plessey
	SGS
Hearing Aid	
Amplifiers	Micro Pwr
	Panasonic
	Raytheon
Hobby	
Model Airplane Controls	Hughes
	Exar
	Signetics
Medica	
Pacemakers	Micro Pwr
Receiver	
AM Receivers	Fairchild
	Ferranti
	Hitachi
	Lithic Sys
	Motorola
	National
	Nippon
	Panasonic
	Plessey
	RCA
	SGS
	Signetics
	Sprague
CATV Amplifiers	Motorola
Communications Receiver	Lithic Sys
	Plessey
FM, Detectors	Fairchild
	Hitachi
	ITT
	Lithic Sys
	Motorola
	National
	Nippon
	Panasonic
	Plessey
	RCA
	Signetics
	Sprague
	Toshiba
FM, IF/RF	Fairchild
	Hitachi
	ITT
	Lithic Sys
	Motorola
	National
	Nippon
	NPC
	(continued)

† Military Temperature Range (−55°C to 125°C) * — Typical Values
Bold face indicates additional data is provided on the page noted.

LINEAR—Industrial/Consumer Circuits (cont)

Function	Source
Receiver (cont)	
FM, IF/RF (continued)	Panasonic
	Plessey
	RCA
	SGS
	Signetics
	Sprague
	Toshiba
FM, Multiplex Decoders	Exar
	Fairchild
	Hitachi
	Interdesign
	Mitsubishi
	Motorola
	National
	Nippon
	Panasonic
	RCA
	Signetics
	Sprague
	Toshiba
FM, Tuning Logic	AMI
Pocket Pagers	Micro Pwr
Single Sideband	Lithic Sys
	Plessey
TV, AFT	Fairchild
	Hitachi
	ITT
	Motorola
	National
	Nippon
	NPC
	Panasonic
	Plessey
	RCA
	Sprague
	Toshiba
TV, Chroma	Fairchild
	Hitachi
	ITT
	Mitsubishi
	Motorola
	National
	Nippon
	Panasonic
	Plessey
	RCA
	Sprague
	Toshiba
TV, Horizontal & Vertical Circuits	Fairchild
	Hitachi
	ITT
	Mitsubishi
	Motorola
	National
	Nippon
	NPC
	Panasonic
	Plessey
	RCA
	SGS
	Sprague
	Toshiba
Receiver (cont)	
TV, IF	Fairchild
	Hitachi
	ITT
	Mitsubishi
	Motorola
	National
	Nippon
	NPC
	Panasonic
	Plessey
	RCA
	SGS
	Signetics
	Sprague
	Toshiba
TV, Remote Control	GI
	Hughes
	ITT
	Motorola
	National
	RCA
	Sprague
	Toshiba
TV, Sound System	Fairchild
	Hitachi
	ITT
	Motorola
	National
	Nippon
	NPC
	Panasonic
	Plessey
	RCA
	SGS
	Signetics
	Sprague
	Toshiba
TV, Tuning Logic	AMI
	Fairchild
	Hitachi
	ITT
	National
	Plessey
Telephone	
Baseband Amplifiers/Modulators	Lithic Sys
	Plessey
Cross-point Switches	Motorola
	Raytheon
	Signetics
Dialler Circuits	Collins
	GI
	ITT
	Motorola
	Nitron
	Plessey
Speaker Phone	Interdesign
Transmitter	
Single Sideband Circuits	Lithic Sys
	Plessey
Transmitter (cont)	
Transceivers	Lithic Sys
Transmitters	Lithic Sys
Video Recorder	
VTR Circuits	Panasonic
Weighing	
Electronic Scale	OKI

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers

General Purpose

Function	Device	Source
The 101A series consists of the 101A (−55°C to 125°C), the 201A (−25°C to 85°C) and the 301 (0°C to 70°C). These units require an external compensation capacitor which permits the bandwidth to be optimized for particular applications.	LM101A	AMD
	AD101A	**AD**
	see page 625	
	μA101A	Fairchild
	101A	Intersil
	MLM101A	Motorola
	LM101A	National
	CA101AG	**RCA**
	see page 661	
	LM101A	Raytheon
	LM101A	Signetics
	SG101A	Silicon G
	LM101A	Siliconix
	LM101A	Teledyne S
	SN52101A	TI
The performance of the 741 series is similar to the 101. These units include internal compensation to make the device stable and to eliminate the need for an external capacitor.	741	AMD
	AD741	**AD**
	see page 625	
	μA741	Fairchild
	HA17741	Hitachi
	741	Intersil
	ITT741	ITT
	MC1741	Motorola
	LM741	National
	SFC2741	NPC
	SSS741	PMI
	CA741G	**RCA**
	see page 661	
	RC741	Raytheon
	SG741	Silicon G
	μA741	Signetics
	SN72741	TI
Dual Amplifiers. The 1458 (0°C to 70°C) and the 1558 (−55°C to 125°C) offer approximately the same performance as the 741. Compensation is built in.	XR1458	Exar
	1458	Fairchild
	MC1458	Motorola
	LM1458	National
	SSS1458	PMI
	CA1458G	RCA
	RC1458	Raytheon
	MC1458	Signetics
	SG1458	Silicon G
	1458	Teledyne S
	SN72558	TI

High Speed

Unity Gain Slew Rate (v/μs min)	Device	Source
50	LM118	† AMD
	LM218	AMD
	LM318	AMD
	AD518J	**AD**
	see page 624	
	AD518K	**AD**
	see page 624	
	AD518S	**† AD**
	see page 624	
	AD528J	**AD**
	see page 624	
	AD528K	**AD**
	see page 624	
	AD528S	**† AD**
	see page 624	
	1009M	† DDC
	HA-2510	† Harris
	LH0062	† National
	LH0062C	National
	LM118	† National
	LM218	National
	LM318	National
	SFC2118	† NPC
	SFC2218	NPC
	SFC2318	NPC
	LM118	† National
	LM218	Raytheon
	LM318	Raytheon
	SG118	† Silicon G
	SG218	Silicon G
	SG318	Silicon G
	141410	Teledyne P
65	3550J	Burr-Brown
	3550S	† Burr-Brown
80	**AD509J**	**AD**
	see page 624	
	3507J	Burr-Brown
	1322	† Teledyne P
	132201	Teledyne P
100	**AD509K**	**AD**
	see page 624	
	AD509S	**† AD**
	see page 624	
	3550K	Burr-Brown
	HA-2520	† Harris
120	AD505J	AD
	AD505K	AD
	AD505S	† AD
250	1010C	DDC
	HA-2535	Harris
	LH0024C	National
280	1010M	† DDC
	HA-2530	† Harris
350	LH0032	† National
	LH0032C	National

High Speed (cont)

Unity Gain Slew Rate (v/μs min)	Device	Source
400	LH0024	† National
500	1430	Teledyne P
1000	825	† Beckman

† Military Temperature Range (−55°C to 125°C)

Master Selection Guide

LINEAR

LINEAR—Operational Amplifiers (cont)

High Voltage

Maximum Supply Voltage	Device	Source
±30	MC1436C	Motorola
	LM343	National
	SG1436C	Silicon G
±34	MC1436	Motorola
	SG1436	Silicon G
±35	3580J	Burr-Brown
±40	3571AM	† Burr-Brown
	3572AM	† Burr-Brown
	AM-464	Datel
	HA-2640	† Harris
	HA-2645	Harris
	MC1536	† Motorola
	LH0004	† National
	LH0004C	National
	LM143	† National
	LM243	National
	SG1536	Silicon G
	1332	Teledyne P
±75	3581J	† Burr-Brown
±150	3582J	† Burr-Brown
±225 (5v Internal regulator)	ZN417	Ferranti
450 (5v internal regulator)	ZN417	Ferranti

Low Drift—Single

Voltage Drift (μv/°C Max)	Device	Source
0.4	HA-2904	Harris
0.5	**AD504M**	**AD**
	see page 625	
	LH0044A	† National
	LH0044AC	National
	LH0044B	National
	OP-05A	PMI
0.6	1012	† DDC
	SSS725A	† AMD
	HA-2900	† Harris
	OP-05E	PMI
	OP-07A	† PMI
	SSS725A	† PMI
	SSS725E	PMI
1.0	**AD504S**	**† AD**
	see page 625	
	3500E	Burr-Brown
	3521L	Burr-Brown
	μA725A	† Fairchild
	μA725E	Fairchild
	LH0044	† National
	LH0044C	National
	LM725A	National
	SSS725	† PMI
	SSS725B	PMI
	OP-05	† PMI
	142302	Teledyne P
1.0 (Dual Unit)	OP-10	† PMI
	OP-10A	† PMI
	OP-10E	PMI
1.3	OP-07	† PMI
	OP-07E	PMI
1.5	OP-05C	PMI
	SSS725C	PMI
1.5 (Dual Unit)	OP-10C	PMI
1.6	OP-07C	PMI
2.0	142301	Teledyne P

Low Offset

Offset Voltage	Device	Source
0.025	**AD510L**	**AD**
	see page 625	
	AD510S	**† AD**
	see page 625	
	LH0044A	† National
	LH0044AC	National
	OP-07A	PMI
0.050	**AD510K**	**AD**
	see page 625	
	HA-2904	Harris
	LH0044	† National
	LH0044B	National
0.060	1012M	† DDC
	HA-2900	† Harris
0.075	OP-07	† PMI
	OP-07E	† PMI
0.080	1012C	DDC
	HA-2905	Harris
	1340	Teledyne P
0.10	SSS725A	† AMD
	AD510J	**AD**
	see page 625	
	AM-490-2A	Datel
	SSS725A	† PMI
0.15	OP-05A	† PMI
	OP-07C	PMI
0.25	3521J	Burr-Brown
	3521K	Burr-Brown
	3521L	Burr-Brown
	3521R	† Burr-Brown

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers (cont)

Function	Device	Source
Programmable		
Adjustable Current/Performance Single (1 unit per package)	1003C	DDC
	1003M	† DDC
	HA-2720	† Harris
	HA-2725	Harris
	4250	† Intersil
	4250C	Intersil
	8021C	Intersil
	8021M	† Intersil
	MC1776	† Motorola
	MC1776C	Motorola
	MC3776	Motorola
	LM4250	† National
	LM4250C	National
	CA3078 see page 666	**RCA**
	CA3078A see page 666	**† RCA**
	CA3080 see page 666	**RCA**
	CA3080A see page 666	**† RCA**
	CA3094	† RCA
	CA3094A	† RCA
	CA3094B	† RCA
	SG1250	† Silicon G
	SG2250	Silicon G
	SG3250	Silicon G
	SG4250	† Silicon G
	SG4250C	Silicon G
Dual (2 units per package)	μA776C	Fairchild
	μA776M	† Fairchild
	HA-2730	† Harris
	HA-2735	Harris
	8022C	Intersil
	8022M	† Intersil
	LH24250	† National
	LH24250C	National
Triple (3 units per package)	8023C	Intersil
	8023M	† Intersil
	CA3060	RCA
	CA3060	† RCA
	CA3060A	RCA
	CA3060B	RCA
	L144A	† Siliconix
	L144B	Siliconix
	L144C	Siliconix
Quad (4 units per package)	XR4202	Exar

Supply Voltage	Device	Source
Single Supply		
5 to 16	**CA3130** see page 664	**† RCA**
	CA3130A see page 664	**† RCA**
	CA3130B see page 664	**† RCA**
to 24	CA3094	† RCA
to 36	CA3094A	† RCA
to 44	CA3094B	† RCA
Dual (2 units per package)		
3 to 30	LM158	† National
	LM258	National
	LM358	National
	NE532	† Signetics
	SE532	Signetics
8 to 36	TBA231	SGS
Quad (4 units per package)		
4 to 18	μA3401C	Fairchild
	MC5401	Motorola
	CA3401G	† RCA
	RC3401	Raytheon
3 to 26	LM2902	National
4 to 28	XR124	† Exar
	XR224	Exar
	μA3301C	Fairchild
	MC3301	Motorola
	RC3301	Raytheon
3 to 30	XR324	Exar
	LM124	† Intersil
	LM224	Intersil
	LM324	Intersil
	MLM324	Motorola
	LM124	† National
	LM224	National
	LM324	National
	CA124G see page 661	**† RCA**
	CA224G see page 661	**RCA**
	CA324G see page 661	**RCA**
	LM124	† Raytheon
	LM224	Raytheon
	LM324	Raytheon
	LM124	† Signetics
	LM224	Signetics
	LM324	Signetics
	SG124	† Silicon G
	SG224	Silicon G
	SG324	Silicon G
	LM124	† Teledyne S
	LM224	Teledyne S
	LM324	Teledyne S
	(continued)	

Supply Voltage	Device	Source
Quad (4 units per package) (cont)		
3 to 30 (continued)	LM124	† TI
	LM224	TI
	LM324	TI
3 to 32	MLM2902	Motorola
	LM2902	Raytheon
	RC4137	Raytheon
	RM4137	† Raytheon
	RV4137	Raytheon
	2902	Teledyne S
3 to 36	XR3303	Exar
	XR3403	Exar
	XR3503	† Exar
	μA3303C	Fairchild
	μA3403C	Fairchild
	μA3503M	† Fairchild
	MC3303	Motorola
	MC3403	Motorola
	MC3503	† Motorola
	RC3403 see page 649	**Raytheon**
	RM3403 see page 649	**Raytheon**
	RM3503 see page 649	**† Raytheon**
	RV3403	Raytheon
4 to 36	μA2900	Fairchild
	LM2900	National
	LM3900	National
	LM2900	Raytheon
	LM3900	Raytheon

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers (cont)

Unity Gain Bandwidth (MHz)	Device	Source	
Wide Band			
30*			
	μA702C	Fairchild	
	μA702M	† Fairchild	
	LH0003	† National	
	LH0003C	National	
	LH0005	† National	
	LH0005A	National	
	LH0005C	† National	
	RC702	Raytheon	
	RM702	† Raytheon	
	SN52702	† TI	10
	SN72702	TI	
	SN72702A	TI	
30			
	Q25AH	† Teledyne P	
35			
	825	† Beckman	
35*			
	AD507J see page 624	**AD**	
	AD507K see page 624	**AD**	
	AD507S see page 624	**† AD**	
38*			
	CA3100 see page 667	**† RCA**	
50			
	HFS23	DDC	
50*			
	3551J	Burr-Brown	20
	3551S	† Burr-Brown	
	CA3015	† RCA	
	CA3015A	† RCA	
	CA3016	† RCA	
	CA3016A	† RCA	
	CA3030	RCA	
	CA3030A	RCA	
	CA3038	† RCA	
	CA3038A	† RCA	
60*			
	1430	Teledyne P	30
65*			
	μA715C	Fairchild	
	μA715M	† Fairchild	
70*			
	LH0024	† National	
	LH0024C	National	
	LH0032	† National	
	LH0032C	National	
100			
	HFB7	DDC	
	HVA23	DDC	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package													
0.00001	20.0	—	100		0.5*	12 @ 1.2	20K	60	0	to ±18	Ultra Low Bias FET	ICH8500A	Intersil
0.000075	1.0	—	25	0.35	0.3	10 @ 5	50K	70	0	±5 to ±18	FET Electrometer	**AD515L** see page 624	**AD**
0.0001	0.5	0.00005	25	1*	0.6	10 @ 10	100K	80*	0	±5 to ±20	Ultra Low BiasFET	3523L	Burr-Brown
	20.0	—	—		0.5*	12 @ 1.2	20K	60	0	to ±18	Ultra Low Bias FET	ICH8500	Intersil
0.00015	1.0	—	15	0.35	0.3	10 @ 5	100K	80	0	±5 to ±18	FET Electrometer	**AD515K** see page 624	**AD**
0.00025	0.5	0.0001	25	1*	0.6	10 @ 10	100K	80*	0	±5 to ±20	Ultra Low Bias FET	3523K	Burr-Brown
0.0003	3.0	—	50	0.35	0.3	10 @ 5	40K	66	0	±5 to ±18	FET Electrometer	**AD515J** see page 624	**AD**
0.0005	1.0	0.0001*	30	0.5	3	10 @ 5	40K	80		±12 to ±18	Ultra Low Bias FET	142901	Teledyne P
		0.0002	50	1*	0.6	10 @ 10	100K	80*	0	±5 to ±20	Ultra Low Bias FET	3523J	Burr-Brown
	10.0	—	—			10 @ 5	50K		0	±5 to ±20	Inverting Separate FET Input	L137AA	† Siliconix
0.001	0.5	0.0001	5	1*	1.5	10 @ 10	100K	80	0	±5 to ±20	Precision FET	LH0052	† National
	5.0	0.0003*	90	0.5	3	10 @ 5	20K	70		±12 to ±18	Ultra Low Bias FET	1429	Teledyne P
		0.0005*	25	1*	0.6	10 @ 10	50K	90*	0	±5 to ±20	Low Offset FET	3522L	Burr-Brown
	30.0	0.0002*	50	1*	2.5	10 @ 5	20K	86	0	±5 to ±18	Low Bias FET	1001M 8007AM 8007AC	† DDC † Intersil Intersil
		0.0005*	50	1*	2.5	10 @ 5	31K	86*	0	±4 to ±20	High Performance, Low Bias FET	3503C 3503T	Burr-Brown † Burr-Brown
		—	50*	1*	6*	10 @ 5	20K	86	0	±6 to ±18	FET	1439	Teledyne P
	50.0	0.0005*	90	0.5*	3	10 @ 5	20K	70	0	±5 to ±18	Electrometer, FET	**AD523J** see page 624	**AD**
0.005	0.5	0.001*	25	1*	0.6	10 @ 10	50K	90*	0	±5 to ±20	Low Offset FET	3522K 3522S	Burr-Brown Burr-Brown
	1.0	0.0002	10	1*	1	10 @ 10	75K	76	0	±5 to ±20	Precision FET	LH0052C	National
		0.002*	10	1	3	10 @ 5	50K	70		±12 to ±18	Low Bias Current, FET Low Drift	142502	Teledyne P
			25	4*	3	10 @ 5	25K	80*	0	±10 to ±22	General Purpose FET	ADM501C	AD
				1	3	10 @ 5	50K	70		±12 to ±18	Low Bias Current, FET	142501	Teledyne P
		—	10	1*	3	10 @ 5	75K	80	0	±5 to ±18	High Accuracy, FET	**AD506L** see page 624	**AD**
	5.0	0.0006		2*	50*	0.35 ma		80	0	±2 to ±15	Micropower, Transconductance Amplifier	**CA3080** see page 666 **CA3080A** see page 666	**RCA** † **RCA**
	20.0	—	30	0.5*	3	10 @ 5	40K	80	0	±5 to ±18	Electrometer, FET	**AD523K** see page 624	**AD**

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
0.005	20.0	—	—			10 @ 5	25K		0	±5 to ±20	Inverting Separate FET Input	L137CA	Siliconix
0.010	0.25	0.002*	1	1.5*	0.6	10 @ 10	100K	90*	0	±5 to ±20	Ultra Low Drift FET	3521L	Burr-Brown
	1.0	0.002*	50	1*	0.6	10 @ 10	50K	90*	0	±5 to ±20	Low Offset FET	3522J	Burr-Brown
		0.005*	25	1	3	10 @ 5	50K	70		±12 to ±18	Low Drift, FET	142601	Teledyne P
				10*	65	10 @ 10	25K	70*	0	±5 to ±20	Fast Settling, 1 µs to 0.01%	3550J	Burr-Brown
												3550S	† Burr-Brown
				20*	100	10 @ 10	25K	70*	0	±5 to ±20	Fast Settling, 0.6 µs to 0.01%	3550K	Burr-Brown
	1.0	—	25	4*	3	10 @ 5	25K	80*	0	±10 to ±22	General Purpose FET	ADM501B	AD
	1.5	—	25	1*	3	10 @ 5	50K	80	0	±5 to ±18	High Accuracy, FET	**AD506K** **see page 624**	**AD**
			50	1*	3	10 @ 5	50K	80	0	±5 to ±22	High Accuracy, FET	**AD506S** **see page 624**	**† AD**
	2.0	0.0005*	5	1*	6*	10 @ 5	20K	70	0	±5 to ±18	Highest Performance, see 1001C665	1001C113	DDC
				1*	3	10 @ 5	50K	70	0	±5 to ±18	Low Offset Voltage, FET	8007C-1	Intersil
			15	1*	6*	10 @ 5	50K	70	0	±5 to ±18	Highest Performance, see 1001M664	1001M313	† DDC
				1*	3	10 @ 5	50K	70	0	±5 to ±18	Low Offset Voltage, FET	8007C-2	Intersil
												8007M-2	† Intersil
		0.005*	50	1	3	10 @ 5	50K	70		±12 to ±18	Low Bias Current, FET	1425	Teledyne P
		—	75	4*	3	10 @ 5	25K	80*	0	±10 to ±22	General Purpose FET	ADM501A	AD
	4.0	0.002	10	1*	1.5	10 @ 10	100K	80	0	±5 to ±20	High Performance FET	LH0022	† National
	10.0	0.0005*	10	1*	3	10 @ 5	50K	70	0	±5 to ±18	FET Input	8007C-4	Intersil
			15	1*	3	10 @ 5	50K	70	0	±5 to ±18	FET Input	8007C-5	Intersil
												8007M-5	† Intersil
	15.0	0.005	25	1	3	10 @ 10	100K	80		±5 to ±18	General Purpose, Low Drift	142102	Teledyne P
	20.0	0.002*	25	1*	2.5	10 @ 5	31K	86*	0	±4 to ±20	High Performance, Low Bias FET	3503B	Burr-Brown
												3503S	† Burr-Brown
		—	25	0.75*	0.5*	10 @ 5	50K*	70	0	±5 to ±18	Low Noise FET	**AD514L** **see page 624**	**AD**
0.015	0.25	0.002*	2	1.5*	0.6	10 @ 10	100K	90*	0	±5 to ±20	Ultra Low Drift FET	3521K	Burr-Brown
	1.0	—	25	10*	50	10 @ 5	50K	80	0	±15	Fast Wideband, High Accuracy	**AD528K** **see page 624**	**AD**
												AD528S **see page 624**	**† AD**
	3.5	—	75	1*	3	10 @ 5	20K	70	0	±5 to ±18	High Accuracy, FET	**AD506J** **see page 624**	**AD**
	15.0	0.01	25	1	3	10 @ 10	100K	72	0	±5 to ±18	Low Noise	1421-25	Teledyne P
			50	1	3	10 @ 10	100K	72		±5 to ±18	General Purpose, Low Drift	142101	Teledyne P

† Military Temperature Range (—55°C to 125°C) * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
0.015	15.0	0.01*	50	5	8	10 @ 5	100K	72		±12 to ±18	Wideband, FET	142201	Teledyne P
	50.0	—	75	1*	3	10 @ 5	20K	70	0	±5 to ±18	Low Cost FET Input	**AD503J** **see page 624**	**AD**
0.020	0.25	0.002*	5	1.5*	0.6	10 @ 10	50K	90*	0	±5 to ±20	Ultra Low Drift FET	3521J 3521R	Burr-Brown † Burr-Brown
	0.5	0.002*	10	1.5*	0.6	10 @ 10	50K	90*	0	±5 to ±20	Ultra Low Drift FET	3521H	Burr-Brown
	1.5	—	25	1*	50*	10 @ 5	50K	80	1-3	±5 to ±18	High Speed, Laser Trim	AD516K	AD
		—	50	1*	50*	10 @ 5	50K	80	1-3	±5 to ±18	High Speed, Laser Trim	AD516S	† AD
	2.0	0.010	15	4*	10*	12 @ 6	50K	86	1	5 to 16	CMOS, Single Supply, Strobe	CA3130B	† RCA
	3	0.020*	25	3*	20*	70 @ 30	50K	110*	0	±32 to ±75	High Voltage FET	3581J	† Burr-Brown
				3*	20*	145 @ 15	100K	110*	0	±70 to ±150	High Voltage FET	3582J	† Burr-Brown
	4.0	0.0005*	30	1*	3	10 @ 5	50K	70	0	±5 to ±18	FET Input	8007C-3	Intersil
	12.0	0.02	20*	5*	10*	10 @ 5	80K	74	1	±10 to ±17	Wide Band, FET Input	HA-2060A	† Harris
			40*	5*	10*	10 @ 5	80K	70	1	±10 to ±17	Wide Band, FET Input	HA-2065A	Harris
	14.0	0.02	20*	8*	40*	10 @ 5	7.5K	74	1	±5 to ±17	120V/µs Gain = 3	HA-2050A 143401	† Harris † Teledyne P
			40*	8*	40*	10 @ 5	7.5K	70	1	±5 to ±17	120V/µs Gain = 3	HA-2055A 1434	Harris Teledyne P
	20.0	0.0005*	75	1*	6*	10 @ 5	50K	70	0	±5 to ±18	High Performance, FET	8007M	† Intel
		—	25	1*	3	10 @ 5	50K	80	1-3	±5 to ±18	High Speed	AD513K	AD
				0.75*	0.5*	10 @ 5	50K*	70	0	±5 to ±18	Low Noise FET	**AD514K** **see page 624**	**AD**
		—	50	1*	3	10 @ 5	50K	80	1-3	±5 to ±18	High Speed	AD513S	† AD
				0.75*	0.5*	10 @ 5	50K*	70	0	±5 to ±18	Low Noise FET	**AD514S** **see page 624**	**† AD**
	25.0	0.02	50*	5*	10*	10@5	80K	74	1	±5 to ±17	120V/µs Gain = 3	1015M HA-2060 143301	† DDC † Harris † Teledyne P
				8*	40*	10 @ 5	7.5K	74	1	±10 to ±17	High Slew Rate, FET	1014M HA-2050	† DDC † Harris
	50.0	—	75	1*	6*	10 @ 5	50K	70	0	±5 to ±18	Low Performance Limit, See 1001M111	1001M664	† DDC
	60.0	0.02	60*	5*	10*	10 @ 5	80K	70	1	±5 to ±17	Wideband, FET Input	AM-406 1015C HA-2065 1433	Datel DDC Harris Teledyne P
				8*	40*	10 @ 5	7.5K	70	1	±5 to ±17	120V/µs Gain = 3	AM-405 1014C HA-2055	Datel DDC Harris

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
0.025	0.5	0.01*	25	6	20	10 @ 5	100K	80	0	±12 to ±18	Fast Settling, FET	142701	Teledyne P
	1.0	0.01*	5	1	3	10 @ 5	50K	70	0	±12 to ±18	Low Drift, FET	142603	Teledyne P
			10	1	3	10 @ 5	50K	70	0	±12 to ±18	Low Drift, FET	142602	Teledyne P
	2.0	0.01*	50	1	3	10 @ 5	100K	72		±12 to ±18	Low Drift, FET	1426	Teledyne P
	5.0	0.002	25	15*	50	10 @ 10	50K	80	0	±5 to ±20	Precision, High Speed, FET	LH0062	† National
	6.0	0.002	15	1*	1	10 @ 10	75K	70	0	±5 to ±20	High Performance FET	LH0022C	National
	20.0	0.002*	50	1*	0.5*	10 @ 10	25K	80*	0	±5 to ±20	Low Noise	3542J	Burr-Brown
												3542S	† Burr-Brown
		0.010	20	1*	1.5	10 @ 10	50K	70	0	±5 to ±20	Low Cost FET	LH0042	† National
		—	25	1*	6*	10 @ 5	50K	70	0	±5 to ±18	Low Cost FET Input	**AD540K** **see page 624**	**AD**
		—	50	1*	6*	10 @ 5	50K	70	0	±5 to ±22	Low Cost FET Input	AD540S	† AD
		—	60	0.5*	3	10 @ 5	40K	80	0	±5 to ±18	Electrometer, FET	**AD523L** **see page 624**	**AD**
		—	50	1*	0.5*	10 @ 5	25K	80	0	±5 to ±20	FET	AD3542J	AD
	50.0	0.005*	75	1*	2.5	10 @ 5	20K	86*	0	±4 to ±20	High Performance, Low Bias FET	3503A	Burr-Brown
												3503R	† Burr-Brown
0.030	1.0	0.01*	10	1	3	13 @ 2	10K	76	0	±4 to ±24	Battery, FET Micro-power	140202	Teledyne P
	3.0	0.1*	50	1	3	13 @ 2	10K	76	0	±4 to ±24	Battery, FET Micro-power	1402	Teledyne P
		—	50	10*	50	10 @ 5	25K	70	0	±15	Fast Wideband, High Accuracy	**AD528J** **see page 624**	**AD**
	3.5	—	75	1*	50*	10 @ 5	20K	70	1-3	±5 to ±18	High Speed, Laser Trim	AD516J	AD
		0.02	10*	4*	10*	12 @ 6	320K*	80	1	5 to 16	CMOS, Single Supply, Strobe	**CA3130A** **see page 664**	**† RCA**
	20.0	0.005*	20*	1*	6*	10 @ 5	50K	70	0	±6 to ±20	FET	SU536	Signetics
	50.0	—	75	1*	3	10 @ 5	20K	70	1-3	±5 to ±18	High Speed	AD513J	AD
0.050	0.05	0.0005*	75*	1*	6*	10 @ 5	20K	70	0	±5 to ±18	FET	3540J	Burr-Brown
	1.0	0.01*	50	6	20	10 @ 5	100K	80	0	±12 to ±18	Fast Settling, FET	1427	Teledyne P
	2.0	0.01	5	2.5*	3	12 @ 1.2	50K	85	0	±5 to ±20	Bipolar - JFET	LF155A	† National
												LF355A	National
				4	10	12 @ 1.2	50K	85	0	±5 to ±20	Wideband - JFET	LF156A	† National
												LF356A	National
						12 @ 1.2	50K	85	1	±5 to ±20	Wideband Uncompensated	LF157A	† National
												LF357A	National
	3.0	0.015	—	1*	0.3*	13 @ 1.3	40K	80	0	±3 to ±20	High Performance, Low Input Current	LM216A	AMD
												LM316A	AMD
												LM216A	National
												LM316A	National
												LM216A	Raytheon
												LM316A	Raytheon

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
0.050	5.0	0.025	55			10 @ 5	37K	60	0	±6 to ±22	FET Input 741	2740B	Teledyne S
	10.0	0.020*	30	3*	15*	30 @ 60	20K	86*	0	±18 to ±35	High Voltage FET	3580J	† Burr-Brown
		0.025	100			10 @ 5	37K	60	0	±6 to ±22	FET Input 741	2740C	Teledyne S
	15.0	0.025	50	1	3	10 @ 10	50K	72		±5 to ±18	General Purpose	1421	Teledyne P
						10 @ 10	50K	72	0	±5 to ±18	GLow Noise	1421-24	Teledyne P
		0.025*	50	5	8	10 @ 5	50K	72		±12 to ±18	Wideband, FET	1422	Teledyne P
		0.030	10*	4*	10*	12@ 6	320K*	70	1	5 to 16	CMOS, Single Supply, Strobe	**CA3130** **see page 664**	† **RCA**
	20.0	0.005	25	1*	1	10 @ 10	25K	70	0	±5 to ±20	Low Cost FET	LH0042C	National
		0.025	150			10 @ 5	20K	60	0	±6 to ±22	FET Input 741	2740D	Teledyne S
		—	25	1*	6*	10 @ 10	25K	70	0	±5 to ±18	Low Cost FET	AD0042C	AD
	50.0	0.0005*	75	1*	6*	10 @ 5	20K	70	0	±5 to ±18	High Performance, FET	3540J	Burr-Brown
												1001	DDC
												8007C	Intersil
				1*	6*	10 @ 5	20K	70		±12 to ±18	Low Cost FET	1424	Teledyne P
		—	75	0.75*	0.5*	10 @ 5	20K	70	0	±5 to ±18	Low Noise FET	**AD514J** **see page 624**	**AD**
				1*	6*	10 @ 5	20K	70	0	±5 to ±18	Low Cost FET	**AD540J** **see page 624**	**AD**
				1*	6*	10 @ 5	20K	70	0	±5 to ±18	Low Performance Limit See 1001C111	1001C665	DDC
0.065	15.0	0.005	35	15*	50	10 @ 10	25K	70	0	±5 to ±20	Precision, High Speed, FET	LH0062C	National
0.10	1.0	0.01	50	50*	250*	10 @ 10	100K	70*	1	±5 to ±20	Wideband, Fast Settling	3551J	Burr-Brown
												3551S	† Burr-Brown
	2.0	0.05*	40	0.5*	3	30 @ 1A	50K	80	1	±15 to ±40	High Current, High Power	3571A	Burr-Brown
				0.5*	3	30 @ 2A	50K	80	1	±15 to ±40	High Current, High Power	3572A	Burr-Brown
	3.0	—	75	35	1000	10 @ 100	25K	72	0	±12 to ±18	Fast Settling	825	† Beckman
	5.0	0.02	5*	2.5*	5*	12 @ 1.2	50K	85	0	±5 to ±20	Bipolar - JFET	LF155	† National
												LF255	National
				5*	15*	12 @ 1.2	50K	85	0	±5 to ±20	Wideband - JFET	LF156	† National
												LF256	National
						12 @ 1.2	50K	85	1	±5 to ±20	Wideband Uncompensated	LF157	† National
												LF257	National
		0.025	25*	70*	350	10 @ 10	1K	50	2	±5 to ±20	Ultra Fast FET	LH0032	† National
		0.01*	50	10*	50	10 @ 20	100K	74*		±10 to ±18	Fast Differential, FET settles to 0.01% in 1 µsec	141410	Teledyne P
	20.0	—	25	1*	3	10 @ 5	50K	80	0	±5 to ±18	Low Cost FET Input	**AD503K** **see page 624**	**AD**
				1*	3	10 @ 5	50K	80	0	±5 to ±22	Low Cost FET Input	**AD503S** **see page 624**	† **AD**

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
0.10	90.0	0.005*	30*	1*	6*	10 @ 5	50K	64	0	±6 to ±20	FET, High Input, High Impedance	NE536	Signetics
0.15	10.0	0.05	—	1*	0.3*	13 @ 1.3	20K	80	0	±3 to ±20	High Performance, Low Input Current	LM216	AMD
												LM316	AMD
												LM216	National
												LM316	National
												LM216	Raytheon
												LM316	Raytheon
		0.01	55	30	8	11 @ 22	20K	94		±12 to ±18	FET	Q25AH	† Teledyne P
0.20	10.0	0.05	5*	2.5	5*	12 @ 1.2	50K	80	0	±5 to ±18	Bipolar - JFET	LF355	National
				5	15*	12 @ 1.2	50K	80	0	±5 to ±18	Wideband - JFET	LF356	National
						12 @ 1.2	50K	80	1	±5 to ±18	Wideband Uncompen-sated	LF357	National
	15.0	0.05	25*	50*	350	10 @ 10	1K	50	2	±5 to ±20	Ultra Fast FET	LH0032C	National
		0.10	5*	1*	6*	10 @ 5	50K	80	0	to ±22	FET input	LH740A	† National
			15*	1*	6*	10 @ 5	50K	80	0	±5 to ±20	FET input	740	† Intersil
	20.0	0.15	20*	3*	6*	10 @ 5	50K	64	0	±5 to ±22	High Slew Rate FET	μA740M	† Fairchild
			—	3*	6*	10 @ 5	50K	64	0	±5 to ±22	High Slew Rate FET	740	Intersil
				100	1000	10 @ 30	—	—	0	±15	Wideband Inverting	HFB7	DDC
			25	100	600	10 @ 30	—	—	0	±15	Wideband Inverting	HVA23	DDC
0.50	2.0		75	60*	500	10 @ 50	200K		0	±10 to ±18	Inverting, Fast Settling 0.01% in 200 ns	1430	Teledyne P
	20.0	0.15	5*	1*	6*	10 @ 5	50K	80	0	to ±22	FET input	LH740AC	National
			15*	1*	6*	10 @ 5	50K	80	0	±5 to ±20	FET Input	740C	Intersil
1	0.05	0.5	0.4	3*	2.5*	10 @ 5	10M	130	0	±12 to ±20	Chopper Stabilized	HA-2904	Harris
	0.06	0.5	0.6	3*	2.5*	10 @ 5	1000K	120	0	±12 to ±20	Chopper Stabilized	1012M	† DDC
												HA-2900	† Harris
	0.08	0.5	0.2*	3*	2.5*	10 @ 5	1000K	120	0	±10 to ±20	Chopper Stabilized	AM-490	Datel
												1012C	DDC
												HA-2905	Harris
												1340	Teledyne P
2	0.025	2	0.6	1.2*	0.25*	10.5 @ 10.5	300K	110	0	±3 to ±18	Ultra Low Offset Volt-age, Low Drift	OP-07A	† PMI
	0.15	2	0.9	1.2*	0.25*	10.5 @ 10.5	300K	114	0	±3 to ±22	Instrumentation	OP-05A	† PMI
	0.5	0.2	5	1*	0.3*	13 @ 1.3	80K	96	1	±2 to ±20	Precision Bipolar, Low Bias	LM108A	† AMD
												LM208A	AMD
												AD108A **see page 625**	**† AD**
												AD208A **see page 625**	**AD**
												μA108AM	† Fairchild
												μA208AM	Fairchild
												108A	† Intersil
												208A	Intersil
												LM108A	† National
												LM208A	National

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
2	0.5	0.2	5	1*	0.3*	13 @ 1.3	80K	96	1	±2 to ±20	Precision Bipolar, Low Bias (continued)	SFC2108A	† NPC
												SFC2208A	NPC
												LM108A	† Raytheon
												LM208A	Raytheon
												CA108A	† RCA
												CA208A	RCA
												LM108A	† Signetics
												LM208A	Signetics
												SG108A	† Silicon G
												SG208A	Silicon G
												SN52108A	† TI
				0.3*	0.1	13 @ 1.3	80K	96	0	±5 to ±20	Compensated 108A	SG1118A	† Silicon G
												SG2118A	Silicon G
	2.0	0.2	15	1*	0.2*	13 @ 1.3	50K	85	0	±2 to ±20	Micropower, Supply Current 600μa	LM112	† AMD
												LM212	AMD
												LM112	† National
												LM212	National
												LM112	† Raytheon
												LM212	Raytheon
				1*	0.1*	13 @ 1.3	50K	85	0	±5 to ±20	Compensated 108/208	SG1118	† Silicon G
												SG2118	Silicon G
				1*	0.3*	13 @ 1.3	50K	85	1	±2 to ±20	Precision Bipolar	LM108	† AMD
												LM208	AMD
												AD108 **see page 625**	**† AD**
												AD208 **see page 625**	**AD**
												μA108M	† Fairchild
												μA208M	Fairchild
												108	† Intersil
												208	Intersil
												LM108	† National
												LM208	National
												SFC2108	† NPC
												SFC2208	NPC
												CA108	† RCA
												CA208	RCA
												LM108	† Raytheon
												LM208	Raytheon
												LM108	† Signetics
												LM208	Signetics
												SG108	† Silicon G
												SG108	Silicon G
												LM108	† Teledyne S
												LM208	Teledyne S
				0.3*	0.3*	13 @ 1.3	50K	85	1	±5 to ±20	Low Noise 108	108LN	† Intersil
	30*	0.06*		1*	6*	10 @ 5	1000K	80*	0	±5 to ±22	High Slew Rate FET	μA740C	Signetics
	110.0	0.3	20*	1*	6*	10 @ 5	20K	55	0	±5 to ±22	High Slew Rate FET	μA740C	Fairchild

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Single-Unit Package (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
2	110.0	0.3	—	1*	6*	10 @ 5	20K	55	0	±5 to ±22	High Slew Rate FET	740C	Intersil
3	0.075	2.8	1.3	1.2*	0.25*	10.5 @ 10.5	200K	110	0	±3 to ±18	Ultra Low Offset Voltage, Low Drift	OP-07	† PMI
	0.5	2.8	2	1.2*	0.25*	10.5 @ 10.5	200K	114	0	±3 to ±22	Instrumentation	OP-05	† PMI
	2.0	2	10	0.5*	0.1	10 @ 5	45K	100*	0	±3 to ±20	Low Bias Current	3501C 3501T	Burr-Brown † Burr-Brown
4	0.075	3.8	1.3	1.2*	0.25*	10.5 @ 10.5	200K	106	0	±3 to ±18	Ultra Low Offset Voltage, Low Drift	OP-07E	PMI
	0.5	3.8	2	1.2*	0.25*	10.5 @ 10.5	200K	110	0	±3 to ±22	Instrumentation	OP-05E	PMI
	5.0	1	10	1*	0.5*	10 @ 5	20K	80	0	±5 to ±18	Low Input Current	**AD502L see page 625**	**AD**
				0.5*		10 @ 5	15K	65	1	±5 to ±18	Low Input Current 709	AD801B	AD
		2	20	0.5*		10 @ 5	15K	65	1	±5 to ±18	Low Input Current 709	AD801A	AD
			40	0.5*		10 @ 5	15K	65	1	±5 to ±18	Low Input Current 709	AD801S	† AD
5	3.0	3	10*		0.1*	10 @ 2	40K	80	0	±1.2 to ±18	Programmable Amplifier	HA-2720	† Harris
7	0.15	6	1.8	1.2*	0.25*	11.5 @ 5.7	120K	100	0	±3 to ±18	Ultra Low Offset Voltage, Low Drift	OP-07C	PMI
	0.5	1	5	1*	0.3*	13 @ 1.3	80K	96	1	±2 to ±18	Precision Bipolar	LM308A **AD308A see page 625** μA308AC 308A LM308A CA308A LM308A LM308A SG308A	AMD **AD** Fairchild Intersil National RCA Raytheon Signetics Silicon G
				0.3*	0.1	13 @ 1.3	80K	96	0	±5 to ±15	Compensated 308A	SG3118A	Silicon G
	1.3	6	4.5	1.2*	0.25*	11.5 @ 5.7	120K	100	0	±3 to ±22	Instrumentation	OP-05C	PMI
	2.0	3	10	0.5*	0.1	10 @ 5	45K	100*	0	±3 to ±20	Low Bias Current	3501B 3501S	Burr-Brown † Burr-Brown
	5.0	4	20	1*	0.5*	10 @ 5	20K	80	0	±5 to ±18	Low Input Current	**AD502K see page 625**	**AD**
	7.5	1	30	1*	0.3*	13 @ 1.3	25K	80	0	±2 to ±18	Micropower, Supply Current 800μa	LM312 LM312 LM312	AMD National Raytheon
				0.3*	0.1	13 @ 1.3	25K	80	0	±5 to ±18	Compensated 308	SG3118	Silicon G
				1*	0.3*	13 @ 1.3	25K	80	1	±2 to ±18	Precision Bipolar	LM308 **AD308 see page 625** μA308C LM308 LM308 SFC2308 CA308 LM308	AMD **AD** Fairchild Intersil National NPC RCA Raytheon

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Single-Unit Package (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
7	7.5	1		1*	0.3*	13 @ 1.3	25K	80	1	±2 to ±18	Precision Bipolar (continued)	LM308 SG308 LM308	Signetics Silicon G Teledyne S
				0.3*	0.3*	13 @ 1.3	25K	80	1	±5 to ±18	Low Noise 308	308LN	Intersil
7.5	3.0	3	—	.25*	0.16*	12 @ 1.2	100K	70	0	±1 to ±18	Programmable	4250 LM4250	† Intersil † National
10	0.025	2.5	2	0.3*	0.1*	10 @ 5	1000K	110	0	±5 to ±18	Trimmed Offset	**AD510L** **see page 625** **AD510S** **see page 625**	**AD** **† AD**
	3.0	2	15	0.3*	0.13*	10 @ 5	50K	80	0	±3 to ±20	Micropower	RM4132	† Raytheon
				12*	4	10 @ 5	100K	80	0	±9 to ±20	High Impedance	HA-2600	† Harris
	4.0	10	5*	12*	4	10 @ 5	100K	80	0	±5 to ±20	High Impedance	1008M	† DDC
	5.0	5	7*	1*	0.5*	10 @ 5	20K	70	0	±1 to ±18	Low Input Current	8008M	† Intersil
			10*		0.1*	10 @ 2	25K	74	0	±1.2 to ±18	Programmable Amplifier	HA-2725	Harris
		6	—	.25*	0.16*	12 @ 1.2	60K	70	0	±1 to ±18	Programmable	4250C LM4250C SG4250	Intersil National Silicon G
12	3.0	5	4*		0.2*	11 @ 1.1	100K	70	0	±0.75 to ±18	Programmable	SG1250 SG2250	† Silicon G Silicon G
	3.5	2.5	6*		0.04*	13.7 @ 1.37	40K	80	1	±0.75 to ±15	Micropower	**CA3078A** **see page 666**	**† RCA**
					0.04*	13.7 @ 1.37	40K	80	1	±0.75 to ±15	Low Noise, Micropower	CA6078A	† RCA
13	0.05	4.0	1	0.3	0.1*	10 @ 5	1000K	110	0	±5 to ±18	Trimmed Offset	**AD510K** **see page 625**	**AD**
15	0.025	2.5	0.5	0.4*	0.06*	13 @ 1.3	1000K	120	1	±2 to ±20	Precision, Low Noise	LH0044A LH0044AC	† National National
	1.0	7*	3	1.5*	1	10 @ 10	45K	100*	0	±3 to ±20	Low Bias, Low Noise	3500C	Burr-Brown
			5	1.5*	1	10 @ 10	45K	100*	0	±3 to ±20	Low Bias, Low Noise	3500T	† Burr-Brown
		7	—		1.5*		50K		0	to ±22	Low Input Bias, High Slew Rate	ULS-2171	† Sprague
	2.0	5	3	3	1.5	12 @ 6	40K	80	0	±3 to ±22	High Performance, High Gain	RM1556A	† Raytheon
	3.0	15	15	35*	25	10 @ 5	100K	80	1	±5 to ±20	Wideband, General Purpose	**AD507K** **see page 624**	**AD**
	4.0	2	15	4*	2*	12 @ 6	40K	80	0	±3 to ±22	High Performance, High Gain	RM1556	† Raytheon
			—	1*	2.5*	12 @ 6	100K	80	0	±3 to ±22	High Performance	MC1556 SG1556	† Motorola † Silicon G
		15	10*	35*	25	10 @ 15	100K	80	1	±5 to ±20	Wide Band, High Impedance	1018M HA-2620	† DDC † Harris
			20	35*	20	10 @ 5	100K	80	1	±5 to ±20	Wideband, General Purpose	**AD507S** **see page 624**	**† AD**

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
15	5.0	5	20	0.5*	0.1	10 @ 5	45K	100*	0	±3 to ±20	Low Bias Current	3501A	Burr-Brown
												3501R	† Burr-Brown
	7.5	2	30		0.1	13 @ 1.3	25K	80	1	±6 to ±18	Precision	1660	AMD
				0.3*	0.1	13 @ 1.3	25K	80	1	±5 to ±15	Improved 201, 301A	SG1660	Silicon G
				0.3*	0.1	13 @ 1.3	25K	80	0	±5 to ±15	Improved 307, 741	SG1760	Silicon G
20	2.0	10*	5	1.5*	1	10 @ 10	45K	100*	0	±3 to ±20	Low Bias, Low Noise	3500B	Burr-Brown
			10	1.5*	1	10 @ 10	45K	100*	0	±3 to ±20	Low Bias, Low Noise	3500S	† Burr-Brown
	3.0	2.5*	30*	1*	10	12 @ 10	200K	80	0	±5.5 to ±20	Micropower, High Output Current	132301	Teledyne P
				8	25	10 @ 10	100K	80	4	±5.5 to ±20	Micropower, High Output Current	132302	† Teledyne P
		7.5	5*	0.27*	0.16*	11 @ 1.1	50K	70	0	±1 to ±18	Low Power Adjustable Current	1003M	† DDC
												8021M	† Intersil
		10	5*	1*	10	12 @ 6	400K	86	0	±5.5 to ±20	Wide Response, Low Power	1011M	† DDC
												HA-2700	† Harris
												HA-2704	Harris
	5.0	3	—	1*	2*	30 @ 6	100K	80	0	±5 to ±40	High Voltage	MC1536	† Motorola
												SG1536	† Silicon G
	14.0	—	35*	20*	60	10 @ 10	40K*	90	0	±5 to ±17	High Slew Rate	14301	† Teledyne P
			75*	20*	60	10 @ 10	40K*	90	0	±5 to ±17	High Slew Rate	1434	Teledyne P
25	0.1	5	3	3*	0.1*	10 @ 5	250K	94	0	±5 to ±18	Trimmed Offset	**AD510J** **see page 625**	**AD**
	2.0	3	15	0.5	0.5*	10 @ 5	50K	80	1	±5 to ±18	Low Offset Current	μA777M	† Fairchild
												SG777	† Silicon G
												SN52777	† TI
	2.5	5	3	0.3*	0.12*	10 @ 5	250K	94	1	±5 to ±15	Chopperless, Low Drift	**AD508J** **see page 625**	**AD**
		—	15*	4*	120	10 @ 5	200K		0	±5 to ±20	High Speed Inverting	AD505K	AD
												AD505S	† AD
	3.0	5	10*			5 @ 50	4K	60	3	±9 to ±20	Matched Transistors	LH0005A	† National
	4.0	12	15*	4*	5*	35 @ 12	100K	80	0	±10 to ±40	High Voltage	HA-2640	† Harris
	5.0	5	20	0.3*	0.13*	10 @ 5	50K	70	0	±3 to ±18	Micropower	RC4132	Raytheon
		25	10*	12*	4	10 @ 5	80K	74	0	±9 to ±20	High Impedance	AM-460	Datel
												HA-2602	† Harris
												HA-2605	Harris
				35*	20	10 @ 5	80K	74	1	±5 to ±20	Wide Band, High Impedance	AM-462	Datel
												1018C	DDC
												HA-2622	† Harris
												HA-2625	Harris
			20*	12*		10 @ 10	80K	74	0	±8 to ±22	Wideband	3506J	Burr-Brown
			30*	1		10 @ 10	80K	74	1	±8 to ±22	Wideband	3508J	Burr-Brown

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
25	5.0	25		10*	20	10 @ 10	80K	100*	1	±8 to ±22	Wide Band, High Gain	1321	Teledyne P
												132101	† Teledyne P
			—	12*	4	10 @ 5	80K	74	0	±5 to ±20	High Impedance	1008C	DDC
	6.0	10	6*		0.2*	11 @ 1.1	75K	70	0	±0.75 to ±18	Programmable	SG3250	Silicon G
		12	40	1*	0.5*	10 @ 5	20K	80	0	±5 to ±18	Low Input Current	**AD502J** **see page 625**	**AD**
		20	15*		0.5*	10 @ 5	20K	70	0	±1 to ±18	Low Input Current	8008C	Intersil
		25	15*	35*	20	10 @ 5	80K	74	1	±5 to ±20	Wideband, General Purpose	**AD507J** **see page 624**	**AD**
30	0.05	5	0.5	0.4*	0.06*	12 @ 1.2	500K	114	1	±2 to ±20	Precision, Low Noise	LH0044B	National
			1	0.4*	0.06*	12 @ 1.2	500K	114	1	±2 to ±20	Precision Low Noise	LH0044	† National
35	0.5	2	8	0.8	0.25	12 @ 6	100K	90	0	±5 to ±20	General Purpose	OP-02A	† PMI
												OP-02E	PMI
	0.1	5	1	0.4*	0.06*	12 @ 1.2	500K	114	1	±2 to ±20	Precision, Low Noise	LH0044C	National
	0.5	5	5	1*	0.25*	10 @ 5	80K	90	1	±5 to ±18	General Purpose	**AD301AL** **see page 625**	**AD**
	0.7	2	5	2.5*	18*	12 @ 6	50K	90	0	±5 to ±22	High Speed	OP-01	† PMI
												OP-01H	PMI
	1.0	7	10	0.1	0.12	13 @ 1	25K	94	0	±2 to ±18	Micropower	140411	Teledyne P
	2.0	5	15		1.0	10 @ 5	100K	80	0	±5 to ±20	Improved 107	844B	† Teledyne S
					1.0	10 @ 5	100K	80	1	±5 to ±20	Improved 101A	846B	† Teledyne S
	5.0	7	20	0.1	0.12	13 @ 1	25K	94	0	±2 to ±18	Micropower	140410	Teledyne P
		10	20	1.5	3	11 @ 5.5	40K	70	0	±3 to ±18	High Performance, High Gain	RC1556A	Raytheon
		15*	20	1.5*	0.6	10 @ 10	45K	100*	0	±3 to ±20	Low Bias, Low Noise	3500A	Burr-Brown
												3500R	† Burr-Brown
	6.0	10	5*	0.27*	0.16*	11 @ 1.1	50K	70	0	±1 to ±18	Low Power Adjustable Current	1003	DDC
												8021C	Intersil
		30	15*	4*	5*	35 @ 10	100K	74	0	±10 to ±40	High Voltage	AM-464	Datel
												HA-2645	Harris
												1332	Teledyne P
	10.0	10	20	4*	2*	11 @ 5.5	40K	70	0	±3 to ±18	High Performance, High Gain	RC1556	Raytheon
			—	1*	2.5*	11 @ 5.5	70K	70	0	±3 to ±18	High Performance	MC1456	Motorola
												SG1456	Silicon G
40	5.0	2.5	30*	1*	10	12 @ 10	200K	80	0	±5.5 to ±20	Micropower FET High Current Out	1323	Teledyne P
		15	10	1*	10	12 @ 6	200K	80	0	±5.5 to ±20	Wide Response, Low Power	1011C	DDC
												HA-2705	Harris
		20	0.5	0.2	2.5	10 @ 5	1 to 1000	70	1	±5 to ±18	Full Instrumentation	AD520K	AD
												AD520S	† AD

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Bandwidth MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
40	10.0	10	—	1*	2*	20 @ 4	70K	70	0	±5 to ±34	High Voltage	MC1436 SG1436	Motorola Silicon G
50	0.5	5	5	1*	0.5*	10 @ 5	50K	90	0	±5 to ±22	Higher Accuracy 741	**AD741L** **see page 625**	**AD**
		30	1	1.5*	0.8	10 @ 10	100K*	100*	0	±3 to ±20	Low Drift	3500E	Burr-Brown
	2.0	5	8	2.5*	18*	12 @ 6	50K	80	0	±5 to ±22	High Speed	OP-01E OP-01F	PMI † PMI
			10	0.8	0.25	12 @ 6	50K	90	0	±5 to ±20	General Purpose	OP-02 OP-02C	† PMI PMI
			15	1*	0.4	10 @ 5	50K	80	0	±8 to ±22	High Performance, Low Drift	131901	† Teledyne P
			2.2			10 @ 5	100K	80	0	±5 to ±20	High Performance 741	SSS741 SSS741	† AMD † PMI
			—		0.6*		50K		0	to ±22	General Purpose	ULS-2151	† Sprague
		10	15	4*	1.5	10 @ 5	25K	80	0	±3 to ±20	High Performance, High Gain	RM4131	† Raytheon
		50	25	1*	0.4	10 @ 5	50K	80	0	±8 to ±22	High Performance, Low Drift	1319	Teledyne P
	3.0	5	2.2			10 @ 5	50K	80	0	±5 to ±20	Higher Performance	SSS741B	PMI
	5.0	15	—	0.2	0.8*	10 @ 2	100K	70	0	±1.2 to ±18	Programmable Low Power	MC1776	† Motorola
		20	20*		0.8	10 @ 5	25K	80	0	±3 to ±20	General Purpose	1320	Teledyne P
			—		1.5*		25K		0	to ±20	Low Input Bias, High Slew Rate	ULN-2171	Sprague
	6.0	25	—	0.2	0.8*	10 @ 2	50K	70	0	±1.2 to ±18	Programmable Low Power	MC1776C	Motorola
					0.8*	12 @ 1.2	50K	70	0	±6 to ±15	Programmable, Low Power	MC3476	Motorola
	10.0	20	20*			5 @ 50	2K	55	3	±9 to ±20	Matched Input Transistors	LH0005	† National
70	0.1	1	0.6			11 @ 11	1000K	120	4	±1.5 to ±22	Instrumentation	SSS725A	† PMI
			0.8			11 @ 11	1000K	120	4	±3 to ±22	High Performance 725	SSS725A	† AMD
75	0.5	5	2	1	0.005*	10 @ 5	1000K	110	4	±3 to ±22	High Accuracy Instrumentation	μA725AM	† Fairchild
	2.0	10	15	1*	0.5*	10 @ 5	50K	80	0	±5 to ±20	General Purpose, Compensated	LM107 LM207 μA107M μA207M 107 207 MLM107 MLM207 LM107 LM207 SFC2107 SFC2207 LM107 LM207 **CA107G** **see page 661** **CA207G** **see page 661**	† AMD AMD † Fairchild Fairchild † Intersil Intersil † Motorola Motorola † National National † NPC NPC † Raytheon Raytheon **† RCA** **RCA**

† Military Temperature Range (−55°C to 125°C)　　* — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
75	2.0	10	15	1*	0.5*	10 @ 5	50K	80	0	±5 to ±20	General Purpose, Compensated (continued)	LM107	† Signetics
												LM207	Signetics
												SG107	† Silicon G
												SG207	Silicon G
												LM107	† Teledyne S
												LM207	Teledyne S
												SN52107	† TI
				1*	0.5*	10 @ 10	50K	80	0	±5 to ±20	Higher Accuracy 741	**AD741S** see page 625	**AD**
												7411C	Intersil
				1*	0.5*	10 @ 5	50K	90	0	±5 to ±20	Higher Accuracy 741C	**AD741K** see page 625	**† AD**
				1*	0.5*	10 @ 5	50K	80	1	±5 to ±20	General Purpose, Improved 101, Uncompensated	LM101A	† AMD
												LM201A	AMD
												AD101A see page 625	**† AD**
												AD201A see page 625	**AD**
												µA101AM	† Fairchild
												µA201AM	Fairchild
												101A	† Intersil
												201A	Intersil
												MLM101A	† Motorola
												MLM201A	Motorola
												LM101A	† National
												LM201A	National
												LM101A	† Raytheon
												LM201A	Raytheon
												CA101AG see page 661	**† RCA**
												CA201AG see page 661	**RCA**
												LM101A	† Signetics
												LM201A	Signetics
												SG101A	† Silicon G
												SG201A	Silicon G
												LM101A	† Siliconix
												LM201A	Siliconix
												LM101A	† Teledyne S
												LM201A	Teledyne S
												SN52101A	† TI
				0.8*	0.5*	10 @ 5	50K	80	1	±5 to ±20	Low Noise 101A	101ALN	† Intersil
		30			1	10 @ 5	50K	70	0	±5 to ±15	Improved 307	844C	Teledyne S
					1	10 @ 5	50K	70	1	±5 to ±15	Improved 301A	846C	Teledyne S
		—	15*	4*	120	10 @ 5	100K		0	±5 to ±20	High Speed Inverting	AD505J	AD
80	0.75	5	1			11 @ 11	1000K	110	4	±1.5 to ±22	Instrumentation	SSS725B	PMI
			2.8*			11 @ 11	1000K	110	4	±3 to ±22	High Performance 725	SSS725B	AMD

† Military Temperature Range (—55°C to 125°C) * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Single-Unit Package (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Bandwidth MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
80	0.75	5		1*	0.3*	10 @ 5	50K	80	0	±5 to ±22	High Performance	μA741AM	† Fairchild
				0.44	0.3	10 @ 5	50K	80	0	±5 to ±22	High Performance	μA741EC	Fairchild
	1.5	5	0.6			11 @ 11	1000K	120	4	±1.5 to ±22	Instrumentation	SSS725E	PMI
			1			11 @ 11	1000K	120	4	±15 to ±22	Instrumentation	SSS725	† PMI
			2			11 @ 11	1000K	120	4	±3 to ±22	High Performance 725	SSS725	† AMD
				0.5*	0.005*	12 @ 6	1000K	120	4	±3 to ±22	Instrumentation	LM725A	† National
			2*			11 @ 11	1000K	120	4	±3 to ±22	High Performance 725	SSS725E	AMD
		10	0.5	0.3*	0.12*	10 @ 5	1000K	110	1	±5 to ±18	Low Drift, Low Noise	**AD504M** see page 625	AD
			1	0.3*	0.12*	10 @ 5	1000K	110	1	±5 to ±18	Low Drift, Low Noise	**AD504L** see page 625	AD
				0.3*	0.12*	10 @ 5	1000K	110	1	±5 to ±22	Ultra Stable	**AD504S** see page 625	† AD
	10.0	40	1000	0.2	2.5	10 @ 5	1 to 1000	65	1	±5 to ±18	Full Instrumentation	AD520J	AD
90	12.0	25	—	1*	2*	20 @ 4	50K	50	0	±5 to ±30	High Voltage	MC1436C SG1436C	Motorola Silicon G
		30	—	1*	2.5*	10 @ 5	25K	110*	0	±3 to ±18	High Performance	MC1456C SG1456C	Motorola Silicon G
100	1.0	20	4*	1*	0.25*	10 @ 5	25K	70	2	±5 to ±20	General Purpose Low Quiescent Power	LH0001	† National
				1*	0.25*	30 @ 15	30K	70	2	±5 to ±40	High Voltage	LH0004	† National
			5			10 @ 5	1000K	110	4	±5 to ±22	Instrumentation	725	† AMD
				1*	0.005*	10 @ 5	1000K	120	4	±3 to ±22	High Accuracy Instrumentation	μA725M	† Fairchild
				0.5*	0.005*	10 @ 5	1000K	110	4	±3 to ±22	Instrumentation	LM725	† National
					0.01*	10 @ 5	1000K	110	4	±3 to ±22	Instrumentation	RM725	† Raytheon
	1.5	15	3	0.3*	0.12*	10 @ 5	500K	100	1	±5 to ±18	Low Drift, Low Noise	**AD504K** see page 625	AD
		20	10			10 @ 5	500K	100	4	±5 to ±22	Instrumentation	725B	AMD
	2.5	20	3*	1*	0.25*	10 @ 5	25K	70	2	±5 to ±20	Micropower, High Performance	LH0001A	† National
	3.0	20	5*		280	10 @ 5	100K	86	1	±10 to ±20	High Slew Rate Inverting	1010M HA-2530	† DDC † Harris
	5.0	20	10	2.5*	18*	12 @ 6	25K	80	0	±5 to ±20	High Speed	OP-01C OP-01G	PMI † PMI
			30	1*	0.5*	10 @ 5	25K	70	1	±5 to ±18	Precision	777C	Fairchild
				0.5	0.5*	10 @ 5	25K	70	1	±5 to ±15	Precision	SG777C	Silicon G
					0.5*	10 @ 5	25K	70	1	±5 to ±18	Precision	SN72777	TI
	5.0	20	—			10 @ 5	50K	70	0	±5 to ±15	High Performance 741C	SSS741C	AMD
		25	5			10 @ 5	50K	70	0	±5 to ±20	High Performance 741	SSS741G	† PMI

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
100	6.0	25	6			10 @ 5	20K	70	0	±5 to ±18	High Performance 741C	SSS741C	PMI
	10.0	25	25*			4 @ 40	2K	50	3	±9 to ±20	Matched Input Transistors	LH0005C	† National
110	1.3	13	1.5			11.5 @ 5.7	500K	100	4	±1.5 to ±22	Instrumentation	SSS725C	PMI
120	1.5	45	4*	1*	0.25*	30 @ 15	30K	70	2	±5 to ±40	High Voltage	LH0004C	National
125	2.5	35	2*			10 @ 5	250K	96	4	±5 to ±22	Instrumentation	725C	AMD
			2*	1*	0.005*	10 @ 5	250K	94	4	±3 to ±22	High Accuracy Instrumentation	725C LM725C RC725	Fairchild National Raytheon
150	5.0	20	20	4*	2*	10 @ 5	25K	70	0	±3 to ±18	High Performance, High Gain	RC4131	Raytheon
	—	—	25	50	400	10 @ 30		0		±15	Fast Settling, Inverting	HFS23	DDC
170	4.5	32	6*		0.04*	5 @ 0.5	25K	80	1	±0.75 to ±6	Micropower	**CA3078** see page 666	**RCA**
180	5.0	25	6.6*		3*	11 @ 38	22K	93	2	to ±15	High Output Current	CA3033A	† RCA
			—		3*	11 @ 38	22K	93	2	to ±15	High Output Current	CA3047A	RCA
200	1.0	50	6	1*	0.4*	10 @ 5	25K	80	3	±5 to ±18	General Purpose	RM709A	† Raytheon
	2.0	50	10	5*	0.3*	10 @ 5	25K	80	3	±9 to ±15	General Purpose	µA709AM ITT709-A MC1709A LM709A SFC2709A µA709A SN52709A	† Fairchild † ITT † Motorola † National † NPC † Signetics † TI
	2.5	40	5.0	0.3*	0.12*	10 @ 5	250K	94	1	±5 to ±18	Low Drift, Low Noise	**AD504J** see page 625	**AD**
	3.0	50	20	1*	0.5*	10 @ 10	50K	80	0	±5 to ±18	Higher Accuracy 741C	**AD741J** see page 625	**AD**
	3.0	50	20	1*	0.5*	10 @ 10	50K	80	0	±5 to ±18	High Current	AD512K	AD
			25	1*	0.5*	10 @ 10	50K	80	0	±5 to ±18	High Current	AD512S	† AD
	4.0	50	15	12*	10	12 @ 6	50K	80	0	±5 to ±20	High Speed, Fast Settling	**AD518K** see page 624	**AD**
			20	12*	10	12 @ 6	50K	80	0	±5 to ±20	High Speed, Fast Settling	**AD518S** see page 624	**† AD**
		20	5*		250	10 @ 5	100K	80	1	±10 to ±20	High Slew Rate Inverting	101C HA-2535	DDC Harris
		25	20*	12*	25	10 @ 5	20K	80	0	±10 to ±20	High Slew Rate	HA-2500	† Harris
		50	20*	8*	15*	10 @ 5	50K	80	1	±10 to ±20	Four Addressable Inputs Single Amplifier	454C 454M HA-2400 HA-2404	† DDC † DDC † Harris Harris
		60	3*	1*	0.25*	10 @ 5	25K	70	2	±5 to ±20	Micropower, High Performance	LH0001AC	National

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
200	5.0	—	10*	10*	130	10 @ 5	25K		2	2 to ±18	High Speed Inverting	8017M	† Intersil
	7.0	10*	10*	10*	130*	10 @ 5	25K		2	to ±18	High Speed Inverting	8017C	Intersil
	8.0	25	20*	10*	50	10 @ 5	10K	80	0	±10 to ±20	High Slew Rate	1009M	† DDC
												HA-2510	† Harris
				10*	120*	10 @ 5	10K	80	1	±10 to ±20	High Slew Rate	HA-2520	† Harris
			30	20*	100	10 @ 5	10K	80	1	±5 to ±20	High Speed, Fast Settling	**AD509K see page 624**	**AD**
												AD509S see page 624	**† AD**
250	2.5	50	10*	1*	0.25*	14.2 @ 47	100K	90	2	±5 to ±22	High Gain Instrumentation, 50 ma	LH0020	† National
	4.0	50	—	15*	50	12 @ 6	50K	80	0	±5 to ±20	Precision High Speed	LM118	† AMD
												LM218	AMD
												LM118	† National
												LM218	National
												SFC2118	† NPC
												SFC2218	NPC
												LM118	† Raytheon
												LM218	Raytheon
	5.0	20	20	1*	0.5*	10 @ 5	25K	96	1	±5 to ±20	General Purpose	LM301A	Raytheon
				1*	0.5*	10 @ 5	25K	96	0	±5 to ±20	General Purpose	LM307	Raytheon
			25	1*	0.4	10 @ 5	50K	80	0	±8 to ±22	High Performance, Low Drift	1319	Teledyne P
		50	—		0.6*		25K		0	to ±20	General Purpose	ULN-2151	Sprague
	7.5	50	30	1*	0.5*	10 @ 5	25K	70	0	±5 to ±15	General Purpose, Uncompensated	LM307	AMD
												LM307	Fairchild
												μA307C	Intersil
												MLM307	Motorola
												LM307	National
												SFC2307	NPC
												CA307G see page 661	**RCA**
												LM307	Signetics
												SG307	Silicon G
												LM307	Teledyne S
												SN72307	TI
				1*	0.5	10 @ 5	25K	70	1	±5 to ±15	General Purpose, Compensated	LM301A	AMD
												AD301A see page 625	**AD**
												μA301A	Fairchild
												301A	Intersil
												MLM301A	Motorola
												LM301A	National
												SFC2301A	NPC
												CA301AG see page 661	**RCA**
												LM301A	Signetics
												SG301A	Silicon G

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
250	7.5	50		1*	0.5	10 @ 5	25K	70	1	±5 to ±15	General Purpose, Compensated (continued)	LM301A	Siliconix
												LM301A	Teledyne S
												SN72301A	TI
				0.8*	0.5*	10 @ 5	25K	70	1	±5 to ±15	Low Noise 301A	301ALN	Intersil
	8.0	50	20*	12*	20	10 @ 5	15K	74	0	±10 to ±20	High Slew Rate	AM-450	Datel
												HA-2502	† Harris
												HA-2505	Harris
				6*	20	10 @ 10	16K	74	0	±8 to ±20	Fast Slewing	3505J	Burr-Brown
	9.0	50	30*	8*	15*	10 @ 5	50K	74	1	±10 to ±20	Four Addressable Inputs Single Amplifier	HA-2405	Harris
	10.0	50	20*	20*	80	10 @ 5	7.5K	74	1	±5 to ±20	High Speed, Fast Settling	**AD509J** **see page 624**	**AD**
			25*	12*	40	10 @ 5	7.5K	74	0	±10 to ±20	High Slew Rate	HA-2512	† Harris
				20*	80	10 @ 5	7.5K	74	1	±10 to ±20	80V/µs Gain = 3	HA-2522	† Harris
			30*		80	10 @ 10	7K	74	1	±8 to ±20	Fast Slewing	3507J	Burr-Brown
				12*	40	10 @ 5	7.5K	74	0	±10 to ±20	High Slew Rate	HA-2515	Harris
				12*	80	10 @ 5	7.5K	74	1	±10 to ±20	80V/µs Gain = 3	AM-452	Datel
												1009C	DDC
												HA-2525	Harris
				20*	80	10 @ 10	7.5K	89*	1	±8 to ±20	High Slew Rate	1322	Teledyne P
												132201	† Teledyne P
300	3.0	100	3*	1*	1.5*	13 @ 130	100K	70	0	±5 to ±18	0.2 amp Power	LH0041	† National
			10	1*	0.4*	10 @ 5	25K	70	3	±5 to ±18	High Gain	RM709	† Raytheon
			25	1*	1.5	11 @ 1100	100K	70	0	±5 to ±18	1.0 amp Power	LH0021	† National
	5.0	150	10*	7*	3.5	12 @ 6	25K	80	0	±5 to ±20	Low Noise	HA-909	† Harris
350	5.0	35	6.6*		2.7*	9 @ 18	16K	84	2	to ±12	High Output Current	CA3033	† RCA
			—		2.7*	9 @ 18	16K	84	2	to ±12	High Output Current	CA3047	RCA
400	3.0	30*	5	1*	1.2	10 @ 5	45K	90*	1	±12 to ±18	General Purpose	3051	Burr-Brown
												3055	Burr-Brown
500	3.0	60	5*	1*	34*	10 @ 10	50K	80	3	±9 to ±18	Fast General Purpose	133902	† Teledyne P
			—		4.2*		15K		2	to ±18	High Slew Rate	ULS-2139	† Sprague
		75	3*	2*	4.2*	10 @ 10	50K	80	2	±10 to ±18	General Purpose	MC1539	† Motorola
	4.0	40*	10	0.9*	0.9	10 @ 5	45K	90*	1	±12 to ±18	General Purpose	3056	Burr-Brown
				1.0*	1.2	10 @ 10	45K	90*	1	±12 to ±18	General Purpose	3052	Burr-Brown
	5.0	200	3*	1*	0.5*	10 @ 5	50K	70	0	±5 to ±22	General Purpose Compensated	741M	† AMD
												AD741 **see page 625**	**† AD**
												µA741M	† Fairchild
												741	† Intersil
												ITT741-1	† ITT
												MC1741	† Motorola
												LM741 (continued)	† National

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Single-Unit Package (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
500	5.0	200	3*	1*	0.5*	10 @ 5	50K	70	0	±5 to ±22	General Purpose Compensated (continued)	**CA741G** see page 661	**† RCA**
												RM741	† Raytheon
												µA741	† Signetics
												SG741	† Silicon G
												741B	† Teledyne S
												SN52741	† TI
			3*	1*	0.5*	10 @ 5	50K	70	0	±5 to ±22	Low Noise 741	741LN	† Intersil
												CA6741	† RCA
			3*	1*	10	10 @ 5	50K	70	0	±4 to ±22	High Slew Rate 741	MC1741S	† Motorola
			3*	0.8*	5*	10 @ 5	50K	70	0	±15	Wideband 741	SG1217	† Silicon G
			—	1*	0.7	10 @ 5	50K	70	0	±5 to ±18	High Speed 741	741MHS	† Intersil
			3*	1*	0.5*	10 @ 5	50K	70	0	±5 to ±20	Compensated 101	LH101	† National
												LH101	† Raytheon
												LH101	† Siliconix
			3*	1*	0.5*	10 @ 5	50K	70	1	±5 to ±20	General Purpose, Uncompensated	LM101	† AMD
												LM201	AMD
												µA101	† Fairchild
												LM101	† National
												CA101 see page 661	**† RCA**
												LM101	† Raytheon
												LM101	† Signetics
												SG101	† Silicon G
												LM101	† Siliconix
			3*	1*	0.5*	10 @ 5	50K	70	1	±5 to ±20	Uncompensated 741	748M	† AMD
												µA748M	† Fairchild
												MC1748	† Motorola
												LM748	† National
												LM748C	National
												CA748	† RCA
												RM748	† Raytheon
												µA748	† Signetics
												SG748	† Silicon G
												748B	† Teledyne S
												748C	Teledyne S
												SN52748	† TI
			3*	0.5*	0.3*	10 @ 5	25K	70	3	±9 to ±15	General Purpose	µA709M	† Fairchild
												ITT709-1	† ITT
												MC1709	† Motorola
												LM709	† National
												µA709	† Signetics
												709B	† Teledyne S
												SN52709	† TI
			—	0.5*	35	10 @ 5	50K	70	1	±6 to ±18	High Slew Rate	RM4531	† Raytheon
			—	1*	30*	10 @ 5	50K	70	1	±5 to ±18	High Slew Rate	NE531	Signetics

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
500	5.0	200	4*	30*	0.7*	to 100 ma	20K	70	2	to 24/±12	Programmable	CA3094	† RCA
										to 36/±18	Programmable	CA3094A	† RCA
										to 44/±22	Programmable	CA3094B	† RCA
	6.0	100	30	1*	1*	10 @ 1000	100K	70	0	±5 to ±18	1.0 amp Power	LH0021C	National
		200	—	1*	0.5*	10 @ 5*	20-50K	70	0	±5 to ±18	General Purpose Compensated	**AD741C** see page 625	**AD**
												μA741C	Fairchild
												HA17741	Hitachi
												741C	Intersil
												ITT741-5	ITT
												MC1741C	Motorola
												LM741C	National
												SF2741C	NPC
												CA741CG see page 661	**RCA**
												RC741	Raytheon
												μA741C	Signetics
												SG741C	Silicon G
												741C	Teledyne S
												SN72741	TI
			10*	1*	0.5*	10 @ 5	25K	70	0	±5 to ±15	Low Noise 741	741CLN	Intersil
			3*	1*	10	10 @ 5	20K	70	0	±4 to ±18	High Slew Rate 741	MC1741SC	Motorola
			5*	0.8*	5*	10 @ 5	20K	70	0	±15	Wideband 741C	SG3217	Silicon G
			—	1*	0.7	10 @ 5	25K	70	0	±5 to ±18	High Speed 741	741CHS	Intersil
			5*	1*	1	13 @ 130	100K	70	0	±5 to ±18	0.2 amp Power	LH0041C	National
			10*	1*	0.25	14 @ 47	100K	90	2	±5 to ±18	High Gain, Instrumentation 50 ma Output	LH0020C	National
			15*	0.2*	0.2*	11.5 @ 11.5	20K	70	0	±5 to ±18	High Power	μA791C	Fairchild
			—	1*	0.5*	10 @ 5	20-50K	70	1	±5 to ±18	General Purpose	748C	AMD
												μA748C	Fairchild
												MC1748C	Motorola
												SFC2748C	NPC
												CA748C	RCA
												RC748	Raytheon
												μA748C	Signetics
												SG748C	Siliconix
												SN72748	TI
		300	10*	7*	5*	11 @ 5.5	20K	74	0	±5 to ±20	Low Noise	HA-911	Harris
			10*	12*	50	12 @ 6	25K	70	0	±5 to ±20	High Speed, Fast Settling	**AD518J** see page 624	**AD**
			—	15*	50	12 @ 6	25K	70	0	±5 to ±20	Precision High Speed	LM318	AMD
												LM318	National
												SFC2318	NPC
600	6.0	60*	30	0.7*	0.6	10 @ 5	32K	90*	1	±12 to ±18	General Purpose	3057	Burr-Brown

† Military Temperature Range (—55°C to 125°C) * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

Master Selection Guide

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LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
600	6.0	60*	30	0.9*	0.9	10 @ 10	45K	80*	1	±12 to ±18	General Purpose	3053	Burr-Brown
	7.5	60	5*	1*	34*	10 @ 5	40K	80	3	±9 to ±18	Fast General Purpose	133901	Teledyne P
	10.0	200	—	15*	50	12 @ 6	25K	70	2	±5 to ±18	Precision, High Speed	LM318	Raytheon
750	5.0	250	6*	65*	15	10 @ 5	15K	74	3	±6 to ±18	High Speed High Gain	μA715M	† Fairchild
												715	† AMD
	10.0	50	5		5	10 @ 10	20K	80		±8 to ±22	Wideband	1317	† Teledyne P
1000	7.5	100	12*	1*	34*	10 @ 5	15K	80	3	±9 to ±18	Fast General Purpose	1339	Teledyne P
		150	3*	2*	4.2*	10 @ 5	15K	80	2	±10 to ±18	General Purpose	MC1439	Motorola
1500	6.0	200	—	0.5*	35*	10 @ 5	20K	70	1	±6 to ±18	High Slew Rate	RC4531	Raytheon
				1*	20*	10 @ 5	20K	70	1	±5 to ±22	High Slew Rate High Performance	SE531	† Signetics
	7.5	250	6	65*	10	10 @ 5	10K	74	3	±6 to ±18	High Speed	715C	AMD
												μA715C	Fairchild
		500	6*	1*	0.5*	10 @ 5	20K	65	0	±5 to ±20	Compensated 201	LH201	National
												LH201	Raytheon
												LH201	Siliconix
				1*	0.5*	10 @ 5	20K	65	1	±5 to ±20	General Purpose	LM301	AMD
												μA201M	Fairchild
												LM201	National
												CA201 **see page 661**	**RCA**
												LM201	Raytheon
												LM201	Signetics
												SG201	Silicon G
												LM201	Siliconix
			6-10*	1*	0.3*	10 @ 5	15K	65	3	±9 to ±15	General Purpose	μA709C	Fairchild
												ITT709-5	ITT
												LM709C	National
												RC709	Raytheon
												μA709C	Signetics
												709C	Teledyne S
												SN72709	TI
2000	3.0	200	4*	10*		10 @ 100	20K	70	0	±5 to ±20	General Purpose Wide Bandwidth	LH0003	† National
												LH0003C	National
	5.0	400	—	38*	25*	9 @ 4.5	0.6K	76	1	±7 to ±18	Large Signal Wideband	**CA3100** **see page 667**	**† RCA**
	7.5	100	—		4.2*		50K		2	to ±18	High Slew Rate	ULN-2139	Sprague
	10.0	100	2*	10*	5*	3.5 @ 0.5	1K	75	2	±2 to ±8	Differential Output	MC1520	† Motorola
4000	2.0	1500	1.2*	15*	3*	22 @ 4.5*	0.7K	70	1	±3 to ±8	6 Volt, Wideband	CA3008A	RCA
												CA3010A	† RCA
												CA3029A	RCA
												CA3037A	† RCA
	15.0	200	2*	10*	5*	3.0 @ 0.43	0.75K	60	2	±2 to ±8	Differential Output	MC1420	Motorola
5000	2.0	500	2.5*	7*	1.5*	3.5 @ 0.35	2.5K	80	2	−3,6 to −6,12	Wideband	MC1712	† Motorola

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Single-Unit Package (cont)													
5000	2.0	500	10	30*	3.5*	3.5 @ 0.35	2.5K	80	3	−3,6 to −6,12	Wideband	μA702M	† Fairchild
												RM702	† Raytheon
												SN52702A	† TI
6000	2.0	1600	1.2*	50*	7*	4.5 @ 9	2K	80	1	±3 to ±16	12 Volt, Wideband	CA3015A	† RCA
												CA3016A	† RCA
												CA3030A	RCA
												CA3038A	† RCA
7500	5.0	2000	5*	7*	1.5*	3.5 @ 0.35	2K	70	2	−3,6 to −6,12	Wideband	MC1712C	Motorola
			20	30*	3.5*	3.5 @ 0.35	2K	70	3	−3,6 to −6,12	Wideband	μA702C	Fairchild
												RC702	Raytheon
10000	5.0	2000	10*		1.7*	5 @ 0.05	1.4K	70	3	−3,6 to −6,12	General Purpose	SN52702	† TI
												MC1530	† Motorola
12000	5.0	5000	1.2*	15*	3*	22 @ 4.5*	0.7K	70	1	±3 to ±8	6 Volt, Wideband	CA3008	† RCA
												CA3010	† RCA
												CA3029	RCA
												CA3037	† RCA
15000	10.0	5000	5*		1.7*	5 @ 0.05	1K	65	3	−3,6 to −6,12	General Purpose	SN72702	TI
24000	5.0	5000	3.5*	50*	7*	4.5 @ 9	2K	80	1	±3 to ±16	12 Volt, Wideband	CA3015	† RCA
												CA3016	† RCA
												CA3030	RCA
												CA3038	† RCA
30000	4.0	5000	20*	70*	400	12 @ 12	4K	60*	3	±5 to ±18	High Slew Rate	LH0024	† National
40000	8.0	15000	25*	70*	250	12 @ 12	3K	60*	3	±5 to ±18	High Slew Rate	LH0024C	National
Dual-Unit Package													
0.02	20.0	0.0005*	75	1*	6*	10 @ 5	50K	70	0	±5 to ±18	FET Input Dual	1002M	† DDC
												8043M	† Intersil
0.05	50.0	0.0005*	75	1*	6*	10 @ 5	20K	70	0	±5 to ±18	FET Input Dual	1002C	DDC
												8043C	Intersil
2	0.5	0.2	15	1*	0.3*	13 @ 1.3	80K	96	1	±5 to ±20	Dual 108A	LH2108A	† National
												LH2208A	National
												LH2108A	† Signetics
												LH2208A	Signetics
	2.0	0.2	15	1*	0.3*	13 @ 1.3	50K	85	1	±2 to ±20	Dual 108	LH2108	† National
												LH2208	National
												LH2108	† Signetics
												LH2208	Signetics
3	0.5	2.8	2	1.2*	0.25*	10.5 @ 10.5	200K	114	0	to ±22	Dual Matched Instrumentation	OP-10	† PMI
												OP-10A	† PMI
4	0.5	3.8	2	1.2*	0.25*	10.5 @ 10.5	200K	110	0	to ±22	Dual Matched Instrumentation	OP-10E	PMI
5	3.0	3	10*	25*	0.1*	10 @ 2	40K	80	0	±1.2 to ±18	Programmable	HA-2730	† Harris
7	0.5	1	30	1*	0.3*	13 @ 1.3	80K	96	1	±5 to ±20	Dual 308A	LH2308A	National

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Dual-Unit Package (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
7	1.3	6	4.5	1.2*	0.25*	12 @ 6	120K	100	0	to ±22	Dual Matched Instrumentation	OP-10C	PMI
	7.5	1	30	1*	0.3*	13 @ 1.3	25K	80	1	±2 to ±18	Dual 308	LH2308	National
7.5	5.0	3	3*	1*	15*	12 @ 0.16	200K	70	0	±1.2 to ±18	Multi-Purpose Programmable	μA776M	† Fairchild
10	5.0	5	10*		0.1*	10 @ 2	25K	74	0	±1.2 to ±18	Programmable	HA-2735	Harris
	6.0	6	3*	1*	15*	12 @ 0.16	50K	70	0	±1.2 to ±18	Multi-Purpose Programmable	μA776C	Fairchild
15	3.0	5	—	.25*	0.16*	10 @ 1	100K	70	0	±1 to ±18	Programmable Dual LM4250	LH24250	† National
20	3.0	7.5	5*	0.27*	0.16*	11 @ 1.1	50K	70	0	±1 to ±18	Low Power Adjustable Current	8022M	† Intersil
30	6.0	10	5*	0.27*	0.16*	11 @ 1.1	50K	70	0	±1 to ±18	Low Power Adjustable Current	8022C	Intersil
		10	—	.25*	0.16*	10 @ 1	75K	70	0	±1 to ±18	Programmable Dual LM4250	LH24250C	National
50	2.0	5	—			10 @ 5	100K	80	1	±5 to ±20	Dual High Performance 741	SSS747 SSS747	† AMD † PMI
		25	5	1.5*	0.8	10 @ 10	100K*	100*		±3 to ±20	Matched Amplifier Pairs	3500MP	Burr-Brown
	3.0	5	—			10 @ 5	50K	80	0	±5 to ±20	Higher Performance	SSS747B	PMI
75	2.0	10	15	1*	0.5*	10 @ 5	50K	80	1	±5 to ±20	Dual LM101A High Performance	LH2101A LH2201A LH2101A LH2201A	† National National Signetics Signetics
80	3.0	30	15	0.44	0.3	10 @ 5	50K	80	0	±5 to ±22	Dual 741	μA747AM μA747EC	† Fairchild Fairchild
100	3.0	30	8*	8*	2	13 @ 1.3	25K	80	0	±2 to ±20	High Slew Rate	HA-2650	† Harris
	5.0	25	—			10 @ 5	50K	70	0	±5 to ±20	Dual High Performance 741C	SSS747C SSS747C SSS747G SSS1458 SSS1558	AMD PMI † PMI PMI † PMI
		40	—	0.8*	0.5*	10 @ 1	4K	60	0	±5 to ±22	Low Power	SN52L022	† TI
200	5.0	60	8*	8*	2	13 @ 1.3	20K	74	0	±2 to ±20	High Slew Rate	HA-2655	Harris
		80	—	0.8*	0.5*	10 @ 1	1K	60	0	±5 to ±18	Low Power	SN72L022	TI
250	5.0	30		1*		10 ma	100K*	85*	0	3 to 30/±1.5 to ±15	Half LM124	LM158 SE532	† National † Signetics
	7.5	50	30	1*	0.5*	10 @ 5	25K	70	1	±5 to ±20	Dual High Performance	LH2301A	National
500	5.0	200	2-15*	1*	0.5*	10 @ 5	50K	70	0	±5 to ±22	Dual 741	747M XR1558 μA747M μA1558M MC1747 MC1558 LM747 LM1558 **CA747G** **see page 661** (continued)	† AMD † Exar † Fairchild † Fairchild † Motorola † Motorola † National † National **† RCA**

† Military Temperature Range (—55°C to 125°C)   * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Dual-Unit Package (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
500	5.0	200	2-15*	1*	0.5*	10 @ 5	50K	70	0	±5 to ±22	Dual 741 (continued)	CA1558G	† RCA
												RM747	† Raytheon
												RM1558	† Raytheon
												μA747	† Signetics
												SG747	† Silicon G
												SG1558	† Silicon G
												747B	† Teledyne S
												1558	† Teledyne S
												SN52747	† TI
												SN52558	† TI
	6.0	200		1*	0.5*	10 @ 5	20-50K	70	0	±5 to ±18	Dual 741C	747C	AMD
												EX1458	Exar
												μA747C	Fairchild
												μA1458C	Fairchild
												MC1747C	Motorola
												LM747C	National
												LM1458	National
												CA747CG	RCA
												CA1458G	RCA
												RC747	Raytheon
												RC1458	Raytheon
												μA747C	Signetics
												SG747C	Silicon G
												SG1458	Silicon G
												747C	Teledyne S
												1458	Teledyne S
												SN72747	TI
												SN72558	TI
				3*	1*	10 @ 5	20K	70	0	±3 to ±18	Wideband 741	XR4558	Exar
												RC4558 **see page 651**	**Raytheon**
												RC4558	TI
				3*	1*	10 @ 5	20K	70	0	±3 to ±18	Low Noise	XR4739	Exar
												RC4739	Raytheon
	7.0	50		1*		10 ma	100K*	85*	0	3 to 30/±1.5 to ±15	Half LM224	LM258	National
												LM358	National
												NE532	Signetics
700	10.0	300	6*	0.8*	0.3*	9 @ 4.5	20K	60	0	±15	General Purpose	SG1458C	Silicon G
			15*	1.1*	0.8*	9 @ 4.5	20K	60	0	±5 to ±18	General Purpose	μA1458CC	Fairchild
												MC1458C	Motorola
												1458C	Teledyne S
1500	7.5	500	1.5*	1*	0.3*	10 @ 5	15K	65	3	±9 to ±18	Matched Dual 709	RC1437	Raytheon
				1*	0.25*	12 @ 1.2	15K	65	3	±4 to ±18	Matched Dual MC1709C	MC1437	Motorola
2000	6	1000	—		1*		6.5K	70	2	8 to 36/±4 to ±18	Single Supply	TBA231	SGS

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Triple-Unit Package													
30	3.0	7.5	5*	0.27*	0.16*	11 @ 1.1	50K	70	0	±1 to ±18	Low Power, Programmable	8023M	† Intersil
	6.0	10	5*	0.27*	0.16*	11 @ 1.1	50K	70	0	±1 to ±18	Low Power, Programmable	8023C	Intersil
50	20	25		0.5*		4vpp	4K	90*	0	6 to 450	Low input current amplifier of triple unit includes 5v regulator	ZN417	Ferranti
70	5.0	14		0.02*	0.1*	1.3 μa		70	0	to ±18	Micropower, Transconductance Amplifier	CA3060B	† RCA
200	5.0	50	3.3*	0.6*	0.4*	10 @ 0.5	3K	80	0	±1.5 to ±15	Programmable	L144A L144B	† Siliconix Siliconix
250	10.0	70	3.3*	0.6*	0.4*	10 @ 0.5	1K	70	0	±1.5 to ±15	Programmable	L144C	Siliconix
500	2.0	250	5*	10*		4vpp	4K	90*	0	6 to 450	Two amplifiers of Triple unit, includes 5v regulator	ZN417	Ferranti
550	5.0	100		0.045*	1*	15 μa		70	0	to ±7	Micropower, Transconductance Amplifier	CA3060D	† RCA
5000	5.0	1000		0.11*	8*	0.15 ma		70	0	to ±18	Micropower, Transconductance Amplifier	CA3060A CA3060E	† RCA RCA
Quad-Unit Package													
100	5.0	25		1*	0.6*	10 @ 5	50K	70	0	±5 to ±22	Quad 741 with standard npn input stage	LM148 LM248 LM148 LM248	† Intersil Intersil † National National
				5*	3.5*	10 @ 5	50K	70	0	±5 to ±22	Wideband quad 741 for gains >5	LM149 LM249	† National National
		40		0.8*	0.5*	10 @ 1	4K	60	0	±2 to ±22	Low Power	SN52L044	† TI
150	5.0	30		1*		10ma	50K	70	0	3 to 30/ ±1.5 to ±15	Single Supply; I/O Operates to ground	LM124 LM124 LM124 **CA124G** **see page 661** LM124 SG124 LM124 LM124	† Intersil † National † Raytheon **† RCA** † Signetics † Silicon G † Teledyne S † TI
200	6.0	50		1*	0.6*	10 @ 5	25K	70	0	±5 to ±18	Quad 741 with standard npn input stage	LM348 LM348	Intersil National
				5*	3.5*	10 @ 5	25K	70	0	±5 to ±18	Wideband quad for gains >5	LM349	National
	—	—		2.5*	0.5/20*	13.5 @ 2.6	1.2K		0	4 to 36	Current Mirror, Single Supply	μA2900C μA3900C LM2900 LM3900 LM2900 LM3900	Fairchild Fairchild National National Raytheon Raytheon
250	5.0	80		0.8	0.5*	10 @ 1	1K	60	0	±2 to ±18	Low Power	SN72L044	TI

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Quad-Unit Package (cont)													
250	7.0	50		1*		10ma	25K	65	0	3 to 30/ ±1.5 to ±15	Single Supply; I/O Operates to ground	XR324	Exar
												LM234	Intersil
												LM334	Intersil
												MLM324	Motorola
												LM224	National
												LM324	National
												CA224G see page 661	**RCA**
												CA324G see page 661	**RCA**
												LM224	Raytheon
												LM324	Raytheon
												LM224	Signetics
												LM324	Signetics
												SG224	Silicon G
												SG324	Silicon G
												LM224	Teledyne S
												LM324	Teledyne S
												LM224	TI
												LM324	TI
300	5.0	30		1*	0.6	10 @ 5	50K	70	0	to ±22	Quad 741	835B	† Teledyne S
				1.5*	0.8	10 @ 5	50K	70	0	to ±22	Quad 741	836B	† Teledyne S
	—	—		4*	0.6*	3ma	1K		0	4 to 28	Current Mirror, Single Supply	μA3301C	Fairchild
												MC3301	Motorola
												RC3301	Raytheon
				5*	0.6*	5ma	1K		0	5 to 18	Current Mirror, Single Supply	μA3401C	Fairchild
												MC3401	Motorola
												CA3401G	† RCA
												RC3401	Raytheon
400	4.0	50	5*	2.5*	1.3*	20ma	325K*	100*	0	±3 to ±18	Quad 741	HA-4741	Harris
				1*	1.2	10 @ 5	50K	70	0	3 to 36/ ±1.5 to ±18	LM124 with improved output	**RM3503A see page 649**	**† Raytheon**
500	5.0	50	10*	1*	0.6*	10 @ 5	50K	70	0	3 to 36/ ±1.5 to ±18	Single Supply; I/O Operates to ground	XR3503	† Exar
												μA3503M	† Fairchild
												MC3503	† Motorola
												RM3503 see page 649	**† Raytheon**
			—	2	1.6	10 @ 5	20K	70	0	to ±22	Quad 741	**XR4212M see page 639**	**† Exar**
					1.5*	10 @ 3	5K	70	0	±1.5 to ±18	Programmable Quad 741	XR4202	Exar
		200		2	1.5*	10 @ 5	50K	70	0	±3 to ±18	Quad 741, High Gain	**XR4136M see page 640**	**† Exar**
												RM4136 see page 647	**† Raytheon**
												RM4136	† TI

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

Arranged in order of increasing bias current, offset voltage, offset current, and voltage drift.
"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers - Characteristics (cont)

Bias Current na.(25°C)	Offset Voltage mv(25°C)	Offset Current na.(25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Output v @ ma	Voltage Gain v/v	CMRR db	Comp.	Supply Range	Comments	Device	Source
Quad-Unit Package (cont)													
500	6.0	50		1*	1.2*	20ma	25K	70	0	3 to 36/ ±1.5 to ±18	LM324 with improved output	**RC3403A** **see page 649** RV3403A	**Raytheon** Raytheon
			—	2	1.6	10 @ 5	5K	70	0	to ±18	Quad 741	**XR4212C** **see page 639**	**Exar**
		100		1*	0.6*	10 @ 5	25K	70	0	to ±18	Quad 741	835C	Teledyne S
		200		3*	1*	10 @ 5	20K	70	0	±3 to ±18	Quad 741	**XR4136C** **see page 640** **RC4136** **see page 647** RC4136 †	**Exar** **Raytheon** TI
	7.0	50				20ma	100K*	85*	0	3 to 32/ ±1.5 to ±16	Extended Temp LM224	MLM2902 LM2902 2902	Motorola Raytheon Teledyne S
	8.0	50	10*	1*	0.6*	10 @ 5	20K	70	0	3 to 36/ ±1.5 to ±18	Single Supply: I/O Operates to ground	XR3403 μA3403C MC3403 **RC3403** **see page 649**	Exar Fairchild Motorola **Raytheon**
		75	10*	1*	0.6*	10 @ 5	20K	70	0	3 to 36/ ±1.5 to ±18	Supply: I/O Operates to ground	XR3303 μA3303C MC3303	Exar Fairchild Motorola
		100		1.5*	1*	10 @ 5	25K	70	0	to ±18	Quad 741	836C	Teledyne S
	10.0	50	10*	1*	0.6*	10 @ 5	20K	70	0	3 to 36/ ±1.5 to ±18	Single Supply; I/O Operates to ground	XR3403 3403 MC3403 **RC3403** **see page 649**	Exar Fairchild Motorola **Raytheon**
	10.0	50	—	1*		20ma	100K*	85*	0	3 to 26/ ±1.5 to ±13	Single Supply; I/O Operates to ground	LM2902 LM2902	National TI
				1*	2*	20ma	15K	70	0	3 to 32/ ±1.5 to ±16	LM224 with improved output	RV3403A	Raytheon
600	10.0	300		3*	1*	10 @ 5	15K	60	0	±3 to ±18	Quad 741	RC4136C RC41363	Raytheon TI

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Bold face indicates additional data is provided on the page noted.

Master Selection Guide

LINEAR

Linear—Phase Locked Loop, Telecommunication, Timers

Function	Device	Source
Phase Locked Loop Circuits		
Note: Stereo Decoders are not listed		
Counter Logic Control	SP8790	Plessey
Counter Control Logic (Use with MC12012 for high frequency programming)	MC12014	Motorola
Crystal Oscillator (0.1 to 2.0 MHz)	MC12060	Motorola
	MC12560	† Motorola
Crystal Oscillator (2 to 20 MHz)	MC12061	Motorola
	MC12561	† Motorola
Current Controlled Oscillator and Phase Comparator	HA-2820	† Harris
	HA-2825	Harris
Digital Mixer	MC12000	Motorola
FSK Modulator/Demodulator	XR210	Exar
	XR2211 **see page 635**	**† Exar**
	XR2211C **see page 635**	**Exar**
Offset Control System (for synthesizer tuned transceivers)	MC12020	Motorola
	MC12021	Motorola
	MC12520	† Motorola
	MC12521	Motorola
Phase-Frequency Detector	11C44C	Fairchild
	11C44M	Fairchild
	MC4044	Motorola
	MC4344	† Motorola
	MC12040	Motorola
	MC12540	† Motorola
Phase Locked Loop	XR215	Exar
Phase Locked Loop (CMOS)	F4046C	Fairchild
	F4046M	† Fairchild
	MC14046A	† Motorola
	MC14046C	Motorola
	CD4046A **see page 375**	**† RCA**
	CD4046AE **see page 375**	**RCA**
	SCL4046A	† SSS
	SCL4046AE	SSS
	SCL4446	SSS
Tone Decoder	XR567	† Exar
	XR567C	Exar
	XR2211 **see page 635**	**† Exar**
	XR2211C **see page 635**	**Exar**
	LM567	† National
	LM567C	National
	NE567	Signetics
	SE567	† Signetics
Two Modulus Prescaler (÷5/6)	11C91C	Fairchild
	11C91M	† Fairchild
	91H91C	Fairchild
	91H91M	† Fairchild
	SP8740	Plessey

Function	Device	Source
Phase Locked Loop Circuits (cont)		
Two Modulus Prescaler (÷6/7)	SP8741	Plessey
Two Modulus Prescaler (÷8/9)	SP8742	Plessey
Dual Tone Decoder	XR2567	† Exar
	XR2567C	Exar
Tone Generator	FX205	CMA
Two Modulus Prescaler (÷5/9, 10/11, 10/12)	MC12012	Motorola
	MC12512	† Motorola
Two Modulus Prescaler (÷10/11)	11C90C	Fairchild
	11C90M	† Fairchild
	95H90C	Fairchild
	95H90M	† Fairchild
	MC12013	Motorola
	MC12513	† Motorola
	SP8640	Plessey
	SP8641	Plessey
	SP8642	Plessey
	SP8643	Plessey
	SP8685	Plessey
	SP8690A	Plessey
	SP8690B	Plessey
	SP8695	Plessey
Two Modulus Prescaler (÷248/256)	11C83	Fairchild
VCO	11C58C	Fairchild
	MC1648	Motorola
	MC1658	Motorola
	SP1648	Plessey
	SP1658	Plessey
	SN54LS324	† TI
	SN74LS324	TI
VCO—Function Generator	LM566	National
	LM566C	† National
	NE566	Signetics
	SE566	† Signetics
VCO and Phase Comparator	**XR2207** **see page 632**	**Exar**
	XR2207C **see page 632**	**Exar**
	LM565	National
	LM565C	† National
	NE560B	Signetics
	NE561B	Signetics
	NE562B	Signetics
	NE565	Signetics
	SE565	† Signetics
	TA7133	Toshiba
VCO—Waveform Generator	1453C	DDC
	XR205	Exar
	XR2206 **see page 630**	**† Exar**
	XR2206C	Exar
	1453M	† DDC
	8038C	Intersil
	8038M	† Intersil
	LS8038C	Lithic Sys
	LS8038M	† Lithic Sys

† Military Temperature Range (−55°C to 125°C) * — Typical Values

Bold face indicates additional data is provided on the page noted.

Linear—Phase Locked Loop, Telecommunication, Timers (cont)

Function	Device	Source
Phase Locked Loop Circuits (cont)		
VCO, Amplifier, Analog Multiplier	XRS200 XR205	Exar Exar
VCO, Phase Comparator, Multiplier	SL651	† Plessey
VCO, Phase Comparator Multiplier, with Auxiliary Amplifier	SL650	† Plessey
Dual VCO	11C24C MC4024 MC4324 SN54LS124 SN54S124 SN74LS124 SN74S124	Fairchild Motorola † Motorola † TI † TI TI TI

Title	Function	Device	Source
Telecommunication Circuits			
Baseband Modulator/ Demodulator	50db carrier suppression	SL1001	Plessey
Baseband channel Amplifier	24-27db amplifier	SL1020	Plessey
Coin box Circuit	Coin recognition for pay telephones	AY5-9300	GI
Compander (Signal Compressor/Expander)		XR2216	Exar
Push Button Telephone Dialer Circuit	Converts push button inputs to pulses.	CRC8000 AY5-9100 MP9100	Collins GI Plessey
Binary to Pulse Train Converter		MC14408 MC14409	Motorola Motorola
Repertory Dialer	Stores ten telephone numbers.	AY5-9200 MP9200	GI Plessey
Tone Decoder	Three tone (8 combinations) sequential code receiver	FX307	CMA
Tone Decoder	Operates from 0.01 Hz to 500 kHz	XR567 XR567C **XR2211** **see page 635** **XR2211C** **see page 635** LM567 LM567C NE567 SE567	† Exar Exar **† Exar** **Exar** † National National Signetics † Signetics
Dual Tone Decoder	Operates from 0.01 Hz to 500 K Hz.	XR2567	Exar
Dual Tone Decoder		CRC8030	Collins
Relay Driver	For 48v Telephone relays	DS1686 DS1687 DS3686 DS3687	† National † National National National
Encoder (2 of 8 keyboard to Binary Encoder)	4 x 4 Key Input to 4 line output	MC14419	Motorola
Tone Encoder	Accepts 2 of 8 code (4 x 4 Key input), synthesizes 2 freq.	MK5085 MK5086 MC14410	Mostek Mostek Motorola

Title	Function	Device	Source
Telecommunication Circuits (cont)			
Bandpass Filter	Touchtone filters	882	† Beckman
Dual Tone Generator	Generates 12-16 tone pairs	AY3-9400 AY3-9410 AY5-9500	GI GI GI
Modem	Frequency-Shift Keying Modulator/Demodulator—600 bps	MC14412	Motorola
Modem	For Serial Communications at up to 600 bps	MC6860	Motorola
Digital Filter Switch	Tone Decoder	FX105	CMA
Frequency Sensitive Switch	Provides two set points adjustable with external components.	FX101	CMA
Frequency Sensitive switch	Provides set points with widely adjustable hysteresis	FX305	CMA
Frequency Sensitive Switch	Provides two set points and three state outputs	FX401	CMA
Tone Operated Switch	Bistable tone operated switch	FX501	CMA
Tone Operated Monostable Timer	Tone operated for remote switching	FX601	CMA
Tone Transmitter	Three tone sequential code transmitter	FX207	CMA
Tone Transceiver	Decodes and encodes 5 sequential tones	FX407 FX507	CMA CMA
Tone Transceiver	Single tone transmitter-receiver -simplex.	FX107	CMA
Cross Point Array	Double 4 x 4 switch matrix	**RC4444** **see page 659, 660** **RM4444** **see page 659, 660**	**Raytheon** **Raytheon**

Function	Device	Source
Timers		
Timer	NE555 SE555 XR555C NE555 NE555 SE555 LS555N LS555S MC1455 MC1555 LM555C LM555M **CA555G** **see page 661** **CA555CG** **see page 661** RC555 RM555 NE555 SE555 SG555 SG555C SN52555 SN72555	† AMD AMD Exar Fairchild Intersil † Intersil Lithic Sys † Lithic Sys Motorola † Motorola National † National **† RCA** **RCA** Raytheon † Raytheon Signetics † Signetics † Silicon G Silicon G † TI TI

† Military Temperature Range (−55°C to 125°C)

Linear—Phase Locked Loop, Telecommunication, Timers (cont)

Function	Device	Source
Timers (cont)		
Timer, Internal Current Source	XR320	Exar
Timer, Low Power (supply 3v)	SN76812	TI
Timer, Precision	LM122	† National
	LM222	National
	LM322	National
	LM2905	National
	LM3905	National
Timer, Programmable (includes a counter for long time delays) Binary Control	**XR2240C see page 637**	**Exar**
	XR2240M see page 637	**† Exar**
	2240	Fairchild
	ZN1034E	Ferranti
	8240	Intersil
	MC14541A	† Motorola
	MC14541C	Motorola
Timer, Programmable (includes counter) Decimal Control	**XR2250C see page 637**	**Exar**
	XR2250M see page 637	**† Exar**
	8250	Intersil
Timer, Programmable (includes counter) Hours/Minutes/Seconds Control	8260	Intersil
Dual Timer (dual 555)	NE556	AMD
	SE556	† AMD
	XR556C	Exar
	XR556M	† Exar
	NE556	Fairchild
	NE556	Intersil
	SE556	† Intersil
	LM556	National
	RC556	Raytheon
	RM556	† Raytheon
	556	Teledyne S
	NE556	Signetics
	SE556	† Signetics
	SG556	† Silicon G
	SG556C	Silicon G
Dual Timer (dual 555), pinout variations	XR2556C	Exar
	XR2556M	† Exar
	LS555-2	Lithic Sys
	D555	Teledyne S
Dual Monostable Timer	FX109	CMA
Quad Timer, Current Sink Output	NE553	Signetics
	SE553	† Signetics
Quad Timer, Current Source Output	NE554	Signetics
	SE554	† Signetics
Tone Triggered Timer	FX601	CMA

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

ABBREVIATIONS OF COMPANY NAMES

AD	Analog Devices
AMD	Advanced Micro Devices
AMI	American Microsystems, Inc.
AMS	Advanced Memory Systems
Analogic	Analogic Corp.
Beckman	Beckman Instruments, Helipot Division
Burr-Brown	Burr-Brown Research
Cermetek	Cermetek
CMA	Consumer Microcircuits of America
Collins	Collins Radio
Datel	Datel Systems
DDC	ILC Data Devices Corp.
EA	Electronic Arrays
EMM/Semi	EMM Semi, Div. of Electronic Memories & Magnetics
Exar	Exar Integrated Systems
Fairchild	Fairchild Semiconductor
Ferranti	Ferranti Electric
GI	General Instrument
Harris	Harris Semiconductor
Hitachi	Hitachi America, Ltd.
Hughes	Hughes Aircraft Co., MOS Divison
Hybrid Sys.	Hybrid Systems
IMI	International Microcircuits, Inc.
Intech	Intech
Intel	Intel
Interdesign	Interdesign
Intersil	Intersil
IPI	Integrated Photomatrix, Inc.
ITT	ITT Semiconductors
Lithic Sys.	Lithic Systems
Litronix	Litronix
LSI Comp.	LSI Computer Systems
Micro Net	Micro Networks
Micropac	Micropac Industries
Micro Power	Micro Power Systems
Mitsubishi	Mitsubishi International
MMI	Monolithic Memories, Inc.
MOS	MOS Technology
Mostek	Mostek
Motorola	Motorola Semiconductor
National	National Semiconductor
NCR	National Cash Register, Microelectronics Div.
NEC	NEC Microcomputers
Nippon	Nippon Electric Co.
Nitron	Nitron
Nortec	Nortec Electronics
NPC	Nucleonic Products Co.
OKI	OKI Electronics of America, Inc.
Panasonic	Panasonic, Matsushita Electric Corp.
Plessey	Plessey Semiconductors
PMC	Power Monolithics Co.
PMI	Precision Monolithics, Inc.
Ragen	Ragen Semiconductor
Raytheon	Raytheon Semiconductor
RCA	RCA Solid State Division
Reticon	Reticon
Rockwell	Rockwell International, Microelectronic Div.
Sanken	Sanken Electric
SGS	SGS-ATES Semiconductor
Signetics	Signetics
Silicon G	Silicon General
Siliconix	Siliconix
SMC	SMC Microsystems Corp.
Solitron	Solitron Devices
Sprague	Sprague Electric Company
SSS	Solid State Scientific
SW	Stewart-Warner Microcircuits
Synertek	Synertek
Teledyne C	Teledyne Crystalonics
Teledyne P	Teledyne Philbrick
Teledyne S	Teledyne Semiconductor
TI	Texas Instruments
TMX	TMX, Inc.
Toshiba	Toshiba
TRW	TRW
Transitron	Transitron Electronics
Western	Western Digital

LINEAR—Voltage Regulators

Fixed, Positive

Output Voltage	Output Current	Device	Source
2.6	100 ma	µA78L26C	Fairchild
		78L02C see page 673	**Signetics**
5	100 ma	µA78L05C	Fairchild
		LM3910-05	National
		LM78L05C	National
		78L05C see page 673	**Signetics**
		78L05C	TI
	200 ma	MLM109G	Motorola
		MLM209G	Motorola
		MLM309G	Motorola
		LM109H	† National
		LM209H	National
		LM309H	National
		LM342-5	National
		SFC2109	† NPC
		SFC2209	NPC
		SFC2309	NPC
		SL78L05	Plessey
		LM109H	† Raytheon
		LM209H	Raytheon
		LM309H	Raytheon
		LM109DB	† Signetics
		LM209DB	Signetics
		LM309DB	Signetics
		SG109T	† Silicon G
		SG209T	Silicon G
		SG309T	Silicon G
		SG705T	† Silicon G
		SG705T	Silicon G
		SN52109	† TI
		SN72309	TI
	500 ma	805V5	† Beckman
		µA78M05C	Fairchild
		µA78M05M	† Fairchild
		MC7705C	Motorola
		MC78M05C	Motorola
		LM341-5	National
		78M05	† Signetics
		78M05C	Signetics
	600 ma	L005T1	SGS
	750 ma	809V5	† Beckman
	850 ma	L129	SGS
	1 a	µA109M	† Fairchild
		µA209M	Fairchild
		µA309C	Fairchild
		µA7805C	Fairchild
		µA7805M	† Fairchild
		MLM109	† Motorola
		MLM209K	Motorola
		MLM309	Motorola
		MC7805	Motorola
		LM109K	† National
		LM209K	National
		LM309K	National
		LM340-5	National
		LM7805	National
		SFC2109M	NPC
		LM109K	† Raytheon
		LM209K	Raytheon
		LM309K	Raytheon
		7805 see page 668 (continued)	**† Signetics**

Fixed, Positive (cont)

Output Voltage	Output Current	Device	Source
5 (continued)	1 a	**7805C** see page 668	**Signetics**
		LM109DA	† Signetics
		LM209DA	Signetics
		LM309DA	Signetics
		LM340-5	Signetics
		SG109K	† Silicon G
		SG209K	Silicon G
		SG309K	Silicon G
		SG7805K	† Silicon G
		SG7805KC	Silicon G
		7805C	TI
	1.5 a	PMC15K-5	PMC
	3 a	SH0323	Fairchild
		PMC14J-5	PMC
		PMC14K-5	PMC
		SI3554	Sanken
		LM123	† National
		LM223	National
		LM323	National
	5 a	µA78H05	Fairchild
		42050-055	Micropac
	10 a	42050-510	Micropac
6	100 ma	78L06C	National
		LM3910-06	National
	200 ma	PC521	† GI
		LM342-6	National
		SL78L06	Plessey
		SG7806T	† Silicon G
		SG7806TC	Silicon G
	500 ma	805V6	† Beckman
		µA78M06C	Fairchild
		µA78M06M	† Fairchild
		MC7706C	Motorola
		MC78M06	Motorola
		LM341-6	National
	750 ma	809V6	† Beckman
	1 a	µA7806C	Fairchild
		µA7806M	† Fairchild
		MC7806C	Motorola
		LM340-6	National
		LM7806	National
		SG7806KC	Silicon G
		SG7806K	† Silicon G
		7806 see page 668	**† Signetics**
		7806C see page 668	**Signetics**
		LM340-6	Signetics
	1.5 a	PMC15K-6	PMC
	3 a	PMC14K-6	PMC
	10 a	42050-610	Micropac
6.2	100 ma	78L62C	Fairchild
		78L06C see page 673	**Signetics**
		78L06C	TI
	1 a	7806C	TI
7	10 a	42050-710	Micropac
8	100 ma	µA78L08C	Fairchild
		LM3910-08	National
		LM78L08C	National
		78L08C see page 673	**Signetics**

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Voltage Regulators (cont)

Output Voltage	Output Current	Device	Source
Fixed, Positive (cont)			
8	200 ma	LM342-8	National
		SL78L08	Plessey
		SG7808T	† Silicon G
		SG7808TC	Silicon G
	500 ma	μA78M08C	Fairchild
		μA78M08M	† Fairchild
		MC7708C	Motorola
		MC78M08	Motorola
		LM341-8	National
	1 a	μA7808C	Fairchild
		μA7808M	† Fairchild
		MC7808C	Motorola
		LM340-8	National
		LM7808	National
		7808 **see page 668**	† **Signetics**
		7808C **see page 668**	**Signetics**
		LM340-8	Signetics
		SG7808KC	Silicon G
		SG7808K	† Silicon G
	1.5 a	PMC15K-8	PMC
	3 a	PMC14J-8	PMC
		PMC14K-8	PMC
	10 a	42050-810	Micropac
9	500 ma	801V9	† Beckman
	750 ma	809V9	† Beckman
10	100 ma	78L10C	National
		LM3910-10	National
	200 ma	LM342-10	National
	1.5 a	PMC15K-10	PMC
	3 a	PMC14J-10	PMC
		PMC14K-10	PMC
	9 a	42050-109	Micropac
12	50 ma	829B	† Teledyne S
		829C	Teledyne S
	100 ma	μA78L12C	Fairchild
		LM3910-12	National
		LM78L12C	National
		78L12C **see page 673**	**Signetics**
		78L12C	TI
	200 ma	PC501	† GI
		LM342-12	National
		SL78L12	Plessey
		SG7812TC	Silicon G
		SG7812T	† Silicon G
	500 ma	801V12	† Beckman
		μA78M12C	Fairchild
		μA78M12M	† Fairchild
		MC7712C	Motorola
		MC78M12	Motorola
		LM341-12	National
		L036T1	SGS
	720 ma	L130	SGS
	750 ma	809V12	† Beckman
	1 a	μA7812C	Fairchild
		μA7812M	† Fairchild
		MC7812C	Motorola
		LM340-12	National
		LM7812	National
		SI3120E (continued)	Sanken
Fixed, Positive (cont)			
12 (continued)	1 a	**7812** **see page 668**	† **Signetics**
		7812C **see page 668**	**Signetics**
		LM340-12	Signetics
		SG7812K	† Silicon G
		SG7812KC	Silicon G
		7812C	TI
	1.5 a	PMC15K-12	PMC
	3 a	PMC14J-12	PMC
		PMC14K-12	PMC
	8 a	42050-128	Micropac
14	8 a	42050-148	Micropac
15	400 μa	L037T1	SGS
	50 ma	830B	† Teledyne S
		830C	Teledyne S
	100 ma	μA78L15C	Fairchild
		LM3910-15	National
		LM78L15C	National
		78L15C **see page 673**	**Signetics**
		78L15C	TI
	200 ma	LM342-15	National
		SL7815	Plessey
		SG7815TC	Silicon G
		SG7815T	† Silicon G
	500 ma	801V15	† Beckman
		μA78M15C	Fairchild
		μA78M15M	† Fairchild
		MC7715C	Motorola
		MC78M15C	Motorola
		LM341-15	National
	600 ma	L131	SGS
	750 ma	809V15	† Beckman
	1 a	μA7815C	Fairchild
		μA7815M	† Fairchild
		MC7815C	Motorola
		LM340-15	National
		LM7815	National
		SI3150E	Sanken
		7815 **see page 668**	† **Signetics**
		7815C **see page 668**	**Signetics**
		LM340-15	Signetics
		SG7815KC	Silicon G
		SG7815K	† Silicon G
		7815C	TI
	1.5 a	PMC15K-15	PMC
	3 a	PMC14J-15	PMC
		PMC14K-15	PMC
	8 a	42050-158	Micropac
16	8 a	42050-168	Micropac
18	100 ma	LM3910-18	National
		LM78L18C	National
	200 ma	LM342-18	National
		SL78L18	Plessey
		SG7818TG	Silicon G
		SG7818T	† Silicon G
	500 ma	801V18	† Beckman
		MC7718C	Motorola
		MC78M18C (continued)	Motorola

† Military Temperature Range (−55°C to 125°C)

Regulator Sections: Fixed—Positive, Negative, Dual; Adjustable—Positive, Negative, Dual

LINEAR—Voltage Regulators (cont)

Output Voltage	Output Current	Device	Source
Fixed, Positive (cont)			
18 (continued)	500 ma	LM341-18	National
	750 ma	809V18	† Beckman
	1 a	μA7818C	Fairchild
		μA7818M	† Fairchild
		MC7818C	Motorola
		LM340-18	National
		LM7818	National
		7818 see page 668	† **Signetics**
		7818C see page 668	**Signetics**
		SG7818KC	Silicon G
		SG7818K	† Silicon G
	1.5 a	PMC15K-18	PMC
	3 a	PMC14J-18	PMC
		PMC14K-18	PMC
	8 a	42050-188	Micropac
20	200 ma	SL78L20	Plessey
	500 ma	μA78M20C	Fairchild
		μA78M20M	† Fairchild
		MC7720C	Motorola
		MC7820C	Motorola
		78M20C	Signetics
	1.5 a	PMC15K-20	PMC
	3 a	PMC14J-20	PMC
		PMC14K-20	PMC
	8 a	42050-208	Micropac
21	500 ma	809V21	† Beckman
	750 ma	809V21	† Beckman
22	4 a	42050-224	Micropac
24	100 ma	LM3910-24	National
		LM78L24C	National
	200 ma	NC512	† GI
		PC502	† GI
		PC512	† GI
		LM342-24	National
		SL78L24	Plessey
		SG7824T	† Silicon G
		SG7824TC	Silicon G
	500 ma	803V24	† Beckman
		μA78M24C	Fairchild
		μA78M24M	† Fairchild
		MC7724C	Motorola
		MC78M24C	Motorola
		LM341-24	National
		78M24C	Signetics
	750 ma	809V24	† Beckman
	1 a	μA7824C	Fairchild
		μA7824M	† Fairchild
		MC7824C	Motorola
		LM340-24	National
		LM7824	National
		SI3240E	Sanken
		7824 see page 668	† **Signetics**
		7824C see page 668	**Signetics**
		LM340-24	Signetics
		SG7824K	† Silicon G
		SG7824KC	Silicon G

Output Voltage	Output Current	Device	Source
Fixed, Positive (cont)			
24	1.5 a	PMC15K-24	PMC
	3 a	PMC14J-24	PMC
		PMC14K-24	PMC
	4 a	42050-244	Micropac
26	4 a	42050-264	Micropac
28	500 ma	803V28	† Beckman
	750 ma	809V28	† Beckman
	1.5 a	PMC15K-28	PMC
	3 a	PMC14J-28	PMC
		PMC14K-28	PMC
	4 a	42050-284	Micropac
30	200 ma	SL78L30	Plessey
	4 a	42050-304	Micropac
32	Shunt Reg.	AN155	Panasonic
	500 ma	803V32	† Beckman
	4 a	42050-324	Micropac
34	4 a	42050-344	Micropac
36	4 a	42050-364	Micropac
Fixed, Negative			
2	1 a	MC7902C	Motorola
	1.5 a	PMC18K-2	PMC
	2 a	79E02	† Fairchild
		79E02C	Fairchild
4	1 a	MC7904C	Motorola
5	500 ma	855V5	† Beckman
		μA79M05C	Fairchild
		LM120H05	† National
		LM220H05	National
		LM320H05	National
		SG120-05T	† Silicon G
		SG220-05T	Silicon G
		SG320-05T	Silicon G
	750 ma	859V5	† Beckman
	1 a	μA7905C	Fairchild
		MC7905C	Motorola
	1.5 a	LM120K05	† National
		LM220K05	National
		LM320K05	National
		LM320T05	National
		PMC18K-5	PMC
		SG120-05K	† Silicon G
		SG220-05K	Silicon G
		SG320-05K	Silicon G
	2 a	79E05	† Fairchild
		79E05C	Fairchild
	3 a	LM145K5.0	† National
		LM245K5.0	National
		LM345K5.0	National
	5 a	42051-055	Micropac
5.2	500 ma	LM120H5.2	† National
		LM220H5.2	National
		LM320H5.2	National
		LM320M5.2	National
	1 a	MC7905.2C	Motorola
	1.5 a	LM120K5.2	† National
		LM220K5.2	National
		LM320K5.2	National
		LM320T05 (continued)	National

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Voltage Regulators (cont)

Fixed, Negative (cont)

Output Voltage	Output Current	Device	Source
5.2 (continued)	1.5 a	PMC18K-5.2	PMC
	3 a	LM145K5.2	† National
		LM245K5.2	National
		LM345K5.2	National
6	200 ma	PC523	GI
	500 ma	855V6	† Beckman
		μA79M06C	Fairchild
		LM120H06	† National
		LM220H06	National
		LM320H06	National
		LM320M06	National
	750 ma	859V6	† Beckman
	1 a	μA7906C	Fairchild
		MC7906C	Motorola
	1.5 a	LM120K06	† National
		LM220K06	National
		LM320K06	National
		LM320T06	National
		PMC18K-6	PMC
	5 a	42051-065	Micropac
7	5 a	42051-075	Micropac
8	500 ma	μA79M08C	Fairchild
		LM120H08	† National
		LM220H08	National
		LM320H08	National
		LM320M08	National
	1 a	μA7908C	Fairchild
		MC7908C	Motorola
	1.5 a	LM120K08	† National
		LM220K08	National
		LM320K08	National
		LM320T08	National
		PMC18K-8	PMC
	5 a	42051-085	Micropac
9	500 ma	851V9	† Beckman
	750 ma	859V12	† Beckman
	1.5 a	42051-095	Micropac
10	1.5 a	PMC18K-10	PMC
	5 a	42051-105	Micropac
12	200 ma	PC503	† GI
		LM120H12	† National
		LM220H12	National
		LM320H12	National
		SG120-12T	† Silicon G
		SG220-12T	Silicon G
		SG320-12T	Silicon G
	500 ma	851V12	† Beckman
		μA79M12C	Fairchild
	750 ma	859V12	† Beckman
	1 a	μA7912C	Fairchild
		MC7912C	Motorola
		LM120K12	† National
		LM220K12	National
		LM320K12	National
		LM320T12	National
		SG120-12K	† Silicon G
		SG220-12K	Silicon G
		SG320-12K	Silicon G
	1.5 a	PMC18K-12	PMC
12	4 a	42051-124	Micropac
14	4 a	42051-144	Micropac
15	200 ma	LM120H15	† National
		LM220H15	National
		LM320H15	National
		LM320M15	National
		SG120-15T	† Silicon G
		SG220-15T	Silicon G
		SG320-15T	Silicon G
	500 ma	851V15	† Beckman
		μA79M15C	Fairchild
	750 ma	859V15	† Beckman
	1 a	μA7915C	Fairchild
		MC7915C	Motorola
		LM120K15	† National
		LM220K15	National
		LM320K15	National
		LM320T15	National
		SG120-15K	† Silicon G
		SG220-15K	Silicon G
		SG320-15K	Silicon G
	1.5 a	PMC18K-15	PMC
	4 a	42051-154	Micropac
16	4 a	42051-164	Micropac
18	200 ma	LM120H18	† National
		LM220H18	National
		LM320H18	National
	500 ma	851V18	† Beckman
		LM320M18	National
	750 ma	859V18	† Beckman
	1 a	μA7918C	Fairchild
		MC7918C	Motorola
		LM120K18	† National
		LM220K18	National
		LM320K18	National
		LM320T18	National
	1.5 a	PMC18K-18	PMC
	4 a	42051-184	Micropac
20	500 ma	μA79M20C	Fairchild
	1.5 a	PMC18K-20	PMC
	3 a	42051-204	Micropac
21	500 ma	851V21	† Beckman
	750 ma	859V21	† Beckman
22	3 a	42051-223	Micropac
24	200 ma	PC514	GI
		LM120H24	† National
		LM220H24	National
		LM320H24	National
	500 ma	853V24	† Beckman
		μA79M24C	Fairchild
		LM320M24	National
	1 a	μA7924C	Fairchild
		MC7924C	Motorola
		LM120K24	† National
		LM220K24	National
		LM320K24	National
		LM320T24	National
	1.5 a	PMC18K-24	PMC
	3 a	42051-243	Micropac

† Military Temperature Range (−55°C to 125°C)

LINEAR—Voltage Regulators (cont)

Output Voltage	Output Current	Device	Source
Fixed, Negative (cont)			
26	3 a	42051-263	Micropac
27	500 ma	853V27	† Beckman
	750 ma	859V27	† Beckman
28	500 ma	853V28	† Beckman
	750 ma	859V28	† Beckman
	1.5 a	PMC18K-28	PMC
	3 a	MIVR42051-283	Micropac
30	3 a	42051-303	Micropac
32	Shunt Reg.	AN155	Panasonic
	500 ma	853V32	† Beckman
	3 a	42051-323	Micropac
34	3 a	42051-343	Micropac
36	3 a	42051-363	Micropac
Fixed, Dual			
±6	5 a	MIVR42051	Micropac
±12	100 ma	LM126	† National
		LM226	National
		LM326	National
	300 ma	843-V-12	Beckman
		844-V-12	† Beckman
		844V-12	† Beckman
	300 ma	843V-12	Beckman
−12,5	100 ma	LM127	† National
		LM227	National
		LM327	National
±15	100 ma	XR1468	Exar
		XR1568	† Exar
		MC1468	Motorola
		MC1568	† Motorola
		LM125	† National
		LM225	National
		LM325	National
		RC4195 see page 657, 658	**Raytheon**
		RM4195 see page 657	**† Raytheon**
		SG1468	Silicon G
		SG1568	† Silicon G
		SG1501	† Silicon G
		SG2501	Silicon G
		SG3501	Silicon G
		SG4501	Silicon G
	200 ma	SG1501A	† Silicon G
		SG2501A	Silicon G
		SG3501A	Silicon G
	300 ma	843V-15	† Beckman
		844V-15	† Beckman

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Voltage Regulators

Output Voltage Hi	Output Voltage Low	Output Current	Device	Source
Adjustable, Positive				
7	1	50 ma	NC520	† GI
		200 ma	NC521	† GI
9	3	500 ma	806	† Beckman
16	4	150 ma	NC109T	GI
17	2.5	200 ma	MC1460G	Motorola
			MC1560G	† Motorola
		500 ma	MC1460R	Motorola
			MC1560R	† Motorola
19	4.1	200 ma	MFC4063A	Motorola
			MFC4064A	Motorola
			MFC6033A	Motorola
			MFC6034A	Motorola
20	2	20 ma	LM300	Intersil
			LM300	National
			SFC2300	NPC
			SG300	Silicon G
	10	800 ma	NC562	† GI
21	9	500 ma	802	† Beckman
26	1.8	12 ma	CA3085	† RCA
30	4.5	12 ma	LM305	AMD
			μA305C	Fairchild
			305	Intersil
			MLM305	Motorola
			LM305	National
			LM305	Raytheon
			SG305	Silicon G
			SN72305	TI
	2	20 ma	100	† Intersil
			200	Intersil
			LM100	† National
			LM200	National
			SFC2100	† NPC
			SFC2200	NPC
			SG100	† Silicon G
			SG200	Silicon G
	5	500 ma	μA78MG	Fairchild
32	2.5	200 ma	MC1469G	Motorola
			MC1461G	Motorola
		500 ma	MC1461R	Motorola
			MC1469R	Motorola
	20	500 ma	804	† Beckman
35	4.1	200 ma	MFC4060A	Motorola
			MFC4062A	Motorola
			MFC6030A	Motorola
			MFC6032A	Motorola
	2	4 a	MPC1000	Motorola
36	1.7	100 ma	CA3085A	† RCA
37	3	2 ma	NE550A	Signetics
		50 ma	SE550	† Signetics
	2	150 ma	723	† AMD
			723C	AMD
			μA723C	Fairchild
			μA723M	† Fairchild
			HA17723	Hitachi
			723	† Intersil
			723C	Intersil
			MC1723	† Motorola
			MC1723C	Motorola
			LM723	† National
			LM723C	National
			SFC2723C (continued)	† NPC
Adjustable, Positive (cont)				
37 (continued)	2	150 ma	SFC2723EC	NPC
			CA723	† RCA
			CA723C	RCA
			RC723	Raytheon
			RM723	† Raytheon
			μA723	† Signetics
			μA723C	Signetics
			SG723	† Silicon G
			SG723C	Silicon G
			723BE	† Teledyne S
			723CE	Teledyne S
			823BE	† Teledyne S
			SN52723	TI
			SN72723	TI
	2.5	200 ma	MC1561G	† Motorola
			MC1569G	† Motorola
		500 ma	MC1561R	† Motorola
			MC1569R	† Motorola
	5	25 ma	μA376C	Fairchild
			LM376N	National
			LM376	Teledyne S
			SN72376	TI
38	8	250 ma	NC501	† GI
			NC530	† GI
			NC531	† GI
			NC511	† GI
			PC511	† GI
	12	625 ma	NC581	† GI
	13	250 ma	NC572	† GI
40	4.5	12 ma	LM105	AMD
			LM205	AMD
			μA105M	† Fairchild
			105	† Intersil
			205	Intersil
			MLM105	† Motorola
			MLM205	Motorola
			LM105	† National
			LM205	National
			SFC2105	† NPC
			SFC2205	NPC
			LM105	† Raytheon
			LM205	Raytheon
			SG105	† Silicon G
			SG205	† Silicon G
			LM105	† Teledyne S
			LM205	Teledyne S
			SN52105	† TI
		45 ma	LM305A	AMD
			μA305AC	Fairchild
			305A	Intersil
			LM305A	National
			SFC2305	NPC
			SG305A	Silicon G
			LM305A	Raytheon
			LM305A	Teledyne S
			SN72305A	TI
	2	50 ma	NE550	Signetics
	3	50 ma	822BE	† Teledyne S
	2	150 ma	SE550L	† Signetics
			823AE	† Teledyne S
46	1.7	100 ma	CA3085B	† RCA
1000	0	100 ma	MC1466	Motorola
			MC1566	† Motorola

† Military Temperature Range (—55°C to 125°C)

Regulator Sections: Fixed—Positive, Negative, Dual; Adjustable—Positive, Negative, Dual

LINEAR—Voltage Regulators (cont)

Output Voltage Hi	Output Voltage Low	Output Current	Device	Source
Adjustable, Negative				
7	1	200 ma	N523	† GI
9	3	500 ma	856	† Beckman
21	9	500 ma	852	† Beckman
30	.035	20 ma	LM304 MLM304G LM304 LM304 LM304	Fairchild Motorola National Raytheon Teledyne S
	.015	20 ma	SN72304	TI
	2.2	500 ma	79MG	Fairchild
	4	5 a	MPC900	Motorola
32	3.8	200 ma	MC1463G MC1463R	Motorola Motorola
		500 ma	MC1463R	Motorola
	20	500 ma	854	† Beckman
37	3.6	200 ma	MC1563G	† Motorola
		500 ma	MC1563R	† Motorola
38	8	250 ma	NC503 NC513 PC513	GI GI GI
	12	625 ma	NC583	† GI
40	.015	20 ma	μA104HM LM104H LM204H SFC2104 SFC2204 LM104 LM204 LM104H LM204H	† Fairchild † National National † NPC NPC † Raytheon Raytheon † Teledyne S Teledyne S
		20 ma	MLM104G MLM204G SN52104	† Motorola Motorola † TI
Adjustable, Dual				
20	8	100 ma	XR1468 XR1568 MC1468L MC1568L SG1468J SG1568J	Exar † Exar Motorola † Motorola Silicon G † Silicon G
	±14.5	100 ma	MC1568R MC1468R SG1468T SG1568T	† Motorola Motorola Silicon G † Silicon G
±23	8	200 ma	SG3501A SG1501A SG2501A	Silicon G † Silicon G Silicon G
	±10	100 ma	SG1501 SG2501 SG3501 SG4501 SG3502 SG1502 SG2502	† Silicon G Silicon G Silicon G Silicon G Silicon G † Silicon G Silicon G
±32	±.05	100 ma	XR4194CN **RC4194D** **see page 655**	Exar **Raytheon**
		200 ma	XR4194CK **RC4194TK** **see page 655**	Exar **Raytheon**
Adjustable, Dual (cont)				
±37	±20	150 ma	**RC4194TK** **see page 655**	**Raytheon**
±42	±.05	100 ma	RX4194M **RM4194D** **see page 655**	† Exar **† Raytheon**
		200 ma	XR4194MK **RM4194TK** **see page 655**	† Exar **† Raytheon**

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Other Devices

Function	Device	Source
Other Linear Devices		
AC Amplifier, Quad, Single Supply	CA3048	RCA
AC Detector (Detects presence or absence of ac signals, includes adjustable threshold and time delay.)	3050	Intech
Active Filters	881	Beckman
	UAF21	Burr-Brown
	UAF21H	† Burr-Brown
	UAF25	Burr-Brown
	UAF25H	† Burr-Brown
	UAF31	Burr-Brown
	8681	DDC
Alarm Circuits, Triple Alert/Alarm (Each circuit has two inputs, when the first one is low an open collector LED driver is turned on. When the second one is low - independent of the first- the output is flashed at an adjustable rate).	3020	Intech
Alarm Circuits, Temperature	3030	Intech
Alarm Circuits, Tone Alarm (Comparator with ac output)	3010	Intech
Amplifiers—SeecLinear firing SCRs or operating relays)	ULN-2301	Sprague
Amplifier-SCR firing Circuit	ULN-2300	Sprague
Analog-Digital Control Circuit (Wide bandwidth op amp and high speed, dual threshold comparator)	MC1407	Motorola
	MC1507	† Motorola
Analog Shift Register, 130x2, with storage (See also Serial Analog Delay, Bucket Brigade below)	CCD311	Fairchild
Balanced Modulator/Demodulator	μA796C	Fairchild
	LS1496	Lithic Sys
	LS1596	† Lithic Sys
	MC1496	Motorola
	MC1596	† Motorola
	LM1496	National
	LM1596	† National
	SL640C	Plessey
	SL641C	Plessey
	SL1001A	Plessey
	SL1001B	Plessey
	SL1496	Plessey
	SL1596	† Plessey
	N5596	Signetics
	S5596	† Signetics
	SG1496	Silicon G
	SG1596	Silicon G
Ring Modulator, four transistor	SL355	Plessey
Blowout Resistant Transistor (simulates 40 v transistor with special protection)	LM195	† National
	LM295	National
	LM395	National
Bucket Brigade Device (Special/Dual 512 stage, acts as a variable delay line in the audio frequency range)	MN3001	Panasonic
	MN3002	Panasonic
Crystel Oscillators	SP705	Plessey
	SL680	Plessey
Comparators, Programmable with Memory (High/Low Comparator)	CA3098	† RCA
	CA3099	† RCA
Customized Arrays (Linear and Digital circuits, customized in final metalization)	XR-CHIP	Exar
	EX-IIL-CHIP (continued)	Exar

Function	Device	Source
Other Linear Devices (cont)		
Customized Arrays (Linear and Digital circuits, customized in final metalization) (continued)	ULA	Ferranti
	MONOCHIP	Interdesign
	ECL-ARRAY	Plessey
	IIL-ARRAY	Plessey
	RTL-ARRAY	Plessey
DC to DC Converter (2.5 to 12 v input; Output determined by external transformer)		
Dual Transistors, Monolithic, Matched, See Linear Array Section		
DVM Circuits—See Interface-Analog to Digital Converters, also Digital-Special		
Flasher (LED)	LP1000	Lithic Sys
	LM3909	National
Frequency/Tone Operated Devices—See Telecommunciation Circuits		
Frequency to Voltage/Voltage to Frequency Converter	A8400	Intech
	A8400	† Intech
Hall Effect Devices (Sense magnetic field) See also Digital—Other Digital Devices	DN831	Panasonic
	ULN-3008	Sprague
	ULN-3100	Sprague
Image Sensor, 256 x 1, CCD	CCD110	Fairchild
Image Sensor, 500 x 1, CCD	CCD101	Fairchild
Image Sensor, 1728x1, CCD	CCD121	Fairchild
Image Sensor, Linear Self Scanning	IPL7050	IPI
	IPL7064	IPI
	IPL7100	IPI
	IPL7128	IPI
	IPL7256	IPI
	M128	IPI
	M256	IPI
	M512	IPI
	M768	IPI
	M1024	IPI
	RL16	Reticon
	RL64	Reticon
	RL128	Reticon
	RL256	Reticon
	RL512	Reticon
	RL936	Reticon
	RL1024	Reticon
	RL1872	Reticon
Image Area Sensor, Self Scanning	RA32X32	Reticon
	RA50X50	Reticon
	RA100X100	Reticon
Image Area Sensor, Circular, Self Scanning	RO64	Reticon
Image Area Sensor, 100 x 100, CCD	CCD201	Fairchild
Level Detector, Precision (with internal reference)	SN72560	TI
Level Detector, Precision Dual	SN72D560	TI
Light to Frequency Converter	IPL13	IPI
Light Detector (with buffer amplifier)	IPL16	IPI
	CA3062	RCA

† Military Temperature Range (−55°C to 125°C)

Regulator Sections: Fixed—Positive, Negative, Dual; Adjustable—Positive, Negative, Dual

LINEAR—Other Devices (cont)

Function	Device	Source
Other Linear Devices (cont)		
Light Activated Switch	IPL15	IPI
	IPL17	IPI
	PS12	IPI
	PS24	IPI
Low Battery Indicator, triggers on 3dv (for use with 3 NiCd cells)	ICM7201	Intersil
Multipliers	AD532J	AD
	AD532K	AD
	AD532S	† AD
	XR2208 **see page 634**	**Exar**
	8013C	Intersil
	8013M	† Intersil
	LS1495	Lithic Sys
	LS1595	† Lithic Sys
	MC1494	Motorola
	MC1594	† Motorola
	MC1495	Motorola
	MC1595	† Motorola
	SL1495	Plessey
	SL1595	† Plessey
	CD8091	† RCA
	SG1402	† Silicon G
	SG2402	Silicon G
	SG3402	Silicon G
	SG1495	Silicon G
	SG1595	† Silicon G
Multipliers/Dividers	AD530J	AD
	AD530K	AD
	AD530L	AD
	AD530S	† AD
	AD533J	AD
	AD533K	AD
	AD533L	AD
	AD533S	† AD
	4201J	Burr-Brown
	4203J	Burr-Brown
	4203K	Burr-Brown
	4203S	† Burr-Brown
	4204J	Burr-Brown
	4204K	Burr-Brown
	4205J	Burr-Brown
	4205K	Burr-Brown
	4205S	† Burr-Brown
	1401	† DDC
Multifunction Convertors $(XY/Z)^m$	AD531J	AD
	AD531K	AD
	AD531L	AD
	AD531S	† AD
	4301	Burr-Brown
	4302	Burr-Brown
Motor Speed Regulator (for small dc motors)	SL440	Plessey
	TCA900	SGS
	TCA910	SGS

Function	Device	Source
Other Linear Devices (cont)		
PIN Diode Switch Driver	DH0035	† National
	DH0035C	National
Power Supply Control (Oscillator with variable mark/space for switching supplies)	SL442	Plessey
Pressure Transducers	SH4207	Fairchild
	LX1400	National
	LX1600	National
	LX1700	National
	LX3700	National
	LX3800	National
Radio Transmitter	LP2000	Lithic Sys
	LP2001	Lithic Sys
Voltage Reference Diode (two terminal active circuit)1.220v ±5%	LM113	† National
	LM313	National
Voltage Reference, 2.5v	AD580	† AD
Voltage Reference Source, 6.9v temperature stabilized	LM199	† National
	LM299	National
	LM399	National
Voltage Reference Source, 10v	AD2700J/K/L	AD
	AD2700S/T/U	AD †
	MN2000	Micro Net
	MN2001	Micro Net
	MN2002	Micro Net
	MN2003	Micro Net
Voltage Reference Source, ±10v	MN2004	Micro Net
	MN2005	Micro Net
Voltage Reference, Adjustable 2.5 to 33v	SN72499	TI
Regulator Diode (two terminal active circuit) 1.8 to 5.6v	LM103	† National
RMS to DC Converter	4340	Burr-Brown
	4341	Burr-Brown
Sample and Hold Circuits	AD582	AD
	AD583	AD
	SHC23	Burr-Brown
	SHC23ET	† Burr-Brown
	SHC80	Burr-Brown
	SHC85	Burr-Brown
	SH85ET	Burr-Brown
	SHM-IC-1	Datel
	1502	DDC
	HA-2420	Harris
	HA-2425	† Harris
	IH5110	† Intersil
	IH5111	† Intersil
	MN343	† Micro Net
	LH0023	† National
	LH0023C	National
	LH0043	† National
	LH0043C	National
	LH0053	† National
	LH0053C	National
	SHM6401 (continued)	National

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Other Devices (cont)

Function	Device	Source
Other Linear Devices (cont)		
Sample and Hold Circuits (continued)	4856	Teledyne P
SCR/TRIAC Control (Burst Control)	L121	SGS
SCR/TRIAC Control (Phase Control)	SL440	Plessey
	L121	SGS
Serial Analog Delay (Analog storage units with read in/read out shift register) (See also Analog Shift Registers, Bucket Brigade above)	SAD-100	Reticon
	SAD512	Reticon
	SAD-1024	Reticon
Serial Analog Memory (Analog storage with independent read-in and read-out shift registers)	SAM64	Reticon
	SAM128	Reticon
Serial Analog Processor (Analog storage with versatile input and output shift registers)	SAP-128	Reticon
Sinewave Generator	FX205	CMA
Square Law Device (two quadrant)	SL645	Plessey
Thermal Converter (matched transistors, differential resistors)	4131	Burr-Brown
Temperature Controlled Differential Pair	ITT726-1	† ITT
	ITT726-5	ITT
	μA726C	Fairchild
	μA726M	† Fairchild
Temperature Transducers	LM3911	National
	LX5600	† National
	LX5700	† National
Dual Voltage Level Alarm (activated if either input differs by more than ±5 to ±25% of selected value)	3041	Intech
Quad Voltage Level Monitor /Alarm (activated if any of 4 inputs differs by more than ±5, ±10 or ±20% of selected value)	3040	Intech
Voltage to Frequency Converter	**RC4151** **see page 653**	**Raytheon**
	RM4151 **see page 653**	† **Raytheon**
	RV4151	Raytheon
Voltage to Frequency/Frequency to Voltage Converter	A8400	Intech
	A8900	† Intech
Zero Voltage Switches	XR742	Exar
	742C	Fairchild
	MFC8070	Motorola
	SL447	Plessey
	SL448	Plessey
	SL449	† Plessey
	CA3058	RCA
	CA3059	RCA
	CA3079	RCA
	SN72440	TI

† Military Temperature Range (−55°C to 125°C)

FET INPUT IC OP AMPS

Analog Devices provides the broadest range of IC FET-INPUT OP AMPS in the industry. For use in applications where low bias current and high input impedance are imperative, ADS FET-input amplifiers are available in versions where low offset voltage, speed, low noise, ultra-low bias current or cost are also design considerations. The newest addition to the ADS FET-INPUT OP AMP line is the AD515. With bias current as low as 75fA and offset voltage below 1.0mV, the AD515 represents the ultimate in FET amplifier design.

Type No	Temp Range	I_b pA	V_{OS} mV	$\Delta V_{OS}/\Delta T$ µV/°C	V_{DIFF} @ Rated I_B ±V	Gain	V_{OUT} ±V @ mA	CMRR dB	Frequency Response Unity Gain MHz	Slew Rate V/µsec	Price (100's) ($)	Package
AD503J	C	15	50	75	4.0(T)	20k	10/5	70	1.0(T)	3.0	11.40	H
AD503K	C	10	20	25	4.0(T)	50k	10/5	80	1.0(T)	3.0	16.00	H
AD503S	M	10	20	50	4.0(T)	50k	10/5	80	1.0(T)	3.0	20.00	H
AD506J	C	15	3.5	75	44.0(T)	20k	10/5	70	1.0(T)	3.0	9.50	H
AD506K	C	10	1.5	25	4.0(T)	50k	10/5	80	1.0(T)	3.0	11.00	H
AD506L	C	5	1.0	10	4.0(T)	75k	10/5	80	1.0(T)	3.0	16.00	H
AD506S	M	10	1.5	50	4.0(T)	50k	10/5	80	1.0(T)	3.0	17.60	H
AD515J	C	.300	3.0	50	20	40k	10/5	66	.35(T)	0.3	9.90	H
AD515K	C	.150	1.0	15	20	100k	10/5	80	.35(T)	0.3	14.00	H
AD515L	C	.075	1.0	25	20	50k	10/5	70	.35(T)	0.3	18.00	H
AD514J	C	50	50	75	20	20k	10/5	70	.75	0.5	5.90	H
AD514K	C	20	20	25	20	50k	10/5	70	.75	0.5	7.90	H
AD514L	C	10	20	25	20	50k	10/5	70	.75	0.5	9.90	H
AD514S	M	20	20	50	20	50k	10/5	70	.75	0.5	11.90	H
AD523J	C	1.0	50	90	4.0(T)	20k	10/5	70	0.5(T)	3.0	14.00	H
AD523K	C	0.5	20	30	4.0(T)	40k	10/5	80	0.5(T)	3.0	16.75	H
AD523L	C	0.25	20	60	4.0(T)	40k	10/5	80	0.5(T)	3.0	18.75	H
AD528J	C	30	3	50	20(T)	25k	10/5	70	10(T)	50	12.00	H
AD528K	C	15	1	25	20(T)	50k	10/5	80	10(T)	50	16.00	H
AD528S	M	15	1	25	20(T)	50k	10/5	80	10(T)	50	28.00	H
AD540J	C	50	50	75	20(T)	20k	10/5	70	1.0(T)	6.0(T)	4.45	H
AD540K	C	25	20	25	20(T)	50k	10/5	70	1.0(T)	6.0(T)	5.95	H
AD540S	M	25	20	50	20(T)	50k	10/5	70	1.0(T)	6.0(T)	9.95	H

FAST WIDEBAND IC OP AMPS

High Speed Op Amps are those characterized by wide bandwidth (>4MHz), high slew rate (>20V/micro second) and low settling time. The devices listed below offer the user a variety of AC specifications for any applications including 8, 10 and 12-bit converters.

Type No	Temp Range	Gain	V_{OUT} ±V @ mA	Unity Gain MHz	Slew Rate V/µsec	Settling Time µsec to 0.1%	V_{OS} mV	$\Delta V_{OS}/\Delta T$ µV/°C	I_b nA	I_{OS} nA	CMRR dB	Price (100's) ($)	Package
AD507J	C	80k	10/5	35(T)	20	0.9(T)	5.0	15(T)	25	25	25	6.95	H
AD507K	C	100k	10/5	35(T)	25	0.9(T)	3.0	15	15	15	80	10.00	H
AD507S	M	100k	10/5	35(T)	20	0.9(T)	4.0	20	15	15	80	15.00	H
AD509J	C	7.5k	10/5	20	80	0.2(T)	10.0	20	250	50	74	8.95	H
AD509K	C	10k	10/5	20	80	0.5(T)	8.0	30	200	25	80	12.50	H
AD509S	M	10k	10/5	20	100	0.5(T)	8.0	30	200	25	80	19.75	H
AD518J	C	25k	10/5	12	50	0.8(T)	10.0	10	500	200	70	1.95	H
AD518K	C	50k	10/5	12	50	0.8(T)	4.0	15	250	50	80	4.95	H
AD518S	M	50k	10/5	12	50	0.8(T)	4.0	20	250	50	80	11.95	H

Route 1 Industrial Park; P.O. Box 280; Norwood, Mass. 02062
Tel: 617/329-4700 **TWX: 710/394-6577**
West Coast 213/595-1783 **Mid-West** 312/894-3300 **Texas** 214/231-5094

Analog Devices

LINEAR

HIGH ACCURACY IC OP AMPS

Where low offset voltage, low drift, low noise and long term stability are paramount, Analog Devices provides a line of HIGH ACCURACY OP AMPS at extremely low costs. As well as high performance versions of the popular 741 and 301 type amplifiers, ADS offers high accuracy devices with offset voltage laser-trimmed to 25μV max, drift below 25μV/°C and voltage noise of 1μV p-p, such as the new AD510.

Type No	Temp Range	Gain	V_{OUT} ±V @ mA	V_{OS} mV	$\Delta V_{OS}/\Delta T$ μV/°C	I_b nA	I_{OS} nA	CMRR dB	Noise μV p-p (0.01 to 10Hz)	Frequency Response Unity Gain MHz	Frequency Response Slew Rate V/μsec	Price (100's) ($)	Package
AD301AL	C	80k	10/5	0.5	5.0	30	5.0	90	3.0(T)	1.0 to 8.0(T)*	0.5 to 10(T)*	6.00	H,N
AD504J	C	250k	10/5	2.5	5.0	200	40	94	1.0(T)	0.3 to 1.0(T)*	0.12 to 2.5(T)*	8.40	H
AD504K	C	500k	10/5	1.5	3.0	100	15	100	1.0(T)	0.3 to 1.0(T)*	0.12 to 2.5(T)*	15.30	H
AD504L	C	1000k	10/5	0.5	1.0	80	10	110	1.0(T)	0.3 to 1.0(T)*	0.12 to 2.5(T)*	20.40	H
AD504M	C	1000k	10/5	0.5	0.5	80	10	110	0.6**	0.3 to 1.0(T)*	0.12 to 2.5(T)*	22.00	H
AD504S	M	1000k	10/5	0.5	1.0	80	10	110	1.0(T)	0.3 to 1.0(T)*	0.12(T)*	24.00	H
AD508J	C	250k	10/5	2.5	3.0	25	5.0	94	1.0(T)	0.3 to 1.0(T)*	0.12 to 2.5(T)*	14.00	H
AD510J	C	250k	10/5	.100	3.0	25	5	94	1.0(T)	0.3(T)	0.10(T)	5.95	H
AD510K	C	1000k	10/5	.050	1.0	13	4	110	1.0(T)	0.3(T)	0.10(T)	9.95	H
AD510L	C	1000k	10/5	.025	0.5	10	2.5	110	1.0(T)	0.3(T)	0.10(T)	14.95	H
AD510S		1000k	10/5	.050	1.0	13	4	110	1.0(T)	0.3(T)	0.10(T)	24.50	H
AD741J	C	50k	10/10	3.0	20	200	50	80	3.0(T)	1.0(T)	0.5(T)	1.25	H,N
AD741K	C	50k	10/5	2.0	15	75	10	90	3.0(T)	1.0(T)	0.5(T)	2.25	H,N
AD741L	C	50k	10/5	0.5	5.0	50	5	90	3.0(T)	1.0(T)	0.5(T)	6.00	H,N
AD741S	M	50k	10/10	2.0	15	75	10	80	3.0(T)	1.0(T)	0.5(T)	3.30	H

*Parameter range with various external compensation schemes.
**100% tested and guaranteed from 0.1 to 10Hz.

GENERAL PURPOSE IC OP AMPS

Where only moderate performance is required, a good *General Purpose Op Amp* is the best price/performance choice. Analog Devices provides the popular 741, 301 and 308 type devices with performance and reliability a cut above the standard general purpose op amp.

Type No	Temp Range	Gain	V_{OUT} ±V @ mA	Frequency Response Unity Gain MHz	Frequency Response Slew Rate V/μsec	V_{OS} mV	$\Delta V_{OS}/\Delta T$ μV/°C	I_b nA	I_{OS} nA	CMRR dB	Noise μV p-p (0.01 to 10Hz)	Price (100's) ($)	Package
AD101A	M	50k	10/5	1.0 to 8.0(T)	0.5 to 10(T)	2.0	15	75	10	80	3.0(T)	2.25	H
AD201A	I	50k	10/5	1.0 to 8.0(T)	0.5 to 10(T)	2.0	15	75	10	80	3.0(T)	1.75	H,N
AD301A	I	25k	10/5	1.0 to 8.0(T)	0.5 to 10(T)	7.5	30	250	50	70	3.0(T)	1.00	H,N
AD108	M	50k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	2.0	15	2.0	0.2	85	2.0(T)	12.50	H
AD208	I	50k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	2.0	15	2.0	0.2	85	2.0(T)	4.75	H
AD308	I	25k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	7.5	30	7.0	1.0	80	2.0(T)	3.50	H
AD108A	M	80k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	0.5	5.0	2.0	0.2	96	2.0(T)	17.50	H
AD208A	I	80k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	0.5	5.0	2.0	0.2	96	2.0(T)	14.00	H
AD308A	I	80k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	0.5	5.0	7.0	1.0	96	2.0(T)	7.00	H
AD502J	I	20k	10/5	1.0(T)	0.5(T)	6.0	40	25	12	80	15(T)	3.85	H
AD502K	I	20k	10/5	1.0(T)	0.5(T)	5.0	20	7	4	80	15(T)	7.75	H
AD502L	I	20k	10/5	1.0(T)	0.5(T)	5.0	10	4	1	80	15(T)	16.15	H
AD502S	M	20k	10/5	1.0(T)	0.5(T)	5.0	20	10	5	80	15(T)	12.85	H
AD741	M	50k	10/5	1.0(T)	0.5(T)	5.0	-	500	200	70	3.0(T)	2.00	H,N
AD741C	I	20k	10/5	1.0(T)	0.5(T)	6.0	-	500	200	70	3.0(T)	1.00	H,N

Specifications are min and max values unless specified as typical (T)

Package Designation: H – TO-99 can
N – 8 pin mini DIP

ANALOG DEVICES

IC Functional Circuits

AD530, AD531, AD532, AD533

Analog Devices is the industry's leading supplier of Analog Functional Circuits. Utilizing the patented Gilbert Linearized Transconductance Technique, ADS has developed a line of low cost, monolithic circuits with multiplying, dividing, squaring and square rooting functions. The laser trimmed AD532 is the most recent development; it requires no external pots or adjustments making it the easiest-to-use device on the market.

The Analog Devices AD530 is the industry's first integrated circuit multiplier to include the transconductance multiplying element, stable reference, and output amplifier on a monolithic silicon chip. The AD530 multiplies in four (4) quadrants with a transfer function of XY/10, divides in two (2) quadrants with 10Z/X transfer function, and square roots in one (1) quadrant with a transfer function of $-\sqrt{10Z}$.

The AD531 is the first monolithic programmable multiplier/divider to provide the true transfer function $V_X \cdot V_Y/kI_Z$ without the need for an external level shifting op amp at the output. Not just a multiplier, the AD531 is truly a computation circuit that is ideally suited to such applications as automatic gain control (AGC), true RMS-to-DC conversion, ratio determination and vector operations; in addition, it provides the normal mathematical functions of four-quadrant multiplication, two-quadrant division and squaring, and square rooting. Flexibility of operation is achieved by means of the variable scale factor kI_Z, which can be set by an external resistor or varied dynamically by an externally derived reference current to obtain the overall transfer function $V_X \cdot V_Y/V_Z$.

SPECIFICATIONS (typical @ V_S = ±15V and T_A = +25°C unless otherwise noted)

Models	530J (530K) (530L) (530S)	531J (531K) (531L) (531S)	532J (532K) (532S)
Full Scale Accuracy	2% (1%) (0.5%) (1%)	2% (1%) (0.5%) (1%)	2% (1%) (1%)
Divides and Square Roots	YES	YES	YES
Multiplication Characteristics			
Output Function	XY/10	XY/I_{REF}	$(X_1 - X_2)(Y_1 - Y_2)/10$
Accuracy vs. Temperature (±)	0.06(0.03)(0.01)(0.02 max)%/°C	0.06(0.03)(0.01)(0.02 max)%/°C	0.06(0.03)(0.02)%/°C
Accuracy vs. Supply (±)	0.2%/%	0.2%/%	0.2%/%
Output Offset (±)			
Initial	Adj. to zero	Adj. to zero	±50mV max(±20mV max)(±20mV max)
Average vs. Temperature 0 to +70°C	0.2mV/°C	0.2mV/°C	0.7(0.7)(2.0 max)mV/°C
Scale Factor (±)	Fixed	Dynamically Variable	Fixed
Initial Error	Adj. to 1%(0.5%)(0.2%)(0.5%)	Adj. to 1%(0.5%)(0.2%)(0.5%)	Adj. to 1%(0.5%)(0.5%)
Nonlinearity (±)			
X Input (X = 20V p-p, Y = ±10VDC)	0.8%(0.5%)(0.3%)(0.5%)	0.8%(0.5%)(0.3%)(0.5%)(1)	0.8%(0.5%)(0.5%)
Y Input (Y = 20V p-p, X = ±10VDC)	0.3%(0.2%)(0.2%)(0.2%)	0.3%(0.2%)(0.2%)(0.2%)(1)	0.3%(0.2%)(0.2%)
Feedthrough			
X = 0, Y = 20V p-p 50Hz	–	–	150mV(100mV)(100mV)p-p max
with external trim	100mV(60mV)(30mV)(60mV)p-p max	150mV(80mV)(40mV)(80mV)p-p max(1)	–
Y = 0, X = 20V p-p 50Hz	–	–	200mV(100mV)(100mV)p-p max
with external trim	150mV(80mV)(40mV)(80mV)p-p max	100mV(60mV)(30mV)(60mV)p-p max(1)	–
Bandwidth			
-3dB Small Signal	1MHz	1MHz	1MHz
Full Power Response	750kHz	750kHz	750kHz
Slew Rate	45V/μsec	45V/μsec	45V/μsec
Output Characteristics			
Voltage at Rated Load (min)	±10V	±10V	±10V
Current (min)	±5mA	±5mA	±5mA
Input Resistance			
X/Y/Z Input(2)	10MΩ/6MΩ/36kΩ	10MΩ/6MΩ/36kΩ	10MΩ/10MΩ/36kΩ
Input Bias Current			
X/Y/Z Input	2μA/2μA/5μA	2μA/2μA/5μA	2μA/3μA/5μA
Power Supply (V_S)			
Rated Performance	±15V	±15V	±15V
Operating	±12 to ±18V	±12 to ±18V	±10 to ±18V
Quiescent Current	±4mA	±4.5mA	±4mA
Price (100's)	$15.00($22.50)($27.50)($34.00)	$8.90($13.35)($30.25)($35.85)	$16.00($24.50)($32.50)

(1) I_{REF} = full scale.
(2) Z input current is proportional to Z input voltage.

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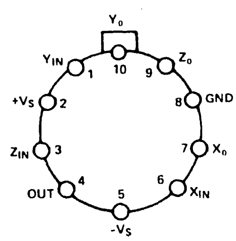
The AD532 is the first pretrimmed single chip monolithic multiplier/divider. It guarantees a maximum multiplying error of ±1.0% and a ±10V output voltage without the need for any external trimming resistors or output op amp. Because the AD532 is internally trimmed, its simplicity of use provides design engineers with an attractive alternative to modular multipliers, and its monolithic construction provides significant advantages in size, reliability and economy. Further, the AD532 can be used as a direct replacement for other IC multipliers that require external trim networks (such as the AD530).

The Analog Devices AD533 is a low cost integrated circuit multiplier comprised of a transconductance multiplying element, stable reference, and output amplifier on a monolithic silicon chip. Specified accuracy is easily achieved by the straightforward adjustment of feedthrough, output zero, and gain trim pots. The AD533 multiplies in four quadrants with a transfer function of XY/10, divides in two quadrants with a 10Z/X transfer function, and square roots in one quadrant with a transfer function of $-\sqrt{10Z}$.

533J (533K) (533L) (533S)
2% (1%) (0.5%) (1%)
YES
XY/10
0.04(0.03)(0.01)(0.01)%/°C
0.5%/%
Adj. to zero
0.7mV/°C
Fixed
Adj. to 1%
0.8%(0.5%)(0.5%)(0.5%)
0.3%(0.2%)(0.2%)(0.5%)
–
150mV(100mV)(50mV)(100mV)p-p max
–
200mV(100mV)(50mV)(100mV)p-p max
1MHz
750kHz
45V/μsec
±10V
±5mA
10MΩ/6MΩ/36kΩ
3μA(7.5μA max)(5μA max)(7.5μA max)
±15V
±12 to ±18V
±4mA
$5.95($9.95)($25.00)($30.00)

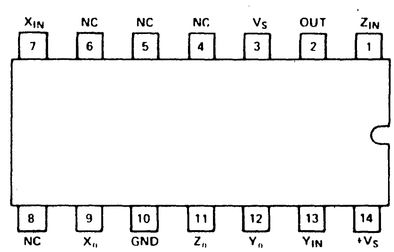
AD530, 532, 533
PIN OUT – TO-100

TOP VIEW



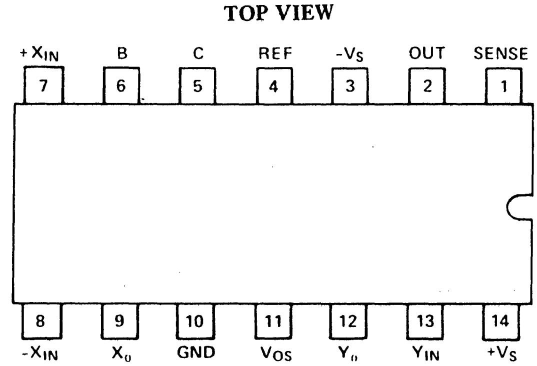
AD530, 532, 533
PIN OUT – TO-116

TOP VIEW



AD531
PIN OUT – TO-116

TOP VIEW



ANALOG DEVICES

IC Instrumentation Amplifiers

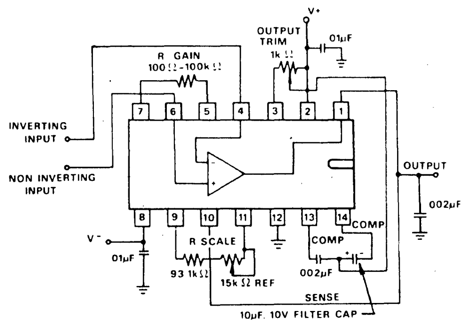
AD520, AD521

An *Instrumentation Amplifier* is a controlled gain block with differential inputs and an accurately programmable input/output gain relationship. Its excellent common mode rejection and low gain error make it a natural choice for extracting and amplifying low level signals in the presence of high common mode noise voltages. Instrumentation amplifiers are commonly used as transducer amplifiers for thermo couples, strain gauge bridges, current shunts, biological amplifiers, or simply as preamplifiers for processing small differential signals superimposed on common mode voltages.

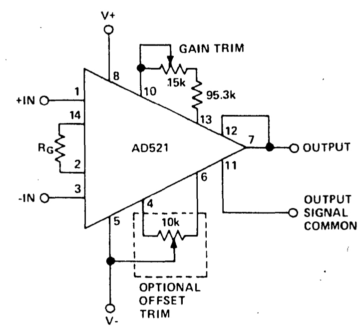
Instrumentation amplifiers should not be confused with op amps even through Analog Devices offers op amps that can be used as building blocks in variable gain instrumentation amplifier circuits. An op amp is merely a high gain component requiring the addition of external feedback to complete the amplification function. Because of the limitations of resistor matching in the external feedback circuit and the relatively low input impedance resulting from the input resistors, an instrumentation amplifier circuit designed around op amps frequently provides less than satisfactory performance. Instrumentation amplifiers manufactured by ADS, the AD520 and AD521, are complete amplification circuits which do not depend upon external resistor matching for input/output isolation, they maintain their high CMRR in any application. In addition, the high impedance inputs are fully protected against over voltages up to 15V greater than the supply voltage.

The AD520 and AD521 are the first instrumentation amplifiers to be maufactured in integrated circuit form; previously available commercial designs or user-made circuits were often costly, difficult to implement and often bulky. Now the benefits of a true instrumentation amplifier are available at a cost and ease of use that previously made them prohibitive.

AD520



AD521



SPECIFICATIONS (typical @ V_S = ±15V and T_A = +25°C unless otherwise noted)

	AD520J	AD520K	AD520S	AD521J	AD521K	AD521S
GAIN						
Range	1 to 1000	•	•	1 to 1000	•	•
Equation	$G = R_S/R_G$ V/V	•	•	$G = R_S/R_G$ V/V	•	•
Nonlinearity	±0.5% max	•	•	±0.2% max	•	•
OUTPUT	±10V @ 5mA min	•	•	±10V @ 5mA min	•	•
BANDWIDTH (±3dB)						
G = 1	200kHz	•	•	2MHz	•	•
G = 1000	25kHz	•	•	40kHz	•	•
SLEW RATE	2.5V/μs	•	•	10V/μs	•	•
VOLTAGE OFFSET, Output		MUST BE NULLED		(400 + 3 x G)mV max	(200 + 1.5G)mV max	••
DRIFT, Output @ G = 1	1mV/°C max	0.5mV/°C max	••	.415mV/°C max	.205mV/°C max	••
INPUT BIAS CURRENT	80nA max	40nA max	••	80nA max	40nA max	••
INPUT OFFSET CURRENT	40nA max	20nA max	••	20nA max	10nA max	••
INPUT IMPEDANCE						
Differential	$2 \times 10^9 \Omega$	•	•	$3 \times 10^9 \Omega$	•	•
Common Mode	$2 \times 10^9 \Omega$	•	•	$6 \times 10^{10} \Omega$	•	•
CMRR						
G = 1	65dB min	70dB min	••	70dB min	74dB min	••
G = 100	95dB min	106dB min	••	100dB min	110dB min	••
TEMP RANGE	0 to +70°C	•	−55 to +125°C	0 to +70°C	•	−55 to +125°C
PRICE (100's)	$12.00	$16.00	$22.00	$8.50	$12.00	$20.00

*Same as J specifications. **Same as K specifications.

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ANALOG DEVICES

Peripheral Circuits

AD111, AD211, AD311, AD580, AD583

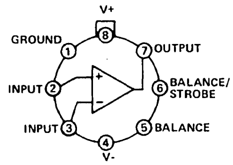
IC COMPARATOR

The AD111, AD211, and AD311 are precision voltage comparators designed for low level signal detection and high level output drive capability. Offering significant improvement over the earlier 710-type comparator in terms of bias currents and gain, the AD111 series operates on supply voltages from +5V (single ended) up to ±18V. TTL strobe capability is available with the addition of two external components. The AD311 is specified from 0 to +70°C, the AD211 from -25°C to +85°C and the AD111 over the full military temperature range -55°C to +125°C. All versions are available in the TO-99 can; the AD311 is also available in the 8 pin mini dip.

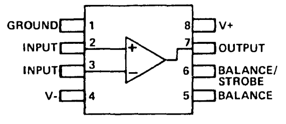
	AD311	AD211	AD111
Voltage Gain	200k	200k	200k
Offset Voltage (mV max)	7.5	3.0	3.0
Bias Current (nA max)	250	100	100
Maximum Output to $-V_S$	50V	50V	50V
Maximum Ground to $-V_S$	30V	30V	30V
Power Supply	+5V min*	+5V min*	+5V min*
Response Time, to TTL Logic Threshold (nsec)	200	200	200
Temp. Range (°C)	0 to +70	-25 to +85	-55 to +125

*Single Ended

TO-99
Top View



MINI-DIP
Top View



IC SAMPLE-HOLD

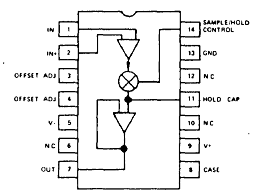
The AD583 is a monolithic sample and hold circuit consisting of a high performance operational amplifier in series with an ultra-low leakage analog switch and a MOSFET input unity gain amplifier. An external holding capacitor, connected to the switch output, completes the sample-and-hold or track-and-hold function.

With the analog switch closed, the AD583 functions like a standard op amp; any feedback network may be connected around the device to control gain and frequency response. With the switch open the capacitor holds the output at its previous level.

The AD583 may also be used as a versatile operational amplifier with a gated output for applications such as analog switches, peak holding circuits, etc.

	AD583K
Open Loop Gain $R_L = 2k\Omega$	25k min
Output Swing	±10V min
Gain Bandwidth	2MHz
Acquisition Time (0.1%) $A_V = 1, R_L = 2k, C_L = 50pF$	4μsec
Aperture Time	50nsec
Drift Current	50pA max
Charge Transfer	20pC max
Operating Temp.	0 to +70°C
Price (100's)	$14.85

PIN CONFIGURATION TO-116 DIP



IC REFERENCE

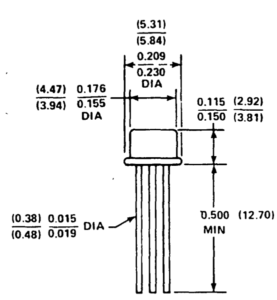
The AD580 is a three-terminal, low cost, temperature compensated, bandgap voltage reference which provides a fixed 2.5V output voltage for inputs between 4.5V and 30V. A unique combination of advanced circuit design and sophisticated thin film resistor processing capability provides the AD580 with a temperature stability of better than 10ppm/°C and long term stability of better than 250μV. In addition, the low quiescent current drain of 1.0mA max offers a clear advantage over classical zener techniques.

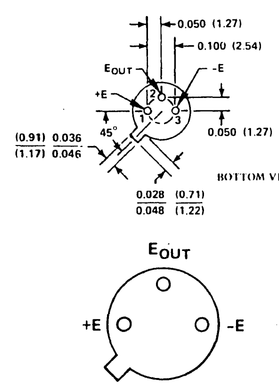
Model	Output Voltage	T.C. ppm/°C max	Temp. Range	Price
AD580J	2.500 ±3%	85	C	$2.00
AD580K	2.500 ±2%	40	C	$4.00
AD580L	2.500 ±2%	25	C	$5.75
AD580M	2.500 ±1%	10	C	$8.25
AD580S	2.500 ±3%	55	M	$7.50
AD580T	2.500 +2%	25	M	$12.00
AD580U	2.500 +1%	10	M	$25.00

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

CASE 27 TO-52 PACKAGE





BOTTOM VIEW

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XR-2206

EXAR INTEGRATED SYSTEMS, INC.
750 Palomar Ave., Sunnyvale, CA 94086 Sales: (408) 733-7700

Monolithic Function Generator

ELECTRICAL CHARACTERISTICS Preliminary

Test Conditions: Test Circuit of Fig. 2, $V^+ = 12V$, $T_A = 25°C$, $C = 0.01\ \mu F$, $R_1 = 100\ K\Omega$, $R_2 = 10\ K\Omega$ $R_3 = 25\ K\Omega$ unless otherwise specified. S_1 open for triangle, closed for sinewave.

CHARACTERISTICS	XR-2206M, XR-2206			XR-2206C			UNITS	CONDITIONS
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.		
Supply Voltage								
Single Supply	10		26	10		26	V	
Split Supply	±5		±13	±5		±13	V	
Supply Current		12	17		14	20	mA	$R_1 \geq 10\ K\Omega$
Oscillator Section								
Max. Operating Frequency	0.5	1		0.5	1		MHz	$C = 1000$ pF, $R_1 = 1\ K\Omega$
Lowest Practical Frequency		0.01			0.01		Hz	$C = 50\ \mu F$, $R_1 = 2\ M\Omega$
Frequency Accuracy		±1	±4		±2		% of f_o	$f_o = 1/R_1C$
Temperature Stability		±10	±50		±20		ppm/°C	$0°C \leq T_A \leq 75°C$, $R_1 = R_2 = 20\ K\Omega$
Supply Sensitivity		0.01	0.1		0.01		%	$V_{LOW} = 10V$, $V_{HIGH} = 20V$, $R_1 = R_2 = 20\ K\Omega$
Sweep Range	1000:1	2000:1			2000:1		$f_H = f_L$	f_H @ $R_1 = 1\ K\Omega$ f_L @ $R_1 = 2\ M\Omega$
Sweep Linearity								
10:1 Sweep		2			2		%	$f_L = 1$ kHz, $f_H = 10$ kHz
1000:1 Sweep		8			8		%	$f_L = 100$ Hz, $f_H = 100$ kHz
FM Distortion		0.1			0.1		%	±10% Deviation
Recommended Timing Components								
Timing Capacitor: C	0.001		100	0.001		100	μF	See Figure 5
Timing Resistors: R_1 & R_2	1		2000	1		2000	$K\Omega$	
Triangle/Sinewave Output								See Note 1, Fig. .
Triangle Output		160			160		$mV/K\Omega$	Fig. 2 S_1 Open
Sinewave Output	40	60	80		60		$mV/K\Omega$	Fig. 2 S_1 Closed
Max. Output Swing		6			6		Vpp	
Output Impedance		600			600		Ω	
Triangle Linearity		1			1		%	
Amplitude Stability		0.5			0.5		dB	For 1000:1 Sweep
Sinewave Distortion								$R_1 = 30\ K\Omega$
Without Adjustment		2.5			2.5		%	See Figure 11.
With Adjustment		0.4	1.0		0.5	1.5	%	See Figure 12
Amplitude Modulation								
Input Impedance	50	100		50	100		$K\Omega$	
Modulation Range		100			100		%	
Carrier Suppression		55			55		dB	
Linearity		2			2		%	For 95% modulation
Square Wave Output								Measured at Pin 11
Amplitude		12			12		Vpp	
Rise Time		250			250		nsec	$C_L = 10$ pF
Fall Time		50			50		nsec	$C_L = 10$ pF
Saturation Voltage		0.2	0.4		0.2	0.4	V	$I_L = 2$ mA
Leakage Current		0.1	20		0.1		μA	$V_{11} = 12V$
FSK Keying Level (Pin 9)	0.8	1.4	2.4	0.8	1.4	2.4	V	See Section on Circuit Controls
Reference Bypass Voltage	2.9	3.1	3.3	2.5	3	3.5	V	Measured at Pin 10.

Note 1: Output Amplitude is inversely proportional to the resistance R_3 on Pin 3. See Figure 3

APPLICATIONS INFORMATION

SINEWAVE GENERATION

A) Without External Adjustment

Figure 11 shows the circuit connection for generating a sinusoidal output from the XR-2206. The potentiometer R_1 at pin 7 provides the desired frequency tuning. The maximum output swing is greater than $V^+/2$ and the typical distortion (THD) is < 2.5%. If lower sinewave distortion is desired, additional adjustments can be provided as described in the following section.

The circuit of Figure 11 can be converted to split supply operation simply by replacing all ground connections with V^-. For split supply operation, R_3 can be directly connected to ground.

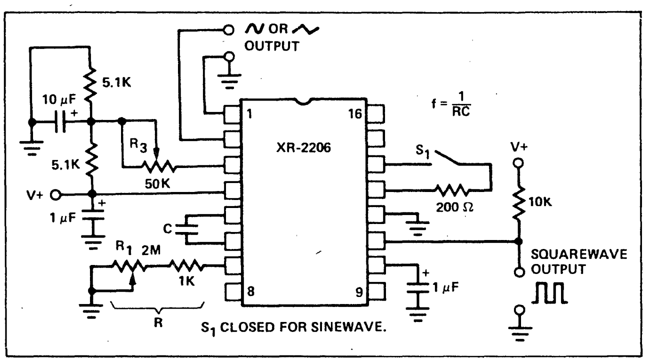


Figure 11. Circuit for Sinewave Generation Without External Adjustment. (See Fig. 3 for choice of R_3)

B) With External Adjustment

The harmonic content of sinusoidal output can be reduced to ≈0.5% by additional adjustments as shown in Figure 12 The potentiometer R_A adjusts the sine-shaping resistor; and R_B provides the fine-adjustment for the waveform symmetry. The adjustment procedure is as follows:

1. Set R_B at mid-point and adjust R_A for minimum distortion.
2. With R_A set as above, adjust R_B to further reduce distortion.

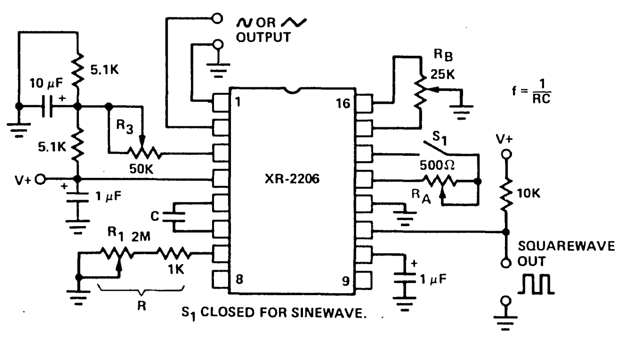


Figure 12. Circuit for Sinewave Generation With Minimum Harmonic Distortion. (R_3 Determines output Swing

TRIANGLE WAVE GENERATION

The circuits of Figures 11 and 12 can be converted to triangle wave generation by simply open circuiting pins 13 and 14 (i.e., S_1 open). Amplitude of the triangle is approximately twice the sinewave output.

FSK GENERATION

Figure 13 shows the circuit connection for sinusoidal FSK signal generation. Mark and space frequencies can be independently adjusted by the choice of timing resistors R_1 and R_2; and the output is phase-continuous during transitions. The keying signal is applied to pin 9. The circuit can be converted to split-supply operation by simply replacing ground with V^-.

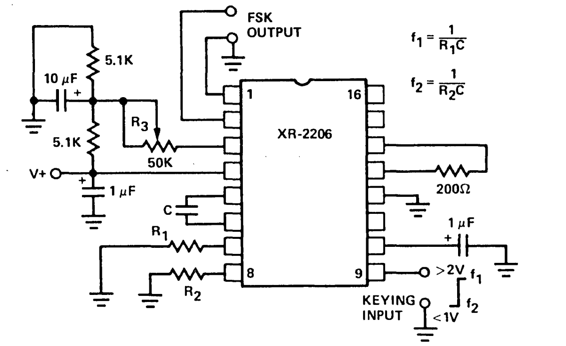


Figure 13. Sinusoidal FSK Generator

PULSE AND RAMP GENERATION

Figure 14 shows the circuit for pulse and ramp waveform generation. In this mode of operation, the FSK keying terminal (pin 9) is shorted to the square-wave output (pin 11); and the circuit automatically frequency-shift keys itself between two separate frequencies during the positive and negative going output waveforms. The pulse-width and the duty cycle can be adjusted from 1% to 99% by the choice of R_1 and R_2. The values of R_1 and R_2 should be in the range of 1 KΩ to 2 MΩ.

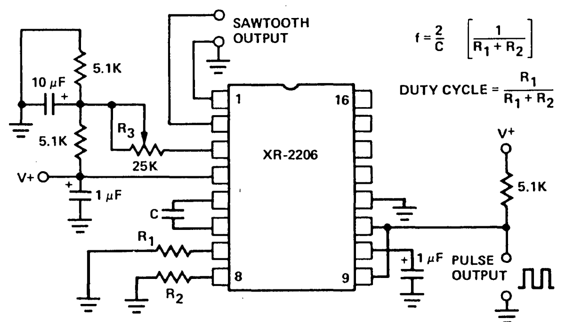
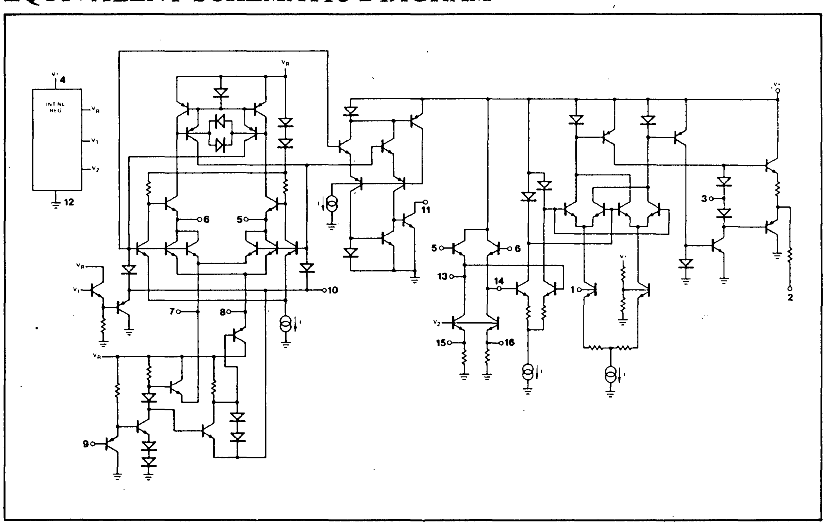
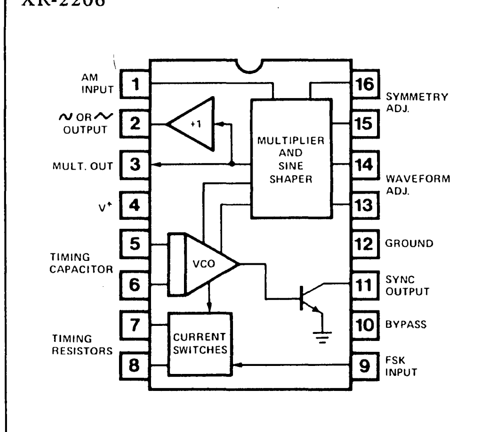


Figure 14. Circuit for Pulse and Ramp Generation

EQUIVALENT SCHEMATIC DIAGRAM



FUNCTIONAL BLOCK DIAGRAM



XR-2207

EXAR INTEGRATED SYSTEMS, INC.
750 Palomar Ave., Sunnyvale, CA 94086 Sales: (408) 733-7700

Voltage - Controlled Oscillator

ELECTRICAL CHARACTERISTICS

Test Conditions: Test Circuit of Figure 2, $V^+ = V^- = 6V$, $T_A = +25°C$, C = 5000 pF, $R_1 = R_2 = R_3 = R_4 = 20\ K\Omega$, $R_L = 4.7\ K\Omega$, Binary Inputs grounded, S_1 and S_2 closed unless otherwise specified.

PARAMETERS	XR-2207			XR-2207C			UNITS	CONDITIONS
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.		
GENERAL CHARACTERISTICS								
Supply Voltage								
Single Supply	8		26	8		26	V	See Figure 3
Split Supplies	±4		±13	±4		±13	V	
Supply Current								
Single Supply		5	7		5	8	mA	Measured at pin 1, S_1 open see Figure 2
Split Supplies								
Positive		5	7		5	8	mA	Measured at pin 1, S_1, S_2 open
Negative		4	6		4	7	mA	Measured at pin 12, S_1, S_2 open
OSCILLATOR SECTION – FREQUENCY CHARACTERISTICS								
Upper Frequency Limit	0.5	1.0		0.5	1.0		MHz	C = 500 pF, $R_3 = 2\ K\Omega$
Lowest Practical Frequency		0.01			0.01		Hz	C = 50 μF, $R_3 = 2\ M\Omega$
Frequency Accuracy		±1	±3		±1	±5	% of f_o	
Frequency Matching		0.5			0.5		% of f_o	
Frequency Stability								
Temperature		20	50		30		ppm/°C	$0° < T_A < 75°C$
Power Supply		0.15			0.15		%/V	
Sweep Range	1000:1	3000:1			1000:1		f_H/f_L	$R_3 = 1.5\ K\Omega$ for f_{H1} $R_3 = 2\ M\Omega$ for f_L
Sweep Linearity							%	C = 5000 pF
10:1 Sweep		1	2		1.5			$f_H = 10$ kHz, $f_L = 1$ kHz
1000:1 Sweep		5			5			$f_H = 100$ kHz, $f_L = 100$ Hz
FM Distortion		0.1			0.1		%	±10% FM Deviation
Recommended Range of Timing Resistors	1.5		2000	1.5		2000	KΩ	See Characteristic Curves
Impedance at Timing Pins		75			75		Ω	Measured at pins 4, 5, 6, or 7
DC Level at Timing Terminals		10			10		mV	
BINARY KEYING INPUTS								
Switching Threshold	1.4	2.2	2.8	1.4	2.2	2.8	V	Measured at pins 8 and 9, Refer to pin 10
Input Impedance		5			5		KΩ	
OUTPUT CHARACTERISTICS								
Triangle Output								Measured at pin 13
Amplitude	4	6		4	6		Vpp	
Impedance		10			10		Ω	
DC Level		+100			+100		mV	Referenced to pin 10 from 10%
Linearity		0.1			0.1		%	to 90% of swing
Squarewave Output								Measured at pin 13, S_5 closed
Amplitude	11	12		11	12		Vpp	
Saturation Voltage		0.2	0.4		0.2	0.4	V	Referenced to pin 12
Rise Time		200			200		nsec	$C_L \leq 10$ pF
Fall Time		20			20		nsec	$C_L \leq 10$ pF

APPLICATIONS

SPLIT SUPPLY OPERATION

Figure 1 is the recommended circuit connection for split supply operation. The frequency of operation is determined by the timing capacitor, C, and the activated timing resistors (R_1 through R_4). The timing resistors are activated by the logic signals at the binary keying inputs (pins 8 and 9), as shown in the logic table in Figure 9. If a single timing resistor is activated, the frequency is 1/RC. Otherwise, the frequency is either $1/(R_1 \parallel R_2)C$ or $1/(R_3 \parallel R_4)C$.

The squarewave output is obtained at pin 13 and has a peak-to-peak voltage swing equal to the supply voltages. This output is an "open-collector" type and requires an external pull-up load resistor (nominally 5 KΩ) to the positive supply. The triangle waveform obtained at pin 14 is centered about ground and has a peak amplitude of V+/2.

LOGIC LEVEL 8 9	SELECTED TIMING PINS	FREQUENCY	DEFINITIONS
0 0	6	f_1	$f_1 = 1/R_3C$, $\Delta f_1 = 1/R_4C$
0 1	6 and 7	$f_1 + \Delta f_1$	$f_2 = 1/R_2C$, $\Delta f_2 = 1/R_1C$
1 0	5	f_2	Logic Levels: 0 = Ground
1 1	4 and 5	$f_2 + \Delta f_2$	1 = > 3 V

TABLE 1. Logic Table for Binary Keying Controls

Note: For Single-Supply Operation, Logic Levels are Referenced to Voltage at Pin 10

The circuit operates with supply voltages ranging from ±4V to ±13V. Minimum drift occurs with ±6 volt supplies. For operation with unequal supply voltages, see Figure 3.

SINGLE SUPPLY OPERATION

The circuit should be interconnected as shown in Figure 2 for single supply operation. Pin 12 should be grounded, and pin 11 biased from V^+ through a resistive divider to a value of bias voltage between $V^+/3$ and $V^+/2$. Pin 10 is bypassed to ground through a 1 μF capacitor.

For single supply operation, the dc voltage at pin 10 and the timing terminals (pins 4 through 7) are equal and approximately 0.6V above V_B, the bias voltage at pin 11. The logic levels at the binary keying terminals are referenced to the voltage at pin 10.

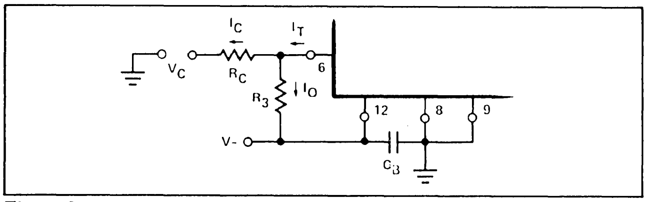


Figure 9. Frequency Sweep Operation

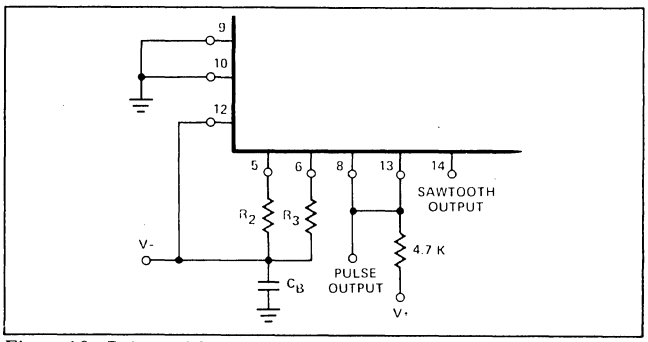


Figure 10. Pulse and Sawtooth Generation

FREQUENCY CONTROL (SWEEP AND FM)

The frequency of operation is controlled by varying the total timing current, I_T, drawn from the activated timing pins 4, 5, 6, or 7. The timing current can be modulated by applying a control voltage, V_C, to the activated timing pin through a series resistor R_C as shown in Figure 9.

For split supply operation, a *negative* control voltage, V_C, applied to the circuits of Figure 9 causes the total timing current, I_T, and the frequency, to increase.

As an example, in the circuit of Figure 9, the binary keying inputs are grounded. Therefore, only timing pin 6 is activated.

The frequency of operation is determined by:

$$f = \frac{1}{R_3C}\left[1 - \frac{V_CR_3}{R_CV^-}\right]\text{Hz}$$

PULSE AND SAWTOOTH GENERATION

The duty cycle of the output waveforms can be controlled by frequency shift keying at the end of every half cycle of oscillator output. This is accomplished by connecting one or both of the binary keying inputs (pins 8 or 9) to the squarewave output at pin 13. The output waveforms can then be converted to positive or negative pulses and sawtooth waveforms.

Figure 10 is the recommended circuit connection for duty cycle control. Pin 8 is shorted to pin 13 so that the circuit switches between the "0, 0" and the "1, 0" logic states given in Figure 9. Timing pin 5 is activated when the output is "high," and pin 6 is activated when the squarewave output goes to a low state.

The duty cycle of the output waveforms is given as:

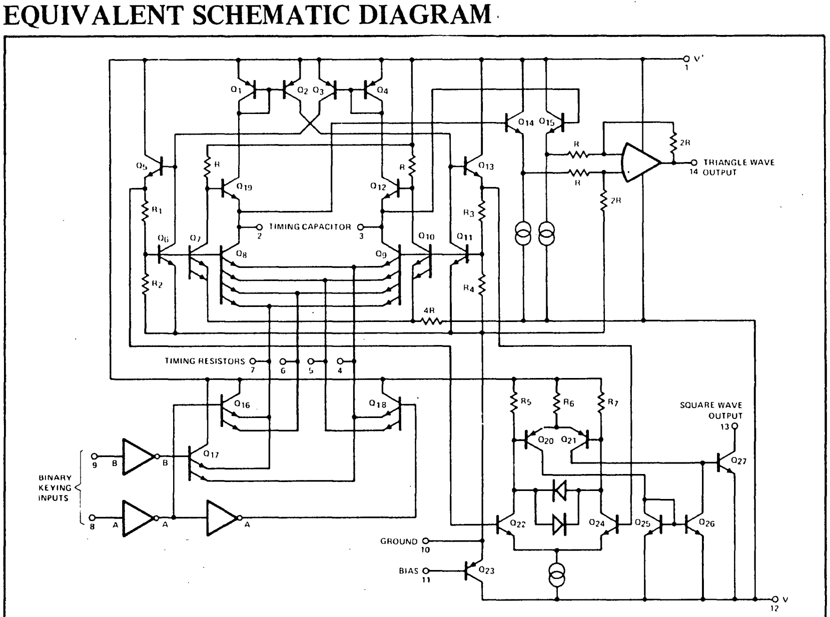
$$\text{Duty Cycle} = \frac{R_2}{R_2 + R_3}$$

and can be varied from 0.1% to 99.9% by proper choice of timing resistors. The frequency of oscillation, f, is given as:

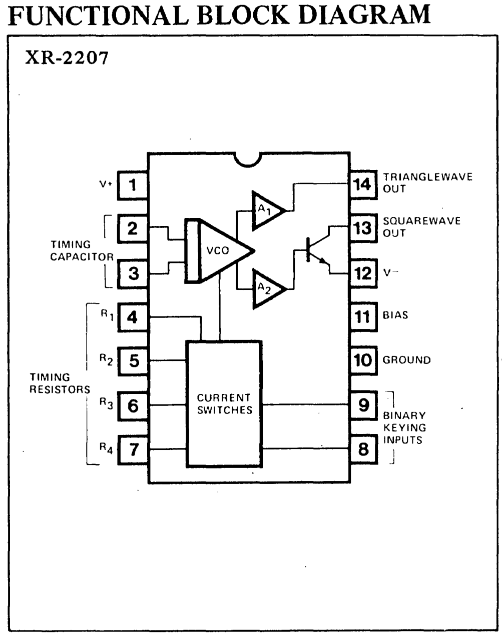
$$f = \frac{2}{C}\left[\frac{1}{R_2 + R_3}\right]$$

The frequency can be modulated or swept without changing the duty cycle by connecting R_2 and R_3 to a common control voltage V_C, instead of to V^-. The sawtooth and the pulse output waveforms are shown in Figure 5.

EQUIVALENT SCHEMATIC DIAGRAM



FUNCTIONAL BLOCK DIAGRAM



Exar

LINEAR

XR-2208

EXAR INTEGRATED SYSTEMS, INC.
750 Palomar Ave., Sunnyvale, CA 94086 Sales: (408) 733-7700

Operational Multiplier

ELECTRICAL CHARACTERISTICS

Test Conditions: Supply Voltage = ±15V, T_A = 25°C, unless otherwise specified.

CHARACTERISTICS	XR-2208/XR-2208M			XR-2208C			UNITS	CONDITIONS
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.		
I. GENERAL								
Supply Voltage	±4.5		±16	±4.5		±16		
Supply Current		4	7		5	8		Measured at pin 16
II. MULTIPLIER SECTION								
Non-linearity								No external offset rim
(Output Error in % of Full Scale)		0.3	0.5		0.5	1.0	%	V_y = ±10V, −10V < V_x < +10V
		0.3	0.5		0.5	1.0	%	V_x = ±10V, −10V < V_y < +10V
		0.7	1.0		0.8		%	$T_{LOW} \leq T_A \leq T_{HIGH}$ (Note 1)
								f = 50 Hz
Feedthrough								
a) With Offset Adjustment								
X-input		45	80		70		mVp-p	V_x = 20 Vp-p, V_y = 0
Y-input		60	100		90		mVp-p	V_y = 20 Vp-p, V_x = 0
b) No Offset Adjustment								
X-input		120			200		mVp-p	V_x = 20 Vp-p, V_x = 0
Y-input		120			200		mVp-p	V_y = 20 Vp-p, V_x = 0
Temperature Coefficient of Scale Factor		±0.07			±0.07		%/°C	$T_{LOW} \leq T_A \leq T_{HIGH}$ (Note 1)
Input Bias Current								
X, Y input		2	6		3	8	μA	I_3, I_5
Common input		4	12		6	16	μA	I_4
Input Resistance	0.5	1.0			1.0		MΩ	Measured looking into pin 3 or pin 5
Output Offset Voltage		50	80		80	140	mV	Measured across pins 1 and 2
Average Temperature Drift		0.5			0.5		mV/°C	$T_{LOW} \leq T_A \leq T_{HIGH}$
Dynamic Response								See Definition Section
3-dB Bandwidth								
X-input	6	8		6	6	8	MHz	
Y-input	3	4		3	3	4	MHz	
3° Phase-Shift Bandwidth		1.2			1.2		MHz	
1% Absolute Error Bandwidth		30			30		kHz	
Transconductance Bandwidth		100			100		MHz	
Output Impedance		6			6		KΩ	Measured looking into pins 1 or 2
III. BUFFER AMPLIFIER								
Output Impedance		200			200		Ω	Measured looking into pin 15
Gain		1.0			1.0			
IV. OPERATIONAL AMPLIFIER								
Input Offset Voltage		1	3		2	6	mV	R_S < 50Ω
Temperature Coefficient of Input Offset Voltage		6	20		9	30	μV/°C	$T_{LOW} \leq T_A \leq T_{HIGH}$
Input Offset Current		4	75		10	100	nA	$I_{B1} - I_{B2}$
Input Bias Current		30	200		50	300	nA	$\frac{I_{B1} + I_{B2}}{2}$
Voltage Gain	70	75		70	75		dB	$R_L \geq$ 2K, V_o = ±10V, f = 20 Hz
Differential Input Resistance	0.5	3			3		MΩ	
Output Voltage Swing	±10	±12		±10	±12		V	$R_L \geq$ 2K, $T_{LOW} \leq T_A \leq T_{HIGH}$
Input Common	+12	+14		+12	+14			
Mode Range	−10	−12		−10	−12		V	
Common Mode Rejection	70	90		70	90		dB	f = 20 Hz
Output Resistance		2			2		kΩ	
Slew Rate		0.5			0.5		V/μs	Gain = 1, $R_L \geq$ 2K, $C_L \leq$ 100 pF, C_C = 20 pF
Power Supply Sensitivity		30			30		μV/V	$R_S \leq$ 10K

Note 1: T_{LOW} = −55°C, T_{HIGH} = +125°C for XR-2208M T_{LOW} = 0°C, T_{HIGH} = +75°C for XR-2208/XR-2208C

The XR-2208 operational multiplier combines a four-quadrant analog multiplier (or modulator), a high frequency buffer amplifier, and an operational amplifier in a monolithic circuit that is ideally suited for both analog computation and communications signal processing application. As shown in the functional block diagram, for maximum versatility the multiplier and operational amplifier sections are not internally connected. They can be interconnected, with a minimum number of external components, to perform arithmetic computation, such as multiplication, division, square-root extraction. The operational amplifier can also function as a pre-amplifier for low-level input signals, or as a post detection amplifier for synchronous demodulator applications. For signal processing, the high frequency buffer amplifier output is available at pin 15. This multiplier/buffer amplifier combination extends the small signal 3-db bandwidth to 8-MHz and the transconductance bandwidth to 100 MHz.

FEATURES

Maximum Versatility
- Independent Multiplier, Op Amp, and Buffer

Excellent Linearity (0.3% typ.)

Wide Bandwidth
- 3 dB B.W. – 8 MHz typ.
- 3° Phase Shift B.W. – 1.2 MHz typ.
- Transconductance B.W. – 100 MHz typ.

Simplified Offset Adjustments

Wide Supply Voltage Range (±4.5V to ±16V)

APPLICATIONS

Analog Computation
- Multiplication
- Division
- Squareing
- Square–Root

Signal Processing
- AM Generation
- Frequency Doubling
- Frequency Translation
- Synchronous AM Detection

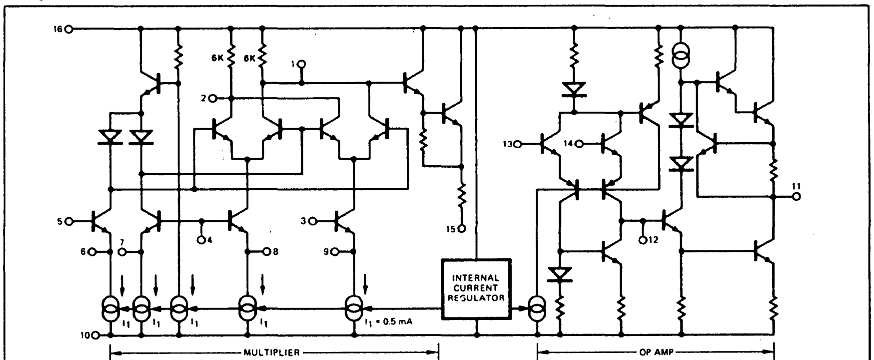
Triangle-to-Sinewave Converter

AGC Amplifier

Phase Detector

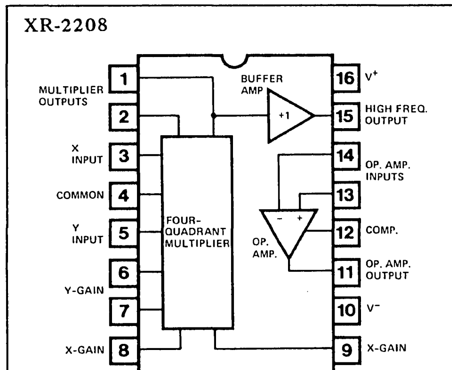
Phase-Locked Loop (PLL) Applications
- Motor Speed Control
- Precision PLL
- Carrier Detection
- Phase-Locked AM Demodulation

EQUIVALENT SCHEMATIC DIAGRAM



CAUTION: When using only the op amp or only the multiplier section of the XR-2208, the input terminals to the unused section *must be grounded.* Thus, when using the multiplier section alone, ground pin 13 and 14; when using the op amp section alone ground pins 3, 4 and 5.

FUNCTIONAL BLOCK DIAGRAM



XR-2211

EXAR INTEGRATED SYSTEMS, INC.
750 Palomar Ave., Sunnyvale, CA 94086 Sales: (408) 733-7700

FSK Demodulator/Tone Decoder

The XR-2211 is a monolithic phase-locked loop (PLL) system especially designed for data communications. It is particularly well suited for FSK modem applications. It operates over a wide supply voltage range of 4.5 to 20V and a wide frequency range of 0.01 Hz to 300 kHz. It can accommodate analog signals between 2 mV and 3V, and can interface with conventional DTL, TTL and ECL logic families. The circuit consists of a basic PLL for tracking an input signal within the pass band, a quadrature phase detector which provides carrier detection, and an FSK voltage comparator which provides FSK demodulation. External components are used to independently set center frequency, bandwidth, and output delay.

FSK DECODING WITH CARRIER-DETECT:

The lock-detect section of XR-2211 can be used as a carrier-detect option, for FSK decoding. The recommended circuit connection for this application is shown in Fig. 10. The open-collector lock-detect output, Pin 6, is shorted to data. output (Pin 7). Thus, data output will be disabled at "low" state, until there is a carrier within the detection band of the PLL, and the Pin 6 output goes "high", to enable the data output.

The value of lock-detect filter capacitance, C_D, can be calculated from design equation: $C_D \geq 50/f_0$ (Hz) μF.

LINEAR FM DETECTION:

XR-2211 can be used as a linear FM detector for a wide range of analog communications and telemetry applications. The recommended circuit connection for this applications is shown in Fig. 12. The demodulated output is taken from the loop phase detector output (Pin 11), through a post detection filter made up of R_F and C_F, and an external buffer amplifier. This buffer amplifier is necessary because of the high impedance output at Pin 11. Normally, a non-inverting unity

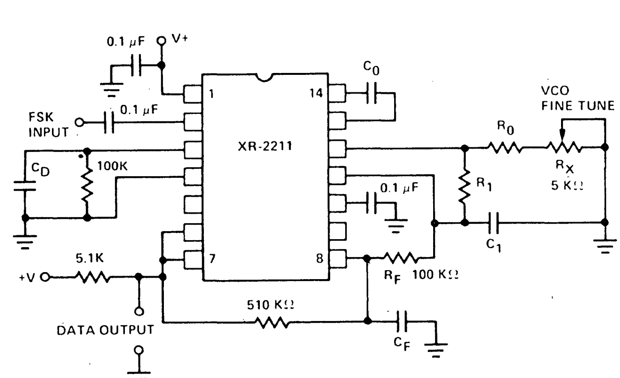


Figure 10. External Connections for FSK Demodulation with Carrier-Detect Capability.
Note: Data Output is "Low" When No Carrier is Present.

gain op amp can be used as a buffer amplifier, as shown in Fig. 12.

The FM detector gain, i.e., the output voltage change per unit of FM deviation, can be given as:

$$V_{out} = R_1 V_R / 100\ R_0 \quad \text{Volts/\%deviation}$$

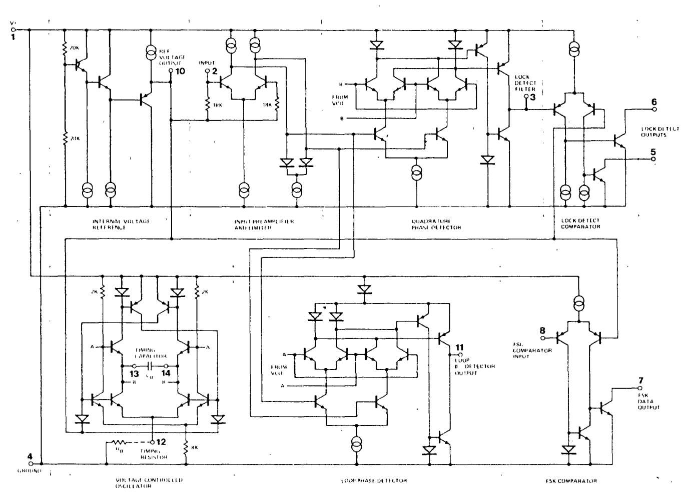
where V_R is the internal reference voltage. ($V_R = V+/2 - 650$ mV). For the choice of external components R_1, R_0, C_D, C_1 and C_F, see section on Design Equations.

ELECTRICAL CHARACTERISTICS --PRELIMINARY–

Test Conditions: $V^+ = +12V$, $T_A = +25°C$, $R_0 = 30\ K\Omega$, $C_0 = 0.033\ \mu F$. See Fig. 2 for component designation.

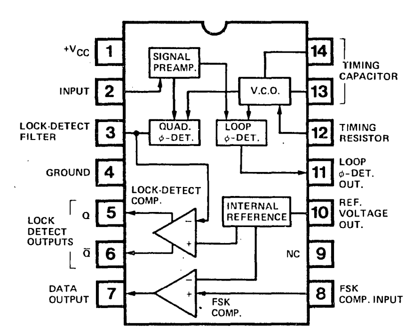
CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
GENERAL					
Supply Voltage	4.5		20	V	
Supply Current		5	9	mA	$R_0 \geq 10\ K\Omega$. See Fig. 4.
OSCILLATOR SECTION					
Frequency Accuracy		±1		%	Deviation from $f_0 = 1/R_0C_0$
Frequency Stability					$R_1 = \infty$
Temperature		±20		ppm/°C	See Fig. 8.
Power Supply		0.05		%/V	$V^+ = 12 \pm 1V$. See Fig. 7.
		0.2		%/V	$V^+ = 5 \pm 0.5V$. See Fig. 7.
Upper Frequency Limit		300		kHz	$R_0 = 8.2\ K\Omega$, $C_0 = 400$ pF
Lowest Practical Operating Frequency		0.01		Hz	$R_0 = 2\ M\Omega$, $C_0 = 50\ \mu F$
Timing Resistor, R_0					See Fig. 5.
Operating Range	5		2000	KΩ	
Recommended Range	15		100	KΩ	See Fig. 7 and 8.
LOOP PHASE DETECTOR SECTION					
Peak Output Current	±100	±200	±300	μA	Measured at Pin 11.
Output Offset Current		±2		μA	
Output Impedance		1		MΩ	
Maximum Swing	±4	±5		V	Referenced to Pin 10.
QUADRATURE PHASE DETECTOR					Measured at Pin 3.
Peak Output Current		150		μA	
Output Impedance		1		MΩ	
Maximum Swing		11		Vpp	
INPUT PREAMP SECTION					Measured at Pin 2.
Input Impedance		20		KΩ	
Input Signal					
Voltage Required to Cause Limiting		2		mV rms	
Max. Input Voltage		3		V rms	
VOLTAGE COMPARATOR SECTIONS					
Input Impedance		2		MΩ	Measured at Pins 3 and 8.
Input Bias Current		100		nA	
Voltage Gain	55	70		dB	$R_L = 5.1\ K\Omega$
Output Voltage Low		300		mV	$I_C = 3$ mA
Output Leakage Current		10		nA	$V_0 = 12V$
INTERNAL REFERENCE					Measured at Pin 10.
Voltage Level	4.75	5.3	5.85	V	
Output Impedance		100		Ω	

EQUIVALENT SCHEMATIC DIAGRAM



FUNCTIONAL BLOCK DIAGRAM

XR-2211



XR-2240
XR-2250

EXAR INTEGRATED SYSTEMS, INC.
750 Palomar Ave., Sunnyvale, CA 94086 Sales: (408) 733-7700

Programmable Timer/Counter

ELECTRICAL CHARACTERISTICS

Test Conditions: See Figure 3, $V^+ = 5V$, $T_A = 25°C$, R = 10 kΩ, C = 0.1 μF, unless otherwise noted.

PARAMETERS	XR-2240/2250			XR-2240C/2250C			UNIT	CONDITIONS
	MIN	TYP	MAX	MIN	TYP	MAX		
GENERAL CHARACTERISTICS								
Supply Voltage	4		15	4		15	V	For $V^+ < 4.5V$, Short Pin 15 to Pin 16
Supply Current								
Total Circuit		3.5	6		4	7	mA	$V^+ = 5V$, $V_{TR} = 0$, $V_{RS} = 5V$
		12	16		13	18	mA	$V^+ = 15V$, $V_{TR} = 0$, $V_{RS} = 5V$
Counter Only		1			1.5		mA	See Figure 4
Regulator Output, V_R	4.1	4.4		3.9	4.4		V	Measured at Pin 15, $V^+ = 5V$
	6.0	6.3	6.6	5.8	6.3	6.8	V	$V^+ = 15V$, See Figure 5
TIME BASE SECTION								See Figure 3
Timing Accuracy *		0.5	2.0		0.5	5	%	$V_{RS} = 0$, $V_{TR} = 5V$
Temperature Drift		150	300		200		ppm/°C	$V^+ = 5V$ $0°C \leq T \leq 75°C$
		80			80		ppm/°C	$V^+ = 15V$
Supply Drift		0.05	0.2		0.08	0.3	%/V	$V^+ \geq 8$ Volts
Max Frequency	100	130			130		kHz	R = 1 kΩ, C = 0.007 μF
Modulation Voltage								Measured at Pin 12
Level	3.00	3.50	4.0	2.80	3.50	4.20	V	$V^+ = 5V$
		10.5			10.5		V	$V^+ = 15V$
Recommended Range of Timing Components								See Figure 6
Timing Resistor, R	0.001		10	0.001		10	MΩ	
Timing Capacitor, C	0.007		1000	0.01		1000	μF	
TRIGGER/RESET CONTROLS								
Trigger								Measures at Pin 11, $V_{RS} = 0$
Trigger Threshold		1.4	2.0		1.4	2.0	V	
Trigger Current		8			10		μA	$V_{RS} = 0$, $V_{TR} = 2V$
Impedance		25			25		kΩ	
Response Time **		1			1		μsec	
Reset								
Reset Threshold		1.4	2.0		1.4	2.0	V	
Reset Current		8			10		μA	$V_{TR} = 0$, $V_{RS} = 2V$
Impedance		25			25		kΩ	
Response Time **		0.8			0.8		μsec	
COUNTER SECTION								See Figure 5, $V^+ = 5V$
Max. Toggle Rate	0.8	1.5			1.5		MHz	$V_{RS} = 0$, $V_{TR} = 5V$ Measured at Pin 14
Input:								
Impedance		20			20		kΩ	
Threshold	1.0	1.4		1.0	1.4		V	
Output:								Measured at Pins 1 thru 8
Rise Time		180			180		nsec.	$R_L = 3K\Omega$, $C_L = 10$ pF
Fall Time		180			180		nsec.	
Sink Current	3	5		2	4		mA	$V_{OL} \leq 0.4V$
Leakage Current		0.01	8		0.01	15	μA	$V_{OH} \leq 15V$

*Timing error solely introduced by XR-2240, measured as % of ideal time-base period of T = 1.00 RC.
**Propagation delay from application of trigger (or reset) input to corresponding state change in counter output at pin 1.

APPLICATIONS INFORMATION (2240)

PRECISION TIMING (Monostable Operation)

In precision timing applications, the XR-2240 is used in its monostable or "self-resetting" mode. The circuit connection for this application is shown in Figure 9.

ASTABLE OPERATION

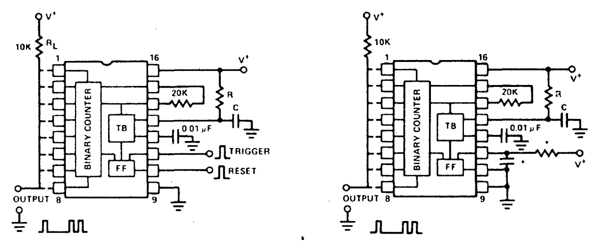
The XR-2240 can be operated in its astable or free-running mode by disconnecting the reset terminal (pin 10) from the counter outputs. Two typical circuit connections for this mode of operation are shown in Figure 12. In the circuit connection of Figure 12(a), the circuit operates in its free-running mode, with external trigger and reset signals. It will start counting and timing subsequent to a trigger input until an external reset pulse is applied. Upon application of a positive-going reset signal to pin 10, the circuit reverts back to its rest state. The circuit of Figure 12(a) is essentially the same as that of Figure 6, with the feedback switch S_1 open.

The circuit of Figure 12(b) is designed for continuous operation. The circuit self-triggering automatically when the power supply is turned on, and continues to operate in its free-running mode indefinitely.

In astable or free-running operation, each of the counter outputs can be used individually as synchronized oscillators; or they can be interconnected to generate complex pulse patterns.

OPERATION WITH EXTERNAL CLOCK

The XR-2240 can be operated with an external clock or time-base, by disabling the internal time-base oscillator and applying the external clock input to pin 14. The internal time-base can



(a) Operation with External Trigger and Reset Controls

(b) Free-running or Continuous Operation

Figure 12. Circuit Connections for Astable Operation

be de-activated by connecting a 1 KΩ resistor from pin 13 to ground. The counters are triggered on the negative-going edges of the external clock pulse. For proper operation, a minimum clock pulse amplitude of 3 volts is required. Minimum external clock pulse width must be $\geq 1\ \mu S$.

For operation with supply voltages of 6V or less, the internal time-base section can be powered down by open-circuiting pin 16 and connecting pin 15 to V^+. In this configuration, the internal time-base does not draw any current, and the over-all current drain is reduced by ≈ 3 mA.

FREQUENCY SYNTHESIS WITH HARMONIC LOCKING: The harmonic synchronization property of the XR-2240 time-base can be used to generate a wide number of discrete frequencies from a given input reference frequency. The circuit connection for this application is shown in Figure 13. If the time base is synchronized to $(m)^{th}$ harmonic of input frequency where $1 \leq m \leq 10$, as described in the section on "Harmonic Synchronization", the frequency f_O of the output waveform in Figure 25 is related to the input reference frequency f_R as:

$$f_O = f_R \frac{m}{(N+1)}$$

where m is the harmonic number, and N is the programmed counter modulus. For a range of $1 \leq N \leq 255$, the circuit of Figure 13 can produce 1500 separate frequencies from a single fixed reference.

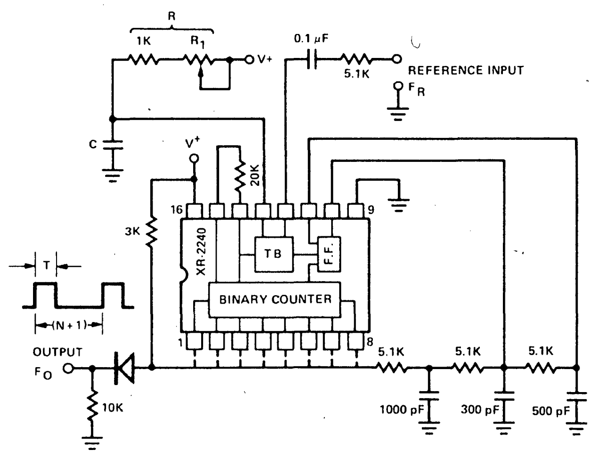
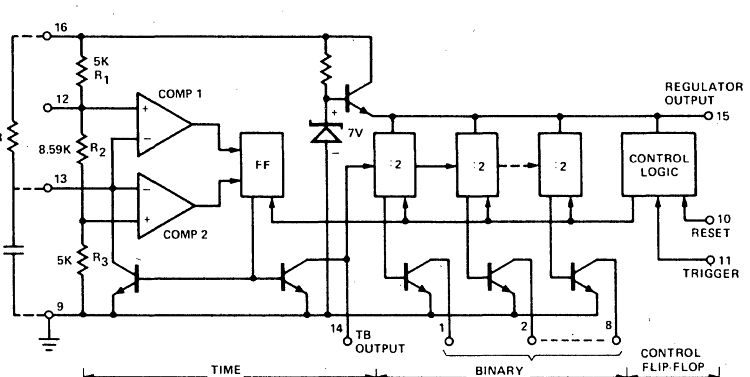


Figure 13. Frequency Synthesis by Harmonic Locking to an External Reference

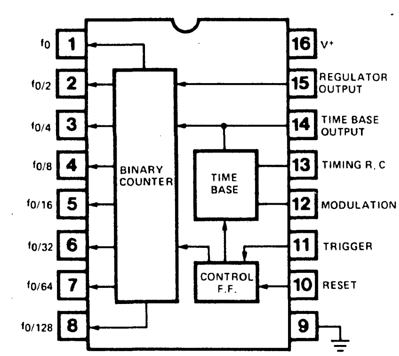
One particular application of the circuit of Figure 13 is generating frequencies which are not harmonically related to a reference input. For example, by choosing the external R-C to set m = 10 and setting N = 5, one can obtain a 100 Hz output frequency synchronized to 60 Hz power line frequency.

SIMPLIFIED SCHEMATIC DIAGRAM



FUNCTIONAL BLOCK DIAGRAM

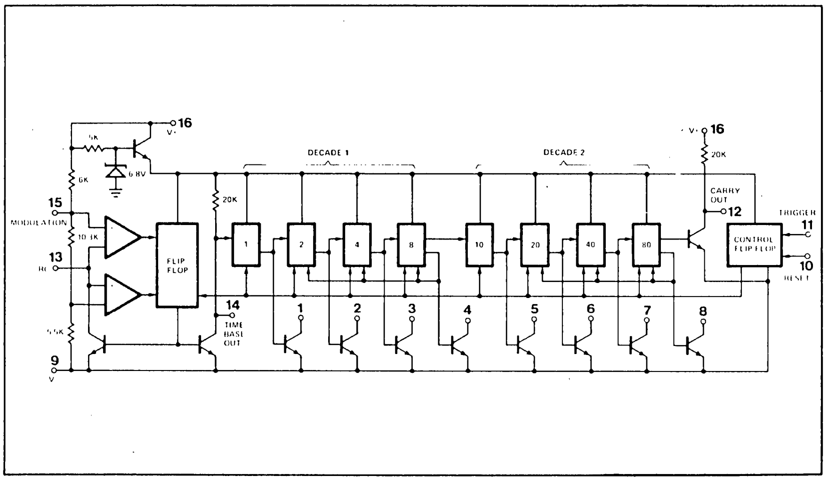
XR-2240



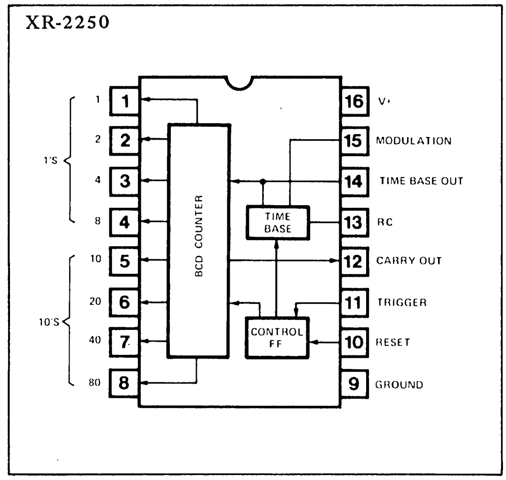
XR-2250 PROGRAMMABLE TIMER/COUNTER

The XR-2250 BCD Programmable Timer/Counter is a monolithic controller capable of producing ultra-long time delays without sacrificing accuracy. In most applications, it provides a direct replacement for mechanical or electromechanical timing devices and generates programmable time delays from micro-seconds up to 24 hours. Two timing circuits can be cascaded to generate time delays up to six months.

EQUIVALENT SCHEMATIC DIAGRAM



FUNCTIONAL BLOCK DIAGRAM



XR-4136
XR-4212

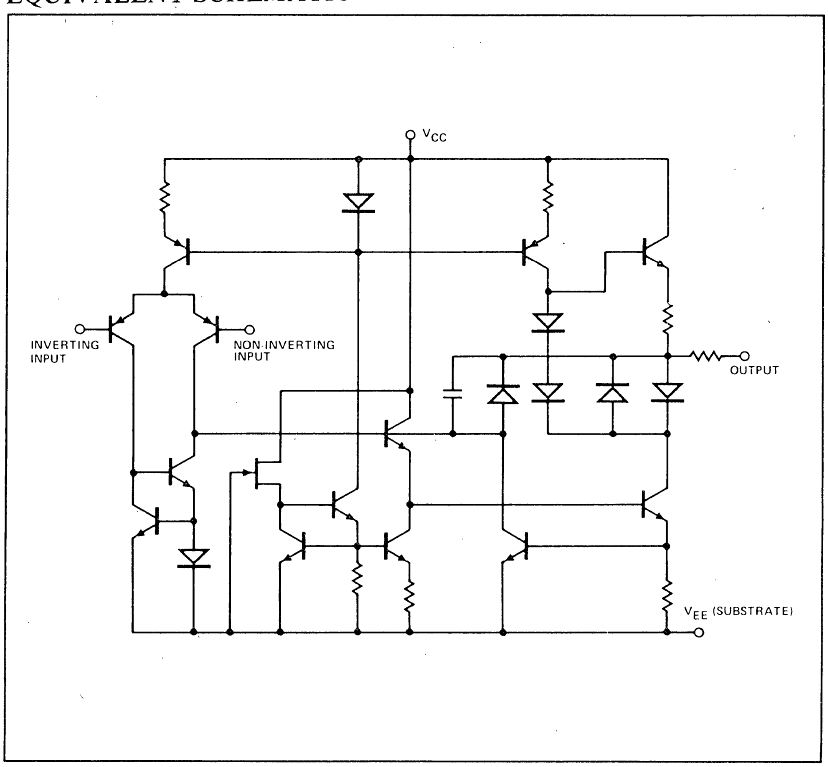
EXAR INTEGRATED SYSTEMS, INC.
750 Palomar Ave., Sunnyvale, CA 94086 Sales: (408) 733-7700

Quad Operational Amplifier

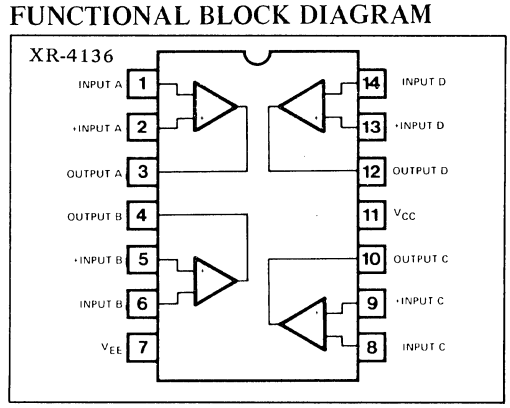
The XR-4136 is an array of four independent internally compensated operational amplifiers on a single silicon chip, each similar to the popular 741, but with a power consumption less than one 741. Good thermal tracking and matched gain-bandwidth products make these Quad Op-amps useful for active filter applications.

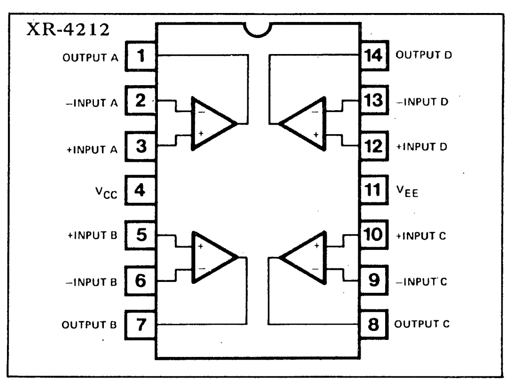
The XR-4212 is an array of four independent internally compensated operational amplifiers on a single silicon chip, each similar to the popular 741, but with a power consumption less than one 741. Good thermal tracking and matched gain-bandwidth products make these Quad Op-amps useful for active filter applications.

EQUIVALENT SCHEMATIC



FUNCTIONAL BLOCK DIAGRAM





ELECTRICAL CHARACTERISTICS $T_A = +25°C, V_S = \pm 15V$ unless otherwise specified

CHARACTERISTICS	XR4136M/4212M MIN.	XR4136M/4212M TYP.	XR4136M/4212M MAX.	XR4136C/4212C MIN.	XR4136C/4212C TYP.	XR4136C/4212C MAX.	UNITS	SYMBOLS	CONDITIONS
Input Offset Voltage		1	5.0		1	6.0	mV	$\lvert V_{io} \rvert$	$R_S \leq 10\ K\Omega$
Input Offset Current		10	200		10	200	nA	$\lvert I_{io} \rvert$	
Input Bias Current		80	500		80	500	nA	$\lvert I_b \rvert$	
Input Resistance	0.3	1.8		0.3	1.8		MΩ	R_{in}	
Large Signal Voltage Gain 4136	50	60		20	40		V/mV	A_{VOL}	$R_L \geq 2\ K\Omega$
Large Signal Voltage Gain 4212	20	60		5	40				$V_{out} = \pm 10V$
Output Voltage Swing	±12	±14		±12	±14		V	V_{out}	$R_L \geq 10\ K\Omega$
	±10	±12		±10	±12		V	V_{out}	$R_L \geq 2\ K\Omega$
Input Voltage Range	±12	±13.5		±12	±13.5		V	V_{iCM}	
Common Mode Rejection Ratio	70	105		70	105		dB	CMRR	$R_S \leq 10\ K\Omega$
Supply Voltage Rejection Ratio		10	150		10	150	µV/V	PSRR	$R_S \leq 10\ K\Omega$
Power Consumption		50	120		50	120	mW	P_i	
Transient Response (unity gain)									$V_{in} = 20\ mV$, $R_L = 2\ K\Omega$
Risetime		0.07			0.07		µs	t_r	$C_L \leq 100\ pF$
Overshoot		20			20		%	t_o	
Unity Gain Bandwidth	2.0	3.0			3.0		MHz	BW	
Slew Rate (unity gain)		1.6			1.6		V/µs	dV_{out}/dt	$R_L \geq 2\ K\Omega$
Channel Separation (open loop)		120			120		dB		f = 10 KHz, $R_s = 1\ K\Omega$
(Gain of 100)		105			105		dB		f = 10 KHz, $R_s = 1\ K\Omega$
The following specifications apply for $-55°C \leq T_A \leq +125°C$ for XR-4136M: $0°C \leq T_A \leq +70°C$ for XR-4136C									
Input Offset Voltage			6.0			7.5	mV	$\lvert V_{io} \rvert$	$R_S \leq 10\ K\Omega$
Input Offset Current			500			300	nA	$\lvert I_{io} \rvert$	
Input Bias Current			1500			800	nA	I_b	
Large-Signal Voltage Gain	25			15			V/mV	A_{VOL}	$R_L \geq 2\ K\Omega$, $V_{out} = \pm 10V$
Output Voltage Swing	±10			±10			V	V_{out}	$R_L \geq 2\ K\Omega$
Power Consumption									$V_s = \pm 15V$
			150			150	mW	P_i	T_A = High
			200			200	mW	P_i	T_A = Low
Output Short-Circuit Current	5	17	35	5	17	35	mA	I_{SC}	

TYPICAL PARAMETER MATCHING:
$T_A = +25°C, V_S = \pm 15V$ unless otherwise noted

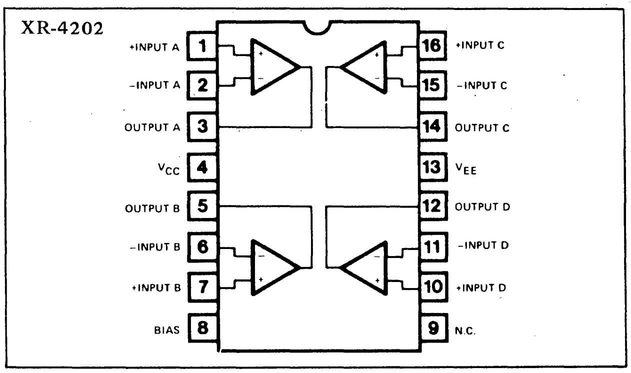
CHARACTERISTICS	XR4136M TYP.	XR4136C TYP.	UNITS	SYMBOLS	CONDITIONS
Input Offset Voltage	±1.0	±2.0	mV	$\lvert V_{io} \rvert$	$R_S \geq 10\ K\Omega$
Input Offset Current	±7.5	±7.5	nA	$\lvert I_{io} \rvert$	
Input Bias Current	±15	±15	nA	I_b	
Voltage Gain	±0.5	±1.0	dB	A_{VOL}	$R_S \geq 2\ K\Omega$

XR-4202

EXAR INTEGRATED SYSTEMS, INC.
750 Palomar Ave., Sunnyvale, CA 94086 Sales: (408) 733-7700

Programmable Quad Operational Amplifier

FUNCTIONAL BLOCK DIAGRAM



FEATURES

Programmable
Micropower Operation
Wide Input Voltage and Common Mode Range
Internal Frequency Compensation
No Latch-Up
Matched Parameters
Short-Circuit Protection

ELECTRICAL CHARACTERISTICS HIGH POWER MODE (V_S = ±15V, I_{SET} = 75 μA and T_A = +25°C unless otherwise specified)

CHARACTERISTICS	MIN	TYP	MAX	UNITS	SYMBOL	CONDITIONS
Short Circuit Current	5	17	30	mA	I_{SC}	0°C ≤ T_A ≤ 75°C
Supply Current	0.8	1.7	4.0	mA	I_s	Note 3
Input Offset Voltage		0.8	5.0	mV	V_{io}	R_s ≤ 10 KΩ
Input Bias Current		80	500	nA	I_b	
Input Off-set Current		10	50	nA	I_{io}	
Input Resistance	0.1	0.6		MΩ	R_{in}	
Input Common Mode Voltage Range	12	±14		±V	V_{iCM}	
Common Mode Rejection Ratio	70	110		dB	CMRR	
Voltage Supply Rejection Ratio		15	150	μV/V	PSRR	
Large Signal Voltage Gain	74	88		dB	A_{VOL}	R_L = 3 KΩ; ΔV_o = ±10V
Output Voltage Swing	±10	±13.6		±V	V_{out}	R_L = 3 KΩ
Gain-Bandwidth Product		3.5		MHz	f_1	
Phase Margin		45		Deg.		
Rise Time		70		ns	t_R	ΔV_o = ±20 mV
Overshoot		20		%	t_o	ΔV_o = ±20 mV
Channel Separation		120		dB		Any amp. pair: freq. = 1 Hz, R_L = 3 KΩ
		105		dB		Any amp. pair: freq. = 10 KHz, R_L = 3 KΩ
Slew Rate		1.5		V/μs	$dV_{out/dt}$	
Input Voltage Noise		25		nV/√Hz	e_n	Bandwidth 100 Hz to 10 KHz

Note: Short circuit may be taken to either supply line or ground on only one amplifier at a time.

ELECTRICAL CHARACTERISTICS MICROPOWER MODE (I_{SET} = 1 μA, V_S = ±1.5V)

CHARACTERISTICS	MIN	TYP	MAX	UNITS	SYMBOL	CONDITIONS
Supply Current	20		40	μA	I_s	Note 3
Input Bias Current			100	nA	I_B	
Input Offset Current			10	nA	I_{OS}	
Input Offset Voltage		0.5	5	mV	V_{os}	R_s ≤ 10 KΩ
Input Resistance	0.5			MΩ	R_{in}	
Input Common Mode Voltage Range	0.3	±0.8		±V	V_{iCM}	
Common Mode Rejection Ratio	60	100		dB	CMRR	
Voltage Supply Rejection Ratio		20	200	μV/V	PSRR	
Large Signal Voltage Gain	66	80		dB	A_{vol}	R_L ≥ 100 KΩ
Gain-Bandwidth Product		50		KHz	f_1	
Phase Margin		75		Deg.		
Slew-Rate		20		V/ms	$dV_{out/dt}$	
Rise Time		7		μs	t_R	ΔV_o = ±20 mV
Overshoot		0		%	t_o	ΔV_o = ±20 mV
Channel Separation		120		dB		Freq. = Hz: R_L = 20 KΩ, ΔV_o = ±0.5V
		120		dB		Freq. = 1 KHz: R_L = 10 KΩ, ΔV_o = ±0.5V
Equivalent Input Voltage Noise		200		nV/√Hz	e_n	Bandwidth = 100 Hz to 10 KHz

PARAMETER MATCHING (I_{SET} = 75 μA$^{(2)}$)

CHARACTERISTICS	MIN	TYP	MAX	UNITS	SYMBOL	CONDITIONS
Input Offset Voltage		1		±mV	V_{os}	R_s ≤ 10 KΩ
Input Bias Current		10		±nA	I_B	
Input Offset Current		2		±nA	I_{os}	
Gain-Bandwidth Product		100		±KHz	f_1	
Slew Rate		0.2		±V/μs	$dV_{o/dt}$	

NOTES:

1. All tests refer to a single Op. amp unless otherwise specified.
2. Tests apply for parameter matching between any Op. amp pair.
3. Tests apply to four Op. amps and bias network.

EXAR-CHIP

EXAR INTEGRATED SYSTEMS, INC.
750 Palomar Ave., Sunnyvale, CA 94086 Sales: (408) 733-7700

Custom IC Design Kit

HOW THE XR-CHIP PROGRAM WORKS:	The XR-CHIP design approach involves only *6 simple steps*, from the beginning of circuit design to completion of monolithic prototypes. The first three of these steps is done by the customer in consultation with Exar; the last three are performed by Exar:

Step 1

Customer designs and breadboards his circuit using XR-CHIP kit.

Customer purchases the XR-Chip Design Kit, made up of XR-Chip Instruction Manual and 33 monolithic kit parts or building blocks. Customer then breadboards his circuit and evaluates its performance using these kit parts. The electrical characteristics of kit parts are virtually identical to those which will be on the finished IC chip. Thus, this stage provides a true simulation of final IC performance.

Step 2

Customer does circuit layout.

After completion of breadboard evaluation, customer prepares a layout of the circuit on the selected XR-Chip by following the basic layout rules given in XR-Chip Instruction Manual. The layout is done simply by interconnecting appropriate device terminals with pen or pencil lines on oversize drawings of the XR-Chips supplied with the kit.
NOTE: As an option, Exar also offers a layout service, at a nominal charge.

Step 3

Submit layout to Exar for review:

Exar reviews the circuit layout and schematic to check:
a) That basic circuit function is feasible
b) No layout rules are violated
c) Circuit layout accurately represents the circuit schematic.

NOTE: Steps 1, 2, and 3 are done at *no cost* to the customer, except for the nominal cost of the XR-Chip design kit. Exar offers free consulting service and design advice during these first three steps. The "formal" part of the program is initiated at the completion of Step 3.

Step 4

Exar generates custom interconnection pattern.

Using the XR-Chip circuit layout supplied by the customer, Exar generates a custom interconnection pattern, or "metal mask" to be applied to pre-fabricated XR-Chip wafers.

Step 5

Exar fabricates customized IC wafers.

Exar applies the custom interconnection patterns to pre-fabricated XR-Chip wafers. These wafers are then tested for semiconductor device characteristics (such as resistor values, diode and transistor characteristics) using special "test-patterns" etched on the wafer. The wafers are then accepted as a "qualified wafers" if these device parameters are within the specified limits (see Table of Electrical Characteristics listed on pages 6 and 7).

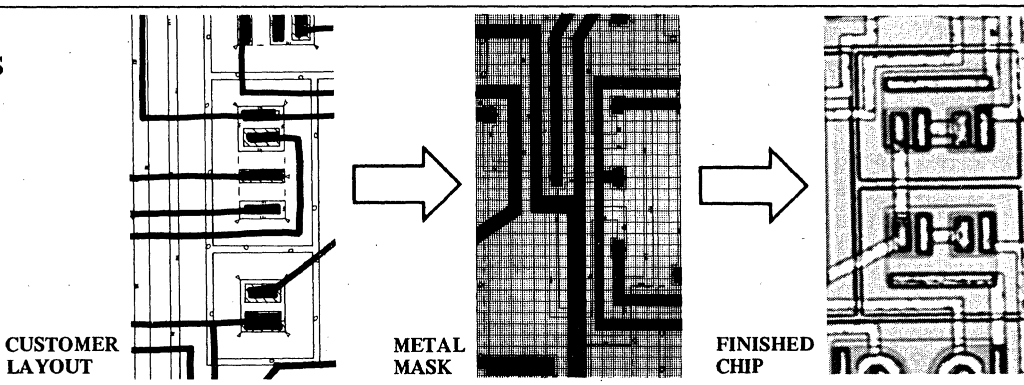
Step 6

Exar assembles and delivers monolithic prototypes.

The customized IC wafers are scribed or cut into individual IC chips. After a visual inspection, a number of these custom IC chips are assembled in dual-in-line IC packages and delivered to the customer for electrical evaluation, to conclude the program.

In addition to the monolithic prototype IC's, the following technical information is also delivered to the customer:
a) A computer printout of device characteristics measured in Step 5, using special "test-patterns" on the IC wafers.
b) An enlarged photo-micrograph of the finished IC chip showing the custom interconnection pattern.

METAL MASK FABRICATION STEPS



ANSWERS TO MOST FREQUENTLY ASKED QUESTIONS:

Based on our long experience with the XR-Chip, we have compiled a comprehensive glossary of the "most often asked questions" concerning the program. The following is a list of these questions and their answers:

WHAT IS THE COST OF THE BASIC PROGRAM?

The approximate cost of the basic 6-step XR-Chip program as outlined on Page 3, is in the range of $1,500 to $2,200, depending on circuit complexity. The above prices also include the cost of 50 monolithic prototypes delivered at the completion of the program.

Additional untested prototypes for evaluation are available at a cost of $3.50 each, in minimum quantities of 100 units. These cost examples are for budgetary purposes only, and are subject to change without notice.

WHAT IS THE DEVELOPMENT TIME?

Typical development time for the basic XR-Chip program, starting with the customer's XR-Chip layout and ending with the monolithic prototypes is *four* to *six* weeks.

WHAT IF ADDITIONAL DESIGN CYCLES ARE NEEDED?

Upon evaluation of 50 monolithic prototypes, if the customer desires to modify the design or the layout, a complete design iteration cycle can be completed within *four* weeks, starting with the modified layout and ending with 50 prototypes of the *modified* design. Typical cost of additional design cycles or iterations is $1,000 per design cycle, including the cost of 50 additional prototypes.

IS THERE A SECOND-SOURCE FOR XR-CHIP IC'S?

In most high-volume production applications of IC's, the customer often requires more than one supplier of a given IC. Anticipating this "alternate-source" requirement, Exar has made contractual agreements with other IC manufacturers to provide a second-source for the XR-Chip custom IC's.

In addition, the XR-A100 and the XR-B100 chips of the XR-Chip product family are direct replacements for the "Monochip A" and the "Monochip B" products manufactured by Interdesign, Inc. of Sunnyvale, California.

WHAT ABOUT PRODUCTION PRICING?

The production pricing of monolithic IC's depend on three key factors:

a) Circuit complexity (i.e., yield)
b) Quantity
c) Package type

In the case of a custom IC, it is impossible to anticipate the impact of these factors in advance, since each custom IC by definition, has some unique requirement or feature associated with it. However, based on experience, typical unit prices associated with a fully-tested medium complexity XR-Chip IC in 14- or 16-pin plastic dual-in-line package are in the range of $3.50 at 1,000 piece-level; decreasing to $2.00 at 10,000-piece level; and to $1.20 at 100,000-piece level.

The above price estimates are for budgetary purposes only. After reviewing the circuit performance and quantity requirements, Exar shall provide the customer with a detailed proposal outlining the cost breakdown and production pricing for a given circuit.

CAN EXAR DO THE IC LAYOUT?

Exar also offers a circuit layout service to translate the customer's circuit schematic into an XR-Chip layout. Essentially, this corresponds to the "Step 2" of the 6-step XR-Chip program, outlined on page 3. The cost of this layout service is in the range of $400 to $1,000, depending on complexity.

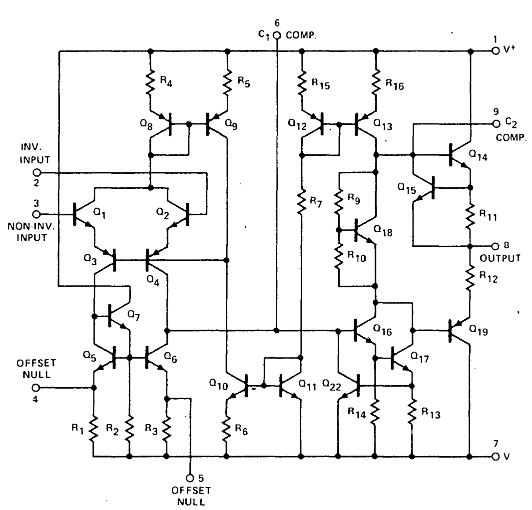
DOES EXAR HAVE OTHER XR-CHIPS FOR SPECIAL APPLICATIONS?

Exar also has over twenty different types of monolithic IC chips which have been originally developed as standard IC products. Many of these chips contain additional device types, such as high-current or high-voltage transistors and MOS capacitors. Some of these are shown on page 8.

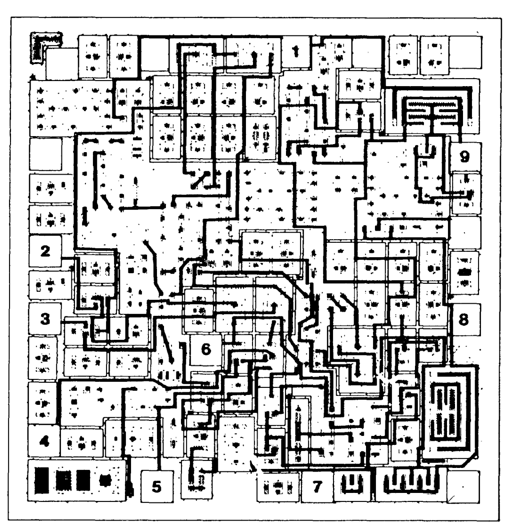
Any one of these monolithic chips can also be used as a part of the XR-Chip program, by simply applying a custom metal interconnection pattern to it. For example, if a given circuit configuration does not fit on the conventional XR-A100, -B100, or -C100 chips because of lack of appropriate device types, such a circuit may still be fitted on any one of these twenty other chips available from Exar.

For further information on these additional XR-Chips and their characteristics, contact your Exar representative, or Exar Applications Department.

DESIGN EXAMPLE USING EXAR-CHIP APPROACH



CIRCUIT SCHEMATIC



XR-CHIP LAYOUT

XR-CHIP CUSTOM DESIGN KIT CONTENTS

ITEM	PART NO.	DESCRIPTION	KIT QUAN.	DEVICES PER ARRAY
1	XR-B101	Small Signal NPN Transistor Array	8	5
2	XR-B102	PNP Transistor Array	2	5
3	XR-C101	Small Signal NPN Transistor Array	8	5
4	XR-C102	PNP Transistor Array	2	5
5	XR-C103	Special Purpose NPN Transistors	4	5
6	XR-C104	Small Value Resistors	5	10
7	XR-C105	Large Value Resistors	3	8
8	XR-C106	Functional Building Blocks	1	3
		Total Arrays	33	
9		Design Manual	1	–

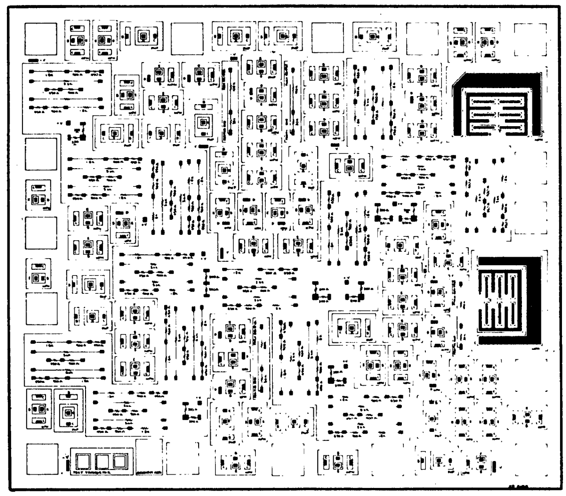
Notes:
1. B-101 and B-102 arrays are suitable only for A-100 and B-100 Chips.
2. C-101 and C-102 arrays are suitable only for C-100 Chip. However, substrate PNP transistors in C-102 are also available in A-100 Chip.
3. C-103 thru C-106 devices are suitable for both B-100 and C-100 Chips.

TABLE OF COMPONENTS ON XR-CHIPS

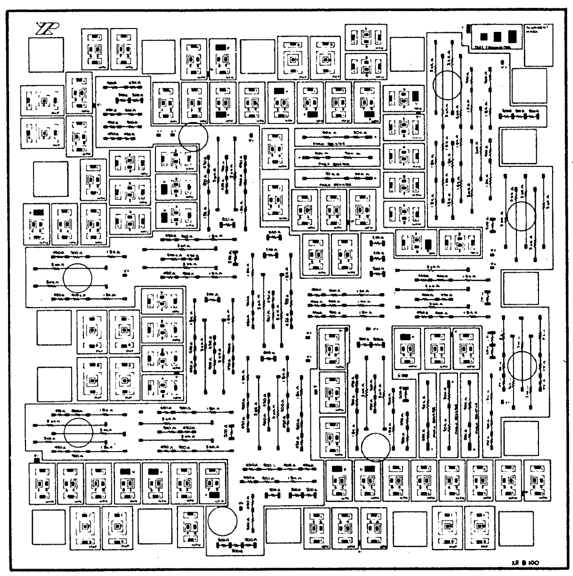
COMPONENT TYPE	A-100	B-100	C-100
Small NPN Transistors	58	53	46
Small NPN Transistors/Common Collector			8
Small NPN Transistor w/Schottky Diodes	15	16	3
100 mA NPN Transistors			2
200 mA NPN Transistors	2		
Lateral PNP Transistors	18	12	8
Vertical PNP			2
Resistors 50 Ohms			4
Resistors 100 Ohms			4
Resistors 150 Ohms			10
Resistors 200 Ohms	16	27	10
Resistors 400 Ohms			30
Resistors 450 Ohms	43	44	
Resistors 800 Ohms			29
Resistors 900 Ohms	43	46	
Resistors 1.6k Ohms			20
Resistors 1.8K	29	39	
Resistors 3.2K Ohms	29		15
Resistors 3.6K	28	39	
Resistors 5K			4
Resistors 30K Ohms Pinch	4	6	5
Resistors 100K Ohms Pinch	4	6	1
Maximum Number of Bonding Pads	16	24	19
+ V Contacts	7	12	10
– V Contacts	8	14	13
Component Total	260	288	201
Chip Size (Mils)	83x73	85x85	76x78

XR-CHIP LAYOUTS

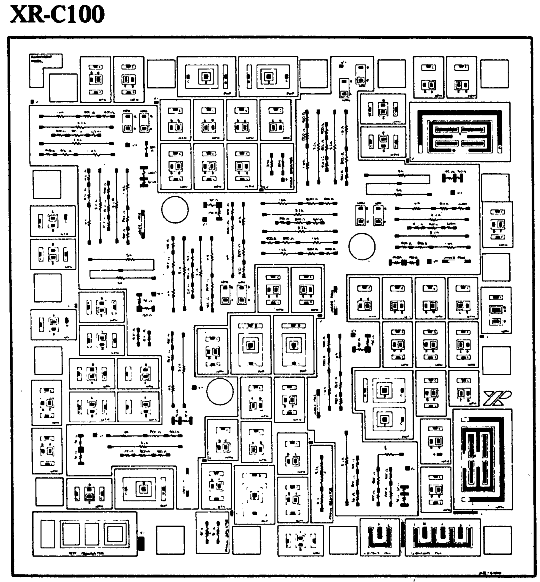
XR-A100



XR-B100



XR-C100



Exar

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ELECTRICAL CHARACTERISTICS OF EXAR CHIP COMPONENTS

The following tables list the electrical characteristics of active and passive circuit components available on the XR-A100, XR-B100 and the XR-C100 custom IC chips. Whenever applicable, the worst-case tolerances and the parameter distributions are also listed. The parameter distributions are given in terms of the anticipated "Standard-deviation," σ.

1. Small NPN Transistors

Parameter	Typical Values
Current gain (h_{FE}) @ 1 mA, 5V	180
Temperature Coefficiency of h_{FE}	
−55°C to 25°C	+0.5%/°C
25°C to 125°C	+1%/°C
Matching of h_{FE}	–
Breakdown voltage (LV_{CEO})	
A-100/B-100	23V
C-100	27V
Collector-Base Leakage Current @ 20V	1 nA
Cutoff Frequency (f_T)	500 MHz
Storage Time (t_s)	50 nsec
Saturation Resistance	
One collector contact	100 Ohms
Two collector contact	50 Ohms

2. Large NPN Transistors (A-100/C-100 only)

Parameter	Typical Values
Current Gain (h_{FE})	
@ 1 mA, 5V	180
@ 100 mA, 5V	100
Temperature Coefficient of h_{FE}	
−55°C to 25°C	+0.5%/°C
25°C to 125°C	+1%/°C
Matching h_{FE}	–
Breakdown Voltage (LV_{CEO})	27V
Collector-Base Leakage Current @ 20V	20 nA
Cutoff Frequency (f_T)	100 MHz
Storage Time (t_s)	200 nsec
Saturation Resistance	5 Ohms

3. Lateral PNP Transistors (All XR-Chips)

Parameters	Typical Values
Current Gain (h_{FE}) @ 100 μA, 5V	20
Temperature Coefficient of h_{FE}	±0.1%/°C
Matching of h_{FE}	–
Breakdown Voltage (LV_{CEO})	40V
Collector-Base Leakage Current @ 20V	5 nA
Cutoff Frequency (f_T)	5 MHz
Storage Time (t_s)	500 nsec
Saturation Resistance	600 Ohms

4. Vertical PNP Transistors (C-100 only)

Parameters	Typical Values
Current Gain (h_{FE}) @ 1 mA, 5V	20
Breakdown Voltage @ 150 μA (LV_{CEO})	35V
Cutoff Frequency (f_T)	15 MHz

5. Transistors connected as diodes (collector and base shorted)

Parameters	Typical Values
Small NPN (All XR-Chips)	
Reverse Breakdown Voltage	6.7V
Forward Voltage Drop @ 1 mA, 25°C	0.74V
Forward Voltage Matching	–
Forward Voltage Tracking	–
Large NPN (A-100 and C-100 only)	
Reverse Breakdown Voltage	6.7V
Forward Voltage Drop @ 100 mA, 25°C	0.62V
Forward Voltage Matching	–
Forward Voltage Tracking	–
Lateral PNP (All XR-Chips)	
Reverse Breakdown Voltage	40V
Forward Voltage Drop @ 200 μA, 25°C	0.70V
Forward Voltage Matching	–
Forward Voltage Tracking	–

6. NPN Base-Emitter Junctions used as Zener Diodes

Parameters		Typical Values
Small NPN Transistors		
A-100/B-100		
Breakdown Voltage	@ 10 μA	6.3V
	@ 100 μA	6.35V
	@ 1 mA	6.45V
Temperature Co-Efficient	@ 10 μA	+2.4 mV/°C
	@ 100 μA	+2.5 mV/°C
	@ 1 mA	+2.5 mV/°C
C-100		
Breakdown Voltage	@ 10 μA	6.68V
	@ 100 μA	6.75V
	@ 1 mA	6.80V
Temperature Co-Efficient	@ 10 μA	+2.4 mV/°C
	@ 100 μA	+2.45 mV/°C
	@ 1 mA	+2.5 mV/°C

7. Schottky-Barrier Diodes (All XR-Chips)

Parameters	Typical Values
Forward Voltage Drop @ 10 μA	0.28V
Temperature Co-Efficient of Forward Voltage Drop	−1.5 mV/°C
Reverse Breakdown Voltage	30V
Leakage Current @ 20V	200 nA

8. Diffused Resistors (All XR-Chips)

Parameters		Typical Values
Absolute Values		–
Temperature Co-Efficients	−55°C to −25°C	−650 ppm/°C
	−25°C to 0°C	+150 ppm/°C
	0°C to 25°C	+680 ppm/°C
	25°C to 75°C	+1040 ppm/°C
	75°C to 125°C	+1400 ppm/°C
Matching between resistors		
Identical values		–
200 – 450		–
200 – 900		–
200 – 1.8K		–
200 – 3.6K		–
450 – 900		–
450 – 1.8K		–
450 – 3.6K		–
900 – 1.8K		–
900 – 3.6K		–
1.8K – 3.6K		–

9. Typical capacitances (in pF) for the various junctions in Exar Chip.

	1V	5V
Small NPN Transistors		
Collector-Base	1.2 pF	0.85 pF
Emitter-Base	1.0	0.65
Collector-Substrate	1.5	1.2
Large NPN Transistors		
Collector-Base	7.5	6.3
Emitter-Base	12.5	9.9
Collector-Substrate	9.5	8.1
Lateral PNP Transistors		
Collector-Base	2.5	2.1
Emitter-Base	1.5	1.3
Base-Substrate	1.8	1.4
Schottky-Barrier Diodes		
Metal to N-layer	0.6	0.4
Resistors		
200 Ohms	1.2	0.85
450 Ohms	0.2	0.13
900 Ohms	0.4	0.28
1.8K Ohms	0.7	0.5
3.6K Ohms	1.5	1.0
Pinch	1.5	1.2

EXAR INTEGRATED SYSTEMS, INC.
750 Palomar Ave., Sunnyvale, CA 94086 Sales: (408) 733-7700

Custom I^{2}L Design Kit

With the XR-400K I^{2}L Design Kit, Exar now offers a unique method of manufacturing an almost unlimited variety of custom *linear* and *digital* circuits using I^{2}L technology with greatly reduced cost and development time. Exar makes this possible by stocking I^{2}L silicon wafers that are completely built except for the final process step of device interconnection. These pre-fabricated wafers are then customized by application of *two* additional "masking" steps, one to open the contact windows on the chip, and one to form the desired metal interconnection pattern.

WHAT IS THE EXAR I^{2}L DESIGN KIT?

Exar's XR-400K I^{2}L Design Kit is made up of 30 monolithic I^{2}L logic blocks and bipolar transistor arrays. These monolithic IC's or "kit parts" comprise the basic building blocks for complex analog or digital LSI systems. The XR-400K I^{2}L Design Kit also contains a comprehensive "Design and Applications Manual" which enables the kit user to breadboard his system with I^{2}L logic, and develop his own custom LSI circuit.

The XR-400K I^{2}L Design Kit contains all the basic building blocks used in system design, such as:

- I^{2}L Gate Arrays
- I^{2}L Flip/Flop and Counter Arrays
- Latches and Shift Registers
- TTL/I^{2}L Input/Output Interface Circuits
- Bipolar NPN/PNP Transistor Arrays

The heart of the Exar I^{2}L Design Kit is the XR-400 Master Chip, which contains a logic matrix made up of over 1000 I^{2}L transistors and more than 200 conventional bipolar transistors and resistors. All of the logic building blocks, or kit parts, which comprise the Exar I^{2}L Design Kit are derived from the XR-400 Master Chip, with different metal interconnection patterns. Thus, the performance of the circuit components in the Exar I^{2}L Design Kit are virtually identical to those on the XR-400 Master Chip.

Once a complex analog or digital system is breadboarded using the I^{2}L Design Kit components, Exar can convert the entire design into a monolithic custom LSI by applying a custom interconnection pattern to the XR-400 Master Chip. The availability of the I^{2}L Design Kit allows the system designer to design and develop his custom I^{2}L LSI at a fraction of the development cost and time associated with conventional custom IC programs. If the complexity of the LSI system exceeds the capability of the XR-400 Master Chip, then Exar can develop a complete custom design, using the I^{2}L Kit components as "cells" in generating a full-custom LSI design.

TABLE OF COMPONENT XR-400 I^{2}L MASTER CHIP

COMPONENT TYPE	QUANTITY
Quad I^{2}L Gates	256
High-Freq. I^{2}L Gates	16
Input/Output Buffers	23
Bipolar Transistors	103
Resistors	120
Under-passes	210
Bonding Pads	40
Chip Size	110 x 110 mils

EXAR's CUSTOM I^{2}L PROGRAM

Exar's custom I^{2}L LSI program is based on the XR-400K design kit and the XR-400 Master Chip. The basic development program involves only 7 simple steps. The first four of these steps is done by the customer, using the I^{2}L Design Kit, in consultation with Exar:

Step 1: Customer designs and breadboards his system using I^{2}L Design Kit.

Step 2: Customer, in consultation with Exar, evaluates design feasibility.

Step 3: Customer prepares circuit layout of his system on XR-400 Master Chip following basic instructions given in I^{2}L Design Kit manual. Layout is done simply by interconnecting appropriate device terminals with pencil lines on oversize drawings of XR-400 chips.

NOTE: As an option, Exar offers layout service at nominal charge.

Step 4: Customer submits his layout to Exar for final review.

NOTE: Steps 1, 2, 3 and 4 are done with no cost from EXAR to customer. The formal part of the program is initiated at the completion of Step 4.

Step 5: Exar generates custom "contact" and "interconnection" patterns to be applied to pre-fabricated XR-400 wafers.

Step 6: Exar fabricates customized I^{2}L wafers from XR-400 chip, using tooling generated in Step 5.

Step 7: Exar assembles and delivers monolithic prototypes of custom IC to complete the program.

ADDITIONAL INFORMATION ON EXAR'S CUSTOM I^{2}L PROGRAM

Development Cost:
Typical development costs for initial prototypes are in the range of $3,500 to $5,000.

Development Time:
Typical development time to complete steps 5, 6 and 7 of development program is 8 weeks.

Additional Design Cycles:
If additional design cycles are needed, the typical cost is $1,500 to $2,000 per design iteration, which includes the cost of additional prototypes.

Layout Services:
Exar can perform the circuit layout (step 3) at a nominal charge of $1,000 to $2,000 depending on complexity.

Full Custom Design:
If the circuit complexity is in excess of the capability of XR-400 Master Chip, Exar can tool-up for a full-custom IC layout and design. In this case, the I^{2}L kit parts used in circuit breadboarding get used as logic "cells" in the circuit layout. Typical full-custom design and fabrication cycle takes about 16 to 20 weeks.

QUAD 741 HIGH-GAIN OPERATIONAL AMPLIFIERS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	RM4136: ±22V RC4136: ±18V
Internal Power Dissipation (Note 1)	800mW
Differential Input Voltage	±30V
Input Voltage (Note 2)	±15V
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	RM4136: −55°C to +125°C RC4136: 0°C to +70°C
Lead Temperature (Soldering, 60s)	300°C
Output Short-Circuit Duration (Note 3)	Indefinite

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$, $V_{CC} = \pm15V$ unless otherwise specified)

PARAMETER	CONDITIONS	RM4136			RC4136			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$R_S \leq 10$ kΩ		0.5	5.0		0.5	6.0	mV
Input Offset Current			5.0	200		5.0	200	nA
Input Bias Current			40	500		40	500	nA
Input Resistance		0.3	5.0		0.3	5.0		MΩ
Large-Signal Voltage Gain	$R_L \geq 2$ kΩ $V_{out} = \pm10V$	50,000	300,000		20,000	300,000		
Output Voltage Swing	$R_L \geq 10$ kΩ	±12	±14		±12	±14		V
	$R_L \geq 2$ kΩ	±10	±13		±10	±13		V
Input Voltage Range		±12	±14		±12	±14		V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	70	90		70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10$ kΩ		30	150		30	150	µV/V
Power Consumption			210	340		210	340	mW
Transient Response (unity gain) Risetime	$V_{in} = 20$ mV $R_L = 2$ kΩ $C_L \leq 100$ pF		0.13			0.13		µs
Transient Response (unity gain) Overshoot	$V_{in} = 20$ mV $R_L = 2$ kΩ $C_L \leq 100$ pF		5.0			5.0		%
Unity Gain Bandwidth		2.0	3.0			3.0		MHz
Slew Rate (unity gain)	$R_L \geq 2$ kΩ		1.5			1.0		V/µs
Channel Separation (open loop)	f = 10 kHz $R_S = 1$ kΩ		105			105		dB
(Gain = 100)	f = 10 kHz $R_S = 1$ kΩ		105			105		dB
The following specifications apply for −55°C ≤ T_A ≤ +125°C for RM4136; 0°C ≤ T_A ≤ +70°C for RC4136.								
Input Offset Voltage	$R_S \leq 10$ kΩ			6.0			7.5	mV
Input Offset Current				500			300	nA
Input Bias Current				1500			800	nA
Large-Signal Voltage Gain	$R_L \geq 2$ kΩ $V_{out} = \pm10V$	25,000			15,000			
Output Voltage Swing	$R_L \geq 2$ kΩ	±10			±10			V
Power Consumption	$V_S = \pm15V$							
	T_A = High		180	300		180	300	mW
	T_A = Low		240	400		240	400	

NOTES:
1. Rating applies for ambient temperature of +25°C; derate linearly at 6.4 mW/°C for ambient temperatures above +25°C.
2. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
3. Short-circuit may be to ground, one amplifier only. I_{SC} = 45mA (typical).

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QUAD 741 HIGH-GAIN OPERATIONAL AMPLIFIERS

DESIGN FEATURES

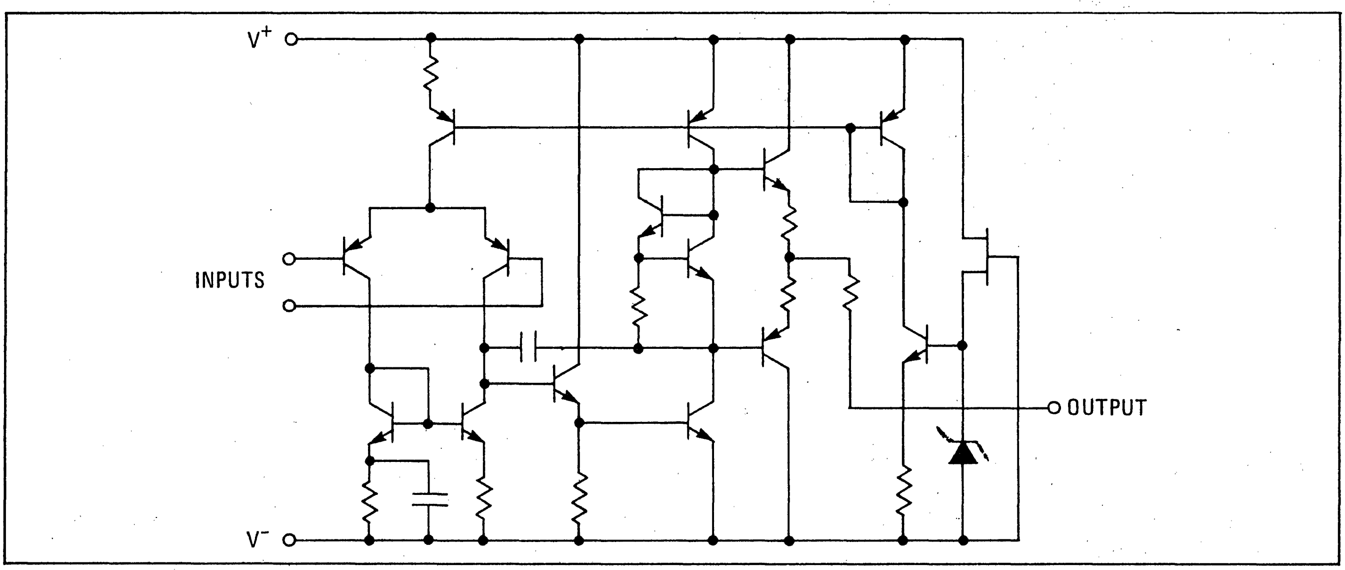
- Unity Gain Bandwidth 3MHz
- Continuous Short Circuit Protection
- No Frequency Compensation Required
- No Latch-up
- Large Common Mode and Differential Voltage Ranges
- Low Power Consumption
- Parameter Tracking Over Temperature Range
- Gain and Phase Match Between Amplifiers

The RM4136/RC4136 include four independent high gain operational amplifiers internally compensated and constructed on a single silicon chip using the planar epitaxial processes.

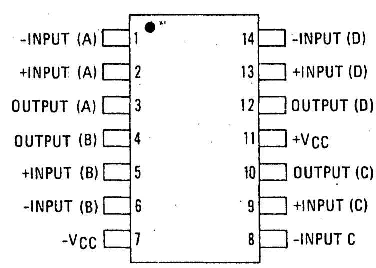
These amplifiers meet or exceed all specifications for 741 type amplifiers. Excellent channel separation allows the use of the 4136 quad amplifier in all 741 operational amplifier applications providing the highest possible packaging density.

The specially designed low noise input transistors allow the 4136 to be used in low noise signal processing applications such as audio preamplifiers and signal conditioners.

SCHEMATIC DIAGRAM



CONNECTION INFORMATION



D and DP
Dual In-line Packages
(Top View)

Order Part Nos.:
RM4136D, RC4136D, RC4136DP

TOTAL QUAD OPERATIONAL AMPLIFIER

3403A
3503A

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V^+	36V or ±18V
Differential Input Voltage	36V
Input Voltage	-0.3V to +36V
Power Dissipation	
"DB" package	500mW (molded DIP epoxy "B")
"DC" package	650mW (hermetic DIP)
Operating Temperature Range	
RM3503A	-55°C to +125°C
RC3403A	0°C to +70°C
RV3403A	-40°C to +85°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 60 sec.)	300°C

ELECTRICAL CHARACTERISTICS V_{CC} = ±15V and T_A = 25°C unless otherwise specified

PARAMETER	CONDITIONS	RM3503A MIN	RM3503A TYP	RM3503A MAX	RC/RV3403A MIN	RC/RV3403A TYP	RC/RV3403A MAX	UNITS
Input Offset Voltage	$R_S = 0\Omega$		2	4		2	6	mV
Input Bias Current	$I_{in}-$ or $I_{in}+$		-150	-400		-150	-500	nA
Input Offset Current	$I_{in}-$ or $I_{in}+$		±30	±50		±30	±50	nA
Input Common Mode Voltage Range		0		V^+-2	0		V^+-2	V
Supply Current	$R_L = \infty$ on all op-amps		3	4		3	5	mA
Large Signal Voltage Gain	$R_L > 2k\Omega$	50	100		25	100		V/mV
Output Voltage Swing	$R_L = 2k\Omega$	±10	±13		±10	±13		V
Common Mode Rejection Ratio	DC	70	90		70	90		dB
Channel Separation	±1 kHz to 20 kHz (in ref)		-120			-120		dB
Output Source Current	$V_{IN}+ = 1V$, $V_{IN}- = 0V$	20	40		20	40		mA
Output Sink Current		10	20		10	20		mA
Small Signal Bandwidth			1			1		MHz
Slew Rate	$A_V = 1$, $-10 < V_i < +10$		1.2			1.2		V/µs
Distortion (crossover)	f = 20 kHz, $V_O = 10V_{pp}$		1			1		%
Power Bandwidth	$V_O = 10V_{pp}$		40			40		kHz
Power Supply Rejection Ratio			20	50		20	100	µV/V

LOW VOLTAGE ELECTRICAL CHARACTERISTICS V_{CC} = +5V, V_{EE} = GND, T_A = 25°C unless otherwise noted

PARAMETER	CONDITIONS	RM3503A MIN	RM3503A TYP	RM3503A MAX	RC/RV3403A MIN	RC/RV3403A TYP	RC/RV3403A MAX	UNITS
Input Offset Voltage	$R_S = 0\Omega$		2.0	5.0		2.0	10	mV
Input Bias Current	$I_{in}- + I_{in}+/2$		-150	-500		-150	-500	nA
Input Offset Current	$I_{in}- - I_{in}+$		30	50		30	50	nA
Supply Current	$R_L = \infty$ all amplifiers		2.5	4.0		2.5	5.0	mA
Large Signal Voltage Gain	$R_L = 2k\Omega$	20	200		20	200		V/mW
Output Voltage Range[1]	$R_L = 10k\Omega$	3.5			3.5			V_{p-p}
Channel Separation	1 kHz ≤ F ≤ 200 kHz (input referred)		-120			-120		dB
Power Supply Rejection Ratio				50			150	µV/V

[1] Output will swing to ground.

ELECTRICAL CHARACTERISTICS GUARANTEED OVER TEMPERATURE

V_{cc} = ±15V
Range: RM3503A -55°C to +125°C
RC3403A 0°C to + 70°C
RV3403A -40°C to + 85°C

Raytheon reserves the right to change these specifications without notice.

PARAMETER	CONDITIONS	RM3503A MIN	RM3503A MAX	RC3403A MIN	RC3403A MAX	RV3403A MIN	RV3403A MAX	UNITS
Input Offset Voltage	$R_S = 0\Omega$		6.0		10.0		10.0	mV
Input Bias Current	$I_{in}- + I_{in}+/2$		-1500		-800		-1500	nA
Input Offset Current	$I_{in}- - I_{in}+$		200		200		200	nA
Large Signal Voltage Gain	$R_L = 2k\Omega$	25		15		15		V/mV
Output Voltage Swing	$R_L = 2k\Omega$	±10		±10		±10		V

TOTAL QUAD OPERATIONAL AMPLIFIER

Raytheon Semiconductor

LINEAR

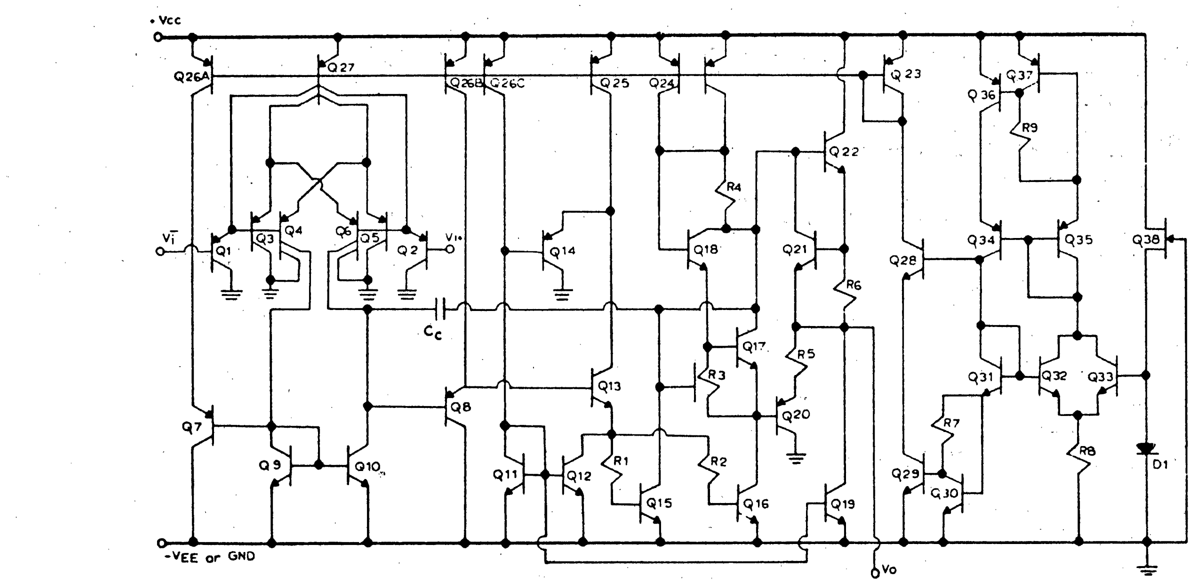
DESCRIPTION

The RC/RV3403A and RM3503A high performance quad op-amps feature improved worst case DC specifications equal to or better than the standard 741 type general purpose op-amp. The devices use a newly developed type of ground-sensing differential input stage which provides increased slew rate.

FEATURES

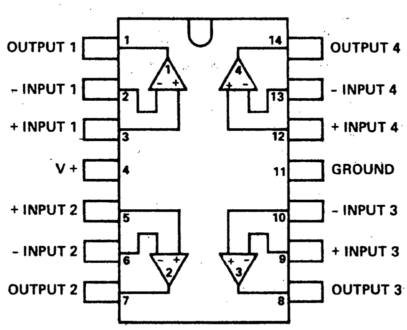
- Class AB output stage; no crossover distortion
- Output voltage swings to ground in single supply operation
- High slew rate: 1.2 V/μs
- Single or split supply operation
- Wide supply operation +2.5V to +36V or ±1.25V to ±18V
- Pin compatible with LM324 and MC3403
- Low power consumption: 0.8 mA/amplifier

SCHEMATIC DIAGRAM



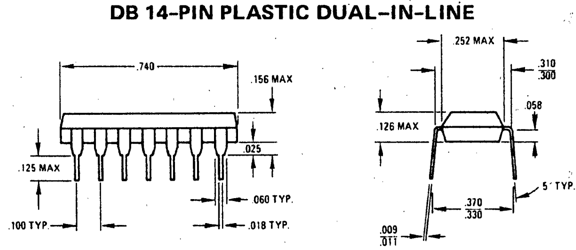
CONNECTION INFORMATION

DB AND DC DUAL-IN-LINE
(Top View)



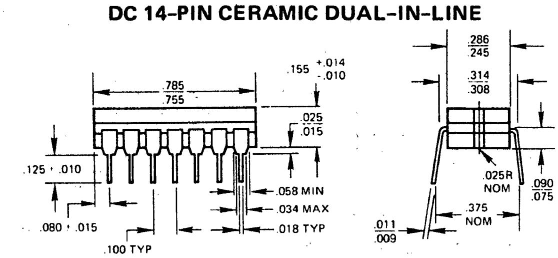
Order Numbers: RC3403ADB, RV3403ADB, RC3403ADC, RM3503ADC

DB 14-PIN PLASTIC DUAL-IN-LINE



Thermal Resistance
θJ-A = 0.16°C/mW
θJ-C = 0.08°C/mW

DC 14-PIN CERAMIC DUAL-IN-LINE



Thermal Resistance
θJ-A = 0.120°C/mW
θJ-C = 0.06°C/mW

MONOLITHIC DUAL HIGH GAIN OPERATIONAL AMPLIFIERS

RM4558
RC4558

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	(RM4558) ±22V
	(RC4558) ±18V
Internal Power Dissipation (Note 1)	500 mW
Differential Input Voltage	±30V
Input Voltage (Note 2)	±15V
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	(RM4558) −55°C to +125°C
	(RC4558) 0°C to +70°C
Lead Temperature (Soldering, 60 sec)	300°C
Output Short-Circuit Duration (Note 3)	Indefinite

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$, $V_{CC} = \pm 15V$ unless otherwise specified)

PARAMETER	CONDITIONS	RM 4558 MIN	RM 4558 TYP	RM 4558 MAX	RC 4558 MIN	RC 4558 TYP	RC 4558 MAX	UNITS
Input Offset Voltage	$R_S \leq 10$ kΩ		1.0	5.0		2.0	6.0	mV
Input Offset Current			30	200		30	200	nA
Input Bias Current			200	500		200	500	nA
Input Resistance		0.3	1.0		0.3	1.0		MΩ
Large-Signal Voltage Gain	$R_L \geq 2$ kΩ, $V_{out} = \pm 10V$	50,000	200,000		20,000	100,000		
Output Voltage Swing	$R_L \geq 10$ kΩ	±12	±14		±12	±14		V
	$R_L \geq 2$ kΩ	±10	±13		±10	±13		V
Input Voltage Range		±12	±13		±12	±13		V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	70	90		70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10$ kΩ		30	150		30	150	μV/V
Power Consumption			100	170		100	170	mW
Transient Response (unity gain)	$V_{in} = 20$ mV, $R_L = 2$ kΩ, $C_L \leq 100$ pF							
Risetime			0.3			0.3		μs
Overshoot			5.0			5.0		%
Slew Rate (unity gain)	$R_L \geq 2$ kΩ		0.5			0.5		V/μs
Channel Separation (open loop)	f = 10 kHz, $R_S = 1$ kΩ		70			70		dB
(Gain = 100)	f = 10 kHz, $R_S = 1$ kΩ		83			83		dB
The following specifications apply for $-55°C \leq T_A \leq +125°C$ for RM4558; $0°C \leq T_A \leq +70°C$ for RC4558								
Input Offset Voltage	$R_S \leq 10$ kΩ			6.0			7.5	mV
Input Offset Current				500			300	nA
Input Bias Current				1.5			800	nA
Large-Signal Voltage Gain	$R_L \geq 2$ kΩ, $V_{out} = \pm 10V$	25,000			15,000			
Output Voltage Swing	$R_L \geq 2$ kΩ	±10			±10			V
Power Consumption	$V_S = \pm 15V$							mW
	$T_A = +125°C$		90	150		90	150	mW
	$T_A = -55°C$		120	200		120	200	mW

MATCHING CHARACTERISTICS ($T_A = 25°C$, $V = \pm 15V$ unless otherwise noted)

PARAMETER	CONDITIONS	RM 4558 TYP	RC 4558 TYP	UNITS
Voltage Gain	$R_L \geq 2$ kΩ	±.5	±1.0	dB
Input Bias Current		±15	±15	nA
Input Offset Current		±7.5	±7.5	nA
Input Offset Voltage	$R_S \geq 10$ kΩ	±.1	±.2	mV

NOTE 1: Rating applies for case temperatures to 125°C; derate linearity at 6.5 mW/°C for ambient temperatures above +75°C for RM4558
NOTE 2: For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
NOTE 3: Short circuit may be to ground or either supply. Rating applies to +125°C case temperature or +75°C ambient temperature for RC4558.

Raytheon Semiconductor

LINEAR

RM4558
RC4558

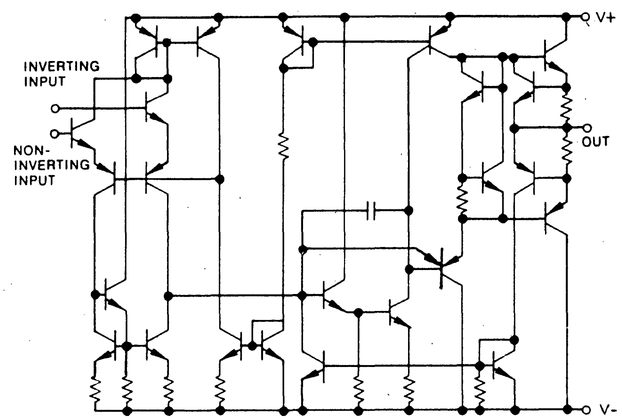
MONOLITHIC DUAL HIGH GAIN OPERATIONAL AMPLIFIERS

The Raytheon RM4558 and RC4558 integrated circuits are high gain operational amplifiers internally compensated and constructed on a single silicon chip using the planar epitaxial process.

The military version, RM4558, operates over a temperature range from −55°C to +125°C. The commercial version, RC4558 operates from 0°C to +70°C.

Combining all of the outstanding features of the 741 with the close parameter matching and tracking of a dual device on a monolithic chip results in unique performance characteristics. Excellent channel separation allows the use of the dual device in all single 741 operational amplifier applications providing the highest possible packaging density. It is especially well suited for applications in differential-in, differential-out as well as in potentiometric amplifiers and where gain and phase matched channels are mandatory.

SCHEMATIC DIAGRAM



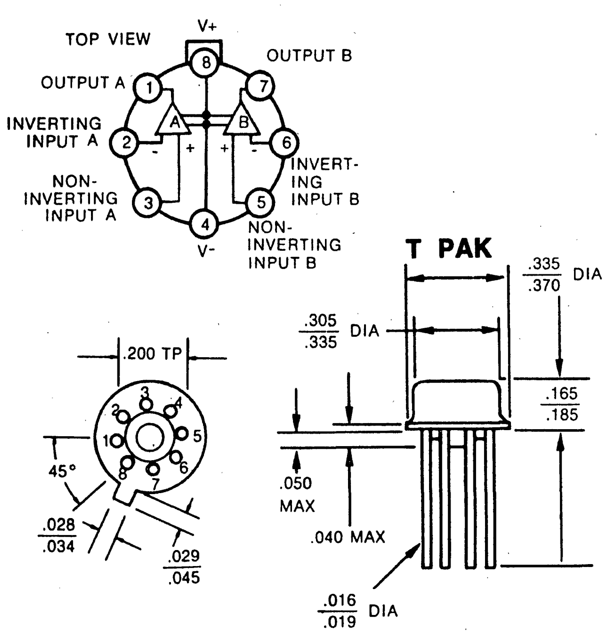
DESIGN FEATURES

- Supply voltage ±22V for RM4558, ±18V for RC4558
- Continuous short circuit protection
- No frequency compensation required
- No latch-up
- Large common-mode and differential voltage ranges
- Low power consumption
- Parameter tracking over temperature range
- Gain and phase match between amplifiers

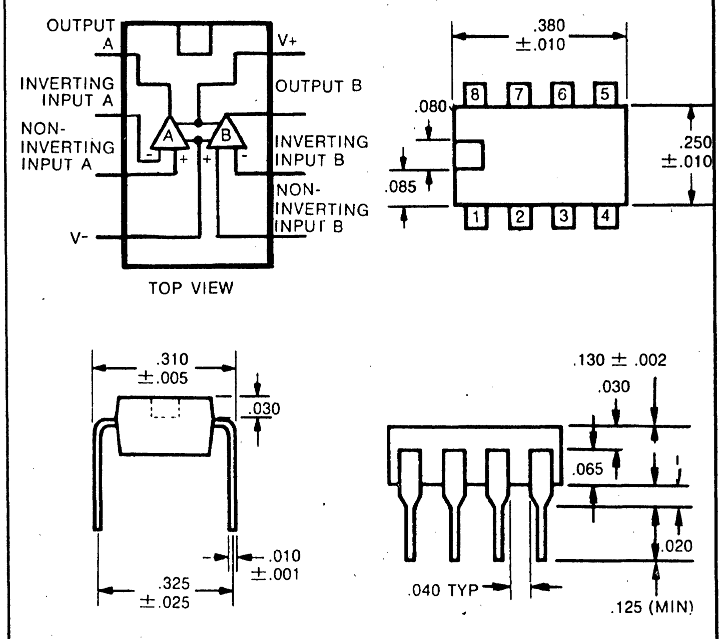
PACKAGE DATA

The RM4558 is available in the 8-pin TO-5 package and the RC4558 is available in the dual-in-line 8-pin mini-dip and the 8-pin TO-5 packages.

TO-5



8-PIN MOLDED DUAL-IN-LINE PACKAGE



VOLTAGE-TO-FREQUENCY CONVERTER

ABSOLUTE MAXIMUM RATINGS

Supply voltages . . . . . +8.0 to +22V
Output sink current 20mA
Internal power dissipation 500mW
Input voltage . . . . . -0.2V to $+V_{CC}$
Output short circuit to ground . . . . . Continuous
Temperature Range

	Storage	Operating
RM4151:	-65°C to +150°C	-55°C to +125°C
RV4151:	-55°C to +125°C	-40°C to + 85°C
RC4151:	-55°C to +125°C	0°C to + 70°C

ELECTRICAL CHARACTERISTICS V_{CC} = +15V, T_A = +25°C, unless otherwise specified

PARAMETER	CONDITIONS	TYP	UNITS
SUPPLY CURRENT	$8V < V_{CC} < 15V$	4.0	mA
	$15V < V_{CC} < 22V$	6.0	mA
CONVERSION ACCURACY			
Scale Factor	Circuit Figure 2, V_I = 10V	1.00	kHz/V
Drift with Temperature	Circuit Figure 2, V_I = 10V	±50	ppM/°C
Drift with V_{CC}	Circuit Figure 2, V_I = 1.0V $8V < V_{CC} < 18V$	0.2	%/V
INPUT COMPARATOR			
Offset Voltage		5	mV
Offset Current		±50	nA
Input Bias Current		-100	nA
Common Mode Range		0 to V_{CC}-2	V
ONE-SHOT			
Threshold Voltage, Pin 5		.667	xV_{CC}
Input Bias Current, Pin 5		-100	nA
Reset V_{SAT}	Pin 5, I = 2.2mA	0.15	V
CURRENT SOURCE			
Output Current	Pin 1, Figure 2, V = 0	138.7	μA
Change with Voltage	Pin 1, V = 0V to V = 10V	1.0	μA
Off Leakage	Pin 1, V = 0V	1	nA
REFERENCE VOLTAGE	Pin 2, Figure 2	1.9	V
LOGIC OUTPUT			
V_{SAT}	Pin 3, I = 3.0mA	0.15	V
V_{SAT}	I = 2.0mA	0.10	V
Off Leakage		.1	μA

Preliminary Specifications — Subject to change without notice.

Raytheon Semiconductor

LINEAR

RAYTHEON SEMICONDUCTOR DIVISION • 350 ELLIS STREET • MOUNTAIN VIEW, CALIFORNIA 94040

DESCRIPTION

The RC4151 and RM4151 provide a simple low-cost method of analog-to-digital conversion. They have all the inherent advantages of the voltage-to-frequency conversion technique. The output of the 4151 is a series of pulses of constant duration. The frequency of the pulses is proportional to the applied input voltage. These converters are designed for use in a wide range of data conversion and remote sensing applications.

PRINCIPLE OF OPERATION

Single Supply Mode VFC

In this application the RC/RM4151 functions as a stand-alone voltage to frequency converter operating on a single positive power supply. Refer to Figure 1, the simplified block diagram. The RC/RM4151 contains a voltage comparator, a one-shot, and a precision switched current source. A positive input voltage applied to pin 7 is compared to the voltage at pin 6. If the input voltage is higher, the input comparator will fire the one-shot. The output of the one-shot is connected to both the logic output and the precision switched current source. During the one-shot period, T, the logic output will go low and the current source will turn on with current I. At the end of the one-shot period the logic output will go high and the current source will shut off. At this time the current source has injected an amount of charge Q = IT into the network R_B-C_B. If this charge has not increased the voltage V_B such that $V_B \geqslant V_I$, the comparator again fires the one-shot and the current source injects another lump of charge, Q, into the R_B-C_B network. This process continues until $V_B \geqslant V_I$. When this condition is achieved the current source remains off and the voltage V_B decays until V_B is again equal to V_I. This completes one cycle. The VFC will now run in a steady state mode. The current source dumps lumps of charge into the capacitor C_B at a rate fast enough to keep $V_B \geqslant V_I$. Since the discharge rate of capacitor C_B is proportional to V_B/R_B, the frequency at which the system runs will be proportional to the input voltage.

FEATURES

- Single supply operation (+8V to +22V)
- Pulse output compatible with all logic forms
- Programmable scale factor (K)
- Linearity ±0.5% typical - precision mode
- Temperature stability ±50 ppm/°C typical
- High noise rejection
- Inherent monotonicity
- Easily transmittable output
- Simple full scale trim
- Single-ended input, referenced to ground
- Also provides frequency-to-voltage conversion

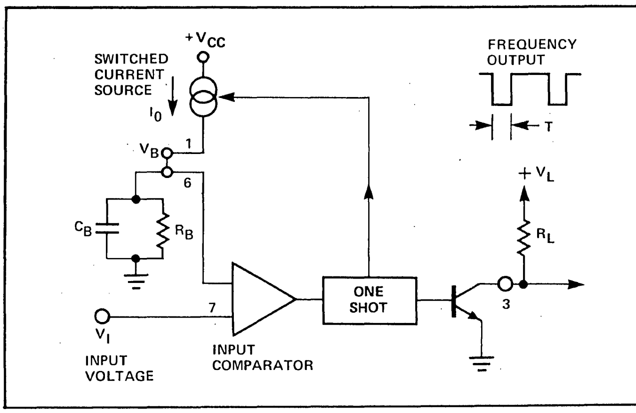
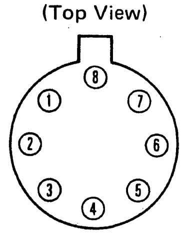


Figure 1. Simplified Block Diagram, Single Supply Mode

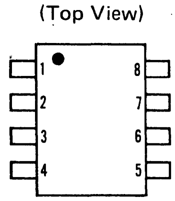
TE (TO-5) METAL CAN
(Top View)



Order Part Nos.: RC4151T, RM4151T

NOTE: PIN 4 CONNECTED TO CASE

NB MINIATURE DUAL-IN-LINE
(Top View)



Order Part Nos.: RC4151NB, RV4151NB

PIN	FUNCTION
1	CURRENT SOURCE
2	SCALE FACTOR
3	LOGIC OUTPUT
4	GROUND
5	ONE-SHOT R, C
6	REFERENCE
7	INPUT VOLTAGE
8	V_{CC}

DUAL TRACKING VOLTAGE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage ±V to Ground	RM4194: ±45V RC4194: ±35V
Input-Output Voltage Differential	RM4194: ±45V RC4194: ±35V
Power Dissipation at T_A = 25°C	
D Package	900mW
TK Package	3.0W
Load Current	
D Package	150mA
TK Package	250mA
Operating Junction Temperature Range	RM4194: −55°C to +150°C RC4194: 0°C to +125°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10s)	+300°C

ELECTRICAL CHARACTERISTICS

($\pm 5 \leq V_{OUT} \leq V_{MAX}$ • RM4194: $-55°C \leq T_j \leq +125°C$; RC4194: $0°C \leq T_j \leq +70°C$)

PARAMETER	CONDITIONS	RM4194			RC4194			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Line Regulation	$\Delta V_{in} = 0.1V_{in}$		0.02	0.1		0.02	0.1	% V_{out}
Load Regulation	4194TK: I_L = 1 to 200mA 4194D: I_L = 1 to 100mA		.001	.002		.001	.004	% V_o/mA
TC of Output Voltage			0.002	0.015		0.003	0.015	%/°C
Stand-By Current Drain (Note 1)	$V_{in} = V_{max}$, V_o = 0V		+0.3	+1.0		+0.3	+1.5	mA
	$V_{in} = V_{max}$, V_o = 0V		−1.2	−2.0		−1.2	−3.0	mA
Input Voltage Range		±9.5		±45	±9.5		±35	V
Output Voltage Scale Factor	R_{set} = 71.5K T_j = 25°C	2.45	2.5	2.55	2.38	2.5	2.62	KΩ/V
Output Voltage Range	R_{set} = 71.5K	0.05		±42	0.05		±32V	V
Output Voltage Tracking				1.0			2.0	%
Ripple Rejection	f = 120Hz, T_j = 25°C		70			70		dB
Input-Output Voltage Differential	I_L = 50mA	3.0			3.0			V
Output Short Circuit Current	V_{in} = ±30V Max.		300			300		mA
Output Noise Voltage	C_L = 4.7μF, V_o = ±15V f = 10Hz to 100KHz		250			250		μV RMS
Internal Thermal Shutdown			175			175		°C

THERMAL CHARACTERISTICS

PARAMETER	CONDITIONS	PACKAGE	
		D	TK (TO-66)
Power Dissipation	T_A = 25°C	900mW	3W
	T_C = 25°C	2.2W	17.5W
Thermal Resistance	Junction to Ambient, θ_{J-A}	128°C/W	41.6°C/W
	Junction to Case, θ_{J-C}	55°C/W	7.15°C/W

NOTE:
$\pm I_{Quiescent}$ will increase by 50μA/V_{OUT} on positive side and 100μA/V_{OUT} on negative side.

DUAL TRACKING VOLTAGE REGULATORS

DESIGN FEATURES

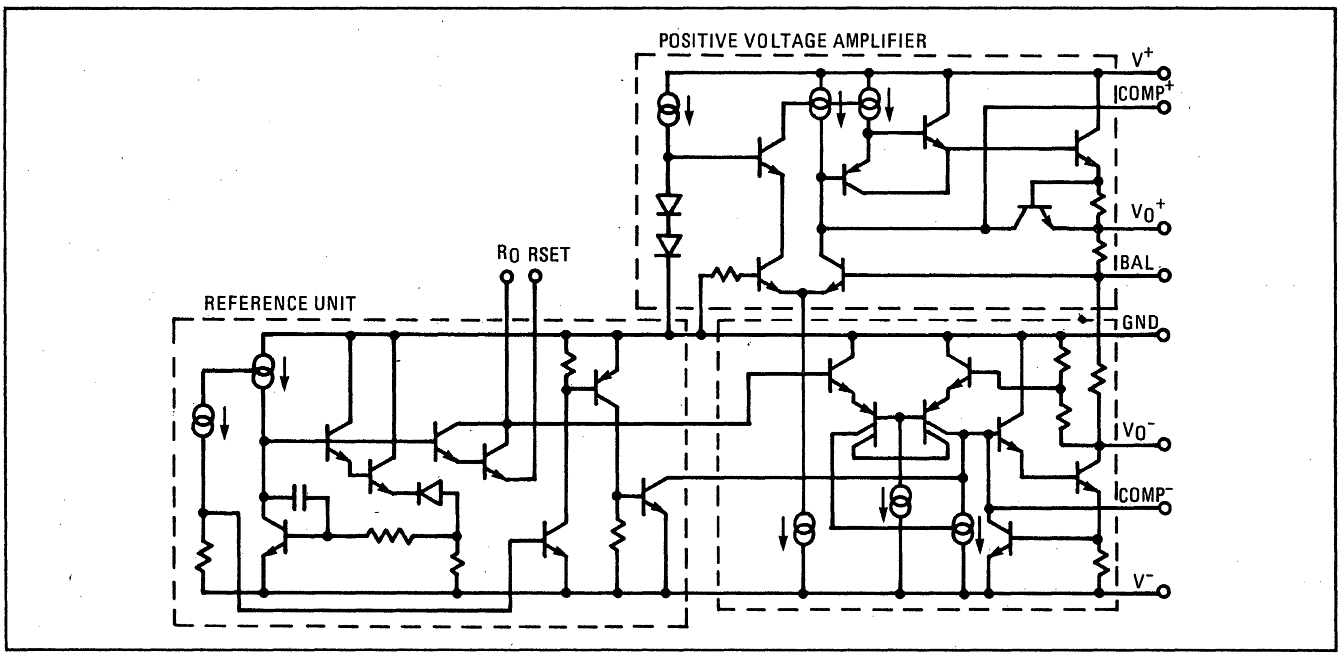
- Simultaneously Adjustable Outputs With One Resistor to ±42V.
- Load Current ±200mA with .2% Load Regulation
- Internal Thermal Shutdown at T_j = 175°C
- External Balance for $\pm V_O$ Unbalancing
- 3W Power Dissipation

The RM4194 and RC4194 are dual polarity tracking regulators designed to provide balanced or unbalanced positive and negative output voltages at currents to 200mA. A single external resistor adjustment can be used to change both outputs between the limits of ±50mV and ±42V.

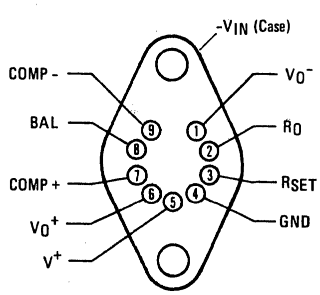
These devices are designed for local "on-card" regulation, eliminating distribution problems associated with single-point regulation. To simplify application the regulators require a minimum number of external parts.

The device is available in two package types to accommodate various power requirements. The TK (TO-66) power package can dissipate up to 3W at T_A = 25°C. The D 14-pin dual in-line will dissipate up to 900mW.

SCHEMATIC DIAGRAM

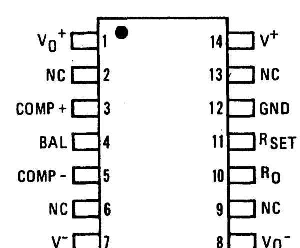


CONNECTION INFORMATION



TK (TO-66) Package
(Bottom View)

Order Part Nos.:
RC4194TK, RM4194TK



D Dual In-line Package
(Top View)

Order Part Nos.:
RC4194D, RM4194D

FIXED ±15V DUAL-TRACKING VOLTAGE REGULATORS

ABSOLUTE MAXIMUM RATINGS

Input Voltage ±V to Ground .... ±30V
Power Dissipation @ T_A = +25°C
TK Package 2.4W
T Package 800mW
DN Package 600mW
Load Current 150mA
Operating Junction Temperature Range .... RM4195: −55°C to +150°C. RC4195: 0°C to +125°C
Storage Junction Temperature Range .... RM4195: −65°C to +150°C. RC4195: −65°C to +125°C
Lead Temperature (Soldering, IO's) .... +300°C

ELECTRICAL CHARACTERISTICS (I_L = 1mA, V_{CC} = ±20V, C_L = 10μT unless otherwise specified)

PARAMETER	CONDITIONS	RM4195			RC4195			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Line Regulation	V_{in} = ±18 to ±30V		2	20		2	20	mV
Load Regulation	I_L = 1 to 100mA		5	30		5	30	mV
Output Voltage Temperature Stability			0.005	0.015		0.005	0.015	%/°C
Standby Current Drain	V_{IN} = ±30V,, I_L = 0mA		±1.5	±2.5		±1.5	±3.0	mA
Input Voltage Range		18		30	18		30	V
Output Voltage	T_j = +25°C	14.8	15	15.2	14.5	15	15.5	V
Output Voltage Tracking			±50	±150		±50	±300	mV
Ripple Rejection	f = 120Hz, T_j = +25°C		75			75		dB
Input-Output Voltage Differential	I_L = 50mA	3			3			V
Short-circuit Current	T_j = +25°C		220			220		mA
Output Noise Voltage	T_j = +25°C, f = 100Hz to 10KHz		60			60		μV RMS
Internal Thermal Shutdown			175			175		°C

THERMAL CHARACTERISTICS

PARAMETER	CONDITIONS	PACKAGE			UNITS
		DN	T (TO-99)	TK (TO-66)	
Power Dissipation	T_A = 25°C	0.6	0.8	2.4	W
	T_C = 25°C		2.1	9	
Thermal Resistance	φj-C		70	17	°C/W
	φj-A	210	185	62	

FIXED ±15V DUAL-TRACKING VOLTAGE REGULATORS

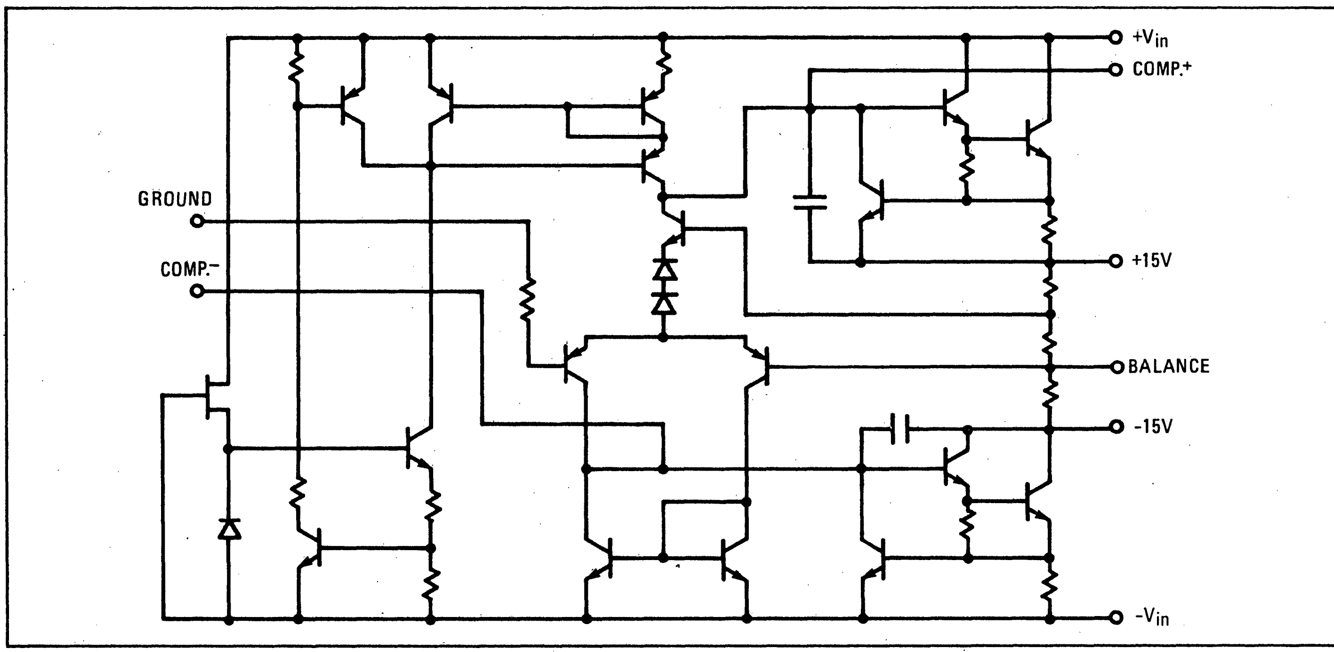
DESIGN FEATURES

- ±15V Op-Amp power at reduced cost and component density
- Thermal shutdown at T_j = +175°C in addition to short-circuit protection
- Output currents to 100mA
- May be used as single output regulator with up to +50V output
- Available in TO-66, TO-99, and 8-pin plastic mini-DIP

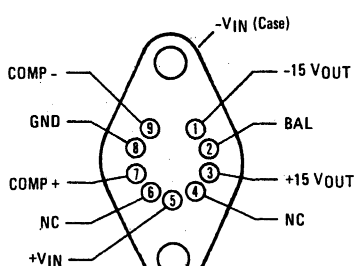
The RM4195 and RC4195 are dual polarity tracking regulators designed to provide balanced positive and negative 15 volt output voltages at currents to 100mA. These devices are designed for local "on-card" regulation eliminating distribution problems associated with single point regulation. The regulator is intended for ease of application. Only two external components are required for operation (two 10μF bypass capacitors).

The device is available in three package types to accommodate various applications requiring economy, high power dissipation, and reduced component density.

SCHEMATIC DIAGRAM

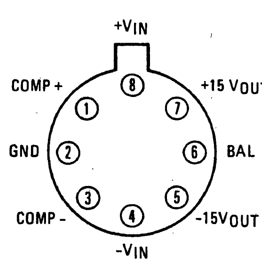


CONNECTION INFORMATION



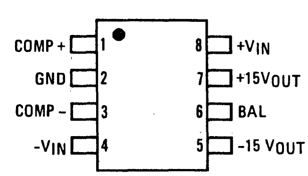
TK (TO-66) Power Package
(Bottom View)

Order Part Nos.:
RC4195TK,
RM4195TK



T Metal Can Package
(Top View)

Order Part Nos.:
RC4195T,
RM4195T



DN Dual In-line
(Top View)

Order Part No.:
RC4195DN

4 × 4 × 2 BALANCED SWITCHING CROSSPOINT ARRAY

RC4444

ABSOLUTE MAXIMUM RATINGS

Operating Voltage[1]	25V
Internal Power Dissipation[2]	900mW
Operating Current per Crosspoint[2]	100mA
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	0°C to + 70°C
Lead Temperature (Soldering, 60s)	300°C

ELECTRICAL CHARACTERISTICS (0°C ≤ T_A ≤ 70°C)

PARAMETER	SYMBOL	UNIT	MIN	TYP	MAX
Off resistance @ V_{AK}= 12V	R_{off}	MΩ	10		
On resistance @ 12mA	R_{on}	Ω	3	7	11
Max bias current	I_{AK}	mA			50
Holding current	I_H	mA	0.85	2.00	3.80
V_{on} at 12mA	V_{AK}	V			1.05
Gate firing current/SCR		mA	4		
Gate pulse width		μsec		6	10
Forward breakdown voltage	V_{AK}	V	20	30	
Reverse breakdown voltage	V_{KA}	V	20	30	
Rate firing limit	dv/dt	V/μs	300	500	
Capacitance	C_{AK}	pf		1.7	3
Insertion loss @1KHz I_B = 12mA, 600 Ω load		dB		0.2	0.25
Frequency response upper limit, 3dB rel to 1KHz		KHz	500		
Crosstalk isolation @ 1KHz		dB	90	100	
Base emitter forward voltage (PNP)		V		0.7	
Base emitter reverse breakdown voltage (PNP)		V	20		
Gate enabling voltage at 4mA (P+ to K_T or K_R)		V	3		
Forward breakdown voltage (P+ to K_T or K_R)		V			20
Reverse breakdown voltage (P+ to K_T or K_R)		V			20
Gate enabling voltage (P– to K_T or K_R)		V	3		
Reverse breakdown (P– to K_T or K_R)		V			20

NOTES:
1. Maximum voltage from anode to cathode
2. Package thermal resistance θJA typically .055·c/mW. Package power dissipation limited to 900 mW.

Raytheon Semiconductor

LINEAR

4 × 4 × 2 BALANCED SWITCHING CROSSPOINT ARRAY

DESIGN FEATURES

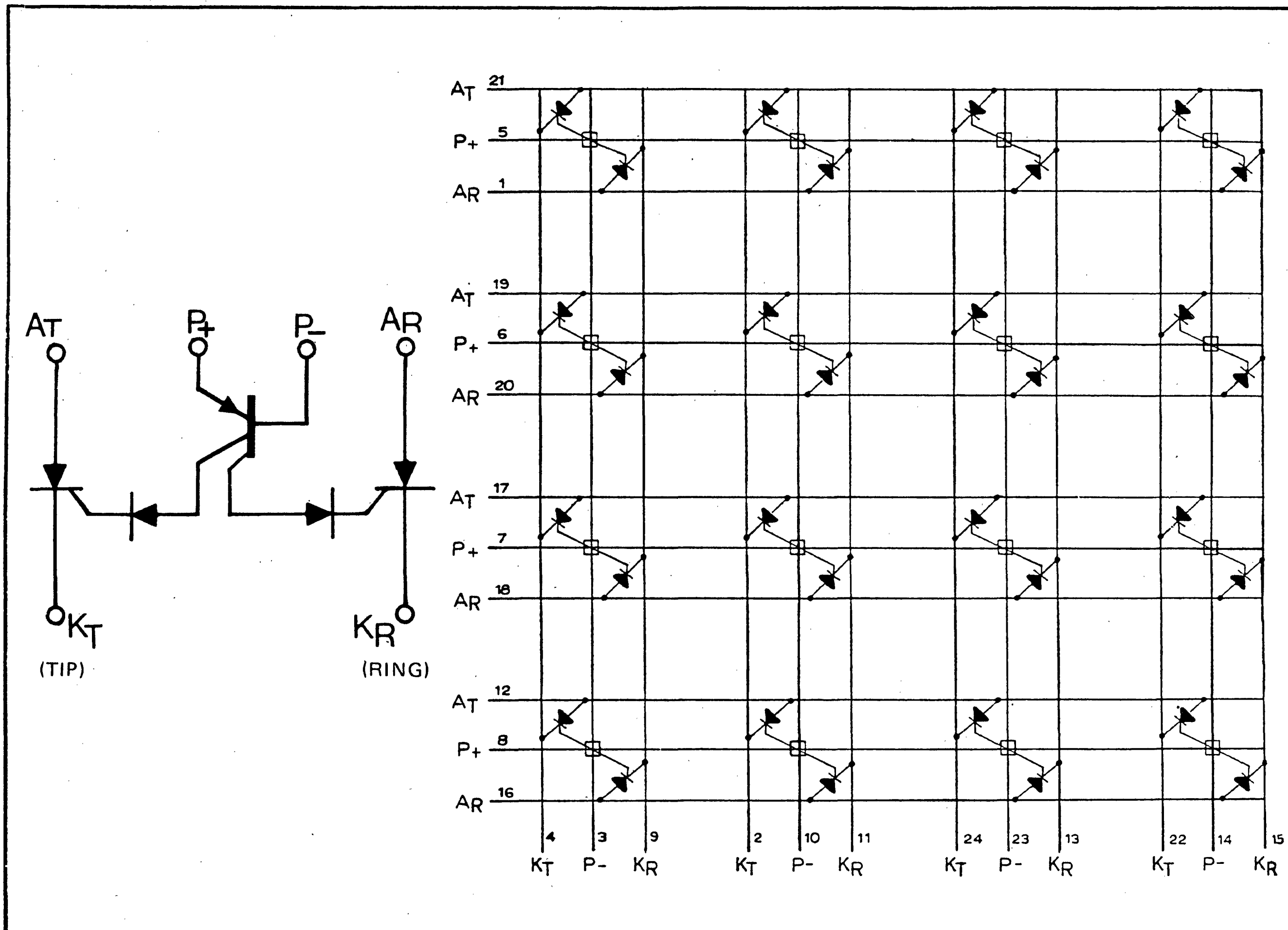
- Low Bi-Directional R_{on}
- High R_{off}
- Excellent Matching of Gates
- Low Capacitance
- High Rate Firing
- Predictable Holding Current

The RC4444 is a monolithic dielectrically isolated crosspoint array arranged into a 4 x 4 x 2 matrix. The primary applications are for balanced switching of 600 ohm transmission lines. The ring and tip are selected by selective biasing of the P+ and P- gate.

Designed to replace reed-relays in telephone switchboards, it does not require a constant gate drive to keep the SCR in the "on" condition. It is several orders faster, with no bouncing, and has a much longer operating life than its mechanical counterpart.

The 16 SCR pairs with the gating system are packaged in a 24 pin dual-in-line package.

SCHEMATIC DIAGRAM



RCA Gold CHIP Linear Integrated Circuits

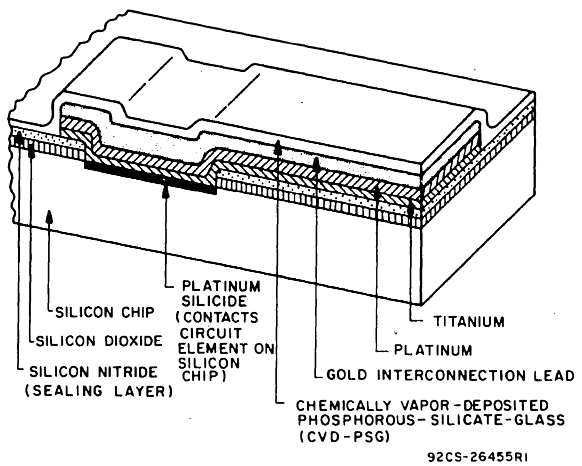
Chip Hermeticity In Plastic

RCA's hermetic IC gold-chip in-line plastic package system, identified by a "G" suffix, is a major technical and commercial innovation in dual-in-line plastic package styles. This new plastic package system, which introduces a gold-metallized hermetic chip encapsulated with RCA's proven plastic formulation, can provide hermetic performance. In other words, RCA's new G-series linear integrated circuits are impervious to moisture under high humidity and reverse-bias conditions and can withstand severe shock and vibration and elevated temperatures. This new package system offers economical improved reliability both in mass-produced equipment and in those critical industrial and military applications where hermeticity, resistance to shock and vibration, and operation over the temperature range of $-55^{o}C$ to $+125^{o}C$ are primary design requirements.

The new G-series circuits are available in 8-, 14-, and 16-lead dual-in-line configurations as required for specific types. The electrical and mechanical characteristics of the G-series types are identical to the characteristics of their non-hermetic counter-parts in similar packages.

Although RCA linear integrated circuits using conventional aluminum-metal chips encapsulated in plastic (epoxy) have demonstrated excellent performance in a wide range of applications over the temperature range of $-55^{o}C$ to $+125^{o}C$, these circuits are non-hermetic and are not completely impervious to moisture. To overcome susceptibility of the devices to the effects of moisture, RCA developed a hermetic gold chip which uses silicon nitride passivation and tri-metal processing involving three precious metals – titanium, platinum, and gold – rather than the traditional aluminum-metal system in the metallization step. This hermetic chip is assembled into the mechanically and chemically sound RCA plastic package to provide an improved reliability level (by at least one order of magnitude MTBF) not previously achievable with conventional dual-in-line plastic-package devices. (See page 2 for reliability test results on RCA hermetic IC gold chips.)

The silicon nitride passivation and the titanium/platinum/gold metallization system used in the processing of the hermetic IC gold chip are similar to that developed for beam-lead wafer technology up to the point at which the circuit-connecting metal film is applied. The cross-sectional view in Fig.1 shows the various metal and passivation layers in the construction of the gold chip, which begins with the conventional diffusion, epitaxial, and photolithographic steps. After the transistors, diodes, and resistors have been formed in the silicon wafer, the gold chip is processed in the sequence shown at the right of Fig.1.



1. A passivation layer of silicon nitride is deposited to protect the silicon surface from the deteriorating effects of both moisture and contaminants.
2. Low-resistance ohmic contacts are made to the device junctions using platinum silicide, an extremely stable, non-corrosive intermetallic compound.
3. A titanium layer is deposited to provide maximum adherence to contact regions and silicon nitride surfaces.
4. A platinum layer is deposited to act as a diffusion barrier between the titanium and the top layer of gold.
5. A gold layer is deposited which, in addition to its high reliability, is highly conductive, has readily bondable surface and exhibits an excellent step-coverage capability.
6. A second passivation ("overcoat") layer of phosphorus-doped, chemically vapor-deposited silicon dioxide glass is then deposited for device passivation and mechanical protection. Phosphorus eliminates stress cracking, and avoids shorting caused by electroplating phenomena.

Fig.1 – Cross-Sectional View of Silicon-Nitride-Passivated Hermetic IC Gold-Chip Structure.

The manufacturing processes used in packaging the hermetic gold chip in the dual-in-line plastic (epoxy) package are essentially similar to those used with conventional aluminum-metal non-hermetic chips. In the hermetic gold-chip package, gold wires are used to interconnect the gold-surfaced bonding pads on the IC chip and the gold-plated bonding surfaces on the package lead terminals.

Reliability

The actual improvement in reliability of the hermetic gold-chip system over the aluminum-metal chip system was determined from a reliability test program designed with special emphasis on those tests normally used to explore failure mechanisms associated with integrated circuits in plastic packages. Table I lists these tests, together with the test conditions proposed for this program. The linear circuits evaluated consisted of

Reliability (Cont'd)

product in the 14-lead dual-in-line plastic package. The results shown in Table I and in Figs.2 and 3, as well as the results of tests conducted at the U.S. Army's Tropical Test Center in the Panama Canal Zone, clearly demonstrate that hermetic gold-chip metallization is superior to aluminum metallization under the most severe environmental conditions, and that plastic-package devices utilizing hermetic gold chips are capable of being used in critical industrial and military equipment subjected to harsh environments.

Fig.2 shows the median-time-to-failure (MTF) estimates obtained from accelerated operating-life tests conducted on integrated circuits employing the silicon nitride passivation and titanium/platinum/gold metallization. These tests are plotted on Arrhenius paper as a function of junction temperature. Extrapolation of these data to the maximum rated operating temperature of +125°C indicates an MTF of approximately 3×10^7 hours.

Data obtained from both temperature-humidity-bias (THB) and pressure-cooker tests were plotted on a Weibull Probability Chart, as shown in Fig.3, for comparison with data taken on devices using aluminum-metal chips. All hermetic gold-chip devices passed 5000 hours of reverse-bias/humidity life testing without a single failure.

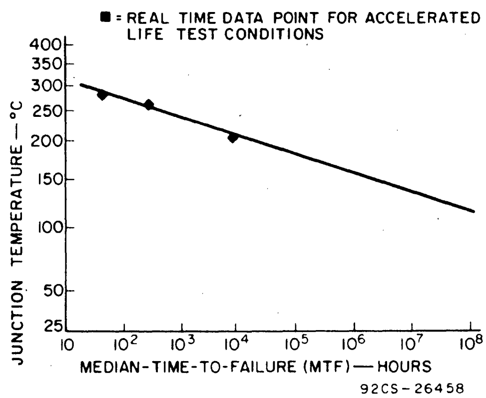


Fig.2 – MTF vs. Junction Temperature with Hermetic-Gold-Chip IC Metallization.

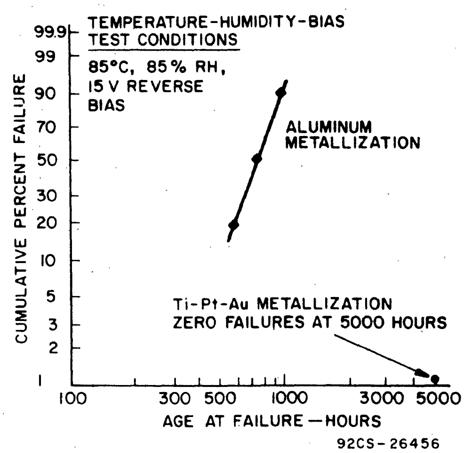


Fig.3 – Test Results for Hermetic Gold Chip vs. Aluminum Metallization.

The Electronics Technology and Devices Laboratory of the U.S. Army Technical Command at Fort Monmouth, N.J., is evaluating RCA hermetic gold-chip plastic packages at the Army's Tropical Test Center, Panama Canal Zone. In these tests, devices were operated at the seashore and in the jungle under conditions in which the only protection offered was louvered wooden enclosures, similar to the housings used for weather instruments, to protect the devices and test racks from direct exposure to rain. The tests were conducted at 4.5 V reverse bias, 80°F (27°C) ambient temperature, and 90% to 98% relative humidity. According to the most current data, 63 devices have been operated continuously for 14,322 hours (per device) without a single failure. Based on the cumulative device time of 896,616 hours, the failure rate is less than 0.25% per 1000 hours with a 90% confidence level.

TABLE I – HERMETIC GOLD-CHIP RELIABILITY TEST RESULTS

Reliability Data Summary

TEST	CONDITIONS	DURATION (HOURS/CYCLES)	TOTAL SAMPLE	UNIT HOURS OR UNIT CYCLES	FAILURES
Operating Life	T_j = 167°C	2,000 hours	40	80,000	0
	T_j = 158°C	1,000 hours	19	19,000	0
	T_j= 127°C	2,000 hours	35	70,000	0
Temperature Humidity Bias (THB)	@ 85°C/85% R.H. 15 V Reverse Bias	5,000 hours	200	1,000,000	0
		3,000 hours	35	105,000	0
		2,000 hours	60	120,000	0
		1,000 hours	19	19,000	0
Thermal Fatigue	T_j on = 141°C t = 0.5 min. $T_j$off = 28°C t = 2.5 min.	40,000 cycles	15	600,000	0

Accelerated Reliability Test-Data Summary

TEST	CONDITIONS	DURATION (HOURS/CYCLES)	TOTAL SAMPLE	UNIT HOURS OR UNIT CYCLES	CATASTROPHIC FAILURES
Pressure Cooker	30 psia 121°C	250 hours	230	57,500	0
		200 hours	50	10,000	0
Thermal Shock	–65°C to +150°C	600 cycles	230	138,000	0
	MIL-STD-883	400 cycles	50	20,000	0
	Method 1011C	200 cycles	183	36,000	0
Temperature Cycle	–65°C to +150°C MIL-STD-883 Method 1010C	1,000 cycles	230	230,000	0

G-Series Types

For Commercial, Industrial, and Military Applications
Full Military Operating-Temperature Range (–55°C to +125°C)

Package Features	User Benefits
• Hermetic Gold Chip • Gold Chip Interconnect Metallization and Gold Bonding Pads • Gold Wires	• Improved Mean Time Between Failure by at least 1 Order of Magnitude which means – less board rework, less field service calls, less equipment downtime, improved customer satisfaction.
• Rugged RCA Plastic Encapsulation • Rated Over Full Military Temperature Range (–55°C to +125°C)	• Can be designed into critical industrial and military equipment where *both* high mechanical shock and hermeticity are design requirements.
• Standard Dual-In-Line Lead Arrangement	• Eliminates the number of different packaging styles required in inventory. • Adapts readily to existing automatic insertion equipment
• Low Manufacturing Cost	• Can now afford hermetic packaging even where hermeticity is not the critical factor but improved reliability is of concern.
• Readily Adapts to Automatic Chip Assembly Manufacturing	• Portends even lower component costs in the near future.

Type Numbers	Description	Dual-In-Line Plastic Package
CA101AG, CA201AG, CA301AG CA107G, CA207G, CA307G CA741G, CA741CG CA1458G, CA1558G	Operational Amplifiers	8-Lead
CA747G, CA747CG		14-Lead
CA124G, CA224G, CA324G CA3401G	Quad Operational Amplifiers	14-Lead
CA111G, CA211G, CA311G	Voltage Comparators	8-Lead
CA139G, CA239G, CA339G CA139AG, CA239AG, CA339AG	Quad Voltage Comparators	14-Lead
CA3724G, CA3725G	1-A n-p-n Transistor Arrays	14-Lead
CA555G, CA555CG	Timers	8-Lead

RCA-CA3130

COS/MOS Operational Amplifiers

With MOS/FET Input

RCA-CA3130T, CA3130S, CA3130AT, CA3130AS, CA-3130BT, and CA3130BS are integrated-circuit operational amplifiers that combine the advantages of both COS/MOS and bipolar transistors on a monolithic chip.

Gate-protected p-channel MOS/FET (PMOS) transistors are used in the input circuit to provide very-high-input impedance, very-low-input current, and exceptional speed performance. The use of PMOS field-effect transistors in the input stage results in common-mode input-voltage capability down to 0.5 volt below the negative-supply terminal, an important attribute in single-supply applications.

A complementary-symmetry MOS (COS/MOS) transistor pair, capable of swinging the output voltage to within 10 millivolts of either supply-voltage terminal (at very high values of load impedance), is employed as the output circuit.

The CA3130 Series circuits operate at supply voltages ranging from 5 to 16 volts, or ±2.5 to ±8 volts when using split supplies. They can be phase compensated with a single external capacitor, and have terminals for adjustment of offset voltage for applications requiring offset-null capability. Terminal provisions are also made to permit strobing of the output stage.

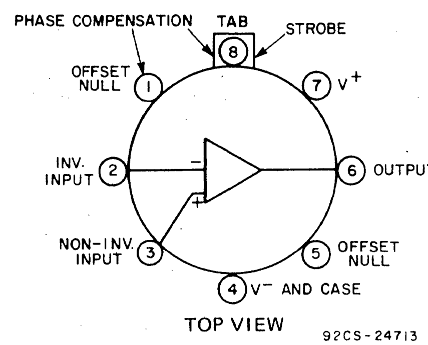
The CA3130 Series is supplied in either the standard 8-lead TO-5-style package (T suffix) or in the 8-lead dual-in-line formed-lead TO-5-style package "DIL-CAN" (S suffix) and operates over the full military-temperature range of $-55^{o}C$ to $+125^{o}C$. The CA3130B is intended for applications requiring premium-grade specifications and with limits established for: input current, temperature coefficient of input-offset voltage, and gain over the range of $-55^{o}C$ to $+125^{o}C$. The CA3130A offers superior input characteristics over those of the CA3130.

Features:

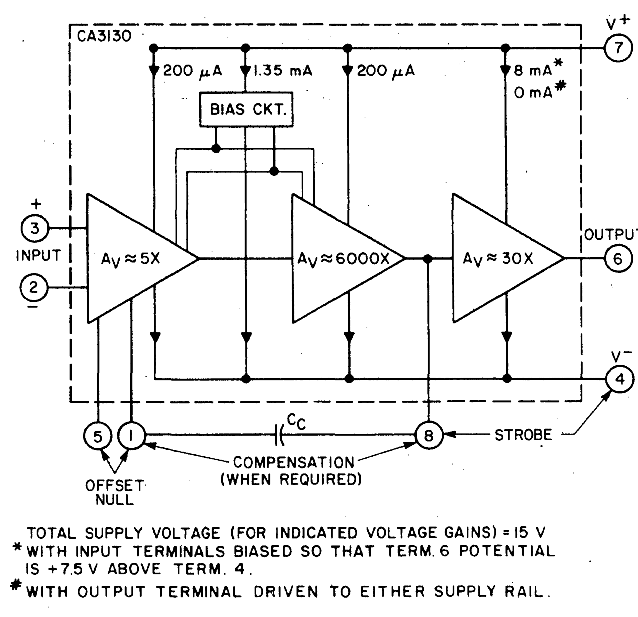
- **MOS/FET input stage provides:**
  very high Z_I = 1.5 TΩ (1.5 x 10^{12} Ω) typ.
  very low I_I = 5 pA typ. at 15 V operation
  2 pA typ. at 5 V operation
- **Common-mode input-voltage range includes negative supply rail; input terminals can be swung 0.5 V below negative supply rail** — **Ideal for single-supply applications**
- **COS/MOS output stage permits signal swing to either (or both) supply rails** — **Ideal for single-supply applications**
- **Low V_{IO}: 2 mV max. (CA3130B)**
- **Wide BW: 15 MHz typ. (unity-gain crossover)**
- **High SR: 10 V/μs typ. (unity-gain follower)**
- **High output current (I_O): 20 mA typ.**
- **High A_{OL}: 320,000 (110 dB) typ.**
- **Compensation with single external capacitor**

Applications:

- **Ground-referenced single-supply amplifiers**
- **Fast sample-hold amplifiers**
- **Long-duration timers/monostables**
- **High-input-impedance comparators (ideal interface with digital COS/MOS)**
- **High-input-impedance wideband amplifiers**
- **Voltage followers (e.g., follower for single-supply D/A converter)**
- **Voltage regulators (permits control of output voltage down to zero volts)**
- **Peak detectors**
- **Single-supply full-wave precision rectifiers**
- **Photo-diode sensor amplifiers**



Functional diagram of the CA3130 Series.



Block diagram of the CA3130 Series.

MAXIMUM RATINGS, *Absolute-Maximum Values*

DC SUPPLY VOLTAGE
(BETWEEN V^+ AND V^- TERMINALS) .... 16 V
DIFFERENTIAL-MODE INPUT VOLTAGE .... ±8 V
COMMON-MODE DC INPUT VOLTAGE .... (V^+ +8 V) to (V^- -0.5 V)
INPUT-TERMINAL CURRENT .... 1 mA
DEVICE DISSIPATION:
WITHOUT HEAT SINK–
UP TO 55°C .... 630 mW
ABOVE 55°C .... Derate linearly 6.67 mW/°C
WITH HEAT SINK–
AT 125°C .... 418 mW
BELOW 125°C .... Derate linearly 16.7 mW/°C
TEMPERATURE RANGE:
OPERATING .... –55 to +125°C
STORAGE .... –65 to +150°C
OUTPUT SHORT-CIRCUIT DURATION* .... INDEFINITE
LEAD TEMPERATURE (DURING SOLDERING):
AT DISTANCE 1/16 ± 1/32 INCH (1.59 ± 0.79 MM)
FROM CASE FOR 10 SECONDS MAX. ....+265°C

*Short circuit may be applied to ground or to either supply.

ELECTRICAL CHARACTERISTICS – For Equipment Design

CHARACTERISTIC	SYMBOL	TEST CONDITIONS V^+=15 V, V^-=0 V, T_A=25°C (Unless Specified Otherwise)	CA3130B Min.	CA3130B Typ.	CA3130B Max.	CA3130A Min.	CA3130A Typ.	CA3130A Max.	CA3130 Min.	CA3130 Typ.	CA3130 Max.	UNITS
Input Offset Voltage	$\|V_{IO}\|$	$V^\pm$=±7.5 V	–	0.8	2	–	2	5	–	8	15	mV
Input Offset Current	$\|I_{IO}\|$	$V^\pm$=±7.5 V	–	0.5	10	–	0.5	20	–	0.5	30	pA
Input Current	I_I	$V^\pm$=±7.5 V	–	5	20	–	5	30	–	5	50	pA
Large-Signal Voltage Gain	A_{OL}	V_O=10 $V_{p\text{-}p}$	100 k	320 k	–	50 k	320 k	–	50 k	320 k	–	V/V
		R_L=2 kΩ	100	110	–	94	110	–	94	110	–	dB
Common-Mode Rejection Ratio	CMRR		86	100	–	80	90	–	70	90	–	dB
Common-Mode Input-Voltage Range	V_{ICR}		0	–0.5 to 12	10	0	–0.5 to 12	10	0	–0.5 to 12	10	V
Power-Supply Rejection Ratio	$\Delta V_{IO}/\Delta V^+$	$V^\pm$=±7.5 V	–	32	100	–	32	150	–	32	320	µV/V
	$\Delta V_{IO}/\Delta V^-$		–	32	100	–	32	150	–	32	320	µV/V
Maximum Output Voltage	V_{OM}^+	R_L=2 kΩ	12	13.3	–	12	13.3	–	12	13.3	–	V
	V_{OM}^-		–	0.002	0.01	–	0.002	0.01	–	0.002	0.01	V
	$\|V_{OM}^+\|$	R_L=∞	14.99	15	–	14.99	15	–	14.99	15	–	V
	$\|V_{OM}^-\|$		–	0	0.01	–	0	0.01	–	0	0.01	V
Maximum Output Current: Source	I_{OM}^+	V_O=0 V	12	22	45	12	22	45	12	22	45	mA
Sink	I_{OM}^-	V_O=15 V	12	20	45	12	20	45	12	20	45	mA
Supply Current	I^+	V_O=7.5 V, R_L=∞	–	10	15	–	10	15	–	10	15	mA
		V_O=0 V, R_L=∞	–	2	3	–	2	3	–	2	3	mA
Input Current	I_I	T_A=–55 to 125°C, $V^\pm$=±7.5 V ▲, V_O=10 $V_{p\text{-}p}$ *, R_L=2 kΩ *	–	Fig. 11	15	–	Fig. 11	–	–	Fig. 11	–	nA
Input Offset Voltage Temperature Drift	$\Delta V_{IO}/\Delta T$		–	5	15	–	10	–	–	10	–	µV/°C
Large-Signal Voltage Gain	A_{OL}		50 k	320 k	–	–	320 k	–	–	320 k	–	V/V
			94	110	–	–	110	–	–	110	–	dB

▲ Applies only to I_I and $\Delta V_{IO}/\Delta T$.
* Applies only to A_{OL}.

RCA-CA3078

Micropower Operational Amplifier

The RCA CA3078T and CA3078AT are high-gain monolithic operational amplifiers which can deliver milli-amperes of current yet only consume microwatts of standby power. Their operating points are externally adjustable and frequency compensation may be accomplished with one external capacitor. The CA3078T and CA3078AT provide the designer with the opportunity to tailor the frequency response and improve the slew rate without sacrificing power. Operation with a single 1.5-volt battery is a practical reality with these devices.

The CA3078AT is a premium device having a supply voltage range of $V^{\pm}$ = 0.75V to $V^{\pm}$ = 15V. The CA3078T has the same lower supply voltage limit but the upper limit is V^{+} = +6V and V^{-}=-6V.

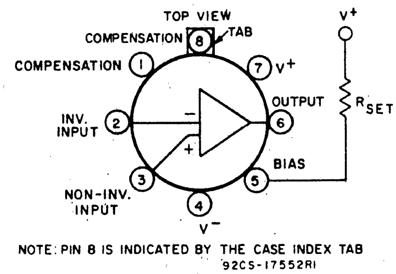
The CA3078 and CA3078A are supplied in either the standard 8-lead TO-5 package ("T" suffix), or in the 8-lead dual-in-line formed-lead "DIL-CAN" package ("S" suffix).

Features:

- Low standby power: as low as 700 nW
- Wide supply voltage range: ±0.75 to ±15 V
- High peak output current: 6.5 mA min.
- Adjustable quiescent current
- Output short-circuit protection

Applications:

- Portable electronics
- Medical electronics
- Instrumentation
- Telemetry



Functional diagram of the CA3078T and CA3078AT.

RCA-CA3080

Operational Transconductance Amplifiers (OTA's)

Gateable-Gain Blocks

The RCA-CA3080 and CA3080A are Gateable-Gain Blocks which utilize the unique Operational Transconductance Amplifier (OTA) concept described in Application Note ICAN-6668, "Applications of the CA3080 and CA3080A High-Performance Operational Transconductance Amplifiers".

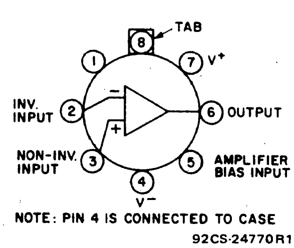
The CA3080 and CA3080A have differential input and a single-ended, push-pull, class A output. In addition, these types have an amplifier bias input which may be used either for gating or for linear gain control. These types also have a high output impedance and their transconductance (g_m) is directly proportional to the amplifier bias current (I_{ABC}).

The CA3080A is rated for operation over the full military-temperature range (−55 to +125°C) and its characteristics are specifically controlled for applications such as sample-hold, gain-control, multiplex, etc.

These types are supplied in the 8-lead TO-5 style package (CA3080, CA3080A), and in the 8-lead TO-5 style package with dual-in-line formed leads ("DIL-CAN", CA3080S, CA3080AS). The CA3080E is also supplied in the 8-lead dual-in-line plastic ("MINI-DIP") package (CA3080E), and in chip form (CA3080H).

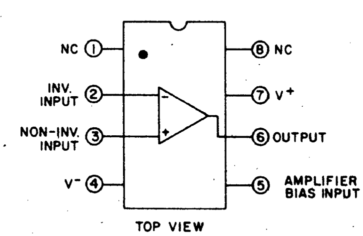
Features:

- Slew rate (unity gain, compensated): 50 V/µs
- Adjustable power consumption: 10µW to 30 mW
- Flexible supply voltage range: ± 2 V to ± 15 V
- Fully adjustable gain: 0 to $g_m R_L$ limit
- Tight gm spread: CA3080 (2:1), CA3080A (1.6:1)
- Extended g_m linearity: 3 decades



TOP VIEW

TO-5 Style Package



TOP VIEW

Plastic Package (CA3080E)

Functional diagrams

See Special RCA DATABOOK offer on inside back cover

RCA-CA3095
Super-Beta Transistor Array

Differential Cascode Amplifier Plus 3 Independent Transistors

RCA-CA3095E is a monolithic array of transistors connected as a super-beta differential cascode amplifier with three independent n-p-n transistors.

The differential cascode amplifier incorporates two cascode amplifiers consisting of transistors Q1, Q3 and Q2, Q4, respectively, plus a voltage-limiting circuit, consisting of diodes D1, D2 and p-n-p transistor Q5. Two of these transistors, Q1 and Q2, are super-beta types that have an $h_{FE} > 1000$ and are capable of operating over a wide current range of 1 μA to 2 mA. Each of these types comprises the input section of its respective cascode amplifier. The output section of each cascode amplifier employs a conventional n-p-n transistor, Q3, Q4, respectively. The output signal is obtained at the collectors of these transistors.

The independent transistors, Q6, Q7 and Q8, are high-voltage silicon n-p-n conventional types for general use in signal processing systems in the frequency range from dc through vhf. Separate terminals for each of these transistors permit maximum flexibility in circuit design.

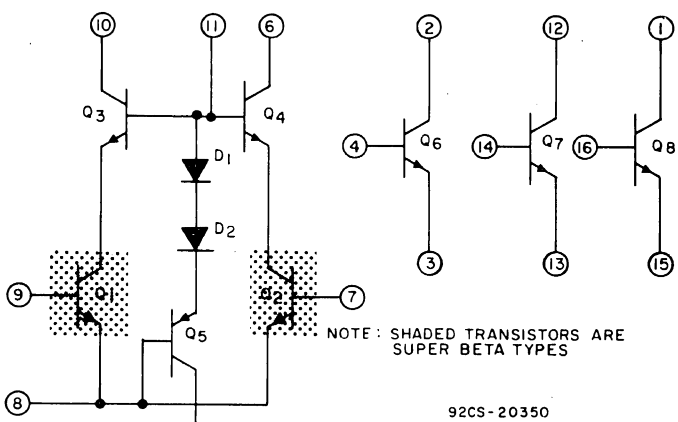
The CA3095E is supplied in a 16-lead dual-in-line plastic package and operates over the ambient temperature range of −40 °C to +85 °C.

Features

- **Two super-beta n-p-n transistors — $h_{FE} > 1000$**
- **Voltage-limiting circuitry (D1, D2, Q5)**
- **Operation possible at I_{IB} down to < 1 nA**
- **Matched pair (Q1 and Q2) —**
  V_{IO} = 5 mV max. at I_C = 100 μA dc
  I_{IO} = 20 nA max. at I_C = 100 μA dc
- **Wide current range — < 1 μA to 2 mA**

Independent Transistors:

- **h_{FE} = 300 typ. for each transistor**
- **Wide current range — < 1 μA to 10 mA**
- **Matched general-purpose transistors**
- **High voltage — V_{CBO} = 45 V max.**



Schematic Diagram – CA3095E.

RCA-CA3100
Wideband Operational Amplifier

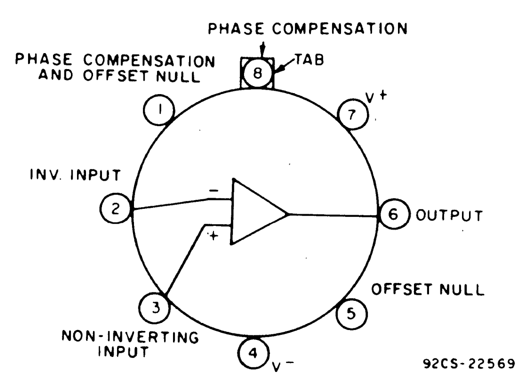
RCA-CA3100S, CA3100T is a large-signal wideband, high-speed operational amplifier which has a unity gain crossover frequency (f_T) of approximately 38 MHz and an open-loop, 3 dB corner frequency of approximately 110 kHz. It can operate at a total supply voltage of from 14 to 36 volts (±7 to ±18 volts when using split supplies) and can provide at least 18 V p-p and 30 mA p-p at the output when operating from ±15 volt supplies. The CA3100 can be compensated with a single external capacitor and has dc offset adjust terminals for those applications requiring offset null.

The CA3100 circuit contains both bipolar and P-MOS transistors on a single monolithic chip.

The CA3100 is supplied in either the standard 8-lead TO-5 package ("T" suffix), or in the 8-lead TO-5 dual-in-line formed-lead "DIL-CAN" package ("S" suffix).

Features:

- **High open-loop gain at video frequencies — 42 dB typ. at 1 MHz**
- **High unity-gain crossover frequency (f_T) — 38 MHz typ.**
- **Wide power bandwidth — V_O = 18 V p-p typ. at 1.2 MHz**
- **High slew rate — 70 V/μs (typ.) in 20 dB amplifier**
  25 V/μs (typ.) in unity-gain amplifier
- **Fast settling time — 0.6 μs typ.**
- **High output current — ± 15 mA min.**
- **LM118, 748/LM101 pin compatibility**
- **Single capacitor compensation**
- **Offset null terminals**



Functional Diagram TOP VIEW

DESCRIPTION

The μA7800 series of monolithic Three-Terminal Positive Voltage Regulators employ internal current limiting, thermal shutdown and safe-area compensation, making them essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. They are intended as fixed-voltage regulators in a wide range of applications including local, on-card regulation for elimination of distribution problems associated with single point regulation. In addition to use as fixed voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents and also as the power pass element in precision regulators.

FEATURES

- OUTPUT CURRENT IN EXCESS OF 1 AMP
- NO EXTERNAL COMPONENTS
- INTERNAL THERMAL OVERLOAD PROTECTION
- INTERNAL SHORT CIRCUIT CURRENT LIMITING
- OUTPUT TRANSISTOR SAFE-AREA COMPENSATION
- AVAILABLE IN THE TO-220 AND THE TO-3 PACKAGE
- OUTPUT VOLTAGES OF 5, 6, 8, 12, 15, 18, AND 24 VOLTS

ABSOLUTE MAXIMUM RATINGS

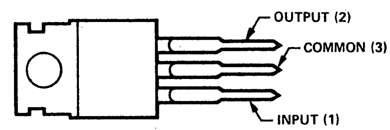
Input Voltage (5V through 18V)	35V
(24V)	40V
Internal Power Dissipation (Note 1)	Internally Limited
Storage Temperature Range	−65°C to +150°C
Operating Junction Temperature Range (Note 2)	
7800	−55°C to +150°C
7800C	0°C to +125°C
Lead Temperature	
TO-3 Package	
(Soldering, 60 second time limit)	300°C
TO-220 Package	
(Soldering, 10 second time limit)	230°C

NOTES:

1. Thermal resistance of the packages (without a heat sink)
   Junction to Case: TO-3 Package 4° C/W; TO-220 Package 2° C/W
   Junction to Ambient: TO-3 Package 35° C/W; TO-220 Package 50° C/W
2. Operating Ambient Temperature Range 7800 −55° C to +125° C
   7800C 0° C to +85° C

CONNECTION DIAGRAMS

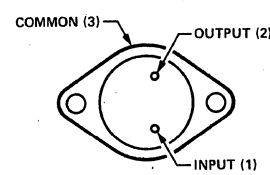
TO-220 PACKAGE (TOP VIEW) PACKAGE OUTLINE U



ORDER INFORMATION

OUTPUT VOLTAGE	ORDER PART NO.
5V	7805CU
6V	7806CU
8V	7808CU
12V	7812CU
15V	7815CU
18V	7818CU
24V	7824CU

TO-3 PACKAGE (TOP VIEW) PACKAGE OUTLINE DA

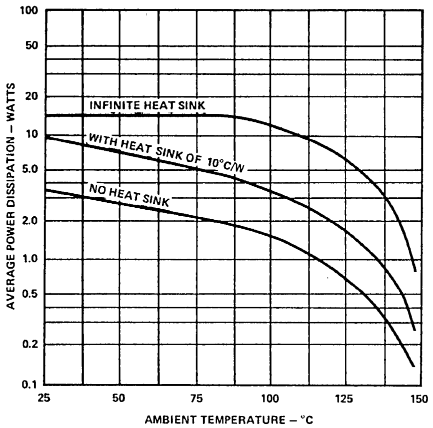


ORDER INFORMATION

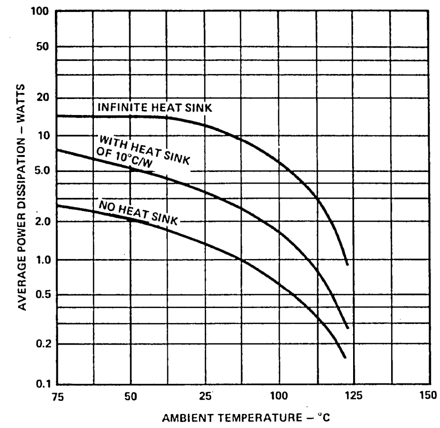
OUTPUT VOLTAGE	ORDER PART NO.
5V	7805DA
6V	7806DA
8V	7808DA
12V	7812DA
15V	7815DA
18V	7818DA
24V	7824DA
5V	7805CDA
6V	7806CDA
8V	7808CDA
12V	7812CDA
15V	7815CDA
18V	7818CDA
24V	7824CDA

TYPICAL CURVES FOR 7800 SERIES

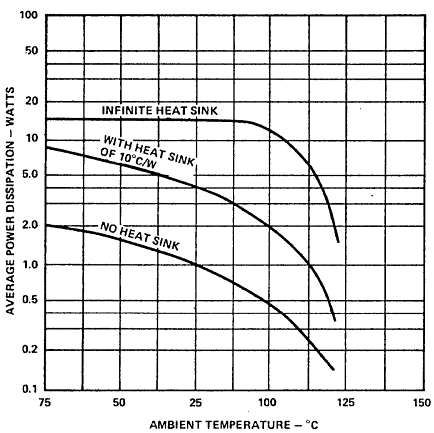
MAXIMUM AVERAGE POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE (TO-3, 7800)



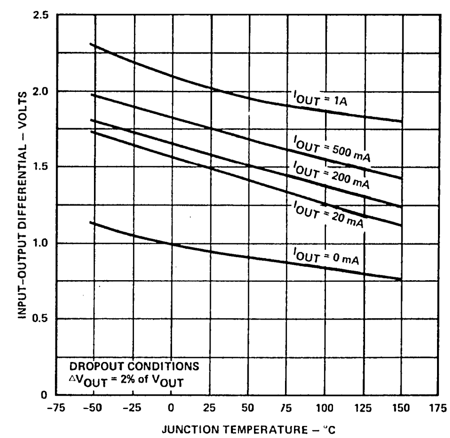
MAXIMUM AVERAGE POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE (TO-3, 7800C)



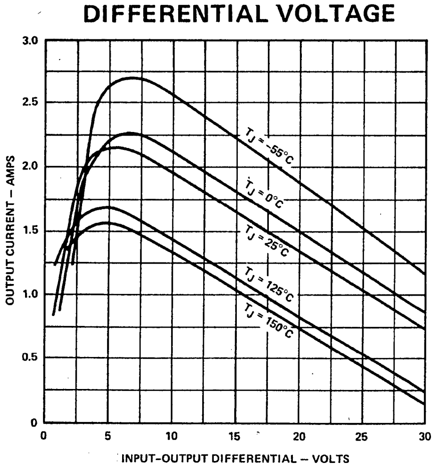
MAXIMUM AVERAGE POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE (TO-220, 7800C)



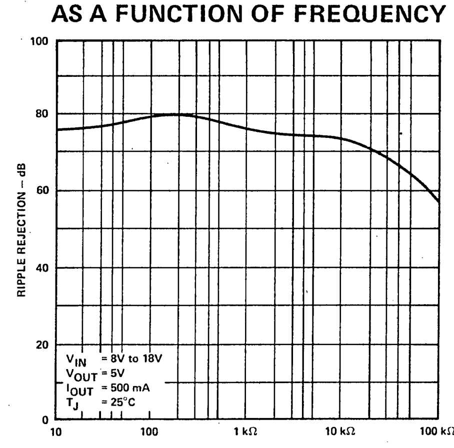
DROPOUT VOLTAGE AS A FUNCTION OF JUNCTION TEMPERATURE



PEAK OUTPUT CURRENT AS A FUNCTION OF INPUT/OUTPUT DIFFERENTIAL VOLTAGE



RIPPLE REJECTION AS A FUNCTION OF FREQUENCY

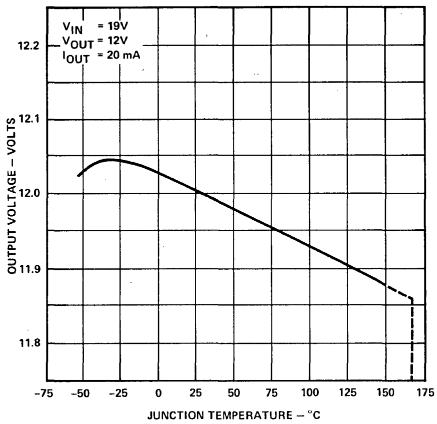


Signetics

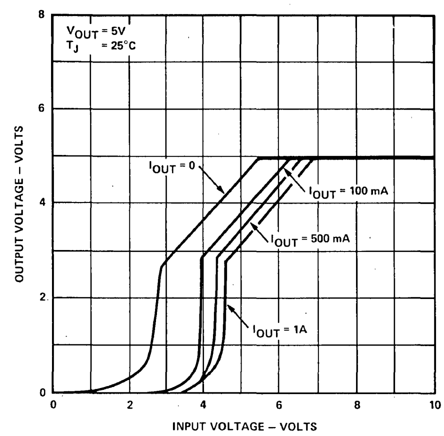
LINEAR

TYPICAL CURVES FOR 7800 SERIES (Continued)

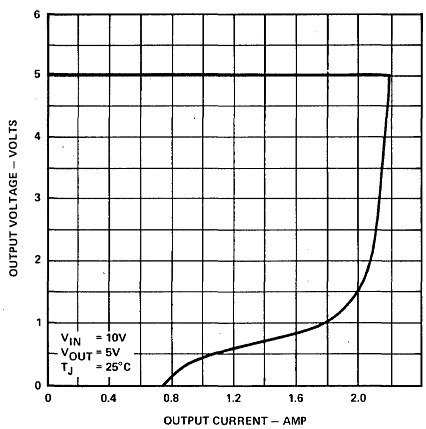
OUTPUT VOLTAGE AS A FUNCTION OF JUNCTION TEMPERATURE



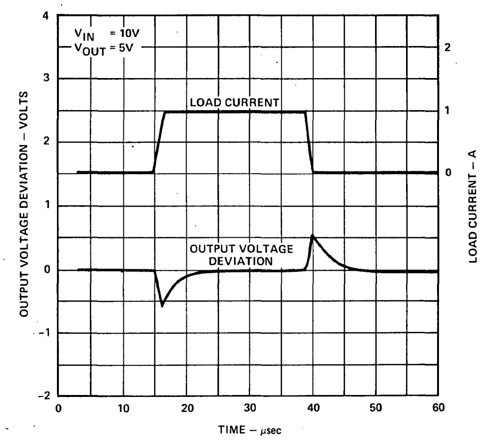
DROPOUT CHARACTERISTICS



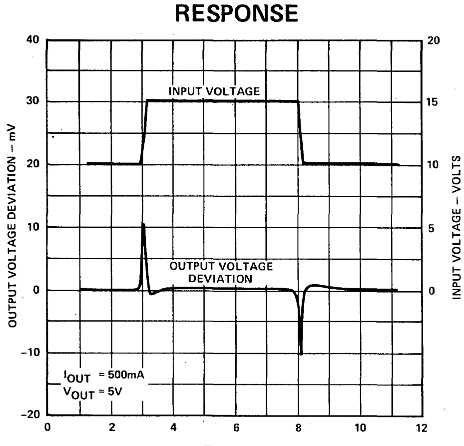
CURRENT LIMITING CHARACTERISTICS



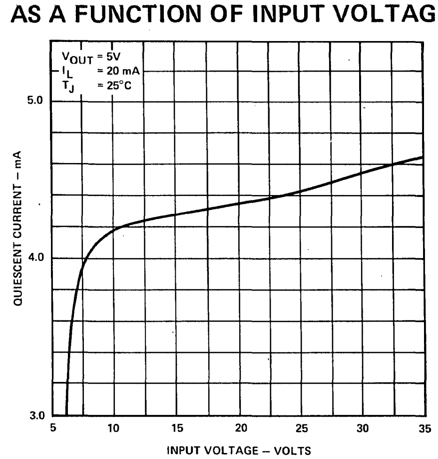
LOAD TRANSIENT RESPONSE



LINE TRANSIENT RESPONSE



QUIESCENT CURRENT AS A FUNCTION OF INPUT VOLTAGE

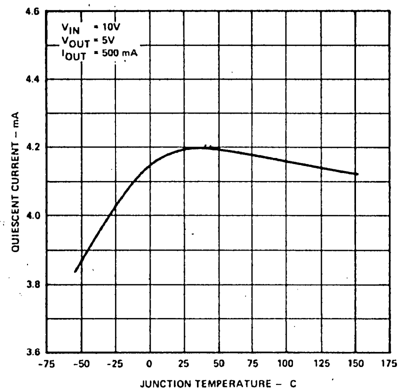


Signetics

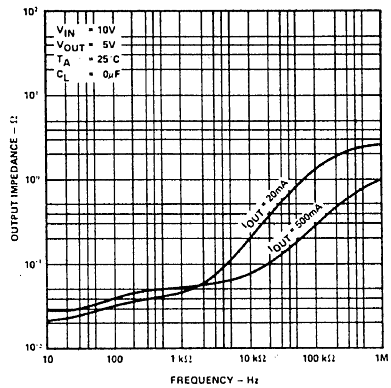
LINEAR

TYPICAL CURVES FOR 7800 SERIES (Continued)

QUIESCENT CURRENT AS A FUNCTION OF TEMPERATURE



OUTPUT IMPEDANCE AS A FUNCTION OF FREQUENCY



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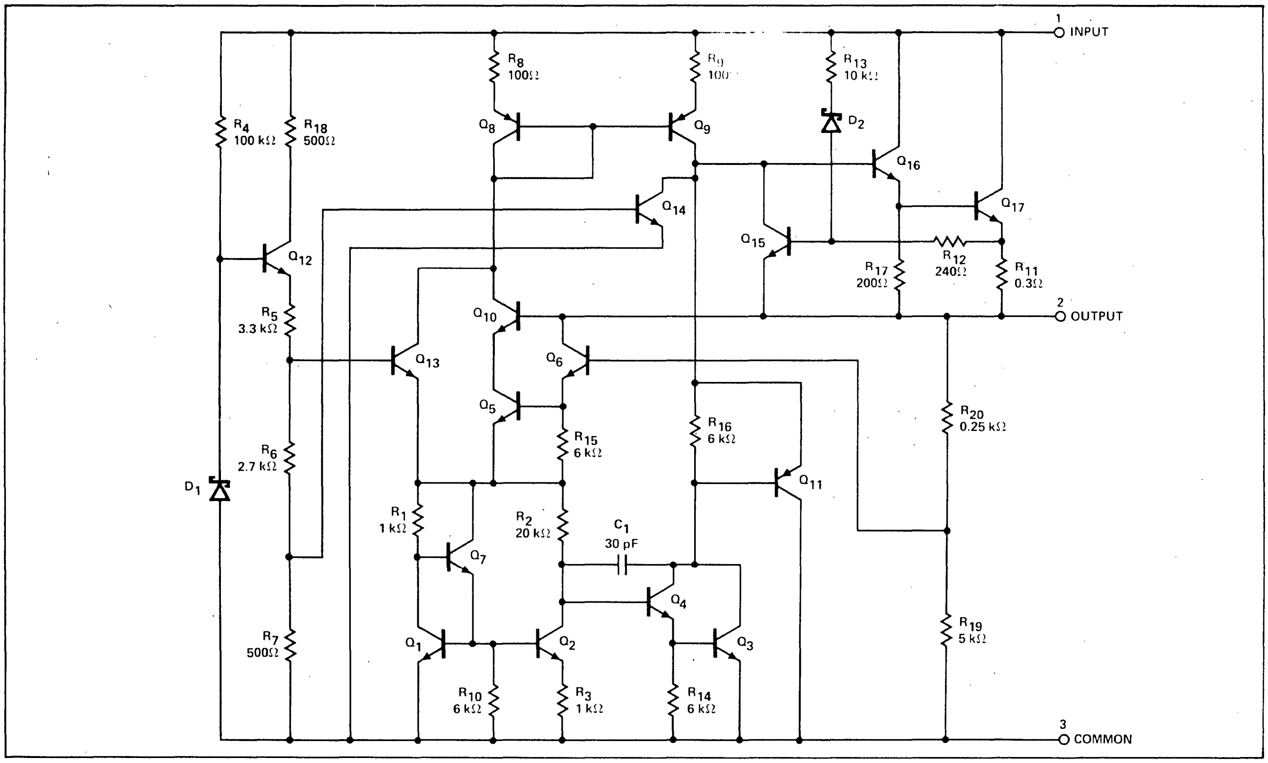
LINEAR

ELECTRICAL CHARACTERISTICS I_{OUT} = 40mA, 0°C < T_J < +125°C, C_{IN} = 0.33μF, C_{OUT} = 0.1μF (Unless Otherwise Specified)

	OUTPUT VOLTAGE (V)			LINE REGULATION mV						LOAD REGULATION mV						OUTPUT VOLTAGE (V)			QUIESCENT CURRENT mA			QUIESCENT CURRENT CHANGE – mA WITH LINE		
	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
V_{IN} = 10V	T_J = 25°C			T_J = 25°C; $7V \le V_{IN} \le 25V$			$8V \le V_{IN} \le 12V$			T_J = 25°C; $5mA \le I_{OUT} \le 1.5mA$			$250mA \le I_{OUT} \le 750mA$			$P \le 15W$; $5mA \le I_{OUT} \le 1.0A$; $8V \le V_{IN} \le 20V$			T_J = 25°C			$8V \le V_{IN} \le 25V$		
7805	4.8	5.0	5.2		3	50		1	25		15	50		5	25	4.65		5.35		4.2	6.0			0.8
																$7V \le V_{IN} \le 20V$						$7V \le V_{IN} \le 25V$		
7805C	4.8	5.0	5.2		3	100		1	50		15	100		5	50	4.75		5.25		4.2	8.0			1.3
V_{IN} = 11V				$8V \le V_{IN} \le 25V$			$9V \le V_{IN} \le 13V$									$9V \le V_{IN} \le 21V$						$9V \le V_{IN} \le 25V$		
7806	5.75	6.0	6.25		5	60		1.5	30		14	60		4	30	5.65		6.35		4.3	6.0			0.8
																$8V \le V_{IN} \le 25V$						$8V \le V_{IN} \le 25V$		
7806C	5.75	6.0	6.25		5	120		1.5	60		14	120		4	60	5.7		6.3		4.3	8.0			1.3
V_{IN} = 14V				$10.5V \le V_{IN} \le 25V$			$11V \le V_{IN} \le 17V$									$11.5V \le V_{IN} \le 23V$						$11.5V \le V_{IN} \le 25V$		
7808	7.7	8.0	8.3		6	80		2	40		12	80		4	40	7.6		8.4		4.3	6.0			0.8
																$10.5V \le V_{IN} \le 23V$						$10.5V \le V_{IN} \le 25V$		
7808C	7.7	8.0	8.3		6	160		2	80		12	160		4	80	7.6		8.4		4.3	8.0			1.0
V_{IN} = 19V				$14.5V \le V_{IN} \le 30V$			$16V \le V_{IN} \le 22V$									$15.5V \le V_{IN} \le 27V$						$15V \le V_{IN} \le 30V$		
7812	11.5	12.0	12.5		10	120		3	60		12	120		4	60	11.4		12.6		4.3	6.0			0.8
																$14.5V \le V_{IN} \le 27V$						$14.5V \le V_{IN} \le 30V$		
7812C	11.5	12.0	12.5		10	240		3	120		12	240		4	120	11.4		12.6		4.3	8.0			1.0
V_{IN} = 23V				$17.5V \le V_{IN} \le 30V$			$20V \le V_{IN} \le 26V$									$18.5V \le V_{IN} \le 30V$						$18.5V \le V_{IN} \le 30V$		
7815	14.4	15.0	15.6		11	150		3	75		12	150		4	75	14.25		15.75		4.4	6.0			0.8
																$17.5V \le V_{IN} \le 30V$						$17.5V \le V_{IN} \le 30V$		
7815C	14.4	15.0	15.6		11	300		3	150		12	150		4	75	14.25		15.75		4.4	8.0			1.0
V_{IN} = 27V				$21V \le V_{IN} \le 33V$			$24V \le V_{IN} \le 30V$									$22V \le V_{IN} \le 1.0A$						$22V \le V_{IN} \le 33V$		
7818	17.3	18.0	18.7		15	180		5	90		12	180		4	90	17.1		18.9		4.5	6.0			0.8
																$21V \le V_{IN} \le 33V$						$21V \le V_{IN} \le 33V$		
7818C	17.3	18.0	18.7		15	360		5	180		12	360		4	180	17.1		18.9		4.5	8.0			1.0
V_{IN} = 33V				$27V \le V_{IN} \le 38V$			$30V \le V_{IN} \le 36V$									$28V \le V_{IN} \le 38V$						$28V \le V_{IN} \le 38V$		
7824	23.0	24.0	25.0		18	240		6	120		12	240		4	120	22.8		25.2		4.6	6.0			0.8
																$28V \le V_{IN} \le 38V$						$27V \le V_{IN} \le 38V$		
7824C	23.0	24.0	25.0		18	480		6	240		12	480		4	240	22.8		25.2		4.6	8.0			1.0

SCHEMATIC DIAGRAM



ELECTRICAL CHARACTERISTICS (Continued)

QUIESCENT CURRENT CHANGE – mA WITH LOAD		OUTPUT NOISE VOLTAGE μV	LONG TERM STABILITY mV	RIPPLE REJECTION dB		DROPOUT VOLTAGE V	OUTPUT RESISTANCE mΩ	SHORT CIRCUIT CURRENT mA	PEAK OUTPUT CURRENT A	AVERAGE TEMPERATURE COEFFICIENT OF INPUT VOLTAGE mV/°C
MIN TYP	MAX	MIN TYP MAX	MIN TYP MAX	MIN	TYP MAX	MIN TYP MAX	MIN TYP MAX	MIN TYP MAX	MIN TYP MAX	MIN TYP MAX
$5mA \leq I_{OUT} \leq 1.0mA$		$T_A = 25°C$ $10Hz \leq f \leq 100kHz$		f = 120Hz $8V \leq V_{IN} \leq 18V$		$T_J = 25°C$ $I_{OUT} = 1.0A$	f = 1kHz	$T_J = 25°C$	$T_J = 25°C$	$I_{OUT} = 5mA$ $0°C \leq T_J \leq 150°C$
7805	0.5	40	20	68	78	2.0	17	750	2.2	1.1
7805C	0.5	40	20	62	78	2.0	17	750	2.2	$0°C \leq T_J \leq 125°C$ 1.1
7806	0.5	45	24	$9V \leq V_{IN} \leq 19V$ 65	75	2.0	19	550	2.2	$0°C \leq T_J \leq 150°C$ 0.8
7806C	0.5	45	24	59	75	2.0	19	550	2.2	$0°C \leq T_J \leq 125°C$ 0.8
7808	0.5	52	32	$11.5V \leq V_{IN} \leq 21.5V$ 62	72	2.0	16	450	2.2	$0°C \leq T_J \leq 150°C$ 0.8
7808C	0.5	52	32	56	72	2.0	16	450	2.2	$0°C \leq T_J \leq 125°C$ 0.8
7812	0.5	75	48	$15V \leq V_{IN} \leq 25V$ 61	71	2.0	18	350	2.2	$0°C \leq T_J \leq 150°C$ 1.0
7812C	0.5	75	48	61	71	2.0	18	350	2.2	$0°C \leq T_J \leq 125°C$ 1.0
7815	0.5	90	60	$18.5V \leq V_{IN} \leq 28.5V$ 60	70	2.0	19	230	2.1	$0°C \leq T_J \leq 150°C$ 1.0
7815C	0.5	90	60	60	70	2.0	19	230	2.1	$0°C \leq T_J \leq 125°C$ 1.0
7818	0.5	110	72	$22V \leq V_{IN} \leq 32V$ 59	69	2.0	22	200	2.1	$0°C \leq T_J \leq 150°C$ 1.0
7818C	0.5	110	72	59	69	2.0	22	200	2.1	$0°C \leq T_J \leq 125°C$ 1.0
7824	0.5	170	96	$28V \leq V_{IN} \leq 38V$ 56	66	2.0	28	150	2.1	$0°C \leq T_J \leq 150°C$ 1.5
7824C	0.5	170	96	56	66	2.0	28	150	2.1	$0°C \leq T_J \leq 125°C$ 1.5

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3-TERMINAL POSITIVE VOLTAGE REGULATOR μA78L00 SERIES

LINEAR INTEGRATED CIRCUITS

DESCRIPTION

The μA78L00 is a series of 3-Terminal Positive Voltage Regulators. These regulators employ internal current limiting and thermal shutdown, making them essentially indestructible. If adequate heat sinking is provided, they can deliver up to 100mA output current. They are intended as fixed voltage regulators in a wide range of applications including local or on card regulation for elimination of noise and distribution problems associated with single point regulation. In addition, they can be used with power pass elements to make high current voltage regulators. The μA78L00 used as a Zener diode/resistor combination replacement, offers an effective output impedance improvement of typically two orders of magnitude, along with lower quiescent current and lower noise.

FEATURES

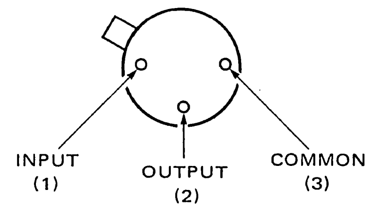
- OUTPUT CURRENT UP TO 100mA
- NO EXTERNAL COMPONENTS
- INTERNAL THERMAL OVERLOAD PROTECTION
- INTERNAL SHORT CIRCUIT CURRENT LIMITING
- AVAILABLE IN JEDEC TO-92 AND LOW PROFILE TO-39 PACKAGES
- OUTPUT VOLTAGES OF 2.6V, 5V, 6.2V, 12V AND 15V
- OUTPUT VOLTAGE TOLERANCES OF ±5% (78L00-AC) AND ±10% (78L00C) OVER THE TEMPERATURE RANGE

ABSOLUTE MAXIMUM RATINGS

Input Voltage	
2.6V, 5V and 6.2V	30V
12V and 15V	35V
Internal Power Dissipation	Internally Limited
Storage Temperature Range	
Metal Can (TO-39 Type)	−65°C to +150°C
Molded TO-92	−55°C to +150°C
Operating Junction Temperature Range	0°C to +150°C
Lead Temperatures	
Metal Can (Soldering, 60 s time limit)	300°C
Molded TO-92 (Soldering, 10 s time limit)	260°C

CONNECTION DIAGRAMS

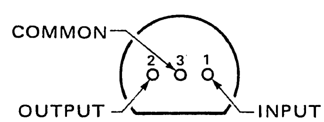
TO-39 TYPE METAL CAN
(TOP VIEW)
PACKAGE OUTLINE DB



ORDER INFORMATION

OUTPUT VOLTAGE	PART NO.
5V	78L05A DB
5V	78L05 DB
12V	78L12A DB
12V	78L12 DB
15V	78L15A DB
15V	78L15 DB

JEDEC (TO-92) PACKAGE
(TOP VIEW)
PACKAGE OUTLINE S



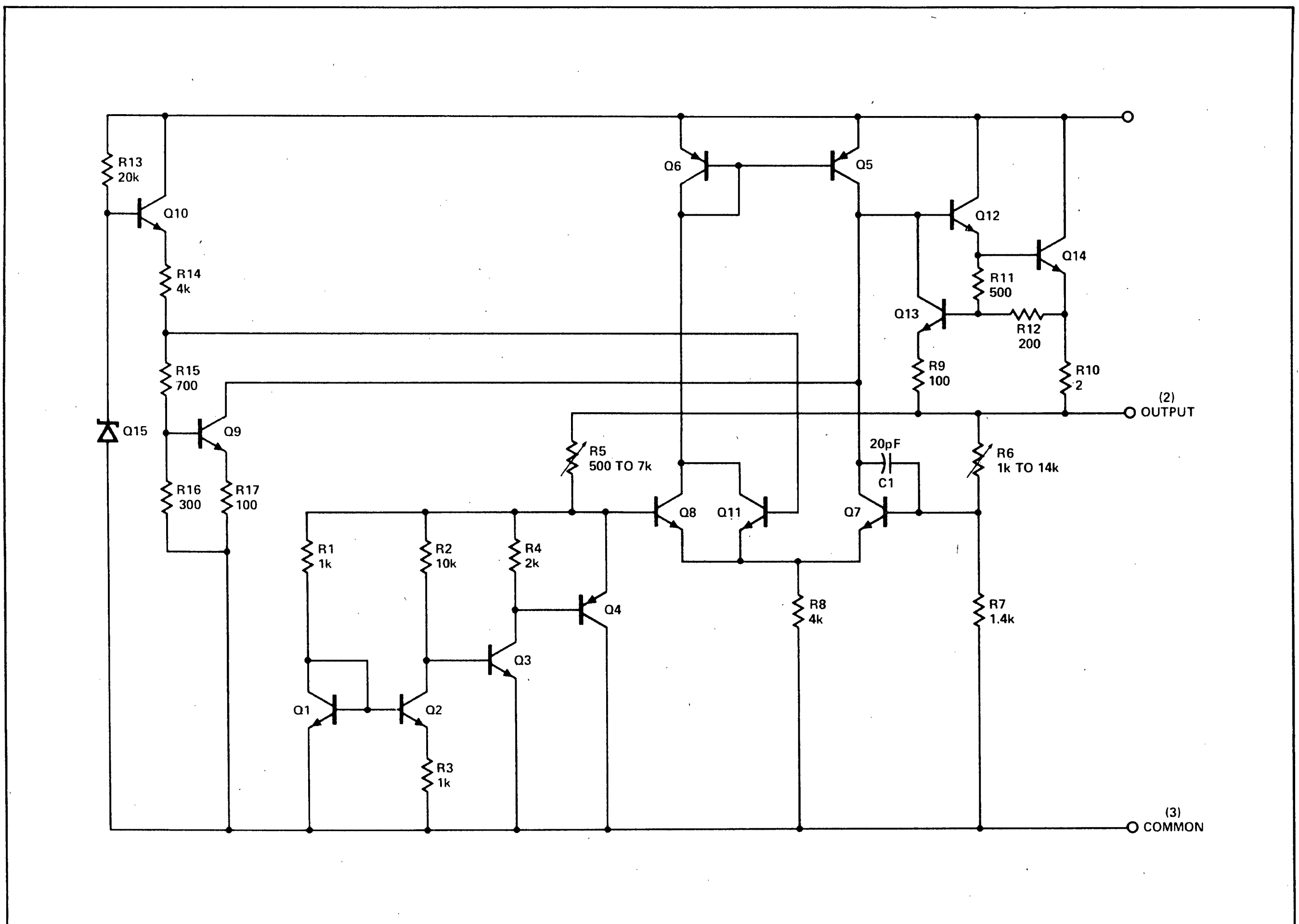
ORDER INFORMATION

OUTPUT VOLTAGE	PART NO.
2.6V	78L02A S
2.6V	78L02 S
5V	78L05A S
5V	78L05 S
6.2V	78L06A S
6.2V	78L06 S
12V	78L12A S
12V	78L12 S
15V	78L15A S
15V	78L15 S

ELECTRICAL CHARACTERISTICS I_{OUT} = 40mA, 0°C < T_J < +125°C, C_{IN} = 0.33μF, C_{OUT} = 0.1μF (Unless Otherwise Specified)

	OUTPUT VOLTAGE (V)			LINE REGULATION mV						LOAD REGULATION mV						OUTPUT VOLTAGE V					
	T_J = 25°C			T_J = 25°C						T_J = 25°C, 1mA ≤ I_{OUT} ≤ 100mA			1mA ≤ I_{OUT} ≤ 40mA			1mA ≤ I_{OUT} ≤ 70mA			1mA ≤ I_{OUT} ≤ 40		
	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	M
V_{IN} = 9.0V				4.75V ≤ V_{IN} ≤ 20V			5V ≤ V_{IN} ≤ 20V												4.75V ≤ V_{IN} ≤ 2		
78L02AC	2.5	2.6	2.7		40	100		30	75		10	50		4.0	25	2.45		2.75	2.45		2
78L02C	2.4	2.6	2.8		40	125		30	100		10	50		4.0	25	2.35		2.85	2.35		2
V_{IN} = 10V				7V ≤ V_{IN} ≤ 20V			8V ≤ V_{IN} ≤ 20V												7V ≤ V_{IN} ≤ 20		
78L05AC	4.8	5.0	5.2		55	150		45	100		11	60		5.0	30	4.75		5.25	4.75		5
78L05C	4.6	5.0	5.4		55	200		45	150		11	60		5.0	30	4.5		5.5	4.5		
V_{IN} = 12V				8.5V ≤ V_{IN} ≤ 20V			9V ≤ V_{IN} ≤ 20V												8.5V ≤ V_{IN} ≤ 2		
78L06AC	5.95	6.2	6.45		65	175		55	125		13	80		6.0	40	5.90		6.5	5.90		
78L06C	5.7	6.2	6.7		65	200		55	150		13	80		6.0	40	5.6		6.8	5.6		
V_{IN} = 19V				14.5V ≤ V_{IN} ≤ 27V			16V ≤ V_{IN} ≤ 27V												14.5V ≤ V_{IN} ≤ 2		
78L12AC	11.5	12	12.5		120	250		100	200		20	100		10	50	11.4		12.6	11.4		1
78L12C	11.1	12	12.9		120	250		100	200		20	100		10	50	10.8		13.2	10.8		
V_{IN} = 23V				17.5V ≤ V_{IN} ≤ 30V			20V ≤ V_{IN} ≤ 30V												17.5V ≤ V_{IN} ≤ 3		
78L15AC	14.4	15	15.6		130	300		110	250		25	150		12	75	14.25		15.75	14.25		15
78L15C	13.8	15	16.2		130	300		110	250		25	150		12	75	13.5		16.5	13.5		

EQUIVALENT CIRCUIT



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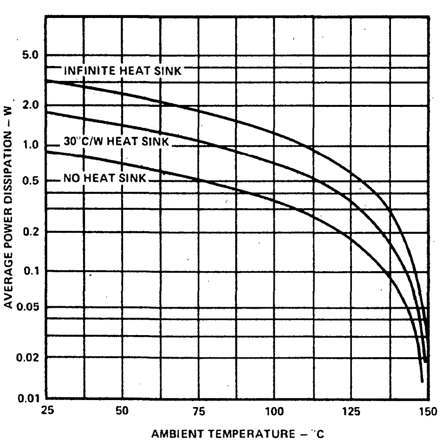
ELECTRICAL CHARACTERISTICS (Continued)

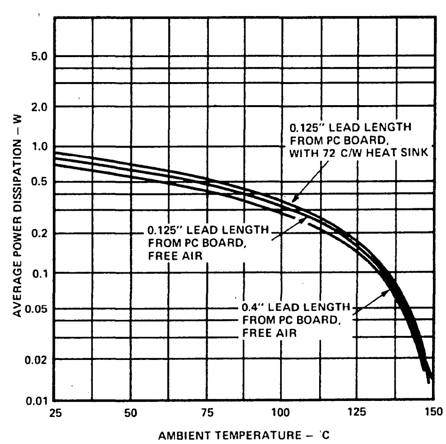
QUIESCENT CURRENT mA						QUIESCENT CURRENT CHANGE mA						OUTPUT NOISE VOLTAGE μV			LONG TERM STABILITY mV			RIPPLE REJECTION dB			DROPOUT VOLTAGE V		
						WITH LINE			WITH LOAD														
T_J = 25 C			T_J = 125 C			1mA ≤ I_{OUT} ≤ 40mA						T_J = 25 C 10Hz ≤ f ≤ 100kHz						T_J = 25 C f = 120Hz			T_A = 25 C		
MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
						5V ≤ V_{IN} ≤ 20V												6V ≤ V_{IN} ≤ 16V					
	3.6	6.0			5.5			2.5			0.1		30			10		43	51			1.7	
	3.6	6.0			5.5			2.5			0.2		30			10		42	51			1.7	
						8V ≤ V_{IN} ≤ 20V												8V ≤ V_{IN} ≤ 18V					
	3.8	6.0			5.5			1.5			0.1		40			12		41	49			1.7	
	3.8	6.0			5.5			1.5			0.2		40			12		40	49			1.7	
						9.0V ≤ V_{IN} ≤ 20V												10V ≤ V_{IN} ≤ 20V					
	3.9	6.0			5.5			1.5			0.1		50			14		40	46			1.7	
	3.9	6.0			5.5			1.5			0.2		50			14		39	46			1.7	
						16V ≤ V_{IN} ≤ 27V												15V ≤ V_{IN} ≤ 23V					
	4.2	6.5			6.0			1.5			0.1		80			24		37	42			1.7	
	4.2	6.5			6.0			1.5			0.2		80			24		36	42			1.7	
						20V ≤ V_{IN} ≤ 30V												18.5V ≤ V_{IN} ≤ 28.5V					
	4.4	6.5			6.0			1.5			0.1		90			30		34	39			1.7	
	4.4	6.5			6.0			1.5			0.2		90			30		33	39			1.7	

DESIGN CONSIDERATIONS

MAXIMUM AVERAGE POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE TO-39 TYPE PACKAGE



MAXIMUM AVERAGE POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE TO-92 TYPE PACKAGE



NOTE:
Typical thermal resistance of the TO-39 type metal can package without a heat sink is junction to case of 40°C/W and junction to ambient of 140°C/W. Typical thermal resistance of the TO-92 package is junction to ambient of 180°C/W with .400 inch leads from PC board and 160°C/W with .125 inch lead length.

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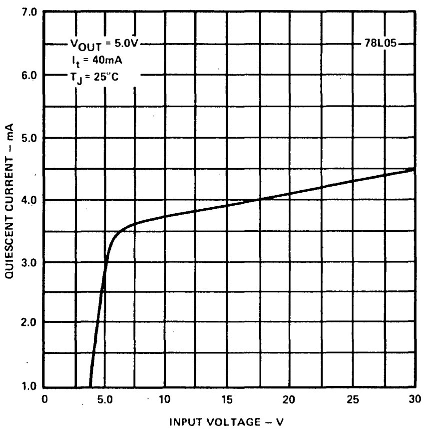
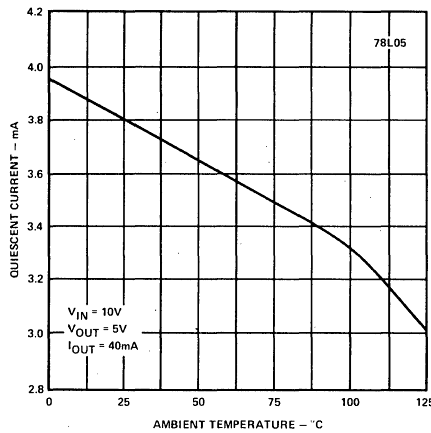
TYPICAL ELECTRICAL PERFORMANCE CURVES

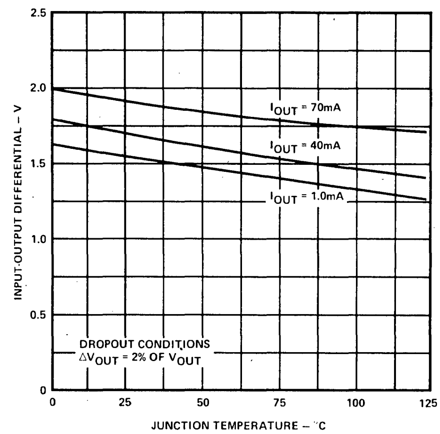
QUIESCENT CURRENT AS A FUNCTION OF INPUT VOLTAGE



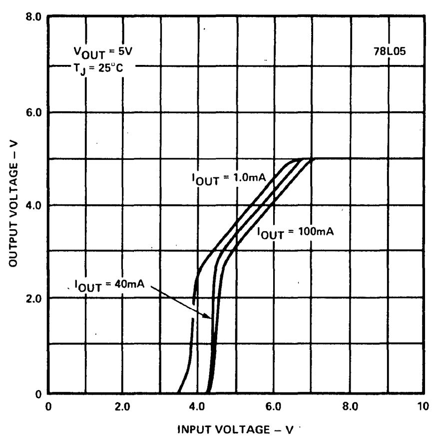
QUIESCENT CURRENT AS A FUNCTION OF TEMPERATURE



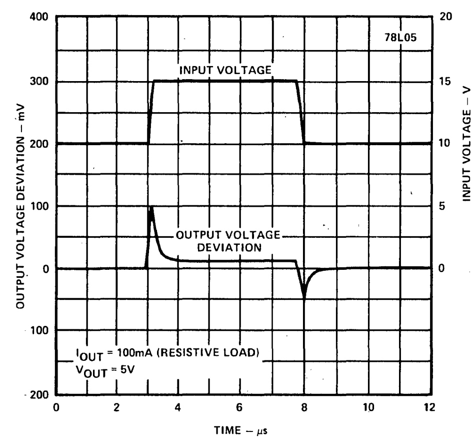
DROPOUT VOLTAGE AS A FUNCTION OF JUNCTION TEMPERATURE



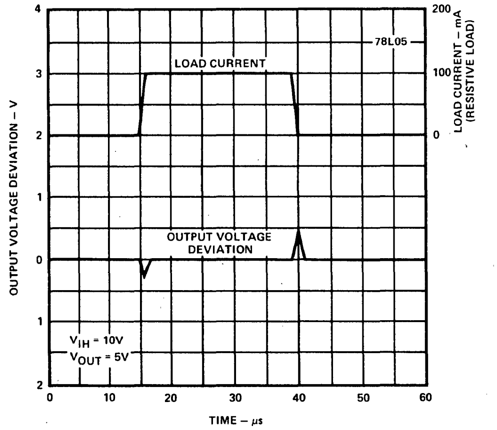
DROPOUT CHARACTERISTICS



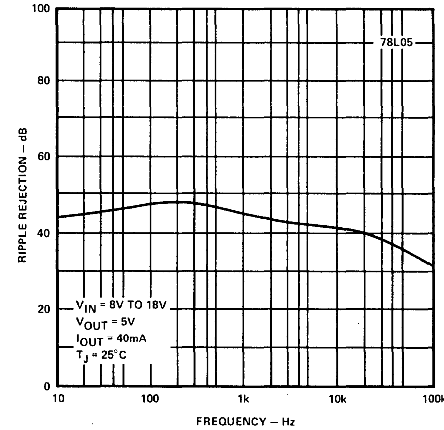
LINE TRANSIENT RESPONSE



LOAD TRANSIENT RESPONSE



RIPPLE REJECTION AS A FUNCTION OF FREQUENCY



NOTE: Other μA78L00 Series Devices have similar curves.

INTRODUCTION TO MEMORY

The Master Selection Guide provides sufficient information to make initial product selections, to lead you to a group of device numbers and manufacturers' names. It enables you to find the products which are most appropriate to fulfill your major requirements and then provides data for many of the more important products.

All devices that appear in this section, both in the initial selection guide and in the data pages, are included in the Part Number and Product Indexes. These index listings lead to the page and the line on that page where each device appears.

The Memory Section provides initial selection information and data on PROMs, RAMs, and ROMs as well as other memory devices. In these particular sections, the devices are characterized by organization (words and bits/words) and by access times. In order to assure that the access times are comparable, whenever possible the values have been shown in nanoseconds over the full rated temperature range for the devices (i.e., 0° to 70°C for commercial units and −55°C to 125°C for military units). The full temperature nanosecond value is marked "nsF." When this value isn't specified, the guaranteed nanosecond value at room temperature is listed followed by "nsR." In some cases a guaranteed value has not yet been established; then the typical value is shown followed by "ns*" (* means typical throughout this book). "Typical" values are invariably much faster than the guaranteed ones so that such listings place these memories higher on the list than they otherwise would appear.

The manufacturers listed above are providing detailed information on their latest and most significant products. They have made this investment to help you. Some chose not to.

If you want to see more data in future editions, tell the manufacturers through their salesmen and distributors.

MEMORY—Character Generators

Character Generators

Format	Number of Output Lines	Input Logic Levels	Supply Voltage	Device	Source
4 x 5	25	MOS	−12,14	4881	Nortec
5 x 5	25	MOS	−12,14	4881	Nortec
6 x 8	8	TTL	5	MM4241	† National
			−12	MM5241	National
5 x 7	5	MOS	−28	NCM1121	Nitron
			−28	NCM1122	Nitron
			±12	4481	Nortec
		TTL	5	RO3-2513	EMM/Semi
			5	6061	MMI
			5	6055	MMI
			−12,±5	2513	Signetics
			−12,5	CRC3504	Collins
			−12,5	CRC3505	Collins
			−12,5	3258	Fairchild
				RO3-2513	GI
			−12,5	TMS2501	TI
	7	MOS	±12	MCS1004	MOS
			±12	MCS1005	MOS
			±14	NCM1130	Nitron
			±14	NCM1131	Nitron
			±14	NCM1132	Nitron
			±14	TMS4103	TI
			−14,−28	MK2002	Mostek
		TTL	±12	EA40105	EA
			−12,5	3257	Fairchild
			−12,5	RO5-2240S	GI
			−12,5	MK2302	Mostek
	8	TTL	5	N8205CB1016	Signetics
	10	TTL	−12,5	MK2408	Mostek
5 x 8	5	MOS	±12	MM4240	† National
7 x 8	4	TTL	5	N8228CB162	Signetics
	10	MOS	±12	EA4004	EA
	35	MOS	−12,14	4881	Nortec
7 x 9	7	MOS	±5	MCS2017	MOS
		TTL	±5	MCS2022	MOS
		TTL	−12,5	3260	Fairchild
			5	5297	† MMI
			5	6071	MMI
			5	6072	MMI
			5	6297	MMI
			5	MCM6571	Motorola
			−3,5,12	MCM6570	Motorola
			−3,5,12	MCM6571A	Motorola
			−3,5,12	MCM6572	Motorola
			−3,5,12	MCM6573	Motorola
			−3,5,12	MCM6574	Motorola
			−3,5,12	MCM6575	Motorola
			−3,5,12	MCM6576	Motorola
			−3,5,12	MCM6577	Motorola
			−3,5,12	MCM6578	Motorola
			−3,5,12	MCM6579	Motorola
			−3,5,12	NCM6571	Nitron
			−3,5,12	NCM6572	Nitron
	9	MOS	−12,−24	EA3815	EA
			±12	EA4001	EA

Character Generators (cont)

Format	Number of Output Lines	Input Logic Levels	Supply Voltage	Device	Source
7 x 9	9	MOS/TTL	±5	MCS2024	MOS
		TTL	5	6074	MMI
			5	6073	MMI
			−3,5,12	MCM6580	Motorola
			−3,5,12	MCM6581	Motorola
			−3,5,12	MCM6583	Motorola
			−3,5,12	NCM6581	Nitron
			−3,5,12	NCM6583	Nitron
7 x 10	7	MOS/TTL	±5	MSC2020	MOS
		TTL	±12	EA4016	EA
7 x 11	1	TTL	5	CG5004L	SMC
9 x 9	9	TTL	−12,5	RO5-5184	GI
9 x 9	9	TTL	5	5299	† MMI
			5	6299	MMI
10 x 12	10	MOS/TTL	±5	MCS2018	MOS
			±5	MCS2025	MOS

† Military Temperature Range (−55°C to 125°C) * — Typical Values
Bold face indicates additional data is provided on the page noted.

MEMORY—Code Converters

Code Converters

Code Conversion From - To	Bits In	Bits Out	Process	Supply Voltage	Device	Source
ASCII - BCDIC	6	6	PMOS	±12	MM4220LR	† National
				±12	MM5220LR	National
ASCII - EBCDIC	6	7	PMOS	±12	MM4220EK	† National
				±12	MM5220EK	National
	7	8	PMOS	5	CRC3502-1-2	Collins
				5	CRC3502-2-2	Collins
				±12	MM4220AE	† National
				±12	MM5220AE	National
				±12	MM4221RR	† National
				±12	MM5221RR	National
			Bipolar	5	N8224CB180	Signetics
	8	8	Bipolar	5	N8204YCB504	Signetics
			PMOS	−12,5	MK2503	Mostek
				−12,5	MK2601	Mostek
				±12	MM4230QY	† National
				±12	MM5230QY	National
		10	PMOS	±12	EA4015	EA
	9	8	Bipolar	5	N8205CB175	Signetics
ASCII - HOLLERITH	9	10	PMOS	−24	EA4035	EA
ASCII - SELECTRIC	7	7	PMOS	−12,5	3512A	Fairchild
				−12,5	3514A/B	Fairchild
				±12	MM4230KP	† National
				±12	MM5230KP	National
	8	10	PMOS	−24,−12	NCM1151	Nitron
BCD - BINARY	6	6	Bipolar	5	SN54184	† TI
				5	SN74184	TI
BCDIC - ASCII	6	7	PMOS	±12	MM4220AP	† National
				±12	MM5220AP	National
				±12	MM4220LR	† National
				±12	MM5220LR	National
BCDIC - EBCDIC	6	7	PMOS	±12	MM4220EK	† National
				±12	MM4230JT	† National
				±12	MM5220EK	National
				±12	MM5230JT	National
Baudot - ASCII	5	8	PMOS	±12	MM4220BL	† National
				±12	MM5220BL	National
BINARY - BCD	6	6	Bipolar	5	SN54185A	† TI
				5	SN74185A	TI
	8	9	Bipolar	5	MCM4067AL	Motorola
				5	MCM4068AL	Motorola
EBCDIC - ASCII		8	Bipolar	5	N8204CB505	Signetics
			PMOS	−12,5	MK2503	Mostek
				−12,5	MK2601	Mostek
				±12	MM4230QX	† National
				±12	MM4231RP	† National
				±12	MM5230QX	National
				±12	MM5231RP	National
					(continued)	

Code Converters (cont)

Code Conversion From - To	Bits In	Bits Out	Process	Supply Voltage	Device	Source
			PMOS	(continued)		
				−12,5	N2461/CM4030	Signetics
		9	PMOS	−12,5	CRC3503-1-2	Collins
				−12,5	CRC3503-2-2	Collins
		10	PMOS	±12	EA4015	EA
	9	8	PMOS	±12	N2430YCM000	Signetics
				5	N8205CB175	Signetics
	12	8	Bipolar		DM8576AAA	National
EBCDIC - DCDIC	7	6	PMOS	±12	MM4230JT	† National
				±12	MM5230JT	National
EBCDIC - HOLLERITH	9	10	MOS	−24	EA4034	EA
		10	PMOS	−24	EA4035	EA
	12	8	PMOS	−24,−12	NCM1111	Nitron
				−24,−12	NCM1112	Nitron
			Bipolar	5	MCM4069A	Motorola
				5	MCM4070A	Motorola
EBCDIC - SELECTRIC	8	8	PMOS	±12	MM4230FE	† National
				±12	MM5230FE	National
HOLLERITH - ASCII	8	8	PMOS	±12	MM4230BO	† National
				±12	MM5230BO	National
HOLLERITH - EBCDIC	8	8	PMOS	±12	MM4230QW	† National
				±12	MM5230QW	National
	9	10	PMOS	−24	EA4034	EA
Multiple SELECTRIC, HOLLERITH - EBCDIC - ASCII			NMOS	−3,5,12	MCM6561	Motorola
				−3,5,12	MCM6562	Motorola
				−3,5,12	NCM6561	Nitron
Multiple ASCII-SELECTRIC, EBCDIC, HOLLERITH			NMOS	−3,5,12	MCM6591	Motorola
					NCM6591	Nitron
SELECTRIC - ASCII	8	10	PMOS	−24,−12	NCM1151	Nitron
SELECTRIC - EBCDIC	8	8	PMOS	±12	MM4230FE	† National
				±12	MM5230FE	National

† Military Temperature Range (−55°C to 125°C)   * — Typical Values

MEMORY—EAROMs, FIFOs, LIFOs

EAROMs Electrically Alterable, ROMs

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
1	1	NMOS			±20	NOM201C	Plessey
	2	NMOS			±20	NOM202C	Plessey
	4	NMOS			±20	NOM204C	Plessey
8	8	MNOS			20	NOM401C	Plessey
	16	MNOS		Serial	±15	NC7030	Nitron
16	8	MNOS		Serial	±15	NC7030	Nitron
32	16	MNOS	4 µs		−29,5	ER2050	GI
64	1	MNOS	800 nsF		−30	NC7001	Nitron
100	4	MNOS	3.4 ms		−35	ER1400	GI
256	4	MNOS	2 µF			1105	GI
					±12	1105	NCR
512	2	MNOS	2 µs*	TS	−30	NC7002	Nitron
			25 µsR	TS	−30	NC7010	Nitron
1024	1	MNOS	2 µs*	TS	−30	NC7002	Nitron
			25 µsR	TS	−30	NC7010	Nitron
					−30	2400	NCR
	4	MNOS	2 µs		±5	ER2401	GI

First-In First-Out

Words	Bits/ Word	Data Rate MHz (max)	Supply Voltage	Device	Source
4	4	—		**CD40105B** see page 375	† RCA
				CD40105BE see page 375	RCA
16	4	10.0	5	9403C	Fairchild
			5	9403M	† Fairchild
	5	20.0	5	SN74S225	TI
24	4	2.5	5-16	MS618	† Ragen
32	8	0.25	−12,5	MP3812A	† Plessey
				MP3812B	Plessey
		0.5	−12,5	AM2812C	AMD
			−12,5	AM2812M	† AMD
		1.0	−12,5	AM2812AC	AMD
			−12,5	AM2812AM	† AMD
	9	0.25		MP3813	Plessey
			−12,5	MP3813A	† Plessey
		0.5	−12,5	AM2813C	AMD
			−12,5	AM2813M	† AMD
		1.0	−12,5	AM2813AC	AMD
			−12,5	AM2813AM	† AMD
40	9	0.25	−12,5	FR1502E-02	Western
		0.5	−12,5	FR1502E-01	Western
		1.0	−12,5	FR1502E	Western
				COM5014	SMC
		2.0	−12,5	33511C	Fairchild
			−12,5	33511M	† Fairchild
			−12,5	33512C	Fairchild
64	4	0.75	−12,5	3341C	AMD
			−12,5	3341C	Fairchild
		1.0	−12,5	AM2841C	AMD
			−12,5	AM2841M	† AMD
			−12,5	3341AC	Fairchild
			−12,5	3341AM	† Fairchild
		2.0	−12,5	ITT3341	ITT
			−12,5	ITT3342	ITT
		10.0	5	5741	† MMI
			5	6741	MMI

First-In First-Out (cont)

Words	Bits/ Word	Data Rate MHz (max)	Supply Voltage	Device	Source
64	9	0.25	−12,5	TMS4024	TI

Last-In First-Out

Words	Bits/ Word	Data Rate MHz (max)	Supply Voltage	Device	Source
16	4	10.5	5	9404C	Fairchild
				9404M	† Fairchild

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperatur
OC—Open Collector TS—Three-State OE—Open Emitte

Bold face indicates additional data is provided on the page noted.

MEMORY—PROMs

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
PROMs							
32	8	ECL	20 nsR	OE	−5.2	10139	† Signetics
				OE	−5.2	SN10139	TI
		TTL	40 nsF	OC	5	**HM7602-5** **see page 746**	**Harris**
				TS	5	**HM7603-5** **see page 746**	**Harris**
				OC	5	SN74S188	TI
				TS	5	SN74S288	TI
			50 nsF	OC	5	**HM7602-2** **see page 746**	**† Harris**
				TS	5	**HM7603-2** **see page 746**	**† Harris**
				OC	5	**N82S23** **see page 804, 826, 828,**	**Signetics**
				TS	5	**N82S123** **see page 804, 826, 828,**	**Signetics**
				OC	5	SN54S188	† TI
				TS	5	SN54S288	† TI
			50 nsR	OC	5	HPROM8256-2	Harris †
				OC	5	HPROM8256-5	Harris
				OC	5	IM5600C	Intersil
				OC	5	IM5600M	† Intersil
				TS	5	IM5610C	Intersil
				TS	5	IM5610M	† Intersil
				OC	5	5330	† MMI
				OC	5	6330	MMI
				TS	5	5331	† MMI
				TS	5	6331	MMI
				OC	5	DM7577	† National
				OC	5	DM8577	National
				TS	5	DM7578	† National
				TS	5	DM8578	National
				OC	5	SN54188A	† TI
				OC	5	SN74188A	TI
			55 nsF	OC	5	AM27LS08C	AMD
				TS	5	AM27LS09C	AMD
			65 nsF	OC	5	**S82S23** **see page 804, 826, 828,**	**† Signetics**
				TS	5	**S82S123** **see page 804, 826, 828,**	**† Signetics**
			70 nsR	OC	5	IM5600CF	Intersil
				TS	5	IM5610CF	Intersil
			75 nsF	OC	5	AM27LS08M	† AMD
				TS	5	AM27LS09M	† AMD
64	8	TTL	75 nsR	OC	5	JAN38510/201	Harris †
				OC	5	HPROM0512-2	Harris †
				OC	5	HPROM0512-5	Harris
				OC	5	MCM5003A	Motorola
					5	MCM5004A	Motorola
				OC	5	MCM5303A	† Motorola
					5	MCM5304A	† Motorola
				OC	5	SN54186	† TI
				OC	5	SN74186	TI
256	4	ECL	20 nsF	OE	−5.2	10149	Signetics
			25 nsR	OE	−5.2	MCM10149	Motorola
			25 ns*	OE	−5.2	10149	MMI

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
PROMs (cont)							
256	4	ECL	50 ns*	OE	−5.2	F10416C	Fairchild
		TTL	40 nsF	OC	5	**HM7610A-5** **see page 746**	**Harris**
				TS	5	**HM7611A-5** **see page 746**	**Harris**
				OC	5	**N82S27** **see page 804, 826, 832,**	**Signetics**
			45 nsF	OC	5	93417C	Fairchild
				TS	5	93427C	Fairchild
			45 ns*	OC	5	DM54S387	† National
				TS	5	DM54S287	† National
			50 nsF	OC	5	**3601-1** **see page 772, 773**	**Intel**
				TS	5	**3621-1** **see page 772, 773**	**Intel**
				OC	5	DM74S387	National
				TS	5	DM74S287	National
				OC	5	**N82S126** **see page 804, 826, 835,**	**Signetics**
				TS	5	N82S129	Signetics
			60 nsF	OC	5	93417M	† Fairchild
				TS	5	93427M	† Fairchild
				OC	5	**HM7610-5** **see page 746**	**Harris**
				TS	5	**HM7611-5** **see page 746**	**Harris**
			60 nsR	OC	5	AM27LS10C	AMD
				OC	5	AM27LS10M	† AMD
				TS	5	AM27LS11C	AMD
				TS	5	AM27LS11M	† AMD
				OC	5	IM5603AC	Intersil
				OC	5	IM5603AM	† Intersil
				TS	5	IM5623C	Intersil
				TS	5	IM5623M	† Intersil
				OC	5	5300-1	† MMI
				OC	5	6300-1	MMI
				TS	5	5301-1	† MMI
				TS	5	6301-1	MMI
			65 nsF	OC	5	SN74S387	TI
				TS	5	SN74S287	TI
			70 nsF	OC	5	**3601** **see page 772, 773**	**Intel**
					5	**3621** **see page 772, 773**	**Intel**
				OC	5	**S82S126** **see page 804, 826, 835,**	**† Signetics**
				TS	5	**S82S129** **see page 804, 826, 835,**	**† Signetics**
			70 nsR	OC	5	HPROM1024A-2	Harris †
				OC	5	HPROM1024A-5	Harris
				TS	5	HPROM1024-2	Harris †
				TS	5	HPROM1024-5	Harris
			75 nsF	OC	5	**HM7610-2** **see page 746**	**† Harris**
				TS	5	**HM7611-2** **see page 746**	**† Harris**
				OC	5	SN54S387	† TI

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

MEMORY—PROMs (cont)

PROMs (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
256	4	TTL	75 nsF	TS	5	SN54S287	† TI
			80 nsF	OC	5	DM7573	† National
				OC	5	DM8573	National
				TS	5	DM7574	† National
				TS	5	DM8574	National
			90 nsF	OC	5	M3601	† Intel
	8	TTL	60 nsF	TS	5	**N82S114** see page 804, 826, 840,	**Signetics**
			70 nsF	OC	5	SN74S470	TI
				TS	5	SN74S471	TI
			80 nsF	OC	5	SN54S470	† TI
				TS	5	SN54S471	† TI
			90 nsF	TS	5	**S82S114** see page 804, 826, 840,	**† Signetics**
			90 nsR	OC	5	5335-1	† MMI
				OC	5	6335-1	MMI
				TS	5	5336-1	† MMI
				TS	5	6336-1	MMI
		PMOS Erasable	450 nsF	TS	−9,5	1702A-1	Intel
						MK3702	Mostek
			650 nsF	TS	−9,5	1702A-2	Intel
			750 nsF	TS	−9,5	9702-1	AMD
				TS	−9,5	MM1702AQ-1	National
			1 μsF	TS	−9,5	1702A	AMD
				TS	−9,5	9702	AMD
				TS	−9,5	1702A	Intel
				TS	−9,5	MM1702AQ	National
			1 μsR	TS	−12,5	MM4203Q	National
				TS	−12,5	MM5203Q	National
			1.3 μsF	TS	−9,5	8702A	AMD
				TS	−9,5	**8702A** see page 960	**Intel**
				TS	−9,5	MM8702A	National
			1.5 μsF	TS	−9,5	1702A-6	AMD
				TS	−9,5	1702A-6	Intel
				TS	−9,5	MM1702AQ-6	National
			1.7 μsF	TS	−10,5	4702A	AMD
				TS	−10,5	4702A	Intel
				TS	−10,5	MM4702A	National
			2.3 μsF	TS	−9,5	**8702A-4** see page 960	**Intel**
				TS	−9,5	MM8702A-4	National
		PMOS	750 nsF	TS	−9,5	1602A-1	Intel
				TS	−9,5	MM1702AD-1	National
			1 μsF	TS	−9,5	1602A	Intel
				TS	−9,5	MM1702AD	National
			1 μsR	TS	−12,5	MM4203D	National
				TS	−12,5	MM5203D	National
			1.5 μsF	TS	−9,5	1602A-6	Intel
512	4	TTL	50 nsF	OC	5	93436C	Fairchild
				TS	5	93446C	Fairchild
				OC	5	**HM7620A-5** see page 746	**Harris**
				TS	5	**HM7621A-5** see page 746	**Harris**
				OC	5	**N82S130** see page 804, 826, 838,	**Signetics**

PROMs (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
512	4	TTL	50 nsF	TS	5	**N82S131** see page 804, 826, 838,	**Signetics**
			60 nsF	OC	5	93436M	† Fairchild
				TS	5	93446M	† Fairchild
			70 nsF	OC	5	**HM7620-5** see page 746	**Harris**
				TS	5	**HM7621-5** see page 746	**Harris**
				OC	5	**3602** see page 774, 775	**Intel**
				TS	5	**3622** see page 774, 775	**Intel**
				OC	5	**S82S130** see page 804, 826, 838,	**† Signetics**
				TS	5	**S82S131** see page 804, 826, 838,	**† Signetics**
			70 nsR	OC	5	5305-1	† MMI
				OC	5	6305-1	MMI
				TS	5	5306-1	† MMI
				TS	5	6306-1	MMI
				OC	5	IM5604C	Intersil
				OC	5	IM5604M	† Intersil
				TS	5	IM5624C	Intersil
				TS	5	IM5624M	† Intersil
			85 nsF	OC	5	**HM7620-2** see page 746	**† Harris**
				TS	5	**HM7621-2** see page 746	**† Harris**
			90 nsF	OC	5	**3602-4** see page 774, 775	**Intel**
				TS	5	**3622-4** see page 774, 775	**Intel**
			120 nsF	OC	5	**3602L-6**	**Intel**
				TS	5	**3622L-6** see page 774, 775	**Intel**
		PMOS Erasable	1 μsR	TS	−12,5	MM4203Q	National
				TS	−12,5	MM5203Q	National
				TS	−9,±5	T3181A	Toshiba
			1.5 μsR	TS	−9,±5	T3181B	Toshiba
		PMOS	1 μsR	TS	−12,5	MM4203D	National
				TS	−12,5	MM5203D	National
	8	TTL	55 nsF	OC	5	93438C	Fairchild
				TS	5	93448C	Fairchild
			55 ns*	OC	5	SN54S473	† TI
				OC	5	SN74S473	TI
				TS	5	SN54S472	† TI
				TS	5	SN74S472	TI
				OC	5	SN54S475	† TI
				OC	5	SN74S475	TI
				TS	5	SN54S474	† TI
				TS	5	SN74S474	TI
			60 nsF	TS	5	**N82S115** see page 804, 826, 840,	**Signetics**
			70 nsF	OC	5	93438M	† Fairchild
				TS	5	93448M	† Fairchild
				OC	5	**HM7640-5** see page 746	**Harris**

Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—PROMs (cont)

PROMs (cont)

Words	Bits/Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
			70 nsF	TS	5	**HM7641-5** see page 746	**Harris**
				OC	5	**3604** see page 776, 777	**Intel**
				TS	5	**3624** see page 776, 777	**Intel**
				OC	5	IM5605C	Intersil
				TS	5	IM5625C	Intersil
			80 nsF	OC	5	IM5605M	† Intersil
				TS	5	IM5625M	† Intersil
			85 nsF	OC	5	**HM7640-2** see page 746	**† Harris**
				TS	5	**HM7641-2** see page 746	**† Harris**
			90 nsF	TS	5	**S82S115** see page 804, 826, 840,	**† Signetics**
			90 nsR	OC	5	5340-1	† MMI
				OC	5	6340-1	MMI
				TS	5	5341-1	† MMI
				TS	5	6341-1	MMI
			120 nsF	TS	5	**3604L-6** see page 776, 777	**Intel**
		NMOS Erasable	450 nsF	TS	±5,12	**2704** see page 770, 771	**Intel**
			1 μsF	TS	±5,12	**2704-5** see page 770, 771	**Intel**
		PMOS Erasable	575 nsF	TS	−12,5	**S6834** see page 912	**AMI**
			750 nsF	TS	−12,5	**S5204A** see page 706	AMI
			1 μsF	TS	−12,5	MM5204	National
			1.25 μsF	TS	−12,5	MM4204	National
1024	4	TTL	60 nsF	OC	5	6350	MMI
				TS	5	6351	MMI
				OC	5	N82S136	Signetics
				TS	5	N82S137	Signetics
			70 nsF	OC	5	HM7642-5	Harris
				TS	5	HM7643-5	Harris
				—	5	HM7644-5	Harris
				OC	5	3605	Intel
				TS	5	3625	Intel
			75 nsF	OC	5	5350	† MMI
				TS	5	5351	† MMI
			85 nsF	OC	5	HM7642-2	† Harris
				TS	5	HM7643-2	† Harris
				—	5	HM7644-2	† Harris
	8	NMOS Erasable	450 nsF	TS	±5,12	**2708** see page 770, 771	**Intel**
			1 μsF	TS	±5,12	**2708-5** see page 770, 771	**Intel**
		TTL	70 ns*	OC	5	5380	† MMI
				OC	5	6380	MMI
				TS	5	5381	† MMI
				TS	5	6381	MMI

Field Programmable Logic Arrays

Words	Bits/Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
	48	Product Terms	55	OC		**82S100/82S101** see page 845	**Signetics**
				TS			

Field Programmable Logic Arrays (cont)

Words	Bits/Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
1024	48	Product Terms				6870	MMI
				—		6871	MMI
			100	—	5	IM5200	Intersil
				—		5870	† MMI
				—		5871	† MMI

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

ɅEMORY—RAMs

Dynamic

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
1024	1	NMOS	60 nsF		±15	EA1500A	EA
					−5,12	SY7103	Synertek
			80 nsF		−5,12	2105-1	Intel
			85 nsF		−5.2,12	2105-2	Intel
			95 nsF		−5,12	2105	Intel
			120 nsF		±15	EA1500A-1	EA
		PMOS	100 nsF		19,22.5	SY1103A-X	Synertek
			110 nsF		19,22.5	1103A-X	Rockwell
			120 nsF		19,22.5	**S1103X** see page 707	**AMI**
					19,22.5	ITT1103-X	ITT
			125 nsF		19,22.5	**S1103A-X** see page 712	**AMI**
			145 nsF		19,22.5	**S1103A-1** see page 712	**AMI**
					19,22.5	1103A-1	Fairchild
					19,22.5	1103A-2	Fairchild
					19,22.5	1103A-1	Intel
					19,22.5	1103A-2	Intel
					19,22.5	1103A-1	Rockwell
					19,22.5	1103A-2	Rockwell
					19,22.5	SY1103A-1	Synertek
			150 nsF		19,22.5	**S1103-1** see page 707	**AMI**
					20,22.5,7	AMS6002	AMS
					19,22.5	11031C	Fairchild
						HM3503-1	Hitachi
					19,22.5	1103-1	Intel
					19,22.5	ITT1103-1	ITT
					19,22.5	1103-1	Nortec
					20,22.5,7	6002	Nortec
					19,22.5	1103-1	Signetics
					19,22.5	TMS1103-1	TI
					20,22,7	TMS4062	TI
					20,22,7	TMS4063	TI
			205 nsF		19,22.5	S146	AMI
					16,19.5	**S1103A** see page 712	**AMI**
					16,19.5	1103A	Fairchild
					16,19.5	1103A	Intel
					19,22.5	ITT1103-146	ITT
					19,22.5	1103-146	Nortec
					16,22.5	1103A	Rockwell
					16,19.5	SY1103A	Synertek
			220 nsF		16,19.5	1103SC	Fairchild
						HM3503-2	Hitachi
			300 nsF		16,19.5	**S1103** see page 707	**AMI**
					16,19.5	1103C	Fairchild
						HM3503	Hitachi
					16,19.5	1103	Intel
					16,19.5	ITT1103	ITT
					16,19.5	1103	Nortec
					16,19.5	1103	Signetics
					16,19.5	TMS1103	TI
			400 nsF		−12,5	**S4006** see page 706	**AMI**
					−12,5	MK4006	Mostek
					−12,5,7	MM5261	National
			450 nsF		−12,5,7	MM4261 †	National
			500 nsF		−12,5	**S4008** see page 706	**AMI**
					−12,5	MK4008	Mostek

Dynamic (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
1024	1	PMOS	800 nsF		−12,5	**S4008-9** see page 706	**AMI**
2048	1	PMOS	350 nsF		−15,8,5	AMS600311	AMS
					−15,8,5	600311	Nortec
			365 nsF		−15,8.5,5	MM5262	National
			420 nsF		−15,8.5,5	MM4262 †	National
			460 nsF		−15,8.5,5	AMS600310	AMS
					−15,8.5,5	600314	Nortec
4096	1	NMOS	150 nsF	TS	±5,12	MCM6605A-1	Motorola
				TS	±5,12	IM7505A-1	Intersil
				TS	5,12	µPD411-3	NEC
			175 nsF	TS	±5,12	RM1701H-17	Western
			200nsF	TS	±5,12	AMS7005	AMS
				TS	±5,12	AMS7280	AMS
				TS	−5,12	AMS7270	AMS
				TS	−5,12	AMS7271	AMS
				TS	±5,12	9060E	AMD
					−5,12	9050E	AMD
				TS	±5,12	9107	AMD
				TS	±5,12	**S4021-4** see page 722	**AMI**
				TS	±5,12	**S4096** see page 728	**AMI**
				TS	±5,12	S4096-4	AMI
				TS	±5,12	EA4060	EA
				TS	±5,12	EA4116	EA
				TS	±5,12	EA4122-2	EA
				TS	±5,12	4096-2	Fairchild
				TS	±5,12	**2107B** see page 760, 765	**Intel**
				TS	±5,12	IM7505A-2	Intersil
				TS	±5,12	IM7507-2	Intersil
				TS	±5,12	2180	MMI
				TS	−5,12	2170	MMI
				TS	±5,12	MK4027	Mostek
				TS	±5,12	MCM6605A-2	Motorola
				TS	±5,12	MM5280	National
				TS	−5,12	MM5270	National
				TS	±5,12	MW4060V2	RCA
					−5,12	MW4050V2	RCA
				TS	±5,12	1604-1	Rockwell
				TS	−5,12	2670-1	Signetics
				TS	−3,5,12	TMS4030-2	TI
				TS	±5,12	TMS4060-2	TI
					−5,12	TMS4050-2	TI
				TS	±5,12	RM1701H-20	Western
			220 nsF	TS	±5,12	**2107B-2** see page 760, 765	**Intel**
			250 nsF	TS	±5,12	**S4021-3** see page 722	**AMI**
				TS	±5,12	**S4096-3** see page 728	**AMI**
				TS	±5,12	9060D	AMD
					−5,12	9050D	AMD
				TS	±5,12	EA4060-1	EA
				TS	±5,12	EA4122-1	EA
				TS	±5,12	40963	Fairchild

Military Temperature Range (−55°C to 125°C) ns•—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
C—Open Collector TS—Three-State OE—Open Emitter

MEMORY—RAMs (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
Dynamic (cont)							
4096	1	NMOS	250 nsF	TS	±5,12	**2104-2** see page 752, 759	**Intel**
				TS	±5,12	IM7507-1	Intersil
				TS	±5,12	**MK4096-6** see page 778, 781	**Mostek**
				TS	±5,12	MCM6604-2	Motorola
				TS	±5,12	1604-2	Rockwell
				TS	−5,12	2670-2	Signetics
				TS	−3,5,12	TMS4030-1	TI
				TS	±5,12	TMS4060-1	TI
					−5,12	TMS4050-1	TI
					−5,12	TMS4051-1	TI
				TS	±5,12	RM1701H-25	Western
			270 nsF	TS	−5,12	9107-4	AMD
				TS	±5,12	**2107B-4** see page 760, 765	**Intel**
				TS	±5,12	2180	MMI
				TS	−5,12	2170	MMI
				TS	±5,12	MW4060V1	RCA
					±5,12	MW4050V1	RCA
			280 nsF	TS	±5,12	2107A-1	Intel
			300 nsF	TS	±5,12	9060C	AMD
					−5,12	9050C	AMD
				TS	±5,12	**S4021-2** see page 722	**AMI**
				TS	±5,12	**S4096-2** see page 728	**AMI**
				TS	±5,12	EA4060-2	EA
				TS	±5,12	EA4122	EA
				TS	±5,12	40964	Fairchild
				TS	±5,12	HM4503-1	Hitachi
				TS	±5,12	HM4507	Hitachi
				TS	±5,12	**2104-4** see page 752, 759	**Intel**
				TS	±5,12	2107A	Intel
				TS	±5,12	IM7505A	Intersil
				TS	±5,12	IM7507	Intersil
				TS	±5,12	**MK4096-16** see page 778, 781	**Mostek**
				TS	±5,12	**MK4200-16** see page 783	**Mostek**
				TS	±5,12	MCM6604-4	Motorola
				TS	±5,12	MCM6605A	Motorola
				TS	±5,12	MW4060	RCA
					±5,12	MW4050	RCA
				TS	±5,12	**2604** see page 793	**Signetics**
				TS	−5,12	2670-3	Signetics
				TS	±5,12	TMS4060	TI
					−5,12	TMS4050	TI
					−5,12	TMS4051	TI
				TS	−3,5,12	TMS4030	TI
				TS	±5,12	RM1701H	Western
				TS	±5,12	RM1701H-30	Western
			350 nsF	TS	±5,12	9107-6	AMD
				TS	±5,12	**S4096-1** see page 728	**AMI**
				TS	±5,12	4096-3	Fairchild

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
Dynamic (cont)							
4096	1	NMOS	350 nsF	TS	±5,12	**2104** see page 752, 759	**Intel**
				TS	±5,12	2107A-4	Intel
				TS	±5,12	**2107B-6** see page 760, 765	**Intel**
				TS	±5,12	2180	MMI
				TS	−5,12	2170	MMI
				TS	±5,12	**MK4096-11** see page 778, 781	**Mostek**
						MK4200-11 see page 783	**Mostek**
				TS	±5,12	MCM6604	Motorola
				TS	±5,12	1604	Rockwell
				TS	±5,12	RM1701H-35	Western
			400 nsF	TS	±5,12	**S4021** see page 722	**AMI**
				TS	±5,12	RM1701H-40	Western
			420 nsF	TS	±5,12	2107A-5	Intel
				TS	±5,12	2107A-8	Intel
			450 nsF	TS	±5,12	RM1701H-45	Western
			510 nsF	TS	±5,12	**S4096** see page 728	**AMI**
8192	1	NMOS	125 nsF	TS	±5,12	AMS7008	
					±5,12	CCD460	Fairchild
CCDRMemories							
9216-Bits (1024x9)						CCD450	Fairchild
16384-Bits (128x32x4)						CCD460	Fairchild
16384-Bits (256 x 64 x 1)						2416	Intel
Static							
4	4	CMOS	1 μsR	—	45-16	MC14580A	† Motorola
			1.5 μsR	—	3-18	MC14580C	Motorola
					3-18	SCL4580	SSS
		TTL	30 nsF	OC	5	3104	Intel
			40 nsR	OC	5	54170	† Fairchild
						54LS170	† Fairchild
						54LS670	† Fairchild
				OC	5	74170	Fairchild
						74LS170	Fairchild
						74LS670	Fairchild
				OC	5	54170	† Raytheon
				OC	5	74170	Raytheon
				OC	5	SN54170	† TI
				OC	5	SN54LS170	† TI
				TS	5	SN54LS670	† TI
				OC	5	SN74170	TI
				OC	5	SN74LS170	TI
				TS	5	SN74LS670	TI
	8	CMOS	1 μsR	—	3-15	**CD4036A** see page 375	**† RCA**
					3-15	**CD4039A** see page 375	**† RCA**
					3-15	CM4036A	† Solitron
					3-15	CM4039A	† Solitron
8	2	ECL	14.5 nsR	—	−5.2	MCM10143	Motorola
		TTL	50 nsR	TS	5	SN74172	TI
	4	TTL	30 nsF	OC	5	**N82S12** see page 804, 806, 810,	**Signetics**

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

MEMORY—RAMs (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
Static (cont)							
8	4	TTL	30 nsF	TS	5	**N82S112** see page 804, 806, 810,	**Signetics**
16	1	ECL	12 nsR	OE	12	HM2101	Hitachi
		TTL	20 nsR	OC	5	5481	† Raytheon
				OC	5	7481	Raytheon
				OC	5	SN5481A	† TI
				OC	5	SN5484A	† TI
				OC	5	SN7481A	TI
				OC	5	SN7484A	TI
			35 nsR	OC	5	MC4004	Motorola
				OC	5	MC4005	Motorola
				OC	5	MC4304	† Motorola
				OC	5	MC4305	† Motorola
	4	CMOS	120 nsR	TS	3-5	F4710	Fairchild
			280 nsR	TS	3-15	HD54C89	† Harris
				TS	3-15	HD74C89	Harris
				TS	3-15	MM54C89	† National
				TS	3-15	MM74C89	National
				TS	10	MM54C89	† Teledyne S
				TS	10	MM74C89	† Teledyne S
		ECL	6 ns*	OE	−5.2	SN10145	TI
			10 ns*	OE	−5.2	HD10145	Hitachi
				OE	−5.2	MCM10145	† Motorola
			15 nsR	OE	−5.2	10145	Signetics
			25 nsF		−5.2	F95400C	Fairchild
		PMOS	400 ns*	—	−27,−15	CRC4001	Collins
		TTL	35 nsF	OC	5	AM27S02M	† AMD
				TS	5	AM27S03C	AMD
				TS	5	SN74S189	AMD
				OC	5	SN74S289	AMD
				OC	5	93404C	Fairchild
				OC	5	93404A	† Fairchild
				TS	5	93405C	Fairchild
				OC	5	93405M	† Fairchild
				OC	5	3101A	Intel
				OC	5	6560	MMI
				TS	5	6561	MMI
				OC	5	DM74S289	National
				TS	5	DM74S189	National
				OC	5	**N3101A** see page 804, 806, 814,	**Signetics**
				TS	5	N74S189	Signetics
				TS	5	SN74S189	TI
				OC	5	SN74S289	TI
			35 nsR	TS	5	AM27S03M	† AMD
			45 nsF	OC	5	M3101A	† Intel
			45 nsR	OC	5	MC5484	† Motorola
				OC	5	MC7484	Motorola
				TS	5	DM7599	† National
				TS	5	DM8599	National
			50 nsF	TS	5	SN54S189	† AMD
				OC	5	SN54S289	† AMD
				OC	5	DM54S289	† National
				TS	5	DM54S189	† National
				OC	5	**N82S25** see page 804, 806, 814,	**Signetics**

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
Static (cont)							
16	4	TTL	50 nsF	OC	5	**S3101A** see page 804, 806, 814,	**† Signetics**
				TS	5	S54S189	† Signetics
				TS	5	SN54S189	† TI
				OC	5	SN54S289	† TI
			60 nsF	OC	5	3101	AMD
				OC	5	3101	Intel
				OC	5	5560	† MMI
				TS	5	5561	† MMI
			60 nsR	OC	5	7489	Fairchild
				OC	5	HM2502	Hitachi
				OC	5	IM5501C	Intersil
				OC	5	IM5501M	† Intersil
				OC	5	MCM4064L	Motorola
				OC	5	MCM4364	† Motorola
				OC	5	DM5489	† National
				OC	5	DM7489	National
				OC	5	SN7489	TI
				OC	5	7489	TRW
			75 nsF	OC	5	31013	† AMD
				OC	5	M3101	† Intel
			80 nsF	OC	5	L6560	MMI
				TS	5	L6561	MMI
			100 nsF	OC	5	L5560	† MMI
				TS	5	L5561	† MMI
			110 nsR	OC	5	31L01C	AMD
				OC	5	31L01M	† AMD
			150 nsR	OC	5	DM54L89A	† National
				OC	5	DM74L89A	National
				TS	5	DM76L99	† National
				TS	5	DM86L99	National
16+1	4	TTL	19 nsF	TS	5	9410C	Fairchild
32	2	TTL	50 nsF	OC	5	DM86S21	National
				OC	5	**N82S21** see page 804, 806, 812,	**Signetics**
64	1	CMOS	270 nsR	—	3-18	MCM14505A	† Motorola
			350 nsR	—	4.5-16	MCM14505C	Motorola
		ECL	10 nsR	OE	−5.2	SN10142	TI
			12 nsR	OE	−5.2	MCM10140	Motorola
				OE	−5.2	MCM10142	Motorola
				OE	−5.2	MCM10148	Motorola
			15 nsR	OE	−5.2	10140	Signetics
				OE	−5.2	10148	Signetics
				OE	−5.2	10151	Signetics
				OE	−5.2	SN10140	TI
				OE	−5.2	SN10148	TI
	4	CMOS	200 ns*	TS	5-15	SCM5555D	SSS
					5	MM74C910	National
			1.05 µsR		5-15	MCM14552A	† Motorola
			2.1 µsR	TS	5-15	MCM14552C	Motorola
	8	NMOS	450 nsF	TS	5	TMS4036-2	TI
			650 nsF	TS	5	TMS4036-1	TI
			1 µsF	TS	5	TMS4036	TI
	9	TTL	45 nsF	OC	5	93419C	Fairchild
				OC	5	**N82S09** see page 804, 806, 817,	**Signetics**

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—RAMs (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
Static (cont)							
64	9	TTL	60 nsF	OC	5	93419M	† Fairchild
					5	6555	MMI
			65 nsF	OC	5	**S82S09** see page **804, 806, 817,**	† **Signetics**
			80 nsF		5	5555	† MMI
128	1	ECL	12 nsR	OE	−5.2	MCM10147	Motorola
			15 nsF	OE	−5.2	F10405C	Fairchild
			15 nsR	OE	−5.2	SN10147	TI
	8	NMOS	500 nsF	TS	5	MCM6810A	Motorola
			575 nsF	TS	5	**S6810-1** see page **884**	**AMI**
			1 μsF	TS	5	**S6810** see page **884**	**AMI**
256	1	CMOS	100 nsF	TS	3-15	SCM5520S	† SSS
			100 ns*	TS	10	CD40061	RCA
			200 ns*	TS	3-15	F4720	Fairchild
					3-15	**CD4061A** see page **375**	† **RCA**
			400 nsR	TS	3-15	HD54C200	† Harris
				TS	3-15	HD74C200	Harris
				TS	3-15	MM54C200	† National
				TS	3-15	MM74C200	National
				TS	3-15	MM54C200	† Teledyne S
				TS	3-15	MM74C200	Teledyne S
			500 nsR	—	3-7	IM6523C	Intersil
					3-7	IM6523M	† Intersil
			1.4 μsR	—	3-18	MCM14537A	† Motorola
			2 μsR	—	3-16	MCM14537C	Motorola
		ECL	30 nsF	OE	−5.2	F10410C	Fairchild
				OE	−5.2	10144	Signetics
			30 nsR	OE	−5.2	MCM10144	Motorola
			35 nsF	OE	−4.25	F10411C	Fairchild
				OE	−5.2	HM2105	Hitachi
				OE	−5.2	RC10144	Raytheon
			35 nsR	OE	−5.2	SN10144	TI
			40 nsF		−5.2	F95410C	Fairchild
				OE	−5.2	HM2104	Hitachi
				OE	−5.2	RI10144	Raytheon
		PMOS	500 nsF	TS	−9,5	MM1101A2	National
			650 nsF	TS	−9,5	MM4250	† National
			800 nsF	—	−7,5	IM7511C	Intersil
			900 nsF		−12,5	MK4007	Mostek
			1 μsF	TS	−9,5	1101A1	AMD
				TS	−9,5	1101A1	Intel
					−7,5	IM7511M	† Intersil
				TS	−9,5	MM1101A1	National
				TS	−9,5	1101	Signetics
					−9,5	2501	Signetics
					−12,5	N25L01	Signetics
					−7,5	μA2556	† Solitron
			1.5 μsF	TS	−9,5	1101A	AMD
				TS	−10,5	1101AM	† AMD
				TS	−9,5	1101A	Intel
				TS	−7,5	IM7501C	Intersil
				TS	−7,5	IM7501M	† Intersil
				TS	−7,5	IM7512C	Intersil
				TS	−9,5	MM1101A	National

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
Static (cont)							
256	1	PMOS	1.8 μSF	TS	−7,5	IM7512M	† Intersil
		TTL	36 nsF	TS	5	AM27LS00AC	AMD
			40 nsF	TS	5	93421AC	Fairchild
				TS	5	**N82S116** see page **804, 806, 815,**	**Signetics**
				OC	5	**N82S117** see page **804, 806, 815,**	**Signetics**
			45 nsF	OC	5	AM27LS01C	AMD
				TS	5	AM27LS00C	AMD
				TS	5	AM27LS00AM	AMD †
				OC	5	93410AC	Fairchild
				OC	5	93411AC	Fairchild
				TS	5	93L420C	Fairchild
			50 nsF	TS	5	93421C	Fairchild
				TS	5	RC5340	Raytheon
				OC	5	**N82S17** see page **804, 806, 815,**	**Signetics**
				TS	5	**N82S16** see page **804, 806, 815,**	**Signetics**
				OC	5	**N74S301** see page **804, 806, 815,**	**Signetics**
				TS	5	N74S200	Signetics
				TS	5	**N74S201** see page **804, 806, 815,**	**Signetics**
			50 ns*	OC	5	DM8582	† National
				TS	5	DM74S200	National
			55 nsF	OC	5	AM27LS01M	† AMD
				TS	5	AM27LS00M	† AMD
				OC	5	93411C	Fairchild
				TS	5	93L420M	† Fairchild
				OC	5	6530	MMI
				TS	5	6531	MMI
				OC	5	RC5330	Raytheon
			60 nsF	OC	5	93410C	Fairchild
				TS	5	93421M	† Fairchild
				TS	5	3106A	Intel
				OC	5	3107A	Intel
				OC	5	IM5503AC	Intersil
				TS	5	IM5523AC	Intersil
				OC	5	IM5533AC	Intersil
				OC	5	DM74S206	National
			65 nsF	OC	5	93411M	† Fairchild
				TS	5	HM2505	Hitachi
				OC	5	S93410A	† Signetics
				TS	5	SN74S201	TI
				OC	5	SN74S301	TI
			70 nsF	OC	5	93410M	† Fairchild
				OC	5	IM5503AM	† Intersil
				TS	5	IM5523AM	† Intersil
				OC	5	IM5533AM	† Intersil
				OC	5	5530	† MMI
				TS	5	5531	† MMI
				TS	5	DM54S200	† National
				TS	5	RM5340	† Raytheon
				OC	5	S82S17	† Signetics
				TS	5	S82S16	† Signetics

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

MEMORY—RAMs (cont)

Static (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
256	1	TTL	70 nsF	OC	5	**S54S301** see page 804, 806, 815,	† Signetics
				TS	5	**S54S200** see page 804, 806, 815,	† Signetics
				TS	5	**S54S201** see page 804, 806, 815,	† Signetics
			75 nsF	OC	5	RM5330	† Raytheon
			80 nsF	TS	5	3106-8	Intel
				OC	5	3107-8	Intel
				TS	5	3106-	Intel
				OE	5	3107-	Intel
				OC	5	IM5503C	Intersil
				TS	5	IM5523C	Intersil
				OC	5	IM5533C	Intersil
				OC	5	DM54S206	† National
			80 nsR	OC	5	IM5503M	† Intersil
				TS	5	IM5523M	† Intersil
				OC	5	IM5533M	† Intersil
			85 nsF	OC	5	SN54S301	† TI
				TS	5	SN54S201	† TI
			90 nsF	TS	5	93L421C	Fairchild
			100 nsF	TS	5	93L421M	† Fairchild
			115 nsF	OC	5	L6530	MMI
				TS	5	L6531	MMI
			130 nsF	OC	5	L5530	† MMI
				TS	5	L5531	† MMI
	4	CMOS	100 nsF	TS		SCL5501S	† SSS
			100 nsR	TS	4-11	HM6551A-9	Harris
				TS	4-11	HM6561A-9	Harris
				TS	4-11	HM6562A-9	Harris
				TS	4-11	HM6551A-2	† Harris
				TS	4-11	HM6561A-2	† Harris
				TS	4-11	HM6562A-2	† Harris
			100 ns*	TS	10	**MWS5540** see page 786	**RCA**
			150 ns*	TS	5	**MWS5040** see page 786	**RCA**
			160 nsR	TS	4-11	HM6551C-9	Harris
				TS	4-11	HM6561C-9	Harris
				TS	4-11	HM6562C-9	Harris
				TS	4-11	HM6551C-2	† Harris
				TS	4-11	HM6561C-2	† Harris
				TS	4-11	HM6562C-2	† Harris
			305 nsF	TS	5	HM6551B-9	Harris
				TS	5	HM6561B-9	Harris
				TS	5	HM6562B-9	Harris
				TS	5	HM6551B-2	† Harris
				TS	5	HM6561B-2	† Harris
				TS	5	HM6562B-2	† Harris
			425 nsF	TS	5	HM6551-9	Harris
				TS	5	HM6561-9	Harris
				TS	5	HM6562-9	Harris
			450 nsF	TS	5	**5101-1** see page 960	**Intel**
			465 nsF	TS	5	HM6551-2	† Harris
				TS	5	HM6561-2	† Harris
256	4	CMOS	465 nsF	TS	5	HM6562-2	† Harris
			650 nsF	TS	5	**S5101** see page 716	**AMI**
				TS	5	**5101** see page 960	**Intel**
				TS	5	**5101L** see page 960	**Intel**
				TS	5	**5101-3** see page 960	**Intel**
				TS	5	**5101L-3** see page 960	**Intel**
				TS	5	SY5101	Synertek
				TS	5	SY5111	Synertek
				TS	5	SY5112	Synertek
			800 nsF	TS	5	M5101-4	Intel
			850 nsF	TS	5	**5101-8** see page 960	**Intel**
		NMOS	150 nsF	TS	5	SY21H01-1	Synertek
				TS	5	SY21H11-1	Synertek
				TS	5	SY21H12-1	Synertek
			175 nsF	TS	5	SY21H01	Synertek
				TS	5	SY21H11	Synertek
				TS	5	SY21H12	Synertek
			200 nsF	TS	5	SY21H01-2	Synertek
				TS	5	SY21H11-2	Synertek
				TS	5	SY21H12-2	Synertek
			200 ns*	TS	±5,12	MW7040	RCA
			250 nsF	TS	5	AMS7101	AMS
				TS	5	AMS7111	AMS
				TS	5	AMS7112	AMS
				TS	5	9101D	AMD
				TS	5	9111D	AMD
				TS	5	9112D	AMD
				TS	5	SY2101A-2	Synertek
				TS	5	SY2111A-2	Synertek
				TS	5	SY2112A-2	Synertek
			300 nsF	TS	5	91L01C	AMD
				TS	5	9101C	AMD
				TS	5	9101CM	† AMD
				TS	5	91L11C	AMD
				TS	5	9111C	AMD
				TS	5	9111CM	† AMD
				TS	5	91L12C	AMD
				TS	5	9112C	AMD
				TS	5	9112CM	† AMD
				TS	5	EA2101	EA
				TS	5	EA2111	EA
				TS	5	EA2112	EA
			350 nsF	TS	5	3538F	Fairchild
				TS	5	SY2101A	Synertek
				TS	5	SY2111A	Synertek
				TS	5	SY2112A	Synertek
			400 nsF	TS	5	91L01B	AMD
				TS	5	9101B	AMD
				TS	5	9101BM	† AMD
				TS	5	91L11B	AMD

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—RAMs (cont)

Static (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
256	4	NMOS	400 nsF	TS	5	9111B	AMD
				TS	5	9111BM	† AMD
				TS	5	91L12B	AMD
				TS	5	9112B	AMD
				TS	5	9112BM	† AMD
				TS	5	EA2101M	† EA
				TS	5	EA2111M	† EA
				TS	5	EA2112M	† EA
				TS	5	35L38B	Fairchild
			450 nsF	TS	5	3538-1	Fairchild
				TS	5	RA3-4256-A1	GI
				TS	5	RA3-4256-C1	GI
				TS	5	RA3-4256-E1	GI
				TS	5	SY2101A-4	Synertek
				TS	5	SY2111A-4	Synertek
				TS	5	SY2112A-4	Synertek
				TS	5	TMS4039-2	TI
				TS	5	TMS4042-2	TI
				TS	5	TMS4043-2	TI
			500 nsF	TS	5	2101-1	AMD
				TS	5	2111-1	AMD
				TS	5	2112-1	AMD
				TS	5	91L01A	AMD
				TS	5	9101A	AMD
				TS	5	9101AM	† AMD
				TS	5	91L11A	AMD
				TS	5	9111A	AMD
				TS	5	9111AM	† AMD
				TS	5	91L12A	AMD
				TS	5	9112A	AMD
				TS	5	9112AM	† AMD
				TS	5	RA3-4256	EMM/Semi
				TS	5	35L38A	Fairchild
				TS	5	RA3-4256	GI
				TS	5	2101-1	Intel
				TS	5	2111-1	Intel
				TS	5	2112-1	Intel
				TS	5	MM2101-1	National
				TS	5	MM2111-1	National
				TS	5	**2606-1** see page **798**	**Signetics**
					5	SY2111	Synertek
					5	SY2112	Synertek
					5	SY2113	Synertek
				TS	5	SY2101-1	Synertek
				TS	5	SY2111-1	Synertek
				TS	5	SY2112-1	Synertek
			650 nsF	TS	5	2101-2	AMD
				TS	5	2111-2	AMD
				TS	5	2112-2	AMD
				TS	5	RA3-4256B	EMM/Semi
					5	RA3-4256A	EMM/Semi
				TS	5	3538-2	Fairchild
				TS	5	35L38	Fairchild
				TS	5	RA3-4256-A	GI

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
256	4	NMOS	650 nsF	TS	5	RA3-4256-C	GI
				TS	5	RA-4256-E	GI
				TS	5	2101-2	Intel
				TS	5	2111-2	Intel
				TS	5	2112-2	Intel
				TS	5	MM2101-2	National
				TS	5	MM2111-2	National
				TS	5	MM2112-2	National
				TS	5	SY2101-2	Synertek
				TS	5	SY2111-2	Synertek
				TS	5	SY2112-2	Synertek
				TS	5	TMS4039-1	TI
				TS	5	TMS4042-1	TI
				TS	5	TMS4043-1	TI
			750 nsF	TS	5	**2606** see page **798**	**Signetics**
			1 μsF	TS	5	2101	AMD
				TS	5	2111	AMD
				TS	5	2112	AMD
				TS	5	RA3-4256	EMM/Semi
				TS	5	RA3-4256B	EMM/Semi
				TS	5	2101	Intel
				TS	5	2111	Intel
				TS	5	2112	Intel
				TS	5	MM2101	National
				TS	5	MM2111	National
				TS	5	MM2112	National
				TS	5	SY2101	Synertek
				TS	5	SY2111	Synertek
				TS	5	SY2112	Synertek
				TS	5	TMS4039	TI
				TS	5	TMS4042	TI
				TS	5	TMS4043	TI
		TTL	30 ns*	OC	5	93412C	Fairchild
				TS	5	93422C	Fairchild
				OC	5	93412M	† Fairchild
				TS	5	93422M	† Fairchild
	8	NMOS	400 nsF	TS	5	3539-1	Fairchild
			500 nsF	TS	5	3539-2	Fairchild
			600 nsF	TS	5	3539	Fairchild
512	1	CMOS	200 nsF		10	**S2222** see page **706**	**AMI**
					10	2222	Nortec
			400 nsF		10	**S2222A** see page **706**	**AMI**
					10	2222A	Nortec
	5	NMOS	450 nsF	TS	5	RO3-2560	GI
1024	1	CMOS	80 ns*	TS	10	**MWS5501** see page **786**	**RCA**
					10	**MWS5502** see page **786**	**RCA**
			100 nsF	TS	3-15	SCM5502S	† SSS
			100 nsR	TS	4-11	HM6508A-9	Harris
				TS	4-11	HM6518A-9	Harris
				TS	4-11	HM6508A-2	† Harris
				TS	4-11	HM6518A-2	† Harris

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter
Bold face indicates additional data is provided on the page noted.

MEMORY—RAMs (cont)

Static (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
1024	1	CMOS	150 nsF	TS	5	**MWS5002**	**RCA**
						MWS5502	**RCA**
						see page 786	
			160 nsR	TS	4-11	HM6508C-9	Harris
				TS	4-11	HM6518C-9	Harris
				TS	4-11	HM6508C-2	† Harris
				TS	4-11	HM6518C-2	† Harris
			250 nsF		3-10	IM6508C	Intersil
					3-10	IM6508M	† Intersil
					3-10	IM6518C	Intersil
					3-10	IM6518M	† Intersil
			305 nsF	TS	5	HM6508B-9	Harris
				TS	5	HM6518B-9	Harris
				TS	5	HM6508B-2	† Harris
				TS	5	HM6518B-2	† Harris
			425nsF	TS	5	HM6508-9	Harris
				TS	5	HM6518-9	Harris
			465 nsF	TS	5	HM6508-2	† Harris
				TS	5	HM6518-2	† Harris
			1.5 µsF		5	TC5006	Toshiba
		ECL	30 nsF		−4.5	F100415C	Fairchild
			35 nsF	OE	−5.2	F10415AC	Fairchild
			35 nsR	OE	−5.2	10146	Signetics
			60 nsF	OE	−5.2	F10415C	Fairchild
			75 nsF		−5.2	F95415C	Fairchild
		NMOS	60 nsF	—	−3,7,15	AMS7001	AMS
					−3,7,15	MCM7001	Motorola
					−3,7,15	7001	Nortec
					−3,7,15	MW7001I	RCA
			70 nsF		−3.5,15	1802	EMM/Semi
					−3.5,15	RA3-1802	GI
				OC	5	**2115-2**	**Intel**
						see page 766, 769	
				TS	5	**2125-2**	**Intel**
						see page 766, 769	
			75 nsF		−3,7,15	MCM7001-1	Motorola
			90 nsF	TS	−3.5,5,15	1801	EMM/Semi
				TS	−3.5,15	RA3-1801	GI
				OC	5	**2115**	**Intel**
						see page 766, 769	
				TS	5	**2125**	**Intel**
						see page 766, 769	
			95 nsF	OC	5	2115L	Intel
				TS	5	**2125L**	**Intel**
						see page 766, 769	
			100 nsR	OC	5	IM5508C	Intersil
			100 nsF	—	−3.5,5,15	1218A	EMM/Semi
			120 nsF	—	−3.5,5,15	1218	EMM/Semi
				TS	5	3542-2	Fairchild
				OC	5	**2115-4**	**Intel**
						see page 766, 769	
				TS	5	**2125-4**	**Intel**
						see page 766, 769	
			135 nsF	TS	−3.5,5,15	1217A	EMM/Semi
			150 nsF	TS	5	3542	Fairchild
				TS	5	SY21H02-1	Synertek
				TS	5	SYMC21H02-1	Synertek †
			160 nsF	TS	−3.5,5,15	1217	EMM/Semi

Static (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
1024	1	NMOS	175 nsF	TS	5	SY21H02	Synertek
			200 nsF	TS	5	SY21H02-2	Synertek
				TS	5	SYMC21H02-2	Synertek †
			250 nsF	TS	5	9102D	AMD
				TS	5	2102F2	Fairchild
				TS	5	2102A-2	Intel
				TS	5	21F02-2	Signetics
			275 nsF	TS	5	MK4102-6	Mostek
				TS	5	SY2102-6	Synertek
			300 nsF	TS	5	91L02C	AMD
				TS	5	91L02CM	† AMD
				TS	5	9102C	AMD
				TS	5	9102CM	† AMD
			350 nsF	TS	5	2102F	Fairchild
				TS	5	2102LF	Fairchild
				TS	5	HM7202C-5	Harris
				TS	5	2102A	Intel
				TS	5	21F02	Signetics
				TS	5	SY2102A	Synertek
				TS	5	SYMC2102A	† Synertek
			400 nsF	TS	5	91L02B	AMD
				TS	5	9102B	AMD
				TS	5	91L02BM	† AMD
				TS	5	9102BM	† AMD
				TS	5	HM7202C-2	† Harris
				TS	5	21L02-3	Signetics
				TS	5	SY21L02B	Synertek
				TS	5	SYMC21L02B	† Synertek
			450 nsF	TS	5	2102-1	Fairchild
				TS	5	2102L1	Fairchild
				TS	5	2102A-4	Intel
				TS	5	M2102A-4	† Intel
				TS	5	MK4102-1	Mostek
				TS	5	21F02-4	Signetics
				TS	5	M2102-4	† Signetics
				TS	5	TMS4033	TI
			500 nsF	TS	5	2102-1	AMD
				TS	5	9102A	AMD
				TS	5	9102AM	† AMD
				TS	5	91L02A	AMD
				TS	5	91L02AM	† AMD
				TS	5	MM7202B-2	† Harris
				TS	5	MM7202B-5	Harris
				TS	5	2102-1	Intel
				TS	5	IM7552-1C	Intersil
				TS	5	MM2102-1	National
				TS	5	M330	SGS
				TS	5	21L02-1	Signetics
				TS	5	2102-1	Signetics
				TS	5	**2602-1**	**Signetics**
						see page 790	
				TS	5	SY21L02-1	Synertek
				TS	5	SYMC21L02-1	Synertek †
			650 nsF	TS	5	2102-2	AMD
				TS	5	91L02	AMD

Master Selection Guide

MEMORY

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—RAMs (cont)

Static (cont)

Words	Bits/Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
1024	1	NMOS	650 nsF	TS	5	2102	Fairchild
				TS	5	21022C	Fairchild
				TS	5	2102L2	Fairchild
				TS	5	HM7202A-2	† Harris
				TS	5	HM7202A-5	Harris
				TS	5	2102-2	Intel
				TS	5	M2102A-6	† Intel
				TS	5	IM7552-2C	Intersil
				TS	5	MM2102-2	National
				TS	5	M330B	SGS
				TS	5	21L02-2	Signetics
				TS	5	2102-2	Signetics
				TS	5	**2602-2 see page 790**	**Signetics**
				TS	5	M2102-6	† Signetics
				TS	5	TMS4034	TI
			650 nsR	TS	5	IM7552-2M	Intersil
			1 μsF	TS	5	2102	AMD
				TS	5	HM7202-2	† Harris
				TS	5	HM7202-5	Harris
				TS	5	2102	Intel
				TS	5	IM7552C	Intersil
				TS	5	MK4102	Mostek
				TS	5	MM2102	National
				TS	5	M330A	SGS
				TS	5	21L02	Signetics
				TS	5	2102	Signetics
				TS	5	**2602 see page 790**	**Signetics**
				TS	5	SY2102	Synertek
				TS	5	SY21L02	Synertek
				TS	5	TMS4035	TI
			1 μsR	TS	5	IM7552M	† Intersil
			1.5 μsF	TS	5	2102-8	Intel
		TTL	30 ns*	OC	5	SN54S314	† TI
				OC	5	SN74S314	TI
				TS	5	SN54S314	† TI
				TS	5	SN74S314	TI
			35 ns*	OC			
		TTL	35 ns*	OC	5	RM5500	† Raytheon
				OC	5	RC5500	Raytheon
				OC	5	N82S110	Signetics
				TS	5	N82S111	Signetics
			45 nsF	OC	5	93415A	AMD
				OC	5	93415AC	Fairchild
				TS	5	93425AC	Fairchild
				OC	5	**N82S10 see page 804, 806, 818,**	**Signetics**
				TS	5	**N82S11 see page 804, 806, 818,**	**Signetics**
				OC	5	**N93415A see page 804, 806, 819,**	**Signetics**
				TS	5	**N93425A see page 804, 806, 819,**	**Signetics**
			65 nsF	OC	5	**S82S10 see page 804, 806, 818,**	**† Signetics**

Words	Bits/Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
1024	1		65 nsF	TS	5	S82S11	† Signetics
			70 nsF	OC	5	93415C	AMD
				OC	5	93415C	Fairchild
				TS	5	93425C	Fairchild
				OC	5	HM2510	Hitachi
				OC	5	IM55S08C	Intersil
				TS	5	IM55S18C	Intersil
			75 nsF	OC	5	93415M	† AMD
				OC	5	93415M	† Fairchild
				TS	5	93425M	† Fairchild
				OC	5	IM55S08M	† Intersil
				TS	5	IM55S18M	† Intersil
			95 nsF	OC	5	93L415C	Fairchild
				TS	5	93L425C	Fairchild
			100 nsF	OC	5	SN74S309	TI
				TS	5	SN74S209	TI
			140 nsF	OC	5	93L415M	† Fairchild
				TS	5	93L425M	† Fairchild
	4	NMOS	250 nsF	TS	±5,12	**4104 see page 743**	**EMM/Semi**
			450 nsF	TS	5	4804	EMM/Semi
2048	1	NMOS	60 nsF		−3,15,7	AMS7003	AMS
4096	1	NMOS	125 nsF		−5,12	**4402B see page 737**	**EMM/Semi**
			200 nsF	TS	5,12	**4200 see page 740**	**EMM/Semi**
					−5,12	**4402 see page 734**	**EMM/Semi**
					−5,12	RA3-4402	GI

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter
Bold face indicates additional data is provided on the page noted.

MEMORY—ROMs

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
Dynamic							
256	10	PMOS	550 nsF		−12,5	TMS2300	TI
			800 nsR		−12,5	CRC3501	Collins
512	5	PMOS	800 nsR		−12,5	CRC3501	Collins
	10	PMOS	450 nsF	TS	−12,5	**S8771** see page 706	**AMI**
1024	5	PMOS	500 nsF	TS	−12,5	TMS4200	TI
					±5	MCS2023	MOS
	12	PMOS	3.6 μsF		−12,−24	EA3800	EA
2048	4	PMOS	1.3 μsF	TS	−12,5	**S8865** see page 706	**AMI**
			1.6 μsF		−12,5	RO5-8192	GI
	8	NMOS	250 nsF	OC	12	**MK29000** see page 783	**Mostek**
		PMOS	450 nsF		−12,5	MCS2026	MOS
			1.8 μsF	TS	−12,5	**S9996** see page 706	**AMI**
4096	4	NMOS	250 nsF	OC	12	**MK29000** see page 783	**Mostek**
		PMOS	1.8 μsF	TS	−12,5	**S8996** see page 706	**AMI**
Static							
32	8	TTL	45 nsR	OC	5	SN5488A	† TI
				OC	5	SN7488A	TI
			50 nsR	OC	5	93434C	Fairchild
				OC	5	93434M	† Fairchild
				OC	5	6230	MMI
				TS	5	6231	MMI
				OC	5	5230	† MMI
				TS	5	5231	† MMI
				OC	5	MCM4002L	† Motorola
				OC	5	MCM4002P	Motorola
				OC	5	DM5488	† National
				OC	5	DM7488	National
				TS	5	DM7598	† National
				TS	5	DM8598	National
64	8	TTL	75 nsR		5	MCM4003A	Motorola
					5	MCM4303A	† Motorola
			650 nsR		±12	MM4220	† National
					±12	MM5220	National
			950 nsR		−12,5	MM4221	† National
					−12,5	MM5221	National
128	8	PMOS	4 μsR		−27,−12	CRC3001	Collins
					−13,−27	MM3501	National
256	4	CMOS	1.8 μsR		3-15	MCM14524A	† Motorola
					3-15	MCM14524C	Motorola
		PMOS	650 nsR		±12	MM4210	† National
					±12	MM4220	† National
					±12	MM5210	National
					±12	MM5220	National

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
Static (cont)							
256	4	PMOS	950 nsR		−12,5	MM4211	† National
					−12,5	MM4221	† National
					−12,5	MM5211	National
					−12,5	MM5221	National
		TTL	40 nsR	OC		MCM4006A	Motorola
			45 nsF	OC	5	93457C	Fairchild
				TS	5	93467C	Fairchild
			45 nsF	OC	5	H6200	MMI
				TS	5	H6201	MMI
				OC	5	3301A	Intel
			50 nsF	OC	5	93406C	Fairchild
				OC	5	**N82S226/229** see page 822	**Signetics**
				TS	5		
			50 nsR	OC	5	5200	† MMI
				OC	5	6200	MMI
				OC	5	MCM4004A	Motorola
			60 nsF	OC	5	93457M	† Fairchild
				TS	5	93467M	† Fairchild
					5	M3301A	† Intel
				OC	5	H5200	† MMI
				TS	5	H5201	† MMI
			60 nsR	OC	5	DM54187	† National
				OC	5	DM74187	National
				TS	5	DM7597	† National
				TS	5	DM8597	National
				OC	5	SN54187	† TI
				OC	5	SN74187	TI
			75 nsF	OC	5	**S82S226/229** see page 822	**† Signetics**
				TS	5		
			90 nsF	OC	5	M3301A	† Intel
			130 nsR	TS	5	DM76L97	† National
				TS	5	DM86L97	National
	5	TTL	60 nsR	OC	5	6210	MMI
			75 nsR	OC	5	5210	† MMI
	8	PMOS	750 nsR		±12	MM4230	† National
					±12	MM5230	National
			800 nsR		−12,−24	NCM1110	Nitron
			850 nsR		−12,5	MM4213	† National
					−12,5	MM5213	National
			950 nsR		−12,5	MM4231	† National
					−12,5	MM5231	National
			1 μsF	TS	−9,5	1302	Intel
			1.5 μsR		±12	CRC3002	Collins
				TS	−12,5	RO5-1302	GI
		TTL	60 nsF	TS	5	**N82S214** see page 823	**Signetics**
			60 nsR	OC	5	6235	MMI
			70 nsF	OC	5	SN74S271	TI

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—ROMs (cont)

Static (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
256	8	TTL	70 nsF	TS		SN74S371	TI
			75 nsR	OC	5	5235	† MMI
			90 nsF	TS	5	**S82S214 see page 823**	**† Signetics**
			95 nsF	OC	5	SN54S271	† TI
				TS	5	SN54S371	† TI
			180 nsR	OC	5	DM54L187A	† National
				OC	5	DM74L187A	National
	10	PMOS	600 nsF	TS	−12,5	MK2400	Mostek
			800 nsR		−12,−24	NCM1150	Nitron
	12	PMOS	1.4 μsF		−12,5	MM4229	† National
						MM5229	National
320	7	PMOS	700 nsR		−14,−28	MK2000	Mostek
			1 μsF		−12,5	MK2300	Mostek
384	8	PMOS	900 nsR	TS	−12,5	MM4241	† National
						MM5251	National
512	4	PMOS	725 nsR		±12	MM5230	National
					±12	MM4230	† National
			800 nsR		−12,−24	NCM110	Nitron
			850 nsR	TS	−12,5	MM4213	† National
				TS	−12,5	MM5213	National
			950 nsR		−12,5	MM4231	† National
					−12,5	MM5231	National
			1.5 μsR		±12	CRC3002	Collins
		TTL	50 nsF	OC	5	93431C	Fairchild
				TS	5	93441C	Fairchild
				OC	5	**N82S230/231 see page 824**	**Signetics**
				TS	5		
			60 nsF	OC	5	93431M	† Fairchild
				TS	5	93441M	† Fairchild
			60 nsR	OC	5	6205	MMI
				TS	5	6206	MMI
			70 nsF	OC	5	3302	Intel
				TS	5	3322	Intel
				OC	5	**S82S230/231 see page 824**	**† Signetics**
				TS	5		
				OC	5	SN74S270	TI
				TS	5	SN74S370	TI
			90 nsF	OC	5	3302-4	Intel
				TS	5	3322-4	Intel
			90 nsR	OC	5	5205	† MMI
				TS	5	5206	† MMI
			95 nsF	OC	5	SN54S270	† TI
				TS	5	SN54S370	† TI
			120 nsF	OC	5	3302L-6	Intel
				TS	5	3322L-6	Intel
	5	NMOS	450 nsF	TS	5	RO3-2560	EMM/Semi

Static (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
512	5	NMOS	450 nsF	TS	5	RO3-2560	GI
		PMOS	500 nsR		±12	MM4240	† National
						MM5240	National
			800 nsR		−12,−24	NCM1150	Nitron
		TTL	75 nsR	OC	5	6225	MMI
			100 nsR	OC	5	5225	† MMI
	8	NMOS	500 nsF	TS	5	9214C	AMD
				TS	5	9214M	† AMD
				TS	5	RO3-4096	EMM/Semi
				TS	5	RO3-4096	GI
					5	SY3514	Synertek
					5	SY5232	Synertek
		PMOS	600 nsF	TS	−12,5	3515	Fairchild
					−12,5	ITT3514-1	ITT
			700 nsF				
TS					−12,5	MK2500	Mostek
				TS	−12,5	MK2600	Mostek
				TS	−12,5	2530	Signetics
			800 nsR		−12,−28	NCM1140	Nitron
			1 μsF		−12,5	**S3514 see page 706**	**AMI**
					−12,5	**S5232 see page 706**	**AMI**
			1 μsR		−12,5	ITT3514-2	ITT
					−12,5	MM4214	† National
					−12,5	MM4232	† National
					−12,5	MM5214	National
					−12,5	MM5232	National
				TS	−12,5	MM5233	National
		TTL	55 nsF	OC	5	93432C	Fairchild
				TS	5	93442C	Fairchild
			60 nsF	TS	5	**N82S215 see page 823**	**Signetics**
			70 nsF	OC	5	93432M	† Fairchild
				TS	5	93442M	† Fairchild
				OC	5	3304A	Intel
				TS	5	3324A	Intel
			75 nsR	OC	5	H6240	MMI
				TS	5	H6241	MMI
			90 nsF	TS	5	3304A-4	Intel
				TS	5	3324A-4	Intel
				TS	5	**S82S215 see page 823**	**† Signetics**
			90 nsR	OC	5	H5240	† MMI
				TS	5	H5241	MMI
			120 nsF	OC	5	3304AL-6	Intel
			150 nsF	OC	5	AM27S40	AMD
				TS	5	AM27S41	AMD
			150 nsR	OC	5	DM7595	† National

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

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MEMORY—ROMs (cont)

Static (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
	8	TTL	150 nsR	TS	5	DM7596	† National
				OC		DM7795	† National
				TS	5	DM7796	† National
					5	DM8595	National
				TS	5	DM8596	National
				OC	5	DM8795	National
				TS	5	DM8796	National
			175 nsR	OC	5	A5240	† MMI
				TS	5	A5241	† MMI
				OC	5	A6240	MMI
				TS	5	A6241	MMI
			180 nsF	OC	5	AM27S40M	† AMD
				TS	5	AM27S41M	† AMD
	10	NMOS	500 nsF	TS	5	RO3-5120	EMM/Semi
				TS	5	RO3-5120	GI
		PMOS	725 nsF		±12	EA4000	EA
1024	4	PMOS	700 nsF	TS	−12,5	MK2500	Mostek
				TS	−12,5	MK2600	Mostek
			800 nsF		−14,−28	NCM1140	Nitron
			1 μsR	TS	−12,5	**S5232** see page 706	**AMI**
					−12,5	MM4232	† National
				TS	−12,5	MM5232	National
		TTL	75 nsF		5	**N8228** see page 825	**Signetics**
	8	NMOS	290 nsF		±5,12	NCM6560A	Nitron
			350 nsF	TS			
TS					5	EA4700	EA
				TS	−3,5,12	MCM6560	Motorola
				TS	−3,5,12	NCM6560	Nitron
			400 nsF	TS	5	EA2308A	EA
				TS	5	EA4700-1	EA
				TS	5	EA8308A	EA
			450 nsF	TS	5,12	9208C	AMD
				TS	±5,12	TMS4700	TI
			500 nsF	TS	5	EA2308AM	† EA
				TS	±5,12	2308	Intel
				TS	5	MCM6830A	Motorola
			550 nsF	TS	5	EA4700M	† EA
			575 nsF	TS	5	**S6830** see page 887	**AMI**
				TS	5	MCM6830	Motorola
			600 nsF	TS	5,12	9208M	† AMD
			650 nsF	TS	5	**2608** see page 801	**Signetics**
		TTL	60 ns*	OC	5	93454C	Fairchild
				TS	5	93464C	Fairchild

Static (cont)

Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
1024	8	TTL	60 ns*	OC	5	93454M	† Fairchild
				TS	5	93464M	† Fairchild
			125 nsF	OC	5	N82S280	Signetics
				TS	5	N82S281	Signetics
			150 nsF	OC	5	AM27S80	AMD
				TS	5	AM27S81	AMD
				OC	5	6280	MMI
				TS	5	6281	MMI
			175 nsR	OC		5280	† MMI
				TS		5281	† MMI
			180 nsF	OC	5	AM27S80M	† AMD
				TS	5	AM27S81M	† AMD
	9	TTL	150 nsR	OC	5	5260	† MMI
				OC	5	6260	MMI
	10	TTL	120 nsR	OC	5	5255	† MMI
						6255	MMI
	12	CMOS	250 nsR	TS	4-11	HM6312A-2	† Harris
				TS	4-11	HM6312A-9	Harris
			500 nsR	TS	5	HM6312-2	† Harris
				TS	5	HM6312-9	Harris
		PMOS	3μ μsR		±12	MM5215	National
			5 μsR		−12,5	MM5212	National
2048	4	NMOS	290 nsF		±5,12	NCM6560A	Nitron
			350 nsF	TS	−3,5,12	MCM6560	Motorola
				TS	−3,5,12	NCM6560	Nitron
		PMOS	450 nsF	TS	−12,5	RO1492C	Western
			950 nsR		−12,5	**2580** see page 787	**Signetics**
	8	NMOS	450 nsF	TS	5,12	9216C	AMD
				TS	5,12	RO3-8316B	EMM/Semi
			475 nsF		±5,12	NCM6590A	Nitron
			500 nsF	TS	5	**S6831** see page 706	**AMI**
			550 nsF	TS	5	EA4600C	EA
				TS	±5,12	MCM6832	Motorola
				TS	±5,12	NCM6832	Nitron
			550 nsF	TS	5,12	RO3-8316B	GI
			600 nsF	TS	5	**MK31000** see page 783	**Mostek**
			600 nsF	TS	5,12	9216M	† AMD
			750 nsF	TS	5	EA4600M	† EA
			800 nsF	TS	−3,5,12	MCM6590	Motorola
				TS	−3,5,12	NCM6590	Nitron
			850 nsF	TS	5	**RO3-8316A** see page 745	**EMM/Semi**
				TS	5	RO3-8316A	GI

† Military Temperature Range (−55°C to 125°C) ns*—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Master Selection Guide

MEMORY

MEMORY—ROMs (cont)

Static (cont)

	Words	Bits/ Word	Type	Access Time (Max.)	Output	Supply Voltage	Device	Source
	2048	8	NMOS	850 nsF	TS	5	2316A	Intel
			PMOS	600 nsF		−12,5	**MK28000** **see page 783**	**Mostek**
				700 nsF		−12,5	TMS4800	TI
				950 nsF		−12,5	EA4900C	EA
				1.35 μsF		−12,5	EA4900L	EA
			TTL	110 nsF	OC	5	6275	MMI
					TS	5	6276	MMI
				120 nsF	OC	5	5275	† MMI
					TS	5	5276	† MMI
10	4096	4	NMOS	550 nsF	TS	5	EA4600C	EA
				750 nsF	TS	5	EA4600M	† EA
				1 μsF	TS	5	RO3-16384	EMM/Semi
					TS	5	RO3-16384	GI
			PMOS	600 nsF		−12,5	**MK28000** **see page 783**	**Mostek**
				700 nsF		±12,5	TMS4800	TI
				950 nsF		−12,5	EA4900	EA

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OC—Open Collector TS—Three-State OE—Open Emitter

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MEMORY—Shift Registers

Dynamic

For analog memories, see Linear - Other Devices

Bits Per Register	No. of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
16	4	SS	PMOS	1.0 M	−12,5	CRC1504	Collins
				3.0 M	−28	EA1208	EA
32	4	SS	PMOS	1.0 M	−12,5	CRC1502	Collins
					−12,5	CRC1503	Collins
					−28	EA1201	EA
				3.0 M	−28	EA1200	EA
64	1	SS	PMOS	1.0 M	−14,−28	EA1203	EA
Elect. Variable				3.0 M	−14,−28	EA1202	EA
	2	SS	PMOS	0.1 M	−14	HD3213P	Hitachi
					−14,−9	HS3214P	Hitachi
				2.5 M	−12,5	MM4001AH	† National
					−12,5	MM4010AH	† National
					−12,5	MM5001AH	National
					−12,5	MM5010AH	National
					−12,5	MM5011A	National
	3	SS	PMOS	0.1 M	−14	HD3214P	Hitachi
				2.5 M	−12,5	MM4015	† National
					−12,5	MM4018	† National
					−12,5	MM5015	National
	4	SS	PMOS	3.0 M	−12,5	MP3417	Plessey
				5.0 M	−12,5	TMS3417	TI
					±5	HD3508	Hitachi
66	3	SS	PMOS	1.0 M	−14	CRC1505	Collins
				2.0 M	−24,-14	MTS1016	MOS
72	3	SS	PMOS	5.0 M	±5	HD3523	Hitachi
					±5	HD3524	Hitachi
80	4	SS	PMOS	2.5 M	−12,5	IM7780C	Intersil
					−12,5	MK1007	Mostek
				3.0 M	−12,5	MP3409	Plessey
				5.0 M	−12,5	TMS3409	TI
100	2	SS	PMOS	1.0 M	±5	HD3506	Hitachi
					±5	HD3507	Hitachi
				2.0 M	−10	MTS1001	MOS
					±5	1406	† AMD
					±5	1407	† AMD
					±5	1506	AMD
					±5	1507	AMD
					±5	1406	† Intel
					±5	1407	† Intel
					±5	1506	Intel
					±5	1507	Intel
				2.5 M	−12,5	MM4006	† National
					−12,5	MM4007	† National
					−12,5	MM5006	National
					−12,5	MM5007D	National
				3.0 M	±5	MTS2013	MOS
					±5	2506	Signetics
					±5	2507	Signetics
					±5	2517	Signetics

Dynamic (cont)

Bits Per Register	No. of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
128	2	SS	PMOS	5.0 M	±5	HD3509	Hitachi
200	1	SS	CMOS	5.0 M	3-15	**CD4062A** **see page 375**	**† RCA**
			pmos	1.0 M	−28	EA1221	EA
213	2	SS	PMOS	4.0 M	−6,5	S1015A	† Siliconix
					−6,5	S1015B	Siliconix
256	1	SS	PMOS	1.0 M	−28	EA1205	EA
				2.0 M	−12,5	3383	Fairchild
				2.5 M	±5	HD3510	Hitachi
				3.0 M	−14	EA1204	EA
	2	SS	PMOS	2.5 M	−12,5	MM4019	† National
					−12,5	MM5019	National
				3.0 M	−14	EA1210	EA
	4	SS	PMOS	2.5 M	±5	SY1402B	Synertek
					±5	SY1402BR	Synertek
				5.0 M	±5	1402AC	AMD
					±5	1402AM	† AMD
					±5	HD3502	Hitachi
					±5	1402A	Intel
					±5	MM1402A	National
					±5	1402	Nortec
					±5	1402A	Nortec
					±5	M141	SGS
					±5	SY1402A	Synertek
					±5	SY1402AR	Synertek
				8.0 M	±5	2502	Signetics
				10.0 M	±5	AM2802C	AMD
					±5	AM2802M	† AMD
					±5	SY2802	Synertek
	64	SS	CCD	1.0 M	−5,12	2416	Intel
360	1	SS	PMOS	2.5 M	−12,5	MM4104H	† National
					−12,5	MM5104H	National
480	2	SS	PMOS	1.0 M	−12,5	S1685	AMI
				5.0 M	−12,5	TMS3402	TI
512	1	SS	PMOS	2.0 M	±5	1405A	Intel
				2.5 M	±5	2505	Signetics
					−12,5	MM4016	† National
					−12,5	MM5016	National
				3.0 M	±5	AM2805M	† AMD
					±5	AM2807M	† AMD
					±5	2524	Signetics
					−14	EA1212	EA
				4.0 M	±5	AM2805C	AMD
					±5	AM2807C	AMD
				5.0 M	±5	HD3505	Hitachi
					±5	MTS2100	MOS
					−12,5	TMS3401	TI
					−27	EA1206	EA
	2	SS	PMOS	2.5 M	−12,5	MM4017	† National
					−12,5	MM5017	National
					±5	SY1403B	Synertek
					±5	SY1403BR	Synertek

† Military Temperature Range (−55°C to 125°C) * — Typical Values SS = Serial In, Serial Out PP = Parallel In, Parallel Out

MEMORY—Shift Registers (cont)

Dynamic (cont)

Bits Per Register	No. of Reg.	Oper-ation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
512	2	SS	PMOS	5.0 M	±5	1403AC	AMD
					±5	1403AM	† AMD
					±5	HD3503	Hitachi
					±5	1403A	Intel
					±5	MM1403A	National
					±5	1403A	Nortec
					±5	M136	SGS
					±5	SY1403A	Synertek
					±5	SY1403AR	Synertek
				8.0 M	±5	2503	Signetics
				10.0 M	±5	AM2803C	AMD
					±5	AM2803M	† AMD
					±5	SY2803	Synertek
1024	1	SS	NMOS	1.0 M	5	2405	Intel
					5	SY2405	Synertek
			PMOS	2.5 M	±5	2512	Signetics
					−12,5	MM4013	† National
					−12,5	MM5013	National
					±5	2525	Signetics
					±5	SY1404B	Synertek
					±5	SY1404BR	Synertek
				3.0 M	±5	AM2806M	† AMD
					±5	AM2808M	† AMD
					±5	IM7712	Intersil
					±5	IM7722	Intersil
					±5	2512	Nortec
				4.0 M	±5	AM2806C	AMD
					±5	AM2808M	AMD
					±5	2512	Nortec
				5.0 M	±5	1404AC	AMD
					±5	1404AM	† AMD
					±5	HD3504	Hitachi
					±5	1404A	Intel
					±5	MM1404A	National
					±5	MM5024A	National
					±5	1404A	Nortec
					5	SY1404A	Synertek
					5	SY1404AR	Synertek
				8.0 M	±5	2504	Signetics
					±5	M130	SGS
				10.0 M	±5	AM2804C	AMD
					±5	AM2804M	† AMD
					±5	SY2804	Synertek
	2	SS	NMOS	1.0 M	5	AM2401	AMD
					5	2401	Intel
					5	SY2401	Synertek
				2.0 M	5	9401C	AMD
					5	9401M	† AMD
				2.5 M	5	SY2401-1	Synertek
			PMOS	1.0 M	−12,5	MM4025	† National
					−12,5	MM4026	† National
				3.0 M	−12,5	MM5025	National
					−12,5	MM5026	National
					−12,5	SY5025	Synertek
					−12,5	SY5026	Synertek

Dynamic (cont)

Bits Per Register	No. of Reg.	Oper-ation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
1024	2	SS	PMOS	4.0 M	−10.5,5	AM2825M	† AMD
					−10.5,5	AM2826M	† AMD
					−10,5.5	SY2825	Synertek
					−10,5.5	SY2826	Synertek
				6.0 M	−10.5,5	AM2825C	AMD
					−10.5,5	AM2826C	AMD
	9	SS	CCD	2.0 M	−2.5,5,12	CCD450A	Fairchild
2048	1	SS	PMOS	1.0 M	−12,5	MM4027	† National
				3.0 M	−12,5	MM5027	National
					−12,5	SY5027	Synertek
				4.0 M	−10.5,5	AM2827M	† AMD
					−12,5	SY5028	Synertek
				6.0 M	−10.5,5	AM2827C	AMD
4096	4	PP	CCD	5.0 M	±5,12	CCD460	Fairchild

Static

Bits Per Register	No. of Reg.	Oper-ation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
4	1	PP	Bipolar	3 M	5	SN54L95	TI
					5	SN54L99	† TI
					5	SN74L95	TI
					5	SN74L99	TI
				5 M	5	93L00C	† AMD
					5	93L00M	† AMD
				6 M	5	DM54L95	† National
					5	DM74L95	National
				15 M	5	9300C	AMD
					5	9300M	† AMD
					5	93L00C	† Fairchild
					5	93L00M	† Fairchild
					5	ITT9300-1	† ITT
					5	ITT9300-5	ITT
					5	MC8300	Motorola
					5	MC9300	† Motorola
					5	DM7600	† National
					5	DM8600	National
					5	RC9300	Raytheon
					5	RM9300	† Raytheon
					5	N8270	Signetics
					5	N8271	Signetics
				20 M	5	HD2534	Hitachi
					5	MC7270	Motorola
					5	MC7271	Motorola
					5	MC8270	Motorola
					5	MC8271	Motorola
					5	DM5495	† National
					5	DM7495	National
					5	RC8270	Raytheon
					5	RC8271	Raytheon
					5	RM8270	† Raytheon
					5	RM8271	† Raytheon
					5	SW5495	† SW
					5	SW7495	SW
				25 M	5	SN54194	† AMD
					5	SN74194	AMD
					5	5495	† Fairchild
					5	7495	Fairchild

(continued)

† Military Temperature Range (−55°C to 125°C) SS = Serial In, Serial Out PP = Parallel In, Parallel Out

Bold face indicates additional data is provided on the page noted.

MEMORY—Shift Registers (cont)

Static (cont)

Bits Per Register	No. of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
4 (continued)	1	PP	Bipolar	25 M	5	54178	† Fairchild
					5	54179	† Fairchild
					5	54194	† Fairchild
					5	74178	Fairchild
					5	74179	Fairchild
					5	74194	Fairchild
					5	ITT5495	† ITT
					5	ITT54194	† ITT
					5	ITT7495	ITT
					5	ITT74194	ITT
					5	54194	† Raytheon
					5	74194	Raytheon
					5	S5495	† Signetics
					5	N7495	Signetics
					5	N74194	Signetics
					5	S54194	† Signetics
					5	SN5495A	† TI
					5	SN54178	† TI
					5	SN54179	† TI
					5	SN54194	TI
					5	SN7495A	TI
					5	SN74178	TI
					5	SN74179	TI
					5	SN74194	TI
				30 M	5	SN54195	† AMD
					5	SN74195	AMD
					5	54LS95	† Fairchild
					5	74LS95	Fairchild
					5	5495	† Fairchild
					5	7495	Fairchild
					5	54LS194	Fairchild
					5	74LS194	Fairchild
					5	54LS195	† Fairchild
					5	74LS195	Fairchild
					5	54LS295	† Fairchild
					5	74LS295	Fairchild
					5	ITT54195	† ITT
					5	ITT74195	ITT
					5	MC54195	† Motorola
					5	MC74195	Motorola
					5	DM8300	National
					5	DM9300	† National
					5	54195	† Raytheon
					5	74195	Raytheon
					5	N74195	Signetics
					5	S54195	† Signetics
					5	SN54195	† TI
					5	SN74195	TI
				31 M	5	MC5495	† Motorola
					5	MC7495	Motorola
				35 M	5	MC4012	Motorola
				38 M	5	9300C	Fairchild
					5	9300M	† Fairchild
				55 M	5	93H00C	† Fairchild
					5	93H00M	† Fairchild
4	1	PP	Bipolar	60 M	5	93H72C	Fairchild
					5	93H72M	† Fairchild
					5	N82S70	Signetics
					5	N82S71	† Signetics
				70 M	5	SN54S194	† AMD
					5	SN54S195	† AMD
					5	SN74S194	AMD
					5	SN74S195	AMD
					5	93S00C	Fairchild
					5	93S00M	† Fairchild
					5	93S194C	Fairchild
					5	93S194M	† Fairchild
					5	SN54S194	† TI
					5	SN54S195	† TI
					5	SN74S194	TI
					5	SN74S195	TI
				75 M	5	S54S194	Signetics
					5	N74S194	Signetics
				150 M	−4.5	F10000	Fairchild
					−5.2	MC10141	Motorola
					−5.2	10141	Signetics
					−5.2	SN10141	TI
				190 M	−5.2	95H00C	Fairchild
				250 M	−5.2	F10141	Fairchild
		PS	Bipolar	1 M	11	MC794P	Motorola
				10 M	5	5494	† Fairchild
					5	7494	Fairchild
					5	ITT5494	† ITT
					5	ITT7494	ITT
					5	MC5494	† Motorola
					5	MC7494	Motorola
					5	N7494	Signetics
					5	S5494	Signetics
					5	SW7494	SW
					5	SN5494	† TI
					5	SN7494	TI
		SP		325 M	−5.2	MC1694L	† Motorola
		SS		0.5 M	15	MC686	Motorola
		PP	CMOS	2 M	3-15	34035M	† Fairchild
					3-15	340194M	† Fairchild
					3-15	340195M	† Fairchild
					3-15	**HD4035A-9** **see page 266**	**† Harris**
					3-15	MC14035C	Motorola
					3-15	**CD4035AE** **see page 375**	**RCA**
					3-15	SCL4035	SSS
					3-15	CM4035AE	Solitron
					3-15	TC4035	Toshiba
				3 M	3-15	34035C	Fairchild
					3-15	340194C	Fairchild
					3-15	340195C	Fairchild
					3-15	**HD4035A-2** **see page 266**	**Harris**
					3-15	MC14035A (continued)	† Motorola

† Military Temperature Range (−55°C to 125°C) SS = Serial In, Serial Out PP = Parallel In, Parallel Out

MEMORY—Shift Registers (cont)

Static (cont)

Bits Per Register	No. of Reg.	Oper-ation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
4 (continued)	1	PP	CMOS	3 M	3-15	**CD4035A** **see page 375**	**† RCA**
					3-15	CM4035A	† Solitron
					3-15	TP4035A	TI
	2	SP	CMOS	1 M	5	CM4015AE	Solitron
				1.5 M	5	CM4015AD	† Solitron
					3-15	TP4015A	TI
				1.8 M	3-15	TF4015A	† TI
				2.5 M	3-15	34015C	Fairchild
					3-15	**HD4015A-9** **see page 266**	**Harris**
					3-16	MC14015C	Motorola
					3-15	CD4015C	National
					3-15	**CD4015AE** **see page 375**	**RCA**
					3-15	TC4015	Toshiba
				3 M	3-15	34015M	† Fairchild
					3-15	**HD4015A-2** **see page 266**	**† Harris**
					3-18	MC14015A	† Motorola
					3-15	CD4015M	† National
					3-15	**CD4015A** **see page 375**	**† RCA**
					3-15	SCL4015A	† SSS
					3-15	SCL4015AE	SSS
		PP	PMOS	1 M	−12,5	SS5-2004	GI
					−12,5	SS6-2004	† GI
5	1	PP	Bipolar	10 M	5	5496	† Fairchild
					5	7496	Fairchild
					5	ITT5496	† ITT
					5	ITT7496	ITT
					5	MC5496L	† Motorola
					5	MC7496P	Motorola
					5	DM5496	† National
					5	DM7496	National
					5	N7496	Signetics
					5	S5496	† Signetics
					5	SW5496	† SW
					5	SW7496	SW
					5	SN5496	† TI
					5	SN7496	TI
					5	7496	TRW
	2	PP	Bipolar	35 M	5	HD2546	Hitachi
	4	SS	CMOS	1.2 M	5	CM4006AE	Solitron
				1.5 M	5	CM4006AD	† Solitron
				2 M	3-15	CM4006	† Solitron
					3-15	CM4006AE	Solitron
					3-15	**CD4006AE** **see page 375**	**RCA**
				2.5 M	3-15	**CD4006A** **see page 375**	**† RCA**
				3 M	3-15	SCL4006A	† SSS
					3-15	SCL4006A	SSS
5	4	SS	CMOS	4 M	5-15	MC14006C	Motorola
				7 M	5-15	MC14006A	† Motorola
8	1	PP	Bipolar	15 M	5	DM7576	† National
					5	DM8576	National
				25 M	5	54198	† Fairchild
					5	54199	† Fairchild
					5	74198	Fairchild
					5	74199	Fairchild
					5	DM54198	† National
					5	DM54199	† National
					5	DM74198	National
					5	DM74199	National
					5	54198	† Raytheon
					5	54199	† Raytheon
					5	74198	Raytheon
					5	74199	Raytheon
					5	N74198	Signetics
					5	N74199	Signetics
					5	S54198	† Signetics
					5	S54199	† Signetics
					5	SN54198	† TI
					5	SN54199	† TI
					5	SN74198	TI
					5	SN74199	† TI
				70 M	5	SN74S299	TI
		PS		14 M	5	DM7590D	† National
					5	DM8590N	National
				20 M	5	54165	† Fairchild
					5	74165	Fairchild
					5	54165	† Raytheon
					5	74165	Raytheon
					5	S54165	† Signetics
					5	N74165	Signetics
					5	SN54165	† TI
					5	SN74165	TI
				25 M	5	54166	† Fairchild
					5	74166	Fairchild
					5	DM54166	† National
					5	DM74166	National
					5	54166	† Raytheon
					5	74166	Raytheon
					5	S54166	† Signetics
					5	N74166	Signetics
					5	SN54166	† TI
					5	SN74166	TI
		SP		12 M	5	SN54L164	† TI
					5	SN74L164	TI
				14 M	5	MC54164A	† Motorola
					5	MC74164A	Motorola
					5	DM7570	† National
					5	DM8570	National
				25 M	5	54164	† Fairchild
					5	74164	Fairchild
					5	54LS164	† Fairchild
					5	74LS164	Fairchild
					5	54164 (continued)	† Raytheon

† Military Temperature Range (−55°C to 125°C) SS = Serial In, Serial Out PP = Parallel In, Parallel Out

Bold face indicates additional data is provided on the page noted.

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MEMORY—Shift Registers (cont)

Static (cont)

Bits Per Register	No. of Reg.	Oper-ation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
8 (continued)	1	SP		25 M	5	74164	Raytheon
					5	N74164	Signetics
					5	S54164	† Signetics
		SS		3 M	5	SN54L91	† TI
					5	SN74L91	TI
				4 M	5	DM54L91	† National
					5	DM74L91	National
				10 M	5	5491	† Fairchild
					5	7491	Fairchild
					5	HD2524	Hitachi
					5	MC5491A	† Motorola
					5	MC7491A	Motorola
					5	N7491	Signetics
					5	S5491	† Signetics
					5	SW5491A	† SW
					5	SW7491A	SW
					5	SN5491A	† TI
					5	SN7491A	TI
				15 M	5	N8276	Signetics
		PP	CMOS	2.5 M	3-18	MC14034C	Motorola
					3-15	SCL4034AE	SSS
					5	CM4034AE	Solitron
				3 M	3-18	MC14034A	Motorola
					3-15	**CD4034A** see page 375	**† RCA**
					3-15	SCL4034A	† SSS
					5	CM4034A	† Solitron
					3-15	TC4034	Toshiba
		PS		1 M	3-15	34014C	Fairchild
					3-15	34021C	Fairchild
					3-15	CM4014AD	† Solitron
				1.3 M	3-15	TP4021A	TI
				1.8 M	3-15	TF4021A	† TI
				2.5 M	3-15	**HD4014A-9** see page 266	**Harris**
					3-15	**HD4021A-9** see page 266	**Harris**
					3-15	MC14021C	Motorola
					3-15	**CD4014AE** see page 375	**RCA**
					3-15	**CD4021A** see page 375	**† RCA**
					3-15	**CD4021AE** see page 375	**RCA**
					3-15	TC4014	Toshiba
					3-15	TC4021	Toshiba
				3 M	3-15	34014M	† Fairchild
					3-15	34021M	† Fairchild
					3-15	**HD4014A-2** see page 266	**† Harris**
					3-15	**HD4021A-2** see page 266	**† Harris**
					3-15	MC14021A	† Motorola
					3-15	**CD4014A** see page 375 (continued)	**† RCA**

Static (cont)

Bits Per Register	No. of Reg.	Oper-ation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
8 (continued)	1	PS		3 M	3-15	**CD4021A** see page 375	**† RCA**
					3-15	SCL4014A	† SSS
					3-15	SCL4021A	† SSS
					3-15	CM4021AD	† Solitron
	2	SS	Bipolar	10 M	5	93L28C	AMD
					5	93L28M	† AMD
					5	93L28M	† Fairchild
					5	93L28C	Fairchild
					5	MC8328	Motorola
					5	MC9328	† Motorola
				15 M	5	RC8277	Raytheon
					5	RM8277	† Raytheon
					5	N8277	Signetics
				20 M	5	9328C	AMD
					5	9328M	† AMD
					5	9328C	Fairchild
					5	9328M	† Fairchild
	16	SS	MNOS	0.5 M	5	NC7031	Nitron
10	1	PP	TTL	0.5 M	5	RC8274	Raytheon
					5	RM8274	† Raytheon
					5	N8274	Signetics
					5	S8274	† Signetics
		SP	PMOS	0.5 M	5	RC8273	Raytheon
					5	RM8273	† Raytheon
					5	N8273	Signetics
					5	S8273	† Signetics
16	2	SS	PMOS	2 M	−12,5	SS5-8211	GI
					−12,5	SS5-8212	GI
					−12,5	SS6-8211	† GI
					−12,5	SS6-8212	† GI
	3	SS	PMOS	252 K		M120T1	SGS
	4	SS	PMOS	2 M	−12,5	SL5-4016	GI
	8	SS	MNOS	0.5 M	−30	NC7030	Nitron
20	1	SP	PMOS	5 K	−14,9	HD32112	Hitachi
24	4	SS	CMOS	2.5 M	5-16	MS618	† Ragen
25	4	SS	PMOS	1 M	−12,5	SL5-4025	GI
					−12,5	SL6-4025	† GI
				2 M	−12,5	MCS2104	† MOS
32	1	SS	PMOS	1 M	−12,5	SS5-1032	GI
					−12,5	SS6-1032	† GI
	2	SS	PMOS	1 M	−16,−10	MTS1002	MOS
				1.5 M	−28	EA1003	EA
					−28	EA1007	EA
				2 M	−12,5	MTS2103	† MOS
	4	SS	PMOS	1 M	−12,5	SL5-4032	GI
					−12,5	SL6-4032	† GI
	6	SS	PMOS	1 M	−12,5	3348	Fairchild
					−12,5	3349	Fairchild
				2 M	−12,5	2518	Signetics
					−12,5	TMS3112	TI
					−12,5	TMS3122	TI
					−12,5	TMS3123	TI

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† Military Temperature Range (−55°C to 125°C) SS = Serial In, Serial Out PP = Parallel In, Parallel Out

MEMORY—Shift Registers (cont)

Static (cont)

Bits Per Register	No. of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
40	6	SS	PMOS	2 M	−12,5	2519	Signetics
50	2	SS	PMOS	1 M	−12,5	SL5-2050	GI
					−12,5	SL6-2050	† GI
				1.5 M	−14, 12	EA1013	EA
					−12,±5	2059	Signetics
				3 M	−14, 12	EA1012	EA
64	1	SS	CMOS	1 M	3-15	**CD4031AE** see page 375	**RCA**
				2 M	3-15	**CD4031A** see page 375	† **RCA**
				2.7 M	3-16	MC14557A	† Motorola
				5 M	3-18	MC14557C	Motorola
				10 M	5-16	MS612	† Ragen
	2	SS	CMOS	4 M	3-15	MC14517C	Motorola
					3-15	MC14517A	† Motorola
					3-15	SCL4517A	SSS
			PMOS		−12,5	SL5-2064	GI
					−12,5	SL6-2064	† GI
				1.3 M	−12,5	SI2064A	† Siliconix
					−12,5	SI2064C	Siliconix
				2 M	−12,5	MTS2105	† MOS
				2.5 M	−12,5	TMS3103	TI
	4	SS	CMOS	4 M	3-15	F4731	Fairchild
			PMOS	1.5 M	−12,5	3342	Fairchild
				2 M	−12,5	ITT3342	ITT
				2.5 M	−12,5	TMS3121	TI
80	2	SS	PMOS	1 M	−12,5	TMS3102	TI
				1.5 M	−14,12	EA1009	EA
				2.5 M	−12,5	AM2847M	† AMD
					−12,5	TMS3102	TI
				3 M	−12,5	AM2847C	AMD
					−14,12	EA1008	EA
	4	SS	NMOS	3 M	5	M142	SGS
		SS	PMOS	1.5 M	−12,5	3343	Fairchild
					−12,5	2532	Signetics
				2 M	−12,5	3357-2	Fairchild
						ITT3347	ITT
				2.5 M	−12,5	AM2847M	† AMD
					−12,5	TMS3120	TI
				3.0 M	−12,5	AM2847C	AMD
					−12,5	ITT3357	ITT
				4.0 M	−12,5	3357-1	Fairchild
	9	SS	PMOS	1.5 M	−12,5	TMS3135	TI
96	2	SS	PMOS	2.5 M	−12,5	TMS3126	TI
	4	SS	PMOS	2.5 M	−12,5	AM2896M	† AMD
				3.0 M	−12,5	AM2896C	AMD
100	1	SS	PMOS	1.5 M	−14, 12	EA1005	EA
				2.5 M	−12,5	TMS3101	TI
					−12,5	TMS3127	TI

Static (cont)

Bits Per Register	No. of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
100	1	SS	PMOS	3 M	−14,12	EA1004	EA
	2	SS	PMOS	1 M	−28,−14	MTS1102	MOS
				1.5 M	−27,−13	M127	SGS
					−12,±5	2510	Signetics
				2 M	−12,5	MCS2102	† MOS
					−12,5	SL5-C2100	GI
	4	SS	PMOS	2.2 M	−12,5	MM5061	National
	9	SS	PMOS	1.5 M	−12,5	TMS3137	TI
128	1	SS	CMOS	5 M	12	MS625	† Ragen
	2	SS	PMOS	1 M	−12,5	MK1002	AMD
					−12,5	MK1002	Mostek
					−12,5	SL5-2128	GI
				1.5 M	−12,5	2521	Signetics
					−12,5	MTS2107	† MOS
					−12,5	MM5060AA	National
				2 M	−12,5	AM2809M	† AMD
					−12,5	AM2810	AMD
					−12,5	TMS3114	AMD
					−12,5	3343	Fairchild
					−12,5	SL5-C2128	GI
					−12,5	MTS2108	† MOS
					−12,5	TMS3114	TI
				2.5 M	−12,5	AM2809C	AMD
					−12,5	AM2814M	† AMD
					−12,5	TMS3128	TI
					−15,5	UC7325	Solitron
	4	SS	PMOS	1.0 M	−12,5	MM4055	† National
				1.5 M	−12,5	MM5055	National
				2.5 M	−12,5	AM2814	AMD
						AM2855	AMD
					−12,5	AM4055	† AMD
					−12,5	AM5055	AMD
	9	SS	PMOS	1.5 M	−12,5	TMS3138	TI
132	2	SS	PMOS	1.5 M	−12,5	MM5060AB	National
					−12,5	2522	Signetics
				2.5 M	−12,5	TMS3129	TI
	9	SS	PMOS	1.5 M	−12,5	TMS3139	TI
133	2	SS	PMOS	1 M	−12,5	S2181	AMI
				1.5 M	−12,5	MM5060AC	National
				2 M	−12,5	TMS3113	TI
				2.5 M	−12,5	TMS3130	TI
	9	SS	PMOS	1.5 M	−12,5	TMS3140	TI
136	2	SS	PMOS	2.5 M	−12,5	TMS3131	TI
	9	SS	PMOS	1.5 M	−12,5	TMS3141	TI
144	2	SS	PMOS	1.5 M		MM5060AD	National
				2 M	−12,5	3346	Fairchild
				2.5 M	−12,5	TMS3132	TI
	9	SS	PMOS	1.5 M	−12,5	TMS3142	TI
200	2	SS	PMOS	1.5 M	−12,±5	2511	Signetics

† Military Temperature Range (−55°C to 125°C) SS = Serial In, Serial Out PP = Parallel In, Parallel Out
Bold face indicates additional data is provided on the page noted.

MEMORY—Shift Registers (cont)

Bits Per Register	No. of Reg.	Oper-ation	Process	Frequency (Hz - Spec)	Supply Voltage	Device		Source
Static (cont)								
240	2	SS	PMOS	1.5 M	−12,5	2529		Signetics
250	2	SS	PMOS	1.5 M	−12,5	2528		Signetics
256	1	SS	PMOS	2.5 M	−15,5	UC7325		Solitron
	2	SS	PMOS	1.0 M	−12,5	MM4056	†	National
				1.5 M	−12,5	MM5056		National
					−12,5	2527		Signetics
				2.5 M	−12,5	AM2856C		AMD
					−12,5	AM4056	†	AMD
					−12,5	AM5056		AMD
480	2		NMOS	1.5 M	5	SY2535		Synertek
				3.0 M	5	SY2535A		Synertek
512	1	SS	PMOS	1.0 M	−12,5	MM4057	†	National
				1.5 M	−12,5	MM5057		National
				2.5 M	−12,5	AM2857C		AMD
					−12,5	AM4057	†	AMD
					−12,5	AM5057		AMD
	2		NMOS	1.5 M	5	SY2534		Synertek
				3.0 M	5	SY2534A		Synertek
1024	1	SS	NMOS	1.5 M	5	SY2533		Synertek
				2 M	5	IM7733C		Intersil
					5	IM7733M	†	Intersil
				3.0 M	5	SY2833A		Synertek
				4.0 M	5	SY2833B		Synertek
				5.0 M	5	SY2833C		Synertek
			PMOS	1.5 M	−12,5	AM2533C		AMD
					−12,5	2533		Fairchild
					−12,5	MM5058		National
					−12,5	2533		Signetics
				2 M	−12,5	AM2833C		AMD
					−12,5	AM2833M	†	AMD
					−12,5	TMS3133		TI
				4 M	−12,5	3355C		Fairchild

Master Selection Guide

MEMORY

† Military Temperature Range (−55°C to 125°C) SS = Serial In, Serial Out PP = Parallel In, Parallel Out

The next page is 706.

RAMs

Part No.	Organization	Process	T_{ACC} (ns)	R/W T_{Cycle} (ns)	Operating Power (mW)	Standby Power (mW)	Supplies (V)	I/O	Clocks	Page
S2222	512 Static	CMOS SiGate	200	470	7.5	0.002	+10	MOS	0	706
S2222A	512 Static	CMOS SiGate	400	940	7.5	0.001	+10	MOS	0	706
S1103	1024 Dynamic	P-SiGate	310	580	450	-	+16, +19	MOS/Sense A	3	707
S146	1024 Dynamic	P-SiGate	210	390	550	-	+19, +22	MOS/Sense A	3	707
S1103-1	1024 Dynamic	P-SiGate	180	360	550	-	+19, +22	MOS/Sense A	3	707
S1103X	1024 Dynamic	P-SiGate	120	270	550	-	+19, +22	MOS/Sense A	3	707
S1103A	1024 Dynamic	P-SiGate	205	580	425	2.0	+16, +19	MOS/Sense A	2	712
S1103-1	1024 Dynamic	P-SiGate	145	340	660	0.2	+19, +22	MOS/Sense A	2	712
S1103A-X	1024 Dynamic	P-SiGate	125	285	660	0.2	+19, +22	MOS/Sense A	2	712
S4006	1024 Quasi-Static	P-I^2	400	650	450	50	-12, +5	TTL	0	706
S4008	1024 Quasi-Static	P-I^2	500	900	450	50	-12, +5	TTL	0	706
S4008-9	1024 Quasi-Static	P-I^2	800	1000	450	50	-12. +5	TTL	0	706
S4021-4	4096 Dynamic	N-SiGate	200	510	360	1.8	+12, ±5	TTL	1	722
S4021-3	4096 Dynamic	N-SiGate	250	560	360	1.8	+12, ±5	TTL	1	722
S4021-2	4096 Dynamic	N-SiGate	300	600	360	1.8	+12, ±5	TTL	1	722
S4021	4086 Dynamic	N-SiGate	400	1000	360	1.8	+12, ±5	TTL	1	722
S4096-3	4096 Dynamic	N-SiGate	250	510	400	6.0	+12, ±5	TTL	2	728
S4096-2	4096 Dynamic	N-SiGate	300	600	400	6.0	+12, ±5	TTL	2	728
S4096-1	4096 Dynamic	N-SiGate	350	675	400	6.0	+12, ±5	TTL	2	728
S5101	256 x 4 Static	CMOS Si-Gate	650	650	50	0.001	+5	TTL	0	716
S6810	128 x 8 Static	N-SiGate	1000	1000	650	N/A	+5	TTL	0	884
S6810-1	128 x 8 Static	N-SiGate	575	575	650	N/A	+5	TTL	0	884

AMI

MEMORY

ROMs/PROMs

Part No.	Description	Organization	Max. Power Dissip. (mW)	Supplies (V)	Max. Access Time	Process	Page
S3514	4096 Bit Static ROM	512 x 8	500	+5, -12	1 µs	P-I^2	706
S5204A	2048 Bit Reprogrammable PROM	512 x 8	750	-12, +5	750 ns	P-SiGate	706
S5232	4096 Bit Static ROM	512 x 8 or 1024 x 4	500	+5, -12	1 µs	P-I^2	706
S6830	8192 Bit Static ROM	1024 x 8	650	+5	575 ns	N-SiGate	887
S6831	16,384 Bit Static ROM	2048 x 8	500	+5	500 ns	N-SiGate	706
S6834	2048 Bit Programmable PROM	512 x 8	750	-12, +5	575 ns	P-SiGate	912
S8771	5120 Bit ROM	512 x 10	1000	+5, -12	450 ns	P-I^2	706
S8865	8192 Bit ROM	2048 x 4	635	+6, -12	1.3 µs	P-I^2	706
S8996	16,384 Bit ROM	4096 x 4	368	+5, -12	1.8 µs	P-I^2	706
S9996	16,384 Bit ROM	2048 x 8	368	+5, -12	1.8 µs	P-I^2	706

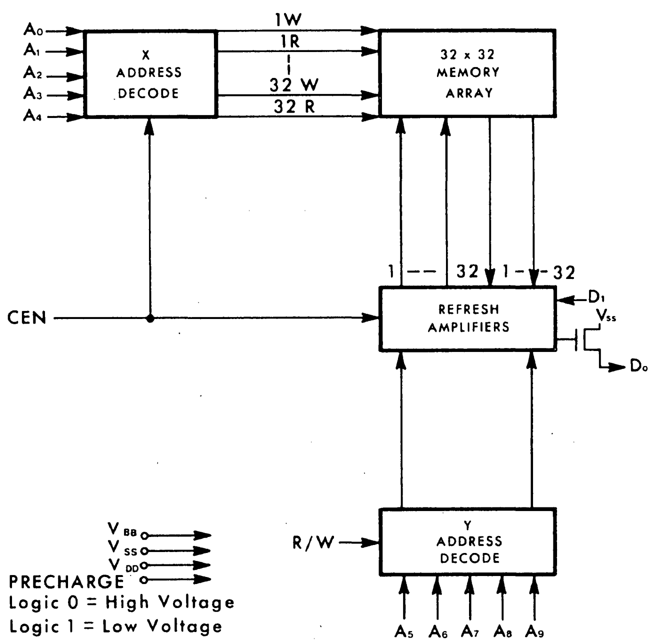
Complete Data Sheets on all Standard Products Available from Your Local AMI Sales Office Listed Inside the Front Cover.

AMI®

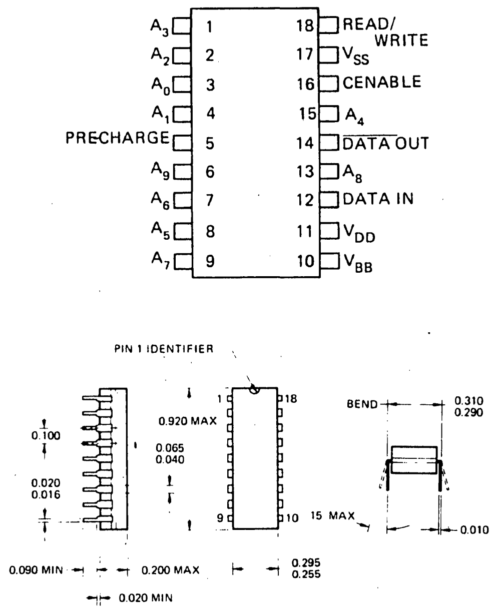
AMERICAN MICROSYSTEMS, INC.

S1103
S146
S1103-1
S1103X

1024 x 1 RANDOM ACCESS MEMORY



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Fast access time, 300/205/150/120ns
- Performance options subject to power supply levels
- Fast cycle time, 580/390/360/270ns
- Full internal decoding
- OR-tie capability
- Chip enable provides low power dissipation
- Simple memory expansion
- Inputs protected against static charge
- Refresh period, 2ms @ 0°C to max. temperature

AMI MEMORY

FUNCTIONAL DESCRIPTION

The AMI S1103 family of random access memories are designed for applications where high performance, low cost and large bit storage are desired, such as main memories. It is a 1024 word by 1 bit array fabricated with low threshold, silicon gate technology. This high density process technology allows the design and production of extremely high performance memory devices.

The proven reliability of this process, and design, coupled with an extremely reliable plastic package, provide an exceptional solution for many memory systems cost and performance problems. And now the CERDIP package offers the advantage of low cost in an hermetic package. The performance levels attainable are a function of the power supply levels used.

Some of the more important operational characteristics are discussed on the following page.

TYPICAL APPLICATIONS

Mainframe Memories, Cache Memories, Buffer Memories Minicomputer Memories, Mass Memories, Terminals.

For a complete data sheet contact your nearest AMI Sales Office

ABSOLUTE MAXIMUM RATINGS

Operating Ambient Temperature	
S1103	0° to 70°C
S146/S1103–1/S1103X	0° to 55°C
Storage Temperature	- 65° to + 150°C
All Input or Ourput Voltages with respect to the most Positive Supply, V_{BB}	–25V to 0.3V
Power Dissipation, max	425mW - S1103 660mW - S146/S1103–1/S1103X

Stresses above maximum ratings may cause permanent device damage. This is a stress rating only; functional operation of the device at any other condition above that indicated in this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

OPERATION

The block diagram, schematic, and timing diagram, assist in the understanding of the operation of the S1103 family. Some important characteristics relative to system design are:

a) Periodic refreshing is required due to dynamic operation. The device must be cycled through the 32 addresses of the A0 – A4 inputs at least every 2 ms.

b) The memory precharge should be held positive on all but the enabled chips to reduce power dissipation. If the precharge input is negative and runs 30% duty cycle, at minimum cycle time, the dissipation is typically 350 mW for the S1103 and 550 mW for the S146, S1103–1 or S1103X.

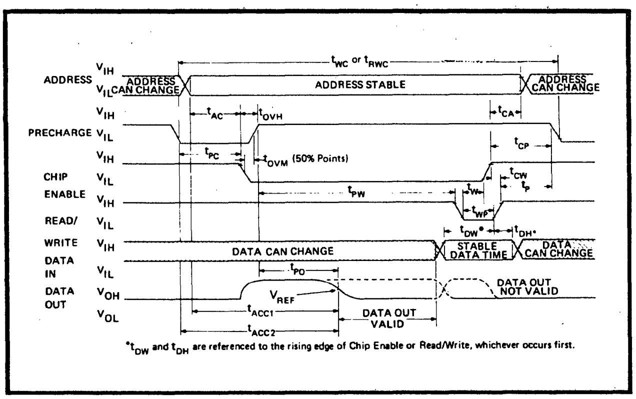
c) Cell readout is non-destructive so the read/write cycle may be shortened for a read only or refresh only cycle, as the read/write pulse is only required for entry of new data. Thus a read only or refresh only cycle can be shorter than a read/write or a write only cycle.

d) A high input (positive) is read as zero current out, and a low input written into the memory is read as current out.

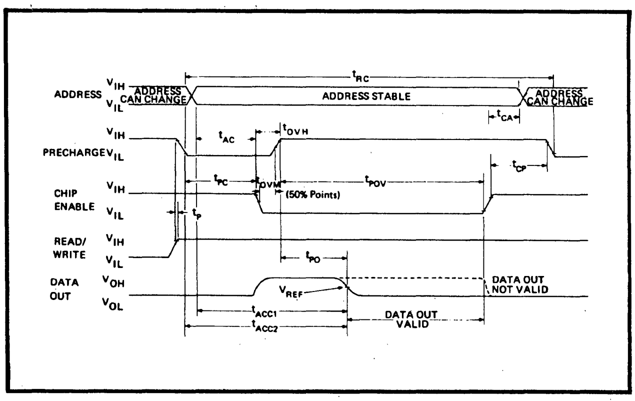
AMI

MEMORY

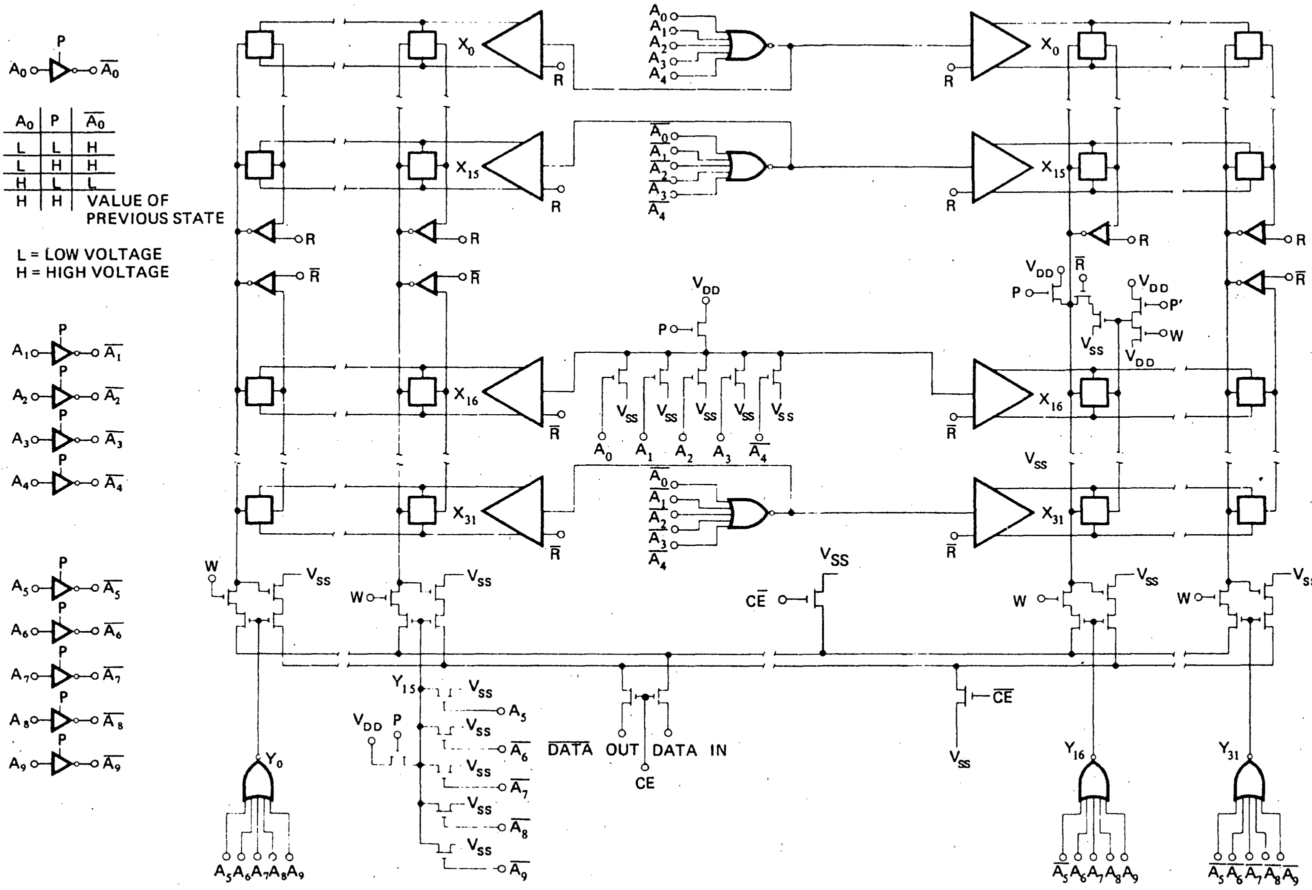
WRITE OR READ/WRITE CYCLE



READ OR REFRESH CYCLE



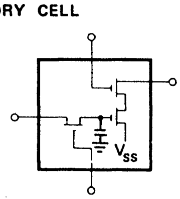
CIRCUIT DIAGRAM

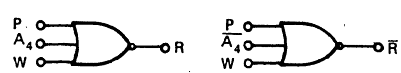


A_0	P	$\overline{A_0}$
L	L	H
L	H	H
H	L	L
H	H	VALUE OF PREVIOUS STATE

L = LOW VOLTAGE
H = HIGH VOLTAGE

BASIC MEMORY CELL





P = PRECHARGE
CE = CENABLE
W = READ/WRITE
LOGIC 0 = HIGH VOLTAGE (H)
LOGIC 1 = LOW VOLTAGE (L)
V_{BB} = SUBSTRATE VOLTAGE

CE	P	P'
L	L	H
L	H	H
H	L	L
H	H	VALUE OF PREVIOUS STATE

OPERATING, AC AND DC CHARACTERISTICS

OPERATING CHARACTERISTICS		S1103		S146		S1103−1		S1103X		UNITS
SYMBOL	**TEST DESCRIPTION**									
T_A	Ambient Temperature	0 to 70		0 to 55		0 to 55		0 to 55		°C
V_{DD}	Negative Supply	0		0		0		0		V
V_{SS}	Positive Supply (1)	16 ± 0.8		19 ± 1		19 ± 1		19 ± 1		V
$V_{BB} - V_{SS}$	Substrate Supply (2)	3.5 ± 0.5		3.5 ± 0.5		3.5 ± 0.5		3.5 ± 0.5		V
C_L	Load Capacitance	100		100		50		50		pF
R_L	Load Resistance (3)	100		100		100		100		Ω
V_{REF}	Output Reference Voltage	40		80		80		80		mV
AC CHARACTERISTICS		**S1103 MIN.**	**MAX.**	**S146 MIN.**	**MAX.**	**S1103−1 MIN.**	**MAX.**	**S1103X MIN.**	**MAX.**	**UNITS**
	READ, WRITE AND READ/WRITE CYCLE									
t_{REF}	Time between Refresh Cycles		2		2		2		2	ms
t_{AC}	Address to Chip Enable Setup Time	115		65		30		30		ns
t_{CA}	Chip Enable to Address Hold Time	10		10		10		10		ns
t_{PC}	Precharge to Chip Enable Delay	125		70		60		35		ns
t_{OVM}	Precharge and Chip Enable Overlap, Midpoint	45	95	25	65	25	50	13	35	ns
t_{OVH}	Precharge and Chip Enable Overlap		140		85		85		85	ns
t_{CP}	Chip Enable to Precharge Delay	85		50		40		40		ns
	READ CYCLE									
t_{RC}	Read Cycle (4,5)	480		330		300		238		ns
t_{POV}	Precharge to end of Chip Enable	165	500	130	500	115	500	114	500	ns
t_{PO}	Precharge to Output Delay		120		100		75		65	ns
t_{ACC1}	Address to Output Access (4, 6)		300		205		150		120	ns
t_{ACC2}	Precharge to Output Access (4, 7)		310		210		180		125	ns
		MIN.	**MAX.**	**MIN.**	**MAX.**	**MIN.**	**MAX.**	**MIN.**	**MAX.**	**UNITS**
	WRITE OR READ/WRITE CYCLE									
t_{WC}	Write Cycle (4, 8)	580		390		360		270		ns
t_{RWC}	Read/Write Cycle (4, 9)	580		390		360		270		ns
t_{PW}	Precharge to Write Delay	165	500	130	500	115	500	114	500	ns
t_{WP}	Write Pulse Width	50		40		40		20		ns
t_W	Write Setup Time	80		40		40		20		ns
t_{DW}	Data Setup Time (10)	105		40		40		25		ns
t_{DH}	Data Hold Time (11)	10		10		10		10		ns
t_{PO}	Precharge to Output Delay		120		100		75	60	65	ns
t_P	Time to Next Precharge	70		35		25		25		ns
t_{CW}	Chip Enable to Write		15		15		15		16	ns

AC CHARACTERISTICS (Cont'd)

		TYP.	MAX.	UNITS	CONDITIONS	
	CAPACITANCE (12)					
C_{AD}	Address	5	7	pF	$V_{IN} = V_{SS}$	All Unused Pins @ AC GND $f_0 = 1$ MHz; $V_{BB} = 3.0V$
C_{PR}	Precharge	15	18	pF	$V_{IN} = V_{SS}$	
C_{CE}	Chip Enable	15	18	pF	$V_{IN} = V_{SS}$	
C_{RW}	Read/Write	12	15	pF	$V_{IN} = V_{SS}$	
C_{IN1}	Data Input	5	7	pF	Enable = V_{DD}, $V_{IN} = V_{SS}$	
C_{IN2}	Data Input	3	5	pF	Enable = V_{SS}, $V_{IN} = V_{SS}$	
C_{OUT}	Data Output	3	4	pF	$V_{OUT} = V_{DD}$	

DC CHARACTERISTICS		S1103 MIN.	S1103 MAX.	S146/S1103-1/S1103X MIN.	S146/S1103-1/S1103X MAX.	UNITS	CONDITIONS
I_{LI}	Input Leakage Current		1		1	μA	$V_{IN}=V_{DD}$ } All Unused Pins at V_{SS}
I_{LO}	Output Leakage Current		1		1	μA	$V_{OUT}=V_{DD}$ } All Unused Pins at V_{SS}
I_{BB}	Substrate Supply Current		100		100	μA	
I_{DD1}	Supply Current During T_{PC}		56		75	mA	Address Prechg=V_{DD}; CE=V_{SS}; T_A = 25°C
I_{DD2}	Supply Current During T_{OVM}		59		80	mA	Address=Prechg=CE= V_{DD}; T_A = 25°C
I_{DD3}	Supply Current During T_{POV}		11		13	mA	Address=CE=V_{DD}; Prechg=R/W=V_{SS}; T_A = 25°C
I_{DD4}	Supply Current During T_{CP}		4.2		5	mA	Address=V_{DD}; Prechg=CE=R/W=V_{SS}; T_A = 25°C
I_{DDAVG}	Average Supply Current (13)		25		33	mA	All Timing Parameters @ Min. Condition;T_A=25°C
I_{OH}	Output High Current	500	4000	850	5000	μA	Over Temperature Range
I_{OL}	Output Low Current		400		800	μA	Over Temperature Range
V_{IL1}	Input Low Voltage (All Add/Data In) (14)	V_{DD}	V_{DD}+1	V_{DD}	V_{DD}+1	V	Over Temperature Range
V_{IL2}	Input Low Voltage (Precharge, CE, RW)	V_{DD}	V_{DD}+1	V_{DD}	V_{DD}+1	V	Over Temperature Range
V_{IH}	Input High Voltage (All Inputs)	V_{SS}−1	V_{SS}+1	V_{SS}−1	V_{SS}+1	V	Over Temperature Range
V_{OH}	Output High Voltage	50	400	85	500	mV	Over Temperature Range
V_{OL}	Output Low Voltage		40		80	mV	Over Temperature Range

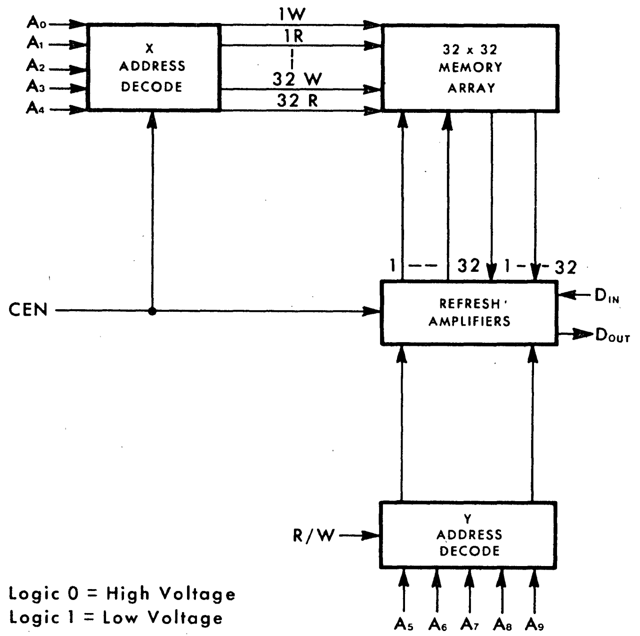
NOTES:

1. V_{SS} current drain is equal to ($I_{DD} + I_{OH}$) or ($I_{DD} + I_{OL}$)
2. ($V_{BB} - V_{SS}$) supply should be applied before V_{SS}.
3. R_L of 100 Ω is chosen for convenience. In application, R_L may range from 100 to 1000 Ω.
4. t_T is defined as the time between the 10% and 90% point of any voltage transition ($t_T \leqslant 20$ns) ($t_T \leqslant 12$ns for S1103X)
5. $t_{RC} = t_{PC} + t_{OVM} + t_{POV} + t_{CP} + 3t_T$
6. $t_{ACC1} = t_{AC} + t_{OVM} + t_{PO} + t_T$
7. $t_{ACC2} = t_{PC} + t_{OVM} + t_{PO} + t_T$
8. $t_{WC} = t_{PC} + t_{OVM} + t_{PW} + t_W + t_{CP} + 4t_T$
9. $t_{RWC} = t_{PC} + t_{OVM} + t_{PW} + t_W + t_{CP} + 4t_T$
10. t_{DW} is referenced to the 90% (negative) point of the rising edge of Chip Enable or Read/Write whichever occurs first.
11. t_{DH} is referenced to the 10% (positive) point of the rising edge of Chip Enable or Read/Write whichever occurs first.
12. All capacitances are periodically sampled and not 100% tested. Capacitance values are for either plastic or ceramic packages.
13. This parameter is periodically sampled and is not 100% tested.
14. V_{IL} Max. and V_{IH} Min. are a linear function of T_A between 0°C to maximum temperature. Interim values may be calculated accordingly.

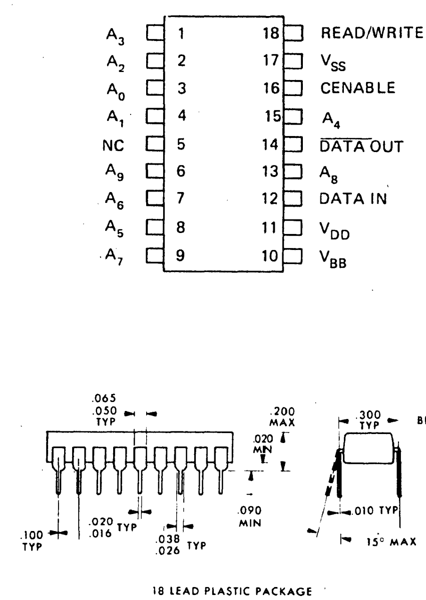
S1103A
S1103A-1
S1103A-X

1024 X 1 RANDOM ACCESS MEMORY

AMERICAN MICROSYSTEMS, INC.



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Fast access time, 205/145/125 ns
- Performance options subject to power supply levels
- Fast cycle time, 580/340/285 ns
- No precharge required – critical precharge timing is eliminated
- Low standby power dissipation – 0.2 μW/bit typical
- Address registers incorporated on the chip
- Simple memory expansion – cenable input lead
- Inputs protected against static charge
- Refresh period, 2 ms @ 0 to 70°C

FUNCTIONAL DESCRIPTION

The AMI S1103A family of random access memories are designed for applications where high performance, low cost and large bit storage are desired, such as main memories. It is a 1024 word by 1 bit array fabricated with low threshold, silicon gate technology. This high density process technology allows the design and production of extremely high performance memory devices.

S1103A systems may be simplified due to the elimination of the precharge clock, its associated circuitry, and critical timing. Only one external clock, CENABLE, is required.

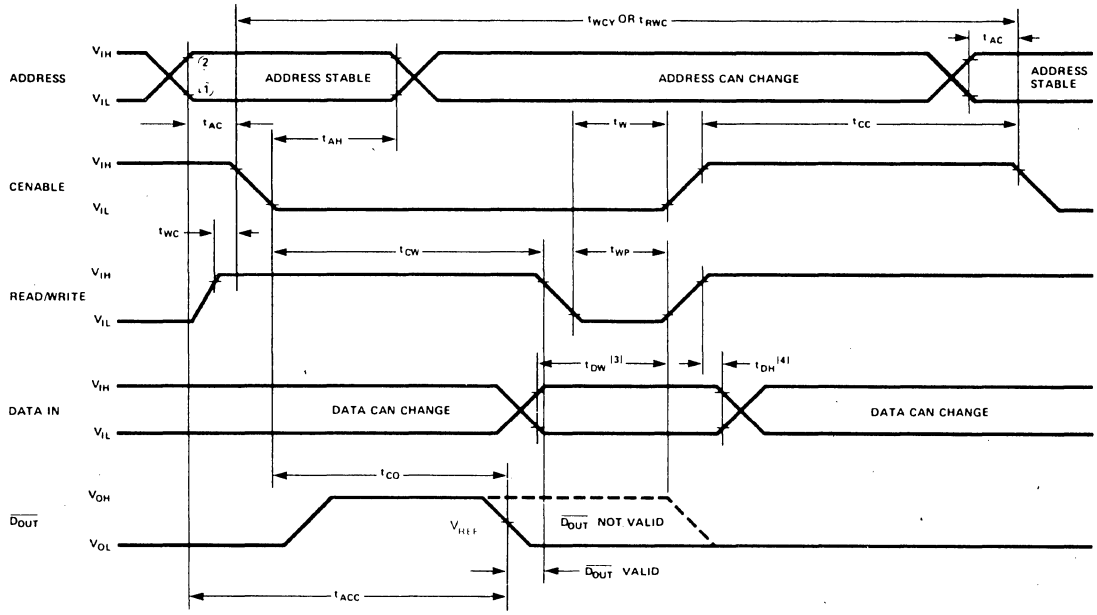
Information stored in the memory is non destructively read. Refreshing of all 1024 bits is accomplished in 32 read cycles (addressing A_0 to A_4) and is required every 2 milliseconds. The memory may be used in a low power standby mode by having cenable at V_{SS} potential.

TYPICAL APPLICATIONS

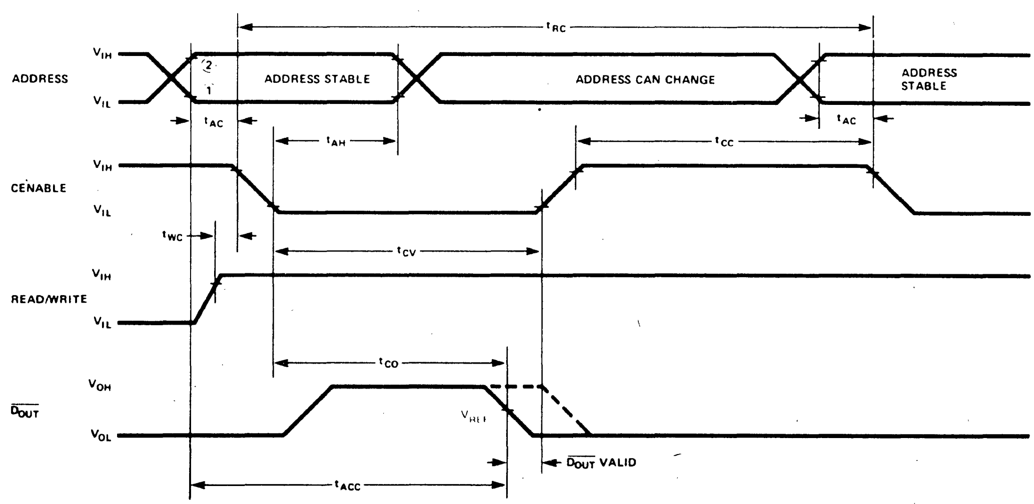
Mainframe Memories, Cache Memories, Buffer Memories, Minicomputer Memories, Mass Memories, Terminals.

WRITE CYCLE OR READ/WRITE CYCLE

Timing illustrated for minimum cycle.



READ CYCLE



NOTES:
1. 90% Point
2. 10% Point — t_T is defined as the transition between these two points
3. t_{DW} is referenced to point 1 of the rising edge of cenable or Read/Write, whichever occurs first.
4. t_{DH} is referenced to point 2 of the rising edge of cenable or Read/Write, whichever occurs first.

OPERATING, AC AND DC CHARACTERISTICS

OPERATING CHARACTERISTICS		S1103A	S1103A – 1	S1103A–X	UNITS
SYMBOL	TEST DESCRIPTION				
T_A	Ambient Temperature	0 to 70	0 to 55	0 to 55	°C
V_{DD}	Negative Supply	0	0	0	V
V_{SS} (5)	Positive Supply	16 ± 0.8	19 ± 1	19 ± 1	V
$V_{BB} - V_{SS}$ (6)	Substrate Supply	3.5 ± 0.5	3.5 ± 0.5	3.5 ± 0.5	V
C_L	Load Capacitance	100	50	50	pF
R_L (7)	Load Resistance	100	100	100	Ω
V_{REF}	Output Reference Voltage	40	80	80	mV

AC CHARACTERISTICS		S1103A		S1103A – 1		S1103A–X		UNITS
		MIN	MAX	MIN	MAX	MIN	MAX	
READ, WRITE AND READ/WRITE CYCLE								
t_{REF}	Time between Refresh Cycles		2		2		2	ms
t_{AC}	Address to Chip Enable Setup Time	0		0		0		ns
t_{AH}	Address Hold Time	100		50		50		ns
t_{CC}	Cenable Off Time	230		120		85		ns
READ CYCLE								
t_{RC} (8)	Read Cycle	480		300		305		ns
t_{CV}	Cenable on time	210	500	140	500	120	500	ns
t_{CO}	Cenable Output Delay		185		125		105	ns
t_{ACC} (9)	Address to Output Access		205		145		125	ns
WRITE OR READ/WRITE CYCLE								
t_{WCY} (10)	Write Cycle	580		340		285		ns
t_{RWC} (10)	Read/Write Cycle	580		340		285		ns
t_{CW}	Cenable to Read/Write Delay	210	500	140	500	120	500	ns
t_{WP}	Read/Write Pulse Width	50		20		20		ns
t_W	Read/Write Setup Time	80		20		20		ns
t_{DW}	Data Setup Time	105		40		40		ns
t_{DH}	Data Hold Time	10		10		10		ns
t_{CO}	Output Delay		185		125		105	ns
t_{WC}	Read/Write to Cenable	0		0		0		

NOTES:

5. V_{SS} current drain is equal to ($I_{DD} + I_{OH}$) or ($I_{DD} + I_{OL}$)
6. ($V_{BB} - V_{SS}$) supply should be applied before V_{SS}
7. R_L of 100 Ω is chosen for convenience. In application, R_L may range from 100 to 1000 Ω
8. $t_{RC} = t_{CV} + t_{CC} + 2\ t_T$
9. $t_{ACC} = t_{AC} + t_{CO} + t_T$
10. $t_{WCY} = t_{RWC} = t_{CW} + t_W + t_{CC} + 3\ t_T$

AC CHARACTERISTICS (Cont'd)

		PLASTIC		CERAMIC	UNIT	CONDITIONS	
		TYP	MAX	MAX			
CAPACITANCE (11)							
C_{AD}	Address	5	7	12	pF	$V_{IN} = V_{SS}$	All Unused Pins @ AC GND f_0 = 1 MHz; V_{BB}= 3.0V, $T_A = 25°C$
C_{CE}	Chip Enable	22	25	28	pF	$V_{IN} = V_{SS}$	
C_{RW}	Read/Write	11	15	20	pF	$V_{IN} = V_{SS}$	
C_{IN1}	Data Input	4	5	8	pF	Cenable = 0V, $V_{IN} = V_{SS}$	
C_{IN2}	Data Input	2	4	7	pF	Cenable = V_{SS},	
C_{OUT}	Data Output	2	3	7	pF	$V_{IN} = V_{SS}$, V_{OUT} = 0V	

DC CHARACTERISTICS		S1103A MIN	S1103A MAX	S1103A-1, S1103A-X MIN	S1103A-1, S1103A-X MAX	UNIT	CONDITIONS
I_{LI}	Input Leakage Current (All Input Pins)		1		10	μA	V_{IN} = 0V
I_{LO}	Output Leakage Current		1		10	μA	V_{OUT} = 0V
I_{BB}	Substrate Supply Current		100		100	μA	
I_{DD1}	Supply Current During Cenable On		11		11	mA	Cenable = 0V, $T_A = 25°C$
I_{DD2}	Supply Current During Cenable Off		4		0.5	mA	Cenable = V_{SS}, $T_A = 25°C$
$I_{DD\ AVG}$	Average Supply Current		25		33	mA	Cycle Time = 580/340 ns $T_A = 25°C$
V_{IL}	Input Low Voltage	$V_{DD} - 1$	$V_{DD} + 1$	$V_{DD} - 1$	$V_{DD} + 1$	V	
V_{IH}	Input High Voltage	$V_{SS} - 1$	$V_{SS} + 1$	$V_{SS} - 1$	$V_{SS} + 1$	V	
I_{OH1}	Output High Current	600	4000	1150	7000	μA	$T_A = 25°C$, R_L (10) = 100Ω
I_{OH2}	Output High Current	500	4000	900	7000	μA	T_A = Max Temp, R_L (10) = 100Ω
I_{OL}	Output Low Current	See Note 12		See Note 12			
V_{OH1}	Output High Voltage	60	400	115	700	mV	$T_A = 25°C$, R_L (10) = 100Ω
V_{OH2}	Output High Voltage	50	400	90	700	mV	T_A = Max Temp, R_L (10) = 100Ω
V_{OL}	Output Low Voltage	See Note 12		See Note 12			

NOTES:

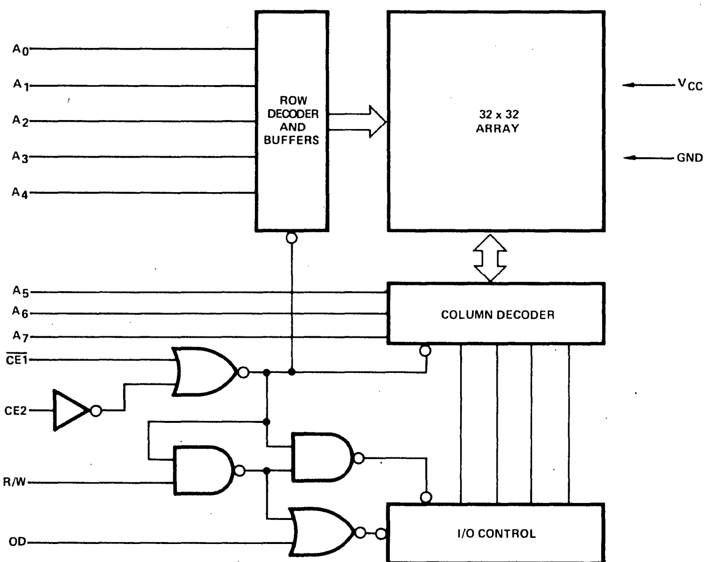
11. All capacitances are periodically sampled at worst case operating conditions and are not 100% tested.
12. I_{OL} = leakage current of the 1103A plus external noise coupled with the output line from the clocks. $V_{OL} = I_{OL}$ across the load resistor.

MEMORY

S5101

1024 BIT (256 x 4)
STATIC CMOS RAM

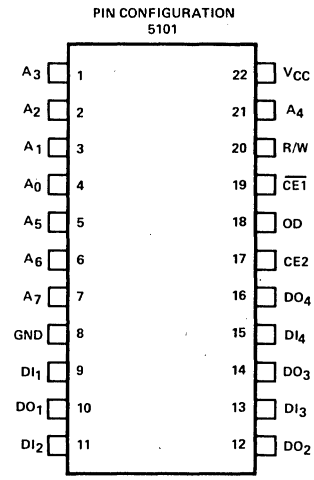
AMI®
AMERICAN MICROSYSTEMS, INC.

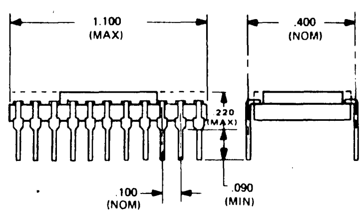


TRUTH TABLE

$\overline{CE1}$	CE2	OD	R/W	OPERATION	OUTPUT
L	H	L	H	Read	Enabled
L	H	H	H	Pseudo Read	HI–Z
L	H	X	L	Write	HI–Z
H	X	X	X	Data I/O Disabled	HI–Z
X	L	X	X	Powered Down	HI–Z

BLOCK DIAGRAM





PIN/PACKAGE CONFIGURATION

FEATURES

- Data Retention Power: 1.0nW/Bit Max.
- Ultra Low Standby Power: 50 μW Max.
- Access Time: 650 ns Max.
- Low Operating Power: 80mW Max.
- Single 5V Power Supply
- Common or Separate Input Output
- Completely TTL Compatible
- Three-State Output
- Replaces the Intel 5101
- Low Power Replacement for 2101

AMI MEMORY

FUNCTIONAL DESCRIPTION

The AMI S5101 family of 256 x 4 bit high speed CMOS RAMs offers ultra low power and fully static operation with a single 5 volt power supply. With data inputs and outputs on adjacent pins, either separate or common data I/O applications can be easily selected for maximum design flexibility. The very low power of these RAMs makes them an ideal choice where battery augmented non-volatile RAM storage is mandatory.

The S5101 family is totally static, making clocking unnecessary for a new address to be accepted. The stored data is read-out non-destructively and in the same polarity as the original input data. The outputs are disabled with output disable (O.D.), either chip enable ($\overline{CE}_1$ or CE_2) or during a write cycle (R/W = LOW). The read/write input or output disable input allow these RAMs to be used in common data I/O systems by forcing the output into a high impedance state during a write operation.

When deselected, the S5101A draws only 10 microamps from a 5.25 volt supply voltage. The S5101AL is identical to the S5101A with the additional benefit of guaranteed data retention at a power supply voltage of 2.0 volts with guaranteed power dissipation of less than 1.0 nanowatt/bit.

ABSOLUTE MAXIMUM RATINGS*

Ambient Temperature Under Bias	0°C to 70°C
Storage Temperature	–65°C to +150°C
Voltage on Any Pin with Respect to Ground	–0.3V to V_{CC} +1.0V
Maximum Power Supply Voltage	+11V
Power Dissipation	1 Watt

*COMMENT: Stresses above those listed under "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

D.C. CHARACTERISTICS FOR S5101

T_A - 0°C to 70°C, V_{CC} = 5V ± 5% Unless Otherwise Specified.

SYMBOL	PARAMETER	LIMIT MIN.	LIMIT MAX.	UNITS	TEST CONDITIONS
I_{LI}	Input Leakage Current	–1	1	μA	V_{IN} = 0V to V_{CC}
I_{LO}	Output HI – Z Leakage	–1	1	μA	$\overline{CE1}$, R/W = V_{IL} and/or CE2, OD = V_{IH} V_O = 0 to V_{CC}
I_{CC}	Operating Supply Current S5101A/AL S5101/L, S5101-3/L-3		 15 22	 mA mA	$\overline{CE1}$ = V_{IL}, CE2 = V_{IH} Outputs = OPEN, fc = 1MHz
I_{CCL}	Standby Supply Current S5101A/AL, S5101/L S5101-3/L-3		 10 200	 μA μA	$\overline{CE1}$ ⩾ V_{CC} –0.8V or CE2 ⩽ 0.8V, V_{IN} = V_0 = 0V to V_{CC}
V_{IL}	Input Low Voltage	–0.3	0.8	V	
V_{IH}	Input High Voltage	2.2	V_{CC} + 0.3	V	
V_{OL}	Output Low Voltage		0.4	V	I_{OL} = 2mA
V_{OH}	Output High Voltage	2.4		V	I_{OH} = 1mA

LOW V_{CC} DATA RETENTION CHARACTERISTICS FOR S5101L,

T_A = 0°C to 70°C

SYMBOL	PARAMETER	LIMIT MIN.	LIMIT MAX.	UNITS	TEST CONDITIONS
V_{DR}	V_{CC} For Data Retention	2.0		V	$\overline{CE1}$ ⩾ V_{DR} –0.2V or CE2 ⩽ 0.2V, V_{CC} = V_{DR}, t_r = t_f = 20ns
I_{CCDR}	Data Retention Supply Current S5101AL S5101L S5101L-3		 0.5 15 200	 μA μA μA	$\overline{CE1}$ ⩾ V_{DR} –0.2V or CE2 ⩽ 0.2V, V_{CC} = V_{DR}, t_r = t_f = 20ns
t_{CDR}	Chip Deselect to Data Retention Time	0		ns	
t_r	Operation Recovery Time	t_{RC}			t_{RC} = Read Cycle Time

A.C. CHARACTERISTICS FOR S5101L

T_A = 0°C to 70°C, V_{CC} = 5V ± 5% Unless Otherwise Specified.

READ CYCLE

SYMBOL	PARAMETER	LIMIT MIN.	LIMIT MAX.	UNITS	TEST CONDITIONS
t_{RC}	Read Cycle Time	650		ns	
t_{ACC}	Access Time		650	ns	
t_{CO1}	$\overline{CE1}$ to Output Delay		600	ns	
t_{CO2}	CE2 to Output Delay		700	ns	
t_{OD}	Output Disable to Enabled Output Delay		350	ns	See A.C. Conditions of Test and A.C. Test Load
t_{DF}	Output Disable to Output HI-Z State Delay	50	150	ns	
t_{DF1}	$\overline{CE1}$ to Output HI-Z Delay	50	220	ns	
t_{DF2}	CE2 to Output HI-Z Delay	50	270	ns	
t_{OH}	Output Data Valid Into Next Cycle	50		ns	

A.C. CHARACTERISTIC FOR S5101 and S5101L

WRITE CYCLE 1 – SEPARATE OR COMMON DATA I/O USING OUTPUT DISABLE

T_A = 0°C to 70°C, V_{CC} = 5V ± 5% Unless Otherwise Specified

SYMBOL	PARAMETER	LIMIT MIN.	LIMIT MAX.	UNITS	TEST CONDITIONS
t_{WC}	Write Cycle Time	650		ns	
t_{AW}	Address to Write Delay	150		ns	
t_{CW1}	$\overline{CE1}$ to End of Write Delay	550		ns	
t_{CW2}	CE2 to End of Write Delay	550		ns	
t_{DW}	Data Set-Up to End of Write Time	400		ns	**See A.C. Conditions of Test and A.C. Test Load**
t_{DH}	Data Hold After End of Write Time	100		ns	
t_{WP}	Write Pulse Width (For Write Cycle 1)	400		ns	
t_{WR}	End of Write to New Address Recovery Time	50		ns	
t_{DS}	Output Disable to Data-In Set-Up Time	150		ns	
t_{ODH}	Output Disable After Data-In Hold Time	0		ns	

WRITE CYCLE 2 – Additional Parameters to Guarantee Common I/O Operation with O.D. = V_{OL}
T_A = 0°C to 70°C, V_{CC} = 5V ± 5% Unless Otherwise Specified

SYMBOL	PARAMETERS	LIMIT		UNITS	TEST CONDITIONS
		MIN.	MAX.		
t_{WF}	Write to Output HI–Z Delay Time		200	ns	See A.C. Conditions of Test and A.C. Test Load
t_{WS}	Write to Data Input Set-Up Time	200		ns	
t_{WDR}	Write to New Data Output Delay Time		300	ns	
t_{WP}	Write Pulse Width (For Write Cycle 2)	450		ns	
t_{AW}	Address to Write Date For Write Cycle 2	150		ns	

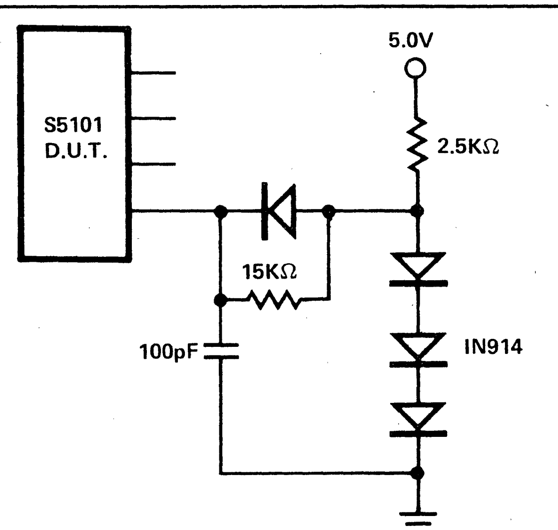
CAPACITANCE

SYMBOL	PARAMETERS	LIMIT		UNITS	TEST CONDITIONS
		MIN.	MAX.		
C_{IN}	Input Capacitance		8	pF	V_{IN} = 0V, on All Input Pin
C_O	Output Capacitance		12	pF	V_O = 0V

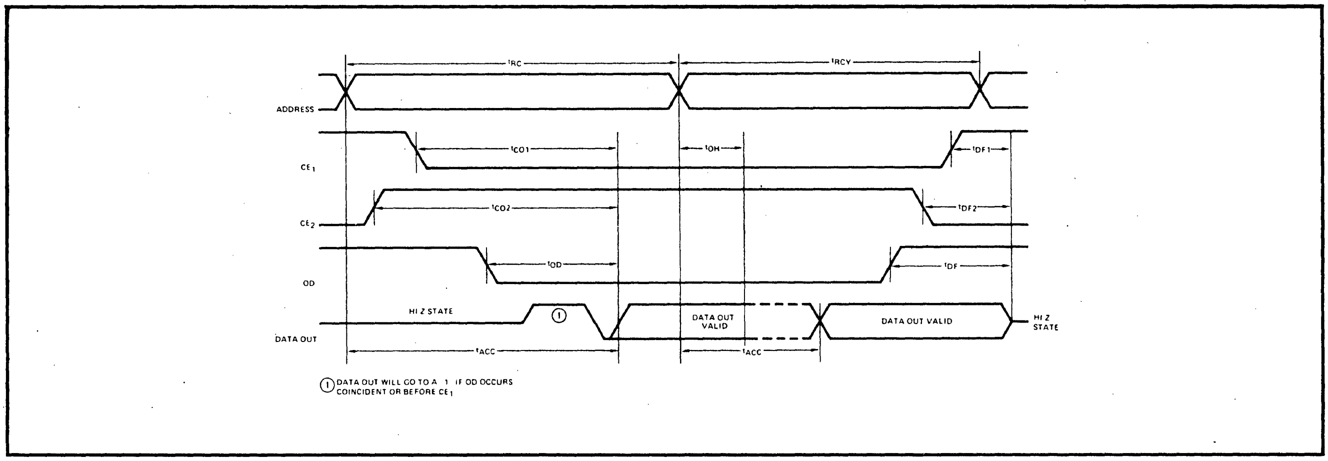
A.C. CONDITION OF TEST

Input Levels	0.8 Volt to 2.2 Volt
Input Rise and Fall	20ns
Timing Measurement Reference Level	1.5 Volt

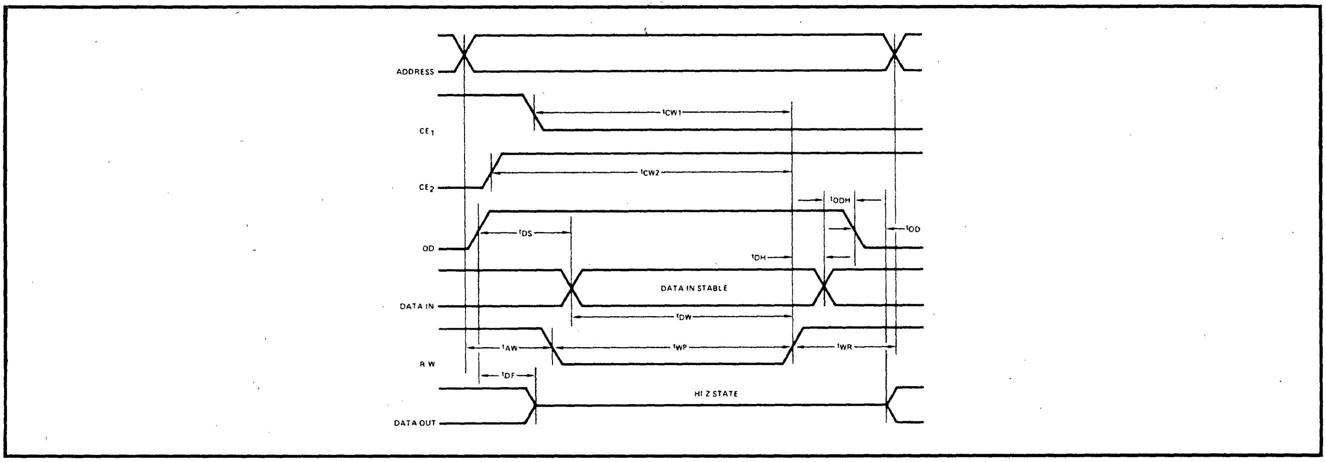
A.C. TEST LOAD



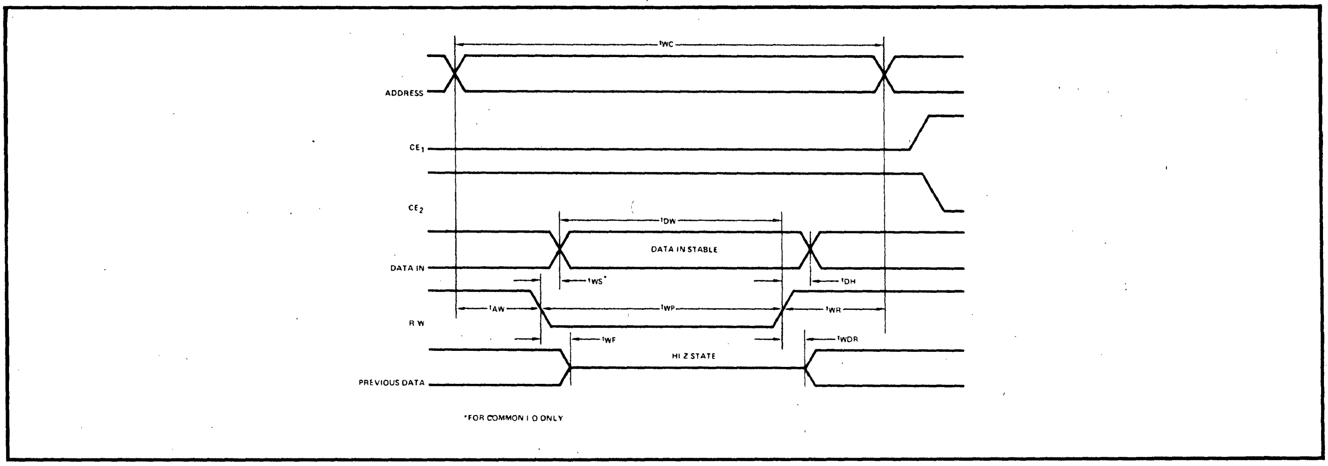
READ CYCLE



WRITE CYCLE 1 – FOR SEPARATE OR COMMON DATA I/O

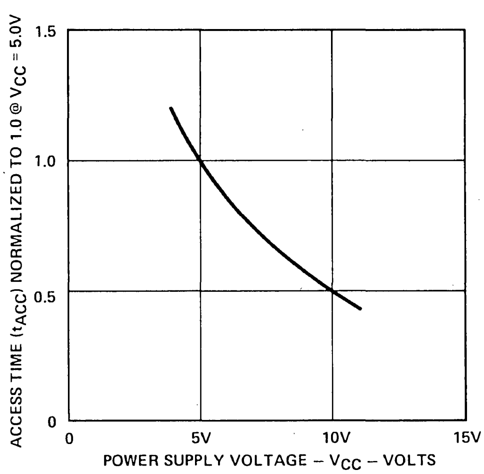


WRITE CYCLE 2 – FOR COMMON DATA I/O

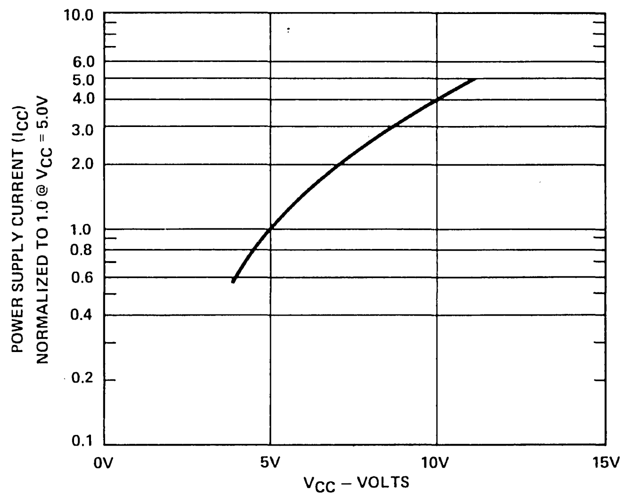


NOTE: OD is Low . *For Common I/O Only

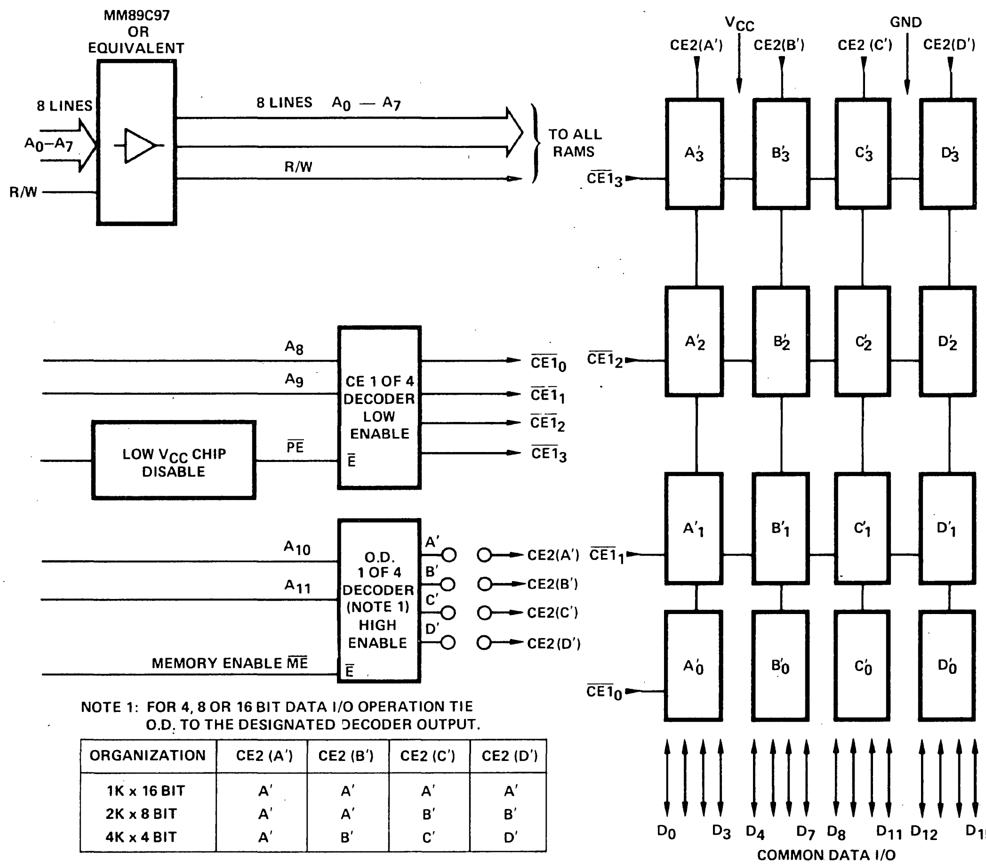
NORMALIZED ACCESS TIME VS. POWER SUPPLY VOLTAGE



NORMALIZED POWER SUPPLY CURRENT VS. POWER SUPPLY VOLTAGE OPERATING AT 1 MHz



A 1024 x 16 BIT (or 2K x 8 or 4K x 4) CMOS READ/WRITE MEMORY



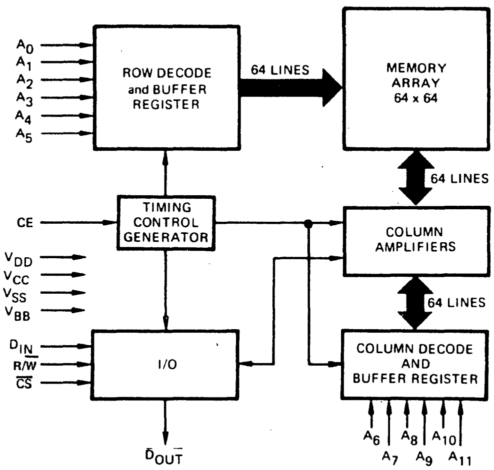
NOTE 1: FOR 4, 8 OR 16 BIT DATA I/O OPERATION TIE O.D. TO THE DESIGNATED DECODER OUTPUT.

ORGANIZATION	CE2 (A′)	CE2 (B′)	CE2 (C′)	CE2 (D′)
1K x 16 BIT	A′	A′	A′	A′
2K x 8 BIT	A′	A′	B′	B′
4K x 4 BIT	A′	B′	C′	D′

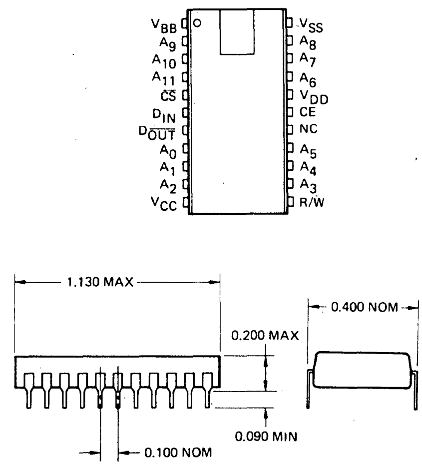
S4021-4
S4021-3
S4021-2

4096 X 1
RANDOM ACCESS MEMORY

AMERICAN MICROSYSTEMS, INC.



BLOCK DIAGRAM



PACKAGE CONFIGURATION

FEATURES

- Fast Access Time – 200/250/300ns (max)
- Fast Read or Write Cycle Time – 400/430/470ns (min)
- Fast Read Modify Write Cycle Time – 580/640/710ns (min)
- Low Power Dissipation – 350 mw Operating (Typical)
  1.8mw Standby (Typical)
- Output – Three State and TTL Compatible
- All Inputs TTL Compatible Except Chip Enable Clock
- Refresh Period – 2ms
- 22 Pin Dual-In-Line Package
- Pin Compatible With TMS 4060 and 2107B
- N-Channel Silicon Gate Technology
- One Transistor Per Cell Design
- Smallest 4096 Bit Dynamic RAM

FUNCTIONAL DESCRIPTION

The AMI S4021 series of dynamic RAM memories is designed for applications where high performance, low cost, high reliability and large bit storage are required. The S4021 is a 4096 word by 1 bit array fabricated with N-channel silicon gate technology. The design uses the single transistor approach to achieve high performance and packing density for lower cost.

All addresses and control inputs are TTL compatible except for the chip enable clock (CE). All decoding is done on chip utilizing low power dynamic design techniques and key control input signals have on-board registers which latch the present state on the chip and provide ease of use in a typical system.

The information read out is non-destructive. Refresh is accomplished by sequencing through the lower order addresses (A_0 - A_5) every 2 ms. This can be done in a single burst mode or by spacing the refresh cycles by 31.25 microseconds.

TYPICAL APPLICATIONS

- Main Frame Memory
- Buffer Memory
- Add-on Memory
- Peripheral Storage
- Terminals
- Controllers, etc.

ABSOLUTE MAXIMUM RATINGS

Voltage on any Pin Relative to Substrate	–0.3V to +20V
Operating Temperature Range	0°C to 70°C
Storage Temperature	–65°C to +150°C

COMMENT: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and is applicable to short duration transient voltages and is not intended to cover those conditions where the device is exposed to voltages equal to or greater than an absolute maximum rating for extended periods. Subjecting the device to voltages equal to or greater than the absolute maximum ratings for extended periods may have a hazardous affect upon the device reliability.

OPERATION

CHIP ENABLE (CE)

The chip enable input is the only clock input to the circuit and with few exceptions is the master signal to which all other timing is related. It is also the only input which is not TTL compatible, requiring a high voltage input signal. (*) When the chip enable input is in the low state the circuit conditions itself, by precharging all internal dynamic nodes, for the subsequent address cycle. This is the low current or standby mode for the device and is the clock condition for which the S4021 dissipates minimum power. When the chip enable input is in the high state and all other inputs properly addressed the device will execute a read or write cycle. The clock high portion of a cycle is the operating segment, during which the device dissipates the maximum power dissipation. The S4021 however, typically, dissipates a low thirty (30) milliamps during the clock high portion of a cycle.

(*) Nominally to 12 volt transitions.

CHIP SELECT (CS)

The chip select input determines which devices in an array will actually execute the read or write cycle. This input controls the data-in, data-out and read/write circuitry on the device enabling or disabling these functions depending on its state. With the proper timing as set out in the timing tables, when chip select is in the low state the device is activated and may execute any designated cycle. When chip select is in the high state the output buffer is in its tri-state mode and the data-in buffer is inhibited from accepting new data. The chip select input buffer is fully TTL compatible and an on-board register is provided for this input so its state may be stored during a cycle execution. The chip select input may be placed in the low state permanently (wire grounded) thereby continuously selecting a particular device; in this mode of operation it is the chip enable input which will determine when the device executes a read or write cycle.

ADDRESS (A_0 - A_{11})

The address inputs to the device collectively determine which memory bit will be read from or written into. By using an address map one can determine precisely which bit inside the device is being addressed; this being helpful when constructing test programs. The address inputs are all fully TTL compatible and also each input is provided with on board register so the address can be stored for one execution cycle, the details of this timing is in the timing diagrams.

READ/WRITE (R/$\overline{W}$)

The read/write input controls the mode in which the circuit operates, that is, whether the circuit will execute a read or write cycle. With the proper timing applied to the device and the read/write input in the high state the device will execute a read cycle; with the read/write input in the low state the device will execute a write cycle. Note that the read/write input can make a transition during one chip enable cycle thereby executing a read-modify-write. The read/write input is also fully TTL compatible, however, this input is not supplied with an on board register for data storage; this is done in order to assure operation of the device in the read-modify-write mode.

DATA-IN (DI)

The data-in terminal is the input where the data is written into the device. This input also is not provided with an on board register and therefore the timing of this signal to the device is critical. This input is fully TTL compatible and can be driven from standard TTL circuits without the use of pullup resistors.

DATA-OUT ($\overline{DO}$)

The three state output buffer provides for direct TTL compatibility with the total capability of driving two TTL loads. The output in the deselected state is in the high impedance of floating mode. Data valid is always preceeded by the output precharging to a low state. Data-out is inverted with respect to the data-in terminal.

REFRESH

Memory refresh must be performed every two milliseconds by cycling through the 64 combinations of the lower order address A_0 through A_5. This operation can take place with read/write (R/W) in either of its two configurations, however, care must be taken to deselect the device (CS in the high state) if the refresh is accomplished in the write mode. The status of the higher order addressed A_6 through A_{11} is don't care during a refresh cycle. It is important to note that the two millisecond refresh rate is guaranteed over the full temperature range of 0°C to 70°C still air ambient.

NOTE: A refresh cycle cannot be prematurely aborted in order to accommodate system interrupts or other higher priority commands. Once the clock (CE) comes high for a refresh cycle the entire cycle must be completed.

D.C. OPERATING CHARACTERISTICS: Unless otherwise stated, the D.C. characteristics are valid over the voltage ranges of: V_{DD} = +12V ±5%, V_{CC} = +5V ±10%, V_{BB} = –5V ±10% and V_{SS} = 0 Volts

Symbol	Parameters	Test Condition	Limits			Units
			Min.	Typ*	Max.	
V_{IH}	High level input voltage (all inputs except chip enable)		2.4		V_{CC}	Volts
V_{IL}	Low level input voltage		0(1)		0.6	Volts
$V_{IH(CE)}$	High level input voltage for chip enable clock		V_{DD} 0.6		V_{DD} +1.0	Volts
$V_{IL(CE)}$	Low level input voltage for chip enable clock		0(1)		0.6	Volts
t_{ref}	Refresh cycle time				2	ms
T_A	Operating free air temperature		0		70	°C
V_{OH}	High level output voltage	I_{OH} = 2.0 mA	2.4		V_{CC}	Volts
V_{OL}	Low level output voltage	I_{OL} = 3.2 mA	V_{SS}		0.4	Volts
I_{DD1}	Operating V_{DD} supply current after transient	V_{BB} = –4.75V, V_{DD} = 12.6V V_{CE} = V_{DD} +1.0, V_{CC} = 5.25V T_A = 0°C All inputs 5.25V		30	45	mA
I_{DD2}	Standby V_{DD} supply current after transient				500	μA
I_{DD3}	V_{DD} supply transient with positive CE transition	Nominal condition		85		mA
I_{DD4}	V_{DD} supply transient with negative CE transition	Nominal condition		60		mA
I_{DD5}	Average current from V_{DD} supply	V_{DD} = 12.6V, V_{BB} = –4.75V, V_{SS} = 0 (duty cycle = 70%) V_{CE} = 0.6 to 13.6V		30	45	mA
I_{BB}	Supply current for V_{BB} supply	V_{DD} = 12.6V, V_{BB} = 5.25V, V_{CE} = 13.6V, V_{SS} = 0V			100	μA
I_{CC}	Average current from V_{CC} supply	V_{CC} = 5.25V duty cycle = 70% from TTL loads			2	mA
I_I	Input leakage on all pins except CE	V_{in} = 0.4 to 5.25V			10	μA
$I_{I(CE)}$	Input leakage on CE	V_{in} = 0.4 to 13.6V			10	μA
I_{OZ}	Output leakage current	V_{out} = 0 to 5.25V CS = 2.4V, CE = 13.6V			10	μA

*All typical values are measured in a still air ambient of 25°C (room temperature).

NOTE (1): Minimum low levels on all inputs may be as negative as the value specified in the "Absolute Maximum Ratings" for a period of time not to exceed thirty (30) nanoseconds.

CAPACITANCE

Symbol	Parameters	Limits			Units
		Min.	Typ.	Max.	
C_{AD}	Address Capacitance		5	7	pf
C_{CE}	CE Capacitance		17	25	pf
C_{IN}	D_{IN} and R/W Capacitance		5	8	pf
C_{OUT}	D_{OUT} Capacitance		4	6	pf

All measurements made with a Boonton meter or equivalent at .25°C ambient temperature.

MEMORY AMI

A.C. OPERATING CHARACTERISTICS $T_A = 0°C$ to $70°C$; $V_{DD} = +12V \pm 5\%$, $V_{CC} = +5V + 10\%$, $V_{BB} = -5V \pm 10\%$, $V_{SS} = 0V$

COMMON READ/WRITE CYCLE TIMING

Symbol	Parameter	S4021-4		S4021-3		S4021-2		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
t_C	Cycle Time	400		430		470		ns
t_{CEH}	Chip Enable High	230	4000	260	4000	300	4000	ns
t_{CEL}	Chip Enable Low	130		130		130		ns
t_R, t_F	Rise Time		20		20		20	ns
t_{AS}	Address Set Up	0		0		0		ns
t_{AH}	Address Hold	150		150		150		ns
t_{CSS}	Chip Sel. Set Up	0		0		0		ns
t_{CSH}	Chip Sel. Hold	150		150		150		ns

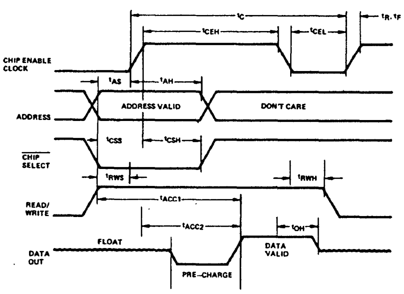
READ CYCLE TIMING

Symbol	Parameter	S4021-4		S4021-3		S4021-2		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
t_{RWS}	Read Set Up	0		0		0		ns
t_{RWH}	Read Hold	40		40		40		ns
t_{ACC1}	Access Time from Address		200		250		300	ns
t_{ACC2}	Access Time from Chip Enable High		180		230		280	ns
t_{OH}	Output Hold	0		0		0		ns

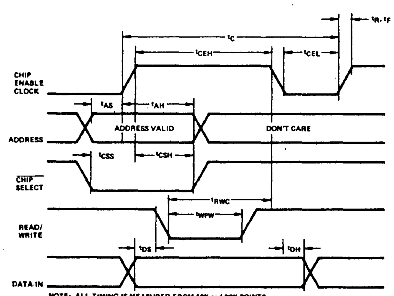
WRITE CYCLE TIMING

Symbol	Parameter	S4021-4		S4021-3		S4021-2		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
t_{WPW}	Write Pulse Width	180		190		200		ns
t_{RWC}	Write Set Up	210		220		240		ns
t_{DS}	Data Set Up	0		0		0		ns
t_{DH}	Data Hold	40		40		40		ns

READ CYCLE TIMING



WRITE CYCLE TIMING



AMI
MEMORY

A.C. OPERATING CHARACTERISTICS

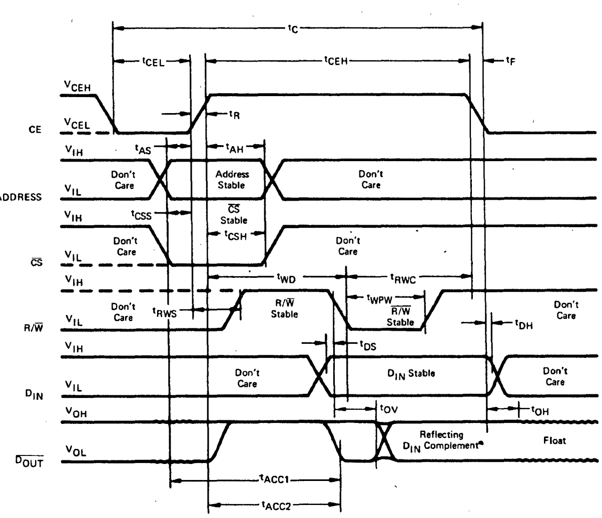
$T_A = 0°C$ to $70°C$; $V_{DD} = +12V \pm 5\%$; $V_{CC} = +5V \pm 10\%$; $V_{BB} = -5V \pm 10\%$; $V_{SS} = 0V$

READ-MODIFY-WRITE CYCLE

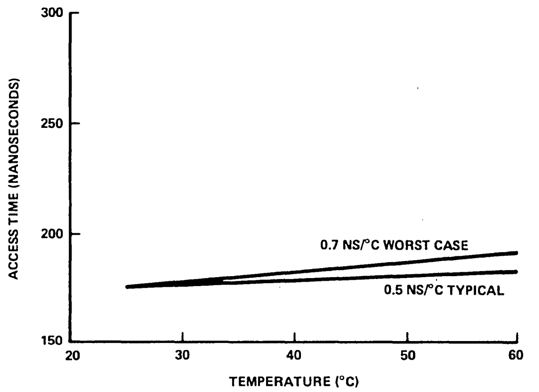
Symbol	Parameter	S4021-4		S4021-3		S4021-2		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
t_C	Cycle Time	580		640		710		ns
t_{CEH}	Chip Enable High	410		470		540		ns
t_{CEL}	Chip Enable Low	130		130		130		ns
t_R, t_F	Rise Time and Fall Time		20		20		20	ns
t_{AS}	Address Set Up	0		0		0		ns
t_{AH}	Address Hold Time	150		150		150		ns
t_{CSS}	Chip Select Set Up	0		0		0		ns
t_{CSH}	Chip Select Hold	150		150		150		ns
t_{RWS}	Read Set Up Time	0		0		0		ns
t_{WPW}	Write Pulse Width	180		190		200		ns
t_{RWC}	Write Pulse Set Up	210		220		240		ns
t_{DS}	Data Set Up	0		0		0		ns
t_{DH}	Data Hold Past Chip Enable	40		40		40		ns
t_{ACC1}	Access Time From Address	200		250		300		ns
t_{ACC2}	Access Time From Chip Enable High	180		230		280		ns
t_{DV}	Output Data Valid Past Write Set Up	0		0		0		ns

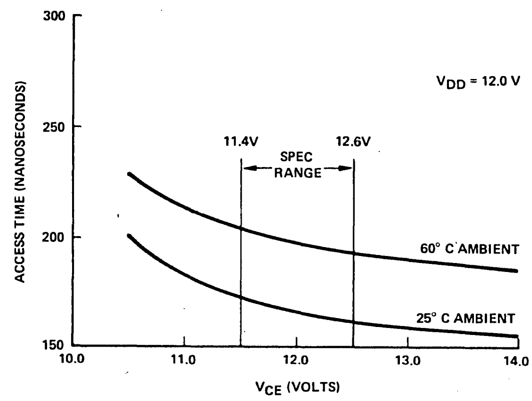
NOTE: (1) The falling edge of the read/write signal for the write cycle portion is 20 ns.
(2) All timing is measured between 10% and 90% points

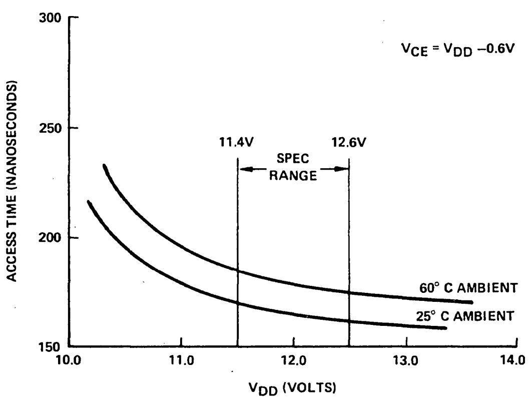
READ-MODIFY-WRITE: TIMING DIAGRAM(2)

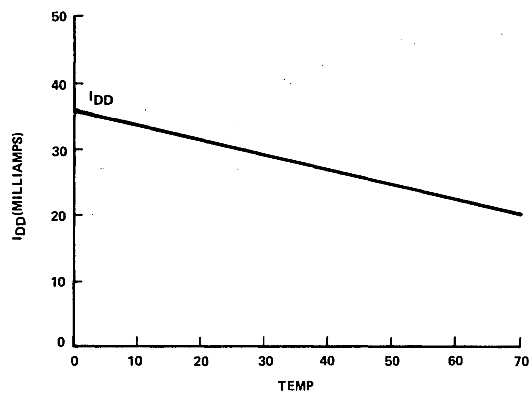


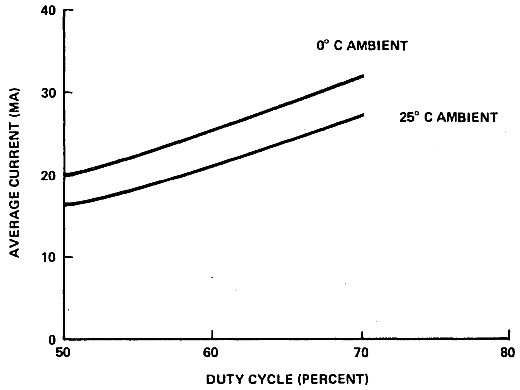
TYPICAL PERFORMANCE CHARACTERISTICS

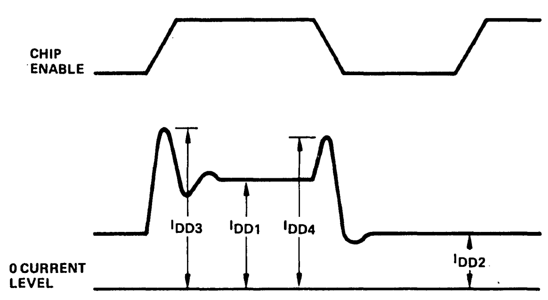












SUPPLY CURRENT PROFILE FROM THE V_{DD} POWER SUPPLY

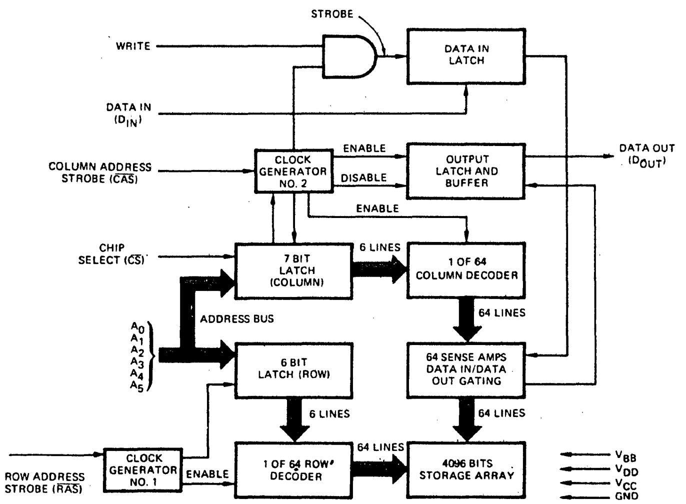
AMI MEMORY

S4096-3
S4096-2
S4096-1

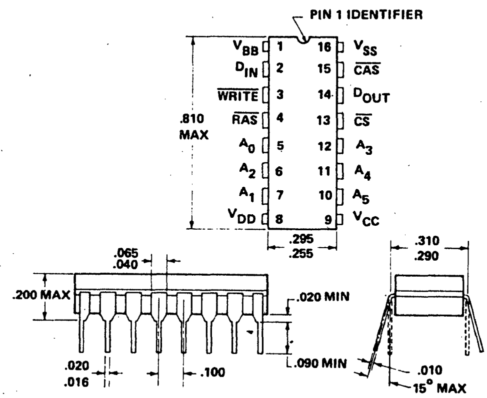
RANDOM ACCESS MEMORY

AMI
AMERICAN MICROSYSTEMS, INC.

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION
16 LEAD CERDIP

FEATURES

- Fast Access Time – 250/300/350 nsec (max)
- Fast Read or Write Cycle – 375/425/475nsec
- Fast Read Modify Write Cycle 520/600/675nsec
- Low Power Dissipation – 400 MW Operating (Typ) 6MW Standby (Typ)
- All Inputs TTL Compatible
- Three State TTL Compatible Output
- On-Chip Latches for Addresses, Chip Select, and Data-In
- Refresh Period – 2 msec
- 16 Pin Dip
- N-Channel Silicon Gate Technology
- Industry Standard Pinout

FUNCTIONAL DESCRIPTION

The AMI S4096 series of dynamic N-Channel MOS RAM's are designed for applications where high performance, low cost and large bit storage are desired such as in mainframe, add-on, buffer memories and peripheral storage. The S4096 is a 4096 word by 1 bit array fabricated with selective oxidation N-Channel silicon gate technology. The S4096 has the same memory array structure and uses the identical process as the S4021, AMI's 22 Pin 4K RAM. The S4096 uses a single transistor cell design to achieve higher performance and smaller die size for low cost.

All inputs are TTL compatible, and the output is three-state TTL compatible. The two low voltage clocks are Row Address Strobe ($\overline{RAS}$) and Column Address Strobe ($\overline{CAS}$) which latch the six row address bits and six column address bits respectively. These twelve bits are multiplexed onto the six address pins. This technique permits packaging of the S4096 in a standard 16 Pin dual-in-line package. In addition, the S4096 has on chip buffers for easy interfacing and optimal input levels for maximum noise immunity and two chip select methods that allows the user to achieve maximum flexibility in selecting the speed/power characteristics most beneficial to his memory system.

The information read out is non-destructive (NDRO). Refresh of the entire memory is accomplished by performing one active cycle on each of the 64 row addresses every 2 ms.

TYPICAL APPLICATIONS

Mainframe Memories, Buffer Memories, Add-On Memories, Minicomputers, Peripheral Storage, Terminals, Controllers, etc.

ADDRESSING

Addressing the cell location is accomplished by multiplexing the 12 address bits onto the 6 address pins. The 6 row address bits are strobed and latched by the Row Address Strobe ($\overline{RAS}$) into the on-chip row buffers. Similarly, the 6 column address bits are, at a later time, strobed and latched by the Column Address Strobe ($\overline{CAS}$) into the on-chip column buffers. Chip Select signal is latched by $\overline{CAS}$ and therefore has no impact on system access or cycle time.

DATA INPUT/OUTPUT

Data to be written into a selected cell is latched into an on-chip register. The data is strobed into the register by a combination of $\overline{WRITE}$ and $\overline{CAS}$. The last of these signals making its negative transition is the strobe for the Data In register. This flexibility in timing permits several options in the write timing. In a write cycle, if the $\overline{WRITE}$ input is activated at the beginning of a cycle, then the Data In is strobed by $\overline{CAS}$ and the set-up and hold time are referenced to this signal. In this instance the output will unconditionally go to a logic 1 at access time. If the cycle were a read-modify-write cycle, the $\overline{WRITE}$ input would not go to a logic 0 until after access time. But, because $\overline{CAS}$ is already at a logic 0, the Data In is strobed in by $\overline{WRITE}$ and the set-up and hold time are referenced to it. The only other timing constraint in write-type cycles besides Data In set-up and hold time is that both $\overline{WRITE}$ and $\overline{CAS}$ be at a logic 0 for a sufficient time to accomplish the write.

At the beginning of a memory cycle the state of the Data Out latch and buffer depends on the previous memory cycle. If during the previous cycle the chip was unselected, the output buffer will be in its open-circuit condition. If the previous cycle was a read or read-modify-write cycle and the chip was selected, then the output latch and buffer will contain the data read from the selected cell. This output data has the same polarity (not inverted) as the input data. If the previous cycle was a write cycle and the chip was selected, then the output will remain high. Regardless of the state of the output it will remain valid until $\overline{CAS}$ goes negative. At that time the output will unconditionally go to its open-circuit state. It will remain open circuit until access time. At access time the toutput will assume the proper state for the type of cycle performed. If the chip is unselected, it will not accept a $\overline{WRITE}$ command and the output will remain in the open-circuit state.

INPUT/OUTPUT LEVELS

All inputs, including the two address strobes, are TTL compatible. The high impedance, low capacitance (< 10pF) input characteristics simplify input driver selection by allowing use of standard logic elements rather than specially designed driver elements. The three-state output buffer is a low impedance to V_{CC} for a logic 1 and a low impedance to V_{SS} for a logic 0. The separate V_{CC} pin goes to the output buffer only and allows it to be powered from the supply voltage of the logic to which the chip is interfaced.

POWER DISSIPATION/STANDBY MODE

Most of the circuitry used in the S4096 is dynamic and draws only AC power. Power dissipation is therefore a function of operating frequency. Worst case power is less than 440 mW at a 500 nsec cycle time. To reduce the overall system power the Row Address Strobe ($\overline{RAS}$) must be decoded and supplied to only the selected chips. The $\overline{CAS}$ must be supplied to all chips (to turn off the unselected outputs). But those chips that did not receive a $\overline{RAS}$ will dissipate only the standby power. If the $\overline{RAS}$ is decoded and supplied to the selected chips, then the Chip Select input of all chips can be a logic 0. The chips that receive a $\overline{CAS}$ but no $\overline{RAS}$ will be unselected (output open-circuited) regardless of the Chip Select input. Thus, the standby mode of the chip is implemented when $\overline{RAS}$ is high regardless of the state of $\overline{CAS}$.

REFRESH

The S 4096 is refreshed by performing a memory cycle at each of the 64 row addresses every 2 milliseconds or less. Any read or read-modify-write cycle refreshes the selected row regardless of the state of the Chip Select. A write cycle can be used to refresh the selected row but the chip must be unselected, or the addressed cell will be written with new information.

ABSOLUTE MAXIMUM RATINGS

Voltage on Any Pin Relative to Substrate	– 0.3V to + 20V	Operating Temperature Range	0°C to + 70°C
		Storage Temperature	–65°C to + 150°C

COMMENT: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification, is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC & OPERATING CHARACTERISTICS

$T_A = 0° - 70°C$, $V_{DD} = +12V \pm 5\%^{(1)}$; $V_{CC} = +5V \pm 10\%^{(1)}$, $V_{BB} = -5V \pm 10\%^{(1)}$, $V_{SS} = 0V^{(1)}$

SYMBOL	PARAMETER	LIMITS MIN	TYP	MAX	UNITS	COMMENTS
V_{IL}	Input Low Voltage. All Inputs	- 1.0		0.6	V	See Note 1
V_{IH}	Input High Voltage. All Inputs except $\overline{RAS}$, $\overline{CAS}$,	2.4		$V_{CC}+1$	V	See Note 1
V_{IHC}	Input High Voltage: $\overline{RAS}$, $\overline{CAS}$	3.0		$V_{CC}+1$	V	See Note 1
V_{OL}	Output Low Voltage			0.4	V	$I_{OL} = 2.0$ mA
V_{OH}	Output High Voltage	2.4		V_{CC}	V	$I_{OH} = -3.0$ mA, See Note 6.
I_{IL}	Input Leakage Current			10	µA	See Note 4
I_{OL}	Output Leakage Current for High Impedance State			10	µA	See Note 5
I_{DDA}	Average V_{DD} to V_{SS} Current Active Mode			35	mA	See Note 8
I_{DDS}	Average V_{DD} to V_{SS} Current, Standby Mode			2	mA	$\overline{RAS}$ at V_{IHC}, $\overline{CAS}$, $\overline{CS}$ DON'T CARE
I_{CC}	V_{CC} Supply Current			10	µA	$\overline{CS}$ = 2.4V $\overline{RAS}$, $\overline{CAS}$ = DON'T CARE
I_{BB}	V_{BB} Supply Current			75	µA	

CAPACITANCE

SYMBOL	PARAMETER	MAX	UNITS
C_C	$\overline{RAS}$, $\overline{CAS}$, $\overline{CS}$ Capacitance	10	pF
C_{IN}	Address, $\overline{CS}$, D_{IN} and $\overline{WRITE}$ Capacitance	7	pF
C_{OUT}	D_{OUT} Capacitance	8	pF

AC OPERATING CHARACTERISTICS

T_A = 0° - 70°C, V_{DD} = +12V ± 5%,[1] V_{CC} = + 5V ± 10%,[4, 6] V_{BB} = - 5V ± 10%,[1] V_{SS} = 0V[1]

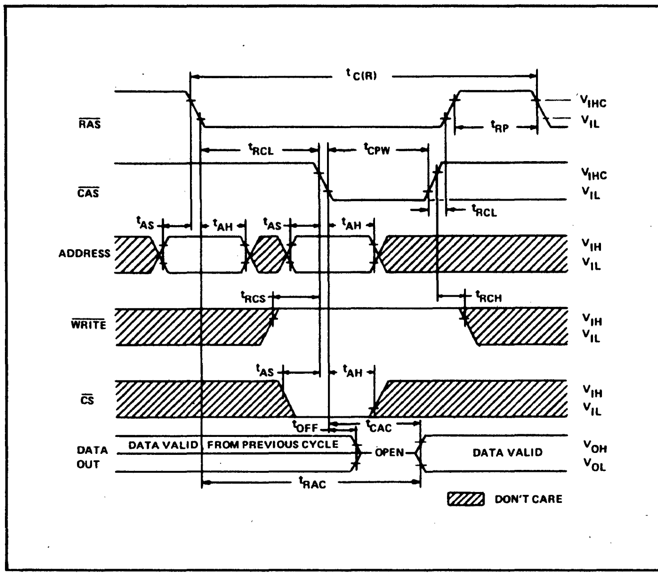
SYMBOL	PARAMETER	S4096–3		S4096–2		S4096–1		UNITS
		MIN	MAX	MIN	MAX	MIN	MAX	
t_{RAC} [7]	Access Time from $\overline{RAS}$		250		300		350	nsec
t_{CAC}	Access Time from $\overline{CAS}$		140		165		200	nsec
$t_{C(R)}$	Read Cycle Time	375		425		475		nsec
$t_{C(W)}$	Write Cycle Time	375		425		475		nsec
$t_{C(RMW)}$	Read Modify, Write Cycle Time	520		600		675		nsec
t_{OFF} [3]	Output Buffer, Turn-Off Delay	0	60	0	80	0	100	nsec
t_{RP}	$\overline{RAS}$ Precharge Time	125		125		125		ns
t_{RCL}	$\overline{RAS}$ to $\overline{CAS}$ Lead Time	70	110	90	130	110	150	ns
t_{CPW}	$\overline{CAS}$ Pulse Width	140		170		200		ns
t_{AS}	Address Set-Up Time	0		0		0		ns
t_{AH}	Address Hold Time	60		80		100		ns
t_{RCS}	Read Command Set-Up Time	0		0		0		ns
t_{RCH}	Read Command Hold Time	0		0		0		ns
t_{WCH} [2]	Write Command Hold Time	110		130		150		ns
t_{CRL}	$\overline{CAS}$ to $\overline{RAS}$ Lead Time	-40	+40	-45	+45	-50	+50	ns
t_{DS}	Data In Set-Up Time	0		0		0		ns
t_{DH}	Data In Hold Time	110		130		150		
t_T	Rise and Fall Times	5	50	5	50	5	50	ns
t_{REF}	Time Between Refresh		2.0		2.0		2.0	ms
t_{MOD}	Modify Time	0	10	0	10	0	10	ns

NOTES:

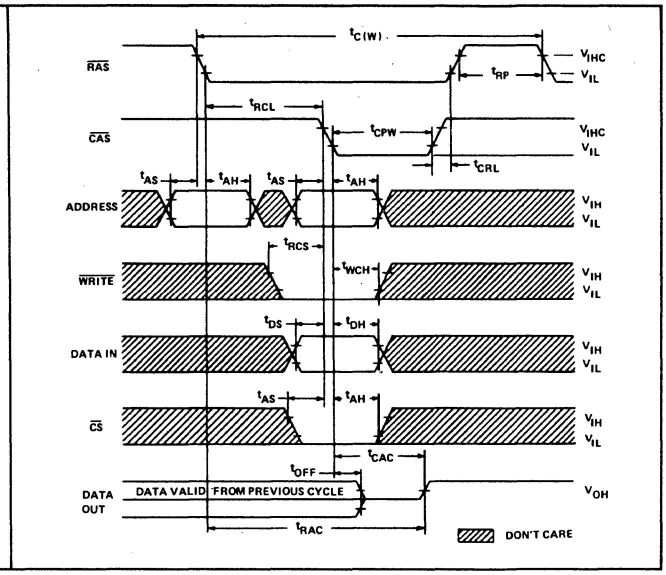
1. *All voltages referenced to V_{SS}*
2. *Write Command Hold Time is important only when performing normal random write cycles.. During read-write or read-modify write cycles, the Write Command Pulse Width is the limiting parameter.*
3. *Depends upon output loading.*
4. *All device pins at 0 volts except V_{BB} at - 5 volts and pin under test which is at + 10 volts.*
5. *Output disabled by chip select input.*
6. *Output voltage will swing from V_{SS} to V_{CC} independent of differential between V_{SS} and V_{CC}*
7. *Assumes t_{RCL} is minimum.*
8. *Typical V_{DD} current at 1.0 MHz cycle rate.*

AMI MEMORY

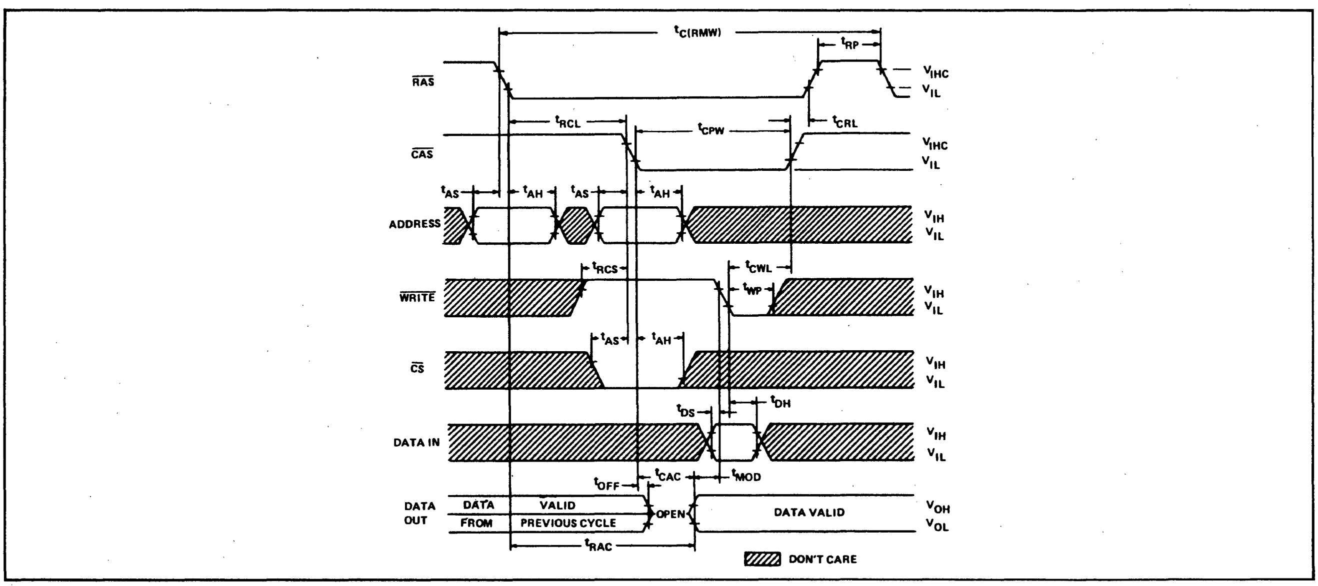
READ CYCLE TIMING



WRITE CYCLE TIMING



READ–MODIFY–WRITE TIMING



SEMI 4402A

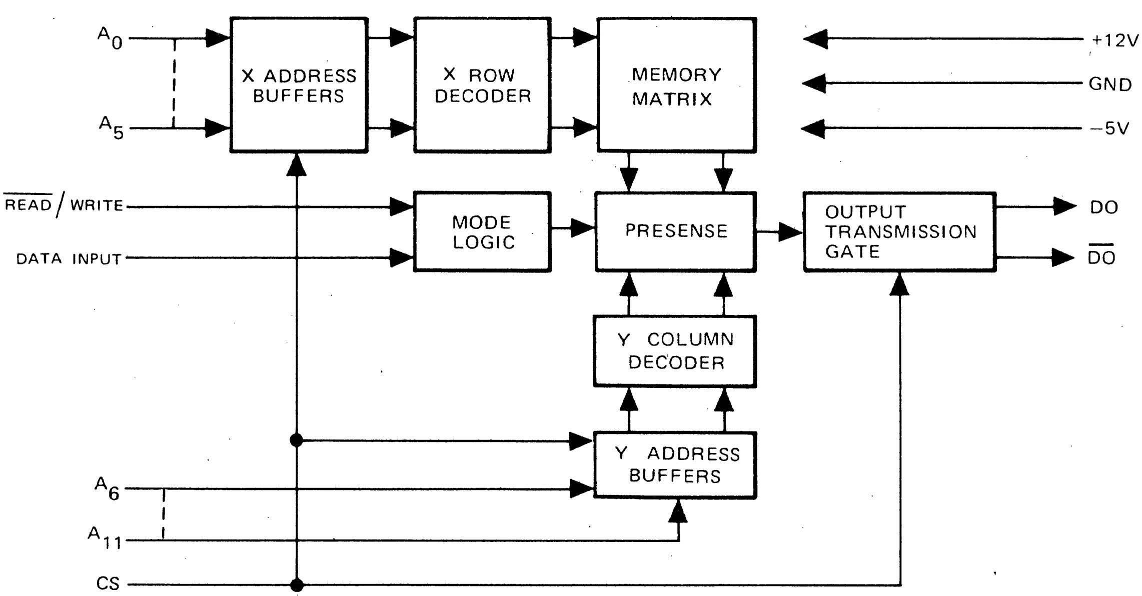
200 NSEC, STATIC, DIFFERENTIAL OUTPUT

4096 x 1 N-MOS RAM

FEATURES

- ☐ STATIC – NO REFRESH OR CHARGE PUMP OSCILLATOR REQUIRED
- ☐ 4096 WORD x 1 BIT ORGANIZATION
- ☐ 200 NSEC ACCESS TIME
- ☐ 350 NSEC CYCLE TIME
- ☐ ON-CHIP ADDRESS REGISTER
- ☐ TTL COMPATIBLE ADDRESS AND DATA INPUTS
- ☐ LOW OPERATING POWER 400 MW TYP.
- ☐ DATA RETENTION TO V_{DD}= 4V
- ☐ STANDARD 22 PIN DIP, PIN AND VOLTAGE COMPATIBLE WITH POPULAR 4096 BIT DYNAMIC RAMS

BLOCK DIAGRAM



EMM SEMI

ABSOLUTE MAXIMUM RATINGS (See Note 1) (Referenced to GND)

Rating	Symbol	Value	Unit
Supply Voltages	V_{DD}	-0.5 to +15	Vdc
	V_{SX}	+0.5 to -7	Vdc
Input & Output Voltages (except Chip Select)	V_I, V_O	V_{SX} to +15	Vdc
Chip Select Input Voltage	V_{CS}	V_{SX} to +15	Vdc
Power Dissipation	P_D	1.6 (Note 2)	W
Operating Ambient Temperature Range	T_{AMB}	0 to +70	°C
Storage Temperature Range	T_{STG}	-65 to +150	°C

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields: however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

Note 1: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMEND OPERATING CONDITIONS. Exposure to higher than recommended or maximum voltages for extended periods of time could affect device reliability.

Note 2: At 25°C ambient, Derate 13.5mw/°C.

RECOMMENDED OPERATING CONDITIONS T_A = 0°C to +70°C

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltages	V_{DD}	11.4	12	12.6	V
	V_{SX}	− 4.5	− 5	− 5.5	V
Logic Levels.					
Input High Voltage (except Chip Select)	V_{IH}	3	−	5.25	V
Input Low Voltage (except Chip Select)	V_{IL}	0	−	0.7	V
Chip Select High Voltage	V_{CH}	$V_{DD}-2$	V_{DD}	$V_{DD}+2$	V
Chip Select Low Voltage	V_{CL}	0	−	0.5	V

DC ELECTRICAL CHARACTERISTICS (Full Operating voltage & temperature range unless otherwise noted)

Characteristics		Symbol	Min	Typ	Max	Unit
Input Current (except Chip Select)	V_{IH} 5.0V (V_{CS} = V_{CH})	I_{IH}	−	5	25	μA
	V_{IL} = 0.5V (V_{CS} = V_{CH})	I_{IL}	−	−5	−25	μA
Chip Select High Input Current, DC (V_{CS} = 12V)		I_{CH}	−	2	3	mA
Chip Select High Input Current, (Pulse Peak) V_{CS} = 12V, T_{CR} = 25ns		I_{CP}	−	70	−	mA
Chip Select Low Input Current (V_{CS} = 5V)		I_{CL}	−	2	3	mA
Supply Current, (T_{AMB} = 25°C; V_{DD}, V_{SX} = nominal; all VI = max V_{IL}: DO, $\overline{DO}$	Unselected (Chip Select = 0 V)	I_{DDU} 25°C	−	1	5	mA
		I_{DDU} 70°C	−	3	15	mA
		I_{SXU}	−	−2	−3	mA
IDD vs Cycle time Selected and Averaged Over One Cycle	Selected CSW 200ns Cycle = 350ns	I_{DD}	−	36	50	mA
		I_{SX}	−	−2	−3	mA
Standby Current at Reduced Voltages V_{DD} = 4V, V_{SX} = -4.5V, V_{CS} = 0V	25°C	I_{DDS}	−	.5	1.8	mA
	70°C	I_{DDS}	−	1.5	5.4	mA
Output Low Voltage CSW · 1μsec		V_{OL}	−	0	.1	V
Output High Voltage CSW · 1μsec		V_{OH}	.35	1	2	V
Output Disabled Current V_{CS} = 0V, V_O = 2V		I_{DO}	+10	−	−10	μA

AC ELECTRICAL CHARACTERISTICS (Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Characteristics	Symbol	Min	Typ	Max	Unit
Chip Select Read Pulse Width	T_{CSR}	200	−	∞	ns
Chip Select Read Recovery Time	T_{CRR}	125	−	∞	ns
Chip Select Write Pulse Width	T_{CSW}	200	−	∞	ns
Chip Select Write Recovery Time	T_{CWR}	125	−	∞	ns
Chip Select Rise Time	T_{CR}	−	10	50	ns
Chip Select Fall Time	T_{CF}	−	10	50	ns
Set Up Time	T_P	10	−	−	ns
Hold Time (Address and Data)	T_H	100	−	−	ns
Access Time (T_{CR} = 10ns)	T_A	−	−	200	ns
Cycle Time (Read or Write, T_{CR} = 10ns, T_{CF} = 10ns)	T_C	350	−	−	ns
Data Recovery	T_{DR}	10	15	−	ns

CAPACITANCE (Over Full Temperature Range and Worst Case Voltage Conditions)

Characteristics	Symbol	Min	Typ	Max	Unit
Input Capacitance (except Chip Select) V_I = 2.4V, V_{CS} = 12V	C_I	−	6	−	pF
Chip Select Input Capacitance	C_{CS}	−	50	−	pF
Output Capacitance (V_O = 2.0V, V_{CS} 0 V)	C_O	−	5	−	pF

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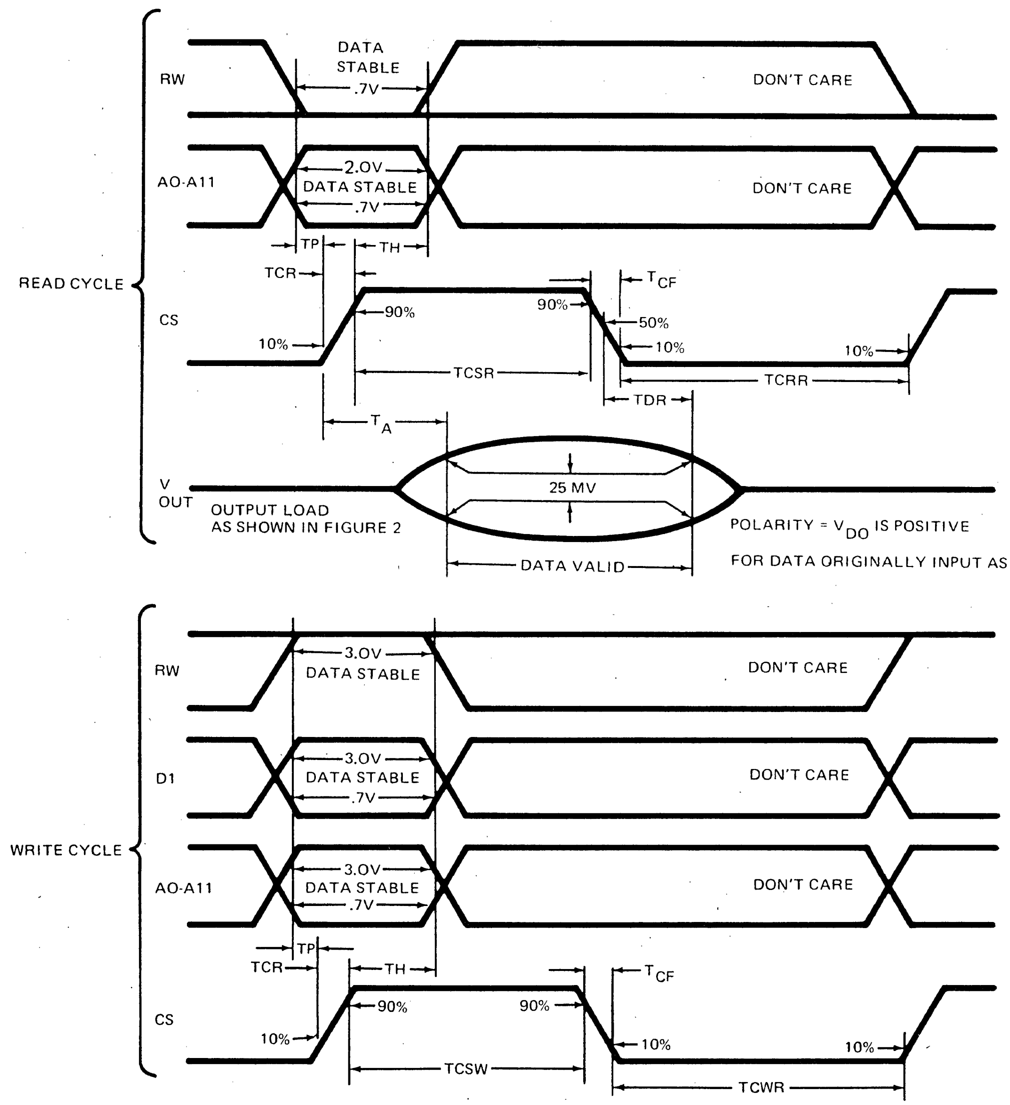
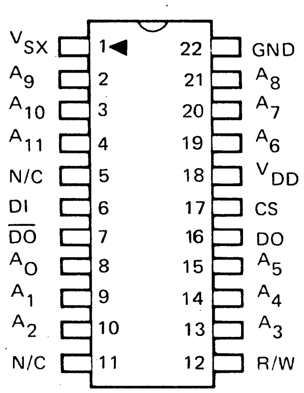
EMM SEMI

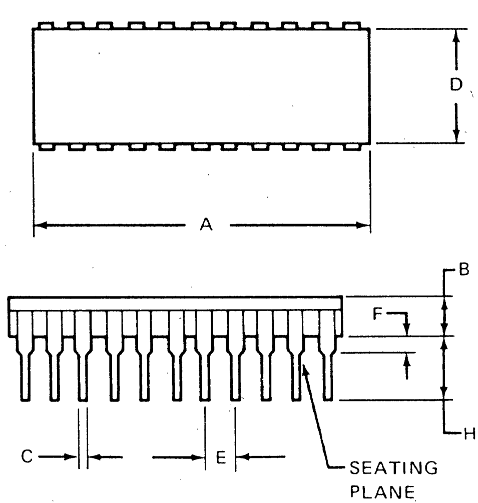
TIMING DIAGRAMS



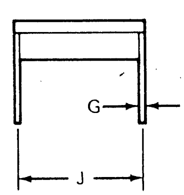
TOP VIEW



PIN ASSIGNMENT



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	27.1	27.8	1.065	1.095
B	–	3.56	–	0.140
C	0.38	0.53	0.015	0.021
D	8.64	10.8	0.340	0.425
E	2.29	2.79	0.090	0.110
F	0.51	1.27	0.020	0.050
G	0.20	0.30	0.008	0.012
H	3.42	3.93	0.135	0.155
J	10.2 REF		0.4 REF	



PACKAGE DIMENSIONS

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SEMI 4402B

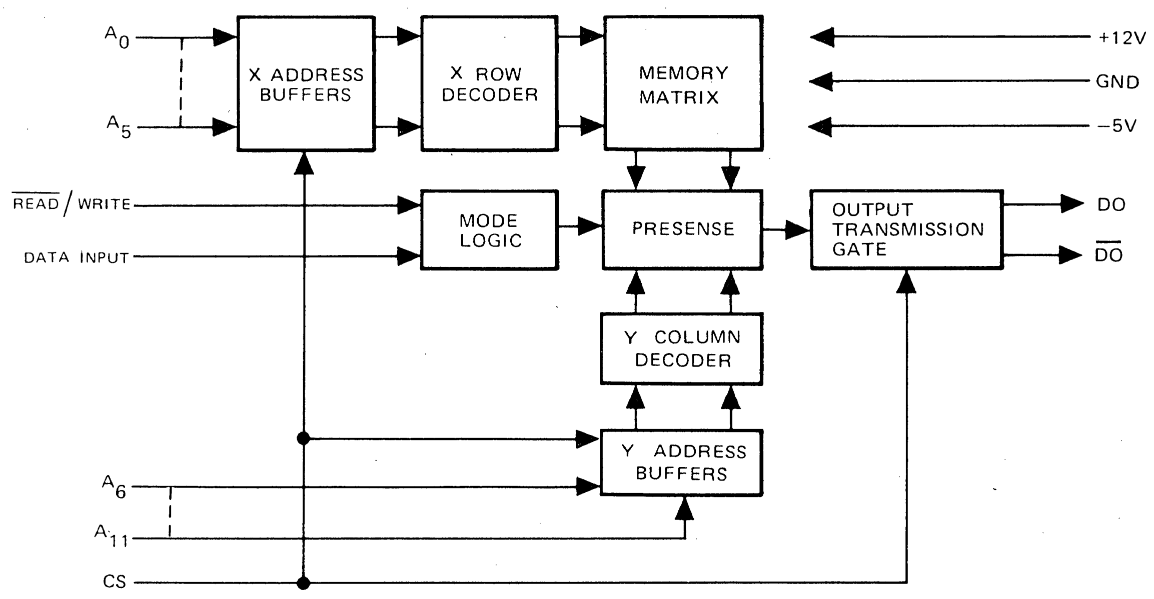
125 NSEC, STATIC, DIFFERENTIAL OUTPUT

4096 x 1 **N-MOS RAM**

FEATURES

- ☐ STATIC – NO REFRESH OR CHARGE PUMP OSCILLATOR REQUIRED
- ☐ 4096 WORD x 1 BIT ORGANIZATION
- ☐ 125 NSEC ACCESS TIME
- ☐ 300 NSEC CYCLE TIME
- ☐ ON-CHIP ADDRESS REGISTER
- ☐ TTL COMPATIBLE ADDRESS AND DATA INPUTS
- ☐ LOW OPERATING POWER 400 MW TYP.
- ☐ DATA RETENTION TO V_{DD} = 4V
- ☐ STANDARD 22 PIN DIP, PIN AND VOLTAGE COMPATIBLE WITH POPULAR 4096 BIT DYNAMIC RAMS

BLOCK DIAGRAM



EMM SEMI

ABSOLUTE MAXIMUM RATINGS (See Note 1) (Referenced to GND)

Rating	Symbol	Value	Unit
Supply Voltages	V_{DD}	-0.5 to +15	Vdc
	V_{SX}	+0.5 to -7	Vdc
Input & Output Voltages (except Chip Select)	V_I, V_O	V_{SX} to +15	Vdc
Chip Select Input Voltage	V_{CS}	V_{SX} to +15	Vdc
Power Dissipation	P_D	1.6 (Note 2)	W
Operating Ambient Temperature Range	T_{AMB}	0 to +70	°C
Storage Temperature Range	T_{STG}	-65 to +150	°C

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields: however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

Note 1: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMEND OPERATING CONDITIONS. Exposure to higher than recommended or maximum voltages for extended periods of time could affect device reliability.

Note 2: At 25°C ambient, Derate 13.5mw/°C.

RECOMMENDED OPERATING CONDITIONS T_A = 0°C to +70°C

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltages	V_{DD}	11.4	12	12.6	V
	V_{SX}	– 4.5	– 5	– 5.5	V
Logic Levels: Input High Voltage (except Chip Select)	V_{IH}	3	–	5.25	V
Input Low Voltage (except Chip Select)	V_{IL}	0	–	0.7	V
Chip Select High Voltage	V_{CH}	V_{DD}–2	V_{DD}	V_{DD}+2	V
Chip Select Low Voltage	V_{CL}	0	–	0.5	V

DC ELECTRICAL CHARACTERISTICS (Full Operating voltage & temperature range unless otherwise noted)

Characteristics		Symbol	Min	Typ	Max	Unit
Input Current (except Chip Select)	V_{IH} = 5.0V (V_{CS} = V_{CH})	I_{IH}	–	5	25	µA
	V_{IL} = 0.5V (V_{CS} = V_{CH})	I_{IL}	–	– 5	–25	µA
Chip Select High Input Current, DC (V_{CS} = 12V)		I_{CH}	–	2	3	mA
Chip Select High Input Current, (Pulse Peak) V_{CS} = 12V, T_{CR} = 25ns		I_{CP}	–	70	–	mA
Chip Select Low Input Current (V_{CS} = 5V)		I_{CL}	–	2	3	mA
Supply Current, (T_{AMB} = 25°C; V_{DD}, V_{SX} = nominal; all VI = max V_{IL}: DO, $\overline{DO}$	Unselected (Chip Select = 0 V)	I_{DDU} 25°C	–	1	5	mA
		I_{DDU} 70°C	–	3	15	mA
		I_{SXU}	–	-2	-3	mA
IDD vs Cycle time Selected and Averaged Over One Cycle	Selected CSW 200ns Cycle = 350ns	I_{DD}	–	36	50	mA
		I_{SX}	–	-2	–3	mA
Standby Current at Reduced Voltages V_{DD} = 4V, V_{SX} = -4.5V, V_{CS} = 0V	25°C	I_{DDS}	–	.5	1.8	mA
	70°C	I_{DDS}	–	1.5	5.3	mA
Output Low Voltage	CSW ≤ 1µsec	V_{OL}	–	0	.1	V
Output High Voltage	CSW ≤ 1µsec	V_{OH}	.35	1	2	V
Output Disabled Current V_{CS} = 0V, V_O = 2V		I_{DO}	+10	—	–10	µA

AC ELECTRICAL CHARACTERISTICS (Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Characteristics	Symbol	Min	Typ	Max	Unit
Chip Select Read Pulse Width	T_{CSR}	125	–	∞	ns
Chip Select Read Recovery Time	T_{CRR}	135	–	∞	ns
Chip Select Write Pulse Width	T_{CSW}	125	–	∞	ns
Chip Select Write Recovery Time	T_{CWR}	135	–	∞	ns
Chip Select Rise Time	T_{CR}	–	10	50	ns
Chip Select Fall Time	T_{CF}	–	10	50	ns
Set Up Time	T_P	10	–		ns
Hold Time (Address and Data)	T_H	100	–	–	ns
Access Time (T_{CR} = 10ns)	T_A	–	–	125	ns
Cycle Time (Read or Write; T_{CR} = 10ns, T_{CF} = 10ns)	T_C	300	–	–	ns
Data Recovery	T_{DR}	10	15	–	ns

CAPACITANCE (Over Full Temperature Range and Worst Case Voltage Conditions)

Characteristics	Symbol	Min	Typ	Max	Unit
Input Capacitance (except Chip Select) V_I = 2.4V, V_{CS} = 12V	C_I	–	6	–	pF
Chip Select Input Capacitance	C_{CS}	–	50	–	pF
Output Capacitance (V_O = 2.0V, V_{CS} = 0 V)	C_O	–	5	–	pF

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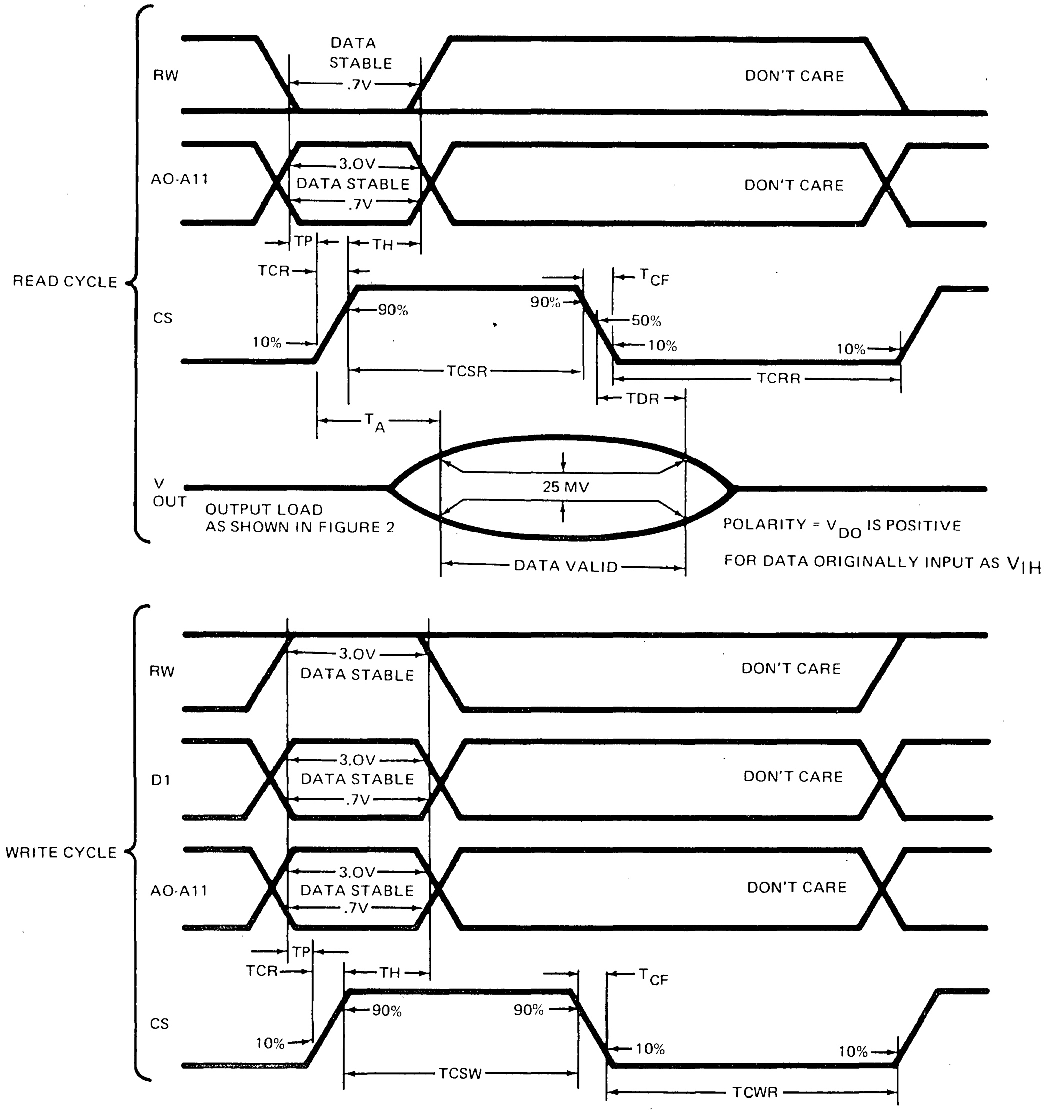
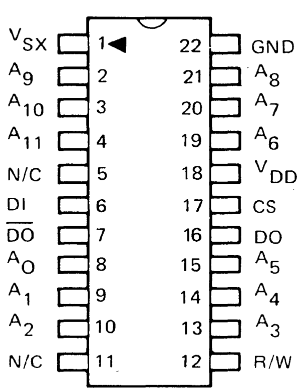
EMM SEMI

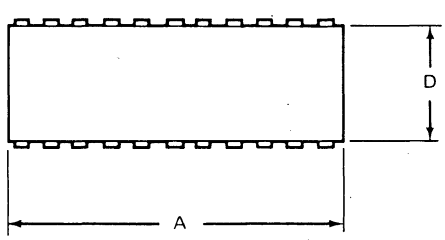
TIMING DIAGRAMS



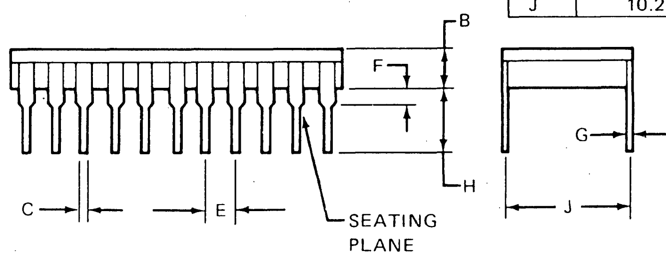
TOP VIEW



PIN ASSIGNMENT



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	27.1	27.8	1.065	1.095
B	–	3.56	–	0.140
C	0.38	0.53	0.015	0.021
D	8.64	10.8	0.340	0.425
E	2.29	2.79	0.090	0.110
F	0.51	1.27	0.020	0.050
G	0.20	0.30	0.008	0.012
H	3.42	3.93	0.135	0.155
J	10.2 REF		0.4 REF	



PACKAGE DIMENSIONS

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SEMI 4200

215 NSEC, STATIC, TTL OUTPUT

4096 x 1 N-MOS RAM

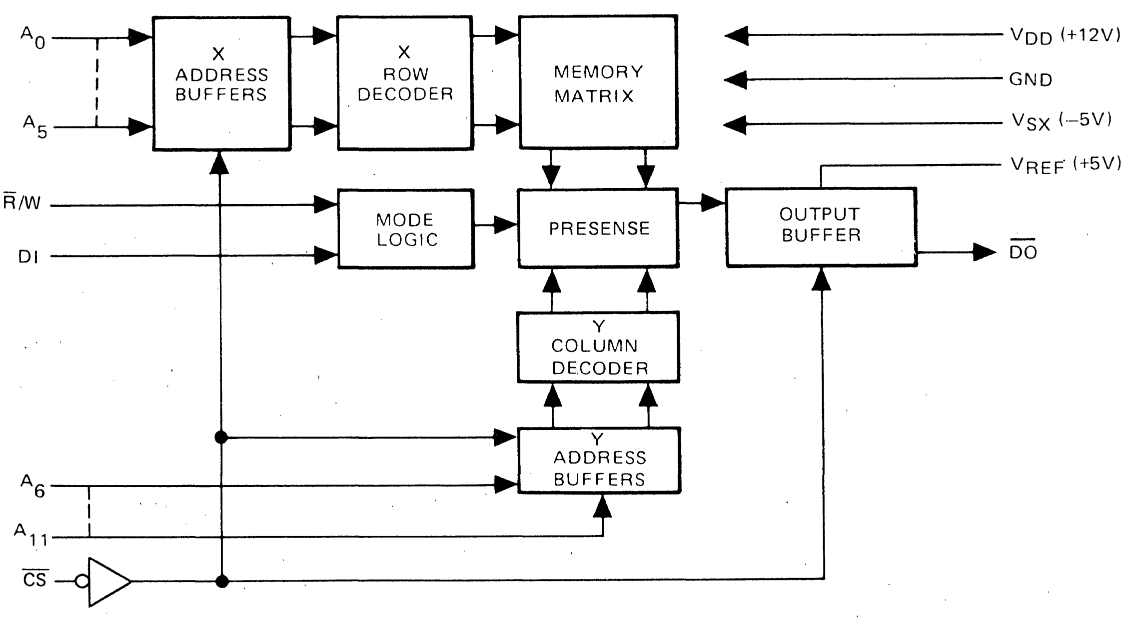
FEATURES

- COMPLETELY STATIC
- ACCESS TIME – 215 NSEC
- CYCLE TIME – 400 NSEC
- TYPICAL OPERATING POWER UNDER 450 mw.
- TYPICAL STANDBY POWER UNDER 35 mw.
- DATA RETENTION WITH LOW V_{DD}
- PIN AND VOLTAGE COMPATIBLE WITH STANDARD 22 PIN 4K DYNAMIC RAMS
- TTL COMPATIBLE TRI-STATE OUTPUTS
- FULLY DECODED
- ACTIVE LOW CHIP SELECT

EMM/SEMI

MEMORY

BLOCK DIAGRAM



EMM SEMI

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

NOTE 1: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended or maximum voltages for extended periods of time could affect device reliability.

NOTE 2: At 25°C ambient. Derate 13.5m w/°C.

ABSOLUTE MAXIMUM RATINGS (See Note 1) (Referenced to GND)

Rating	Symbol	Value	Unit
Supply Voltages	V_{DD}	−.5 to +15	Vdc
	V_{RF}	−.5 to +7	Vdc
	V_{SX}	+.5 to −7	Vdc
Input & Output Voltages (Except Chip Select)	V_I, V_O	V_{SX} to +15	Vdc
Chip Select Input Voltage	V_{CS}	V_{SX} to +15	Vdc
Power Dissipation	P_D	1.6 (Note 2)	W
Operating Ambient Temperature Range	T_{AMB}	0 to +70	°C
Storage Temperature Range	–	−65 to +150	°C

RECOMMENDED OPERATING CONDITIONS T_{AMB} = 0°C to 70°C

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V_{DD}	11.4	12.0	12.6	Vdc
Output Reference Voltage	V_{RF}	4.75	5.0	5.25	Vdc
Substrate Voltage	V_{SX}	−4.5	−5	−5.5	Vdc
Input High Level	V_{IH}	3	–	5.25	Vdc
Input Low Level	V_{IL}	0	–	0.8	Vdc
Chip Select High Level	V_{CH}	V_{DD} −3	V_{DD}	V_{DD}+3	Vdc
Chip Select Low Level	V_{CL}	0	–	0.5	Vdc

DC ELECTRICAL CHARACTERISTICS (Full Operating voltage & temperature range unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit	Conditions
Input Current	I_{IN}	0	±10	±100	μA	V_{IN} = 0.5V or 5.0V
Chip Select Input Current	I_{CS}	–	±10	±100	μA	V_{CS} = 0.5V or 12V
Output "Low" Voltage	V_{OL}	–	0.3	0.5	Vdc	I_O = 2.0mA Fig. 5
Output "High" Voltage	V_{OH}	2.7	3.5	V_{RF}	Vdc	I_O = 500 μA Fig. 5
Output Current (Unselected)	I_{DO}	–	–	−50	μA	V_{OL} = 2.7V, V_{CS} = +12V
Supply Current (Selected and Averaged over one cycle) CSW = 215 nsec TC = 400 nsec For Other Conditions, See Figure 3	I_{DD}	–	36	50	mA	V_{DD} = +12V V_{RF} = +5V V_{SX} = −5V T_{AMB} = 25°C
Supply Current (Unselected) T_{AMB} = 25°C	I_{DDU}	–	2	5	mA	V_{DD} = +12V V_{RF} = +5V V_{SX} = −5V V_{CS} = 12V
Supply Current (Unselected) T_{AMB} = 70°C	I_{DDU}	–	4.5	15	mA	
Substrate Current	I_{SX}	–	−2.2	−3	mA	
Reference Supply Current	I_{RF}	–	50	100	μA	
Standby Current at Reduced Voltages T_{AMB} = 25°C	I_{DDS}	–	0.8	2	mA	V_{CS} = 4V to 15V V_{DD} = 4V V_{SX} = −5V ±10% V_{RF} = 0V
Standby Current at Reduced Voltages T_{AMB} = 70°C	I_{DDS}	–	1.8	6	mA	

AC ELECTRICAL CHARACTERISTICS (Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Characteristics	Symbol	Min	Typ	Max	Unit	Figure
Chip Select Read Pulse Width	T_{CSR}	215ns	–	1ms	–	1
Chip Select Write Pulse Width	T_{CSW}	215ns	–	1 ms	–	2
Chip Select Rise and Fall Time	T_{CR}, T_{CF}	–	10	50	ns	1&2
Set Up Time	T_P	0	–	–	ns	1&2
Access Time	T_A	–	–	215	ns	1
Cycle Time, T_{CR} = T_{CF} =10ns (Read or Write)	T_C	400	–	–	ns	1&2
Data Hold Time	T_H	100	–	–	ns	1&2
Output Recovery Time	T_{DR}	10	15	–	ns	1
Read Recovery Time	T_{CRR}	150	–	–	ns	1
Write Recovery Time	T_{CWR}	150	–	–	ns	2

CAPACITANCE (Over Full Temperature Range and Worst Case Voltage Conditions)

Characteristics	Symbol	Min	Typ	Max	Unit	Conditions
Input Capacitance (Except Chip Select)	C_{IN}	–	6	–	pF	V_{IN} = 2.4V
Input Capacitance Chip Select	C_{CS}	–	20	–	pF	V_{CS} = 12V or 0V
Output Capacitance	C_O	–	8	–	pF	V_O = 2.7V V_{CS} = 12V

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EMM SEMI

TIMING DIAGRAMS

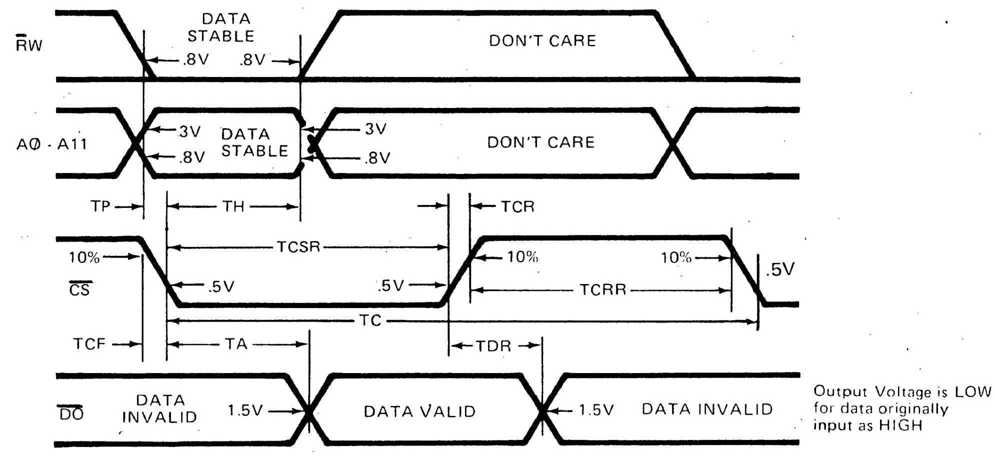


Figure 1 — Read Cycle

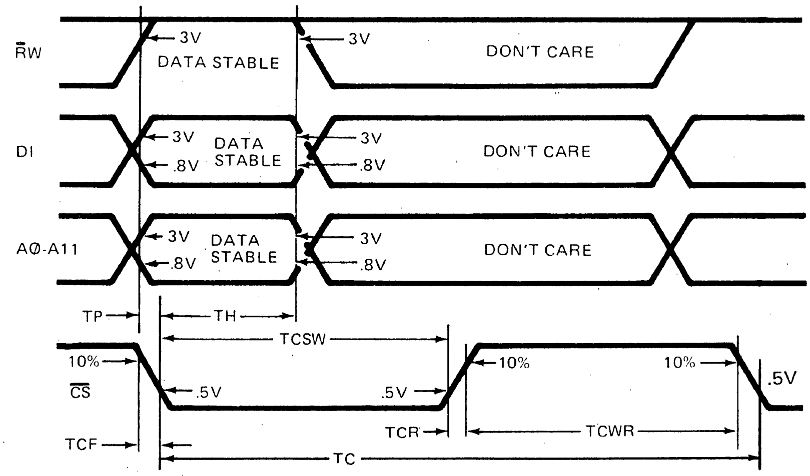
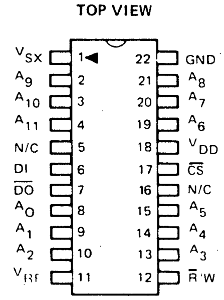


Figure 2 — Write Cycle

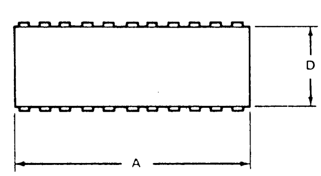
22 PIN DUAL IN-LINE

PIN	SYMBOL	FUNCTION
1	V_{SX}	Supply Voltage (−5V)
2	A_9	Address Input
3	A_{10}	Address Input
4	A_{11}	Address Input
5	N/C	
6	D_1	Data In
7	$\overline{D_0}$	Data Out
8	A_0	Address Input
9	A_1	Address Input
10	A_2	Address Input
11	V_{RF}	Supply Voltage (5V)
12	R̄/W	Read/Write Input
13	A_3	Address Input
14	A_4	Address Input
15	A_5	Address Input
16	N/C	
17	$\overline{CS}$	Chip Select
18	V_{DD}	Supply Voltage (12V)
19	A_6	Address Input
20	A_7	Address Input
21	A_8	Address Input
22	GND	Ground

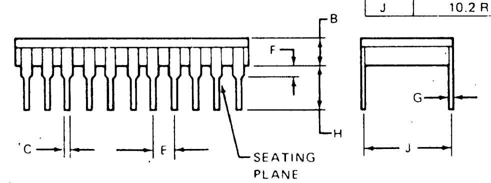
TOP VIEW



PIN ASSIGNMENT



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	27.1	27.8	1.065	1.095
B	–	3.56	–	0.140
C	0.38	0.53	0.015	0.021
D	8.64	10.8	0.340	0.425
E	2.29	2.79	0.090	0.110
F	0.51	1.27	0.020	0.050
G	0.20	0.30	0.008	0.012
H	3.42	3.93	0.135	0.155
J	10.2 REF		0.4 REF	



CERAMIC PACKAGE DIMENSIONS

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SEMI 4104

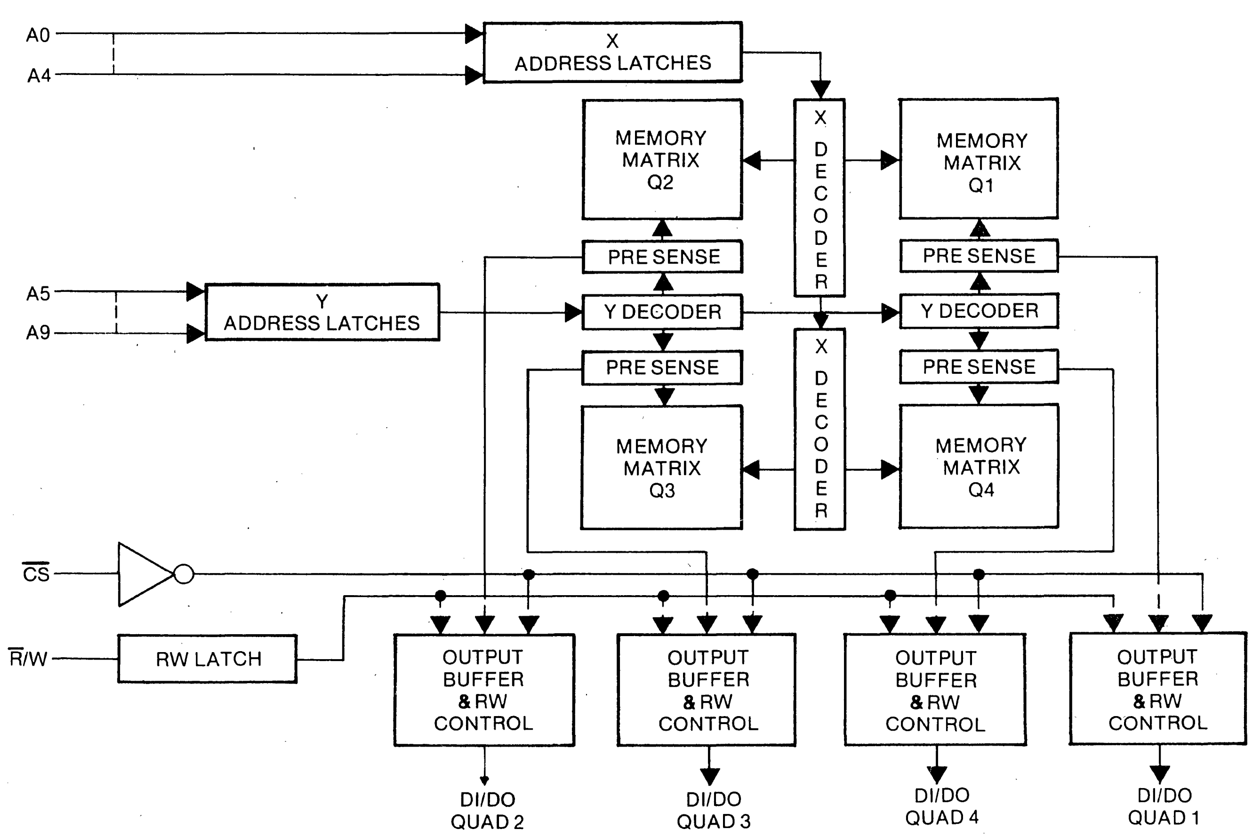
225 NSEC STATIC TTL OUTPUT

1024 x 4 N-MOS RAM

FEATURES

- ☐ COMPLETELY STATIC
- ☐ ACCESS TIME – 225 NSEC
- ☐ CYCLE TIME – 400 NSEC
- ☐ TYPICAL OPERATING POWER UNDER 500 mw.
- ☐ TYPICAL STANDBY POWER UNDER 40 mw.
- ☐ DATA RETENTION WITH LOW V_{DD}
- ☐ TTL COMPATIBLE INPUTS
- ☐ ACTIVE LOW CHIP SELECT
- ☐ TRI-STATE OUTPUTS
- ☐ COMMON I/O BUSS

BLOCK DIAGRAM

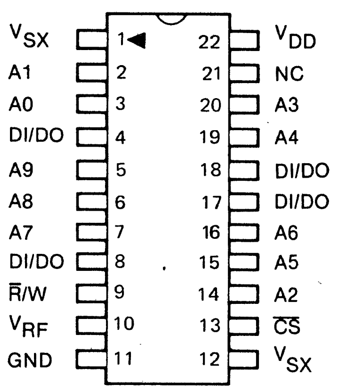


EMM/SEMI

MEMORY

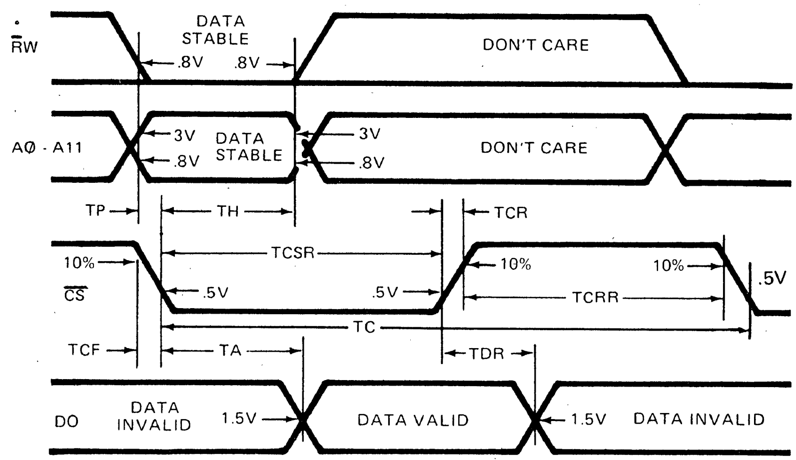
EMM SEMI

TOP VIEW



PIN ASSIGNMENT

TIMING DIAGRAM



Read Cycle

DYNAMIC ELECTRICAL CHARACTERISTICS T_A = 0°C to 70°C, Full Voltage Range

Chip Select Read Pulse Width	225ns min
Chip Select Write Pulse Width	225ns min
Chip Select Rise and Fall Time	50ns max
Set Up Time	0ns min
Access Time	225ns max
Cycle Time	400ns max
Data Hold Time	100ns min
Output Recovery Time	10ns min
Read Recovery Time	150ns min
Write Recovery Time	150ns min

MAXIMUM RATINGS

Supply Voltage	11.4 to 12.6 Vdc
Output Reference Voltage	4.75 to 5.25 Vdc
Substrate Voltage	-4.5 to -5.5 Vdc
Operating Temperature Range	0°C to 70°C
Input High Level	3.0 to 5.25 Vdc
Input Low Level	0.0 to 0.8 Vdc

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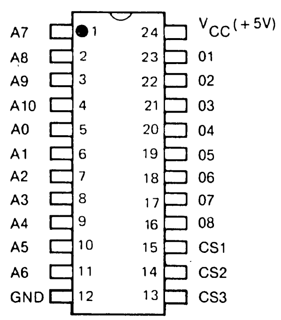
SEMI RO-3-8316A
16384 BIT STATIC NMOS ROM

FEATURES

- 2048 X 8 Organization - ideal for microprocessor memory systems.
- Single +5 Volt Supply.
- TTL Compatible - all inputs and outputs.
- Static Operation - no clocks required.
- 850ns Maximum Access Time.
- 200 mW Typical Power.
- Three-State Outputs - under the control of three mask-programmable Chip Select inputs to simplify memory expansion.
- Totally Automated Custom Programming.
- Zener Protected Inputs.
- Glass Passivation Protection.

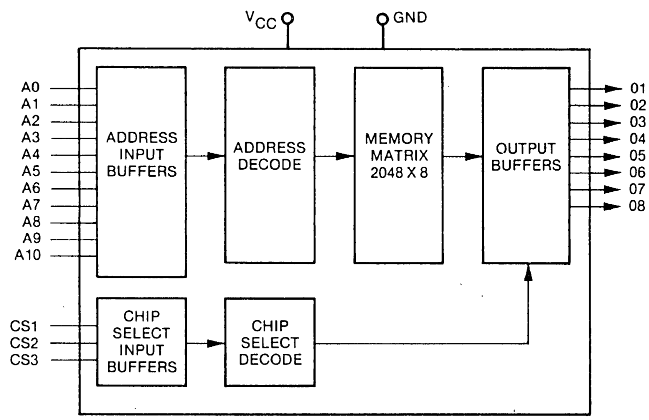
PIN CONFIGURATION

TOP VIEW



A0-A10 ADDRESS INPUTS
01-08 DATA OUTPUTS
CS1-CS3 CHIP SELECT INPUTS

BLOCK DIAGRAM



MAXIMUM RATINGS*

Vcc and input voltages (with respect to GND) .... -0.3V to +8.0V
Storage temperature .... -65°C to +150°C
Operating temperature .... 0°C to +70°C

*Exceeding these ratings could cause permanent damage to this device. Functional operation at these conditions is not implied - operating conditions are specified below.

ELECTRICAL CHARACTERISTICS

Standard conditions: Vcc = +5 volts ±5%
(unless otherwise noted) Temperature (TA) = 0°C to +70°C
Output Loading: One TTL load, CL total = 30 pF.

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.[1]	MAX.	UNITS	CONDITIONS
ADDRESS, CHIP SELECT INPUTS						
Logic "I"	VIH	2.2	—	—	V	
Logic "O"	VIL	—	—	0.65	V	
Leakage	ILI	—	—	10	μA	
DATA OUTPUTS						
Logic "I"	VOH	2.2	—	—	V	IOH = 100 μA
Logic "O"	VOL	—	—	0.45	V	IOL = 1.9 mA
Leakage	ILO	—	—	10	μA	
POWER SUPPLY CURRENT						
ICC	—	—	40	66	mA	Outputs open

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.[1]	MAX.	UNITS	CONDITIONS
ADDRESS, CHIP SELECT INPUTS						
Cycle Time	tc	800	—	—	ns	
Capacitance	CI	—	5	8	pF	f = IMHz
DATA OUTPUTS						
Access Time	tacc	—	600	850	ns	
Chip Select Response Time	tR	—	200	300	ns	
Capacitance	Co	—	8	10	pF	f = IMHz

NOTE: 1. Typical values are at +25°C and nominal voltages.

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HM-76XX
GENERIC PROM FAMILY

ORGANIZATIONS

PART NO.	TOTAL BITS	WORDS x BITS PER WORD
HM-7602 (OC) -7603 (TS)	256	32 x 8
HM-7610 (OC) -7611 (TS)	1024	256 x 4
HM-7620 (OC) -7621 (TS)	2048	512 x 4
HM-7640 (OC) -7641 (TS)	4096	512 x 8

* OC–Open–Collector Output
* TS–Three–State Output

FEATURES

- Common D. C. Electrical Characteristics and Programming Procedure
- Simple, High Speed Programming Procedure (1 second per 1024 Bits)
- Expandable – "Open-Collector" or "Three-State" Outputs and Chip Enable Inputs
- Inputs and Outputs TTL Compatible
  - Low Input Current-400 µA Logic "0", 40 µA Logic "1"
  - Full Output Drive-15mA Sink, 2mA Source
- Fast Access Time-Guaranteed Over Commercial and Military Temperature and Voltage Ranges
- Pin Compatible With Industry Standard PROM's and ROM's

DESCRIPTION

The HM-76XX Generic PROM's comprise a completely compatible family having common D. C. electrical characteristics and identical programming requirements. They are fully decoded, high speed, field programmable ROM's and are available in all commonly used organizations, with both open-collector and three-state outputs. All bits are manufactured storing a logical "1" (outputs high), and can be selectively programmed for a logical "0" (outputs low).

The nichrome fuse technology is the same as is used in the JAN approved MIL 38510/201 PROM, and in all other Harris PROM's.

The field programmable PROM can be custom progammed to any pattern using a simple programming procedure. Schottky Bipolar circuitry provides fast access time, and features temperature and voltage compensation to minimize access time variations.

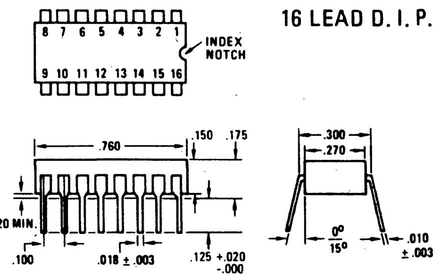
All pinouts are compatible to industry standard PROM's and ROM's.

In addition to the conventional storage array, extra test rows and test columns are included to assure high programmability, and guarantee parametric and A. C. performance. Fuses in these test rows and columns are blown prior to shipment.

PACKAGES

HM-7602/7603, HM-7610/7611, HM-7620/7621

16 LEAD D. I. P. *

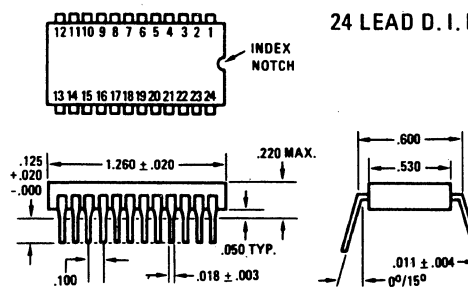


ALL DIMENSIONS IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

* Also Available In Flatpacks

HM-7640/7641

24 LEAD D. I. P. *



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Output or Supply Voltage (Operating)	7.0V
Supply Current	600mA
Address/Enable Input Voltage	5.5V
Address/Enable Input Current	-20mA
Output Sink Current	70mA
Storage Temperature	+ 150°C
Operating Temperature (Ambient)	+ 125°C
Maximum Junction Temperature	+ 175°C

Stresses above those listed under the "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress only rating and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied. (While programming, follow the programming specifications.)

ELECTRICAL CHARACTERISTICS (OPERATING) HM-76XX-5 (V_{CC} = 5.0V ± 5%, T_A = 0°C to 70°C)
HM-76XX-2, HM-76XX-8 (V_{CC} = 5.0V ± 10%, T_A = -55°C to 125°C)

D. C.

PARAMETER		SYMBOL	OPEN-COLLECTOR OUTPUT MIN.	TYP.	MAX.	THREE-STATE OUTPUT MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Address/Enable Input Current	"1"	I_{RA}, I_{RE}			*40			*40	μA	$V_{IH}=V_{CC}$ Max
	"0"	I_{FA}, I_{FE}†		-0.1	*-0.4		-0.1	*-0.4	mA	V_{IL}=0.45V
Input Threshold Voltage	"1"	V_{IH}	2.0			2.0			V	$V_{CC}=V_{CC}$ Min
	"0"	V_{IL}			0.8			0.8	V	$V_{CC}=V_{CC}$ Max
Output Voltage	"1"	V_{OH}	N/A			*2.4	3.4		V	I_{OH}=-2.0mA, $V_{CC}=V_{CC}$ Min
	"0"	V_{OL}		0.35	*0.45		0.35	*0.45	V	I_{OL}=+15mA, $V_{CC}=V_{CC}$ Min
Output Disabled Current	"1"	$I_{OH\overline{E}}$			*100			*100	μA	$V_{OH}, V_{CC}=V_{CC}$ Max
	"0"	$I_{OL\overline{E}}$			N/A			*-100	μA	V_{OL}=+0.3V, $V_{CC}=V_{CC}$ Max
Output Leakage	"1"	I_{OH}			*100			N/A	μA	$V_{OH}, V_{CC}=V_{CC}$ Max
Input Clamp Voltage		V_{CL}			*-1.5			*-1.5	V	I_{in}= -10mA
Output Short Circuit Current		I_{OS}	N/A		N/A	*15	23	30	mA	$V_{CC}=V_{CC}$ Max, V_{OUT}=0.0V One output only for a Max of 1 sec
Power Supply Current										
HM-7602/7603 HM-7610/7611 HM-7620/7621		I_{CC}		90	*130		90	*130	mA	$V_{CC}=V_{CC}$ Max
HM-7640/7641		I_{CC}		125	*170		125	*170	mA	All Inputs Grounded

Typical Measurements at T_A = 25°C, V_{CC} = +5.0V.

†I_{FE} Max. = –1.6mA, CS_3 and CS_4 Inputs (HM-7640/41 only).
*100% Tested for Dash 8.

A. C.

	V_{CC}	5V ± 5%		5V ± 10%			
	T_A	0°C to 70°C		-55°C to 125°C			
	SYMBOL	TYP.	MAX.	TYP.	MAX.	UNITS	TEST CONDITIONS
HM-7602/7603	T_{AA}	35	40	35	50	nS	V_{CC} and T_A Over Full Range
	T_{EA}	20	30	20	40		
HM-7610/7611	T_{AA}	40	60	40	75		
	T_{EA}	15	25	15	30		
HM-7620/7621	T_{AA}	45	70	45	85		
	T_{EA}	15	25	15	30		
HM-7640/7641	T_{AA}	48	70	48	85		
	T_{EA}	30	40	30	50		

T_{AA} – Address to Output Access Time.
T_{EA} – Chip Enable Access Time.

CAPACITANCE (1): T_A = 25°C

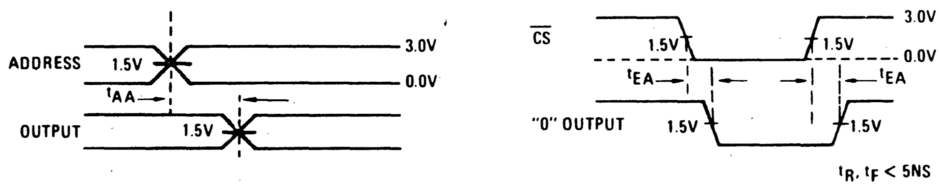
PARAMETER	SYMBOL	TYP.	UNITS	TEST CONDITION
Add. Input Cap.	C_{INA}, C_{INCS}	8	pF	V_{CC} = 5V, V_{IN} = 2.0V, f = 1MHz
Output Cap.	C_{OUT}	8	pF	V_{CC} = 5V, V_{OUT} = 2.0V, f = 1MHz

NOTE: (1) These parameters are only periodically sampled and are not 100% tested.

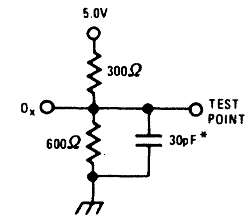
Harris/Semiconductor

MEMORY

SWITCHING TIME DEFINITIONS



A.C. TEST LOAD



*Includes jig & probe total capacitance

PROGRAMMING

The Generic PROM's are manufactured with all bits/outputs Logical "1" (Output High). Any desired bit/output can be programmed to a Logical "0" (Output Low) by following the simple procedure shown below. One may build his own programmer to satisfy the specifications described in Table 1, or buy any of the commercially available programmers which meet these specifications. These PROM's can be programmed automatically or by the manual procedure shown below.

PROGRAMMING SPECIFICATIONS

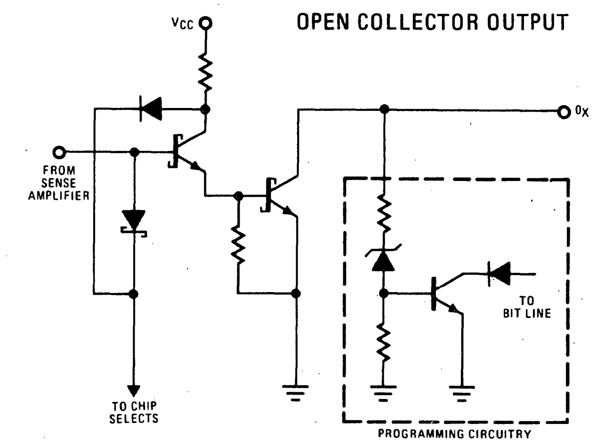
TABLE 1

PARAMETER	SYMBOL	MIN.	RECOMMEND VALUE	MAX.	UNITS
Address Input Voltage (1)	V_{IH} V_{IL}	2.4 0.0	5.0 0.4	5.0 0.8	V V
Programming/Verify Voltage to V_{CC} (2)	V_{PH} V_{PL}	11.5 3.75	12.0 4.0	12.5 5.25	V
Programming Voltage Current Limit	I_{CCP}			600	mA
Programming (V_{CC}) Voltage Rise and Fall Time	t_r t_f	1 1	1 1	10 10	µs µs
Programming Delay	t_d	10	10	100	µs
Programming Pulse Width – First Attempts	t_{p1}	100	100	200	µs
Programming Pulse Width – Subsequent	t_{p2}	10	10	20	ms
Programming Duty Cycle	D.C.	–	10	50	%
Output Voltage Enable Disable (3)	V_{OPE} V_{OPD}	9.5 0	10.0 .45	10.5 5.5	V V
Output Voltage Enable Current Limit	I_{OPE}			10	mA
Case Temp	T_C		25	75	°C

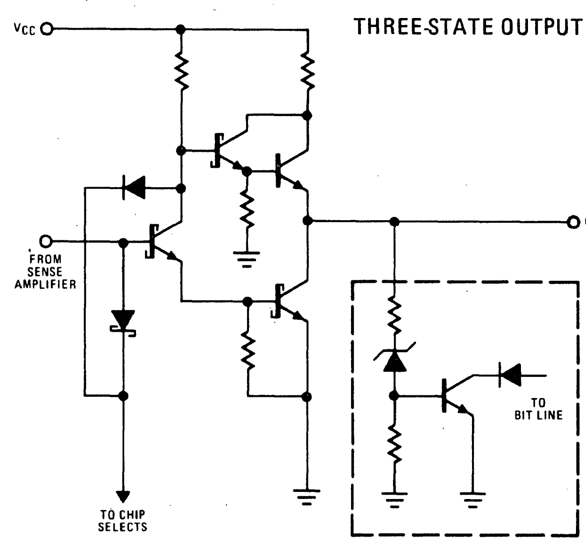
1. Address and chip select should not be left open for V_{IH}.
2. Verification at V_{CC} = 4.0 ± .25 Volts, T_A = 25°C is recommended to guardband performance over full temperature and voltage range.
3. Disable condition will be met with output open circuit.

SCHEMATIC DIAGRAMS

OPEN COLLECTOR OUTPUT



THREE-STATE OUTPUT



Harris/Semiconductor

MEMORY

PROGRAMMING PROCEDURE

1. Address the PROM with the binary address of the selected word to be programmed. Address inputs are TTL compatible. An open circuit should not be used to address the PROM.
2. Disable the chip by applying input highs (V_{IH}) to the $\overline{CS}$ input(s). CS inputs (HM-7640/41 only) must remain at V_{IH} for program and verify. The chip select is TTL compatible. An open circuit should not be used to disable the chip.
3. Disable the programming circuitry by applying an Output Voltage Disable of less than V_{OPD} to the output of the PROM. The output may be left open circuit to achieve the disable.
4. Raise V_{CC} to V_{PH} with rise time equal to t_r.
5. After a delay equal to or greater than t_d, apply a pulse with amplitude equal to V_{OPE} and duration of t_{p1} to the output selected for programming. Note that the PROM is supplied with fuses intact generating an output high. Programming a fuse will cause the output to go low in the verify mode.
6. Other bits in the same word may be programmed while the V_{CC} input is raised to V_{PH} by applying output enable pulses to each output which is to be programmed. The output enable pulses must be separated by a minimum interval of t_d.
7. Lower V_{CC} to 4.0 $\pm$ .25 Volts following a delay of t_d from the last programming enable pulse applied to an output.
8. Enable the PROM for verification by applying a logic "0" (V_{IL}) to the $\overline{CS}$ input(s).
9. If any bit does not verify as programmed, repeat steps 2 through 8 using an output enable pulse width of t_{p1} for up to 15 additional pulses to enhance programming speed. If the bit is still unprogrammed, follow with at least 16 repetitive pulses of t_{p2} in width, to achieve high programming yield. In the event that the bit is still unprogrammed, the part is considered a programming reject and should be returned to the factory. The address and incorrect and desired contents of a location in which a programming failure has occured in any returned device must be included with that return.
10. Repeat steps 1 through 9 for all other bits to be programmed in the PROM.

RECOMMENDED PROGRAMMING CIRCUIT

The circuit and timing diagram shown in Figures 1 and 2 will establish the proper programming condition for the output enable pulse. This allows the use of standard TTL parts for all logic inputs to the PROM. Note the gate which senses the output must be input protected to withstand input up to 12.5 Volts during programming.

FIGURE 1

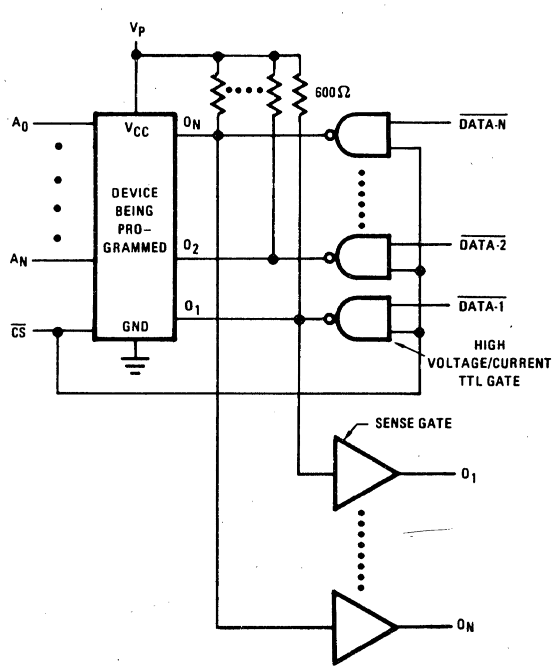
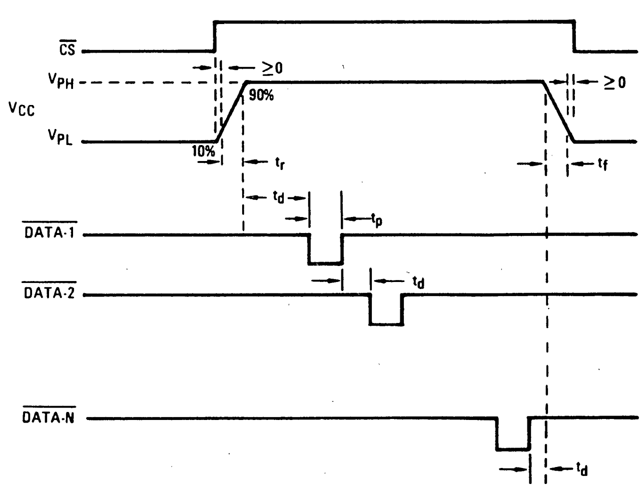
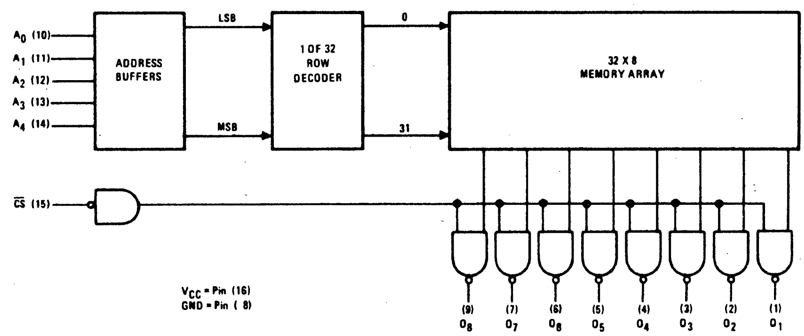


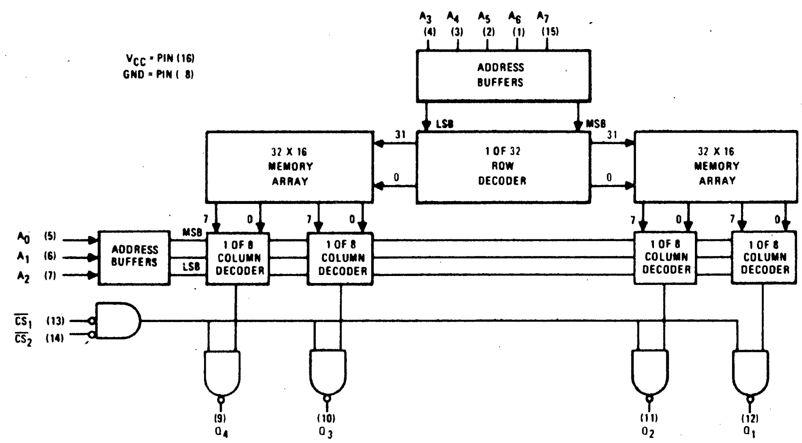
FIGURE 2



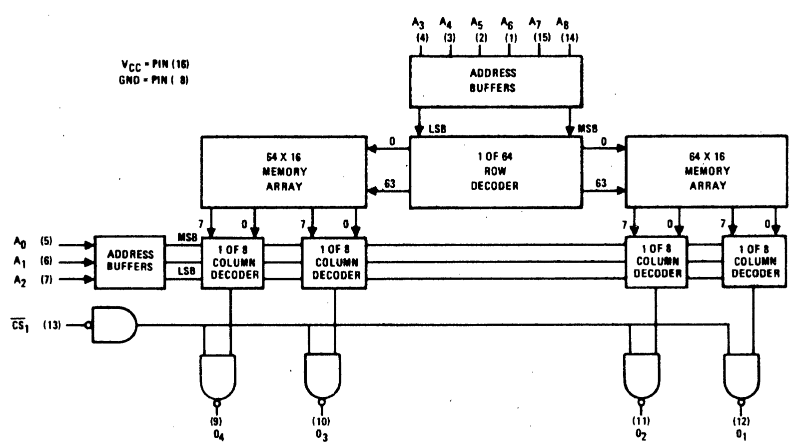
HM-7602/03
32 X 8



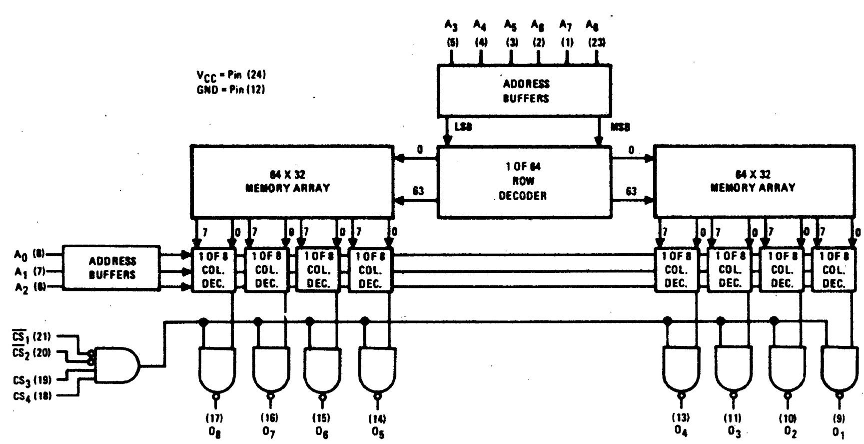
HM-7610/11
256 X 4



HM-7620/21
512 X 4

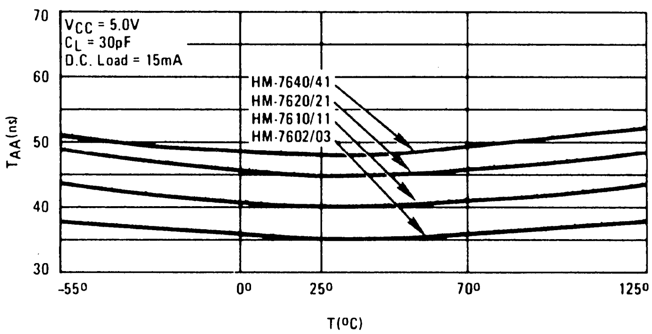


HM-7640/41
512 X 8

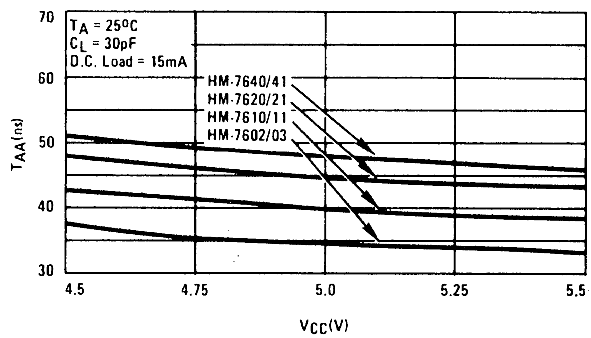


TYPICAL A.C. CHARACTERISTICS

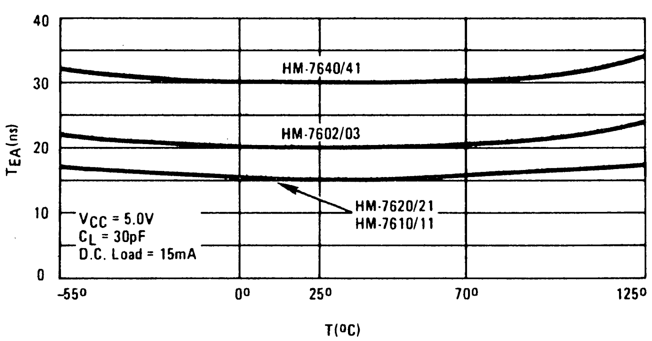
ADDRESS TO OUTPUT DELAY
VS. TEMPERATURE



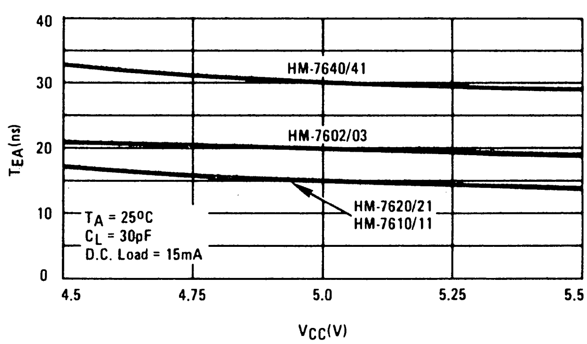
ADDRESS TO OUTPUT DELAY
VS. SUPPLY VOLTAGE



CHIP SELECT TO OUTPUT DELAY
VS. TEMPERATURE



CHIP SELECT TO OUTPUT DELAY
VS. SUPPLY VOLTAGE



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(214) 231-9031

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HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

Silicon Gate MOS 2104

HIGH DENSITY RANDOM ACCESS 4096 BIT DYNAMIC MEMORY

*** Access Time—350 ns Max.**
*** Read, Write Cycle Times—500 ns Max.**
*** Refresh Period—2 ms**

- **Highest Density 4K RAM— Industry Standard 16 Pin Package**
- **Low Standby Power**
- **All Inputs Including Clocks TTL Compatible**
- **Standard Power Supplies +12V, +5V, −5V**
- **Read-Modify-Write Cycle Time— 700 ns**
- **On-Chip Latches for Addresses, Chip Select and Data In.**
- **Simple Memory Expansion— Chip Select**
- **Output is Three State, TTL Compatible; Data is Latched and Valid into Next Cycle**

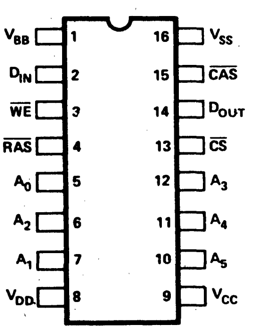
The Intel® 2104 is a 4096 word by 1 bit MOS RAM fabricated with N-channel silicon gate technology for high performance and high functional density. The 2104 uses a single transistor dynamic storage cell and dynamic circuitry to achieve high speed and low power dissipation.

The unique design of the 2104 allows it to be packaged in the industry standard 16 pin dual-in-line package. The 16 pin package provides the highest system bit densities and is compatible with widely available automated handling equipment.

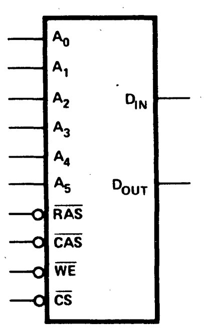
The use of the 16 pin package is made possible by multiplexing the 12 address bits (required to address 1 of 4096 bits) into the 2104 on 6 address input pins. The two 6 bit address words are latched into the 2104 by the two TTL clocks, Row Address Strobe (RAS) and Column Address Strobe (CAS). Non-critical clock timing requirements allow use of the multiplexing technique while maintaining high performance.

The single transistor dynamic storage cell provides high speed along with low power dissipation. The memory cell requires refreshing for data retention. Refreshing is most easily accomplished by performing a read cycle at each of the 64 row addresses every 2 milliseconds.

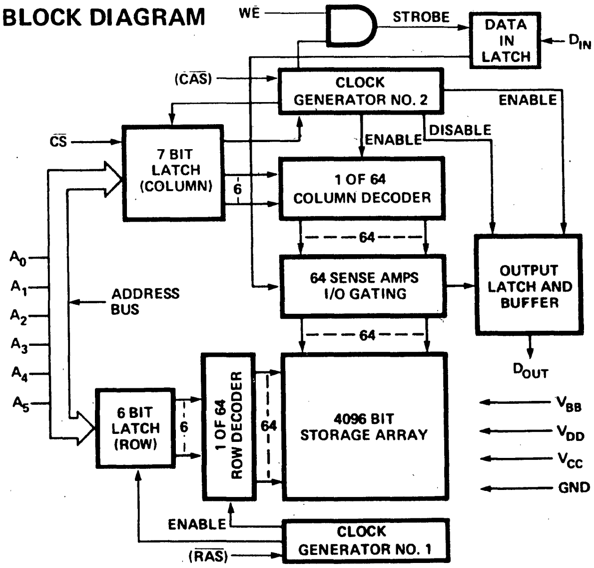
PIN CONFIGURATION



LOGIC DIAGRAM



BLOCK DIAGRAM



PIN NAMES

A_0 - A_5	ADDRESS INPUTS	WE	WRITE ENABLE
CAS	COLUMN ADDRESS STROBE	V_{BB}	POWER (-5V)
CS	CHIP SELECT	V_{CC}	POWER (+5V)
D_{IN}	DATA IN	V_{DD}	POWER (+12V)
D_{OUT}	DATA OUT	V_{SS}	GROUND
RAS	ROW ADDRESS STROBE		

Absolute Maximum Ratings*

Temperature Under Bias .... -10°C to +80°C
Storage Temperature .... -65°C to +150°C
All Input or Output Voltages with
Respect to the most Negative
Supply Voltage, V_{BB} .... +25V to -0.3V
Supply Voltages V_{DD}, V_{CC}, and V_{SS} with
Respect to V_{BB} .... +20V to -0.3V
Power Dissipation 1.25W

**COMMENT:*

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

D.C. and Operating Characteristics [1]

T_A = 0°C to 70°C, V_{DD} = +12V ±5%, V_{CC} = +5V ±10%, V_{BB} = -5V ±10%, V_{SS} = 0V, unless otherwise noted.

Symbol	Parameter	Limits Min.	Typ.[2]	Max.	Unit	Conditions
I_{LI}	Input Load Current (any input)			10	μA	$V_{IN} = V_{IL\,MIN}$ to $V_{IH\,MAX}$
$\|I_{LO}\|$	Output Leakage Current for high impedance state			10	μA	Chip deselected.
I_{DD1}[3]	V_{DD} Supply Current		1	2	mA	$\overline{CAS}$ and $\overline{RAS}$ at V_{IH}. Chip deselected.
$I_{DD\,AV}$[3]	Average V_{DD} Current		45	59	mA	Cycle time=500ns, t_{RP} = 150ns; T_A = 25°C
I_{CC1}[4]	V_{CC} Supply Current when deselected			10	μA	
I_{BB}[3]	Average V_{BB} Current			75	μA	
V_{IL}	Input Low Voltage (any input)	-1.0		0.6	V	
V_{IH}	Input High Voltage (any input)	2.4		V_{CC}+1	V	
V_{OL}	Output Low Voltage	0.0		0.4	V	I_{OL} = 2.0mA
V_{OH}	Output High Voltage	2.4		V_{CC}	V	I_{OH} = -5.0mA

A.C. Characteristics [1]

T_A=0°C to 70°C, V_{DD}=12V ±5%, V_{CC}=5V ±10%, V_{BB}=-5V ±10%, V_{SS}=0V, unless otherwise noted.

Capacitance [5] T_A = 25°C

Symbol	Test	Plastic And Ceramic Pkg. Typ.	Max.	Unit	Conditions
C_{AD}	Address Capacitance		10	pF	$V_{IN} = V_{SS}$
C_C	$\overline{CAS}$, $\overline{RAS}$, $\overline{CS}$ Capacitance		7	pF	$V_{IN} = V_{SS}$
C_{OUT}	Data Output Capacitance		8	pF	V_{OUT} = 0V
C_{IN}	D_{IN} and $\overline{WE}$ Capacitance		10	pF	$V_{IN} = V_{SS}$

Notes:
1. All voltages referenced to V_{SS}. The only requirement for the sequence of applying voltages to the device is that V_{DD}, V_{CC}, and V_{SS} should never be 0.3V or more negative than V_{BB}.
2. Typical values are for T_A = 25°C and nominal power supply voltages.
3. The I_{DD} current flows to V_{SS}. The I_{BB} current is the sum of all leakage currents.
4. When chip is selected V_{CC} supply current is dependent on output loading; V_{CC} is connected to output buffer only.
5. Capacitance measured with Boonton Meter or effective capacitance calculated from the equation:

$$C = \frac{I\Delta t}{\Delta V}$$ with the current equal to a constant 20mA.

Intel

MEMORY

A.C. Characteristics [1] T_A=0°C to 70°C, V_{DD}=12V ±5%, V_{CC}=5V ±10%, V_{BB}=-5V ±10%, V_{SS}=0V, unless otherwise noted.

READ, WRITE, AND READ MODIFY WRITE CYCLES [3]

Symbol	Parameter	Min.	Max.	Unit	Conditions
t_{REF}	Time Between Refresh		2	ms	
t_{RP}	$\overline{\text{RAS}}$ Precharge Time	150		ns	
t_{RCL}	$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Leading Edge Lead Time	110	2000	ns	See Note 2
t_{AS}	Address or $\overline{\text{CS}}$ Set-up Time	0		ns	
t_{AH}	Address or $\overline{\text{CS}}$ Hold Time	100		ns	
t_{AR}	$\overline{\text{RAS}}$ to Address Hold Time	250		ns	
t_{CRL}	$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Trailing Edge Lead Time	-10	+90	ns	Measured from $\overline{\text{RAS}}$ to $\overline{\text{CAS}}$
t_{OFF}	Output Buffer Turn Off Delay	0	100	ns	
t_{CAC}	Access Time From $\overline{\text{CAS}}$		200	ns	1 TTL Load, C_L = 50pF, See Note 2
t_{RAC}	Access Time From $\overline{\text{RAS}}$		350	ns	1 TTL Load, C_L = 50pF, See Note 2

READ CYCLE [3]

Symbol	Parameter	Min.	Max.	Unit	Conditions
t_{CYC}	Random Read or Write Cycle Time	500		ns	
t_{CPW}	$\overline{\text{CAS}}$ Pulse Width	200	10,000	ns	
t_{RPW}	$\overline{\text{RAS}}$ Pulse Width	350	10,000	ns	
t_{RSH}	$\overline{\text{RAS}}$ Hold Time	200		ns	
t_{CSH}	$\overline{\text{CAS}}$ Hold Time	350		ns	
t_{RCH}	Read Command Hold Time	80		ns	
t_{RCS}	Read Command Setup Time	0		ns	

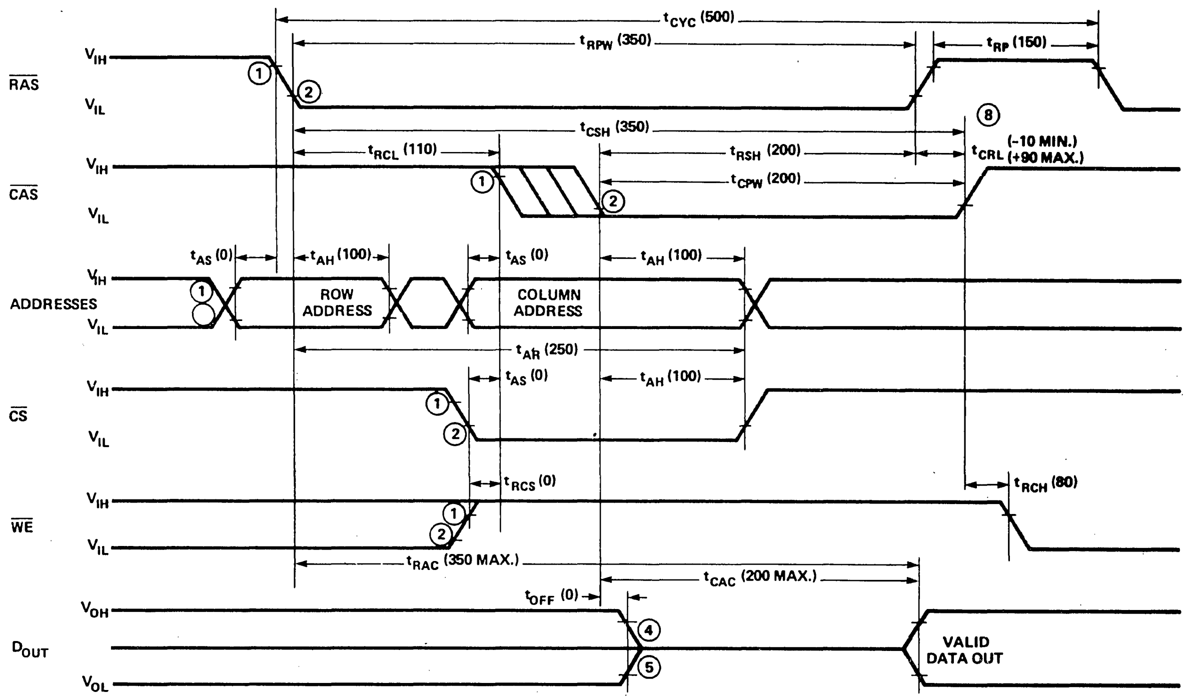
WRITE CYCLE [3]

Symbol	Parameter	Min.	Max.	Unit	Conditions
t_{CYC}	Random Read or Write Cycle Time	500		ns	
t_{CPW}	$\overline{\text{CAS}}$ Pulse Width	200	10,000	ns	
t_{RPW}	$\overline{\text{RAS}}$ Pulse Width	350	10,000	ns	
t_{RSH}	$\overline{\text{RAS}}$ Hold Time	200		ns	
t_{CSH}	$\overline{\text{CAS}}$ Hold Time	350		ns	
t_{CWL}	Write Command to $\overline{\text{CAS}}$ Lead Time	200		ns	
t_{WCH}	Write Command Hold Time	150		ns	
t_{WP}	Write Command Pulse Width	200		ns	
t_{DS}	Data In Setup Time	0		ns	
t_{DH}	Data In Hold Time	200		ns	

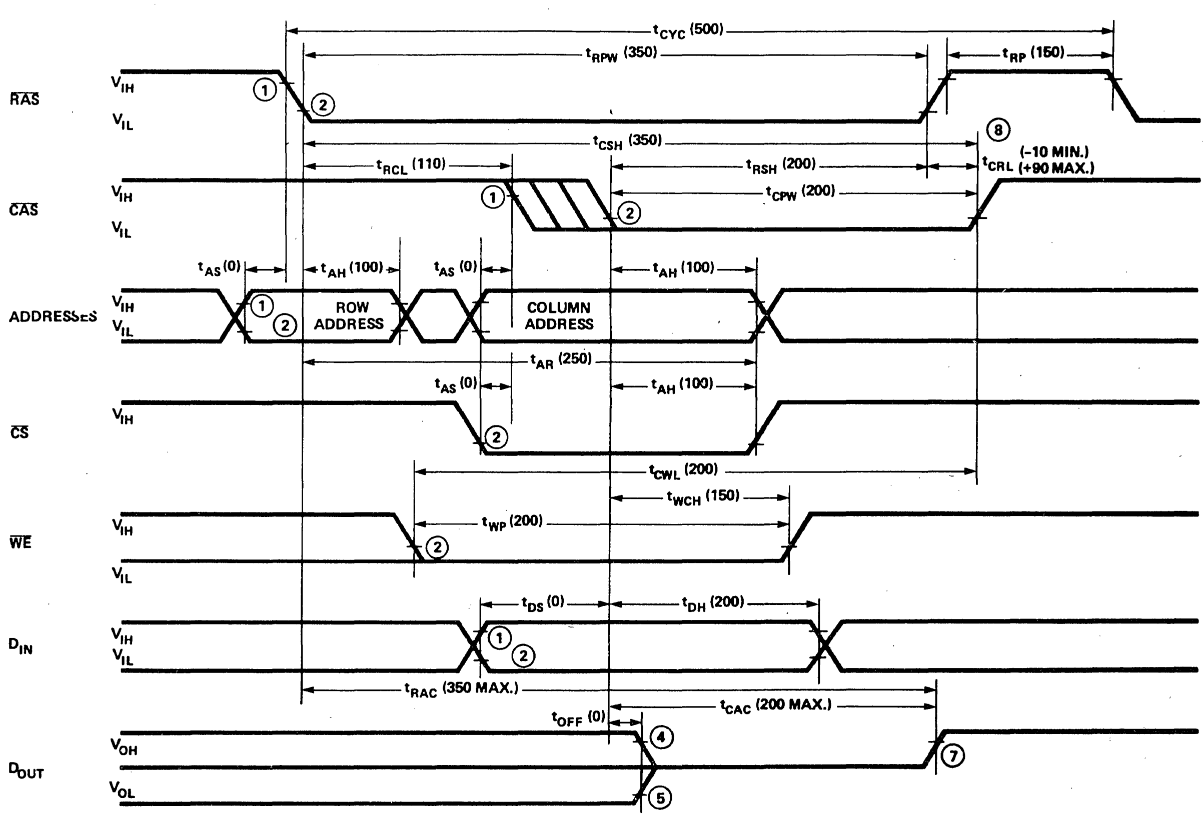
Notes:
1. All voltages referenced to V_{SS}.
2. $\overline{\text{CAS}}$ must remain at V_{IH} a minimum of 110ns after $\overline{\text{RAS}}$ switches to V_{IL}. To achieve the minimum guaranteed access time of 350ns (t_{RAC}), $\overline{\text{CAS}}$ must switch to V_{IL} at or before 150 ns after $\overline{\text{RAS}}$ switches to V_{IL}. Refer to applications information in Read Cycle section.
3. The minimum cycle timing does not allow for t_T or skews.

Waveforms

READ CYCLE (Numbers in parentheses are minimum values in nsec unless otherwise stated.) [6]



WRITE CYCLE (Numbers in parentheses are minimum values in nsec unless otherwise stated.) [6]



See next page for NOTES.

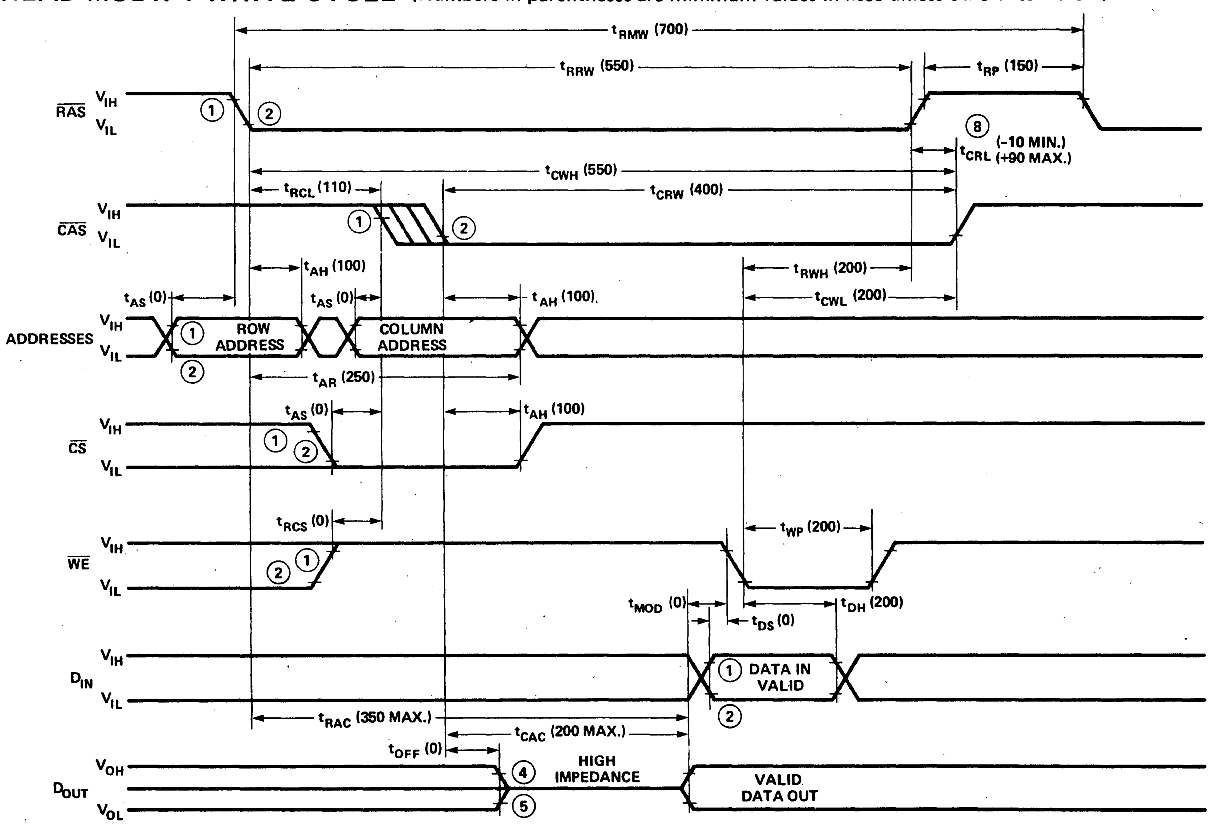
A.C. Characteristics [1] T_A=0°C to 70°C, V_{DD}=12V ±5%, V_{CC}=5V ±10%, V_{BB}=-5V ±10%, V_{SS}=0V, unless otherwise noted.

READ MODIFY WRITE CYCLE [6]

Symbol	Parameter	Min.	Max.	Unit	Conditions
t_{RMW}	Read Modify Write Cycle Time	700		ns	
t_{CRW}	RMW Cycle $\overline{CAS}$ Width	400	10,000	ns	
t_{RRW}	RMW Cycle $\overline{RAS}$ Width	550	10,000	ns	
t_{RWH}	RMW Cycle $\overline{RAS}$ Hold Time	200		ns	
t_{CWH}	RMW Cycle $\overline{CAS}$ Hold Time	550		ns	
t_{CWL}	Write Command to $\overline{CAS}$ Lead Time	200		ns	
t_{WP}	Write Command Pulse Width	200		ns	
t_{RCS}	Read Command Setup Time	0		ns	
t_{MOD}	Modify Time	0		ns	
t_{DS}	Data In Setup Time	0		ns	
t_{DH}	Data In Hold Time	200		ns	

Waveforms

READ MODIFY WRITE CYCLE (Numbers in parentheses are minimum values in nsec unless otherwise stated.) [6]



Notes: 1,2. V_{IHMIN} and V_{ILMAX} are reference levels for measuring timing of input signals.

3. $\overline{CAS}$ must remain at V_{IH} a minimum of 110ns after $\overline{RAS}$ switches to V_{IL}. To achieve the minimum guaranteed access time of 350ns (t_{RAC}), $\overline{CAS}$ must switch to V_{IL} at or before 150ns after $\overline{RAS}$ switches to V_{IL}. Refer to applications information in Read Cycle section.

4,5. V_{OHMIN} and V_{OLMAX} are reference levels for measuring timing of D_{OUT}.

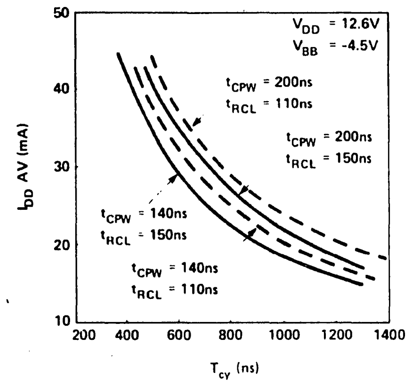
6. Minimum cycle timing does not allow for t_T or signal skew.

7. If $\overline{WE}$ goes low while $\overline{CAS}$ is low, D_{OUT} could go to either V_{OL} or V_{OH} after t_{CAC}. D_{OUT} will go to V_{OH} as shown on page 4 (Write Cycle Waveforms) if $\overline{WE}$ goes low before $\overline{CAS}$ goes low. In a Read-Modify-Write cycle, D_{OUT} is data read and does not change during the Modify-Write portion of the cycle.

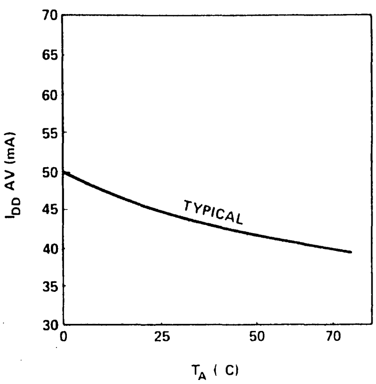
8. For minimum cycle timing, t_{CRL} must be -0 to +90ns.

Intel MEMORY

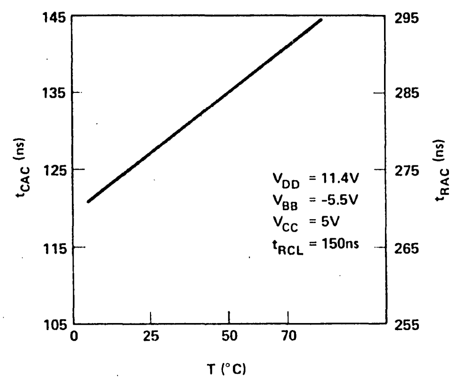
TYPICAL I_{DD} AV VS. CYCLE TIME



I_{DD} AV VS. TEMPERATURE



TYPICAL ACCESS TIME VS. TEMPERATURE



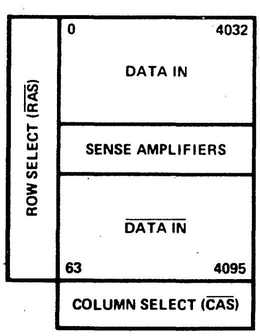
Applications

ADDRESSING

Two externally applied negative going TTL clocks, Row Address Strobe ($\overline{RAS}$), and Column Address Strobe ($\overline{CAS}$), are used to strobe the two sets of 6 addresses into internal address buffer registers. The first clock, $\overline{RAS}$, strobes in the six low order addresses (A_0-A_5) which selects one of 64 rows and begins the timing which enables the column sense amplifiers. The second clock, $\overline{CAS}$, strobes in the six high order addresses (A_6-A_{11}) to select one of 64 column sense amplifiers and Chip Select ($\overline{CS}$) which enables the data out buffer.

An address map of the 2104 is shown below. Address "0" corresponds to all addresses at V_{IL}. Note that data is stored in half of the memory as a logic inversion of the data presented at the input pin as shown. This inversion is completely transparent to the user (i.e., data stored in memory as a "1" or "0" at the input will when subsequently accessed, appear as a "1" or "0" respectively at the output).

2104 Address Map



DATA CYCLES/TIMING

A memory cycle begins with addresses stable and a negative transition of $\overline{RAS}$. See the waveforms on page 4. It is not necessary to know whether a Read or Write cycle is to be performed until $\overline{CAS}$ becomes valid.

Note that Chip Select ($\overline{CS}$) does not have to be valid until the second clock, $\overline{CAS}$. It is, therefore, possible to start a memory cycle before it is known which device must be selected. This can result in a significant improvement in system access time since the decode time for chip select does not enter into the calculation for access time.

Both the $\overline{RAS}$ and $\overline{CAS}$ clocks are TTL compatible and do not require level shifting and driving at high voltage MOS levels. Buffers internal to the 2104 convert the TTL level signals to MOS levels inside the device. Therefore, the delay associated with external TTL-MOS level converters is not added to the 2104 system access time.

READ CYCLE

A Read cycle is performed by maintaining Write Enable ($\overline{WE}$) high during $\overline{CAS}$. The output pin of a selected device will unconditionally go to a high impedance state immediately following the leading edge of $\overline{CAS}$ and remain in this state until valid data appears at the output at access time. The selected output data is internally latched and will remain valid until a subsequent $\overline{CAS}$ is given to the device by a Read, Write, Read-Modify-Write or Refresh cycle. Data-out goes to a high impedance state for all non-selected devices.

Device access time, t_{ACC}, is the longer of two calculated intervals:

1. $t_{ACC} = t_{RAC}$ OR 2. $t_{ACC} = t_{RCL} + t_T + t_{CAC}$

Access time from $\overline{RAS}$, t_{RAC}, and access time from $\overline{CAS}$, t_{CAC}, are device parameters. Row to column address strobe lead time, t_{RCL}, and transition time, t_T, are system dependent timing parameters. Substituting the device parameters and assuming a TTL level transition time of 5ns yields:

3. $t_{ACC} = t_{RAC} = 350\text{ns}$ for $110\text{ns} \leqslant t_{RCL} \leqslant 145\text{ns}$

OR

4. $t_{ACC} = t_{RCL} + t_T + t_{CAC} = t_{RCL} + 205\text{ns}$ for $t_{RCL} > 145\text{ns}$.

Note that if $110\text{ns} \leqslant t_{RCL} \leqslant 145\text{ns}$, device access time is determined by equation 3 and is equal to t_{RAC}> 145 ns access time is determined by equation 4. This 35ns interval (shown in the t_{RCL} inequality in equation 3) in which the falling edge of $\overline{CAS}$ can occur without affecting access time is provided to allow for system timing skew in the generation of $\overline{CAS}$. This allowance for a t_{RCL} skew is designed in at the device level to allow minimum access times to be achieved in practical system designs.

WRITE CYCLE

A Write Cycle is performed by bringing Write Enable ($\overline{WE}$) low before or during $\overline{CAS}$. If Write Enable goes low at or before $\overline{CAS}$ goes low, the input data must be valid at or before the falling edge of $\overline{CAS}$. D_{OUT} will go to V_{OH} as shown on page 4 (Write Cycle) if $\overline{WE}$ goes low before $\overline{CAS}$ goes low. If Write Enable goes low after $\overline{CAS}$, data in must be valid at or before the falling edge of $\overline{WE}$. Data out goes to a high impedance state following the leading edge of $\overline{CAS}$. If $\overline{WE}$ goes low while $\overline{CAS}$ is low, D_{OUT} could go to either V_{OL} or V_{OH} after t_{CAC}.

READ-MODIFY-WRITE CYCLE

A Read-Modify-Write Cycle is performed by bringing Write Enable ($\overline{WE}$) low after access time, t_{ACC}, with $\overline{RAS}$ and $\overline{CAS}$ low. Data in must be valid at or before the falling edge of $\overline{WE}$. In a read-modify-write cycle D_{OUT} is data read and does not change during the modify-write portion of the cycle.

$\overline{CAS}$ ONLY (DESELECT) CYCLE

In some applications, it is desirable to be able to deselect all memory devices without running a regular memory cycle. This may be accomplished with the 2104 by performing a $\overline{CAS}$ Only Cycle. Receipt of a $\overline{CAS}$ without a $\overline{RAS}$ deselects the 2104 and forces the Data Output to the high-impedance state. This places the 2104 in its lowest power, standby condition as will be discussed in the POWER DISSIPATION section below. The cycle timing and $\overline{CAS}$ timing should be just as if a nomal $\overline{RAS}/\overline{CAS}$ cycle was being performed.

CHIP SELECTION/DESELECTION

The 2104 is selected by driving $\overline{CS}$ low during a Read, Write, or Read-Modify-Write cycle. A device is deselected by 1) driving $\overline{CS}$ high during a Read, Write, or Read-Modify-Write cycle or 2) performing a $\overline{CAS}$ Only cycle independent of the state of $\overline{CS}$.

REFRESH CYCLES

Each of the 64 rows internal to the 2104 must be refreshed every 2 msec to maintain data. Any data cycle (Read, Write, Read-Modify-Write) refreshes the entire selected row (defined by the low order row addresses). The refresh operation is independent of the state of chip select. It is evident, of course, that if a Write or Read-Modify-Write cycle is used to refresh a row, the device should be deselected ($\overline{CS}$ high) if it is desired not to change the state of the selected cell.

$\overline{RAS}/\overline{CAS}$ TIMING

The device clocks, $\overline{RAS}$ and $\overline{CAS}$, contol operation of the 2104. The timing of each clock and the timing relationships of the two clocks must be understood by the user in order to obtain maximum performance in a memory system.

The $\overline{RAS}$ and $\overline{CAS}$ have minimum pulse widths as defined by t_{RPW} and t_{CPW} respectively. These minimum pulse widths must be maintained for proper device operation and data integrity. A cycle, once begun by driving $\overline{RAS}$ and/or $\overline{CAS}$ low, must not be ended or aborted prior to fulfilling the minimum clock signal pulse width(s). A new cycle must not begin until the minimum precharge time, t_{RP}, has been met.

The timing relationship of the leading edges of $\overline{RAS}$ and $\overline{CAS}$ is defined by t_{RCL} and is discussed in the READ CYCLE section above. The trailing edge relationship is defined by t_{RSH}, t_{CSH}, and t_{CRL}. The first two parameters define the minimum time during a memory cycle that $\overline{RAS}$ and $\overline{CAS}$ are both low (minimum hold times). Both the minimum clock widths and hold times must be met for proper operation.

For example, using $t_T = 5ns$, $t_{RCL} = 110ns$, $t_{RPW} = 350ns$, and $t_{CPW} = 200ns$; the trailing edge of $\overline{CAS}$ would occur at time (t) where:

$$t = t_{RCL} + t_T + t_{CPW} = 110ns + 5ns + 200ns$$
$$= 315ns$$

however, $t_{CSH} = 350ns$, and, therefore, t_{CPW} would need to be lengthened such that:

$$t_{CPW}\ (actual) = 200ns + (350ns - 315ns) = 235ns$$

in order to meet the minimum t_{CSH} requirement.

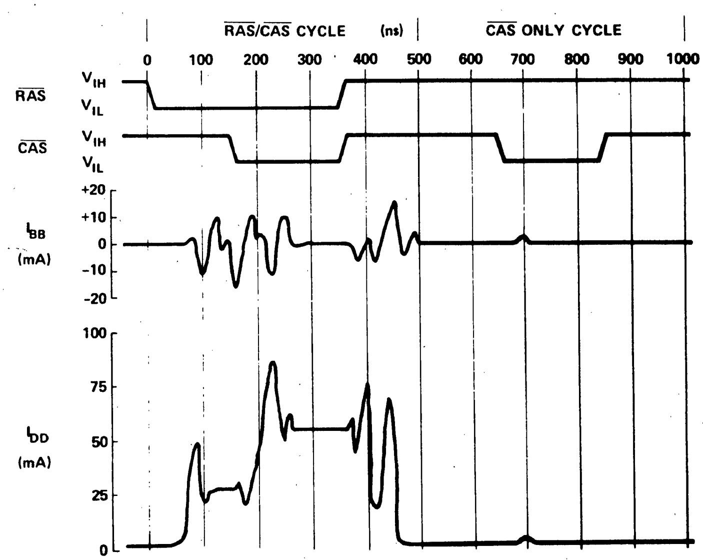
The third parameter, t_{CRL}, defines the lead (−) or lag (+) time allowable for $\overline{CAS}$ with respect to $\overline{RAS}$. If all minimum timing requirements for $\overline{RAS}$ and $\overline{CAS}$ are met, the $\overline{CAS}$ trailing edge may lead the $\overline{RAS}$ trailing edge by up to 10ns or lag by up to 90ns. In a memory cycle with all minimum timing specifications used, $\overline{CAS}$ may lag $\overline{RAS}$ but cannot lead $\overline{RAS}$ since t_{CSH} would be violated if $\overline{CAS}$ led $\overline{RAS}$.

POWER DISSIPATION

OPERATING

The power dissipation of a continuously operating 2104 device is the sum of $V_{DD} \times I_{DDAV}$ and $V_{BB} \times I_{BB}$. For a cycle time of 500ns (including a t_{RP} of 150ns) the typical power dissipation is 540mW.

Typical power supply current waveforms versus time are shown below for both a $\overline{RAS}/\overline{CAS}$ cycle and a $\overline{CAS}$ only cycle. It is evident from examination of the current waveforms that the major portion of the device power dissipation is the $V_{DD} \times I_{DDAV}$ component. Since the average value of I_{DD} is used to compute the power dissipation and I_{DD} is high only while $\overline{RAS}$ and $\overline{CAS}$ are low, minimum $\overline{RAS}$ and $\overline{CAS}$ pulse widths are preferred even with long cycle times to minimize power dissipation.



TYPICAL SUPPLY CURRENTS VS. TIME

STANDBY-REFRESH ONLY

The standby power-refresh only is calculated by the following equation:

5. $P_{REF} = P_{OP} \times (64 \frac{t_{CYC}}{t_{REF}}) + P_{SB} (1\text{-}64 \frac{t_{CYC}}{t_{REF}})$

Where: P_{REF} = Standby power-refresh only.
P_{OP} = Power dissipation-continuous operation.
t_{CYC} = Cycle time for a Refresh cycle.
t_{REF} = Time between refresh.
P_{SB} = Standby power dissipation.

The standby power dissipation P_{SB} is given by:

6. $P_{SB} = V_{DD} \times I_{DD1} + V_{BB} \times I_{BB}$.

The typical power dissipated is a standby-refresh only mode with the device deselected ($\overline{CS}$ high) is 20mW. If the device is selected ($\overline{CS}$ low) during a refresh cycle, the typical power dissipated is 32mW. This is the result of the internal output buffer circuitry being turned on. Since needless power is dissipated for this condition, it is recommended that the device be deselected during standby-refresh only operation.

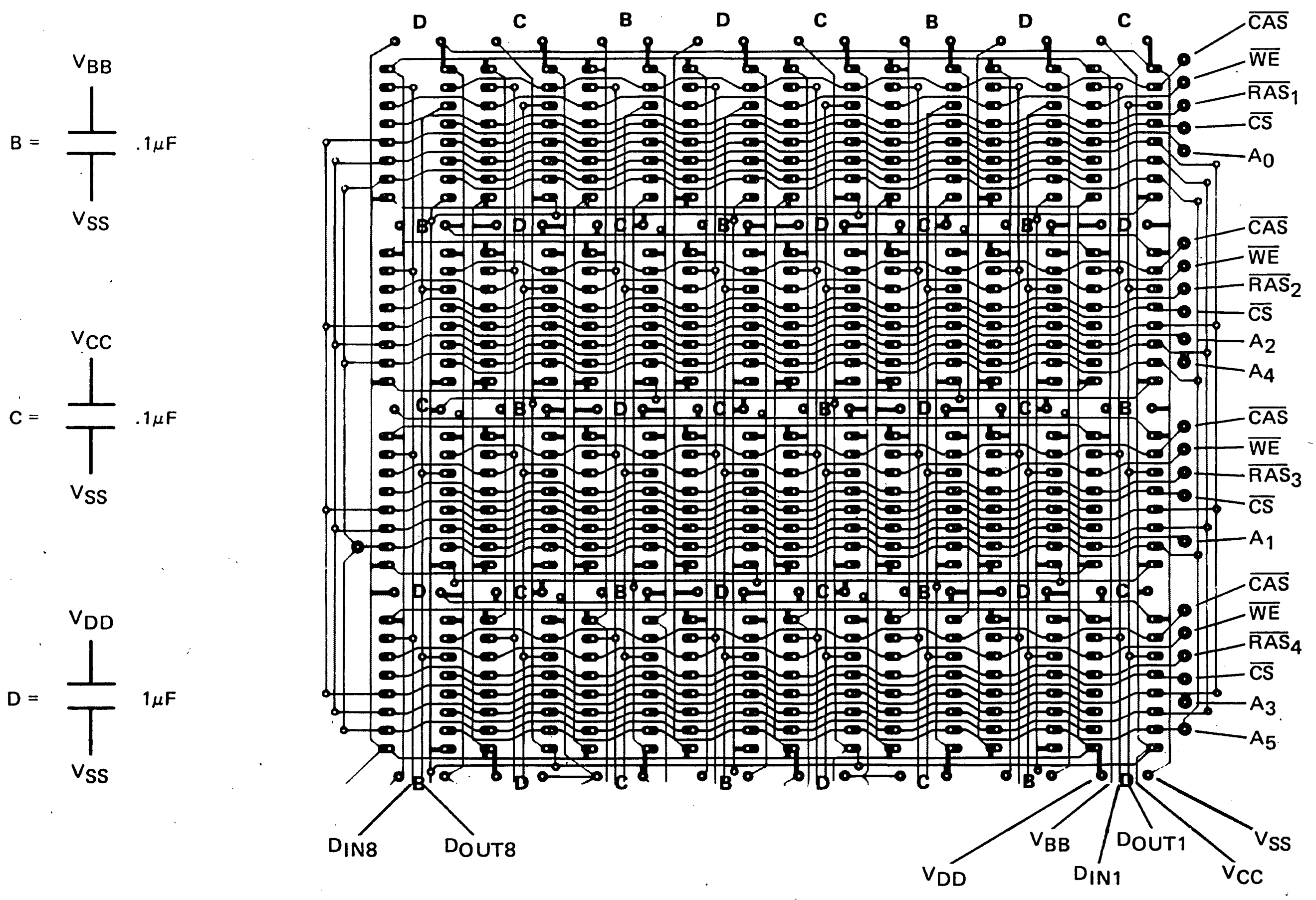
Note that when calculating the standby power for a 2104 memory system it is not necessary to include the power dissipated by TTL to MOS level converters. These converters are incorporated internally to the 2104 and are included in the previous power calculations.

SYSTEM LAYOUT AND DECOUPLING

A two sided memory array layout is shown below.

Decoupling is indicated by a "D" for V_{DD} to V_{SS} and "B" for V_{BB} to V_{SS}. I_{DD} and I_{BB} current surges at $\overline{RAS}$ and $\overline{CAS}$ make adequate decoupling of these supplies important. It is recommended that 1.0μF high frequency, low inductance capacitors be used between V_{DD} and V_{SS} on double sided boards. 0.1μF capacitors can be used between V_{BB} and V_{SS}. V_{CC} to V_{SS} decoupling is indicated by a "C" and 0.1μF capacitors are recommended. For each 36 devices a 100μF tantalum or equivalent capacitor should be placed from V_{DD} to V_{SS} near the array. An equal or slightly smaller bulk capacitor should be placed between V_{BB} and V_{SS} on the memory card.

Note that all power lines (including V_{SS}) are grided both horizontally and vertically at each memory device. This minimizes the power distribution impedance and enhances the effect of the decoupling capacitors.



Two Sided Layout for 16K x 8 Memory

intel®

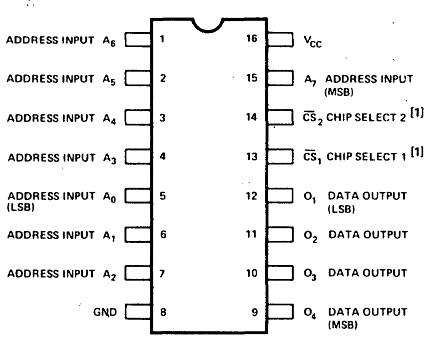
Schottky Bipolar 3601, 3621

HIGH SPEED 1K (256 x 4) PROM

- **Fast Access Time — 50 nsec Maximum (3601-1, 3621-1)**
- **Fast Programming — 1 ms/bit Typically**
- **Three State Outputs (3621)**
- **Open Collector Outputs (3601)**
- **Standard Packaging — 16 Pin Hermetic Dual In-Line Lead Configuration**

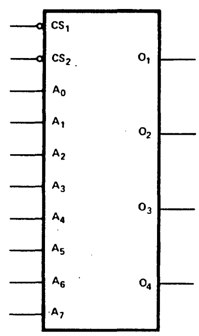
The 3601 and 3621 PROM families are organized as 256 words by 4-bits. The 3601 family is manufactured with all outputs initially low and the 3621 family with all outputs initially high.

PIN CONFIGURATION



NOTE 1. DURING PROGRAMMING THE PROGRAM PULSE MAY BE APPLIED TO EITHER $\overline{CS}_1$ OR $\overline{CS}_2$ FOR THE 3621 FAMILY ONLY.

LOGIC SYMBOL



ABSOLUTE MAXIMUM RATINGS*

Temperature Under Bias	-65°C to +150°C
Storage Temperature	-65°C to +160°C
Output or Supply Voltages	-0.5V to 7 Volts
All Input Voltages	-1.6V to 5.5V
Output Currents	100mA

*COMMENT

Stresses above those listed under "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied.

D. C. Characteristics: All limits apply for V_{CC} = +5.0V ± 5%, T_A = 0°C to +75°C, unless otherwise specified.

Symbol	Parameter	Limits Min.	Limits Typ.[1]	Limits Max.	Unit	Test Conditions
I_{FA}	Address Input Load Current		-0.05	-0.25	mA	V_{CC} = Max., V_A = 0.45V
I_{FS}	Chip Select Input Load Current		-0.05	-0.25	mA	V_{CC} = Max., V_S = 0.45V
I_{RA}	Address Input Leakage Current			40	µA	V_{CC} = Max., V_A = Max.
I_{RS}	Chip Select Input Leakage Current			40	µA	V_{CC} = Max., V_S = Max.
V_{CA}	Address Input Clamp Voltage		-0.9	-1.5	V	V_{CC} = Min., I_A = -10mA
V_{CS}	Chip Select Input Clamp Voltage		-0.9	-1.5	V	V_{CC} = Min., I_S = -10mA
V_{OL}	Output Low Voltage		0.3	0.45	V	V_{CC} = Min., I_{OL} = 15mA
I_{CC}	Power Supply Current		90	130	mA	V_{CC}= Max. V_{A0}→V_{A7} = 0V $\overline{CS}_1$ = $\overline{CS}_2$ = 0V
V_{IL}	Input "Low" Voltage			0.85	V	V_{CC} = 5.0V
V_{IH}	Input "High" Voltage	2.0			V	V_{CC} = 5.0V
I_{CEX} [2]	Output Leakage Current			100	µA	V_{CC} = Max., V_{CE} = Max.
$\|I_O\|$ [3]	Output Leakage for High Impedance Stage			40	µA	V_O= Max., or 0.45V, V_{CC} =5.25V, $\overline{CS}_1$=$\overline{CS}_2$ =2.4V
I_{SC} [3,4]	Output Short Circuit Current	-15		-60	mA	V_{CC} =5.00V, T_A=25°C, V_O = 0V
V_{OH} [3]	Output High Voltage	2.4			V	I_{OH} =-2.4mA, V_{CC} = Min.

NOTES: 1. Typical values are at 25°C and at nominal voltage.
2. This specification only applies to the 3601 family.
3. This specification only applies to the 3621 family.
4. Unmeasured outputs are open during this test.

A. C. Characteristics V_{CC} = +5V ± 5%, T_A = 0°C to + 75°C

SYMBOL	PARAMETER	MAXIMUM LIMITS			UNIT	CONDITIONS
		0°C	25°C	75°C		
t_{A++}, t_{A--} t_{A+-}, t_{A-+}	Address to Output Delay (3601, 3621)	70	60	70	ns	Both C.S. lines must be at ground potential to activate the PROM.
t_{A++}, t_{A--} t_{A+-}, t_{A-+}	Address to Output Delay (3601-1, 3621-1)	50	50	50	ns	
t_{S++}, t_{S--}	Chip Select to Output Delay	25	25	25	ns	

Capacitance [1] T_A = 25°C

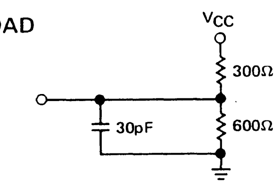
SYMBOL	PARAMETER	LIMITS		UNIT	TEST CONDITIONS
		TYP.	MAX.		
C_{INA}	Address Input Capacitance	4	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{INS}	Chip-Select Input Capacitance	6	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{OUT}	Output Capacitance	7	12	pF	V_{CC} = 5V V_{OUT} = 2.5V

NOTE 1: This parameter is only periodically sampled and is not 100% tested.

Switching Characteristics

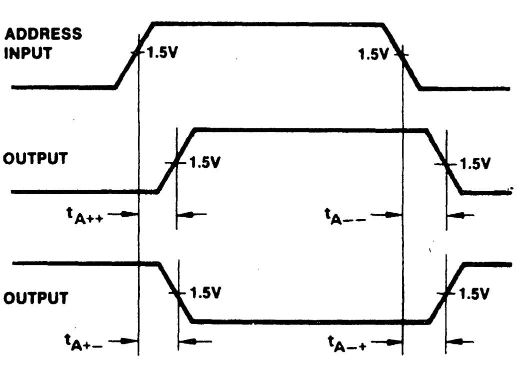
Conditions of Test:
Input pulse amplitudes - 2.5V
Input pulse rise and fall times of
5 nanoseconds between 1 volt and 2 volts
Speed measurements are made at 1.5 volt levels
Output loading is 15 mA and 30 pF
Frequency of test - 2.5 MHz

15 mA TEST LOAD

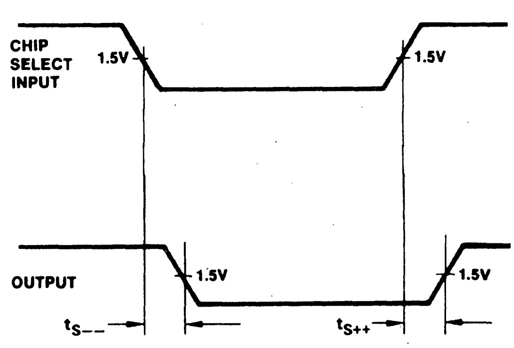


Waveforms

ADDRESS TO OUTPUT DELAY



CHIP SELECT TO OUTPUT DELAY



Intel

MEMORY

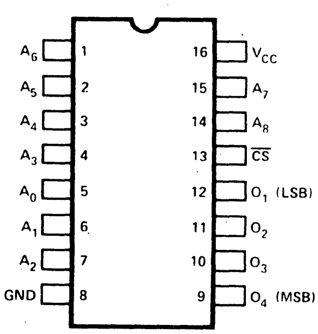
intel® Schottky Bipolar 3602, 3602-4, 3602L-6, 3622, 3622-4, 3622L-6

HIGH SPEED 2K (512 x 4) PROM

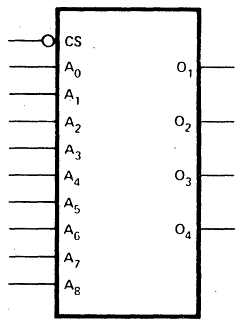
- **Fast Access Time — 70ns (3602, 3622)**
- **Low Standby Power Dissipation (3602L-6, 3622L-6) — 115 μW/bit**
- **Open Collector (3602, 3602-4, 3602L-6) or Three-State (3622, 3622-4, 3622L-6) Outputs**

The 3602 and 3622 families are 512 words by 4 bit PROMs. The PROMs are manufactured with all outputs high and logic low levels can be electrically programmed in selected bit locations.

PIN CONFIGURATION



LOGIC SYMBOL



ABSOLUTE MAXIMUM RATINGS*

Temperature Under Bias	-65°C to +150°C
Storage Temperature	-65°C to +160°C
Output or Supply Voltages	-0.5V to 7 Volts
All Input Voltages	-1.6V to 5.6V
Output Currents	100mA

*COMMENT

Stresses above those listed under "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied.

D. C. Characteristics: All Limits Apply for V_{CC} = +5V ±5%, T_A = 0°C to +75°C, unless otherwise specified.

Symbol	Parameter	Limits Min.	Limits Typ.[1]	Limits Max.	Unit	Test Conditions
I_{FA}	Address Input Load Current		-0.05	-0.25	mA	V_{CC} = 5.25V, V_A = 0.45V
I_{FS}	Chip Select Input Load Current		-0.05	-0.25	mA	V_{CC} = 5.25V, V_S = 0.45V
I_{RA}	Address Input Leakage Current			40	μA	V_{CC} = 5.25V, V_A = 5.25V
I_{RS}	Chip Select Input Leakage Current			40	μA	V_{CC} = 5.25V, V_S = 5.25V
V_{CA}	Address Input Clamp Voltage		-0.9	-1.5	V	V_{CC} = 4.75V, I_A = -10mA
V_{CS}	Chip Select Input Clamp Voltage		-0.9	-1.5	V	V_{CC} = 4.75V, I_S = -10mA
V_{OL}	Output Low Voltage		0.3	0.45	V	V_{CC} = 4.75V, I_{OL} = 15mA
I_{CEX}[2]	Output Leakage Current			100	μA	V_{CC} = 5.25V, V_{CE} = 5.25V
I_{CC1}	Power Supply Current (3602, 3602-4, 3622, 3622-4)			140	mA	V_{CC}=5.25V, V_{A0}→V_{A8}= 0V, $\overline{CS}$ = 0V
I_{CC2}	Power Supply Current (3602L-6, 3622L-6) Active			110	mA	V_{CC}=5.25V, $\overline{CS}$ = 0.45V
	Standby			45	mA	$\overline{CS}$ = 2.4V
V_{IL}	Input "Low" Voltage			0.85	V	V_{CC} = 5.0V
V_{IH}	Input "High" Voltage	2.0			V	V_{CC} = 5.0V
$\|I_O\|$[3]	Output Leakage for High Impedance Stage			40	μA	V_O=5.25V or 0.45V, V_{CC}=5.25V, $\overline{CS}$=2.4V
I_{SC}[3,4]	Output Short Circuit Current	-15	-25	-60	mA	V_{CC}=5.00V, T_A=25°C, V_O = 0V
V_{OH}[3]	Output High Voltage	2.4			V	I_{OH}=-2.4mA, V_{CC}=4.75V

NOTES:
1. Typical values are at 25 C and at nominal voltage.
2. This specification only applies to the 3602 family.
3. This specification only applies to the 3622 family.
4. Unmeasured outputs are open during this test.

Intel MEMORY

A. C. Characteristics V_{CC} = +5V ±5%, T_A = 0°C to +75°C

SYMBOL	PARAMETER	MAX. LIMIT			UNIT	CONDITIONS
		3602 3622	3602-4 3622-4	3602L-6 3622L-6		
t_{A++}, t_{A--} t_{A+-}, t_{A-+}	Address to Output Delay	70	90	90	ns	$\overline{CS}$ = V_{IL} to Select the PROM
t_{S++}	Chip Select to Output Delay	30	30	30	ns	
t_{S--}	Chip Select to Output Delay	30	30	120	ns	

Capacitance [1] T_A = 25°C, f = 1 MHz

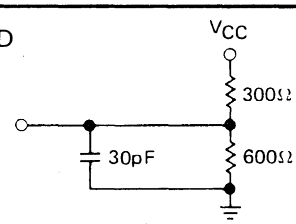
SYMBOL	PARAMETER	LIMITS		UNIT	TEST CONDITIONS
		TYP.	MAX.		
C_{INA}	Address Input Capacitance	4	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{INS}	Chip-Select Input Capacitance	6	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{OUT}	Output Capacitance	7	12	pF	V_{CC} = 5V V_{OUT} = 2.5V

NOTE 1: This parameter is only periodically sampled and is not 100% tested.

Switching Characteristics

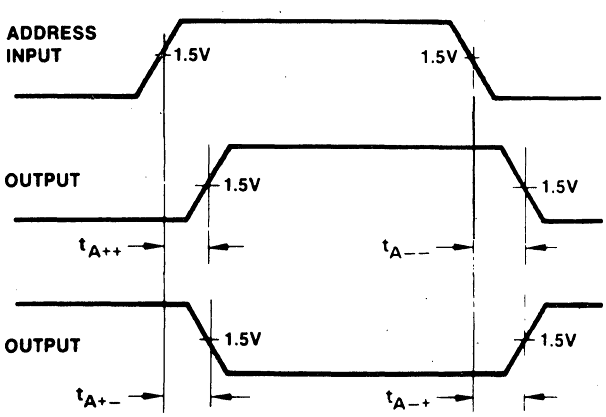
Conditions of Test:
Input pulse amplitudes - 2.5V
Input pulse rise and fall times of
5 nanoseconds between 1 volt and 2 volts
Speed measurements are made at 1.5 volt levels
Output loading is 15 mA and 30 pF
Frequency of test - 2.5 MHz

15 mA TEST LOAD

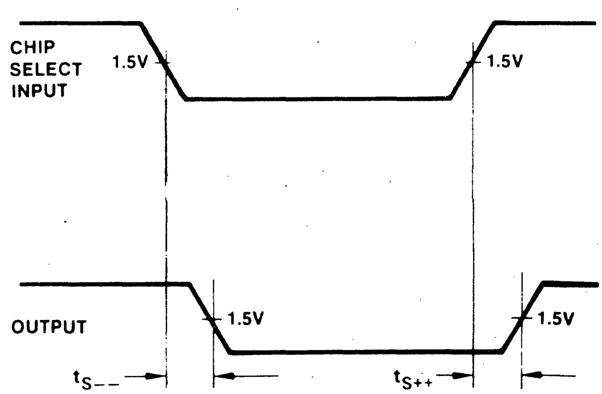


Waveforms

ADDRESS TO OUTPUT DELAY



CHIP SELECT TO OUTPUT DELAY



Intel
MEMORY

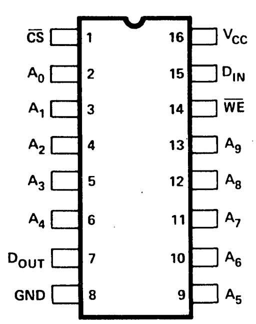
Silicon Gate MOS 2115, 2125

HIGH SPEED STATIC 1024 BIT RAM

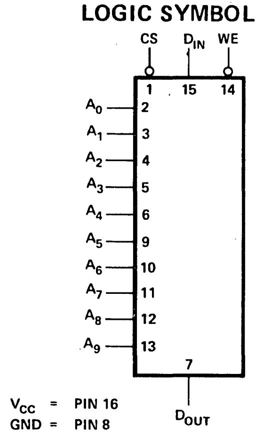
- **Access Time (2115-2/2125-2): 60ns Typical**
- **Fully Pin Compatible to 93415 (2115) and 93425 (2125)**
- **Low Operating Power Dissipation: Typical 0.2mW/bit (2115L, 2125L)**
- **Single +5V Supply**
- **Uncommitted Collector (2115) and Three-State (2125) Output**

The Intel® 2115 and 2125 family are fully static read/write random access memories organized as 1024 words by 1 bit. These RAMs are designed for buffer control storage and high performance main memory applications. They are compatible with TTL logic families in all respects: inputs, output, and a single +5V supply. Both uncommitted collector and three state output are available.

PIN CONFIGURATION



LOGIC SYMBOL



2115, 2125 FAMILY

	2115, 2125	2115-2 2125-2	2115L, 2125L
Typ. T_{AA} (ns)	70	60	75
Typ. I_{CC} (mA)	75	100	50

D.C. Characteristics [1] V_{CC} = 5V ±5%, T_A = 0°C to 75°C

Symbol	Test	Min.	Typ.	Max.	Unit	Conditions
V_{OL1}	2115, 2115L Output Low Voltage			0.45	V	I_{OL} = 12mA
V_{OL2}	2115-2, 2125-2 Output Low Voltage			0.45	V	I_{OL} = 16mA
V_{OL3}	2125, 2125L Output Low Voltage			0.45	V	I_{OL} = 7mA
V_{IH}	Input High Voltage	2.1			V	
V_{IL}	Input Low Voltage			0.8	V	
I_{IL}	Input Low Current		-1	-40	μA	V_{CC}=Max., V_{IN}=0.4V
I_{IH}	Input High Current		1	40	μA	V_{CC}=Max., V_{IN}=4.5V
I_{CEX}	2115 Family Output Leakage Current		10	100	μA	V_{CC}=Max., V_{OUT}=4.5V
$\|I_{OFF}\|$	2125 Family Output Current (High Z)		10	50	μA	V_{CC}=Max., V_{OUT}=0.5V/2.4V
I_{OS}[2]	2125 Family Current Short Circuit to Ground			-100	mA	V_{CC}=4.5V
V_{OH}	2125 Family Output High Voltage	2.4			V	I_{OH}=-3.2mA
I_{CCL}	2115L, 2125L Power Supply Current		50	65	mA	All Inputs Grounded, Output Open
I_{CC1}	2115, 2125 Power Supply Current		75	100	mA	All Inputs Grounded, Output Open
I_{CC2}	2115-2, 2125-2 Power Supply Current			125	mA	All Inputs Grounded, Output Open

Notes:
1. The operating ambient temperature ranges are guaranteed with transverse air flow exceeding 400 linear feet per minute and a two minute warm-up. Typical thermal resistance values of the package at maximum temperature are:
   θ_{JA} (@ 400 fPM air flow) = 45°C/W θ_{JA} (still air) = 60°C/W θ_{JC} = 25°C/W.
2. Duration of short circuit current should not exceed 1 second.

2115 Family A.C. Characteristics[1] V_{CC} = 5V ±5%, T_A = 0°C to 75°C

READ CYCLE

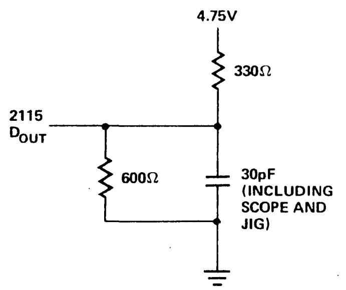
Symbol	Test	2115 Limits Min.	2115 Limits Typ.	2115 Limits Max.	2115-2 Limits Min.	2115-2 Limits Typ.	2115-2 Limits Max.	2115L Limits Min.	2115L Limits Typ.	2115L Limits Max.	Units
t_{ACS}	Chip Select Time	5		45	5		40	5		50	ns
t_{RCS}	Chip Select Recovery Time			40			40			40	ns
t_{AA}	Address Access Time		70	90		60	70		75	95	ns
t_{OH}	Previous Read Data Valid After Change of Address	10			10			10			ns

WRITE CYCLE

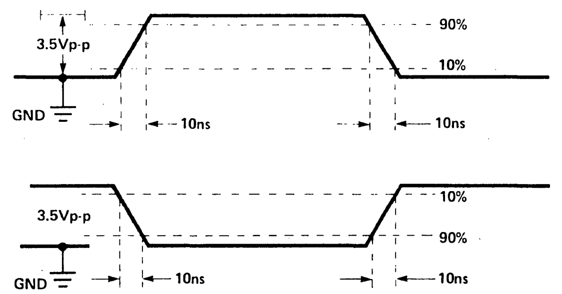
Symbol	Test	2115 Min.	2115 Typ.	2115 Max.	2115-2 Min.	2115-2 Typ.	2115-2 Max.	2115L Min.	2115L Typ.	2115L Max.	Units
t_{WS}	Write Enable Time			40			40			40	ns
t_{WR}	Write Recovery Time	5		45	5		45	5		50	ns
t_W	Write Pulse Width	50			50			60			ns
t_{WSD}	Data Set-Up Time Prior to Write	5			5			15			ns
t_{WHD}	Data Hold Time After Write	5			5			15			ns
t_{WSA}	Address Set-Up Time	15			15			20			ns
t_{WHA}	Address Hold Time	5			5			15			ns
t_{WSCS}	Chip Select Set-Up Time	5			5			15			ns
t_{WHCS}	Chip Select Hold Time	5			5			15			ns

TEST CONDITIONS

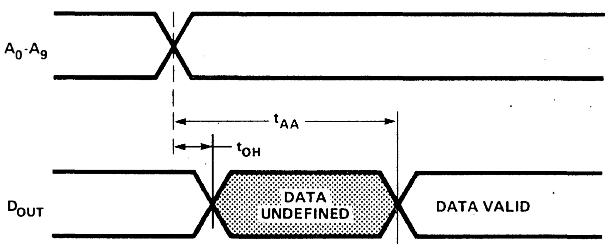
LOADING CONDITIONS



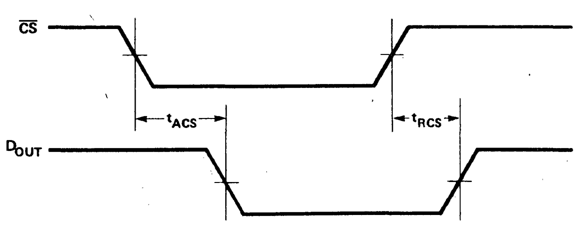
ALL INPUT PULSES



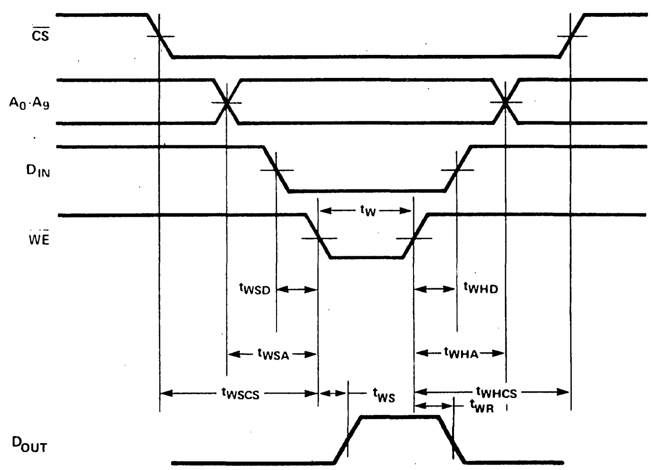
READ CYCLE



PROPAGATION DELAY FROM CHIP SELECT



WRITE CYCLE

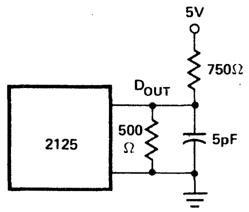


(ALL ABOVE MEASUREMENTS REFERENCED TO 1.5V)

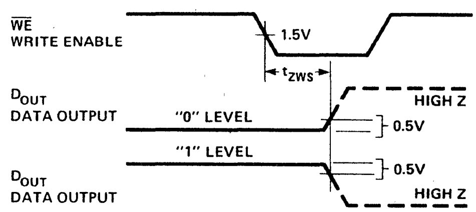
Intel

MEMORY

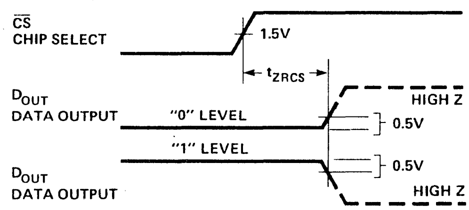
2125 FAMILY WRITE ENABLE TO HIGH Z DELAY



LOAD 1



2125 FAMILY PROPAGATION DELAY FROM CHIP SELECT TO HIGH Z



(All t_{ZXXX} parameters are measured at a delta of 0.5V from the logic level and using Load 1.)

2115/2125 FAMILY CAPACITANCE* V_{CC} = 5V, f = 1 MHz, T_A = 25°C

Symbol	Test	2115 Family Limits Typ.	2115 Family Limits Max.	2125 Family Limits Typ.	2125 Family Limits Max.	Units	Test Conditions
C_I	Input Capacitance	3	5	3	5	pF	All Inputs = 0V, Output Open
C_O	Output Capacitance	5	8	5	8	pF	$\overline{CS}$=5V, All other inputs = 0V, Output Open

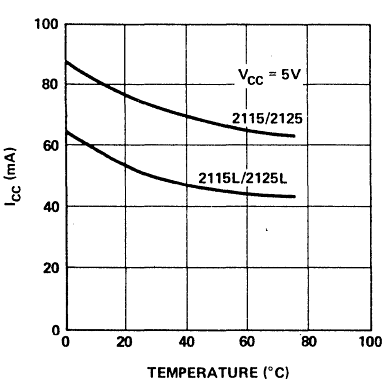
*This parameter is periodically sampled and is not 100% tested.

Intel

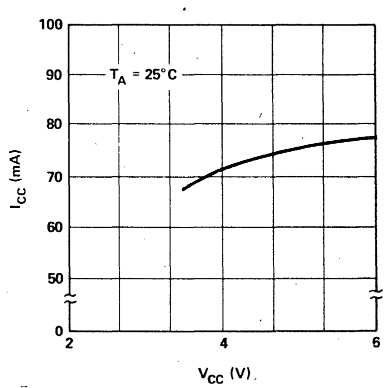
MEMORY

Typical Characteristics

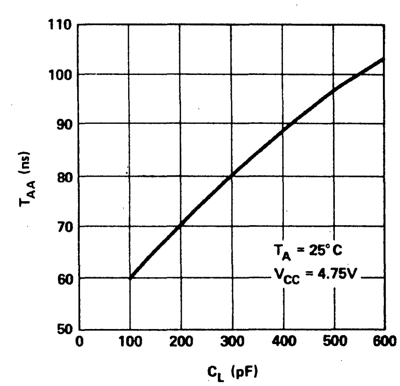
I_{CC} VS. TEMPERATURE



I_{CC} VS. V_{CC}



ACCESS TIME VS. CAPACITANCE



2125 Family A.C. Characteristics [1] $V_{CC} = 5V \pm 5\%$, $T_A = 0°C$ to $75°C$

READ CYCLE

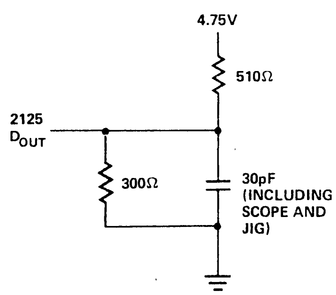
Symbol	Test	2125 Limits Min.	Typ.	Max.	2125-2 Limits Min.	Typ.	Max.	2125L Limits Min.	Typ.	Max.	Units
t_{ACS}	Chip Select Time	5		45	5		40	5		50	ns
t_{ZRCS}	Chip Select to HIGH Z			40			40			40	ns
t_{AA}	Address Access Time		70	90		60	70		75	95	ns
t_{OH}	Previous Read Data Valid After Change of Address	10			10			10			ns

WRITE CYCLE

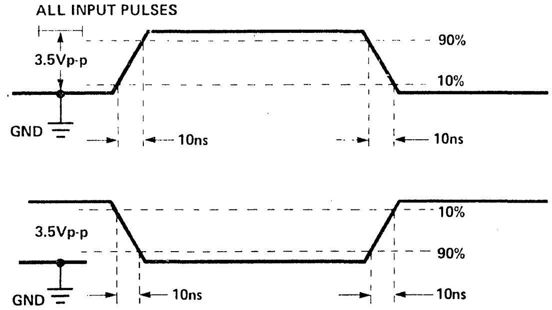
Symbol	Test	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Units
t_{ZWS}	Write Enable to HIGH Z			40			40			40	ns
t_{WR}	Write Recovery Time	5		45	5		45	5		50	ns
t_W	Write Pulse Width	50			50			60			ns
t_{WSD}	Data Set-Up Time Prior to Write	5			5			15			ns
t_{WHD}	Data Hold Time After Write	5			5			15			ns
t_{WSA}	Address Set-Up Time	15			15			20			ns
t_{WHA}	Address Hold Time	5			5			15			ns
t_{WSCS}	Chip Select Set-Up Time	5			5			15			ns
t_{WHCS}	Chip Select Hold Time	5.			5			15			ns

TEST CONDITIONS

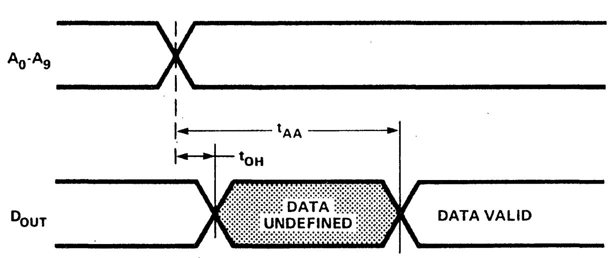
LOADING CONDITIONS



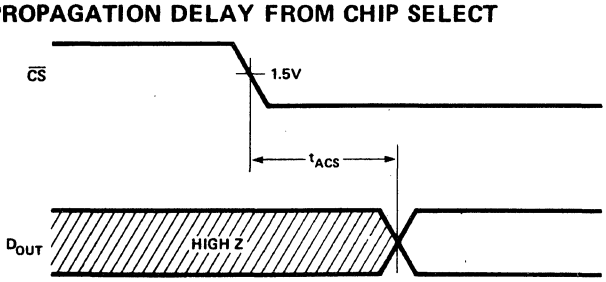
ALL INPUT PULSES



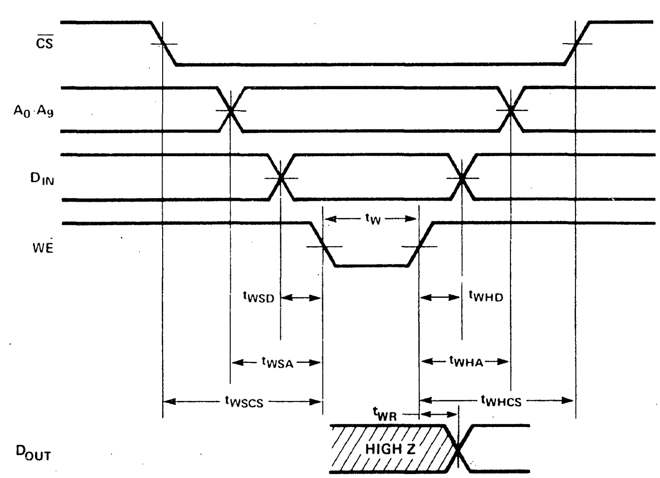
READ CYCLE



PROPAGATION DELAY FROM CHIP SELECT



WRITE CYCLE



(ALL ABOVE MEASUREMENTS REFERENCED TO 1.5V) intel® Silicon Gate MOS **2708/2704**

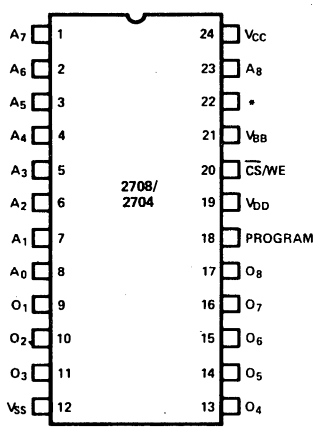
8192/4096 BIT ERASABLE AND ELECTRICALLY REPROGRAMMABLE READ ONLY MEMORY

- **2708 1024x8 Organization**
- **2704 512x8 Organization**

- **Max Access Time — 450ns**
- **Static — No Clocks Required**
- **TTL Compatible**
- **Three-State Output**

The 2708 and 2704 are packaged in a 24 pin dual-in-line package with a transparent lid. The transparent lid allows the user to expose the chip to ultraviolet light to erase the bit pattern. A new pattern can then be written into the device.

PIN CONFIGURATIONS



*2704 = V_{SS}
2708 = A_9

Absolute Maximum Ratings*

Temperature Under Bias	-25°C to +85°C
Storage Temperature	-65°C to +125°C
V_{DD} With Respect to V_{BB}	+20V to -0.3V
V_{CC} and V_{SS} With Respect to V_{BB}	+15V to -0.3V
All Input or Output Voltages With Respect to V_{BB} During Read	+15V to -0.3V
$\overline{CS}$/WE Input With Respect to V_{BB} During Programming	+20V to -0.3V
Program Input With Respect to V_{BB}	+35V to -0.3V
Power Dissipation	1.5W

***COMMENT:**

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

READ OPERATION

D.C. and Operating Characteristics

T_A = 0°C to 70°C, V_{CC} = +5V ±5%, V_{DD} = +12V ±5%, V_{BB} = -5V ±5%, V_{SS} = 0V, Unless Otherwise Noted.

Symbol	Parameter	Min.	Typ.[1]	Max.	Unit	Conditions
I_{LI}	Address and Chip Select Input Load Current			10	µA	V_{IN} = 5.25V
I_{LO}	Output Leakage Current			10	µA	V_{OUT} = 5.25V, $\overline{CS}$/WE = 5V
I_{DD}	V_{DD} Supply Current		50	65	mA	Worst Case Supply Currents:
I_{CC}	V_{CC} Supply Current		6	10	mA	All Inputs High
I_{BB}	V_{BB} Supply Current		30	45	mA	$\overline{CS}$/WE = 5V; T_A = 0°C
V_{IL}	Input Low Voltage	V_{SS}		0.65	V	
V_{IH}	Input High Voltage	3.0		V_{CC}+1	V	
V_{OL}	Output Low Voltage			0.45	V	I_{OL} = 1.6mA
V_{OH1}	Output High Voltage	3.7			V	I_{OH} = -100µA
V_{OH2}	Output High Voltage	2.4			V	I_{OH} = -1mA
P_D	Power Dissipation			800	mW	T_A = 70°C

NOTES: 1. Typical values are for T_A = 25°C and nominal supply voltages.
2. The program input (Pin 18) is tied to VSS during the read mode.

A.C. Characteristics

T_A = 0°C to 70°C, V_{CC} = +5V ±5%, V_{DD} = +12V ±5%, V_{BB} = -5V ±5%, V_{SS} = 0V, Unless Otherwise Noted.

Symbol	Parameter	Min.	Typ.	Max.	Unit
t_{ACC}	Address to Output Delay		280	450	ns
$t_{\overline{CO}}$	Chip Select to Output Delay			120	ns
t_{DF}	Chip De-Select to Output Float	0		120	ns
t_{OH}	Address to Output Hold	0			ns

Capacitance[1] T_A = 25°C, f = 1MHz

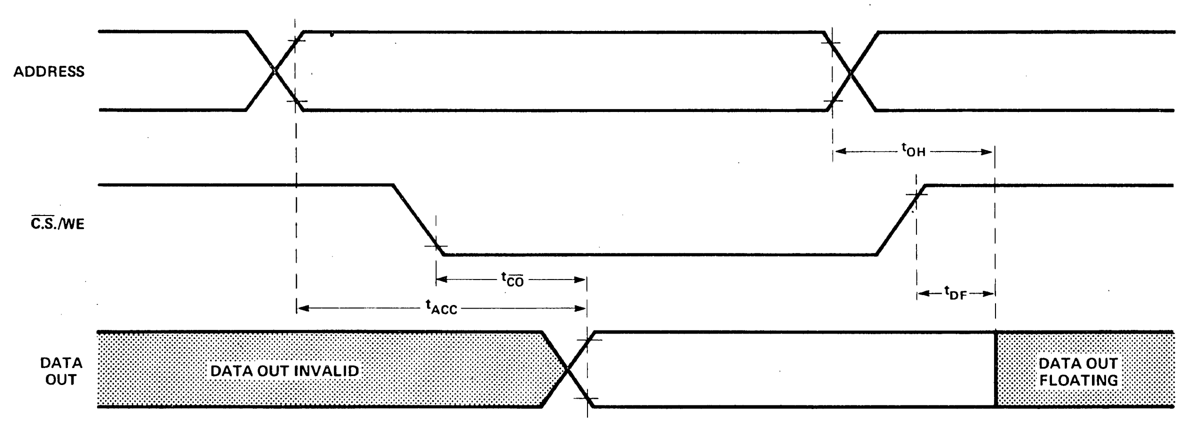
Symbol	Parameter	Typ.	Max.	Unit	Conditions
C_{IN}	Input Capacitance	4	6	pF	V_{IN}=0V
C_{OUT}	Output Capacitance	8	12	pF	V_{OUT}=0V

Note 1. This parameter is periodically sampled and not 100% tested.

A.C. Test Conditions:

Output Load: 1 TTL gate and C_L = 100pF
Input Rise and Fall Times: ≤20ns
Timing Measurement Reference Levels: 0.8V and 2.8V for inputs; 0.8V and 2.4V for outputs
Input Pulse Levels: 0.65V to 3.0V

Waveforms



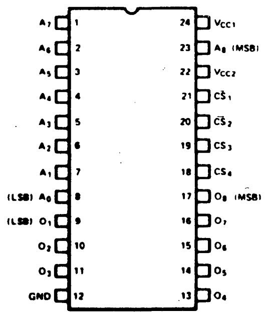
intel® Schottky Bipolar 3604, 3604-4, 3604L-6, 3624, 3624-4

HIGH SPEED 4K (512 x 8) PROM

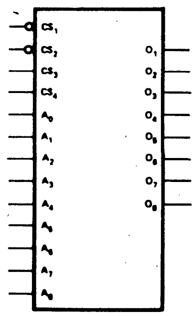
- **Fast Access Time — 70 ns (3604, 3624)**
- **Low Standby Power Dissipation (3604L-6) — 60 μW/bit**
- **Open Collector (3604, 3604-4, 3604L-6) or Three-State (3624, 3624-4) Outputs**

The 3604 and 3624 family are 512 words by 8 bit PROMs. The PROMs are manufactured with all outputs high and logic low levels can be electrically programmed in selected bit locations.

PIN CONFIGURATION



LOGIC SYMBOL



Mode/Pin Connection		Pin 22	Pin 24
Read:	3604, 3604-4,	No Connect or 5V	5V
	3604L-6	+5V	No Connect
Program:	3604, 3604-4,	Pulsed 12.5V	Pulsed 12.5V
	3604L-6	Pulsed 12.5V	Pulsed 12.5V
Standby Power:	3604L-6	Power dissipation is automatically reduced whenever the 3604L-6 is deselected.	

D. C. Characteristics: All Limits Apply for V_{CC}=+5.0V ±5%, T_A=0°C to +75°C, unless otherwise specified.

Symbol	Parameter	Limits Min.	Typ.[1]	Max.	Unit	Test Conditions
I_{FA}	Address Input Load Current		-0.05	-0.25	mA	V_{CC}=5.25V, V_A=0.45V
I_{FS}	Chip Select Input Load Current		-0.05	-0.25	mA	V_{CC}=5.25V, V_S=0.45V
I_{RA}	Address Input Leakage Current			40	μA	V_{CC}=5.25V, V_A=5.25V
I_{RS}	Chip Select Input Leakage Current			40	μA	V_{CC}=5.25V, V_S=5.25V
V_{CA}	Address Input Clamp Voltage		-0.9	-1.5	V	V_{CC}=4.75V, I_A=-10mA
V_{CS}	Chip Select Input Clamp Voltage		-0.9	-1.5	V	V_{CC}=4.75V, I_S= -10mA
V_{OL}	Output Low Voltage		0.3	0.45	V	V_{CC}=4.75V, I_{OL}= 15mA
I_{CEX} [2]	Output Leakage Current			100	μA	V_{CC}=5.25V, V_{CE}=5.25V
I_{CC1}	Power Supply Current (3604, 3604-4)			190	mA	V_{CC1}=5.25V, V_{A0}→V_{A8}=0V, $\overline{CS_1}$=$\overline{CS_2}$=0V, CS_3=CS_4=5.25V
I_{CC2}	Power Supply Current (3624, 3624-4)			190	mA	V_{CC1}=5.25V, V_{A0}→V_{A8}=0V, $\overline{CS_1}$=$\overline{CS_2}$=0V, CS_3=CS_4=5.25V
I_{CC}	Power Supply Current (3604L-6) Active			140	mA	V_{CC2}=5.25V, V_{CC1}=Open, $\overline{CS_1}$=$\overline{CS_2}$=0.45V, CS_3=CS_4=2.4V
	Standby			45	mA	$\overline{CS_1}$=$\overline{CS_2}$=2.5V
V_{IL}	Input "Low" Voltage			0.85	V	V_{CC}=5.0V
V_{IH}	Input "High" Voltage	2.0			V	V_{CC}=5.0V
$\|I_O\|$ [3]	Output Leakage for High Impedance Stage			100	μA	V_O=5.25V or 0.45V, V_{CC}=5.25V, $\overline{CS_1}$=$\overline{CS_2}$=2.4V
I_{SC} [3-4]	Output Short Circuit Current	-15	-25	-60	mA	V_{CC}=5.00V, T_A=25°C, V_O = 0V
V_{OH} [3]	Output High Voltage	2.4			V	I_{OH}=-2.4mA, V_{CC} = 4.75V

NOTES: 1. Typical values are at 25°C and at nominal voltage.
2. This specification only applies to the 3604 family.
3. This specification only applies to the 3624 family.
4. Unmeasured outputs are open during this test.

Intel

MEMORY

A. C. Characteristics V_{CC} = +5V ±5%, T_A = 0°C to +75°C

SYMBOL	PARAMETER	MAX. LIMIT			UNIT	CONDITIONS
		3604 3624	3604-4 3624-4	3604L-6		
t_{A++}, t_{A--} t_{A+-}, t_{A-+}	Address to Output Delay	70	90	90	ns	$\overline{CS_1}=\overline{CS_2}=V_{IL}$ and $CS_3=CS_4=V_{IH}$ to Select the PROM.
t_{S++}	Chip Select to Output Delay	30	30	30	ns	
t_{S--}	Chip Select to Output Delay	30	30	120	ns	

Capacitance [1] T_A = 25°C, f = 1 MHz

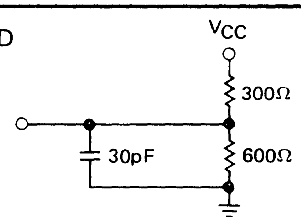
SYMBOL	PARAMETER	LIMITS		UNIT	TEST CONDITIONS
		TYP.	MAX.		
C_{INA}	Address Input Capacitance	4	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{INS}	Chip-Select Input Capacitance	6	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{OUT}	Output Capacitance	7	15	pF	V_{CC} = 5V V_{OUT} = 2.5V

NOTE 1: This parameter is only periodically sampled and is not 100% tested.

Switching Characteristics

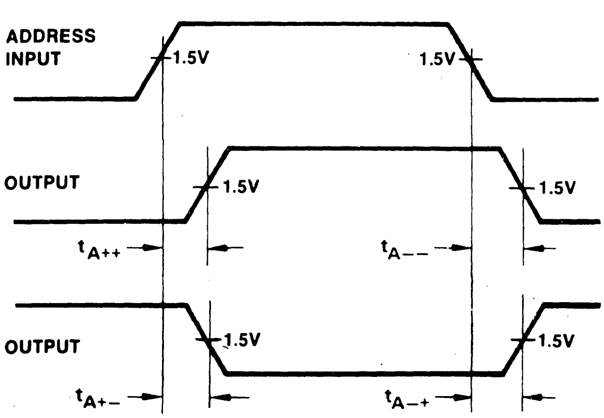
Conditions of Test:
Input pulse amplitudes - 2.5V
Input pulse rise and fall times of
5 nanoseconds between 1 volt and 2 volts
Speed measurements are made at 1.5 volt levels
Output loading is 15 mA and 30 pF
Frequency of test - 2.5 MHz

15 mA TEST LOAD

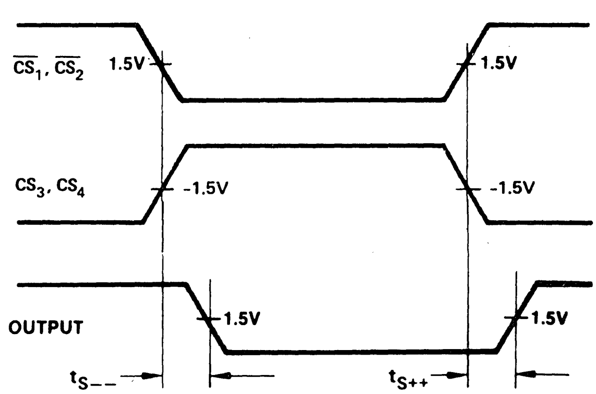


Waveforms

ADDRESS TO OUTPUT DELAY



CHIP SELECT TO OUTPUT DELAY



Intel MEMORY

intel® Silicon Gate MOS 2107B, 2107B-2, 2107B-4, 2107B-6

4096 BIT DYNAMIC RAM

	2107B	2107B-2	2107B-4	2107B-6
Access Time	200ns	220ns	270ns	350ns
Read,Write Cycle	400ns	470ns	470ns	800ns
RMW Cycle	520ns	680ns	590ns	960ns

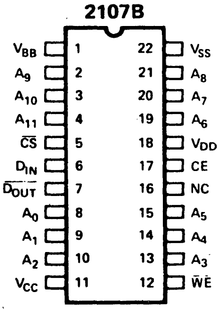
- **Low Cost Per Bit**
- **Low Standby Power**
- **Easy System Interface**
- **Only One High Voltage Input Signal — Chip Enable**
- **TTL Compatible — All Address, Data, Write Enable, Chip Select Inputs**
- **Refresh Period — 2ms for 2107B, 2107B-2, 2107B-4, 1ms for 2107B-6**
- **Address Registers Incorporated on the Chip**
- **Simple Memory Expansion — Chip Select Input Lead**
- **Fully Decoded — On Chip Address Decode**
- **Output is Three State and TTL Compatible**
- **Industry Standard 22-Pin Configuration**

The Intel® 2107B is a 4096 word by 1 bit dynamic n-channel MOS RAM. It was designed for memory applications where very low cost and large bit storage are important design objectives. The 2107B uses dynamic circuitry which reduces the standby power dissipation.

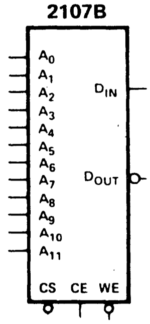
Reading information from the memory is non-destructive. Refreshing is most easily accomplished by performing one read cycle on each of the 64 row addresses. Each row address must be refreshed every two milliseconds. The memory is refreshed whether Chip Select is a logic one or a logic zero.

The 2107B is fabricated with n-channel silicon gate technology. This technology allows the design and production of high performance, easy to use MOS circuits and provides a higher functional density on a monolithic chip than other MOS technologies. The 2107B uses a single transistor cell to achieve high speed and low cost. It is a replacement for the 2107A.

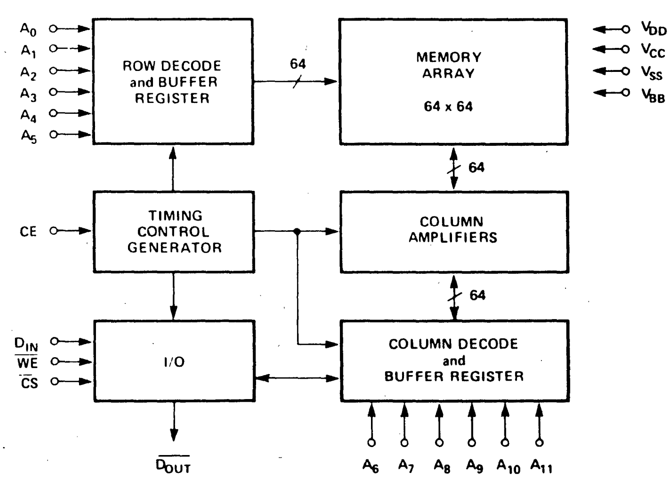
PIN CONFIGURATION



LOGIC SYMBOL



BLOCK DIAGRAM



PIN NAMES

A_0-A_{11}	ADDRESS INPUTS*	V_{BB}	POWER (-5V)
CE	CHIP ENABLE	V_{CC}	POWER (+5V)
$\overline{CS}$	CHIP SELECT	V_{DD}	POWER (+12V)
D_{IN}	DATA INPUT	V_{SS}	GROUND
$\overline{D_{OUT}}$	DATA OUTPUT	$\overline{WE}$	WRITE ENABLE
NC	NOT CONNECTED		

*Refresh Address A_0-A_5.

Absolute Maximum Ratings*

Temperature Under Bias . . . . 0°C to 70°C
Storage Temperature . . . . −65° C to +150°C
All Input or Output Voltages with Respect to the most Negative Supply Voltage, V_{BB} . . . . +25V to −0.3V
Supply Voltages V_{DD}, V_{CC}, and V_{SS} with Respect to V_{BB} . . . . +20V to −0.3V
Power Dissipation 1.25W

**COMMENT:*
Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

D.C. and Operating Characteristics

T_A = 0°C to 70°C, V_{DD} = +12V ±5%, V_{CC} = +5V ±10%, V_{BB} [1] = −5V ±5%, V_{SS} = 0V, unless otherwise noted.

Symbol	Parameter	Limits			Unit	Conditions
		Min.	Typ.[2]	Max.		
I_{LI}	Input Load Current (all inputs except CE)		.01	10	µA	$V_{IN} = V_{IL\,MIN}$ to $V_{IH\,MAX}$ CE = V_{ILC} or V_{IHC}
I_{LC}	Input Load Current		.01	2	µA	$V_{IN} = V_{IL\,MIN}$ to $V_{IH\,MAX}$
$\|I_{LO}\|$	Output Leakage Current for high impedance state		.01	10	µA	CE = V_{ILC} or $\overline{CS} = V_{IH}$ V_O = 0V to 5.25V
I_{DD1}	V_{DD} Supply Current during CE off[3]		110	200	µA	CE = -1V to +.6V
I_{DD2}	V_{DD} Supply Current during CE on			60	mA	CE = V_{IHC}, $\overline{CS} = V_{IL}$
$I_{DD\,AV}$	Average V_{DD} Current		38	54	mA	$\overline{CS} = V_{IL}$; T_A = 25°C; Min cycle time, Min t_{CE}
I_{CC1} [4]	V_{CC} Supply Current during CE off		.01	10	µA	CE = V_{ILC} or $\overline{CS} = V_{IH}$
I_{BB}	V_{BB} Supply Current		5	100	µA	
V_{IL}	Input Low Voltage	-1.0		0.6	V	t_T = 20ns
V_{IH}	Input High Voltage	2.4		V_{CC}+1	V	t_T = 20ns
V_{ILC}	CE Input Low Voltage	-1.0		+1.0	V	
V_{IHC}	CE Input High Voltage	V_{DD}-1		V_{DD}+1	V	
V_{OL}	Output Low Voltage	0.0		0.45	V	I_{OL} = 2.0mA
V_{OH}	Output High Voltage	2.4		V_{CC}	V	I_{OH} = -2.0mA

NOTES:
1. The only requirement for the sequence of applying voltage to the device is that V_{DD}, V_{CC}, and V_{SS} should never be .3V or more negative than V_{BB}.
2. Typical values are for T_A = 25°C and nominal power supply voltages.
3. The I_{DD} and I_{CC} currents flow to V_{SS}. The I_{BB} current is the sum of all leakage currents.
4. During CE on V_{CC} supply current is dependent on output loading, V_{CC} is connected to output buffer only.

Intel
MEMORY

A.C. Characteristics $T_A = 0°C$ to $70°C$, $V_{DD} = 12V \pm 5\%$, $V_{CC} = 5V \pm 10\%$, $V_{BB} = -5V \pm 5\%$,

READ, WRITE, AND READ MODIFY/WRITE CYCLE $V_{SS} = 0V$, unless otherwise noted.

Symbol	Parameter	2107B		2107B-2		2107B-4		2107B-6		Units	Note
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
t_{REF}	Time Between Refresh		2		2		2		1	ms	
t_{AC}	Address to CE Set Up Time	0		0		0		10		ns	3
t_{AH}	Address Hold Time	100		150		100		100		ns	
t_{CC}	CE Off Time	130		150		130		380		ns	
t_T	CE Transition Time	10	40	10	40	10	40	10	40	ns	
t_{CF}	CE Off to Output High Impedance State	0		0		0		0		ns	

READ CYCLE

Symbol	Parameter	2107B		2107B-2		2107B-4		2107B-6		Units	Note
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
t_{CY}	Cycle Time	400		470		470		800		ns	4
t_{CE}	CE On Time	230	4000	280	4000	300	4000	380	4000	ns	
t_{CO}	CE Output Delay		180		200		250		320	ns	5
t_{ACC}	Address to Output Access		200		220		270		350	ns	6
t_{WL}	CE to $\overline{WE}$	0		0		0		0		ns	
t_{WC}	$\overline{WE}$ to CE on	0		0		0		0		ns	

WRITE CYCLE

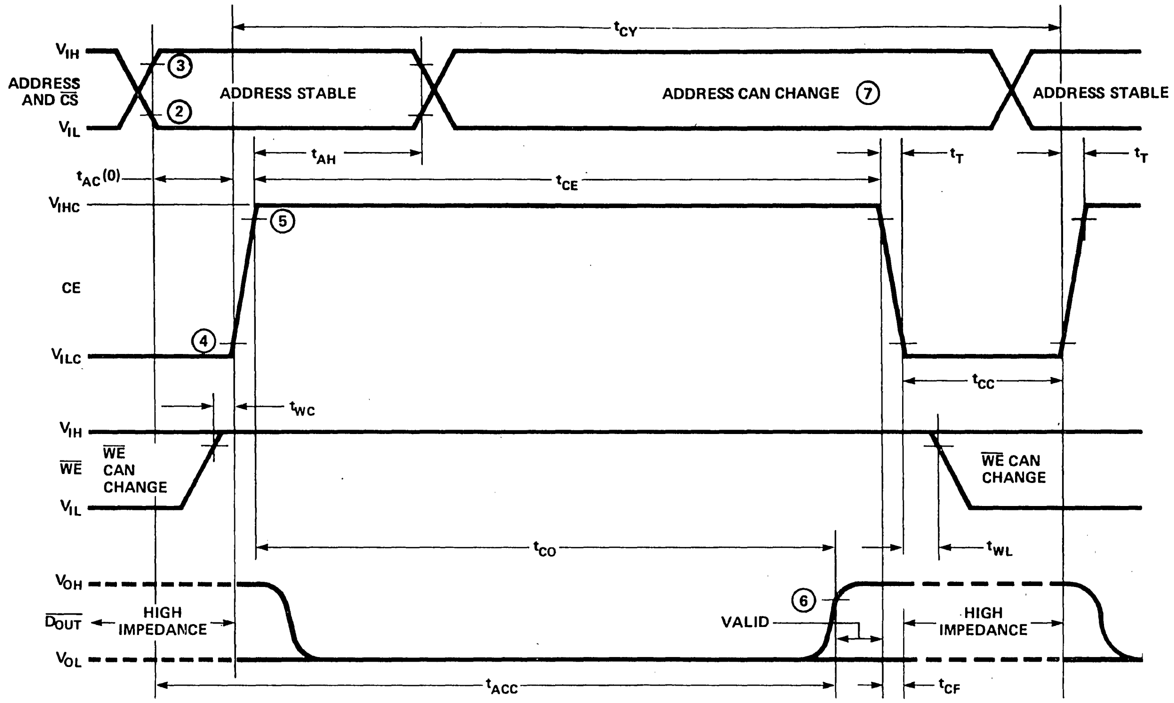
Symbol	Parameter	2107B		2107B-2		2107B-4		2107B-6		Units	Note
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
t_{CY}	Cycle Time	400		470		470		800		ns	4
t_{CE}	CE On Time	230	4000	280	4000	300	4000	380	4000	ns	
t_W	$\overline{WE}$ to CE Off	150		140		150		200		ns	
t_{CW}	CE to $\overline{WE}$	150		150		150		150		ns	
t_{DW}	D_{IN} to $\overline{WE}$ Set Up	0		0		0		0		ns	1
t_{DH}	D_{IN} Hold Time	0		0		0		0		ns	
t_{WP}	$\overline{WE}$ Pulse Width	50		100		50		100		ns	

Capacitance[2] $T_A = 25°C$

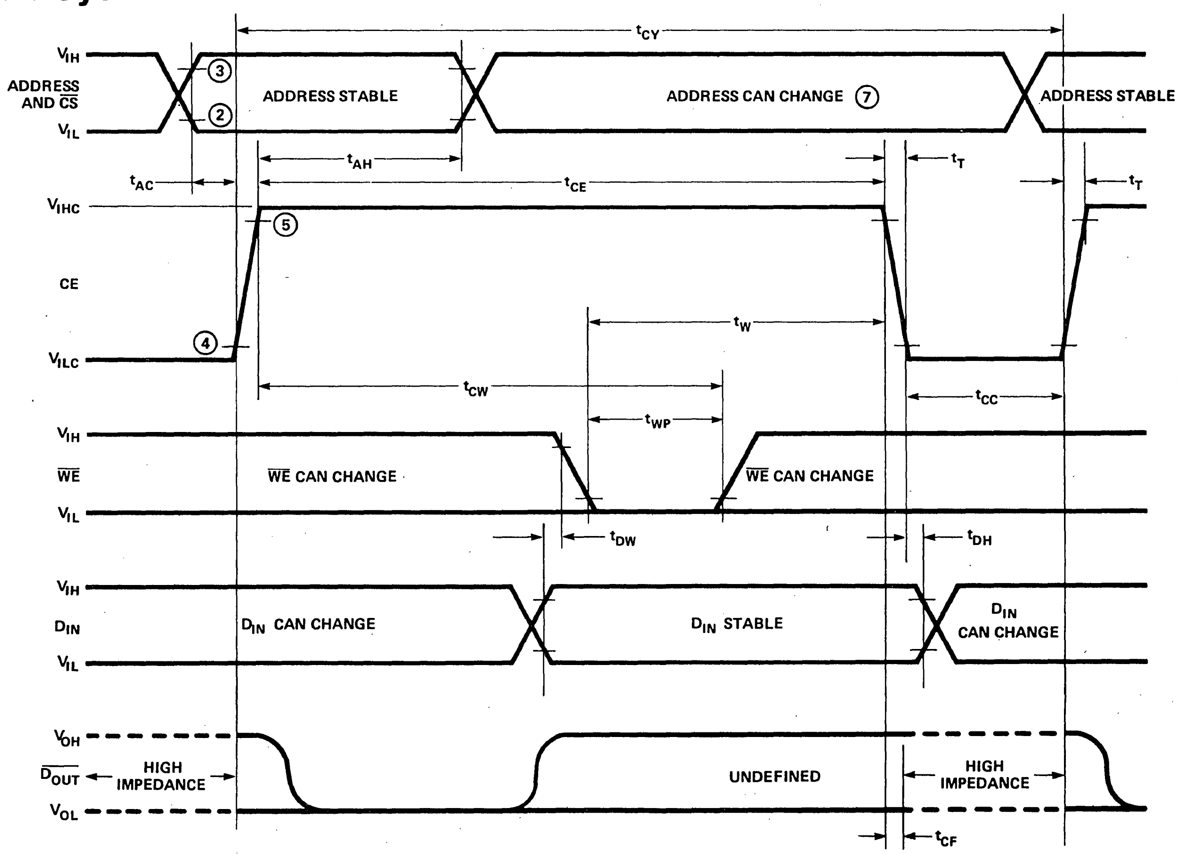
Symbol	Test	Plastic And Ceramic Pkg. Typ.	Max.	Unit	Conditions
C_{AD}	Address Capacitance, $\overline{CS}$	4	6	pF	$V_{IN} = V_{SS}$
C_{CE}	CE Capacitance	17	25	pF	$V_{IN} = V_{SS}$
C_{OUT}	Data Output Capacitance	5	7	pF	$V_{OUT} = 0V$
C_{IN}	D_{IN} and $\overline{WE}$ Capacitance	8	10	pF	$V_{IN} = V_{SS}$

Notes:
1. If $\overline{WE}$ is low before CE goes high then D_{IN} must be valid when CE goes high.
2. Capacitance measured with Boonton Meter or effective capacitance calculated from the equation.
   $C = \frac{I\Delta t}{\Delta V}$ with the current equal to a constant 20mA.
3. t_{AC} is measured from end of address transition.
4. $t_T = 20ns$
5. $C_{LOAD} = 50pF$, Load = One TTL Gate, Ref = 2.0V.
6. $t_{ACC} = t_{AC} + t_{CO} + 1t_T$

Read and Refresh Cycle [1]



Write Cycle



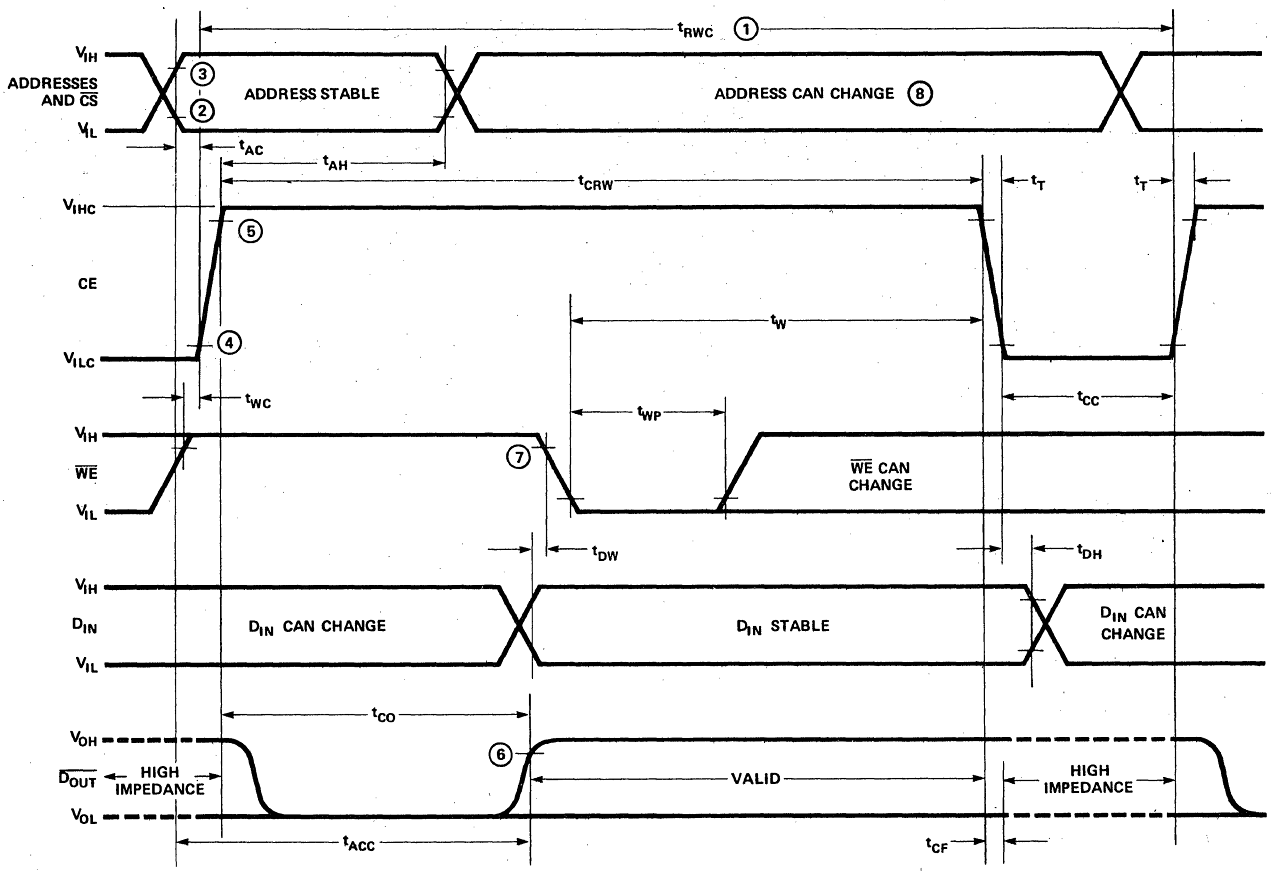
NOTES:
1. For Refresh cycle row and column addresses must be stable before t_{AC} and remain stable for entire t_{AH} period.
2. V_{IL} MAX is the reference level for measuring timing of the addresses, $\overline{CS}$, $\overline{WE}$, and D_{IN}.
3. V_{IH} MIN is the reference level for measuring timing of the addresses, $\overline{CS}$, $\overline{WE}$, and D_{IN}.
4. V_{SS} +2.0V is the reference level for measuring timing of CE.
5. V_{DD} −2V is the reference level for measuring timing of CE.
6. V_{SS} +2.0V is the reference level for measuring the timing of $\overline{D_{OUT}}$.
7. During CE high typically 0.5mA will be drawn from any address pin which is switched from low to high.

Intel

MEMORY

Read Modify Write Cycle [1]

Symbol	Parameter	2107B		2107B-2		2107B-4		2107B-6		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
t_{RWC}	Read Modify Write (RMW) Cycle Time	520		680		590		960		ns
t_{CRW}	CE Width During RMW	350	4000	490	4000	420	4000	540	3000	ns
t_{WC}	$\overline{WE}$ to CE on	0		0		0		0		ns
t_W	$\overline{WE}$ to CE off	150		140		150		200		ns
t_{WP}	$\overline{WE}$ Pulse Width	50		100		50		100		ns
t_{DW}	D_{IN} to $\overline{WE}$ Set Up	0		0		0		0		ns
t_{DH}	D_{IN} Hold Time	0		0		0		0		ns
t_{CO}	CE to Output Delay		180		200		250		320	ns
t_{ACC}	Access Time ($t_{ACC} = t_{AC} + t_{CO} + 1t_T$)		200		220		270		350	ns



NOTES:
1. Minimum cycle timing is based on t_T of 20ns.
2. V_{IL} MAX is the reference level for measuring timing of the addresses, $\overline{CS}$, $\overline{WE}$, and D_{IN}.
3. V_{IH} MIN is the reference level for measuring timing of the addresses, $\overline{CS}$, $\overline{WE}$, and D_{IN}.
4. V_{SS} +2.0V is the reference level for measuring timing of CE.
5. V_{DD} -2V is the reference level for measuring timing of CE.
6. V_{SS} +2.0V is the reference level for measuring the timing of $\overline{D_{OUT}}$. C_{LOAD} = 50pF. Load = One TTL Gate.
7. $\overline{WE}$ must be at V_{IH} until end of t_{CO}.
8. During CE high typically 0.5mA will be drawn from any address pin which is switched from low to high.

Typical Characteristics

Fig. 1. I_{DD} AV VS. TEMPERATURE

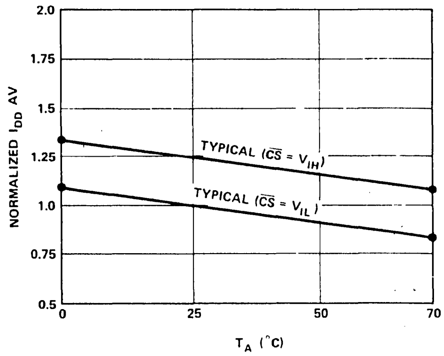


Fig. 2. TYPICAL I_{DD} AVERAGE VS. CYCLE TIME

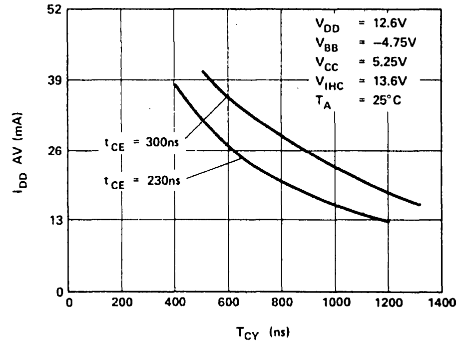


Fig. 3. I_{DD2} VS. TEMPERATURE

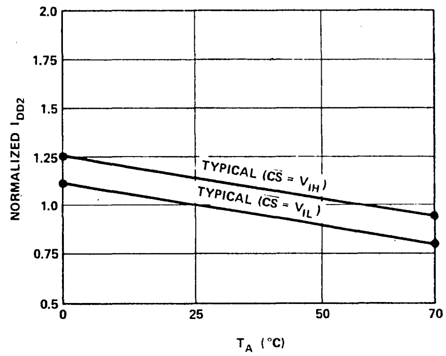
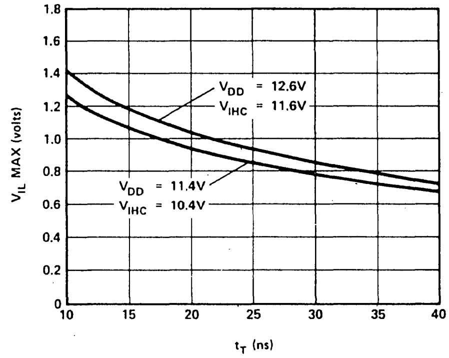
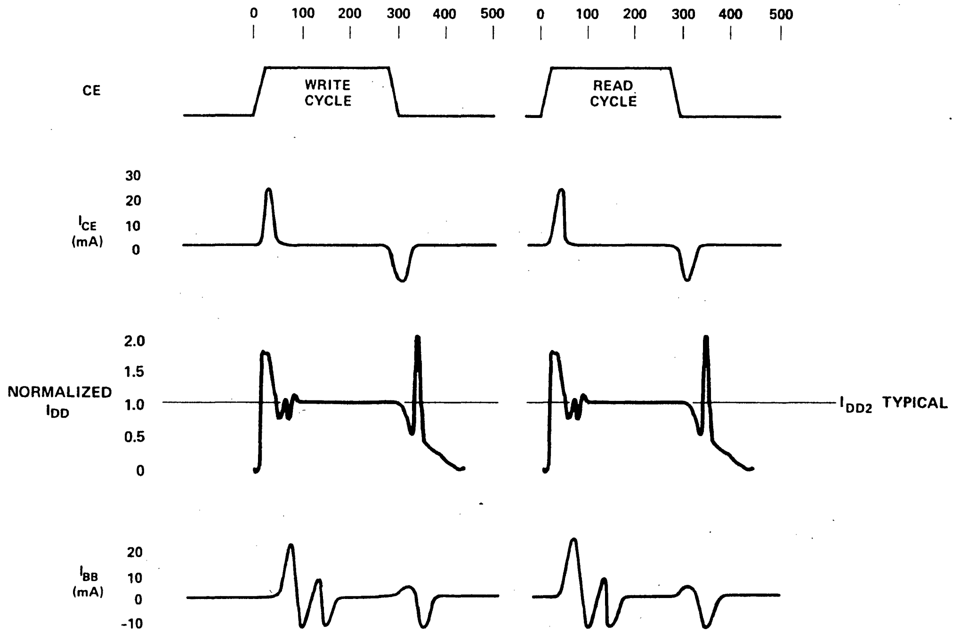


Fig. 4. TYPICAL V_{IL} MAX VS. CE RISE TIME



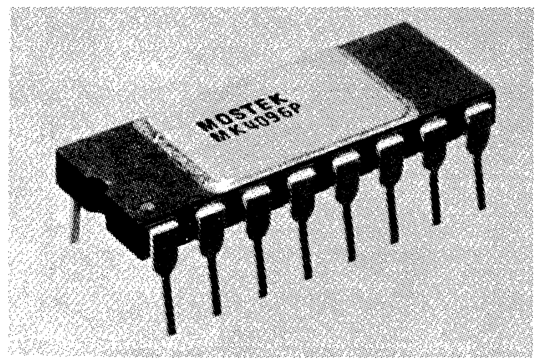
Typical Current Transients vs. Time



For additional typical characteristics and applications information please refer to Intel Application Note AP-10, "Memory System Design With the Intel 2107B 4K RAM" or Intel's Memory Design Handbook.

MOSTEK'S MEMORIES

MK 4096 P/4096 x 1 Bit Dynamic Random Access Memory



FEATURES:

- ☐ Standard 16-pin DIP
- ☐ All inputs TTL compatible
- ☐ On-chip latches for addresses, chip select, and data in
- ☐ Three-State TTL compatible output
- ☐ Chip select decode does not add to access time
- ☐ Output data latched and valid into next cycle
- ☐ Read and write cycles of 375 nsec (-6) 425 nsec (-16), and 500 nsec (-11)
- ☐ Access times of 250 nsec (-6), 300 nsec (-16), 350 nsec (-11)
- ☐ Low power: active power under 380 mW (-16) standby power under 24 mW

DESCRIPTION:

The MK 4096 is a 4096 x 1 bit dynamic random access memory circuit fabricated with MOSTEK's special Self-Aligned, Poly-Interconnect, N-Channel (SPIN) process to minimize cell area and optimize circuit performance. The single transistor cell uses a dynamic storage technique and each of the 64 row addresses requires refreshing every 2 milliseconds.

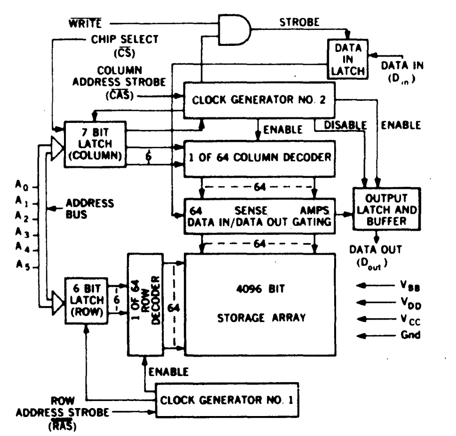
A unique multiplexing and latching technique for the address inputs permits the MK 4096 to be packaged in a standard 16-pin DIP on 0.3 inch centers. This package size provides high system bit densities and is compatible with widely available automated testing and insertion equipment.

System oriented features on the MK 4096 include direct interfacing capability with TTL, 6 instead of 12 address lines to drive, on-chip registers which can eliminate the need for interface registers, input logic levels selected to optimize the noise immunity, and two chip select methods to allow the user to determine the speed/power characteristics of his memory system.

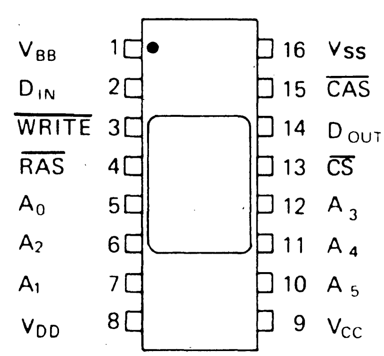
ADDRESSING:

The 12 address bits required to decode 1 of 4096 cell locations are multiplexed onto the 6 address pins and latched into the on-chip row and column address latches. The Row Address Strobe (RAS) latches the 6 row address bits into the chip. The Column Address Strobe (CAS) latches the 6 column address bits plus Chip Select (CS) into the chip. Since the Chip Select signal is not required until well into the cycle, its decoding time does not add to the system access or cycle time.

FUNCTIONAL DIAGRAM



PIN CONNECTIONS



ABSOLUTE MAXIMUM RATINGS*

Voltage on any pin relative to V_{BB} .... –0.5V to +25.0V
Operating Temperature T_A (Ambient) .... 0°C to 70°C
Storage Temperature (Ambient) .... –55°C to 150°C

RECOMMENDED DC OPERATING CONDITIONS
($0° \leq T_A \leq 70°C$)

	PARAMETER	MIN	TYP	MAX	UNITS
V_{DD}	Supply Voltage	11.4	12.0	12.6	volts
V_{CC}	Supply Voltage	V_{SS}	5.0	V_{DD}	volts
V_{SS}	Supply Voltage	0	0	0	volts
V_{BB}	Supply Voltage	–4.5	–5.0	–5.5	volts
V_{IH}	Logic 1 Voltage all inputs except RAS, CAS WRITE	2.4	5.0	7.0	volts
V_{IL}	Logic 0 voltage, all inputs	–1.0	0	.8	volts
V_{IHC}	logic 1 Voltage RAS, CAS, WRITE	2.7	5.0	7.0	volts

DC ELECTRICAL CHARACTERISTICS
($0°C \leq T_A \leq 70°C$) (V_{DD} = 12.0V ±5%; V_{CC}= 5.0V±10%; V_{SS}= 0V, V_{BB}= – 5.0V± 10%)

	PART NUMBER	4096–6		4096-11/16		
	PARAMETER	MIN	MAX	MIN	MAX	UNITS
I_{DD1}	Average V_{DD} Power Supply Current		35		30	mA
I_{CC}	V_{CC} Power Supply Current					mA
I_{BB}	Average V_{BB} Power Supply Current		75		75	μA
I_{DD2}	Standby V_{DD} Power Supply Current		2		2	mA
$I_{I(L)}$	Input Leakage Current (any input)		10		10	μA
$I_{O(L)}$	Output Leakage Current		10		10	μA
V_{OH}	Output Logic 1 Voltage @ I out = –5 mA	2.4		2.4		volts
V_{OL}	Output Logic 0 Voltage @ I out = 2 mA		0.4		0.4	volts

AC ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS
($0°C \leq T_A \leq 70°C$) (V_{DD} = 12.0V± 5%; V_{CC}= 5.0V±10%, V_{SS}= 0V, V_{BB}= –5.0V±10%)

	PART NUMBER	4096-6		4096-16		4096-11		
	PARAMETER	MIN	MAX	MIN	MAX	MIN	MAX	UNITS
t_{RC}	Random Read or Write Cycle Time	375		425		500		nsec
t_{RAC}	Access Time from Row Address Strobe		250		300		350	nsec
t_{CAC}	Access Time from Column Address Strobe		140		165		200	nsec

* Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

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DATA INPUT/OUTPUT

Data to be written into a selected cell is latched into an on-chip register by a combination of $\overline{WRITE}$ and $\overline{CAS}$. The last of these signals making its negative transition is the strobe for the Data In register. This permits several options in the write timing. In a write cycle, if the $\overline{WRITE}$ input is brought low prior to $\overline{CAS}$, the Data In is strobed by $\overline{CAS}$ and the set-up and hold time are referenced to this signal. If the cycle is to be a read-write cycle, or read-modify-write cycle, then the $\overline{WRITE}$ input will not go to a logic 0 until after access time. But now, because $\overline{CAS}$ is already at a logic 0, the Data In is strobed in by $\overline{WRITE}$ and the set-up and hold time are referenced to it.

At the beginning of a memory cycle the state of the Data Out Latch and buffer depend on the previous memory cycle. If during the pervious cycle the chip was unselected, the output buffer will be in its open-circuit condition. If the previous cycle was a read, read-write, or read-modify-write cycle and the chip was selected, then the output latch and buffer will contain the data read from the selected cell. This output data is the same polarity (not inverted) as the input data. If the previous cycle was a write cycle ($\overline{WRITE}$ active low before access time) and the chip was selected, then the output latch and buffer will contain a logic 1. Regardless of the state of the output it will remain valid until $\overline{CAS}$ goes negative. At that time the output will unconditionally go to its open-circuit state. It will remain open circuit until access time. At access time the output will assume the proper state for the type of cycle performed. If the chip is unselected, it will not accept a $\overline{WRITE}$ command and the output will remain in the open-circuit state.

INPUT/OUTPUT LEVELS

All inputs, including the two address strobes, will interface with TTL. The high impedance, low capacitance input characteristics simplify input driver selection by allowing use of standard logic elements rather than specially designed driver elements. Even though the inputs may be driven directly by TTL gates, pull-up or termination resistors are normally required in a system to prevent ringing of the input signals due to line inductance and reflections. In high speed memory systems, transmission line techniques must be employed on the signal lines to achieve optimum system speeds. Series rather than parallel terminations may be employed at some degradation of system speed.

The three-state output buffer is a low impedance to V_{CC}, for a logic 1 and a low impedance to V_{SS} for a logic 0. The resistance to V_{CC} is 500-ohms maximum and 150-ohms typically. The resistance to V_{SS} is 200-ohms maximum and 100-ohms typically. The separate V_{CC} pin allows the ouput buffer to be powered from the supply voltage of the logic to which the chip is interfaced. During battery standby operation, the V_{CC} pin may be unpowered without affecting the MK 4096P refresh operation. This allows all system logic except the $\overline{RAS}/\overline{CAS}$ timing circuitry and the refresh address logic to be turned off during battery standby to conserve power.

REFRESH

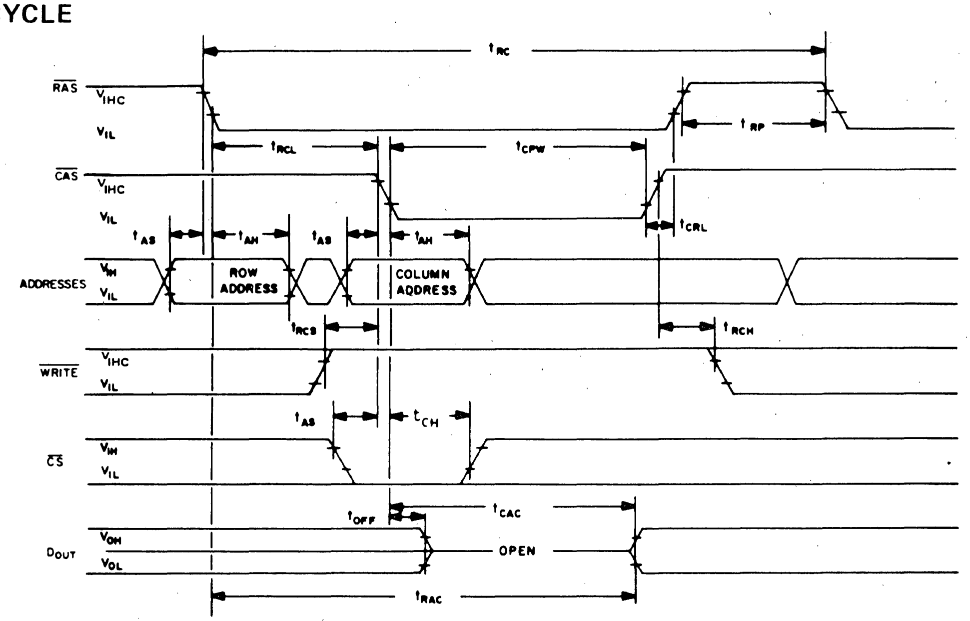
Refresh of the cell matrix is accomplished by performing a memory cycle at each 64 row addresses every 2 milliseconds or less. Any read cycle refreshes the selected row, regardless of the state of the Chip Select. A write, read-write, or read-modify-write cycle also refreshes the selected row but the chip should be unselected to prevent writing data into the selected cell.

POWER DISSIPATION/STANDBY MODE

Most of the circuitry used in the MK 4096P is dynamic and draws power only as the result of an address strobe edge. Because the power is not drawn during the whole time the strobe is active, the dynamic power is a function of operating frequency. Typically, the power is 120mW at a 1µsec cycle time for the MK 4096P; with a worst case power of less than 380mW at a 425 nsec cycle time. To reduce the overall system power the Row Address Strobe ($\overline{RAS}$) must be decoded and supplied to only the selected chips. The $\overline{CAS}$ must be supplied to all chips (to turn off the unselected outputs). But those chips that did not receive a $\overline{RAS}$ will not dissipate any power on the $\overline{CAS}$ edges, except for that required to turn off the output. If the $\overline{RAS}$ is decoded and supplied to the selected chips, then the Chip Select input of all chips can be at a logic 0. The chips that receive a $\overline{CAS}$ but no $\overline{RAS}$ will be unselected (output open-circuited) regardless of the Chip Select input.

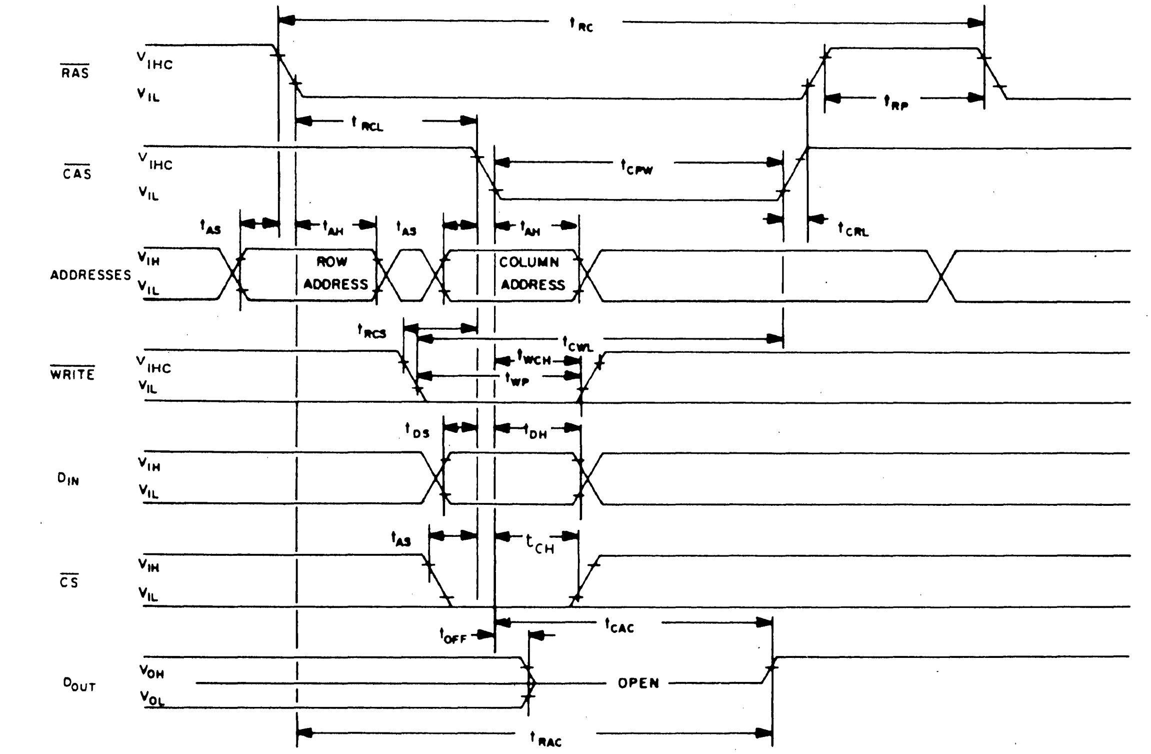
The current waveforms for the current drawn from the V_{DD} and V_{BB} supplies are pulsed and proper power distribution and bypassing techniques are required to maintain system power supply noise levels at an acceptable level. Low inductance supply lines for V_{DD} and V_{SS} are desirable. A minimum of one 0.01 microfarad low inductance bypass capacitance per two MK 4096P devices and one 6.8 microfarad electrolytic capacitor per eight MK 4096P devices on each of the V_{DD} and V_{BB} supply lines is desirable. A noise level of less than 0.5 volts peak-to-peak on both V_{DD} and V_{BB} should be a design goal.

READ CYCLE

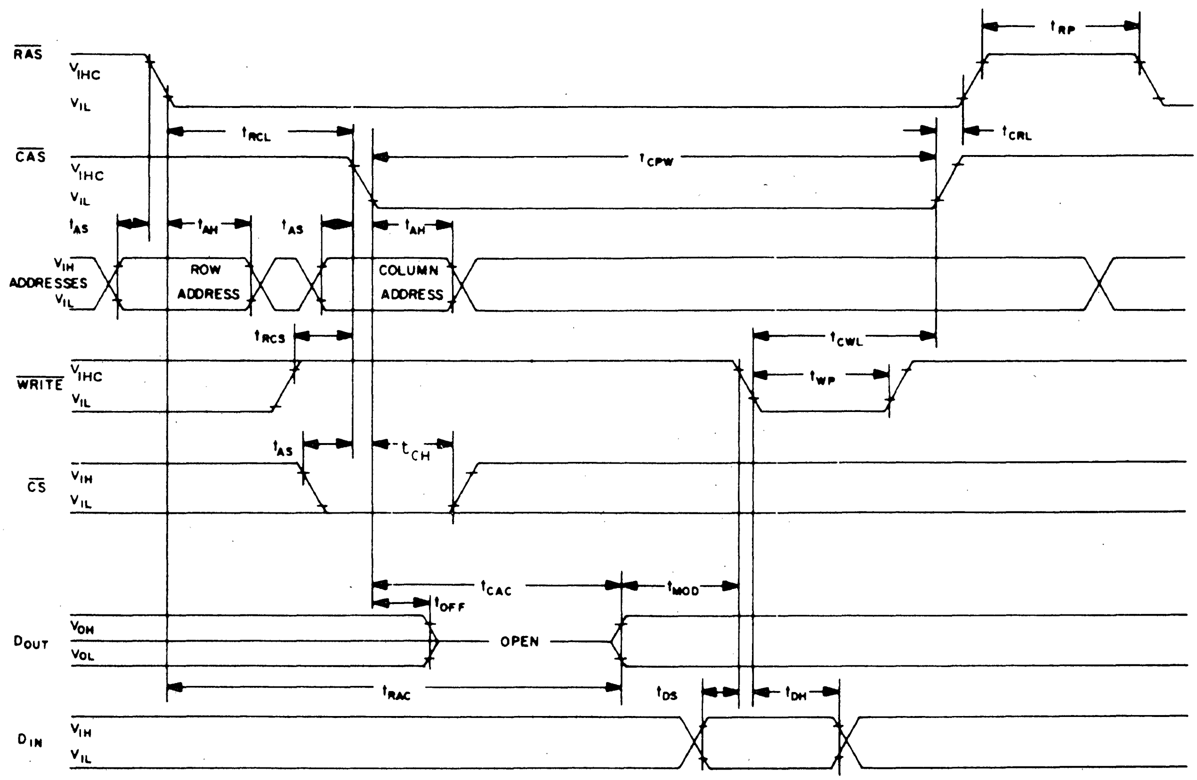


MEMORY Mostek

WRITE CYCLE



READ-MODIFY-WRITE CYCLE



Mostek

MEMORY

MK 4200 P-16/MK 4200 P-11
4096 x 1 Bit Dynamic
MOS Random Access Memory
Low Standby Power

FEATURES:

- ☐ Standard 16-pin DIP
- ☐ Inputs protected against static charge
- ☐ All inputs TTL compatible, except RAS
- ☐ On-chip latches for addresses, chip select, and data in
- ☐ Three-state TTL compatible output
- ☐ Chip select decode does not add to access time
- ☐ Output data latched and valid into next cycle
- ☐ Read and write cycles of 500 nsec (−11) 425 nsec (−16)
- ☐ Access times of 350 nsec (−11) 300 nsec (−16)
- ☐ Low power: active power under 300mW (−11)
  standby power under .6mW

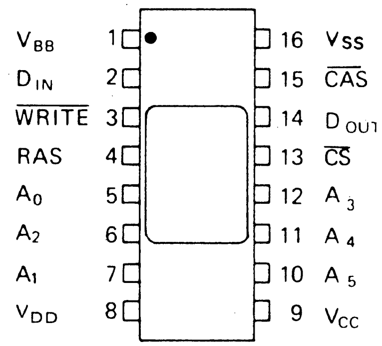
DESCRIPTION:

The MK 4200 is a 4096 x 1 bit dynamic random access memory circuit fabricated with MOSTEK's special Self-Alligned, Poly-Interconnect, N-Channel (SPIN) process to minimize cell area and optimize circuit performance. The single transistor cell uses a dynamic storage technique and each of the 64 row addresses requires refreshing every 2 milliseconds.

A unique multiplexing and latching technique for the address inputs permits the MK 4200 to be packaged in a standard 16-pin DIP on 0.3 each centers. This package size provides high system bit densities and is compatible with widely available automated testing and insertion equipment.

System oriented features on the MK 4200 include very low standby power dissipation, direct interfacing capability with TTL, 6 instead of 12 address lines to drive, on-chip registers input logic levels selected to optimize the noise immunity, and two chip select mehtods to allow the user to determine the speed/power characteristics of his memory system.

PIN CONNECTIONS



MK 28000 P/16K-Bit
MOS Read-Only Memory

FEATURES:

- ☐ 600 ns Maximum Access Time
- ☐ Low Power-Dissipation
  Active—0.01 mW/bit Typ.
  Inactive—.003 mW/bit Typ.
- ☐ EA 4900 and EA 4800 Hi-performance Replacement
- ☐ 100 μsec Minimum Output Data Hold Time
- ☐ 2K x 8 or 4K x 4 organization with Open Drain Outputs
- ☐ Standard Supplies +5 volts, −12 volts
- ☐ Ion-Implanted for Full TTL/DTL Compatibility

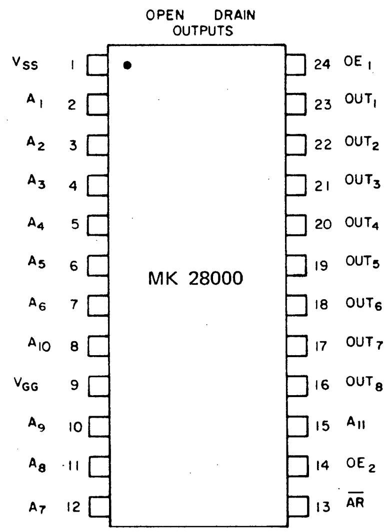
DESCRIPTION:

The MK 28000 is a mask programmable read only memory utilizing low-threshold Ion-Implant P-Channel technology. The MK 28000 is a Hi-performance replacement for the EA 4900. The MK 28000 may be organized as either a 2K x 8 or 4K x 4 memory.

The MK 28000 open drain outputs are divided into two groups with one Output Enable line controlling each group of outputs. This feature allows the MK 28000 to be either a 2K x 8 or a 4K x 4 memory without any internal mask changes. For a 2K x 8 organization, the Output Enables (OE_1, OE_2) are tied together. For a 4K x 4 organization, the four outputs associated with OE_1 are wire-ORed to the four outputs associated with OE_2 . OE_1 and OE_2 are inverted with respect to each other and used as the twelfth address input in the 4K x 4 organization.

The internal circuitry of the MK 28000 is dynamic. This feature means low standby power consumption when the ROM is not being addressed.

PIN CONNECTIONS



All inputs are protected against static charge accumulation. Pullup resistors on all inputs are available as a programmable option.

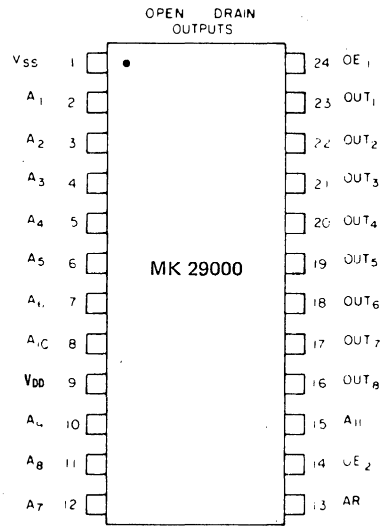
With no address lead time required, system design is simplified; address and AR may appear simultaneously.

MK 29000 P/16K-Bit
MOS Read-Only Memory Fast Access Time

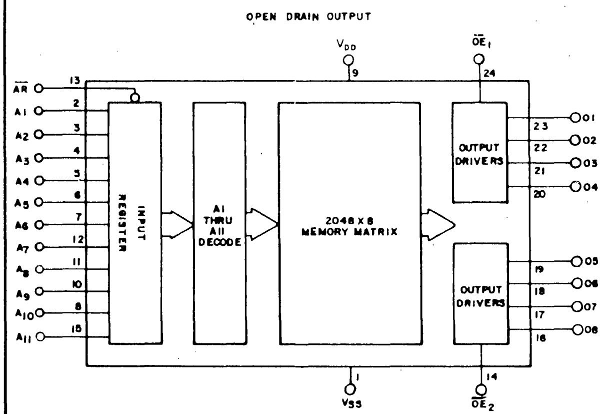
FEATURES:

- ☐ Fast Access, Less Than 250 ns Access Time
- ☐ Single +12 Volt Power Supply
- ☐ 2K x 8 or 4K x 4 Organization With Open-Drain Outputs
- ☐ Ion-Implanted for TTL/DTL Compatibility at All Inputs
- ☐ Low Power Dissipation
- ☐ On-Chip Address Latches

PIN CONFIGURATION



BLOCK DIAGRAM



DESCRIPTION:

The MK 29000 is a mask programmable dynamic, read only memory circuit fabricated with MOSTEK's special Self-Aligned, N-Channel, Metal Gate process to minimize chip size and optimize circuit performance. The MK 29000 is the first of a series of high performance ROM circuits designed to be competitive with many bipolar ROMs in speed, but excel in power dissipation and bit density. The timing requirements for the MK 29000 are such that the part will fit right into many high performance memory systems. The RAS and precharge timing requirements for the MK 4096, 4K dynamic RAM are identical to the AR and precharge requirements of the MK 29000.

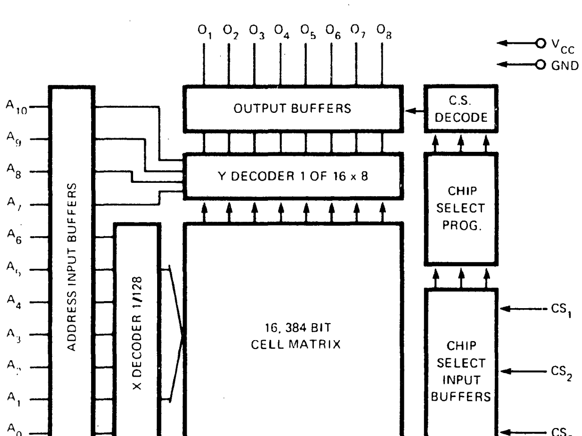
The MK 29001 is a preprogrammed version of the MK 29000 containing six character conversion codes (ASCII to Selectric, EBCDIC, and a modified 8-bit Hollerith/Selectric to ASCII, EBCDIC to ASCII, and a modified Hollerith to ASCII) as well as 128 USASCII characters using mixed character fonts of 5 x 7 and 7 x 7 dot matrices with extra check bits.

MK 31000 P/16K-Bit
MOS Read-Only Memory

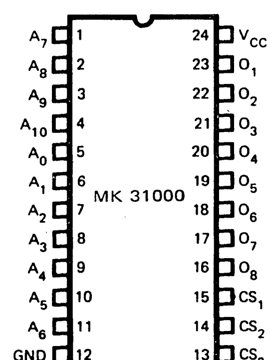
FEATURES:

- ☐ Single +5 volt power supply
- ☐ Completely static operation (no clocks required)
- ☐ Less than 600 ns Access Time
- ☐ Directly TTL compatible
- ☐ Three programmable chip select inputs
- ☐ Input protection against static charge

FUNCTIONAL DIAGRAM



PIN CONFIGURATION



DESCRIPTION:

The MK 31000 is a 16,384 bit read only memory circuit designed as a high performance replacement for the INTEL 2316. The internal organization of the MK31000 is arranged as a 2K x 8 matrix to allow simple interface with eight-bit processor applications. The static operation of the MK 31000 coupled with three programmable chip select inputs provide an easily expandable, high performance memory circuit with extremely simple interface requirements.

The MK 31000 read only memory is fabricated with N-Channel silicon gate technology to minimize chip size and optimize circuit performance. Ion implantation allows TTL compatibility at both the inputs and the outputs.

Mostek

MEMORY

RCA-MWS5001D SOS 1024-Bit COS/MOS LSI Static Random Access Memory

The RCA-MWS5001D is a 1024-word by 1-bit static random access memory designed for use in memory systems where high speed, low power, and ease of use are primary design requirements. These characteristics are obtained primarily from the use of self-aligned silicon-gate COS/MOS SOS technology.

The output state of the MWS5001D is a function of the input address and chip-select states only. Valid data will appear at the output in one access time following the latest address change to a selected chip. After valid data appears, the address may then be changed immediately. It is not necessary to clock the chip select input or any other input terminal for fully static operation, therefore the chip select input may be used as an additional address input. When the device is in an unselected state ($\overline{CS}$=1), the internal write circuitry and output sense amplifier are disabled. This feature allows the three-state data outputs from many arrays to be OR-tied to a common bus for ease of memory expansion.

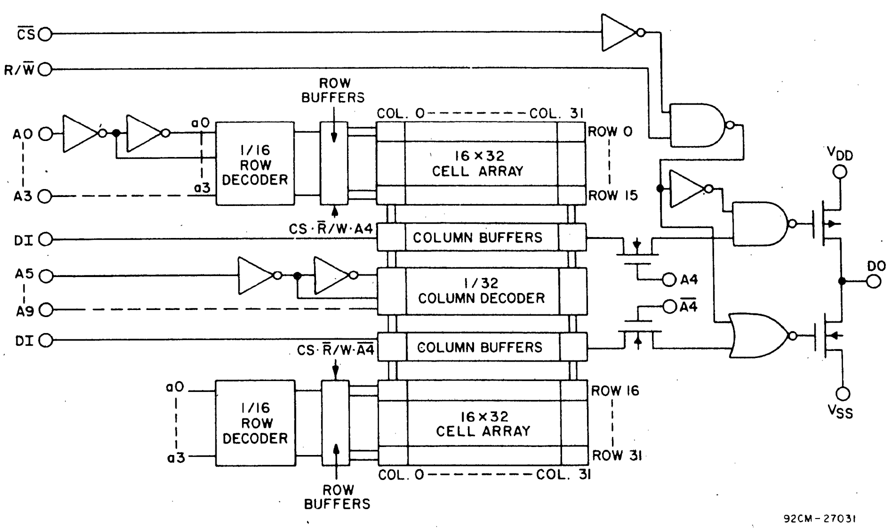
The MWS5001 is supplied in a hermetically sealed 16-lead dual-in-line ceramic package (D suffix) or in chip form (H suffix).

MAXIMUM RATINGS,
Absolute-Maximum Values:

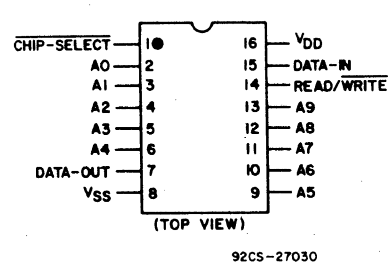
STORAGE TEMPERATURE RANGE .... −65 to +150°C
OPERATING TEMPERATURE RANGE .... −20 to +85°C
DC SUPPLY VOLTAGE RANGE
($V_{DD}-V_{SS}$) .... −0.5 to +6 V
ALL INPUTS .... $V_{SS} \leqslant V_I \leqslant V_{DD}$
RECOMMENDED DC SUPPLY VOLTAGE
($V_{DD}-V_{SS}$) .... 4.5 to 6 V
LEAD TEMPERATURE (During Soldering):
At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10 seconds max. .... 265°C

Features:

- **Organization—1024 words by 1 bit**
- **Fully static operation—no external clocks required**
- **Access time—150 ns (typ.) @ V_{DD} = 5 V**
- **Cycle time—160 ns (typ.) @ V_{DD} = 5 V**
- **Low power dissipation:**
  0.1 μW/Bit (typ.) standby @ V_{DD} = 5 V
  4 μW/Bit (typ.) operating @ V_{DD} = 5 V
- **Operation from a single power supply—V_{DD} = 4.5 to 6 V**
- **High noise immunity—30% of V_{DD} (typ.)**
- **TTL output drive capability**
- **Three-state data output for bus-oriented systems**



Functional block diagram.



Terminal Assignment

STATIC ELECTRICAL CHARACTERISTICS at T_A = 25°C, V_{DD} = 5 V ± 5%

CHARACTERISTIC		TEST CONDITIONS	V_O (V)	TYPICAL VALUES	UNITS
Quiescent Device Current*	I_L			20	μA
Quiescent Device Dissipation*	P_D			100	μW
Output Voltage: Low Level	V_{OL}			0.01	V
High Level	V_{OH}			4.99	V
Noise Immunity	V_{NL}	All Inputs	3.6	1.5	V
	V_{NH}	All Inputs	1.4	1.5	V
Output Drive Current: N-Channel (Sink)	I_DN	Data Output (Sink)	0.4	2	mA
P-Channel (Source)	I_DP	Data Output (Source)	4.6	1	mA
Data Output Off-Resistance	R_O(Off)	Data Output High Impedance State		5	MΩ
Input Current	I_I	Any Input		1	nA

* Standby current is independent of any input state.

DYNAMIC ELECTRICAL CHARACTERISTICS at T_A = 25°C, V_{DD} = 5 V ± 5%, Input t_r,t_f = 20 ns, and C_L = 30 pF

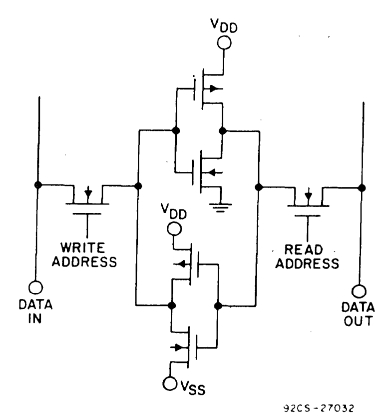
CHARACTERISTIC		TYPICAL VALUES	UNITS
Read Cycle Times:			
Read Access	t_{RA}	150	ns
Read Cycle	t_{RC}	160	ns
Output Enable	t_{EN}	60	ns
Read/Write Hold	t_{WH}	50	ns
Read/Write Set-Up	t_{WS}	50	ns
Output Disable	t_{DIS}	20	ns
Write Cycle Times:			
Write Cycle	t_{WC}	160	ns
Read/Write Hold	t_{WH}	50	ns
Read/Write Pulse Width	t_W	60	ns
Read/Write Set-Up	t_{WS}	50	ns
Input Data Set-Up	t_{DS}	30	ns
Input Data Hold	t_{DH}	30	ns
Read/Modify/Write Cycle Times:			
Read/Modify/Write Cycle	t_{MC}	270	ns
Read Hold	t_{RH}	160	ns
Read Access	t_{RA}	150	ns
Output Enable	t_{EN}	60	ns
Read/Write Pulse Width	t_W	60	ns
Read/Write Set-Up	t_{WS}	50	ns
Input Data Set-Up	t_{DS}	30	ns
Input Data Hold	t_{DH}	30	ns
Output Disable	t_{DIS}	20	ns

TRUTH TABLE

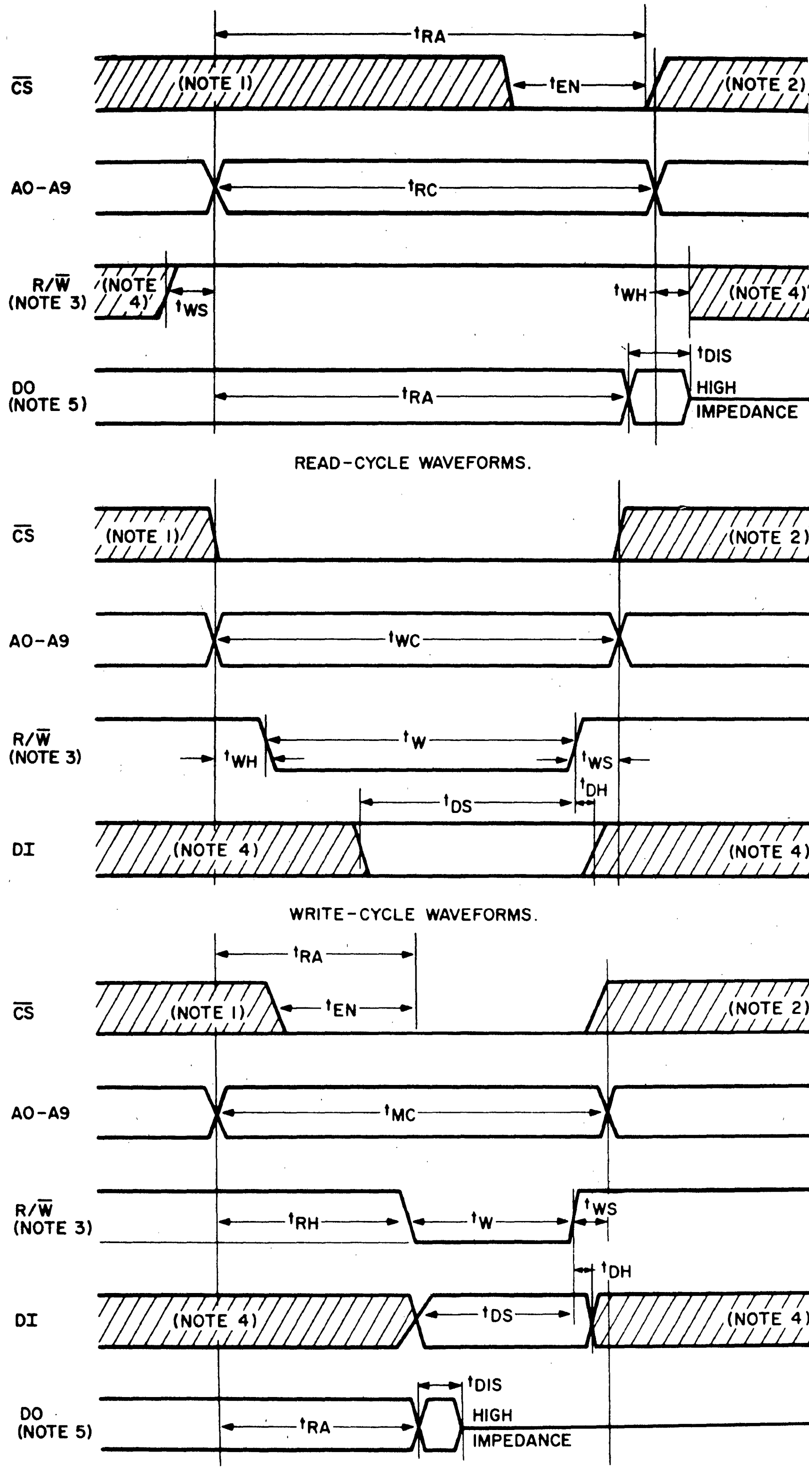
INPUTS		OUTPUT
READ/WRITE R/$\overline{W}$	CHIP-SELECT $\overline{CS}$	DATA OUTPUT DO
X	1	High Impedance
0	X	High Impedance
1	0	Contents of Addressed Cell

X = DON'T CARE

LOGIC 1 ≡ HIGH
LOGIC 0 ≡ LOW



Memory cell configuration.



Read cycle, write cycle, and read/modify/write cycle waveforms.

Note 1. Chip-Select ($\overline{CS}$) permitted to change from high to low level or remain low on a selected device.
Note 2. Chip-Select ($\overline{CS}$) permitted to change from low to high level or remain low.
Note 3. Read/Write (R/$\overline{W}$) must be at a high level during all address transitions.
Note 4. Don't care.
Note 5. Data-Out (DO) is a high impedance within t_{DIS} ns after the falling edge of R/$\overline{W}$ or the rising edge of $\overline{CS}$.

Other RCA SOS Memories

MWS5501D
1024-Word x 1-Bit Static RAM with Three-State Output
16-lead dual-in-line ceramic package

Access Time	80 (typ.)	ns
Power Supply	+10	V
Operating Power Dissipation	20	mW

MWS5002D
1024-Word x 1-Bit Static RAM with Open-Drain Output
16-lead dual-in-line ceramic package

Access Time	150 (typ.)	ns
Power Supply	+5	V
Operating Power Dissipation	3	mW

MWS5502D
1024-Word x 1-Bit Static RAM with Open-Drain Output
16-lead dual-in-line ceramic package

Access Time	80 (typ.)	ns
Power Supply	+10	V
Operating Power Dissipation	20	mW

MWS5040D
256-Word x 4-Bit Static RAM with Three-State Output
22-lead dual-in-line ceramic package

Access Time	150 (typ.)	ns
Power Supply	+5	V
Operating Power Dissipation	3	mW

MWS5540D
256-Word x 4-Bit Static Fully Decoded RAM with Three-State Output
22-lead dual-in-line ceramic package

Access Time	80 (typ.)	ns
Power Supply	+10	V
Operating Power Dissipation	20	mW

signetics

8192-BIT STATIC READ-ONLY MEMORY 2580

OBJECTIVE SPECIFICATION

2580–N,I

DESCRIPTION

The 2580 is an 8,192-Bit Read-Only Memory available in a 2048x4 organization. This device has TTL compatible inputs and outputs and requires +5V and −12V power supplies. A READ input controls the entry of data from the ROM into output latches. Three-state outputs allow OR tying for implementing larger memories. The outputs are enabled by a programmable four bit select code applied to four binary chip select terminals.

FEATURES

- 2048x4 ORGANIZATION
- 625ns TYPICAL ACCESS TIME
- OUTPUT LATCHES
- 1 OF 16 CHIP ENABLE DECODING
- TTL/DTL COMPATIBLE INPUTS AND OUTPUTS
- THREE-STATE OUTPUTS
- V_{CC} = +5V' V_{GG} = −12V, V_{DD} = 0V
- 24 PIN SILICONE DIP
- P-MOS SILICON GATE TECHNOLOGY

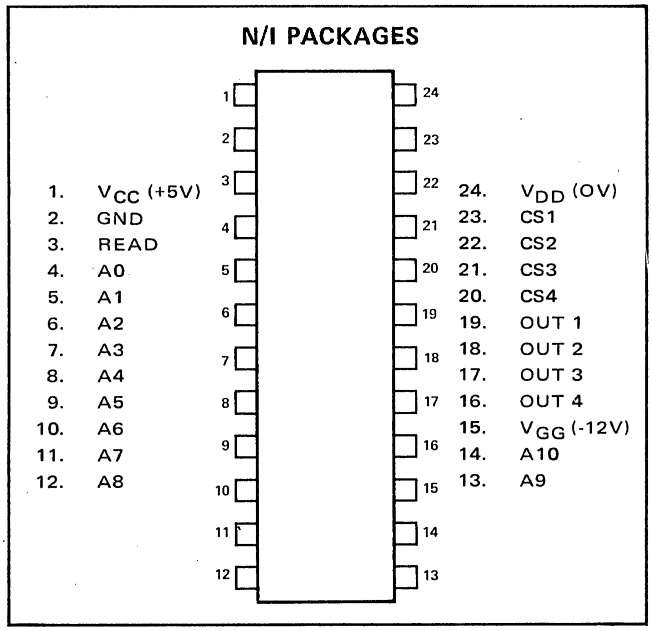
APPLICATIONS

MICRO-PROGRAMMING
LOOK-UP TABLES
DATA STORAGE
CODE CONVERSION
RANDOM LOGIC SYNTHESIS
CHARACTER GENERATION
PROGRAM STORAGE

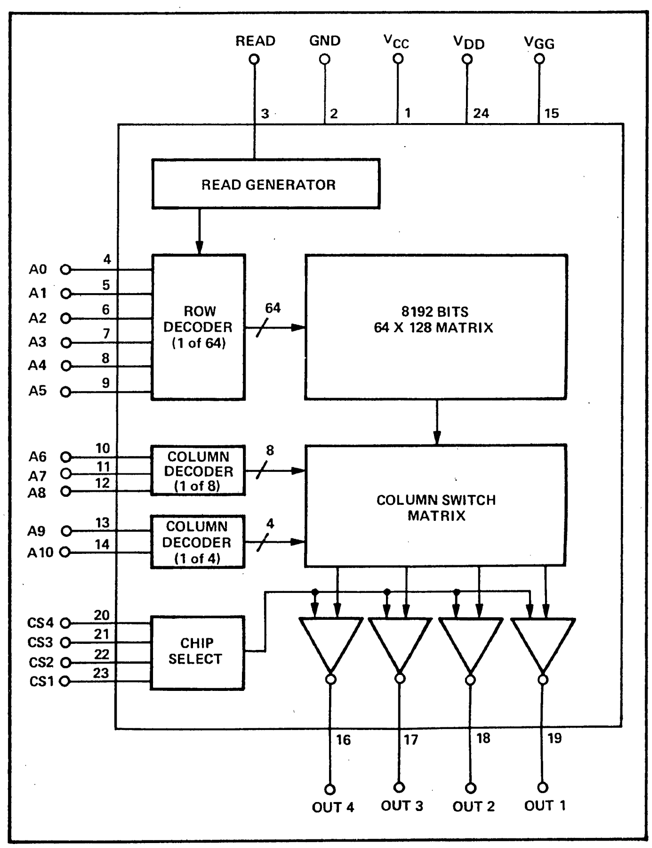
BIPOLAR COMPATIBILITY

All inputs of the 2580 can be driven directly by standard TTL level signals. The data output buffers are capable of sinking a minimum of 1.6mA sufficient to drive one standard TTL load.

PIN CONFIGURATION (TopView)



BLOCK DIAGRAM



Signetics

MEMORY

DC CHARACTERISTICS

$T_A = 0°C$ to $+70°C$; $V_{CC} = +5V \pm 5\%$, $V_{DD} = 0V$, $V_{GG} = -12V \pm 5\%$ unless otherwise noted. (See notes 4, 5, 6, 7)

SYMBOL	TEST	MIN	TYP	MAX	UNIT	CONDITIONS
I_{LI}	Input Load Current		10	500	nA	$V_{IN} = -5.5V$ $T_A = 25°C$
I_{LO}	Output Leakage Current		10	1000	nA	$V_{OUT} = 0V$ $T_A = 25°C$ $V_{CE} = V_{CC}$
I_{CC}	V_{CC} Power Supply Current		23	35	mA	(8)
I_{GG}	V_{GG} Power Supply Current		23	35	mA	(8)
V_{IL}	Input Logic "0"			+0.6	V	Note 12
V_{IH}	Input Logic "1"	+3.4		5.3	V	Note 12

AC CHARACTERISTICS

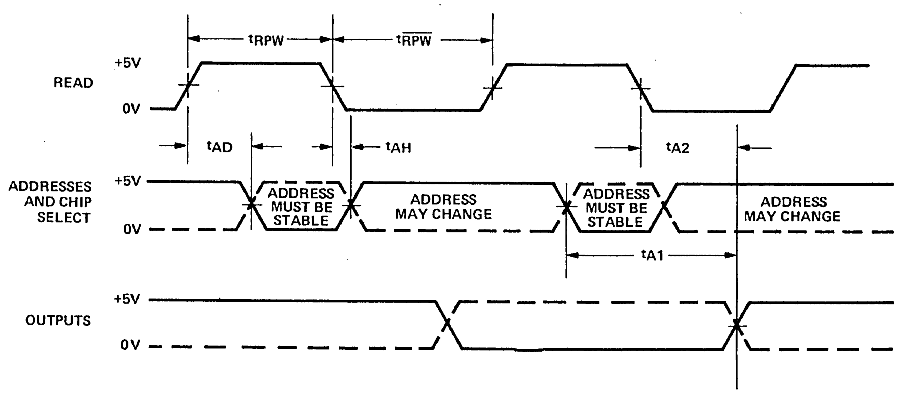
$T_A = 25°C$; $V_{CC} = 5V \pm 5\%$, $V_{DD} = 0V$, $V_{GG} = -12V \pm 5\%$ unless otherwise noted.

SYMBOL	TEST	MIN	TYP	MAX	UNIT	CONDITIONS
V_{OL}	Output Logic "0"			+0.5	V	$I_{OL} = 1.6mA$
V_{OH}	Output Logic "1"	+3.8			V	$I_{OH} = 100\mu A$
t_{RPW}[10]	Read Pulse Width	650	500		ns	
$t_{\overline{R}PW}$[9]	$\overline{\text{Read}}$ Pulse Width	500	400		ns	
t_{AD}	Address Delay Time (11)			50	ns	
t_{AH}	Address Hold Time	0			ns	
t_{A1}	Address to Output Delay		625	950	ns	
t_{A2}	End of Read Pulse to Output Delay		250	350		
C_{IN}	Input Capacitance			10	pF	f = 1MHz, V_{AC} = 25mV p-p $V_{IN} = V_{CC}$

NOTES:

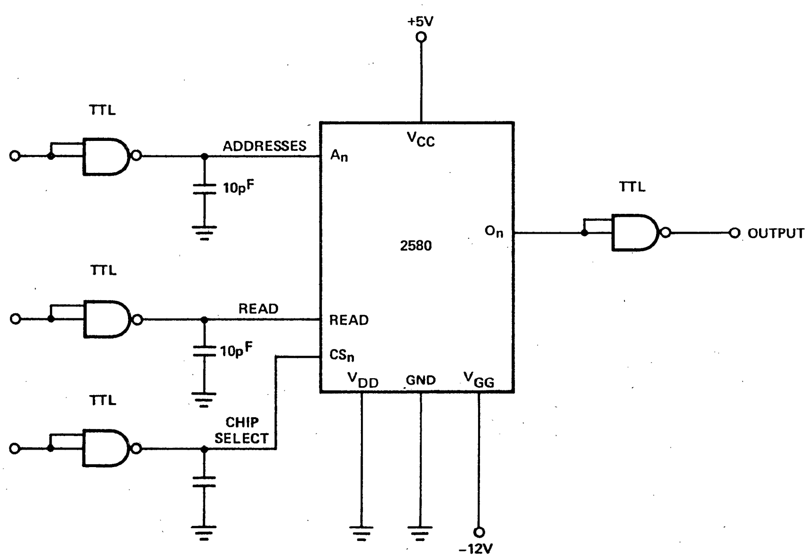
1. Stresses above those listed under "Maximum Guaranteed Rating" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.
2. For operating at elevated temperatures the device must be derated based on a +150°C maximum junction temperature and a thermal resistance of 110°C/W junction to ambient.
3. All inputs are protected against static charge.
4. Parameters are valid over operating temperature range unless specified.
5. All voltage measurements are referenced to ground.
6. Manufacturer reserves the right to make design and process changes and improvements.
7. Typical values are at +25°C and nominal supply voltages.
8. Outputs open, t_{RPW} = 500ns, $t_{\overline{R}PW}$ = 500ns.
9. During $t_{\overline{R}PW}$ data is clocked into the output latches and the address decoders are precharged in preparation for the next cycle.
10. During t_{RPW} addresses are decoded and sent to the memory matrix; and the stored memory data is moved to the data inputs of the output RS latches. This data is clocked into the output latches at the end (falling edge) of the READ pulse. After t_{A2}, data appears at the output terminals.
11. Addresses must be stable within 50ns after the READ line rises and must remain stable until the READ line falls.
12. Guaranteed input levels are stated for worst case conditions including a ±5% variation in V_{CC} and a temperature variation of 0°C to +70°C. Actual input requirements with respect to V_{CC} are $V_{IH} = V_{CC} - 1.85V$ and $V_{IL} = V_{CC} - 4.15V$.

TIMING DIAGRAM



Note: All measurements made at 50% points.
Input $t_r = t_f = 10ns$.

AC TEST SETUP



1024-BIT RANDOM ACCESS READ/WRITE STATIC MEMORY

2602-1 2602-2

2602 - 1, 2602 -2 - B

DESCRIPTION

The Signetics 2602 is a static random access read/write memory offering a 1024x1 organization. Fabricated with low threshold N-Channel silicon gate technology, the 2602-2 offers an access and read cycle time of less than 650 ns. Write cycle time is 650 ns.

The 2602-2 is fully static, requiring no clocks and is completely DTL/TTL compatible including the single +5V power supply requirement.

FEATURES

- 1024x1 ORGANIZATION
- COMPLETELY STATIC OPERATION
- +5V POWER SUPPLY ONLY
- TTL COMPATIBLE INPUTS
- THREE-STATE TTL OUTPUT
- 16-PIN DIP PACKAGE
- 200 mW DISSIPATION TYPICAL
- N-CHANNEL SILICON GATE
- NO CLOCKS, NO REFRESHING, NO SENSING
- ACCESS TIMES: 2602 - 1 500ns
  2602 - 2 650ns
- CYCLE TIMES: 2602 - 1 500ns
  2602 - 2 650ns

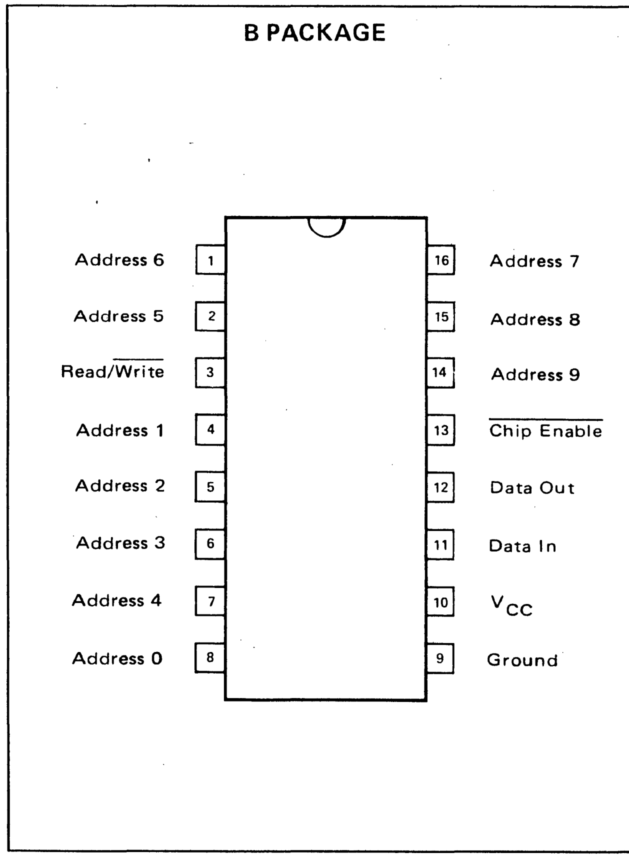
APPLICATIONS

PERIPHERAL MEMORIES
BUFFER MEMORIES
MINICOMPUTER MEMORY

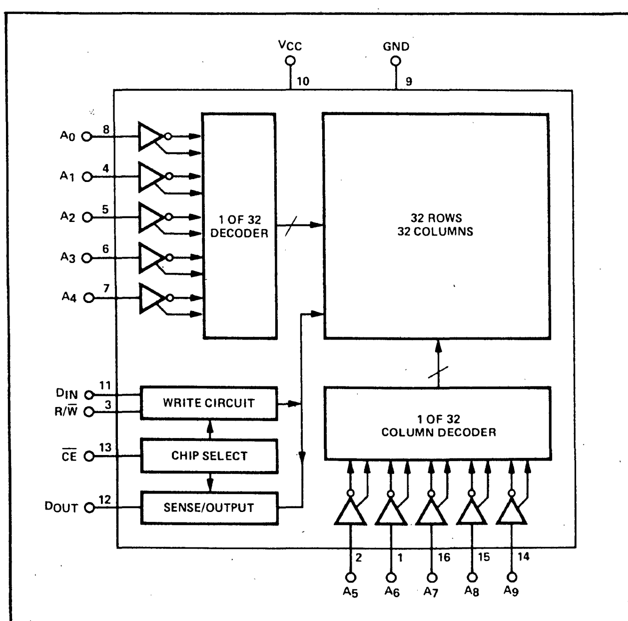
MAXIMUM GUARANTEED RATINGS[1]

Operating Ambient Temperature	0°C to +70°C
Storage Temperature	−65°C to +150°C
All Input, Output, and Supply Voltages with respect to ground	−0.5 V to +7 V
Package Power Dissipation [2] "B" Pkg.	640 mW

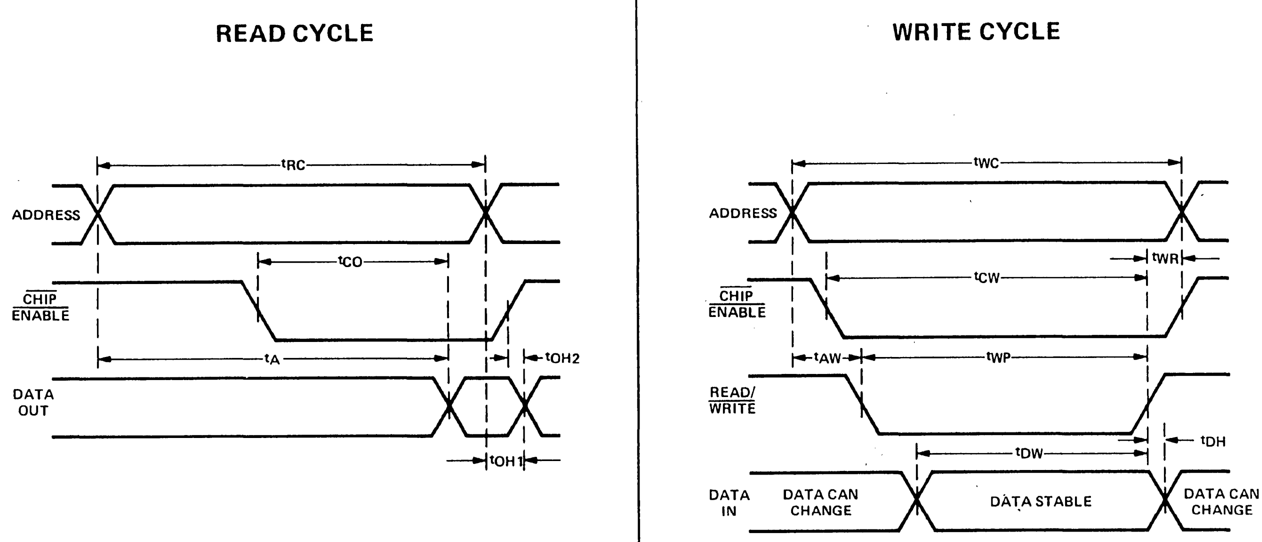
PIN CONFIGURATION



BLOCK DIAGRAM



TIMING DIAGRAMS



A.C. CHARACTERISTICS $T_A = 0°C$ to $70°C$, $V_{CC} = 5V \pm 5\%$ unless otherwise specified.

PARAMETER		LIMIT 2602-1			LIMIT 2602-2			
		MIN	TYP	MAX	MIN	TYP	MAX	
READ CYCLE								
t_{RC}	Read cycle	500			650			ns
t_A	Access time			500			650	ns
t_{CO}	Chip enable to output time			350			400	ns
t_{OH1}	Previous read data valid with respect to address	50			50			ns
t_{OH2}	Previous read data valid with respect to chip enable	0			0			ns
WRITE CYCLE								
t_{WC}	Write cycle	500			650			ns
t_{AW}	Address to write setup time	150			200			ns
t_{WP}	Write pulse width	300			400			ns
t_{WR}	Write recovery time	50			50			ns
t_{DW}	Data setup time	330			450			ns
t_{DH}	Data hold time	100			100			ns
t_{CW}	Chip enable to write setup time	400			550			ns

A.C. CONDITIONS OF TEST

Input Pulse Levels:	+0.65 Volt to +2.2 Volt
Input Pulse Rise and Fall Times:	20nsec
Timing Measurement Reference Level:	1.5 Volt
Output Load:	1 TTL Gate and C_L = 100 pF

D.C. OPERATING CHARACTERISTICS $T_A = 0°C$ to $+70°C$, $V_{CC} = 5V \pm 5\%$ unless otherwise specified.

PARAMETER		TEST CONDITIONS	LIMITS MIN	TYP	MAX	UNIT
I_{LI}	Input load current (All input pins)	V_{IN} = 0 to 5.25V			10 10	μA μA
I_{LOH}	Output leakage current	CE = 2.2V, V_{OUT} = 4.0V			10	μA
I_{LOL}	Output leakage current	CE = 2.2V, V_{OUT} = 0.45V			-100	μA
I_{CC1}	Power supply current	All input = 5.25V Data Out Open T_A = 25°C		30	60	mA
I_{CC2}	Power supply current	All inputs = 5.25V Data Out Open T_A = 0°C			70	mA
V_{IL}	Input "low" voltage		-0.5		+0.65	V
V_{IH}	Input "high" voltage		2.2		V_{CC}	V
V_{OL}	Output "low" voltage	I_{OL} = 1.9 mA			+0.45	V
V_{OH}	Output "high" voltage	I_{OH} = -100 μA	2.4			V
C_{IN}	Input capacitance	V_{IN} = 0V		3	5	pF
C_{OUT}	Output capacitance	V_{OUT} = 0V		7	10	pF

NOTES:
1. All inputs protected against static charge.

Signetics

MEMORY

signetics

4096-BIT READ/WRITE RANDOM ACCESS DYNAMIC MEMORY

2604 2604A

MOS 2600 SERIES

DESCRIPTION

Signetics 2604 is a high speed, fully decoded, dynamic, read/write, random access memory. It is organized as 4096 X 1 and achieves an access time of less than 300ns. All inputs except the CE Clock are fully TTL compatible and no special drivers or level shifters are required. The tri-state output buffers can drive 2 standard TTL loads.

The CE Clock is the only high level input required for the 2604. It is a low capacitance load and uses a nominal 12 volt signal swing. When the CE Clock goes low, internal signal nodes are pre-charged and the memory then assumes its standby mode and consumes very little power. All active operations are performed with the clock high.

The 2604 is a dynamic memory and each bit must be periodically refreshed. The internal organization allows refreshing to be accomplished by performing an operation at each of the 64 row addresses (derived from inputs A_0—A_5) every 2 milliseconds. The chip need not be selected during the refresh cycles.

FEATURES

- CAPACITY OF 4096-BITS
- ACCESS TIME 300ns MAXIMUM
- CYCLE TIME 470ns MAXIMUM
- ION-IMPLANTED N-CHANNEL SILICON GATE MOS TECHNOLOGY
- STANDARD SUPPLY VOLTAGES OF +12, +5, −5 VOLTS
- SINGLE LOW CAPACITANCE HIGH LEVEL CLOCK INPUT
- ADDRESS, CONTROL AND DATA INPUTS FULLY TTL COMPATIBLE
- LATCHES FOR ADDRESS AND CONTROL INPUTS PROVIDED ON CHIP
- TTL TRI-STATE OUTPUT BUFFER
- LOW POWER DISSIPATION
- STANDARD 22-PIN DUAL-IN-LINE PACKAGE

MAXIMUM GUARANTEED RATING*

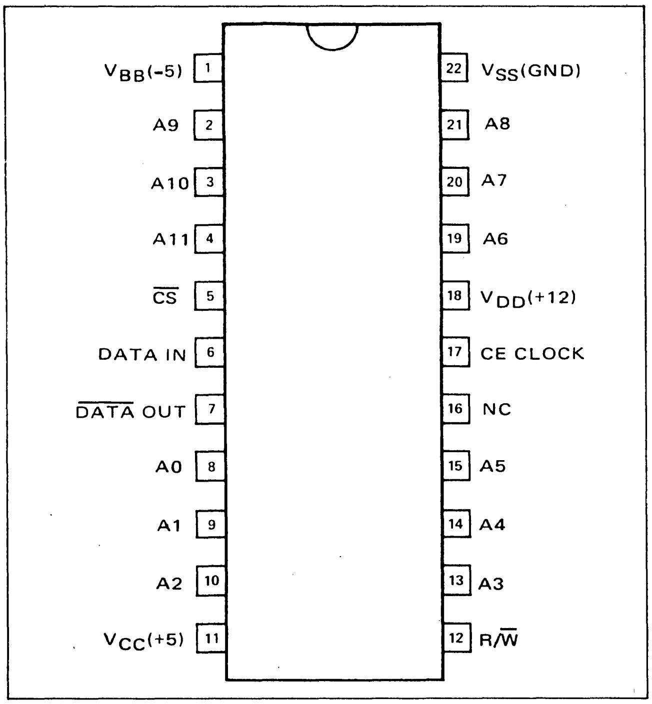
Operating Ambient Temperature	0°C to +70°C
Storage Temperature	−65°C to +150°C
All Voltages With Respect To V_{BB}	−0.3 to +20 volts

*Stresses above those listed may cause permanent damage to the device. These are stress ratings only and functional operation under these conditions is not implied.

ORDER INFORMATION

For V_{BB} = −3.0V, Order No. is 2604A.
For V_{BB} = −5.0V, Order No. is 2604.

PIN CONFIGURATION



PIN DESCRIPTION

Chip Enable Clock

The master operating signal input is called the Chip Enable Clock. This signal is the only non-TTL-level input required to operate the 2604. Internal operations are executed while Chip Enable is in the "high" state. When Chip Enable is low, the 2604 is in the standby state (low power consumption) pre-charging internal nodes in preparation for the next memory cycle.

$\overline{\text{Chip Select}}$

The data in, data out, and read/write functions are all affected by the $\overline{\text{Chip Select}}$ input. Data is not accepted on the Data In terminal unless $\overline{\text{Chip Select}}$ and Read/$\overline{\text{Write}}$ are low. The write state of the Read/$\overline{\text{Write}}$ terminal is not recognized unless $\overline{\text{Chip Select}}$ is low. The output drivers are disconnected (tri-state) unless $\overline{\text{Chip Select}}$ has gone low at the appropriate time in a given cycle. $\overline{\text{Chip Select}}$ may be changed to the low state any time during a cycle as long as the correct write pulse timing is maintained. However, if $\overline{\text{Chip Select}}$ goes low more than 80 nsec into the cycle, the access time is lengthened accordingly. $\overline{\text{Chip Select}}$ may go high anytime after the minimum $\overline{\text{Chip Select}}$ pulse width requirement has been met. The chip remains selected for the remainder of the cycle. As with all other inputs to the 2604 except Chip Enable, $\overline{\text{Chip Select}}$ responds to a standard TTL-level signal without an external pull-up resistor.

PIN DESCRIPTION (Continued)

Read/$\overline{\text{Write}}$

Whether a given memory cycle is a read or a write cycle is determined by the Read/$\overline{\text{Write}}$ input. When Read/$\overline{\text{Write}}$ is high and the chip is selected, a read cycle is executed. When Read/$\overline{\text{Write}}$ is low and the chip is selected, a write cycle is executed. The internal write pulse width is determined by the falling edge of $\overline{\text{Chip Select}}$ or Read/$\overline{\text{Write}}$, whichever is later, and the trailing edge of Read/$\overline{\text{Write}}$.

Addresses

All address inputs respond to TTL-level signals. The addresses in a given cycle must be stable before Chip Enable goes high. Addresses are latched on the 2604 so that the address inputs can change after the address hold time requirements have been met.

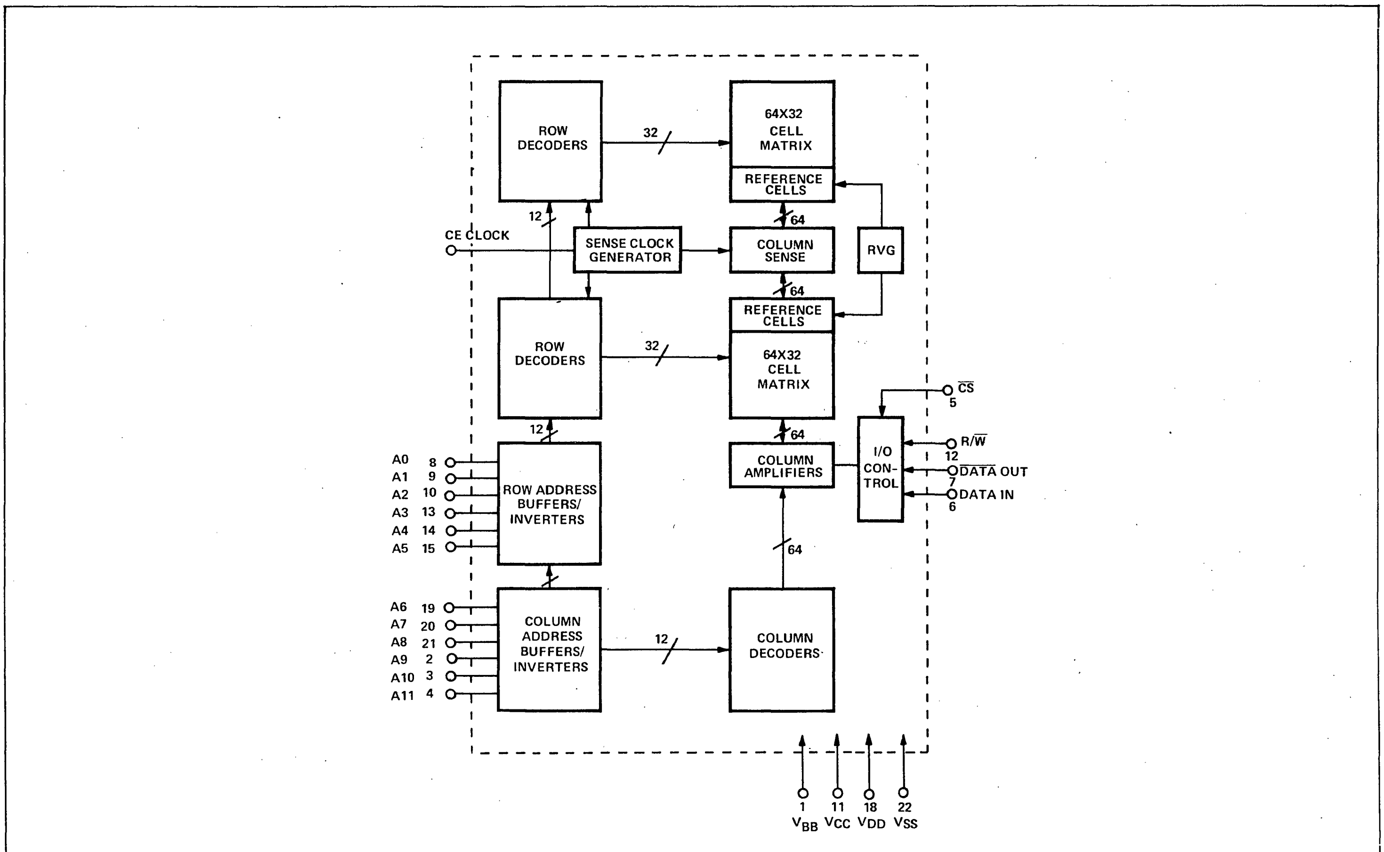
Data-in

Input data is supplied to the 2604 on the Data-in terminal. This TTL-compatible input is used during a write cycle or read-modify-write cycle.

$\overline{\text{Data}}$-out

The output buffer is a totem-pole tri-state structure that will drive two standard TTL loads. The high impedance (disconnect) state occurs when Chip Enable is low or when the $\overline{\text{Chip Select}}$ input is high. When enabled, the output goes to a TTL "0" level before valid data appears. Output data is the complement of input data.

BLOCK DIAGRAM



RECOMMENDED SUPPLY VOLTAGES[1] (Measured with respect to V_{SS}.)

PARAMETER	LIMITS			UNIT
	MIN	TYP	MAX	
V_{DD}	11.4	12.0	12.6	V
V_{BB} (For 2604 only)	−4.5	−5.0	−5.5	V
V_{BB} (For 2604A only)	−2.7	−3.0	−3.3	V
V_{CC}	4.5	5	V_{DD}	V
V_{SS}		0.0		V

DC CHARACTERISTICS T_A = 0°C to +70°C, See "Recommended Supply Voltages"

PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP[2]	MAX	
V_{IH}	Input High Voltage (Non-clock inputs)		2.2		V_{DD}	V
V_{IL}	Input Low Voltage (Non-clock inputs)		−0.6		0.6	V
V_{CH}	Clock Input High Voltage		$V_{DD}-1$	V_{DD}	$V_{DD}+1$	V
V_{CL}	Clock Input Low Voltage		−0.6		0.6	V
I_I	Input Current (All inputs)	V_{IN} = +5V			10	µA
I_{LO}	Output Leakage Current	V_{OUT} = +5V, Output Disabled			10	µA
I_{BB}	V_{BB} Supply Current	V_{BB} = −5V, V_{DD} = 12V, V_{SS} = 0V			100	µA
I_{DD1}	V_{DD} Supply Current During CE Clock High			40	60	mA
I_{DD2}	V_{DD} Supply Current During CE Clock Low			0.2	0.5	mA
I_{DD3}	Average V_{DD} Supply Current During t_{WC} or t_{RC}	t_{CE} = 320ns, t_{WC} = t_{RC} = 470ns		33		mA
I_{DD4}	Average V_{DD} Supply Current During t_{RMWC}	t_{CE} = 560ns, t_{RMWC} = 710ns		35		mA
I_{CC1}	V_{CC} Supply Current (Operating)	Note 7				
I_{CC2}	V_{CC} Supply Current				100	µA
V_{OH}	Output High Voltage	I_{OUT} = −2.0mA	2.4		V_{CC}	V
V_{OL}	Output Low Voltage	I_{OUT} = 3.2mA			0.4	V

CAPACITANCE T_A = +25°C

PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP[2]	MAX	
C_{IN1}	Input Capacitance (Address and Read/Write)	V_{CL} = 0V, V_{DD} = +12V		5	7	pF
C_{IN2}	Input Capacitance (Chip Select and Data In)	V_{BB} = −5V, V_{CC} = +5V, f = 1mHz		4	6	pF
C_{OUT}	Output Capacitance	V_{CL} = 0V, V_{DD} = +12V		5	7	pF
C_{INC}	Clock Input Capacitance	V_{CH} = +12V, V_{BB} = −5V		18	22	pF
		V_{CL} = 0V, V_{CC} = +5V, F = 1mHz		23	27	pF

AC CHARACTERISTICS T_A = 0°C to +70°C, See "Recommended Supply Voltages"

PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP[2]	MAX	
READ, WRITE, AND READ-MODIFY-WRITE CYCLES						
t_{AS}	Address Set-up Time		0			ns
t_{AH}	Address Hold Time		150			ns
t_{CSS}	Chip Select Set-up Time		240			ns
t_{CSW}	Chip Select Pulse Width		150			ns
t_t	Transition Time (Rise and Fall)				20	ns
t_{REF}	Time Between Refresh				2	ms
$t_{\overline{CE}}$	$\overline{\text{Chip Enable}}$ Pulse Width		150			ns

Signetics

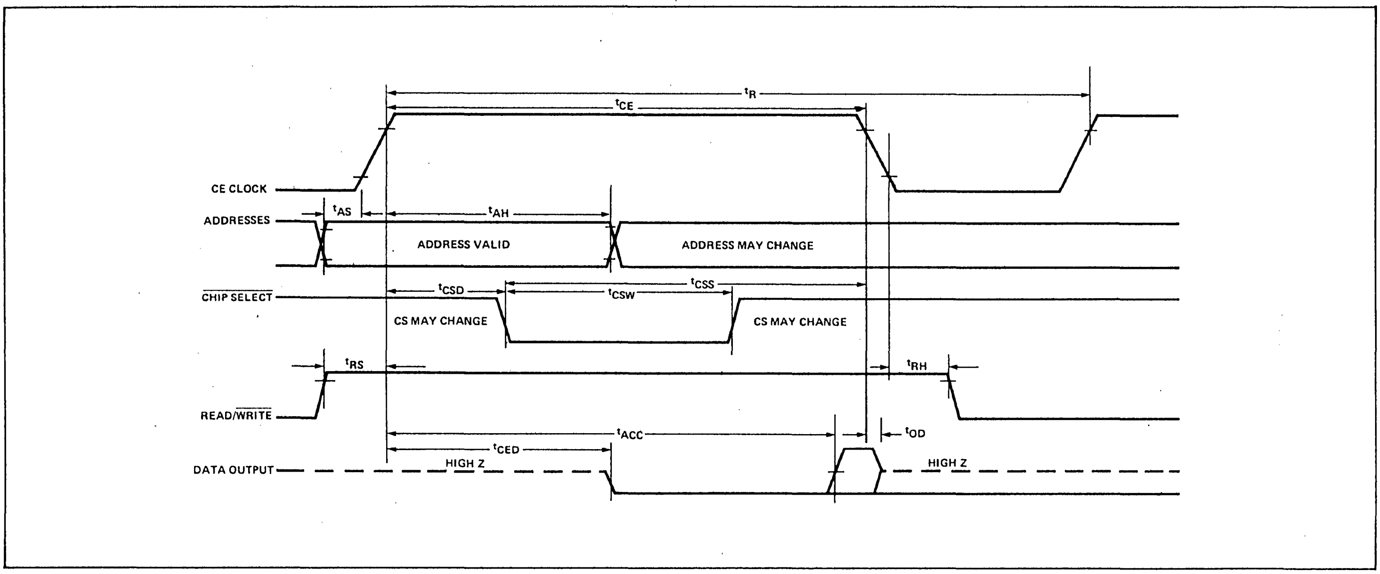
MEMORY

AC CHARACTERISTICS (Continued) $T_A = 0°C$ to $+70°C$, See "Recommended Supply Voltages"

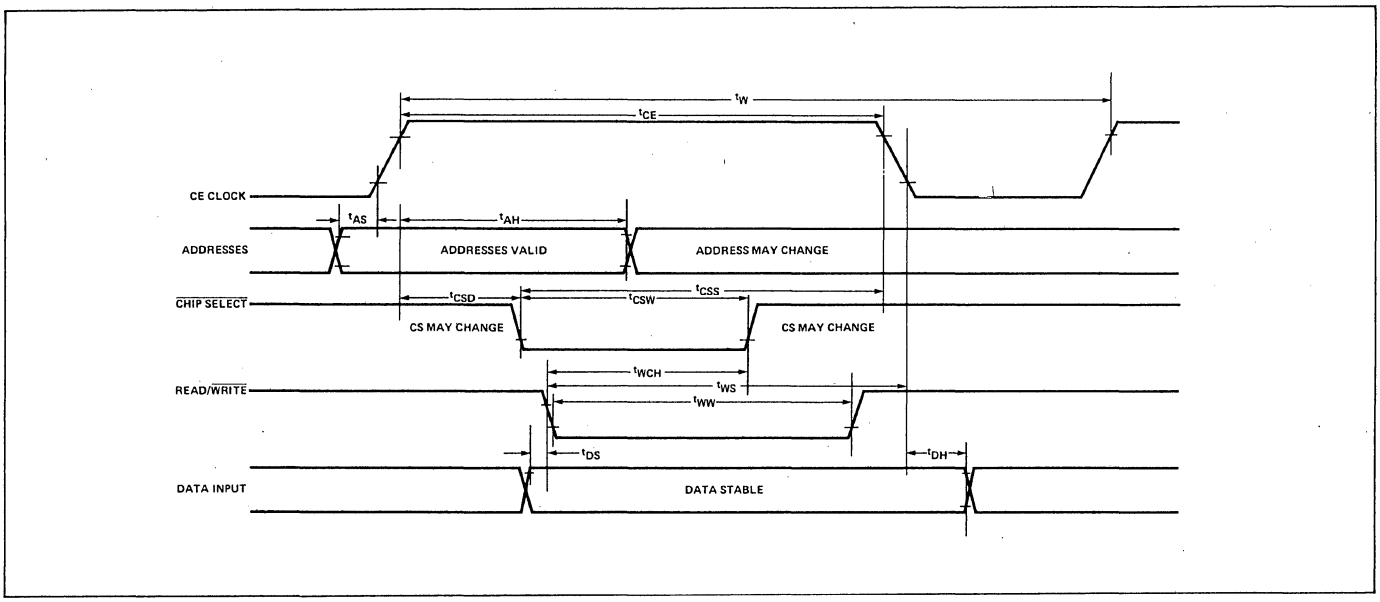
PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP[2]	MAX	
READ CYCLE						
t_R	Read Cycle Time		470			ns
t_{CE}	Chip Enable Pulse Width		320			ns
t_{RS}	Read Set-up Time		0			ns
t_{RH}	Read Hold Time		40			ns
t_{CED}	Chip Enable to Output Enabled	Note 3		150		
t_{OD}	$\overline{\text{Chip Enable}}$ to Output High Impedance State		10			ns
t_{ACC}	Chip Enable to $\overline{\text{DATA}}$ Valid				300	ns
t_{CSD}	Chip Select Delay from CE Clock	Note 4			80	ns
WRITE CYCLE						
t_W	Write Cycle Time		470			ns
t_{CE}	Chip Enable Pulse Width		320			ns
t_{WS}	Write Set-up Time		240			ns
t_{WW}	Write Pulse Width		200			ns
t_{DS}	Data Set-up Time with Respect to R/$\overline{\text{W}}$	Note 5	0			ns
t_{DH}	Data Hold Time with Respect to CE Clock		40			ns
t_{WCH}	Write to Chip Select Hold Time	Note 6	200			ns
READ-MODIFY-WRITE CYCLE						
t_{RMW}	Read-Modify-Write Cycle Time		710			ns
t_{CE}	Chip Enable Clock Pulse Width		560			ns
t_{RS}	Read to Chip Enable Set-up Time		0			ns
t_{RH}	Read to Chip Enable Hold Time		320			ns
t_{WW}	Write Pulse Width		200			ns
t_{WS}	Write Set-up Time		240			ns
t_{VW}	Previous Data Valid with Respect to Write Pulse		50			ns
t_{CSD}	$\overline{\text{Chip Select}}$ Delay from CE Clock	Note 4			80	ns
t_{DS}	Data Set-up Time with Respect to Write Pulse		0			ns
t_{DH}	Data Hold Time with Respect to CE Clock		40			ns
t_{OD}	Chip Enable to Output Disabled		10			ns
t_{CED}	Chip Enable to Output Enabled			150		ns
t_{ACC}	Chip Enable to $\overline{\text{Data}}$ Valid				300	ns

NOTES:
1. This product includes circuitry specifically designed for the protection of its internal devices from the damaging effects of excessive static charge. Nonetheless, it is suggested that conventional precautions be taken to avoid applying any voltage larger than the rated maximum.
2. Typical values are at +25°C and nominal supply voltages.
3. Valid data is always preceded by a logic "0" output when the output buffers are enabled.
4. If CS goes low later than maximum t_{CSD}, data access time, and therefore cycle time, are increased accordingly.
5. If CS goes low after R/$\overline{\text{W}}$ goes low, t_{DS} is with respect to the falling edge of CS rather than R/W.
6. The internal write signal is a combination of CS and R/W. As a result, the internal write pulse width is a function of t_{WCH} as well as t_{WW}.
7. Depends on output loading. The V_{CC} supply is connected to the output buffer only.
8. Input rise and fall times of 20ns are used to measure the access and cycle times.

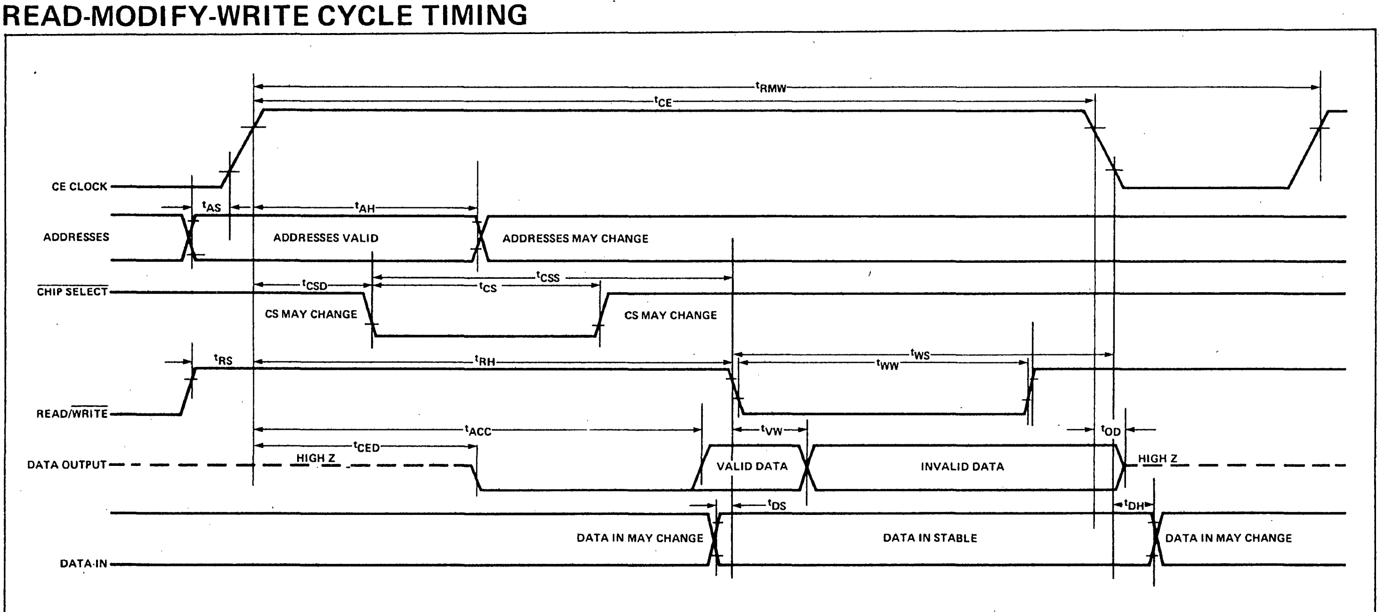
READ CYCLE TIMING



WRITE CYCLE TIMING



READ-MODIFY-WRITE CYCLE TIMING



Signetics

256X4 RANDOM ACCESS READ/WRITE STATIC MEMORY

2606 2606-1

2606, 2606-1-B

PRELIMINARY SPECIFICATIONS

N CHANNEL SILICON GATE MOS 2600 SERIES

DESCRIPTION

Signetics'2606 is a fully decoded, static, read/write, random access memory. It has a capacity of 1024 bits and is organized as 256 x 4. The 2606 is fabricated with N-Channel silicon gate MOS technology and achieves an access time of less than 750 nanoseconds. No clocks are required and all interface signals are directly TTL compatible including the power supply.

FEATURES

- 256 x 4 ORGANIZATION
- STATIC OPERATION
- ACCESS TIME: 2606 750ns; 2606-1 500ns
- CYCLE TIME: 2606 750ns; 2606-1 500ns
- SINGLE 5 VOLT POWER SUPPLY
- TTL COMPATIBLE INPUTS AND OUTPUTS
- 200mW TYPICAL POWER DISSIPATION
- MULTIPLEXED DATA BUS
- TRI-STATE OUTPUTS
- N-CHANNEL SILICON GATE TECHNOLOGY
- STANDARD 300-MIL 16 PIN PACKAGE

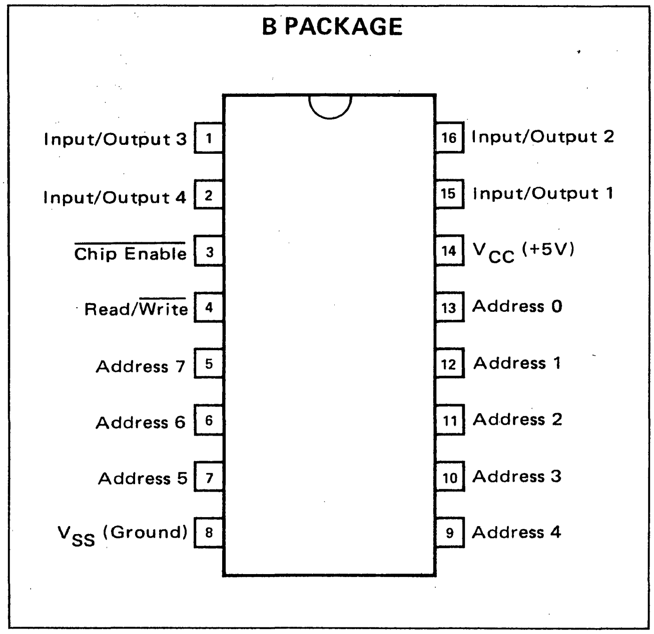
APPLICATIONS

MICROCOMPUTER MEMORIES
PERIPHERAL DEVICES
TERMINALS
DATA BUFFERS

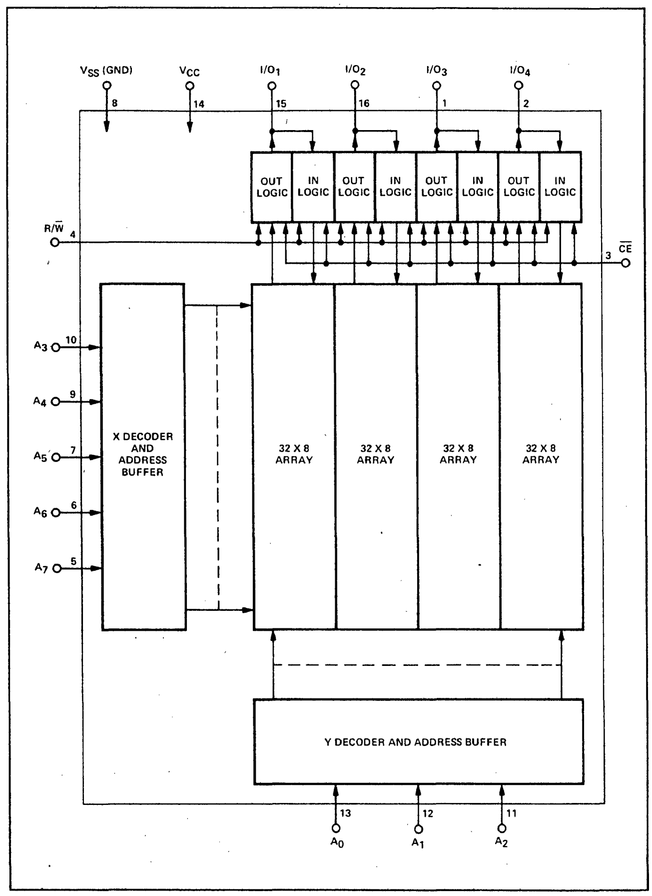
MAXIMUM GUARANTEED RATINGS(1)

Operating Ambient Temperature	0°C to +70°C
Storage Temperature	-65°C to +150°C
All Input, Output, and Supply Voltages with respect to ground pin(3)	-0.5V to +6V
Package Power Dissipation(2) "B" Pkg.	640 mW

PIN CONFIGURATION



BLOCK DIAGRAM



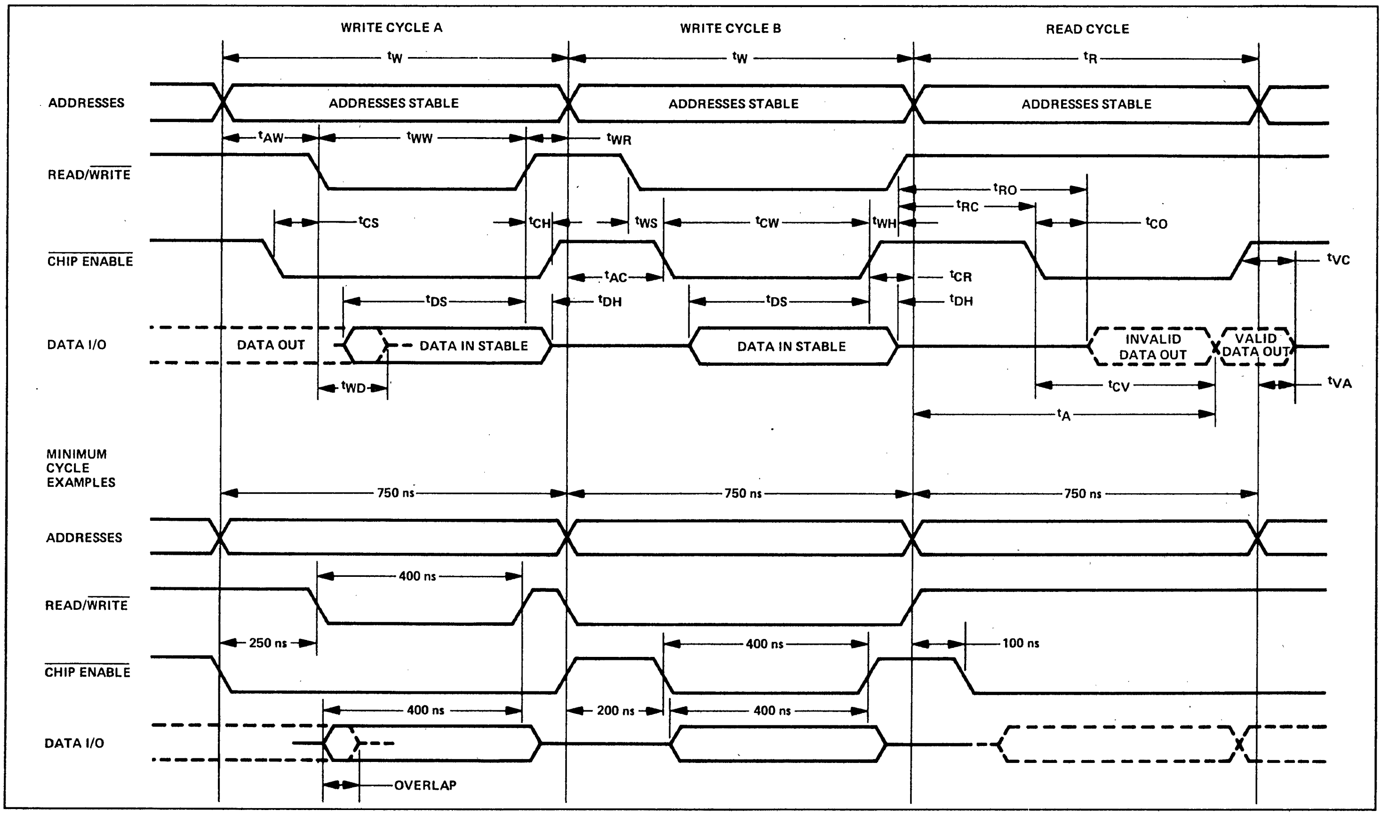
D.C. OPERATING CHARACTERISTICS

$T_A = 0°C$ to $+70°C$, $V_{CC} = +5V \pm 5\%$ unless otherwise specified. See Notes 3, 4, 5, 6 & 7.

SYMBOL	PARAMETER	LIMITS MIN	TYP	MAX	UNIT	TEST CONDITIONS
I_{LI}	Input load current			10	μA	V_{IN} = 0 to 5.25V
I_{BH}	Bus high current			10	μA	$\overline{CE}$ = 2.2V, V_{OUT} = 4.0V
I_{BL}	Bus low current			−100	μA	$\overline{CE}$ = 2.2V, V_{OUT} = 0.45V
I_{CC}	Power supply current		40	70 80	mA mA	All inputs = 5.25V Data Bus Open $T_A = 25°C$ $T_A = 0°C$
V_{IL}	Input low voltage	−0.5		+0.65	V	
V_{IH}	Input high voltage	2.2		V_{CC}	V	
V_{OL}	Output low voltage			+0.45	V	I_{OL} = 1.9mA
V_{OH}	Output high voltage	2.4			V	I_{OH} = −100μA
C_{IN}	Input capacitance		4	7	pF	V_{IN} = 0V
$C_{I/O}$	Data bus capacitance		7	10	pF	V_{OUT} = 0V

NOTES
1. Stresses above those listed under "Maximum Guaranteed Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or at any other condition above those indicated in the operation sections of this specification is not implied.
2. For operating at elevated temperatures the device must be derated based on a +150°C maximum junction temperature and a thermal resistance of 150°C/W junction to ambient ("B" pkg.)
3. This product includes circuitry specifically designed for the protection of its internal devices from the damaging effects of excessive static charge. Nonetheless, it is suggested that conventional precautions be taken to avoid applying any voltages larger than the rated maxima.
4. Parameter valid over operating temperature range unless otherwise specified.
5. All voltage measurements are referenced to ground.
6. Manufacturer reserves the right to make a design and process changes and improvements.
7. Typical values are at +25°C, nominal supply voltages, and nominal processing parameters.

TIMING DIAGRAM



Signetics

MEMORY

SWITCHING CHARACTERISTICS

T_A = 0°C to 70°C, V_{CC} = +5V ±5% unless otherwise specified. See Notes E, F, G & H.

		2606			2606-1	
WRITE CYCLE A		**MIN**	**MAX**	**UNIT**	**MIN**	**MAX**
t_{AW}	Address to write time	250		ns	150	
t_{WW}	Write pulse width	400		ns	300	
t_{WR}	Write recovery time	100		ns	50	
t_{CS}	Chip enable set-up	0		ns	0	
t_{CH}	Chip enable hold	0		ns	0	
t_{DS}	Data in set-up	380		ns	280	
t_{DH}	Data in hold (Note A)	0		ns	0	
t_{WD}	Write to data out disable delay (Note D)		125	ns		100
t_W	Write cycle time	750		ns	500	
WRITE CYCLE B						
t_{AC}	Address to chip enable time	250		ns	150	
t_{CW}	Chip enable pulse width	400		ns	300	
t_{CR}	Chip enable recovery time	100		ns	50	
t_{WS}	Write set-up (Note B)	200		ns	100	
t_{WH}	Write hold	0		ns	0	
t_{DS}	Data in set-up	380		ns	280	
t_{DH}	Data in hold (Note A)	0		ns	0	
t_W	Write cycle time	750		ns	500	
READ CYCLE						
t_R	Read cycle time	750		ns	500	
t_A	Access time		750	ns		500
t_{RO}	Read to output enable (Note C)	100		ns	75	
t_{CO}	Chip enable to output enabled (Note C)	0		ns	0	
t_{VC}	Previous data valid with respect to chip disable	0	150	ns	0	100
t_{VA}	Previous data valid with respect to address change	50		ns	50	
t_{CV}	Chip enable to data valid delay		400	ns		300
t_{RC}	Read to chip enable	100		ns	50	

NOTES

A. Maximum t_{DH} governed by potential conflict with data out during next cycle.
B. Write set-up required to prevent data overlap. For write cycle B the R/$\overline{W}$ line will typically change with the addresses.
C. R/$\overline{W}$ must be high and $\overline{CE}$ must be low in order for output buffers to turn on.
D. The output buffers will turn off within the specified time after write mode is selected.
E. Input levels swing between 0.65 volt and 2.2 volts.
F. Input signal transition times are 20 ns.
G. Timing reference level is 1.5 volts.
H. Bus load is 100pf, one TTL input and one TTL tristate output.

PRELIMINARY SPECIFICATIONS

N CHANNEL SILICON GATE MOS 2600 SERIES

DESCRIPTION

The 2608 is a fully decoded, static, mask programmable read-only memory. It has a capacity of 8192 bits organized 1024 X 8. The 2608 is fabricated with low threshold N-Channel silicon gate MOS technology which allows extreme ease of use with low voltage logic families such as transistor-transitor logic.

Requiring only 5 volts and ground power connections, the 2608 features a maximum access time of 650ns. Since the 2608 uses static logic throughout, no clocks are required. Four mask programmable chip selects are provided for easy word expansion. All 2608 inputs and outputs are TTL-compatible.

FEATURES

- 1024 X 8 ORGANIZATION
- STATIC OPERATION – NO CLOCKS
- 650ns ACCESS TIME
- SINGLE 5V POWER SUPPLY
- TTL COMPATIBLE INPUTS AND OUTPUTS
- 400mW MAXIMUM POWER DISSIPATION
- TRI-STATE OUTPUTS
- 4 MASK PROGRAMMABLE CHIP SELECTS FOR EASY WORD EXPANSION
- N-CHANNEL SILICON GATE TECHNOLOGY
- STANDARD 24-PIN PACKAGE

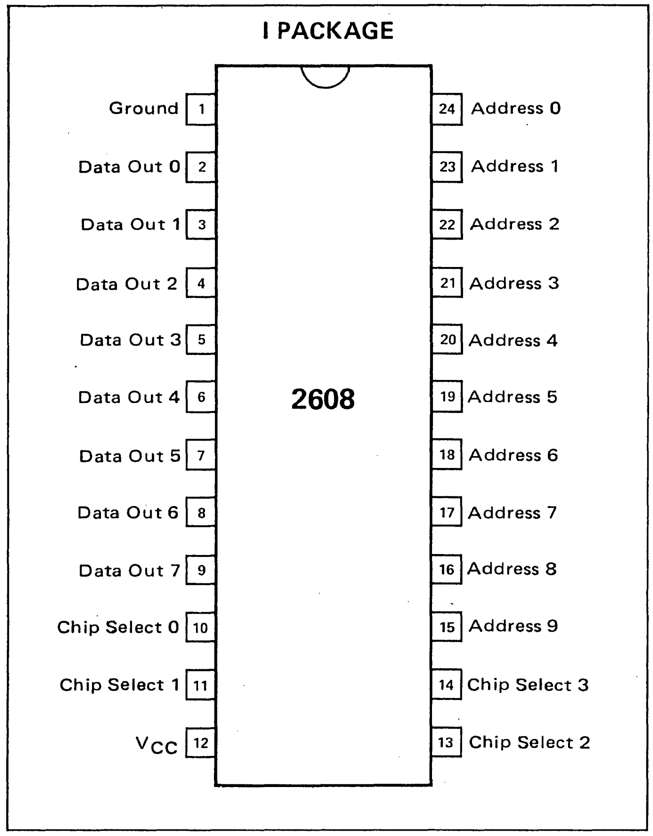
MAXIMUM GUARANTEED RATINGS[1]

Operating Ambient Temperature	$0^\circ C$ to $+70^\circ C$
Storage Temperature	$-65^\circ C$ to $+150^\circ C$
All Input, Output, and Supply Voltages with Respect to Ground Pin	$-0.5V$ to $+7V$

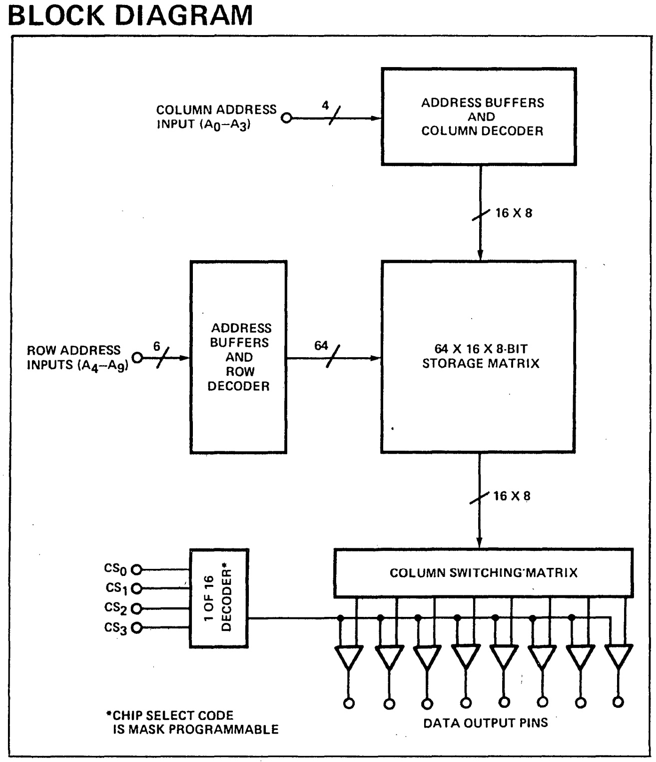
PART IDENTIFICATION

TYPE	OPERATING TEMPERATURE RANGE	PACKAGE
2608I	$0^\circ C$ – $+70^\circ C$	24-pin ceramic dip

PIN CONFIGURATION



BLOCK DIAGRAM



DC OPERATING CHARACTERISTICS $T_A = 0°C$ to $+70°C$, $V_{CC} = +5V \pm 5\%$ (Unless Otherwise Noted)[3,4,5,6,7]

PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP	MAX	
I_{IN}	Input Load Current	$0 \leqslant V_{IN} \leqslant 5.25V$			10	μA
I_{LOH}	Output Leakage Current	$V_0 = 2.4V$, Device Deselected			10	μA
I_{LOL}	Output Leakage Current	$V_0 = 0.4V$, Device Deselected			10	μA
I_{CC}	Supply Current	$V_{CC} = 5.25V$, $T_A = 0°C$			80	mA
V_{IL}	Input Low Voltage		−0.5		0.65	V
V_{IH}	Input High Voltage		2.2			V
V_{OL}	Output Low Voltage	$I_{OL} = 1.6mA$			0.45	V
V_{OH}	Output High Voltage	$I_{OH} = -100\mu A$	2.4			V
C_{IN}	Input Capacitance	$V_{IN} = 0V$			7.5	pF
C_{OUT}	Output Capacitance	$V_{OUT} = 0V$			15	pF

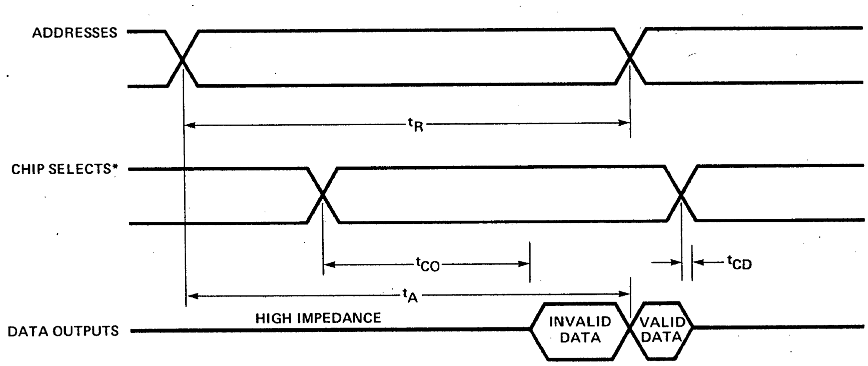
NOTES:
1. Stresses above those listed under "Maximum Guaranteed Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or at any other condition above those indicated in the operation sections of this specification is not implied.
2. For operating at elevated temperatures the device must be derated based on a +150°C maximum junction temperature and a thermal resistance of 50°C/W junction to ambient.
3. This product includes circuitry specifically designed for the protection of its internal devices from the damaging effects of excessive static charge. Nonetheless, it is suggested that conventional precautions be taken to avoid applying any voltages larger than the rated maxima.
4. Parameter valid over operating temperature range unless otherwise specified.
5. All voltage measurements are referenced to ground.
6. Manufacturer reserves the right to make design and process improvements.
7. Typical values are at +25°C, nominal supply voltages, and nominal processing parameters.

AC OPERATING CHARACTERISTICS $T_A = 0°C$ to $+70°C$, $V_{CC} = +5V \pm 5\%$ (See Notes A, B & C)

SYMBOL	PARAMETER	MIN	MAX	UNITS	NOTES
t_R	Read Cycle Time	650		ns	
t_{CO}	Chip Select to Output Enable		300	ns	Note D
t_{CD}	Chip Select to Output Disable	10	150	ns	Note D
t_A	Access Time	100	650	ns	Note D

NOTES:
A. Input levels swing between 0.65 volts and 2.2 volts.
B. Input signal transition times are 20 nsec.
C. Timing reference level is 1.5 volts.
D. Output load is one standard TTL load plus 130pF.

TIMING DIAGRAM



*CUSTOMER CHOOSES PARTICULAR CHIP SELECT CODE DESIRED. THE OTHER FIFTEEN COMBINATIONS OF FOUR CHIP SELECT INPUTS DISABLE THE OUTPUTS.

ABSOLUTE MAXIMUM GUARANTEED RATINGS

PARAMETER		LIMITS		UNIT
		MIN	MAX	
T_A	Operating Ambient Temperature			
	S82S - Military Range	−55	+125	°C
	N82S - Commercial Range	0	+70	°C
T_{STG}	Storage Temperature	−65	+150	°C
	Package Power Dissipation @ 70°C			
	B Package		640	mW
	I Package		730	mW
	N Package		730	mW
V_{CC}	Power Supply Voltage		+7	Vdc

NOTES:

1. Stresses above those listed under "Maximum Guaranteed Ratings" may cause permanent damage to the device. This is a stress rating only, and functional operation of the device of these or any other condition above those indicated in the operation section of the device specifications is not implied.
2. For operating at elevated temperatures, the device must be derated based on a +150°C maximum junction temperature and a thermal resistance of 150°C/W junction to ambient.
3. For operating at elevated temperatures, the devices must be derated based on a +150°C maximum junction temperature and a thermal resistance of 110°C/W junction to ambient.

ELECTRICAL CHARACTERISTICS

S82S DEVICES – $-55°C \leq T_A \leq +125°C$, $4.5V \leq V_{CC} \leq 5.5$

N82S DEVICES – $0°C \leq T_A \leq +75°C$, $4.7V \leq V_{CC} \leq 5.25$

PARAMETER		INPUT VOLTAGE									OUTPUT VOLTAGE						INPUT CURRENT		
		V_{IL}[5] (V) LOW LEVEL			V_{IH}[5] (V) HIGH LEVEL			V_{IC}[1,5] (V) CLAMP VOLTAGE			V_{OL}[2] (V) LOW LEVEL			V_{OH} (V) HIGH LEVEL			I_{IL} (μA) LOW LEVEL		
TEST CONDITIONS		V_{CC} = MIN			V_{CC} = MAX			I_{IN} = −18 mA V_{CC} = MIN			I_{OL} = −16 mA V_{CC} = MIN			I_{OUT} = −2.0 mA $CE_1 = CE_2$ = "0" "1" STORED			V_{IN} = 0.45V		
DEVICE		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
												I_{OUT} = 11.2 mA			I_{OUT} = −1.0 mA				
8228				.85	2.0			−1.2					0.5	2.7					
									I_{IN} = −12 mA			I_{OL} = 6.4 mA							
82S09	S			.80	2.2				−1.0	−1.5		0.35	0.50			5.5		−10	−150
	N			.85	2.0							0.35	0.5					−10	−100
									I_{IN} = −12 mA										
82S10	S			.80	2.1				−1.0	−1.5		0.35	0.50			5.5		−10	−150
	N			.85								0.35	0.45					−10	−100
									I_{IN} = −12 mA										
82S11	S			.80	2.1				−1.0	−1.5		0.35	0.50	2.4				−10	−150
	N			.85								0.35	0.45					−10	−100
82S12				0.85	2.0			−1.2				N/A							
									I_{IN} = −12 mA						I_{OH} = −3.2 mA				
82S16	S			0.8	2.0				−1.0	−1.5		0.35	0.5	2.4				−10	−250
	N			0.85								0.35	0.45	2.6				−10	−100
									I_{IN} = −12 mA										
82S17	S			0.8	2.0				−1.0	−1.5		0.35	0.5			5.5		−10	−250
	N			0.85								0.35	0.45					−10	−100
82S21				0.85		N/A		−1.2					.45		N/A				
82S23	S			0.8	2.0				−0.8	−1.2			0.5			5.5			−150
	N			0.85									0.45						−100
									I_{IN} = −12 mA										
82S25	S			.80	2.0				−1.0	−1.5		0.35	0.5			5.5		−10	−150
	N			.85								0.35	0.45					−10	−100
									I_{IN} = −12 mA										
82S27				.80	2.0				−1.0	−1.5		0.45	0.50			5.5			
												I_{OL} = 9.6 mA							
82S100				0.8	2				−0.8	−1.2		0.35	0.45	2.4				−10	−100
												I_{OL} = 9.6 mA							
82S101				0.8	2				−0.8	−1.2		0.35	0.45	2.4				−10	−100
															I_{OUT} = −3.2 mA				
82S112				0.85	2.0			−1.2				N/A		2.6					−250
												I_{OL} = 9.6 mA							
82S114				.85	2.0				−0.8	−1.2			0.5	2.7	3.3				−100
												I_{OL} = 9.6 mA							
82S115				.85	2.0				−0.8	−1.2			0.5	2.7	3.3				−100
									I_{IN} = −12 mA						I_{OH} = −3.2 mA				
82S116				0.85	2.0				−1.0	−1.5		0.35	0.45	2.6				−10	−100
									I_{IN} = −12 mA										
82S117				0.85	2.0				−1.0	−1.5		0.35	0.45			5.5		−10	−100
82S123	S			0.8	2.0				−0.8	−1.2			0.5	2.4					−150
	N			0.85									0.45						−100
82S126	S			.80	2.0				−0.8	−1.2			0.5			5.5			−150
	N			.85															−100
82S129	S			.80	2.0				−0.8	−1.2			0.5	2.4					−150
	N			.85															−100
82S130	S			.80	2.0				−0.8	−1.2			0.5			5.5			−150
	N			.85									0.45						−100
82S131	S			.80	2.0				−0.8	−1.2			0.5	2.4					−150
	N			.85									0.45						−100
												I_{OUT} = 9.6 mA							
82S214	S			.8	2.0				−0.8	−1.2			0.5	2.4	3.3				−150
	N			.85										2.7	3.3				−100
												I_{OUT} = 9.6 mA							
82S215	S			.8	2.0				−0.8	−1.2			0.5	2.4	3.3				−150
	N			.85										2.7	3.3				−100

NOTES:
1. Test each input one at the time.
2. Measured with the logic "0" stored. Output sink current is supplied through a resistor to V_{CC}.
3. I_{CC} is measured with the write enable and memory enable input grounded, all other inputs at 4.5V, and the outputs open.
4. Measured with V_{IH} applied to CE.
5. All voltage values are with respect to network ground terminal.
6. Duration of the short-circuit should not exceed one second.
7. All sense outputs in "0" state.

Signetics

MEMORY

ELECTRICAL CHARACTERISTICS (Continued)

PARAMETER		INPUT CURRENT			OUTPUT CURRENT									SUPPLY CURRENT			CAPACITANCE					
		I_{IH} (μA) HIGH LEVEL			I_{OLK} (μA) LEAKAGE			I_O (OFF) HI-Z STATE			I_{OS} (mA)[6] SHORT-CIRCUIT			I_{CC} (mA)[6]			C_{IN} (pF) INPUT			C_{OUT}[4] (pF) OUTPUT		
TEST CONDITIONS		V_{IN} = 5.5V			V_{CC} = MAX, V_{OUT} = 5.5V, CE_1 OR CE_2 = "1"			V_{CC} = MAX, V_{OUT} = 5.5V			V_{OUT} = 0V, V_{CC} = MAX			V_{CC} = MAX			V_{IN} = 0V, V_{CC} = 2.0V			V_{CC} = 5.0V, V_{OUT} = 2.0V		
DEVICE		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
8228											-20		-70									
82S09	S		1	40		1	60		N/A			N/A			150	200		5			8	
	N		1	25		1	40								150	190						
82S10	S		1	40		1	60		N/A			N/A										
	N		1	25		1	40															
82S11	S		1	40		N/A			1	100	-20		-100					4			7	
	N		1	25					1	60												
								V_{OUT} = 0.45V		6												
									-1	-100												
									-1	-80								4			7	
82S12																						
82S16	S		1	25		N/A			1	50												
	N								1	40												
								V_{OUT} = 0.45V														
									-1	-50												
									-1	-40	-20		-70					5			8	
82S17	S N		1	25		1	40		N/A			N/A						5			8	
82S21				25			40		N/A			N/A			N/A			N/A			N/A	
82S23	S			50			50		N/A			N/A			65	85		5			8	
	N						40								65	77						
						V_{CC} = MIN									NOTE 7							
82S25	S			25		<1	100		N/A			N/A			80	120		5			8	
	N			10											80	105						
82S27				1			100		N/A			N/A			120	140		5			8	
			V_{IN} = 2.4V																			
				40																		
82S100			<1	25		N/A			N/A	-20			-70		120	170		5			8	
82S101			<1	25		N/A			N/A			N/A			120	170		5			8	
82S112				25		N/A			N/A			N/A			N/A			N/A			N/A	
82S114				25		N/A				40												
								V_{OUT} = 0.5V		-40	-20		-70		135	185		5			8	
82S115				25		N/A				40												
								V_{OUT} = 0.5V		-40	-20		-70		135	185		5			8	
82S116			1	25		N/A			1	40	-20		-70		80	115		5			8	
								V_{OUT} = 0.4V	-1	-40												
82S117			1	25		1	40		N/A			N/A			80	115		5			8	
82S123	S			50		N/A				50	-20		-100		65	85		5			8	
	N									40	-20		-90		65	77						
								V_{OUT} = 0.5V														
										-50												
										-40												
82S126	S			50			60		N/A			N/A			105	125		5			8	
	N			40			40								105	120						
82S129	S			50		N/A				60	-15		-85		105	125		5			8	
	N			40						40	-20		-70		105	120						
								V_{OUT} = 0.5V														
										-60												
										-40												
82S130	S			50			60		N/A			N/A			120	140		5			8	
	N			40			40															
82S131	S			50		N/A				60	-15		-85		120	140		5			8	
	N			40						40	-20		-70									
								V_{OUT} = 0.5V														
										-60												
										-40												
82S214	S			50		N/A				100	-15		-85		130	185		5			8	
	N			25						40	-20		-70		130	175						
82S215	S			50		N/A		V_{OUT} = 0.5V		-100	-15		-85		130	185		5			8	
	N			25						-40	-20		-70		130	175						

Signetics

MEMORY

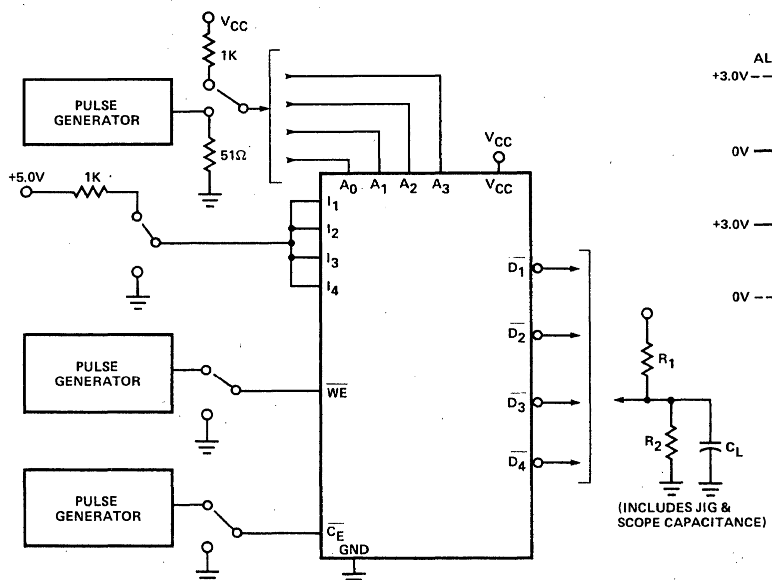
RAMS

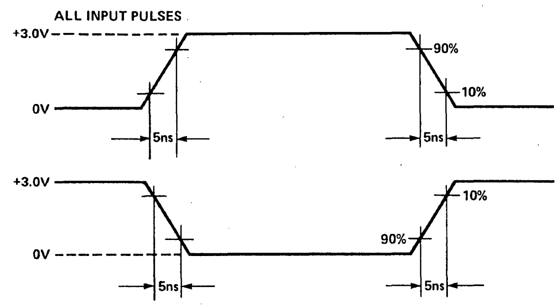
Random Access Memories

Signetics offers a complete line of Schottky-clamped TTL, read/write memory arrays. All feature open collector or tri-state output options for optimization of word expansion in bussed organizations. Memory expansion is further enhanced by full on-chip address decoding, chip enable function, and PNP input transistors which reduce input loading requirements.

All devices offer high performance read access and write cycle times making these devices ideally suited in high speed memory applications such as "caches", buffers, scratch pads, writeable control store, main store, etc.

AC TEST LOAD AND WAVEFORMS





MEASUREMENTS: ALL CIRCUIT DELAYS ARE MEASURED AT THE +1.5V LEVEL OF INPUTS AND OUTPUT.

Signetics

MEMORY

SWITCHING CHARACTERISTICS

S82S $-55°C \leqslant T_A \leqslant +125°C$, $4.5V \leqslant V_{CC} \leqslant 5.5V$

N82S $0°C \leqslant T_A \leqslant +75°C$, $4.75V \leqslant V_{CC} \leqslant 5.25V$

# OF BITS	DEVICE		PROPAGATION DELAYS														
			T_{AA} (ns) ADDRESS ACCESS TIME			T_{CE} (ns) CHIP ENABLE ACCESS TIME			T_{CD} (ns) CHIP DISABLE TIME			T_{WD} (ns) WRITE ENABLE TO OUTPUT DISABLE TIME			T_{WR} (ns) WRITE ENABLE TO OUTPUT DISABLE TIME		
	C_L = 30 pF R_1 = 270Ω R_2 = 600Ω		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
64	82S21			40	50		40	50		40	50		30	40			
	82S25	S		35	60		20	35		20	35		20	30		35	60
		N		35	50		20	35		20	35		20	25		35	50
	3101A	S		25	50		12	25		12	25		15	25		22	40
		N	10		35	5		17	5		17			20			35
256	82S16	S		40	70		30	40		30	40		30	55			
		N		40	50		30	40		30	40		30	40			
	82S17	S		40	70		30	40		30	40		30	55			
		N		40	50		30	40		30	40		30	40			
	82S116	N		30	40		15	25		15	25		30	40			
	82S117	N		30	40		15	25		15	25		30	40			
	C_L = 15 pF R_1 = 270Ω R_2 = 1 kΩ																
	54/74S200	54		40	70			45			30			40			50
		74		40	50			35			20			30			40
	54/74S201	54		40	70			45			30			40			50
		74		40	50			35			20			30			40
	54/74S301	54		40	70			45			30			40			50
		74		40	50			35			20			30			40
576	C_L = 30 pF R_1 = 600Ω R_2 = 900Ω																
	82S09	S		30	80		15	50		15	50		N/A				
		N		30	45		15	30		15	30						
1024	R_1 = 270Ω R_2 = 600Ω																
	82S10	S		30	70		15	45		15	45		20	45		20	45
		N		30	45		15	30		15	30		20	30		20	30
	82S11	S		30	70		15	45		15	45		20	45		20	45
		N		30	45		15	30		15	30		20	30		20	30
	93415A			30	45		15	30		15	30		20	30		20	30
	93425A			30	45		15	30		15	30		20	30		20	30

Signetics

MEMORY

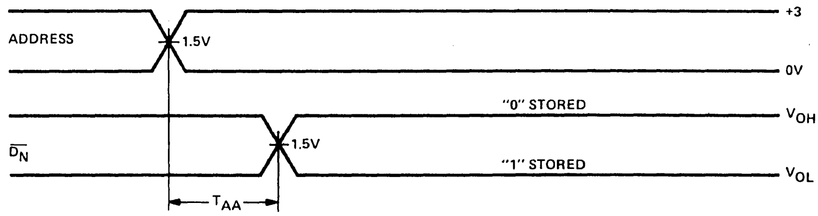
SWITCHING CHARACTERISTICS (Continued)

# OF BITS	DEVICE		WRITE SET-UP TIMES						WRITE HOLD TIMES							
			T_{WSA} (ns)		T_{WSD} (ns)		T_{WSC} (ns)		T_{WHA} (ns)		T_{WHD} (ns)		T_{WHC} (ns)		T_{WP} (ns)	
			ADDRESS TO WRITE ENABLE		DATA IN TO WRITE ENABLE		CE TO WRITE ENABLE		ADDRESS TO WRITE ENABLE		DATA IN TO WRITE ENABLE		CE TO WRITE ENABLE		WRITE ENABLE PULSE WIDTH	
	C_L = 30 pF R_1 = 270Ω R_2 = 600Ω		MIN	TYP	MIN	TYP	MIN	TYP	MIN	TYP	MIN	TYP	MIN	TYP	MIN	TYP
64	82S21		15	10	25		15	10	5	0	5	0	5	0	25	
	82S25	S	10	−8	25	5	0	−5	10	0	10	−3	5	0	30	18
		N	0	−8	20		0	−5	5	0	5	−3	5	0	30	18
	3101A	S	0		25		0		0		0		0		25	18
		N	0	−8	20	5	0	−5	0		0	−3	0		25	18
256	82S16	S	20	5	50	40	10	0	10	0	10	0	10	0	40	20
		N	20	5	40	30	10	0	5	0	5	0	5	0	30	15
	82S17	S	20	5	50	40	10	0	10	0	10	0	10	0	40	20
		N	20	5	40	30	10	0	5	0	5	0	5	0	30	15
	82S116	N	0	−5	25	15	0	−5	0	−5	0	−5	0	−5	25	15
	82S117	N	0	−5	25	15	0	−5	0	−5	0	−5	0	−5	25	15
	C_L = 15 pF R_1 = 270Ω R_2 = 1 kΩ															
	54/74S200	54	0		50		0		10		10		0		50	
		74	0		40		0		10		10		0		40	
	54/74S201	54	0		50		0		10		10		0		50	
		74	0		40		0		10		10		0		40	
	54/74S301	54	0		50		0		10		10		0		50	25
		74	0		40		0		10		10		0		40	25
576	C_L = 30 pF R_1 = 600Ω R_2 = 900Ω															
	82S09	S	10	0	50	25	10	0	10	0	5	0	10	0	50	25
		N	5	0	35	25	5	0	5	0	5	0	5	0	35	25
1024	R_1 = 270Ω R_2 = 600Ω															
	82S10	S	15	0	55	35	5	0	10	0	5	0	5	0	50	25
		N	5	0	40	35	5	0	5	0	5	0	5	0	35	25
	82S11	S	15	0	55	35	5	0	10	0	5	0	5	0	50	25
		N	5	0	40	35	5	0	5	0	5	0	5	0	35	25
	93415A		5	0	40	35	5	0	5	0	5	0	5	0	35	25
	93425A		5	0	40	35	5	0	5	0	5	0	5	0	35	25

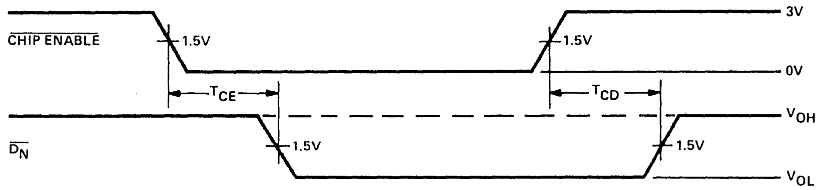
SWITCHING PARAMETERS MEASUREMENT INFORMATION

READ CYCLE

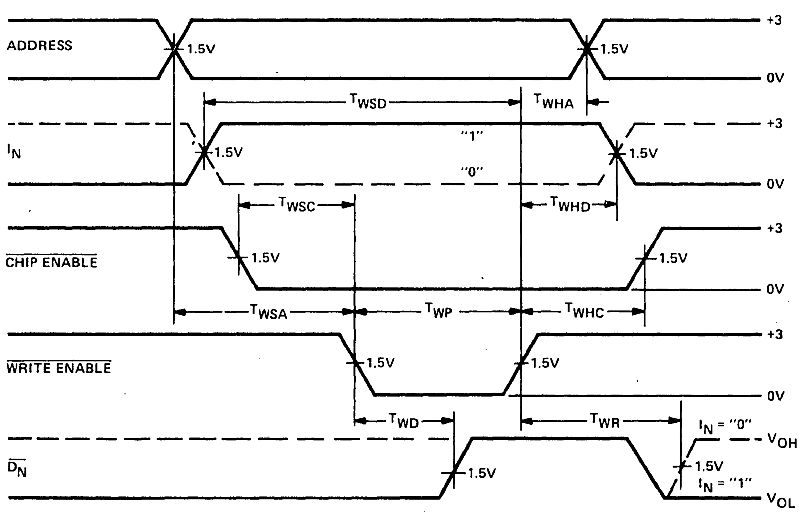
ADDRESS ACCESS TIME



CHIP ENABLE/DISABLE TIMES



WRITE CYCLE



MEMORY TIMING DEFINITIONS

T_{WR} Delay between end of WRITE ENABLE pulse and when DATA OUTPUT becomes valid. (Assuming ADDRESS still valid – not as shown.)

T_{CE} Delay between beginning of CHIP ENABLE low (with ADDRESS valid) and when DATA OUTPUT becomes valid.

T_{CD} Delay between when CHIP ENABLE becomes high and DATA OUTPUT is in off state.

T_{AA} Delay between beginning of valid ADDRESS (with CHIP ENABLE low) and when DATA OUTPUT becomes valid.

T_{WSC} Required delay between beginning of valid CHIP ENABLE and beginning of WRITE ENABLE pulse.

T_{WHD} Required delay between end of WRITE ENABLE pulse and end of valid INPUT DATA.

T_{WP} Width of WRITE ENABLE pulse.

T_{WSA} Required delay between beginning of valid ADDRESS and beginning of WRITE ENABLE pulse.

T_{WSD} Required delay between beginning of valid DATA INPUT and end of WRITE ENABLE pulse.

T_{WD} Delay between beginning of WRITE ENABLE pulse and when DATA OUTPUT is in off state.

T_{WHC} Required delay between end of WRITE ENABLE pulse and end of CHIP ENABLE.

T_{WHA} Required delay between end of WRITE ENABLE pulse and end of valid ADDRESS.

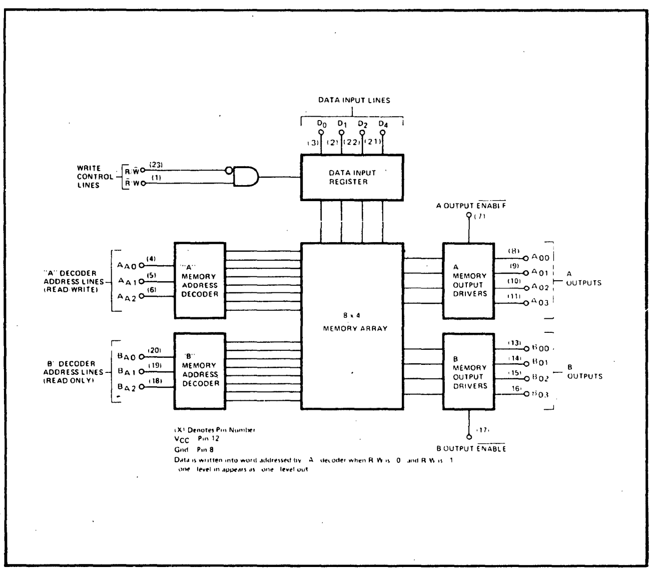
DESCRIPTION

The 82S12/112 is a Schottky TTL 32 bit multiport memory organized in 8 words of 4 bits each. The device is ideally suited for high speed accumulators and buffer memories.

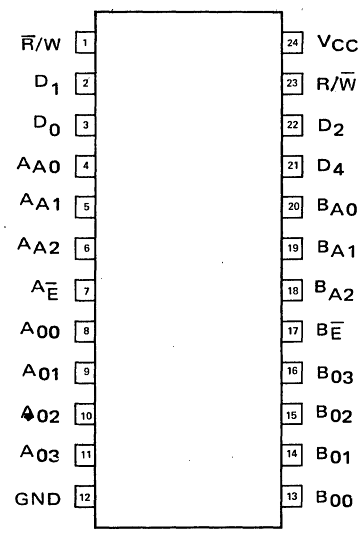
Stored data is addressed through 2 independent sets of 3-input decoders, and read out when the corresponding output enable line is low. Two separate word locations can, therefore, be read at the same time by enabling both the A and B output drivers. In addition, data can be read and written at the same time by utilizing the "A" address to specify the location of the word to be written, and the "B" address to specify the word to be read.

The 82S12/112 can be used in larger memory arrays since it includes all the control logic required to disable the chip and the outputs are open-collector devices suitable for "Wire-ORing."

BLOCK DIAGRAM



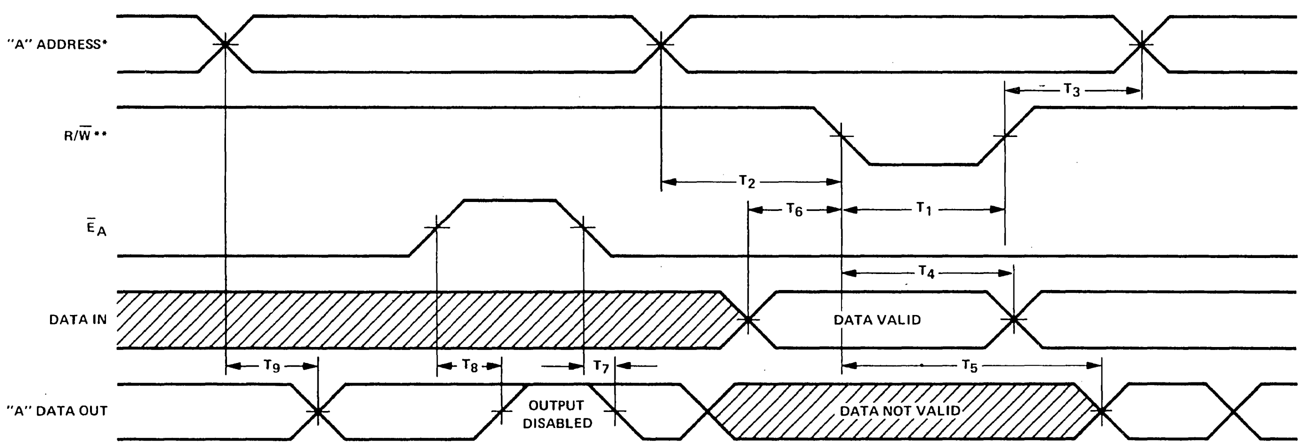
PIN CONFIGURATION



TRUTH TABLE

$\overline{R}$/W	R/$\overline{W}$	A OUTPUT ENABLE	B OUTPUT ENABLE	MODE	OUTPUTS A	OUTPUTS B
0	X	1	1	Outputs Disabled	"1"	"1"
0	X	1	0	Read	"1"	Data
0	X	0	1	Read	Data	"1"
0	X	0	0	Read	Data	Data
1	1	1	1	Read	"1"	"1"
1	1	1	0	Read	"1"	Data
1	1	0	1	Read	Data	"1"
1	1	0	0	Read	Data	Data
1	0	1	1	Write	"1"	"1"
1	0	1	0	Write	"1"	Data "B" Address
1	0	0	1	Write	Data Being Written	"1"
1	0	0	0	Write	Data Being Written	Data "B" Address

TIMING DIAGRAM



T_1 WRITE PULSE WIDTH – Width of write pulse (when R/W="1" and R/W="0")

T_2 ADDRESS SETUP TIME – Required delay between beginning of valid Address and beginning of Write pulse.

T_3 ADDRESS HOLD TIME – Required delay between end of Write pulse and end of valid Address.

T_4 DATA INPUT HOLD TIME – Required delay between start of Write pulse and end of Valid Data input.

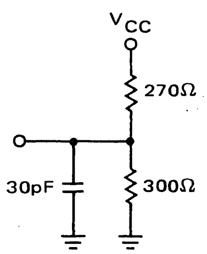
T_5 WRITE ACCESS TIME – Delay between beginning of Write pulse and Data Out at new value.

T_6 DATA INPUT SET-UP TIME – Required delay between beginning ov Valid Data Input and start of Write pulse.

T_7 OUTPUT ENABLE TIME – Delay between beginning of Output Enable high and when Data Output becomes valid.

T_8 OUTPUT DISABLE TIME – Delay between when Output Enable becomes low and Data Output is in off state.

T_9 ADDRESS ACCESS TIME – Delay between beginning of Valid Address (with Output Enable high, R/W high and R/W low) and when Data Output becomes valid.



A. C. LOAD

NOTES

*"B" Address functions identically in read mode. No write mode through B address decoder.

**R/W input is either the reverse of R/W or held high.

Outputs can be disabled during write cycle to penetrate a known output state during write.

64-BIT BIPOLAR HIGH SPEED WRITE-WHILE-READ RAM (32x2 RAM)

82S21

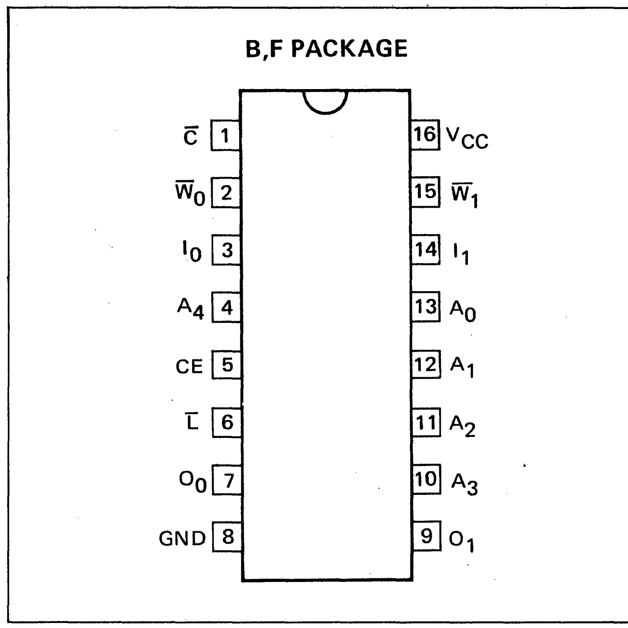
DESCRIPTION

The 82S21 is a TTL 64 bit Write-While-Read Random Access Memory organized in 32 words of 2 bits each. The 82S21 is ideally suited for high speed buffers and as the memory element in high speed accumulators.

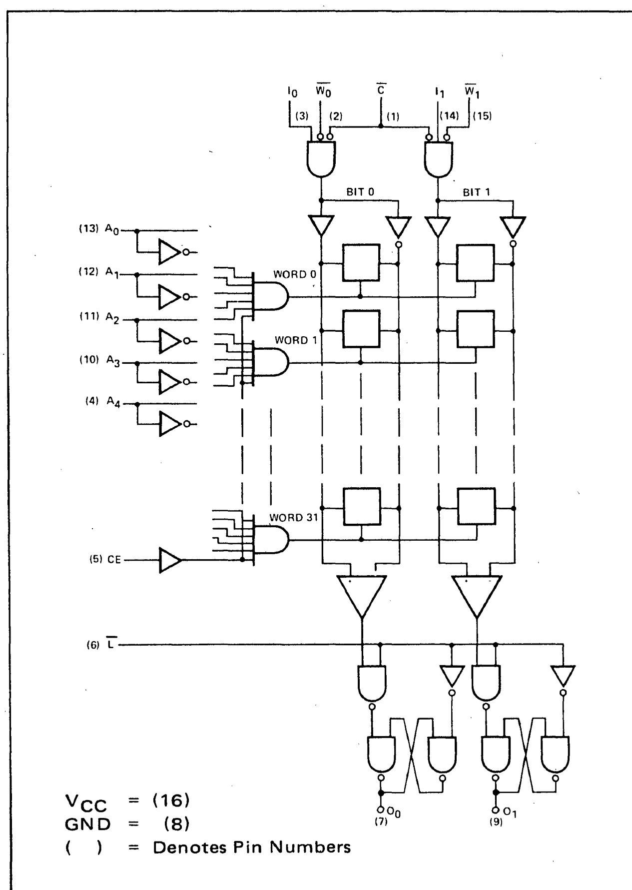
Words are selected through a 5 input decoder when the Read-Write enable input, CE is at logic "1". $\overline{W_0}$ and $\overline{W_1}$ are the write inputs for bit 0 and bit 1 of the word selected. $\overline{C}$ is the write control input. When $\overline{W_X}$ and $\overline{C}$ are both at logic "0" data on the I_0 and I_1 data lines are written into the addressed word. The read function is enabled when either $\overline{W_X}$ or $\overline{C}$ is at logic "1".

An internal latch is on the chip to provide the Write-While-Read capability. When the latch control line, $\overline{L}$, is logic "1" and data is being read from the 82S21, the latch is effectively bypassed. The data at the output will be that of the addressed word. When $\overline{L}$ goes from a logic "1" to logic "0" the outputs are latched and will remain latched regardless of the state of any other address or control line. When $\overline{L}$ goes from "0" to "1" the outputs unlatch and the outputs will be that of the present address word.

PIN CONFIGURATION



LOGIC DIAGRAM



TRUTH TABLE

CE	$\overline{C}$	$\overline{W_0}$	$\overline{W_1}$	$\overline{L}$	Mode	Outputs
X	X	X	X	0	Output Hold	Data from last addressed word when CE = "1"
0	X	X	X	1	Read & Write Disabled	Disabled logic "1"
1	1	X	X	X	Read	Data stored in addressed word
1	0	1	1	X	Read	Data stored in addressed word
1	0	0	0	0	Write Data	Data from last word address when L went from "1" to "0"
1	0	0	0	1	Write Data	Data being written into memory
1	0	0	1	X	Write Data into Bit 0 Only	If $\overline{L}$ = 0: Data from last word address when L went from "1" to "0"
1	0	1	0	X	Write Data into Bit 1 Only	If $\overline{L}$ = 1: Data being written into the selected bit location and stored in other addressed location

AC WAVEFORM

Read Access Time

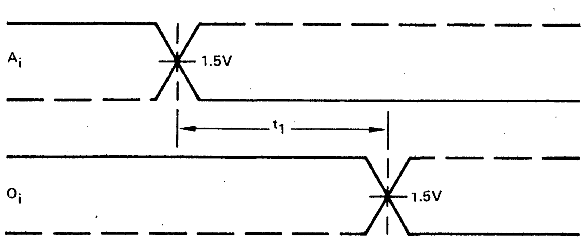
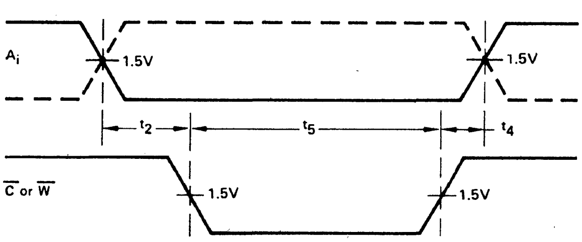


FIGURE 1

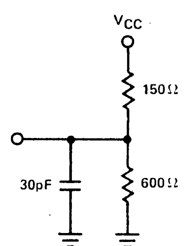
Address Setup and Hold Time



$t_r = t_f \leqslant 5$ ns, INPUT VOLTAGE = 2.8 Volts

FIGURE 2

TEST LOAD

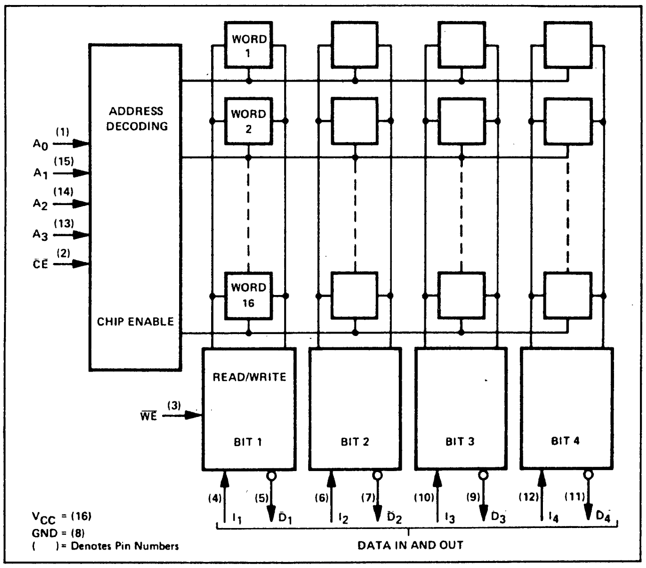


signetics

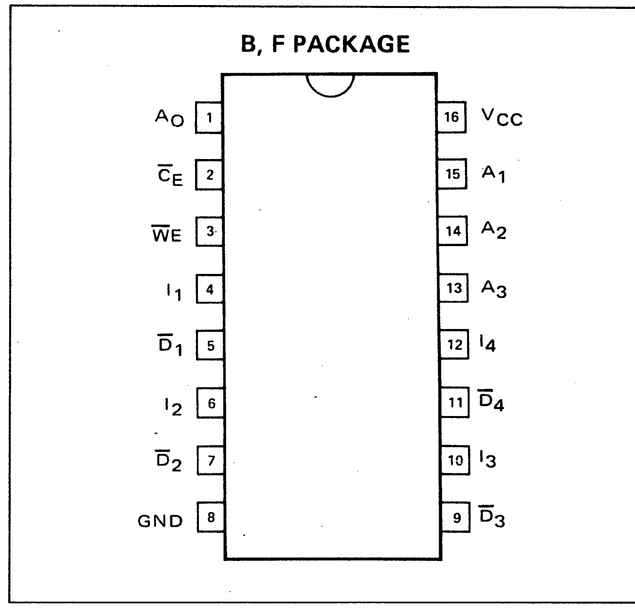
64-BIT BIPOLAR SCRATCH PAD MEMORY (16x4 RAM) 82S25 3101A

N82S25-B,F • S82S25-F
N3101A-B,F • S3101A-F

BLOCK DIAGRAM



PIN CONFIGURATION



TRUTH TABLE

MODE	$\overline{CE}$	$\overline{WE}$	In	$\overline{D}n$
Read	0	1	X	Complement of data stored
Write "0"	0	0	0	1
Write "1"	0	0	1	1
Disabled	1	X	X	1

X = Don't care.

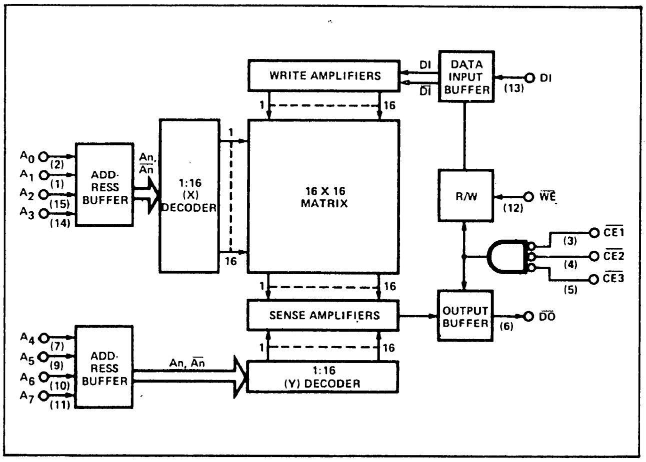
signetics

256-BIT BIPOLAR RAM (256x1 RAM)

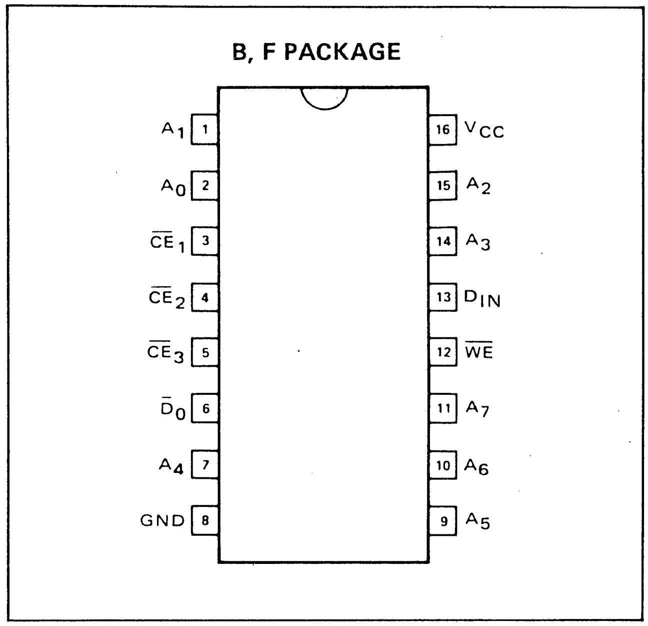
82S16
82S17
82S116
82S117
54/74S200
54/74S201
54/74S301

N82S16/17/116/117-B,F
54S200/201/301-F
74S200/201/301-B,F

BLOCK DIAGRAM



PIN CONFIGURATION



TRUTH TABLE

MODE	$\overline{CE}$*	$\overline{WE}$	D_{IN}	$\overline{D_{OUT}}$ 82S16/116	82S17/117	54/74S 200/201	54/74S301
READ	0	1	X	STORED $\overline{\text{DATA}}$	STORED $\overline{\text{DATA}}$	STORED $\overline{\text{DATA}}$	STORED $\overline{\text{DATA}}$
WRITE "0"	0	0	0	1	1	HIGH-Z	1
WRITE "1"	0	0	1	0	0	HIGH-Z	1
DISABLED	1	X	X	High-Z	1	HIGH-Z	1

*"0" = All $\overline{CE}$ inputs low; "1" = one or more $\overline{CE}$ inputs high.

X = Don't care.

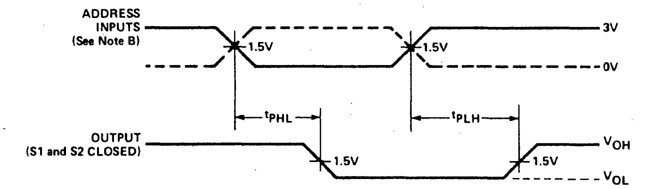
Signetics

MEMORY

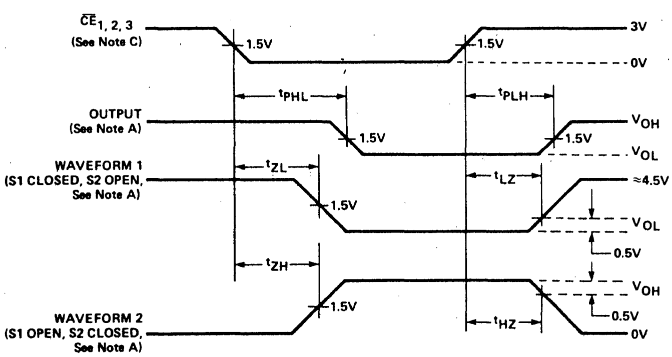
SWITCHING PARAMETER MEASUREMENT INFORMATION

READ CYCLE

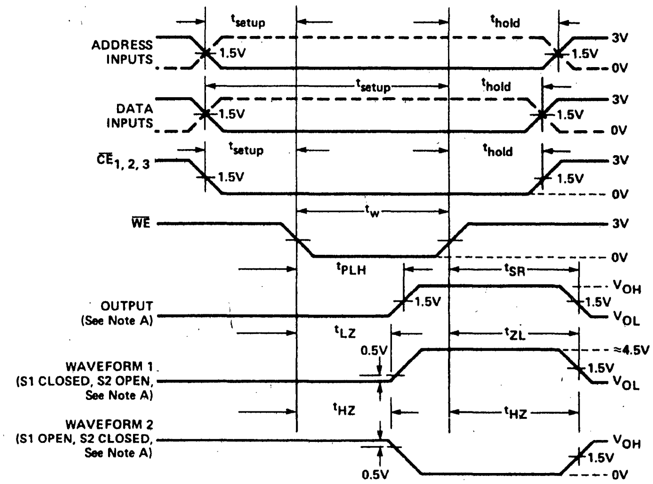
ACCESS TIME FROM ADDRESS



CHIP ENABLE AND DISABLE TIME

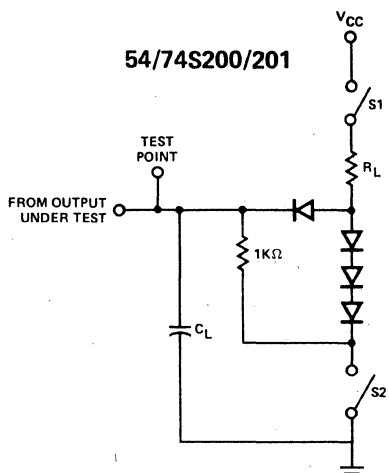


WRITE CYCLE

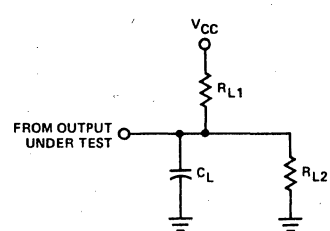


AC TEST LOAD

54/74S200/201



54/74S301



C_L INCLUDES PROBE AND JIG CAPACITANCE.
ALL DIODES ARE 1N3064.

NOTES:

A. Waveform 1 is for the output with internal conditions such that the output is low except when disabled. Waveform 2 is for the output with internal conditions such that the output is high except when disabled.
B. When measuring delay times from address inputs, the chip enable inputs are low and the write enable input is high.
C. When measuring delay times from chip enable inputs, the address inputs are steady-state and the write enable input is high.
D. Input waveforms are supplied by pulse generators having the following characteristics: $t_r \leq 2.5ns$, $t_f \leq 2.5ns$, PRR $\leq$ 1MHz, and $Z_{out} \approx 50\Omega$.
E. t_{PLH} propagation delay time, low-to-high-level output, t_{PHL} propagation delay time, high-to-low-level output.
F. t_{ZH} propagation delay time, hi-Z to high-level output, t_{ZL} propagation delay time, hi-Z to low-level output.
G. t_{HZ} propagation delay time, high-level to hi-Z output, t_{LZ} propagation delay time, low--level to hi-Z output.
H. Minimum required to guarantee a WRITE into the slowest bit.

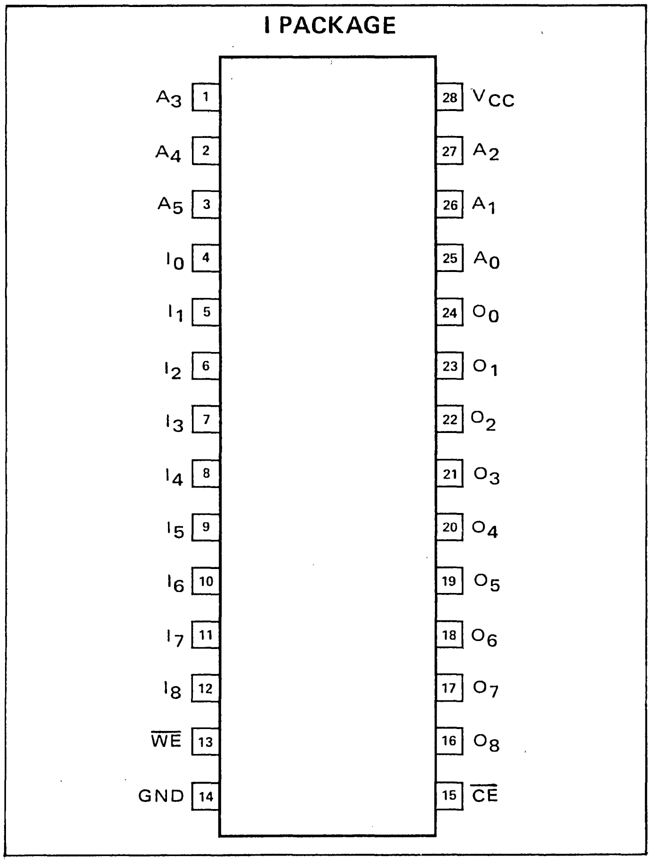
DESCRIPTION

The 82S09 is a 576-Bit, Schottky clamped TTL, random access memory, organized as 64X9. This organization allows byte manipulation of data, including parity. Where parity is not monitored, the ninth bit can be used as a flag or status indicator for each word stored. With a typical access time of 30ns, it is ideal for scratch-pad, push-down stacks, buffer memories, and other internal memory applications in which cost and performance requirements dictate a wide data path in favor of word depth.

The 82S09 is fully TTL compatible, and features open collector outputs, chip enable input, and a very low current PNP input structure to enhance memory expansion.

During WRITE operation, the logic state of the device output follows the complement of the data input being written. This feature allows faster execution of WRITE-READ cycles, enhancing the performance of systems utilizing indirect addressing modes, and/or requiring immediate verification following a WRITE cycle.

PIN CONFIGURATION

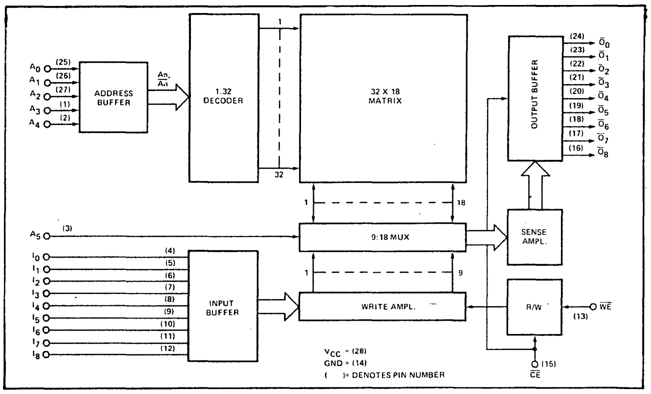


TRUTH TABLE

MODE	CE	WE	I_N	O_N
READ	0	1	X	Complement of Data Stored
WRITE "0"	0	0	0	1
WRITE "1"	0	0	1	0
DISABLED	1	X	X	1

X = Don't care.

BLOCK DIAGRAM

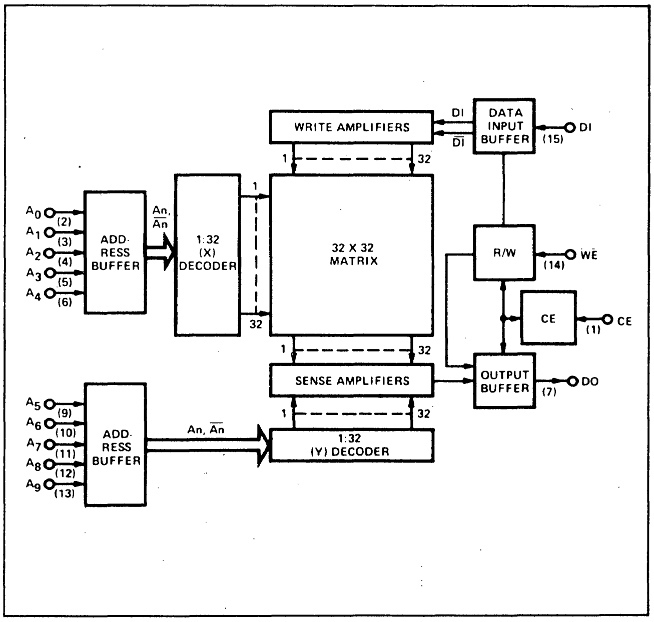


Signetics

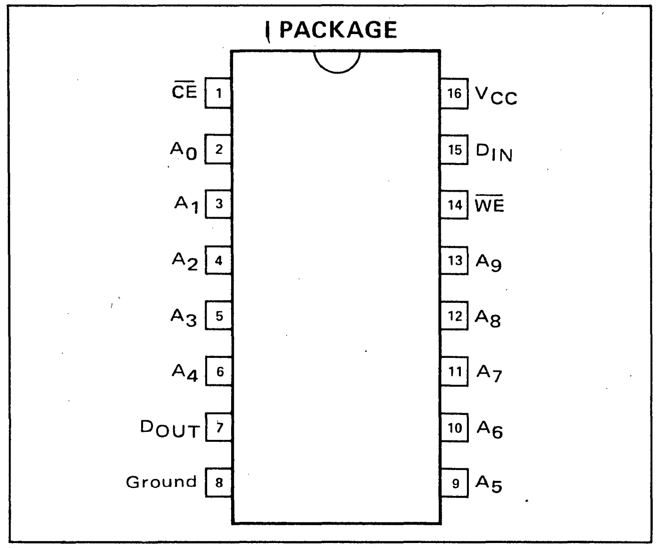
MEMORY

82S10
82S11

BLOCK DIAGRAM



PIN CONFIGURATION



TRUTH TABLE

MODE	$\overline{CE}$	$\overline{WE}$	D_{IN}	D_{OUT} 82S10	D_{OUT} 82S11
READ	0	1	X	STORED DATA	STORED DATA
WRITE "0"	0	0	0	1	High-Z
WRITE "1"	0	0	1	1	High-Z
DISABLED	1	X	X	1	High-Z

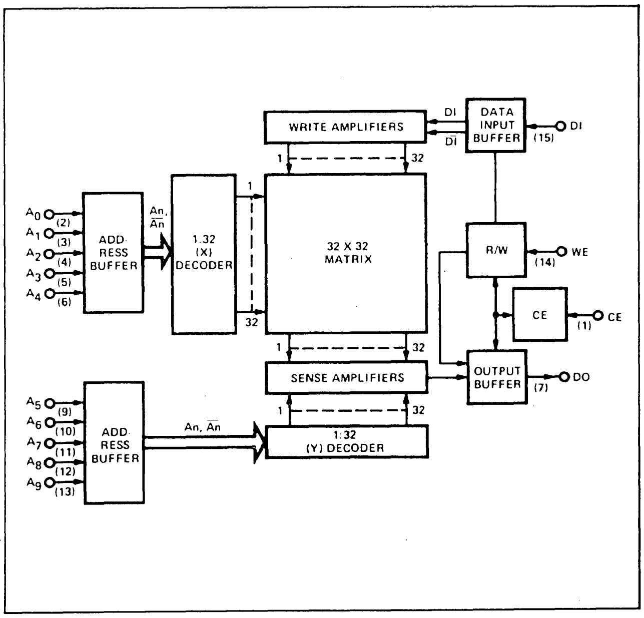
X = Don't care.

signetics

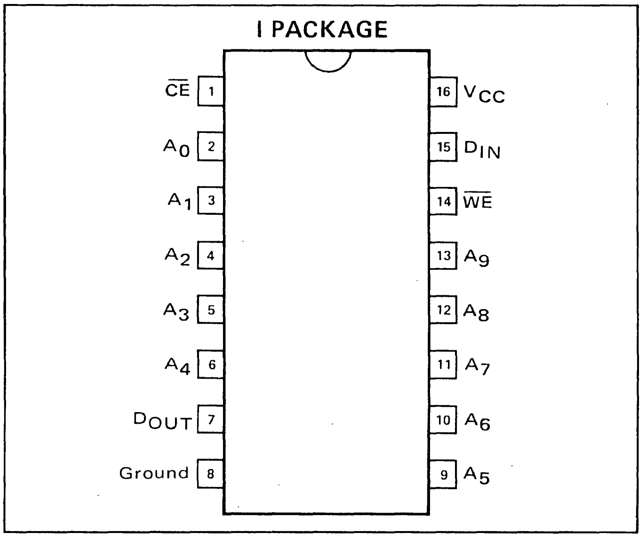
1024-BIT BIPOLAR RAM (1024 x 1) 93415A 93425A

93415A-I, 93425A-I

BLOCK DIAGRAM



PIN CONFIGURATION



TRUTH TABLE

MODE	$\overline{CE}$	$\overline{WE}$	D_{IN}	D_{OUT}	
				93415A	93425A
READ	0	1	X	STORED DATA	STORED DATA
WRITE "0"	0	0	0	1	High-Z
WRITE "1"	0	0	1	1	High-Z
DISABLED	1	X	X	1	High-Z

X = Don't care.

ROMS

Mask Programmable Read Only Memories

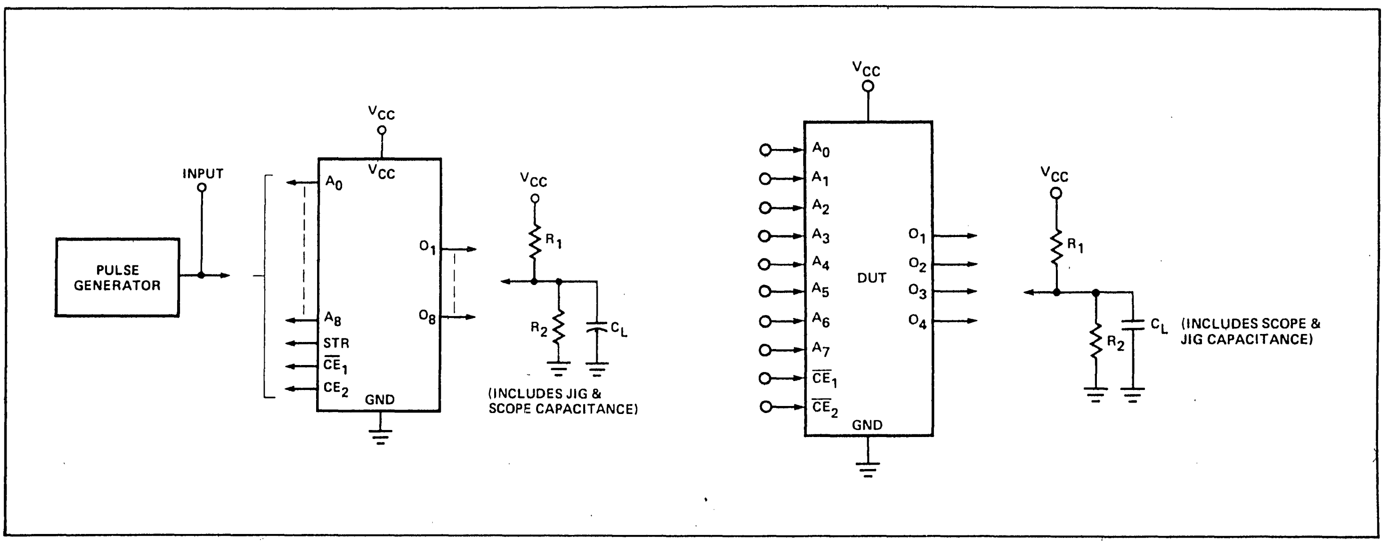
Signetics offers the industry's broadest line of High Performance Bipolar ROMs. Most Signetics ROMs have pin and performance compatible PROMs offering the user the ultimate in flexibility and long term cost reduction.

All ROMs are fully TTL compatible and include on-chip decoding and chip enable function for ease of memory expansion. Tri-state and open collector functions are available, and low input current requirements reduce the need for input buffering.

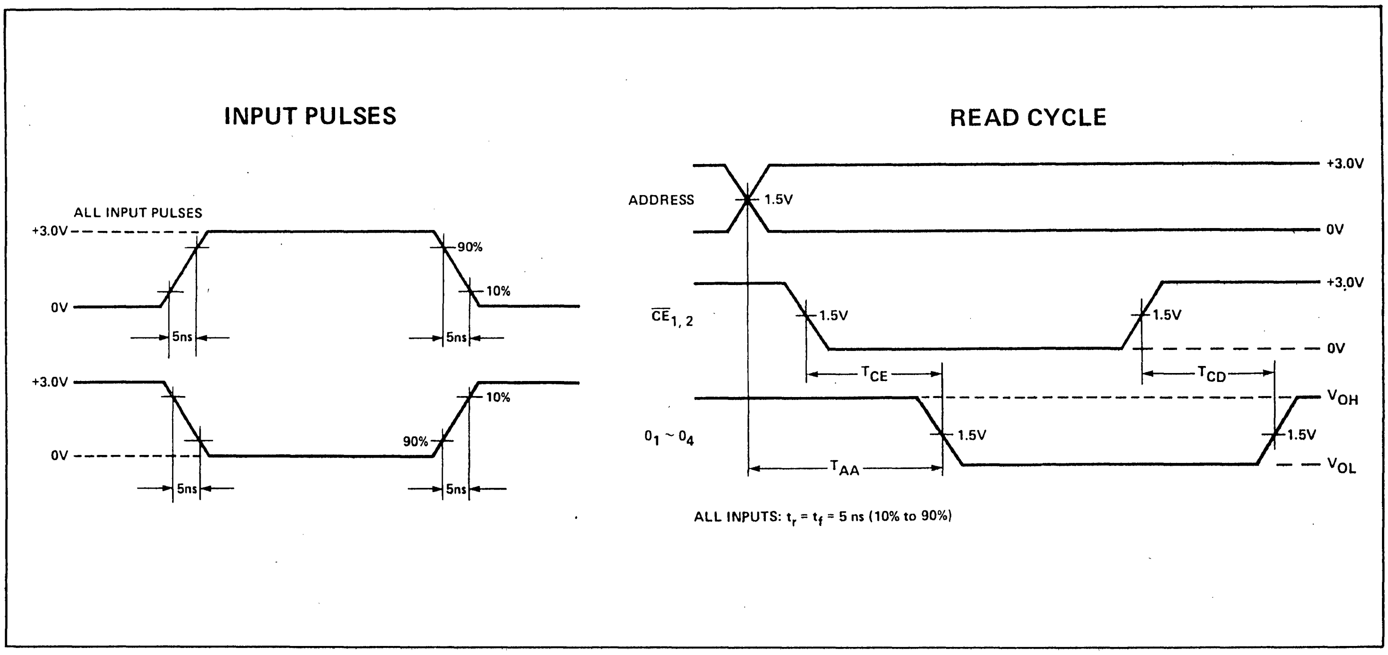
SWITCHING CHARACTERISTICS S82S $.55°C \leqslant T_A \leqslant +125°C, 4.5V \leqslant V_{CC} \leqslant 5.5V$
N82S $0°C \leqslant T_A \leqslant +75°C, 4.75V \leqslant V_{CC} \leqslant 5.25V$

# OF BITS	DEVICE		T_{AA} (ns) ADDRESS ACCESS TIME			T_{CE} (ns) CHIP ENABLE ACCESS TIME			T_{CD} (ns) CHIP DISABLE TIME		
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
	C_L = 30 pF R_1 = 270Ω R_2 = 600Ω										
1024	82S226	S		35	70		15	35		15	35
		N		35	50		15	20		15	20
	82S229	S		35	70		15	35		15	35
		N		35	50		15	20		15	20
2048	R_1 = 470Ω R_2 = 1kΩ		LATCHED OR TRANSPARENT READ[2]			LATCHED OR TRANSPARENT READ[2]			LATCHED OR TRANSPARENT READ[2]		
	82S214	S		35	90		20	50		20	50
		N		35	60		20	40		20	40
	82S215	S		35	90		20	50		20	50
		N		35	60		20	40		20	40
	R_1 = 270Ω R_2 = 600Ω										
	82S230	S		40	70		20	30		20	30
		N		40	50		20	30		20	30
	82S231	S		40	70		20	30		20	30
		N		40	50		20	30		20	30
4096	8228			50	70[4]						

AC TEST LOAD AND WAVEFORMS



AC TEST FIGURE AND WAVEFORM



signetics

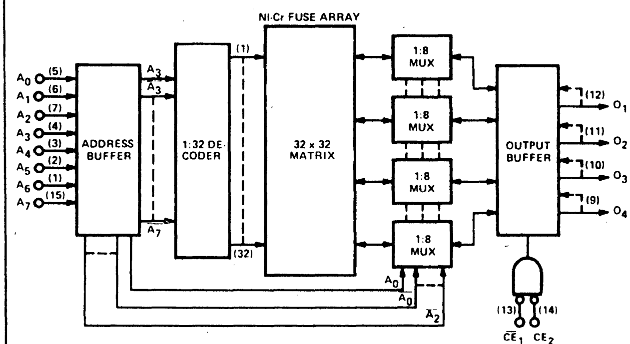
1024-BIT BIPOLAR READ ONLY MEMORY (256x4 ROM)

82S226 82S229

FULLY COMPATIBLE W/82S126

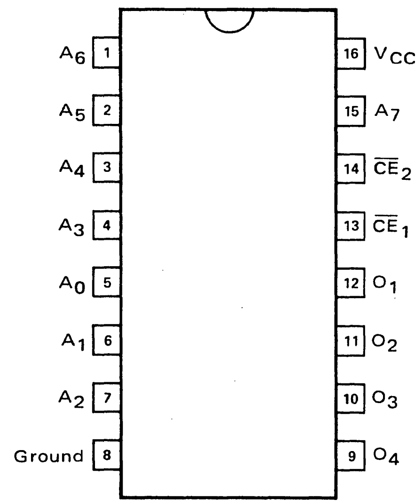
N82S226-B,F • S828226-F

BLOCK DIAGRAM



PIN CONFIGURATION

B, F PACKAGE



82S214
82S215

2048-BIT BIPOLAR ROM (256x8 ROM)

FULLY COMPATIBLE W/82S114

N82S214-I • S82S214-I

DESCRIPTION

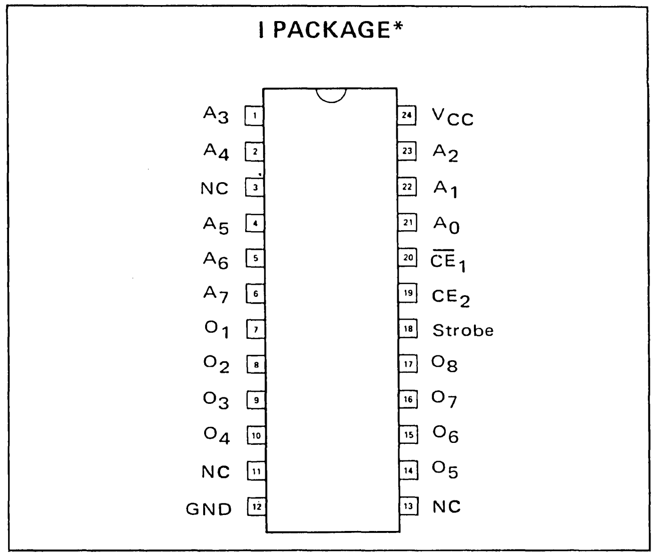
The 82S214 and 82S215 are Schottky-clamped Read Only Memories, incorporating on-chip data output registers.

The 82S214 and 82S215 are fully TTL compatible, and include on-chip decoding and two chip enable inputs for ease of memory expansion. They feature Tri-State outputs for optimization of word expansion in bussed organizations. A D-type latch is used to enable the Tri-State output drivers. In the TRANSPARENT READ mode, stored data is addressed by applying a binary code to the address inputs while holding STROBE high. In this mode the bit drivers will be controlled solely by $\overline{CE1}$ and CE2 lines.

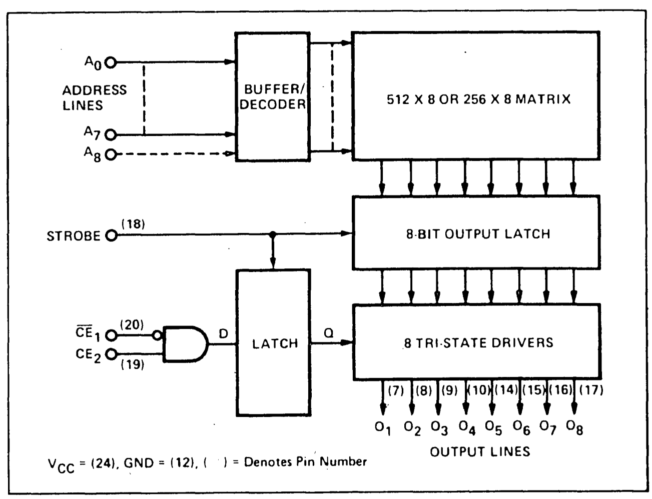
In the LATCHED READ mode, outputs are held in their previous state (1, 0, or high Z) as long as STROBE is low, regardless of the state of address or chip enable. A positive STROBE transition causes data from the applied address to reach the outputs if the chip is enabled, and causes outputs to go to the high Z state if the chip is disabled.

A negative STROBE transition causes outputs to be locked into their last Read Data condition if the chip was enabled, or causes outputs to be locked into the high Z condition if the chip was disabled.

PIN CONFIGURATION



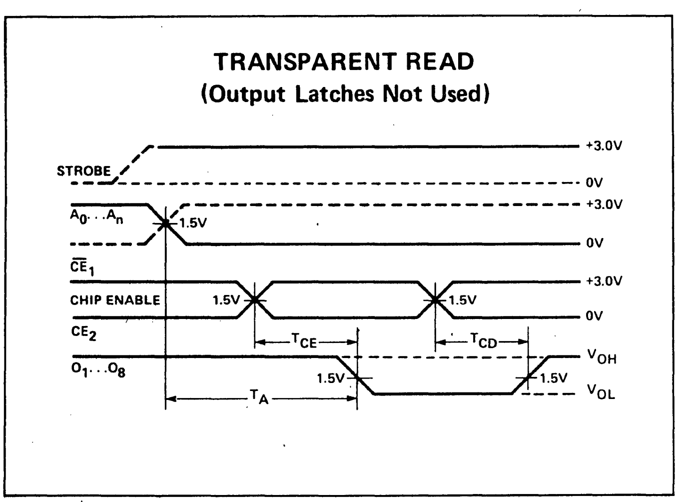
BLOCK DIAGRAM

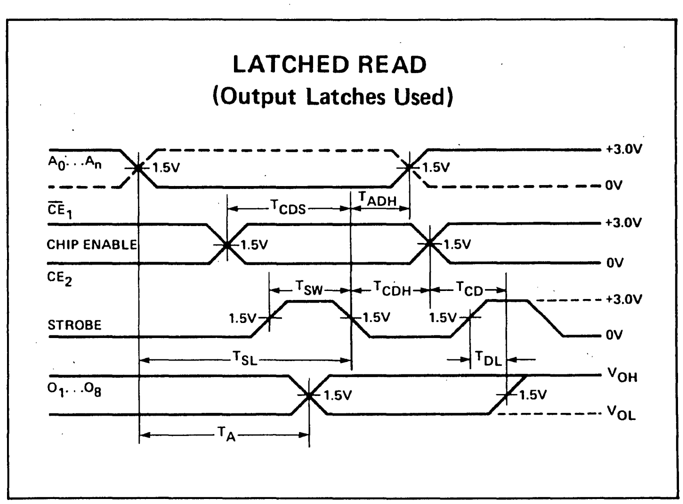


Signetics

MEMORY

MEMORY TIMING



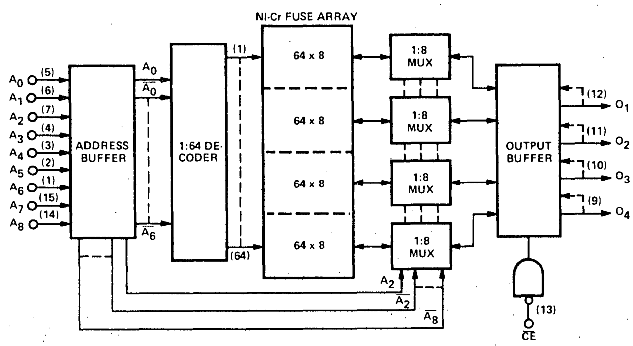


2048-BIT BIPOLAR ROM (512x4 ROM) 82S230 82S231

FULLY COMPATIBLE W/82S130

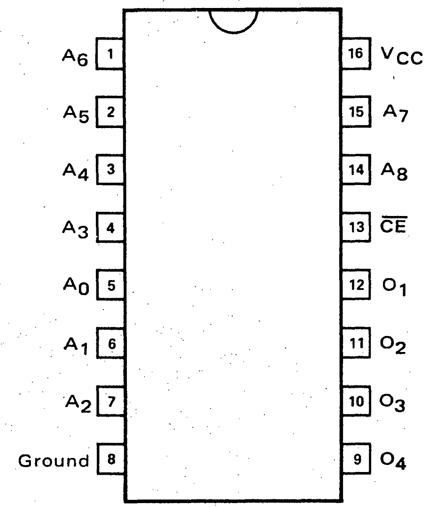
N82S230-F • S82S230-F

BLOCK DIAGRAM



PIN CONFIGURATION

F PACKAGE*



*F — Cerdip

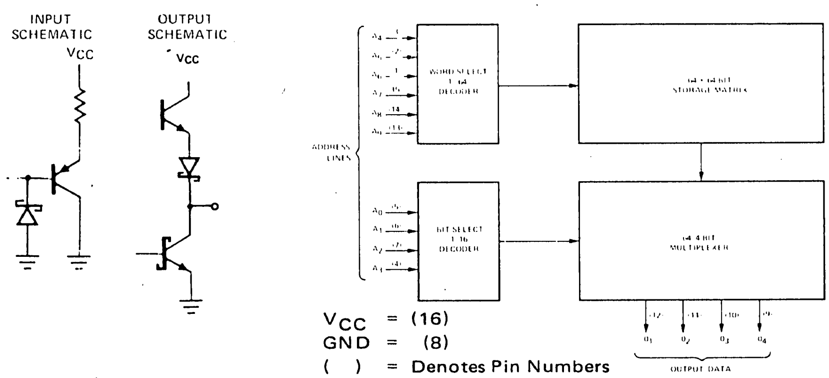
signetics

4096 BIT BIPOLAR ROM (1024x4 ROM)

8228

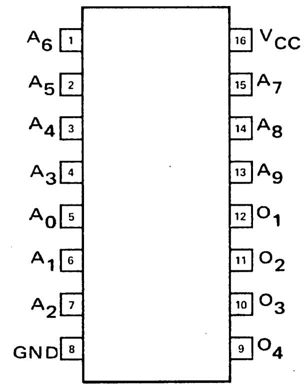
8228-I

BLOCK DIAGRAM



PIN CONFIGURATION

I PACKAGE



PROMS

Field Programmable Read Only Memories

Signetics offers the industry's broadest line of Bipolar High Performance PROMs. These PROMs are field programmable, which means that custom patterns are immediately available by following the provided fusing procedures. Signetics PROMs are supplied with all outputs at logical "0". Outputs are programmed to a logic "1" at any specified address by fusing a Ni-Cr link matrix.

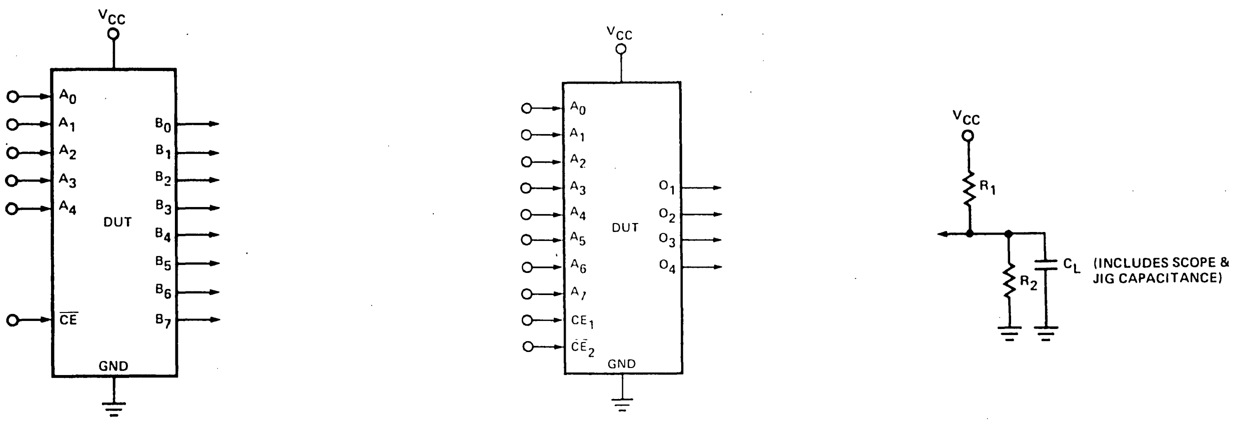
All PROMs are fully TTL compatible, and include on-chip decoding and chip enable functions for ease of memory expansion. Tri-state and open collector output functions are available, and low input currents reduce input buffer requirements.

Most Signetics PROMs also have pin and performance compatible ROMs, offering the user the ultimate in flexibility and cost reduction.

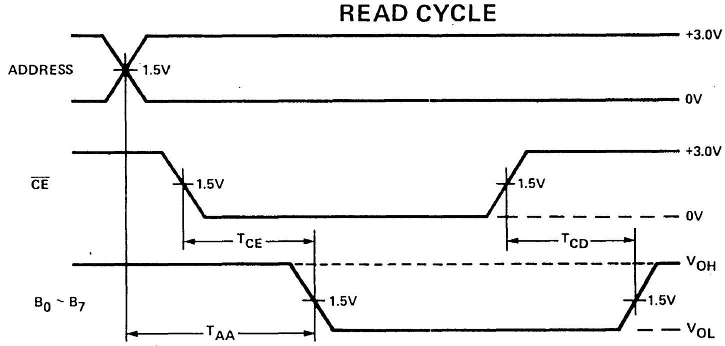
SWITCHING CHARACTERISTICS S82S $-55°C \leqslant T_A \leqslant +125°C$, $4.5V \leqslant V_{CC} \leqslant 5.5V$
N82S $0°C \leqslant T_A \leqslant +75°C$, $4.75V \leqslant V_{CC} \leqslant 5.25V$

			PROPAGATION DELAYS								
# OF BITS	DEVICE		T_{AA} (ns) ADDRESS ACCESS TIME			T_{CE} (ns) CHIP ENABLE ACCESS TIME			T_{CD} (ns) CHIP DISABLE TIME		
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
	C_L = 30 pF R_1 = 270Ω R_2 = 600Ω										
256	82S23	S		35	65		25	40		25	40
		N		35	50		25	35		25	35
	82S123	S		35	65		25	40		25	40
		N		35	50		25	35		25	35
	10139			15	20						
1024	82S27	N		30	40		15	20		15	20
	82S126	S		35	70		15	35		15	35
		N		35	50		15	20		15	20
	82S129	S		35	70		15	35		15	35
		N		35	50		15	20		15	20
	82S130	S		40	70		20	30		20	30
		N		40	50		20	30		20	30
	82S131	S		40	70		20	30		20	30
		N		40	50		20	30		20	30
2048			LATCHED OR TRANSPARENT READ[2]			LATCHED OR TRANSPARENT READ[2]			LATCHED OR TRANSPARENT READ[2]		
	82S114	N		35	60		20	40		20	40
	82S115	N		35	60		20	40		20	40

AC TEST FIGURE AND WAVEFORM

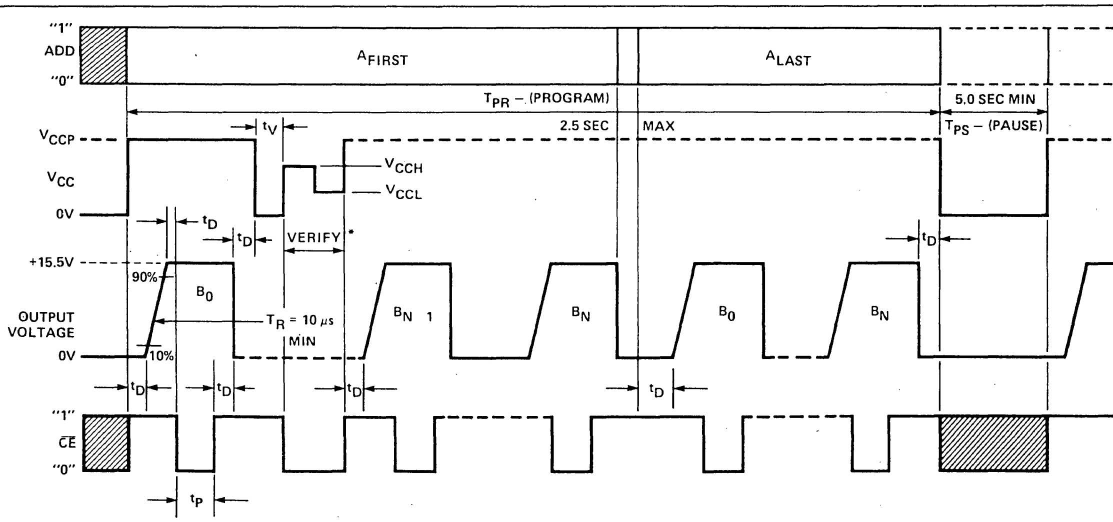


READ CYCLE



ALL INPUTS: $t_r = t_f = 5$ ns (10% to 90%)

TYPICAL PROGRAMMING SEQUENCE



*PROGRAMMING VERIFICATION AT BOTH HIGH AND LOW V_{CC} MARGINS IS OPTIONAL. FOR CONVENIENCE, VERIFICATION CAN ALSO BE EXECUTED AT THE OPERATING V_{CC} LIMITS SPECIFIED IN THE DC CHARACTERISTICS.

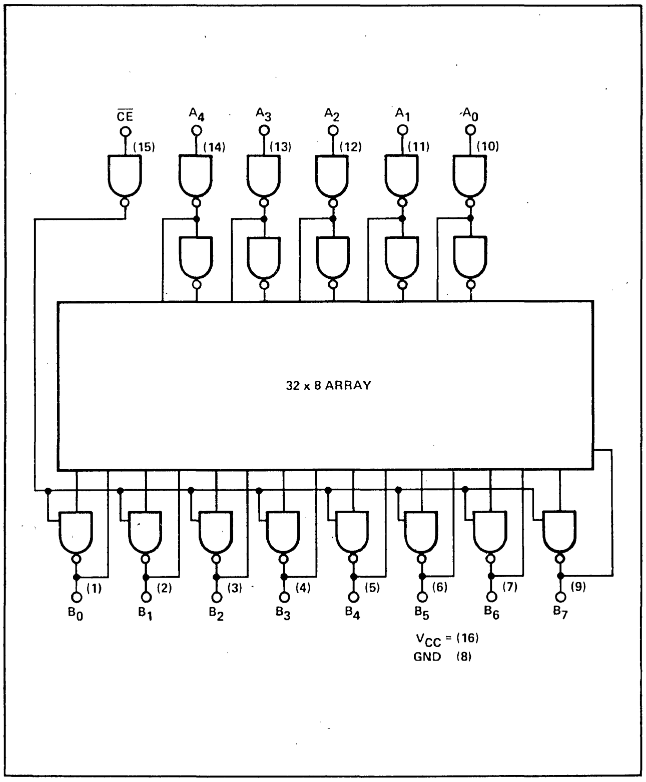
Signetics

MEMORY

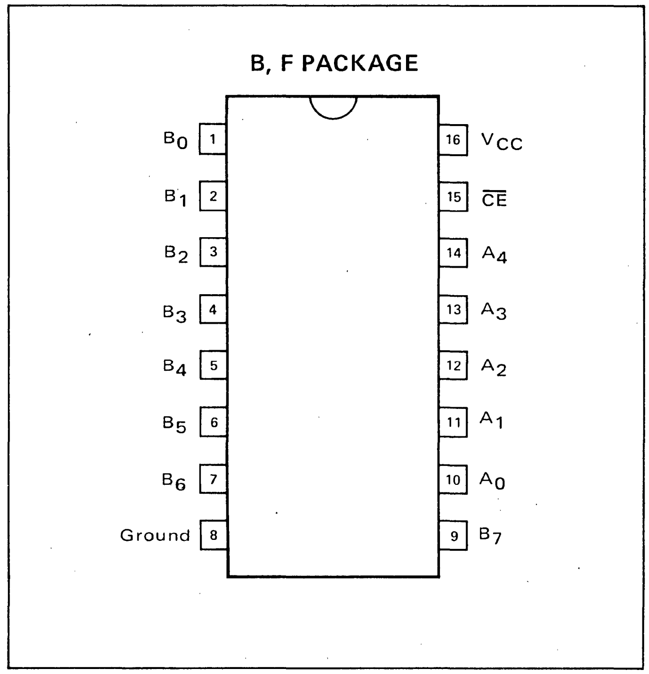
82S23 / 82S123 256-BIT BIPOLAR PROM (32x8)

N82S23/123-B,F • S82S23/123-F

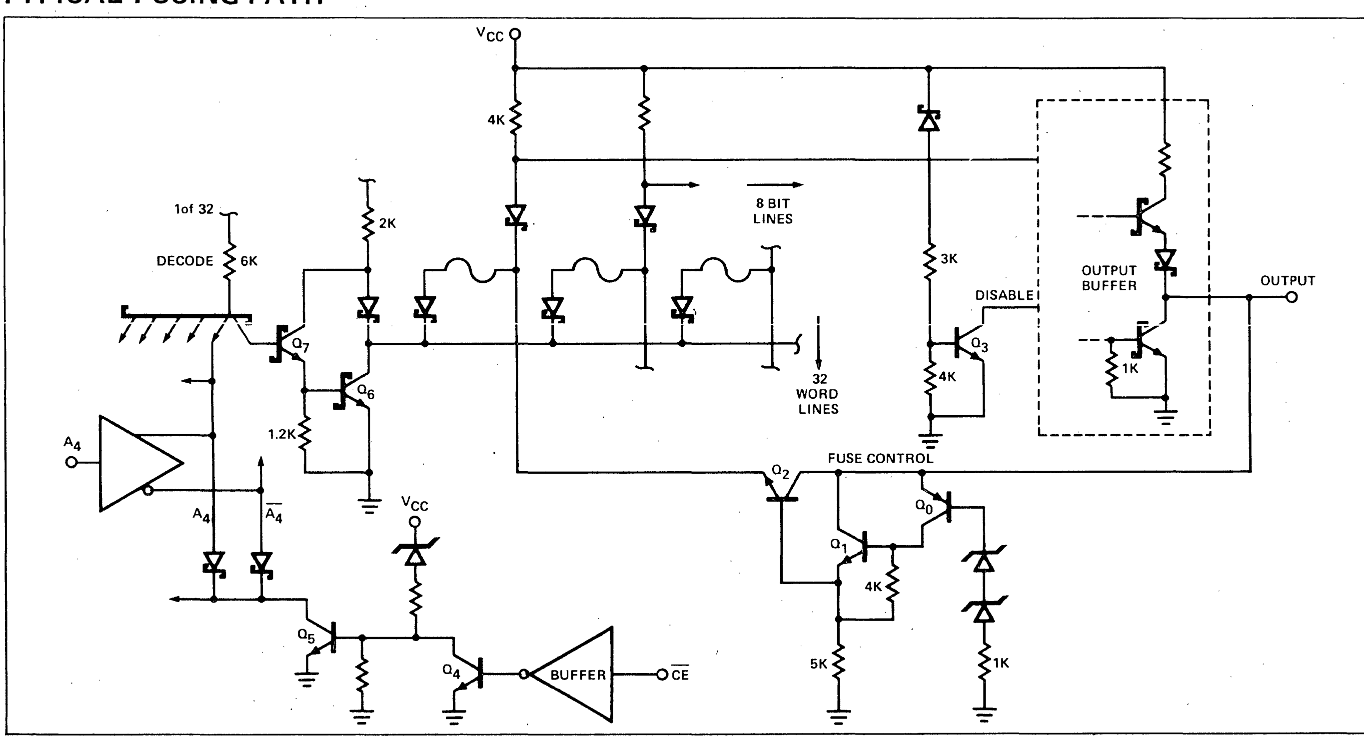
LOGIC DIAGRAM



PIN CONFIGURATION



TYPICAL FUSING PATH



PROGRAMMING SPECIFICATIONS (Testing of these limits may cause programming of device.) $T_A = +25°C$

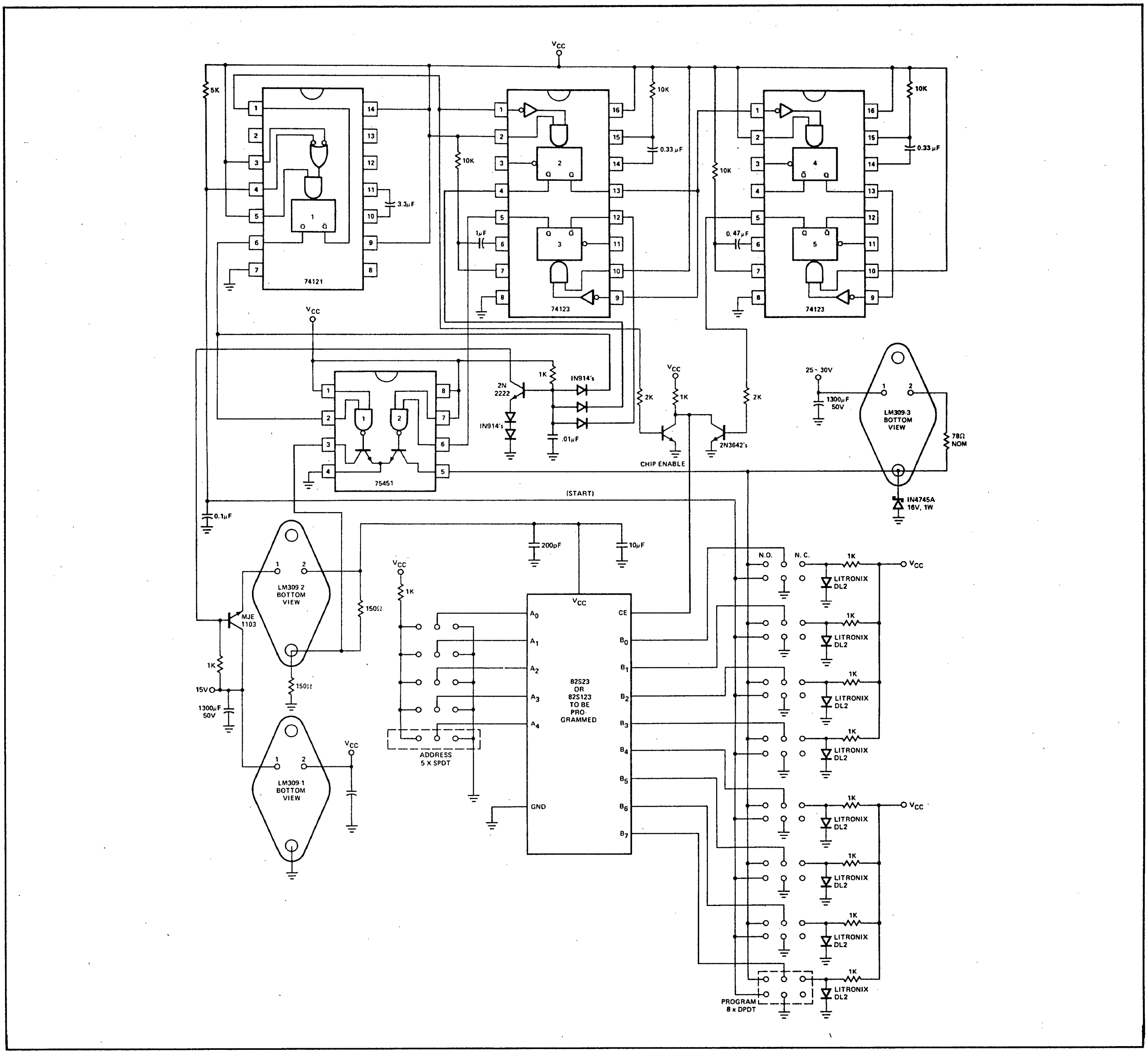
PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP	MAX	
Power Supply Voltage						
V_{CCP}[1]	To Program	$I_{CCP} = 250 \pm 50mA$ (Transient or steady state)	9.5	10.0	10.5	V
V_{CCH}	Upper Verify Limit		5.3	5.5	5.7	V
V_{CCL}	Lower Verify Limit		4.3	4.5	4.7	V
V_S[3]	Verify Threshold		0.9	1.0	1.1	V
I_{CCP}	Programming Supply Current	$V_{CCP} = +10.0 \pm 0.5V$	200	250	300	mA
Input Voltage						
V_{IH}	Logical "1"		2.4		5.5	V
V_{IL}	Logical "0"		0	0.4	0.8	V
Input Current						
I_{IH}	Logical "1"	$V_{IH} = +5.5V$			50	µA
I_{IL}	Logical "0"	$V_{IL} = +0.4V$			-500	µA
V_{OUT}[2]	Output Programming Voltage	$I_{OUT} = 65 \pm 3mA$ (Transient or steady state)	15.0	15.5	16.0	V
I_{OUT}	Output Programming Current	$V_{OUT} = +15.5 \pm 0.5V$	62	65	68	mA
T_R	Output Pulse Rise Time		10		50	µs
t_P	$\overline{CE}$ Programming Pulse Width		1		2	ms
t_V	Verify Delay		50			µs
t_D	Pulse Sequence Delay		10			µs
T_{PR}	Programming Time	$V_{CC} = V_{CCP}$			2.5	sec
T_{PS}	Programming Pause	$V_{CC} = 0V$	5			sec
$\frac{T_{PR}}{T_{PR}+T_{PS}}$[4]	Programming Duty Cycle				33	%

PROGRAMMING PROCEDURE

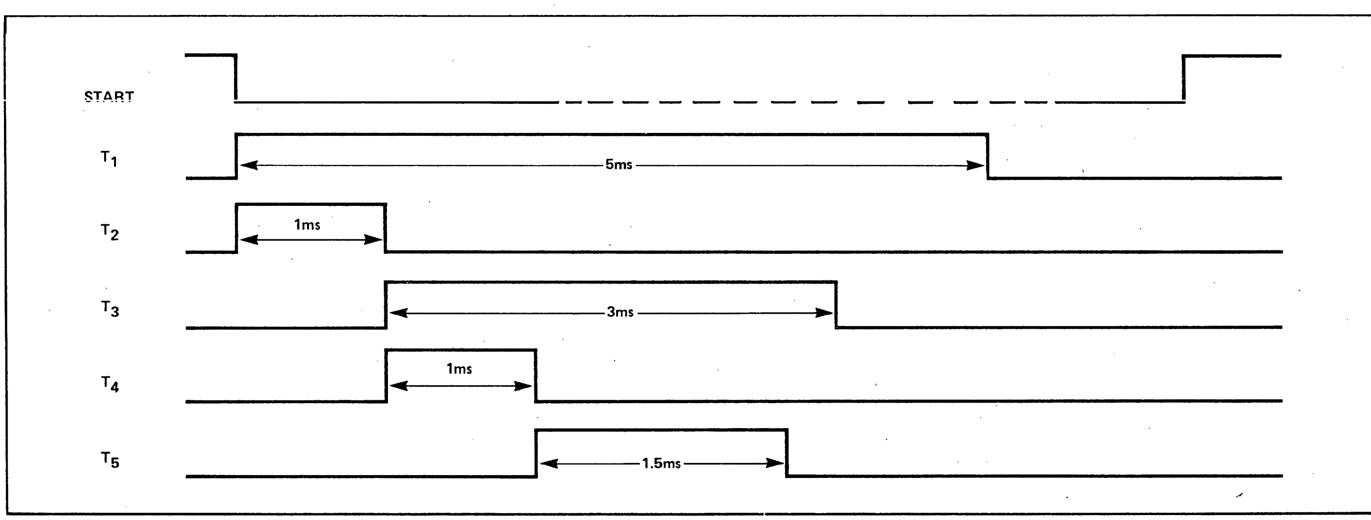
1. Terminate all device outputs with a 10KΩ resistor to V_{CC}.
2. Select the Address to be programmed, and raise V_{CC} to $V_{CCP} = +10 \pm 0.5V$.
3. After 10µs delay, apply $I_{OUT} = 65 \pm 3mA$ to the output to be programmed. Program one output at a time.
4. After 10µs delay, pulse the $\overline{CE}$ input to logic "0" for 1 to 2 ms.
5. After 10µs delay, remove I_{OUT} from the programmed output.
6. After 10µs delay, return V_{CC} to 0V.
7. To verify programming, after 50µs delay, raise V_{CC} to $V_{CCH} = +5.5 \pm .2V$, and apply a logic "0" level to the $\overline{CE}$ input. The programmed output should remain in the "1" state. Again, lower V_{CC} to $V_{CCL} = +4.5 \pm .2V$, and verify that the programmed output remains in the "1" state.
8. Raise V_{CC} to $V_{CCP} = +10 \pm 0.5V$ and repeat steps 3 through 7 to program other bits at the same address.
9. After 10µs delay, repeat steps 2 through 8 to program all other address locations.

NOTES:
1. Bypass V_{CC} to GND with a 0.01µF capacitor to reduce voltage spikes.
2. Care should be taken to insure that +15.5 ± 0.5V output voltage is maintained during the entire fusing cycle. The recommended supply is a constant current source clamped at the specified voltage limit.
3. V_S is the sensing threshold of the PROM output voltage for a programmed bit. It normally constitutes the reference voltage applied to a comparator circuit to verify a successful fusing attempt.
4. Continuous fusing for an unlimited time is also allowed, provided that a 33% duty cycle is maintained. This may be accomplished by following each Program-Verify cycle with a Rest period (V_{CC} = 0V) of 4ms.

MANUAL PROGRAMMER



TIMING SEQUENCE



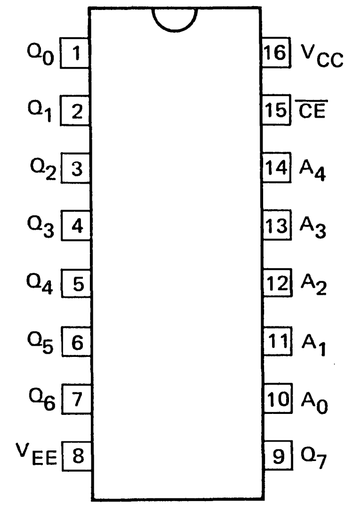
10139-F

DESCRIPTION

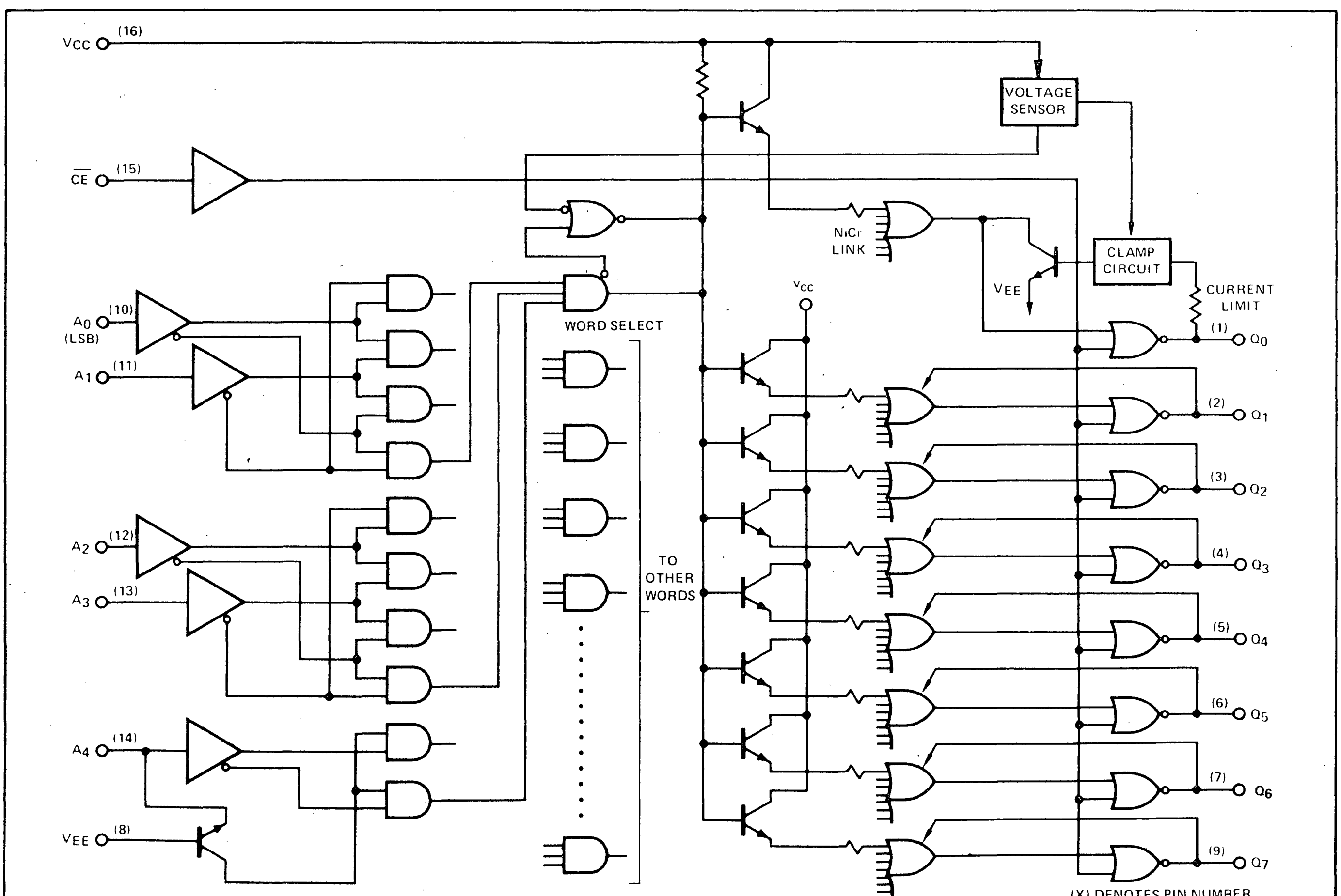
The 10139 is an ECL 256-Bit Read Only Memory organized as 32 words with 8 bits per word. The words are selected by five binary address lines; full word decoding is incorporated on the chip. A chip enable input is provided for additional decoding flexibility, which causes all eight outputs to go to low state when the chip enable input is high. This device is fully compatible with all of Signetics series 10,000 products. Address to output access time is 15 ns typical. Power dissipation is 580 milliwatts typical with separate internal bond wires and metal systems for V_{CC1} and V_{CC2}. The 10139 may be programmed to any desired pattern by the user. The 10139 is suitable for use in high performance ECL systems.

PIN CONFIGURATION

F PACKAGE



BLOCK DIAGRAM



SWITCHING CHARACTERISTICS ($T_A = +25°C$, $V_{CC} = 0V$, $V_{EE} = -5.2V$, $R_L = 50\Omega$)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Chip Enable Prop Delay			10	15	ns
Output Rise Time (20 to 80%) Output Fall Time (20 to 80%)			4.2 4.2		ns ns
Access Time Address to Output	T_{AD}		15	20	ns

RECOMMENDED PROGRAMMING PROCEDURE

The 10139 is shipped with all bits at logical "0" (low). To write logical "1's", proceed as follows:

MANUAL (see Fig. 1)

STEP 1

Connect V_{EE} (Pin 8) to ground and V_{CC} (Pin 16) to +5.2 volts. Address the word to be programmed by applying 4.0 to 4.6 volts for a logic "1" and 0.0 to 1.0 volts for a logic "0" to the appropriate address inputs.

STEP 2

Raise V_{CC} (Pin 16) to 12 volts.

STEP 3

After V_{CC} has stabilized at 12 volts (including any ringing which may be present on the V_{CC} line) apply a current pulse of 2.5 mA to the output pin corresponding to the bit to be programmed to a logic "1".

STEP 4

Return V_{CC} to 5.2 volts.

CAUTION: To prevent excessive chip temperature rise, V_{CC} should not be allowed to remain at 12 volts for more than 1 second.

STEP 5

Verify that the selected bit has programmed by connecting a 460Ω resistor to ground and measuring the voltage at the output pin. If a logic "1" is not detected at the output, the procedure should be repeated once.

STEP 6

If verification is positive, proceed to the next bit to be programmed.

AUTOMATIC (see Fig. 2)

STEP 1

Connect V_{EE} (Pin 8) to ground and V_{CC} (Pin 16) to +5.2 volts. Apply the proper address data and raise V_{CC} (Pin 16) to 12 volts.

STEP 2

After a minimum delay of 100 μs and a maximum delay of 1.0 ms, apply a 2.5 mA current pulse to the first bit to be programmed ($0.5 \leqslant PW \leqslant 1$ ms).

STEP 3

Repeat Step 2 for each bit of the selected word specified as a logic "1". (Program only one bit at a time; The delay between output programming pulses should be equal to or less than 1.0 ms.)

STEP 4

After all the desired bits of the selected word have been programmed, change address data and repeat Steps 2 and 3.

NOTE: If all the maximum times listed above are maintained, the entire memory will program in less than 1 second. Therefore, it would be permissible for V_{CC} to remain at 12 volts during the entire programming time.

STEP 5

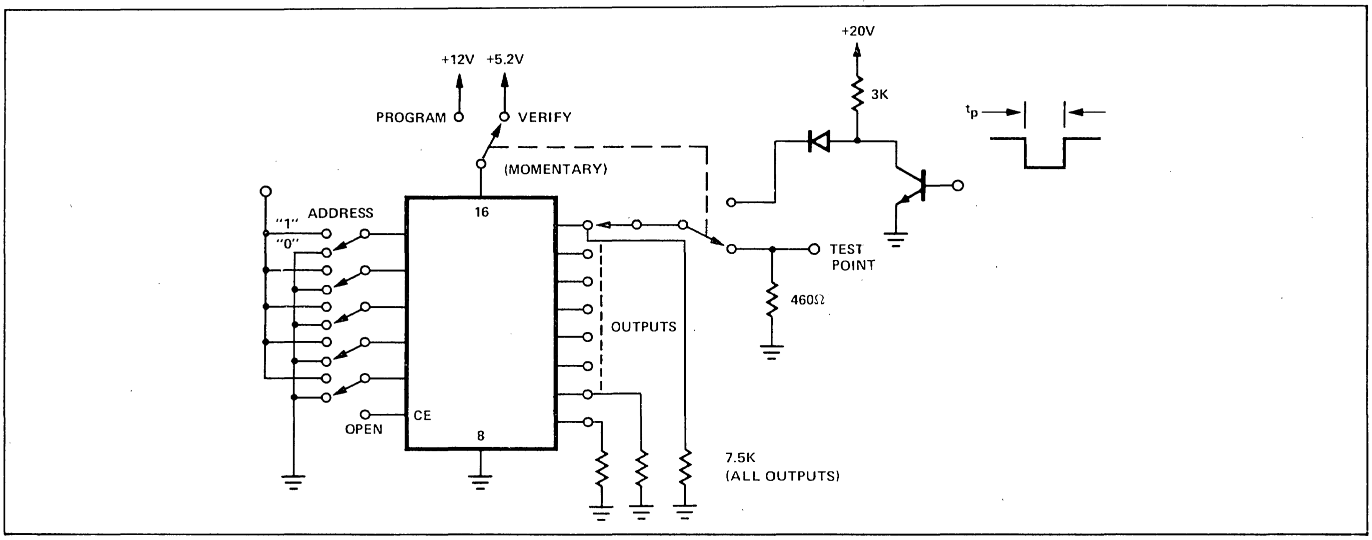
After stepping through all address words, return V_{CC} to +5.2 and verify that each bit has programmed. If one or more bits have not programmed, repeat the entire procedure once.

PROGRAMMING SPECIFICATIONS

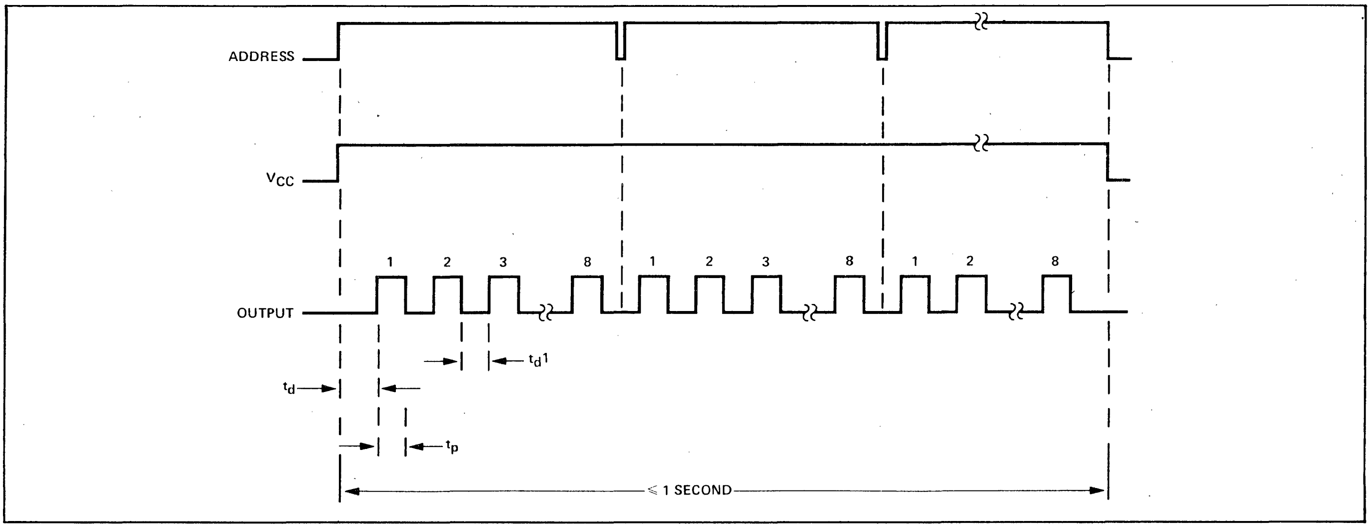
CHARACTERISTIC	SYMBOL	LIMITS			UNITS	CONDITIONS
		MIN.	TYP.	MAX.		
Power Supply Voltage To Program To Verify	 V_{CCP} V_{CCV}	 11.5 5.0	 12.0 5.2	 12.5 5.4	 Volts Volts	
Programming Supply Current	I_{CCP}			250	mA	V_{CC} = 12.0 Volts
Address Voltage logical "1" logical "0"	 V_{IH} V_{IL}	 4.0 0.0		 4.6 1.0	 Volts Volts	
Max. Time at $V_{CC} = V_{CCP}$				1.0	Sec.	
Output Programming Current	I_{OP}	2.0	2.5	3.0	mA	
Output Program Pulse Width	t_p	0.5		1.0	ms	
Output Pulse Rise Time				10	μs	
Programming Pulse Delay (1) following V_{CC} change between output pulses	 t_d t_d1	 0.1 0.01		 1.0 1.0	 ms ms	

NOTE: (1) Maximum is specified to minimize the amount of time V_{CC} is at 12 volts.

MANUAL PROGRAMMING CIRCUIT



AUTOMATIC PROGRAMMING CIRCUIT

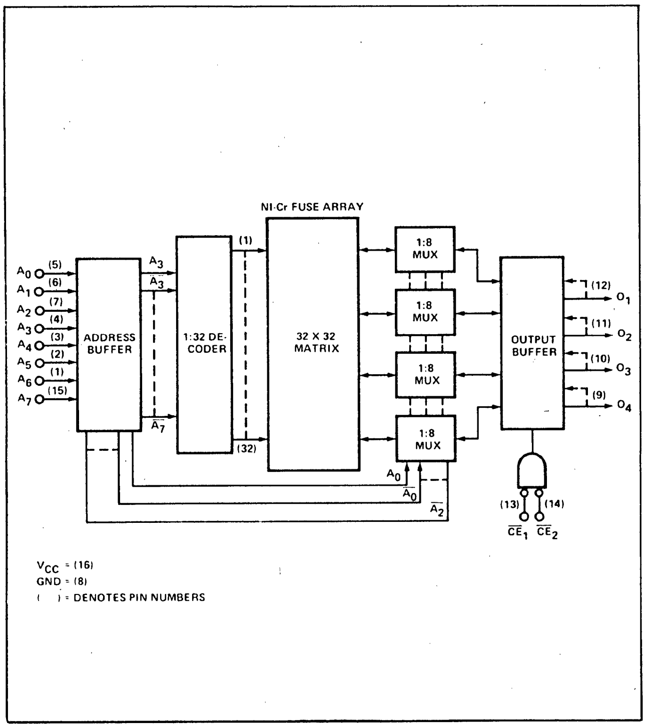


1024-BIT BIPOLAR PROGRAMMABLE ROM (256X4 PROM)

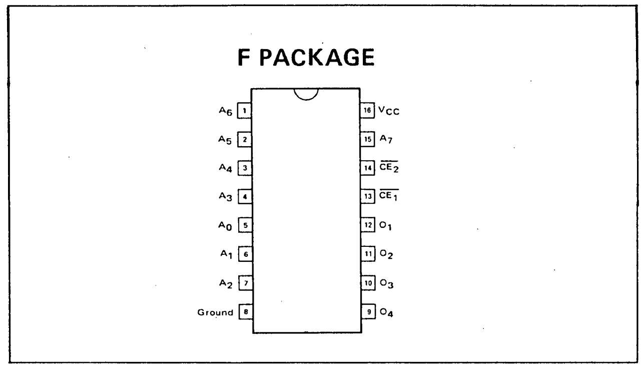
82S27

N82S27-F

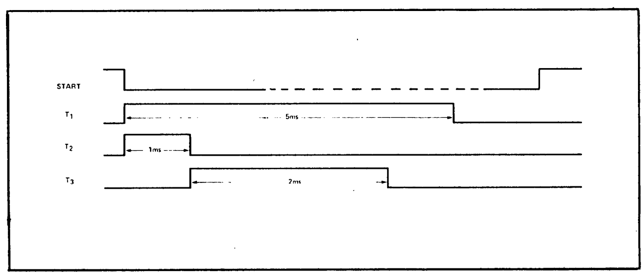
BLOCK DIAGRAM



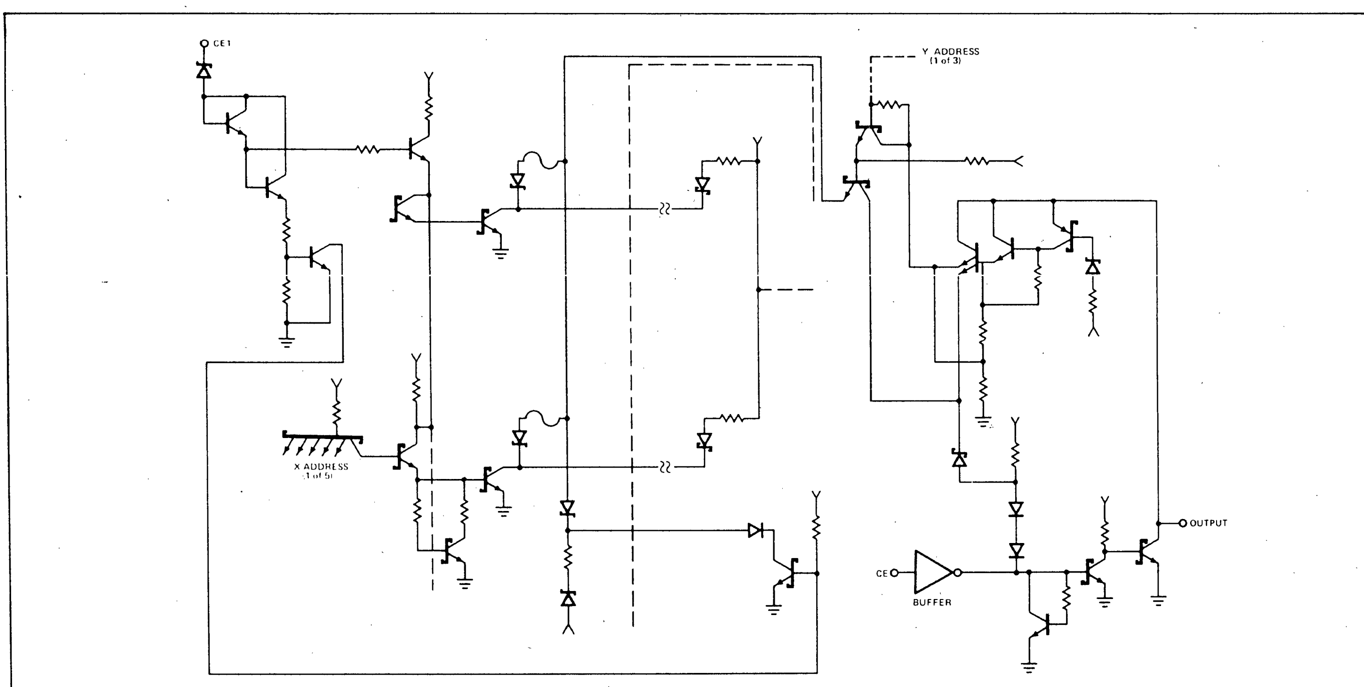
PIN CONFIGURATION



TIMING SEQUENCE



TYPICAL FUSING PATH



PROGRAMMING SPECIFICATIONS (Testing of these limits may cause programming of device.) T_A = +25°C

PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP	MAX	
Power Supply Voltage						
V_{CCP}[1]	To Program	I_{CCP} = 300 ± 50mA (Transient or steady state)	5.0		5.25	V
V_{CCH}	Upper Verify Limit		5.0	5.25	5.5	V
V_{CCL}	Lower Verify Limit		4.5	4.75	5.0	V
V_S[3]	Verify Threshold		0.9	1.0	1.1	V
I_{CCP}	Programming Supply Current	V_{CCP} = +5.0 ± 0.25V	250	300	350	mA
Input Voltage						
V_{IH}	Logical "1" (Except $\overline{CE}_1$)		3.0		5.0	V
V_{IN}	Program Level ($\overline{CE}_1$ Only)		14.0	14.5	15.0	V
V_{IL}	Logical "0"		0	0.4	0.5	V
Input Current						
I_{IH}	Logical "1"	V_{IH} = +3.0V			100	μA
I_{IL}	Logical "0"	V_{IL} = +0.5V			-1.6	mA
I_{IN}	Program Level ($\overline{CE}_1$ Only)	V_{IN} = +15.0V			15	mA
V_{OUT}[2]	Output Programming Voltage	I_{OUT} = 115 ± 10mA (Transient or steady state)	16.5	17.0	17.5	V
I_{OUT}	Output Programming Current	V_{OUT} = +17.0 ± 0.5V	105	115	125	mA
T_R[5]	Output Pulse Rise Time		0.2		0.5	μs
t_P	Programming Pulse Width		1		2	ms
t_D	Pulse Sequence Delay		10			μs
T_{PR}	Programming Time	$V_{CC} = V_{CCP}$			2.5	sec
T_{PS}	Programming Pause	V_{CC} = 0V	5			sec
$\frac{T_{PR}}{T_{PR}+T_{PS}}$[4]	Programming Duty Cycle				33	%

PROGRAMMING PROCEDURE

The 82S27 is shipped with all bits at logical "0" (low). To write logical "1", proceed as follows:

SET-UP

a. Apply GND to pin 12.

b. Terminate all device outputs with a 10kΩ resistor to V_{CC}.

c. Set $\overline{CE}_2$ to logic "0".

PROGRAM-VERIFY SEQUENCE

Step 1 Raise V_{CC} to V_{CCP}, and address the word to be programmed by applying TTL "1" and "0" logic levels to the device address inputs.

Step 2 After 10μs delay, apply to $\overline{CE}_1$ (pin 13) a voltage source of 14.5 ± 0.5V, with 15mA sourcing current capability.

Step 3 After 10μs delay, apply a voltage source of +17.0 ± 0.5V to the output to be programmed. The source must have a current limit of 115mA. Program one output at the time.

Step 4 After 10μs delay, remove +17.0V supply from programmed output.

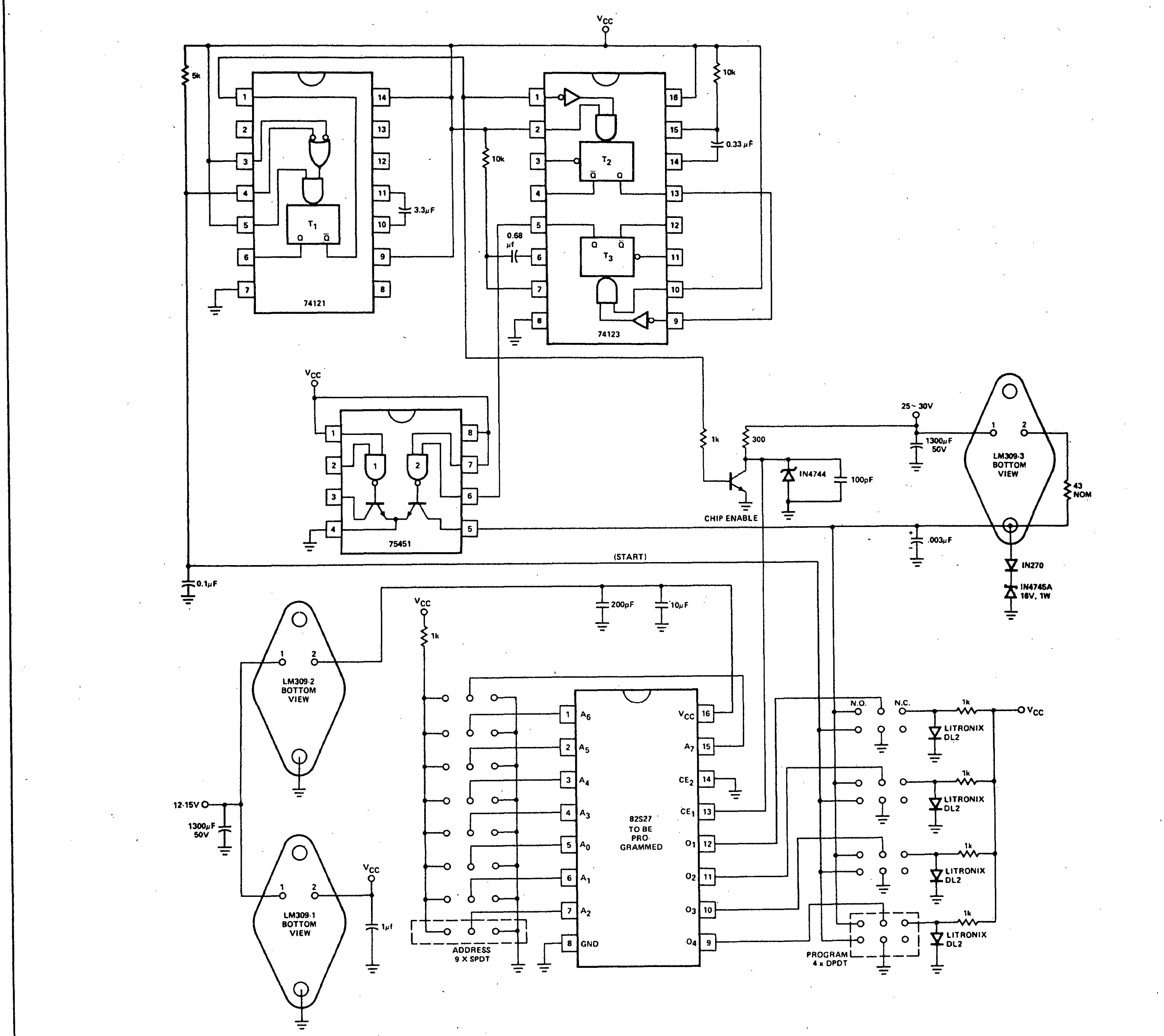
Step 5 To verify programming, after 10μs delay, return $\overline{CE}_1$ to 0V. Raise V_{CC} to V_{CCH} = +5.25 ± .25V. The programmed output should remain in the "1" state. Again, lower V_{CC} to V_{CCL} = +4.75 ± .25V, and verify that the programmed output remains in the "1" state.

Step 6 Raise V_{CC} to V_{CCP}, and repeat steps 2 through 5 to program other bits at the same address.

Step 7 Repeat steps 1 through 6 to program all other address locations.

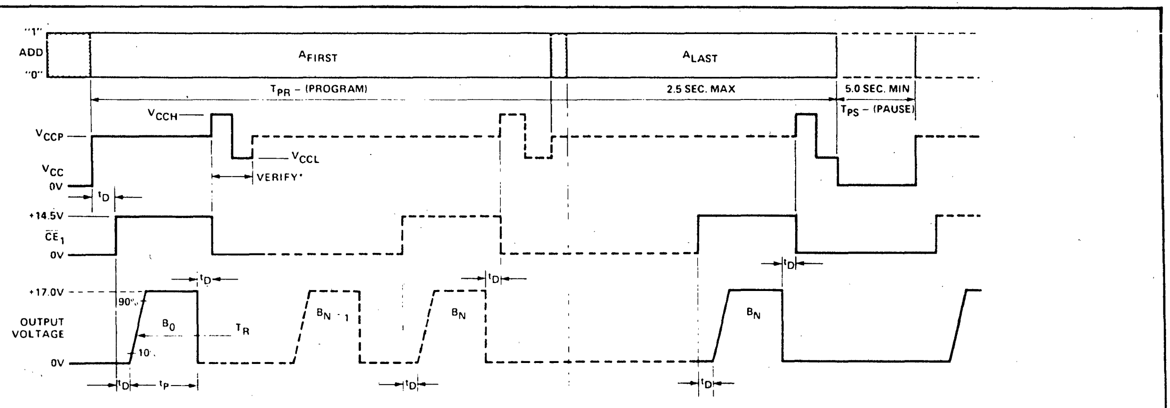
NOTES:
1. Bypass V_{CC} to GND with a 0.01μF capacitor to reduce voltage spikes.
2. Care should be taken to insure the 17 ± 0.5V output voltage is maintained during the entire fusing cycle. The recommended supply is a constant current source clamped at the specified voltage limit.
3. V_S is the sensing threshold of the PROM output voltage for a programmed bit. It normally constitutes the reference voltage applied to a comparator circuit to verify a successful fusing attempt.
4. Continuous fusing for an unlimited time is also allowed, provided that a 33% duty cycle is maintained. This may be accomplished by following each Program Verify cycle with a Rest period (V_{CC} = 0V) of 4ms.
5. Measured with a 1k dummy load connected across the fusing source.

MANUAL PROGRAMMER



NOTE: ALL RESISTORS VALUES ARE TYPICAL AND IN OHMS.

TYPICAL PROGRAMMING SEQUENCE



*PROGRAMMING VERIFICATION AT BOTH HIGH AND LOW V_{CC} MARGINS IS OPTIONAL. FOR CONVENIENCE, VERIFICATION CAN ALSO BE EXECUTED AT THE OPERATING V_{CC} LIMITS SPECIFIED IN THE DC CHARACTERISTICS.

Signetics

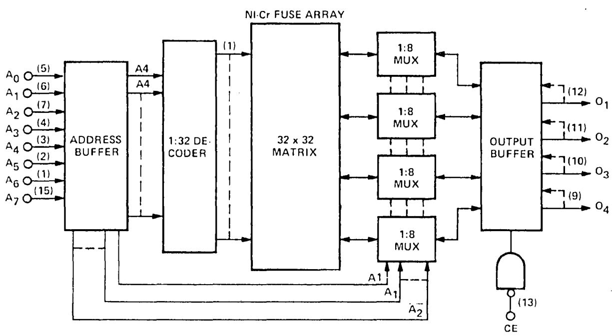
MEMORY

1024-BIT BIPOLAR PROGRAMMABLE ROM (256x4 PROM)

82S126 82S129

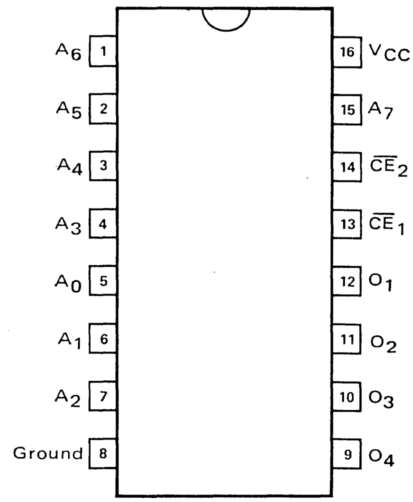
N82S126/129-B,F • S82S126/129-F

BLOCK DIAGRAM



PIN CONFIGURATION

B, F PACKAGE



Signetics

MEMORY

PROGRAMMING SPECIFICATIONS (Testing of these limits may cause programming of device.) T_A = +25°C

PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP	MAX	
Power Supply Voltage						
V_{CCP}[1]	To Program	I_{CCP} = 350 ± 50mA (Transient or steady state)	8.5	8.75	9.0	V
V_{CCH}	Upper Verify Limit		5.3	5.5	5.7	V
V_{CCL}	Lower Verify Limit		4.3	4.5	4.7	V
V_S[3]	Verify Threshold		0.9	1.0	1.1	V
I_{CCP}	Programming Supply Current	V_{CCP} = +8.75 ± .25V	300	350	400	mA
Input Voltage						
V_{IH}	Logical "1"		2.4		5.5	V
V_{IL}	Logical "0"		0	0.4	0.8	V
Input Current						
I_{IH}	Logical "1"	V_{IH} = +5.5V			50	μA
I_{IL}	Logical "0"	V_{IL} = +0.4V			−500	μA
V_{OUT}[2]	Output Programming Voltage	I_{OUT} = 200 ± 20mA (Transient or steady state)	16.0	17.0	18.0	V
I_{OUT}	Output Programming Current	V_{OUT} = +17 ± 1V	180	200	220	mA
T_R	Output Pulse Rise Time		10		50	μs
t_P	$\overline{CE}$ Programming Pulse Width		1		2	ms
t_D	Pulse Sequence Delay		10			μs
T_{PR}	Programming Time	$V_{CC} = V_{CCP}$			2.5	sec
T_{PS}	Programming Pause	V_{CC} = 0V	5			sec
$\frac{T_{PR}}{T_{PR}+T_{PS}}$[4]	Programming Duty Cycle				33	%

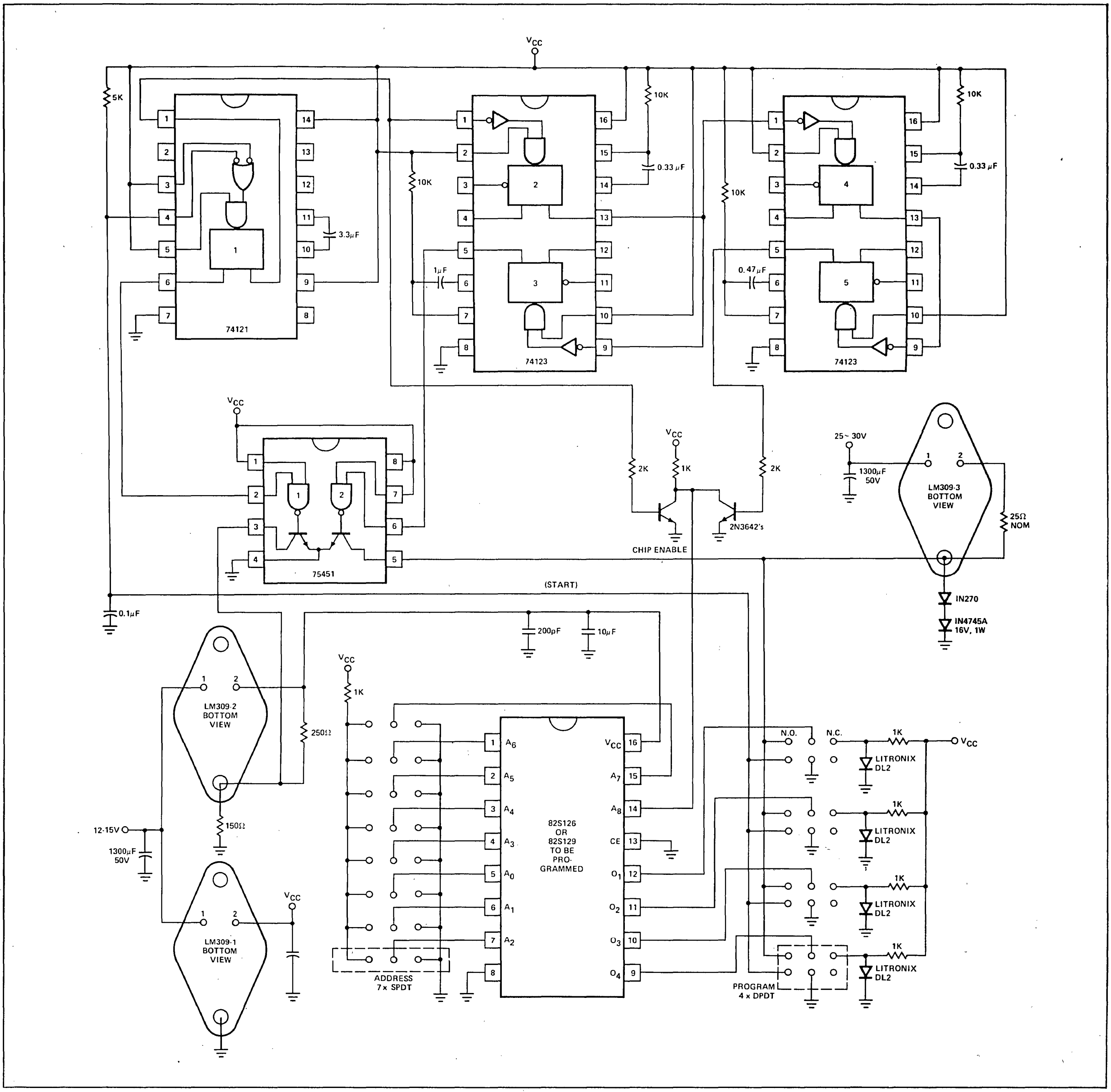
PROGRAMMING PROCEDURE

1. Terminate all device outputs with a 10KΩ resistor to V_{CC}.
2. Select the Address to be programmed, and raise V_{CC} to V_{CCP} = 8.75 ± .25V.
3. After 10μs delay, apply V_{OUT} = +17 ± 1V to the output to be programmed. Program one output at the time.
4. After 10μs delay, pulse both $\overline{CE}$ inputs to logic "0" for 1 to 2 ms.
5. After 10μs delay, remove +17V from the programmed output.
6. To verify programming, after 10μs delay, lower V_{CC} to V_{CCH} = +5.5 ± .2V, and apply a logic "0" level to both $\overline{CE}$ inputs. The programmed output should remain in the "1" state. Again, lower V_{CC} to V_{CCL} = +4.5 ± .2V, and verify that the programmed output remains in the "1" state.
7. Raise V_{CC} to V_{CCP} = 8.75 ± .25V, and repeat steps 3 through 6 to program other bits at the same address.
8. After 10μs delay, repeat steps 2 through 7 to program all other address locations.

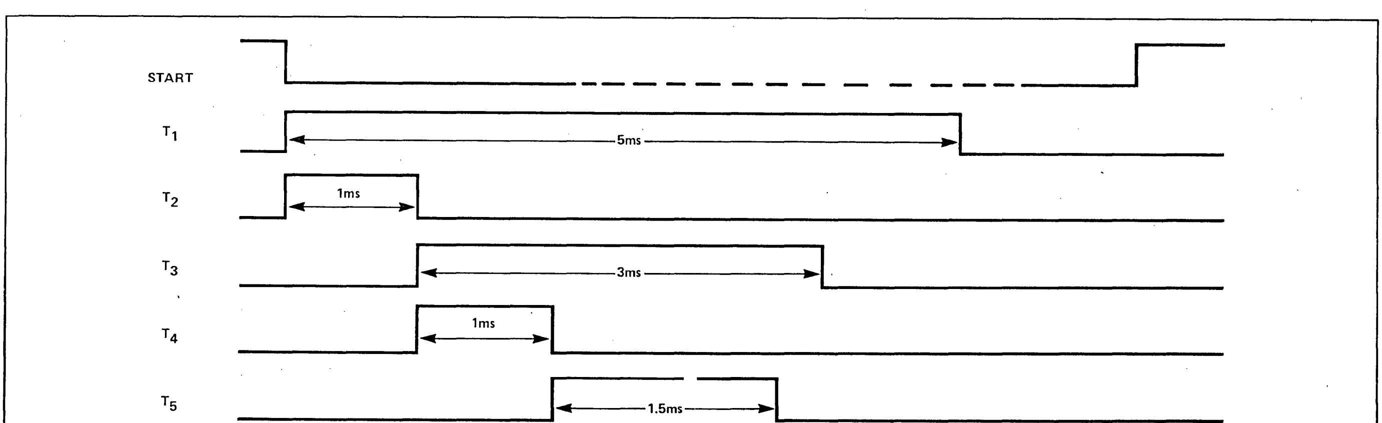
NOTES:

1. Bypass V_{CC} to GND with a 0.01μF capacitor to reduce voltage spikes.
2. Care should be taken to insure the 17 ± 1V output voltage is maintained during the entire fusing cycle. The recommended supply is a constant current source clamped at the specified voltage limit.
3. V_S is the sensing threshold of the PROM output voltage for a programmed bit. It normally constitutes the reference voltage applied to a comparator circuit to verify a successful fusing attempt.
4. Continuous fusing for an unlimited time is also allowed, provided that a 33% duty cycle is maintained. This may be accomplished by following each Program-Verify cycle with a Rest period (V_{CC} = 0V) of 4ms.

MANUAL PROGRAMMER



TIMING SEQUENCE



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MEMORY

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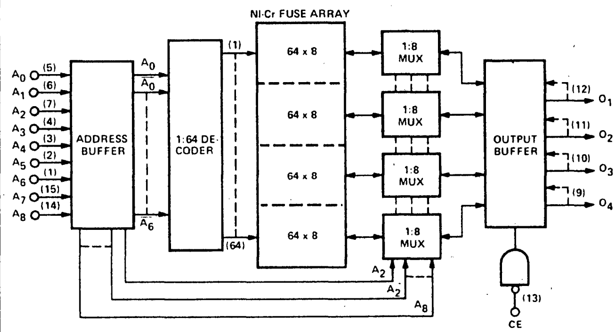
2048-BIT BIPOLAR PROGRAMMABLE ROM (512x4 PROM) 82S130 82S131

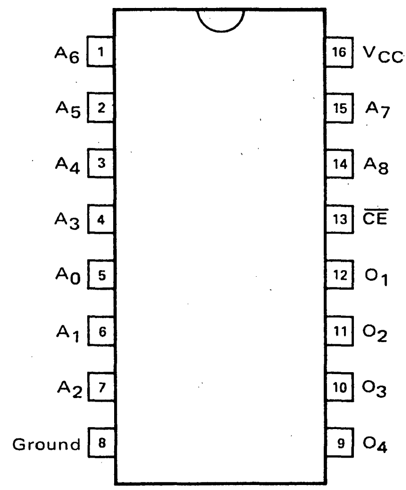
N82S130-F • S82S130-F

BLOCK DIAGRAM

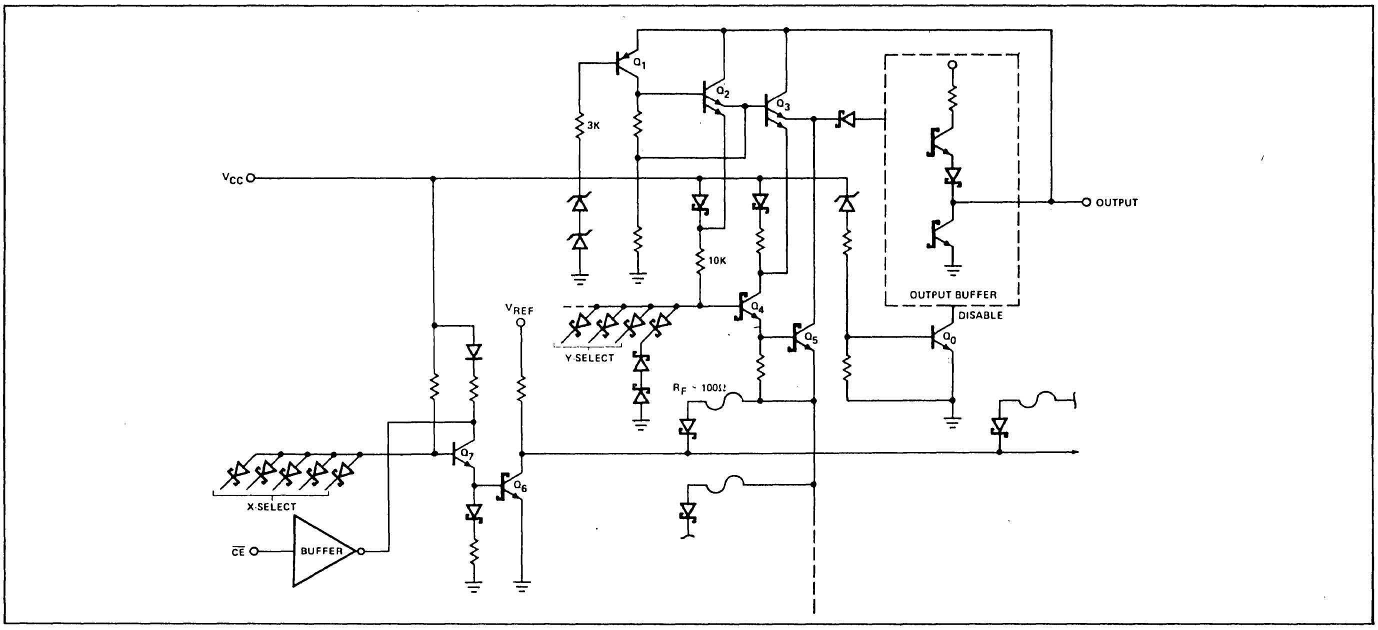


PIN CONFIGURATION

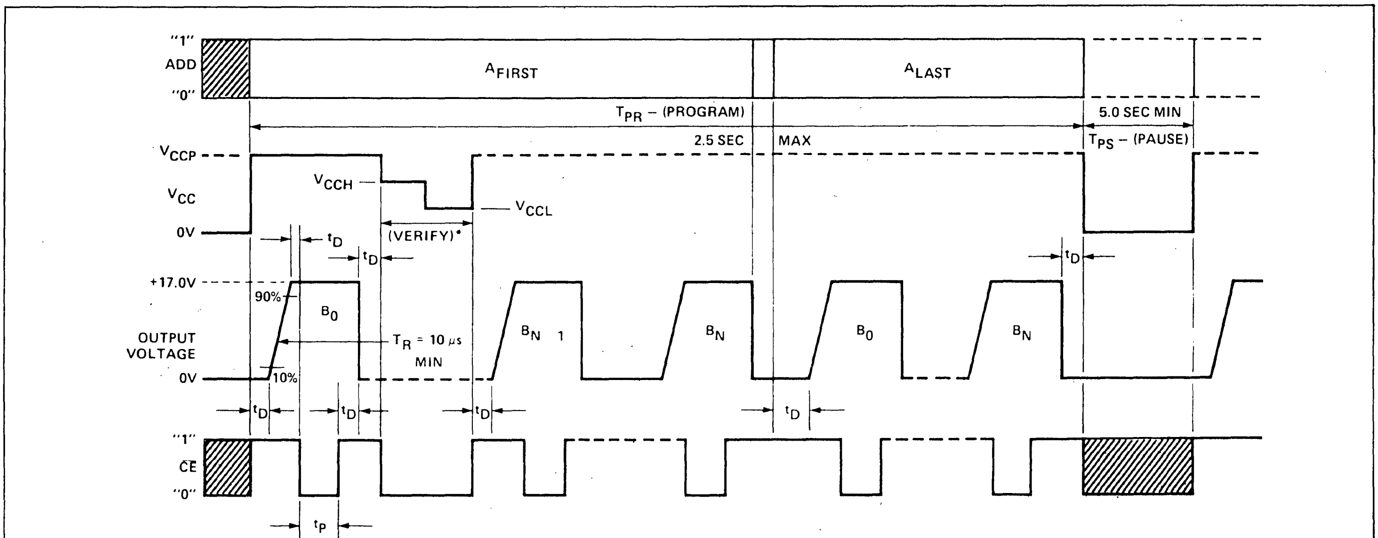
F PACKAGE



TYPICAL FUSING PATH



TYPICAL PROGRAMMING SEQUENCE



*PROGRAMMING VERIFICATION AT BOTH HIGH AND LOW V_{CC} MARGINS IS OPTIONAL. FOR CONVENIENCE, VERIFICATION CAN ALSO BE EXECUTED AT THE OPERATING V_{CC} LIMITS SPECIFIED IN THE DC CHARACTERISTICS.

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2048-BIT BIPOLAR ROM (256x8 PROM)
4096-BIT BIPOLAR ROM (512x8 PROM)

82S114
82S115

N82S114-I

DESCRIPTION

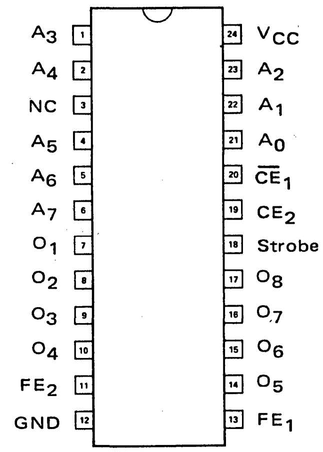
The 82S114 and 82S115 are fully TTL compatible, and include on-chip decoding and two chip enable inputs for ease of memory expansion. They feature Tri-State outputs for optimization of word expansion in bussed organizations. A D-type latch is used to enable the Tri-State output drivers. In the TRANSPARENT READ mode, stored data is addressed by applying a binary code to the address inputs while holding STROBE high. In this mode the bit drivers will be controlled solely by $\overline{CE}1$ and CE2 lines.

In the LATCHED READ mode, outputs are held in their previous state (1, 0, or high Z) as long as STROBE is low, regardless of the state of address or chip enable. A positive STROBE transition causes data from the applied address to reach the outputs if the chip is enabled, and causes outputs to go to the high Z state if the chip is disabled.

A negative STROBE transition causes outputs to be locked into their last Read Data condition if the chip was enabled, or causes outputs to be locked into the high Z condition if the chip was disabled.

PIN CONFIGURATION

I PACKAGE*



RECOMMENDED PROGRAMMING PROCEDURE

The 82S114/115 are shipped with all bits at logical "0" (low). To write logical "1", proceed as follows:

SET-UP

a. Apply GND to pin 12.

b. Terminate all device outputs with a 10KΩ resistor to V_{CC}.

c. Set $\overline{CE}1$ to logic "0", and CE2 to logic "1" (TTL levels).

d. Set Strobe to logic "1" level.

PROGRAM-VERIFY SEQUENCE

Step 1 Raise V_{CC} to V_{CCP}, and address the word to be programmed by applying TTL "1" and "0" logic levels to the device address inputs.

Step 2 After 10μs delay, apply to FE1 (pin 13) a voltage source of +5.0 ± 0.5V, with 10 mA sourcing current capability.

Step 3 After 10μs delay, apply a voltage source of +17.0 ± 1.0V to the output to be programmed. The source must have a current limit of 200 mA. Program one output at the time.

Step 4 After 10μs delay, raise FE2 (pin 11) from 0V to +5.0 ± 0.5V for a period of 1ms, and then return to 0V. Pulse source must have a 10 mA sourcing current capability.

Step 5 After 10μs delay, remove +17.0V supply from programmed output.

Step 6 To verify programming, after 10μs delay, return FE1 to 0V. Raise V_{CC} to V_{CCH} = +5.5 ± .2V. The programmed output should remain in the "1" state. Again, lower V_{CC} to V_{CCL} = +4.5 ± .2V, and verify that the programmed output remains in the "1" state.

Step 7 Raise V_{CC} to V_{CCP}, and repeat steps 2 through 6 to program other bits at the same address.

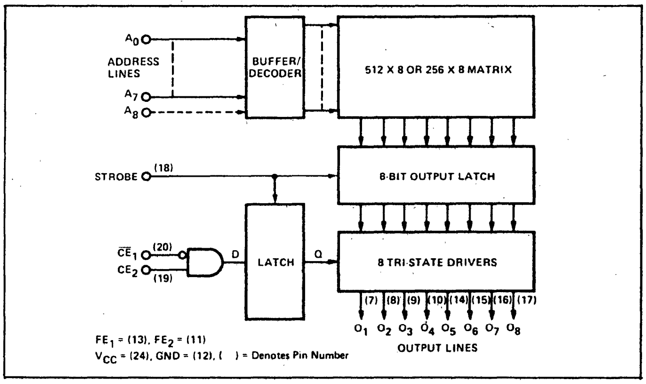
Step 8 Repeat steps 1 through 7 to program all other address locations.

PROGRAMMING SPECIFICATIONS (Testing of these limits may cause programming of device.) $T_A = +25°C$

PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP	MAX	
Power Supply Voltage						
V_{CCP}[1]	To Program	$I_{CCP} = 200 \pm 25$ mA (Transient or steady state)	4.75	5.0	5.25	V
V_{CCH}	Upper Verify Limit		5.3	5.5	5.7	V
V_{CCL}	Lower Verify Limit		4.3	4.5	4.7	V
V_S[3]	Verify Threshold		0.9	1.0	1.1	V
I_{CCP}	Programming Supply Current	$V_{CCP} = +5.0 \pm .25V$	175	200	225	mA
Input Voltage						
V_{IL}	Low Level Input Voltage		0	0.4	0.8	V
V_{IH}	High Level Input Voltage		2.4		5.5	V
Input Current (FE_1 & FE_2 Only)						
I_{IL}	Low Level Input Current	$V_{IL} = +0.45V$			-100	μA
I_{IH}	High Level Input Current	$V_{IH} = +5.5V$			10	mA
Input Current (Except FE_1 & FE_2)						
I_{IL}	Low Level Input Current	$V_{IL} = +0.45V$			-100	μA
I_{IH}	High Level Input Current	$V_{IH} = +5.5V$			25	μA
V_{OUT}[2]	Output Programming Voltage	$I_{OUT} = 200 \pm 20$ mA (Transient or steady state)	16.0	17.0	18.0	V
I_{OUT}	Output Programming Current	$V_{OUT} = +17 \pm 1V$	180	200	220	mA
T_R	Output Pulse Rise Time		10		50	μs
t_P	FE_2 Programming Pulse Width		1		1.5	ms
t_D	Pulse Sequence Delay		10			μs
T_{PR}	Programming Time	$V_{CC} = V_{CCP}$			10	sec
T_{PS}	Programming Pause	$V_{CC} = 0V$	7			sec
$\frac{T_{PR}}{T_{PR}+T_{PS}}$[4]	Programming Duty Cycle				60	%

NOTES:
1. Bypass V_{CC} to GND with a 0.01 μF capacitor to reduce voltage spikes.
2. Care should be taken to insure the 17 ± 1V output voltage is maintained during the entire fusing cycle. The recommended supply is a constant current source clamped at the specified voltage limit.
3. V_S is the sensing threshold of the PROM output voltage for a programmed bit. It normally constitutes the reference voltage applied to a comparator circuit to verify a successful fusing attempt.
4. Continuous fusing for an unlimited time is also allowed, provided that a 60% duty cycle is maintained. This may be accomplished by following each Program-Verify cycle with a Rest period (V_{CC} = 0V) of 3 mS.

BLOCK DIAGRAM



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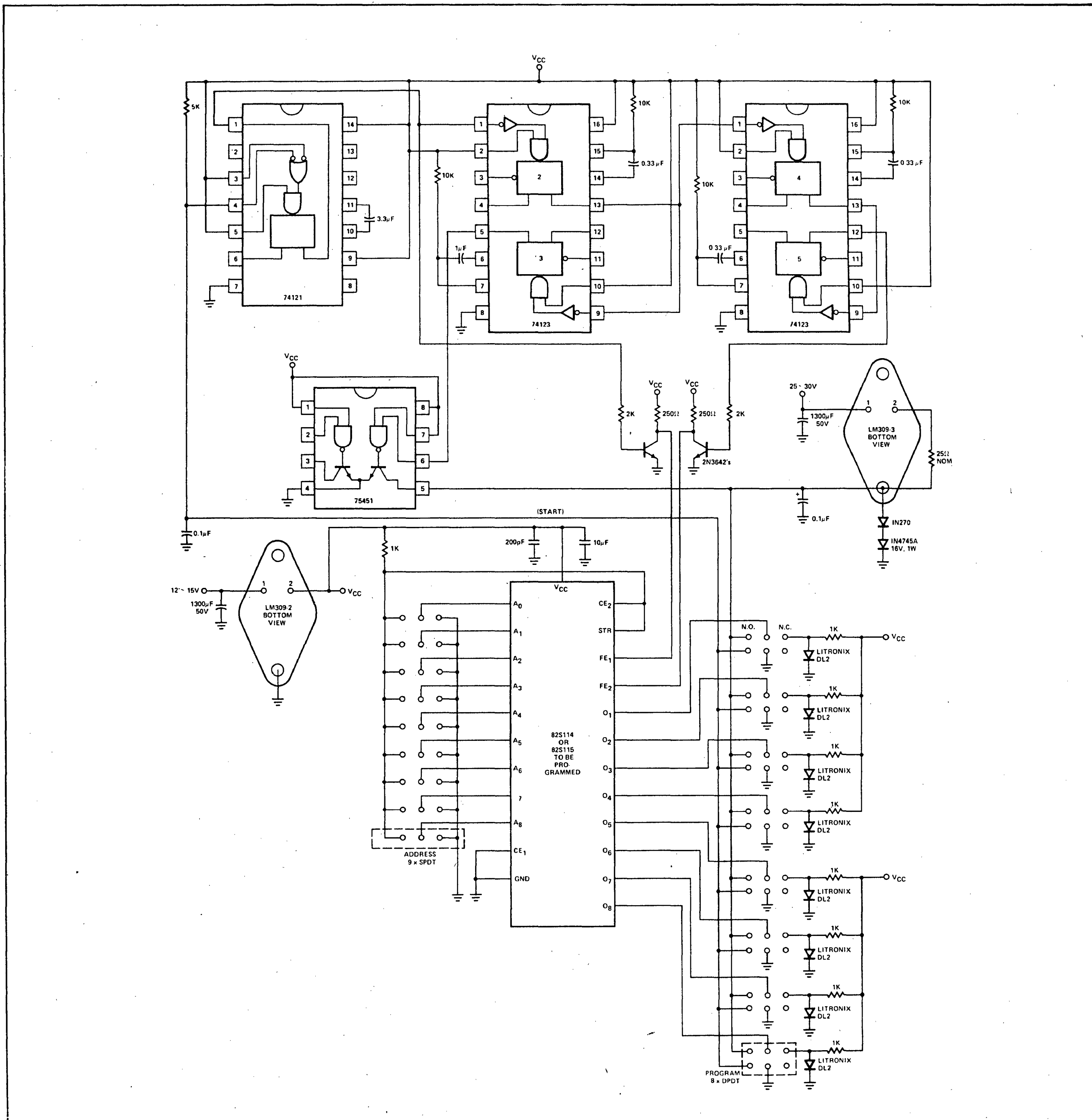
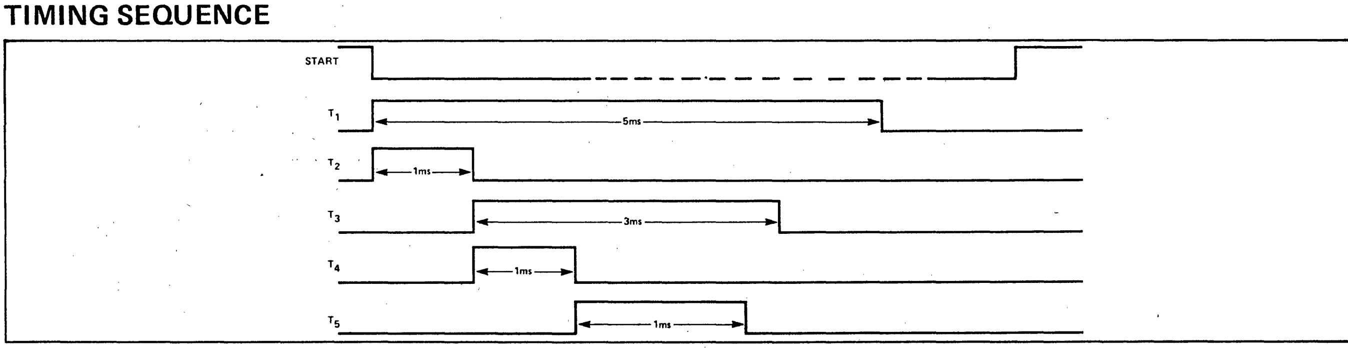
MEMORY

82S114/115 MANUAL PROGRAMMER



TIMING SEQUENCE



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MEMORY

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BIPOLAR FIELD-PROGRAMMABLE LOGIC ARRAY (16X8X48 FPLA) 82S101 (OPEN COLLECTOR) 82S100 (TRI-STATE)

82S100 82S101

OBJECTIVE SPECIFICATION

APRIL 1975

DIGITAL 8000 SERIES TTL/MEMORY

DESCRIPTION

The 82S100 (Tri-State Outputs) and the 82S101 (Open Collector Outputs) are Bipolar Programmable Logic Arrays, containing 48 Product terms (AND terms), and 8 output functions. Each output function can be programmed either true active-High (Fp), or true active-Low (F_p^*). The true state of the output functions is controlled via an output Sum (OR) Matrix by a logical combination of 16-input variables, or their complements, up to 48 terms.

Both devices are field-programmable, which means that custom patterns are immediately available by following the fusing procedure outlined in this data sheet.

The 82S100 and 82S101 are fully TTL compatible, and include a chip-enable clocking input for output deskewing and inhibit. They feature either Open Collector or Tri-State outputs for ease of expansion of product terms and/or input variables.

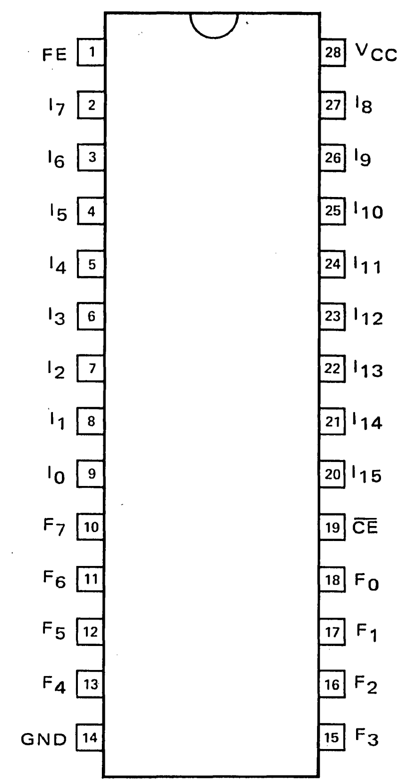
FEATURES

- FIELD PROGRAMMABLE (Ni-Cr LINK)
- INPUT VARIABLES – 16
- OUTPUT FUNCTIONS – 8
- PRODUCT TERMS – 48
- ADDRESS ACCESS TIME – 50ns, MAXIMUM
- POWER DISSIPATION – 600mW, TYPICAL
- INPUT LOADING – (−100μA), MAXIMUM
- OUTPUT OPTION:
  TRI-STATE OUTPUTS – 82S100
  OPEN COLLECTOR OUTPUTS – 82S101
- OUTPUT DISABLE FUNCTION:
  TRI-STATE – Hi-Z
  OPEN COLLECTOR – Hi
- CERAMIC DIP

APPLICATIONS

LARGE READ ONLY MEMORY
RANDOM LOGIC
CODE CONVERSION
PERIPHERAL CONTROLLERS
LOOK-UP AND DECISION TABLES
MICROPROGRAMMING
ADDRESS MAPPING
CHARACTER GENERATORS
SEQUENTIAL CONTROLLERS

PIN CONFIGURATION



TRUTH TABLE

LET:

$P_n = \Pi_0^{15} (k_m I_m + j_m \overline{I_m})$; k = 0, 1, X (Don't Care)

n = 0, 1, 2, ... , 47

where:

Unprogrammed state : $j_m = k_m = 0$

Programmed state : $j_m = \overline{k_m}$

$S_r = f(\Sigma_0^{47} P_n)$; $r \equiv p = 0, 1, 2, \ldots, 7$

MODE	P_n	$\overline{CE}$	F_p	F_p^*	$S_r \stackrel{?}{=} f(P_n)$
Disabled (82S101)	X	1	1	1	X
Disabled (82S100)			Hi-Z	Hi-Z	
Read	1	0	1	0	YES
	0	0	0	1	
	X	0	0	1	NO

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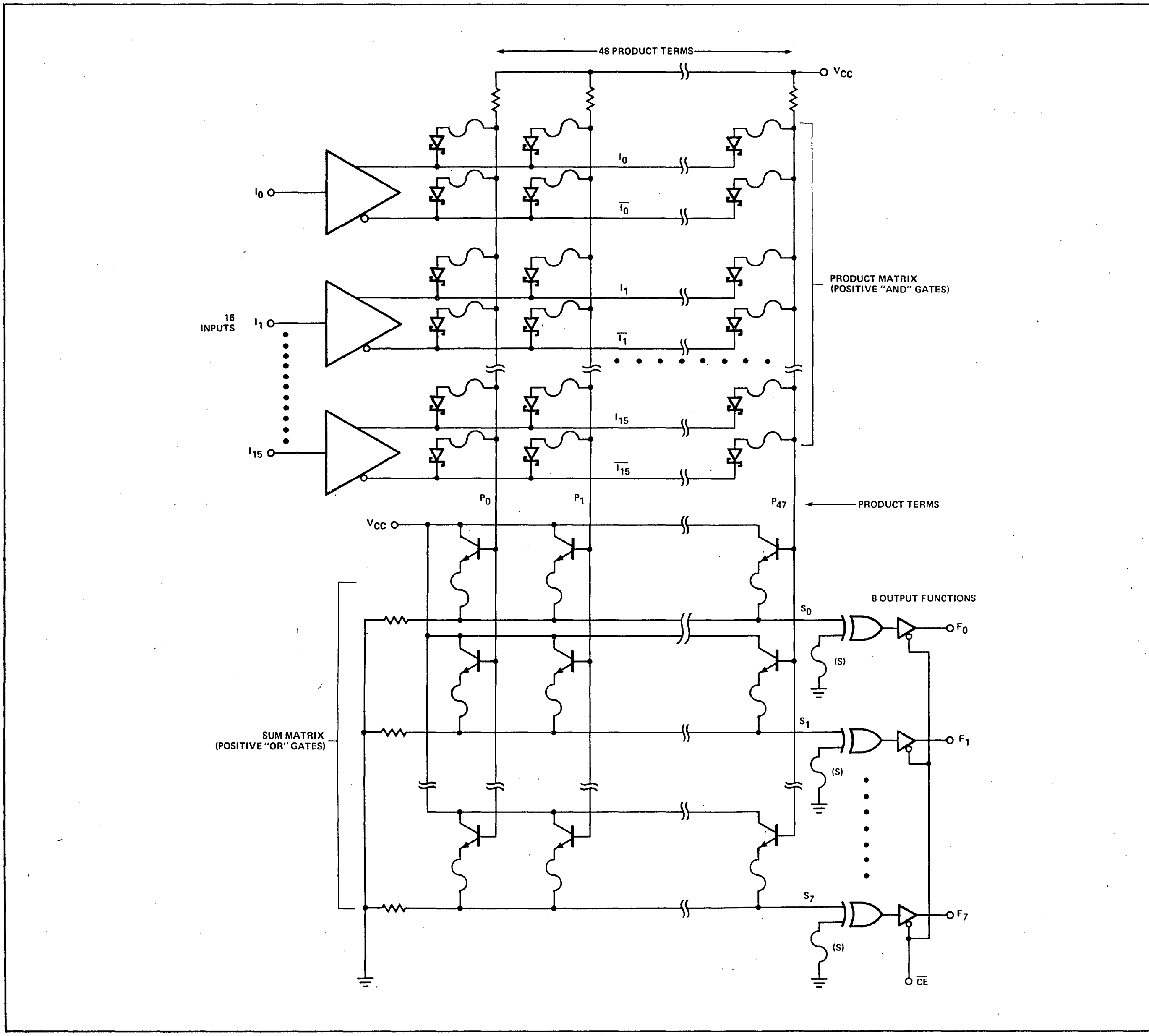
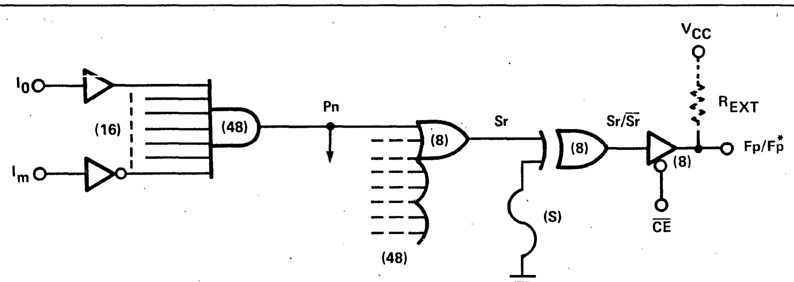
MEMORY

BLOCK DIAGRAM



FPLA TYPICAL LOGIC PATH



NOTE:
FOR EACH OF THE 8 OUTPUTS, EITHER THE FUNCTION Fp (ACTIVE HIGH) OR Fp* (ACTIVE LOW) IS AVAILABLE, BUT NOT BOTH. THE REQUIRED FUNCTION POLARITY IS USER PROGRAMMABLE VIA FUSE (S).

$Pn = I_0 \overline{I_1} \overline{I_2} I_3 \ldots\ldots \overline{I_m}$

$Sr = P_0 + P_1 + P_2 + \ldots\ldots Pn$

$\overline{Sr} = \overline{P_0} \bullet \overline{P_1} \bullet \overline{P_2} \bullet \ldots\ldots \overline{Pn}$

$Fp = (\overline{CE}) + (Sr) = (\overline{CE}) + (P_0 + P_1 + P_2 + \ldots\ldots Pn)$ @ S = SHORT

$Fp^* = (\overline{CE}) + (\overline{Sr}) = (\overline{CE}) + (\overline{P_0} \bullet \overline{P_1} \bullet \overline{P_2} \bullet \ldots\ldots \overline{Pn})$ @ S = OPEN

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MEMORY

ABSOLUTE MAXIMUM RATINGS

PARAMETER[1]		RATING	UNIT
V_{CC}	Power Supply Voltage	+7	Vdc
V_{in}	Input Voltage	+5.5	Vdc
V_{OH}	High Level Output Voltage (82S101)	+5.5	Vdc
V_O	Off-State Output Voltage (82S100)	+5.5	Vdc
T_A	Operating Temperature Range	0° to +75°	°C
T_{stg}	Storage Temperature Range	−65° to +150°	°C

ELECTRICAL CHARACTERISTICS $0°C \leq T_A \leq 75°C$; $4.75V \leq V_{CC} \leq 5.25V$

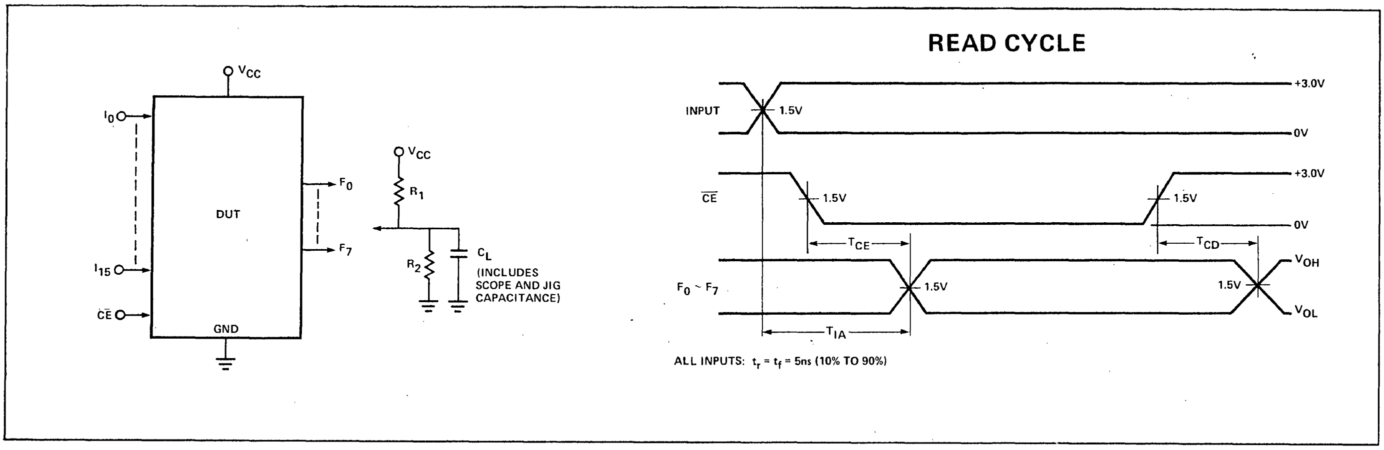
PARAMETER		TEST CONDITIONS		LIMITS MIN	TYP[2]	MAX	UNIT	NOTES
V_{IH}	High-Level Input Voltage	V_{CC} = 5.25V		2			V	1
V_{IL}	Low-Level Input Voltage	V_{CC} = 4.75V				0.8	V	1
V_{IC}	Input Clamp Voltage	V_{CC} = 4.75V, I_{IN} = −18mA			−0.8	−1.2	V	1, 7
V_{OH}	High-Level Output Voltage (82S100)	V_{CC} = 4.75V, I_{OH} = −2mA		2.4			V	1, 5
V_{OL}	Low-Level Output Voltage	V_{CC} = 4.75V, I_{OL} = 9.6mA			0.35	0.45	V	1, 8
I_{OLK}	Output Leakage Current (82S101)	V_{CC} = 5.25V	V_{OUT} = 5.25V		1	40	μA	6
$I_{O(OFF)}$	Hi-Z State Output Current (82S100)	V_{CC} = 5.25V	V_{OUT} = 5.25V		1	40	μA	6
			V_{OUT} = 0.45V		−1	−40	μA	6
I_{IH}	High-Level Input Current	V_{IN} = 5.5V			<1	25	μA	
I_{IL}	Low-Level Input Current	V_{IN} = 0.45V			−10	−100	μA	
I_{OS}	Short-Circuit Output Current (82S100)	V_{CC} = 5.25V, V_{OUT} = 0V		−20		−70	mA	3, 7
I_{CC}	V_{CC} Supply Current (82S100, 82S101)	V_{CC} = 5.25V			120	170	mA	4
C_{IN}	Input Capacitance	V_{CC} = 5.0V	V_{IN} = 2.0V		5		pF	
C_O	Output Capacitance	V_{CC} = 5.0V	V_{OUT} = 2.0V		8		pF	6

NOTES:
1. All voltage values are with respect to network ground terminal.
2. All typical values are at V_{CC} = 5V, T_A = 25°C.
3. Duration of short circuit should not exceed one second.
4. I_{CC} is measured with the chip enable input grounded, all other inputs at 4.5V and the outputs open.
5. Measured with V_{IL} applied to $\overline{CE}$ and a logic "1" stored.
6. Measured with V_{IH} applied to $\overline{CE}$.
7. Test each output one at the time.
8. Measured with a programmed logic condition for which the output under test is at a "0" logic level. Output sink current is supplied thru a resistor to V_{CC}.

SWITCHING CHARACTERISTICS $0°C \leq T_A \leq +75°C$, $4.75V \leq V_{CC} \leq 5.25V$

PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP[2]	MAX	
Propagation Delay						
T_{IA}	Input to Output	C_L = 30pF		35	50	ns
T_{CD}	Chip Disable to Output	R_1 = 270		15	20	ns
T_{CE}	Chip Enable to Output	R_2 = 600		15	20	ns

AC TEST FIGURE AND WAVEFORM



NOTES:
1. Positive current is defined as into the terminal referenced.
2. Typical values are at V_{CC} = 5.0V, and T_A = +25°C.

OBJECTIVE PROGRAMMING PROCEDURE

The 82S100/101 are shipped in an unprogrammed state, characterized by:

A. All internal Ni-Cr links are intact.

B. Each product term (P-term) contains both true and complement values of every input variable I_m (P-terms always logically "FALSE").

C. The Sum Matrix contains all 48 P-terms.

D. The polarity of each output is set to active HIGH (F_p function).

E. All outputs are at a LOW logic level.

To program each of 8 Boolean logic functions of 16 true or complement variables, including up to 48 P-terms, follow the Program/Verify procedures for the Product Matrix, Sum Matrix, and Output Polarity outlined below.

OUTPUT POLARITY

PROGRAM ACTIVE LOW (F_p^* Function)

Program output polarity before programming Product Matrix and Sum Matrix. Program one output at the time.

1. Set GND (pin 14) to OV.
2. Do not apply power to the device (V_{CC}, pin 28, open).
3. Apply V_{OUT} = +18V to the appropriate output for 1ms, and return to OV.
4. Repeat step 3 to program other outputs.

VERIFY OUTPUT POLARITY

1. Set GND (pin 14) to OV, and V_{CC} (pin 28) to +5V.
2. Enable the chip by setting $\overline{CE}$ (pin 19) to LOW logic level.
3. Disable input variables by applying V_{IN} = +10V to all inputs I_0 through I_{15}.
4. Verify output polarity by sensing the logic state of outputs F_0 through F_7. All outputs at a HIGH logic level are programmed active HIGH (F_p function), while all outputs at a LOW logic level are programmed active LOW (F_p^* function).
5. Remove V_{IN} = +10V from inputs I_0 through I_{15}.

PRODUCT MATRIX

PROGRAM INPUT VARIABLE

Program one input at the time and one P-term at the time. All input variable links of unused P-terms are not required to be fused. However, unused input variables must be programmed as Don't Care for all programmed P-terms.

1. Set GND (pin 14) to OV, and V_{CC} (pin 28) to +5V.
2. Disable the chip by setting $\overline{CE}$ (pin 19) to HIGH logic level.
3. Disable input variables by applying V_{IN} = +10V to all inputs I_0 through I_{15}.
4. Address the P-term to be programmed (No. 0 through 47) by applying the corresponding binary code to

outputs F_0 through F_5 with F_0 as LSB. Use standard TTL logic levels.

5a. If the P-term contains neither I_0 nor $\overline{I_0}$ (input is a Don't Care), fuse both I_0 and $\overline{I_0}$ links by executing both steps 5b and 5c, before continuing with step 7.

5b. If the P-term contains I_0, set to fuse the $\overline{I_0}$ link by lowering the input voltage to I_0 from V_{IN} = +10V to a HIGH logic level. Execute step 6.

5c. If the P-term contains $\overline{I_0}$, set to fuse the I_0 link by lowering the input voltage to I_0 from V_{IN} = +10V to a LOW logic level. Execute step 6.

6a. After 10μs delay, raise FE (pin 1) from 0V to +17V. The source must have a current limit of 250mA, and rise time of 10 to 50μs.

6b. After 10μs delay, pulse the $\overline{CE}$ input to +10V for a period of 1ms.

6c. After 10μs delay, return FE input to 0V.

7. Return input I_0 to a disable state by applying V_{IN} = +10V.
8. Repeat steps 5 through 7 for all other input variables.
9. Repeat steps 4 through 8 for all other P-terms.
10. Remove V_{IN} = +10V from all input variables.

VERIFY INPUT VARIABLE

1. Set GND (pin 14) to 0V, and V_{CC} (pin 28) to +5V.
2. Enable F_7 output by setting $\overline{CE}$ to +10V.
3. Disable input variables by applying V_{IN} = +10V to inputs I_0 through I_{15}.
4. Address the P-term to be verified (No. 0 through 47) by applying the corresponding binary code to outputs F_0 through F_5.
5. Interrogate input variable I_0 as follows:
   A. Lower the input voltage to I_0 from V_{IN} = +10Vto a HIGH logic level, and sense the state of output F_7.
   B. Lower the input voltage to I_0 from a HIGH to a LOW logic level, and sense the logic state of output F_7.

The state of I_0 contained in the P-term is determined in accordance with the following truth table:

I_0	F_7	Input Variable State Contained In P-Term
0 1	1 0	$\overline{I_0}$
0 1	0 1	I_0
0 1	1 1	Dont Care
0 1	0 0	(I_0), $(\overline{I_0})$

Note that two tests are required to uniquely determine the state of the input variable contained in the P-term.

6. Return input I_0 to a disable state by applying V_{IN} = +10V.
7. Repeat steps 5 and 6 for all other input variables.
8. Repeat steps 4 through 7 for all other P-terms.
9. Remove V_{IN} = +10V from all input variables.

SUM MATRIX

PROGRAM PRODUCT TERM

Program one output at the time for one P-term at the time. All P_n links of unused P-terms in the Sum Matrix are not required to be fused.

1. Set GND (pin 14) to 0V, and V_{CC} (pin 28) to +8.5V.
2. Disable the chip by setting $\overline{CE}$ (pin 19) to a HIGH logic level.
3. Address the P-term to be programmed (No. 0 through 47) by applying the corresponding binary code to input variables I_0 through I_5, with I_0 as LSB. Use standard TTL levels.

4a. If the P-term is contained in output function F_0 (F_0 = 1 or F_0^* = 0), go to step 6.

4b. If the P-term **is not** contained in output function F_0 (F_0 = 0 or F_0^* = 1), set to fuse the P_n link by applying V_{OUT} = +10V to output F_0.

5a. After 10μs delay, raise FE (pin 1) from 0V to +17V.

5b. After 10μs delay, pulse the $\overline{CE}$ input to +10V for a period of 1ms.

5c. After 10μs delay, return FE input to 0V.

6. Repeat steps 4 and 5 for all other output functions.
7. Repeat steps 3 through 6 for all other P-terms.
8. Remove +8.5V from V_{CC}.

VERIFY PRODUCT TERM

1. Set GND (pin 14) to 0V, and V_{CC} (pin 28) to +8.5V.
2. Enable the chip by setting $\overline{CE}$ (pin 19) to a LOW logic level.
3. Address the P-term to be verified (No. 0 through 47) by applying the corresponding binary code to input variables I_0 through I_5, with I_0 as the LSB. Use standard TTL levels.
4. To determine the status of the P_n link in the Sum Matrix for each output function F_p or F_p^*, sense the state of outputs F_0 through F_7. The status of the link is given by the following truth table:

Output		P-term Link
Active HIGH (F_p)	Active LOW (F_p^*)	
0	1	FUSED
1	0	PRESENT

5. Repeat steps 3 and 4 for all other P-terms.
6. Remove +8.5V from V_{CC}.

Signetics

MEMORY

INTRODUCTION TO MICROPROCESSORS

This section briefly describes microprocessors from 22 manufacturers. It gives you an overview of all the products currently available, followed by detailed information from the manufacturers on key products.

The facts about each system are presented on the first 11 pages. They include a complete list of the parts in each microprocessor family available from that manufacturer. When the entry states "standard devices", the manufacturer offers non-specialized devices, usually RAM and ROM, that are suitable not only for use with the microprocessor but for general applications as well.

The extent of informations, support, and applications assistance available from manufacturers is an important factor in selecting microprocessors. Therefore, the detailed facts presented on these first 11 pages include descriptions of additional hardware and software items. The descriptions indicate whether complete operating cards are offered. They also indicate if "prototyping systems" or developmental operating systems are available. The listings also cover the availability of "in-system emulators". These units are usually black boxes that look to the system like a real time IC device. But using them the designer can modify the program and can effectively gain access to what would be interior portions of the integrated circuit to test, analyze, and debug the microprocessor while it is connected to the system.

With the rapid evaluation of microprocessors, new products are being introduced frequently. All these new products will be covered in the March, June, and September issues of the magazine IC UPDATE.

INDEX TO MICROPROCESSORS SECTION

MICROPROCESSORS

Manufacturer Model For Detailed Data See:	AMD 2901	AMD 9080A	AMI S6800 Page 862	AMI 9209 Page 917
Generar Structure	4-Bit Slice	8-Bit CPU	8-Bit CPU	4-Bit Microcontroller
Type	TTL	NMOS	NMOS	PMOS
No. of Devices per CPU		1	1	1
CPU Size (Pins)	40	40	40	40
Supply Voltage	5	±5, 12	5	−15
CPU Power Dissipation (mw)	925	780	600	160
Part Family (from this mfr.) CPU	2901	9080A	S6800	9209
Clock Driver		Standard Devices		On-chip oscillator
I/O Interface	2905/6/7 Bus Transceivers		S8620 Peripheral Interface Adaptor	
RAM	2950/51 (256x1) 2952 (1024x1)	Standard Devices	S6810 (128x8)	256-bits on-chip (64x4)
ROM	2960/61 (1024x8)	Standard Devices	S6830 (1024x8)	756x8 on-chip
PROM	2970/71 (256x4)	Standard Devices	S6834 (512x8)	
UART/USRT		Standard Devices	S6850 Async. Comm. Interface Adaptor	
Other System Parts	2909 Microprogram Sequencer		S6860 Modem	
Architecture Data Word Size (bits)	Multiple of 4	8	8	4
Instruction Word Size (bits)	9	8, 16, 24	8, 16, 24	8
Directly Addressable Instruction Words (No.)		65K	65K	756 (Internal)
Clock Frequency (Hz/ext. phases required)	to 10 MHz/1ϕ	to 3 MHz/1ϕ	1 MHz/2ϕ	500 kHz/0ϕ
Register to Register Add Time (μsec/data word)	0.125	2 (2 MHz clock)	2	15
No. of Registers Arithmetic	0	1	2	2
Index	0	0	1 (16 bit)	0
General Purpose	17	6	0	0
Return Stack Size (No. x bits)	4x4 (2909)	External RAM	External RAM	2x10
Interrupts	Optional	Standard	Standard	None
Type		Vectored 8 level	Vectored, Multilevel	
Direct Memory Access	Optional	Standard	Optional	None
BCD Arithmetic (Hardware)	No	Yes	Yes	Yes
Microprogrammable	Yes	No	No	Yes
Extended Temp. Range Available	−55°C to 125°C	−55°C to 125°C	No	No
Hardware Support Processor Cards (CPU system on a card)	No	No	Yes	No
Prototyping System (Hardware and software development system)	No	No	Yes	No
In-System Emulator (Tests system in place)	No	No	Yes	No
Software Support (from this manufacturer) Resident Assembler	No	No	Yes	No
Cross Assembler	No	No	Fortran IV	Yes
Simulator	No	No	Fortran IV	Yes
High Level Language	No	No	No	No
Programs Debug	No	No	Yes	
Diagnostic	No	No	Yes	
Edit	No	No	Yes	
User Library (> 25 programs from user)	No	No	No	No
Delivery Start (Qtr.-Year)	3 Qtr. 75	3 Qtr. 75	1 Qtr. 75	3 Qtr. 75
Alternate Sources	Raytheon 2901	Intel, TI 8080	Motorola MC6800	None
Comments		Priority interrupts with Intel 8214.	DMA through HALT and three state control.	

Tinted column indicates additional data is provided on the page noted.

MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Electronic Arrays EA9002	EMM/SEMI CP-1600/A	Fairchild F8 Page 923	Fairchild F4705
Generar Structure	8-Bit CPU	16-Bit CPU	8-Bit CPU	4-Bit Slice
Type	NMOS	NMOS	NMOS	CMOS
No. of Devices per CPU	1	1	1	Expandable
CPU Size (Pins)	28	40	40	24
Supply Voltage	5	−3, 5, 12	5, 12	3 to 15
CPU Power Dissipation (mw)	600	750	600	< 1.0
Part Family (from this mfr.) CPU	EA9002	CP-1600	3850 Central Processing Unit	F4705
Clock Driver	No		Oscillator on-chip	TTL or CMOS
I/O Interface			In CPU and PSU	Any CMOS 3-State Devices
RAM	64x8 on-chip, Standard Devices	Standard Devices	Standard Devices	F4720 (256x1)
ROM	Standard Devices	Standard Devices	3851 Program Storage Unit, Standard Devices	TTL or MOS
PROM	No	None	Standard Devices	TTL or MOS
UART/USRT	No		3843 USART	
Other System Parts			3852 Dynamic Memory Interface 3853 Static Memory Interface 3854, 3855 DMA	Macrologic CMOS F4704, F4706, F4707, F4710
Architecture Data Word Size (bits)	8	16	8	Multiple of 4
Instruction Word Size (bits)	8, 16	10, 20, 30	8, 16, 24	3 to 12
Directly Addressable Instruction Words (No.)	4K	65K	65K	
Clock Frequency (Hz/ext. phases required)	4 MHz/1ϕ	5 MHz/2ϕ	2 MHz/0ϕ	2 MHz
Register to Register Add Time (μsec/data word)	2	2.4	2	1.0
No. of Registers Arithmetic	1	0	1	8
Index	0	0	2	
General Purpose	8	8	64	8 + 16
Return Stack Size (No. x bits)	7x12	External RAM	33x16 or RAM	(4x16) F4706
Interrupts	Standard	Standard	Standard	None
Type	Vectored, 1 Level	Vectored, Multilevel	Vectored, 1 level/PSU	
Direct Memory Access	Optional	Standard	Optional (3854, 3855)	No
BCD Arithmetic (Hardware)	Yes	No	Yes	No
Microprogrammable	No	No	No	Yes
Extended Temp. Range Available			−55°C to 125°C	−55°C to 125°C
Hardware Support Processor Cards (CPU system on a card)	Yes	Yes	Yes	No
Prototyping System (Hardware and software development system)	No	Yes	Yes	No
In-System Emulator (Tests system in place)	No	No	Yes	No
Software Support (from this manufacturer) Resident Assembler	Yes	Yes	Yes	No
Cross Assembler	Fortran IV, Timesharing	Fortran IV	Fortran IV	No
Simulator	Yes	Fortran IV	Prototyping Sys, Fortran IV	No
High Level Language	No	No	No	No
Programs Debug	No	Yes	Yes	No
Diagnostic	No	Yes	Yes	No
Edit	No	Yes	Yes	No
User Library (> 25 programs from user)	No	No	Yes	No
Delivery Start (Qtr.-Year)	4 Qtr. 75	1 Qtr. 76	1 Qtr. 75	4 Qtr. 75
Alternate Sources	None	General Instrument CP-1600/A	Mostek F8	None
Comments	DMA through addition of three state level to address bus.	CP-1600 2.4 μsec add time with 3.3 MHz clock	64 bytes of RAM in CPU, 1024 bytes of ROM in PSU, Programmable Timer.	

Tinted column indicates additional data is provided on the page noted.

MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Fairchild 9405	General Instrument ALPS	General Instrument CP-1600/A	Harris HM6100 Page 938
Generar Structure	4-Bit Slice	8-Bit CPU	16-Bit CPU	12-Bit CPU
Type	TTL	PMOS	NMOS	CMOS
No. of Devices per CPU	Expandable	1	1	1
CPU Size (Pins)	24	40	40	40
Supply Voltage	5	−12, 5	−3, 5, 12	5
CPU Power Dissipation (mw)	500	500	750	10
Part Family (from this mfr.) CPU	9405	LP8000	CP-1600	HM6100
Clock Driver	Any TTL	LP1030 Clock Drive		Not required
I/O Interface	Any TTL 3-State Devices	LP1000 I/O		HM6101 Parallel Interface Element
RAM	Standard Devices	Standard Devices	Standard Devices	HM6508 (1024x1) HM6518 (1024x1) HM6551 (256x4) HM6561 (256x4)
ROM	Standard Devices	LP6000	Standard Devices	HM6312 (1024x12)
PROM	Standard Devices	None	None	Standard Devices
UART/USRT		Standard Devices	Standard Devices	HM6402/03 UART
Other System Parts	Macrologic TTL 9404/06/07/10	LP1010 Memory Interface		
Architecture Data Word Size (bits)	Multiple of 4	8	16	12
Instruction Word Size (bits)	3 to 12	8, 16, 24	10, 20, 30	12
Directly Addressable Instruction Words (No.)		65K	65K	4K (Expandable to 32K)
Clock Frequency (Hz/ext. phases required)	10 MHz	720 kHz/1ϕ	5 MHz/2ϕ	4 MHz/0ϕ
Register to Register Add Time (μsec/data word)	0.2	5.5	2.4	5
No. of Registers Arithmetic	8	1	0	2
Index		0	0	0
General Purpose	8 + 16	48	8	4
Return Stack Size (No. x bits)	(4x16) 9406	1x8 or RAM	Standard	None
Interrupts	None	Standard	External RAM	Standard
Type		Vectored, 1 level	Vectored, Multilevel	Vectored, 1 level
Direct Memory Access	No	No	Standard	Standard
BCD Arithmetic (Hardware)	No	Yes	No	No
Microprogrammable	Yes	No	No	No
Extended Temp. Range Available	−55°C to 125°C			−55°C to 125°C
Hardware Support Processor Cards (CPU system on a card)	No	Yes	Yes	Yes
Prototyping System (Hardware and software development system)	No	Yes	Yes	Yes
In-System Emulator (Tests system in place)	No	No	No	No
Software Support (from this manufacturer) Resident Assembler	No	Yes	Yes	Yes
Cross Assembler	No	Fortran IV	Fortran IV	Fortran IV
Simulator	No	Fortran IV	Fortran IV	No
High Level Language	No	No	No	Focal, Basic, Fortran
Programs Debug	No	Yes	Yes	Yes
Diagnostic	No	Yes	Yes	Yes
Edit	No	Yes	Yes	Yes
User Library (▷ 25 programs from user)	No	No	No	
Delivery Start (Qtr.-Year)	2 Qtr. 75	2 Qtr. 75	3 Qtr. 74	1 Qtr. 76
Alternate Sources	None	None	EMM/SEMI CP-1600/A	Intersil IM6100
Comments			CP-1600 2.4 μsec add time with 3.3 MHz clock	Processor executes programs written for the PDP8E (DEC minicomputer)

Tinted column indicates additional data is provided on the page noted.

MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Harris HM6100A Page 938	Intel 3002	Intel 4004	Intel 4040
Generar Structure	12-Bit CPU	2-Bit Slice	4-Bit CPU	4-Bit CPU
Type	CMOS	TTL	PMOS	PMOS
No. of Devices per CPU	1	≥ 2	1	1
CPU Size (Pins)	40	28 and 40	16	24
Supply Voltage	4-11	5	15 (or −10, 5)	15 (or −10, 5)
CPU Power Dissipation (mw)	40	800	450	1000
Part Family (from this mfr.) CPU	HM6100A	3001 Miprogram Control Unit 3002 Control Processing Element	4004	4040
Clock Driver	Not required		4201 Clock Generator	4201 Clock Generator
I/O Interface	HM6101A Parallel Interface Element		4207/9/11 General Purpose I/O	4207/9/11 General Purpose I/O
RAM	HM6508A (1024x1) HM6518A (1024x1) HM6551A (256x4) HM6561A (256x4)	Standard Devices	4002 (320 bit and I/O) 4101 (256x4 and I/O)	4002 (320 bit and I/O) 4101 (256x4 and I/O)
ROM	HM6312A (1024x12)	Standard Devices	4001 (256x8 and I/O) 4308 (1024x8), 4316 (2048x8)	4001 (256x8 and I/O) 4308 (1024x8), 4316 (2048x8)
PROM	Standard Devices	Standard Devices	4702 (256x8)	4702 (256x8)
UART/USRT	HM6402A/03A UART	None	8251 USART	8251 USART
Other System Parts		3003 Look-Ahead Carry Generator 3212 Multimode Latch Buffer 3214 Interrupt Control	4003 Shift Register 4008/9 Standard Memory Interface 4289 Standard Memory Interface	4003 Shift Register 4008/9 Standard Memory Interface 4289 Standard Memory Interface
Architecture Data Word Size (bits)	12	Multiple of 2	4	4
Instruction Word Size (bits)	12		8, 16	8, 16
Directly Addressable Instruction Words (No.)	4K (Expandable to 32K)	512 (Microinstructions)	4K	4K
Clock Frequency (Hz/ext. phases required)	8 MHz/0ϕ	to 6 MHz/1ϕ	500 to 750 kHz/2ϕ	740 kHz/2
Register to Register Add Time (μsec/data word)	2.5	0.15 (16 bits)	10.8	10.8
No. of Registers Arithmetic	2	2	1	1
Index	0	0	0	0
General Purpose	4	11	16	24
Return Stack Size (No. x bits)	None	None	3x12	7x12
Interrupts	Standard	Optional	None	Standard
Type	Vectored, 1 level	8 Level Priority (3214)		Vectored, 1 Level
Direct Memory Access	Standard	No	None	None
BCD Arithmetic (Hardware)	No	No	Yes	Yes
Microprogrammable	No	Yes	No	No
Extended Temp. Range Available	−55°C to 125°C	−55°C to 125°C	−55°C to 85°C	−55°C to 85°C
Hardware Support Processor Cards (CPU system on a card)	Yes	No	Yes	Yes
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	Yes
In-System Emulator (Tests system in place)	No	Yes	No	No
Software Support (from this manufacturer) Resident Assembler	Yes	No	Yes	Yes
Cross Assembler	Fortran IV	CROMIS Microassembler	Fortran IV	Fortran IV
Simulator	No	No	Fortran IV	Fortran IV
High Level Language	Focal, Basic, Fortran	No	No	No
Programs Debug	Yes	No	Yes	Yes
Diagnostic	Yes	No	Yes	Yes
Edit	Yes	No	Yes	Yes
User Library (> 25 programs from user)		No	Yes	Yes
Delivery Start (Qtr.-Year)	1 Qtr. 76	3 Qtr. 74	2 Qtr. 71	4 Qtr. 74
Alternate Sources	Intersil IM6100	Signetics N3002	National	None
Comments	Processor executes programs written for the PDP8E (DEC minicomputer)			

Tinted column indicates additional data is provided on the page noted.

MICROPROCESSORS (Cont'd)

Manufacturer **Model** **For Detailed Data See:**	Intel 8008	**Intel** **8080A** **Page 958**	Intersil IM6100	Monolithic Memories 5701-1/6101-1
Generar Structure	8-Bit CPU	8-Bit CPU	12-Bit CPU	4-Bit Slice
Type	PMOS	NMOS	CMOS	TTL
No. of Devices per CPU	1	1	1	
CPU Size (Pins)	18	40	40	40
Supply Voltage	−9, 5	±5, 12	5 to 10 (5 nominal)	5
CPU Power Dissipation (mw)	420	780	10	900
Part Family (from this mfr.) CPU	8008 500 kHz 8008-1 800 kHz	8080A (Commercial) M8080A (Military)	IM6100	5701 (Military) 6701 (Commercial)
Clock Driver	8201 Generator/Driver	8224 Generator/Driver	Not required	Not required
I/O Interface	8212 I/O Port 8216 Bus Driver 8255 Prog. Perif. Inter.	8212 I/O Port 8216/26 Bus Drivers 8255 Prog. Perif. Inter.	IM6101 Parallel Interface Element	6718 I/O Controller
RAM	8101 (256x4 with I/O) 8102A (1024x1), 8107B (4086x1), 8111 (256x4 with I/O)	8101 (256x4 with I/O) 8102A (1024x1), 8107B (4086x1), 8111 (256x4 with I/O)	Standard Devices	Standard Devices
ROM	8308 (1024x8) 8316 (2048x8)	8308 (1024x8) 8316A (2048x8)	IM6312, Standard Devices	Standard Devices
PROM	8604 (512x8), 8702 (256x8)	8604 (512x8), 8702A (256x8)	Standard Devices	Standard Devices
UART/USRT	8251 USART	8251 USART	IM6402 UART	None
Other System Parts	8205 1 of 8 Decoder 8210 Level Shifter/Clock Driver 8214 Priority Interrupt 8253 Interval Timer 8257 DMA Controller	8205 1 of 8 Decoder 8210/22 RAM Driver/Controller 8214 Priority Interrupt 8253 Interval Timer, 8257 DMA Controller 8259 Interrupt Cont. 8704 (512x8), 8708 (1024x8) Erasable PROMs		6710 Microprogram Control Unit 6717 DMA Controller 6716 Interrupt Control Unit 6780 FPLA
Architecture Data Word Size (bits)	8	8	12	Multiple of 4
Instruction Word Size (bits)	8, 16, 24	8, 16, 24	12	8
Directly Addressable Instruction Words (No.)	16K	65K	4K (Expandable to 32K)	
Clock Frequency (Hz/ext. phases required)	800 kHz/2ϕ	2 MHz/1ϕ (2.6 and 3 MHz opt.)	4 MHz/0ϕ	0 to 10 MHz/1ϕ
Register to Register Add Time (μsec/data word)	12.5	2 (2 MHz clock)	5 (2.5 at 10v)	0.085 typ.
No. of Registers Arithmetic	1	1	2	0
Index	0	0	0	0
General Purpose	6	6	4	17
Return Stack Size (No. x bits)	7x14	External RAM	None	6710 MCU
Interrupts	Standard	Standard	Standard	6716
Type	Vectored, 8 Level	Vectored, 8 Level (8214)	Vectored, 1 Level	8 Vectored
Direct Memory Access	Optional (8257)	Standard	Standard	6717
BCD Arithmetic (Hardware)	No	Yes	No	Microprogrammable
Microprogrammable	No	No	No	Yes
Extended Temp. Range Available	−55°C to 85°C	−55°C to 125°C	−55°C to 125°C	−55°C to 125°C
Hardware Support Processor Cards (CPU system on a card)	Yes	Yes	Yes	MMI 300 Minicomputer
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	MMI 300 Minicomputer
In-System Emulator (Tests system in place)	No	Yes	No	No
Software Support (from this manufacturer) Resident Assembler	Yes	Yes	Yes	
Cross Assembler	Fortran IV	Fortran IV	Yes	
Simulator	Fortran IV	Fortran IV	Forpal III	
High Level Language	PL/M (Fortran IV)	PL/M (Fortran IV)	Yes	
Programs Debug	Yes	Yes	Yes	Yes (MMI 300)
Diagnostic	Yes	Yes	Yes	Yes (MMI 300)
Edit	Yes	Yes	Yes	
User Library (> 25 programs from user)	Yes	Yes	Yes (DEC)	No
Delivery Start (Qtr.-Year)	1 Qtr. 72	4 Qtr. 73	2 Qtr. 75	4 Qtr. 75
Alternate Sources	None	AMD 9080, TI8080	Harris 6100	To be announced
Comments	8 level interrupts with 8214 Priority Interrupt IC.		Executive PDP-8, Instruction Set	RAM on-chip

Tinted column indicates additional data is provided on the page noted.

MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	MOS Technology 6501/2/3/4	Mostek F8 Page 964	Mostek MK5065-1	Motorola M6800
Generar Structure	8-Bit CPU	8-Bit CPU	8-Bit CPU	8-Bit CPU
Type	NMOS	NMOS	PMOS	NMOS
No. of Devices per CPU	1	1	1	1
CPU Size (Pins)	40 or 28	40	40	40
Supply Voltage	5	5, 12	−12, ±5	5
CPU Power Dissipation (mw)	200	600	600	600
Part Family (from this mfr.) CPU	6501 (2φ clock) 6502/3 (self clocking)	MK3850 Central Processing Unit	MK5065-1	MC6800
Clock Driver	Not required	Oscillator on-chip	None	MC6870/71 Clock Generators*
I/O Interface	Yes	In CPU and PSU		MC6820 Peripheral Interface Adaptor
RAM	Standard Devices	Standard Devices	Standard Devices	MCM6810A (128x8)
ROM	Standard Devices	MK3851 Program Storage Unit	Standard Devices	MCM6830A (1024x8)
PROM	No	Yes	None	No
UART/USRT	None	None	None	MC6850 Async. Comm. Interface Adaptor
Other System Parts	6530 Memory, I/O, Timer Array	MK3852 Dynamic Memory Interface MK3853 Static Memory Interface MK3854 DMA		MC6860 Modem
Architecture Data Word Size (bits)	8	8	8	8
Instruction Word Size (bits)	8, 16, 24	8, 16, 24	8, 16	8, 16, 24
Directly Addressable Instruction Words (No.)	65K	65K	32K	65K
Clock Frequency (Hz/ext. phases required)	to 2 MHz/1φ	2 MHz/0φ	2 MHz/3φ	1 MHz/2φ
Register to Register Add Time (μsec/data word)	1	2	7	2
No. of Registers Arithmetic	1	1	3	2
Index	2	2	0	1 (16 bit)
General Purpose	0	65	0	0
Return Stack Size (No. x bits)	External RAM	1x8 or RAM	External RAM	External RAM
Interrupts	Standard	Standard	Standard	Standard
Type	Vectored, 2 Level	Vectored, 1 Level/PSU	Vectored, 3 Level	Vectored, Multilevel
Direct Memory Access	Optional	Optional (MK3854)	Standard	Optional
BCD Arithmetic (Hardware)	Yes	Yes	No	Yes
Microprogrammable	No	No	No	No
Extended Temp. Range Available	−55°C to 85°C		No	No
Hardware Support Processor Cards (CPU system on a card)	Yes	Yes	Yes	Yes
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	Yes
In-System Emulator (Tests system in place)	Yes	Yes	No	Yes
Software Support (from this manufacturer) Resident Assembler	Yes	Yes	Yes	Yes
Cross Assembler	Fortran IV	Fortran IV	Fortran IV	Fortran IV
Simulator	Fortran IV	Timesharing	Prototyping System	Fortran IV
High Level Language	No	No	No	No
Programs Debug	Yes	Yes	Yes	Yes
Diagnostic	Yes	Yes	Yes	Yes
Edit	No	Yes	Yes	Yes
User Library (> 25 programs from user)	No	No	No	No
Delivery Start (Qtr.-Year)	3 Qtr. 75	3 Qtr. 75	1 Qtr. 74	2 Qtr. 74
Alternate Sources	Synertek SY6501/2/3/4	Fairchild F8	None	AMI
Comments	DMA based on a stopping CPU, but address bus connections are not 3 state.	64 bytes of RAM in CPU, 1024 bytes of RCM in PSU, programmable timer.	Three level system services interrupts with multiple program counters and accumulators.	DMA through HALT and three state control *MC6870 and MC6871 from Motorola Component Products, Franklin Park, Ill.

Tinted column indicates additional data is provided on the page noted.

MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	National IMP-4/8/16	National INS4004 (FIPS)	National IPC-16 (PACE) Page 970	National ISP500A (SCMP) Page 981
Generar Structure	4-Bit Slice	4-Bit CPU	16-Bit CPU	8-Bit CPU
Type	PMOS	PMOS	PMOS	PMOS
No. of Devices per CPU		1	1	1
CPU Size (Pins)	24	16	40	40
Supply Voltage	−12, 5	15 (or −10, 5)	−12, 5	−5, 9
CPU Power Dissipation (mw)		450	700	420
Part Family (from this mfr.) CPU	Register and Arithmetic Unit	INS4004	Processing and Control Element	
Clock Driver	Clock Generator		System Timing Element	On-chip Oscillator
I/O Interface	Interface Latches, 8/16-bit Transceivers		Bidirectional Transceiver Element	
RAM	Standard Devices	INS4002 (320 bit and I/O)	256x4	Standard Devices
ROM	Control ROM Standard Devices	INS4001 (256x8 and I/O)	1024x16	Standard Devices
PROM	Standard Devices		512x8	Standard Devices
UART/USRT			None	Standard Device
Other System Parts	Interface Logic Address Latches	INS4003 Shift Register INS4008/9 Standard Memory Interface	Address Latch, Interface Latch	
Architecture Data Word Size (bits)	4/8/16	4	8 or 16	8
Instruction Word Size (bits)	8, 12, 16, 20	8, 16	16	8, 16
Directly Addressable Instruction Words (No.)	4K/65K/65K	4K	65K	65K
Clock Frequency (Hz/ext. phases required)	to 700 kHz/4ϕ	500 to 740 kHz/2ϕ	2 MHz/2ϕ	1 MHz/0ϕ
Register to Register Add Time (μsec/data word)	12/4.6/4.6	10.8	8	28
No. of Registers Arithmetic	4	1	0	1
Index	0	0	0	4
General Purpose	0	16	4	3
Return Stack Size (No. x bits)	16 x No. of bits	3x12	10x16	
Interrupts	Standard	None	Standard	Standard
Type	1/2/2 Level		Vectored, 6 Level	Vectored
Direct Memory Access	Optional	None	Optional	Standard
BCD Arithmetic (Hardware)	No	Yes	Standard	Standard
Microprogrammable	Yes	No	No	No
Extended Temp. Range Available	−55°C to 85°C			−25°C to 85°C
Hardware Support Processor Cards (CPU system on a card)	Yes	No	Yes	Yes
Prototyping System (Hardware and software development system)	Yes	No	Yes	Yes
In-System Emulator (Tests system in place)	No	No	No	No
Software Support (from this manufacturer) Resident Assembler	Yes	No	Yes	Yes
Cross Assembler	Fortran IV	No	Fortran IV	Fortran IV, Timesharing
Simulator	No	No	No	Yes
High Level Language	SM/PL	No	SM/PL	SM/PL
Programs Debug	Yes	No	Yes	Yes
Diagnostic	Yes	No	Yes	Yes
Edit	Yes	No	Yes	Yes
User Library (> 25 programs from user)	No	No	No	Yes
Delivery Start (Qtr.-Year)	1 Qtr. 73	3 Qtr. 75	3 Qtr. 75	1 Qtr. 76
Alternate Sources	None	Intel	None	Rockwell (Future)
Comments	DMA requires external controller.		DMA requires external controller.	

Tinted column indicates additional data is provided on the page noted.

MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Raytheon Semi 2901	RCA CDP1800 (COSMAC) Page 993	Rockwell PPS-4/2	Rockwell PPS-8
Generar Structure	4-Bit Slice	8-Bit CPU	4-Bit CPU	8-Bit CPU
Type	TTL	CMOS	PMOS	PMOS
No. of Devices per CPU		2	1	1
CPU Size (Pins)	40	28 or 40	42	42
Supply Voltage	5	3 to 15	17 (or −12, 5)	17 (or −12, 5)
CPU Power Dissipation (mw)	925	60	225	225
Part Family (from this mfr.) CPU	2901	CDP1801U Control CDP1801R Register	PPS-4	PPS-8
Clock Driver		Standard Devices	Clock Gen. or On-chip	Clock Generator
I/O Interface	2905/6/7 Bus Transceivers		GP I/O (12 bits) Bus Interface	GP I/O (12 bits) Bus Interface
RAM	2950/51 (256x1) 2952 (1024x1)	Standard Devices	256x4	256x8
ROM	2960/61 (102x8)	Standard Devices	1024x8, 2048x8	1024x8, 2048x8
PROM	2970/71 (256x4)	None	Elect. Alt. ROM	Elect. Alt. ROM
UART/USRT		None	Serial Data Controller, Telecommunications Data Interface (incl. Modem)	Serial Data Controller, Telecommunications Data Interface (incl. Modem)
Other System Parts	2909 Microprogram Sequencer		Display Controller (Panaplex) GP Keyboard Display, Keyboard Printer Control, Victor Printer Control	DMA Controller Parallel Data Controller Floppy Disc Controller Display Cont. (Panaplex), Keyboard Printer Control, Victor Printer Control
Architecture Data Word Size (bits)	Multiple of 4	8	4	8
Instruction Word Size (bits)	9	8	8, 16 (Multifunction Instr.)	8, 16, 24 (Multifunction Instr.)
Directly Addressable Instruction Words (No.)		65K	4K	16K
Clock Frequency (Hz/ext. phases required)	to 10 MHz/1ϕ	0 to 4 MHz/1ϕ	199 KHz/0 or 2ϕ	256 kHz/2ϕ
Register to Register Add Time (μsec/data word)	0.125	6 (2.7 MHz clock)	5	4
No. of Registers Arithmetic	0	1	0	0
Index	0	0	0	0
General Purpose	17	32	3	6
Return Stack Size (No. x bits)	4x4 (2909)	External RAM	2x12	32x8
Interrupts	Optional	Standard	None	Standard
Type		1 Level		3 Level
Direct Memory Access	Optional	Standard (on-chip)	None	Optional DMA Controller
BCD Arithmetic (Hardware)	No	No	No	No
Microprogrammable	Yes	No	No	No
Extended Temp. Range Available	−55°C to 125°C	−55°C to 125°C Standard	−55°C to 125°C	−55°C to 125°C
Hardware Support Processor Cards (CPU system on a card)	No	No	Yes	Yes
Prototyping System (Hardware and software development system)	No	Yes	Yes	Yes
In-System Emulator (Tests system in place)	No	No	Yes	Yes
Software Support (from this manufacturer) Resident Assembler	No	Yes	Yes	Yes
Cross Assembler	No	Fortran IV, Timesharing	Fortran IV, Timesharing	Fortran IV, Timesharing
Simulator	No	Yes	Yes	Yes
High Level Language	No	No	No	No
Programs Debug	No	Yes	Yes	Yes
Diagnostic	No	Yes	Yes	Yes
Edit	No	Yes	Yes	Yes
User Library (▷ 25 programs from user)	No	No	Yes	No
Delivery Start (Qtr.-Year)	1 Qtr. 76	1 Qtr. 75	PPS-4 3 Qtr. 72, PPS-4/2 3 Qtr. 75	1 Qtr. 75
Alternate Sources	AMD 2901	None	National PPS-4 (Future)	National PPS-8 (Future)
Comments		DMA address pointer and control logic on chip.	The PPS-4/2 is 2 chip clock, direct display drive, expanded I/O on CPU chip; 128-4 RAM, 2048x8 ROM, 16 I/O ports on separate memory-I/O chip.	

Tinted column indicates additional data is provided on the page noted.

MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Signetics 2650 Page 997	Signetics N3002 Page 1007	Synertek SY6501/2/3/4	Texas Instruments SBP0400
Generar Structure	8-Bit CPU	2-Bit Slice	8-Bit CPU	4 Bit Slice
Type	NMOS	TTL	NMOS	I²L
No. of Devices per CPU	1		1	
CPU Size (Pins)	40	28 and 40	40 or 28	40
Supply Voltage	5	5	5	200 mA at 0.85V
CPU Power Dissipation (mw)	500	800	200	170
Part Family (from this mfr.) CPU	2650	N3001 Microprogram Control Unit N3002 Control Processing Element	SY6501 (2ϕ clock) SY6502/3 (self clocking)	SBP0400
Clock Driver	Standard Devices	Standard Devices	Not required	Standard Devices
I/O Interface	Standard Devices	Standard Devices	Yes	Standard Devices
RAM	Standard Devices	Standard Devices	Standard Devices	Standard Devices
ROM	Standard Devices	Standard Devices	Standard Devices	Standard Devices
PROM	Standard Devices	Standard Devices	No	Standard Devices
UART/USRT	None	None	None	Standard Devices
Other System Parts		N3214 Interrupt Control	SY6520 Peripheral Interface Adapter SY6530 (1K ROM, 64 bytes RAM, 16 I/O)	
Architecture Data Word Size (bits)	8	Multiple of 2	8	9 (Microinstruction Select)
Instruction Word Size (bits)	8, 16, 24	$\geq$ 18	8, 16, 24	
Directly Addressable Instruction Words (No.)	32K	512	65K	(512 Microinstructions)
Clock Frequency (Hz/ext. phases required)	0 to 1.25 MHz/1ϕ	to 6 MHz/1ϕ	to 2 MHz/1ϕ	to 2 MHz/1ϕ
Register to Register Add Time (μsec/data word)	4.8		1	0.5 (2 MHz clock)
No. of Registers Arithmetic	0	2	1	2
Index	0	0	2	0
General Purpose	7	10	0	8
Return Stack Size (No. x bits)	8x15	None	External RAM	None
Interrupts	Standard	Optional	Standard	Optional
Type	Vectored	8 Level Priority	Vectored, 2 Level	Optional
Direct Memory Access	Standard	No	Optional	Standard
BCD Arithmetic (Hardware)	Standard	No	Yes	Microprogrammable
Microprogrammable	No	Yes	No	(512 Microinstructions)
Extended Temp. Range Available	No	No	−55°C to 85°C	−55°C to 125°C
Hardware Support Processor Cards (CPU system on a card)	Yes	No	Yes	No
Prototyping System (Hardware and software development system)	Yes	No	Yes	Yes (hardware)
In-System Emulator (Tests system in place)	Yes	No	Yes	No
Software Support (from this manufacturer) Resident Assembler	No	No	Yes	No
Cross Assembler	Fortran IV, PDP-11	No	Fortran IV	Fortran microassembler
Simulator	Fortran IV	No	Fortran IV	No
High Level Language	No	No	No	No
Programs Debug	Yes	No	Yes	No
Diagnostic	Yes	No	Yes	No
Edit	Yes	No	No	No
User Library (> 25 programs from user)	No	No	No	No
Delivery Start (Qtr.-Year)	2 Qtr. 75	3 Qtr. 75	4 Qtr. 75	1 Qtr. 75
Alternate Sources	None	Intel	MOS Technology 6501/2/3/4	None
Comments	Any of the general purpose registers can be used as an index register.	Uses 74S182 for Look-Ahead Carry.	DMA based on a stopping CPU, but address bus connections are not 3 state.	Current drain can be set from 0.001 to 200 mA.

Tinted column indicates additional data is provided on the page noted.

MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Texas Instruments TMS1000/1200	Texas Instruments TMS1070/1270	Texas Instruments TMS1100/1300	Texas Instruments TMS8080
Generar Structure	4-Bit Microcomputer	4-Bit Microcomputer	4-Bit Microcomputer	8-Bit CPU
Type	PMOS	PMOS	PMOS	NMOS
No. of Devices per CPU	1	1	1	1
CPU Size (Pins)	28 or 40	28 or 40	28 or 40	40
Supply Voltage	15	15	15	±5, 12
CPU Power Dissipation (mw)	90	100	90	1500
Part Family (from this mfr.) CPU	TMS1000 (28 pin) TMS1200 (40 pin)	TMS1070 (28 pin) TMS1270 (40 pin)	TMS1100 (28 pin) TMS1300 (40 pin)	TMS8080
Clock Driver	On-chip Oscillator	On-chip oscillator	On-chip oscillator	None
I/O Interface	On-chip output encoder, addressable output latches.	On-chip output encoder, addressable output latches	On-chip output encoder, addressable output latches	SN74S412 I/O Port, TMS5501 Multifunction I/O Controller
RAM	64x4 on-chip	64x4	128x4 on-chip	Standard Devices
ROM	1024x8 on-chip	1024x8	2048x8 on-chip	Standard Devices
PROM	Not required	Not required	Not required	Standard Devices
UART/USRT	None	None	None	TMS5501, TMS6011
Other System Parts	None	None	None	SN74S240/241 Line Driver
Architecture Data Word Size (bits)	4	4	4	8
Instruction Word Size (bits)	8	8	8	8, 16, 24
Directly Addressable Instruction Words (No.)	1K	1k	2K	65K
Clock Frequency (Hz/ext. phases required)	300 kHz/0ϕ	300 kHz/0ϕ	300 kHz/0ϕ	2 MHz/2ϕ
Register to Register Add Time (μsec/data word)	34 (350 kHz clock)	34 (350 kHz clock)	34 (350 kHz clock)	2
No. of Registers Arithmetic	1	1	1	1
Index	0	0	0	0
General Purpose	1	1	1	6
Return Stack Size (No. x bits)	1x10	1x10	1x10	External RAM
Interrupts	None	None	None	Standard
Type				Vectored, 8 Level
Direct Memory Access	None	None	None	Standard
BCD Arithmetic (Hardware)	Microprogrammable	Microprogrammable	Microprogrammable	Yes
Microprogrammable	Yes	Yes	Yes	No
Extended Temp. Range Available		Yes	Yes	No
Hardware Support Processor Cards (CPU system on a card)	No	No	No	No
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	No
In-System Emulator (Tests system in place)	Yes	No	Yes	No
Software Support (from this manufacturer) Resident Assembler	Yes	Yes	Yes	No
Cross Assembler	Timesharing	Yes	Yes	Timesharing
Simulator	Timesharing	Yes	Yes	Timesharing
High Level Language	No	No	No	No
Programs Debug	Yes	Yes	Yes	Yes
Diagnostic	Yes	Yes	Yes	Yes
Edit	Yes	Yes	Yes	Yes
User Library (▷ 25 programs from user)				No
Delivery Start (Qtr.-Year)	1 Qtr. 75	4 Qtr. 75	4 Qtr. 75	2 Qtr. 75
Alternate Sources	None	None	None	AMD 9080, Intel 8080
Comments	A 64 pin version, TMS1099/SE-1, permits use of external PROM, RAM or ROM for program development.	35v output drive capability.	A 64-pin version, TMS1098/SE-2 permits use of external PROM/RAM/ROM for program development.	

Tinted column indicates additional data is provided on the page noted.

MICROPROCESSORS (Cont'd)

Manufacturer **Model** **For Detailed Data See:**	Texas Instruments TMS9900	Toshiba TLCS-12A	Western Digital MP1600	Western Digital MCP1600
Generar Structure	16-Bit CPU	12-Bit CPU	16-Bit CPU	8-Bit CPU
Type	NMOS	PMOS	NMOS	NMOS
No. of Devices per CPU	1	1	3	3
CPU Size (Pins)	64	36	40/device	40/device
Supply Voltage	±5, 12	±5	±5, 12	±5, 12
CPU Power Dissipation (mw)	1000	800	600	600
Part Family (from this mfr.) CPU	TMS9900	T3190	MP1651 Data Chip MP1661 Control Chip	CP1611 Data Chip CP1621 Control Chip
Clock Driver	Standard Devices	Internal Oscillator	None	None
I/O Interface	Standard Devices	T3218 I/O Control Unit	CP1851 GPIO	CP1851 GPIO
RAM	Standard Devices	T3151 (128x4)	Standard Devices	Standard Devices
ROM	Standard Devices	Standard Devices	CP1631 Microm, Standard Devices	CP1631 Microm, Standard Devices
PROM	Standard Devices	T3181 Erasable ROM	Not required	Not required
UART/USRT	Standard Devices	No	Standard Devices	Standard Devices
Other System Parts		T3216 Memory Control Unit T3320 General Purpose 4 + 8 bit I/O Register	DM1881 DMA, FD1771 Floppy Disk, UC1671 ASTRO	DM1881 DMA, FD1771 Floppy Disk, UC1671 ASTRO
Architecture Data Word Size (bits)	16	12	16	8 or 16
Instruction Word Size (bits)	16, 32, 48	12, 24	16	16
Directly Addressable Instruction Words (No.)	65K	4K	65K	65K (84 Microinstructions)
Clock Frequency (Hz/ext. phases required)	3 MHz/4ϕ	1.2 MHz/0ϕ	3.3 MHz/4ϕ	3.3 MHz/4ϕ
Register to Register Add Time (μsec/data word)	4.67	13	2.7	0.3 (8-bit), 0.6 (16-bit)
No. of Registers Arithmetic	16	0	4	0
Index	15	0	2	0
General Purpose	16 (in memory)	7	2	26
Return Stack Size (No. x bits)	None		External RAM	External RAM
Interrupts	Standard	Yes	Standard	Standard
Type	Vectored, 16 Level		Vectored	Vectored, 4 Level
Direct Memory Access	Standard	Optional	Standard	Standard
BCD Arithmetic (Hardware)	No	No	Standard	Microprogrammable
Microprogrammable	No	No	Yes	Yes
Extended Temp. Range Available	No		No	No
Hardware Support Processor Cards (CPU system on a card)	Yes 990/4	No	Yes	Yes
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	Yes
In-System Emulator (Tests system in place)	No	No	No	Yes
Software Support (from this manufacturer) Resident Assembler	Yes		Yes	No
Cross Assembler	Timesharing	Yes	No	Timesharing, PDP-11
Simulator	Timesharing	Yes	No	Timesharing, PDP-11
High Level Language	Fortran, Cobol	Yes	No	No
Programs Debug	Yes	Yes	Yes	Yes
Diagnostic	Yes	Yes	Yes	Yes
Edit	Yes	Yes	Yes	Yes
User Library (> 25 programs from user)	Yes	Yes	No	No
Delivery Start (Qtr.-Year)	2 Qtr. 76	2 Qtr. 74	1 Qtr. 75	3 Qtr. 75
Alternate Sources	None	None	None	None
Comments	Instructions include hardware multiply and divide and are software compatible with 990 minicomputers.			Can cross assemble and simulate with DEC PDP-11. Microcontroller version avail.

Tinted column indicates additional data is provided on the page noted.

S6800: The whole Kit.

Smart Terminal.
Complete program editing through CRT and keyboard. Also includes Modem communication to remote computers.

Magnetic Tape.
Cross product software—assembler, loader, simulator.

S6800 Family.
It's all here: MPU, RAM, ROM, PIA, ACIA, PROM, USRT and Modem. By test, the best.

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Includes everything you need to evaluate parts, program PROMs and, connected with a peripheral, run programs.

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Storage for resident software—assembler, editor, etc.

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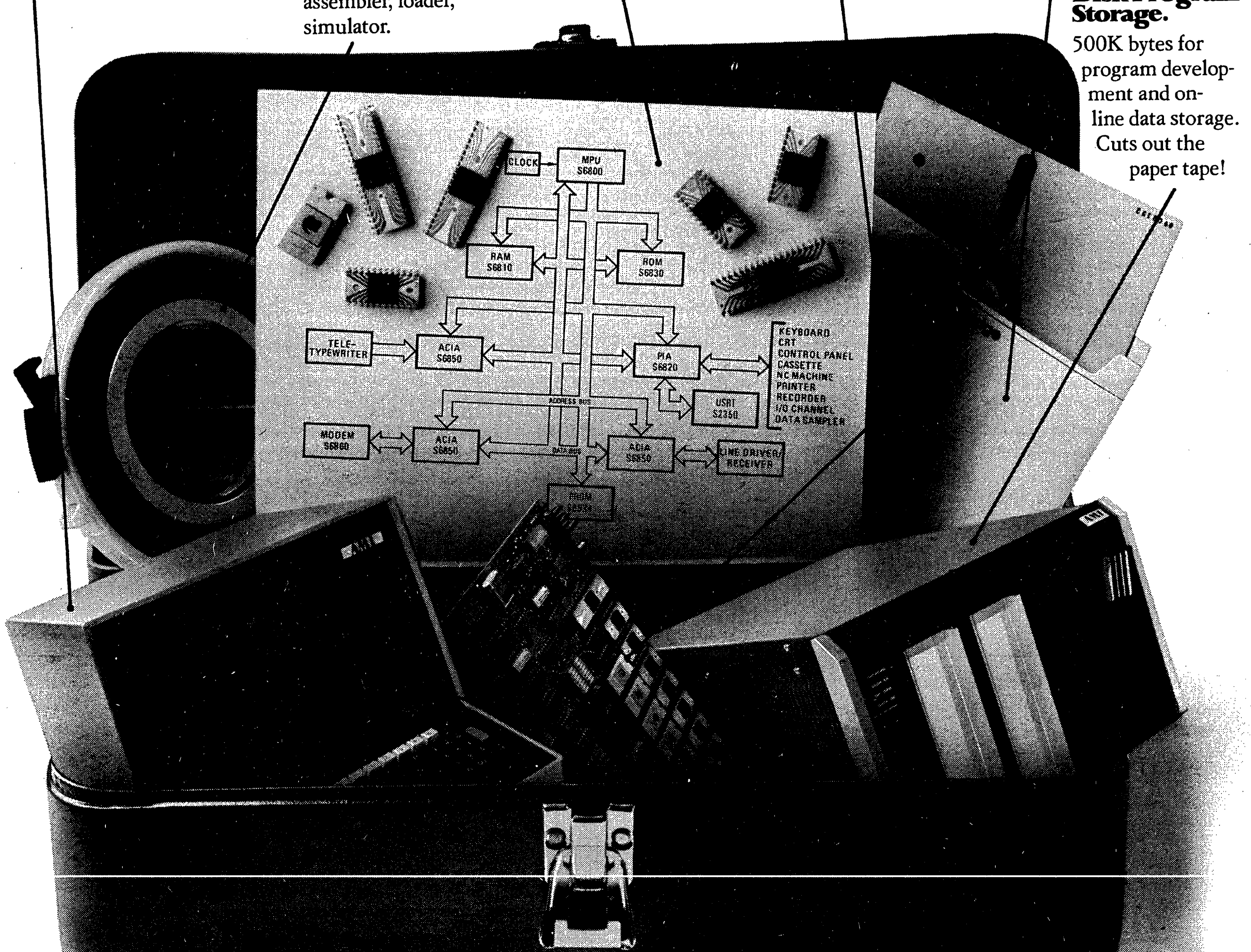
500K bytes for program development and on-line data storage. Cuts out the paper tape!



Our S6800 Kit is a big step forward in simplifying your design, evaluation and test programs. For example, our intelligent CRT is simple to operate with either resident or remote software. It really is smart, because it contains an S6800! And it's planned to have an in-circuit emulator added later.

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Now for the Caboodle. The dictionary calls it a "package." You'll call it the neatest set of instructions for any kit you've ever bought.

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A rundown on AMI software products including assembler, loader and simulator.

S6800 Brochure.
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Evaluation Board Application Notes.
The why and wherefore of our Prototyping System, and how to make the most of it!

NCSS Users Manual.
All the magic necessary to work with National CSS time-sharing network.

Assembly Language Programming Manual.
Describes the instruction set and how to use the AMI Assembler and Simulator.

AMI Guide to Standard Products.
All the MOS you might need in addition to microprocessors.

Hardware Reference Manual.
A detailed description of each component in the system, and how to make them work!

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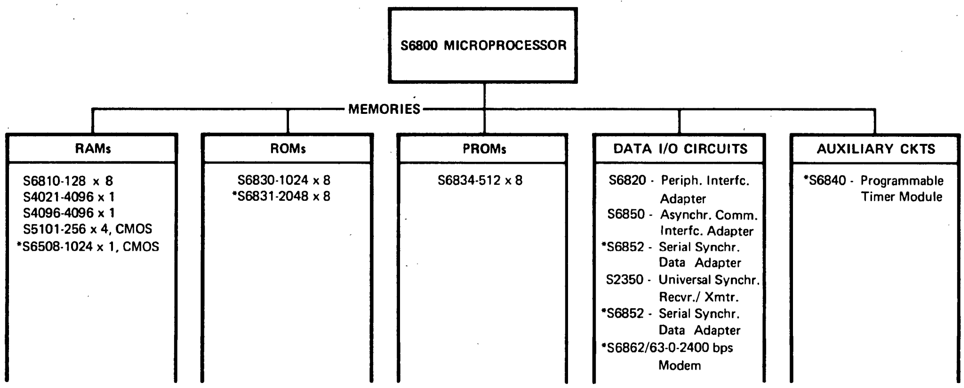
S6800 Microcomputer Family



*Future Products – watch for the introduction of these and other S6800 Family products from AMI.

S6800 Microprocessor (MPU) – an 8-bit parallel processor, with the ability to address up to 65K bytes of memory, and execute instructions in 2 microseconds. It is manufactured using N-channel MOS technology and operates on a single +5V power supply. All inputs and outputs are TTL compatible. The MPU has six internal registers, four types of vectored interrupts and 72 basic instructions. The basic instructions can be used in different addressing modes to save instruction execution time and memory space.

S6810 Static Read/Write Memory, 128 x 8 – an N-channel MOS memory designed and organized to be compatible with the S6800 MPU. Its data, address and control line organization and functions match those of the MPU, all signal levels are TTL compatible and no clocks or refreshing are needed. There are two versions of this memory: S6810 with 1.0 μsec maximum access time, and S6810-1 with 575 nsec. maximum access time.

ROMs – 1024 x 8 and 2048 x 8 – two N-channel MOS mask programmable read only memories that are used for storing the S6800 MPU operating programs. These ROMs have data, address, and control line organization compatible with that of the MPU; signal levels are TTL compatible and access times of 575 nsec. and 500 nsec., respectively.

S6820 Peripheral Interface Adapter (PIA) – a general purpose programmable interface circuit that provides the means for most any kind of peripheral device or circuit to communicate with the S6800 MPU. The PIA has two 8-bit input/output ports for communicating with the peripherals and the MPU can program either port to send or receive data. Each port has two control lines associated with it. These also can be programmed by the MPU to handle interrupt and handshake routines with the peripherals.

S6850 Asynchronous Communication Interface Adapter (ACIA) – a general purpose communications interface that allows an asynchronous serial communications device to transmit data to and receive data from a S6800 microcomputer system. The ACIA can be programmed for handling different word lengths at various data rates; it also has parity generation and checking capability. For interfacing with the S6860 modem, the ACIA provides three status and command lines.

S6852 Serial Synchronous Data Adapter – a bus compatible high speed synchronous communications interface.

S6860 Modem – A 0-600 bps digital modem providing the necessary modulation, demodulation and supervisory controls to implement a serial data communications link over a voice grade channel. The modem is fully compatible with the S6800 microcomputer system, interfaces directly with the S6850 ACIA, and can be used in a wide variety of stand-alone modems, data communication terminals, I/O interfaces, and other data handling systems. N-channel silicon gate technology permits the modem to operate on a single +5V power supply and its inputs and outputs are TTL.

S6862/63 2400 Baud Modem – a two-chip synchronous high-speed modem.

S6800 SYSTEM COMPATIBLE COMPONENTS

S2350 Universal Synchronous Receiver/Transmitter (USRT) – a general purpose communications interface that allows a high speed synchronous communications device to transmit data to and receive data from a S6800 microcomputer system. It connects to the peripheral device via separate serial transmit and receive lines and to the S6800 system data and address bus through a S6820 PIA.

The USRT has separate internal receiver and transmitter sections, which can be clocked by two separate clocks. It has the capability to handle different word lengths, generate and check parity and other conditions, detect sync during receive, and send a fill character during transmit operation.

RAMs – 4K (22-pin and 16-pin) – two N-channel Si-gate dynamic RAMs for large volume low cost read/write storage. Both have TTL compatible inputs and outputs, that can be easily interfaced to the S6800 system bus; access times as low as 200 nsec.

RAMs – 1K, CMOS – two silicon-gate CMOS RAMs for low power and non-volatile memory systems. TTL compatible I/O; can be operated either at +5V, or +10V.

S6800 Microcomputer Systems

THE FIRST FAMILY

The AMI S6800 Microcomputer Family is an LSI integrated circuit family for building microcomputers. In its hardware concept it is the same as the SSI and MSI families, except with SSI/MSI each integrated circuit is only an individual logic element (or segment of a larger random logic circuit), whereas in the LSI family each is a whole subsystem of a microcomputer.

By bringing to LSI microcomputer hardware the advantages of the family concept – a series of functionally and electrically matched circuits – the AMI S6800 allows the circuit designer to build complete microcomputer systems of different configurations by simply selecting from the matched subsystem circuits, interconnecting them with the microprocessor into a system, and providing the necessary operating voltages and clock signals. Such a method is superior to choosing an MPU and then matching different memory or I/O circuits to it through interfaces, as must be done with most microprocessor products. The matched LSI family makes the design task simple, fast, and the functional complexity of the system can be increased, while physical size is reduced.

The AMI S6800 Microcomputer Family is a leader in developing this family concept, because S6800 has a wider selection of compatible memory, I/O, and auxiliary circuits, has comprehensive hardware and software support, and wide user acceptance.

COMPLETE AND EASY

The AMI S6800 Microcomputer Family hardware includes the S6800 Microprocessor, a selection of RAM, ROM, and PROM memories, a wide variety of data input/output circuits, and various other support circuits. These components may be assembled in a building block manner into a simple or complex microcomputer system, for many general and special purpose applications. It remains to the user to integrate the microcomputer into his own larger system and to program it for a specific task.

One important design feature of the S6800 family is that within any microcomputer system all components are directly compatible in the system bus and I/O protocol, as well as in individual signal functions, circuit performance characteristics, and logic levels. All operate on a single +5V power supply.

To facilitate system design and programming, AMI provides versatile and easy to use prototyping hardware, various software packages for program generation, an economical CRT/disc system for on-site program generation and debugging, comprehensive hardware and software reference documentation, and other applications support. Such backup is a continuous and expanding effort at AMI.

THE BASIC SYSTEM

A basic S6800 system is shown in Figure 1. In this system the S6800 Microprocessor (MPU) is supported by RAM and ROM (or PROM) memory and controls one input/output circuit. The 1024-byte ROM (or 512-byte eraseable PROM) is used to store the operating program, the 128-byte RAM provides working storage for the MPU, and the Peripheral Interface Adapter (PIA) provides two independently programmable 8-bit input/output ports for communicating with two peripheral devices.

The S6800 system is bus oriented. Eight lines form the data bus and 16 more lines make up the address bus. The MPU controls the bus and all other devices – the memories and the PIA – attach to the bus and wait for instructions from the MPU to supply or receive data. In the system shown in Figure 1, the MPU uses address lines A2, A13, and A14 to select one of the three devices on the bus and uses the Read/Write and Valid Memory Address lines to instruct the devices to receive or send data to the MPU. When communicating with the PIA, address lines A0 and A1 are used to select among the two peripheral devices A and B; the CA1, CA2, CB1, and CB2 lines can be used to send out control signals to the peripherals, or receive service requests.

The basic system is a complete microcomputer, which can be used for a large variety of applications. It is simple but versatile. It can be easily reprogrammed by changing the ROM or using the eraseable PROM instead. The user must provide only the two-phase clock signal source, a power-up/restart circuit, and a single +5V power supply to complete the hardware.

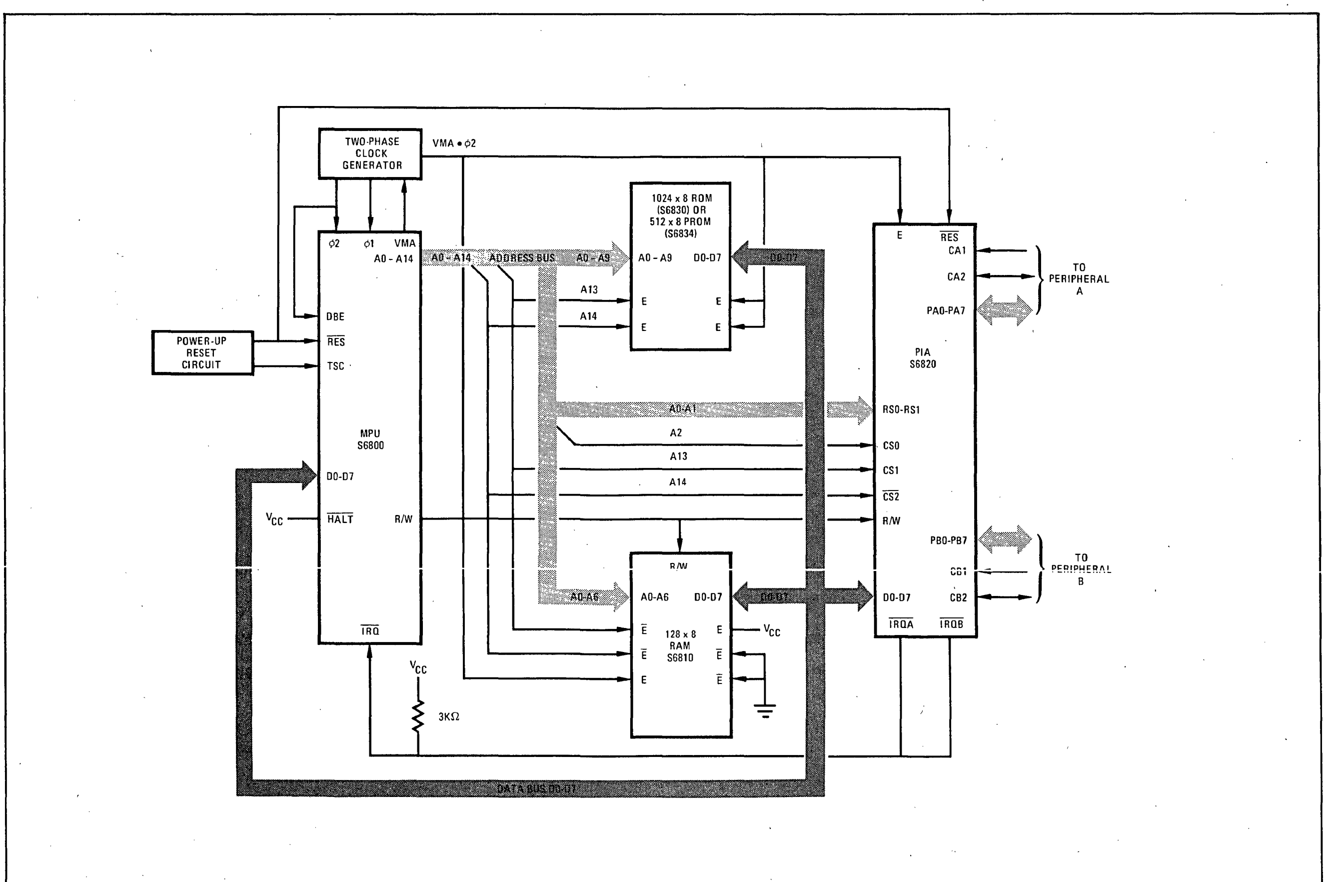
AN S6800 SYSTEM EXPANDS GRACEFULLY

The S6800 Microcomputer Family is easy to expand. It has every one of the basic types of memories – RAM, ROM, and PROM – and all essential forms of interfaces for digital telecommunication and peripherals – serial, parallel, asynchronous, and synchronous. System memory is easy to expand because multiple addressing modes of the MPU make memory access fast and efficient; all I/O devices are designed for operational flexibility and efficiency in MPU cycle utilization. Memory, I/O, and other devices in the S6800 family are all compatible in load levels and the entire system can run on one common clock. Consequently, you often can eliminate all circuit design, save for the simple clock and power-up/restart circuits.

In general, the system can be expanded in a modular manner, by simply connecting onto the bus the required devices. These can be any combination of memory and input/output circuits. In this modular manner a system of nearly any complexity and configuration can be assembled. Because you are designing with a small number of integrated circuits, your circuit layout task is simple and the entire microcomputer can be located on a single circuit card. (Systems with more than ten devices on the bus require the addition of address and data bus buffers to operate at full speed).

In some special purpose applications you may need to attach your own interface devices to the bus. As a result, more circuit design will be required, but you will find the S6800 MPU easy to work with. It has features that allow it to be used in many different modes of operation and in various systems. For example, by using the Halt, Three State Control, and Data Bus Enable lines you can easily design a direct memory access system, in which either the MPU or a peripheral device can read or write into the RAM and utilize the bus on a priority basis. You can also design a multiprocessor system, in which several MPUs are attached to the same bus and share processing assignments, as well as memory space.

FIGURE 1 BASIC S6800 MICROCOMPUTER SYSTEM



S6800 INPUT/OUTPUT

One other important advantage that S6800 has to offer in comparison with any other microcomputer system is input/output versatility. In any computer system, large or small, the CPU internal functions are determined by its architecture and the user usually has little opportunity or need to alter them. On the other hand, the I/O configuration is almost always determined by the user and subject to change as peripherals are added or other system alterations are introduced. The I/O configuration is important to the user because it affects the efficiency of the CPU itself, determines the ease and speed with which peripherals can interact with the system and determines the thruput rate of the system.

Therefore, the efficiency and versatility with which a CPU can handle its I/O – both in hardware and software – is an important criteria and of particular concern to the user. It is in this area that the S6800 MPU excels.

- In an S6800 system, the MPU relegates most of the I/O control to such I/O interfaces as the PIA or ACIA. Each of these circuits is programmable and can interface with peripheral devices without directly involving the MPU. For example, the MPU can preprogram a PIA to either input data into the MPU or to receive it. Thereafter, the PIA circuits assume all functions of interfacing with the peripherals and the MPU never has to look at the interface until service is required. It must service interrupts from the PIA, but never needs to wait for input data to become available or for output data to be accepted. This relieves the MPU of its I/O functions, makes it more efficient in its primary task of data processing, and significantly increases system thruput.

- The I/O interfaces and memory are both located in the same address space within the S6800 system. The MPU can access any I/O device the same as a memory location – with address lines, instead of separate I/O control lines. Therefore, it can manipulate data in the I/O interface registers with the same programmed instructions as it uses for memory locations. This adds programming flexibility and increases system efficiency.

- The S6800 Instruction Set complements the above I/O addressing capability with specific instructions that can be used to access memory as well as I/O circuit registers and perform directly various manipulations on the data.

S6800 INSTRUCTION SET

The S6800 MPU has a set of 72 basic instructions. These include binary and decimal arithmetic functions, as well as logical, shift, rotate, load, store, branch, interrupt, and stack manipulation functions. Most of the instructions have several variations and most can be used with several memory addressing modes. Thus, the total complex of instructions available to the programmer actually is 197.

An instruction can be from one to three bytes long, depending on the addressing mode used with the instruction. In single byte instructions no memory address is required because the operation is performed on one of the internal MPU registers. In multiple byte instructions the second and third byte can be the operand, or a memory address for the operand.

A noteworthy feature of the S6800 MPU is that some of the instructions can operate directly on any memory location. In most computer systems it is common that the processor fetches an operand from memory, stores it in the accumulator, then executes the operation in the ALU, and finally writes the result back into the memory. The S6800 is able to accomplish the same with only a single instruction, because it operates with any external location in the same manner as with an internal register. For example, it can directly increment or decrement the contents of a memory location. Because the MPU addresses I/O devices just like a memory location, it can do the same with registers inside the PIA or ACIA.

HARDWARE/SOFTWARE SUPPORT.

The S6800 Microcomputer Family hardware is completely supported by an array of application program development software, various levels of hardware and software reference documentation, a software development station, and a hardware prototyping evaluation board. These comprehensive software and hardware aids have many advanced timesaving features that make the S6800 software/hardware support structure the most modern and convenient.

The program development software includes an Assembler, a Linking-Loader, and a Simulator program, all of which are suitable for direct implementation on large-scale computer systems and also are available through several timesharing networks. The reference documention consists of

- The S6800 Microprocessor Brochure
- The Software Data Brochure
- Assembly Language Programming Manual
- Hardware Reference Manual
- Other Application and User Information

The software development station is a complete self-contained S6800 microcomputer/keyboard/CRT, with a separate floppy disc memory. Together, they provide the user with a complete, convenient, and economical program development facility. The disc memory contains the Resident Assembler and also has space for storage of programs in development, or other data.

The prototyping evaluation board is a fully functional microcomputer, with the MPU, ROM, RAM, and PROM memory, as well as several I/O provisions on the board. The S6800 bus extends to the edge connector, so that any amount of external I/O can be connected also. It has a resident operating system program stored in ROM and all PROM programming hardware is right on the board. This board can be used for circuit evaluation, PROM programming, or as a microprocessor board in low quantity systems.

Cross-Assembler. The AMI 6800 Cross-Assembler is designed to operate on large-scale computers and converts S6800 Assembly Language input statements into machine language for the purpose of generating application programs. It defines the form and syntax according to which the S6800 instruction set can be structured into statements and thus forms the backbone for the usage of the S6800 Microcomputer System. The Cross-Assembler contains many advanced programming features for convenience and efficiency.

- Local Labels – a directive which permits symbol definition within a local region. Since the symbol is only referenced within that region, the same symbol can be reused in a different local region.
- Full Macro Capability – a sequence of instructions and associated variable parameters can be designated by a symbolic label. The assembler will substitute the complete sequence for the label, wherever the label is called out.
- Conditional Assembly – when parts of a program are the same for different versions of the program, the conditional assembly feature can be used to instruct the assembler to automatically include only those parts needed for a particular version of the program.

  Symbolic Expressions – symbolic labels can be used for memory locations as well as for program constants, thus generally simplifying the programmers task.

  Relocatable Program Segments – the object code within a program segment is always defined with respect to the start of the segment, thus allowing the Linking Loader to assign actual memory addresses later. This gives maximum flexibility in final assembly.
- Formatted Listings – assembly listings are formatted into 11-inch pages, with a two line header identifying the page number, date and time of assembly, program name, and column labels for the assembly printout.

The Cross-Assembler is available for computers supporting standard ANSI FORTRAN IV. For low-cost, high-speed program development, it is also written in SYSTEM 360/370 BAL and is available through timesharing networks, such as National CSS, Inc.

Linking Loader. – The Linking Loader is a program used to assign fixed memory locations to programs generated by the Cross-Assembler and thus structure the users program for a particular memory configuration. The Linking Loader is programmed to operate on the same (large-scale) computer as the Cross-Assembler and is also available on timesharing networks (NCSS and others). It can be used to produce a listing of the external definitions and load map, and a program tape suitable for a prototype system hexadecimal loader or a PROM programmer. Alternatively, it can also generate memory image file for use by the AMI S6800 Simulator program described below.

Simulator. – The AMI S6800 Simulator program is a means by which the user can conveniently check out the operation of programs written for the S6800. It is a program that can be operated on a cross-computer (other than S6800) and cause that computer to respond the same as a S6800 would.

The simulator simulates all S6800 Microprocessor hardware. A complete set of commands is provided for loading and examining the simulated registers and memory, and for controlling the simulator.

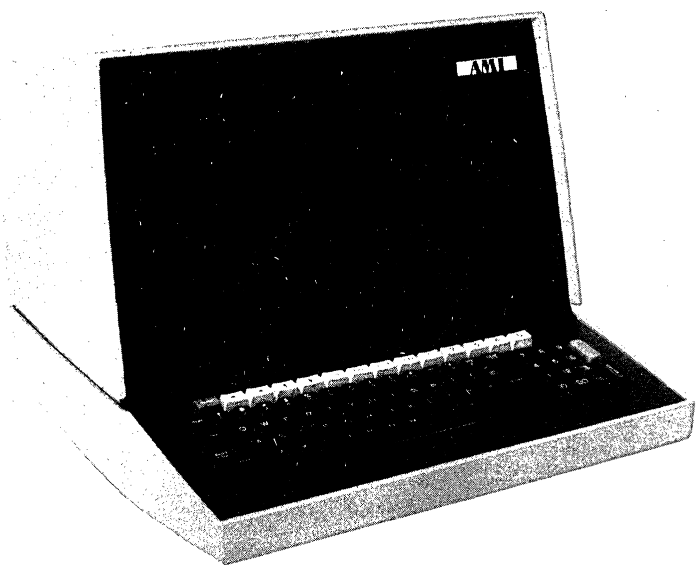
Hardware/Software Development Station

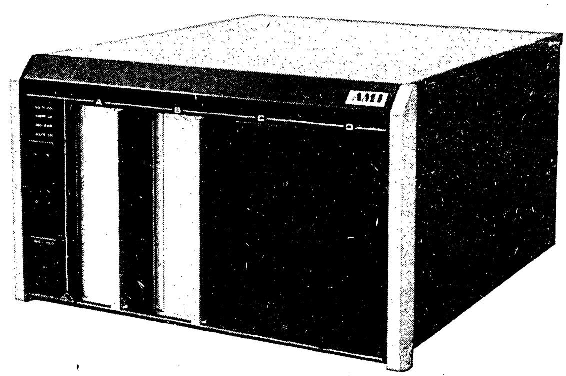
Basic Features

- Resident Assembler Software
- Floppy Disk Operating System
- Resident Debug Software
- 8K Bytes of User RAM
- RS-232 Interface
- System I/O Assigned to Upper Memory Locations
- Full ASCII Keyboard
- 25 x 80 Character CRT Display

Options

- Memory Expandable to 56K Bytes
- Additional PCB Positions Available for Customer Designed Interfaces
- In-circuit Emulation for Hardware Debugging
- PROM Programming Capability





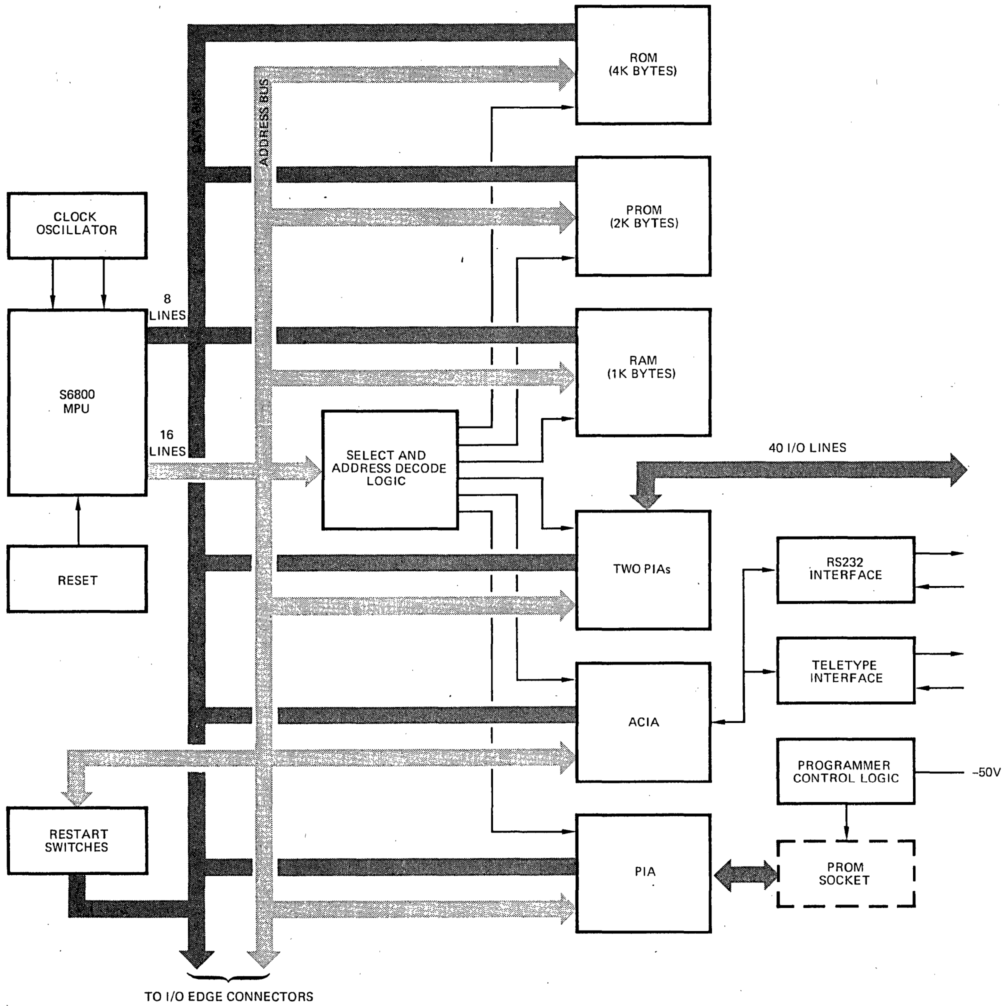
The Hardware/Software Development Station is an intelligent CRT Terminal with the required software and memory space to enable you to develop, debug, and operate S6800 application programs. The CRT/Keyboard terminal contains an S6800 microcomputer, RAM, ROM and PROM memory, as well as interface circuits. The dual floppy disk stores the Basic Operating System, a Resident Assembler, and any other optional system software. It provides over 500K bytes of on-line memory, of which the basic system software takes up less than 25K bytes.

The Hardware/Software Development Station lets you enter source statements on the keyboard, debug your program while viewing it on the CRT, and store the final edited assembled version on the removable diskette.

Alternatively, you can use the CRT Terminal by itself to develop your program on a timeshared computer, then store segments of it in RAM, and debug off line.

Prototyping Evaluation Board

A complete S6800 Microcomputer System on one circuit board – with maximum operational flexibility, to make your hardware development easy.



Hardware Features

- CPU Fully Buffered
- Variable Frequency Clock (can also be locked to 1 MHz)
- On-board PROM Programmer
- Provisions for:
  4K bytes of ROM
  2K bytes of PROM
  1K bytes of RAM
- Two User Available PIAs
- Current-loop or RS-232 TTY Interfaces (50 to 19.2K Baud)
- Switch-changeable Restart Vector
- Three Types of DMA Available

Resident Software

- Load Memory
- Display Memory
- Display MPU Registers
- Move Memory
- Read ROM or PROM
- Program PROM
- Verify PROM
- RS^3 Subroutine Library
- Punch Tape
- Start Execution from Any Location

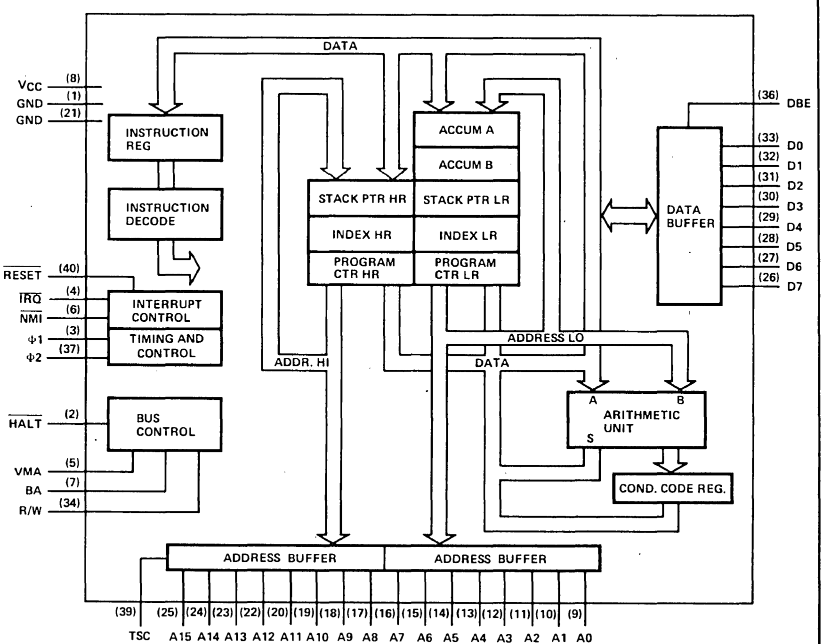
AMI

AMERICAN MICROSYSTEMS, INC.

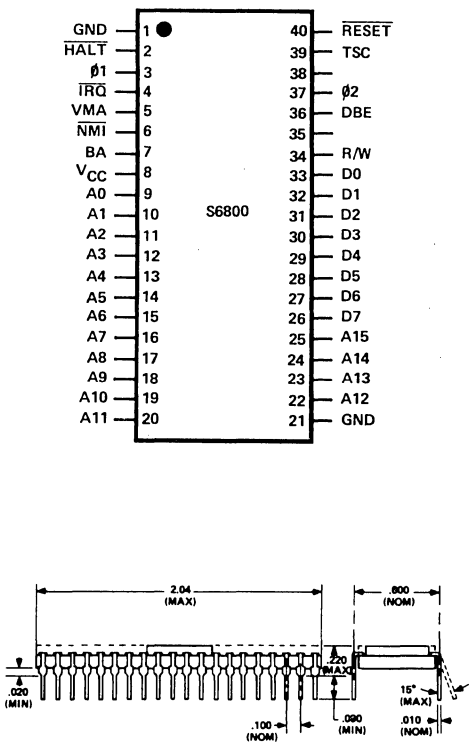
S6800

8-BIT
MICROPROCESSOR

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Eight-Bit Parallel Processing
- Bi-Directional Data Bus
- Sixteen-Bit Address Bus – 65536 Bytes of Addressing
- 72 Instructions – Variable Length
- Seven Addressing Modes – Direct, Relative, Immediate, Indexed, Extended, Implied and Accumulator
- Variable Length Stack
- Vectored Restart
- 2 Microsecond Instruction Execution
- Maskable Interrupt Vector
- Separate Non-Maskable Interrupt – Internal Registers Saved in Stack
- Six Internal Registers – Two Accumulators, Index Register, Program Counter, Stack Pointer and Condition Code Register
- Direct Memory Access (DMA) and Multiple Processor Capability
- Clock Rates as High as 1 MHz
- Simple Bus Interface Without TTL
- Halt and Single Instruction Execution Capability

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	–0.3 to +7.0V
Input Voltage V_{in}	–0.3 to +7.0V
Operating Temperature Range T_A	0 to +70°C
Storage Temperature Range T_{stg}	–55 to +150°C

DC (STATIC) CHARACTERISTICS

(V_{CC} = 5.0 V ± 5%, T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min.	Typ.	Max.	Unit
Input High Voltage (Normal Operating Levels)	Logic	V_{IH}	+ 2.4	–	V_{CC}	Vdc
	$\phi1,\phi2$	V_{IHC}	V_{CC} –0.3	–	V_{CC} +0.1	
Input Low Voltage (Normal Operating Levels)	Logic	V_{IL}	–0.3	–	+ 0.4	Vdc
	$\phi1,\phi2$	V_{ILC}	–0.1	–	+0.3	
Clock Overshoot/Undershoot – Input High Level		V_{OS}	V_{CC} –0.5	–	V_{CC} +0.5	Vdc
– Input Low Level			–0.5	–	+0.5	
Input High Threshold Voltage	$\overline{Reset}$, $\overline{NMI}$, $\overline{Halt}$, $\overline{IRQ}$, Data	V_{IHT}	+ 2.0	–	–	Vdc
Input Low Threshold Voltage	$\overline{Reset}$, $\overline{NMI}$, $\overline{Halt}$, $\overline{IRQ}$, Data	V_{ILT}	–	–	+ 0.8	Vdc
Input Leakage Current (V_{in} = 0 to 5.25 V, V_{CC} = 5.25V)	Logic*	I_{in}	–	–	2.5	μAdc
	$\phi1,\phi2$		–	–	100	
Three-State (Off State) Input Current (V_{in} = 0.4 to 2.4 V, V_{CC} = max)	Data	I_{TSI}	–	–	10	μAdc
	A0-A15, R/W		–	–	100	
Output High Voltage (I_{Load} = –100 μAdc, V_{CC} = min)		V_{OH}	+ 2.4	–	–	Vdc
Output Low Voltage (I_{Load} = 1.6 mAdc, V_{CC} = min)		V_{OL}	–	–	+ 0.4	Vdc
Power Dissipation		P_D	–	0.600	1.2	W
Capacitance** (V_{in} = 0, T_A = 25°C, f = 1.0 MHz)	Logic	C_{in}	–	–	10	pF
	Data, TSC		–	–	15	
	$\phi1,\phi2$		80	120	160	
	A0-A15, R/W	C_{out}	–	–	12	pF

*Except IRQ and NMI, which require 3 kΩ pullup load resistors for wire-OR capability at optimum operation.
**Capacitances are periodically sampled rather than 100% tested.

AC (DYNAMIC) CHARACTERISTICS

(V_{CC} = 5.0 volt ± 5%, T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min.	Typ	Max.	Unit
Frequency of Operation	f	0.1	–	1.0	MHz
Clock Timing for 1-MHz Operation (Figure 1) (C_{clock} = 200 pF) Cycle Time	t_{cyc}	1.0	–	10	μs
Clock Pulse Width (Measured at V_{CC} –0.3 V) φ1	$PW_{\phi H}$	430	–	4500	ns
φ2		450	–	4500	
Total φ1 and φ2 UP Time	t_{ut}	940	–	–	ns
Rise and Fall Times φ1,φ2 (Measured between 0.3 V and V_{CC} –0.3 V)	t_r, t_f	5.0	–	50	ns
Delay Time or Clock Overlap (Measured at 0.5 V)	t_d	0	–	9100	ns
Overshoot/Undershoot Duration	t_{os}	0	–	40	ns

READ/WRITE TIMING

Figures 2 and 3, f = 1.0 MHz, Loading = 130 pF and one TTL Load except VMA and BA Loading = 30 pF and one

Characteristic	Symbol	Min.	Typ	Max.	Unit
Read/Write Setup Time from MPU	T_{ASR}	–	100	300	ns
Address Setup Time from MPU	T_{ASC}	–	200	300	ns
Memory Read Access Time $t_{cyc} - (T_{ASC} + T_{DSU} + t_r)$	T_{ACC}	–	–	575	ns
Data Setup Time	T_{DSU}	100	–	–	ns
Address Setup Time from MPU for VMA	T_{VSC}	–	150	300	ns
Data Hold Time	T_H	10	30	–	ns
Enable High Time for DBE Input	T_{EH}	470	–	–	ns
Data Setup Time from MPU	T_{ASD}	–	150	200	ns

FIGURE 1 – CLOCK TIMING WAVEFORM

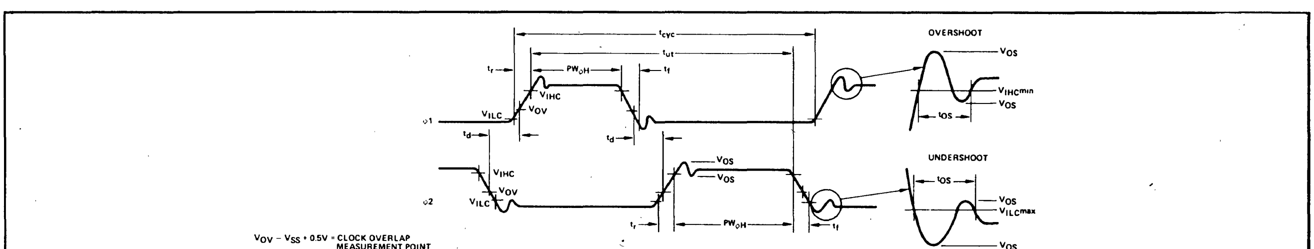


FIGURE 2 – READ DATA FROM MEMORY OR PERIPHERALS

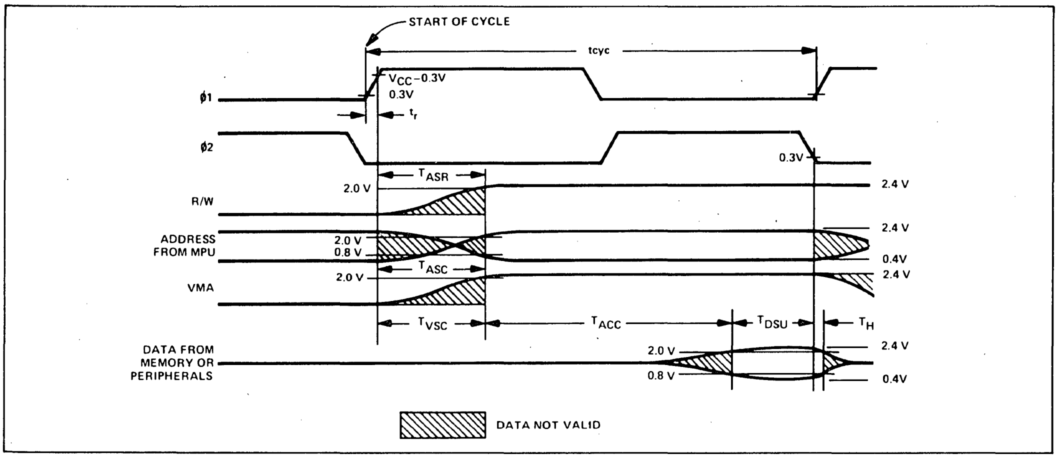
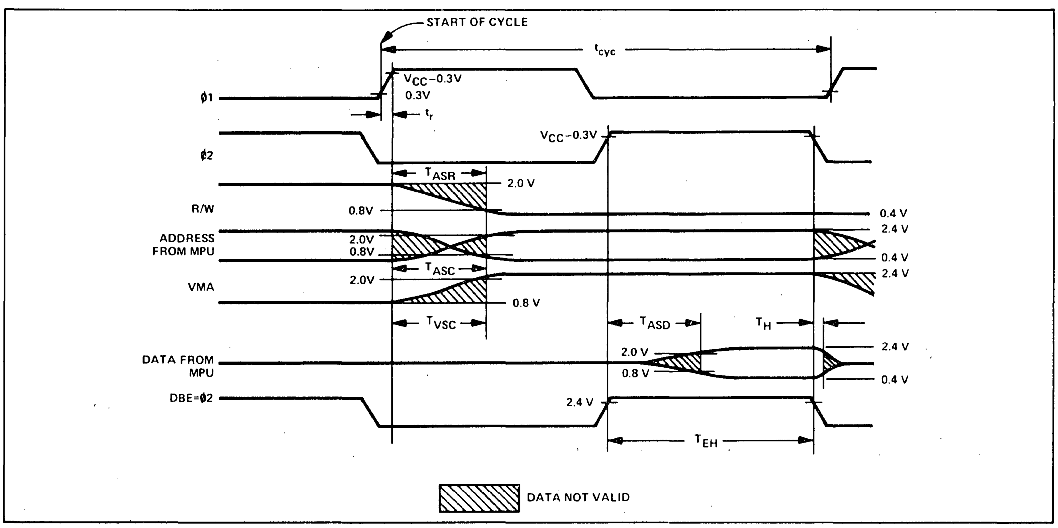


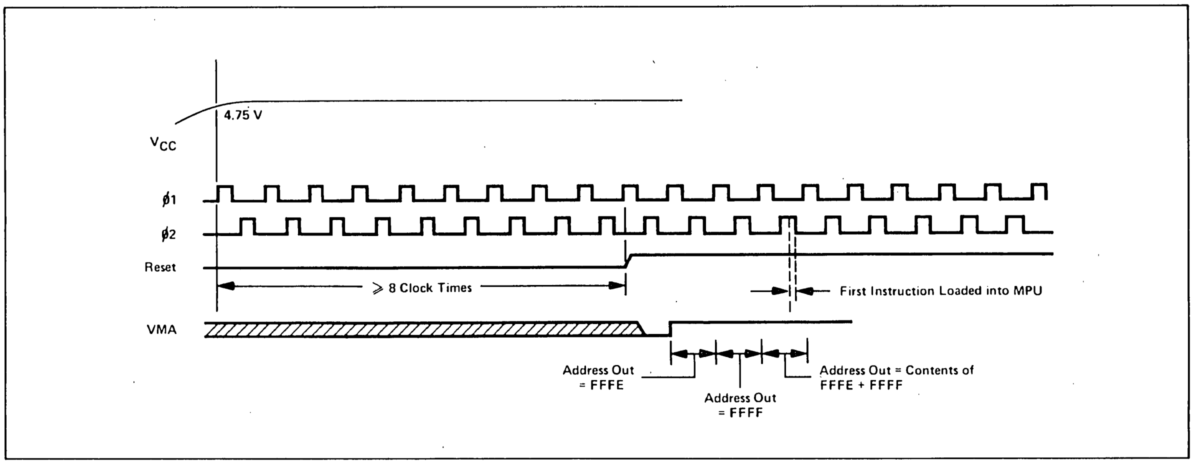
FIGURE 3 – WRITE DATA IN MEMORY OR PERIPHERALS



INTERFACE DESCRIPTION

Pin	Label	Function
ϕ1 ϕ2	(3) (37)	**Clocks Phase One and Phase Two** – Two pins are used for a two-phase non-overlapping clock that runs at the V_{CC} voltage level.
$\overline{\text{RESET}}$	(40)	**$\overline{\text{Reset}}$** – This input is used to reset and start the MPU from a power down condition, resulting from a power failure or an initial start-up of the processor. If a positive edge is detected on the input, this will signal the MPU to begin the restart sequence. This will start execution of a routine to initialize the processor from its reset condition. All the higher order address lines will be forced high. For the restart, the last two (FFFE, FFFF) locations in memory will be used to load the program that is addressed by the program counter. During the restart routine, the interrupt mask bit is set and must be reset before the MPU can be interrupted by $\overline{\text{IRQ}}$. $\overline{\text{Reset}}$ must be held low for at least eight clock periods after V_{CC} reaches 4.75 volts (Figure 4). If $\overline{\text{Reset}}$ goes high prior to the leading edge of ϕ2, on the next ϕ1 the first restart memory vector address (FFFE) will appear on the address lines. This location should contain the higher order eight bits to be stored into the program counter. Following, the next address FFFF should contain the lower order eight bits to be stored into the program counter.

FIGURE 4 INITIALIZATION OF MPU AFTER RESTART



INTERFACE DESCRIPTION (CONT'D)

Pin	Label	Function
VMA	(5)	**Valid Memory Address** – This output indicates to peripheral devices that there is a valid address on the address bus. In normal operation, this signal should be utilized for enabling peripheral interfaces such as the PIA and ACIA. This signal is not three-state. One standard TTL load and 30 pF may be directly driven by this active high signal.
A0 • • • A15	(9) (25)	**Address Bus** – Sixteen pins are used for the address bus. The outputs are three-state bus drivers capable of driving one standard TTL load and 130 pF. When the output is turned off, it is essentially an open circuit. This permits the MPU to be used in DMA applications.
TSC	(39)	**Three-State Control** – This input causes all of the address lines and the Read/Write line to go into the off or high impedance state. This state will occur 500 ns after TSC = 2.4 V. The Valid Memory Address and Bus Available signals will be forced low. The data bus is not affected by TSC and has its own enable (Data Bus Enable). In DMA applications, the Three-State Control line should be brought high on the leading edge of the Phase One Clock. The $\phi1$ clock must be held in the high state and the $\phi2$ in the low state for this function to operate properly. The address bus will then be available for other devices to directly address memory. Since the MPU is a dynamic device, it can be held in this state for only 5.0 μs or destruction of data will occur in the MPU.
D0 • • D7	(33) (26)	**Data Bus** – Eight pins are used for the data bus. It is bi-directional, transferring data to and from the memory and peripheral devices. It also has three-state output buffers capable of driving one standard TTL load at 130 pF.
DBE	(36)	**Data Bus Enable** – This input is the three-state control signal for the MPU data bus and will enable the bus drivers when in the high state. This input is TTL compatible; however in normal operation, it can be driven by the phase two clock. During an MPU read cycle, the data bus drivers will be disabled internally. When it is desired that another device control the data bus such as in Direct Memory Access (DMA) applications, DBE should be held low.
R/W	(34)	**Read/Write** – This TTL compatible output signals the peripherals and memory devices whether the MPU is in a Read (high) or Write (low) state. The normal standby state of this signal is Read (high). Three-State Control going high will turn Read/Write to the off (high-impedance) state. Also, when the processor is halted, it will be in the off state. This output is capable of driving one standard TTL load and 130 pF.

INTERFACE DESCRIPTION (CONT'D)

Pin	Label	Function
$\overline{\text{HALT}}$	(2)	**$\overline{\text{Halt}}$** – When this input is in the low state, all activity in the machine will be halted. This input is level sensitive. In the halt mode, the machine will stop at the end of an instruction, Bus Available will be at a one level, Valid Memory Address will be at a zero, and all other three-state lines will be in the three-state mode. Transition of the $\overline{\text{Halt}}$ line must not occur during the last 250 ns of phase one. To insure single instruction operation, the $\overline{\text{Halt}}$ line must go high for one Phase One Clock cycle.
BA	(7)	**Bus Available** – The Bus Available signal will normally be in the low state; when activated, it will go to the high state indicating that the microprocessor has stopped and that the address bus is available. This will occur if the $\overline{\text{Halt}}$ line is in the low state or the processor is in the WAIT state as a result of the execution of a WAIT instruction. At such time, all three-state output drivers will go to their off state and other outputs to their normally inactive level. The processor is removed from the WAIT state by the occurrence of a maskable (mask bit I = 0)or nonmaskable interrupt. This output is capable of driving one standard TTL load and 30 pF.
$\overline{\text{IRQ}}$	(4)	**$\overline{\text{Interrupt Request}}$** – This level sensitive input requests that an interrupt sequence be generated within the machine. The processor will wait until it completes the current instruction that is being executed before it recognizes the request. At that time, if the interrupt mask bit in the Condition Code Register is not set, the machine will begin an interrupt sequence. The Index Register, Program Counter, Accumulators, and Condition Code Register are stored away on the stack. Next the MPU will respond to the interrupt request by setting the interrupt mask bit high so that no further interrupts may occur. At the end of the cycle, a 16-bit address will be loaded that points to a vectoring address which is located in memory locations FFF8 and FFF9. An address loaded at these locations causes the MPU to branch to an interrupt routine in memory. The $\overline{\text{Halt}}$ line must be in the high state for interrupts to be recognized. The $\overline{\text{IRQ}}$ has a high impedance pullup device internal to the chip; however a 3 kΩ external resistor to V_{CC} should be used for wire-OR and optimum control of interrupts.
$\overline{\text{NMI}}$	(6)	**$\overline{\text{Non-Maskable Interrupt}}$** – A low-going edge on this input requests that a non-mask interrupt sequence be generated within the processor. As with the $\overline{\text{Interrupt Request}}$ signal, the processor will complete the current instruction that is being executed before it recognizes the $\overline{\text{NMI}}$ signal. The interrupt mask bit in the Condition Code Register has no effect on $\overline{\text{NMI}}$. The Index Register, Program Counter, Accumulators, and Condition Code Register are stored away in the stack. At the end of the cycle, a 16-bit address will be loaded that points to a vectoring address which is located in memory locations FFFC and FFFD. An address loaded at these locations causes the MPU to branch to a non-maskable interrupt routine in memory. $\overline{\text{NMI}}$ has a high impedance pullup resistor internal to the chip; however a 3 kΩ external resistor to V_{CC} should be used for wire-OR and optimum control of interrupts.

Inputs $\overline{\text{IRQ}}$ and $\overline{\text{NMI}}$ are hardware interrupt lines that are acknowledged during $\phi 2$ and will start the interrupt routine on the $\phi 1$ following the completion of an instruction.

INTERRUPTS – As outlined in the interface description the S6800 requires a 16-bit vector address to indicate the location of routines for Restart, Non-maskable Interrupt, and Maskable Interrupt. Additionally an address is required for the Software Interrupt Instruction (SWI). The processor assumes the uppermost eight memory locations, FFF8 – FFFF, are assigned as interrupt vector addresses as defined in Figure 5.

After completing the current instruction execution the processor checks for an allowable interrupt request via the $\overline{\text{IRQ}}$ or $\overline{\text{NMI}}$ inputs as shown by the simplified flow chart in Figure 6. Recognition of either external interrupt request or a Wait for Interrupt (WAI) or Software Interrupt (SWI) instruction causes the contents of the Index Register, Program Counter, Accumulators and Condition Code Register to be transferred to the stack as shown in Figure 7.

FIGURE 5 MEMORY MAP FOR INTERRUPT VECTORS

Vector MS	Vector LS	Description
FFFE	FFFF	Restart
FFFC	FFFD	Non-maskable Interrupt
FFFA	FFFB	Software Interrupt
FFF8	FFF9	Interrupt Request

FIGURE 6 – MPU FLOW CHART

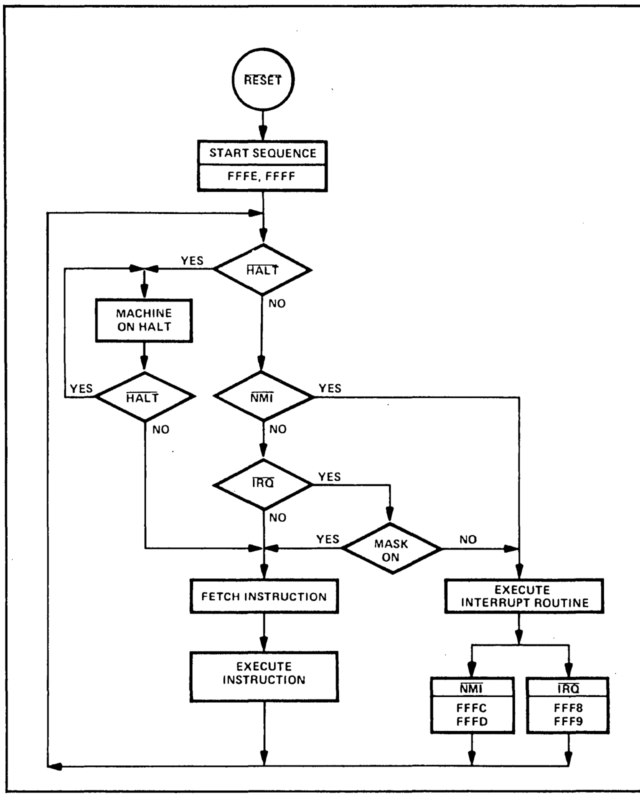
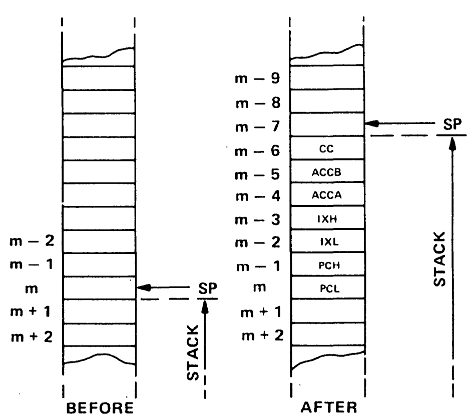
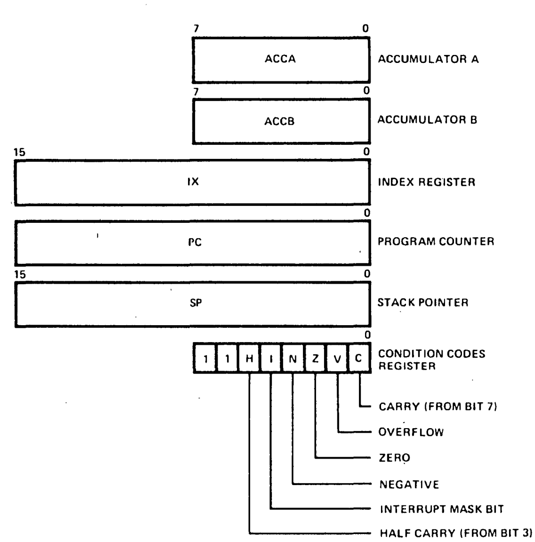


FIGURE 7 – SAVING THE STATUS OF THE MICROPROCESSOR IN THE STACK



SP = Stack Pointer
CC = Condition Codes
Also called the Processor Status Byte)
ACCB = Accumulator B
ACCA = Accumulator A
IXH = Index Register, Higher Order 8 Bits
IXL = Index Register, Lower Order 8 Bits
PCH = Program Counter, Higher Order 8 Bits
PCL = Program Counter, Lower Order 8 Bits

FIGURE 8 – PROGRAMMING MODEL OF THE MICROPROCESSOR



MPU REGISTERS

The MPU has three 16-bit registers and three 8-bit registers available for use by the programmer.

Program Counter – The program counter is a two byte (16-bits) register that points to the current program address.

Stack Pointer – The stack pointer is a two byte register that contains the address of the next available location in an external push-down/pop-up stack. This stack is normally a random access Read/Write memory that may have any location (address) that is convenient. In those applications that require storage of information in the stack when power is lost, the stack must be non-volatile.

Index Register – The index register is a two byte register that is used to store data or a sixteen bit memory address for the Indexed mode of memory addressing.

Accumulators – The MPU contains two 8-bit accumulators that are used to hold operands and results from the arithmetic logic unit (ALU).

Condition Code Register – The condition code register indicates the results of an Arithmetic Logic Unit operation: Negative (N), Zero (Z), Overflow (V), Carry from bit 7 (C), and half carry from bit 3 (H). These bits of the Condition Code Register are used as testable conditions for the conditional branch instructions. Bit 4 is the interrupt mask bit (I). The unused bits of the Condition Code Register (b6 and b7) are ones.

MPU ADDRESSING MODES

The S6800 eight-bit microprocessing unit has seven address modes that can be used by a programmer, with the addressing mode a function of both the type of instruction and the coding within the instruction. A summary of the addressing modes for a particular instruction can be found in Figure 9 along with the associated instruction execution time that is given in machine cycles. With a clock frequency of 1 MHz, these times would be microseconds.

ACCUMULATOR ADDRESSING (ACCX)

OP CODE

A single byte instruction addressing operands only in accumulator A or accumulator B.

IMPLIED ADDRESSING

OP CODE

Single byte instruction where the operand address is implied by the instruction definition (i.e., Stack Pointer, Index Register or Condition Register).

IMMEDIATE ADDRESSING

OP CODE	IMMEDIATE OPERAND

HIGHER	IMMEDIATE OPERAND	IMMEDIATE OPERAND LOWER

Two or three byte instructions with an eight or sixteen bit operand respectively. For accumulator operations the eight bit operand is contained in the second byte of a two byte instruction. For Index Register operations (e.g. LDX) sixteen bit operand is contained in the second and third byte of a three byte instruction.

DIRECT ADDRESSING

OP CODE	ADDRESS 0-255

Two byte instructions with the address of the operand contained in the second byte of the instruction. This format allows direct addressing of operands within the first 256 memory locations.

EXTENDED ADDRESSING

OP CODE	ADDRESS HIGHER	ADDRESS LOWER

Three byte instructions with the higher eight bits of the operand address contained in the second byte and the lower eight bits of address contained in the third byte of the instruction. This format allows direct addressing of all 65,536 memory locations.

INDEXED ADDRESSING

OP CODE	INDEX ADDRESS

Two byte instructions where the 8 bit unsigned address contained in the second byte of the instruction is added to the sixteen bit Index Register resulting in a sixteen bit effective address. The effective address is stored in a temporary register and the contents of the Index Register are unchanged.

RELATIVE ADDRESSING

OP CODE	RELATIVE ADDRESS

Two byte instructions where the relative address contained in the second byte of the instruction is added to the sixteen bit program counter plus two. The relative address is interpreted as a two's complement number allowing relative addressing within a range of −125 to +129 bytes of the present instruction.

FIGURE 9 – S6800 INSTRUCTION SET

Instruction	Mnemonic	Implied (OP MC PB)	Immediate (OP MC PB)	Direct (OP MC PB)	Extended (OP MC PB)	Indexed (OP MC PB)	Relative (OP MC PB)	Boolean/Arith Operation	H (5)	I (4)	N (3)	Z (2)	V (1)	C (0)
Load accumulator	LDAA		86 2 2	96 3 2	B6 4 3	A6 5 2		M → A	●	●	↕	↕	R	●
	LDAB		C6 2 2	D6 3 2	F6 4 3	E6 5 2		M → B	●	●	↕	↕	R	●
Load stack pointer	LDS		8E 3 3	9E 4 2	BE 5 3	AE 6 2		$M \to SP_H, (M+1) \to SP_L$	●	●	9	↕	R	●
Load index register	LDX		CE 3 3	DE 4 2	FE 5 3	EE 6 2		$M \to X_H, (M+1) \to X_L$	●	●	9	↕	R	●
Store accumulator	STAA			97 4 2	B7 5 3	A7 6 2		A → M	●	●	↕	↕	R	●
	STAB			D7 4 2	F7 5 3	E7 6 2		B → M	●	●	↕	↕	R	●
Store stack pointer	STS			9F 5 2	BF 6 3	AF 7 2		$SP_H \to M, SP_L \to (M+1)$	●	●	9	↕	R	●
Store index register	STX			DF 5 2	FF 6 3	EF 7 2		$X_H \to M, X_L \to (M+1)$	●	●	9	↕	R	●
Transfer accumulators	TAB	16 2 1						A → B	●	●	↕	↕	R	●
	TBA	17 2 1						B → A	●	●	↕	↕	R	●
Transfer Acc. to cond. reg.	TAP	06 2 1						A → CCR	Note 12					
Transfer cond. reg. to Acc.	TPA	07 2 1						CCR → A	●	●	●	●	●	●
Transfer stck ptr to index	TSX	30 4 1						SP + 1 → X	●	●	●	●	●	●
Transfer index to stck ptr	TXS	35 4 1						X – 1 → SP	●	●	●	●	●	●
Pull data	PULA	32 4 1						$SP + 1 \to SP, M_{SP} \to A$	●	●	●	●	●	●
	PULB	33 4 1						$SP + 1 \to SP, M_{SP} \to B$	●	●	●	●	●	●
Push data	PSHA	36 4 1						$A \to M_{SP}, SP - 1 \to SP$	●	●	●	●	●	●
	PSHB	37 4 1						$B \to M_{SP}, SP - 1 \to SP$	●	●	●	●	●	●
Add accumulators	ABA	1B 2 1						A + B → A	↕	●	↕	↕	↕	↕
Add	ADDA		8B 2 2	9B 3 2	BB 4 3	AB 5 2		A + M → A	↕	●	↕	↕	↕	↕
	ADDB		CB 2 2	DB 3 2	FB 4 3	EB 5 2		B + M → B	↕	●	↕	↕	↕	↕
Add with carry	ADCA		89 2 2	99 3 2	B9 4 3	A9 5 2		A + M + C → A	↕	●	↕	↕	↕	↕
	ADCB		C9 2 2	D9 3 2	F9 4 3	E9 5 2		B + M + C → B	↕	●	↕	↕	↕	↕
Subtract accumulators	SBA	10 2 1						A – B → A	●	●	↕	↕	↕	↕
Subtract	SUBA		80 2 2	90 3 2	B0 4 3	A0 5 2		A – M → A	●	●	↕	↕	↕	↕
	SUBB		C0 2 2	D0 3 2	F0 4 3	E0 5 2		B – M → B	●	●	↕	↕	↕	↕
Subtract with carry	SBCA		82 2 2	92 3 2	B2 4 3	A2 5 2		A – M – C → A	●	●	↕	↕	↕	↕
	SBCB		C2 2 2	D2 3 2	F2 4 3	E2 5 2		B – M – C → B	●	●	↕	↕	↕	↕
Increment	INCA	4C 2 1						A + 1 → A	●	●	↕	↕	5	●
	INCB	5C 2 1						B + 1 → B	●	●	↕	↕	5	●
	INC				7C 6 3	6C 7 2		M + 1 → M	●	●	↕	↕	5	●
Increment stack pointer	INS	31 4 1						SP + 1 → SP	●	●	●	●	●	●
Increment index reg.	INX	08 4 1						X + 1 → X	●	●	●	↕	●	●
Decrement	DECA	4A 2 1						A – 1 → A	●	●	↕	↕	4	●
	DECB	5A 2 1						B – 1 → B	●	●	↕	↕	4	●
	DEC				7A 6 3	6A 7 2		M – 1 → M	●	●	↕	↕	4	●
Decrement stack pointer	DES	34 4 1						SP – 1 → SP	●	●	●	●	●	●
Decrement index register	DEX	09 4 1						X – 1 → X	●	●	●	↕	●	●
Complement (1's)	COMA	43 2 1						$\overline{A} \to A$	●	●	↕	↕	R	S
	COMB	53 2 1						$\overline{B} \to B$	●	●	↕	↕	R	S
	COM				73 6 3	63 7 2		$\overline{M} \to M$	●	●	↕	↕	R	S
Complement (2's)	NEGA	40 2 1						00 – A → A	●	●	↕	↕	1	2
	NEGB	50 2 1						00 – B → B	●	●	↕	↕	1	2
	NEG				70 6 3	60 7 2		00 – M → M	●	●	↕	↕	1	2
Decimal adjust accumulator	DAA	19 2 1							●	●	↕	↕	↕	3

OP = Operation Code MC = Number of MPU Cycles PB = Number of Program Bytes

FIGURE 9 S6800 INSTRUCTION SET (CONT'D)

Instruction	Mnemonic	Implied OP	Implied MC	Implied PB	Immediate OP	Immediate MC	Immediate PB	Direct OP	Direct MC	Direct PB	Extended OP	Extended MC	Extended PB	Indexed OP	Indexed MC	Indexed PB	Relative OP	Relative MC	Relative PB	Boolean/Arith Operation	H (5)	I (4)	N (3)	Z (2)	V (1)	C (0)
Logical and	ANDA				84	2	2	94	3	2	B4	4	3	A4	5	2				A • M → A	•	•	↕	↕	R	•
	ANDB				C4	2	2	D4	3	2	F4	4	3	E4	5	2				B • M → B	•	•	↕	↕	R	•
Inclusive or	ORAA				8A	2	2	9A	3	2	BA	4	3	AA	5	2				A + M → A	•	•	↕	↕	R	•
	ORAB				CA	2	2	DA	3	2	FA	4	3	EA	5	2				B + M → B	•	•	↕	↕	R	•
Exclusive or	EORA				88	2	2	98	3	2	B8	4	3	A8	5	2				A ⊕ M → A	•	•	↕	↕	R	•
	EORB				C8	2	2	D8	3	2	F8	4	3	E8	5	2				B ⊕ M → B	•	•	↕	↕	R	•
Shift left arithmetic	ASLA	48	2	1																A: C ← b7 … b0 ← 0	•	•	↕	↕	6	↕
	ASLB	58	2	1																B	•	•	↕	↕	6	↕
	ASL										78	6	3	68	7	2				M	•	•	↕	↕	6	↕
Shift right arithmetic	ASRA	47	2	1																A: b7 (retained) → b7 … b0 → C	•	•	↕	↕	6	↕
	ASRB	57	2	1																B	•	•	↕	↕	6	↕
	ASR										77	6	3	67	7	2				M	•	•	↕	↕	6	↕
Shift right logical	LSRA	44	2	1																A: 0 → b7 … b0 → C	•	•	R	↕	6	↕
	LSRB	54	2	1																B	•	•	R	↕	6	↕
	LSR										74	6	3	64	7	2				M	•	•	R	↕	6	↕
Rotate left	ROLA	49	2	1																A: C ← b7 ← b0 ← C	•	•	↕	↕	6	↕
	ROLB	59	2	1																B	•	•	↕	↕	6	↕
	ROL										79	6	3	69	7	2				M	•	•	↕	↕	6	↕
Rotate right	RORA	46	2	1																A: C → b7 → b0 → C	•	•	↕	↕	6	↕
	RORB	56	2	1																B	•	•	↕	↕	6	↕
	ROR										76	6	3	66	7	2				M	•	•	↕	↕	6	↕
Compare accumulators	CBA	11	2	1																A − B	•	•	↕	↕	↕	↕
Compare	CMPA				81	2	2	91	3	2	B1	4	3	A1	5	2				A − M	•	•	↕	↕	↕	↕
	CMPB				C1	2	2	D1	3	2	F1	4	3	E1	5	2				B − M	•	•	↕	↕	↕	↕
Compare index register	CPX				8C	3	3	9C	4	2	BC	5	3	AC	6	2				$X_H - M, X_L - (M+1)$	•	•	7	↕	8	•
Test (zero or minus)	TSTA	4D	2	1																A − 00	•	•	↕	↕	R	R
	TSTB	5D	2	1																B − 00	•	•	↕	↕	R	R
	TST										7D	6	3	6D	7	2				M − 00	•	•	↕	↕	R	R
Bit test	BITA				85	2	2	95	3	2	B5	4	3	A5	5	2				A • M	•	•	↕	↕	R	•
	BITB				C5	2	2	D5	3	2	F5	4	3	E5	5	2				B • M TEST	•	•	↕	↕	R	•
Branch	BRA																20	4	2		•	•	•	•	•	•
Branch if carry clear	BCC																24	4	2	C = 0	•	•	•	•	•	•
Branch if carry set	BCS																25	4	2	C = 1	•	•	•	•	•	•
Branch if overflow clear	BVC																28	4	2	V = 0	•	•	•	•	•	•
Branch if overflow set	BVS																29	4	2	V = 1	•	•	•	•	•	•
Branch if equal to zero	BEQ																27	4	2	Z = 1	•	•	•	•	•	•
Branch if greater or equal to zero	BGE																2C	4	2	N ⊕ V = 0	•	•	•	•	•	•
Branch if greater than zero	BGT																2E	4	2	Z + (N ⊕ V) = 0	•	•	•	•	•	•
Branch if less than zero	BLT																2D	4	2	N ⊕ V = 1	•	•	•	•	•	•
Branch if less than or equal to zero	BLE																2F	4	2	Z + (N ⊕ V) = 1	•	•	•	•	•	•
Branch if not equal to zero	BNE																26	4	2	Z = 0	•	•	•	•	•	•
Branch if minus	BMI																2B	4	2	N = 1	•	•	•	•	•	•
Branch if plus	BPL																2A	4	2	N = 0	•	•	•	•	•	•
Branch if higher	BHI																22	4	2	C + Z = 0	•	•	•	•	•	•
Branch if lower or same	BLS																23	4	2	C + Z = 1	•	•	•	•	•	•

OP = Operation Code   MC = Number of MPU Cycles   PB = Number of Program Bytes

FIGURE 9 S6800 INSTRUCTION SET (CONT'D)

		Addressing Modes																			Condition Reg.					
		Implied			Direct			Immediate			Extended			Indexed			Relative			Boolean/Arith	5	4	3	2	1	0
Instruction	Mnemonic	OP	MC	PB	OP	MC	PB	OP	MC	PB	OP	MC	PB	OP	MC	PB	OP	MC	PB	Operation	H	I	N	Z	V	C
Branch to subroutine	BSR																8D	8	2	See Special Operations	•	•	•	•	•	•
Jump to subroutine	JSR										BD	9	3	AD	8	2					•	•	•	•	•	•
Jump	JMP										7E	3	3	6E	4	2					•	•	•	•	•	•
Return from subroutine	RTS	39	5	1																	•	•	•	•	•	•
Return from interrupt	RTI	3B	10	1																	Note 10					
Software interrupt	SWI	3F	12	1																	•	S	•	•	•	•
Wait for interrupt	WAI	3E	9	1																	•	11	•	•	•	•
No operation	NOP	02	2	1																PC + 1 → PC	•	•	•	•	•	•
Clear	CLRA	4F	2	1																00 → A	•	•	R	S	R	R
	CLRB	5F	2	1																00 → B	•	•	R	S	R	R
	CLR										7F	6	3	6F	7	2				00 → M	•	•	R	S	R	R
Clear carry	CLC	0C	2	1																0 → C	•	•	•	•	•	R
Clear interrupt mask	CLI	0E	2	1																0 → I	•	R	•	•	•	•
Clear overflow	CLV	0A	2	1																0 → V	•	•	•	•	R	•
Set carry	SEC	0D	2	1																1 → C	•	•	•	•	•	S
Set interrupt mask	SEI	0F	2	1																1 → I	•	S	•	•	•	•
Set overflow	SEV	0B	2	1																1 → V	•	•	•	•	S	•

CONDITION CODE SYMBOLS:

- H Half-carry from bit 3;
- I Interrupt mask
- N Negative (sign bit)
- Z Zero (byte)
- V Overflow, 2's complement
- C Carry from bit 7
- R Reset Always
- S Set Always
- ↕ Test and set if true, cleared otherwise
- ∘ Not Affected

LEGEND:

- OP Operation Code (Hexadecimal):
- MC Number of MPU Cycles;
- PB Number of Program Bytes;
- + Arithmetic Plus;
- – Arithmetic Minus;
- ∘ Boolean AND;
- M_{SP} Contents of memory location pointed to by Stack Pointer;
- + Boolean Inclusive OR;
- ⊕ Boolean Exclusive OR;
- $\overline{M}$ Complement of M;
- → Transfer Into;
- 0 Bit = Zero;
- 00 Byte = Zero;

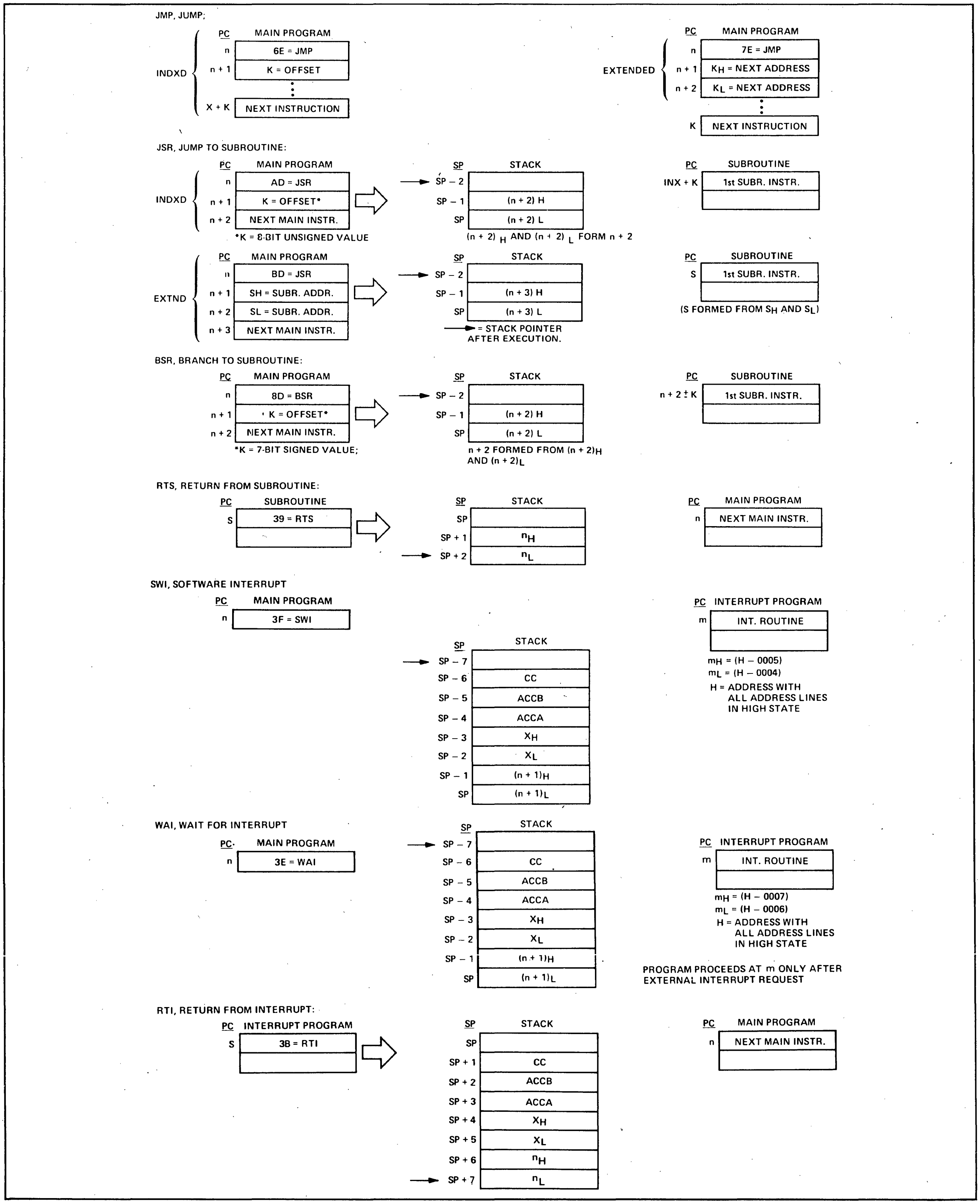
Note – Accumulator addressing mode instructions are included in the IMPLIED addressing.

CONDITION CODE REGISTER NOTES:

(Bit set if test is true and cleared otherwise)

1 (Bit V) Test: Result = 10000000?
2 (Bit C) Test: Result = 00000000?
3 (Bit C) Test: Decimal value of most significant BCD Character greater than nine? (Not cleared if previously set.)
4 (Bit V) Test: Operand = 10000000 prior to execution?
5 (Bit V) Test: Operand = 01111111 prior to execution?
6 (Bit V) Test: Set equal to result of N ⊕ C after shift has occurred.
7 (Bit N) Test: Sign bit of most significant (MS) byte = 1?
8 (Bit V) Test: 2's complement overflow from subtraction of MS bytes?
9 (Bit N) Test: Result less than zero? (Bit 15 = 1)
10 (All) Load Condition Code Register from Stack. (See Special Operations)
11 (Bit I) Set when interrupt occurs, if previously set, a Non-Maskable Interrupt is required to exit the wait state.
12 (ALL) Set according to the contents of Accumulator A

SPECIAL OPERATIONS



SYSTEMS OPERATION

To demonstrate the great versatility of the functional building block concept, a typical system configuration is shown. This configuration will demonstrate how easily a basic system may be upgraded and expanded for a number of different applications.

The Microprocessing Unit (MPU) may be configured with a Read Only Memory (ROM), Random Access Memory (RAM), a Peripheral Interface Adapter (PIA), restart circuitry and clock circuitry to form a minimum functional system (Figure 10). Such a system can easily be adapted for a number of small scale applications by simply changing the content of the ROM.

TWO-PHASE CLOCK CIRCUITRY AND TIMING—The MPU requires a two-phase non-overlapping clock which has a frequency range as high as 1 MHz. In addition to the two phases, this circuit should also generate an enable signal E, and its complement $\overline{E}$, to enable ROMs, RAMs, PIAs and ACIAs. This Enable signal and its complement is obtained by ANDing $\phi 2$ and VMA (Valid Memory Address).

CHIP SELECTION AND ADDRESSING—The minimum system configuration permits direct selection of the ROM, RAM, ACIA and PIA without the use of special TTL select logic. This is accomplished by simply wiring the address lines A13 and A14 to the Enable or chip select lines on the memories and PIA. This permits the devices to be addressed as follows:

Device	A14	A13	Hex Addresses
RAM	0	0	0000–007F
PIA	0	1	2004–2007 (Registers)
ROM	1	1	6000–63FF

Other addressing schemes can be utilized which use any combination of two of the lines A10 through A14 for chip selection.

PERIPHERAL CONTROL—All control and timing for the peripherals that are connected to the PIA is accomplished by software routines under the control of the MPU.

RESTART AND NON-MASKABLE INTERRUPT—Since this basic system does not have a nonvolatile RAM, special circuitry to handle loss of power using NMI is not required. Circuitry is, however, required to insure proper initialization of the MPU when power is turned on. This circuit should insure that the Restart signal is held low for eight $\phi 1$ clock cycles after the V_{CC} power supply reaches a voltage of approximately 4.75 volts DC. Also, in order to insure that a PIA or ACIA is not inadvertently selected during the power-on sequence, Three-State Control (TSC) should be held high until the positive transition of Restart.

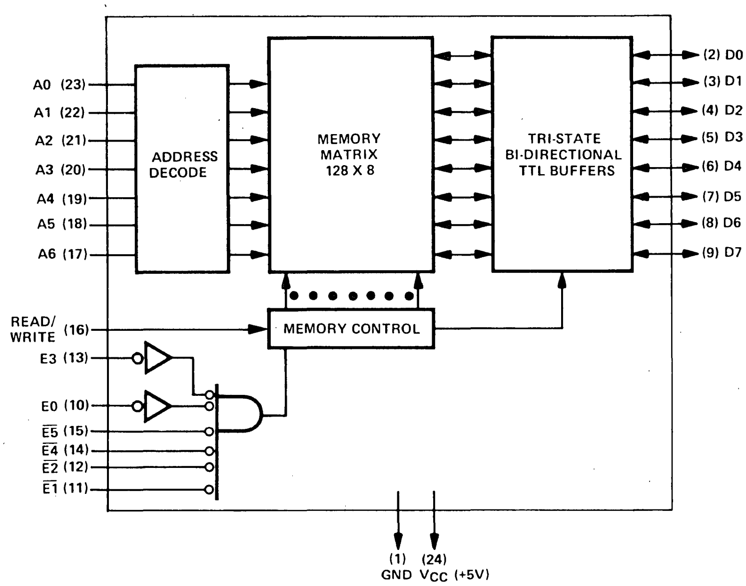
$\overline{\text{HALT}}$—The $\overline{\text{Halt}}$ line is tied to V_{CC} and will automatically place the MPU in the run state when power is turned on. This signal may be used to halt the MPU if a switch is used to tie the line to ground for HALT and to V_{CC} for RUN.

S6810

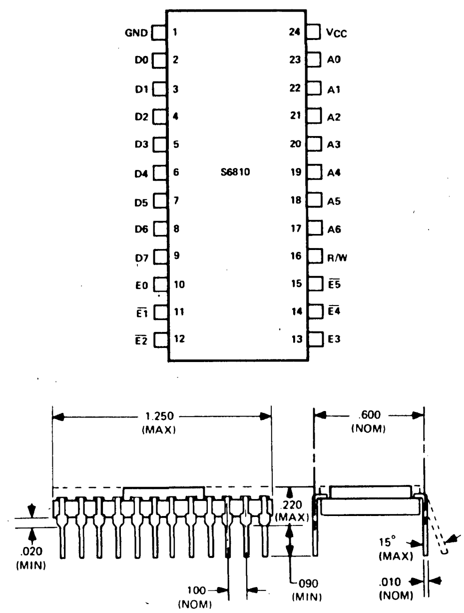
128 X 8 STATIC
READ/WRITE MEMORY

AMI®
AMERICAN MICROSYSTEMS, INC.

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Organized as 128 Bytes of 8 Bits
- Static Operation
- Bi-Directional Three-State Data Input/Output
- Six Chip Enable Inputs (Four Active Low, Two Active High)
- Single 5-Volt Power Supply
- TTL Compatible
- Maximum Access Time = 1.0μs for S6810
  575 ns for S6810-1

FUNCTIONAL DESCRIPTION

The S6810 is a static 128 x 8 Read/Write Memory designed and organized to be compatible with the S6800 Microprocessor. Interfacing to the S6810 consists of an 8 Bit Bi-directional Data Bus, Seven Address Lines, a single Read/Write Control line, and six Chip Enable lines, four negative and two positive.

For ease of use, the S6810 is a totally static memory requiring no clocks or cell refresh. The S6810 is fabricated with N channel silicon gate technology to be fully DTL/TTL compatible with only a single +5 volt power supply required.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	–0.3 to +7.0V
Input Voltage V_{in}	–0.3 to +7.0V
Operating Temperature Range T_A	0 to +70°C
Storage Temperature Range T_{stg}	–55 to +150°C

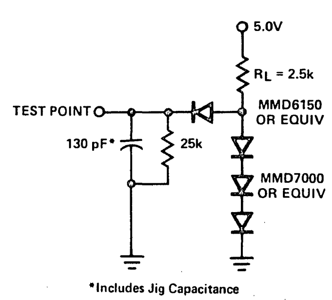
DC (STATIC) CHARACTERISTICS
(V_{CC} = 5.0 Volt ± 5%; T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Condition
Input High Voltage (Normal Operating Levels)	V_{IH}	2.4	–	5.25	V	
Input Low Voltage (Normal Operating Levels)	V_{IL}	-0.3	–	0.4	V	
Input Current (A_n, R/W, E_n, $\overline{E}_n$) (V_{in} = 0 to 5.25 V)	I_{in}	–	–	2.5	μA	
Input High Threshold Voltage	V_{IHT}	2.0	–	–	V	
Input Low Threshold Voltage	V_{ILT}	–	–	0.8	V	
Output High Voltage (I_{OH} = -100 μA)	V_{OH}	2.4	–	–	V	
Output Low Voltage (I_{OL} = 1.6 mA)	V_{OL}	–	–	0.4	V	
Output Leakage Current (D0 – D7) (V_O = 2.4 V, E = 0.4 V, $\overline{E}$ = 2.4 V)	I_{LIH}	–	–	10	μA	
Output Leakage Current (D0 – D7) (V_O = 0.4 V, E = 0.4 V, $\overline{E}$ = 2.4 V)	I_{LOL}	–	–	10	μA	
Supply Current (V_{CC} = 5.25 V, T_A = 0°C)	I_{CC}	–	–	130	mA	
Input Capacitance	C_{IN}	–	–	7.5	pF	f = 1.0MHz, T_A = 25°C
Output Capacitance	C_{OUT}	–	–	15	pF	

AC (DYNAMIC) CHARACTERISTICS
(V_{CC} = 5.0 Volt ∓ 5%, T_A = 0°C to + 70°C)

Characteristic		Symbol	Min.	Max.	Unit
Address Setup Time		t_{AS}	30	–	ns
Address Hold Time		t_{AH}	0	–	ns
Chip Enable Pulse Width	S6810 S6810-1	t_{CS}	800 400	–	ns

FIGURE 1 – AC TEST LOAD



READ CYCLE

(All timing with $t_r = t_f = 20$ ns, Load of Figure 1)

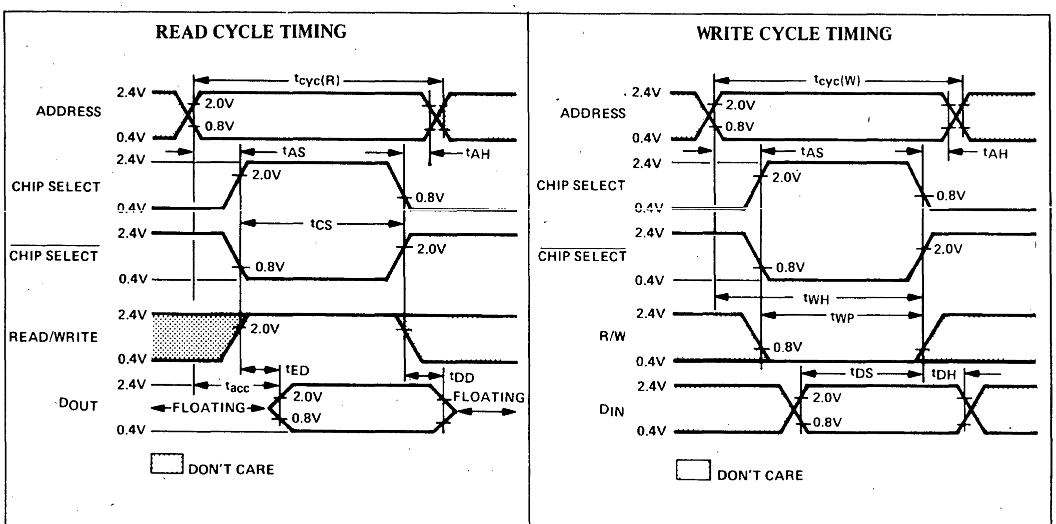
Characteristic		Symbol	Min.	Max.	Unit
Read Cycle Time	S6810 S6810-1	$t_{cyc(R)}$	1000 575	– –	ns ns
Output Enable Delay Time	S6810 S6810-1	t_{ED}	– –	400 300	ns ns
Output Disable Delay Time	S6810 S6810-1	t_{DD}	10 10	200 150	ns ns
Read Access Time	S6810 S6810-1	t_{acc}	– –	1000 575	ns ns

WRITE CYCLE

(All timing with $t_r = t_f = 20$ ns, Load of Figure 1)

Characteristic		Symbol	Min.	Max.	Unit
Write Cycle Time	S6810 S6810-1	$t_{cyc(W)}$	1000 500	– –	ns ns
Write Pulse Width	S6810 S6810-1	t_{WP}	800 400	– –	ns ns
Write Pulse Hold Time	S6810 S6810-1	t_{WH}	1000 500	– –	ns ns
Data Setup Time	S6810 S6810-1	t_{DS}	500 300	– –	ns ns
Data Hold Time	S6810 S6810-1	t_{DH}	0	–	ns

TIMING CHARACTERISTICS

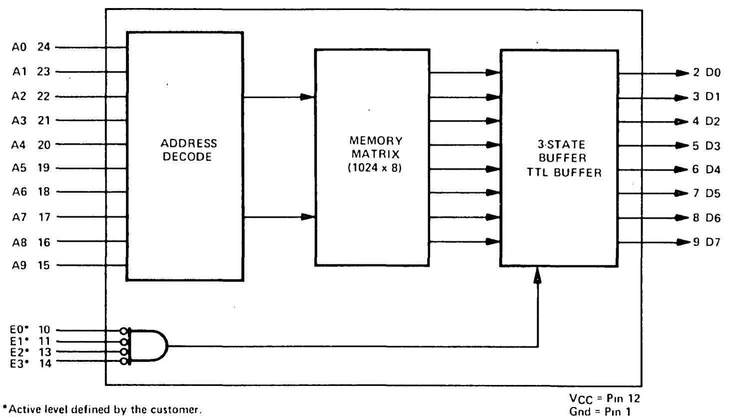


AMERICAN MICROSYSTEMS, INC.

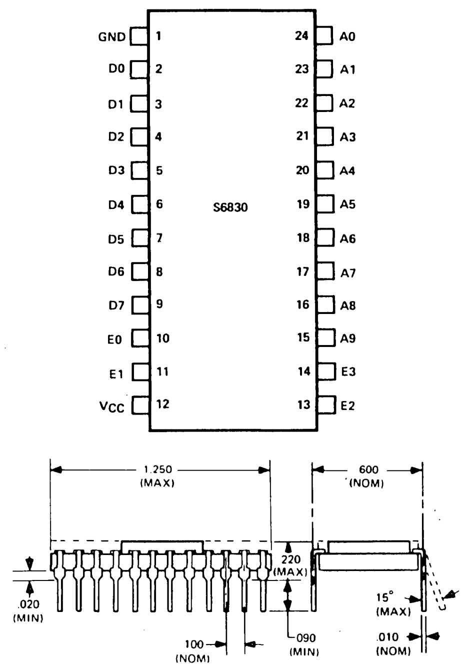
S6830

1024 X 8
READ ONLY MEMORY

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Organized as 1024-Bytes of 8 Bits
- Static Operation
- Three-State Data Output
- Four Chip Enable Inputs (Mask Programmable)
- Single 5-Volt Power Supply
- TTL Compatible Input/Output
- Maximum Access Time = 575 ns

FUNCTIONAL DESCRIPTION

The S6830 is a mask programmable read only memory organized 1024 words x 8 bits for application in byte organized systems. The S6830 is totally bus compatible with the S6800 microprocessor. Interfacing to the S6830 consists of an 8 bit three-state data bus, four mask programmable chip selects and ten address lines.

The S6830 is a totally static memory requiring no clocks. Access time is compatible with maximum data rates in a S6800 microprocessor system. The device operates from a single +5 volt power supply and is fabricated with N channel silicon gate technology.

ABSOLUTE MAXIMUM RATINGS (See Note 1)

Supply Voltage V_{CC}	−0.3 to +7.0V
Input Voltage V_{in}	−0.3 to +7.0V
Operating Temperature Range T_A	0 to +70°C
Storage Temperature Range T_{stg}	−55 to +150°C

NOTE: 1. Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

DC (STATIC) CHARACTERISTICS

(V_{CC} = +5 Volt ± 5%; T_A = 0°C to +70°C) **RECOMMENDED DC OPERATING CONDITIONS**

Parameter	Symbol	Min.	Max.	Unit
Input High Voltage (Norm. Op. Levels)	V_{IH}	2.4	5.25	Vdc
Input Low Voltage (Norm. Op. Levels)	V_{IL}	-0.3	0.4	Vdc
Input Current (V_{in} = 0 to 5.25 V)	I_{in}	–	2.5	μAdc
Input High Threshold Voltage	V_{IHT}	2.0	–	Vdc
Input Low Threshold Voltage	V_{ILT}	–	0.65	Vdc
Output High Voltage (I_{OH} = -100 μA)	V_{OH}	2.4	–	Vdc
Output Low Voltage (I_{OL} = 1.6 mA)	V_{OL}	–	0.45	Vdc
Output Leakage Current (V_{OH} = 2.4 V, E = 0.4 V, $\overline{E}$ = 2.4 V)	I_{LOH}	–	10	μAdc
Output Leakage Current (V_{OH} = 0.4 V, E = 0.4 V, $\overline{E}$ = 2.4 V)	I_{LOL}	–	10	μAdc
Supply Current (V_{CC} @ 5.25V, T_A = 0°C)	I_{CC}	–	130	mAdc

CAPACITANCE

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Conditions
Input Capacitance	C_{in}	–	–	7.5	pF	f = 1.0 MHz
Output Capacitance	C_{out}	–	–	15	pF	T_A = 25°C

AC (DYNAMIC) CHARACTERISTICS **READ CYCLE** (All timing with t_r = t_f = 20 ns, Load of Figure 1)

V_{CC} = +5 Volt ± 5%; T_A = 0°C to +70°C

Characteristic	Symbol	Min.	Max.	Unit
Read Cycle Time	t_{cyc} (R)	575	–	ns
Output Enable Delay Time	t_{ED}	–	300	ns
Output Disable Delay Time	t_{DD}	10	150	ns
Read Access Time	t_{acc}	–	575	ns

READ CYCLE TIMING

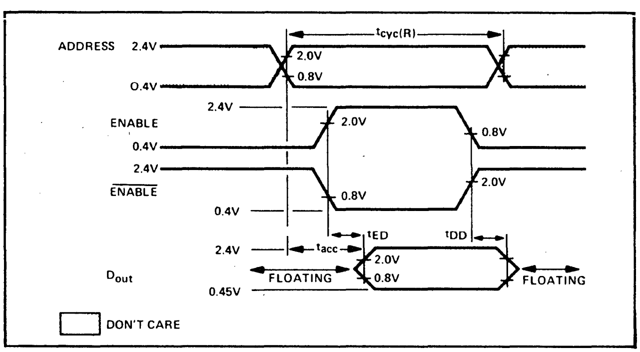
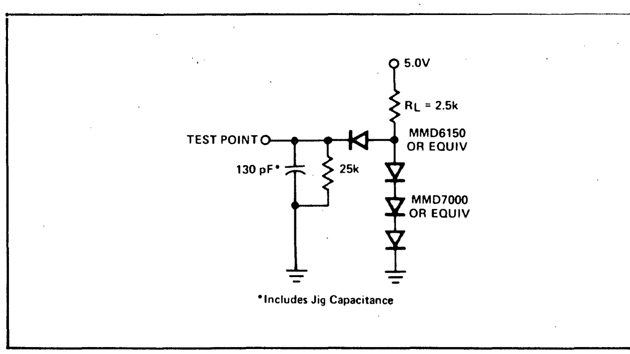


FIGURE 1 – AC TEST LOAD



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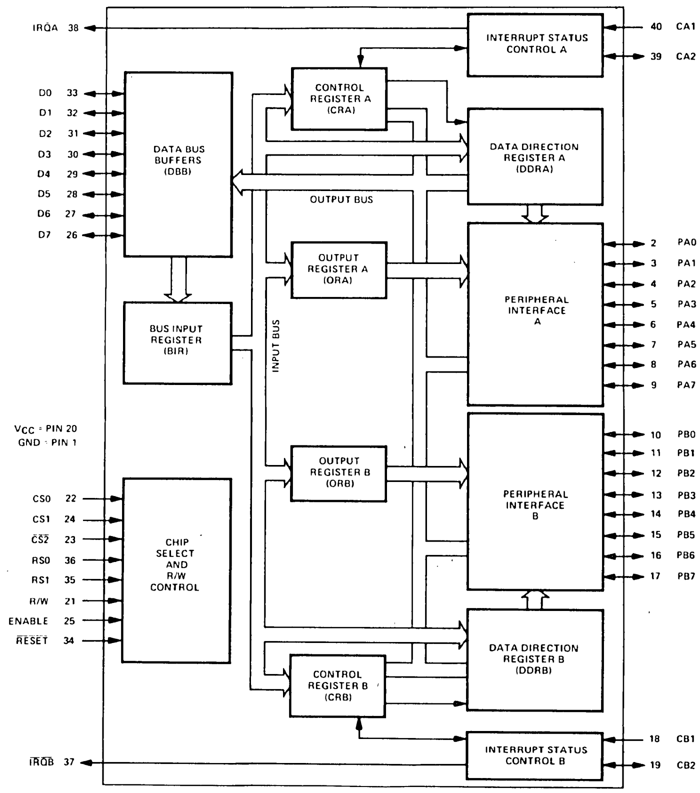
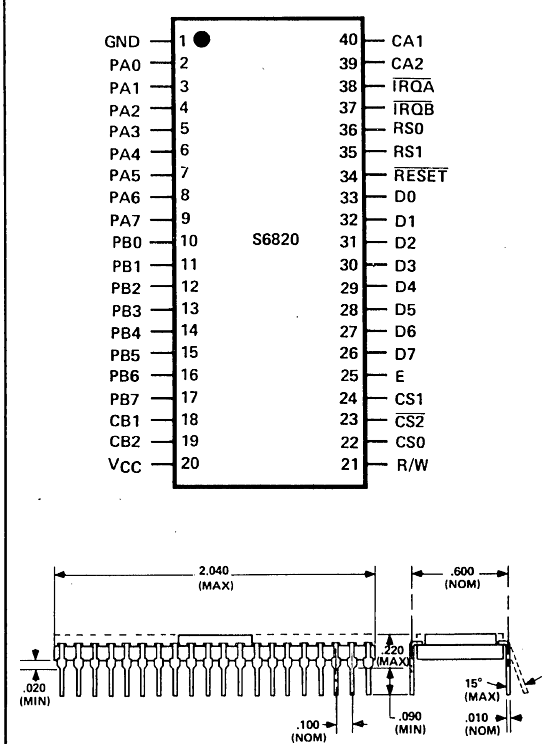
S6820

PERIPHERAL INTERFACE ADAPTER (PIA)



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- 8-Bit Bidirectional Data Bus for Communication with the MPU
- Two Bidirectional 8-Bit Buses for Interface to Peripherals
- Two Programmable Control Registers
- Two Programmable Data Direction Registers
- Four Individually-Controlled Interrupt Input Lines; Two Usable as Peripheral Control Outputs
- Handshake Control Logic for Input and Output Peripheral Operation
- High-Impedance 3-State and Direct Transistor Drive Peripheral Lines
- Program Controlled Interrupt and Interrupt Disable Capability
- CMOS Compatible Peripheral Lines

FUNCTIONAL DESCRIPTION

The S6820 Peripheral Interface Adapter provides the universal means of interfacing peripheral equipment to the S6800 Microprocessing Unit (MPU). This device is capable of interfacing the MPU to peripherals through two 8-bit bidirectional peripheral data buses and four control lines. No external logic is required for interfacing to most peripheral devices.

The functional configuration of the PIA is programmed by the MPU during system initialization. Each of the peripheral data lines can be programmed to act as an input or output, and

FUNCTIONAL DESCRIPTION (CONT'D)

each of the four control/interrupt lines may be programmed for one of several control modes. This allows a high degree of flexibility in the over-all operation of the interface.

The PIA interfaces to the S6800 MPU with an eight-bit bidirectional data bus, three chip select lines, two register select lines, two interrupt request lines, read/write line, enable line and reset line. These signals, in conjunction with the S6800 VMA output, permit the MPU to have complete control over the PIA. VMA may be utilized to gate the input signals to the PIA.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	−0.3 to +7.0V
Input Voltage V_{in}	−0.3 to +7.0V
Operating Temperature Range T_A	0 to +70°C
Storage Temperature Range T_{stg}	−55 to +150°C

NOTE: This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields, however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

DC (STATIC) CHARACTERISTICS (V_{CC} = 5.0V ± 5%, T_A = 25°C unless otherwise noted.)

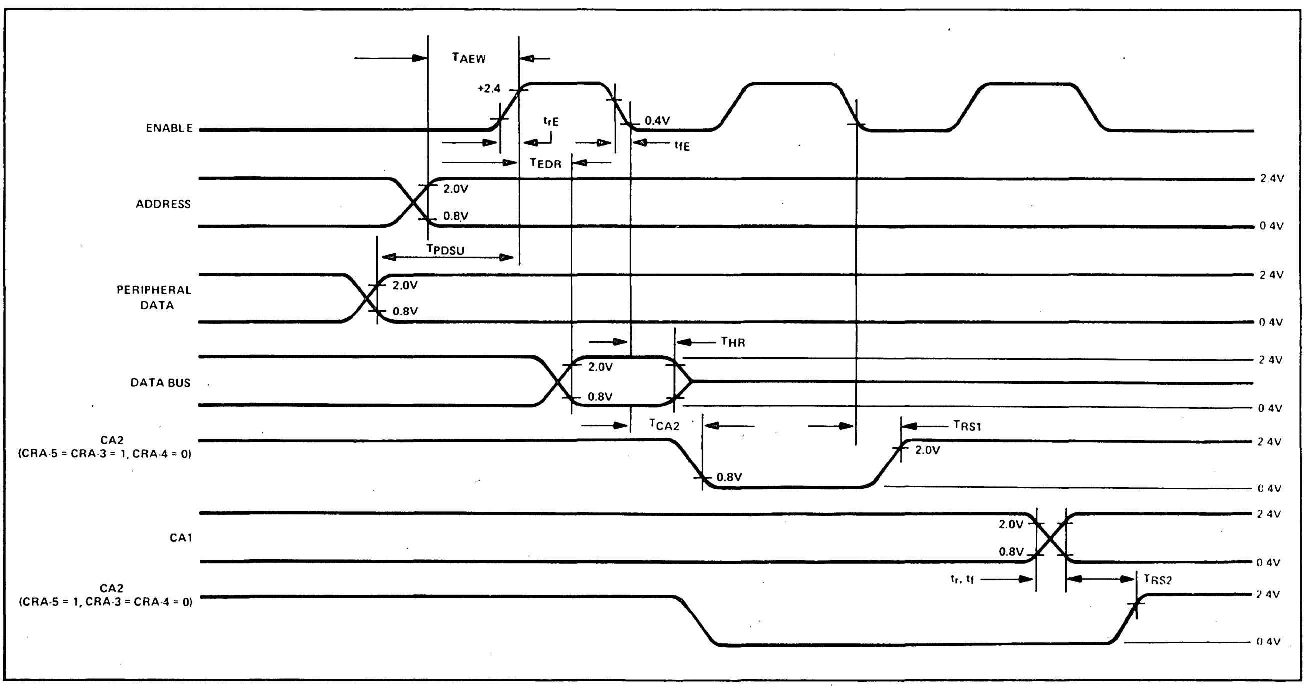
Characteristic	Symbol	Min.	Typ.	Max.	Unit
Input High Voltage (Normal Operating Levels)	V_{IH}	+2.4	–	V_{CC}	Vdc
Input Low Voltage (Normal Operating Levels)	V_{IL}	−0.3	–	+0.4	Vdc
Input High Threshold Voltage All Inputs Except Enable	V_{IHT}	+2.0	–	–	Vdc
Input Low Threshold Voltage All Inputs Except Enable	V_{ILT}	–	–	+0.8	Vdc
Input Leakage Current (V_{in} = 0 to 5.0 Vdc) R/W, $\overline{Reset}$, RS0, RS1, CS0, CS1, $\overline{CS2}$, CA1, CB1, Enable	I_{in}	–	1.0	2.5	μAdc
Three-State (Off State) Input Current (V_{in} = 0.4 to 2.4 Vdc, V_{CC} = max) D0-D7, PB0-PB7, CB2	I_{TSI}	–	2.0	10	μAdc
Input High Current PA0-PA7, CA2 (V_{IH} = 2.4 Vdc)	I_{IH}	100	250	–	μAdc
Input Low Current PA0-PA7, CA2 (V_{IL} = 0.4 Vdc)	I_{IL}	–	1.0	1.6	mAdc
Output High Voltage (V_{CC} = min, I_{Load} = −100 μAdc, Enable Pulse Width < 25 μs)	V_{OH}	+2.4	–	–	Vdc
Output Low Voltage (V_{CC} = min, I_{Load} = 1.6 mAdc)	V_{OL}	–	–	+0.4	Vdc
Output High Current (Sourcing) (V_{OH} = 2.4 Vdc) (V_{OH} = 1.5 Vdc, the current for driving other than TTL, e.g., Darlington Base) PB0-PB7, CB2	I_{OH}	 −100 −1.0	 −1000 −2.5	 – –	 μAdc mAdc
Output Low Current (Sinking) (V_{OL} = 0.4 Vdc)	I_{OL}	1.6	–	–	mAdc
Output Leakage Current (Off State) $\overline{IRQA}$, $\overline{IRQB}$	I_{off}	–	1.0	10	μAdc
Power Dissipation	P_D	–	300	600	mW
Input Capacitance (V_{in} = 0, T_A = 25°C, f = 1.0 MHz) D0-D7, PA0-PA7, PB0-PB7, CA2, CB2 R/W, $\overline{Reset}$, RS0, RS1, CS0, CS1, $\overline{CS2}$, CA1, CB1 Enable	C_{in}	 – – –	 – – –	 10 7.0 20	pF
Output Capacitance (V_{in} = 0, T_A = 25°C, f = 1.0 MHz)	C_{out}	–	–	10	pF

AC (DYNAMIC) CHARACTERISTICS Loading = 30 pF and one TTL load for PA0-PA7, PB0-PB7, CA2, CB2
= 130 pF and one TTL load for D0-D7, $\overline{IRQA}$, $\overline{IRQB}$

READ TIMING CHARACTERISTICS (Figure 1)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Delay Time, Address valid to Enable positive transition	T_{AEW}	180	–	–	ns
Delay Time, Enable positive transition to Data valid on bus	T_{EDR}	–	–	395	ns
Peripheral Data Setup Time	T_{PDSU}	300	–	–	ns
Data Bus Hold Time	T_{HR}	10	–	–	ns
Delay Time, Enable negative transition to CA2 negative transition	T_{CA2}	–	–	1.0	µs
Delay Time, Enable negative transition to CA2 positive transition	T_{RS1}	–	–	1.0	µs
Rise and Fall Time for CA1 and CA2 input signals	t_r, t_f	–	–	1.0	µs
Delay Time from CA1 active transition to CA2 positive transition	T_{RS2}	–	–	2.0	µs
Rise and Fall Time for Enable input	t_{rE}, t_{fE}	–	–	25	µs

FIGURE 1 – READ TIMING CHARACTERISTICS



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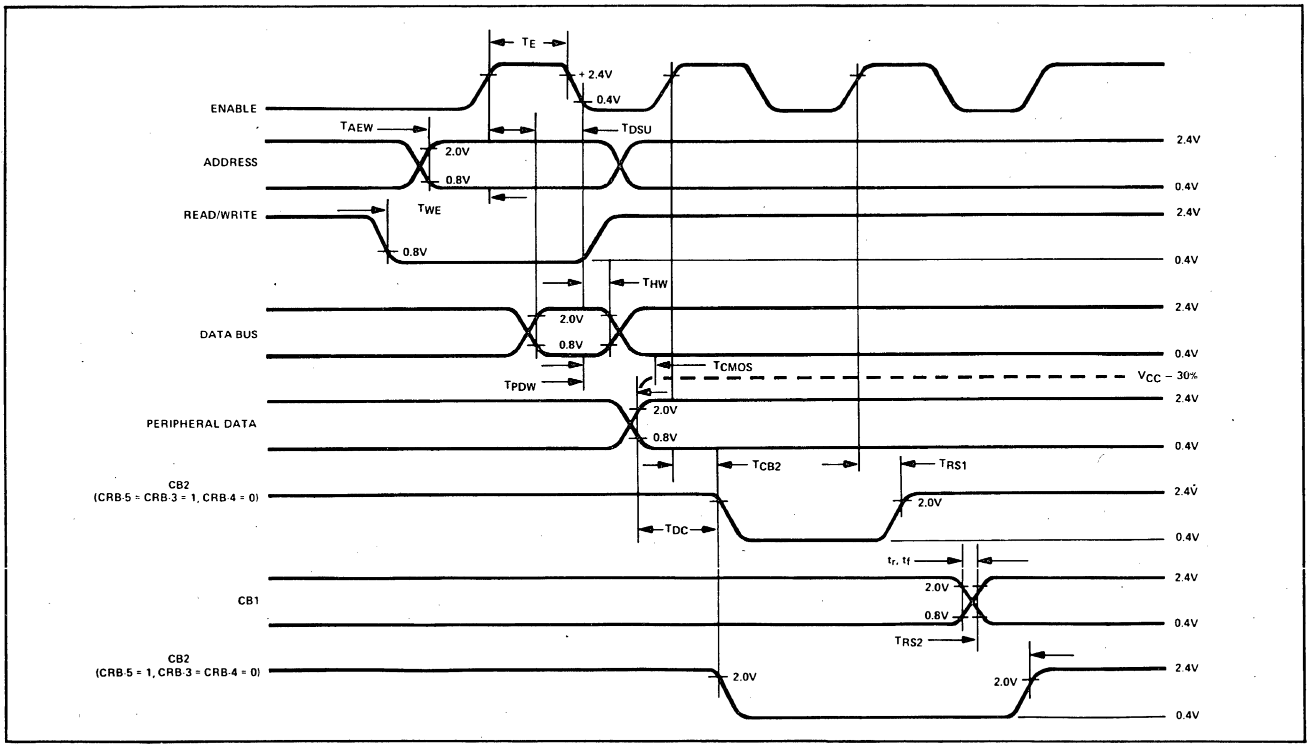
WRITE TIMING CHARACTERISTICS (Figure 2)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Enable Pulse Width	T_E	0.470	–	25	μs
Delay Time, Address valid to Enable positive transition	T_{AEW}	180	–	–	ns
Delay Time, Data valid to Enable negative transition	T_{DSU}	300	–	–	ns
Delay Time, Read/Write negative transition to Enable positive transition	T_{WE}	130	–	–	ns
Data Bus Hold Time	T_{HW}	10	–	–	ns
Delay Time, Enable negative transition to Peripheral Data valid	T_{PDW}	–	–	1.0	μs
Delay Time, Enable negative transition to Peripheral Data valid, CMOS (V_{CC} - 30%) PA0-PA7, CA2	T_{CMOS}	–	–	2.0	μs
Delay Time, Enable positive transition to CB2 negative transition	T_{CB2}	–	–	1.0	μs
Delay Time, Peripheral Data valid to CB2 negative transition	T_{DC}	0	–	1.5	μs
Delay Time, Enable positive transition to CB2 positive transition	T_{RS1}	–	–	1.0	μs
Rise and Fall Time for CB1 and CB2 input signals	t_r, t_f	–	–	1.0	μs
Delay Time, CB1 active transition to CB2 positive transition	T_{RS2}	–	–	2.0	μs

FIGURE 2 – WRITE TIMING CHARACTERISTICS



INTERFACE DESCRIPTION

MPU/PIA INTERFACE

Pin	Label	Function
(33) (32) (31) (30) (29) (28) (27) (26)	D0 D1 D2 D3 D4 D5 D6 D7	**Bi-Directional Data** – The bi-directional data lines (D0-D7) allow the transfer of data between the MPU and the PIA. The data bus output drivers are three-state devices that remain in the high-impedance (off) state except when the MPU performs a PIA read operation. The Read/Write line is in the Read (high) state when the PIA is selected for a Read operation.
(25)	E	**Enable** – The enable pulse, E, is the only timing signal that is supplied to the PIA. Timing of all other signals is referenced to the leading and trailing edges of the E pulse. This signal will normally be a derivative of the S6800 $\phi 2$ Clock. The E pulse is used to condition the interrupt/control lines CA1, CA2, CB1, and CB2. At least one E pulse must occur from the inactive edge to the active edge of the input signal to set the interrupt flag, when the lines are used as inputs.
(21)	R/W	**Read/Write** – This signal is generated by the MPU to control the direction of data transfers on the Data Bus. A low state on the PIA Read/Write line enables the input buffers and data is transferred from the MPU to the PIA on the E signal if the device has been selected. A high on the Read/Write line sets up the PIA for a transfer of data to the bus. The PIA output buffers are enabled when the proper address and the enable pulse E are present.
(34)	$\overline{\text{RESET}}$	**$\overline{\text{Reset}}$** – The active low $\overline{\text{Reset}}$ line is used to reset all register bits in the PIA to a logical zero (low). This line can be used as a power-on reset and as a master reset during system operation.
(22) (24) (23)	CS0 CS1 $\overline{\text{CS2}}$	**Chip Select** – These three input signals are used to select the PIA. CS0 and CS1 must be high and $\overline{\text{CS2}}$ must be low for selection of the device. Data transfers are then performed under the control of the Enable and Read/Write signals. The chip select lines must be stable for the duration of the E pulse.
(36) (35)	RS0 RS1	**PIA Register Select** – The two register select lines are used to select the various registers inside the PIA. These two lines are used in conjunction with internal Control Registers to select a particular register that is to be written or read. The Register select lines should be stable for the duration of the E pulse while in the read or write cycle.
(38) (37)	$\overline{\text{IRQA}}$ $\overline{\text{IRQB}}$	**Interrupt Request** – The active low Interrupt Request lines ($\overline{\text{IRQA}}$ and $\overline{\text{IRQB}}$) act to interrupt the MPU either directly or through interrupt priority circuitry. These lines are "open source" (no load device on the chip) and are capable of sinking a current of 1.6 mA from an external source. This permits all interrupt request lines to be tied together in a wire-OR configuration. Each Interrupt Request line has two internal interrupt flag bits that will cause the Interrupt Request line to go low. Each flag bit is associated with a particular peripheral interrupt line. Also four interrupt enable bits are provided in the PIA which may be used to inhibit a particular interrupt from a peripheral device. Servicing an interrupt by the MPU is accomplished by a software routine that, on a prioritized basis, sequentially reads and tests the two control registers in each PIA for interrupt flag bits that are set. The Interrupt Flag is cleared (zeroed) as a result of an MPU Read Peripheral Data Operation.

PIA/PERIPHERAL INTERFACE

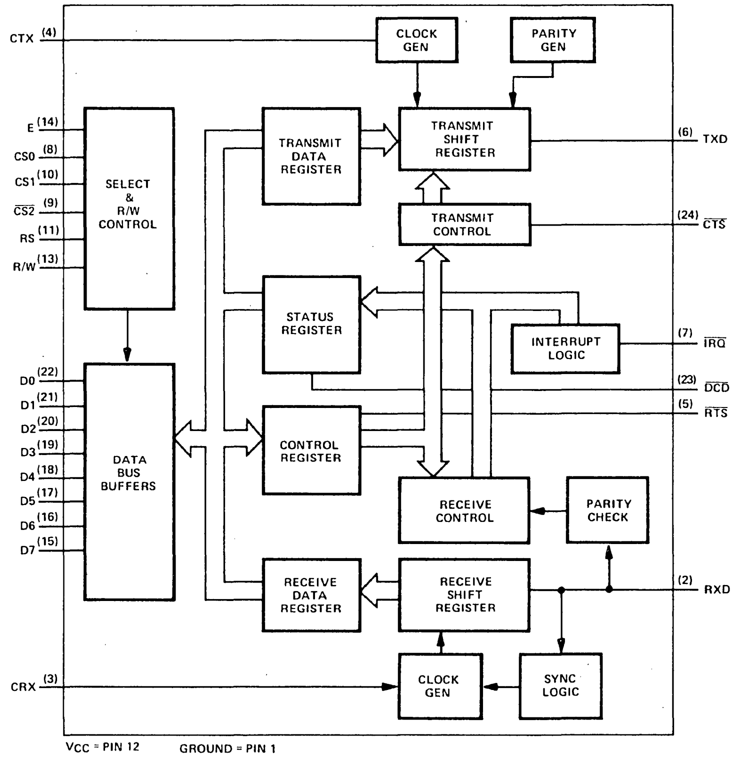
Pin	Label	Function
(2) (3) (4) (5) (6) (7) (8) (9)	PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7	**Section A Peripheral Data** – Each of the peripheral data lines can be programmed to act as an input or output. This is accomplished by setting a "1" in the corresponding Data Direction Register bit for those lines which are to be outputs. A "0" in a bit of the Data Direction Register causes the corresponding peripheral data line to act as an input. During an MPU Read Peripheral Data Operation, the data on peripheral lines programmed to act as inputs appears directly on the corresponding MPU Data Bus lines. In the input mode the internal pullup resistor on these lines represents a maximum of one standard TTL load. The data in Output Register A will appear on the data lines that are programmed to be outputs. A logical "1" written into the register will cause a "high" on the corresponding data line while a "0" results in a "low". Data in Output Register A may be read by an MPU "Read Peripheral Data A" operation when the corresponding lines are programmed as outputs. This data will be read properly if the voltage on the peripheral data lines is greater than 2.0 volts for a logic "1" output and less than 0.8 volt for a logic "0" output. Loading the output lines such that the voltage on these lines does not reach full voltage causes the data transferred into the MPU on a Read operation to differ from that contained in the respective bit of Output Register A.
(10) (11) (12) (13) (14) (15) (16) (17)	PB0 PB1 PB2 PB3 PB4 PB5 PB6 PB7	**Section B Peripheral Data** - The peripheral data lines in the B Section of the PIA can be programmed to act as either inputs or outputs in a similar manner to PA0-PA7. However, the output buffers driving these lines differ from those driving lines PA0-PA7. They have three-state capability, allowing them to enter a high impedance state when the peripheral data line is used as an input. In addition, data on the peripheral data lines PB0-PB7 will be read properly from those lines programmed as outputs even if the voltages are below 2.0 volts for a "high". As outputs, these lines are compatible with standard TTL and may also be used as a source of up to 1 milliampere at 1.5 volts to directly drive the base of a transistor switch.
(40) (18)	CA1 CB1	**Interrupt Input** – Peripheral Input lines CA1 and CB1 are input-only lines that set the interrupt flags of the control registers. The active transition for these signals is also programmed by the two control registers.
(39)	CA2	**Peripheral Control** – The peripheral control line CA2 can be programmed to act as an interrupt input or as a peripheral control output. As an output, this line is compatible with standard TTL; as an input the internal pullup resistor on this line represents one standard TTL load. The function of this signal line is programmed with Control Register A.
(19)	CB2	**Peripheral Control** – Peripheral Control line CB2 may also be programmed to act as an interrupt input or peripheral control output. As an input, this line has high input impedance and is compatible with standard TTL. As an output it is compatible with standard TTL and may also be used as a source of up to 1 milliampere at 1.5 volts to directly drive the base of a transistor switch. This line is programmed by Control Register B.
(1)	GND	**Ground**
(20)	V_{CC}	+5 Volts ± 5%

AMERICAN MICROSYSTEMS, INC.

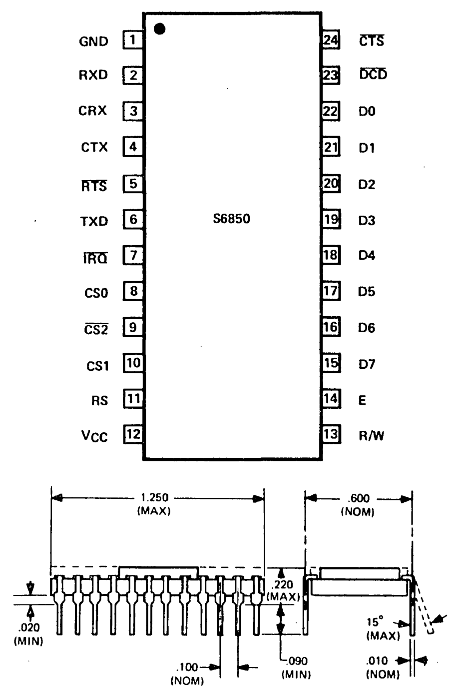
S6850

ASYNCHRONOUS COMMUNICATION INTERFACE ADAPTER (ACIA)

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- 8 Bit Bidirectional Data Bus for Communication with MPU.
- False start bit deletion.
- Peripheral/modem control functions.
- Double buffered Receiver and Transmitter
- One or two stop bit operation.
- Eight and nine-bit transmission with optional even and odd parity.
- Parity, overrun and framing error checking.
- Programmable control register.
- Optional ÷1, ÷16, and ÷64 clock modes.
- Up to 500,000 bps transmission.

FUNCTIONAL DESCRIPTION

The S6850 Asynchronous Communications Interface Adapter (ACIA) provides the data formatting and control to interface serial asynchronous data communications to bus organized systems such as the S6800 Microprocessing Unit.

The S6850 includes select enable, read/write, interrupt and bus interface logic to allow data transfer over an eight bit bi-directional data bus. The parallel data of the bus system is serially transmitted and received by the asynchronous data interface, with proper formatting and error checking. The functional configuration of the ACIA is programmed via the data bus during system initialization. Word lengths, clock division ratios and transmit control through the Request to Send output may be programmed. For modem operation three control lines are provided. These lines allow the ACIA to interface directly with the S6860 0-600 bps digital modem.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	−0.3 to +7.0V	Operating Temperature Range T_A	0 to +70°C
Input Voltage V_{in}	−0.3 to +7.0V	Storage Temperature Range T_{stg}	−55 to +150°C

NOTE: This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields, however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

DC (STATIC) CHARACTERISTICS (V_{CC} = 5.0V ± 5%, T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Input High Voltage (Normal Operating Levels)	V_{IH}	+2.4	–	V_{CC}	Vdc
Input Low Voltage (Normal Operating Levels)	V_{IL}	−0.3	–	+0.4	Vdc
Input High Threshold Voltage — All Inputs Except Enable	V_{IHT}	+2.0	–	–	Vdc
Input Low Threshold Voltage — All Inputs Except Enable	V_{ILT}	–	–	+0.8	Vdc
Input Leakage Current (V_{in} = 0 to 5.0 Vdc) R/W, RS, CS0, CS1, $\overline{CS2}$, Enable	I_{in}	–	1.0	2.5	µAdc
Three-State (Off State) Input Current (V_{in} = 0.4 to 2.4 Vdc, V_{CC} = max) D0-D7,	I_{TSI}	–	2.0	10	µAdc
Output High Voltage (I_{Load} = −100 µAdc, Enable Pulse Width < 25 µs) All Outputs Except $\overline{IRQ}$	V_{OH}	+2.4	–	–	Vdc
Output Low Voltage (I_{Load} = 1.6 mAdc) Enable Pulse Width < 25 µs	V_{OL}	–	–	+0.4	Vdc
Output Leakage Current (Off State) $\overline{IRQ}$	I_{LOH}	–	1.0	10	µAdc
Power Dissipation	P_D	–	300	525	mW
Input Capacitance (V_{in} = 0, T_A = 25°C, f = 1.0 MHz)	C_{in}				pF
D0-D7		–	–	10	
R/W, RS, CS0, CS1, $\overline{CS2}$, RXD, CTX, CRX, $\overline{CTS}$, $\overline{DCD}$		–	–		
Enable		–	–	10	
Output Capacitance (V_{in} = 0, T_A = 25°C, f = 1.0 MHz)	C_{out}	–	–	10	pF

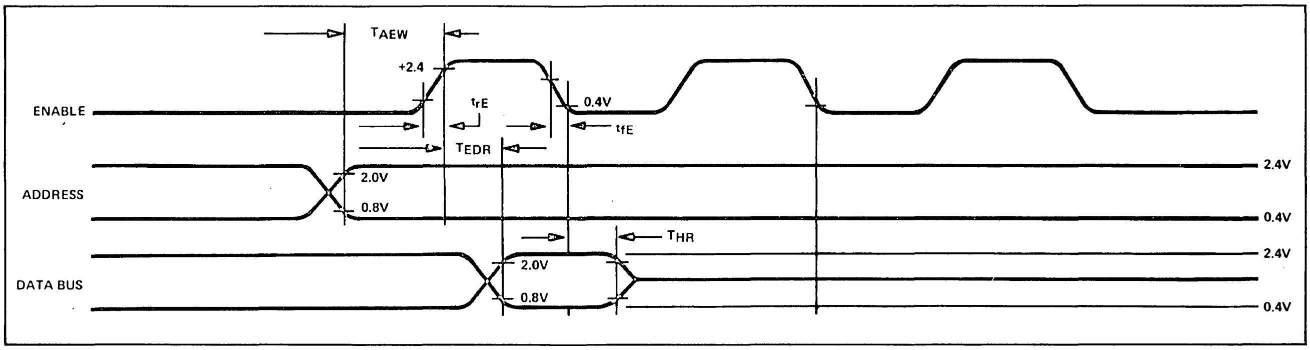
AC (DYNAMIC) CHARACTERISTICS

Loading = 130 pF and one TTL load for D0-D7 = 20pF and 1 TTL load for $\overline{RTS}$ and TXD = 100pF and 3KΩ to V_{CC} for $\overline{IRQ}$.

READ TIMING CHARACTERISTICS (Figure 1)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Setup Time, Address valid to Enable positive transition	T_{AEW}	180	–	–	ns
Setup Time, Enable positive transition to Data valid on bus	T_{EDR}	–	–	395	ns
Data Bus Hold Time	T_{HR}	10	–	–	ns
Rise and Fall Time for Enable input	t_{rE}, t_{fE}	–	–	25	µs

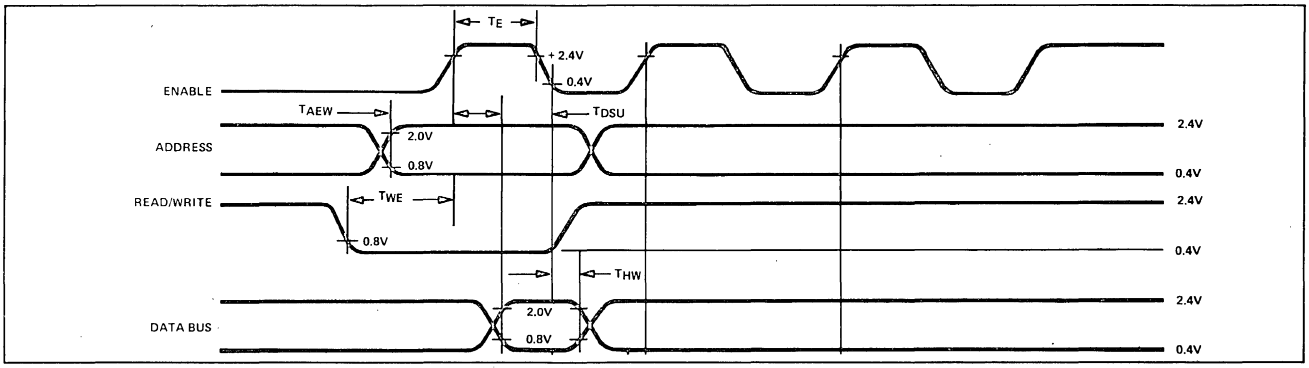
FIGURE 1 – READ TIMING CHARACTERISTICS



WRITE TIMING CHARACTERISTICS (Figure 2)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Enable Pulse Width	T_E	0.470	–	25	μs
Setup Time, Address valid to Enable positive transition	T_{AEW}	180	–	–	ns
Setup Time, Data valid to Enable netative transition	T_{DSU}	300	–	–	ns
Setup time, Read/Write negative transition to Enable positive transition	T_{WE}	130	–	–	ns
Data Bus Hold Time	T_{HW}	10	–	–	ns

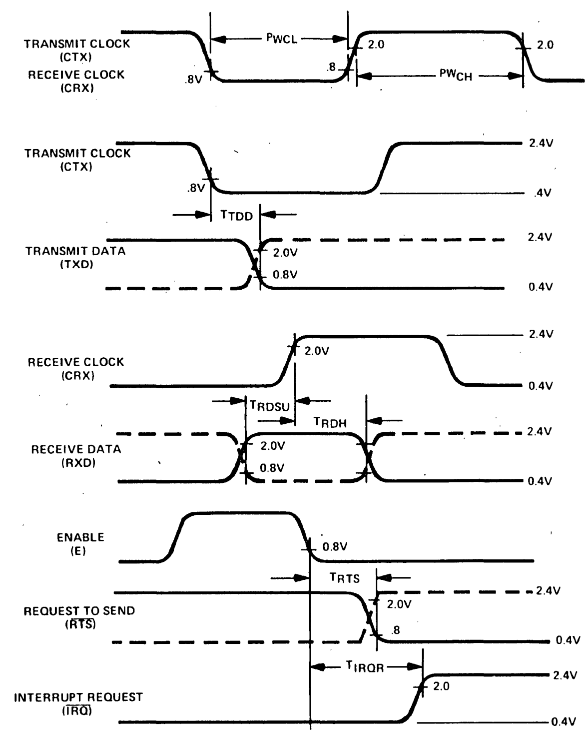
FIGURE 2 – WRITE TIMING CHARACTERISTICS



TRANSMIT/RECEIVE CHARACTERISTICS (Figure 3)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Clock Frequency ÷ 1 mode ÷ 16 mode ÷ 64 mode	f_C			 500 800 800	 KHz KHz KHz
Clock Pulse Width, Low State	PW_{CL}	600			nsec
Clock Pulse Width, High State	PW_{CH}	600			nsec
Delay Time, Transmit Clock to Data Out	T_{TDD}			1.0	μsec
Set up Time, Receive Data	T_{RDSU}	500			nsec
Hold Time, Receive Data	T_{RDH}	500			nsec
Delay Time, Enable to $\overline{IRQ}$ Reset	T_{IRQR}			1.2	μsec
Delay Time, Enable to $\overline{RTS}$	T_{RTS}			1.0	μsec

FIGURE 3 – TRANSMIT/RECEIVE TIMING



MPU/ACIA INTERFACE

Pin	Label	Function
(22) (21) (20) (19) (18) (17) (16) (15)	D0 D1 D2 D3 D4 D5 D6 D7	**ACIA BI-DIRECTIONAL DATA LINES**–The bi-directional data lines (D0-D7) allow for data transfer between the ACIA and the MPU. The data bus output drivers are three-state devices that remain in the high-impedance (off) state except when the MPU performs an ACIA read operation. The Read/Write line is in the read (high) state when the ACIA is selected for a read operation.
(14)	E	**ACIA ENABLE SIGNAL**–The Enable signal (E) is a high impedance TTL compatible input that enables the bus input/output data buffers and clocks data to and from the ACIA. This signal will normally be a derivative of the S6800 $\phi 2$ clock.
(13)	R/W	**READ/WRITE CONTROL SIGNAL**–The Read/Write line is a high impedance input that is TTL compatible and is used to control the direction of data flow through the ACIA's input/output data bus interface. When Read/Write is high (MPU Read cycle), the ACIA output driver is turned on and a selected register is read. When it is low, the ACIA output driver is turned off and the MPU writes into a selected register. Thus, the Read/Write signal is used to select the Read Only or Write Only registers within the ACIA.
(8) (10) (9)	CS0 CS1 $\overline{CS2}$	**CHIP SELECT SIGNALS**–These three high impedance TTL compatible input lines are used to address an ACIA. A particular ACIA is selected when CS0 and CS1 are high and $\overline{CS2}$ is low. Transfers of data to and from ACIA are then performed under the control of Enable, Read/Write, and Register Select.

MPU/ACIA INTERFACE (CONT'D)

Pin	Label	FUNCTION
(11)	RS	**REGISTER SELECT SIGNAL**—The Register Select line is a high impedance input that is TTL compatible and is used to select the Transmit/Receive Data or Control/Status registers in the ACIA. The Read/Write signal line is used in conjunction with Register Select to select the Read Only or Write Only register in each register pair.
(7)	$\overline{IRQ}$	**INTERRUPT REQUEST SIGNAL**—Interrupt request is a TTL compatible, open drain active low output that is used to interrupt the MPU. The Interrupt Request remains low as long as the cause of the interrupt is present and the appropriate interrupt enable within the ACIA is set.

ACIA/MODEM OR PERIPHERAL INTERFACE

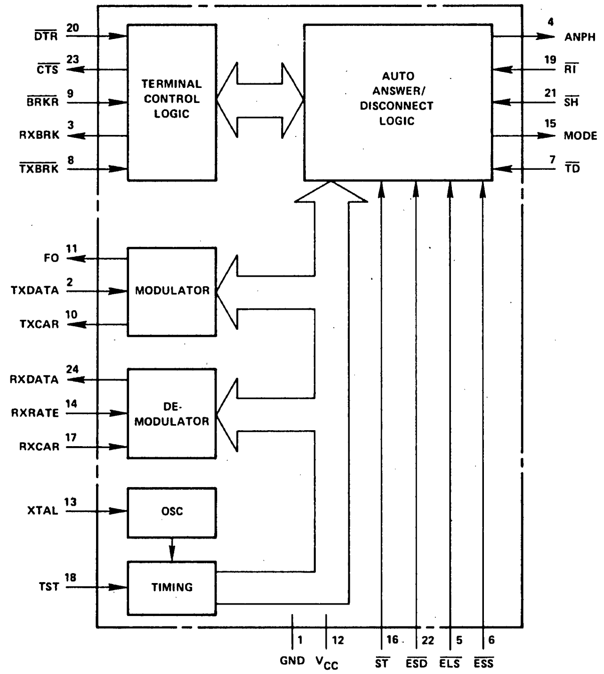
Pin	Label	FUNCTION
(4)	CTX	**TRANSMIT CLOCK**—The Transmit Clock is a high impedance TTL compatible input used for the clocking of transmitted data. The transmitter initiates data on the negative transition of the clock. Clock frequency of 1, 16, or 64 times the data rate may be selected.
(3)	CRX	**RECEIVE CLOCK**—The Receive Clock is a high impedance TTL compatible input used for synchronization of received data. (In the ÷ 1 mode, the clock and data must be synchronized externally.) The receiver strobes the data on the positive transition of the clock. Clock frequency of 1, 16, or 64 times the data rate may be selected.
(2)	RXD	**RECEIVED DATA**—The Received Data line is a high impedance TTL compatible input through which data is received in a serial NRZ(Non Return to Zero) format. Synchronization with a clock for detection of data is accomplished internally when clock rates of 16 or 64 times the bit rate are used. Data rates are in the range of 0 to 500 Kbps when external synchronization is utilized.
(6)	TXD	**TRANSMIT DATA**—The Transmit Data output line transfers serial NRZ data to a modem or other peripheral device. Data rates are in the range of 0 to 500Kbps when external synchronization is utilized.
(24)	$\overline{CTS}$	**CLEAR-TO-SEND**—This high impedance TTL compatible input provides automatic control of the transmitting end of a communications link via the modem's "clear-to-send" active low output by inhibiting the Transmitter Data Register Empty status bit (TDRE).
(5)	$\overline{RTS}$	**REQUEST-TO-SEND**—The Request-to-Send output enables the MPU to control a peripheral or modem via the data bus. The active state is low. The Request-to-Send output is controlled by the contents of the ACIA control register.
(23)	$\overline{DCD}$	**DATA CARRIER DETECTED**—This high impedance TTL compatible input provides automatic control of the receiving end of a communications link by means of the modem "Data-Carrier-Detect" or "Received-Line-Signal Detect" output. The $\overline{DCD}$ input inhibits and initializes the receiver section of the ACIA when high. A low to high transition of the Data Carrier Detect initiates an interrupt to the MPU to indicate the occurrence of a loss of carrier when the Receiver Interrupt Enable (RIE) is set.
(12)	V_{CC}	**+5 volts ± 5%**
(1)	GND	**GROUND**

S6860

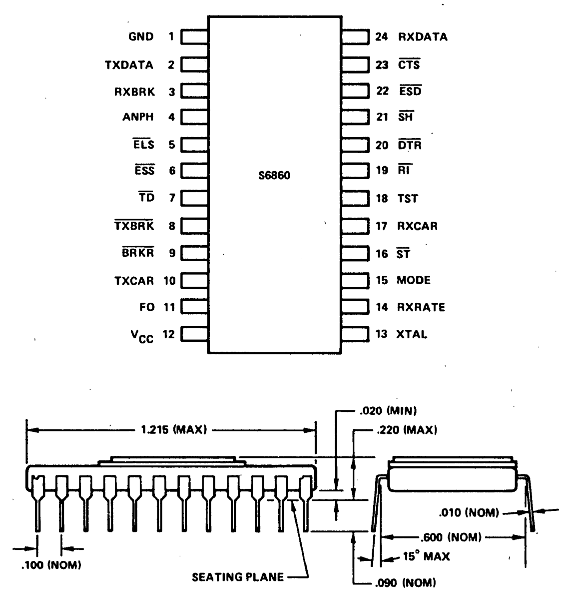
0-600 BPS
DIGITAL MODEM

AMERICAN MICROSYSTEMS, INC.

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Full or half duplex operation
- Originate and answer mode
- Auto answer and disconnect
- Modem self test
- TTL compatible terminal interfaces
- Crystal/External reference control
- Compatible functions for 100 series data sets and 1001 A/B data couplers

FUNCTIONAL DESCRIPTION

The S6860 is a 0-600 bps Digital Modem circuit designed to be integrated into a wide range of equipment utilizing serial data communications.

The modem provides the necessary modulation, demodulation and supervisory control functions to implement a serial data communications link, over a voice grade channel, utilizing frequency shift keying (FSK) a bit rates up to 600 bps. The S6860 can be implemented into a wide range of data handling systems, including stand alone modems, data storage devices, remote data communication terminals and I/O interfaces for minicomputers.

N-channel silicon gate technology permits the S6860 to operate using a single voltage supply and be fully TTL compatible.

The modem is compatible with the S6800 microcomputer family, interfacing directly with the Asynchronous Communications Interface Adapter (ACIA) to provide low-speed data communications capability.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	- 0.3 to +7.0V	Operating Temperature Range T_A	0 to 70°C
Input Voltage V_{IN}	- 0.3 to +7.0V	Storage Temperature Range T_{STG}	- 50 to 150°C

NOTE: This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields, however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

DC (STATIC) CHARACTERISTICS

(V_{CC} = 5.0V ± 5%, T_A = 25°C unless otherwise noted.)

SYMBOL	CHARACTERISTIC	MIN	TYP	MAX	UNIT
V_{IH}	Input High Voltage, All inputs Except Crystal	2.0	–	V_{CC}	Vdc
V_{IL}	Input Low Voltage, All inputs Except Crystal	-0.3	–	0.8	Vdc
V_{IN}	Crystal Input Voltage (Crystal Input Driven from an External Reference, Input Coupling Capacitor = 200 pF, Duty Cycle = 50 ± 5%)	1.5	–	2.0	$V_{p\text{-}p}$
I_{IN}	Input Current				mAdc
	(V_{IN} = GND) All Inputs Except RXCAR,TXDATA, $\overline{TD}$, TST, $\overline{RI}$, $\overline{SH}$	–	–	-0.2	
	$\overline{RI}$, $\overline{SH}$ Inputs	–	–	-1.6	
I_{IL}	Input Leakage Current (V_{IN} = 0 to 5.0 Vdc)	–	–	1.	μAdc
V_{OH1}	Output High Voltage, All Outputs Except ANPH and TXCAR (I_{OH1} = -0.04 mAdc, Load A)	2.4	–	V_{CC}	Vdc
V_{OL1}	Output Low Voltage, All Outputs Except ANPH and TXCAR (I_{OL1} = 1.6 mAdc, Load A)	-0.3	–	0.4	Vdc
I_{OH2}	Output High Current, ANPH (V_{OH2} = 0.8 Vdc, Load B)	0.3	–	–	mAdc
V_{OL2}	Output Low Voltage, ANPH (I_{OL2}) = 0, Load B)	-0.3	–	0.3	Vdc
C_{IN}	Input Capacitance (f = 0.1 MHz)	–	5.	–	pF
C_{OUT}	Output Capacitance (f = 0.1 MHz)	–	10	–	pF
V_{CO}	Transmit Carrier Output Voltage (Load C)	0.20	0.35	0.50	V(RMS)
V_{2H}	Transmit Carrier Output 2nd Harmonic (Load C)	-25	-32	–	dB
I_{DD}	V_{CC} Supply Current (All Inputs at GND & All Outputs Open)	–	30	65	mAdc

AC (DYNAMIC) CHARACTERISTICS

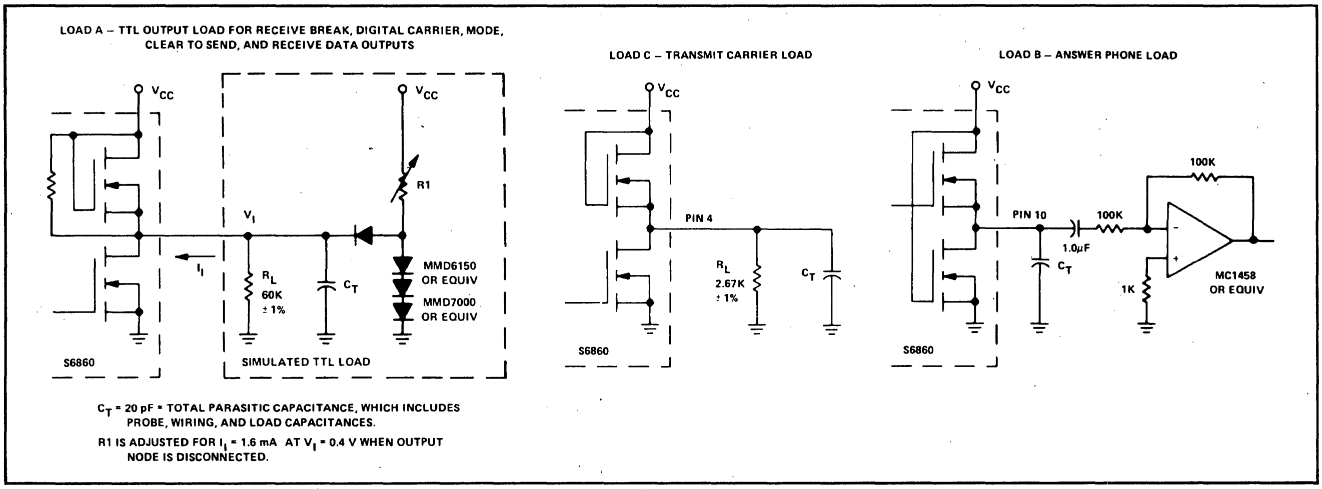
(Loading is as shown in Figure 1 unless otherwise noted.)

SYMBOL	CHARACTERISTIC	MIN	TYP	MAX	UNIT
t_r	Input Transition Times, All Inputs Except Crystal	–	–	1.*	μs
t_f	(Operating in the Crystal Input Mode; from 10% to 90% Points)	–	–	1.*	
t_r	Input Transition Times, Crystal Input	–	–	30	ns
t_f	(Operating in External Input Reference Mode)	–	–	30	
t_r	Output Transition Times, All Outputs Except TXCAR	–	–	5.	μs
t_f	(From 10% to 90% Points)	–	–	5.	

*Maximum Input Transition Times are ⩽0.1 x Pulse Width or the specified maximum of 1.0 μs, whichever is smaller.

AC (DYNAMIC) CHARACTERISTICS (CONT'D)

FIGURE 1 TEST LOADING



MODEM/TERMINAL INTERFACE

PIN	LABEL	FUNCTION
(2)	TXDATA	**Transmit Data** – Serial data transferred to the modem via the ACIA for transmitting to the receiving terminal.
(8)	$\overline{\text{TXBRK}}$	**Transmit Break** – Used to signal the remote modem to stop transmitting data. A Transmit Break (low) greater than 34 ms forces the modem to send a continuous space signal for 233 ms. Transmit Break must be initiated only after $\overline{\text{CTS}}$ has been established. This is a negative edge sense input. Prior to initiating $\overline{\text{TXBRK}}$ this input must be held high for a minimum of 34 ms.
(24)	RXDATA	**Receive Data** – The data resulting from demodulating the Receive Carrier signal. A high level is a mark.
(3)	RXBRK	**Receive Break** – Upon receipt of a continuous 150 ms space, the modem automatically clamps the Receive Break output high. This output is also clamped high until Clear-to-Send is established.
(9)	$\overline{\text{BRKR}}$	**Break Release** – The Receive Break output (clamp high condition) can be removed by holding the Break Release signal low for at least 20 μs after receiving a minimum 150 ms space signal.
(20)	$\overline{\text{DTR}}$	**Data Terminal Ready** – Enables the modem function when low. When $\overline{\text{DTR}}$ is held high for 34 ms minimum, a disconnect is initiated and will occur 3 sec. later.
(23)	$\overline{\text{CTS}}$	**Clear-to-Send** – A low on the $\overline{\text{CTS}}$ output indicates the Transmit Data input has been unclamped from a steady Mark, thus allowing data transmission.
(16)	$\overline{\text{ST}}$	**Self Test** – With this input at a low level, the demodulator is switched to the modulator frequency and demodulates the transmitted FSK signal. Channel establishment, which occurred during the initial handshake, is not lost during self test. The Mode Control output changes state during Self Test, permitting the receive filters to pass the local Transmit Carrier.
(18)	TST	**Test Clock** – A high input signal decreases the modem test time. This input **must be low** for normal operation.
(11)	FO	**Frequency Output** – A test signal is output to decrease modem test time. The signal is a square wave at the transmit frequency.

Self Test truth table:

$\overline{\text{ST}}$	$\overline{\text{SH}}$	$\overline{\text{RI}}$	MODE
H	L	H	H
H	H	L	L
L	L	H	L
L	H	L	H

EXTERNAL MODEM INTERFACE

PIN	LABEL	FUNCTION
(12)	V_{CC}	+ 5 Volts ± 5%
(1)	GND	**Ground**
(22)	$\overline{\text{ESD}}$	**Enable Space Disconnect** – When $\overline{\text{ESD}}$ is strapped low and $\overline{\text{DTR}}$ is pulsed to initiate a disconnect, the modem transmits a space for either 3 s or until a loss of threshold is detected, whichever occurs first. If $\overline{\text{ESD}}$ is strapped high, data instead of a space is transmitted. A disconnect occurs at the end of 3 s.
(5)	$\overline{\text{ELS}}$	**Enable Long Space Disconnect** – A strapping option which, when low, will automatically hang up the phone upon receipt of a continuous space for 1.5 s.
(6)	$\overline{\text{ESS}}$	**Enable Short Space Disconnect** – A strapping option which, when low, will automatically hang up the phone upon receipt of a continuous space for 0.3 s. **$\overline{\text{ESS}}$ and $\overline{\text{ELS}}$ must not be simultaneously strapped low.**
(13)	XTAL	**Crystal** – A 1.0 MHz crystal is required to use the on-chip oscillator. A 1.0 MHz square wave can also be applied to this pin to satisfy the clock requirements. Crystal parameteres are as follows:

Mode:	Parallel
Frequency:	1.0 MHz ± 0.1%
Series Resistance:	750 ohms max
Shunt Capacitance:	7.0 pF max
Temperature:	0 - 70°C
Test Level:	1.0 mW
Load Capacitance:	13 pF

When using the 1.0 MHz crystal, external parasitic capacitance, including crystal shunt capacitance, must be ⩽ 9 pF at the crystal input.

PIN	LABEL	FUNCTION
(14)	RXRATE	**Receive Data Rate** – The demodulator has been optimized for signal-to-noise performance at 300 bps and 600 bps. The Receive Data Rate input must be low for 0-600 bps and should be high for 0-300 bps.

MODEM/DATA COUPLER INTERFACE

PIN	LABEL	FUNCTION
(15)	MODE	**Mode** – Indicates the Originate (high) or Answer (low) status of the modem. This output changes when a Self Test ($\overline{\text{ST}}$) signal is applied.
(19)	$\overline{\text{RI}}$	**Ring Indicator** – The modem function will recognize the receipt of a call from the CBT if at least 20 cycles of the 20 - 47 Hz ringing signal (low level ⩾ 50% of the duty cycle) are present. The CBS $\overline{\text{RI}}$ signal must be level-converted to TTL according to the EIA RS-232 specification before interfacing it with the modem function. The receipt of a call from the CBS is recognized if the $\overline{\text{RI}}$ signal is present for at least 51 ms. This input is held high except during ringing. A $\overline{\text{RI}}$ signal automatically places the modem function in the Answer Mode.
(21)	$\overline{\text{SH}}$	**Switch Hook** – Interfaces directly with the CBT type Data Coupler and via the EIA RS-232 level conversion for the CBS type. An $\overline{\text{SH}}$ signal automatically places the modem function in the Originate Mode. $\overline{\text{SH}}$ is low during origination of a call. The modem will automatically hang up 17 s after releasing $\overline{\text{SH}}$ if the handshaking routine has not been accomplished.

MODEM/DATA COUPLER INTERFACE (Continued)

PIN	LABEL	FUNCTION
(4)	ANPH	**Answer Phone** – Upon receipt of Ring Indicator or Switch Hook signal and Data Terminal Ready, the Answer Phone output goes high ($[\overline{SH} + \overline{RI}] \bullet \overline{DTR}$). This signal drives the base of a transistor which activates the Off Hook and Data Transmission control lines in the data coupler. Upon call completion, the Answer Phone signal returns to a low level.
(7)	$\overline{TD}$	**Threshold Detect** – This input is derived from an external threshold detector. If the signal level is sufficient, the $\overline{TD}$ input must be low for 20 μs at least once every 32 ms to maintain normal operation. An insufficient signal level indicates the absence of the Receive Carrier; an absence for less than 32 ms will not cause channel establishment to be lost; however, data during this interval will be invalid.
		If the signal is present and the level is acceptable at all times, then the threshold input can be low permanently. Loss of threshold for 51 ms or longer results in a loss of Cler-to-Send. The Transmit Carrier of the originate modem is clamped off and a constant Mark is transmitted from the answer modem.
(17)	RXCAR	**Receive Carrier** – The FSK input to the demodulators. The local Transmit Carrier must be balanced or filtered out prior to this input, leaving only the Receive Carrier in the signal. The Receive Carrier must also be hard limited. Any half cycle period greater than or equal to 429 ± 1.0 μs for the low band or 235 ± 1.0 μs for the high band is detected as a space.
(10)	TXCAR	**Transmit Carrier** – A digitally synthesized sine wave derived from a 1.0 MHz crystal reference (see Figure 2). Frequency characteristics are given in the following table.

MODE	DATA	FREQUENCY	TOLERANCE*
Originate	Mark	1270 Hz	- 0.15 Hz
Originate	Space	1070 Hz	- 0.09 Hz
Answer	Mark	2225 Hz	- 0.31 Hz
Answer	Space	2025 Hz	- 0.71 Hz

*The reference frequency tolerance is not included.

The proper output frequency is transmitted within 3.0 μs following a data bit change with no more than 2.0 μs phase discontinuity. The typical output level is 0.35 V (RMS) into a 100K-ohm load impedance.

The second harmonic is typically 32 dB below the fundamental (see Figure 3).

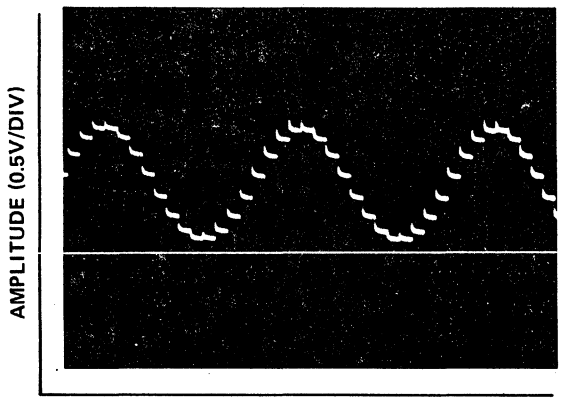


FIGURE 2 TRANSMIT CARRIER SINE WAVE

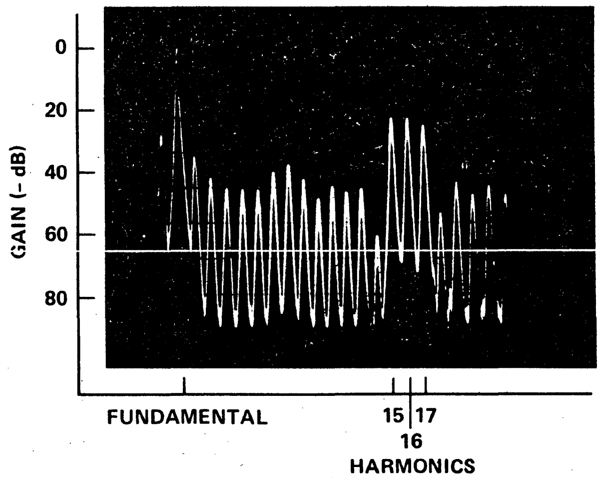


FIGURE 3 TRANSMIT CARRIER FREQUENCY SPECTRUM

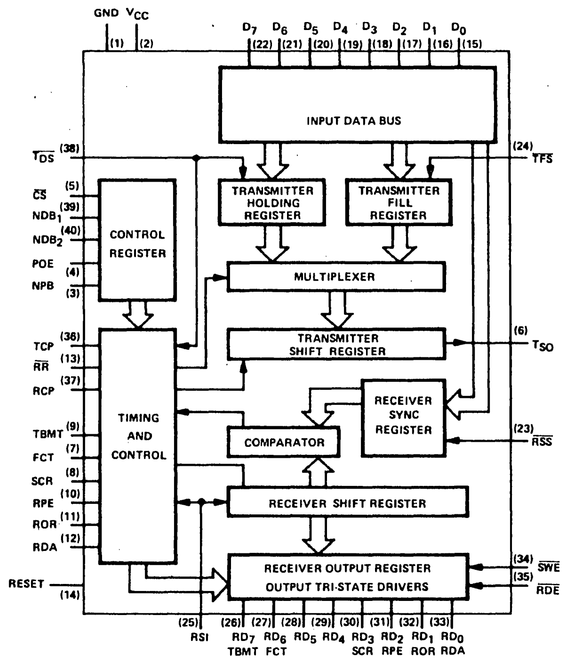
AMI®

AMERICAN MICROSYSTEMS, INC.

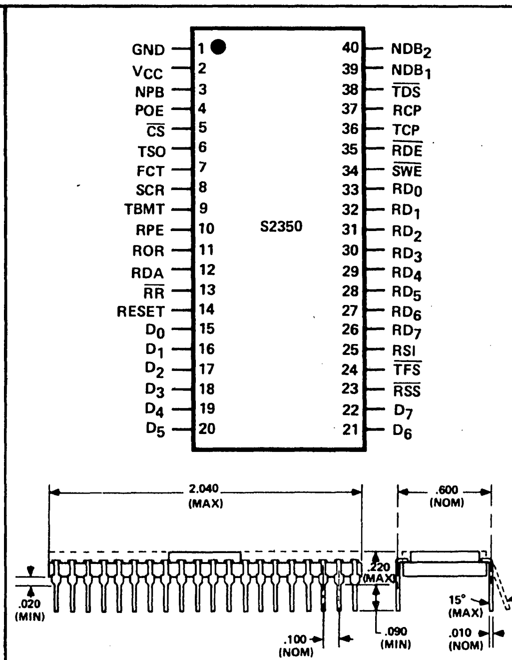
S2350

UNIVERSAL SYNCHRONOUS
RECEIVER/TRANSMITTER (USRT)

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- 500 KHz Data Rates
- Internal Sync Detection
- Fill Character Register
- Double Buffered Input/Output
- Bus Oriented Outputs
- 5–8 Bit Characters
- Odd/Even or No Parity
- Error Status Flags
- Single Power Supply (+5v)
- Input/Output TTL Compatible

FUNCTIONAL DESCRIPTION

The S2350 Universal Synchronous Receiver Transmitter (USRT) is a single chip MOS/LSI device that totally replaces the serial to parallel and parallel to serial conversion logic required to interface a word parallel controller or data terminal to a bit-serial, synchronous communication network.

The USRT consists of separate receiver and transmitter sections with independent clocks, data lines and status. Common with the transmitter and receiver are word length and parity mode. Data is transmitted and received in a NRZ format at a rate equal to the respective input clock frequency.

Data messages are transmitted as a contiguous character stream, bit synchronous with respect to a clock and character synchronous with respect to framing or "sync" characters initializing each message. The USRT receiver compares the contents of the internal Receiver Sync Register with the incoming data stream in a bit transparent mode. When a compare is made, the receiver becomes character synchronous formatting a 5, 6, 7, or 8 bit character for output each character time. The receiver has an output buffer register allowing a full character time to transfer the data out. The receiver status outputs indicate received data available (RDA), receiver overrun (ROR), receive parity error (RPE) and sync character received (SCR). Status bits are available on individual output lines and can also be multiplexed onto the output data lines for bus organized systems. The data lines have tri-state outputs.

The USRT transmitter outputs 5, 6, 7, or 8 bit characters with correct parity at the transmitter serial output (TSO). The transmitter is buffered to allow a full character time to respond to a transmitter buffer empty (TBMT) request for data. Data is transmitted in a NRZ format changing on the positive transition of the transmitter clock (TCP). The character in the transmitter fill register is inserted into the data message if a data character is not loaded into the transmitter after a TBMT request.

TYPICAL APPLICATIONS

- Computer Peripherals
- Communication Concentrators
- Integrated Modems
- High Speed Terminals
- Time Division Multiplexing
- Industrial Data Transmission

ABSOLUTE MAXIMUM RATINGS

Ambient temperature under bias	0°C to + 70°C
Storage temperature	–65°C to +150°C
Positive voltage on any pin with respect to GROUND	+7 volt
Negative voltage on any pin with respect to GROUND	–0.5 volt
Power dissipation	0.75 watt

DC (STATIC) CHARACTERISTICS*

V_{CC} = +5V ±5V ±5%, T_A = 25°C unless otherwise noted.

Symbol	Parameter	Min.	Max.	Unit	Condition
V_{IH}	Input High Voltage	2.0	V_{CC}	Volt	
V_{IL}	Input Low Voltage	- 0.5	+0.8	Volt	
I_{IL}	Input Leakage Current		10	μa	V_{IN} = OTO V_{CC} Volts
V_{OH}	Output High Voltage	2.4		Volts	I_{OH} = –100μa
V_{OL}	Output Low Voltage		+0.4	Volts	I_{OL} = 1.6ma
C_{IN}	Input Capacitance		10	pf	} V_{IN} = 0 Volt
C_{OUT}	Output Capacitance		12	pf	} f = 1.0 MHZ
I_{CC}	V_{CC} Supply Current		100	ma	No Load

*Electrical characteristics included in this advanced product description are objective specifications and may be subject to change.

AC (DYNAMIC) CHARACTERISTICS

V_{CC} = +5V ±5%, T_A = 25°C unless otherwise noted.

Symbol	Parameter	Min.	Max.	Unit	Condition
TCP, RCP	Clock Frequency	DC	500	KHz	

Input Pulse Widths

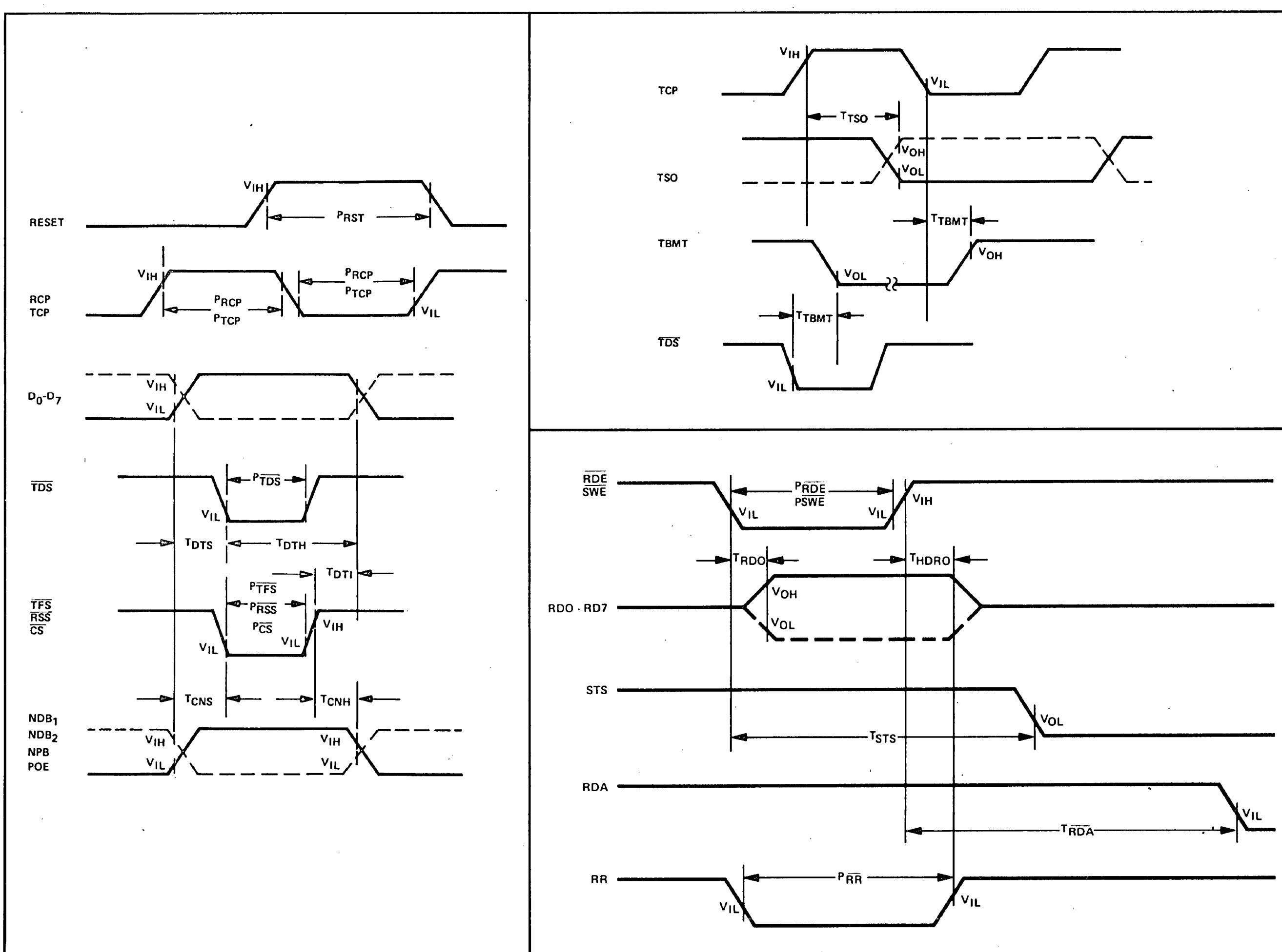
P_{TCP}	Transmit Clock	900		nsec	C_L = 20pf
P_{RCP}	Receive Clock	900		nsec	1TTL Load
P_{RST}	Reset	500		nsec	
$P_{\overline{TDS}}$	Transmit Data Strobe	200		nsec	
$P_{\overline{TFS}}$	Transmit Fill Strobe	200		nsec	
$P_{\overline{RSS}}$	Receive Sync Strobe	200		nsec	
$P_{\overline{CS}}$	Control Strobe	200		nsec	
$P_{\overline{RDE}}$	Receive Data Enable	400		nsec	Note 1
$P_{\overline{SWE}}$	Status Word Enable	400		nsec	Note 1
$P_{\overline{RR}}$	Receiver Restart	500		nsec	

AC (DYNAMIC) CHARACTERISTICS (CONT'D)
SWITCHING CHARACTERISTICS

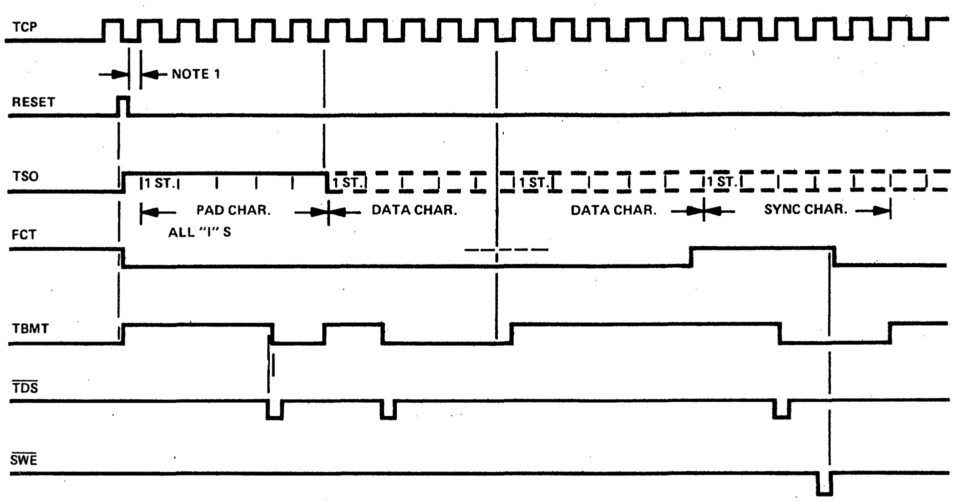
T_{TSO}	Delay, TCP Clock to Serial Data Out		700	nsec	
T_{TBMT}	Delay, TCP Clock to TBMT Output		1.4	μsec	
T_{TBMT}	Delay, $\overline{TDS}$ to TBMT		700	nsec	
T_{STS}	Delay, $\overline{SWE}$ to Status Reset		700	nsec	
T_{RDO}	Delay, $\overline{SWE}$, $\overline{RDE}$ to Data Outputs		400	nsec	1 TTL Load
T_{HRDO}	Hold Time $\overline{SWE}$, $\overline{RDE}$ to Off State		400	nsec	C_L = 130 pf
T_{DTS}	Data Set Up Time $\overline{TDS}$, $\overline{TFS}$, $\overline{RSS}$, $\overline{CS}$	0		nsec	
T_{DTH}	Data Hold Time $\overline{TDS}$	700		nsec	
T_{DTI}	Data Hold Time $\overline{TFS}$, $\overline{RSS}$	200		nsec	
T_{CNS}	Control Set Up Time NDB1, NDB2, NPB, POE	0		nsec	
T_{CNH}	Control Hold Time NDB1, NDB2, NPB, POE	200		nsec	
T_{RDA}	Delay $\overline{RDE}$ to $\overline{RDA}$ Output	700		nsec	

NOTE 1: Required to reset status and flags.

TIMING WAVEFORMS

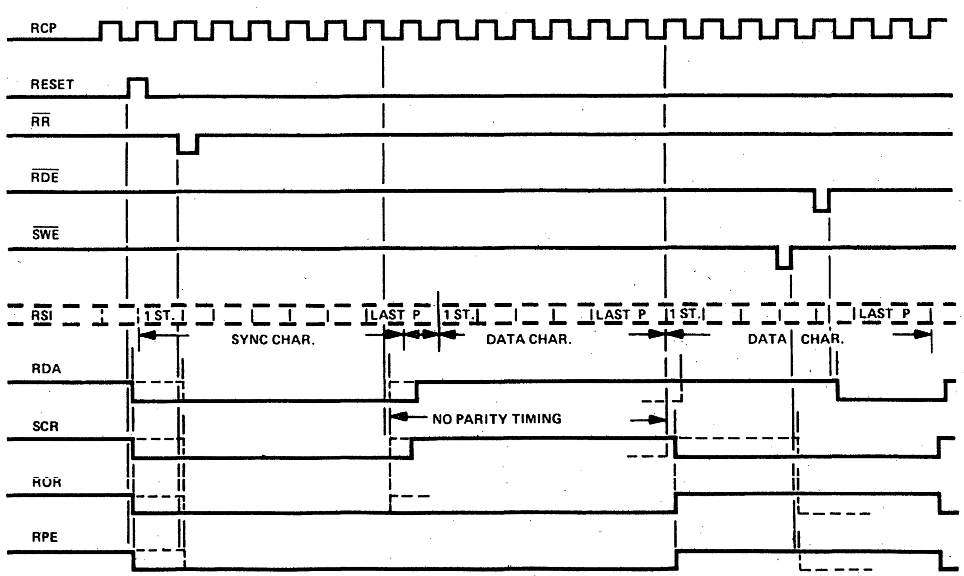


TRANSMITTER TIMING DIAGRAM



NOTE 1 DATA TRANSMISSION WILL START ON THE FIRST LOW TO HIGH TRANSITION OF TCP AFTER RESET IS LOW. THE INITIAL RESET PULSE SHOULD NOT OCCUR UNTIL 100 MICROSECONDS AFTER POWER IS APPLIED.

RECEIVER TIMING DIAGRAM



MPU/ACIA INTERFACE (CONT'D)

Pin	Label	Function
(1)	GND	Ground
(2)	V_{CC}	+5 VOLTS ±5%
(14)	RESET	MASTER RESET A V_{IH} initializes both the receiver and transmitter. The Transmitter Shift Register is set to output a character of all logic 1's. FCT is reset to V_{OL} and TBMT set to V_{OH} indicating the Transmitter Holding Register is empty. The receiver status is initialized to a V_{OL} on RPE, SCR, and RDA. The sync character detect logic is inhibited until a RR pulse is received.
(15) (16) (17) (18) (19) (20) (21) (22)	D0 D1 D2 D3 D4 D5 D6 D7	DATA INPUTS Data on the eight data lines are loaded into the Transmitter Holding Register by $\overline{TDS}$, the Transmitter Fill Register by $\overline{TFS}$, and the Receiver Sync Register by $\overline{RSS}$. The character is right justified with the LSB at D0. For word lengths less than 8 bits, the unused inputs are ignored. Data transmission is LSB first.
(38)	$\overline{TDS}$	TRANSMIT DATA STROBE A V_{IL} loads data on D0-D7 into the Transmitter Holding Register and resets TBMT to a V_{OL}.
(24)	$\overline{TFS}$	TRAMSMIT FILL STROBE A V_{IL} loads data on D0-D7 into the Transmitter Fill Register. The character in the Transmitter Fill Register is transmitted whenever a new character is not loaded in the allotted time.
(23)	$\overline{RSS}$	RECEIVER SYNC STROBE A V_{IL} loads data on D0-D7 into the Receiver Sync Register. SCR is set to V_{OH} whenever data in the Receiver Shift Register compares with the character in the Receiver Sync Register.
(9)	TBMT	TRANSMIT BUFFER EMPTY A V_{OH} indicates the data in the Transmitter Holding Register has been transferred to the Transmitter Shift Register and new data may be loaded. TBMT is reset to V_{OL} by a V_{IL} on $\overline{TDS}$. A V_{IH} on RESET sets TBMT to a V_{OH}. TBMT is also multiplexed onto the RD7 output (26) when $\overline{SWE}$ is at V_{IL} and $\overline{RDE}$ is at V_{IH}.
(6)	TSO	TRANSMITTER SERIAL OUTPUT Data entered on D0-D7 are transmitted serially, least significant bit first, on TSO at a rate equal to the Transmit Clock frequency, TCP. Source of the data to the transmitter shift register is the Transmitter Holding Register or Transmitter Fill Register.
(36)	TCP	TRANSMIT CLOCK Data is transmitted on TSO at the frequency of the TCP input in a NRZ format. A new data bit is started on each negative to positive transition (V_{IL} to V_{IH}) of TCP.
(26) (27) (28) (29) (30) (31) (32)	RD7 RD6 RD5 RD4 RD3 RD2 RD1	RECEIVED DATA OUTPUTS RD0-RD7 contain data from the Receiver Output Register or selective status conditions depending on the state of $\overline{SWE}$ and $\overline{RDE}$ per the following table:

MPU/ACIA INTERFACE (CONT'D)

Pin	Label	Function
(33)	RD0	see table below

(34)	(35)	(33)	(32)	(31)	(30)	(39)	(28)	(27)	(26)
$\overline{SWE}$	$\overline{RDE}$	RD0	RD1	RD2	RD3	RD4	RD5	RD6	RD7
V_{IL}	V_{IL}	X	X	X	X	X	X	X	X
V_{IL}	V_{IH}	RDA	ROR	RPE	SCR	V_{OL}	V_{OL}	FCT	TBMT
V_{IH}	V_{IL}	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7
V_{IH}	V_{IH}	X	X	X	X	X	X	X	X

X Output is in the OFF or Tri-State condition
DB0 LSB of Receiver Output Register
DB7 MSB of Receiver Output Register
The two unused outputs are held at V_{OL} in the output status condition.

Pin	Label	Function
(35)	$\overline{RDE}$	RECEIVE DATA ENABLE A V_{IL} enables the data in the Receiver Output Register onto the output data lines RD0–RD7. The trailing edge (V_{IL} to V_{IH} transition) of $\overline{RDE}$ resets RDA to the V_{OL} condition.
(7)	FCT	FILL CHARACTER TRANSMITTED A V_{OH} on FCT indicates data from the Transmitter Fill Register has been transferred to the Transmitter Shift Register. FCT is reset to V_{OL} when data is transferred from the Transmitter Holding Register to the Transmitter Shift Register, or on the trailing edge (V_{IL} to V_{IH}) of the $\overline{SWE}$ pulse, or when RESET is V_{IH}. FCT is multiplexed onto the RD6 output (27) when $\overline{SWE}$ is at V_{IL} and $\overline{RDE}$ is at V_{IH}.
(25)	RSI	RECEIVER SERIAL INPUT Serial data is clocked into the Receiver Shift Register, least significant bit first, on RSI at a rate equal to the Receive Clock frequency RCP.
(37)	RCP	RECEIVE CLOCK Data is transferred from RSI input to the Receiver Shift Register at the frequency of the RCP input. Each data bit is entered on the positive to negative transition (V_{IH} to V_{IL}) of RCP.
(12)	RDA	RECEIVED DATA AVAILABLE A V_{OH} indicates a character has been transferred from the Receiver Shift Register to the Receiver Output Register. RDA is reset to V_{OL} on the trailing edge (V_{IL} to V_{IH} transition) of $\overline{RDE}$, by a V_{IL} on $\overline{RR}$ or a V_{IH} on RESET. RDA is multiplexed onto the RD0 output (33) when $\overline{SWE}$ is V_{IL} and $\overline{RDE}$ is V_{IH}.
(8)	SCR	SYNC CHARACTER RECEIVED A V_{OH} indicates the data in the Receiver Shift Register is identical to the data in the Receiver Sync Register. SCR is reset to a V_{OL} when the character in the Receiver Shift Register does not compare to the Receiver Sync Register, on the trailing edge (V_{IL} to V_{IH} transition) of $\overline{SWE}$, by a V_{IL} on $\overline{RR}$ or a V_{IH} on RESET. SCR is multiplexed onto the RD3 output (30) when $\overline{SWE}$ is a V_{IL} and $\overline{RDE}$ is V_{IH}.

MPU/ACIA INTERFACE (CONT'D)

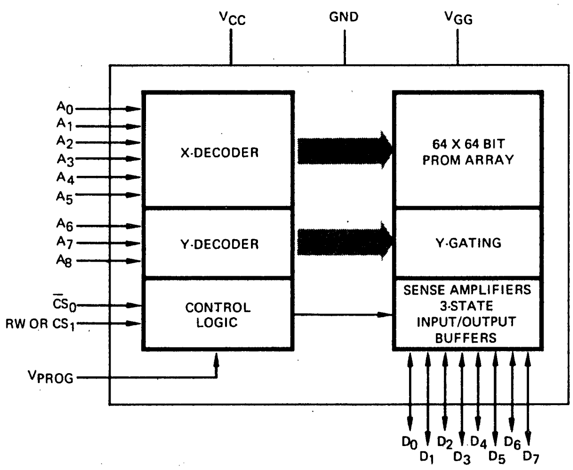
<table>
<tr><th>Pin</th><th>Label</th><th>Function</th></tr>
<tr><td>(34)</td><td>$\overline{SWE}$</td><td>STATUS WORD ENABLE A V_{IL} enables the internal status conditions onto the output data lines RD0–RD7.
The trailing edge of $\overline{SWE}$ pulse resets FCT, ROR, RPE, and SCR to V_{OL}.</td></tr>
<tr><td>(11)</td><td>ROR</td><td>RECEIVER OVERRUN A V_{OH} indicates data has been transferred from the Receiver Shift Register to the Receiver Output Register when RDA was still set to V_{OH}. The last data in the Output Register is lost.
ROR is reset by the trailing edge (V_{IL} to V_{IH}) of $\overline{SWE}$, a V_{IL} on $\overline{RR}$, a V_{IH} on RESET or a V_{OL} to V_{OH} transition of RDA.
ROR is multiplexed onto the RD1 output (32) when $\overline{SWE}$ is V_{IL} and $\overline{RDE}$ is V_{IH}.</td></tr>
<tr><td>(10)</td><td>RPE</td><td>RECEIVER PARITY ERROR A V_{OH} indicates the accumulated parity on the received character transferred to the Output Register does not agree with the parity selected by POE.
RPE is reset with the next received character with correct parity, the trailing edge (V_{IL} to V_{IH}) of $\overline{SWE}$, a V_{IL} on $\overline{RR}$ or a V_{IH} on RESET.
RPE is multiplexed onto the RD2 output (31) when $\overline{SWE}$ is V_{IL} and $\overline{RDE}$ is V_{IH}.</td></tr>
<tr><td>(13)</td><td>$\overline{RR}$</td><td>RECEIVER RESTART A V_{IL} resets the receiver section by clearing the status RDA, SCR, ROR, and RPE to V_{OL}. The trailing edge of $\overline{RR}$ (V_{IL} to V_{IH}) also puts the receiver in a bit transparent mode to search for a comparison, each bit time, between the contents of the Receiver Shift Register and the Receiver Sync Register. The number of data bits per character for the comparison is set by NDB1 and NDB2. After a compare is made SCR is set to V_{OH}, the sync character is transferred to the Receiver Output Register, and the receiver enters a word synchronous mode framing an input character each word time.
NOTE: Parity is not checked on the first sync character but is enabled for every succeeding character.</td></tr>
<tr><td>(39)</td><td>NDB1</td><td>NUMBER DATA BITS The number of Data Bits per character are determined by NDB1 and NDB2. The number of data bits does not include the parity bit.
<table>
<tr><th>NDB2</th><th>NDB1</th><th>CHARACTER LENGTH</th></tr>
<tr><td>V_{IL}</td><td>V_{IL}</td><td>5 Bits</td></tr>
<tr><td>V_{IL}</td><td>V_{IH}</td><td>6 Bits</td></tr>
<tr><td>V_{IH}</td><td>V_{IL}</td><td>7 Bits</td></tr>
<tr><td>V_{IH}</td><td>V_{IH}</td><td>8 Bits</td></tr>
</table>
For character lengths less than 8 bits, unused inputs are ignored and unused outputs are held to V_{OL}. Data is always right justified with D0 and RD0 being the least significant bits.</td></tr>
<tr><td>(3)</td><td>NPB</td><td>NO PARITY BIT A V_{IH} eliminates generation of a parity bit in the transmitter and checking of parity in the receiver. With parity disabled, the RPE status bit is held at V_{OL}.</td></tr>
<tr><td>(4)</td><td>POE</td><td>PARITY ODD/EVEN A V_{IH} directs both the transmitter and receiver to operate with even parity. A V_{IL} forces odd parity operation. NPB must be VIL for parity to be enabled.</td></tr>
<tr><td>(5)</td><td>$\overline{CS}$</td><td>CONTROL STROBE A V_{IL} loads the control inputs NDB1, NDB2, POE, and NPB into the Control Register. For static operation, $\overline{CS}$ can be tied directly to ground.</td></tr>
</table>

S6834

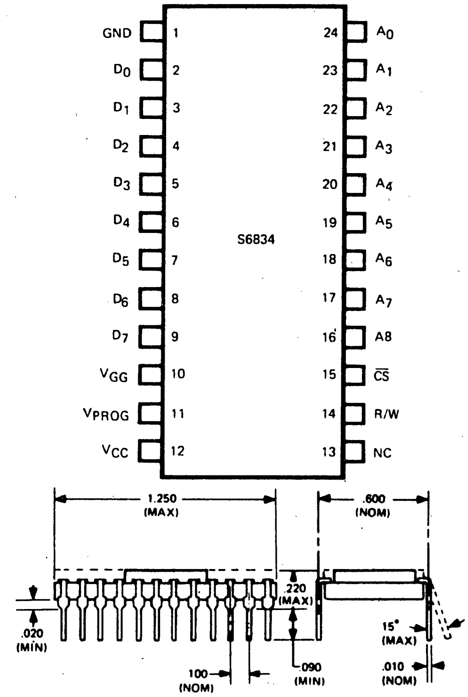
512 X 8 BIT
ERASEABLE AND
ELECTRICALLY REPROGRAMMABLE
READ ONLY MEMORY

AMERICAN MICROSYSTEMS, INC.

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- On-Board Programmability
- Fast Access Time – 500 ns Typ.
- Pin Configuration Similar to the S6830 1K x 8 Bit ROM
- High Speed Programming – Less than 1 Minute for all 4096 Bits
- Programmed with R/W, CS and V_{PROG} Pins
- Completely TTL Compatible – Excluding the V_{PROG} Pin
- Ultraviolet Light Erasable – Less than 10 Minutes
- Static Operation – No Clocks Required
- Three-State Data I/O
- Standard Power Supplies +5V and –12V
- Mature P-Chan Process

MICROPROCESSOR AMI

FUNCTIONAL DESCRIPTION

The S6834 is a high speed, static, 512 x 8 bit, eraseable and electrically programmable read only memory designed for use in bus-organized systems. Both input and output are TTL compatable during both read and write modes. Packaged in a 24 pin hermetically sealed dual in-line package the bit pattern can be erased by exposing the chip to an ultra-violet light source through the transparent lid, after which a new pattern can be written.

TYPICAL APPLICATIONS

- ROM Program Debugging
- Code Translation
- Microprogramming
- Look-up Tables
- Random Logic Replacement
- Programmable Waveforms
- Character Generation
- Electronic Keyboards

ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS} except the V_{PROG} pin	+0.3 to –20V
Voltage on the V_{PROG} pin relative to V_{SS}	+0.3 to –55V
Operating Temperature	0°C to +70°C
Storage Temperature (programmed)	–55°C to +85°C
Storage Temperature (unprogrammed)	–55°C to 150°C

NOTE: This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields, however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

DC (STATIC) CHARACTERISTICS (V_{CC} = +5.0V ± 5%, V_{GG} = –12.0V ± 5% T_A = 0 – 70°C unless otherwise noted).

SYMBOL	CHARACTERISTIC	MIN	MAX	UNIT
V_{IL}	INPUT VOLTAGE LOW		0.8	V
V_{IH}	INPUT VOLTAGE HIGH	V_{CC} –2.25	V_{CC} to .3	V
V_{OL}	OUTPUT VOLTAGE LOW I_{OL} = 1.6 ma		0.4	V
V_{OH}	OUTPUT VOLTAGE HIGH I_{OH} = 40 μa	2.4		V
I_{LI}	INPUT LEAKAGE CURRENT		20	μa
I_{LO}	OUTPUT LEAKAGE CURRENT CS = 5V		10	μa
I_{GG}	V_{GG} SUPPLY CURRENT		45	ma
I_{CC}	V_{CC} SUPPLY CURRENT		50	ma
P_D	POWER DISSIPATION		750	mw

NOTE: Program input V_{PROG} may be tied to V_{CC} during the Read.

AC (DYNAMIC) CHARACTERISTICS (Loading is as shown in Figure 1 unless otherwise noted).

SYMBOL	CHARACTERISTIC	MIN	MAX (6834)	MAX (6834–1)	UNIT
T_{ACC}	ACCESS TIME		575	750	ns
T_{CO}	CHIP SELECT TO OUTPUT DELAY		300	400	ns
T_{DD}	CHIP DESELECT TO OUTPUT DELAY		250	325	ns

FIGURE 1 — TEST CONDITIONS

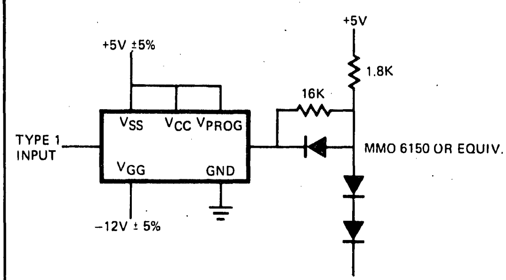
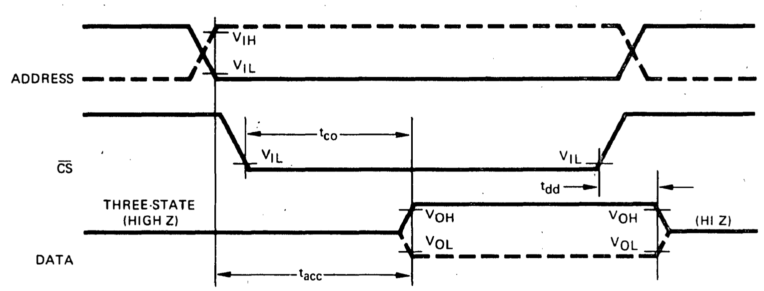


FIGURE 2 — READ CYCLE TIMING WAVEFORMS



PROGRAM CHARACTERISTICS (R/W G_{nd}, Program pulse rise and fall time (10% to 90%) are both at 1μs max).

SYMBOL	CHARACTERISTICS	MIN	MAX	UNIT
T_{AS}	ADDRESS SET UP TIME	10		μs
T_{CSS}	CHIP SELECT SET UP TIME	10		μs
T_{DS}	DATA SET UP TIME	10		μs
T_{AH}	ADDRESS HOLD TIME	10		μs
T_{CSH}	CHIP SELECT HOLD TIME	10		μs
T_{DH}	DATA HOLD TIME	10		μs
T_{PWL}	PROGRAM PULSE WIDTH LOW	3	5	ms
T_{PWH}	PROGRAM PULSE WIDTH HIGH	500		μs
V_{PROG}	PROGRAM AMPLITUDE	−55	−50	V
I_{PROG}	PROGRAM CURRENT		35	ma
T_{WS}	WRITE SET UP TIME	10		μs
T_{WH}	WRITE HOLD TIME	5		μs
T_{RS}	READ SET UP TIME	10		μs

FIGURE 3 —PROGRAMMING CYCLE TIMING WAVEFORMS

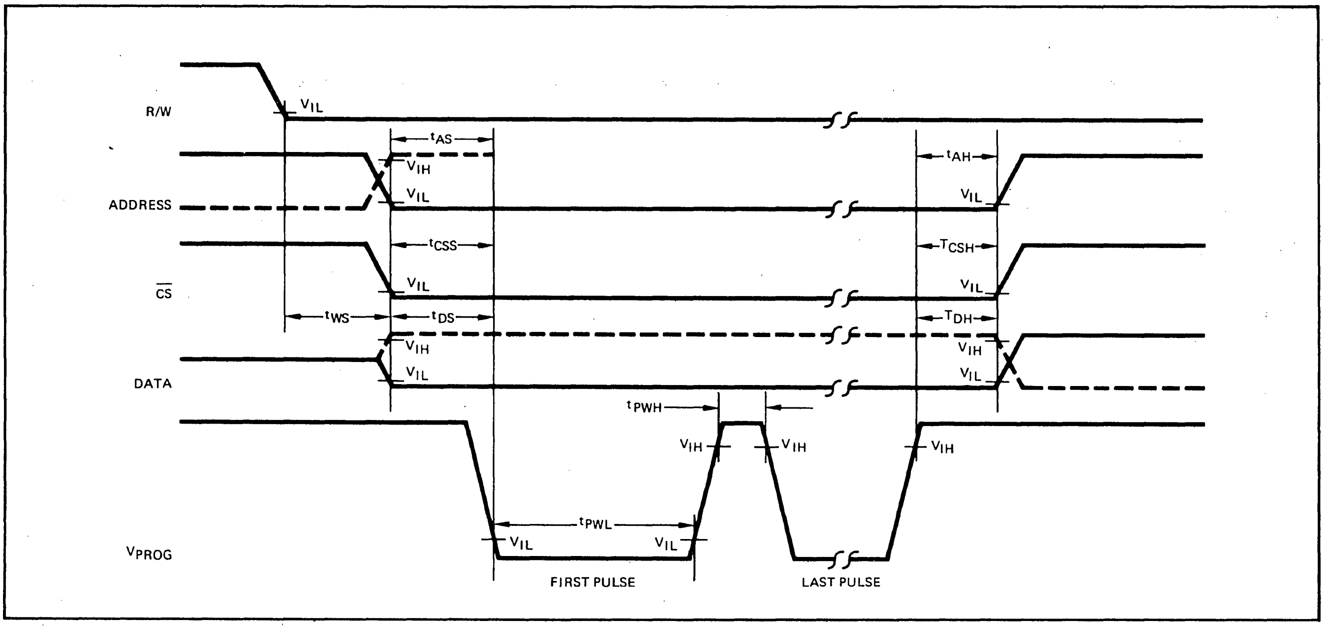
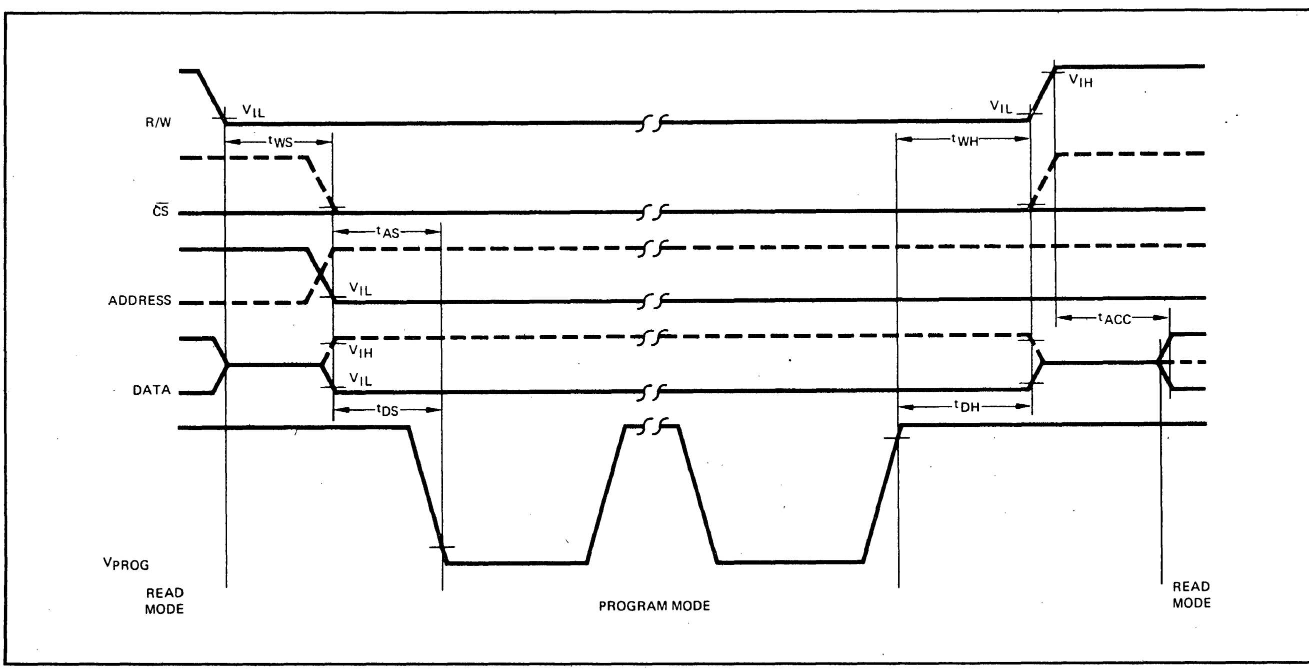


FIGURE 4 —READ/PROGRAM/READ CYCLE TIMING WAVEFORM



CONTROL FUNCTION TRUTH TABLE

CS	R/W	V_{PROG}	MODE	OUTPUTS
0	0	V_{PROG}	Write	Active Data Inputs
0	1	V_{CC}	Read	Active
1	X	X	Standby	Floating

OPERATION

Initially, and after each erasure, all bits of the 6834 are in the logic "0" state (output 0 volts). Data is stored by selectively programming a logic "1" into the desired bit locations. The R/W input (pin 14) is used to select the desired mode of operation. When the R/W input is at logic "0" the chip is in the write enable mode of operation. The outputs (0_1 -0_8) are disabled (floating) with the corresponding pins becoming the data inputs (0_1 → $D_{IN\ 1}$ etc.). The word address is selected in the same manner as in the read mode. Data to be programmed are presented 8 bits in parallel and after the address and data are set up a programming pulse (V_P −50 volts) is applied. V_{PROG} electrically writes the data into the memory array. Writing may be inhibited by deselecting the chip with the CS input at a logic "1" during the write cycle. This feature allows true "on board" programming in bus organized systems where the R/W and V_{PROG} inputs are common and the device to be programmed is selected by means of the chip select input as during read operations.

The amount of program energy required to insure memory retention may be defined as a function of the number of program pulses (N) times the program pulse width (t_{pw}) (N x $t_{pw} \geqslant 60$ msec). This means if a 3 ms pulse is used, 20 program pulses are required, and if a 5 ms pulse is used 12 program pulses are required.

The read operation is accomplished by a logic "1" at the R/W input with the program input connected to V_{SS} potential. True data (data out = data in) is valid after the address is stable. The CS input will disable (float) the outputs when at a logic "1" to allow or tie capability.

Erasure is accomplished by exposing the array to a high intensity ultra-violet light source (such as, Ultra-Violet Products, Inc. Lamp Model S52 or UVS-54) for a period of 7 to 10 minutes. The clear optical lid should be approximately one inch away from the lamp tubes.

INTERFACE DESCRIPTION

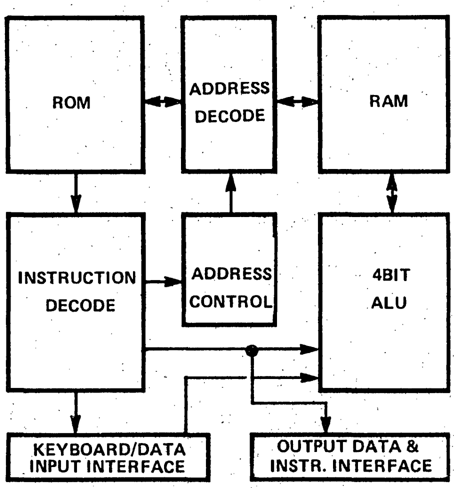
Pin	Label	Function
(2) (3) (4) (5) (6) (7) (8) (9)	D0 D1 D2 D3 D4 D5 D6 D7	**Data Lines** – with the R/W line selected for Read (V_{IH}), the Data Lines (D0 through D7) are set to reflect the contents of the selected memory location. When the R/W line is set for Write (V_{IL}), the Data Lines are input to the addressed location of the 6834 when V_{PROG} is present. The Data Bus output drivers are three-state devices that remain in the high impedance (off) state whenever CS is in the V_{IH} state.
(14)	R/W	**Read/Write** – When this input line is set to V_{IH}, the device is in the Read mode, a low (V_{IL}) signal puts it into the Write mode.
(15)	CS	**Chip Select** – This input line must be set to V_{IL} for a Read or Write operation to be performed. When it is High (V_{IH}) the output data bus is set to a high-impedance three-state condition.
(11)	V_{PROG}	**Program** – In the Write mode, a programming pulse (−50V dc) at this input causes the data at the Data Lines to be stored in the selected address. This pin should be tied to V_{CC} for normal Read operations.
(24) (23) (22) (21) (20) (19) (18) (17) (16)	A0 A1 A2 A3 A4 A5 A6 A7 A8	**Address Lines** – These lines select the 8 bit word in memory for Read or Write operation

AMERICAN MICROSYSTEMS, INC.

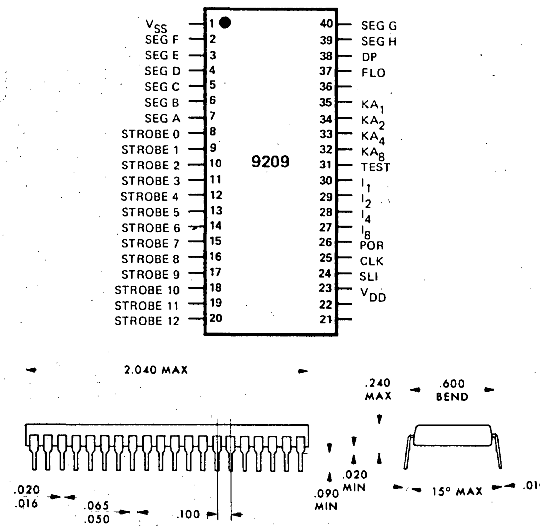
9209

MICROPROGRAMMABLE
4-BIT CONTROLLER

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



NOTE: FOR APPLICATIONS REQUIRING FEWER INPUTS AND OUTPUTS, A 28 PIN PACKAGE IS AVAILABLE

PIN/PACKAGE CONFIGURATION
PLASTIC PACKAGE

FEATURES

- 4-bit parallel ALU
- 6048 bit internal ROM
- 256 bit internal RAM
- Two Accumulators
- Microinstruction decoding and control logic
- Clock generator integral to the chip
- Programmable keyboard matrix and debounce
- Programmable output
- Automatic power-on clear or initialization
- Outputs drive LED segments or flourescent displays directly
- Separate Input/Output Circuits

FUNCTIONAL DESCRIPTION

The 9209 Microprogrammable Controller (MPC) provides a flexible method of creating a variety of calculator and display-oriented microprocessor circuits. Designed to handle numeric input/output and display of up to 12 digits, the MPC contains all the essential elements of a microcomputer on one MOS chip (see block diagram).

These elements—combined with an unusually versatile instruction set—allow the MPC to be used in a wide variety of calculator and non-calculator fixed program applications.

TYPICAL APPLICATIONS

The relatively low cost of the MPC combined with its on-chip ROM and RAM functions permits its use in a wide variety of specialized systems requiring a nominal amount of data processing and data manipulation capability. Its area of application lies between special purpose (custom) LSI chips and standard high performance microprocessors.

The MPC can be used by itself or, with a small amount of external hardware, several may be connected in tandem for applications requiring increased capability. Figure 2 on the following page shows a typical multichip application in a high-end printing calculator using a 9209, a peripheral interface chip and a keyboard buffer chip.

Figure 3 shows the use of the 9209, a UART (Universal Asynchronous Receiver/Transmitter), and some TTL devices to implement a small terminal, used for the verification of

TYPICAL APPLICATIONS (Cont'd.)

credit sales and similar applications. All terminals in this network are periodically interrogated by the CPU and when a terminal receives its ID code (which is read in from the ID jumper matrix), it responds with "no transaction," or with the data which has been keyed in by the operator. In the latter case, the CPU responds with a discrete (OK, HOLD, WAIT, etc.) a credit limit, or other data such as a phone number to call, or a number sequence which must be given by the customer. Other applications include order entry and billing terminals.

A third application shown is the use of the 9209 MPC as the controller for a digital FM tuner. The system is capable of storing ten station frequencies and includes automatic and manual search modes. Preselected stations are called up by depressing a single pushbutton.

As station entries are made, they are checked to assure that a valid frequency entry has been made. The preselected frequencies can be stored in the MPC's internal RAM, but normally are stored in a CMOS shift register with a separate battery supply to prevent loss of station data in the event of power failure.

In addition to the preceding, the main use of the MPC is in single and multichip calculator and counting systems. AMI offers as standard products the following calculators which use the MPC chip:

S9414 – 12 digit, five function display calculator with memory, item count, average and mark-up.
S9651 – 10 digit, 7 function "slide-rule" with scientific notation and memory, square root and reciprocals.

Examples of two of these are shown below, as a guide to the functional complexity possible with this chip.

FIGURE 1 TYPICAL KEYBOARD

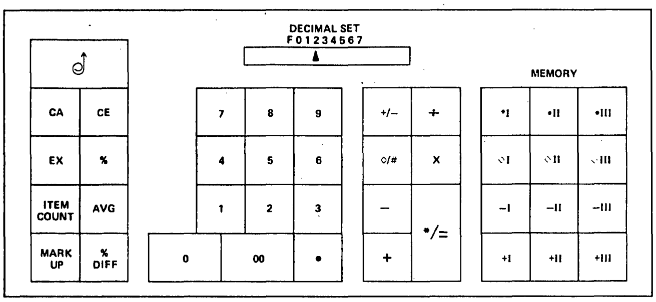


FIGURE 3 CREDIT VERIFICATION TERMINAL

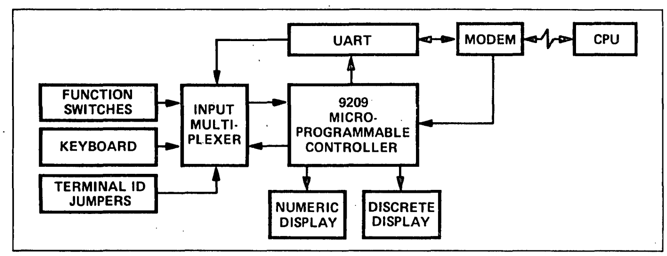


FIGURE 2 12-DIGIT PRINTING CALCULATOR SYSTEM

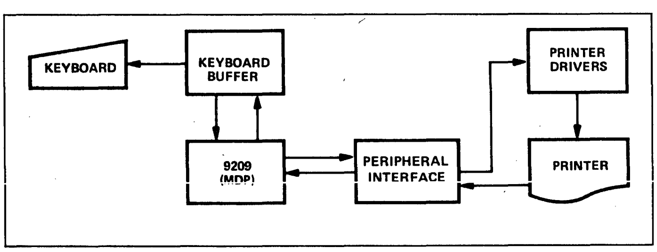


FIGURE 4 DIGITAL TUNER

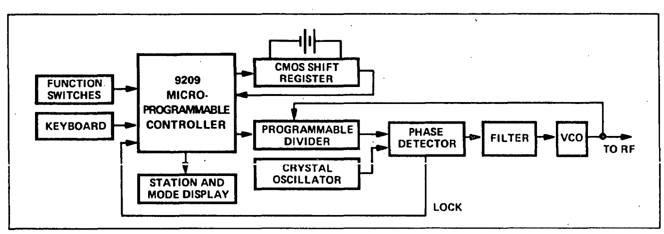
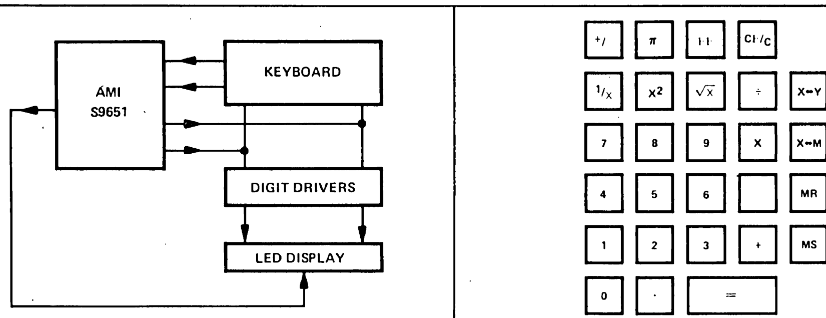


FIGURE 5 S9651 SLIDERULE CALCULATOR



BLOCK DIAGRAM | **TYPICAL KEYBOARD**

DETAILED FUNCTIONAL DESCRIPTION

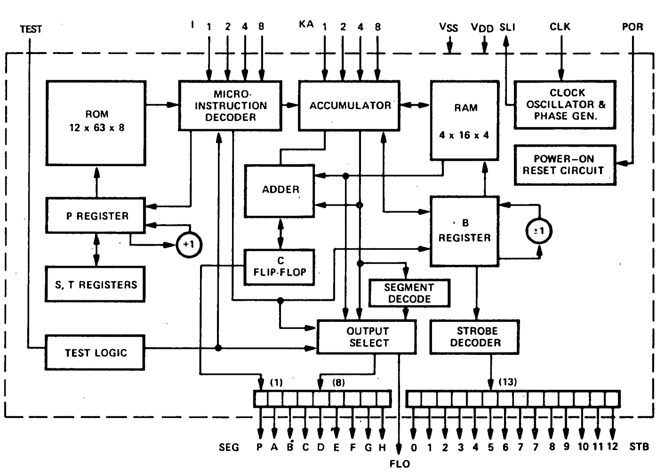
The detailed block diagram shows the major functional parts of the MPC. These are:

- A 6048-bit ROM containing microinstructions (12 x 63 x 8 organization).
- A 256-bit RAM memory for storing information (4 x 16 x 4 organization).
- A 4-bit parallel binary adder.
- Two 4-bit accumulators.
- A 6-bit RAM address register.
- A 10-bit ROM address register.
- Microinstruction decoding and control logic.
- A polynominal counter for incrementing the ROM address register.
- Two 10-bit address save registers.
- Input and output circuits.

The MPC is programmed by using microinstructions coded into the ROM. The ROM is organized into twelve "blocks" or "pages" each containing 63 words, which are addressed by the upper four bits of the address register. The lower 6 bits address the specific 8-bit word in each block.

The ROM addressing system consists of the P, S and T registers, each composed of an upper four bits and a lower six bits, a 6-bit polynomial counter, and two address control flip-flops. Normally, the polynomial counter is incremented once each instruction cycle and its contents transferred to the PL register to address the next ROM instruction. The counter can also be set to a specific starting address. The S and T registers form a stack used for storing return addresses when calling subroutines. The "pushing" and "popping" of the stack is controlled by the program.

FIGURE 6 9209 MPC DETAILED BLOCK DIAGRAM



DETAILED FUNCTIONAL DESCRIPTION (Cont'd.)

The RAM is used for storage of information in the processor. It is organized as four registers each containing sixteen 4-bit words. Data in the RAM can be loaded into the accumulator, exchanged with the accumulator, added to the accumulator or compared to the accumulator. Individual bits of the RAM can also be set, reset, and tested.

The adder is a parallel 4-bit binary adder having a carry input from the C flip-flop and two data inputs. The sum output is stored in the accumulator. The carry output can be stored in the C flip-flop and can be used by the control logic to skip microinstructions.

The main accumulator is a 4-bit register which can be loaded from the RAM, from the data input lines, from the ROM, from the adder or from the second accumulator. The latter is also a 4-bit register which can be loaded from the RAM.

The MPC also contains thirteen strobe outputs, which are under program timing and control. These outputs can be used for sampling a keyboard and/or driving a display. Segment data outputs for a display, four discrete data inputs, and an input for binary data into the accumulator are also available. Optionally data can be output in binary, together with a data sampling pulse (FLO) for external use.

Also included are an internal oscillator, clock generators, and a power-on initializing circuit.

INSTRUCTION SET

The MPC operation is programmed by use of instructions stored in the ROM. The instruction set includes arithmetic, load, test and flag, addressing, and miscellaneous groups, and is summarized in the table below. The instructions operate on digits (4 bits) or individual bits of the data stored in the RAM. Register handling instructions, can be implemented by the use of subroutines.

The nominal instruction cycle time is 15 usec. All instructions are executed in one cycle, with the exception of transfer and return instructions, which require two cycles.

There are also several mask programmed options which control the operation of hardware portions of the chip and which define parameters for the instructions. These include coding of the segment ROM and specifying the register length for register operations.

9209 INSTRUCTION SET SUMMARY

ARITHMETIC

ADD
ADD WITH CARRY
ADD IMMEDIATE
COMPLEMENT

LOAD A

LOAD IMMEDIATE
LOAD FROM RAM
EXCHANGE WITH RAM
EXCHANGE AND INCREMENT POINTER
EXCHANGE AND DECREMENT POINTER
LOAD FROM K INPUTS
LOAD FROM POINTER
LOAD FROM A2

TEST AND FLAG

SET, RESET, TEST C
SET, RESET, TEST BIT OF RAM
TEST A EQUAL RAM
TEST DISCRETE INPUTS
TEST KEY DOWN

ADDRESSING

JUMP
JUMP TO SUBROUTINE
JUMP TO MACROROUTINE
RETURN
RETURN AND SKIP
LOAD PAGE REGISTER

MISCELLANEOUS

SET POINTER
LOAD POINTER FROM A
LOAD STROBE OUTPUT
LOAD SEGMENT OUTPUTS FROM DECODE ROM
LOAD SEGMENT OUTPUTS FROM A AND RAM

PROGRAMMING SUPPORT

The following aids are available to assist in microprogram development for the MPC.

- Detailed hardware description and programming guide.
- Computer simulator.
- Cross-Assembler.
- Hardware simulator.
- Sentry test program generator.

The hardware and software simulators both include diagnostic capabilities to assist the debugging of microprograms. All software runs on AMI's internal B6700 computer system.

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS (All voltages measured with respect to V_{SS})

	Min.	Max.	Units
Storage Temperature	−55	+125	°C
Operating Temperature	0	+70	°C
Maximum Positive Voltage (any pin)		+0.3	V
Maximum Negative Voltage (any pin)		−30	V
Maximum Output Current (Segments)		11	mA
Maximum Output Current (Strobes)		5	mA

ELECTRICAL CHARACTERISTICS: V_{DD} = −15 ± 1V, T_A = 0 −55°C (All voltages measured with respect to V_{SS})

	Min.	Typ.	Max.	Units
Input High Level (Note 1)	−1.8		V_{SS}	V
Input Low Level (Note 1)	V_{DD}		−4.6V	V
Output High Level: (Note 6)				
Seg A - Seg H, DP; I = 6.5 mA	−3.0		V_{SS}	V
SO - S12, I=2.8 mA; FLO, SL1, I = 1.0 mA	−1.5		V_{SS}	V
Output Low Current; V_0 = − 10V			25	μA
Supply Current		6.6	10.0	mA
Power Dissipation (Note 2)		100	160	MW
Power Reset Capacitor (Note 3)		560		pF
Oscillator Timing Resistor (Note 4)		24		KΩ
Oscillator Timing Capacitor (Note 5)		100		pF

NOTE 1. Inputs I1 − I8, KA_1 − KA_8. Each of these inputs has an internal resistor to V_{DD}. R_{MIN} = 125 KΩ.

NOTE 2. Does not include power dissipated in digit and segment drivers.

NOTE 3. Connected between POR pin and V_{SS}.

NOTE 4. Connected between CLK pin and V_{DD}.

NOTE 5. Connected between CLK pin and V_{SS}.

NOTE 6. All outputs are open drain MOS transistors to V_{SS}.

FAIRCHILD

F8 MICROPROCESSOR

THINK F8 UNIVERSAL STANDARD MICROPROCESSOR

VERSATILE . . EFFICIENT . . COST EFFECTIVE

The ultimate goal, from F8 design concept through development and production, was to produce the most versatile, efficient, cost-effective microprocessor system available today. To accomplish this, five stringent parameters, based on user experience with other systems, were set forth as guidelines for the F8.

- Minimum Parts Count
- Cost Effectiveness
- Simple Peripheral Interfaces
- Easy Expansion through Modular Architecture
- Simplified Programming and Debugging

HOW WERE F8 GOALS MET ?

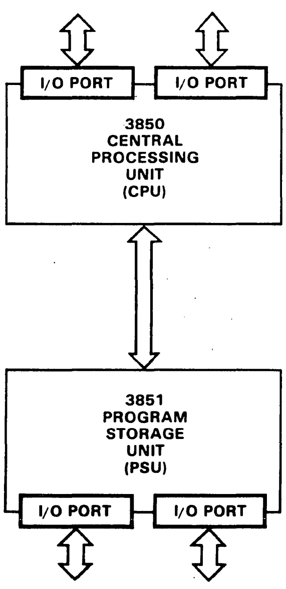
By . . . *unique system partitioning* the system functions have been divided among the various circuits of the F8 family to provide sophisticated modularity. As a result, it is now possible to build a minimum microprocessor system with only two devices. To this system PSU, RAM and I/O devices can be added to form medium size or memory intensive systems with a minimum use of external parts. And, finally, for solving complex problems, the F8 devices can be connected as subsystems into a synergistic system of independent microprocessors.

By . . . *incorporating the I/O structure on the chips* so that the majority (95%) of the peripheral devices can be directly controlled without the need for special circuits. The trick is to accommodate the characteristics of a given peripheral device in the software. The I/O hardware structure includes a programmable timer, an efficient interrupt system and bidirectional I/O ports.

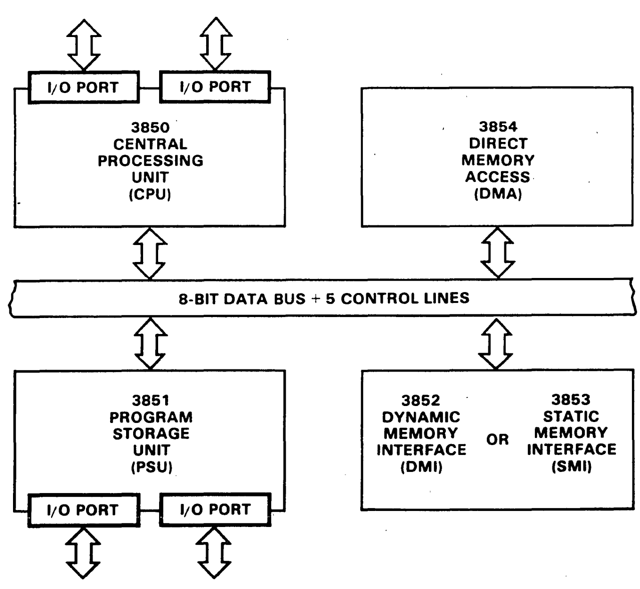
By . . . providing *carefully thought out software* for generating and debugging microprograms and a choice of three hardware modules for speeding up prototype development.

WHAT IS THE RESULT ?

. . . *a complete family of LSI circuits* that can be used as building blocks to construct versatile, efficient, cost effective systems from the most simple to the highly complex.



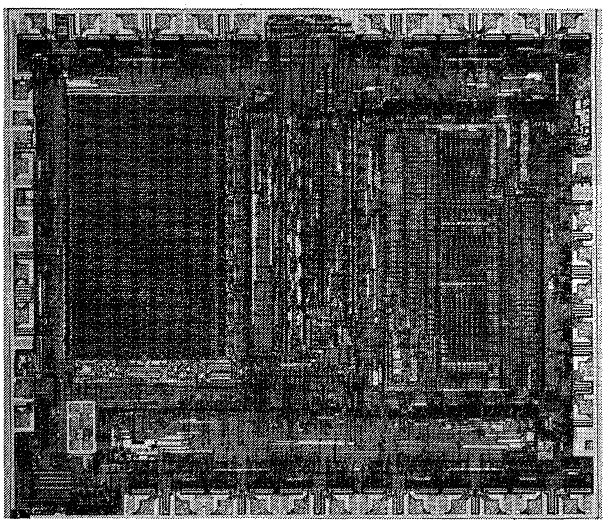
MINIMUM SYSTEM

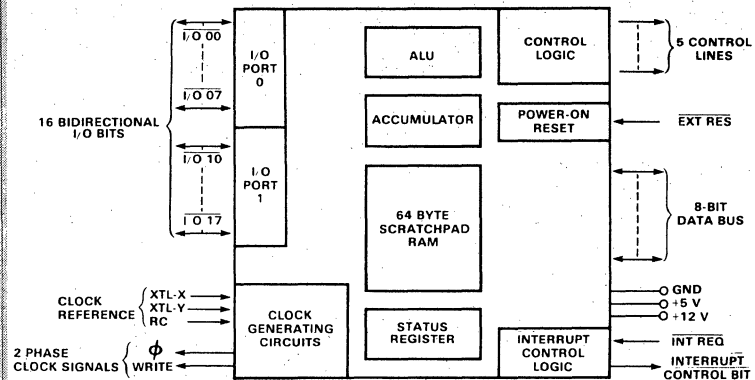


F8 DEVICE FAMILY

3850 CENTRAL PROCESSING UNIT

Fairchild's F8 Central Processing Unit (CPU) contains all of the functions of an ordinary central processor and adds some time and money saving features uniquely its own. For instance, the 64 bytes of scratchpad RAM memory already included on the F8 CPU eliminate the need for external RAM circuits in many applications. Clock and power-on-reset circuitry, normally requiring additional integrated circuit packages, are included on-chip. Fairchild's CPU also contains 16 bits of fully bidirectional input and output lines internally latched (for storing output data) and capable of driving a standard TTL load.



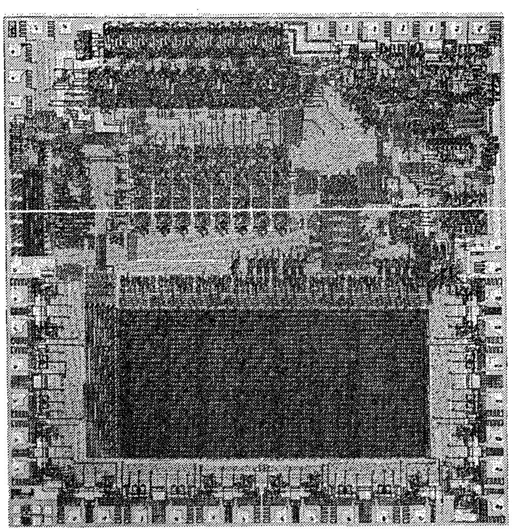


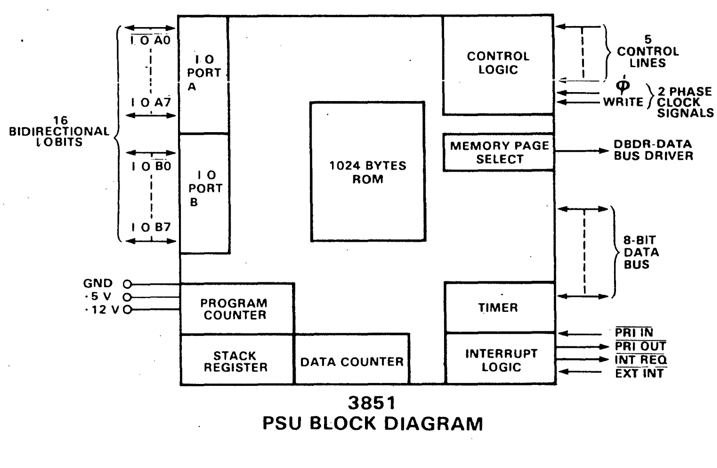
3850
CPU BLOCK DIAGRAM

3851 PROGRAM STORAGE UNIT

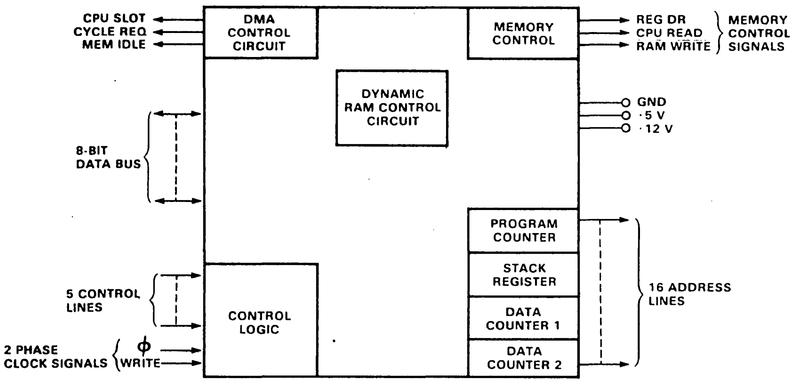
It is important to note that Fairchild's Program Storage Unit (PSU) is not just a conventional Read Only Memory. In addition to containing 1024 bytes of mask programmable ROM for program and constant storage, the F8 PSU includes the addressing logic for memory referencing, a Program Counter, an Indirect Address Register (the Data Counter) and a Stack Register. A complete vectored interrupt level, including an external interrupt line to alert the central processor, is provided. All of the logic necessary to request, acknowledge and reset the interrupt is on the F8 PSU. The 8-bit Programmable Timer is especially useful for generating real time delays. The PSU has an additional 16 bits of TTL compatible, bidirectional, fully latched I/O lines.

Systems requiring more program storage may be expanded by adding more PSU circuits. For example, one F8 CPU and three F8 PSUs will produce a microprocessor system complete with 64 bytes of RAM, 3072 bytes of ROM, 64 I/O bits, three interrupt levels, and three programmable timers. This complete system will require only four IC packages.

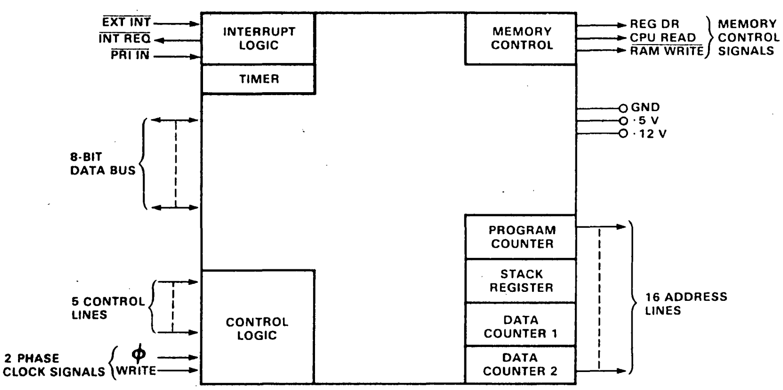




3851
PSU BLOCK DIAGRAM



3852
DMI BLOCK DIAGRAM

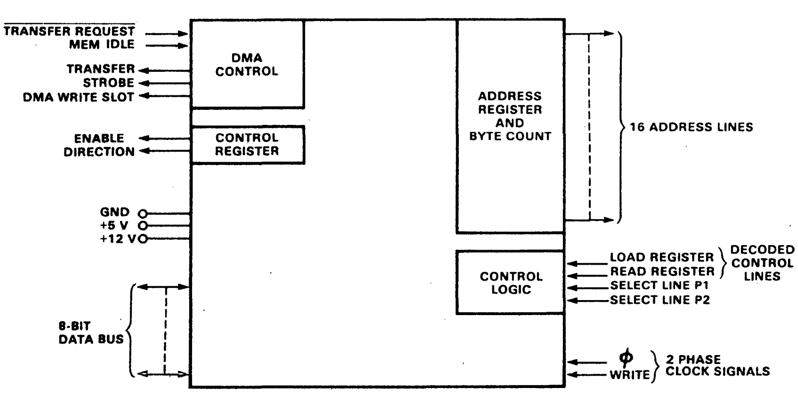


3853
SMI BLOCK DIAGRAM

3852/3853 MEMORY INTERFACE

For applications requiring more than the 64 byte RAM located on the CPU, two memory interface circuits are included in the F8 set. Each device generates the 16 address lines and the signals necessary to interface with up to 65K bytes of RAM, PROM or ROM memory. Either device may be used in conjunction with standard static semiconductor memory devices.

The Static Memory Interface (SMI) contains a full level of interrupt capability and a programmable timer. The Dynamic Memory Interface (DMI) contains all of the logic necessary to refresh MOS dynamic memories without degrading the system throughput time. The F8 DMI can also interface with static memories when desired.



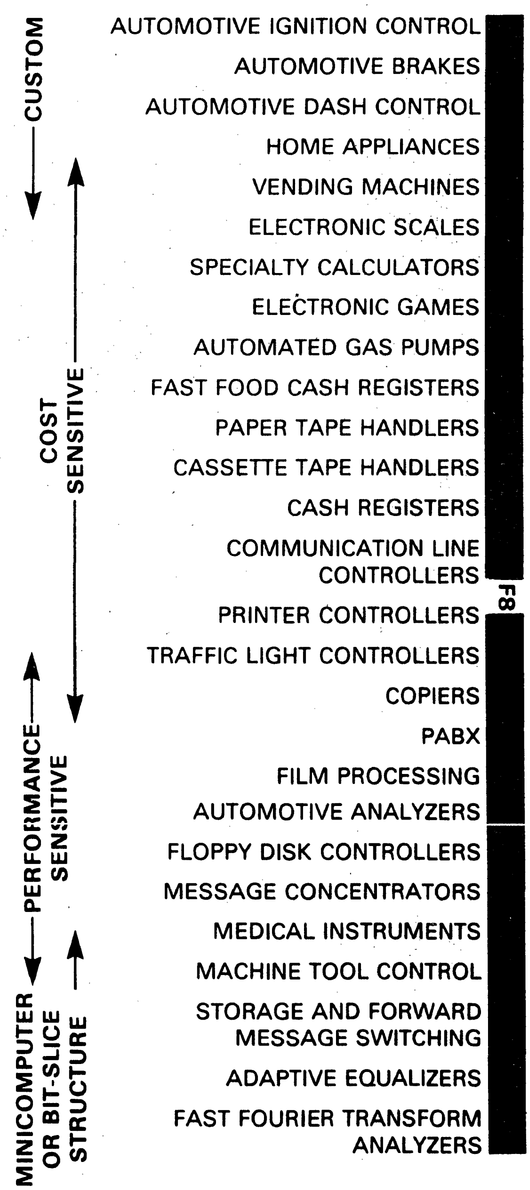
3854
DMA BLOCK DIAGRAM

3854 DIRECT MEMORY ACCESS

Fairchild's Direct Memory Access (DMA) device sets up a high speed data path to link F8 memory with peripheral electronics. The F8 DMA circuit, when working in conjunction with the F8 DMI, does not require overhead electronics to keep track of memory addresses, bytes transferred and handshaking signals. The data transfer is initiated by the CPU under program control. Once started, the DMA transfer will continue without CPU intervention. The CPU can sense the enable line of the DMA to determine the completion of a transfer. The entire DMA transfer will take place without halting the central processor.

F8 MICROPROCESSOR APPLICATION SPECTRUM

Because of its unique system partitioning, the F8 device set can be applied across a wide range of applications. The minimum two-circuit system is the basis for a modular architecture that can handle increasingly complex problems. A system of medium complexity can be designed by adding more F8 PSUs. The use of an F8 memory interface device allows up to 65K bytes of standard memories to be incorporated into the F8 system. For highly complex applications, independent F8 subsystems can be connected into a multiprocessing system in which each subsystem can operate independently yet can be controlled by one CPU that is the coordinator.



A TWO-CIRCUIT SYSTEM

The two-circuit F8 microprocessor is suitable for small data terminals, controllers, and specialty calculators. The keyboard is connected directly to the F8 I/O ports without special interfaces. Switch-bounce protection, rollover, and key encoding are all under software control. Software also decodes signals for LED readouts.

As an appliance controller, for example, the two-circuit system can perform all input-output sensing, actuating, timing, and computation operations. A system like the combination washing-machine-and-dryer controller in *Figure 1* requires more than 250 components when other microprocessor device sets are used, but with the F8 devices uses only 55 components, including 28 LEDs and the power semiconductor devices and relays used to control the motors. A set of custom circuits would also require about 50 parts, but initial engineering expense is heavy and severe penalties are incurred if changes are required. With the F8 system changes can be made by merely changing the program.

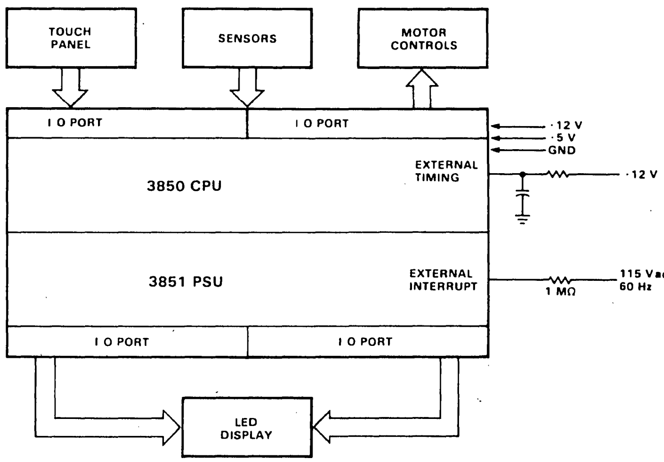


Fig. 1. Two-Circuit System

A MORE COMPLEX SYSTEM

The versatility of the F8 system is indicated by the traffic-light-controls system in *Figure 2*. The use of one CPU and two PSU circuits provides the designer with two timers, two interrupts, an onboard clock, onboard power-on reset, onboard switch decoding, and 48 bidirectional I/O bits. This system could be tied to vehicle detectors in the road, to monitor traffic for left-turn lanes as well as through-traffic flow in four directions. It would also react to interrupts from the pedestrian control buttons at each corner. There also is sufficient I/O capability to permit communication with and control of neighboring intersections and to allow the system to be operated manually or tested for proper operation.

Five F8 features are of particular interest for this type of application. One of the interrupts can eliminate the need for such external circuits as a comparator to compare a count of the cars with a predetermined value to cause the light to change. (The CPU can handle the simple arithmetic of counting cars.) This interrupt also eliminates the need for continuous polling of traffic count by the microcomputer. The second interrupt would be ideal for permitting pedestrian control to override the automatic system. The internal clock, with an external crystal, can also control light routines.

The two timers permit simultaneous counting of delay for vehicle signals and flashing warning lights for pedestrians. The onboard power-on reset acts in case of power failure to start the system automatically when power is renewed. The bidirectional I/Os have built-in latches that eliminate the need for external latches for the job of "holding" commands for lights as well as the momentary commands provided by timers and sensors.

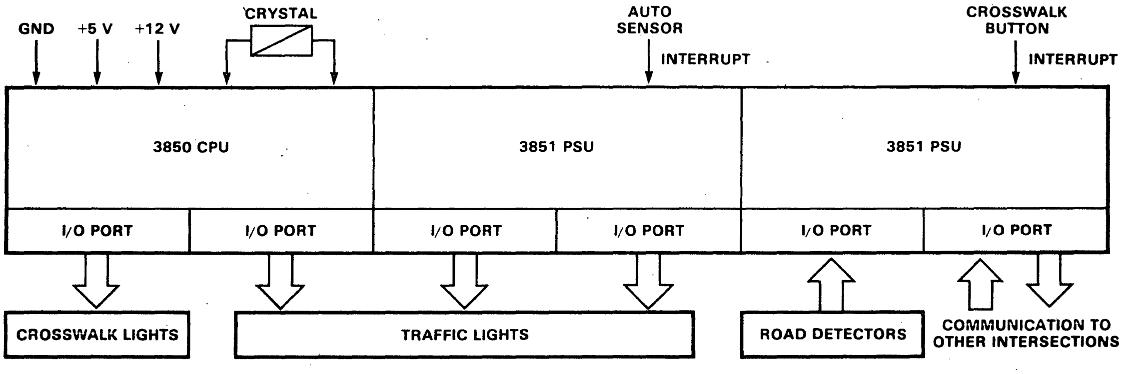


Fig. 2. Medium Complexity System

A MEMORY INTENSIVE SYSTEM

A typical application is a printing credit-verification terminal *(Figure 3)*. Such a system requires high performance and yet must be low in cost if it is to reach a large market. Only four different F8 devices are required to handle a keyboard input, visual display, card reader, and printer as well as provide a modem interface and memory interface for external RAM storage. This printing credit-verification system might be compared to a "bare mini-computer" in terms of utility; however, a detailed engineering evaluation would show that it costs less, has fewer parts and a more flexible I/O structure.

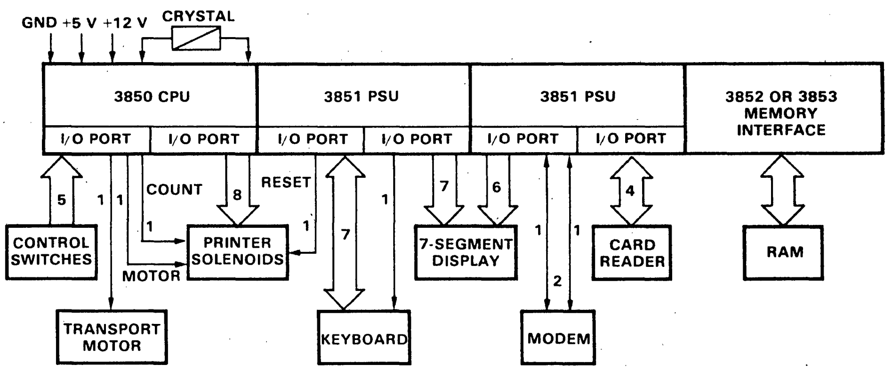


Fig. 3. Memory Intensive System

MULTI-MICROPROCESSOR SYSTEM

Figure 4 shows a specific application of the multi-processing concept as applied to a keyboard-to-floppy-disk system. Possibly this is the most cost-effective way of implementing this system, conservatively costing less than 50% of a conventional implementation. This system involves concurrent operation of three floppy disks, magnetic tape, CRT, keyboard, printer, and modem. While the low-speed devices (the keyboard, printer, and modem) can be adequately handled by the programmed I/O structure, the high-speed devices (disks, magnetic tape, and CRT) require separate F8 CPUs and PSUs.

This scheme provides simplicity of control, modularity, and freedom to expand. In this case, the units operating concurrently are: one magnetic-tape unit (25 μs/byte); three floppy-disk units (32 μs/byte each); and a CRT unit (71 μs/byte). This combination requires an aggregate bandwidth of 0.1478 byte/μs. This is well within the F8's upper bandwidth limit of 0.5 byte/μs.

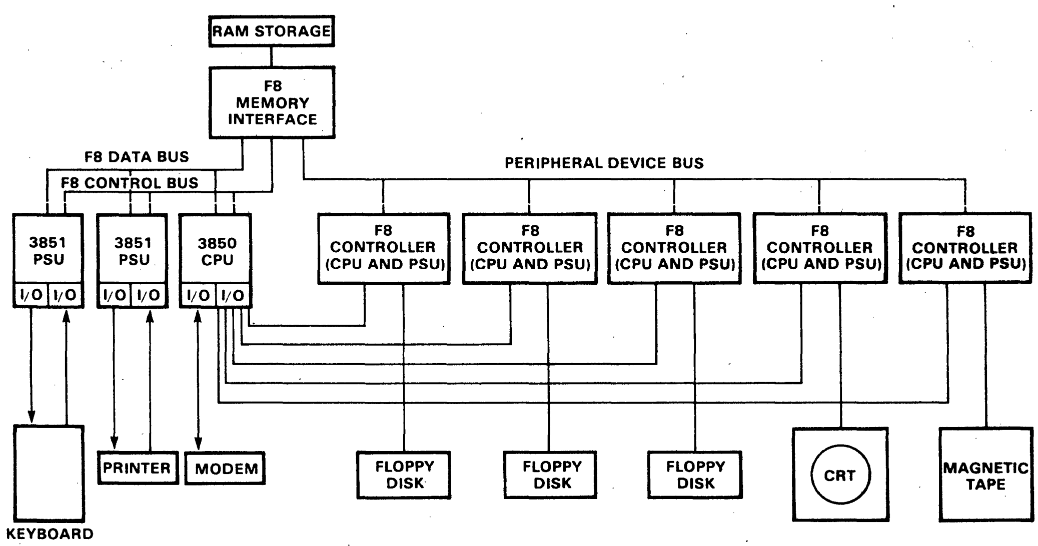


Fig. 4. Multi Microprocessor System

F8 MICROPROCESSOR SUPPORT DOCUMENTATION

F8 MICROPROCESSOR PROGRAMMER'S GUIDE
Provides tutorial instruction on microprocessor programming in general and, in particular, describes how to program Fairchild's F8 Microprocessor.

F8 CIRCUIT DATA BOOK
Provides electrical parameter data for all Fairchild F8 Microprocessor devices.

F8 TIMESHARE OPERATING SYSTEMS MANUAL
Explains how to assemble and debug F8 Microprocessor programs on NCSS and GE Timeshare Networks.

F8 CIRCUIT REFERENCE MANUAL
Describes the interactive timing and signal sequences which occur between devices in the F8 Microprocessor family.

F8S AND F8SEM USERS MANUALS
Describe how to assemble and debug microprocessor programs on the F8S and F8SEM hardware modules.

F8 FORMULATOR USERS AND REFERENCE MANUALS
Describe how to use and maintain Fairchild's F8 Formulator developmental hardware.

F8 MICROPROCESSOR DEVELOPMENT SUPPORT HARDWARE

Development support hardware is an integral part of Fairchild's F8 Microprocessor product concept. Fairchild's Microprocessor Support Engineering Group has developed an extensive set of design aids to enable customers to shorten their development cycle time and speed up programming. The F8 development support hardware provides a working model of the user's system and facilitates:

- Evaluation of F8 Microprocessor hardware operation
- Reduction of engineering time and development costs
- Preparation of system software and firmware programs
- Reduction of system hardware, software and firmware evaluation and debug time

F8 MICROPROCESSOR EVALUATION KIT
The lowest cost method for quick evaluation of the operation of the F8 Microprocessor hardware. Comes complete with a preprogrammed debug ROM device, PC card, complete instructions on the operation of all devices in the kit and all pertinent F8 literature.

F8M – MICROMODULE
A complete printed circuit subassembly capable of demonstrating the operation of a customer's program. Comes complete with F8M User's Manual and all pertinent F8 literature.

F8S – DEVELOPMENT MODULE
A complete printed circuit subassembly capable of developing, debugging and demonstrating the operation of a customer's program. Comes complete with F8S User's Manual and all pertinent F8 literature.

F8SEM – SYSTEM EXPANSION MODULE
A printed circuit subassembly designed to be used with the F8S Development Module to expand the system memory in 4K byte increments, and to expand the number of I/O ports in increments of four each.

F8SPDM – DEVELOPMENT MODULE SET
A combination set of modules containing one F8S Development Module, two F8SEM System Expansion Modules, an F8S Native Assembler, F8S and SEM User's Manuals and all other pertinent F8 literature. A more economical solution for the user requiring the expansion modules.

F8 FORMULATOR – COMPLETE MICROPROCESSOR DEVELOPMENT SYSTEM
A benchtop self-contained, modularized F8 development system, complete with front panel controls, cabinet, power supply, resident assembler and text editor, complete F8 Formulator Operating and System Reference manuals, and all other pertinent F8 literature.

F8 MICROPROCESSOR EVALUATION KIT

Fairchild's Microprocessor Evaluation Kit is designed for use by engineers, scientists and technicians in order to provide a straightforward method for constructing, using and evaluating prototype F8 microprocessor systems in real applications or training situations. It provides all of the semiconductor components, technical specifications, and instructions necessary to interconnect devices, demonstrate microprocessor programs up to 1K bytes in length, and to debug those programs.

The F8 Microprocessor Evaluation Kit contains the following semiconductor parts and documentation:

- 16 Semiconductor Devices, including

  1 – 3850 Central Processing Unit
  1 – 3851A* FAIR-BUG Programmed Storage Unit
  1 – 3853 Static Memory Interface
  8 – 2102-2 1K Static RAM Devices

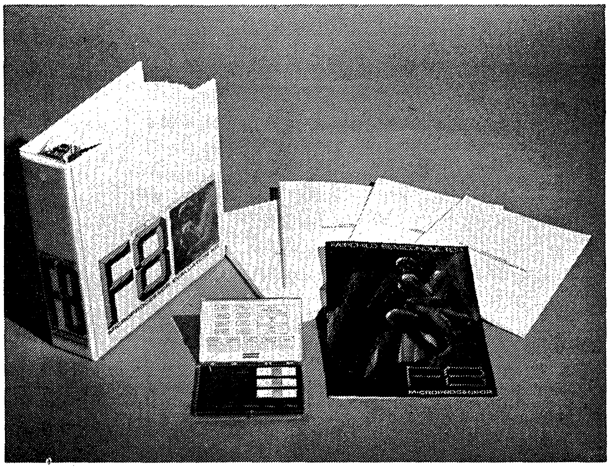
*The 3851 FAIR-BUG PSU is a fixed programmed Fairchild 3851 PSU which provides the programmer with all its I/O subroutines and allows the programmer to display or alter memory and register contents via a teletype terminal.

  1 – 34001, 2 – 340097, 1 – 34023: CMOS Gates and Buffers
  1 – 9N06 TTL Hex Inverter

- 1 PC Card to Facilitate Device Hook-up
- F8 Microprocessor Brochure
- F8 Design Evaluation Kit Instruction Manual
- A Guide to Programming the Fairchild F8 Microprocessor
- F8 Microprocessor Data Book
- F8 Timesharing Systems Operators Guide

The F8 Microprocessor Evaluation Kit is available now from your local Fairchild Franchised Distributor.

Unit Price: $295.00



F8M – MICROMODULE

The F8M Micromodule is an inexpensive prototyping subassembly for the development and breadboarding of F8 Microprocessor designs. It is a complete printed circuit subassembly, requiring only the addition of power supplies and connection to a teleprinter to become fully operational.

Features of the F8M include:

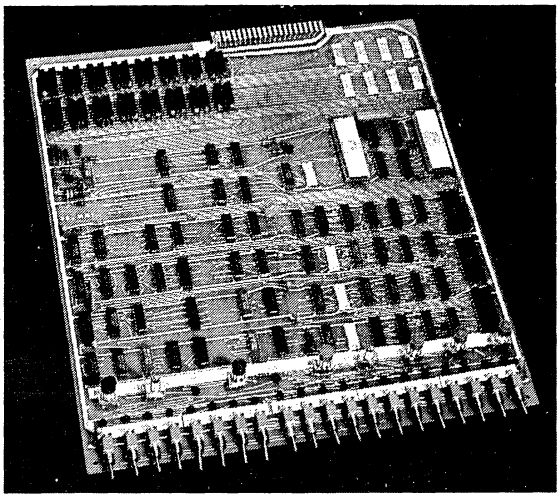
- Switches and LEDs Provide Control and Monitor Functions
- 1K Bytes of Static MOS RAM
- Sockets for 2K Bytes of Bipolar PROM (Fairchild 93426)
- 2 Preprogrammed 93426 Devices Forming a Bootstrap Loader
- External Interrupt
- 4 I/O Ports Available on the Edge Connector
- Programmable Interval Timer
- Serial Communications Interface, RS232 Format, 20 mA Current Loop

The customer's system is ready to demonstrate after the connection of peripheral circuits and either loading an object program into the RAM, or plugging in preprogrammed PROMs. The program can be halted and single-stepped to demonstrate statically how the design functions. Any PROM or ROM memory location can be monitored by halting the program. RAM memory locations can be altered before resuming operation of the system.

The F8M is supported by a Cross Assembler available for purchase from Fairchild Semiconductor or through a National Timesharing Network. Contact your Fairchild Sales Representative for more information.

The F8M Micromodule is available off the shelf for immediate delivery from your Fairchild Franchised Distributor.

Unit Price: $850.00



F8S – DEVELOPMENT MODULE

The F8S is an inexpensive F8 development and debugging subassembly. A self-contained complete printed circuit module, the F8S needs only power supply and connection to a teleprinter and the customer's peripheral circuits to form a complete F8 microcomputer system. Memory may be expanded to a maximum of 64K bytes with the system expansion modules described elsewhere in this brochure.

Features of the F8S include:

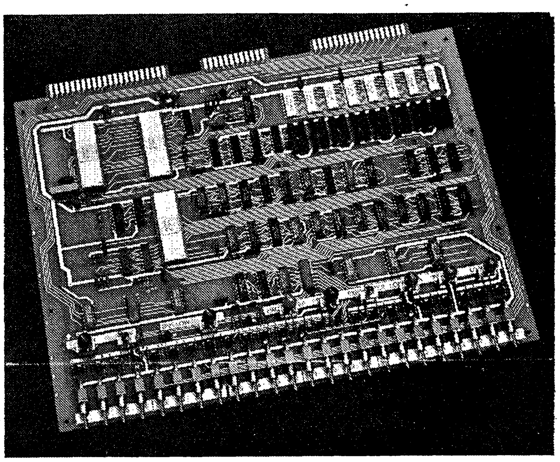
- Switches and LEDs Provide Control and Monitor Functions
- 64K Bytes of Addressable Memory Space (1K of Semiconductor Static RAM is Provided)
- Sockets for 2K Bytes of Bipolar PROM (Fairchild 93446)
- 2 External Interrupts
- 2 Programmable Interval Timers
- 4 Input/Output Ports (8 Bits Each)
- FAIR-BUG* Debugging Program

The F8S Development Module, with System Expansion Modules, allows source programs to be assembled inexpensively at the customer's location. Switches permit program RUN, HALT, and Single Step. Program breakpoints may be activated by changing instructions at the breakpoint locations. When a breakpoint is encountered, FAIR-BUG turns control over to you through the teleprinter. Commands consisting of single alphabetics allow you to examine or alter the contents of any memory location, group of locations or internal register of the CPU. Connection of peripheral circuits to the input/output ports enables the user to demonstrate his application.

The F8S is available now from your local Fairchild Franchised Distributor.

Unit Price: $995.00

*The 3851 FAIR-BUG PSU is a fixed programmed Fairchild 3851 PSU which provides the programmer with all its I/O subroutines and allows the programmer to display or alter memory and register contents via a teletype terminal.



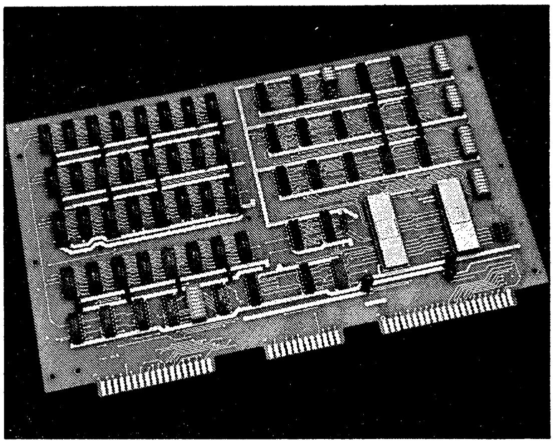
F8SEM – SYSTEM EXPANSION MODULE

Designed to operate with the F8S Development Module, the F8SEM System Expansion Module adds 4K byte increments of memory to the F8 development system and four additional I/O ports. Switches contained on the module allow the user to select the active page address that the module will respond to, the addresses of the input/output ports and the interrupt addresses.

Features of the F8SEM System Expansion Module include:

- 4K Bytes of Static RAM
- Memory Page Selection
- 4 Input/Output Ports (8 Bits Each)
- Switch Selectable I/O Port Addresses
- 2 External Interrupts
- 2 Programmable Interval Timers
- Switch Selectable Interrupt Addresses

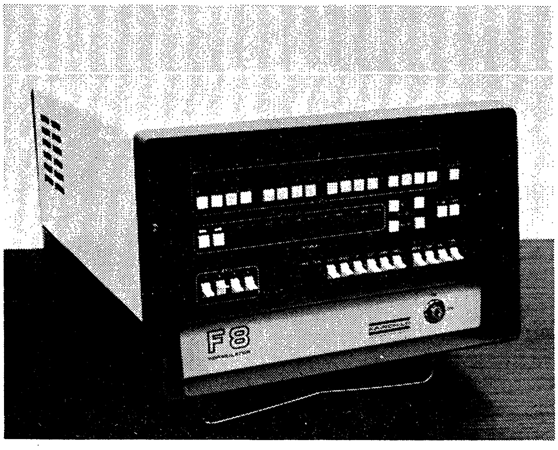
Unit Price: $695.00



F8SPDM – DEVELOPMENT MODULE SET

The F8SPDM is a combination set of modules containing one F8S module card, two F8SEM module cards, a paper tape F8S Native Assembler, and all necessary users manuals and F8 documentation literature.

Unit Price: $2,160.00



F8 FORMULATOR

The F8 Formulator is a complete benchtop microprocessor development system designed to support every F8 application.

F8 Formulator features and capability include:

- F8 CPU Module
- Up to 64K Bytes of Addressable Memory
- Control and Monitor Console
- Virtually Unlimited Expansion of I/O Ports
- 2 External Interrupts Available for Every 4 I/O Ports
- Modular Construction
- Self-contained Power Supplies
- Resident Assembler
- Source Text Editor
- Complete Debug Capability

Standard memory modules and input/output modules permit expansion of the F8 Formulator to meet your need. Additional peripheral interfaces will also be available.

Contact your local Fairchild salesman, representative or franchised distributor for pricing information.

F8 INSTRUCTION SET SUMMARY

The F8 instruction set contains over 60 different instructions which may be subdivided into 10 categories: Accumulator, Scratchpad Register, Indirect Scratchpad Address Register, Memory Reference, Data Counter, Status Register, Program Counter, Branch, Interrupt Control and Input/Output instructions. Because 55% of the F8 instructions are only one byte long, programs are short and memory requirements significantly reduced. An alphabetic listing of the instructions is shown below. The following pages contain a complete description of the F8 instructions, including the cycle time. Each cycle is 2 μs for a system with a 2 MHz clock frequency.

F8 ADDRESSING MODES

The F8 instruction set has eight modes of referencing either I/O, CPU registers or bulk memory.

Implied Addressing – The data for this one-byte instruction is implied by the actual instruction. For example, the POP instruction automatically implies that the content of the Program Counter will be set to the value contained in the Stack Register.

Direct Addressing – In these two-byte instructions, the address of the operand is contained in the second byte of the instruction. The Direct Addressing mode is used in the Input/Output class of instructions.

Short Immediate Addressing – Instructions whose addressing mode is Short Immediate have the instruction op code as the first four bits and the operand as the last four bits. They are all one-byte instructions.

Long Immediate Addressing – In these two-byte instructions, the first instruction byte is the op code and the second byte is the 8-bit operand.

Direct Register Addressing – This mode of addressing may be used to directly reference the Scratchpad Registers. By including the register number in the one-byte instruction, 12 of the 64 Scratchpad Registers may be referenced directly.

Indirect Register Addressing – All 64 Scratchpad Registers may be indirectly referenced, using the Indirect Scratchpad Register in the CPU. This 6-bit register, which acts as a pointer to the scratchpad memory, may either be incremented, decremented, or left unchanged while accessing the scratchpad register.

Indirect Memory Addressing – A 16-bit Indirect Address Register, the Data Counter, points to either data or constants in bulk memory. A group of one-byte instructions is provided to manipulate this area of memory. These instructions imply that the Data Counter is pointing to the desired memory byte. The Data Counter is self-incrementing, allowing for an entire data field to be scanned and manipulated without requiring special instructions to increment its content. The memory interface circuit contains two interchangeable data counters.

Relative Addressing – All F8 Branch Instructions use the relative addressing mode. Whenever a branch is taken, the Program Counter is updated by an 8-bit relative address contained in the second byte of the instruction. A branch may extend 128 locations forward or 127 locations back.

ALPHABETIC LIST OF INSTRUCTIONS

ADC	Add Data Counter with Accumulator
AI	Add Immediate with Accumulator
AM	Add Binary Accumulator with Memory
AMD	Add Decimal Accumulator with Memory
AS	Add Binary Accumulator with Scratchpad Register
ASD	Add Decimal Accumulator with Scratchpad Register
BC	Branch on Carry
BF	Branch on False Condition
BM	Branch if Negative
BNC	Branch if no Carry
BNO	Branch if no Overflow
BNZ	Branch if no Zero
BP	Branch if Positive
BR	Unconditional Branch
BR7	Branch if ISAR is not 7
BT	Branch on True Condition
BZ	Branch on Zero Condition
CI	Compare Immediate
CLR	Clear Accumulator
CM	Compare with Memory
COM	Complement Accumulator
DCI	Load Data Counter Immediate
DI	Disable Interrupt
DS	Decrement Scratchpad Register
EI	Enable Interrupt
INC	Increment Accumulator
IN	Input
INS	Input Short
JMP	Jump
LI	Load Accumulator Immediate
LIS	Load Accumulator Short
LISL	Load ISAR – Lower 3 Bits
LISU	Load ISAR – Upper 3 Bits
LM	Load Memory
LNK	Link Carry into Accumulator
LR	Load Register (5 Types)
	Scratchpad
	Program Counter
	ISAR
	Status
	Data Counter
NI	Logical AND Accumulator Immediate
NM	Logical AND from Memory
NOP	No Operation
NS	Logical AND Scratchpad and Accumulator
OI	Logical OR Immediate
OM	Logical OR Memory with Accumulator
OUT	Output
OUTS	Output Short
PI	Push Program Counter into Stack Register Set Program Counter to New Location
PK	Push Program Counter into Stack Register Set Program Counter from Scratchpad
POP	Put Stack Register into Program Counter
SL	Shift Left
SR	Shift Right
ST	Store to Memory
XDC	Exchange Data Counters
XI	Exclusive OR Immediate
XM	Exclusive OR Accumulator with Memory
XS	Exclusive OR Accumulator with Scratchpad

ACCUMULATOR GROUP INSTRUCTIONS

OPERATION	MNEMONIC OP CODE	OPERAND	FUNCTION	MACHINE CODE	BYTES	CYCLES	STATUS BITS OVF	ZERO	CRY	SIGN
ADD CARRY	LNK		ACC←(ACC) + CRY	19	1	1	1/0	1/0	1/0	1/0
ADD IMMEDIATE	AI	ii	ACC←(ACC) + H'ii'	24ii	2	2.5	1/0	1/0	1/0	1/0
AND IMMEDIATE	NI	ii	ACC←(ACC) ∧ H'ii'	21ii	2	2.5	0	1/0	0	1/0
CLEAR	CLR		ACC←H'00'	70	1	1	–	–	–	–
COMPARE IMMEDIATE	CI	ii	H'ii' + $\overline{(ACC)}$ + 1	25ii	2	2.5	1/0	1/0	1/0	1/0
COMPLEMENT	COM		ACC←(ACC) ⊕ H'FF	18	1	1	0	1/0	0	1/0
EXCLUSIVE-OR IMMEDIATE	XI	ii	ACC←(ACC) ⊕ H'ii'	23ii	2	2.5	0	1/0	0	1/0
INCREMENT	INC		ACC←(ACC) + 1	1F	1	1	1/0	1/0	1/0	1/0
LOAD IMMEDIATE	LI	ii	ACC←H'ii'	20ii	2	2.5	–	–	–	–
LOAD IMMEDIATE SHORT	LIS	i	ACC←H'0i'	7i	1	1	–	–	–	–
OR IMMEDIATE	OI	ii	ACC←(ACC) ∨ H'ii'	22ii	2	2.5	0	1/0	0	1/0
SHIFT LEFT ONE	SL	1	SHIFT LEFT 1	13	1	1	0	1/0	0	1/0
SHIFT LEFT FOUR	SL	4	SHIFT LEFT 4	15	1	1	0	1/0	0	1/0
SHIFT RIGHT ONE	SR	1	SHIFT RIGHT 1	12	1	1	0	1/0	0	1
SHIFT RIGHT FOUR	SR	4	SHIFT RIGHT 4	14	1	1	0	1/0	0	1

BRANCH INSTRUCTIONS

In all conditional branches $PC_0 \leftarrow (PC_0) + 2$ if the test condition is not met. Execution is complete in 3.0 cycles.

OPERATION	MNEMONIC OP CODE	OPERAND	FUNCTION	MACHINE CODE	BYTES	CYCLES	STATUS BITS OVF	ZERO	CRY	SIGN
BRANCH ON CARRY	BC	aa	$PC_0 \leftarrow [(PC_0) + 1]$ + H'aa' if CRY = 1	82aa	2	3.5	–	–	–	–
BRANCH ON POSITIVE	BP	aa	$PC_0 \leftarrow [(PC_0) + 1]$ + H'aa' if SIGN = 1	81aa	2	3.5	–	–	–	–
BRANCH ON ZERO	BZ	aa	$PC_0 \leftarrow [(PC_0) + 1]$ + H'aa' if ZERO = 1	84aa	2	3.5	–	–	–	–
BRANCH ON TRUE	BT	t, aa	$PC_0 \leftarrow [(PC_0) + 1]$ + H'aa' if any test is true	8taa	2	3.5	–	–	–	–

t = TEST CONDITION

2^2	2^1	2^0
ZERO	CRY	SIGN

OPERATION	MNEMONIC OP CODE	OPERAND	FUNCTION	MACHINE CODE	BYTES	CYCLES	STATUS BITS OVF	ZERO	CRY	SIGN
BRANCH IF NEGATIVE	BM	aa	$PC_0 \leftarrow [(PC_0) + 1]$ + H'aa' if SIGN = 0	91aa	2	3.5	–	–	–	–
BRANCH IF NO CARRY	BNC	aa	$PC_0 \leftarrow [(PC_0) + 1]$ + H'aa' if CARRY = 0	92aa	2	3.5	–	–	–	–
BRANCH IF NO OVERFLOW	BNO	aa	$PC_0 \leftarrow [(PC_0) + 1]$ + H'aa' if OVF = 0	98aa	2	3.5	–	–	–	–
BRANCH IF NOT ZERO	BNZ	aa	$PC_0 \leftarrow [(PC_0) + 1]$ + H'aa' if ZERO = 0	94aa	2	3.5	–	–	–	–
BRANCH IF FALSE TEST	BF	t, aa	$PC_0 \leftarrow [(PC_0) + 1]$ + H'aa' if all tests are met	9taa	2	3.5	–	–	–	–

t = TEST CONDITION

2^3	2^2	2^1	2^0
OVF	ZERO	CRY	SIGN

OPERATION	MNEMONIC OP CODE	OPERAND	FUNCTION	MACHINE CODE	BYTES	CYCLES	STATUS BITS OVF	ZERO	CRY	SIGN
BRANCH IF ISAR (LOWER) ≠ 7	BR7	aa	$PC_0 \leftarrow [(PC_0) + 1]$ + H'aa' if ISARL ≠ 7 $PC_0 \leftarrow (PC_0) + 2$ if ISARL = 7	8Faa	2	2.5 2.0	– –	– –	– –	– –
BRANCH RELATIVE	BR	aa	$PC_0 \leftarrow [(PC_0) + 1]$ + H'aa'	90aa	2	3.5	–	–	–	–
JUMP*	JMP	aaaa	$PC_0 \leftarrow$ H'aaaa'	29aaaa	3	5.5	–	–	–	–

*Privileged instruction

MEMORY REFERENCE INSTRUCTIONS

In all Memory Reference Instructions, the Data Counter is incremented DC←DC + 1

OPERATION	MNEMONIC OP CODE	OPERAND	FUNCTION	MACHINE CODE	BYTES	CYCLES	STATUS BITS OVF	ZERO	CRY	SIGN
ADD BINARY	AM		ACC←(ACC)+((DC))	88	1	2.5	1/0	1/0	1/0	1/0
ADD DECIMAL	AMD		ACC←(ACC) + ((DC))	89	1	2.5	1/0	1/0	1/0	1/0
AND	NM		ACC←(ACC)∧((DC))	8A	1	2.5	0	1/0	0	1/0
COMPARE	CM		((DC)) + ($\overline{ACC}$) + 1	8D	1	2.5	1/0	1/0	1/0	1/0
EXCLUSIVE OR	XM		ACC←(ACC) ⊕ ((DC))	8C	1	2.5	0	1/0	0	1/0
LOAD	LM		ACC←((DC))	16	1	2.5	-	-	-	-
LOGICAL OR	OM		ACC←(ACC)∨((DC))	8B	1	2.5	0	1/0	0	1/0
STORE	ST		(DC)←(ACC)	17	1	2.5	-	-	-	-

ADDRESS REGISTER GROUP INSTRUCTIONS

OPERATION	MNEMONIC OP CODE	OPERAND	FUNCTION	MACHINE CODE	BYTES	CYCLES	STATUS BITS OVF	ZERO	CRY	SIGN
ADD to DATA COUNTER	ADC		DC←(DC) + (ACC)	8E	1	2.5				
CALL to SUBROUTINE*	PK		PC_0U←(r12); PC_0L←(r13); PC_1←(PC_0)	OC	1	4				
CALL to SUBROUTINE IMMEDIATE*	PI	aaaa	PC_1←(PC_0); PC_0←H'aaaa	28aaaa	3	6.5				
EXCHANGE DC	XDC		(DC_0) ⇄ (DC_1)	2C	1	2				
LOAD DATA COUNTER	LR	DC,Q	DCU←(r14); DCL←(r15)	OF	1	4				
LOAD DATA COUNTER	LR	DC,H	DCU←(r10); DCL←(r11)	10	1	4				
LOAD DC IMMEDIATE	DCI	aaaa	DC←H aaaa	2Aaaaa	3	6				
LOAD PROGRAM COUNTER	LR	PO,Q	PC_0U←(r14); PC_0L←(r15)	OD	1	4				
LOAD STACK REGISTER	LR	P,K	PC_1U←(r12); PC_1L←(r13)	09	1	4				
RETURN FROM SUBROUTINE*	POP		PC_0←(PC_1)	1C	1	2				
STORE DATA COUNTER	LR	Q,DC	r14←(DCU); r15←(DCL)	OE	1	4				
STORE DATA COUNTER	LR	H,DC	r10←(DCU); r11←(DCL)	11	1	4				
STORE STACK REGISTER	LR	K,P	r12←(PC_1U); r13←(PC_1L)	08	1	4				

SCRATCHPAD REGISTER INSTRUCTIONS

(Refer to Scratchpad Addressing Modes)

OPERATION	MNEMONIC OP CODE	OPERAND	FUNCTION	MACHINE CODE	BYTES	CYCLES	STATUS BITS OVF	ZERO	CRY	SIGN
ADD BINARY	AS	r	ACC←(ACC) + (r)	Cr	1	1	1/0	1/0	1/0	1/0
ADD DECIMAL	ASD	r	ACC←(ACC) + (r)	Dr	1	2	1/0	1/0	1/0	1/0
DECREMENT	DS	r	r←(r) + H'FF'	3r	1	1.5	1/0	1/0	1/0	1/0
LOAD	LR	A,r	ACC←(r)	4r	1	1	-	-	-	-
LOAD	LR	A,KU	ACC←(r12)	00	1	1	-	-	-	-
LOAD	LR	A,KL	ACC←(r13)	01	1	1	-	-	-	-
LOAD	LR	A,QU	ACC←(r14)	02	1	1	-	-	-	-
LOAD	LR	A,QL	ACC←(r15)	03	1	1	-	-	-	-
LOAD	LR	r,A	r←(ACC)	5r	1	1	-	-	-	-
LOAD	LR	KU,A	r12←(ACC)	04	1	1	-	-	-	-
LOAD	LR	KL,A	r13←(ACC)	05	1	1	-	-	-	-
LOAD	LR	QU,A	r14←(ACC)	06	1	1	-	-	-	-
LOAD	LR	QL,A	r15←(ACC)	07	1	1	-	-	-	-
AND	NS	r	ACC←(ACC) ∧ (r)	Fr	1	1	0	1/0	0	1/0
EXCLUSIVE OR	XS	r	ACC←(ACC) ⊕ (r)	Er	1	1	0	1/0	0	1/0

*Privileged instruction

MISCELLANEOUS INSTRUCTIONS

OPERATION	MNEMONIC OP CODE	OPERAND	FUNCTION	MACHINE CODE	BYTES	CYCLES	STATUS BITS OVF	ZERO	CRY	SIGN
DISABLE INTERRUPT	DI		RESET ICB	1A	1	2	–	–	–	–
ENABLE INTERRUPT*	EI		SET ICB	1B	1	2	–	–	–	–
INPUT	IN	aa	ACC←(INPUT PORT aa)	26aa	2	4	0	1/0	0	1/0
INPUT SHORT	INS	a	ACC←(INPUT PORT a)	Aa	1	4***	0	1/0	0	1/0
LOAD ISAR	LR	IS,A	ISAR←(ACC)	0B	1	1	–	–	–	–
LOAD ISAR LOWER	LISL	a	ISARL←a	01101a**	1	1	–	–	–	–
LOAD ISAR UPPER	LISU	a	ISARU←a	01100a**	1	1	–	–	–	–
LOAD STATUS REGISTER*	LR	W,J	W←(r9)	1D	1	2	1/0	1/0	1/0	1/0
NO-OPERATION	NOP		PC_0←(PC_0) + 1	2B	1	1	–	–	–	–
OUTPUT	OUT	aa	OUTPUT PORT aa←(ACC)	27aa	2	4	–	–	–	–
OUTPUT SHORT	OUTS	a	OUTPUT PORT a←(ACC)	Ba	1	4***	–	–	–	–
STORE ISAR	LR	A,IS	ACC←(ISAR)	0A	1	1	–	–	–	–
STORE STATUS REG	LR	J,W	r9←(W)	1E	1	1	–	–	–	–

*Privileged instruction
**3-bit octal digit
***2 machine cycles for CPU ports

NOTES

Each lower case character represents a Hexadecimal digit
Each cycle equals 4 machine clock periods
Lower case denotes variables specified by programmer

Function Definitions

←	is replaced by
( )	the contents of
(–)	Binary "1"s complement of
+	Arithmetic Add (Binary or Decimal)
⊕	Logical "OR" exclusive
∧	Logical "AND"
∨	Logical "OR" inclusive
H' '	Hexadecimal digit

Register Names

a	Address Variable
A	Accumulator
DC	Data Counter (Indirect Address Register)
DC_0	Data Counter #0 (Indirect Address Register #0)
DC_1	Data Counter #1 (Indirect Address Register #1)
DCL	Least significant 8 bits of Data Counter Addressed
DCU	Most significant 8 bits of Data Counter Addressed
H	Scratchpad Register #10 and #11
i and ii	immediate operand
ICB	Interrupt Control Bit
IS	Indirect Scratchpad Address Register
ISAR	Indirect Scratchpad Address Register
ISARL	Least Significant 3 bits of ISAR
ISARU	Most Significant 3 bits of ISAR
J	Scratchpad Register #9
K	Registers #12 and #13
KL	Register #13
KU	Register #12
PC_0	Program Counter
PC_0L	Least Significant 8 bits of Program Counter
PC_0U	Most Significant 8 bits of Program Counter
PC_1	Stack Register
PC_1L	Least Significant 8 bits of Program Counter
PC_1U	Most Significant 8 bits of Active Stack Register
Q	Registers #14 and #15
QL	Register #15
QU	Register #14
r	Scratchpad Register (any address thru 11)
W	Status Register

Scratchpad Addressing Modes (Machine Code Format)

r = C	(Hexadecimal), Register Addressed by ISAR (Unmodified)
r = D	(Hexadecimal), Register Addressed by ISAR; ISARL Incremented
r = E	(Hexadecimal). Register Addressed by ISAR; ISARL Decremented
r = F	(No operation performed)
r = 0 thru B	(Hexadecimal), Register 0 thru 11 addressed directly from the Instruction

Status Register

–	No change in condition
1/0	is set to "1" or "0" depending on conditions
CRY	Carry Flag
OVF	Overflow Flag
SIGN	Sign of Result Flag
ZERO	Zero Flag

POWER REQUIREMENTS: V_{DD} = +5.0 V ±5%; V_{GG} = +12.0 V ±5%; V_{SS} = 0 V; T_A = 0°C to 70°C; f = 2 MHz

PART TYPE	SYMBOL	PARAMETER	TYP	MAX	UNITS	TEST CONDITIONS (Outputs Unloaded)
3850	I_{DD} I_{GG}	V_{DD} Current V_{GG} Current	30 15	80 25	mA mA	2 MHz
3851	I_{DD} I_{GG}	V_{DD} Current V_{GG} Current	30 10	70 18	mA mA	2 MHz
3852 3853	I_{DD} I_{GG}	V_{DD} Current V_{GG} Current	35 13	70 30	mA mA	2 MHz
3854	I_{DD} I_{GG}	V_{DD} Current V_{GG} Current	20 15	40 28	mA mA	2 MHz

SIGNAL ELECTRICAL SPECIFICATIONS: V_{DD} = +5.0 V ±5%; V_{GG} = +12.0 V ±5%; V_{SS} = 0 V; T_A = 0°C to 70°C; f = 2 MHz

SIGNAL NAME (NUMBER, TYPE)	SOURCE OR RECEIVING DEVICE	V_{OH} MIN	V_{IH} MIN	V_{OL} MAX	V_{IL} MAX	LOAD
DATA BUS (8 INPUTS/OUTPUTS)	3850 3851 3852/3 3854	3.9	3.5	0.4	0.8	100 pF I_{SOURCE} 100 µA I_{SINK} 900 µA
CONTROL BUS (5 OUTPUTS)	3850	3.9		0.4		100 pF, I_{SINK} = 900 µA I_{SOURCE} 100 µA
CONTROL BUS (5 INPUTS)[1]	3851 3852/3		3.5		0.8	
I/O PORTS (16 INPUTS/OUTPUTS)	3850 3851	2.9 (1 TTL) 3.9 (unloaded)	3.5[2]	0.4	0.8	100 pF plus 1 H-TTL Load
CLOCK REFERENCE (INPUT)	3850		4.0		0.8	
SYSTEM CLOCKS (PHI AND WRITE OUTPUTS)	3850	4.4		0.4		100 pF, I_{SINK} = 900 µA I_{SOURCE} = -100 µA
SYSTEM CLOCKS (PHI AND WRITE INPUTS)	3851 3852/3 3854		4.0		0.8	
RESET (INPUT)	3850		3.5[2]		0.8	I_{IL} = 0.3 mA Max at V_{IN} = V_{SS}
INTERRUPT CONTROL BIT (OUTPUT)	3850	3.9		0.4		50 pF plus 100 µA I_{SOURCE} or I_{SINK}
INTERRUPT REQUEST (INPUT)	3850		3.5[2]		0.8	I_{IL} = 1 mA Max at V_{IN} = 0.4
INTERRUPT REQUEST (OUTPUT)	3851 3853	OPEN DRAIN		0.4		100 pF plus I_{SINK} = 1 mA
EXTERNAL INTERRUPT (INPUT)	3851 3853		3.5		1.2	
PRIORITY IN (INPUT)	3851 3853		3.5		0.8	
PRIORITY OUT (OUTPUT)	3851	3.9		0.4		50 pF plus 100 µA I_{SOURCE} or I_{SINK}
DBDR (OUTPUT)	3851	OPEN DRAIN[3]		0.4		100 pF plus I_{SINK} = 2.5 mA
ADDRESS LINES and RAM WRITE (16 OUTPUTS)	3852/3 3854	4.0		0.4		500 pF plus 2 TTL Loads
REGDR (INPUT/OUTPUT)	3852/3	3.9	3.5	0.4	0.8	100 pF plus 1 H-TTL Load
CPU READ (OUTPUT)	3852/3	3.9		0.4		50 pF plus 1 H-TTL Load
MEM IDLE, CYCLE REQ and CPU SLOT (OUTPUTS)	3852	3.9		0.4		50 pF plus 1 H-TTL Load
MEM IDLE (INPUT)	3854		3.5		0.8	
ENABLE, DIRECTION, TRANSFER, DMA WRITE SLOT, STROBE (OUTPUTS)	3854	3.9		0.4		50 pF plus 1 H-TTL Load
XFER REQ, P1,P2 (INPUTS)	3854		3.5		0.8	
LOAD REG, READ REG (INPUTS)	3854		3.5		0.8	

[1]3854 receives two control signals from external decoding device. [2]Internal pull-up resistor to V_{DD}. [3]External pull-up resistor required.

INTRODUCTION

HM6100 MICROPROCESSOR

The HM6100 and HM6100A are single address, fixed word length, parallel transfer microprocessors using 12-bit, two's complement arithmetic. The processors recognize the instruction set of Digital Equipment Corporation's PDP8/E minicomputer. The internal circuitry is completely static and is designed to operate at any speed between DC and the maximum operating frequency. Two pins are available to allow for an external crystal thereby eliminating the need for clock generators and level translators. The crystal can be removed and the processor clocked by an external clock generator. A 12-bit memory-accumulator ADD instruction is performed in 5μsec by the HM6100 using a +5 volt supply and in 2.5μ sec by the HM6100A using a +10 volt supply. The device design is optimized to minimize the number of external components required for interfacing with standard memory and peripheral devices.

FEATURES

DESIGN
- Silicon Gate Complementary MOS
- Fully Static-0 to 8 MHz
- Single Power Supply
  - HM6100 V_{cc}=5 volts
  - HM6100A V_{cc}=10 volts
- Crystal Controlled On Chip Timing
- Low Power Dissipation <10 mW @ 4 MHz @ 5 volts
- Single Power Supply 4V $\leq V_{cc} \leq$ 11V
- TTL Compatible at 5 Volts
- Excellent Noise Immunity
- −55°C to +125°C Operation

ARCHITECTURAL
- Executes PDP-8/E, MP-12 and D-112 Instruction Set
- Direct, Indirect, and Autoindexed Memory Addressing
- 12-Bit Memory Accumulator ADD Instruction
  - HM6100 5μsec @ +5 volts
  - HM6100A 2.5μsec @ +10 volts
- Input-Output Instruction
  - HM6100 8.5μsec @ +5 volts
  - HM6100A 4.25μsec @ +10 volts
- Single-Clock, Single-Instruction Capability
- Direct Memory Access (DMA)
- Interrupt
- Dedicated Control Panel Features

INTERFACE
- Memory—Any Speed
- Control Panel
- Switch Register
- Asynchronous CPU—Memory and CPU—Device Communication
- 64 I/O Devices with PDP-8/E Compatible Interface
- Device Controlled Input-Output
- All Control Signals Produced By The CPU
- Power-on Initialize

APPLICATIONS

- Intelligent Computer Terminals
- POS Terminals
- Portable Terminals
- Aerospace/Satellite System
- Automotive Systems
- Remote Data Acquisition Systems
- Process Control
- Instrumentation
- Medical Electronics
- Displays
- Traffic Control
- Navigation

HARRIS SEMICONDUCTOR
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CONTENTS HM6100 MICROPROCESSOR (continued)

SECTIONS

FIGURES

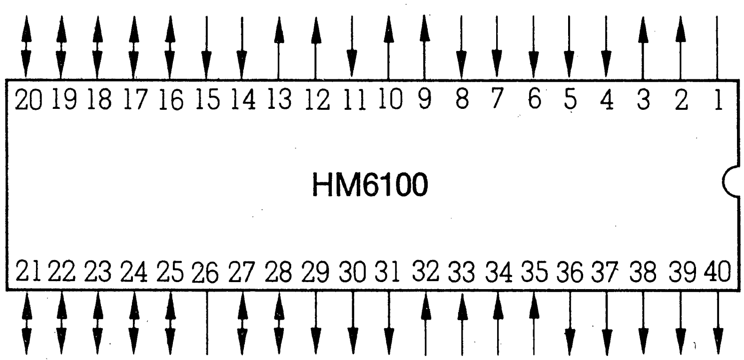
TABLES

Harris/Semiconductor MICROPROCESSOR

PIN ASSIGNMENTS

PIN	SYMBOL	ACTIVE LEVEL	DESCRIPTION
1	V_{cc}		Supply voltage.
2	RUN	H	The signal indicates the runstate of the CPU and may be used to power down the external circuitry
3	DMAGNT	H	Direct Memory Access Grant—DX lines are three-state.
4	DMAREQ	L	Direct Memory Access Request—DMA is granted at the end of the current instruction. Upon DMA grant, the CPU suspends program execution until the DMAREQ line is released.
5	CPREQ	L	Control Panel Request—a dedicated interrupt which bypasses the normal device interrupt request structure.
6	RUN/HLT	L	Pulsing the Run/Halt line causes the CPU to alternately run and halt by changing the state of the internal RUN/HLT flip flop.
7	RESET	L	Clears the AC and loads 7777_8 into the PC. CPU is halted.
8	INTREQ	L	Peripheral device interrupt request.
9	XT_A	H	External coded minor cycle timing—signifies input transfers to the HM6100.

PIN	SYMBOL	ACTIVE LEVEL	DESCRIPTION
10	LXMAR	H	The Load External Address Register is used to store memory and peripheral address externally.
11	WAIT	L	Indicates that peripherals or external memory is not ready to transfer data. The CPU state gets extended as long as WAIT is active. The CPU is in the lowest power state with clocks running.
12	XT_B	H	External coded minor cycle timing—signifies output transfers from the HM6100.
13	XT_C	H	External coded minor cycle timing—used in conjunction with the Select Lines to specify read or write operations.
14	OSC OUT		Crystal input to generate the internal timing (also external clock input).
15	OSC IN		See Pin 14—OSC OUT (also external clock ground)
16	DX_O		DataX—multiplexed data in, data out and address lines.
17	DX_1		See Pin 16—DX_O.
18	DX_2		See Pin 16—DX_O.
19	DX_3		See Pin 16—DX_O.
20	DX_4		See Pin 16—DX_O.



PIN	SYMBOL	ACTIVE LEVEL	DESCRIPTION
21	DX_5		See Pin 16—DX_O.
22	DX_6		See Pin 16—DX_O.
23	DX_7		See Pin 16—DX_O.
24	DX_8		See Pin 16—DX_O.
25	DX_9		See Pin 16—DX_O.
26	GND		Ground
27	DX_{10}		See Pin 16—DX_O.
28	DX_{11}		See Pin 16—DX_O.
29	LINK	H	Link flip flop.
30	DEVSEL	L	Device Select for I/O transfers.
31	SWSEL	L	Switch Register Select for the OR THE SWITCH REGISTER INSTRUCTION (OSR). OSR is a Group 2 Operate Instruction which reads a 12 bit external switch register and OR's it with the contents of the AC.
32	C_O	L	Control line inputs from the peripheral device during an I/O transfer (Table 5).

PIN	SYMBOL	ACTIVE LEVEL	DESCRIPTION
33	C_1	L	See Pin 32—C_O.
34	C_2	L	See Pin 32—C_O.
35	SKP	L	Skips the next sequential instruction if active during an I/O instruction.
36	IFETCH	H	Instruction Fetch Cycle
37	MEMSEL	L	Memory Select for memory transfers.
38	CPSEL	L	The Control Panel Memory Select becomes active, instead of the MEMSEL, for control panel routines. Signal may be used to distinguish between control panel and main memories.
39	INTGNT	H	Peripheral device Interrupt Grant
40	DATAF	H	Data Field pin indicates the execute phase of indirectly addressed AND, TAD, ISZ and DCA instructions so that the data transfers are controlled by the Data Field, DF, and not the Instruction Field, IF, if Extended Memory Control hardware is used to extend the addressing space from 4K to 32K words.

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	HM6100	+4.0V to +7.0V
	HM6100A	+4.0V to 11.0V
Input or Output Voltage Applied		GND −0.3V to V_{CC} +0.3V
Storage Temperature Range		−65°C to +125°C

Operating Temperature Range	
Industrial	−40°C to +85°C
Military	−55°C to +125°C

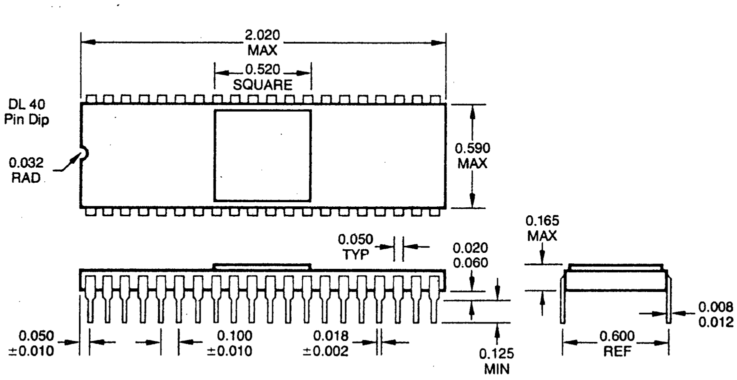
DC CHARACTERISTICS V_{cc} = 5.0V ± 10%(HM6100),10.0V ± 10% (HM6100A),T_A = Industrial or Military

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Logical "1" Input Voltage	V_{IH}		70% V_{cc}			V
Logical "0" Input Voltage	V_{IL}				20%V_{CC}	V
Input Leakage	I_{IL}	OV ≤ V_{IN} ≤ V_{CC}	−1.0		1.0	μA
Logical "1" Output Voltage	V_{OH2}	I_{OUT}=0	V_{cc}−0.01			V
Logical "1" Output Voltage	V_{OH1}	I_{OH}=−0.2mA	2.4			V
Logical "0" Output Voltage	V_{OL2}	I_{OUT} =0			GND +0.01	V
Logical "0" Output Voltage	V_{OL1}	I_{OL} =1.6 mA			0.45	V
Output Leakage	I_O	OV · V_o · V_{cc}	−1.0		1.0	μA
Supply Current	I_{CC}	V_{IN} = GND or V_{cc}; Output Open; T_A = 25°C; F_{clock} = o		400		μA
Input Capacitance	C_{IN}			5.0		pF
Output Capacitance	C_O			8.0		pF

ORDERING INFORMATION Circuit marking and product code explanation

HM 1 6 1 00 A DL

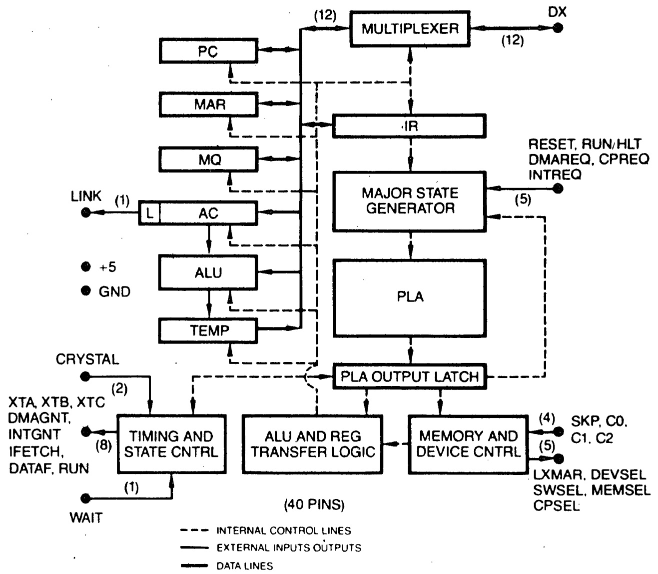
- DL — Temperature Range
  - -2 −55°C to +85°C
  - -9 −40°C to +85°C
- A — Version
- 00 — Specific Type
- 1 — General Type Microprocessor
- 6 — CMOS Process
- 1 — Package — 40 Pin Dip
- HM — HARRIS SEMICONDUCTOR



ARCHITECTURE

The HM6100/A has 6 twelve bit registers, a programmable logic array, an arithmetic and logic unit and associated gating and timing circuitry. A block diagram of the HM6100 is shown in Figure 1.

FIGURE 1



ACCUMULATOR (AC)
The AC is a 12-bit register with which arithmetic and logical operations are performed. Data words may be fetched from memory to the AC or stored from the AC into memory. Arithmetic and logical operations involve two operands, one held in the AC and the other fetched from the memory. The result of the operation is left in the AC. The AC may be cleared, complemented, tested, incremented or rotated under program control. The AC also serves as an input-output register. All programmed data transfers pass through the AC.

LINK (L)
The Link is a 1-bit flip-flop that serves as a high-order extension of the AC. It is used as a carry flip-flop for 2's complement arithmetic. A carry out of the ALU complements the Link. Link can be cleared, set, complemented and tested under program control and rotated as part of the AC.

MQ REGISTER (MQ)
The MQ is a 12-bit temporary register which is program accessible. The contents of AC may be transferred to the MQ for temporary storage. MQ can be OR'ed with the AC and the result stored in the AC. The contents of the AC and the MQ may also be exchanged.

MEMORY ADDRESS REGISTER (MAR)
While accessing memory, the 12-bit MAR register contains the address of the memory location that is currently selected for reading or writing. The MAR is also used as an internal register for microprogram control during data transfers to and from memory and peripherals.

PROGRAM COUNTER (PC)
The 12-bit PC contains the address of the memory location from which the next instruction is fetched. During an instruction fetch, the PC is transferred to MAR and the PC is then incremented by 1. When there is a branch to another address in memory, the branch address is set into the PC. Branching normally takes place under program control. However, during an input-output operation, a device may specify a branch address. A skip (SKP) instruction increments the PC by 1, thus causing the next instruction to be skipped. The SKP instruction may be unconditional or conditional on the state of the AC and/or the Link. During an input-output operation, a device can also cause the next sequential instruction to be skipped.

ARITHMETIC AND LOGICAL UNIT (ALU)
The ALU performs both arithmetic and logical operations—2's complement binary addition, AND, OR and complement. The ALU can perform a single position shift either to the left or to the right. A double rotate is implemented in two single bit shifts. The ALU can also shift by 3 positions to implement a byte swap in two steps. The AC is always one of the inputs to the ALU. However, under internal microprogram control, AC may be gated off and all one's or all zero's gated in. The second input may be any one of the other registers under internal microprogram control.

TEMPORARY REGISTER (TEMP)
The 12-bit TEMP register latches the result of an ALU operation before it is sent to the destination register to avoid race conditions. The TEMP is also used as an internal register for microprogram control.

INSTRUCTION REGISTER (IR)
During an instruction fetch, the 12-bit IR contains the instruction that is to be executed by the CPU. The IR specifies the initial step of the microprogram sequence for each instruction and is also used as an internal register to store temporary data for microprogram control.

MULTIPLEXER (DX)
The 12-bit Input/Output Multiplexer handles data, address and instruction transfers, into and out of, the CPU, from or into, the main memory and peripheral devices on a time-multiplexed basis.

MAJOR STATE GENERATOR AND THE PROGRAMMED LOGIC ARRAY (PLA)
During an instruction fetch the instruction to be executed is loaded into the IR. The PLA is then used for the correct sequencing of the CPU for the appropriate instruction. After an instruction is completely sequenced, the major state generator scans the internal priority network. The state of the priority network decides whether the machine is going to fetch the next instruction in sequence or service one of the external request lines.

PLA OUTPUT LATCH
The PLA Output Latch latches the PLA output thereby permitting the PLA to be pipelined; it fetches the next control sequence while the CPU is executing the current sequence.

MEMORY AND DEVICE CONTROL, ALU AND REG TRANSFER LOGIC
The Memory and Device Control Unit provides external control signals to communicate with peripheral devices (DEVSEL), switch register (SWSEL), memory (MEMSEL) and/or control panel memory (CPSEL). During I/O instructions this unit also modifies the PLA outputs depending on the states of the four device control lines (SKP, C_0, C_1, C_2). The ALU and Register Transfer Logic provides the control signals for the internal register transfers and ALU operation.

TIMING AND STATE CONTROL

The HM6100/A generates all the timing and state signals internally. A crystal is used to control the CPU operating frequency. The CPU divides the crystal frequency by two. With a 4MHz crystal, the internal states will be of 500ns duration. The major timing states are described in Figure 2.

T_1 For memory reference instructions, a 12-bit address is sent on the DataX, DX, lines. The Load External Address Register, LXMAR, is used to clock an external register to store the address information externally, if required. When executing an Input-Output I/O instruction, the instruction being executed is sent on the DX lines to be stored externally. The external address register then contains the device address and control information.

Various CPU request lines are priority sampled if the next cycle is an Instruction Fetch cycle. Current state of the CPU is available externally.

T_2 Memory/Peripheral data is read for an input transfer (READ). WAIT controls the transfer duration. If WAIT is active during input transfers, the CPU waits in the T_2 state. The wait duration is an integral multiple of the crystal frequency—250ns for 4MHz.

For memory reference instructions, the Memory Select, MEMSEL, line is active. For I/O instructions the Device Select, DEVSEL, line is active. Control lines, therefore, distinguish the contents of the external register as memory or device address.

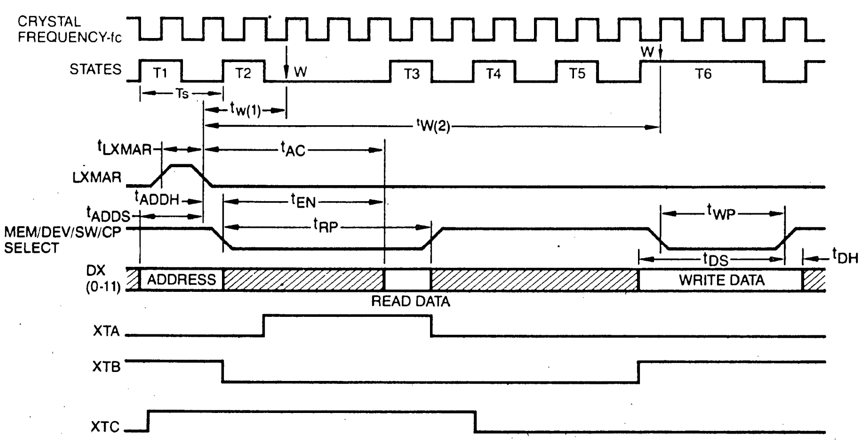
External device sense lines, C_0, C_1, C_2, and SKP, are sampled if the instruction being executed is an I/O instruction.

Control Panel Memory Select, CPSEL, and Switch Register Select, SWSEL, become active low for data transfers between the HM6100 and Control Panel Memory and the Switch Register, respectively.

T_3, T_4, T_5 ALU operation and internal register transfers.

T_6 This state is entered for an output transfer (WRITE). The address is defined during T_1. WAIT controls the time for which the Write data must be maintained.

FIGURE 2



HM6100 TIMING AND STATE SIGNALS

AC CHARACTERISTICS (T_A = 25° C)

PARAMETER	SYMBOL	HM6100 V_{CC} = 5.0, f_c = 4MHz TYP	HM6100/A V_{CC} = 10.0, f = 8 MHz TYP	UNITS
Major State Time	T_S	500	250	ns
LXMAR Pulse Width	t_{LXMAR}	250	125	ns
Address Setup Time	t_{ADDS}	50	50	ns
Address Hold Time	t_{ADDH}	250	125	ns
Read WAIT Valid Time	$t_{W(1)}$	250	125	ns
Write WAIT Valid Time	$t_{W(2)}$	1800	900	ns
Access Time From CS	t_{AC}	450	225	ns
Output Enable Time	t_{EN}	300	150	ns
Read Pulse Width	t_{RP}	700	350	ns
Write Pulse Width	t_{WP}	250	125	ns
Data Setup Time	t_{DS}	250	125	ns
Data Hold Time	t_{DH}	100	50	ns

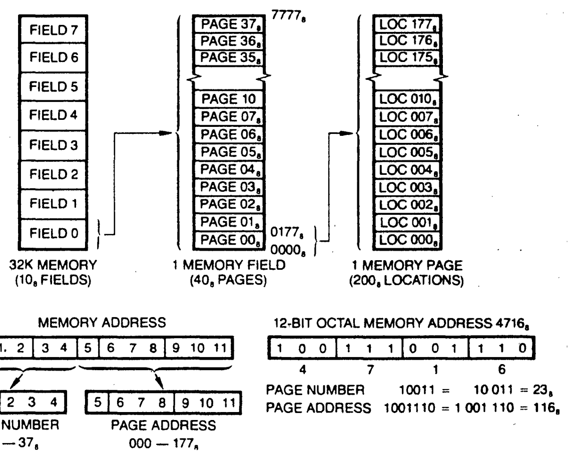
MEMORY AND PROCESSOR INSTRUCTIONS

The HM6100 instructions are 12-bit words stored in memory. The HM6100 makes no distinction between instructions and data; it can manipulate instructions as stored variables or execute data as instructions when it is programmed to do so. There are three general classes of HM6100 instructions. They are referred to as Memory Reference Instruction (MRI), Operate Instruction (OPR) and Input/Output Transfer Instruction (IOT).

Before proceeding further, we will discuss the Specific Memory Organization with which the HM6100 interfaces.

MEMORY ORGANIZATION

The HM6100 has a basic addressing capacity of 4096 12-Bit words. The addressing capacity may be extended by Extended Memory Control hardware. The memory system is organized in 4096 word blocks, called MEMORY FIELDS. The first 4096 words of memory are in Field 0. If a full 32K of memory is installed, the uppermost Memory Field will be numbered 7. In any given Memory Field every location has a unique 4 digit octal (12 bit binary) address, 0000_8 to 7777_8 (0000_{10} to 4095_{10}). Each Memory Field is subdivided into 32 PAGES of 128 words each. Memory Pages are numbered sequentially from Page 00_8, containing addresses 0000-0177_8, to Page 37_8, containing addresses 7600_8-7777_8. The first 5 bits of a 12-bit MEMORY ADDRESS denote the PAGE NUMBER and the low order 7 bits specify the PAGE ADDRESS of the memory location within the given Page.



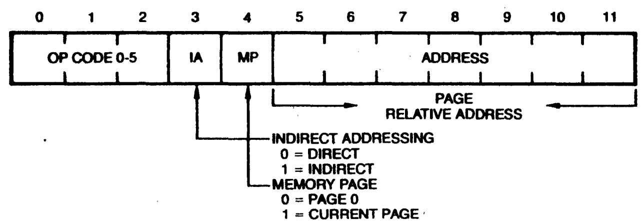
MEMORY ORGANIZATION

During an instruction fetch cycle, the HM6100 fetches the instruction pointed to by the PC. The contents of the PC are transferred to the MAR. The PC is incremented by 1. The PC now contains the address of the 'next' sequential instruction. The MAR contains the address of the 'current' instruction which must be fetched from memory. Bits 0-4 of the MAR identify the CURRENT PAGE, that is, the Page from which instructions are currently being fetched and bits 5-11 of the MAR identify the location within the Current Page. (PAGE ZERO (0), by definition, denotes the first 128 words of memory, 0000_8-0177_8.)

MEMORY REFERENCE INSTRUCTIONS (MRI)

The Memory Reference Instructions operate on the contents of a memory location or use the contents of a memory location to operate on the AC or the PC. The first 3 bits of a Memory Reference Instruction specify the operation code, or OPCODE, and the low order 9 bits, the OPERAND address, as shown in Figure 3.

FIGURE 3



MEMORY REFERENCE INSTRUCTION FORMAT

Bits 5 through 11, the PAGE ADDRESS, identify the location of the OPERAND on a given page, but they do not identify the page itself. The page is specified by bit 4, called the CURRENT PAGE OR PAGE 0 BIT. If bit 4 is a 0, the page address is interpreted as a location on Page 0. If bit 4 is a 1, the page address specified is interpreted to be on the Current Page.

For example, if bits 5 through 11 represent 123_8 and bit 4 is a 0, the location referenced is the absolute address 0123_8. However, if bit 4 is a 1 and the current instruction is in a memory location whose absolute address is 4610_8 the page address 123_8 designates the absolute address 4723_8, as shown below.

4610_8 = 100 110 001 000 = PAGE 10 011 = PAGE 23_8

Location 4610_8 is in PAGE 23_8. Location 123_8 in PAGE 23_8, CURRENT PAGE, will be:

10 011 | 1 010 011 = 100 111 010 011 = 4723_8

PAGE NUMBER 23_8 — PAGE ADDRESS 123_8

By this method, 256 locations may be directly addressed, 128 on PAGE 0 and 128 on the CURRENT PAGE. Other locations are addressed by utilizing bit 3. When bit 3 is a 0, the operand address is a DIRECT ADDRESS. An INDIRECT ADDRESS (pointer address) identifies the location that contains the desired address (effective address). To address a location that is not directly addressable, not in PAGE 0 or in the CURRENT PAGE, the absolute address of the desired location is stored in one of the 256 directly addressable locations (pointer address). Upon execution, the MRI will operate on the contents of the location identified by the address contained in the pointer location.

It should be noted that locations 0010_8-0017_8 in PAGE 0 are AUTOINDEXED. If these locations are addressed indirectly, the contents are incremented by 1 and restored before they are used as the operand address. These locations may, therefore, be used for indexing applications.

Table 1 lists the mnemonics for the five memory reference instruction, their OPCODE, the operations they perform, the number of states and the execution time at +5.0V and +10.0V, assuming a crystal frequency of 4MHz and 8MHz or a state time period of 500 ns and 250ns, respectively.

It should be noted that the data is represented in Two's Complement Integer notation. In this system, the negative of a number is formed by complementing each bit in the data word and adding "1" to the complemented number. The sign is indicated by the most significant bit. In the 12-bit word used by the HM6100, when bit 0 is a "0", it denotes a positive number and when bit 0 is a "1", it denotes a negative number. The maximum number ranges for this system are 3777_8 (+2047) and 4000_8 (−2048).

Notations applied in Table 1, are defined as follows:

( ) Denotes the contents of the register or location within the parenthesis. (EA) is read as " ... the contents of the Effective Address".

(( )) Denotes the contents of the location pointed to by the contents of the location within the double parenthesis. ((PA)) is read as " ... the contents of the location pointed to by the contents of the Pointer Address."

<— Denotes " ... is replaced by ... "

∧ Denotes, logical AND operation

∨ Denotes, logical OR operation

TABLE 1

MNEMONIC	OP CODE	OPERATION	NUMBER OF STATES	EXECUTION TIME (μs) HM6100 +5.0V	EXECUTION TIME (μs) HM6100 +10.0V
AND	0_8	LOGICAL AND DIRECT (I = 0) Operation: (AC) <—(AC)∧(EA) Description: Contents of the EA are logically AND'ed with the contents of the AC and the result is stored in AC.	10	5.0	2.50
		INDIRECT (I = 1, PA ≠ 0010-0017$_8$) Operation: (AC) <—(AC)∧(PA))	15	7.5	3.75
		AUTOINDEX (I = 1, PA = 0010-0017$_8$) Operation: (PA) <—(PA) + 1; (AC) <—(AC)∧((PA))	16	8.0	4.00
TAD	1_8	BINARY ADD DIRECT (I = 0) Operation: (AC) <—(AC) + (EA) Description: Contents of the EA are ADD'ed with the contents of the AC and the result is stored in the AC; carry out complements the LINK. If AC is initially cleared, this instruction acts as LOAD from Memory	10	5.0	2.50
		INDIRECT (I = 1, PA ≠ 0010-0017$_8$) Operation: (AC) <—(AC) + ((PA))	15	7.5	3.75
		AUTOINDEX (I = 1, PA = 0010-0017$_8$) Operation: (PA) <—(PA) + 1; (AC) <—(AC) + ((PA))	16	8.0	4.00
ISZ	2_8	INCREMENT AND SKIP IF ZERO DIRECT (I = 0) Operation: (EA) <—(EA) +1; if (EA) = 0000_8, PC <—PC + 1 Description: Contents of the EA are incremented by 1 and restored. If the result is zero, the next sequential instruction is skipped.	16	8.0	4.00
		INDIRECT (I = 1, PA ≠ 0010-0017$_8$) Operation: ((PA)) <—((PA)) + 1; if ((PA)) = 0000_8, PC <—PC + 1	21	10.5	5.25
		AUTOINDEX (I = 1, PA = 0010-0017$_8$) Operation: (PA) <—(PA) +1; ((PA)) <—((PA)) + 1; if ((PA)) = 0000_8, PC <—PC + 1	22	11.0	5.50
DCA	3_8	DEPOSIT AND CLEAR THE ACCUMULATOR DIRECT (I = 0) Operation: (EA) <—(AC); (AC) <—0000_8 Description: The contents of the AC are stored in EA and the AC is cleared.	11	5.5	2.75
		INDIRECT (I = 1, PA ≠ 0010-0017$_8$) Operation: ((PA)) <—(AC); (AC) <—0000_8	16	8.0	4.00
		AUTOINDEX (I = 1, PA = 0010-0017$_8$) Operation: (PA) <—(PA) + 1; ((PA)) <—(AC); (AC) <—0000_8	17	8.5	4.25
JMS	4_8	JUMP TO SUBROUTINE DIRECT (I = 0) Operation: (EA) <—(PC), (PC) <—EA + 1 Description: The contents of the PC are stored in the EA. The PC is incremented by 1 immediately after every instruction fetch. The contents of the EA now point to the next sequential instruction following the JMS (return address). The next instruction is taken from EA + 1.	11	5.5	2.75
		INDIRECT (I = 1, PA ≠ 0010-0017$_8$) Operation: ((PA)) <—PC, (PC) <—(PA) + 1	16	8.0	4.00
		AUTOINDEX (I = 1, PA = 0010-0017$_8$) Operation: (PA) <—(PA) + 1; ((PA)) <—PC, (PC) <—(PA) + 1	17	8.5	4.25
JMP	5_8	JUMP DIRECT (I = 0) Operation: (PC) <—EA Description: The next instruction is taken from the EA.	10	5.0	2.50
		INDIRECT (I = 1, PA ≠ 0010-0017$_8$) Operation: (PC) <—(PA)	15	7.5	3.75
		AUTOINDEX (I = 1, PA = 0010-0017$_8$) Operation: (PA) <—(PA) + 1; (PC) <—(PA)	16	8.0	4.00

MEMORY REFERENCE INSTRUCTIONS

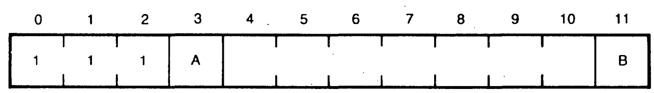
OPERATE INSTRUCTIONS

The Operate Instructions, which have an OPCODE of 7_8 (111), consists of 3 groups of microinstructions. Group 1 microinstructions, which are identified by the presence of a 0 in bit 3, are used to perform logical operations on the contents of the accumulator and link. Group 2 micro instructions, which are identified by the presence of a 1 in bit 3 and a 0 in bit 11, are used primarily to test the contents of the accumulator and then conditionally skip the next sequential instruction. Group 3 microinstructions have a 1 in bit 3 and a 1 in bit 11 and are used to perform logical operations on the contents of the AC and MQ.

The basic OPR instruction format is shown in Figure 4.

Operate microinstructions from any group may be microprogrammed with other operate microinstructions of the same group. The actual code for a microprogrammed combination of two, or more, microinstructions is the bitwise logical OR of the octal codes for the individual microinstructions. When more than one operation is microprogrammed into a single instruction, the operations are performed in a prescribed sequence, with logical sequence number 1 microinstructions performed first, logical sequence number 2 microinstructions performed second, logical sequence number 3 microinstructions performed third and so on. Two operations with the same logical sequence number, within a given group of microinstructions, are performed simultaneously.

FIGURE 4



MICROINSTRUCTION	A	B
GROUP 1	0	0 1
GROUP 2	1	0
GROUP 3	1	1

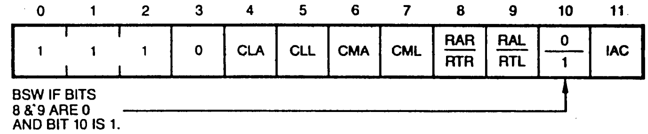
BASIC OPR INSTRUCTION FORMAT

GROUP 1 MICROINSTRUCTIONS

Figure 5 shows the instruction format of a group 1 microinstruction. Any one of bits 4 to 11 may be set, loaded with a binary 1, to indicate a specific group 1 microinstruction. If more than one of these bits is set, the instruction is a microprogrammed combination of group 1 microinstructions, which will be executed according to the logical sequence shown in Figure 5.

Table 2 lists commonly used group 1 microinstructions, their assigned mnemonics, octal number, instruction format, logical sequence, the operation they perform, the number of states and the execution time at +5.0V and +10.0V, assuming a crystal frequency of 4 MHz and 8 MHz or a state time period of 500 ns and 250 ns, respectively. The same format is followed in Table 3 and 4 which correspond to group 2 and 3 microinstructions, respectively.

FIGURE 5



LOGICAL SEQUENCES:
1—CLA, CLL
2—CMA, CML
3—IAC
4—RAR, RAL, RTR, RTL, BSW

GROUP 1 MICROINSTRUCTION FORMAT

TABLE 2

MNEMONIC	OCTAL CODE	LOGICAL SEQUENCE	OPERATION	NUMBER OF STATES	EXECUTION TIME (μs) IM6100 +5.0V	IM6100A +10.0V
NOP	7000	1	NO OPERATION—This instruction causes a 10 state delay in program execution, without affecting the state of the IM6100. It may be used for timing synchronization or as a convenient means of deleting an instruction from a program.	10	5.0	2.50
IAC	7001	3	INCREMENT ACCUMULATOR—The content of the AC is incremented by one (1) and carry out complements the Link (L).	10	5.0	2.50
RAL	7004	4	ROTATE ACCUMULATOR LEFT—The contents of the AC and L are rotated one binary position to the left. AC (1) is shifted to L and L is shifted to AC (11).	15	7.5	3.75
RTL	7006	4	ROTATE TWO LEFT—The contents of the AC and L are rotated two binary positions to the left. AC (1) is shifted to L and L is shifted to AC (10).	15	7.5	3.75
RAR	7010	4	ROTATE ACCUMULATOR RIGHT—The content of the AC and L are rotated one binary position to the right. AC (11) is shifted to L and L is shifted to AC (0).	15	7.5	3.75
RTR	7012	4	ROTATE TWO RIGHT—The contents of the AC and L are rotated two binary positions to the right. AC (10) is shifted to L and L is shifted to AC (1).	15	7.5	3.75
BSW	7002	4	BYTE SWAP—The right six (6) bits of the AC are exchanged or SWAPPED with the left six bits. AC (0) is swapped with AC (6), AC (1) with AC (7), etc. L is not affected.	15	7.5	3.75
CML	7020	2	COMPLEMENT LINK—The content of the link is complemented.	10	5.0	2.50
CMA	7040	2	COMPLEMENT ACCUMULATOR—The content of each bit of the AC is complemented having the effect of replacing the content of the AC with its one's complement.	10	5.0	2.50
CIA	7041	2,3	COMPLEMENT AND INCREMENT ACCUMULATOR—The content of the AC is replaced with its two's complement. Carry out complements the LINK.	10	5.0	2.50
CLL	7100	1	CLEAR LINK—The link is loaded with a binary 0.	10	5.0	2.50
CLL RAL	7104	1,4	CLEAR LINK—ROTATE ACCUMULATOR LEFT.	15	7.5	3.75
CLL RTL	7106	1,4	CLEAR LINK—ROTATE TWO LEFT.	15	7.5	3.75
CLL RAR	7110	1,4	CLEAR LINK—ROTATE ACCUMULATOR RIGHT.	15	7.5	3.75
CLL RTR	7112	1,4	CLEAR LINK—ROTATE TWO RIGHT.	15	7.5	3.75
STL	7120	1,2	SET THE LINK—The LINK is loaded with a binary 1 corresponding with a microprogrammed combination of CLL and CML.	10	5.0	2.50
CLA	7200	1	CLEAR ACCUMULATOR—The accumulator is loaded with binary 0's.	10	5.0	2.50
CLA IAC	7201	1,3	CLEAR ACCUMULATOR—INCREMENT ACCUMULATOR.	10	5.0	2.50
GLT	7204	1,4	GET THE LINK—The AC is cleared; the content of L is shifted into AC (11), a 0 is shifted into L. This is a microprogrammed combination of CLA and RAL.	15	7.5	3.75
CLA CLL	7300	1	CLEAR ACCUMULATOR—CLEAR LINK.	10	5.0	2.50
STA	7240	1,2	SET THE ACCUMULATOR—Each bit of the AC is set to 1 corresponding to a microprogrammed combination of CLA and CMA.	10	5.0	2.50

GROUP 1 OPERATION MICROINSTRUCTIONS

GROUP 2 MICROINSTRUCTIONS

Figure 6 shows the instruction format of group 2 microinstructions. Bits 4—11 may be set to indicate a specific group 2 microinstruction. If more than one of bits 4—7 or 9—10 is set, the instruction is a microprogrammed combination of group 2 microinstructions, which will be executed according to the logical sequence shown in Figure 6.

Skip microinstructions may be microprogrammed with CLA, OSR, or HLT microinstructions. Skip microinstructions which have a 0 in bit 8, however, may not be microprogrammed with skip microinstructions which have a 1 in bit 8. When two or more skip microinstructions are microprogrammed into a single instruction, the resulting condition on which the decision will be based is the logical OR of the individual conditions when bit 8 is 0, or, when bit 8 is 1, the decision will be based on the logical AND.

FIGURE 6

0	1	2	3	4	5	6	7	8	9	10	11
1	1	1	1	CLA	SMA / SPA	SZA / SNA	SNL / SZL	0 / 1	OSR	HLT	0

LOGICAL SEQUENCES:
1 (Bit 8 is Zero) — SMA or SZA or SNL
(Bit 8 is One) — SPA and SNA and SZL
2 — CLA
3 — OSR, HTL

GROUP 2 MICROINSTRUCTION FORMAT

TABLE 3

MNEMONIC	OCTAL CODE	LOGICAL SEQUENCE	OPERATION	NUMBER OF STATES	EXECUTION TIME (μs) HM6100 +5.0V	EXECUTION TIME (μs) HM6100 +10.0V
NOP	7400	1	NO OPERATION—See GROUP 1 MICROINSTRUCTIONS	10	5.0	2.50
HLT	7402	3	HALT—Program stops at the conclusion of the current machine cycle. If HLT is combined with others in OPR 2, the other operations are completed before the end of the cycle.	10	5.0	2.50
OSR	7404	3	OR WITH SWITCH REGISTER—The content of the Switch Register if OR'ed with the content of the AC and the result is stored in the AC. The OSR INSTRUCTION TIMING is shown in Figure 7. The IM6100 sequences the OSR instruction through a 2-cycle execute phase referred to as OPR 2A and OPR 2B.	15	7.5	3.75
SKP	7410	1	SKIP—The content of the PC is incremented by 1, to skip the next sequential instruction.	10	5.0	2.50
SNL	7420	1	SKIP ON NON-ZERO LINK—The content of L is sampled, the next sequential instruction is skipped if L contains a 1. If L contains a 0, the next instruction is executed.	10	5.0	2.50
SZL	7430	1	SKIP ON ZERO LINK—The content of L is sampled, the next sequential instruction is skipped if L contains a 0. If the L contains a 1, the next instruction is executed.	10	5.0	2.50
SZA	7440	1	SKIP ON ZERO ACCUMULATOR—The content of the AC is sampled; the next sequential instruction is skipped if the AC has all bits which are 0. If any bit in the AC is a 1, the next instruction is executed.	10	5.0	2.50
SNA	7450	1	SKIP ON NON-ZERO ACCUMULATOR—The content of the AC is sampled; the next sequential instruction is skipped if the AC has any bits which are not 0. If every bit in the AC is 0, the next instruction is executed.	10	5.0	2.50
SZA SNL	7460	1	SKIP ON ZERO ACCUMULATOR, ***OR*** SKIP ON NON-ZERO LINK, ***OR*** BOTH	10	5.0	2.50
SNA SZL	7470	1	SKIP ON NON-ZERO ACCUMULATOR ***AND*** SKIP ON ZERO LINK	10	5.0	2.50
SMA	7500	1	SKIP ON MINUS ACCUMULATOR—If the content of AC (0) contains a 1, indicating that the AC contains a negative two's complement number, the next sequential instruction is skipped. If AC (0) contains a 0, the next instruction is executed.	10	5.0	2.50
SPA	7510	1	SKIP ON POSITIVE ACCUMULATOR—The contents of AC (0) are sampled. If AC (0) contains a 0, indicating that the AC contains a positive two's complement number, the next sequential instruction is skipped. If AC (0) contains a 1, the next instruction is executed.	10	5.0	2.50
SMA SNL	7520	1	SKIP ON MINUS ACCUMULATOR ***OR*** SKIP ON NON-ZERO LINK ***OR*** BOTH	10	5.0	2.50
SPA SZL	7530	1	SKIP ON POSITIVE ACCUMULATOR ***AND*** SKIP ON ZERO LINK	10	5.0	2.50
SMA SZA	7540	1	SKIP ON MINUS ACCUMULATOR ***OR*** SKIP ON ZERO ACCUMULATOR ***OR*** BOTH	10	5.0	2.50
SPA SNA	7550	1	SKIP ON POSITIVE ACCUMULATOR ***AND*** SKIP ON NON-ZERO ACCUMULATOR	10	5.0	2.50
SMA SZA SNL	7560	1	SKIP ON MINUS ACCUMULATOR ***OR*** SKIP ON ZERO ACCUMULATOR ***OR*** SKIP ON NON-ZERO LINK ***OR*** ALL	10	5.0	2.50
SPA SNA SZL	7570	1	SKIP ON POSITIVE ACCUMULATOR ***AND*** SKIP ON NON-ZERO ACCUMULATOR ***AND*** SKIP ON ZERO LINK	10	5.0	2.50
CLA	7600	2	CLEAR ACCUMULATOR—The AC is loaded with binary 0's.	10	5.0	2.50
LAS	7604	1,3	LOAD ACCUMULATOR WITH SWITCH REGISTER—The content of the AC is loaded with the content of the SR, bit for bit. This is equivalent to a microprogrammed combination of CLA and OSR.	15	7.5	3.75
SZA CLA	7640	1,2	SKIP ON ZERO ACCUMULATOR ***THEN*** CLEAR ACCUMULATOR	10	5.0	2.50
SNA CLA	7650	1,2	SKIP ON NON-ZERO ACCUMULATOR ***THEN*** CLEAR ACCUMULATOR	10	5.0	2.50
SMA CLA	7700	1,2	SKIP ON MINUS ACCUMULATOR ***THEN*** CLEAR ACCUMULATOR	10	5.0	2.50
SPA CLA	7710	1,2	SKIP ON POSITIVE ACCUMULATOR ***THEN*** CLEAR ACCUMULATOR	10	5.0	2.50

GROUP 2 OPERATE MICROINSTRUCTIONS

GROUP 3 MICROINSTRUCTIONS

Figure 7 shows the instruction format of group 3 microinstructions which requires bits 3 and 11 to contain a 1. Bits 4, 5 or 7 may be set to indicate a specific group 3 microinstruction. If more than one of the bits is set, the instruction is a microprogrammed combination of group 3 microinstructions following the logical sequence listed in Figure 7.

FIGURE 7

0	1	2	3	4	5	6	7	8	9	10	11
1	1	1	1	CLA	MQA	•	MQL	•	•	•	1

LOGICAL SEQUENCE:
1—CLA
2—MQA, MQL
3—ALL OTHERS

•Don't Care

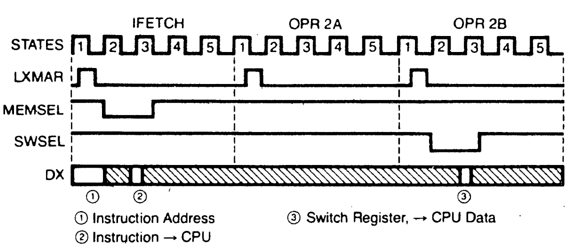
GROUP 3 MICROINSTRUCTION FORMAT

TABLE 4

MNEMONIC	OCTAL CODE	LOGICAL SEQUENCE	OPERATION	NUMBER OF STATES	EXECUTION TIME (μs) HM6100 +5.0V	EXECUTION TIME (μs) HM6100 +10.0V
NOP	7401	3	NO OPERATION—See Group 1 Microinstructions	10	5.0	2.50
MQL	7421	2	MQ REGISTER LOAD—The content of the AC is loaded into the MQ, the AC is cleared and the original content of the MQ is lost.	10	5.0	2.50
MQA	7501	2	MQ REGISTER INTO ACCUMULATOR—The content of the MQ is OR'ed with the content of the AC and the result is loaded into the AC. The original content of the AC is lost but the original content of the MQ is retained. This instruction provides the programmer with an inclusive OR operation.	10	5.0	2.50
SWP	7521	3	SWAP ACCUMULATOR AND MQ REGISTER—The content of the AC and MQ are interchanged accomplishing a microprogrammed combination of MQA and MQL.	10	5.0	2.50
CLA	7601	1	CLEAR ACCUMULATOR			
CAM	7621	3	CLEAR ACCUMULATOR AND MQ REGISTER—The content of the AC and MQ are loaded with binary 0's. This is equivalent to a microprogrammed combination of CLA and MQL.	10	5.0	2.50
ACL	7701	3	CLEAR ACCUMULATOR AND LOAD MQ REGISTER INTO ACCUMULATOR—This is equivalent to a microprogrammed combination of CLA and MQA.	10	5.0	2.50
CLA SWP	7721	3	CLEAR ACCUMULATOR AND SWAP ACCUMULATOR AND MQ REGISTER—The content of the AC is cleared. The content of the MQ is loaded into the AC and the MQ is cleared.	10	5.0	2.50

GROUP 3 OPERATE MICROINSTRUCTIONS

FIGURE 8



OSR INSTRUCTION TIMING

INPUT/OUTPUT TRANSFER INSTRUCTIONS (IOT)

The input/output transfer instructions, which have an OPCODE of 6_8, are used to initiate the operation of peripheral devices and to transfer data between peripherals and the HM6100. Three types of data transfer may be used to receive or transmit information between the HM6100 and one or more peripheral I/O devices. PROGRAMMED DATA TRANSFER provides a straightforward means of communicating with relatively slow I/O devices, such as Teletypes, cassettes, card readers and CRT displays. INTERRUPT TRANSFERS use the interrupt system to service several peripheral devices simultaneously, on an intermittent basis, permitting computational operations to be performed concurrently with the data I/O operations. Both Programmed Data Transfers and Program Interrupt Transfers use the accumulator as a buffer, or storage area, for all data transfers. Since data may be transferred only between the accumulator and the peripheral, only one 12 bit word at a time may be transferred. DIRECT MEMORY ACCESS, DMA, transfers variable-size blocks of data between high-speed peripherals and the memory with a minimum of program control required by the HM6100.

IOT INSTRUCTION FORMAT

The Input/Output Transfer Instruction format, the number of states and the execution time at +5.0V and +10.0V, assuming a crystal frequency of 4 MHz and 8 MHz or a state time period of 500 ns and 250 ns, respectively is represented in Figure 9.

The first three bits, 0-2, are always set to 6_8 (110) to specify an IOT instruction. The next six bits, 3-8, contain the device selection code that determines the specific I/O device for which the IOT instruction is intended and, therefore, permit interface with up to 64 I/O devices. The last three bits, 9-11, contain the operation specification code that determines the specific operation to be performed. The nature of this operation for any given IOT instruction depends entirely upon the circuitry designed into the I/O device interface.

PROGRAMMED DATA TRANSFER

Programmed Data Transfer is the easiest, simplest, most convenient and most common means of performing data I/O. For microprocessor applications, it may also be the most cost effective approach. The data transfer begins when the HM6100 fetches an instruction from the memory and recognizes that the current instruction is an IOT. This is referred to as IFETCH and consists of five (5) internal states. The HM6100 sequences the IOT instruction through a 2-cycle execute phase referred to as IOT_A and IOT_B. Bits 0-11 of the IOT instruction are available on DX 0-11 at $IOT_A \cdot LXMAR$. These bits must be latched in an external address register. DEVSEL is active low to enable data transfers between the HM6100 and the peripheral device(s). Input-Output Instruction Timing is shown in Figure 10. The selected peripheral device communicates with the HM6100 through 4 control lines—C_0, C_1, C_2 and SKP. In the HM6100 the type of data transfer, during an IOT instruction, is specified by the peripheral device(s) by asserting the control lines as shown in Table 5.

The control line SKP, when low during an IOT, causes the HM6100 to skip the next sequential instruction. This feature is used to sense the status of various signals in the device interface. The C_0, C_1, and C_2 lines are treated independently of the SKP line. In the case of a RELATIVE or ABSOLUTE JUMP, the skip operation is performed after the jump. The input signals to the HM6100, DX 0-11, C_0, C_1, C_2, and SKP, are sampled at IOT_A during $\overline{DEVSEL}\cdot XT_C$. The data from the HM6100 is available to the device(s) during $\overline{DEVSEL}\cdot\overline{XT_C}$. IOT_B cycle is internal to the HM6100 to perform the operations requested during IOT_A. Both IOT_A and IOT_B consist of six (6) internal states.

In summary, Programmed Data Transfer performs data I/O with a minimum of hardware support. The maximum rate at which programmed data transfers may take place is limited by the HM6100 instruction execution rate. However, the data rate of the most commonly used peripheral devices is much lower than the maximum rate at which programmed transfers can take place in the HM6100. The major drawback associated with Programmed Data Transfer is that the HM6100 must hang up in a waiting loop while the I/O device completes the last transfer and prepares for the next transfer. On the other hand, this technique permits easy hardware implementation and simple, economical interface design. For this reason, almost all devices except bulk storage units rely heavily on programmed data transfer for routine data I/O.

FIGURE 9

0	1	2	3	4	5	6	7	8	9	10	11
1	1	0	DEVICE SELECTION						CONTROL		

IOT INSTRUCTION FORMAT

Number of States	Execution Time (μs)	
	+5.0V	+10.0V
17	8.5	3.4

IOT NUMBER OF STATES/EXECUTION TIME

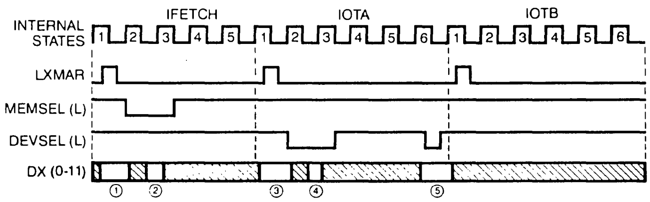
TABLE 5

CONTROL LINES C_0	C_1	C_2	OPERATION	DESCRIPTION
H	H	H	DEV <—AC	The contents of the AC is sent to the device.
L	H	H	DEV <—AC;CLA	The contents of the AC is sent to a device and then the AC is cleared.
H	L	H	AC <—AC V DEV	Data is received from a device, OR'ed with the data in the AC and the result is stored in the AC.
L	L	H	AC <—DEV	Data is received from a device and loaded into the AC.
*	H	L	PC <—PC + DEV	Data from the device is added to the contents of the PC. This is referred to as a RELATIVE JUMP.
*	L	L	PC <—DEV	Data is received from a device and loaded into the PC. This is referred to as an ABSOLUTE JUMP.

*Don't Care

PROGRAMMED I/O CONTROL LINES

FIGURE 10



① INSTRUCTION ADDRESS
② INSTRUCTION
③ DEVICE ADDRESS AND CONTROL
④ DEVICE DATA IN, C0, C1, C2, SKP
⑤ AC OUT

INPUT-OUTPUT INSTRUCTION TIMING

INTERRUPT TRANSFER

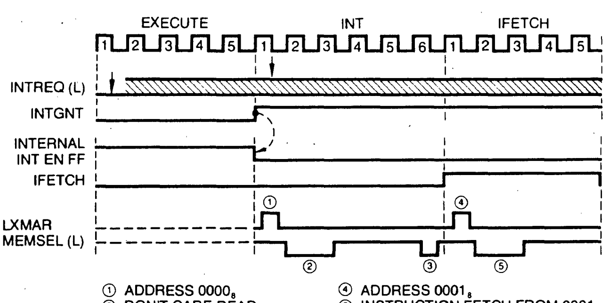
PROGRAM INTERRUPT TRANSFERS

The program interrupt system may be used to initiate programmed data transfers in such a way that the time spent waiting for device status is greatly reduced or eliminated altogether. It also provides a means of performing concurrent programmed data transfers between the HM6100 and the peripheral devices. This is accomplished by isolating the I/O handling routines from the mainline program and using the interrupt system to ensure that these routines are entered only when an I/O device status is set, indicating that the device is actually ready to perform the next data transfer, or that it requires some sort of intervention from the running program.

The interrupt system allows certain external conditions to interrupt the computer program by driving the INTREQ input to the HM6100 Low. If no higher priority requests are outstanding and the interrupt system is enabled, the HM6100 grants the device interrupt at the end of the current instruction. After an interrupt has been granted, the Interrupt Enable Flip-Flop in the HM6100 is reset so that no more interrupts are acknowledged until the interrupt system is re-enabled under program control.

The current content of the Program Counter, PC, is deposited in location 0000_8 of the memory and the program fetches the instruction from location 0001_8. The return address is available in location 0000_8. This address must be saved in a software stack if nested interrupts are permitted. The INTGNT, Figure 11, signal is activated by the HM6100 when a device interrupt is acknowledged. This signal is reset by executing any IOT instruction as shown in Figure 12. The INTGNT signal is necessary to implement the Extended Memory Control hardware when more than 4K of memory is required. The INTGNT is also useful in implementing an External Vectored Priority Interrupt network.

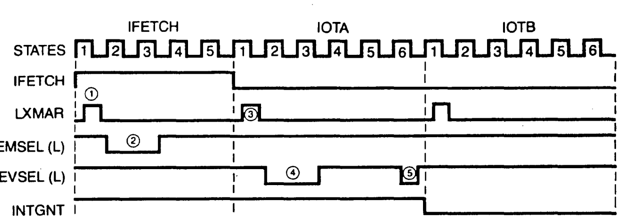
FIGURE 11



① ADDRESS 0000_8
② DON'T CARE READ
③ PC WRITTEN IN LOC 0000_8
④ ADDRESS 0001_8
⑤ INSTRUCTION FETCH FROM 0001_8 OF MEM

DEVICE INTERRUPT GRANT TIMING

FIGURE 12



① INSTRUCTION ADDRESS
② 6XXX FROM MEMORY
③ ADDRESS 6XXX
④ DATA TRANSFER FROM PERIPHERAL DEVICES AS CONTROLLED BY C_0, C_1, AND C_2
⑤ DATA TRANSFER TO PERIPHERAL DEVICES AS CONTROLLED BY C_0, C_1, AND C_2

DEVICE INTERRUPT GRANT RESET TIMING

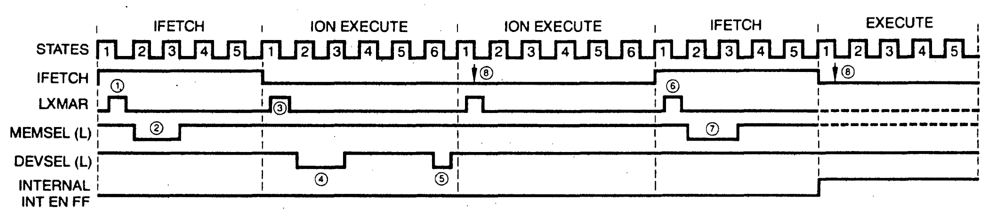
INPUT/OUTPUT TRANSFER INSTRUCTIONS (IOT) CONTINUED

TABLE 6

MNE-MONIC	OCTAL CODE	OPERATION
SKON	6000	SKIP IF INTERRUPT ON—If Interrupt system is enabled, the next sequential instruction is skipped. The Interrupt system is disabled.
ION	6001	INTERRUPT TURN ON—The internal interrupt acknowledge system is enabled. The interrupt system is enabled after the CPU executes the next sequential instruction. The INTERRUPT ENABLE TIMING is shown in Figure 13.
IOF	6002	INTERRUPT TURN OFF—The interrupt system is disabled. Note that the interrupt system is automatically disabled when the CPU acknowledges an INT request.
SRQ	6003	SKIP IF INT REQUEST—The next sequential instruction is skipped if the INT request bus is low.
GTF	6004	GET FLAGS—The following machine states are read into the indicated bits of AC. bit 0—Link bit 2—INT request bus bit 4—Interrupt Enable FF Other bits may be modified by external inputs (ex. Extended memory control).
RTF	6005	RETURN FLAGS—Link is restored from AC (0). Interrupt system is enabled after the next sequential instruction is executed. All AC bits are available externally to restore external states. (ex. Extended memory control).
SGT	6006	Operation is determined by external devices, if any.
CAF	6007	CLEAR ALL FLAGS—AC and Link are cleared. Interrupt system is disabled.

PROCESSOR IOT INSTRUCTIONS

FIGURE 13



① INSTRUCTION ADDRESS
② INSTRUCTION FETCH
③ DEVICE ADDRESS (6001_8)
④ DON'T CARE DEV READ, SAMPLE C0, C1, C2 & SKP
⑤ DON'T CARE DEV WRITE
⑥ INSTRUCTION ADDRESS
⑦ INSTRUCTION FETCH
⑧ SAMPLE REQUEST LINES

INTERRUPT ENABLE FF ON (ION)

CONTROL PANEL INTERRUPT TRANSFER

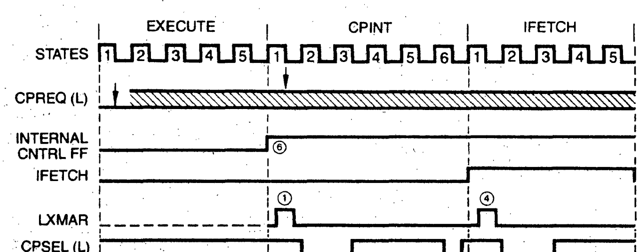
The HM6100 control panel is implemented in software. The software implementation of the control panel need not use any part of the main memory or change the processor state. This is an important feature since the final version of the system may not have a control panel and the system designer would like to use the entire capacity of the main memory for the specific system application.

The control panel communicates with the HM6100 with the Control Panel Request, CPREQ, line. The CPREQ is functionally similar to the INTREQ with some important differences. The CPREQ is granted even when the machine is in the HALT state. The IM6100 is temporarily put in the RUN state for the duration of the panel routine. The HM6100 reverts back to its original processor state after the panel routine has been executed.

The CPREQ bypasses the interrupt enable system and the processor IOT instructions, ION and IOF, are ignored while the HM6100 is in the Control Panel Mode. Once a CPREQ is granted, the HM6100 will not recognize any DMAREQ or INTREQ until CPREQ has been fully serviced.

When a CPREQ is granted, Figure 14, the PC is stored in location 0000_8 of the Panel Memory and the HM6100 resumes operation at location 7777_8 of the Panel Memory. The Panel Memory would be organized with RAM's in the lower pages and PROM's in the higher pages. The control panel service routine would be stored in the higher pages in the nonvolatile PROM's, starting at 7777_8.

FIGURE 14



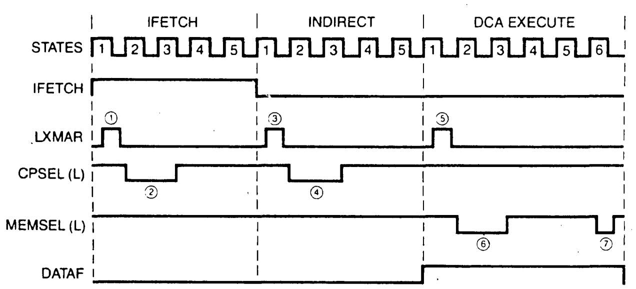
① ADDRESS 0000_8
② DON'T CARE READ
③ PC WRITTEN IN LOC 0000_8 OF CP MEM
④ ADDRESS 7777_8
⑤ INSTRUCTION FETCHED FROM LOC 7777_8 OF CP MEM
⑥ IF CPU IS HALTED, THE RUN IS TRUE AT T1 OF CPINT

CONTROL PANEL INTERRUPT GRANT TIMING

A Control Panel Flip-Flop, CNTRL FF, which is internal to the HM6100, is set when the CPREQ is granted. The CNTRL FF prevents further CPREQ's from being granted.

As long as the CNTRL FF is set, the Control Panel Memory Select, CPSEL, is active instead of the Memory Select, MEMSEL, for memory references. The CPSEL signal may, therefore, be used to distinguish the Control Panel Memory from the Main Memory. However, during the Execute phase of indirectly addressed AND, TAD, ISZ or DCA instructions, the MEMSEL is made active. The instructions are always fetched from the control panel memory. The operand address for indirectly addressed AND, TAD, ISZ or DCA refers first to the control panel memory for an effective address, which, in turn, refers to a location in the main memory. A main memory location may, therefore, be examined and changed by indirectly addressed TAD and DCA instructions, Figure 15, respectively. Every location in the main memory is accessible to the control panel routine.

FIGURE 15



① INSTRUCTION ADDRESS
② INSTRUCTION FROM CP MEMORY
③ EFFECTIVE ADDRESS
④ OPERAND ADDRESS FROM CP MEMORY
⑤ OPERAND ADDRESS
⑥ DON'T CARE MAIN MEM READ
⑦ AC WRITTEN INTO MAIN MEMORY

"DCA INDIRECT" IN CONTROL PANEL ROUTINE

Exiting from the control panel routine is achieved by executing the following sequence with reference made to Figure 16.

ION
JMP I 0000_8 (Loc 0000_8 in CPMEM)

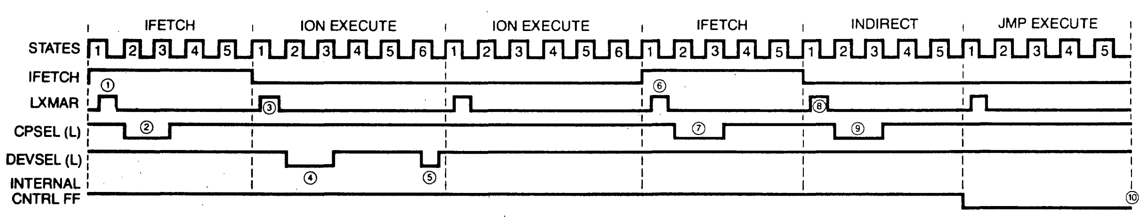
The ION, 6001_8, instruction will reset the CP FF after executing the next sequential instruction. The ION will not affect the interrupt system since the CNTRL FF is still active. Location 0000_8 of the CPMEM contains either the original return address deposited by the IM6100 when the CP routine was entered, or it may be a new starting address defined by the CP routine, for example, by activating the LOAD ADDRESS SWITCH. CPREQ's are normally generated by the manual actuation of the control switches. If the CPU registers must be displayed in real-time, the CPREQ's must be generated by a timer at fixed intervals.

The designer may also make use of the control panel features to implement Bootstrap loaders in the CP Memory so that the loader will be "transparent" to the main memory. Programs will be loaded by DCA I POINTER instruction, the pointer being developed in the CP RAM to point to the main memory location to be loaded.

Approximately 64 P/ROM locations are sufficient to implement all the functions of the PDP8/E Control Panel. The HM6100 provides for a 12 bit switch register which can be read by the HM6100 under program control with the OR THE SWITCH REGISTER, OSR, instruction even without a control panel.

An RTF, 6005_8, instruction also resets the internal CNTRL FF. Exiting from a panel routine can be achieved by activating the RESET line since RESET has a higher priority than CPREQ as shown in Figure 21. If the RUN/HLT line is pulsed while the HM6100 is in the panel mode, it will 'remember' the pulse(s) but defer any action until the HM6100 exits from the panel mode.

FIGURE 16



① INSTRUCTION ADDRESS
② INSTRUCTION FETCH FROM CP MEM
③ DEVICE ADDRESS (6001_8)
④ DON'T CARE DEVICE READ, SAMPLE C0, C1, C2 & SKP
⑤ DON'T CARE DEVICE WRITE
⑥ INSTRUCTION ADDRESS
⑦ INSTRUCTION FETCH FROM CP MEM
⑧ EFFECTIVE ADDRESS (0000_8)
⑨ JMP ADDRESS FROM CP MEM LOC 0000_8
⑩ IF CPU WAS IN THE HALT STATE, THE RUN IS FLASE AT T1

"ION; JMP I 0000_8" IN CONTROL PANEL ROUTINE

INPUT/OUTPUT TRANSFER INSTRUCTIONS CONTINUED

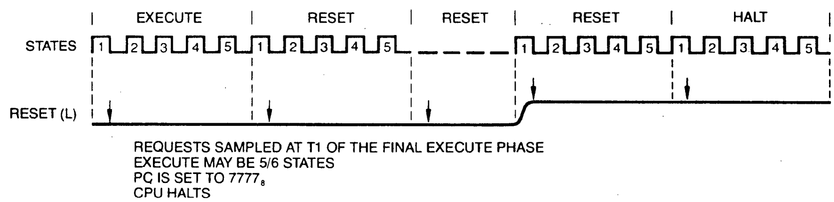
RESET

The Reset initializes all internal HM6100 flags and clears the AC and the LINK. The machine is halted.

The HM6100 remains in the Reset state as long as the Reset line is low as shown in Figure 17. The DX lines are three stated. The HM6100 continues to provide the external timing signals XT_A, XT_B and XT_C. All SEL lines are high.

The PC is set to 7777_8. In most applications, the higher memory locations utilize P/ROM's or ROM's. Therefore, a power-up routine starting at the highest memory location can be used to initialize the system.

FIGURE 17



RESET TIMING

RUN/HALT

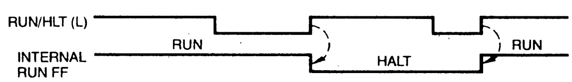
RUN/HLT changes the state of the HM6100's RUN/HLT flip-flop. Pulsing the line low causes the IM6100 to alternately run and halt as shown in Figure 18. The RUN/HLT line is normally high. The HM6100 recognizes the positive transition of the signal.

The RUN/HLT flip-flop can be put in the halt state under program control by executing the HLT, 7402_8, instruction. When the HM6100 is halted, RUN/HLT is functionally identical to the CONTINUE switch of the PDP8/E control panel.

If the HM6100 is in the halt state, the RUN signal is low. The RUN signal can be used to power down external circuitry for a low power system.

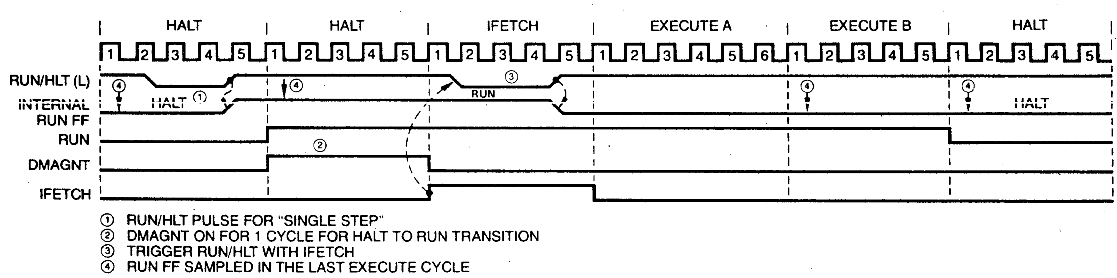
The RUN/HLT can also be used to make the HM6100 execute one instruction at a time as shown in Figure 19. The RUN/HLT combines the functional features of STOP, CONTINUE, and SINGLE INSTRUCTION as defined by the PDP8/E Control Panel.

FIGURE 18



RUN/HALT TIMING

FIGURE 19



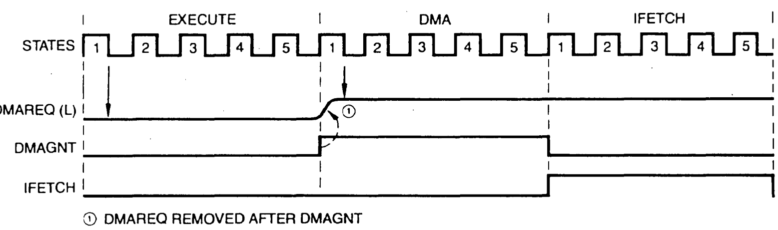
"SINGLE STEP" WITH RUN/HLT

DIRECT MEMORY ACCESS (DMA)

Direct Memory Access, sometimes called data break, is the preferred form of data transfer for use with high-speed storage devices such as magnetic disk or tape units. The DMA mechanism transfers data directly between memory and peripheral devices. The HM6100 is involved only in setting up the transfer; the transfers take place with no processor intervention on a "cycle stealing" basis. The DMA transfer rate is limited only by the bandwidth of the memory and the data transfer characteristics of the device.

The device generates a DMA Request when it is ready to transfer data. The HM6100 grants the DMAREQ by activating the DMAGNT signal at the end of the current instruction as shown in Figure 20. The HM6100 suspends any further instruction fetches until the DMAREQ line is released. The DX lines are tri-stated, all SEL lines are high, and the external timing signals XT_A, XT_B, and XT_C are active. The device which generated the DMAREQ must provide the address and the necessary control signals to the memory for data transfers. The DMAREQ line can also be used as a level sensitive "pause" line.

FIGURE 20



DIRECT MEMORY ACCESS (DMA)

INTERNAL PRIORITY STRUCTURE

After an instruction is completely sequenced, the major state generator scans the internal priority network as shown in Figure 21. The state of the priority network decides the next sequence of the HM6100

The request lines, RESET, CPREQ, RUN/HLT, DMAREQ and INTREQ, are sampled in the last cycle of an instruction execution, at time T1. The worst case response time of the HM6100 to an external request is, therefore, the time required to execute the longest instruction preceded by any 6-state execution cycle. For the HM6100, this is an autoindexed ISZ, 22 states, preceded by any 6-state execution cycle instruction. The worst case response time is, therefore, 28 states, 14 μs at 5 volts.

When the HM6100 is initially powered up, the state of the timing generator is undefined. The generator is automatically initialized with a maximum of 68 clock pulses. The request inputs, as the HM6100 is powered on, must span at least 92 clock pulses to be recognized, 68 clocks for the counter to initialize and a maximum of two HM6100 cycles (20 to 24 clocks) for the state generator to sample the request lines.

The internal priority is RESET, CPREQ, RUN/HLT, DMAREQ, INTREQ, and IFETCH.

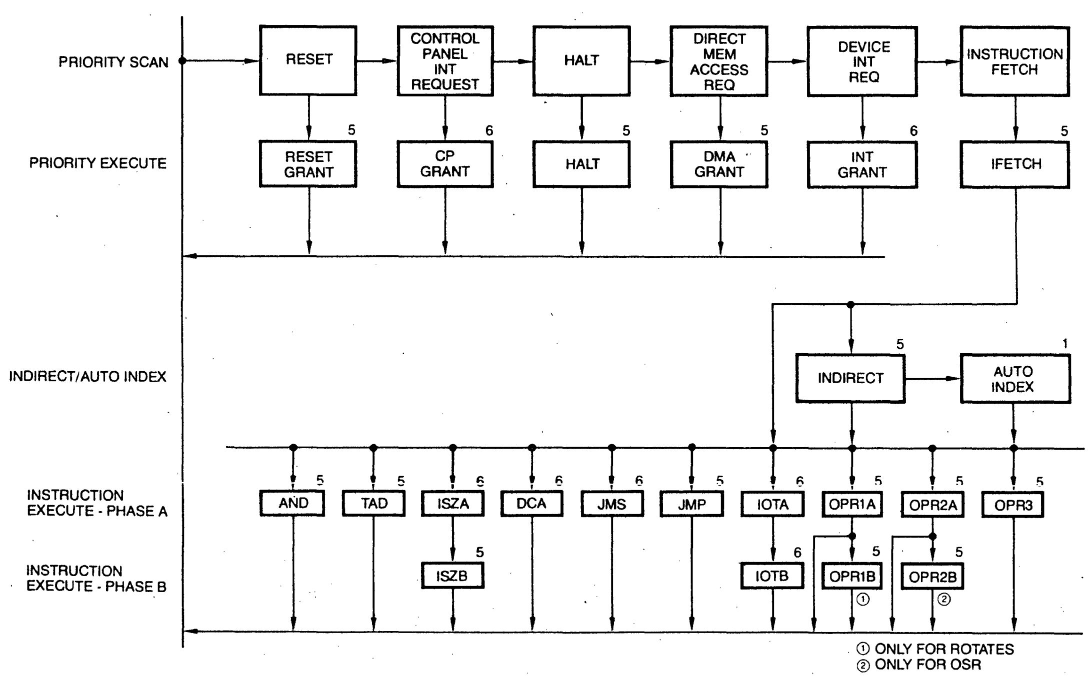
IFETCH

If no external requests are pending, the HM6100 fetches the next instruction pointed to by the contents of the PC. The IFETCH line is active during the cycle in which the instruction is fetched. External devices can monitor DX, 0-2, during IFETCH·XT_A to determine the functional class of the current instruction. For example, the external memory extension hardware must know when JMP or JMS instructions are fetched to implement the Extended Memory Control.

The Programmable Logic Array, PLA, in the HM6100 sequences the HM6100 to execute the fetched instruction. All INDIRECT and AUTOINDEX Memory Reference Instructions go through a common state sequence to generate the Effective Address, EA, of the operand. The subsequent sequence, referred to as the EXECUTE phase, is controlled by the functional class of the instruction. The EXECUTE phase of AND, TAD, DCA, JMS, JMP and OPR Group 3 Microinstruction consists of only one cycle. ISZ and IOT have a 2-cycle EXECUTE phase. OPR Group 1 and Group 2 Microinstructions have an optional second cycle, depending on the microcoding of the OPR instructions. An HM6100 cycle consists of 5 states, T_1, T_2, T_3, T_4, and T_5, with an optional sixth state, T_6, for Output Transfers (WRITE).

The state sequence for internal (processor) and external IOT instructions are identical. The Device Address and Control bits are available in the External Address Register for internal IOT instructions. External hardware, for example Extended Memory Control, can control the C-lines for data transfers to implement Get Flags (GTF), Return Flags (RTF), and Clear All Flags (CAF) instructions. External Control of the C-lines is necessary to implement these internal IOT instructions since the flag bits may be distributed both inside and outside the HM6100.

FIGURE 21



MAJOR PROCESSOR STATES AND NUMBER OF CLOCK CYCLES IN EACH STATE

Harris/Semiconductor

MICROPROCESSOR

PDP-8/E COMPATIBILITY

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

The HM6100 and the PDP-8/E MP12 and D112 are software compatible. The basic PDP-8/E paper-tape software system supplied by Digital Equipment Corporation will operate properly with the HM6100. This basic software package includes Binary Loaders, PAL III Assembler, Symbolic Editor, Dynamic Debugging Technique (DDT), Octal Debugging Technique (ODT), 23 Bit Floating Point Package and FOrmula CALculator (FOCAL)®. The HM6100 will execute the complete set of CPU diagnostics for PDP-8/E.

Since the bus structure of the HM6100 can be adapted to provide a subset of the PDP-8/E OMNIBUS® signals, all programmed I/O interfaces for the PDP-8/E, for example, Teletype, Papertape Reader/Punch, etc., will operate with the HM6100 without any hardware or software modification.

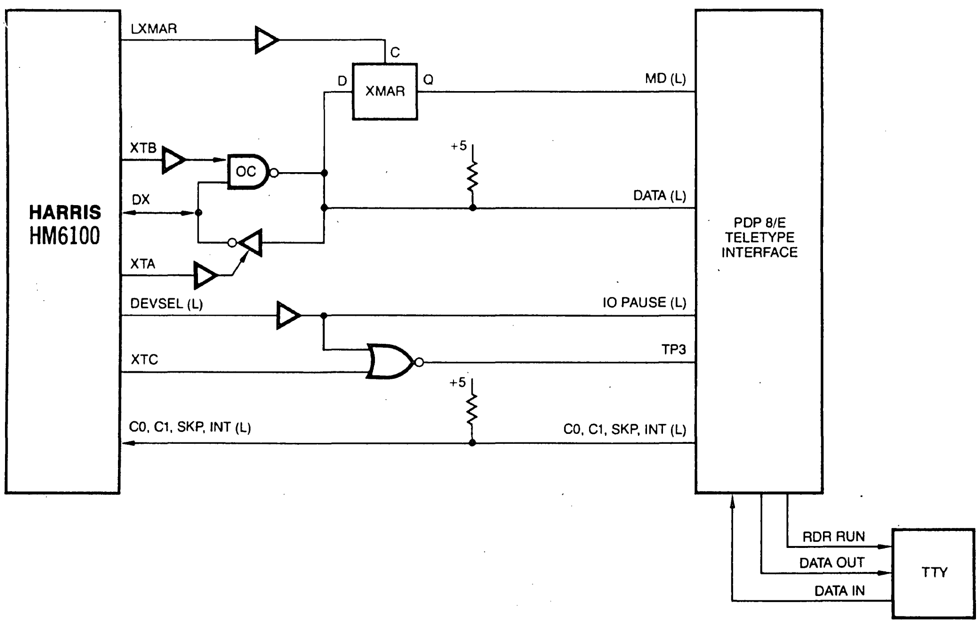
The Direct Memory Access, DMA, structure of the HM6100 and PDP-8/E are different, the HM6100 DMA structure is similar to the PDP-8 1-CYCLE BREAK, but not compatible.

The HM6100 handles 4K words of memory directly. Like the PDP-8/E, an external Extended Memory Control element can be used to extend the addressing space up to 32K. All necessary control and timing signals to implement the memory extension controller are generated by the HM6100.

The Extended Arithmetic Element, EAE, and the User Flag, UF, processor options of the PDP-8/E cannot be used with the HM6100. The EAE is used for hardwired Multiply/Divide and the UF for timesharing.

The HM6100 treats the Control Panel as a programmed I/O device with certain special features. The Control Panel has a dedicated INT request line to the HM6100 and the control panel program can reside in a separate memory, distinct from the normal program memory. The control panel service routine can be made transparent to the user and the user program can occupy the entire 4K of main memory. The bootstrap routines may also reside in the dedicated control panel memory. Unlike the PDP-8/E, the HM6100 bootstrap routines and the loaded user programs, can, therefore, share common address space.

FIGURE 22



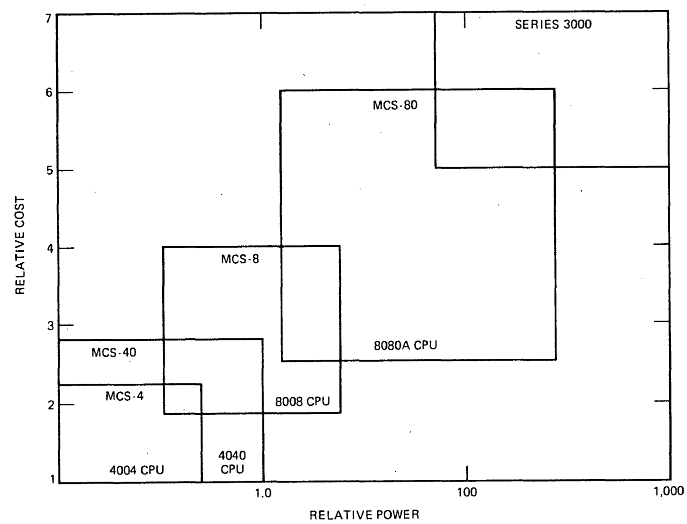
EXAMPLE OF A PDP-8/E PROGRAMMED I/O PERIPHERAL INTERFACE

®Registered Trademark of Digital Equipment Corporation

Why more engineers use the Intel 8080 system

Intel microcomputer systems.

Since 1971, equipment manufacturers have used Intel microcomputer systems to reduce the cost and increase the versatility of their products. These LSI systems have replaced hardwired assemblies in hundreds of applications, such as POS equipment, intelligent terminals, analytical instruments, process controls, communications systems, rapid transit toll systems, word processors and business equipment.



Today, Intel delivers five microcomputer system families. Four are based on MOS central processor units and the fifth on Series 3000 Schottky bipolar LSI central processor elements. All the microprocessors are supported with optional I/O, peripheral and memory building blocks, which provide a large variety of system configurations in each family.

As indicated by the graph above, Intel systems cover the broadest possible cost-performance range. This lets you produce the most cost-effective design, whether your application calls for low cost replacement of electromechanical controls or high performance processing.

Why more engineers choose the 8080 system.

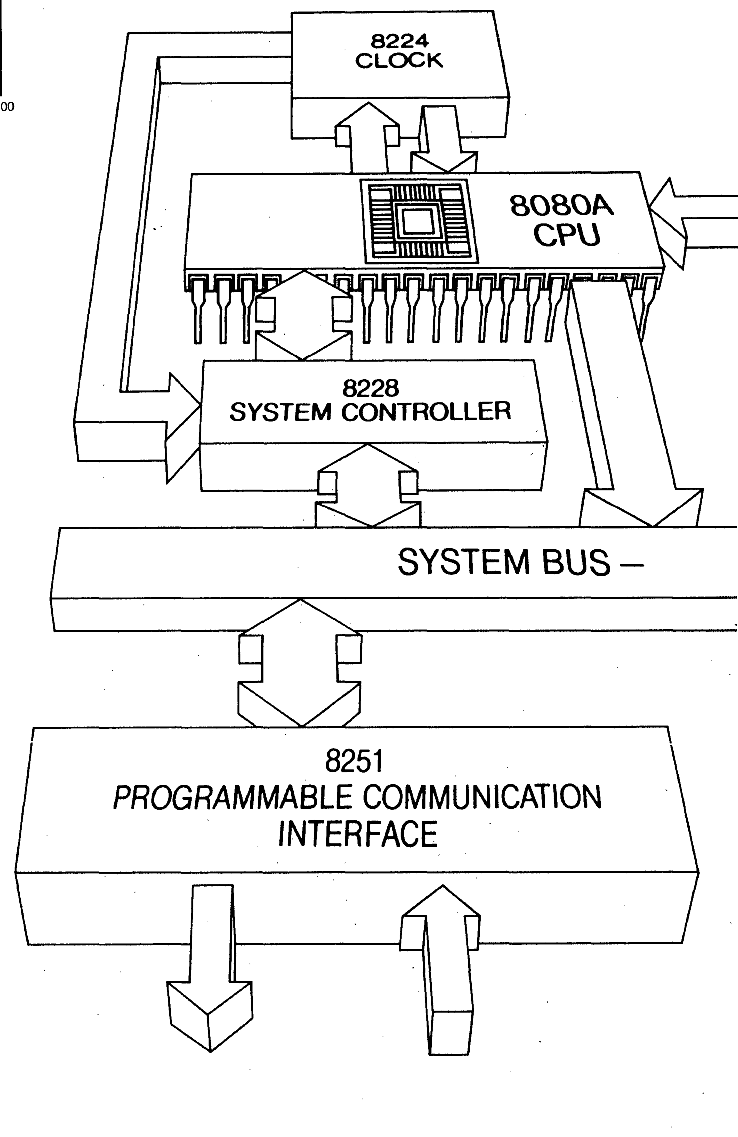
The broad center of the microcomputer cost-performance range is covered by the Intel® 8080 system—the 8080A CPU, other MCS-80™ system components, and nine software packages. First delivered in December, 1973, the 8080 system has become the basis for more new OEM products than all other microcomputers combined.

Some major reasons for the 8080 system's popularity are a powerful CPU group with four CPU options, five programmable I/O and peripheral devices, 21 other system components, production deliveries since April, 1974, major second sources, and the industry's most useful software and hardware development systems. These add up to higher profitability for the 8080 user.

How the 8080 system increases your profitability.

MCS-80™ systems feature a simple building block architecture and high performance, enabling them to replace hundreds of TTL packages and numerous discrete components in a great variety of control and processing applications.

With MCS-80™ building blocks, complete LSI systems are easy to design, program and modify. As a result, the 8080 system helps you get new products to market faster and at lower cost; sharply reduces documentation, production and maintenance overhead; and simplifies enhancement of your product line to meet changing market conditions.



than all other microcomputers combined.

The system's completeness solves design problems.

MCS-80™ components form complete systems with many optional configurations. They eliminate the problems of hardwired design by integrating control and processing functions in LSI blocks that interface with one another through a standard system bus.

The systems building blocks include:

• The basic CPU Group, which defines and drives the bus—the 8080A CPU, 8224 Clock Generator and 8228 System Controller.

• Three CPU options for higher speed and extended temperature range applications.

• Twelve I/O and peripherals options, five are programmable LSI devices that control and communicate with external equipment in software selectable modes.

• Thirteen memory options, including 8K erasable PROMs, 16K ROMs, low power 1K CMOS RAMs, and low cost 4K RAMs—all with industry standard configurations for ease of use and economy.

You choose the blocks, program the CPU, check out the hardware and software, and then make the program part of the system by storing it in read-only memory. A program change is usually the only modification required to adapt the microcomputer system to changes and enhancements of your product line.

Intel support minimizes development time.

Intel has supported designers of microcomputer based products since 1971. Today, we back 8080 system users with:

• A third-generation microcomputer development system—the Intellec® MDS-800. It is the first system to support simultaneous development of hardware and software. Moreover, with the MDS-800 you can now develop your system in its actual operating environment.

• Nine software packages—six Intellec® resident products and three cross products for rapid program design with symbolic and high level languages.

• System design kits—the new MCS-80™ kit provides a complete system's hardware, circuit card, control program and documentation.

• Seven reference and programming manuals—complete documentation of 8080 hardware, software and development systems.

• User's program library—over a hundred programs developed by 8080 system users.

• Training for engineers and programmers—courses and workshops at Intel regional centers, or on-site.

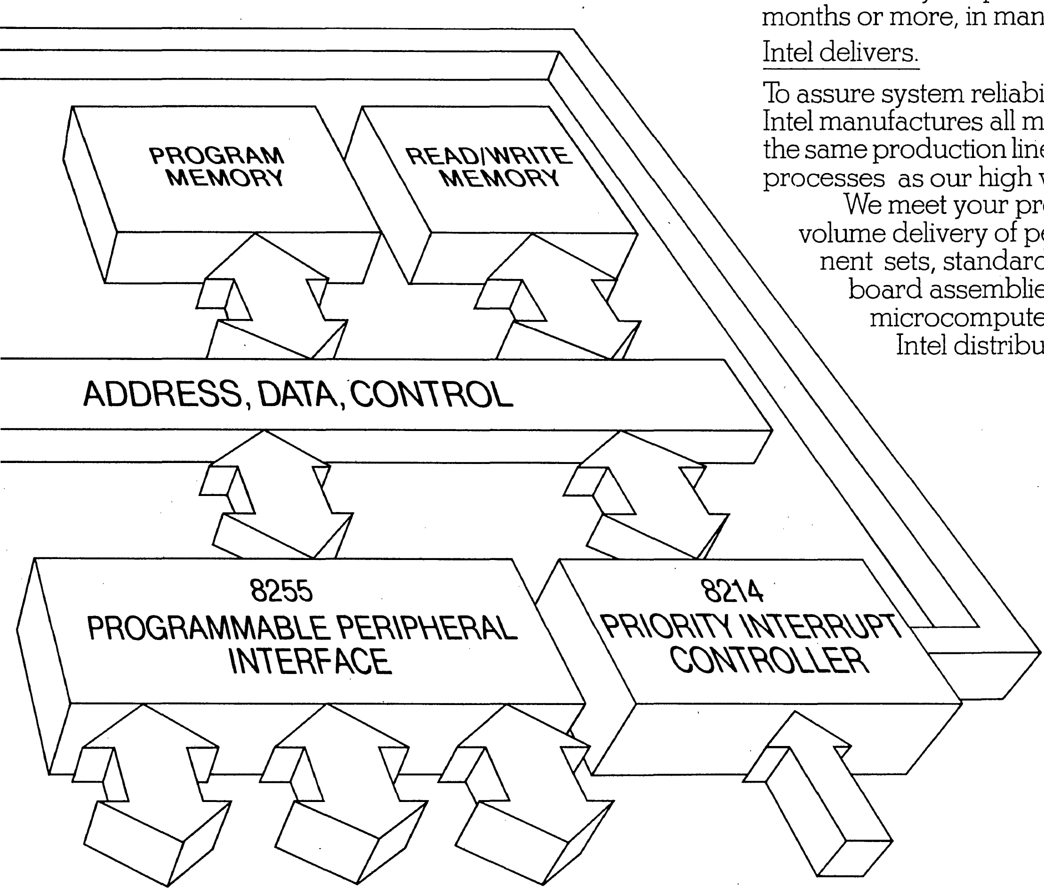
• Applications assistance—provided in the field by the industry's most experienced staff.

These systems and services eliminate repetitious debugging and help prevent false starts. They can cut months from your product development cycle—six months or more, in many cases.

Intel delivers.

To assure system reliability, economy and delivery, Intel manufactures all microcomputer components on the same production lines and with the same processes as our high volume memory products.

We meet your production requirements with volume delivery of performance matched component sets, standard board systems, or custom board assemblies. In addition, we stock microcomputer systems world-wide at Intel distributors.



The most complete hardware system.

MCS-80™ system components are performance matched to make system design, assembly and modification as easy as possible. Higher performance options include CPU instruction cycle times down to 1.3 microseconds or operation at −55 to +125°C.

The components interface with each other through a standard system bus, defined and controlled by the CPU Group. The group simplifies timing throughout the system by making all CPU inputs asynchronous in nature. Combined with performance matching, this approach results in a simple, building block architecture.

To provide complete systems in scores of configurations, there are 27 I/O, peripherals and memory options. You just choose the blocks needed to interface, control and communicate with external equipment and connect them to the bus. All major blocks are software-configurable, so changes in product models usually require little or no change in an MCS-80™ system's hardware design.

Start with the powerful CPU Group.

The bus drive and system controls required for simple interface are built into the CPU Group, along with the auxiliary timing and control functions most designs require. Simple interface and high performance are assured by the use of two LSI technologies: silicon gate n-channel MOS in the 8080A CPU, and Schottky bipolar in the 8224 Clock Generator and 8228 System Controller.

The 8080A CPU is a byte processor with vectored interrupt, unlimited subroutine nesting and direct addressing of up to 512 I/O lines and 65 kilobytes of memory. An 8080 system can operate with almost any

	Part No.	MCS-80 System Components Description
CPU GROUP	8080A	8 bit CPU, 2 μsec Cycle
	8224	Clock Generator
	8228	System Controller
CPU OPTIONS	8080A-1	1.3 μsec cycle
	8080A-2	1.5 μsec cycle
	M8080A	2 μsec cycle (−55 to +125°C)
I/O	8212	8-bit I/O Port
	8251	Programmable Communications Interface
	8255	Programmable Peripheral Interface
PERIPHERALS	8205	1 of 8 Binary Decoder
	8210	Dynamic RAM Driver (8107B)
	8214	Priority Interrupt Control Unit
	8216	Bidirectional Bus Driver
	8226	Bidirectional Bus Driver
	8222	Dynamic RAM Refresh Controller (8107B)
	8253	Programmable Interval Timer
	8257	Programmable DMA Controller
	8259	Programmable Interrupt Controller
PROMs	8604	512 x 8, 100 ns
	8702A	256 x 8 Erasable, 1.3 μs
	8704	512 x 8 Erasable, 450 ns
	8708	1K x 8 Erasable, 450 ns
ROMs	8302	256 x 8, 1μs
	8308	1K x 8, 450 ns
	8316A	2K x 8, 850 ns
RAMs	5101	256 x 4 Static CMOS, 650 ns
	8101-2	256 x 4 Static, 850 ns
	8102A-6	1K x 1 Static, 650 ns
	8102A-4	1K x 1 Static, 450 ns
	8111-2	256 x 4 Static, Common I/O, 850 ns
	8107B	4K x 1 Dynamic, 420 ns

number of peripherals because the CPU is ideal for applications involving multilevel priority interrupts and DMA (direct memory address).

The crystal controlled 8224 generates TTL & MOS clocks, power-on reset and other timing functions. A high current, bidirectional bus driver and single-level interrupt control are integrated with the asynchronous bus control logic in the 8228 System Controller.

Add more versatile I/O and peripheral blocks.

The system's five programmable I/O and peripheral blocks eliminate the hardwired design normally required to operate external equipment. Each is a general purpose replacement for up to 75—or more—TTL packages.

System software can reconfigure these blocks "on the fly," dynamically adapting the system to changes in control and communications modes, interrupt priorities and other functions. Or, you can program predefined modes. Either way you get a lower cost, more versatile system with minimum inventory requirements.

Large system requirements for additional bus drive and expansion of memory and I/O are handled by Schottky bipolar components.

For maximum economy and ease of use, all MCS-80™ memory circuits have industry standard configurations. They are Intel standard products, selected for lowest cost and matched to system performance. The 15 options range from low power CMOS RAMs to high density PROMs and ROMs.

Built into the CPU Group are the extra functions most designs require, as well as central logic and bus control:

- TTL & MOS crystal controlled clocks for system timing.
- Auxiliary timing functions and single level interrupt control.
- High current sinking capability to keep memory and I/O interfaces simple regardless of system size.

Implements virtually any 8-bit I/O function with parallel latch/buffer and bus service request logic, Schottky bipolar for 15 mA output drive.

Operates under program control in virtually all serial data transmission protocols in use today, including IBM Bi-Sync.

Three 8-bit ports, software configurable for interface to printers, keyboards, displays, motor drives . . .

Expands memory and I/O address capability, Schottky bipolar for high speed.

High voltage clock driver and quad address driver, two enable inputs simplify address or data decoding.

Provides eight levels of interrupt control, cascades for simple expansion, current status register saves memory.

Non-inverting 4-bit, Schottky bipolar driver, 50mA outputs drive long bus lines and terminations.

Inverting version of 8216 Bidirectional Bus Driver.

Controls refresh of large, asynchronous dynamic RAM system, has adjustable control oscillator and internal address multiplexer.

Controls three active intervals with independent 16-bit counters at DC to 3 MHz, counts binary or BCD.

Provides four channels of priority DMA request logic for direct access of peripherals & memories.

Eight-level interrupt controller, priority algorithms can be varied with software, expandable to 64 levels.

All PROMs can be automatically programmed with the Intellec® MDS PROM programmer peripheral.

- High speed programming—1ms/bit for 8604 bipolar Schottky PROM, and 8704, 8708 reprogrammable MOS PROMs.
- All 2048 bits of 8702A reprogrammable MOS PROM can be programmed in 2 minutes.

8302 2K ROM directly replaces 8702A PROM
8308 8K ROM directly replaces 8704 or 8708 PROMs
High density program storage with 8316A 16K ROM

CPU interfaces directly with static RAMs.

- 5101 CMOS RAM reduces standby power to 75nW/bit.
- Static RAMs are the low-cost, easy to use approach for small and medium systems.

Dynamic 4K RAM reduces cost and improves speed of large systems.

- System design simplified by use of Intel drivers and refresh controllers.

The most useful development systems.

Intel supplies 8080 system users with the industry's most advanced development and software systems, complete documentation, design kits, training courses and application assistance. They support product development from initial concept through prototyping and into production.

Intellec® MDS-800 microcomputer development system.

Months can be cut from a product development cycle with the Intellec® MDS-800. It provides all the programming, prototyping and diagnostic resources required for rapid development. It also serves as an automated instrument for troubleshooting production assemblies and for field engineering and programming.

As the first system to support simultaneous development of software and hardware, the Intellec® MDS-800 makes it practical to integrate hardware/software development early in the cycle. Furthermore, prototypes can be debugged in the actual product environment with the In-Circuit Emulator. These advances eliminate repetitious debugging and virtually guarantee that production models will operate properly.

8080 software packages work as a system.

Choose the optimum method of programming your system.

Compose programs with an efficient, symbolic assembly language. The Intellec® MDS-800 and resident software translate the programs into code and provide real-time emulation on 8080 hardware for checkout.

MICROCOMPUTER DEVELOPMENT SYSTEM	Intellec® MDS	With its ICE-80 In-Circuit Emulator module, the Intellec® MDS supports programming, prototyping and hardware/software debugging in the product's own environment. The mainframe is an 8080 system with expandable memory and I/O, DMA, interrupt logic, multiprocessor bus, clocks, and power supplies. Peripherals include diskette system, bipolar ROM simulator, universal PROM programmer, high speed paper tape reader, and standard interfacing for a CRT console, teletypewriter, high speed tape punch and line printer.
COMPREHENSIVE SOFTWARE PACKAGES	System Monitor	Supports the system's comprehensive diagnostic aids, controls the system and drives peripherals. Enables programs to be checked out in real time and supports simultaneous software/hardware debugging. Allows use of Intellec® MDS-800 hardware as prototyping resources, provides linkage to special peripherals, and loads developed programs into PROMs via PROM programmer.
	Macro Assembler	You can compose 8080 programs in a symbolic assembly language, which the macro assembler translates to machine code. There's no need to rewrite similar program segments. Like MAC-80, this package provides full macro and conditional assembly capabilities.
	Text Editor	A comprehensive tool for program entry and correction. Edits characters or lines of text. Commands include string search, substitution, insertion and deletion. The monitor provides I/O and other facilities required for easy entry and editing.
	DOS	Intel's new diskette operating system substantially reduces the time required to assemble, edit and execute programs. It's comprehensive file management capabilities enable program and data files to be represented symbolically. Disk files can be created, edited, assembled and executed easily and quickly, through simple commands from the system console.
	ICE-80	The In-Circuit Emulator ICE-80 provides a unique powerful tool for total hardware/software system debug through the Intellec® MDS. ICE-80 allows all the resources of the MDS to be used directly in the prototype environment to run it, debug it and perform final production and field testing. It also allows software to be developed simultaneously with the prototype and to run on the prototype from the earliest possible time.
	ROM-SIM	The Rom Simulator is a high speed, random access memory which simulates Intel bipolar PROMs and ROMs. Its 130 ns access time eliminates the necessity to program and use bipolar PROMs/ROMs when ultra high speed memory is required during prototype development.

TRAINING	Intel regional training centers give courses in system design and programming, and also conduct weekly workshops that provide hands-on experience. On-site courses and seminars are also available.
APPLICATIONS ASSISTANCE	Call the nearest Intel sales office. Assistance is available in the field through Intel field applications engineers and field marketing engineers.
PRODUCTION SUPPORT	Intel delivers standard subsystems, standard boards and custom boards, as well as system components. Standard products are stocked world-wide at Intel distributors.

Design your software rapidly with Intel's PL/M high level language or cross macro assembler and simulator, using your own large computer or a time shared network.

Combine both methods. The resident and cross products work together as a system, using fully compatible assembly language and producing machine code which may be loaded on the Intellec® MDS-800.

Many 8080 system programmers prefer the third approach, since it allows high level design to be done with minimum computer charges and retains the advantages of integrated software/hardware development with the Intellec® MDS-800.

Design kits: the easiest way to get started.

The MCS-80™ System Design Kit contains all the components of a basic 8080 system, all board assembly parts including the PC board, a control program, and design manuals.

To order the MCS-80™ Design Kit call your nearest Intel franchised U.S. distributor: Almac/Stroum, Component Specialties, Cramer, Elmar, Hamilton-Avnet, Industrial Components, Liberty, Pioneer, Sheridan or L.A. Varah. In Europe or the Orient, contact the Intel Marketing Office for the name of your nearest Intel distributor.

Intellec® MDS Development Systems, software and all documentation are available now.

MCS-80 SYSTEM DESIGN KIT	This kit contains all the components and software required to assemble and operate a basic 8080 system: • CPU Group (8080A, 8224, 8228) • Two Programmable I/O blocks (8251 and 8255) • Two decoders (8205) • PROM and RAM memory (8708, two 8111)	• Printed circuit board and connectors • Clock crystal and other required components • Control program (monitor stored in ROM) • 8080 system user's and programming manual

CROSS PRODUCT SOFTWARE	PL/M™ Cross Compiler	Developed by Intel in 1973, PL/M is the only high level program language for microcomputer system software design. It has significantly reduced programming costs. It produces code that can be stored in ROM. Should you ever need to use machine language coding, PL/M also provides the mechanism for linking to assembly language routines.	Time Sharing Networks United States: United Computing GE
	MAC-80 Cross Assembler	This powerful macro assembler simplifies software design and eliminates the need to write redundant code. It has full macro capability, coupled with conditional assembly directives. The assembly language is fully compatible with the Intellec® resident assembler.	Tymshare Europe: Tymshare
	INTERP/80 Simulator	INTERP/80 helps you to quickly debug your programs. It enables computers to simulate program execution by the 8080A CPU. The package has complete debugging facilities, including all timing details, breakpoints, full file buffered I/O, and a host of commands that permit you to examine and modify program execution.	Timesharing LTD Honeywell Japan: Dentsu Canada:
	Availability	All three cross products are written in ANSI standard FORTRAN IV. All run on medium or large scale computers, 32-bit Integer format. They can be purchased from Intel on magnetic tape or used via the computer time sharing networks listed at the right.	GE Australia: Honeywell

USER'S LIBRARY	This large library contains hundreds of 8080 programs, such as floating point math package, multiple precision arithmetic routines, a quick-sort program, a floating point I/O conversion package, BCD to/from binary, binary to ASCII and gray to binary conversion. Members receive a manual documenting programs in the library, plus frequent updates. Memberships are free to users who submit accepted programs.

DOCUMENTATION	• 8080 Microcomputer Systems User's Manual* • Intellec® MDS Hardware Reference Manual • Intellec® MDS Operator's Manual** • 8080 Assembly Language Programming Manual** *Includes MCS-80™ system design information and data sheets for system components. **Also documents resident software.	• PL/M Programming Manual • MAC-80 User's Manual • INTERP/80 User's Manual

intel® Microcomputers. First from the beginning.

MOSTEK'S F8 ...The benchmark in programmable logic.

VERSATILE . . EFFICIENT . . COST EFFECTIVE

The ultimate goal, from F8 design concept through development and production, was to produce the most versatile, efficient, cost-effective microprocessor system available today. To accomplish this, five stringent parameters, based on user experience with other systems, were set forth as guidelines for the F8.

- Minimum Parts Count
- Cost Effectiveness
- Simple Peripheral Interfaces
- Easy Expansion through Modular Architecture
- Simplified Programming and Debugging

HOW WERE F8 GOALS MET ?

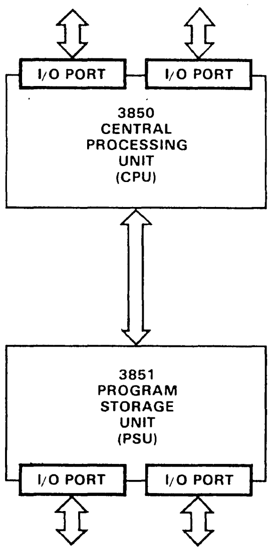
By . . . unique system partitioning the system functions have been divided among the various circuits of the F8 family to provide sophisticated modularity. As a result, it is now possible to build a minimum microprocessor system with **only two devices.** To this system PSU, RAM and I/O devices can be added to form medium size or memory intensive systems with a minimum use of external parts. And, finally, for solving complex problems, the F8 devices can be connected as subsystems into a synergistic system of independent microprocessors.

By . . . incorporating the I/O structure on the chips so that the majority (95%) of the peripheral devices can be directly controlled without the need for special circuits. The trick is to accommodate the characteristics of a given peripheral device in the software. The I/O hardware structure includes a programmable timer, an efficient interrupt system and bidirectional I/O ports.

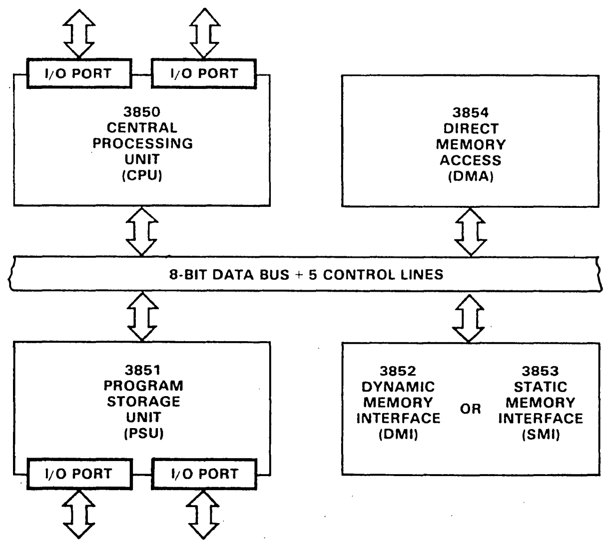
By . . . providing carefully thought out support software and hardware for generating and debugging microprograms.

WHAT IS THE RESULT ?

. . . a complete family of LSI circuits that can be used as building blocks to construct versatile, efficient, cost effective systems from the most simple to the highly complex.



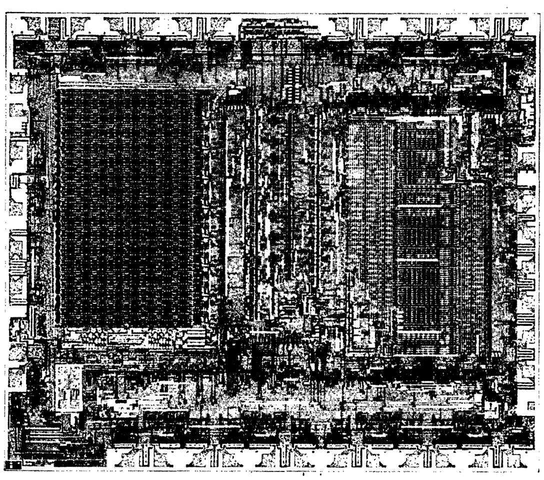
MINIMUM SYSTEM

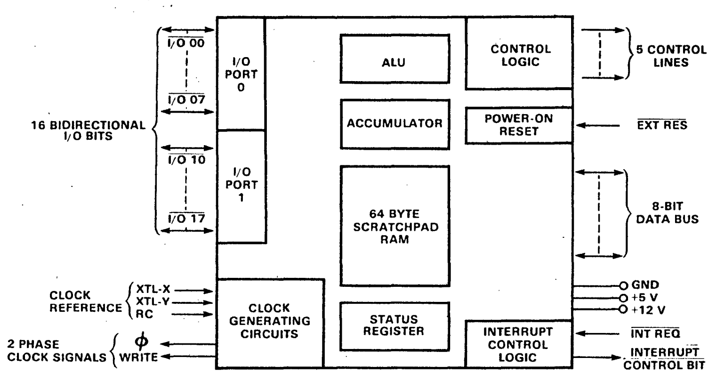


F8 DEVICE FAMILY

MK 3850 CENTRAL PROCESSING UNIT

MOSTEK's F8 Central Processing Unit (CPU) contains all of the functions of an ordinary central processor and adds some time and money saving features uniquely its own. For instance, the 64 bytes of scratchpad RAM memory already included on the F8 CPU eliminate the need for external RAM circuits in many applications. Clock and power-on-reset circuitry, normally requiring additional integrated circuit packages, are included on-chip. MOSTEK's CPU also contains 16 bits of fully bidirectional input and output lines internally latched (for storing output data) and capable of driving a standard TTL load.





MK 3850
CPU BLOCK DIAGRAM

THE MOSTEK SURVIVAL KIT

The Mostek F8 Kit is comprised of the following parts: F8 CPU, Program Storage Unit (PSU), Static Memory Interface (SMI), 1K x 8 of random access memory, 2.00 MHz crystal, two CMOS buffers, and a 6.75" x 5.5" printed circuit board.

When assembled, the F8 Kit will form a basic F8 evaluation/development microcomputer with these features:

- ☐ 24 bits of I/O arranged in three 8 bit ports
- ☐ 1024 bits of Random Access Memory
- ☐ Full duplex TTY Interface (20 mA loop)
- ☐ Crystal control clock
- ☐ Automatic power on reset
- ☐ Hardware reset
- ☐ Non-volatile operating system in PSU firmware called designer development tool # 1 (DDT-1)

A user need only attach a 110 or 300 BAUD ASCII terminal (such as a teletype or CRT monitor system) and +5 and +12 V_{DC} power supply to begin operating the system. A user can then use DDT-1 to load, debug, and modify his own software in the 1K byte of RAM provided on the kit.

The operating system (DDT-1) provides the user with the following features that can be accessed from the ASCII terminal:

- ☐ Load command - used to load memory from paper tape
- ☐ Dump command - used to format data and output to paper tape punch
- ☐ Type command - used to examine blocks of memory
- ☐ Memory Display and Modify Command used to examine and modify memory one byte at a time
- ☐ Copy command - used to move blocks of memory from one location to another
- ☐ Port commands - used to display and modify the 24 I/O lines
- ☐ Hexadecimal arithmetic commands - used to perform Hexidecimal arithmetic
- ☐ Execute command - used to execute programs at a specific location
- ☐ Breakpoint command used in debugging users software

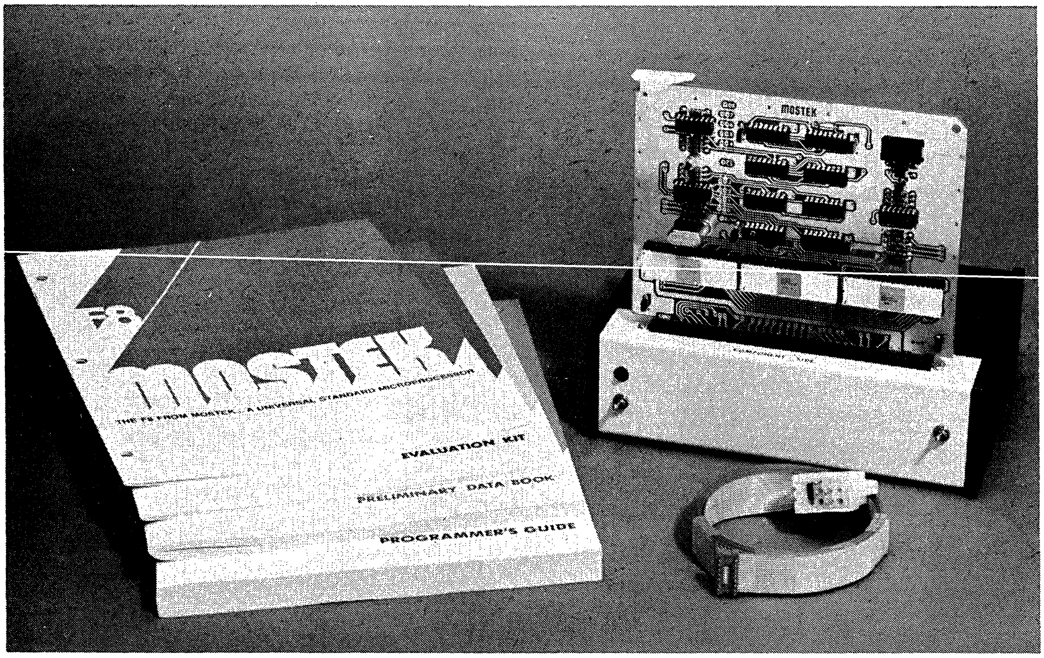
Using these DDT-1 features a user can immediately begin to write and execute his own software.

The F8 Kit comes with complete documentation including a detailed application note, programming guide, and a listing of the DDT-1 program.

The Mostek F8 Kit may be purchased in kit form (order MD 79001) or as an assembled tested unit (order MK 79002). A power supply box (order MK79003) that provides an edge card connector, all necessary power, switch selectable BAUD rate and a TTY cable is also available.

SOFTWARE AVAILABLE FOR THE F8

- ☐ Resident Assembler
- ☐ Resident Text Editor
- ☐ Fortran IV Cross Assembler
- ☐ Designer's Debugging Tool 1 (DDT—1) (included in the F8 Evaluation Kit)
- ☐ Designer's Debugging Tool 2 (DDT—2) (included with the Software Development Board)



THE EMULATOR FROM MOSTEK

The F8 PSU Emulator is a development aid for designing and field testing F8 microprocessor systems which utilize one or more MK 3851 program storage unit (PSU) chips. The Emulator is electrically equivalent to the PSU but is field programmable instead of mask programmable. This enables a user to obtain final hardware verification of all PSU programming prior to ordering custom PSU chips. Also, since the Emulator even "plugs in" like a PSU chip (via a male, 40 pin connector on the end of an "umbilical cord"), prototype systems can be converted to final production status by simply unplugging the Emulator(s) and plugging in the corresponding custom PSU(s).

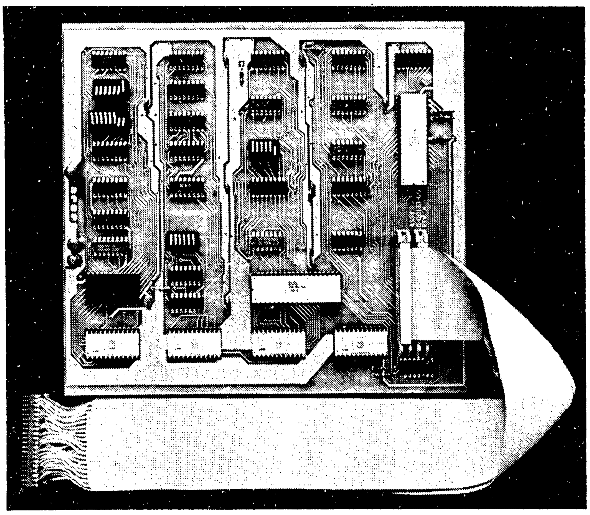
The MK 3851 itself, is a 40 pin integrated circuit that provides 1K bytes of ROM, two 8 bit latched I/O ports, a software programmable timer and interrupt circuitry for vectored addressing and priority control. Multiple MK 3851 PSU chips can be used in a single system, providing up to 128 bit I/O 64 timers, 64K of ROM, and 64 levels of interrupt.

The Emulator performs all the functions of the PSU:

- ROM
- INPUT/OUTPUT PORTS
- INTERRUPT VECTOR
- TIMER

The ROM section of the Emulator uses either four 256 x 8 bit ultraviolet eraseable PROMs or a single 1K x 8 bit ultraviolet eraseable PROM to provide non-volatile storage of the users' program. The PROM(s) should be programmed using a PROM programmer and then installed on the Emulator. The six ROM address select switches can then be used to establish the location of the PROM in the system memory map.

Input/output ports on the Emulator are implemented using an actual PSU. Six I/O port address assignment switches on the Emulator allow the user to select the I/O port address desired for each Emulator. Also, since the PSU is available with three types of output driver circuits, the Emulator has three output options for the I/O ports:



- Standard current limited output
- Open drain outputs
- Pull-up driver outputs

While the Emulator is normally supplied with a PSU containing standard current limited output drivers, PSUs containing the other output options are also available for the Emulator.

Fifteen interrupt vector select switches on the Emulator allow the user to select the interrupt vector desired. Only fifteen switches are required because bit seven of the interrupt vector is set by the interrupt control logic. Bit seven is set to a logic zero if the timer interrupt is enabled and to a logic one if the external interrupt is enabled.

COMING SOON . . .

F8 ROM DEVELOPMENT BOARD (RDB)

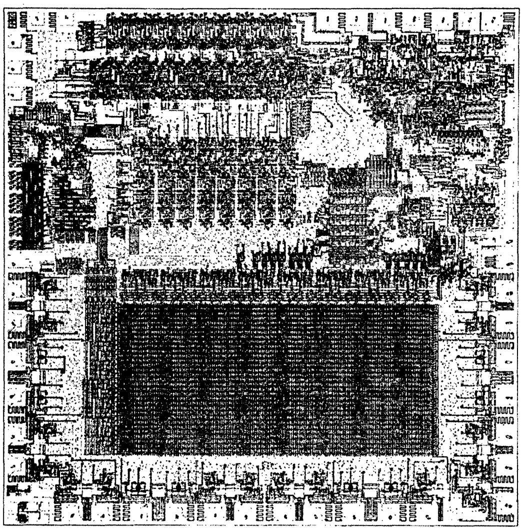
The RDB is a sophisticated development aid for "in circuit" debugging of 3851 PSU firmware. The RDB is similar in function to the PSU emulator, with the exception that the 1K x 8 of program storage is located in RAM instead of in ultraviolet PROM. This permits the user to interactively monitor and debug his "PSU" software in the actual hardware configuration required for his application.

In normal use, the application hardware is breadboarded in the actual configuration for the final system, with empty sockets being substituted for each 3851 PSU chip to be used. RDBs are then connected to the system from the RDB interface cables to the corresponding PSU sockets. The RDBs are then inserted into a standard F8 development system which contains a single SDB for monitoring and controlling each of the RDBs.

F8 SOFTWARE DEVELOPMENT BOARD (SDB)

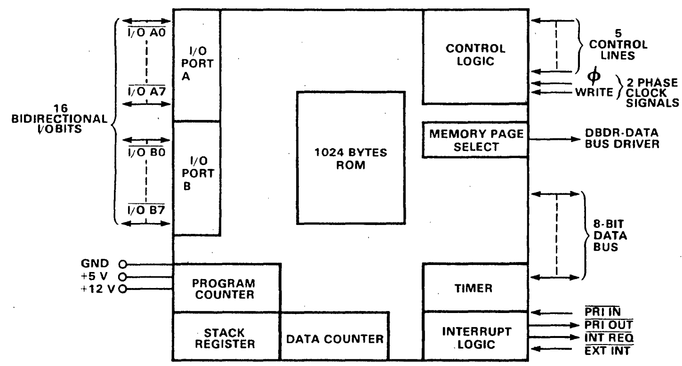
The software Development Board is a complete F8 microprocessor system which has been designed to aid in developing and designing software for the F8. When combined with power supplies, card cage, and a TTY (or the equivalent), it will enable the user to develop the software for most types of F8 system applications. This not only includes the ability to execute and debug user software, but also the ability to create and edit "source" listings (using the resident text editor) and assemble them into corresponding "object" listings (using the resident assembler). Its other features include 8K x 8 of RAM (expandable with additional memory boards), a variable speed ASCII interface, and resident debugging and console routines (in two 3851 PSU's). Provisions have also been made for interfacing with additional peripherals, such as a high speed paper tape reader/punch.

MK 3851 PROGRAM STORAGE UNIT

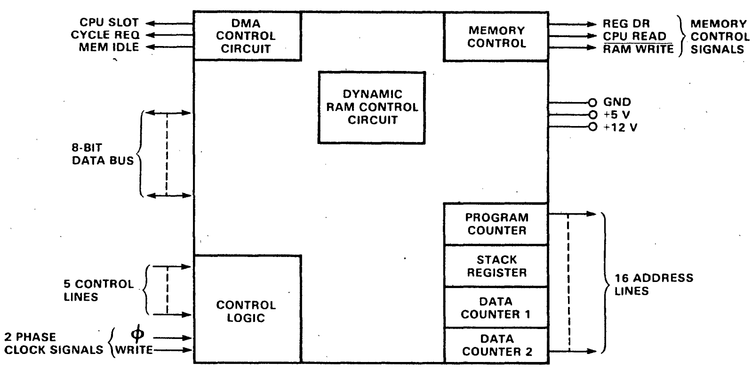


It is important to note that MOSTEK's Program Storage Unit (PSU) is not just a conventional Read Only Memory. In addition to containing 1024 bytes of mask programmable ROM for program and constant storage, the F8 PSU includes the addressing logic for memory referencing, a Program Counter, an Indirect Address Register (the Data Counter) and a Stack Register. A complete vectored interrupt level, including an external interrupt line to alert the central processor, is provided. All of the logic necessary to request, acknowledge and reset the interrupt is on the F8 PSU. The 8-bit Programmable Timer is especially useful for generating real time delays. The PSU has an additional 16 bits of TTL compatible, bidirectional, fully latched I/O lines.

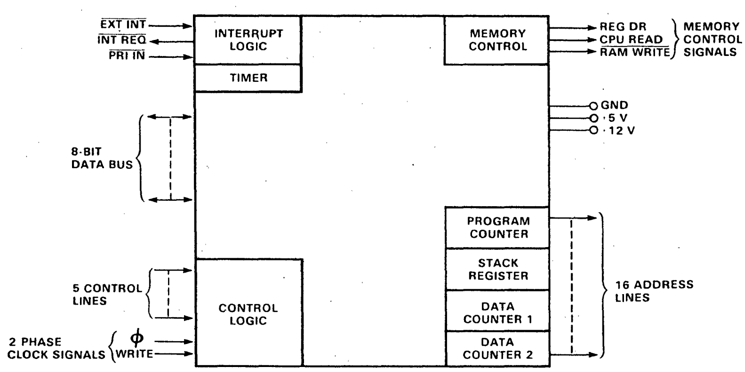
Systems requiring more program storage may be expanded by adding more PSU circuits. For example, one F8 CPU and three F8 PSUs will produce a microprocessor system complete with 64 bytes of RAM, 3072 bytes of ROM, 64 I/O bits, three interrupt levels, and three programmable timers. This complete system will require only four IC packages.



MK 3851
PSU BLOCK DIAGRAM



MK 3852
DMI BLOCK DIAGRAM

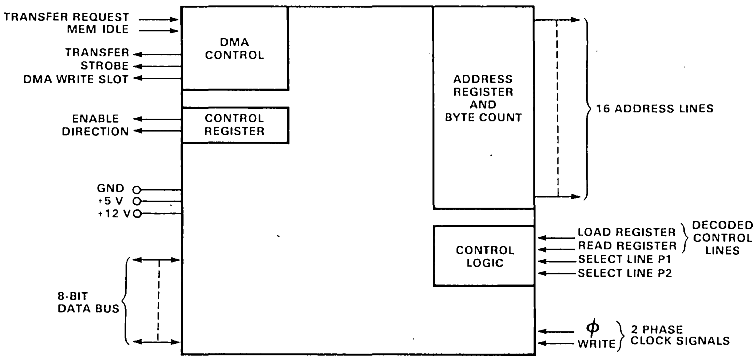


MK 3853
SMI BLOCK DIAGRAM

MK 3852/MK 3853 MEMORY INTERFACE

For applications requiring more than the 64 byte RAM located on the CPU, two memory interface circuits are included in the F8 set. Each device generates the 16 address lines and the signals necessary to interface with up to 65K bytes of RAM, PROM or ROM memory. Either device may be used in conjunction with standard static semiconductor memory devices.

The Static Memory Interface (SMI) contains a full level of interrupt capability and a programmable timer. The Dynamic Memory Interface (DMI) contains all of the logic necessary to refresh MOS dynamic memories without degrading the system throughput time. The F8 DMI can also interface with static memories when desired.



MK 3854
DMA BLOCK DIAGRAM

MK 3854 DIRECT MEMORY ACCESS

MOSTEK's Direct Memory Access (DMA) device sets up a high speed data path to link F8 memory with peripheral electronics. The F8 DMA circuit, when working in conjunction with the F8 DMI, does not require overhead electronics to keep track of memory addresses, bytes transferred and handshaking signals. The data transfer is initiated by the CPU under program control. Once started, the DMA transfer will continue without CPU intervention. The CPU can sense the enable line of the DMA to determine the completion of a transfer. The entire DMA transfer will take place without halting the central processor.

F8 MICROPROCESSOR SYSTEMS

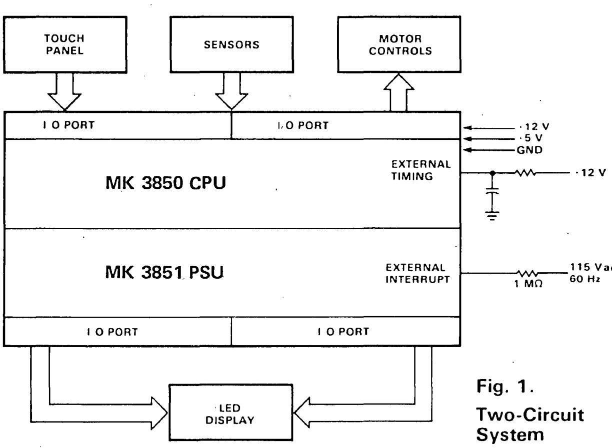


Fig. 1.
Two-Circuit System

A TWO-CIRCUIT SYSTEM

The two-circuit F8 microprocessor is suitable for small data terminals, controllers, and specialty calculators. The keyboard is connected directly to the F8 I/O ports without special interfaces. Switch-bounce protection, rollover, and key encoding are all under software control. Software also decodes signals for LED readouts.

As an appliance controller, for example, the two-circuit system can perform all input-output sensing, actuating, timing, and computation operations. A system like the combination washing-machine-and-dryer controller in *Figure 1* requires more than 250 components when other microprocessor device sets are used, but with the F8 devices uses only 55 components, including 28 LEDs and the power semiconductor devices and relays used to control the motors. A set of custom circuits would also require about 50 parts, but initial engineering expense is heavy and severe penalties are incurred if changes are required. With the F8 system changes can be made by merely changing the program.

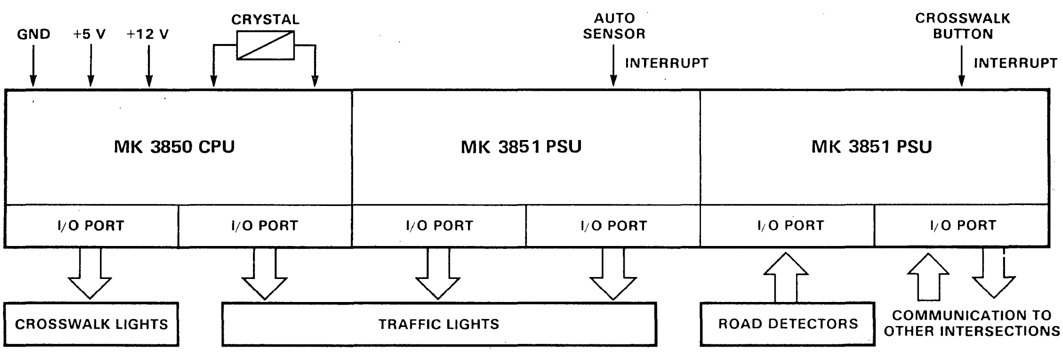
A MORE COMPLEX SYSTEM

The versatility of the F8 system is indicated by the traffic-light-controls system in *Figure 2*. The use of one CPU and two PSU circuits provides the designer with two timers, two interrupts, an onboard clock, onboard power-on reset, onboard switch decoding, and 48 bidirectional I/O bits. This system could be tied to vehicle detectors in the road, to monitor traffic for left-turn lanes as well as through-traffic flow in four directions. It would also react to interrupts from the pedestrian control buttons at each corner. There also is sufficient I/O capability to permit communication with and control of neighboring intersections and to allow the system to be operated manually or tested for proper operation.

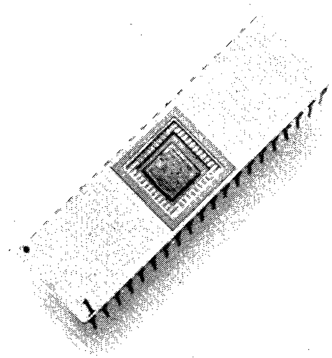
Five F8 features are of particular interest for this type of application. One of the interrupts can eliminate the need for such external circuits as a comparator to compare a count of the cars with a predetermined value to cause the light to change. (The CPU can handle the simple arithmetic of counting cars.) This interrupt also eliminates the need for continuous polling of traffic count by the microcomputer. The second interrupt would be ideal for permitting pedestrian control to override the automatic system. The internal clock, with an external crystal, can also control light routines.

The two timers permit simultaneous counting of delay for vehicle signals and flashing warning lights for pedestrians. The onboard power-on reset acts in case of power failure to start the system automatically when power is renewed. The bidirectional I/Os have built-in latches that eliminate the need for external latches for the job of "holding" commands for lights as well as the momentary commands provided by timers and sensors.

Fig. 2.
Medium Complexity System



PACE...
THE FIRST SINGLE CHIP 16-BIT MICROPROCESSOR



National Semiconductor believes a new four-letter word is about to change the way you do things.

That word is PACE™; an acronym... a short way to say Processing And Control Element.

And the things PACE will help you do are things like... replacing complex, hard-wired-device systems for sequential logic operations... replacing all but very-high-speed minicomputers in even larger, more complex systems... replacing most other forms of programmable controllers. And PACE does these in applications such as small business machines, cash registers, terminals, peripheral devices, traffic controllers, instrumentation, process and numerical control equipments, machine tools. You name it, and PACE will do it for you.

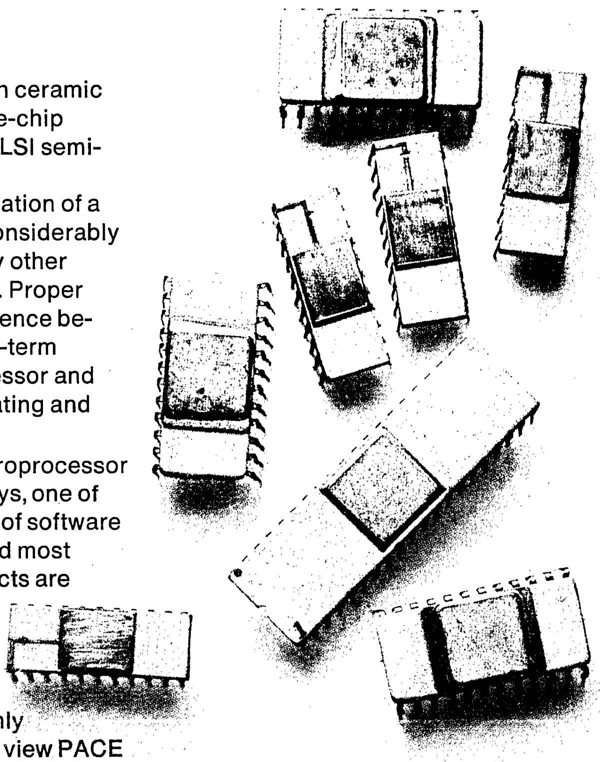
And PACE does it for you with fewer circuit boards and connectors, with smaller power supplies and cooling systems, with a reduced inventory, with a shorter design time and lower assembly and test costs, than has ever been possible with any other, comparable-power microprocessor.

For that is what PACE is—a microprocessor. But it's not just another microprocessor. No indeed. That's not the way National does things. Instead, PACE sets the pace as the industry's first single-monolithic-chip, 16-bit microprocessor.

On its single chip, PACE contains control logic, four working registers (accumulators), a ten-word stack and interrupt control circuitry. All you add are a single-phase true and complement clock driver, buffering system memory, and PACE is ready to go to work. All of these supporting elements are standard parts in the PACE product family.

And, if you change your mind about what you want your system to do, you can reconfigure a PACE-controlled system with software alone.

PACE... PLUS A COMPLETE FAMILY OF CHIPS



A standard, hermetic, 40-pin ceramic DIP houses the PACE single-chip CPU. It looks like any other LSI semiconductor component.

But the successful application of a microprocessor requires considerably more support than does any other semiconductor component. Proper support makes all the difference between the successful, short-term application of a microprocessor and a long-term series of frustrating and time consuming problems.

Thus we support our microprocessor products in a number of ways, one of which is an extensive array of software and hardware products. And most such PACE-oriented products are shared with our very compatible IMP-16 microprocessor family, for PACE is an extension of the IMP-16—albeit a highly sophisticated one. You may view PACE as a monolithic integration not only of the five IMP-16 MOS/LSI chips, but of the IMP-16's TTL-implemented functions as well.

In other words, you save money in design time, software and hardware with PACE because we have implemented everything on one chip—status and control circuitry, sense circuitry for conditional branches, interrupt logic and even the multiphase portion of the clock generation circuitry.

Even with presently available off-the-shelf components, you need only a dozen packages to implement a complete PACE microprocessor system—and we mean one with 16,384 bits of read-only program storage and a 16-bit TTL data bus interface.

But with our PACE-optimized support and memory products, you can implement the same system even more simply, minimizing the system package count and greatly simplifying all system interfaces while providing a true-TTL, Tri-State® system data bus.

PACE Blue Chips These support the CPU, and include a System Timing Element (IPC-16A/502), an eight-bit Bidirectional Transceiver Element (IPC-16A/501) and a 16-bit Address Latch Element (IPC-16A/518).

The single-package clock and an external crystal provide complete system timing, eliminating all other discrete, passive components, while two bidirectional transceivers. provide a complete, 16-bit TTL system address and bidirectional data bus. In a driver-only mode, a third bidirectional transceiver package may be used as the control bus buffer, generating seven TTL control signals and flags for distribution.

PACE Green Chips These peripheral interface chips, called Interface Latch Elements, provide storage and buffering between the PACE TTL system bus and user peripherals. They are available in eight-bit increments, as the ILE-8 (IPC-16A/503), and 16-bit increments, as the ILE-16 (IPC-16A/513), to accommodate PACE's unique ability to operate on both eight- and 16-bit data elements under software control.

PACE Memory Elements These too are specially designed for optimal use in PACE-based systems, and include: a 256x4 RAM (IPC-16A/504), which eliminates any need for address latches between PACE and the read/write memory (the chip includes address latches and latched chip enables); a 1024x16 ROM (IPC-16A/505), which alone provides sufficient control storage capacity for many applications, and which also includes on-chip address latches; and a 512x8 PROM (IPC-16A/506) that, in prototyping and preproduction use, does require a supplementary address latch such as our 16-bit Blue Chip Address Latch Element.

With such support and memory devices you can implement that twelve-package, 16,384-bit system mentioned above with fewer than eight packages. When you compare this number to the 30 and more packages needed for most previously available microprocessors, you'll see why PACE lets you implement your system far more easily than you ever thought possible.

PACE... A FULL FEATURE CPU

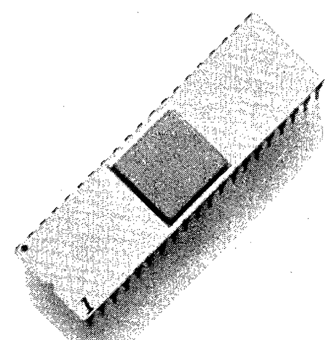
PACE is a true 16-bit central processor unit: it makes use of 16-bit instruction words and 16-bit data words, and features a powerful, efficient and flexible set of 45 instructions.

PACE operates with either eight- or 16-bit data words Only PACE lets you specify—via your program—either eight- or 16-bit operation.

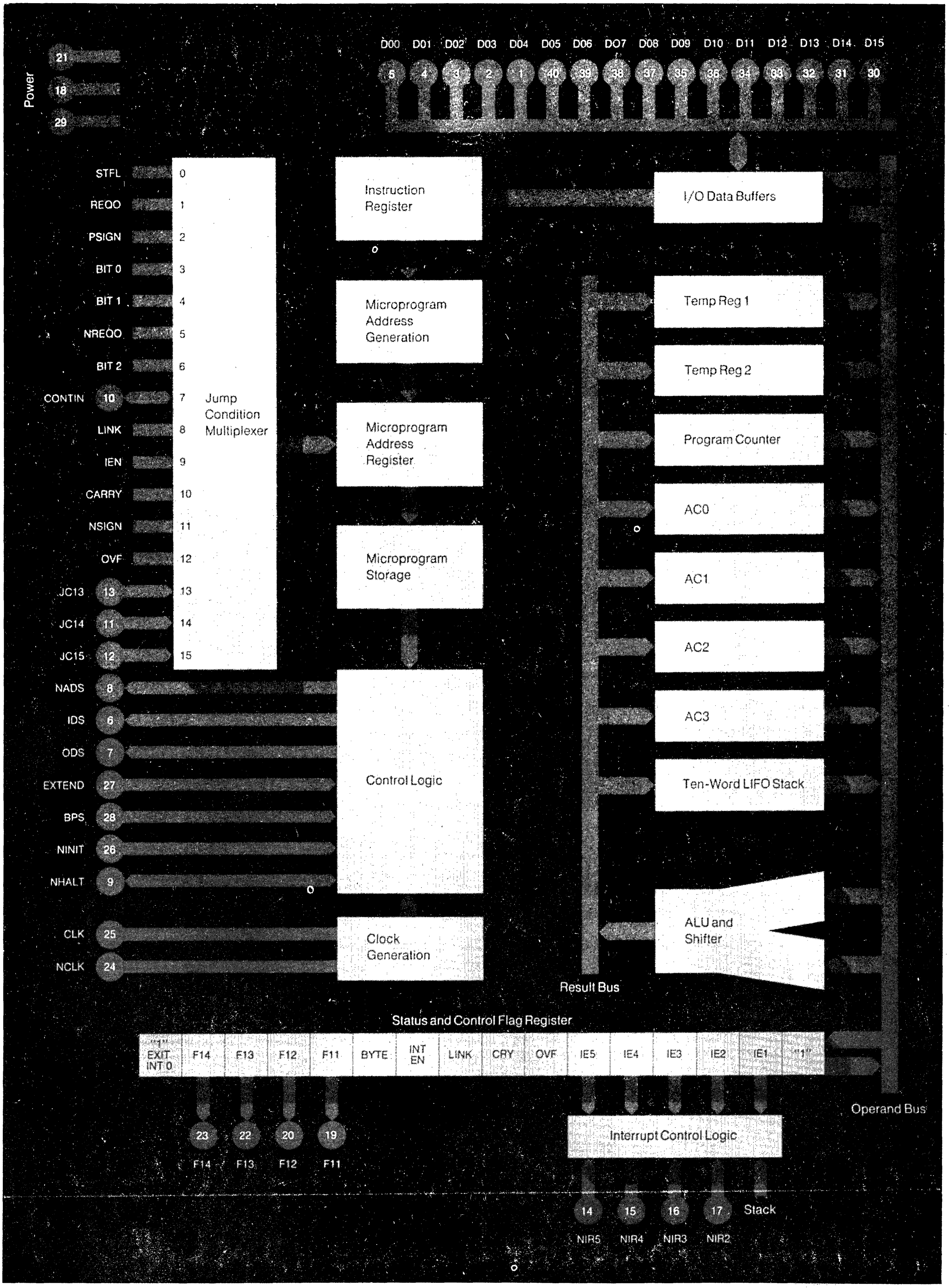
In general, the ability of PACE to operate with 16-bit instruction words on both eight- and 16-bit data words brings significant benefits to your system. It means that PACE is highly efficient in the handling of both eight- and 16-bit interfaces within the same microprocessor-based system. And even in systems dominated by eight-bit data element interfaces, PACE remains extremely cost effective.

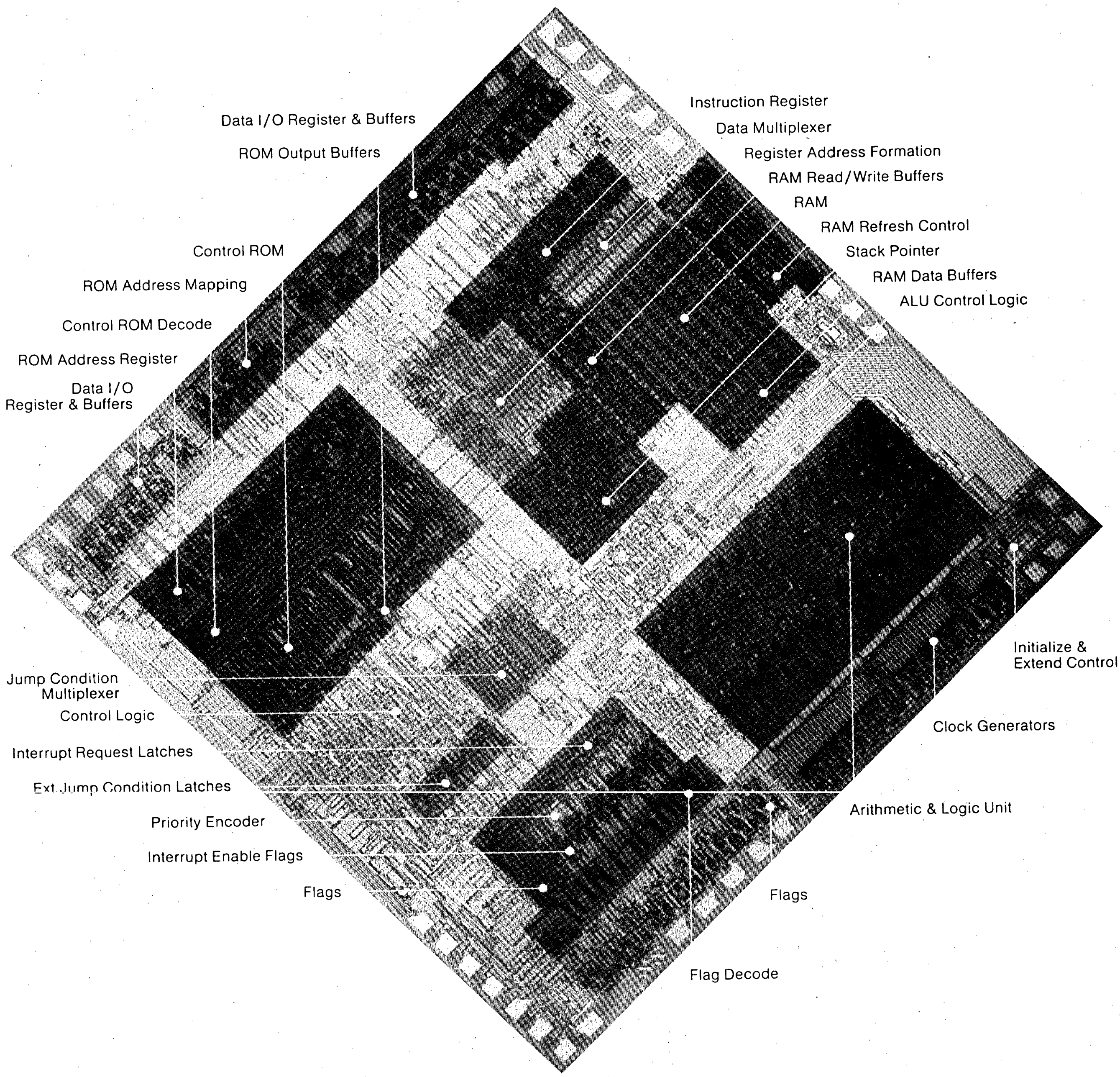
In particular, PACE's 16-bit instruction words greatly increase the power of its instructions beyond those of eight-bit processors. Further, the full 16-bit PACE-generated addresses increase both efficiency and throughput over those of conventional eight-bit CPUs. This results from PACE's reduction in program memory overhead, and its elimination of multiple-precision operations generally required for eight-bit data elements.

In other words, while PACE is a true 16-bit processor, it extends the coding and address generation efficiencies found only in 16-bit microprocessors to eight-bit systems as well, and eliminates complex hardware interfaces and bookkeeping overhead in systems that require both eight-bit and 16-bit interfaces.



16-bit instruction word	**Addressing flexibility, speed**
8- or 16-bit data words	**Wide application**
45 instructions	**Efficient programming**
Common memory and peripheral addressing	**Powerful I/O instructions**
Shares instructions with National's IMP-16	**Allows software compatibility**
Four general purpose accumulators	**Reduces memory data transfers**
Ten-word stack	**Interrupt processing/data storage**
Six vectored priority-interrupt levels	**Simplifies interrupt service and hardware**
Programmer-accessible status register	**May be preserved, tested, or modified**
Typical 10-μs instruction execution	**High speed**
Can use 1k-by-16 ROM	**Single memory package**
Single-phase true and complement clock	**Minimum external components**
+5V, −12V	**Standard supplies**


Power
21
18
29
D00 D01 D02 D03 D04 D05 D06 D07 D08 D09 D10 D11 D12 D13 D14 D15
5 4 3 2 1 40 39 38 37 35 36 34 33 32 31 30
STFL 0
REQO 1
PSIGN 2
BIT 0 3
BIT 1 4
NREQO 5
BIT 2 6
CONTIN 10 7
LINK 8
IEN 9
CARRY 10
NSIGN 11
OVF 12
JC13 13 13
JC14 11 14
JC15 12 15
Jump Condition Multiplexer
Instruction Register
Microprogram Address Generation
Microprogram Address Register
Microprogram Storage
Control Logic
Clock Generation
NADS 8
IDS 6
ODS 7
EXTEND 27
BPS 28
NINIT 26
NHALT 9
CLK 25
NCLK 24
I/O Data Buffers
Temp Reg 1
Temp Reg 2
Program Counter
AC0
AC1
AC2
AC3
Ten-Word LIFO Stack
ALU and Shifter
Result Bus
Operand Bus
Status and Control Flag Register
"1" EXIT INT 0
F14
F13
F12
F11
BYTE
INT EN
LINK
CRY
OVF
IE5
IE4
IE3
IE2
IE1
"1"
23 22 20 19
F14 F13 F12 F11
Interrupt Control Logic
14 15 16 17 Stack
NIR5 NIR4 NIR3 NIR2


Data I/O Register & Buffers
ROM Output Buffers
Control ROM
ROM Address Mapping
Control ROM Decode
ROM Address Register
Data I/O
Register & Buffers
Instruction Register
Data Multiplexer
Register Address Formation
RAM Read/Write Buffers
RAM
RAM Refresh Control
Stack Pointer
RAM Data Buffers
ALU Control Logic
Jump Condition
Multiplexer
Control Logic
Interrupt Request Latches
Ext Jump Condition Latches
Priority Encoder
Interrupt Enable Flags
Flags
Initialize &
Extend Control
Clock Generators
Arithmetic & Logic Unit
Flags
Flag Decode

PACE increases throughput, reduces memory overhead PACE has a number of resources that decrease system program and read/write storage needs, and increase throughput. Principal among these are its four, general-purpose 16-bit working registers and a ten-word (16-bit) last-in-first-out (LIFO) stack.

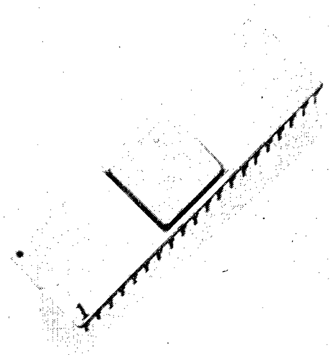
While PACE actually provides seven data registers, its design makes four of them available directly to the programmer, as accumulators. These reduce the number of memory load and store operations associated with saving temporary and intermediate results in system memory. And this means that your system shows increased throughput and a reduction in its program and data storage needs.

PACE's LIFO stack provides even more storage—up to ten 16-bit words more. You may use the LIFO stack to store program-counter contents or to store status information. In some applications (device controllers, for example) this ten-word stack, together with the on-chip registers, eliminate any need for off-chip read/write memory.

The point is that the LIFO stack further reduces program and read/write system storage overhead, while inherently reducing interrupt-response time (because it saves return addresses during interrupt servicing and subroutine execution). Again, memory overhead is reduced and throughput is increased.

PACE eliminates interrupt hardware The PACE microprocessor gives you an on-chip, six level, vectored, priority-interrupt structure. This eliminates any need for external, off-chip interrupt hardware. And it gives you automatic interrupt identification, too, which again eliminates program storage overhead and saves time—the time that other processors usually require to poll peripherals in order to identify the interrupting device.

And if your system involves more than six interrupts, PACE lets you place more than one peripheral on a priority level by means of a simple, open-collector connection to the appropriate priority interrupt request line.



PACE provides quick access to system status information A single, 16-bit status flag register provides all status and control bits for PACE. And because the contents of this register may be loaded from or into any accumulator, or the stack, you can conveniently test, modify or store status information.

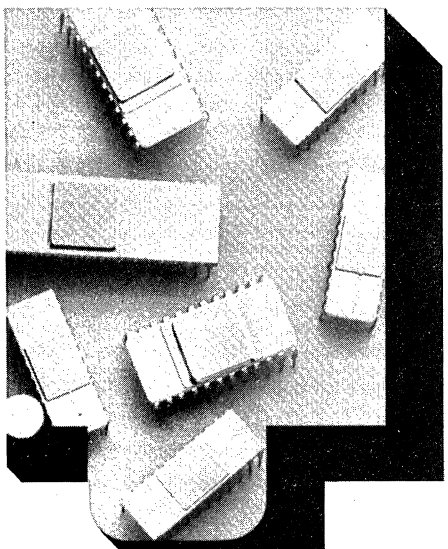
Four of PACE's flags are made accessible so that you may assign specific, programmed functions to them. These flags drive output pins, through which you may directly control system functions or set software status indicators.

Note that the ability to provide status output directly, via the four control flag outputs, requires no external hardware and lets you generate—through software—appropriate control signals.

Additionally, PACE provides convenient status sense capability with four, external, user-assigned sense inputs and twelve, internal, status sense conditions. These sixteen conditions are individually testable by a conditional branch instruction in software.

So PACE saves you hardware and program overhead as well as the throughput usually associated with the implementation, on the system data bus, of such control-flag output functions.

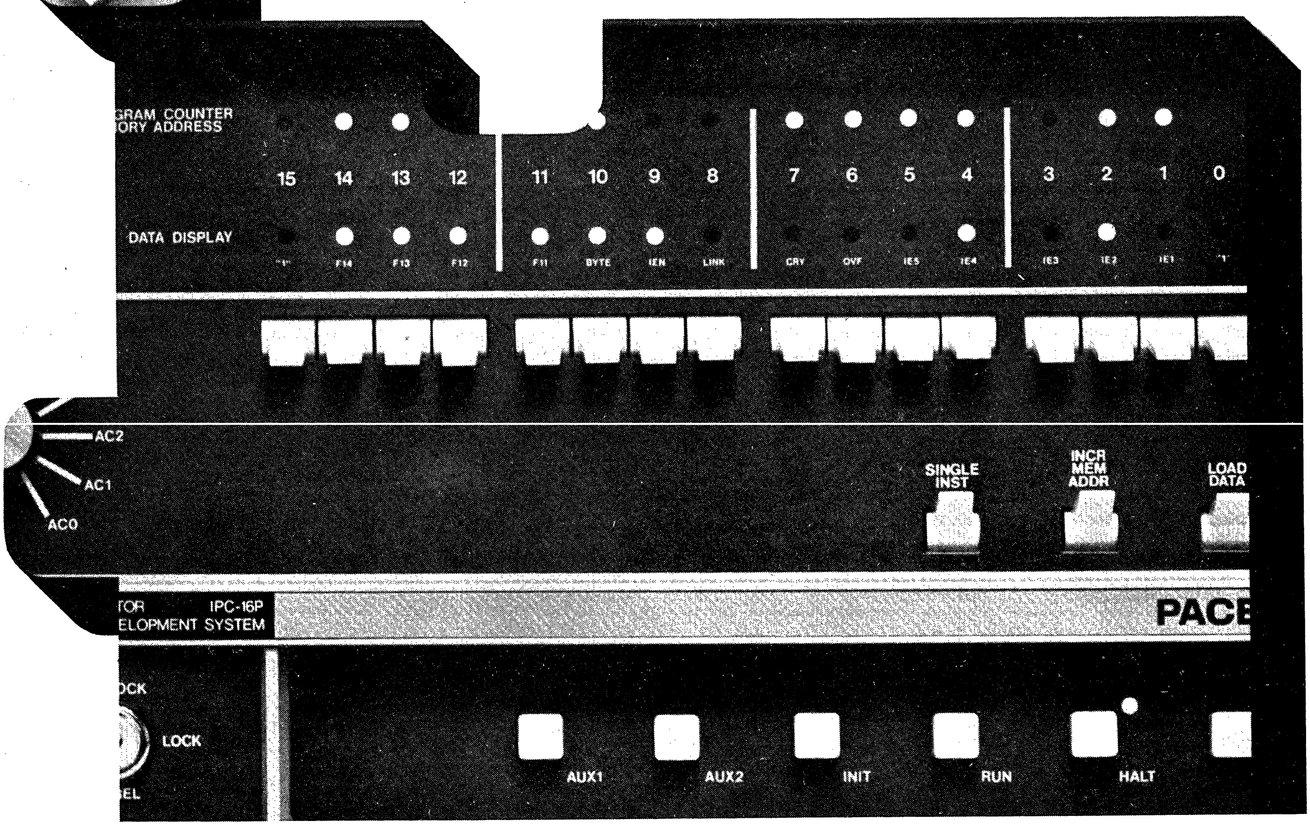
In brief, PACE's status sense inputs, interrupt request inputs and status register are structured to provide fast response to system status, and do so without any complicated algorithms or critical timing considerations.



With our PACE Development System not only can you completely evaluate the microprocessor itself, but you can actually develop a variety of OEM equipment, software and full-scale processing systems: it's a powerful tool indeed.

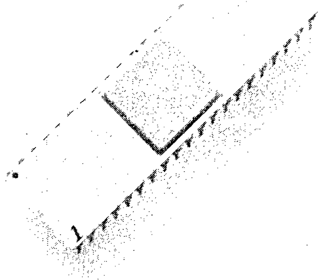
Now, even though PACE is basically a single component, we've developed a variety of application hardware for it. This hardware lets you perform rapid product evaluations, or you may choose to use it in preproduction systems. All of the hardware is on standard, 4.5-inch-square PC cards. These cards are compatible with the extensive line of breadboarding and interfacing cards and card hardware from Augat and a number of other sources.

Standard PACE application hardware includes: a CPU card (IPC-16C/100), which holds a PACE CPU package, a System Timing Element and crystal oscillator, and Bidirectional Transceiver Elements; a 1024x16 RAM card (IPC-16C/001) with on-chip address latches, and on-card cycle-extend circuitry that simplifies interfacing with the CPU card and permits the use of low-performance, low cost memory in PACE-based systems; a PROM/ROM card (IPC-16C/002P) with provision for 2048x16 storage; and a general purpose I/O card (IPC-16C/800) with four, eight-bit increments of the Interface Latch Element for connection to peripheral devices.



NATIONAL BACKS YOU UP

Along with PACE—the CPU itself—comes an immense array of backup support: hardware; software; advisory and maintenance services; and a range of components unmatched elsewhere in the industry, and yet so necessary to implement every part of a full system. Let's take it from the top.

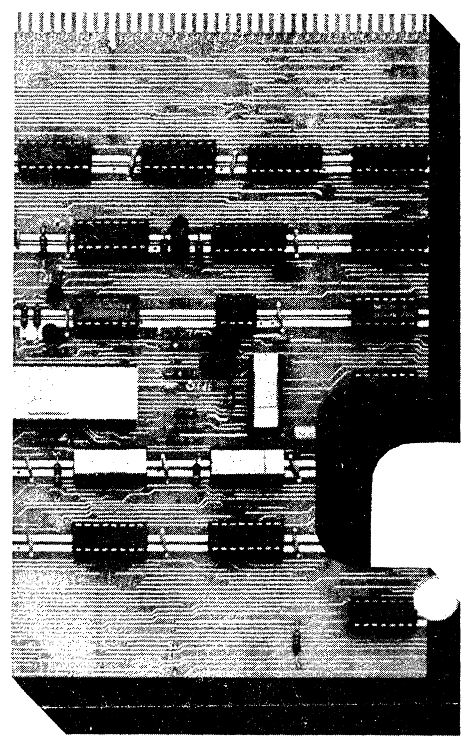


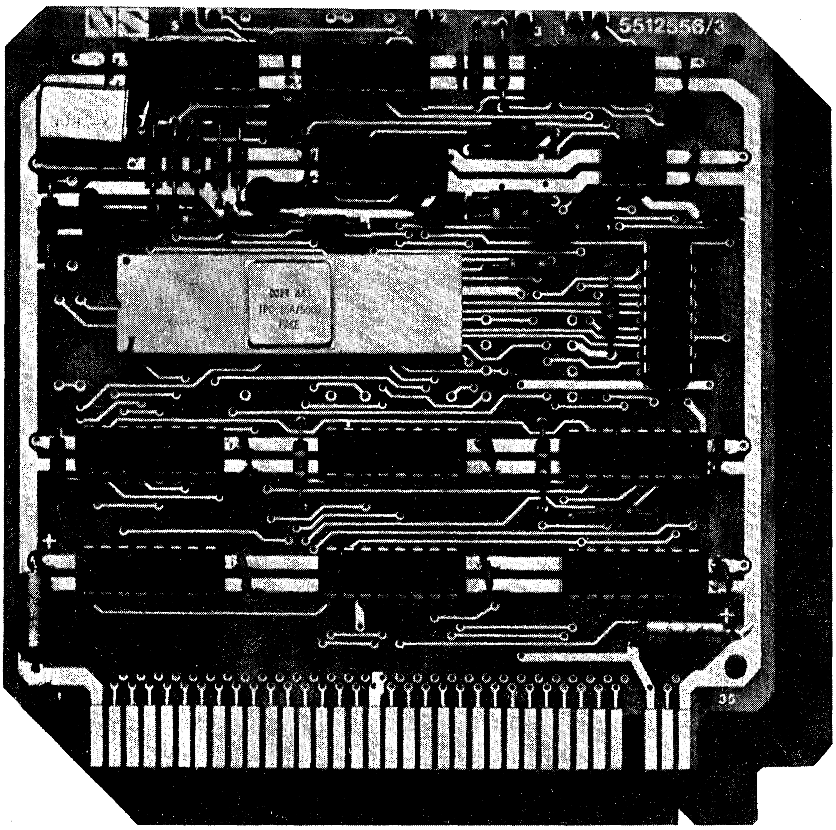
Hardware Support First off, we offer a complete PACE Development System, which makes use of an 8.5x11 inch Development CPU printed-circuit card.

This system gives you a way to develop and debug application hardware, and application software as well. Its control panel lets you examine or change the contents of the LIFO stack, of any register and of any memory location. And this same panel lets you execute one instruction at a time—and perform bootstrap loading operations as well—which is a very efficient way to develop a program. (Try program development on a microprocessor development system without a control-panel interrupt feature and you'll see what we mean.)

Although it provides for teletypewriter-like terminals, the PACE Development System also provides interfaces to a card reader, a line printer, a tape reader and a dual drive floppy disc—very important for high-speed input and output of data. Using such peripherals instead of a TTY can significantly reduce your program development time.

We even offer a PROM programming capability for the PACE Development System. And this means that you can complete all phases of a program development without any outside services and without buying any additional equipment.





The size of PACE hardware cards assures that you'll have no trouble using them in physically-small equipments.

Software Support A wide variety of software is available, which directs your PACE-controlled system to do exactly what you want it to do when you want it to do so.

PACE resident software includes Assemblers, a Source Statement Editor, a DEBUG routine, Loaders, Utility (e.g., Teletypewriter) routines and Diagnostics (memory and CPU).

And, of course, because of the high degree of compatibility between PACE and our IMP-16 microprocessor family, PACE users have access to what is perhaps the most flexible and powerful array of software currently available. For example, current IMP-16 users can use that microprocessor's Source Statement Translator to make their IMP-16 software usable with PACE without incurring additional development costs.

Documentation National provides extensive documentation to support your microprocessor-based system design. Such documentation must serve a number of functions, and PACE documentation covers them all from start to finish. The PACE Product Description, for example, helps you determine the suitability of a microprocessor to the application in question. With suitability established, you use the PACE Technical Description to establish benchmarks and prepare your preliminary system design; this manual also aids you in the development of application programs and the detailed system implementation, including interfaces.

Finally, our PACE User's Manual helps you to debug the application programs and hardware interfaces, and to prepare your system's own hardware and software documentation.

Field Support Our Area System Specialists are engineers specially-trained in microprocessor systems. They fully understand the products—hardware and software—and their applications, and are at your service in numerous locations both domestically and internationally. Besides offering on-site assistance, many of these specialists have operating microprocessor systems in their offices for hands-on explanations and aid.

Back-up Applications Support At National's home base we have an experienced microprocessor applications group. While this group's main

mission is to support you technically through your local Area System Specialist, the group's members can help you directly, as well. All it takes is a letter or a telephone call to them in Santa Clara, California.

Factory Service We can and will repair anything that goes wrong with any National microprocessor product (things sometimes do go wrong; you know it, and we know it too). And this repair service is not only for the OEM user, but for his customer—the end user—as well.

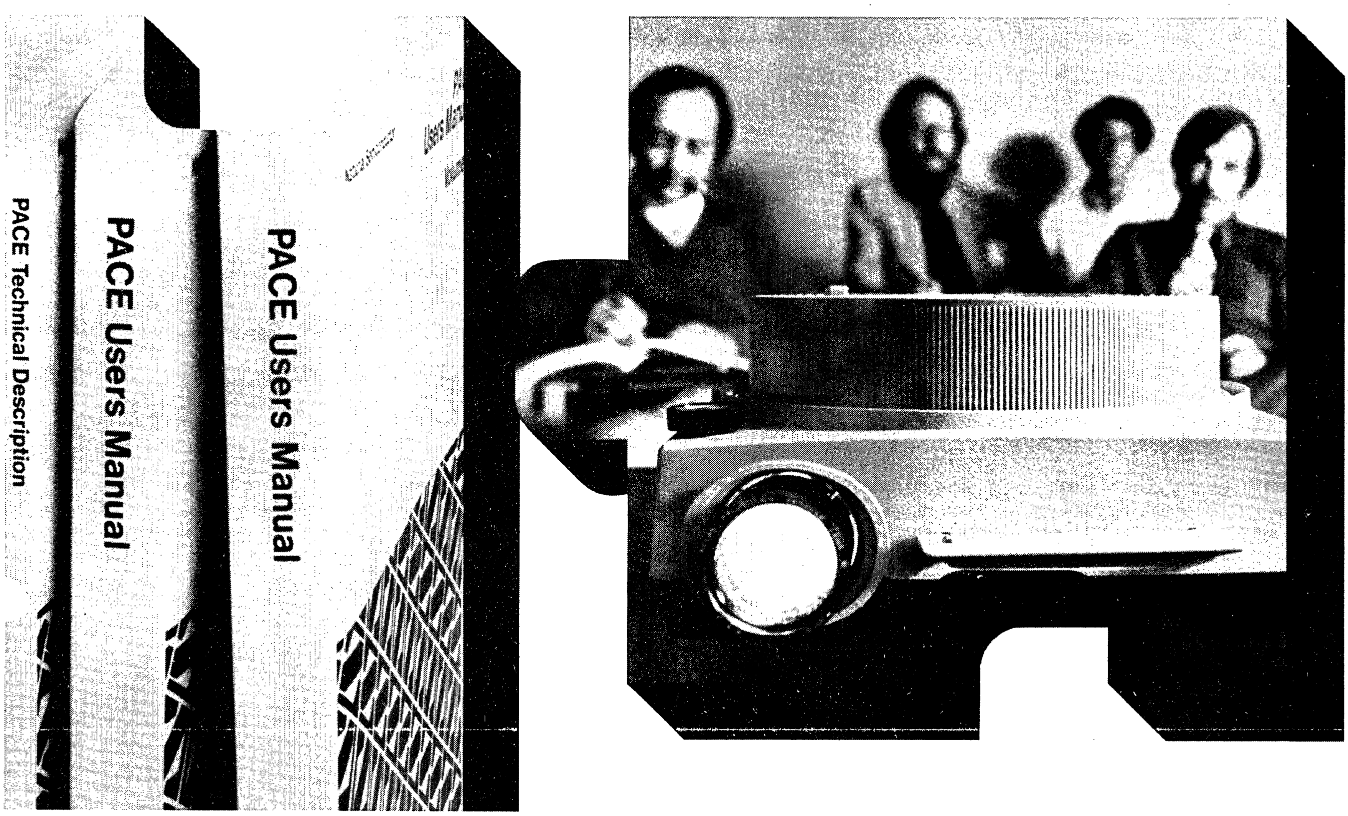
Training We offer complete, from-the-ground-up training courses. These customer workshops are not quickies; they are in-depth, 20-day courses of hands-on instruction divided into four sequential sessions of five days each, which take the student from the basics microprocessors right on up to the development of custom instruction sets through microprogramming.

Users Group The Users Group is an informal organization, with membership open to microprocessor users and those interested in the subject. It is a vehicle of communications between and among National and the group's members.

Our primary support of this group is in the form of a newsletter, which contains just about anything of interest to the group's members as it pertains to National microprocessors—articles, hints and kinks, editorials, letters from members, National announcements of all sorts (pertaining to microprocessors), even classified ads where you may advertise for sale anything you've got that's related to microprocessors.

If members in a given area set up local meetings, these are announced in the newsletter. There is also a Users Group Software Library, from which programs submitted by members are available to other members for the cost of reproduction only.

We want it clearly understood that National's unique working relationship with its customers—whether OEM or end user—helps us understand your problems. And we can help solve them. When you buy a microprocessor from National, you buy more than a chip and a data sheet.



EVERYTHING YOU NEED... FROM NATIONAL

While a microprocessor capable of being easily and inexpensively tailored to new applications is one key to a fast, cost-effective solution to a problem, it is not the only one needed. The second key, just as important as the first, is a broadly-based supplier with expertise in design, production and application of microprocessors, interface elements, input sensors and all other system components.

National Semiconductor makes everything you'll need.

We make memories.

We make clocks and support logic.

We make bus interface elements.

We make multiplexers.

We make A/D and D/A converters.

We make keyboard encoders.

We make positive and negative regulators.

We make line drivers and receivers.

We make display drivers.

We make optoelectronic display devices.

We even make transducers.

We make everything you'll need. And we can help you with everything you'll use. Only National Semiconductor places such an extremely broad-based expertise at your service. When you start your next system design, we're ready to help.

An Industry Leader When you do business with National Semiconductor Corporation, you do business with an acknowledged leader in the semiconductor industry—one of the four largest semiconductor manufacturers in the United States.

National Semiconductor is also a worldwide corporation. We are multinational in our manufacturing operations, and in our marketing and distribution as well. And what does this mean to you? Just this: that wherever your products are manufactured or used...wherever you use our products...wherever you are in the world...National is near at hand to help you.

There's More to Microprocessing Than a Microprocessor.

SC/MP

Easy to use sophistication at the right price— from National, of course

Simple implementation of complex control functions

If you design controls or control-related equipment and systems...if you use mechanical logic or hard-wired, discrete, semiconductor logic arrays...if you avoid the use of sophisticated electronics because it is either too powerful or too expensive for your applications...

...we have something new and very interesting for you.

And while this something new and very interesting is *internally* sophisticated, *externally*—that is, from *your* point of view—we've designed it to be easy to use, to be economical to use and to be powerful without invoking the brute force of overkill.

We're talking about a microprocessor, of course...but a very special one unlike any other available in the marketplace.

We call it SC/MP—a simple-to-use, cost-effective microprocessor.

SC/MP is the first microprocessor designed to fit the immense variety of applications in which 4-bit microprocessors are too difficult to use and for which currently-available 8-bit microprocessors are too powerful and expensive—applications that involve low-speed man/machine interfaces in the industrial/commercial and consumer marketplaces.

In the industrial/commercial arena, for example, SC/MP fills the bill for electronic cash registers...traffic light controllers...elevator controllers ...automatic, computing-type price/weight scales...food processing machinery...lumber and paper mill process controllers...measurement and instrument controllers...word processors.

On the consumer front, SC/MP is ideal for sophisticated calculators... electronic games...appliance controls...home air conditioning, heating and security systems...automatic tuners for TV receivers and mobile communication systems.

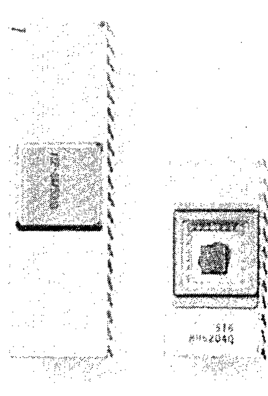
So get rid of your springs, levers, gears, switches, relays and discrete logic arrays by using SC/MP: a new concept in microprocessor control systems, which offers you a unique path to simpler, more economical and more efficient designs—a path not possible with any other microprocessor that you can buy today.

Wherever traditional microprocessors represent overkill... wherever economy is more important than the utmost in high-powered performance...SC/MP gives you *exactly* what you need to compete in today's markets—sophisticated yet easy-to-use electronic controls for your products at the right price, and cost-effective designs for customer satisfaction.

Pull together a power supply, a timing capacitor and a read-only memory (ROM). Connect these to a SC/MP CPU chip and...you've got a control system with three serial-data input ports and four serial-data output ports, commanded by a powerful set of 46 instructions.

We've just described a first-level, CMOS-compatible, SC/MP-based system, which may consist of as few as two integrated circuit packages: the SC/MP CPU chip and a standard ROM (or PROM) memory. Yet even with such a simple system you can implement the control logic for electronic games...traffic signals... simple industrial systems...appliances...vending machines...simple terminals.

With SC/MP, you move up to a higher level of operational capability by adding, to the first-level system, three more packages: a hex D flip-flop; an 8-channel digital multiplexer; and a 1-to-8 demultiplexer. These packages increase the number of serial-data input and output ports to eight each, and yield a system with four general-purpose, latched, control flags, a system that can address 4096 bytes of memory.



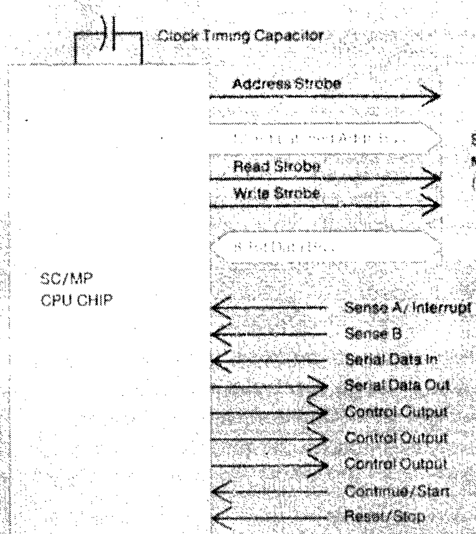
And with this second-level SC/MP system, you can implement direct digital controllers with up to eight process loops...on-board automotive computers...instrument controllers...complex traffic intersection controllers...electronic cash registers.

Finally, by adding to the SC/MP CPU chip our Interface Latch Elements, and some buffering, you move up to a very sophisticated system with high-speed, parallel data transfers—one that can address up to 65k bytes of memory to perform complex control functions as in credit card verification...business and accounting machines...text-editing typewriters...intelligent, stand-alone terminals...complex instrument/measurement systems. But all still very easy to implement and use.

SC/MP systems are easy to use and externally uncomplicated because we've moved most of the needed logic into the very heart of the system—the SC/MP CPU chip itself. And the internal elements—the CPU features—come to life under software control to provide your SC/MP system with architectural characteristics such as...

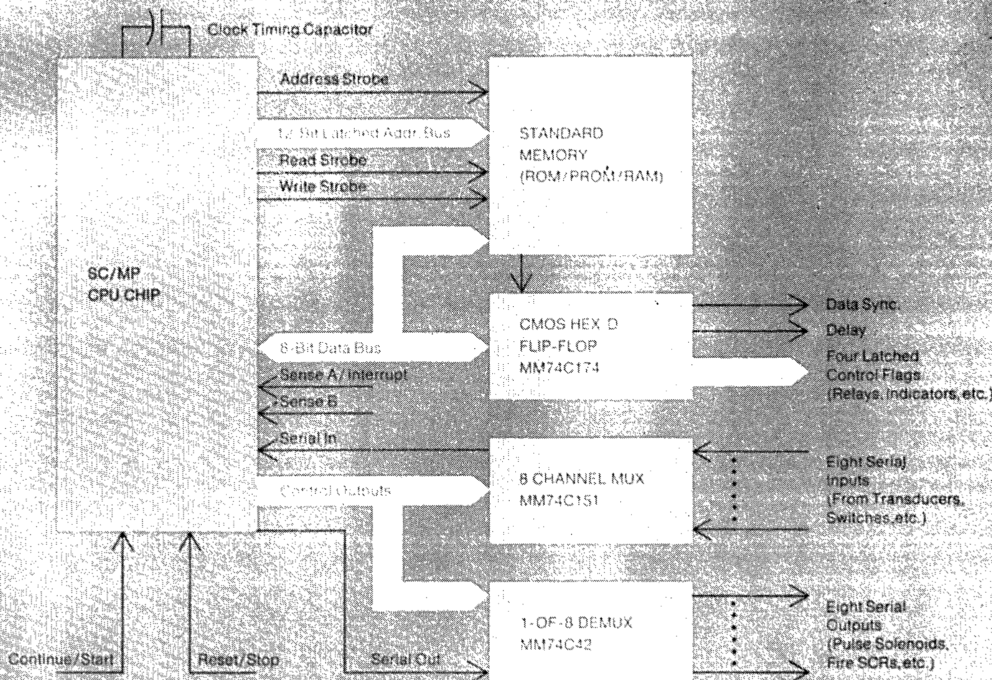
Simpler interfacing	Static operation; Bidirectional, Tri-State® 8-bit data bus, TTL or CMOS compatible options; Simple, yet powerful, interrupt function
Easy program development and debug	Fully supported by prototyping hardware and software;
Simpler I/O hardware	Separate serial-data input and output ports; Two sense inputs; Direct interfacing to standard memory parts; Direct interfacing to CMOS logic and memory
Direct condition testing	On-chip generation of asynchronous control signals for direct interfacing and a capability to use memories of any speed
Direct Memory Access (DMA) and multiprocessor capabilities	Separate bus access control
Direct control output	Three user-accessible control flag outputs
Simplified programming	Multiple addressing modes—program counter relative, pointer relative, immediate data and auto-index
Upward expandability	Address capability to 65k bytes of memory
High performance	2μs/microcycle instruction execution speed
Simplified multiprocessor network design	On-chip multiprocessor network bus-allocation logic: Enable In, Enable Out, Bus Request

First-level SC/MP system



- Electronic games
- Simple traffic controllers
- Appliance controls
- Vending machine controllers
- Simple terminals

Second-level SC/MP system



- Direct multiloop digital controllers
- On-board automotive computers
- Instrument controllers
- Complex traffic controllers
- Electronic cash registers

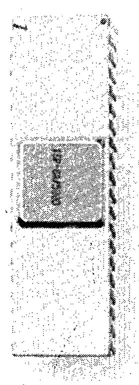
We've provided SC/MP with an interrupt system that, though easy to use, is quite powerful: the interrupt entry-point is completely controlled by software, as is the Enable/Disable function. Your ability to modify this interrupt linkage means that in many types of applications—as in the control of a system based on the counting of events, for example—you can program SC/MP to save software overhead.

And speaking of savings, SC/MP lets you address peripherals in the same manner as memory. Thus, powerful memory-reference instructions (and addressing modes) may be used for peripheral data I/O as well. And SC/MP's straightforward "handshake" I/O allows simple interfacing in DMA and multiprocessor applications. The DMA feature means that fast, direct transfers are possible from memory to peripherals, peripherals to memory and peripheral to peripheral. For example, the use of a priority controller on the DMA bus lets the DMA peripherals move data in and out of the read/write memory (RAM) at high speed, while SC/MP simply continues to chug along at human interface rates.

You can also use SC/MP's DMA lines to wire together several SC/MP CPU chips. This forms a multiprocessor system, in which the CPUs interface to the same address and data buses.

SC/MP has two control lines that provide for easy implementation of multiprocessor structures. Embedded in such structures, SC/MP waits for a non-busy bus, requests access and then waits for a Bus Enable signal. Until SC/MP receives the go-ahead it simply waits, with its address and data buses in their high-impedance states.

When SC/MP is the only bus controller in the system you can wire the Bus Enable line *high*, which lets SC/MP proceed with a bus I/O cycle whenever it is ready to do so.

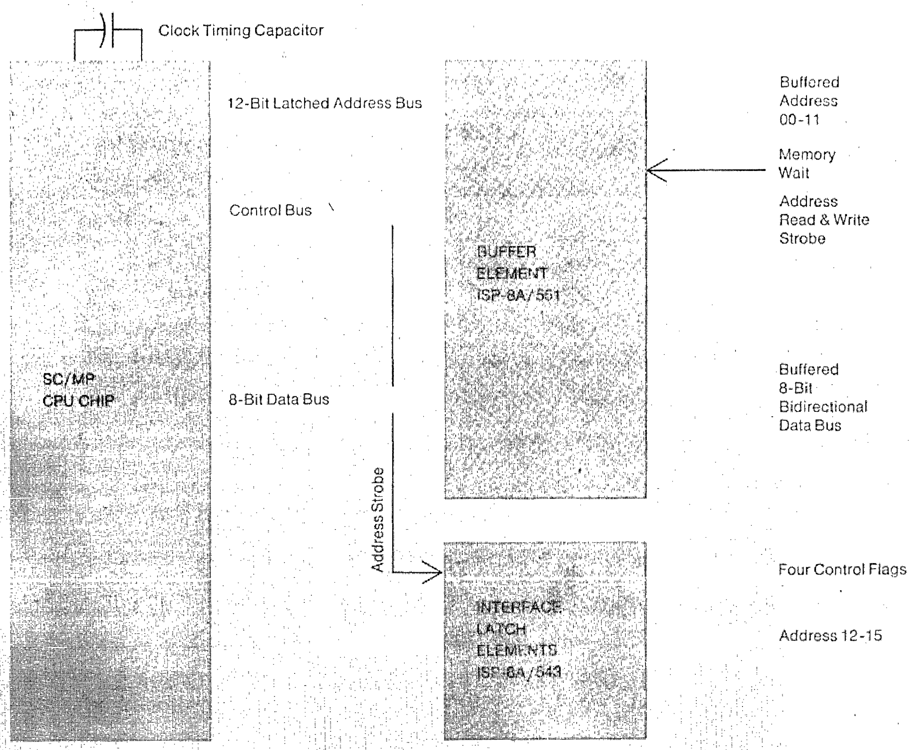


The SC/MP CPU chip

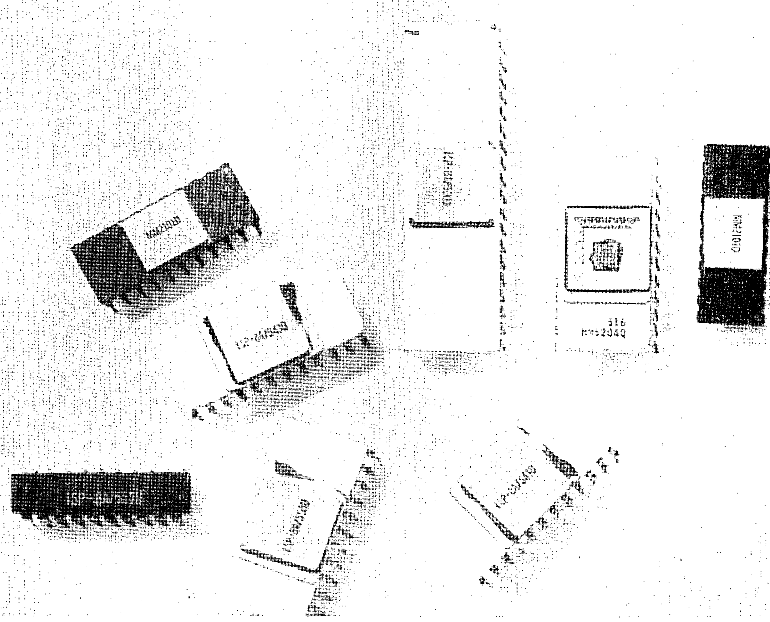
The SC/MP CPU chip is an 8-bit processing unit with 16-bit memory and peripheral addressing capabilities; its built-in features simplify your end of the design while letting SC/MP reach out and do its thing with everything connected to it.

For example, SC/MP provides flexible addressing to 65k bytes of memory or peripheral addresses by means of its four address-pointer registers. Also, you can use the status register's three flag outputs in several ways other than simply to supply internal software flags. By using them as encoded control lines, for instance, you can expand a SC/MP system's data I/O capabilities with input multiplexers and output demultiplexers, you can select particular banks of external memory and so on. And when you tell SC/MP what to do, its preprogrammed, on-chip, programmable logic array (PLA) assures proper instruction sequencing.

Expanded SC/MP system



Credit-card verification
Business/accounting machines
Text-editing typewriters
Stand-alone terminals
Instrument/measurement systems



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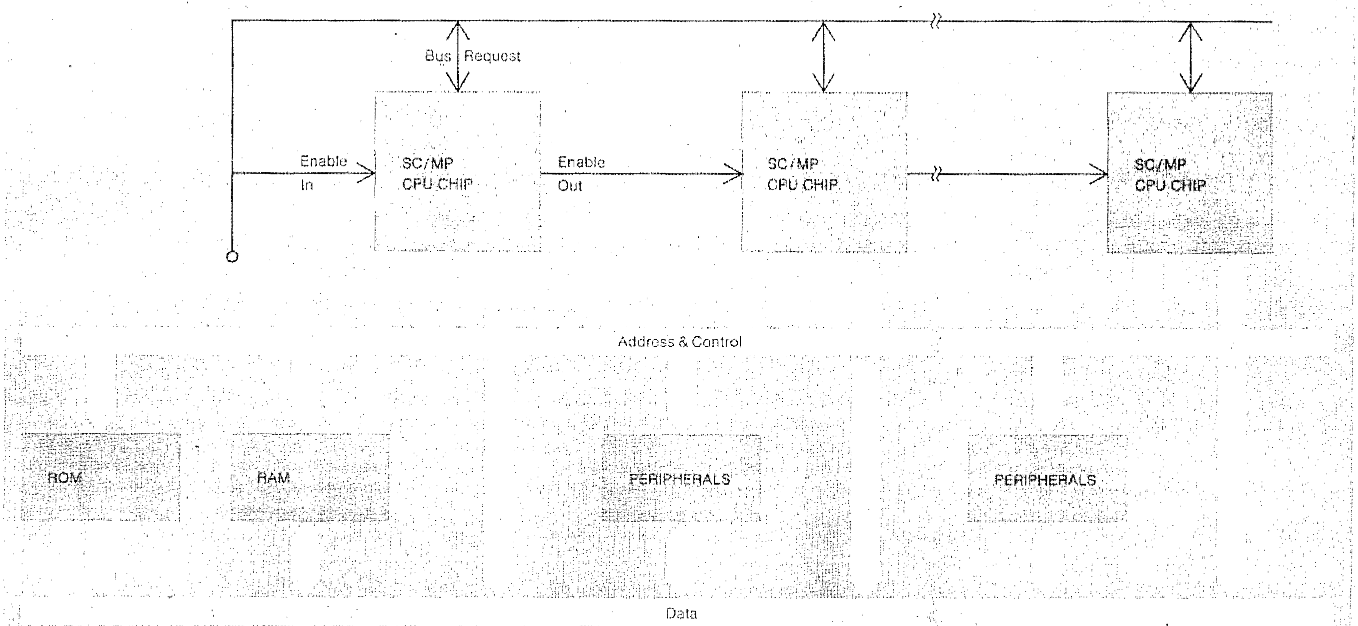
The significant CPU features, many of which are under your control through software, are shown in the table to the right.

The SC/MP CPU chip package features:

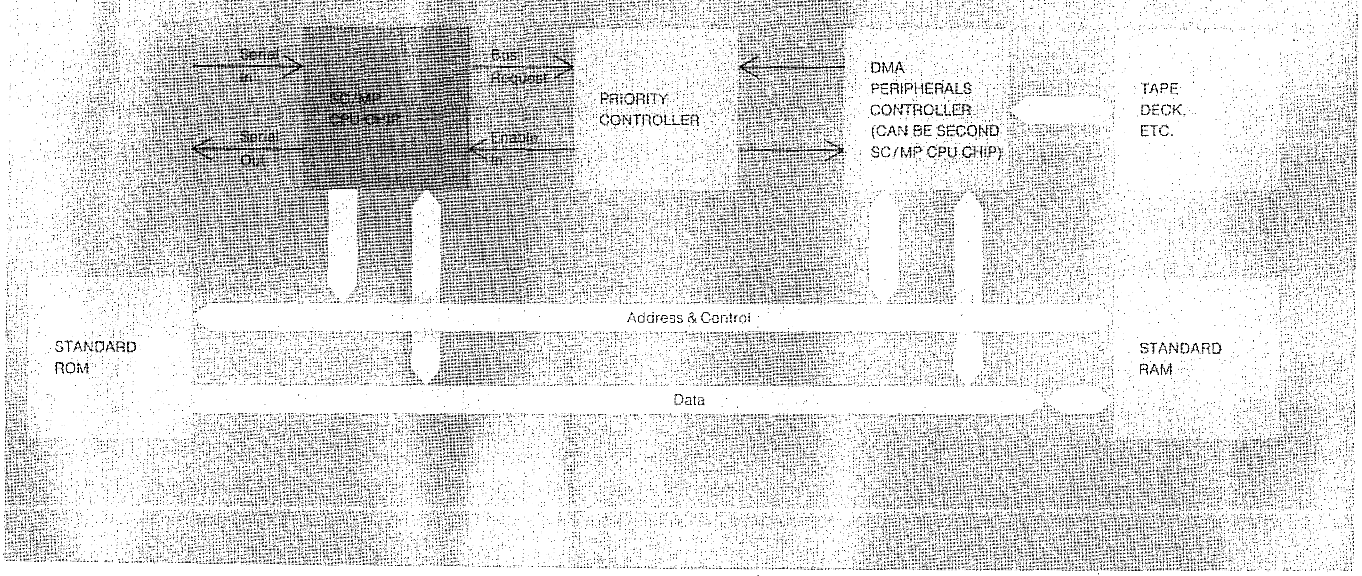
- The use of p-channel silicon-gate, depletion-load technology, which is a mature technology of good yield and low cost, and which is tolerant of power-supply variations
- Single power-supply operation of +10V to +14V, to facilitate direct CMOS interfacing
- A metal mask option for a TTL-compatible Tri-State I/O bus with 5-V logic swing
- A 40-pin dual-inline package available in ceramic or Epoxy B

Arithmetic/Logic Unit (ALU)	8-bit binary ADD, AND, OR, EXCLUSIVE OR; Two-digit BCD ADD
Data registers	8-bit accumulator; 8-bit extension register (provides separate serial I/O)
Address pointer registers	Four, 16-bits each; usable as stack pointers to external memory for unlimited subroutine nesting.
Status/flag register	8-bits wide; contents treatable as data or storable in memory
Address output register	16-bit address (65k bytes); 12-bits static (4k page); 4-bit output at address strobe time
Data I/O register	Buffers 8-bit data in and out
Instruction register	8-bit operations code
Instruction decode and control	Preprogrammed PLA structure assures proper instruction sequencing
Input/Output control	Handshake type for simplified interfacing and multiprocessing applications
Oscillator and timing generator	On-chip timing generation needs only external capacitor or crystal; Reduces component count in low-speed applications

Multiprocessor network



DMA control using multiprocessor network



National Semiconductor
MICROPROCESSOR

National backs you up

There's more to microprocessing than just the microprocessor, so your microprocessor supplier should be able to supply everything you'll need. National is such a supplier, because our philosophy is to sell solutions, not just parts.

Hardware Support We offer a complete Development System for SC/MP. Software is the key to the microprocessor approach to control system design, and our SC/MP Development System is the tool that will help you bring in your jobs on schedule and under budget.

The SC/MP Development System provides everything you'll need to develop, test and debug interfaces, application programs and even complete control systems. The Development System comes supplied with a microprocessor, peripheral interfaces, memory, power supply and chassis, and built-in DEBUG/System Monitor firmware. Its control panel lets you examine or change the contents of any memory location. And this same panel, because of the static design of the CPU, lets you step through your program one instruction at a time, which is a very efficient way to debug a program. (Try program development and debug on a microprocessor system without a control panel and you'll see what we mean.)

I/O to SC/MP's Development System is via teletypewriter or high-speed paper tape, and the system can address up to 65k bytes of memory.

We even offer a PROM programming option for the SC/MP Development System. And this means that you can complete all phases of a program development without any outside services and without buying any additional equipment.

Now, even though SC/MP is basically a single component—a microprocessor chip—we've developed a variety of application hardware for it. This hardware lets you perform rapid product evaluations, or you may choose to use it in preproduction systems. All of the application cards are on 4.38x4.86-inch standard PC cards, a size that assures you'll have no trouble using them in small equipment.

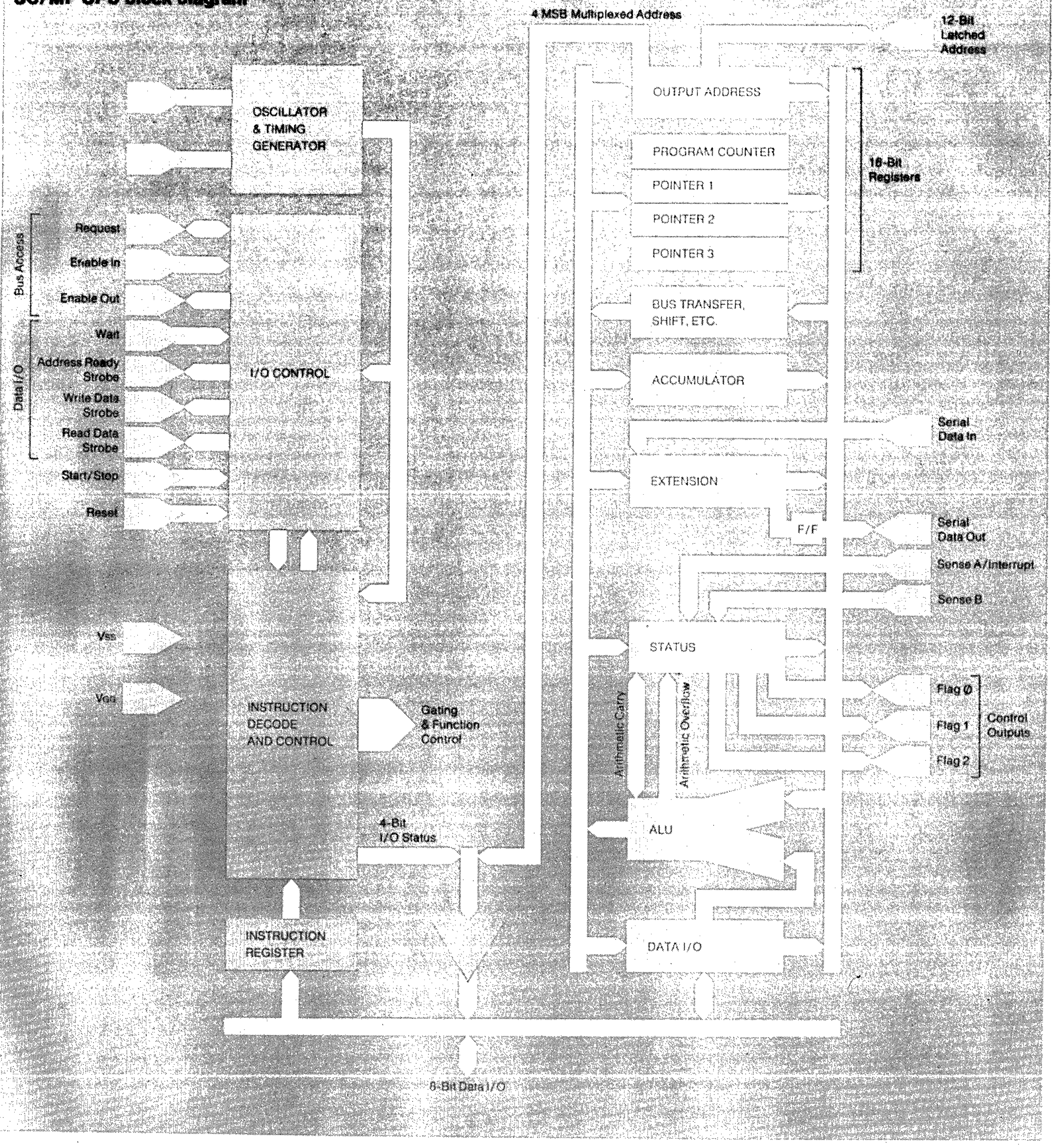
Standard SC/MP application hardware includes: a CPU card (ISP-8C/100), which holds a timing crystal, 256 bytes of RAM, 2k bytes of PROM, and all necessary buffering and address elements, control lines and so on; a 4k x 8 PROM/ROM card (ISP-8C/004P); and a 2k x 8 RAM card (ISP-8C/002).

While SC/MP interfaces directly to CMOS devices, to provide CMOS-level system buses, many of today's interfaces are still TTL-level. And this is where our system support chips come in very handy. SC/MP's Blue Chips™ and Green Chips™ are designed specifically to help you build an efficient, economical microprocessor system with an absolute minimum package count, while still producing a true TTL system bus. SC/MP's Blue Chip ISP-8A/551, for example, provides Tri-State buffering, while the Green Chip ILE/8 (ISP-8A/543) provides bidirectional interface latches.

Software/Firmware Support At National we consider software to be an integral part of microprocessing, not just an afterthought. So we offer a variety of software to support SC/MP in your system: DEBUG/System Monitor... Resident Conversational Assembler/Editor... System Diagnostics... Cross Assembler (available as a Fortran IV program and on timeshare services)... application routines (such as double-precision math, code conversions and so on). In addition, there are peripheral I/O drivers that let you interface your SC/MP system to high-speed paper tape, cassettes, printers and teletypewriters.

Documentation is still another aspect of support. The SC/MP Product Description, for example, fully specifies SC/MP in much the same way as does any component's data sheet. At the next level is the SC/MP Technical Description, which helps you establish system performance and prepare a preliminary system design; this manual also aids in the development of application programs and in the detailed system implementation, including interfaces. Then there is the SC/MP User's Manual, which not only helps you debug the application programs and hardware interfaces, but also helps you in the preparation of your system's own hardware and software documentation.

SC/MP CPU block diagram



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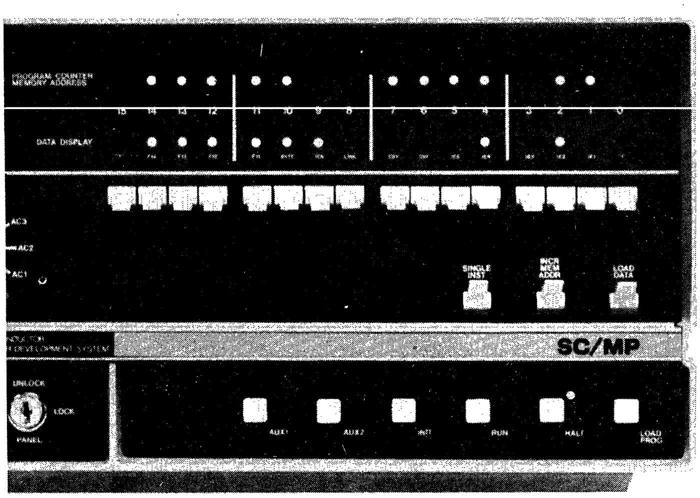
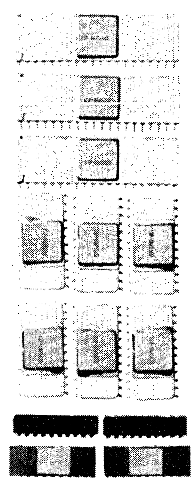
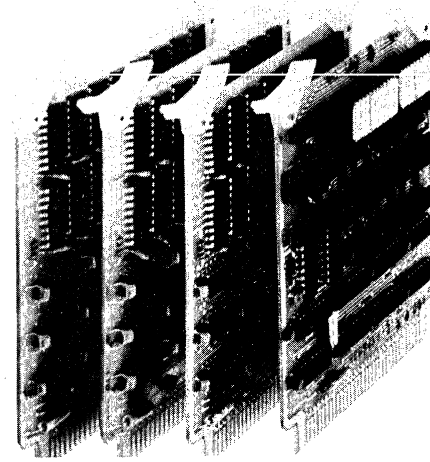
Remember: When you buy a microprocessor from National, you buy more than a chip and a data sheet.



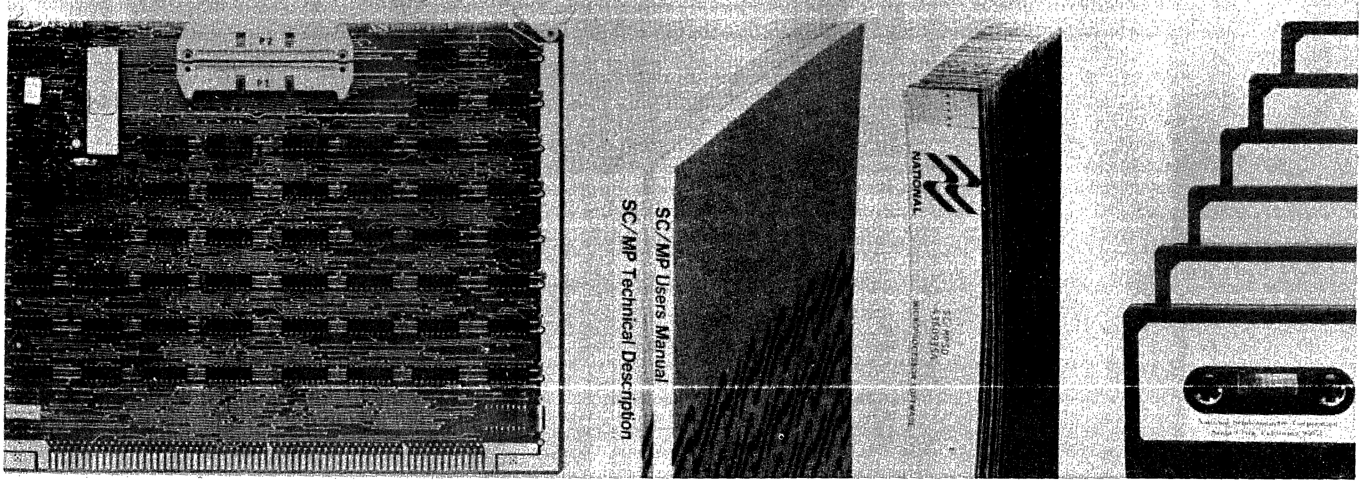




SC/MP instruction summary
(Typical execution time, 2 μs/microcycle)

Double-byte instructions:		Execution time in microcycles
Memory Reference	Load	18
	Store	18
	AND	18
	OR	18
	EXCLUSIVE OR	18
	Decimal ADD	23
	ADD	19
	Complement and ADD	20
Transfer	Jump	11
	Jump if positive	9, 11
	Jump if zero	9, 11
	Jump if not zero	9, 11
Memory Increment/ Decrement	Increment and load	22
	Decrement and load	22
Immediate	Load	10
	AND	10
	OR	10
	EXCLUSIVE OR	10
	Decimal ADD	15
	ADD	11
	Complement and ADD	12
Miscellaneous	Delay	3 to 132,096

Single-byte instructions:		Execution time in microcycles
Extension Register	Load AC from extension	6
	AND extension	6
	OR extension	6
	EXCLUSIVE or extension	6
	Decimal ADD extension	11
	ADD extension	7
	Complement and ADD extension	8
Pointer Register Move	Exchange pointer low	8
	Exchange pointer high	8
	Exchange pointer with PC	7
Shift, Rotate, Serial I/O	Serial I/O	5
	Shift right	5
	Shift right with link	5
	Rotate right	5
	Rotate right with link	5
Miscellaneous	Halt	8
	Exchange AC and extension	7
	Clear carry/link	5
	Set carry/link	5
	Disable interrupts	6
	Enable interrupts	6
	Copy status to AC	5
	Copy AC to status	6
	No operation	5-10



RCA-CDP1801 Microprocessor

The CDP1801 microprocessor is a CMOS 8-bit register-oriented central processing unit (CPU) designed for use as a general-purpose computing or control element in a wide range of stored-program systems or products. It is implemented by two LSI packages: the 40-lead CDP1801U control unit contains the arithmetic logic unit (ALU), the control logic, and various working registers; the 28-lead CDP1801R register unit contains the multi-purpose 16 x 16 register array, a buffer register, associated controls, and an increment/decrement circuit associated with the register array.

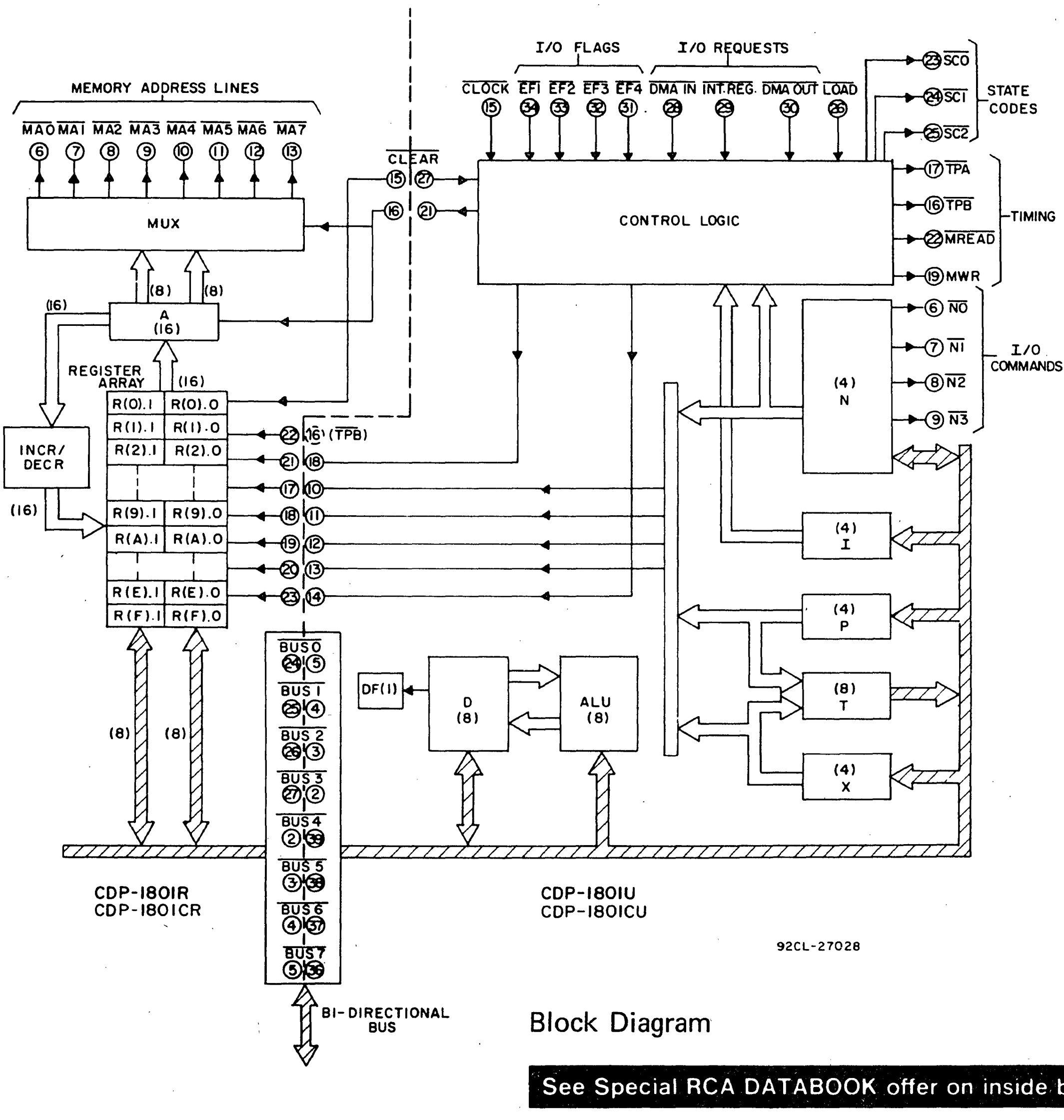
The CDP1801 microprocessor includes all the circuits required for fetching, interpreting, and executing instructions which have been stored in standard memories—RAM or ROM. An efficient one- or two-byte instruction format results in short efficient programs. Extensive input/output I/O control features are also provided to facilitate system design for lowest cost.

The CDP1801 also provides a synchronous interface to memories and external controllers for I/O devices and minimizes the cost of interface controllers. The I/O interface is capable of supporting devices operating in polled, interrupt-driven, or direct-memory-access (DMA) modes.

The CDP1801 is available in two versions for different dc operating-voltage ranges. The basic unit operates over the complete range of 3 to 12 volts. The CDP1801C operates over a narrower range of 4 to 6 volts.

CMOS Technology

The CMOS technology used in the CDP1801 provides a high noise immunity so that the microprocessor can operate in electrically hostile environments. The units can be powered by unregulated power supplies over a wide operating-voltage range. The 1801 has two voltage supply pins so that it can operate at maximum speed while interfacing to various external circuit technologies, including TTL, at a lower voltage. Only a single-phase system clock is required, and the microprocessor power consumption



Block Diagram

RCA-CDP1801 Microprocessor (cont'd)

is very low. Furthermore, the 1801 series is completely static, so that the system clock can be controlled to interface with slow memories or I/O devices. The units are capable of operating over the full −55°C to +125°C temperature range.

When operated from a typical power supply of from 10 to 12 volts, the CDP1801 can have a machine cycle time (8 clock pulses) of about 3 microseconds. If a 400-nanosecond RAM is used, the fetch-execute time for any instruction is 6 microseconds, the DMA rate is 333,000 bytes per second, and the interrupt response time is from 3 to 9 microseconds.

Easy-to-Use Instructions

The COSMAC microprocessor provides a set of simple, easy-to-use, general-purpose instructions. The on-chip scratchpad of sixteen general-purpose 16-bit registers may be used to provide multiple program counters, data pointers, and data storage. Three specific registers are treated by the hardware as an implicit DMA address pointer, a program counter for interrupt servicing, and an interrupt or subroutine stack pointer, respectively. A simple one-step program loading facility is provided on the chip. Unlimited subroutine or interrupt nesting is possible.

The I/O interface is designed to provide direct control of I/O devices so that over-all system complexity and cost can be reduced. Flexible, open-ended I/O instructions allow unlimited device attachment. The hardware I/O interface is capable of supporting devices operating in polled, interrupt-driven, and DMA modes.

The COSMAC Hardware Support Kit is a prototyping system for the development of systems based on the CDP1801 microprocessor. It is available in two versions. The basic Microkit (CDP18S001) is useful primarily for breadboard evaluation. A teletypewriter or equivalent terminal can be attached to this basic system. With such a terminal, the Microkit becomes a complete computer system. It is used primarily with RCA's CSDP—the powerful interactive COSMAC Software Development Package. In this mode of operation, the Microkit may be directly "down-loaded" from the CSDP computer by a single command.

A Stand-Alone Microkit (CDP18S002) is available for software development. This version contains additional RAM, allowing use of the COSMAC Resident Software System (CRSS). When a user-supplied terminal is provided, the Stand-Alone Microkit becomes a complete, self-contained microprocessor prototyping system.

Three software packages are available for use with the CDP1801 microprocessor. The COSMAC Software Development Package (CSDP) is the most versatile. It is available on GE Time-Share or in a Fortran IV version for installation on other interactive computer systems. The CSDP can also be used with the basic Microkit to provide a complete microprocessor prototyping system.

The Batch Assembler is a software program designed especially for users who have IBM-370 computers with virtual storage.

The COSMAC Resident Software System (CRSS) is designed expressly for use in the Stand-Alone Microkit.

OPERATING CONDITIONS AT T_A = 25°C Unless Otherwise Specified
For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges.

CHARACTERISTIC	CONDITIONS		LIMITS				UNITS
	V_{CC}[1] (V)	V_{DD} (V)	CDP1801 Min.	CDP1801 Max.	CDP1801C Min.	CDP1801C Max.	
Supply-Voltage Range (At T_A = Full Package—Temperature Range)	–	–	3	12	4	6	V
Recommended Input Voltage	–	–	V_{SS}	V_{CC}	V_{SS}	V_{CC}	V
Clock Input Rise or Fall Time, t_r, t_f	3 - 15	3 - 15	–	15	–	15	μs
Instruction Time (See Fig. 4)	5	5	16	–	16	–	μs
	5 - 10	10	6	–	–	–	
Clock Input Frequency, f_{CL}	5	5	DC	1	DC	1	MHz
	5 - 10	10	DC	3	–	–	
Clock Pulse Width, t_{WL}, t_{WH}	5	5	500	–	500	–	ns
	5 - 10	10	160	–	–	–	
Clear Pulse Width	5	5	500	–	500	–	ns
	5 - 10	10	160	–	–	–	
Data Hold Time, t_{DH}	5	5	0	–	0	–	ns
	5 - 10	10	0	–	–	–	

Notes:
1. $V_{CC} \leq V_{DD}$. For CD1801C $V_{DD} = V_{CC}$ = 5 volts.
2. Because a large number of nodes may be switching simultaneously, a 0.1 μF by-pass capacitor is recommended in the power supply.
3. In order to maintain proper circuit operation, the CDP1801 intra-unit wiring capacitance should be less than 25 pF.

MAXIMUM RATINGS, *Absolute-Maximum Values*

Storage-Temperature Range (T_{stg}) .... −65 to +150°C
Operating-Temperature Range (T_A) .... −55 to +125°C
DC Supply-Voltage Range (V_{CC}, V_{DD})
(All voltage values referenced to V_{SS} terminal)
$V_{CC} \leq V_{DD}$:
CDP1801 .... 0.5 to +15 V
CDP1801C .... 0.5 to +7 V
Power Dissipation Per Package (P_D):
For T_A = −55 to +100°C .... 500 mW
For T_A = +100 to +125°C .... Derate Linearly to 200 mW
Device Dissipation Per Output Transistor:
For T_A = −55°C to +125°C .... 100 mW
Input Voltage Range, All Inputs .... −0.5 to V_{DD} +0.5 V
Lead Temperature (During Soldering):
At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10 s max. .... +265°C

See Special RCA DATABOOK offer on inside back cover

RCA-CDP1801 Microprocessor (cont'd)

Simple but Powerful Architecture:
- 8-bit parallel organization
- 8-bit bidirectional common data bus for input/output and memory
- multiple program counters
- multiple data registers
- multiple address registers
- immediate address mode
- indirect pointer address mode
- short efficient instructions to keep programs short
- ALU overflow bit testable by branch instructions

Easy-to-Use Instructions:
- one- or two-byte instruction format
- 57 easy to use instructions
- add, subtract, shift, and logical operations
- flexible subroutine nesting procedures
- simple 1-byte subroutine call

I/O Flexibility:
- general-purpose interface for any RAM/ROM memory
- separate memory address lines
- memory addressing up to 65,536 bytes
- program interrupt mode
- program-controlled interrupt mask (enable/disable)
- flexible programmed I/O
- four flag inputs directly testable by branch instructions
- separate 4-bit I/O control signal
- two I/O sync pulses provided
- single-pulse clear
- self-contained DMA control
- built-in program load mode
- TTL compatibility on inputs and outputs, if desired

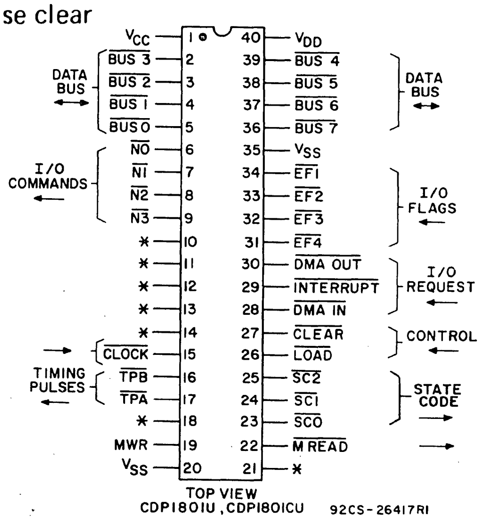
CMOS Technology:
- static CMOS circuitry
- low power consumption
- single supply voltage option
- 3 - 12 V dc operating range (4 - 6 V dc for the CDP1801C)
- high noise immunity
- single-phase clock

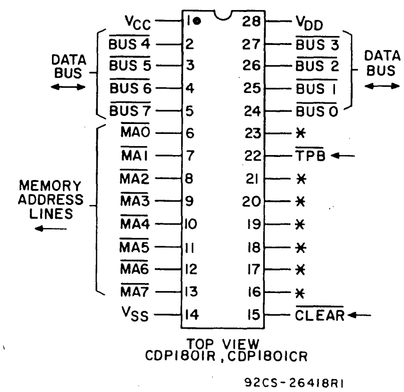
Literature

Form No.	Title	Price
MPM-101	User Manual for the COSMAC Microprocessor	$ 5.00
MPM-102	Program Development Guide for the COSMAC Microprocessor	10.00
MPM-103	COSMAC Microkit Operator's Manual	10.00
MPM-104	Installation Manual for the COSMAC Software Development Package	10.00
MPM-105	Installation Manual for the COSMAC Batch Assembler	10.00
*MPM-106	Library of COSMAC Arithmetic Subroutines	5.00
*MPM-107	Universal COSMAC I/O Design Manual	5.00
MPM-108	COSMAC Resident Software Manual	5.00

*Available 1976

Terminal Assignment Diagrams





Package Interconnections

Pin Terminals To:					*	*	*	*	*		*	*						
CDP1801U,CU	1	2	3	4	5	10	11	12	13	14	16	18	21	27	36	37	38	39	40
CDP1801R,CR	1	27	26	25	24	17	18	19	20	23	22	21	16	15	5	4	3	2	28

* These pins are for interchip connections only.

Notes:
1. Any unused input pins should be connected to V_{DD} or V_{CC}.
2. The DATA BUS lines are bi-directional and have three-state outputs. They may be individually connected to V_{CC} through external pull-up resistors (22 KΩ recommended) to prevent floating inputs.
3. All inputs have the same noise immunity and level-shifing capability. All outputs have the same drive capability whether they have three-state outputs or not.
4. For the CDP1801C, V_{CC} must be connected to V_{DD}.

INTRODUCING THE 2650 FAMILY

"5—VOLT SYSTEM REDUCES SYSTEM COSTS"
"2650 PUTS THE INTERFACE ON THE CHIP...NOT ON THE CIRCUIT BOARD"
"POWERFUL INSTRUCTION SET PROVIDES LOWER COST SYSTEMS"

The greatly increased sophistication and rising production costs of today's logic systems force the system designer to use every available resource in order to economically produce his system. In keeping with this cost reduction goal, Signetics has developed a powerful general purpose integrated microprocessor called the 2650. The first Signetics microprocessor, in conjunction with Signetics MOS and Bipolar memory and interface product lines, offers the system designer a viable and attractive alternative to the hard-wired approach to system design. For many applications, the system designer can use this general purpose microprocessor and standard memory and interface circuits to implement systems with lower cost than the hard-wired logic approach without sacrificing performance.

By using the 2650 and compatible products, the system designer can obtain two other major benefits of microcomputer systems. These benefits are greatly enhanced system flexibility and minimized design or modification cycles compared with the hard-wired logic approach.

The requirements of the majority of applications for integrated microprocessors (logic replacement and control functions) have defined a general set of processor parameters based on system and device economies, ease of use, and speed requirements.

These characteristics include:

- Single chip
- Fixed instruction set
- Eight bit parallel structure
- TTL compatibility

In addition to these characteristics, the design of the 2650 has been optimized around three generalized objectives:

- Lowest system cost
- Ease of use
- Capable of a wide range of applications

The optimum technology choice for implementing these features is the low threshold ion-implanted N-Channel silicon gate process. This process has matured in the past few years, providing a combination of high density, low threshold voltage, moderate speed and good manufacturing yields. Using this technology, a total of 576 bits of ROM, approximately 250 bits of register and about 900 logic gates are used to implement the processor function on the 2650 chip.

The instruction set consists of 75 instructions, of which about 40% consists of arithmetic instructions. This class contains the Boolean, arithmetic, and compare operations, each of which may be executed using any one of eight addressing modes. Another 30% of the instruction set consists of branch instructions which incorporate six addressing modes. The remaining 30% of the instruction set includes, amoung others, I/O instructions, instructions for performing operations on the two status registers, a decimal adjust instruction and the HALT instruction.

Utilizing multiple addressing modes greatly increases coding efficiency, allowing functions to be performed using fewer instructions than less powerful machines. The resulting reduction in routine execution time and memory capacity requirements directly translates into improved system performance and reduced memory cost. In this way the powerful instruction set and addressing modes of the 2650 allow a significant reduction in the memory required to perform a given function, resulting in sizeable system cost savings without sacrificing performance.

PROCESSOR HARDWARE DESCRIPTION

ARCHITECTURE

GENERAL DESCRIPTION

A block diagram of the processor is shown in Figure 1. The first, second, and third bytes of instructions are read into the processor on the data bus and loaded into the Instruction Register, Holding Register, and Data Bus Register, respectively. The instructions are decoded through a combination of ROM and random logic.

The ALU performs arithmetic, Boolean, and combinatorial shifting functions. It operates on eight bits in parallel and utilizes carry-look-ahead logic. A second adder is used to increment the instruction address register and to calculate operand addresses for the indexed and relative addressing modes. This separate address adder allows complex addressing modes to be implemented with no increase in instruction execution time.

The General Purpose Register Stack and the Subroutine Return Address Stack are implemented with static RAM cells. The Register Stack consists of seven 8-bit registers. The Subroutine Stack can contain eight 15-bit addresses, thereby allowing eight levels of subroutine nesting. Placing the Subroutine Stack on the chip allows efficient ROM-only systems to be implemented in some applications. Separate 15-bit Instruction Address and Operand Address Registers and provided. The 2650 is an 8-bit binary processor with BCD capability. See Figure 2 for a diagram of the 2650 registers as seen by the programmer.

PROGRAM STATUS WORD

The Program Status Word (PSW) is a major feature of the 2650 with greatly increases its flexibility and processing power. The PSW is a special purpose register within the processor that contains status and control bits.

It is divided into two bytes called the Program Status Upper (PSU) and Program Status Lower (PSL). The PSW bits may be tested, loaded, stored, preset, or cleared using the instructions which affect the PSW. The bits are utilized as follows:

PSU0, 1,2	— SP	— **Pointer** for the Return Address **Stack.**
PSU5	— II	— Used to **Inhibit** recognition of additional **Interrupts.**
PSU6	— F	— **Flag** is a latch directly driving the flag output.
PSU7	— S	— **Sense** equals the state of the sense input.
PSL0	— C	— **Carry** stores any carry from the high-order bit of the ALU.
PSL1	— COM	— **Compare** determines if a logical or arithmetic comparison is to be made.
PSL2	— OVF	— **Overflow** is set if a two's complement overflow occurs.
PSL3	— WC	— **With Carry** determines is the carry is used in arithmetic and rotate instructions.
PSL4	— RS	— **Register Select** identifies which bank of 3 GP registers is being used.
PSL5	— IDC	— **Inter Digit Carry** stores the bit-3-to-bit-4 carry in arithmetic operations.
PSL6, 7	— CC	— **Condition Code** is affected by compare, test and arithmetic instructions.

INTERRUPT HANDLING CAPABILITY

The 2650 has a single level hardware vectored interrupt capability. When an interrupt occurs, the 2650 finishes the current instruction and sets the

Interrupt Inhibit bit in the PSW. The processor then executes a Branch to Subroutine Relative to location Zero (ZBSR) instruction and sends out Interrupt Acknowledge and Operation Request signals. On receipt of the INTACK signal the interrupting device inputs an 8-bit address, the interrupt vector, on the data bus. The relative and relative indirect addressing modes combined with this 8-bit address allow interrupt service routines to begin at any addressable memory location.

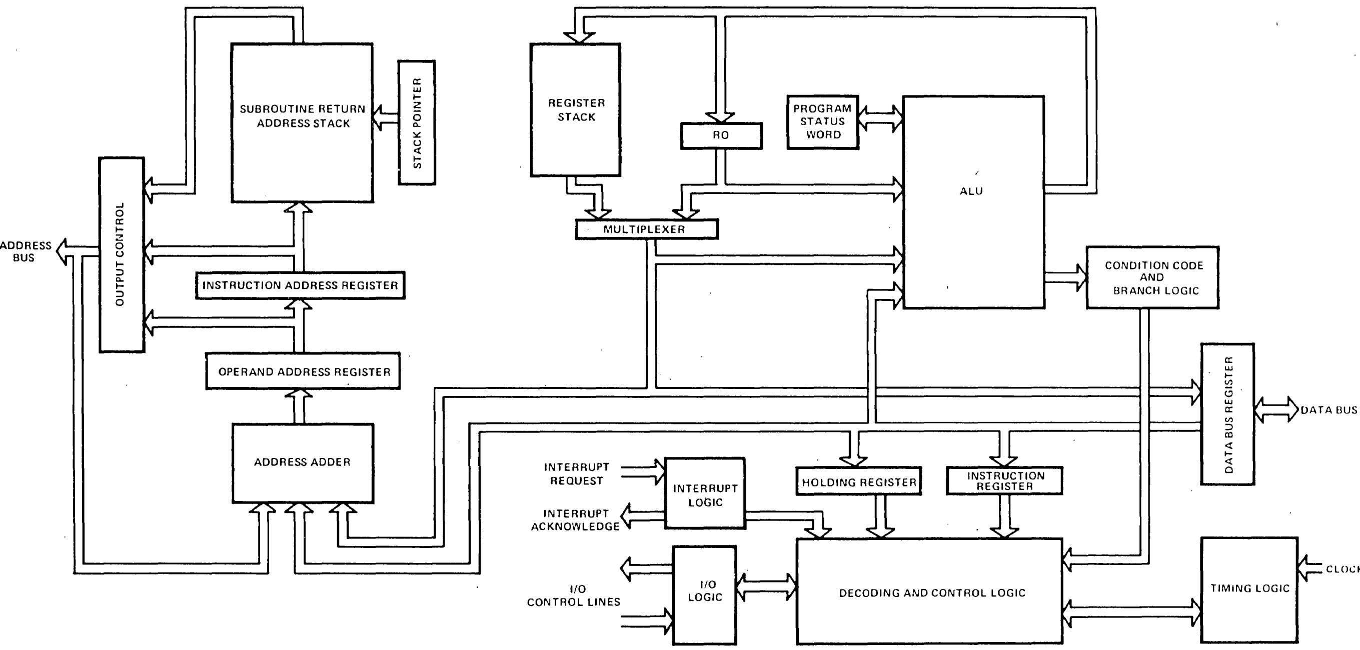
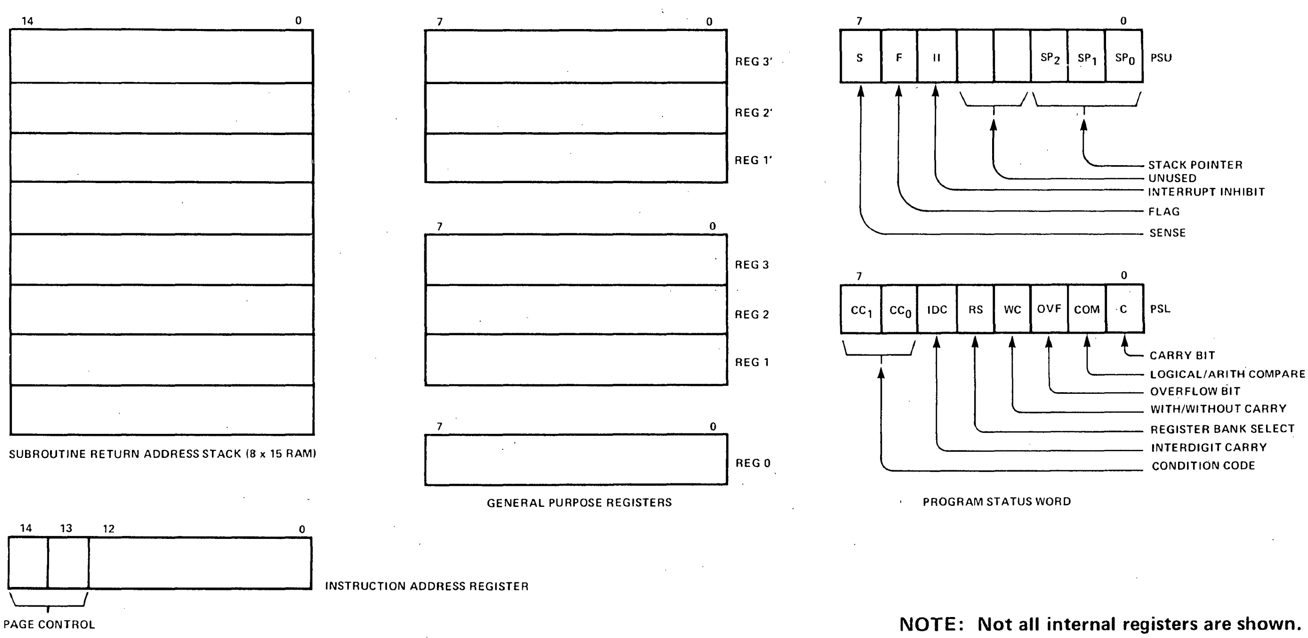


Figure 1. BLOCK DIAGRAM



NOTE: Not all internal registers are shown.

Figure 2. MAJOR 2650 REGISTERS

Signetics

MICROPROCESSOR

INTERFACING

INTRODUCTION TO INTERFACING WITH THE 2650

Five key concepts have been incorporated in the 2650 to make interfacing easy and inexpensive. The extent to which these concepts have been incorporated in the Signetics 2650 provides unique benefits of system density and low cost to the system designer.

1. SINGLE 5V POWER SUPPLY

Low threshold double ion-implanted Silicon Gate N-Channel MOS technology is used to allow operation from one +5V power supply with resultant cost savings and improved reliability. This reduces power consumption significantly compared with the multi-power supply approach.

2. INTERFACE CIRCUIT COMPATIBILITY

The 2650 inputs and outputs are specified to be compatible with widely available, standard, low cost logic families such as TTL, CMOS and Low-power STTL. This includes the single phase clock input which saves the cost of high level multiphase clock driver circuitry. Bus outputs are tri-state and capable of driving one 7400 TTL load or four 74LS loads. The 2650 is capable of driving several loads of pnp-buffered STTL inputs. Many MSI, Interface and Memory LSI circuits (for example, in Signetics 82S00 and 8T00 series) have these low current pnp inputs and are recommended for use in 2650 microcomputer systems. See Table 1 for DC characteristics of the 2650.

3. USE OF STANDARD MEMORIES

One of the major 2650 design achievements is to operate efficiently in a system using industry standard memories, for example 1024 X 1 and 256 X 4 N-channel RAMs and 1024 X 8 N-Channel ROMs. These standard memories are widely available and used in volume with corresponding low cost. Non-standard memories, particularly those produced by only one manufacturer will be less available, run in lower volume and often cost 2 to 3 times as much per bit as industry standard products. The 2650 operates successfully with memories of any access time, due to the completely asynchronous interface that is provided for this purpose. Memories which respond in less than 0.8 microseconds allow the processor to operate at maximum speed.

4. NO SPECIAL INTERFACE PRODUCTS

Similarly, another major achievement is to operate efficiently in a system using no special I/O products. This approach avoids the problems of a system requiring high cost specialized components with restricted availability.

TABLE 1. PRELIMINARY 2650 DC ELECTRICAL CHARACTERISTICS

			LIMITS		
SYMBOL	PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
I_{LI}	Input Load Current	V_{IN} = 0 to 5.25V		10	μA
I_{LOH}	Output Leakage Current	ADREN, DBUSEN = 2.2V, V_{OUT} = 4V		10	μA
I_{LOL}	Output Leakage Current	ADREN, DBUSEN = 2.2V, V_{OUT} = 0.45V		10	μA
I_{CC}	Power Supply Current	V_{CC} = 5.25V, T_A = 0°C		100	mA
V_{IL}	Input Low		-0.6	0.8	V
V_{IH}	Input High		2.2	V_{CC}	V
V_{OL}	Output Low	I_{OL} = 1.6 mA	0.0	0.45	V
V_{OH}	Output High	I_{OH} = -100 μA	2.4	V_{CC}-0.5	V
C_{IN}	Input Capacitance	V_{IN} = 0V		10	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V		10	pF

Conditions: T_A = 0°C to 70°C, V_{CC} = 5V ±5%

5. POWERFUL MEMORY AND I/O INTERFACE

The following features characterize the memory and I/O interfaces:

- Both memory and input/output may operate in a completely asynchronous fashion. Consequently, devices operating at any speed up to the maximum data transfer rate may be connected without buffering. External latching of data from these interfaces is not required.
- Data paths are driven with tri-state buffers, allowing multiprocessor and Direct Memory Access (DMA) configurations to be designed.
- Eight-bit data paths communicate data in parallel.
- One- and two-byte I/O instructions provide maximum flexibility and efficiency when interfacing with I/O devices.

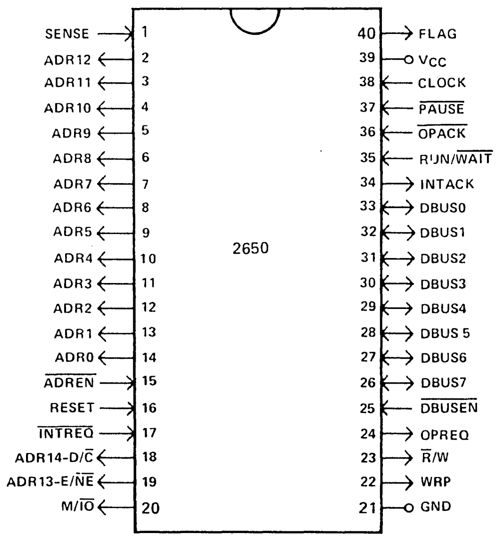


Figure 3. PIN CONFIGURATION

PIN CONFIGURATION AND INTERFACE SIGNAL DEFINITION

Refer to Figure 3 for the 2650 pin configuration. Signals are defined as follows:

ADR0-ADR12 — The low order 13 bits of address for memory access are on these pins. ADR0-ADR7 are also used in two-byte I/O instructions. These outputs are tri-state buffers controlled by ADREN.

ADR13-E/NE — This multiplexed output signal delivers the ADR13 address bit when M/IO is in the M phase or discriminates between Extended and Non-Extended I/O instructions when M/IO is in the I/O phase.

ADR14-D/C — Address 14 or Data/Control is a multiplexed output signal. This pin delivers the ADR14 address bit when M/IO is in the M phase or discriminates between Data and Control I/O instructions when M/IO is in the I/O phase.

ADREN — Address Bus Enable is an input providing the external control for the ADR0-ADR12 tri-state buffer drivers.

DBUS0-DBUS7 — This is the 8-bit, bidirectional tri-state bus over which most data is communicated into or out of the processor.

DBUSEN — Data Bus Enable is an input that controls the tri-state buffer drivers for DBUS0 to DBUS7.

OPREQ — Operation Request is an output signal that informs external devices that the information on other output pins is valid.

OPACK	—	Operation Acknowledge is an input which is used by external devices to end an I/O or memory signaling sequence.
M/IO	—	Memory/Input-Output. This output informs external devices whether Memory or Input/Output functions are being performed.
R/W	—	This output signal describes an I/O or memory operation as Read or Write, and defines whether the bidirectional DBUS is transmitting or receiving.
WRP	—	This Write Pulse is generated during write sequences and may be used to strobe memory or I/O devices.
SENSE	—	Is an input, independent of the other I/O signals, that provides a direct input to the processor.
FLAG	—	This pin provides a direct output signal that is completely independent of the other I/O signals.
INTREQ	—	Interrupt Request. This input is used by external devices to force the processor into the Interrupt sequence.
INTACK	—	Interrupt Acknowledge is the signal used by the processor to inform external devices that it has entered an interrupt sequence.
PAUSE	—	Pause is used to temporarily stop the processor at the end of the current instruction. It may stop processing for an indefinite length of time and is available to use for DMA (Direct Memory Access).
RUN/WAIT	—	Informs external circuits as to the Run/Wait status of the 2650 processor.
RESET	—	Is an input used to cause the 2650 to begin processing from a known state.
CLOCK	—	This is the only clock input to the processor. It accepts standard TTL levels.
VCC	—	+5V power.
GND	—	The logic and power supply ground for the processor.

2650 TIMING

The clock input to the 2650 provides the basic timing information that the processor uses for all its internal and external operations. The clock rate determines the instruction execution time, except to the extent that external memories and devices slow the processor down. The maximum clock rate of the standard 2650 is 1.25 Megacycles (one clock period is 800ns minimum). One unique feature of the 2650 is that the clock frequency may be slowed down to DC, allowing complete timing flexibility for interfacing. This feature permits single stepping the clock which can greatly simplify system checkout. It also provides an easy method to halt the processor. Each 2650 cycle is comprised of three clock periods. Direct instructions require either 2, 3, or 4 processor cycles for execution and, therefore, vary from 4.8 to 9.6μs in duration.

A timing diagram for a memory read cycle is shown in Figure 4. OPREQ (Operation Request) is the master control signal that coordinates all operations external to the processor. When true, OPREQ indicates that other output signals are valid. During a memory read cycle M/IO is in the M (Memory) state and R/W is in the R (Read) state. The address lines and the control lines become valid before OPREQ rises. The data to be read may be returned anytime after OPREQ becomes valid. An OPACK (Operation Acknowledge) should accompany the read data from the memory. The Data and OPACK signals should remain valid for 50 ns after OPREQ falls.

INPUT/OUTPUT INTERFACE

The 2650 microprocessor has a set of versatile I/O instructions and can perform I/O operations in a variety of ways. One- and two-byte I/O instructions are provided, as well as a special single-bit I/O facility. The I/O modes provided by the 2650 are designated as Data, Control, and Extended I/O.

Data or Control I/O instructions are one byte long. Any general purpose register can be used as the source or destination. A special control line indicates if either a Data or Control instruction is being executed. Extended I/O is a two-byte read or write instruction. Execution of an extended I/O instruction will cause an 8-bit address, taken from the second byte of the instruction, to be placed on the low order eight address lines. The data, which can originate or terminate with any general purpose register, is placed on the data bus. This type of I/O can be used to simultaneously select a device and send data to it.

Memory reference instructions that address data outside of physical memory may also be used for I/O operations. When an instruction is executed, the address may be decoded by the I/O device rather than memory.

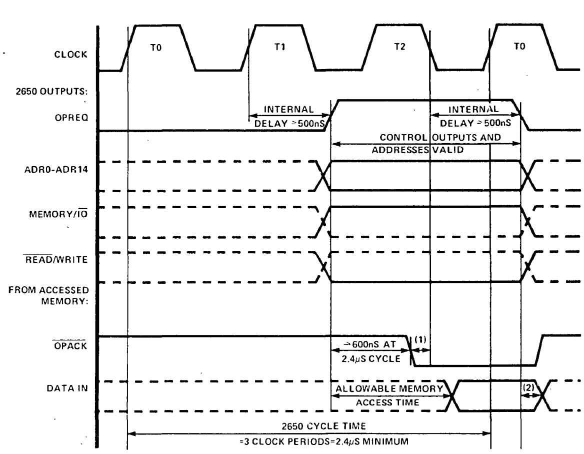
MEMORY INTERFACE

The memory interface consists of the address bus, the 8-bit data bus and several signals that operate in an interlocked or handshaking mode.

The Write Pulse signal is designed to be used as a memory strobe signal for any memory type. It has been particularly optimized to be used as the Chip Enable or Read/Write signal for the Signetics 2602 and 2606 RAMs.

INTERFACING – A MINIMAL SYSTEM EXAMPLE

The 2650 has been designed for low cost, easy interfacing, which is dramatically illustrated by a minimal system configuration shown in Figure 5. This system has a Teletype interface, 1024 bytes of ROM, and 256 bytes of RAM, yet requires only seven (7) standard integrated circuit packages. The ROM can contain a bootstrap loader and I/O driver programs for the Teletype. Other programs could reside in ROM or be read into RAM via the Teletype. An alternative to the 2608 N-Channel MOS ROM is the 82S115 Bipolar PROM which offers a 512 X 8 organization. Only one +5-volt power supply is required for this system. The advantages of conceptual simplicity and minimum system costs of the 2650 approach will be obvious to the system designer, particularly when compared to alternative microprocessor products.



NOTES: (1) $\overline{OPACK}$ must go low at least 100 nS before the trailing edge of T2 in order not to slow down the 2650.
(2) DATA IN signals must be valid for 50nS after the trailing edge of OPREQ.

Figure 4. MEMORY READ CYCLE TIMING

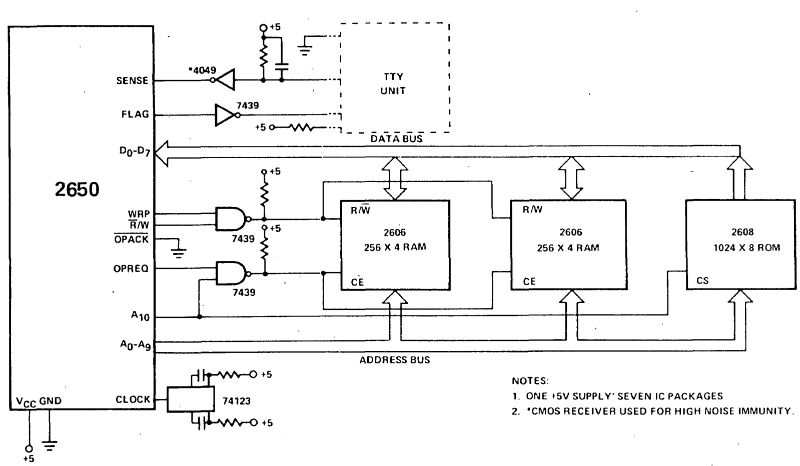


Figure 5. SEVEN PACKAGE MINIMAL SYSTEM

INSTRUCTION SET

It may be seen from examination of the 2650 instruction set that there are many powerful instructions which are all easily understood and are typical of larger computers. There are one-, two-, and three-byte instructions as a result of the multiplicity of addressing modes. See Table 2 for a complete listing and Figure 6 for instruction formats.

Automatic incrementing or decrementing of an index register is available in the arithmetic indexed instructions. All of the branch instructions except indexed branching can be conditional.

Register-to-register instructions are one byte; register-to-storage instructions are two or three bytes long. The two-byte register-to-memory instructions are either immediate or relative addressing types.

TABLE 2. INSTRUCTION SET

	MNEMONIC		OP CODE	FORMAT*	DESCRIPTION OF OPERATION	AFFECTS	CYCLES
LOAD/STORE	LOD	Z	000 000	1Z	Load Register Zero	CC (Note 1)	2
		I	000 001	2I	Load Immediate	CC (Note 1)	2
		R	000 010	2R	Load Relative	CC (Note 1)	3
		A	000 011	3A	Load Absolute	CC (Note 1)	4
	STR	Z	110 000	1Z	Store Register Zero (r≠0)	CC (Note 1)	2
		R	110 010	2R	Store Relative	—	3
		A	110 011	3A	Store Absolute	—	4
ARITHMETIC	ADD	Z	100 000	1Z	Add to Register Zero w/wo Carry	C, CC (Note 1), IDC, OVF	2
		I	100 001	2I	Add Immediate w/wo Carry	C, CC (Note 1), IDC, OVF	2
		R	100 010	2R	Add Relative w/wo Carry	C, CC (Note 1), IDC, OVF	3
		A	100 011	3A	Add Absolute w/wo Carry	C, CC (Note 1), IDC, OVF	4
	SUB	Z	101 000	1Z	Subtract from Register Zero w/wo Borrow	C, CC (Note 1), IDC, OVF	2
		I	101 001	2I	Subtract Immediate w/wo Borrow	C, CC (Note 1), IDC, OVF	2
		R	101 010	2R	Subtract Relative w/wo Borrow	C, CC (Note 1), IDC, OVF	3
		A	101 011	3A	Subtract Absolute w/wo Borrow	C, CC (Note 1), IDC, OVF	4
	DAR		100 101	1Z	Decimal Adjust Register	CC (Note 2)	3
LOGICAL	AND	Z	010 000	1Z	AND to Register Zero (r≠0)	CC (Note 1)	2
		I	010 001	2I	AND Immediate	CC (Note 1)	2
		R	010 010	2R	AND Relative	CC (Note 1)	3
		A	010 011	3A	AND Absolute	CC (Note 1)	4
	IOR	Z	011 000	1Z	Inclusive OR to Register Zero	CC (Note 1)	2
		I	011 001	2I	Inclusive OR Immediate	CC (Note 1)	2
		R	011 010	2R	Inclusive OR Relative	CC (Note 1)	3
		A	011 011	3A	Inclusive OR Absolute	CC (Note 1)	4
	EOR	Z	001 000	1Z	Exclusive OR to Register Zero	CC (Note 1)	2
		I	001 001	2I	Exclusive OR Immediate	CC (Note 1)	2
		R	001 010	2R	Exclusive OR Relative	CC (Note 1)	3
		A	001 011	3A	Exclusive OR Absolute	CC (Note 1)	4
COMPARE	COM	Z	111 000	1Z	Compare to Register Zero Arithmetic/Logical	CC (Note 3)	2
		I	111 001	2I	Compare Immediate Arithmetic/Logical	CC (Note 4)	2
		R	111 010	2R	Compare Relative Arithmetic/Logical	CC (Note 4)	3
		A	111 011	3A	Compare Absolute Arithmetic/Logical	CC (Note 4)	4
ROTATE	RRR		010 100	1Z	Rotate Register Right w/wo Carry	C, CC, IDC, OVF	2
	RRL		110 100	1Z	Rotate Register Left w/wo Carry	C, CC, IDC, OVF	2
BRANCH	BCT	R	000 110	2R	Branch On Condition True Relative	—	3
		A	000 111	3B	Branch On Condition True Absolute	—	3
	BCF	R	100 110	2R	Branch On Condition False Relative	—	3
		A	100 111	3B	Branch On Condition False Absolute	—	3
	BRN	R	010 110	2R	Branch On Register Non-Zero Relative	—	3
		A	010 111	3B	Branch On Register Non-Zero Absolute	—	3
	BIR	R	110 110	2R	Branch On Incrementing Register Relative	—	3
		A	110 111	3B	Branch On Incrementing Register Absolute	—	3
	BDR	R	111 110	2R	Branch On Decrementing Register Relative	—	3
		A	111 111	3B	Branch On Decrementing Register Absolute	—	3
	ZBRR		100 110 11	2ER	Zero Branch Relative, Unconditional	—	3
	BXA		100 111 11	3EB	Branch Indexed Absolute, Unconditional (Note 5)	—	3

TABLE 2. INSTRUCTION SET (CONTINUED)

	MNEMONIC	OP CODE	FORMAT*	DESCRIPTION OF OPERATION	AFFECTS	CYCLES
SUBROUTINE BRANCH/RETURN	BST R	001 110	2R	Branch To Subroutine On Condition True, Relative	SP	3
	BST A	001 111	3B	Branch To Subroutine On Condition True, Absolute	SP	3
	BSF R	101 110	2R	Branch To Subroutine On Condition False, Relative	SP	3
	BSF A	101 111	3B	Branch To Subroutine On Condition False, Absolute	SP	3
	BSN R	011 110	2R	Branch To Subroutine On Non-Zero Register, Relative	SP	3
	BSN A	011 111	3B	Branch To Subroutine On Non-Zero Register, Absolute	SP	3
	ZBSR	101 110 11	2ER	Zero Branch To Subroutine Relative, Unconditional	SP	3
	BSXA	101 111 11	3EB	Branch To Subroutine, Indexed, Absolute Unconditional (Note 5)	SP	3
	RET C	000 101	1Z	Return From Subroutine, Conditional	SP	3
	RET E	001 101	1Z	Return From Subroutine and Enable Interrupt, Conditional	SP, II	3
INPUT/OUTPUT	WRTD	111 100	1Z	Write Data	—	2
	REDD	011 100	1Z	Read Data	CC (Note 1)	2
	WRTC	101 100	1Z	Write Control	—	2
	REDC	001 100	1Z	Read Control	CC (Note 1)	2
	WRTE	110 101	2I	Write Extended	—	3
	REDE	010 101	2I	Read Extended	CC (Note 1)	3
MISC.	HALT	010 000 00	1E	Halt, Enter Wait State	—	2
	NOP	110 000 00	1E	No Operation	—	2
	TMI	111 101	2I	Test Under Mask Immediate	CC (Note 6)	3
PROGRAM STATUS	LPS U	100 100 10	1E	Load Program Status, Upper	F, II, SP	2
	LPS L	100 100 11	1E	Load Program Status, Lower	CC, IDC, RS, WC, OVF, COM, C	2
	SPS U	000 100 10	1E	Store Program Status, Upper	CC (Note 1)	2
	SPS L	000 100 11	1E	Store Program Status, Lower	CC (Note 1)	2
	CPS U	011 101 00	2EI	Clear Program Status, Upper, Masked	F, II, SP	3
	CPS L	011 101 01	2EI	Clear Program Status, Lower, Masked	CC, IDC, RS, WC, OVF, COM, C	3
	PPS U	011 101 10	2EI	Preset Program Status, Upper, Masked	F, II, SP	3
	PPS L	011 101 11	2EI	Preset Program Status, Lower, Masked	CC, IDC, RS, WC, OVF, COM, C	3
	TPS U	101 101 00	2EI	Test Program Status, Upper, Masked	CC (Note 6)	3
	TPS L	101 101 01	2EI	Test Program Status, Lower, Masked	CC (Note 6)	3

***FORMAT CODE: The number indicates the number of bytes. The letter(s) indicate the format type(s).** See Fig. 6.

NOTES:
1. Condition code (CC1, CC0): 01 if positive, 00 if zero, 10 if negative.
2. Condition code is set to a meaningless value.
3. Condition code (CC1, CC0): 01 if R0 > r, 00 if R0 = r, 10 if R0 < r.
4. Condition code (CC1, CC0): 01 if r > V, 00 if r = V, 10 if r < V.
5. Index register must be register 3 or 3′.
6. Condition code (CC1, CC0): 00 if all selected bits are 1s, 10 if not all the selected bits are 1s.

PROGRAM STATUS WORD

PSU

7	6	5	4	3	2	1	0
S	F	II	Not Used	Not Used	SP2	SP1	SP0

PSL

7	6	5	4	3	2	1	0
CC1	CC0	IDC	RS	WC	OVF	COM	C

S Sense
F Flag
II Interrupt Inhibit
SP2 Stack Pointer Two
SP1 Stack Pointer One
SP0 Stack Pointer Zero

CC1 Condition Code One
CC0 Condition Code Zero
IDC Interdigit Carry
RS Register Bank Select
WC With/Without Carry
OVF Overflow
COM Logical/Arith. Compare
C Carry/Borrow

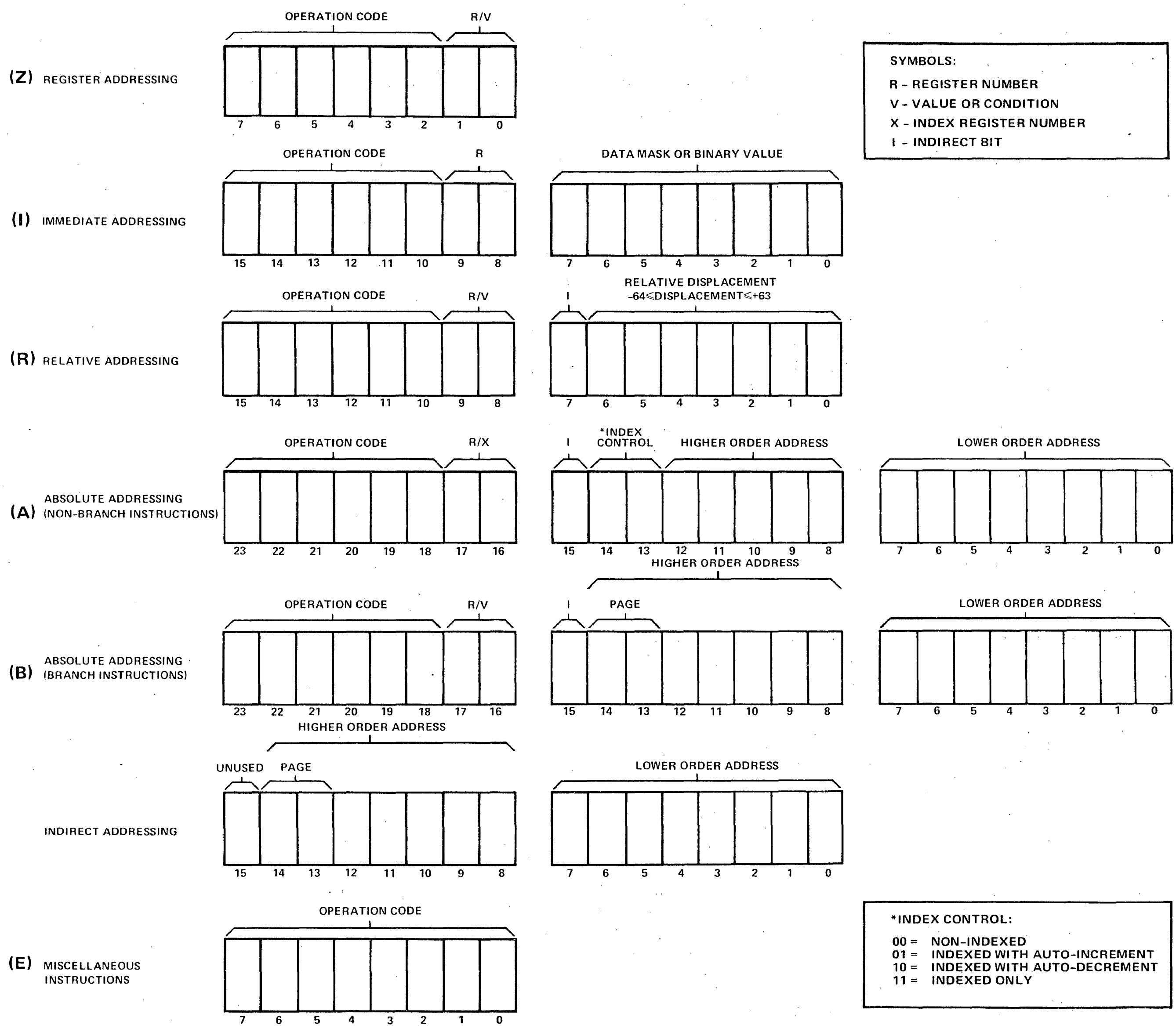


Figure 6. INSTRUCTION FORMATS

INTRODUCING THE SERIES 3000 BIPOLAR MICROPROCESSOR

The introduction of the Signetics Series 3000 Bipolar Microprocessor Chip Set has brought new levels of high performance to microprocessor applications not previously possible with MOS technology. Combining the Schottky bipolar N3001 Microprogram Control Unit (MCU) and N3002 Central Processing Element (CPE) with industry standard memory and support circuits, microinstruction cycle times of 100 nanoseconds are possible.

In the majority of cases, the choice of a bipolar microprocessor slice, as opposed to an MOS device, is based on speed or flexibility of microprogramming. Starting with these characteristics, the design of the Signetics Series 3000 Microprocessor has been optimized around the following objectives:

- Fast cycle time
- All memory and support chips are industry standard
- Cooler operation
- Lower total system cost

Futhermore, systems built with large-scale integrated circuits are much smaller and require less power than equivalent systems using medium and/or small scale integrated circuits.

The two components of the Series 3000 chip set, when combined with industry standard memory and peripheral circuits, allows the design engineer to construct high-performance processors and/or controllers with a minimum amount of auxillary logic. Features such as the multiple independent address and data buses, tri-state logic, and separate output enable lines eliminate the need for time-multiplexing of buses and associated hardware.

Each Central Processing Element represents a complete 2-bit slice through the data processing section of a computer. Several CPE's may be connected in parallel to form a processor of any desired word length. The Microprogram Control Unit controls the sequence in which microinstructions are fetched from the microprogram memory (ROM/PROM), with these microinstructions controlling the step-by-step operation of the processor.

Each CPE contains a 2-bit slice of five independent buses. Although they can be used in a variety of ways, typical connections are:

Input M-bus:	Carries data from external memory
Input I-bus:	Carries data from input/output device
Input K-bus:	Used for microprogram mask or literal (constant) value input
Output A-bus:	Connected to CPE Memory Address Register
Output D-bus:	Connected to CPE accumulator.

As the CPE's are paralleled together, all buses, data paths, and registers are correspondingly expanded.

The microfunction input bus (F-bus) controls the internal operation of the CPE, selecting both the operands and the operation to be executed upon them. The arithmetic logic unit (ALU), controlled by the microfunction decoder, is capable of over 40 Boolean and binary operations as outlined in the FUNCTION DESCRIPTION section of the N3002 data sheet. Standard carry look-ahead outputs (X and Y) are generated by the CPE for use with industry standard devices such as the 74S182.

A typical processor configuration is shown in Figure 1. It should be remembered that in working with slice-oriented microprocessors, the final configuration may be varied to enhance speed, reduce component count, or increase data-processing capability. One method of maximizing a processor's performance is called pipelining. To accomplish this, a group of D-type flip-flops or latches (such as the 74174 Hex D-type Flip-Flop) are connected to the microprogram memory outputs (excluding the address control field AC_0 - AC_6) to buffer the current microinstruction

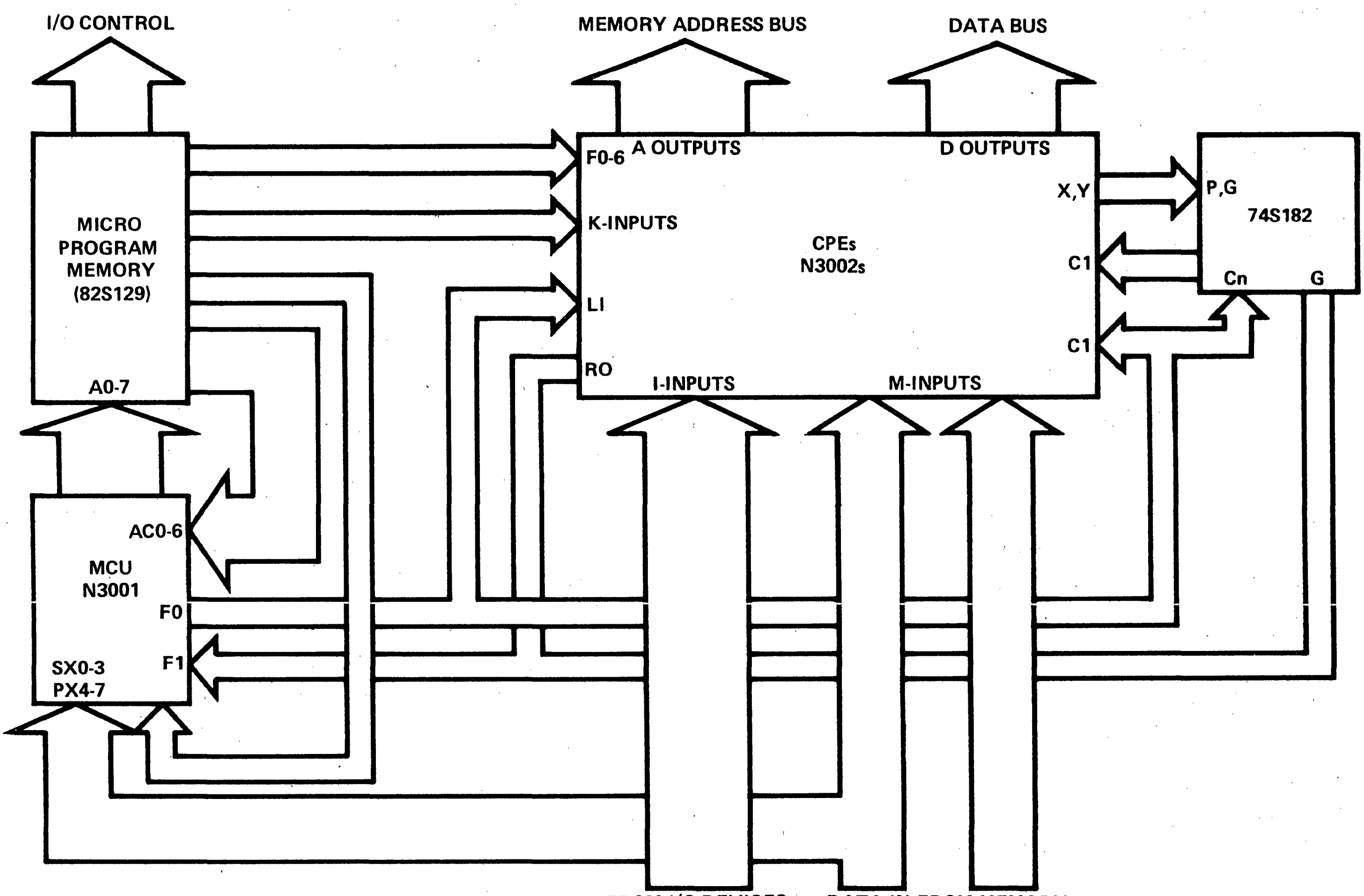


Figure 1: MICROCOMPUTER BLOCK DIAGRAM

and allow the MCU to overlap the fetch of the next instruction with the execution of the current one. The time saved in pipelining operations is the shorter of either the address set-up time to the microprogram memory (ROM/PROM) or the access time of the ROM/PROM. A convenient way of implementing pipelining is to use ROMs with on-board latches, such as the Signetics 82S115.

Figure 2 shows a typical microinstruction format using the 82S114 PROMs contained in the Signetics 3000 Microprocessor Designer's Evaluation Kit. Although this particular example is for a 48-bit word (6 PROMs), the allocation of bits for the mask (K-bus) and optional processor functions depands on the specific application of the system and the trade offs which the designer wishes to make.

In using the K-bus, it should be kept in mind that the K inputs are always ANDed with the B-multiplexer outputs into the ALU. Bit masking, frequently done in computer control systems, can be performed with the mask supplied to the K-bus directly from the microinstruction.

By placing the K-bus in either the all-one or all-zero condition (done with a single control bit in the microinstruction), the accumulator will either be selected or de-selected, respectively, in a given operation. This feature nearly doubles the amount of microfunctions in the CPE. A description of these various microfunctions can be found in the N3002 data sheet under the heading "FUNCTION DESCRIPTION" by referring to the K-bus conditions of all-ones (11) and all-zeros (00).

The MCU controls the sequence in which microinstructions are fetched from the microprogram memory (ROM/PROM). In its classical form, the MCU would use a next-address field in each microinstruction. However, the N3001 uses a modified classical approach in which the microinstruction field specifies conditional tests on the MCU bus inputs and registers. The next-address logic of the MCU also makes extensive use of a row/column addressing scheme, whereby the next address is defined by a 5-bit row address and 4-bit column address. Thus, from a particular address location, it is possible to jump unconditionally to any other location within that row or

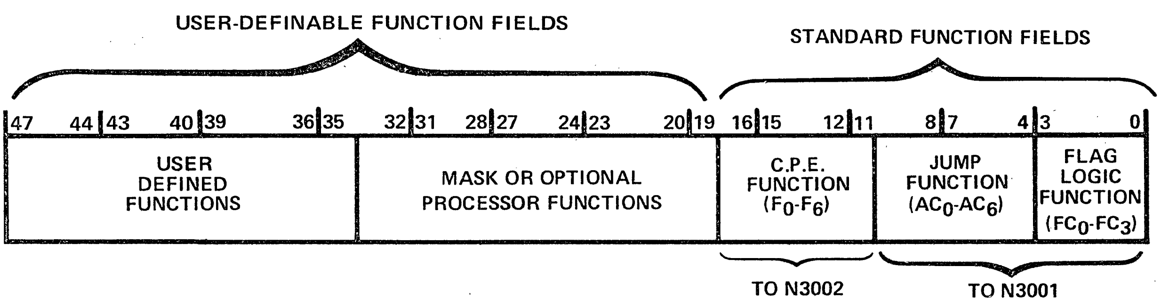


Figure 2: TYPICAL MICROINSTRUCTION FORMAT.

Note: The mask field need only be used during masking operations. At other times, it is entirely user definable.

column, or conditionally to other specified locations in one operation. Using this method, the processor functions can be executed in parallel with program branches.

As an example of this flexibility, let us assume a disk controller is being designed. As part of the sequence logic, three bits of the disk drive status word must be tested and all three must be true in order to proceed with the particular sequencing operation. In any sequencing operation using a status word for conditional branch information, there are innumerable combinations of bits which must be tested throughout the sequencing operation. Using discrete logic techniques, this would involve several levels of gating.

However, the entire operation can be done in two microinstructions. First, the mask (K-bus) field in the microinstruction format is encoded with a one for each corresponding status bit to be tested and a zero for each bit to be discarded. The status word is input via the I-bus and ANDed with the K-bus mask using the CPE microfunction operation from F-Group 2, R-Group III. Assuming we are using low-true logic (TRUE = 0 Volts), we now test the result, which is located in the accumulator AC, for all zeros using the CPE microfunction operation from F-Group 5, R-Group III. Depending on the zero/non-zero status of AC, a one or zero will be loaded into the carryout CO bit. This bit can now be used as a condition for the next address jump calculation within the N3001 MCU. If the AC was zero (status word was true), we will jump to the next address within our controller sequence. If the AC was non-zero (status word not true), then a jump would be made back to the beginning of this two-microinstruction loop and the test sequence repeated until the status word (all three bits) is true.

Figure 3 shows a typical timing diagram for a system operating in the non-pipelined mode. Keep in mind that the maximum clock rate is dependent upon the total of propagation delay times plus required set-up times. It is at the designer's discretion to resolve the speed versus complexity tradeoffs.

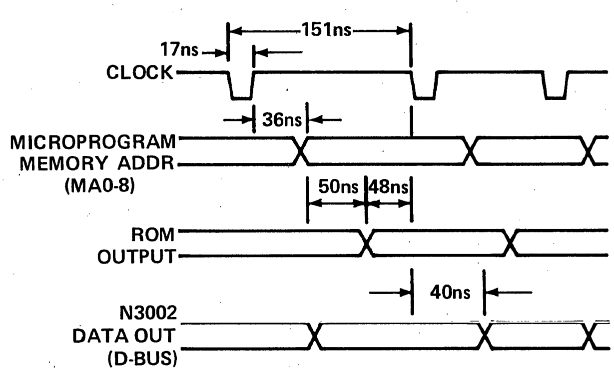


Figure 3: SYSTEM TIMING – NON-PIPELINED CONFIGURATION

Signetics

MICROPROGRAM CONTROL UNIT | N3001

BIPOLAR MICROPROCESSOR

DESCRIPTION

The N3001 MCU is one element of a bipolar microcomputer set. When used with the 3002, 74S182, ROM or PROM memory, a powerful microprogrammed computer can be implemented.

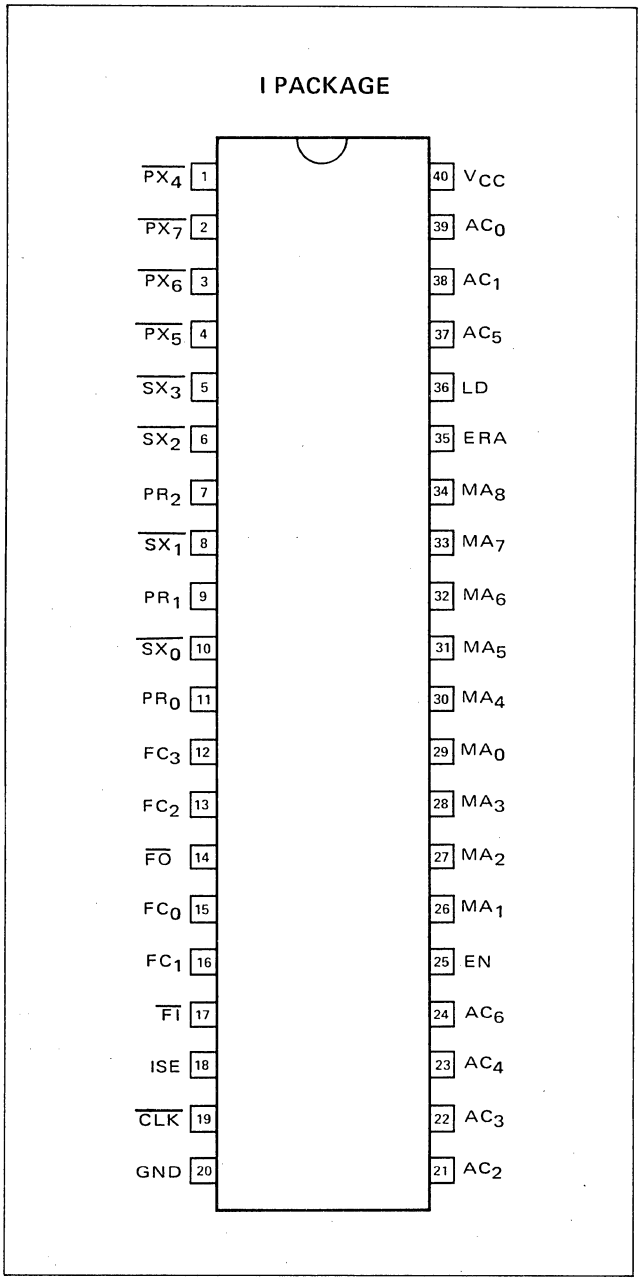
The 3001 MCU controls the fetch sequence of microinstructions from the microprogram memory. Functions performed by the 3001 include:

- Maintenance of microprogram address register
- Selection of next microinstruction address
- Decoding and testing of data supplied via several input busses
- Saving and testing of carry output data from the central processing (CP) array
- Control of carry/shift input data to the CP array
- Control of microprogram interrupts

FEATURES

- SCHOTTKY TTL PROCESS
- 45ns CYCLE TIME (TYP.)
- DIRECT ADDRESSING OF STANDARD BIPOLAR PROM OR ROM
- 512 MICROINSTRUCTION ADDRESSABILITY
- ADVANCED ORGANIZATION:
  - 9-BIT MICROPROGRAM ADDRESS REGISTER AND BUS ORGANIZED TO ADDRESS MEMORY BY ROW AND COLUMN
  - 4-BIT PROGRAM LATCH
  - 2 FLAG REGISTERS
- 11 ADDRESS CONTROL FUNCTIONS:
  - 3 JUMP AND TEST LATCH FUNCTION
  - 16 WAY JUMP AND TEST INSTRUCTION
- EIGHT FLAG CONTROL FUNCTIONS:
  - 4 FLAG INPUT FUNCTIONS
  - 4 FLAG OUTPUT FUNCTIONS

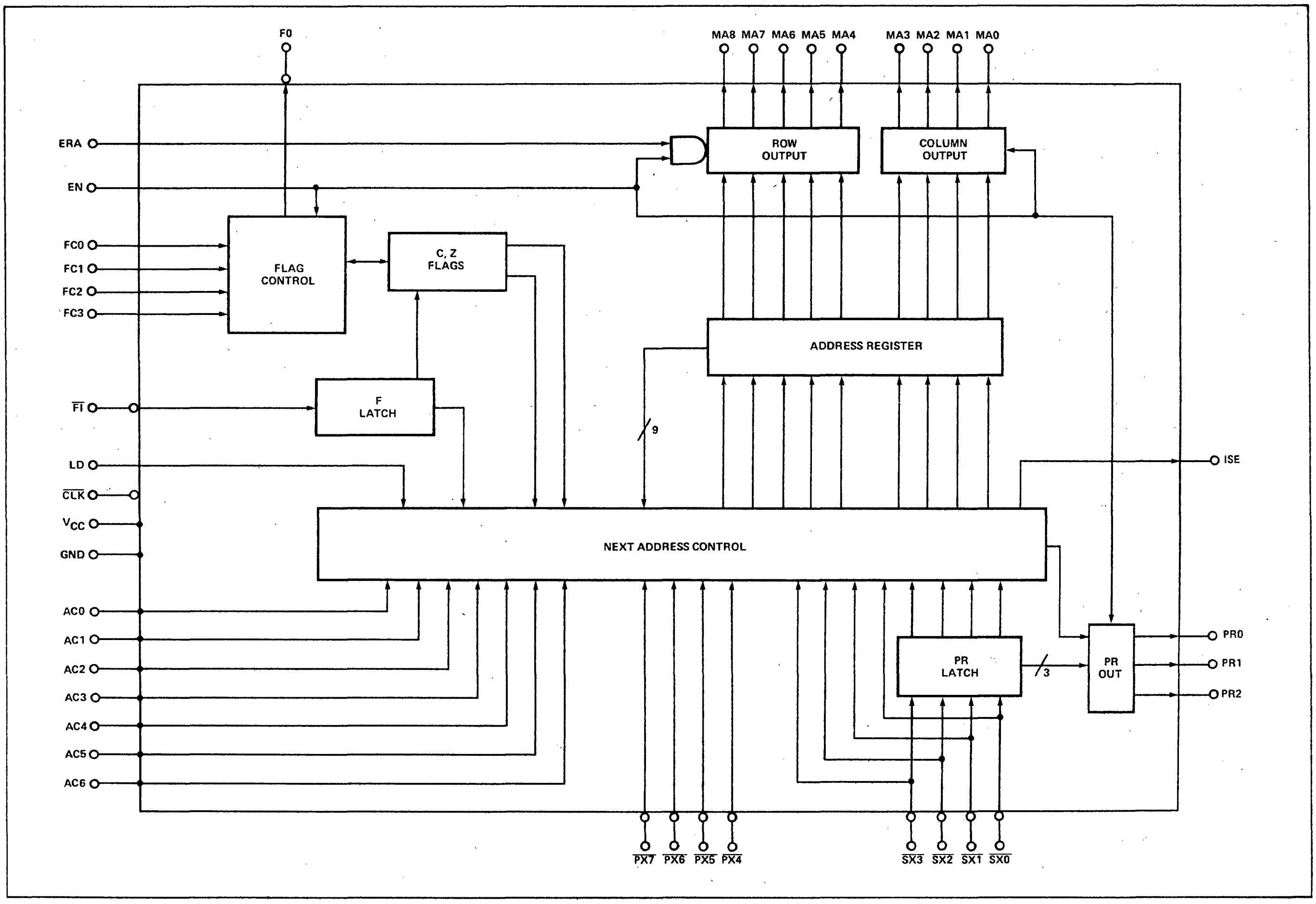
PIN CONFIGURATION



Signetics

MICROPROCESSOR

N3001 BLOCK DIAGRAM



PIN DESCRIPTION

PIN	SYMBOL	NAME AND FUNCTION	TYPE
1–4	$\overline{PX_4}$–$\overline{PX_7}$	Primary Instruction Bus Inputs Data on the primary instruction bus is tested by the JPX function to determine the next microprogram address.	Active LOW
5, 6, 8, 10	$\overline{SX_0}$–$\overline{SX_3}$	Secondary Instruction Bus Inputs Data on the secondary instruction bus is synchronously loaded into the PR-latch while the date on the PX-bus is being tested (JPX). During a subsequent cycle, the contents of the PR-latch may be tested by the JPR, JLL, or JRL functions to determine the next microprogram address.	Active LOW
7, 9, 11	PR_0–PR_2	PR-Latch Outputs The PR-latch outputs (SX0-SX2) are asynchronously enabled by the JCE function. They can be used to modify microinstructions at the outputs of the microprogram memory or to provide additional control lines.	Open Collector
12, 13, 15, 16	FC_0–FC_3	Flag Logic Control Inputs The flag logic control inputs are used to cross-switch the flags (C and Z) with the flag logic input (FI) and the flag logic output (FO).	Active HIGH
14	$\overline{FO}$	Flag Logic Output The outputs of the flags (C and Z) are multiplexed internally to form the common flag logic output. The output may also be forced to a logical O or logical 1.	Active LOW Three-state
17	$\overline{FI}$	Flag Logic Input The flag logic input is demultiplexed internally and applied to the inputs of the flags (C and Z). Note: The flag input data is saved in the F-latch when the clock input (CLK) is low.	Active LOW

Signetics
MICROPROCESSOR

PIN DESCRIPTION (Cont'd)

PIN	SYMBOL	NAME AND FUNCTION	TYPE
18	ISE	Interrupt Strobe Enable Output The interrupt strobe enable output goes to logical 1 when one of the JZR functions are selected (see Functional Description). It can be used to provide the strobe signal required by interrupt circuits.	Active HIGH
19	$\overline{CLK}$	Clock Input	
20	GND	Ground	
21–24 37–39	AC_0–AC_6	Next Address Control Function Inputs All jump functions are selected by these control lines.	Active HIGH
25	EN	Enable Input When in the HIGH state, the enable input enables the microprogram address, PR-latch and flag outputs.	
26–29	MA_0–MA_3	Microprogram Column Address Outputs	Three-state
30–34	MA_4–MA_8	Microprogram Row Address Outputs	Three-state
35	ERA	Enable Row Address Input When in the LOW state, the enable row address input independently disables the microprogram row address outputs. It can be used to facilite the implementation of priority interrupt systems.	Active HIGH
36	LD	Microprogram Address Load Input When the active HIGH state, the microprogram address load input inhibits all jump functions and synchronously loads the date on the instructions busses into the microprogram register. However, it does not inhibit the operation of the PR-latch or the generation of the interrupt strobe enable.	Active HIGH
40	V_{CC}	+5 Volt Supply	

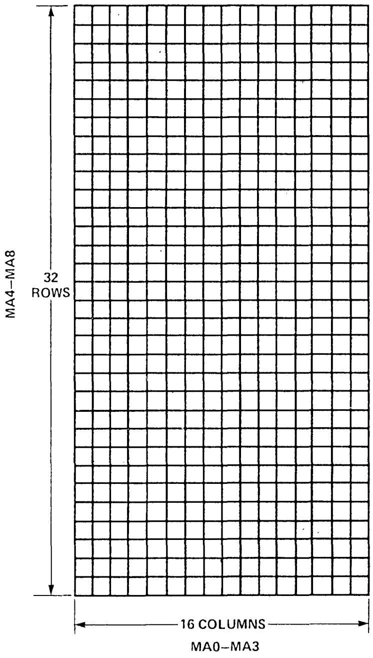
THEORY OF OPERATION

The MCU controls the sequence of microinstructions in the microprogram memory. The MCU simultaneously controls 2 flip-flops (C, Z) which are interactive with the carry-in and carry-out logic of an array of CPEs.

The functional control of the MCU provides both unconditional jumps to new memory locations and jumps which are dependent on the state of MCU flags or the state of the "PR" latch. Each instruction has a "jump set" associated with it. This "jump set" is the total group of memory locations which can be addressed by that instruction.

The MCU utilizes a two-dimensional addressing scheme in the microprogram memory. Microprogram memory is organized as 32 rows and 16 columns for a total of 512 words. Word length is variable according to application. Address is accomplished by a 9-bit address organized as a 5-bit row and 4-bit column address.

ADDRESSING ORGANIZATION



ABSOLUTE MAXIMUM RATINGS

Operating Temperature	0°C to 70°C
Storage Temperature	−65°C to +150°C
Supply Voltages	7V
All Input Voltages	+5.5V
Output Currents	100mA

NOTE:
Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.

DC ELECTRICAL CHARACTERISTICS T_A = 0°C to 70°C

	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP[1]	MAX	
V_C	Input Clamp Voltage (All Input Pins)	V_{CC} = 4.75, I_C = −5mA		−0.8	−1.0	V
I_F	Input Load Current:	V_{CC} = 5.25V, V_F = 0.45V				
	CLK Input			−0.075	−0.75	mA
	EN Input			−0.05	−0.50	mA
	All Other Inputs			−0.025	−0.25	mA
I_R	Input Leakage Current:	V_{CC} = 5.25V, V_R = 5.25V				
	CLK				120	μA
	EN Input				80	μA
	All Other Inputs				40	μA
V_{IL}	Input Low Voltage	V_{CC} = 5.0V			0.8	V
V_{IH}	Input High Voltage		2.0			V
I_{CC}	Power Supply Current	V_{CC} = 5.25V[2]		170	240	mA
V_{OL}	Output Low Voltage (All Output Pins)	V_{CC} = 4.75V, I_{OL} = 10mA		0.35	0.45	V
V_{OH}	Output High Voltage (MA_0–MA_8, ISE, FO)	V_{CC} = 4.75V, I_{OH} = −1mA	2.4	3.0		V
I_{os}	Output Short Circuit Current (MA_0–MA_8, ISE, FO)	V_{CC} = 5.0V	−15	−28	−60	mA
$I_{o\,(off)}$	Off-State Output Current:					
	PR_0–PR_2, MA_0–MA_2, FO	V_{CC} = 5.25V, V_o = 0.45V			−100	μA
	MA_0–MA_8, FO	V_{CC} = 5.25V, V_o = 5.25V			−100	μA

NOTES:
1. Typical values are for T_A = 25°C and 5.0 supply voltage.
2. EN input grounded, all other inputs and outputs open.

FUNCTIONAL DESCRIPTION

The following is a description of each of the eleven address control functions. The symbols shown below are used to specify row and column addresses.

SYMBOL	MEANING
row_n	5-bit next row address where n is the decimal row address.
col_n	4-bit next column address where n is the decimal column address.

UNCONDITIONAL ADDRESS CONTROL (JUMP) FUNCTIONS

The jump functions use the current microprogram address (i.e., the contents of the microprogram address register prior to the rising edge of the clock) and several bits from the address control inputs to generate the next microprogram address.

MNEMONIC	FUNCTION DESCRIPTION
JCC	Jump in current column. AC_0—AC_4 are used to select 1 of 32 row addresses in the current column, specified by MA_0—MA_3, as the next address.
JZR	Jump to zero row. AC_0—AC_3 are used to select 1 of 16 column addresses in row_0, as the next address.
JCR	Jump in current row. AC_0—AC_3 are used to select 1 of 16 addresses in the current row, specified by MA_4—MA_8, as the next address.
JCE	Jump in current column/row group and enable PR-latch outputs. AC_0—AC_2 are used to select 1 of 8 row addresses in the current row group, specified by MA_7—MA_8, as the next row address. The current column is specified by MA_0—MA_3. The PR-latch outputs are asynchronously enabled.

FLAG CONDITIONAL ADDRESS CONTROL (JUMP/TEST) FUNCTIONS

The jump/test flag functions use the current microprogram address, the contents of the selected flag or latch, and several bits from the address control function to generate the next microprogram address.

MNEMONIC	FUNCTION DESCRIPTION
JFL	Jump/test F-latch. AC_0—AC_3 are used to select 1 of 16 row addresses in the current row group, specified by MA_8, as the next row address. If the current column group, specified by MA_3, is col_0—col_7, the F-latch is used to select col_2 or col_3 as the next column address. If MA_3 specifies column group col_8—col_{15}, the F-latch is used to select col_{10} or col_{11} as the next column address.
JCF	Jump/test C-flag. AC_0—AC_2 are used to select 1 of 8 row addresses in the current row group, specified by MA_7 and MA_8, as the next row address. If the current column group specified by MA_8 is col_0—col_7, the C-flag is used to select col_2 or col_3 as the next column address. If MA_3 specifies column group col_8—col_{15}, the C-flag is used to select col_{10} or col_{11} as the next column address.
JZF	Jump/test Z-flag. Identical to the JCF function described above, except that the Z-flag, rather than the C-flag, is used to select the next column address.

PX-BUS AND PR-LATCH CONDITIONAL ADDRESS CONTROL (JUMP/TEST) FUNCTIONS

The PX-bus jump/test function uses the data on the primary instruction bus (PX_4—PX_7), the current microprogram address, and several selection bits from the address control function to generate the next microprogram address. The PR-latch jump/test functions use the data held in the PR-latch, the current microprogram address, and several selection bits from the address control function to generate the next microprogram address.

MNEMONIC	FUNCTION DESCRIPTION
JPR	Jump/test PR-latch. AC_0—AC_2 are used to select 1 of 8 row addresses in the current row group, specified by MA_7 and MA_8, as the next row address. The four PR-latch bits are used to select 1 of 16 possible column addresses as the next column address.
JLL	Jump/test leftmost PR-latch bits. AC_0—AC_2 are used to select 1 of 8 row addresses in the current row group, specified by MA_7 and MA_8, as the next row address. PR_2 and PR_3 are used to select 1of 4 column address in col_4 through col_7 as the next column address.
JRL	Jump/test rightmost PR-latch bits. AC_0 and AC_1 are used to select 1 of 4 high-order row addresses in the current row group, specified by MA_7 and MA_8, as the next row address. PR_0 and PR_1 are used to select 1 of 4 possible column addresses in col_{12} through col_{15} as the next column address.
JPX	Jump/test PX-bus and load PR-latch. AC_0 and AC_1 are used to select 1 of 4 row addresses in the current row group, specified by MA_6—MA_8, as the next row address. PX_4—PX_7 are used to select 1 of 16 possible column addresses as the next column address. SX_0—SX_3 data is locked in the PR-latch at the rising edge of the clock.

Signetics MICROPROCESSOR

FLAG CONTROL FUNCTIONS

The flag control functions of the MCU are selected by the four input lines designated FC_0–FC_3. Function code formats are given in "Flag Control Function summary".

The following is a detailed description of each of the eight flag control functions.

FLAG INPUT CONTROL FUNCTIONS

The flag input control functions select which flag or flags will be set to the current value of the flag input (FI) line. Data on FI is stored in the F-latch when the clock is low. The content of the F-latch is loaded into the C and/or Z flag on the rising edge of the clock.

MNEMONIC	FUNCTION DESCRIPTION
SCZ	Set C-flag and Z-flag to FI. The C-flag and the Z-flag are both set to the value of FI.
STZ	Set Z-flag to FI. The Z-flag is set to the value of FI. The C-flag is unaffected.
STC	Set C-flag to FI. The C-flag is set to the value of FI. The Z-flag is unaffected.
HCZ	Hold C-flag and Z-flag. The values in the C-flag and Z-flag are unaffected.

FLAG OUTPUT CONTROL FUNCTIONS

The flag output control functions select the value to which the flag output (FO) line will be forced.

MNEMONIC	FUNCTION DESCRIPTION
FFO	Force FO to O. FO is forced to the value of logical O.
FFC	Force FO to C. FO is forced to the value of the C-flag.
FFZ	Force FO to Z. FO is forced to the value of the Z-flag.
FF1	Force FO to 1. FO is forced to the value of logical 1.

STROBE FUNCTIONS

The load function of the MCU is controlled by the input line designated LD. If the LD line is active HIGH at the rising edge of the clock, the date on the primary and secondary instruction busses, PX_4–PX_7 and SX_0–SX_3, is loaded into the microprogram address register. PX_4–PX_7 are loaded into MA_0–MA_3 and SX_0–SX_3 are loaded into MA_4–MA_7. The high-order bit of the microprogram address register MA_8 is set to a logical 0. The bits from the primary instruction bus select 1 of 16 possible column addresses. Likewise, the bits from the secondary instruction bus select 1 of the first 16 row addresses.

The MCU generates an interrupt strobe enable on the output line designated ISE. The line is placed in the active high state whenever a JZR to col_{15} is selected as the address control function. Generally, the start of a macroinstruction fetch sequence is situated at row_0 and col_{15} so the interrupt control may be enabled at the beginning of

ADDRESS CONTROL FUNCTION SUMMARY

MNEMONIC	DESCRIPTION	FUNCTION							NEXT ROW					NEXT COL			
		AC_6	5	4	3	2	1	0	MA_8	7	6	5	4	MA_3	2	1	0
JCC	Jump in current column	0	0	d_4	d_3	d_2	d_1	d_0	d_4	d_3	d_2	d_1	d_0	m_3	m_2	m_1	m_0
JZR	Jump to zero row	0	1	0	d_3	d_2	d_1	d_0	0	0	0	0	0	d_3	d_2	d_1	d_0
JCR	Jump in current row	0	1	1	d_3	d_2	d_1	d_0	m_8	m_7	m_6	m_5	m_4	d_3	d_2	d_1	d_0
JCE	Jump in column/enable	1	1	1	0	d_2	d_1	d_0	m_8	m_7	d_2	d_1	d_0	m_3	m_2	m_1	m_0
JFL	Jump/test F-latch	1	0	0	d_3	d_2	d_1	d_0	m_8	d_3	d_2	d_1	d_0	m_3	0	1	f
JCF	Jump/test C-flag	1	0	1	0	d_2	d_1	d_0	m_8	m_7	d_2	d_1	d_0	m_3	0	1	c
JZF	Jump/test Z-flag	1	0	1	1	d_2	d_1	d_0	m_8	m_7	d_2	d_1	d_0	m_3	0	1	z
JPR	Jump/test PR-latch	1	1	0	0	d_2	d_1	d_0	m_8	m_7	d_2	d_1	d_0	p_3	p_2	p_1	p_0
JLL	Jump/test left PR bits	1	1	0	1	d_2	d_1	d_0	m_8	m_7	d_2	d_1	d_0	0	1	p_3	p_2
JRL	Jump/test right PR bits	1	1	1	1	1	d_1	d_0	m_8	m_7	1	d_1	d_0	1	1	p_1	p_0
JPX	Jump/test PX-bus	1	1	1	1	0	d_1	d_0	m_8	m_7	m_6	d_1	d_0	x_7	x_6	x_5	x_4

NOTE:
d_n = Data on address control line n
m_n = Data in microprogram address register bit n
p_n = Data in PR-latch bit n
x_n = Data on PX-bus line n (active LOW)
f, c, z = Contents of F-latch, C-flag, or Z-flag, respectively

STROBE FUNCTIONS Cont'd.

the fetch/execute cycle. The interrupt control responds to the interrupt by pulling the enable row address (ERA) input line low to override the selected next row address from the MCU. Then by gating an alternative next row address on to the row address lines of the microprogram memory, the microprogram may be forced to enter an interrupt handling routine. The alternative row address placed on the microprogram memory address lines does not alter the contents of the microprogram address register. Therefore, subsequent jump functions will utilize the row address in the register, and not the alternative row address, to determine the next microprogram address.

Note, the load function always overrides the address control function on AC_0-AC_6. It does not, however, override the latch enable or load sub-functions of the JCE or JPX instruction, respectively. In addition, it does not inhibit the interrupt strobe enable or any of the flag control functions.

FLAG CONTROL FUNCTION SUMMARY

TYPE	MNEMONIC	DESCRIPTION	FC_1	0
Flag Input	SCZ	Set C-flag and Z-flag to f	0	0
	STZ	Set Z-flag to f	0	1
	STC	Set C-flag to f	1	0
	HCZ	Hold C-flag and Z-flag	1	1

TYPE	MNEMONIC	DESCRIPTION	FC_3	2
Flag Output	FF0	Force FO to 0	0	0
	FFC	Force FO to C-flag	0	1
	FFZ	Force FO to Z-flag	1	0
	FF1	Force FO to 1	1	1

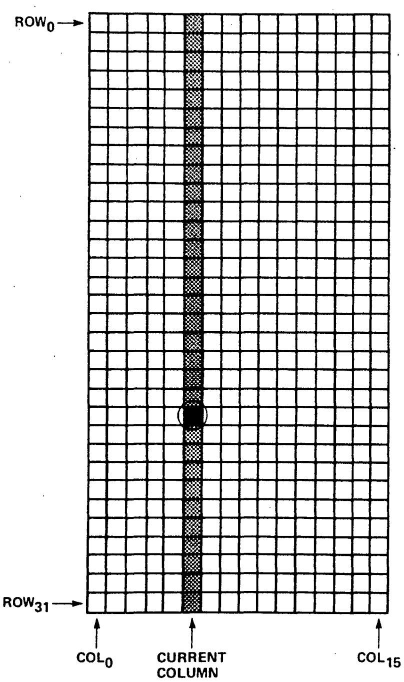
LOAD FUNCTION	NEXT ROW					NEXT COL			
LD	MA_8	7	6	5	4	MA_3	2	1	0
0	See address control function summary								
1	0	x_3	x_2	x_1	x_0	x_7	x_6	x_5	x_4

NOTE:
f = Contents of the F-latch
x_n = Data on PX- or SX-bus line n (active LOW)

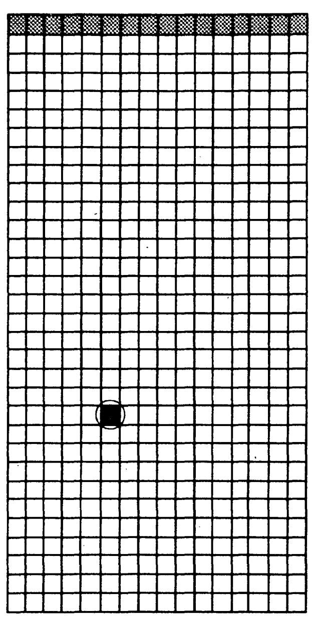
JUMP SET DIAGRAMS

The following ten diagrams illustrate the jump set for each of the eleven jump and jump/test functions of the MCU. Location 341 indicated by the circled square, represents one current row (row_{21}) and current column (col_5) address. The dark boxes indicate the microprogram locations that may be selected by the particular function as the next address.

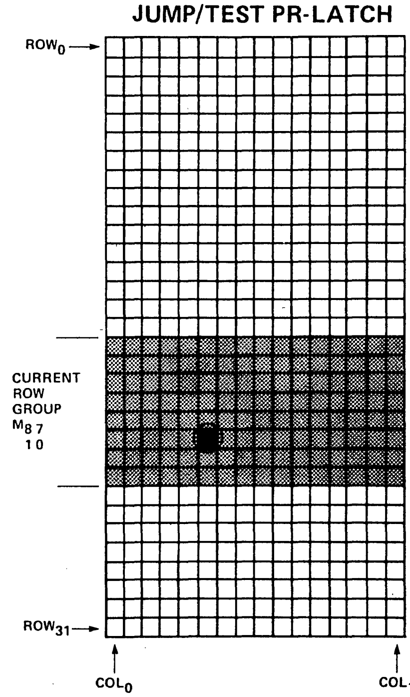
JCC
JUMP IN CURRENT COLUMN



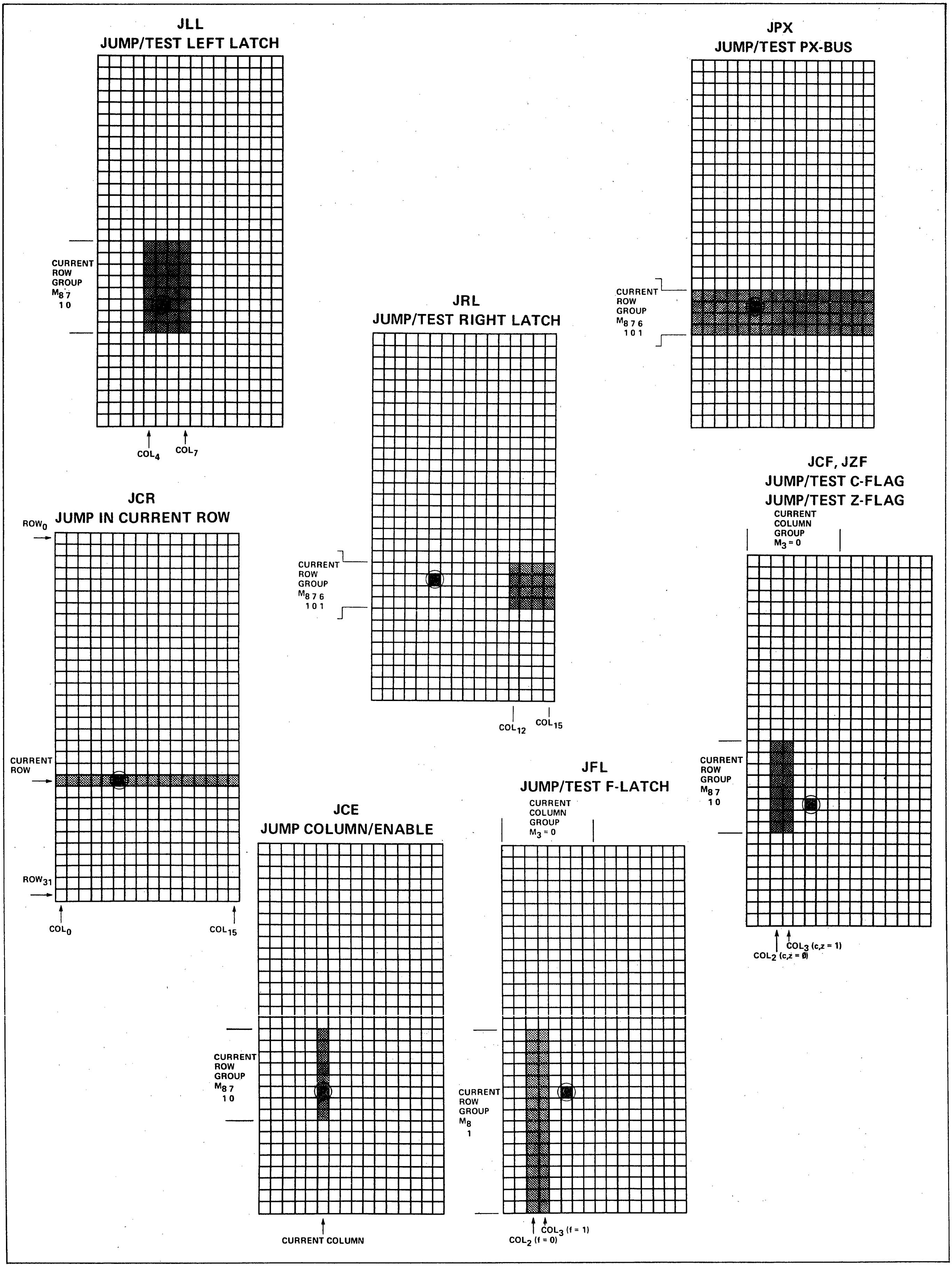
JZR
JUMP TO ZERO ROW



JPR
JUMP/TEST PR-LATCH



JUMP SET DIAGRAMS Cont'd.



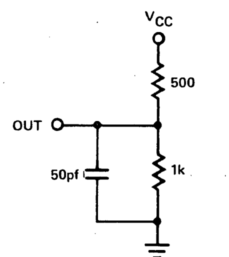
AC ELECTRICAL CHARACTERISTICS $T_A = 0°C$ to $70°C$, $V_{CC} = 5.0V + 5\%$

PARAMETER		LIMITS			UNIT
		MIN	TYP[1]	MAX	
t_{CY}	Cycle Time	60	45		ns
t_{WP}	Clock Pulse Width	17	10		ns
	Control and Data Input Set-Up Times:				
t_{SF}	LD, AC_0–AC_6	7	0		ns
t_{SK}	FC_0, FC_1	7	0		ns
t_{SX}	SX_0–SX_3, PX_4–PX_7	28	20		ns
t_{SI}	FI	12	0		ns
	Control and Data Input Hold Times:				
t_{HF}	LD, AC_0–AC_6	4	0		ns
t_{HK}	FC_0, FC_1	4	0		ns
t_{HX}	SX_0–SX_3, PX_4–PX_7	16	0		ns
t_{HI}	FI	16	6		ns
t_{CO}	Propagation Delay from Clock Input (CLK) to Outputs (MA_0–MA_8, FO)		24	36	ns
t_{KO}	Propagation Delay from Control Inputs FC_2 and FC_3 to Flag Out (FO)		13	24	ns
t_{FO}	Propagation Delay from Control Inputs AC_0–AC_6 to Latch Outputs (PR_0–PR_2)		21	32	ns
t_{EO}	Propagation Delay from Enable Inputs EN and ERA to Outputs (MA_0–MA_8, FO, PR_0–PR_2)		17	26	ns
t_{FI}	Propagation Delay from Control Inputs AC_0–AC_6 to Interrupt Strobe Enable Output (ISE)		19	32	ns

NOTE:
1. Typical values are for $T_A = 25°C$ and 5.0 supply voltage.

PARAMETER MEASUREMENT INFORMATION

LOAD CIRCUIT



NOTE: ALL RESISTORS VALUES ARE TYPICAL AND IN OHMS.

TEST CONDITIONS

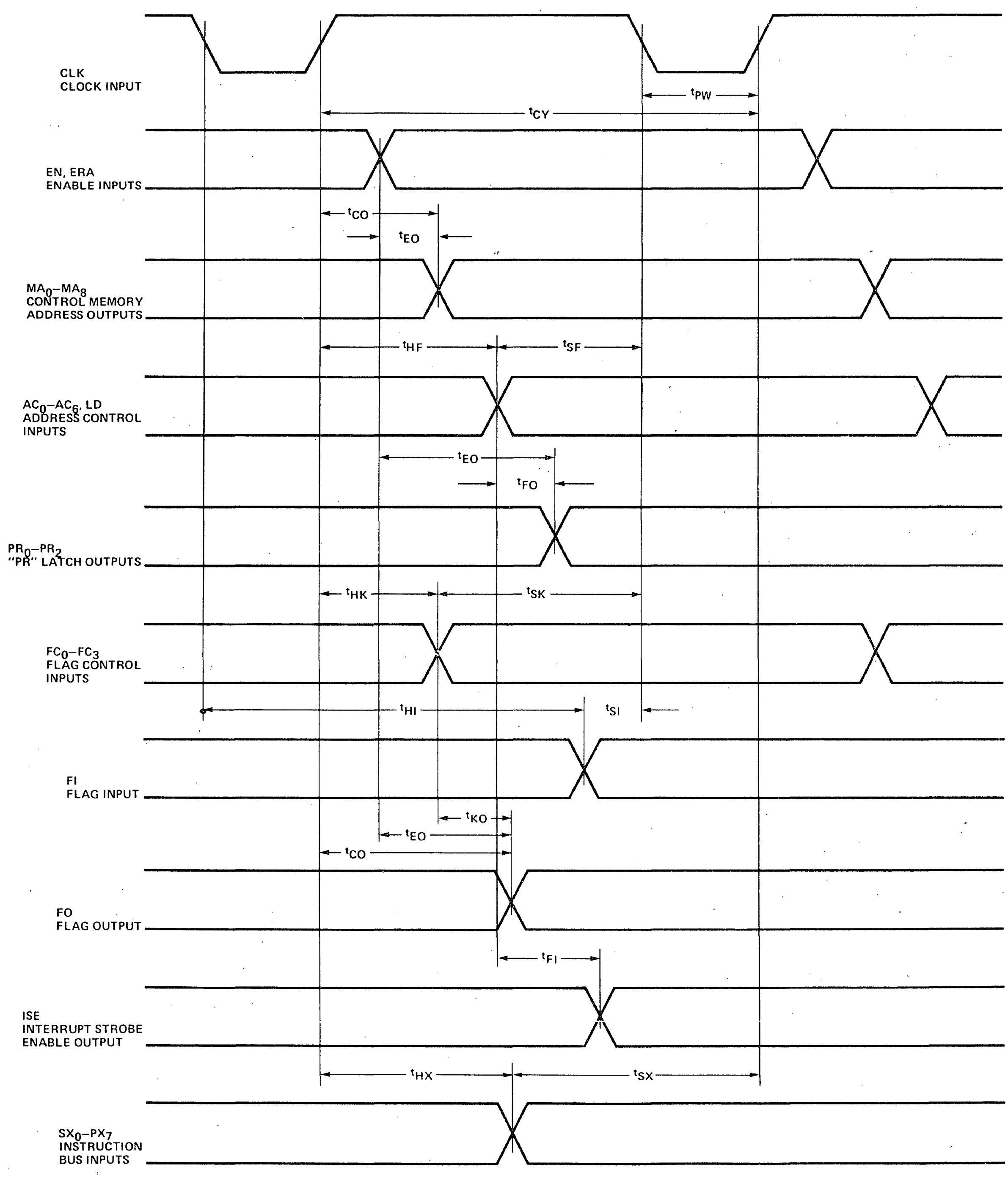
Input pulse amplitude of 2.5 volts.

Input rise and fall times of 5ns between 1 volt and 2 volts.

Output load of 10mA and 50pF.

Speed measurements are taken at the 1.5 volt level.

VOLTAGE WAVEFORMS



signetics

CENTRAL PROCESSING ELEMENT N3002

BIPOLAR MICROPROCESSOR

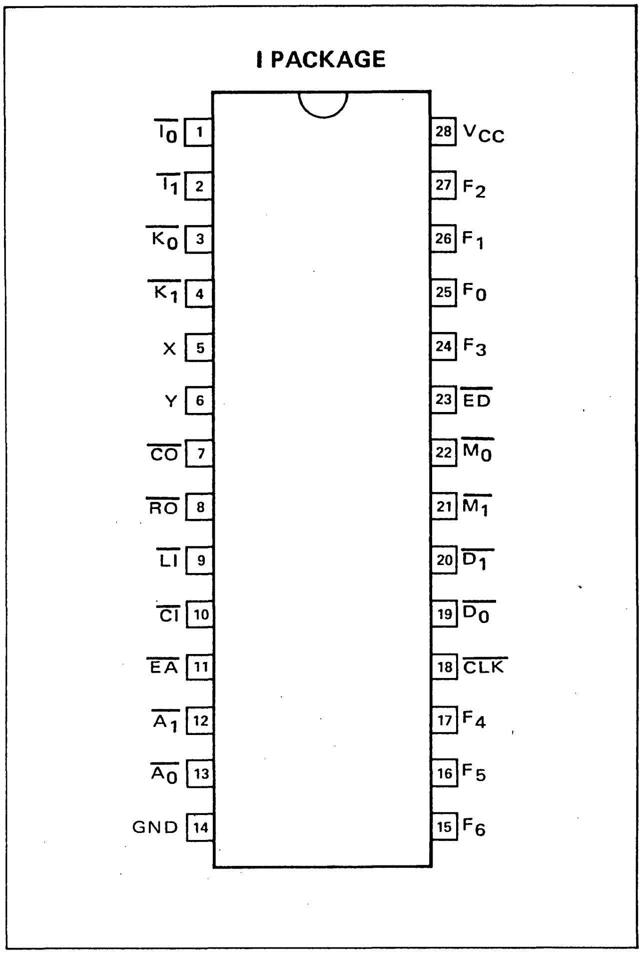
DESCRIPTION

The N3002 Central Processing Element (CPE) is one part of a bipolar microcomputer set. The N3002 is organized as a 2-bit slice and performs the logical and arithmetic functions required by micro – instructions. A system with any number of bits in a data word can be implemented by using multiple N3002s, the N3001 microcomputer control unit, the N74S182 carry look-ahead unit and ROM or PROM memory.

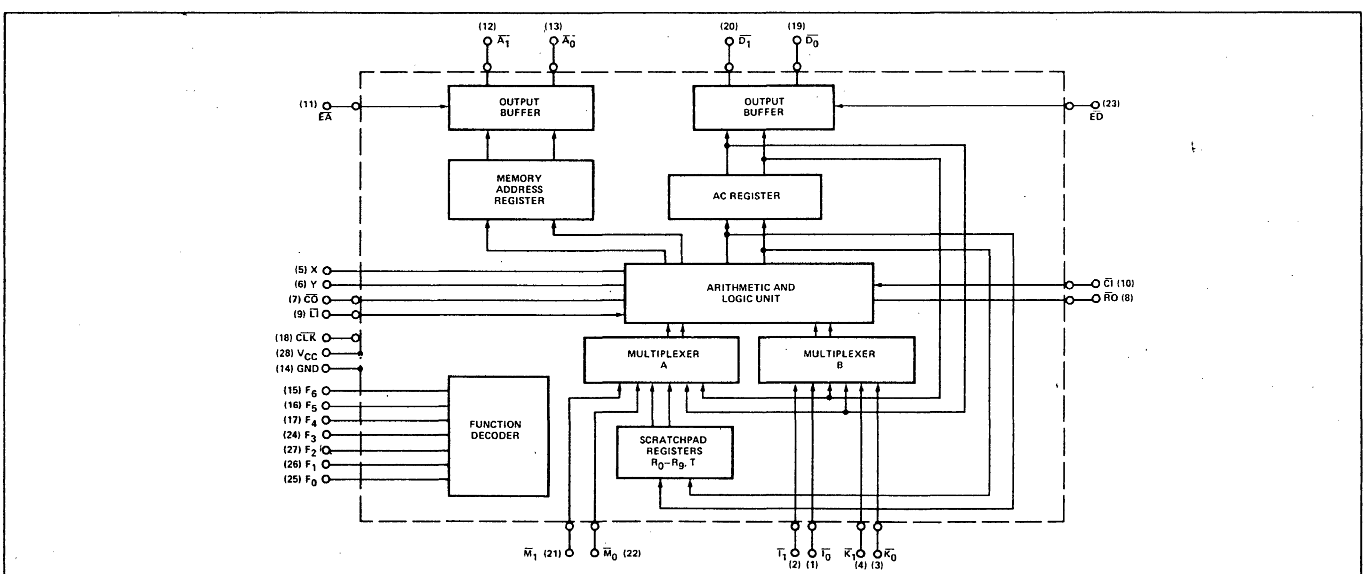
FEATURES

- 45ns CYCLE TIME (TYP.)
- EASY EXPANSION TO MULTIPLE OF 2 BITS
- 11 GENERAL PURPOSE REGISTERS
- FULL FUNCTION ACCUMULATOR
- USEFUL FUNCTIONS INCLUDE:
  - 2's COMPLEMENT ARITHMETIC
  - LOGICAL AND, OR, NOT, EXCLUSIVE-NOR
  - INCREMENT, DECREMENT
  - SHIFT LEFT/SHIFT RIGHT
  - BIT TESTING AND ZERO DETECTION
  - CARRY LOOK-AHEAD GENERATION
  - MASKING VIA K-BUS
  - CONDITIONED CLOCKING ALLOWING NON-DESTRUCTIVE TESTING OF DATA IN ACCUMULATOR AND SCRATCHPAD
- 3 INPUT BUSSES
- 2 OUTPUT BUSSES
- CONTROL BUS

PIN CONFIGURATION



BLOCK DIAGRAM



PIN DESCRIPTION

PIN	SYMBOL	NAME AND FUNCTION	TYPE
1, 2	$\overline{I_0}-\overline{I_1}$	External Bus Inputs The external bus inputs provide a separate input port for external input devices.	Active LOW
3, 4	$\overline{K_0}-\overline{K_1}$	Mask Bus Inputs The mask bus inputs provide a separate input port for the microprogram memory, to allow mask or constant entry.	Active LOW
5, 6	X, Y	Standard Carry Look-Ahead Cascade Outputs The cascade outputs allow high speed arithmetic operations to be performed when they are used in conjunction with the 74S182 Look-Ahead Carry Generator.	Active HIGH
7	$\overline{CO}$	Ripple Carry Output The ripple carry output is only disabled during shift right operations.	Active LOW Three-state
8	$\overline{RO}$	Shift Right Output The shift right output is only enabled during shift right operations.	Active LOW Three-state
9	$\overline{LI}$	Shift Right Input	Active LOW
10	$\overline{CI}$	Carry Input	Active LOW
11	$\overline{EA}$	Memory Address Enable Input When in the LOW state, the memory address enable input enables the memory address outputs (A_0-A_1).	Active LOW
12–13	$\overline{A_0}-\overline{A_1}$	Memory Address Bus Outputs The memory address bus outputs are the buffered outputs of the memory address register (MAR).	Active LOW Three-state
14	GND	Ground	
15–17, 24–27	F_0-F_6	Micro-Function Bus Inputs The micro-function bus inputs control ALU function and register selection.	Active-HIGH
18	CLK	Clock Input	
19–20	$\overline{D_0}-\overline{D_1}$	Memory Data Bus Outputs The memory data bus outputs are the buffered outputs of the full function accumulator register (AC).	Active LOW Three-state
21–22	$\overline{M_0}-\overline{M_1}$	Memory Data Bus Inputs The memory data bus inputs provide a separate input port for memory data.	Active LOW
23	$\overline{ED}$	Memory Data Enable Input When in the LOW state, the memory data enable input enables the memory data outputs (D_0-D_1).	Active LOW
28	V_{CC}	+5 Volt Supply	

SYSTEM DESCRIPTION

1. MICROFUNCTION DECODER AND K-BUS

Basic microfunctions are controlled by a 7-bit bus (F_0-F_6) which is organized into two groups. The higher 3 bits (F_4-F_6) are designated as F-Group and the lower 4 bits (F_0-F_3) are designated as the R-Group. The F-Group specifies the type of operation to be performed and the R-Group specifies the registers involved.

SYSTEM DESCRIPTION (Continued)

The F-Bus instructs the microfunction decoder to:

- Select ALU functions to be performed
- Generate scratchpad register address
- Control A and B multiplexer

The resulting microfunction action can be:

- Data transfer
- Shift operations
- Increment and decrement
- Initialize stack
- Test for zero conditions
- 2's complement addition and subtraction
- Bit masking
- Maintain program counter

2. A AND B MULTIPLEXERS

A and B multiplexers select the proper two operands to the ALU.

A multiplexer selects inputs from one of the following:

- M-bus (data from main memory)
- Scratchpad registers
- Accumulator

B multiplexer selects inputs from one of the following:

- I-bus (data from external I/O devices)
- Accumulator
- K-bus (literal or masking information from micro-program memory)

3. SCRATCHPAD REGISTERS

- Contains 11 registers (R_0–R_9, T)
- Scratchpad register outputs are multiplexed to the ALU via the A multiplexer
- Used to store intermediate results from arithmetic/logic operations
- Can be used as program counter

4. ARITHMETIC/LOGIC UNIT (ALU)

The ALU performs the arithmetic and logic operations of the CPE.

Arithmetic operations are:

- 2's complement addition
- Incrementing
- Decrementing
- Shift left
- Shift right

Logical operations are:

- Transfer
- AND
- Inclusive-OR
- Exclusive-NOR
- Logic complement

ALU operation results are then stored in the accumulator and/or scratchpad registers. For easy expansion to larger arrays, carry look-ahead outputs (X and Y) and cascading shift inputs (LI, RO) are provided.

5. ACCUMULATOR

- Stores results from ALU operations
- The output of accumulator is multiplexed into ALU via the A and B multiplexer as one of the operands

6. INPUT BUSES

M-bus: Data bus from main memory

- Accepts 2 bits of data from main memory into CPE
- Is multiplexed into the ALU via the A multiplexer

I-bus: Data bus from input/output devices

- Accepts 2 bits of data from external input/output devices into CPE
- Is multiplexed into the ALU via the B multiplexer

K-bus: A special feature of the N3002 CPE

- During arithmetic operations, the K-bus can be used to **mask** portions of the field being operated on
- Select or remove accumulator from operation by placing K-bus in all "1" or all "0" state respectively
- During non-arithmetic operation, the carry circuit can be used in conjunction with the K-bus for word-wise-OR operation for bit testing
- Supply literal or constant data to CPE

7. OUTPUT BUSES

A-bus and Memory Address Register

- Main memory address is stored in the memory address register (MAR)
- Main memory is addressed via the A-bus
- MAR and A-bus may also be used to generate device address when executing I/O instructions
- A-bus has Tri-State outputs

D-bus: Data bus from CPE to main memory or to I/O devices

- Sends buffered accumulator outputs to main memory or the external I/O devices
- D-bus has Tri-State outputs

FUNCTION DESCRIPTION

F GROUP	R GROUP	K BUS	NAME	EQUATION	DESCRIPTION
0	I	XX	–	$R_n + (AC \wedge K) + CI \to R_n, AC$	**Logically AND AC with the K-bus.** Add the result to R_n and carry input (CI). Deposit the sum in AC and R_n.
		OO	ILR	$R_n + CI \to R_n, AC$	Conditionally increment R_n and load the result in AC. Used to load AC from R_n or to increment R_n and load a copy of the result in AC.
		11	ALR	$AC + R_n + CI \to R_n, AC$	Add AC and CI to R_n and load the result in AC. Used to add AC to a register. If R_n is AC, then AC is shifted left one bit position.
0	II	XX	–	$M + (AC \wedge K) + CI \to AT$	**Logically AND AC with the K-bus.** Add the result to CI and the M-bus. Deposit the sum in AC or T.
		OO	ACM	$M + CI \to AT$	Add CI to M-bus. Load the result in AC or T, as specified. Used to load memory data in the specified register, or to load incremented memory data in the specified register.
		11	AMA	$M + AC + CI \to AT$	Add the M-bus to AC and CI, and load the result in AC or T, as specified. Used to add memory data or incremented memory data to AC and store the sum in the specified register.
0	III	XX	–	$AT_L \wedge \overline{(I_L \wedge K_L)} \to RO$ $LI \vee [(I_H \wedge K_H) \wedge AT_H] \to AT_H$ $[AT_L \wedge (I_L \wedge K_L)] \vee [AT_H \vee (I_H \wedge K_H)] \to AT_L$	None
		OO	SRA	$AT_L \to RO$ $\quad AT_H \to AT_L$ $\quad LI \to AT_H$	Shift AC or T, as specified, right one bit position. Place the previous low order bit value on RO and fill the high order bit from the data on LI. Used to shift or rotate AC or T right one bit.
1	I	XX	–	$K \vee R_n \to MAR$ $R_n + K + CI \to R_n$	**Logically OR R_n with the K-bus.** Deposit the result in MAR. Add the K-bus to R_n and CI. Deposit the result in R_n.
		OO	LMI	$R_n \to MAR$ $\quad R_n + CI \to R_n$	Load MAR from R_n. Conditionally increment R_n. Used to maintain a macro-instruction program counter.
		11	DSM	$11 \to MAR$ $\quad R_n - 1 + CI \to R_n$	Set MAR to all one's. Conditionally decrement R_n by one. Used to force MAR to its highest address and to decrement R_n.

F GROUP	R GROUP	K BUS	NAME	EQUATION	
1	II	XX	–	$K \vee M \to MAR$ $M + K + CI \to AT$	**Logically OR the M-bus with the K-bus.** Deposit the result in MAR. Add the K-bus to the M-bus and CI. Deposit the sum in AC or T.
		OO	LMM	$M \to MAR$ $\quad M + CI \to AT$	Load MAR from the M-bus. Add CI to the M-bus. Deposit the result in AC or T. Used to load the address register with memory data for macro-instructions using indirect addressing.
		11	LDM	$11 \to MAR$ $M - 1 + CI \to AT$	Set MAR to all ones. Subtract one from the M-bus. Add CI to the difference and deposit the result in AC or T, as specified. Used to load decremented memory data in AC or T.
1	III	XX	–	$(\overline{AT} \vee K) + (AT \wedge K) + CI \to AT$	**Logically OR the K-bus with the complement of AC or T, as specified.** Add the result to the logical AND of specified register with the K-bus. Add the sum to CI. Deposit the result in the specified register.
		OO	CIA	$\overline{AT} + CI \to AT$	Add CI to the complement of AC or T, as specified. Deposit the result in the specified register. Used to form the 1's or 2's complement of AC or T.
		11	DCA	$AT - 1 + CI \to AT$	Subtract one from AC or T, as specified. Add CI to the difference and deposit the sum in the specified register. Used to decrement AC or I.
2	I	XX	–	$(AC \wedge K) - 1 + CI \to R_n$ (See Note 1)	**Logically AND the K-bus with AC.** Subtract one from the result and add the difference to CI. Deposit the sum in R_n.
		OO	CSR	$CI - 1 \to R_n$ (See Note 1)	Subtract one from CI and deposit the difference in R_n. Used to conditionally clear or set R_n to all 0's or 1's, respectively.
		11	SDR	$AC - 1 + CI \to R_n$ (See Note 1)	Subtract one from AC and add the difference to CI. Deposit the sum in R_n. Used to store AC in R_n or to store the decremented value of AC in R_n.
2	II	XX	–	$(AC \wedge K) - 1 + CI \to AT$ (See Note 1)	**Logically AND the K-bus with AC.** Subtract one from the result and add the difference to CI. Deposit the sum in AC or T, as specified.
		OO	CSA	$CI - 1 \to AT$ (See Note 1)	Subtract one from CI and deposit the difference in AC or T. Used to conditionally clear or set AC or T.
		11	SDA	$AC - 1 + CI \to AT$ (See Note 1)	Subtract one from AC and add the difference to CI. Deposit the sum in AC or T. Used to store AC in T, or decrement AC, or store the decremented value of AC in T.

FUNCTION DESCRIPTION (CONT'D)

F GROUP	R GROUP	K BUS	NAME	EQUATION	DESCRIPTION
2	III	XX	–	$(I \wedge K) - 1 + CI \rightarrow AT$ (See Note 1)	**Logically AND the data of the K-bus with the data on the I-bus.** Subtract one from the result and add the difference to CI. Deposit the sum in AC or T, as specified.
		00	CSA	$CI - 1 \rightarrow AT$	Subtract one from CI and deposit the difference in AC or T. Used to conditionally clear or set AC or T.
		11	LDI	$I - 1 + CI \rightarrow AT$	Subtract one from the data on the I-bus and add the difference to CI. Deposit the sum in AC or T, as specified. Used to load input bus data or decremented input bus data in the specified register.
3	I	XX	–	$R_n + (AC \wedge K) + CI \rightarrow R_n$	**Logically AND AC with the K-bus.** Add R_n and CI to the result. Deposit the sum in R_n.
		00	INR	$R_n + CI \rightarrow R_n$	Add CI to R_n and deposit the sum in R_n. Used to increment R_n.
		11	ADR	$AC + R_n + CI \rightarrow R_n$	Add AC to R_n. Add the result to CI and deposit the sum in R_n. Used to add the accumulator to a register or to add the incremented value of the accumulator to a register.
3	II	XX	–	$M + (AC \wedge K) + CI \rightarrow AT$	**Logically AND AC with the K-bus.** Add the result to CI and the M-bus Deposit the sum in AC or T.
		00	ACM	$M + CI \rightarrow AT$	Add CI to M-bus. Load the result in AC or T, as specified. Used to load memory data in the specified register, or to load incremented memory data in the specified register.
		11	AMA	$M + AC + CI \rightarrow AT$	Add the M-bus to AC and CI, and load the result in AC or T, as specified. Used to add memory data or incremented memory data to AC and store the sum in the specified register.
3	III	XX	–	$AT + (I \wedge K) + CI \rightarrow AT$	**Logically AND the K-bus with the I-bus.** Add CI and the contents of AC or T, as specified, to the result. Deposit the sum in the specified register.
		00	INA	$AT + CI \rightarrow AT$	Conditionally increment AC or T. Used to increment AC or T.
		11	AIA	$I + AT + CI \rightarrow AT$	Add the I-bus to AC or T. Add CI to the result and deposit the sum in the specified register. Used to add input data or incremented input data to the specified register.

FUNCTION TRUTH TABLE

FUNCTION GROUP	F_6	F_5	F_4
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

REGISTER GROUP	REGISTER	F_3	F_2	F_1	F_0
I	R_0	0	0	0	0
	R_1	0	0	0	1
	R_2	0	0	1	0
	R_3	0	0	1	1
	R_4	0	1	0	0
	R_5	0	1	0	1
	R_6	0	1	1	0
	R_7	0	1	1	1
	R_8	1	0	0	0
	R_9	1	0	0	1
	T	1	1	0	0
	AC	1	1	0	1
II	T	1	0	1	0
	AC	1	0	1	1
III	T	1	1	1	0
	AC	1	1	1	1

SYMBOL	MEANING
I, K, M	Data on the I, K, and M busses, respectively
CI, LI	Data on the carry input and left input, respectively
CO, RO	Data on the carry output and right output, respectively
R_n	Contents of register n including T and AC (R-Group I)
AC	Contents of the accumulator
AT	Contents of AC or T, as specified
MAR	Contents of the memory address register
L, H	As subscripts, designate low and high order bit, respectively
+	2's complement addition
–	2's complement subtraction
$\wedge$	Logical AND
$\vee$	Logical OR
$\overline{\oplus}$	Exclusive-NOR
$\rightarrow$	Deposit into

NOTE:
1. 2's complement arithmetic adds 111 . . . 11 to perform subtraction of 000 . . . 01.

FUNCTION DESCRIPTION (CONT'D)

F GROUP	R GROUP	K BUS	NAME	EQUATION	DESCRIPTION
4	I	XX	–	$CI \vee (R_n \wedge AC \wedge K) \rightarrow CO$ $R_n \wedge (AC \wedge K) \rightarrow R_n$	**Logically AND the K-bus with AC.** Logically AND the result with the contents of R_n. Deposit the final result in R_n. Logically OR the value of CI with the word-wise OR of the bits of the final result. Place the value of the carry OR on the carry output (CO) line.
		OO	CLR	$CI \rightarrow CO \quad 0 \rightarrow R_n$	Clear R_n to all 0's. Force CO to CI. Used to clear a register and force CO to CI.
		11	ANR	$CI \vee (R_n \wedge AC) \rightarrow CO$ $R_n \wedge AC \rightarrow R_n$	Logically AND AC with R_n. Deposit the result in R_n. Force CO to one if the result is non-zero. Used to AND the accumulator with a register and test for a zero result.
4	II	XX	–	$CI \vee (M \wedge AC \wedge K) \rightarrow CO$ $M \wedge (AC \wedge K) \rightarrow AT$	**Logically AND the K-bus with AC.** Logically AND the result with the M-bus. Deposit the final result in AC or T. Logically OR the value of CI with the word-wise OR of the bits of the final result. Place the value of the carry OR on CO.
		OO	CLA	$CI \rightarrow CO \quad 0 \rightarrow AT$	Clear AC or T, as specified, to all 0's. Force CO to CI. Used to clear the specified register and force CO to CI.
		11	ANM	$CI \vee (M \wedge AC) \rightarrow CO$ $M \wedge AC \rightarrow AT$	Logically AND the M-bus with AC. Deposit the result in AC or T. Force CO to one if the result is non-zero. Used to AND M-bus data to the accumulator and test for a zero result.
4	III	XX	–	$CI \vee (AT \wedge I \wedge K) \rightarrow CO$ $AT \wedge (I \wedge K) \rightarrow AT$	**Logically AND the I-bus with the K-bus.** Logically AND the result with AC or T. Deposit the final result in the specified register. Logically OR CI with the word-wise OR of the final result. Place the value of the carry OR on CO.
		OO	CLA	$CI \rightarrow CO \quad 0 \rightarrow AT$	Clear AC or T, as specified, to all 0's. Force CO to CI. Used to clear the specified register and force CO to CI.
		11	ANI	$CI \vee (AT \wedge I) \rightarrow CO$ $AT \wedge I \rightarrow AT$	Logically AND the I-bus with AC or T, as specified. Deposit the result in the specified register. Force CO to one if the result is non-zero. Used to AND the I-bus to the accumulator and test for a zero result.
5	I	XX	–	$CI \vee (R_n \wedge K) \rightarrow CO$ $K \wedge R_n \rightarrow R_n$	**Logically AND the K-bus with R_n.** Deposit the result in R_n. Logically OR CI with the word-wise OR of the result. Place the value of the carry OR on CO.
		OO	CLR	$CI \rightarrow CO \quad 0 \rightarrow R_n$	Clear R_n to all 0's. Force CO to CI. Used to clear a register and force CO to CI.
		11	TZR	$CI \vee R_n \rightarrow CO$ $R_n \rightarrow R_n$	Force CO to one if R_n is non-zero. Used to test a register for zero. Also used to AND K-bus data with a register for masking and, optionally, testing for a zero result.
5	II	XX	–	$CI \vee (M \wedge K) \rightarrow CO$ $K \wedge M \rightarrow AT$	**Logically AND the K-bus with the M-bus.** Deposit the result in AC or T, as specified. Logically OR CI with the word-wise OR of the result. Place the value of the carry OR on CO.
		OO	CLA	$CI \rightarrow CO \quad 0 \rightarrow AT$	Clear AC or T, as specified, to all 0's. Force CO to CI. Used to clear the specified register and force CO to CI.
		11	LTM	$CI \vee M \rightarrow CO$ $M \rightarrow AT$	Load AC or T, as specified, from the M-bus. Force CO to one if the result is non-zero. Used to load the specified register from memory and test for a zero result. Also used to AND the K-bus with the M-bus for masking and, optionally, testing for a zero result.
5	III	XX	–	$CI \vee (AT \wedge K) \rightarrow CO$ $K \wedge AT \rightarrow AT$	**Logically AND the K-bus with AC or T, as specified.** Deposit the result in the specified register. Logically OR CI with the word-wise OR of the result. Place the value of the carry OR on CO.
		OO	CLA	$CI \rightarrow CO \quad 0 \rightarrow AT$	Clear AC or T, as specified, to all 0's. Force CO to CI. Used to clear the specified register and force CO to CI.
		11	TZA	$CI \vee AT \rightarrow CO$ $AT \rightarrow AT$	Force CO to one if AC or T, as specified, is non-zero. Used to test the specified register for zero. Also used to AND the K-bus to the specified register for masking and, optionally, testing for a zero result.

FUNCTION DESCRIPTION (CONT'D)

F GROUP	R GROUP	K BUS	NAME	EQUATION	DESCRIPTION
6	I	XX	–	$CI \vee (AC \wedge K) \rightarrow CO$ $R_n \vee (AC \wedge K) \rightarrow R_n$	Logically OR CI with the word-wise OR of the logical AND of AC and the K-bus. Place the result of the carry OR on CO. Logically OR R_n with the logical AND of AC and the K-bus. Deposit the result in R_n.
		00	NOP	$CI \rightarrow CO \quad R_n \rightarrow R_n$	Force CO to CI. Used as a null operation or to force CO to CI.
		11	ORR	$CI \vee AC \rightarrow CO$ $R_n \vee AC \rightarrow R_n$	Force CO to one if AC is non-zero. Logically OR AC with R_n. Deposit the result in R_n. Used to OR the accumulator to a register and, optionally, test the previous accumulator value for zero.
6	II	XX	–	$CI \vee (AC \wedge K) \rightarrow CO$ $M \vee (AC \wedge K) \rightarrow AT$	Logically OR CI with the word-wise OR of the logical AND of AC and the K-bus. Place the carry OR on CO. Logically OR the M-bus, with the logical AND of AC and the K-bus. Deposit the final result in AC or T.
		00	LMF	$CI \rightarrow CO \quad M \rightarrow AT$	Load AC or T, as specified, from the M-bus. Force CO to CI. Used to load the specified register with memory data and force CO to CI.
		11	ORM	$CI \vee AC \rightarrow CO$ $M \vee AC \rightarrow AT$	Force CO to one if AC is non-zero. Logically OR the M-bus with AC. Deposit the result in AC or T, as specified. Used to OR M-bus with the AC and, optionally, test the previous value of AC for zero.
6	III	XX	–	$CI \vee (I \wedge K) \rightarrow CO$ $AT \vee (I \wedge K) \rightarrow AT$	Logically OR CI with the word-wise OR of the logical AND of the I-bus and the K-bus. Place the carry OR on CO. Logically AND the K-bus with the I-bus. Logically OR the result with AC or T, as specified. Deposit the final result in the specified register.
		00	NOP	$CI \rightarrow CO \quad R_n \rightarrow R_n$	Force CO to CI. Used as a null operation or to force CO to CI.
		11	ORI	$CI \vee I \rightarrow CO$ $I \vee AT \rightarrow AT$	Force CO to one if the data on the I-bus is non-zero. Logically OR the I-bus to AC or T, as specified. Deposit the result in the specified register. Used to OR I-bus data with the specified register and, optionally, test the I-bus data for zero.
7	I	XX	–	$CI \vee (R_n \wedge AC \wedge K) \rightarrow CO$ $R_n \overline{\oplus} (AC \wedge K) \rightarrow R_n$	Logically OR CI with the word-wise OR of the logical AND of R_n and AC and the K-bus. Place the carry OR on CO. Logically AND the K-bus with AC. Exclusive-NOR the result with R_n. Deposit the final result in R_n.
		00	CMR	$CI \rightarrow CO \quad \overline{R_n} \rightarrow R_n$	Complement the contents of R_n. Force CO to CI.
		11	XNR	$CI \vee (R_n \wedge AC) \rightarrow CO$ $R_n \overline{\oplus} AC \rightarrow R_n$	Force CO to one if the logical AND of AC and R_n is non-zero. Exclusive-NOR AC with R_n. Deposit the result in R_n. Used to exclusive-NOR the accumulator with a register.
7	II	XX	–	$CI \vee (M \wedge AC \wedge K) \rightarrow CO$ $M \overline{\oplus} (AC \wedge K) \rightarrow AT$	Logically OR CI with the word-wise OR of the logical AND of AC and the K-bus and M-bus. Place the carry OR on CO. Logically AND the K-bus with AC. Exclusive NOR the result with the M-bus. Deposit the final result in AC or T.
		00	LCM	$CI \rightarrow CO \quad \overline{M} \rightarrow AT$	Load the complement of the M-bus into AC or T, as specified. Force CO to CI.
		11	XNM	$CI \vee (M \wedge AC) \rightarrow CO$ $M \overline{\oplus} AC \rightarrow AT$	Force CO to one if the logical AND of AC and the M-bus is non-zero. Exclusive-NOR AC with the M-bus. Deposit the result in AC or T, as specified. Used to exclusive-NOR memory data with the accumulator.
7	III	XX	–	$CI \vee (AT \wedge I \wedge K) \rightarrow CO$ $AT \overline{\oplus} (I \wedge K) \rightarrow AT$	Logically OR CI with the word-wise OR of the logical AND of the specified register and the I-bus and K-bus. Place the carry OR on CO. Logically AND the K-bus with the I-bus. Exclusive-NOR the result with AC or T, as specified. Deposit the final result in the specified register.
		00	CMA	$CI \rightarrow CO \quad \overline{AT} \rightarrow AT$	Complement AC or T, as specified. Force CO to CI.
		11	XNI	$CI \vee (AT \wedge I) \rightarrow CO$ $I \overline{\oplus} AT \rightarrow AT$	Force CO to one if the logical AND of the specified register and the I-bus is non-zero. Exclusive-NOR AC with the I-bus. Deposit the result in AC or T, as specified. Used to exclusive-NOR input data with the accumulator.

ABSOLUTE MAXIMUM RATINGS*

Temperature Under Bias	0°C to +70°C
Storage Temperature	−65°C to +160°C
All Output and Supply Voltages	−0.5V to +7V
All Input Voltages	−1.0V to +5.5V
Output Currents	100mA

*COMMENT: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum ratings for extended periods may effect device reliability.

DC CHARACTERISTICS $T_A = 0°C$ to $+70°C$

PARAMETER		TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP[1]	MAX	
V_C	Input Clamp Voltage (All Input Pins)	$V_{CC} = 4.75V$, $I_C = -5mA$		-0.8	-1.0	V
I_F	Input Load Current:					
	F_0–F_6, CLK, K_0, K_1, EA, ED	$V_{CC} = 5.25V$, $V_F = 0.45V$		-0.05	-0.25	mA
	I_0, I_1, M_0, M_1, LI			-0.85	-1.5	mA
	CI			-2.3	-4.0	mA
I_R	Input Leakage Current:					
	F_0–F_6, CLK, K_0, K_1, EA, ED	$V_{CC} = 5.25V$, $V_R = 5.25V$			40	μA
	I_0, I_1, M_0, M_1, LI				60	μA
	CI				180	μA
V_{IL}	Input Low Voltage	$V_{CC} = 5.0V$			0.8	V
V_{IH}	Input High Voltage		2.0			V
I_{CC}	Power Supply Current	$V_{CC} = 5.25V$[2]		145	190	mA
V_{OL}	Output Low Voltage Except X and Y	$V_{CC} = 4.75V$, $I_{OL} = 10mA$		0.3	0.45	V
	X and Y	$V_{CC} = 4.75V$, $I_{OL} = 16mA$		0.35	0.50	V
V_{OH}	Output High Voltage (All Output Pins)	$V_{CC} = 4.75V$, $I_{OH} = -1mA$	2.4	3.0		V
I_{OS}	Short Circuit Output Current (All Output Pins)	$V_{CC} = 5.0V$	-15	-25	-60	mA
$I_{O\,(off)}$	Off State Output Current	$V_{CC} = 5.25V$, $V_O = 0.45V$			-100	μA
	A_0, A_1, D_0 and D_1 Only	$V_{CC} = 5.25V$, $V_O = 5.25V$			100	μA

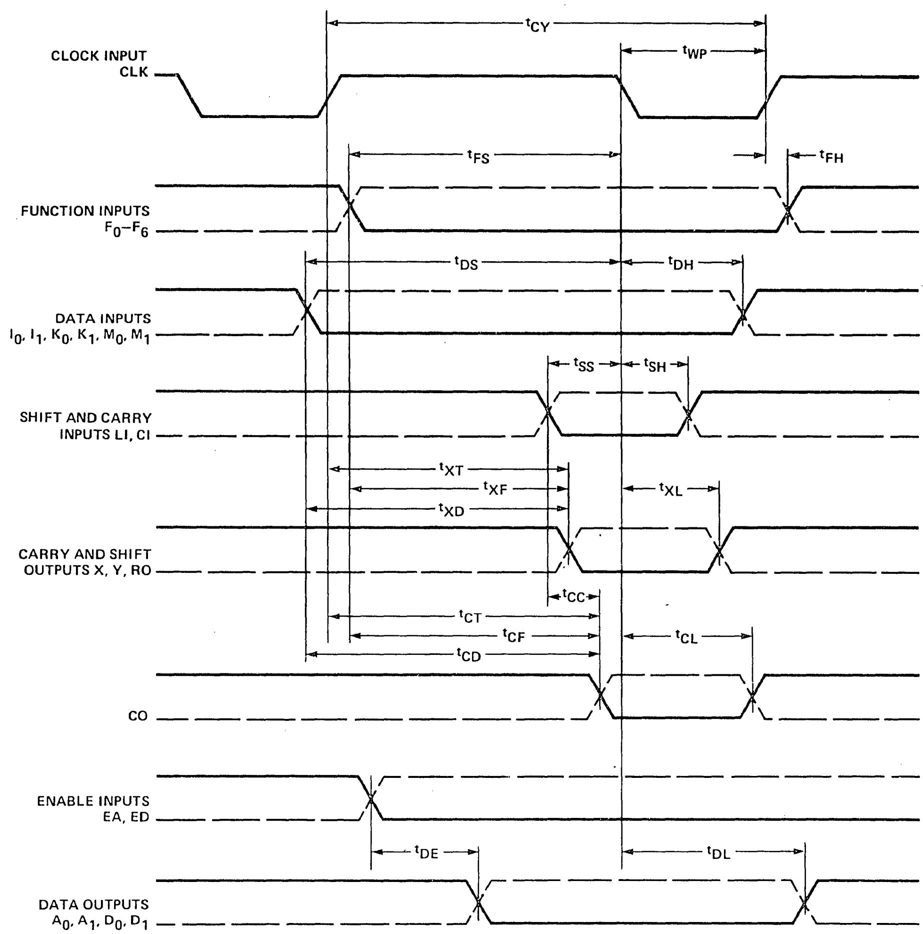
NOTES:
1. Typical values are for $T_A = 25°C$ and typical supply voltage.
2. CLK input grounded, other inputs open.

SWITCHING CHARACTERISTICS $T_A = 0°C$ to $70°C$, $V_{CC} = 5V \pm 5\%$

SYMBOL	PARAMETER	MIN	TYP[1]	MAX	UNIT
t_{CY}	Clock Cycle Time	70	45		ns
t_{WP}	Clock Pulse Width	17	10		ns
t_{FS}	Function Input Set-Up Time (F_0 through F_6)	48	31		ns
	Data Set-Up Time:				
t_{DS}	I_0, I_1, M_0, M_1, K_0, K_1	40	24		ns
t_{SS}	LI, CI	21	7		ns
	Data and Function Hold Time:				
t_{FH}	F_0 through F_6	4	0		ns
t_{DH}	I_0, I_1, M_0, M_1, K_0, K_1	4	0		ns
t_{SH}	LI, CI	12	0		ns
	Propagation Delay to X, Y, RO from:				
t_{XF}	Any Function Input		28	41	ns
t_{XD}	Any Data Input		18	33	ns
t_{XT}	Trailing Edge of CLK		33	48	ns
t_{XL}	Leading Edge of CLK	13	18→40	73	ns
	Propagation Delay to CO from:				
t_{CL}	Leading Edge of CLK	16	24→44	84	ns
t_{CT}	Trailing Edge of CLK		40	56	ns
t_{CF}	Any Function Input		35	52	ns
t_{CD}	Any Data Input		23	44	ns
t_{CC}	CI (Ripple Carry)		13	20	ns
	Propagation Delay to A_0, A_1, D_0, D_1 from:				
t_{DL}	Leading Edge of CLK		25	40	ns
t_{DE}	Enable Input ED, EA		12	20	ns

NOTE:
1. Typical values are for $T_A = 25°C$ and typical supply voltage.

PARAMETER MEASUREMENT INFORMATION



ALTERNATE SOURCE DIRECTORY

The Alternate Source Directory is an industry wide cross reference of those devices which manufacturers claim are pin-for-pin and functional equivalents to IC's made by other firms. It is a compilation of many individual references and shows literally thousands of alternates that aren't implied by their model numbers, especially in the linear and memory areas. Unlike the usual alternate source guides this directory leads you to many alternate sources for any particular device, not just one. It is the most comprehensive alternate source directory ever published and contains over 14,000 cross references.

how to use the alternate source directory

The second column of this Alternate Source Directory shows devices which are replacements for those in the first column. Devices listed in bold face type have technical data in the Master Selection Guide. This information begins on the page listed below the bold face part numbers. Products preceded by a ¶ have been discontinued by the manufacturer. This section does include devices not listed in the Master Selection Guide e.g., discontinued items, consumer circuits, DTL and 54L devices.

This list is compiled from manufacturers' recommendations. Since there is a tendency for every company to only show itself as an alternate to the prominent manufacturers, and for the larger ones to ignore the little ones, not every device is referenced both ways to every other one. Therefore, if you are looking for alternates to a lesser known company's device, take the replacements you find, especially if they are made by prominent companies and look them up to see if you can find any other sources.

In order to maintain this list within some reasonable bounds, the A and B suffixes indicating improved versions generally have been dropped. If this weren't done, for example, every higher speed selection conjured up by a memory manufacturer would result in a device that could replace many equal or slower competitors and this directory would become highly involved in slight performance variations. Moreover, improved performance is only important if your circuits take advantage of it.

One of the difficulties with any cross reference is that devices meant to be alternates do not necessarily perform the same in all circuits. Thus, it will be necessary for you to check specifications, or even to check circuit performance before deciding which alternates are right for you. A major benefit of this list is that it gives you more alternatives to study. But if you don't find what you need here, it may be possible to find additional alternates by locating the device in the Master Selection Guide. Particularly for digital circuits, the other products grouped with it will normally offer similar or identical performance.

Advanced Memory Systems

Manufacturer Device	Replacement Source	Replacement Device
AMS6002	Nortec	6002
AMS6003	Nortec	6003
AMS7001	Motorola	MCM7001
	Nitron	7001
	RCA	MW7001
	TI	TMS7001

Advanced Micro Devices

Manufacturer Device	Replacement Source	Replacement Device
¶ AM2071	Signetics	82S07
AM2505	Raytheon	RC2505
	Raytheon	RM2505
AM2533	Signetics	2533
	TI	TMS3133
AM27LS00	Fairchild	93421
AM27LS01	Fairchild	93411
AM27LS10	Fairchild	93416
	Harris	HPROM1024
	Intel	**3601**
	see page **772, 773**	
AM27LS11	Synertek	3611
AM27S02	Fairchild	93404
	Intersil	IM5501
	MMI	5560
	MMI	6560
	TI	SN54S289
	TI	SN74S289
AM27S03	Fairchild	93405
	MMI	5561
	MMI	6561
	National	DM7599
	National	DM8599
	TI	SN54S189
	TI	SN74S189
AM2700	Fairchild	93421
	Intersil	IM5523
	MMI	6531
	Signetics	**N82S16**
	see page **804, 806, 815,**	
	Signetics	82S06
	TI	SN54S201
	TI	SN74S201
AM2701	Fairchild	93411
	Intersil	IM5533
	MMI	6530
	Signetics	**N82S16**
	see page **804, 806, 815,**	
	TI	SN54S301
	TI	SN74S301
¶ AM2715	Intersil	IM5523
AM2802	Synertek	SY2802
AM2803	Synertek	SY2803
AM2804	Synertek	SY2804
AM2814	TI	TMS3114
AM2825	Synertek	SY5025
AM2826	Synertek	SY5026
AM2827	Synertek	SY2827
AM2833	Synertek	SY2833
	TI	TMS3133
AM4102	Mostek	MK4102
LM101	**AD**	**AD101**
	see page **625**	
	Intersil	LM101
	Motorola	MLM101
	National	LM101
	Raytheon	LM101
	RCA	**CA101**
	see page **661**	
	Signetics	LM101
	Teledyne S	LM101
LM105	Intersil	LM105
	Motorola	MLM105
	National	LM105
	Raytheon	LM105
	Teledyne S	LM105
LM107	Intersil	LM107
	Motorola	MLM107

Manufacturer Device	Replacement Source	Replacement Device
LM107	National	LM107
	Raytheon	LM107
	RCA	**CA107**
	see page **661**	
	Teledyne S	LM107
LM108	**AD**	**AD108**
	see page **625**	
	Intersil	LM108
	National	LM108
	Raytheon	LM108
	Signetics	LM108
LM110	Intersil	LM110
	Motorola	MLM110
	National	LM110
LM111	Harris	HA-2111
	Intersil	LM111
	Motorola	MLM111
	National	LM111
	Raytheon	LM111
	RCA	**CA111**
	see page **661**	
	Signetics	LM111
	Teledyne S	LM111
LM118	**AD**	**AD518**
	see page **624**	
	National	LM118
	Raytheon	LM118
LM201	**AD**	**AD201**
	see page **625**	
	Intersil	LM201
	Motorola	MLM201
	National	LM201
	Raytheon	LM201
	RCA	CA748
	Signetics	LM201
	Teledyne S	LM201
LM202	Motorola	MLM210
LM205	Intersil	LM205
	Motorola	MLM205
	Raytheon	LM205
	Teledyne S	LM205
LM207	Intersil	LM207
	Motorola	MLM207
	Raytheon	LM207
	RCA	**CA207**
	see page **661**	
	Teledyne S	LM207
LM208	**AD**	**AD208**
	see page **625**	
	Intersil	LM208
	Raytheon	LM208
	Teledyne S	LM208
LM210	Intersil	LM210
	Motorola	MLM210
LM211	Harris	HA-2211
	Intersil	LM211
	Motorola	MLM211
	Raytheon	LM211
	RCA	**CA211**
	see page **661**	
	Signetics	LM211
	Teledyne S	LM211
LM218	**AD**	**AD518**
	see page **624**	
	Raytheon	LM218
LM301	**AD**	**AD301**
	see page **625**	
	Intersil	LM301
	Motorola	MLM301
	Raytheon	LM301
	Signetics	LM301
	Teledyne S	LM301
LM305	Intersil	LM305
	Motorola	MLM305
	Raytheon	LM305
	Teledyne S	LM305
LM307	Intersil	LM307
	Motorola	MLM307
	Raytheon	LM307
	RCA	**CA307**
	see page **661**	

Manufacturer Device	Replacement Source	Replacement Device
LM307	Signetics	LM307
	Teledyne S	LM307
LM308	**AD**	**AD308**
	see page **625**	
	Intersil	LM308
	Raytheon	LM308
	Signetics	LM308
	Teledyne S	LM308
LM310	Intersil	LM310
	Motorola	MLM310
LM311	Harris	HA-2311
	Intersil	LM311
	Motorola	MLM311
	Raytheon	LM311
	RCA	**CA311**
	see page **661**	
	Signetics	LM311
	Teledyne S	LM311
LM318	**AD**	**AD518**
	see page **624**	
	Raytheon	LM318
NE555	National	LM555
SN54S189	TI	SN54S189
SN54181	Fairchild	9341
	Raytheon	54181
	TI	SN54181
	TI	SN74181
SN54182	Fairchild	9342
	Raytheon	54182
	TI	SN54182
	TI	SN74182
SN5489	Intersil	IM5501
	MMI	5560
	Raytheon	5489
SN74S160	Fairchild	93S10
SN74S161	Fairchild	93S16
SSS725	PMI	SSS725
1002	Mostek	MK1002
1101	Intersil	IM7501
	Intersil	IM7511
	Mostek	MK4007
1402	Nortec	1402
	Signetics	2502
	Synertek	SY1402
1403	Nortec	1403
	Synertek	SY1403
1404	Nortec	1404
	Synertek	SY1404
1488	Exar	XR1488
	Motorola	MC1488
	National	DS1488
	Raytheon	RC1488
1489	Exar	XR1489
	National	DS1489
	Raytheon	RC1489
1498A	Motorola	MC1498A
1500	Intersil	AM1500
1501	Intersil	AM1501
1660	Intersil	AM166039
2101	EA	EA2101
	Intel	2101
	Synertek	SY2101
2102	Mostek	MK4102
2111	EA	EA2111
	Intel	2111
	Synertek	SY2111
2112	EA	EA2112
	Intel	2112
	Synertek	SY2112
2401	Synertek	SY2401
31L01	MMI	L5560
	MMI	L6560
	Signetics	**N82S25**
	see page **804, 806, 814,**	
31L0101	Intersil	IM5501
	Signetics	N8225
3101	AMI	S1685
	Fairchild	93403
	Intersil	IM5501
	TI	SN7489
3101A	TI	SN54S289

Manufacturer Device	Replacement Source	Replacement Device
3101A	TI	SN74S289
3114	TI	TMS3114
723	Intersil	723
	Raytheon	RC723
	Raytheon	RM723
	RCA	CA723
	Teledyne S	723
725	PMI	SSS725
741	Intersil	741
	PMI	SSS741
	Raytheon	RC741
	Raytheon	RM741
	RCA	**CA741**
	see page **661**	
	Teledyne S	741
747	PMI	SSS747
	Raytheon	RC747
	Raytheon	RM747
	RCA	**CA747**
	see page **661**	
	Teledyne S	747
748	Intersil	748
	Raytheon	RC748
	Raytheon	RM748
	RCA	CA748
	Teledyne S	748
7552	Mostek	MK4102
9080	**Intel**	**8080**
	see page **958**	
	TI	TMS8080
9102	Mostek	MK4102
	Signetics	2402
	Synertek	SY2102
	TI	TMS4033
	TI	TMS4034
93L00	Fairchild	93L00
93L01	Fairchild	93L01
93L08	Fairchild	93L08
93L09	Fairchild	93L09
93L10	Fairchild	93L10
93L11	Fairchild	93L11
93L12	Fairchild	93L12
93L14	Fairchild	93L14
93L16	Fairchild	93L16
93L18	Fairchild	93L18
93L21	Fairchild	93L21
93L22	Fairchild	93L22
93L24	Fairchild	93L24
93L28	Fairchild	93L28
93L34	Fairchild	93L34
93L38	Fairchild	93L38
93L40	Fairchild	93L40
93L41	Fairchild	93L41
93L60	Fairchild	93L60
93L66	Fairchild	93L66
9300	Fairchild	9300
	Raytheon	RM9300
	TI	SN54195
	TI	SN74195
9301	Fairchild	9301
	TI	SN29301
	TI	SN39301
9304	Fairchild	9304
	Raytheon	RM9304
9306	Fairchild	9306
9308	Fairchild	9308
	Raytheon	RM9308
	TI	SN29308
	TI	SN39308
9309	Fairchild	9309
	TI	SN29309
	TI	SN39309
9310	Fairchild	9310
	Raytheon	RM9310
	TI	SN54160
	TI	SN74160
9311	Fairchild	9311
	Raytheon	RM9311
	TI	SN54154
	TI	SN74154
9312	Fairchild	9312

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Advanced Micro Devices (cont)

Manufacturer Device	Replacement Source	Device
9312	Raytheon	RM9312
	TI	SN29312
	TI	SN39312
9314	Fairchild	9314
9316	Fairchild	9316
	Raytheon	RM9316
	TI	SN54161
	TI	SN74161
9318	Fairchild	9318
	TI	SN54148
	TI	SN74148
9321	Fairchild	9321
9322	Fairchild	9322
	Raytheon	RM9322
	TI	SN54157
	TI	SN74157
9324	Fairchild	9324
9328	Fairchild	9328
9334	Fairchild	9334
9338	Fairchild	9338
9340	Fairchild	9340
9341	Fairchild	9341
	Raytheon	RM9341
	TI	SN54181
	TI	SN74181
93415	**Intel**	**2115**
	see page 766, 769	
	TI	SN54S314
	TI	SN74S314
9342	Fairchild	9342
	Raytheon	RM9342
	TI	SN54182
	TI	SN74182
9360	Fairchild	9360
	Raytheon	RM9360
9366	Fairchild	9366
	Raytheon	RM9366
9401	Synertek	SY2401
96L02	Fairchild	96L02
9600	Fairchild	9600
9601	Fairchild	9601
	Raytheon	RF9601
	TI	SN29601
9602	Fairchild	9602
	Raytheon	RF9602
9614	Fairchild	9614
9615	Fairchild	9615
9616	Fairchild	9616
9617	Fairchild	9617
9620	Fairchild	9620
9621	Fairchild	9621
	Raytheon	RM9621

American Microsystems Inc.

Manufacturer Device	Replacement Source	Device
S1103	**see page 707**	
	Intel	1103
S146	Intel	1103-146
	Signetics	2146
¶ S1670	Motorola	MC1160
S1757	**see page 532**	
	GI	AY5-1013
	Western	TR1402
S1883	**see page 533**	
	GI	AY5-1013
	TI	TMS6011
	Western	TR1602
¶ S2076	Intersil	IM7780
¶ S2102	Intersil	IM7552
	Motorola	MCM6605
¶ S2103	Motorola	MC2372
S2222	**see page 706**	
	Nortec	2222
	Signetics	N2222
	Signetics	S2222
S2555	**see page 254**	
	Nitron	NC1183
S2556	**see page 254**	
	Nitron	NC1184
¶ **S2566**	**see page 254**	
	Motorola	MC1182
	Nitron	NC1182
S2567	**see page 254**	
	Nitron	NC1181
S3102	TI	TMS4035
S3102A	TI	TMS4033
S3102B	TI	TMS4034
S3103	Nortec	1103
S4006	**see page 706**	
	Mostek	MK4006
S4008	**see page 706**	
	Mostek	MK4008
S4021	**see page 722**	
	TI	TMS4060
S4096	**see page 728**	
	EA	EA4096
	EMM/Semi	RO3-4096
	Fairchild	4096
	GI	RO3-4096
S5232	**see page 706**	
	Mostek	MK2500
	Mostek	MK2600
	National	MM5232
S6800	**see page 862**	
	Motorola	6800
S6810	**see page 884**	
	Motorola	MCM6810
S6820	**see page 889**	
	Motorola	MC6820
S6830	**see page 887**	
	Motorola	MCM6830
S6850	**see page 895**	
	Motorola	MC6850
S8499	Nitron	NCM1130
S8865	**see page 706**	
	GI	RO5-8192
S8996	**see page 706**	
	EMM/Semi	RO3-16384
	GI	RO3-16384
	Nortec	8996

Analog Devices

Manufacturer Device	Replacement Source	Device
AD101	**see page 625**	
	AMD	LM101
	Fairchild	μA101
	National	LM101
	RCA	**CA101**
	see page 661	
	Signetics	LM101
	Teledyne S	LM101
AD108	**see page 625**	
	AMD	LM108
	Fairchild	μA108
	National	LM108
	RCA	CA108
	Signetics	LM108
	Teledyne S	LM108
AD111	National	LM111
	RCA	**CA111**
	see page 661	
	Signetics	LM111
	Teledyne S	LM111
AD201	**see page 625**	
	AMD	LM201
	Fairchild	LM201
	National	LM201
	RCA	**CA201**
	see page 661	
	Signetics	LM201
	Teledyne S	LM201
AD208	**see page 625**	
	AMD	LM208
	Fairchild	μA208
	National	LM208
	RCA	CA208
AD208	Teledyne S	LM208
AD211	National	LM211
	RCA	**CA211**
	see page 661	
	Signetics	LM211
	Teledyne S	LM211
AD301	**see page 625**	
	AMD	LM301
	Fairchild	μA301
	National	LM301
	Signetics	**LM301**
	Teledyne S	LM301
AD308	**see page 625**	
	AMD	LM308
	Fairchild	μA308
	National	LM308
	Signetics	LM308
	Teledyne S	LM308
AD311	National	LM311
	RCA	**CA311**
	see page 661	
	Signetics	LM311
	Teledyne S	LM311
AD503	**see page 624**	
	National	LH0042
	Teledyne S	2740
AD506	**see page 624**	
	National	LH0022
AD513	National	LH0042
AD516	National	LH0022
AD710	National	LM710
	Raytheon	RM710
	Signetics	μA710
	Teledyne S	710
AD711	National	LM711
	Raytheon	RM711
	Signetics	μA711
	Teledyne S	711
AD741	**see page 625**	
	AMD	741
	Fairchild	μA741
	National	LM741
	PMI	SSS741
	Raytheon	RM741
	RCA	**CA741**
	see page 661	
	Signetics	μA741
	Teledyne S	741
AD7505	**Siliconix**	**DG507**
	see page 561, 563, 564,	
AD7506	**see page 548**	
	Siliconix	**DG506**
	see page 561, 563, 564,	
AD7513	**see page 546**	
	Siliconix	**DG200**
	see page 559, 560	
LM101	Raytheon	LM101
LM108	Raytheon	LM108
LM111	Raytheon	LM111
LM201	Raytheon	LM201
LM208	Raytheon	LM208
LM211	Raytheon	LM211
LM301	Raytheon	LM301
LM308	Raytheon	LM308
LM311	Raytheon	LM311

Burr-Brown Research

Manufacturer Device	Replacement Source	Device
3500	AD	AD3500
3503	**AD**	**AD540**
	see page 624	
	Intersil	ICL3503
3507	AD	AD3509
3508	AD	AD3507
3524	Intersil	ICL3524
3542	AD	AD3542
4201	AD	AD530
4550	Intersil	ICL4550

Electronic Arrays

Manufacturer Device	Replacement Source	Device
EA1004	TI	TMS3003
EA1009	AMI	S2181
¶ EA1012	TI	TMS3002
EA1206	AMI	S1685
EA12065	AMI	S1685
EA12105	AMI	S1685
EA1212	AMI	S1685
EA1400	**AMI**	**S4006**
	see page 706	
¶ EA3000	AMI	S8773
¶ EA3001	AMI	S8773
¶ EA3100	AMI	S8773
¶ EA3101	AMI	S8773
¶ EA3132	AMI	S8773
¶ EA3300	AMI	S8772
¶ EA3307	AMI	S8772
EA3800	AMI	S8773
EA4000	**AMI**	**S8771**
	see page 706	
	GI	RO3-5120
EA4004	**AMI**	**S8771**
	see page 706	
EA4015	**AMI**	**S8771**
	see page 706	
EA4016	**AMI**	**S8771**
	see page 706	
EA4096	**AMI**	**S4096**
	see page 728	
	EMM/Semi	RO3-4096
	Fairchild	4096
	GI	RO3-4096
	Mostek	**MK4096**
	see page 778, 781	
	Rockwell	1604
EA4900	**Mostek**	**MK28000**
	see page 783	
	TI	TMS4800

EMM/Semi

Manufacturer Device	Replacement Source	Device
RA3-4256	GI	RA3-4256
RO3-16384	GI	RO3-16384
RO3-4096	GI	RO3-4096
RA3-4402	**GI**	**see page 734**
		RO3-4402
RO3-5120	GI	RO3-5120
1217	GI	RA3-1217
1218	GI	RA3-1218
1801	GI	RA3-1801
1802	GI	RA-1802

Exar Integrated Systems

Manufacturer Device	Replacement Source	Device
XR1310	National	LM1310
XR1800	National	LM1800
XR2240	**see page 637**	
	Fairchild	7240
XR2556	Teledyne S	D555
XR3503	**Raytheon**	**RM3503**
	see page 649	
XR4194	**Raytheon**	**RC4194**
	see page 655	
XR4558	**Raytheon**	**RC4558**
	see page 651	
XR555	Lithic Sys	LS555
XR556	Raytheon	RC556
XR742	Fairchild	742
4136	**Raytheon**	**RC4136**
	see page 647 640	
555	Teledyne S	555
556	Teledyne S	556

Fairchild Semiconductor

Manufacturer Device	Replacement Source	Device
μA1458	Motorola	MC1458

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

Fairchild Semiconductor (cont)

Manufacturer Device	Replacement Source	Device
µA1558	Motorola	MC1558
µA3018	Lithic Sys	LA3018
µA3018A	Lithic Sys	CA3018A
µA3026	Lithic Sys	LA3026
µA3045	Lithic Sys	LA3045
µA3046	Lithic Sys	LA3046
µA3086	Lithic Sys	LA3086
µA3403	**Raytheon**	**RC3403**
	see page 649	
µA3503	**Raytheon**	**RM3503**
	see page 649	
µA733	Raytheon	RM733
µA734	Intersil	734
µA739	Motorola	MC1303
µA740	Intersil	LH0042
µA753	Sprague	ULN-2209
µA754	National	LM1596
µA758	Exar	XR1800
µA760	National	LM160
µA763	National	LM1496
µA777	Intersil	777
µA78L02	**Signetics**	**78L02C**
	see page 673	
µA78L05	**Signetics**	**78L05C**
	see page 673	
µA78L06	**Signetics**	**78L06C**
	see page 673	
µA78L08	**Signetics**	**78L08C**
	see page 673	
µA78L12	**Signetics**	**78L12C**
	see page 673	
µA78M05	Teledyne S	78M05
µA78M06	Teledyne S	78M06
µA78M12	Teledyne S	78M12
µA78M15	Teledyne S	78M15
µA78M24	Teledyne S	78M24
µA7805	**Signetics**	**7805**
	see page 668	
µA7806	**Signetics**	**7806**
	see page 668	
µA7808	**Signetics**	**7808**
	see page 668	
µA7812	**Signetics**	**7812**
	see page 668	
µA7815	**Signetics**	**7815**
	see page 668	
µA7818	**Signetics**	**7818**
	see page 668	
µA7824	**Signetics**	**7824**
	see page 668	
µA795	Motorola	MC1495
	Motorola	MC1595
µA796	Motorola	MC1596
F10144	Signetics	10144
F10405	TI	SN10147
F10410	TI	SN10144
F4001	Harris	HD4001
F4006	Harris	HD4006
F4007	Harris	HD4007
F4008	Harris	HD4008
F40085	**Harris**	**HD74C85**
	see page 266	
	National	MM74C85
F40097	Harris	HD80C97
	National	MM80C97
F40098	National	MM80C98
F4011	Harris	HD4011
F4012	Harris	HD4012
F4013	Harris	HD4013
F4014	**Harris**	**HD4014**
	see page 266	
F4015	**Harris**	**HD4015**
	see page 266	
F40160	Harris	HD546160
	Harris	**HD74C160**
	see page 266	
	National	MM54C160
	National	MM74C160
	Teledyne S	MM54C160
	Teledyne S	MM74C160
	TI	TF4360

Manufacturer Device	Replacement Source	Device
F40160	TI	TP4360
F40161	**Harris**	**HD54C161**
	see page 266	
	Harris	**HD74C161**
	see page 266	
	National	MM54C161
	National	MM74C161
	Teledyne S	MM54C161
	Teledyne S	MM74C161
	TI	TF4361
	TI	TP4361
F40162	**Harris**	**HD54C162**
	see page 266	
	Harris	**HD74C162**
	see page 266	
	National	MM54C162
	National	MM74C162
	Teledyne S	MM54C162
	TI	TF4362
	TI	TP4362
F40163	Harris	HD54C163
	Harris	HD74C163
	National	MM54C163
	National	MM74C163
	Teledyne S	MM54C163
	Teledyne S	MM74C163
	TI	TF4362
	TI	TP4362
F4017	Harris	HD4017
F40174	Harris	HD54C174
	Harris	HD74C174
	National	MM54C174
	National	MM74C174
F40175	Harris	HD54C175
	Harris	HD74C175
	National	MM54C175
	National	MM74C175
F4018	**Harris**	**HD4018**
	see page 266	
F4019	**Harris**	**HD4019**
	see page 266	
F40192	**Harris**	**HD54C192**
	see page 266	
	Harris	**HD74C192**
	see page 266	
	National	CD40192
	National	MM54C192
	RCA	**CD40192**
	see page 375	
	Teledyne S	MM54C192
	Teledyne S	MM74C192
F40193	**Harris**	**HD54C193**
	see page 266	
	Harris	**HD74C193**
	see page 266	
	National	CD40193
	National	MM54C193
	National	MM74C193
	RCA	**CD40193**
	see page 375	
	Teledyne S	MM54C193
	Teledyne S	MM74C193
F4020	**Harris**	**HD4020**
	see page 266	
F4021	**Harris**	**HD4021**
	see page 266	
F4022	**Harris**	**HD4022**
	see page 266	
F4023	Harris	HD4023
F4024	Harris	HD4024
F4025	Harris	HD4025
F4027	Harris	HD4027
F4028	**Harris**	**HD4028**
	see page 266	
F4029	**Harris**	**HD4029**
	see page 266	
F4030	**Harris**	**HD4030**
	see page 266	
F4035	**Harris**	**HD4035**
	see page 266	
F4040	Harris	HD4040

Manufacturer Device	Replacement Source	Device
F4042	Harris	HD4042
F4043	Harris	HD4043
F4044	Harris	HD4044
F4049	Harris	HD4049
F4050	Harris	HD4050
F4066	Harris	HD4066
F4510	Harris	HD4510
F4512	Harris	HD4512
F4516	Harris	HD4516
F4518	Harris	HD4518
F4519	Harris	HD4519
F4520	Harris	HD4520
LM101	AMD	LM101
	Intersil	LM101
	National	LM101
	Raytheon	LM101
	RCA	**CA101**
	see page 661	
	Signetics	LM101
	Teledyne S	LM101
	TI	SN52101
LM102	AMD	LM102
	Intersil	LM102
	National	LM102
LM104	National	LM104
	Raytheon	LM104
	Teledyne S	LM104
LM105	AMD	LM105
	Intersil	LM105
	National	LM105
	Raytheon	LM105
	Teledyne S	LM105
LM107	AMD	LM107
	Intersil	LM107
	Motorola	MLM107
	National	LM107
	Raytheon	LM107
	Signetics	LM107
	Teledyne S	LM107
	TI	SN52107
LM108	AMD	LM108
	Intersil	LM108
	National	LM108
	Raytheon	LM108
	RCA	CA108
	Signetics	LM108
	Teledyne S	LM108
LM109	National	LM109
	Raytheon	LM109
	TI	SN52109
LM110	AMD	LM110
	Intersil	LM110
	National	LM110
LM111	AMD	LM111
	Harris	HA-2111
	Intersil	LM111
	Raytheon	LM111
	RCA	**CA111**
	see page 661	
	Signetics	LM111
	Teledyne S	LM111
LM201	Intersil	LM201
	National	LM201
	Raytheon	LM201
	RCA	**CA201**
	see page 661	
	Signetics	LM201
	Teledyne S	LM201
LM202	Intersil	LM202
LM204	Teledyne S	LM204
LM205	Intersil	LM205
	National	LM205
	Raytheon	LM205
	Teledyne S	LM205
LM207	Intersil	LM207
	National	LM207
	Raytheon	LM207
	Signetics	LM207
	Teledyne S	LM207
LM208	Intersil	LM208
	National	LM208

Manufacturer Device	Replacement Source	Device
LM208	Raytheon	LM208
	RCA	CA208
	Signetics	LM208
	Teledyne S	LM208
LM209	National	LM209
	Raytheon	LM209
LM210	Intersil	LM210
LM211	Harris	HA-2211
	Intersil	LM211
	National	LM211
	Raytheon	LM211
	RCA	**CA211**
	see page 661	
	Signetics	LM211
	Teledyne S	LM211
LM301	Intersil	LM301
	National	LM301
	Raytheon	LM301
	RCA	**CA301**
	see page 661	
	Signetics	LM301
	Teledyne S	LM301
	TI	SN52301
	TI	SN72301
LM302	Intersil	LM302
LM304	National	LM304
	Raytheon	LM304
	Teledyne S	LM304
LM305	Intersil	LM305
	National	LM305
	Raytheon	LM305
	Teledyne S	LM305
LM306	National	LM306
	Raytheon	LM306
LM3064	National	LM3064
LM3065	National	LM3065
LM307	Intersil	LM307
	National	LM307
	Raytheon	LM307
	Signetics	LM307
	Teledyne S	LM307
	TI	SN52307
	TI	SN72307
LM308	Intersil	LM308
	National	LM308
	Raytheon	LM308
	RCA	CA308
	Signetics	LM308
	Teledyne S	LM308
LM309	TI	SN72309
LM310	Intersil	LM310
LM311	Harris	HA-2311
	Intersil	LM311
	Raytheon	LM311
	RCA	**CA311**
	see page 661	
	Signetics	LM311
	Teledyne S	LM311
LM376	Teledyne S	LM376
MC1458	Harris	HA-2655
	National	LM1458
	Raytheon	RC1458
	Signetics	MC1458
	Teledyne S	1458
	TI	SN72558
MC1558	Harris	HA-2650
	National	LM1558
	Raytheon	RM1558
	Signetics	MC1558
	Teledyne S	1558
	TI	SN52558
SH013	Intersil	IM5013
SH3002	Siliconix	S13002
SN55107A	National	DS55107A
	Raytheon	RM55107A
SN55108A	National	DS55108A
	Raytheon	RM55108A
SN55109	National	DS55109
	Raytheon	RM55109
SN55110	National	DS55110
	Raytheon	RM55110

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Fairchild Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
SN5524	National	DS5524
SN74152	TI	SN74152A
SN75107A	National	DS75107A
	Raytheon	RC75107A
SN75108A	National	DS75108A
	Raytheon	RC75108A
SN75109	National	DS75109
	Raytheon	RC75109
SN75110	Raytheon	RC75110
SN7524	National	DS7524
SN7525	National	DS7525
1103	**AMI**	**S1103A**
	see page 712	
1800	SW	SW1800
	SW	SW1900
	TI	SN151800
	TI	SN151900
1802	SW	SW1802
	SW	SW1902
	TI	SN151802
	TI	SN151902
1805	TI	SN151805
	TI	SN151905
1806	SW	SW1806
	SW	SW1906
	TI	SN151806
	TI	SN151906
1807	TI	SN151807
	TI	SN151907
1808	SW	SW1808
	SW	SW1908
	TI	SN151808
	TI	SN151908
1810	SW	SW1810
	SW	SW1910
	TI	SN151810
	TI	SN151910
1812	SW	SW1812
	SW	SW1912
	TI	SN151812
	TI	SN151912
1814	SW	SW1814
	SW	SW1914
2136	Sprague	ULN-2136
3002	**Siliconix**	**SI3002**
	see page 551	
3064	Sprague	ULN-2264
3065	Sprague	ULN-2165
3067	Sprague	ULN-2267
3075	Sprague	ULN-2129
3257	GI	RO5-2240S
3260	AMI	S8564
3329	AMI	S1685
3330	AMI	S1685
3331	AMI	S1685
3337	AMI	S1685
3341	AMD	3341
3342	TI	TMS3121
3343	AMI	S2181
3344	AMI	S2181
3347	AMI	S2182
	Intersil	IM7780
	Signetics	2518
	TI	TMS3120
3348	TI	TMS3112
3349	TI	TMS3122
3355	Synertek	SY2833
	TI	TMS3133
34001	SSS	SCL4001
34002	SSS	SCL4002
34011	SSS	SCL4011
34012	SSS	SCL4012
34013	SSS	SCL4013
34019	SSS	SCL4019
34023	SSS	SCL4023
34025	SSS	SCL4025
34027	SSS	SCL4027
34030	SSS	SCL4030
34049	SSS	SCL4049
34050	SSS	SCL4050
3501	AMI	S8457
3501	Collins	CRC3501
	National	MM3501
3507	AMI	S8773
3512	AMI	S8773
3513	AMI	S8773
3514	AMI	S8772
	AMI	53514
	Mostek	MK2600
	National	MM4233
	National	MM5233
	Synertek	SY3514
3534	AMI	S2103
3580	AMI	S8773
3705	**Siliconix**	**SI3705**
	see page 551	
3708	**Siliconix**	**SI3705**
	see page 551	
3730	**AMI**	**S1757**
	see page 532	
	GI	AY5-1013
3731	**AMI**	**S1757**
	see page 532	
3850	**see page 924**	
	Mostek	**3850**
	see page 965	
3851	**see page 924**	
	Mostek	**3851**
	see page 965	
3852	**see page 925**	
	Mostek	**3852**
	see page 966	
3853	**see page 925**	
	Mostek	**3853**
	see page 966	
3854	**see page 925**	
	Mostek	**3854**
	see page 966	
4096	**AMI**	**S4096**
	see page 728	
	EA	EA4096
	EMM/Semi	RO3-4096
	GI	RO3-4096
	Mostek	**MK4096**
	see page 778, 781	
	Rockwell	1604
54H00	Motorola	MC54H00
	Raytheon	54H00
	Signetics	S54H00
	TI	SN54H00
54H01	Motorola	MC54H01
	Raytheon	54H01
	Signetics	S54H01
	TI	SN54H01
54H04	Motorola	MC54H04
	Raytheon	54H04
	Signetics	S54H04
	TI	SN54H04
54H05	Motorola	MC54H05
	Raytheon	54H05
	Signetics	S54H05
	TI	SN54H05
54H08	Motorola	MC54H08
54H10	Motorola	MC54H10
	Raytheon	54H10
	Signetics	S54H10
	TI	SN54H10
54H101	Motorola	MC54H101
	TI	SN54H101
54H102	Motorola	MC54H102
	TI	SN54H102
54H108	Motorola	MC54H108
	TI	SN54H108
54H11	Motorola	MC54H11
	Raytheon	54H11
	TI	SN54H11
54H20	Motorola	MC54H20
	Raytheon	54H20
	Signetics	S54H20
	TI	SN54H20
54H21	Motorola	MC54H21
	TI	SN54H21
54H22	Motorola	MC54H22
	Raytheon	54H22
	TI	SN54H22
54H30	Motorola	MC54H30
	Signetics	S54H30
	TI	SN54H30
54H40	Motorola	MC54H40
	Raytheon	54H40
	Signetics	S54H40
	TI	SN54H40
54H50	Motorola	MC54H50
	TI	SN54H50
54H51	Motorola	MC54H51
	TI	SN54H51
54H52	Motorola	MC54H52
	TI	SN54H52
54H53	Motorola	MC54H53
	TI	SN54H53
54H54	Motorola	MC54H54
	TI	SN54H54
54H55	Motorola	MC54H55
	TI	SN54H55
54H60	Motorola	MC54H60
	TI	SN54H60
54H61	Motorola	MC54H61
	TI	SN54H61
54H62	Motorola	MC54H62
	TI	SN54H62
54H71	Motorola	MC54H71
	TI	SN54H71
54H72	Motorola	MC54H72
	TI	SN54H72
54H73	Motorola	MC54H73
	Signetics	S54H73
	TI	SN54H73
54H74	Motorola	MC54H74
	Raytheon	54H74
	TI	SN54H74
54H76	Signetics	S54H76
	TI	SN54H76
5400	Motorola	MC5400
	Raytheon	5400
	Signetics	S5400
	TI	SN5400
5401	Motorola	MC5401
	Raytheon	5401
	Signetics	S5401
	TI	SN5401
5402	Signetics	S5402
	TI	SN5402
5403	Motorola	MC5403
	Raytheon	5403
	Signetics	S5403
	TI	SN5403
5404	Motorola	MC5404
	Raytheon	5404
	TI	SN5404
5405	Motorola	MC5405
	Raytheon	5405
	Signetics	S5405
	TI	SN5405
5406	Motorola	MC5406
	TI	SN5406
5407	Motorola	MC5407
	TI	SN5407
5408	Motorola	MC5408
	Raytheon	5408
	Signetics	S5408
	TI	SN5408
5409	Motorola	MC5409
	Raytheon	5409
	TI	SN5409
5410	Motorola	MC5410
	Raytheon	5410
	Signetics	S5410
	TI	SN5410
54107	AMD	SN54107
	Motorola	MC54107
	TI	SN54107
5411	Raytheon	5411
	Signetics	S5411
5412	Motorola	MC5412
	Raytheon	5412
	TI	SN5412
54121	Motorola	MC9603
	TI	SN54121
54123	Raytheon	54123
	TI	SN54123
54136	Raytheon	54136
	TI	SN54136
54145	Motorola	MC93145
	Raytheon	54145
	TI	SN54145
5415	Raytheon	5415
54150	Motorola	MC93150
	Raytheon	54150
	TI	SN54150
54151	Motorola	MC93151
	Raytheon	54151
	TI	SN54151A
54152	Motorola	MC93152
	Raytheon	54152
	TI	SN54152A
54153	AMD	SN54153
	Motorola	MC93153
	Raytheon	54153
	TI	SN54153
54154	AMD	SN54154
	Motorola	MC9311
	Raytheon	54154
	TI	SN54154
54155	Raytheon	54155
	TI	SN54155
54156	Raytheon	54156
	TI	SN54156
54157	Motorola	MC9322
	Raytheon	54157
54158	Raytheon	54158
54159	Raytheon	54159
	TI	SN54159
5416	Motorola	MC5416
	TI	SN5416
54160	AMD	SN54160
	Motorola	MC9310
	Raytheon	54160
	TI	SN54160
54161	AMD	SN54161
	Motorola	MC9316
	Raytheon	54161
	TI	SN54161
54162	Raytheon	54162
	TI	SN54162
54163	Raytheon	54163
	TI	SN54163
54164	AMD	SN54164
	Motorola	MC93164
	Raytheon	54164
	TI	SN54164
54166	Raytheon	54166
	TI	SN54166
5417	Motorola	MC9417
	TI	SN5417
54170	Raytheon	54170
	TI	SN54170
54174	Raytheon	54174
	TI	SN54174
54175	Raytheon	54175
	TI	SN54175
54176	Motorola	MC93176
	TI	SN54176
54177	Motorola	MC93177
	TI	SN54177
54178	Motorola	MC93178
	TI	SN54178
54179	Motorola	MC93179
	TI	SN54179
54180	Motorola	MC93180
	Raytheon	54180
	TI	SN54180
54181	AMD	SN54181
	Motorola	MC9341
	Raytheon	54181

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

Fairchild Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
54181	TI	SN54181
54182	AMD	SN54182
	Motorola	MC9342
	Raytheon	54182
	TI	SN54182
54190	Raytheon	54190
	TI	SN54190
54191	Raytheon	54191
	TI	SN54191
54192	AMD	SN54192
	Motorola	MC9360
	Raytheon	54192
	Signetics	S54192
	TI	SN54192
54193	AMD	SN54193
	Motorola	MC9366
	Raytheon	54193
	Signetics	S54193
	TI	SN54193
54194	Raytheon	54194
	TI	SN54194
54195	Raytheon	54195
	TI	SN54195
54198	Raytheon	54198
	TI	SN54198
54199	Raytheon	54199
	TI	SN54199
5420	Motorola	MC5420
	Signetics	S5420
	TI	SN5420
5421	Raytheon	5421
5422	Raytheon	5422
5423	Motorola	MC5423
	TI	SN5423
5425	Motorola	MC5425
	TI	SN5425
5426	Motorola	MC5426
	TI	SN5426
5427	Motorola	MC5427
	TI	SN5427
54283	Raytheon	54283
	TI	SN54283
5430	Motorola	MC5430
	Signetics	S5430
	TI	SN5430
5437	Motorola	MC5437
	TI	SN5437
5438	Motorola	MC5438
	TI	SN5438
5440	Motorola	MC5440
	Signetics	S5440
	TI	SN5440
5442	Motorola	MC9352
	Raytheon	5442
	Signetics	S5442
	TI	SN5442
5443	Motorola	MC9353
	Raytheon	5443
	Signetics	S5443
	TI	SN5443
5444	Motorola	MC9354
	Raytheon	5444
	Signetics	S5444
	TI	SN5444
5445	Motorola	MC9345
	Raytheon	5445
	TI	SN5445
5446	Motorola	MC9357A
	TI	SN5446A
5447	Motorola	MC9357B
	TI	SN5447
5448	Motorola	MC9358
	Signetics	S5448
	TI	SN5448
5449	Motorola	MC9359
	TI	SN5449
5450	Motorola	MC5450
	Signetics	S5450
	TI	SN5450
5451	Motorola	MC5451
	Signetics	S5451
5451	TI	SN5451
5453	Motorola	MC5453
	Signetics	S5453
	TI	SN5453
5454	Motorola	MC5454
	Signetics	S5454
	TI	SN5454
5460	Motorola	MC5460
	Signetics	S5460
	TI	SN5460
5470	Motorola	MC5470
	Signetics	S5470
	TI	SN5470
5472	Motorola	MC5472
	Signetics	S5472
	TI	SN5472
5473	Motorola	MC5473
	Signetics	S5473
	TI	SN5473
5474	Motorola	MC5474
	Raytheon	5474
	Signetics	S5474
	TI	SN5474
5475	Motorola	MC9375
	Signetics	S5475
	TI	SN5475
5476	Motorola	MC5476
	Signetics	S5476
	TI	SN5476
5477	Motorola	MC9377
	TI	SN5477
5480	Motorola	MC9380
	Signetics	S5480
	TI	SN5480
5481	Motorola	MC4304
	Raytheon	5481
	TI	SN5481A
5482	Motorola	MC9382
	TI	SN5482
5483	Motorola	MC9383
	Raytheon	5483
	Signetics	S5483
	TI	SN5483
5486	Raytheon	5486
	Signetics	S5486
	TI	SN5486
5488	Motorola	MCM4002
	TI	SN5488A
5489	AMD	SN5489
	Motorola	MC4064
5490	Motorola	MC9390
	Signetics	S5490
	TI	SN5490A
5491	Motorola	MC9391
	Signetics	S5491
	TI	SN5491A
5492	Motorola	MC9392
	Signetics	S5492
	TI	SN5492A
5493	Motorola	MC9393
	Signetics	S5493
	TI	SN5493A
5494	Motorola	MC9394
	Signetics	S5494
	TI	SN5494
5495	Motorola	MC9395
	Signetics	S5495
	TI	SN5495A
5496	Motorola	MC9396
	Signetics	S5496
	TI	SN5496
55107	AMD	SN55107B
	Raytheon	RM55107
	TI	SN55107
55108	AMD	SN55108
	Raytheon	RM55108
	TI	SN55108
55109	AMD	SN55109
	Raytheon	RM55109
	TI	SN55109
55110	AMD	SN55110
55110	Raytheon	RM55110
	TI	SN55110
55235	Motorola	MC55325
702	Motorola	MC1712
	Raytheon	RC702
	Raytheon	RM702
	TI	SN52702
703	National	LM703
709	Motorola	MC1709
	National	LM709
	Raytheon	RC709
	Raytheon	RM709
	Signetics	µA709
	Teledyne S	709
	TI	SN52709
710	Motorola	MC1710
	National	LM710
	Raytheon	RC710
	Raytheon	RM710
	Signetics	µA710
	Silicon G	SG710
	Teledyne S	710
	TI	SN52710
711	Motorola	MC1711
	National	LM711
	Raytheon	RC711
	Raytheon	RM711
	Signetics	µA711
	Silicon G	SG711
	Teledyne S	711
	TI	SN52711
715	AMD	715
720	Sprague	ULN-2137
723	AMD	723
	Intersil	723
	Motorola	MC1723
	National	LM723
	Raytheon	RC723
	Raytheon	RM723
	Signetics	µA723
	Silicon G	SG723
	Teledyne S	723
	TI	SN52723
7240	**Exar**	**XR2240**
	see page 637	
725	AMD	725
	PMI	SSS725
	Raytheon	RC725
	Raytheon	RM725
729	National	LM1034
	Sprague	ULN-2122
732	National	LM1305
	Sprague	ULN-2120
733	AMD	733
	Motorola	MC1733
	National	LM733
	Raytheon	RC733
	Raytheon	RM733
	Signetics	µA733
	Silicon G	SG733
	TI	SN52733
734	Intersil	734
739	SGS	TBA231
74H00	Motorola	MC74H00
	Raytheon	74H00
	Signetics	N74H00
	TI	SN74H00
74H01	Motorola	MC74H01
	Raytheon	74H01
	Signetics	N74H01
	TI	SN74H01
74H04	Motorola	MC74H04
	Raytheon	74H04
	Signetics	N74H04
	TI	SN74H04
74H05	Motorola	MC74H05
	Raytheon	74H05
	Signetics	N74H05
	TI	SN74H05
74H08	Motorola	MC74H08
74H10	Motorola	MC74H10
74H10	Raytheon	74H10
	Signetics	N74H10
	TI	SN74H10
74H101	Motorola	MC74H101
	TI	SN74H101
74H102	Motorola	MC74H102
	TI	SN74H102
74H105	Motorola	MC9001
74H108	Motorola	MC74H108
	TI	SN74H108
74H11	Motorola	MC74H11
	Raytheon	74H11
	TI	SN74H11
74H20	Motorola	MC74H20
	Raytheon	74H20
	Signetics	N74H20
	TI	SN74H20
74H21	Motorola	MC74H21
	TI	SN74H21
74H22	Motorola	MC74H22
	Raytheon	74H22
	TI	SN74H22
74H30	Motorola	MC74H30
	Signetics	N74H30
	TI	SN74H30
74H40	Motorola	MC74H40
	Raytheon	74H40
	Signetics	N74H40
	TI	SN74H40
74H50	Motorola	MC74H50
	TI	SN74H50
74H51	Motorola	MC74H51
	TI	SN74H51
74H52	Motorola	MC74H52
	TI	SN74H52
74H53	Motorola	MC74H53
	TI	SN74H53
74H54	Motorola	MC74H54
	TI	SN74H54
74H55	Motorola	MC74H55
	TI	SN74H55
74H60	Motorola	MC74H60
	TI	SN74H60
74H61	Motorola	MC74H61
	TI	SN74H61
74H62	Motorola	MC74H62
	TI	SN74H62
74H71	Motorola	MC74H71
	TI	SN74H71
74H72	Motorola	MC74H72
	TI	SN74H72
74H73	Motorola	MC74H73
	Signetics	N74H73
	TI	SN74H73
74H74	Motorola	MC74H74
	Raytheon	74H74
	TI	SN74H74
74H76	Signetics	N74H76
	TI	SN74H76
74S158	AMD	SN74S158
	TI	SN74S158
74S175	AMD	SN74S175
	TI	SN74S175
74S194	AMD	SN74S194
	TI	SN74S194
74S258	AMD	SN74S258
	TI	SN74S258
740	Intersil	740
	Signetics	µA740
7400	Hitachi	HD2503
	Motorola	MC7400
	Raytheon	7400
	Signetics	N7400
	TI	SN7400
7401	Hitachi	HD2509
	Motorola	MC7401
	Raytheon	7401
	Signetics	N7401
	TI	SN7401
7402	Hitachi	HD2511
	Motorola	MC7402

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The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Fairchild Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
7402	Signetics	N7402
	TI	SN7402
7403	Hitachi	HD2528
	Motorola	MC7403
	Raytheon	7403
	Signetics	N7403
	TI	SN7403
7404	Hitachi	HD2522
	Motorola	MC7404
	Raytheon	7404
	Signetics	N7404
	TI	SN7404
7405	Hitachi	HD2523
	Motorola	MC7405
	Raytheon	7405
	Signetics	N7405
	TI	SN7405
7406	Motorola	MC7406
	TI	SN7406
7407	Motorola	MC7407
	TI	SN7407
7408	Hitachi	HD2550
	Motorola	MC7408
	Raytheon	7408
	Signetics	N7408
	TI	SN7408
7409	Motorola	MC7409
	Raytheon	7409
	TI	SN7409
741	AMD	741
	Intersil	741
	Motorola	MC1741
	National	LM741
	PMI	SSS741
	Raytheon	RC741
	Raytheon	RM741
	RCA	**CA741**
	see page 661	
	Signetics	μA741
	Silicon G	SG741
	Teledyne S	741
	TI	SN52741
7410	Hitachi	HD2551
	Motorola	MC7410
	Raytheon	7410
	Signetics	N7410
	TI	SN7410
74107	AMD	SN74107
	Hitachi	HD2530
	Motorola	MC74H107
	TI	SN74107
7411	Raytheon	7411
	Signetics	N7411
7412	Raytheon	7412
	TI	SN7412
74121	Motorola	MC8603
	TI	SN74121
74123	Raytheon	74123
	TI	SN74123
74136	Raytheon	74136
	TI	SN74136
74141	Signetics	N74141
	TI	SN74141
74145	Motorola	MC83145
	Raytheon	74145
	TI	SN74145
7415	Raytheon	7415
74150	Motorola	MC83150
	Raytheon	74150
	TI	SN74150
74151	Motorola	MC83151
	Raytheon	74151
	TI	SN74151A
74152	Motorola	MC83152
	Raytheon	74152
74153	AMD	SN74153
	Motorola	MC83153
	Raytheon	74153
	TI	SN74153
74154	AMD	SN74154
	Motorola	MC8311
74154	Raytheon	74154
	TI	SN74154
74155	Raytheon	74155
	TI	SN74155
74156	Raytheon	74156
74157	AMD	SN74157
	Motorola	MC8322
	Raytheon	74157
	TI	SN74157
74158	Raytheon	74158
74159	Raytheon	74159
	TI	SN74159
7416	Motorola	MC7416
	TI	SN7416
74160	AMD	SN74160
	Motorola	MC8310
	Motorola	MC8316
	Raytheon	74160
	TI	SN74160
74161	Raytheon	74161
	TI	SN74161
74162	Raytheon	74162
	TI	SN74162
74163	Raytheon	74163
	TI	SN74163
74164	AMD	SN74164
	Motorola	MC83164
	Raytheon	74164
	TI	SN74164
74165	Motorola	MC83165
	Raytheon	74165
	TI	SN74165
74166	Raytheon	74166
	TI	SN74166
7417	Motorola	MC7417
	TI	SN7417
74170	Raytheon	74170
	TI	SN74170
74174	AMD	SN74174
	Raytheon	74174
	TI	SN74174
74175	AMD	SN74175
	Raytheon	74175
	TI	SN74175
74176	Motorola	MC83176
	TI	SN74176
74177	Motorola	MC83177
	TI	SN74177
74178	Motorola	MC83178
	TI	SN74178
74179	Motorola	MC83179
	TI	SN74179
74180	Motorola	MC83180
	Raytheon	74180
	TI	SN74180
74181	AMD	SN74181
	Motorola	MC8341
	Raytheon	74181
	TI	SN74181
74182	AMD	SN74182
	Motorola	MC8342
	Raytheon	74182
	TI	SN74182
74190	Raytheon	74190
	TI	SN74190
74191	Raytheon	74191
	TI	SN74191
74192	AMD	SN74192
	Motorola	MC8360
	Raytheon	74192
	Signetics	N74192
	TI	SN72192
74193	AMD	SN74193
	Motorola	MC8366
	Raytheon	74193
	Signetics	N74193
	TI	SN74193
74194	Raytheon	74194
	TI	SN74194
74195	Raytheon	74195
	TI	SN74195
74198	Raytheon	74198
	TI	SN74198
74199	Raytheon	74199
	TI	SN74199
742	Exar	XR742
7420	Hitachi	HD2504
	Motorola	MC7420
	Raytheon	7420
	Signetics	N7420
	TI	SN7420
7421	Raytheon	7421
7422	Raytheon	7422
	TI	SN7422
7423	Motorola	MC7423
	TI	SN7423
7425	Motorola	MC7425
	TI	SN7425
7426	Motorola	MC7426
	TI	SN7426
7427	Motorola	MC7427
	TI	SN7427
74283	Raytheon	74283
	TI	SN74283
7430	Hitachi	HD2508
	Motorola	MC7430
	Signetics	N7430
	TI	SN7430
7437	Motorola	MC7437
	TI	SN7437
7438	Motorola	MC7438
	TI	SN7438
7440	Hitachi	HD2501
	Motorola	MC7440
	Signetics	N7440
	TI	SN7440
7441	Motorola	MC8315
	Signetics	N7441
	TI	SN74141
7442	Motorola	MC8352
	Raytheon	7442
	Signetics	N7442
	TI	SN7442A
7443	Motorola	MC8353
	Raytheon	7443
	Signetics	N7443
	TI	SN7443A
7444	Motorola	MC8354
	Raytheon	7444
	Signetics	N7444
	TI	SN7444A
7445	Motorola	MC8345
	Raytheon	7445
	TI	SN7445
7446	Motorola	MC8357
	TI	SN7446A
74464	Teledyne S	75464
7447	Motorola	MC8357
	Signetics	N7447
	TI	SN7447A
7448	Motorola	MC8358
	Signetics	N7448
	TI	SN7448
7449	Motorola	MC8359
7450	Hitachi	HD2506
	Motorola	MC7450
	Signetics	N7450
	TI	SN7450
7451	Hitachi	HD2505
	Motorola	MC7451
	Signetics	N7451
	TI	SN7451
7453	Hitachi	HD2512
	Motorola	MC7453
	Signetics	N7453
	TI	SN7453
7454	Hitachi	HD2514
	Motorola	MC7454
	Signetics	N7454
	TI	SN7454
746	National	LM746
	RCA	CA3072
746	Sprague	ULN-2114
7460	Hitachi	HD2502
	Motorola	MC7460
	Signetics	N7460
	TI	SN7460
747	AMD	747
	Motorola	MC1747
	National	LM747
	PMI	SSS747
	Raytheon	RC747
	Raytheon	RM747
	RCA	**CA747**
	see page 661	
	Signetics	μA747
	Silicon G	SG747
	Teledyne S	747
	TI	SN52747
7470	Hitachi	HD2539
	Motorola	MC7470
	Signetics	N7470
	TI	SN7470
7472	Hitachi	HD2529
	Motorola	MC7472
	Signetics	N7472
	TI	SN7472
7473	Hitachi	HD2515
	Motorola	MC7473
	Signetics	N7473
	TI	SN7473
7474	Hitachi	HD2510
	Motorola	MC7474
	Raytheon	7474
	Signetics	N7474
	TI	SN7474
7475	Motorola	MC8375
	Signetics	N7475
	TI	SN7475
7476	Hitachi	HD2516
	Motorola	MC7476
	Signetics	N7476
	TI	SN7476
7477	Motorola	MC8377
748	AMD	748
	Intersil	748
	Motorola	MC1748
	National	LM101
	National	LM201
	National	LM748
	Raytheon	RC748
	Raytheon	RM748
	RCA	CA748
	Signetics	μA748
	Silicon G	SG748
	Teledyne S	748
	TI	SN52748
7480	Signetics	N7480
	TI	SN7480
7481	Motorola	MC4004
	Raytheon	7481
	TI	SN7481A
7482	Hitachi	HD2513
	Motorola	MC8382
	TI	SN7482
7483	Motorola	MC8383
	Raytheon	7483
	Signetics	N7483
	TI	SN7483A
7486	Hitachi	HD2526
	Raytheon	7486
	Signetics	N7486
	TI	SN7486
7488	Motorola	MC4002
	TI	SN7488A
7489	AMD	SN7489
	Motorola	MC4064
	TI	SN7489
7490	Hitachi	HD2519
	Motorola	MC8390
	Signetics	N7490
	TI	SN7490A
7491	Hitachi	HD2524

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Manufacturer Device	Replacement Source	Replacement Device
7491	Motorola	MC8391
	Signetics	N7491
	TI	SN7491A
7492	Hitachi	HD2521
	Motorola	MC8392
	Signetics	N7492
	TI	SN7492A
7493	Hitachi	HD2520
	Motorola	MC8393
	Signetics	N7493
	TI	SN7493A
7494	Motorola	MC8394
	Signetics	N7494
	TI	SN7494
7495	Hitachi	HD2534
	Motorola	MC8395
	Signetics	N7495
	TI	SN7495A
7496	Motorola	MC8396
	Signetics	N7496
	TI	SN7496
75107	ITT	ITT75107
75108	ITT	ITT75108
75109	ITT	ITT75109
75110	ITT	ITT75110
75234	ITT	ITT75234
75235	ITT	ITT75235
7524	ITT	ITT7524
	Motorola	MC7524
	National	DS7524
	Signetics	N7524
	TI	SN7524
7525	ITT	ITT7525
	Motorola	MC7525
	National	DS7525
	Signetics	N7525
	TI	SN7525
753	Sprague	ULN-2209
75325	Motorola	MC75325
	National	DS75325
	TI	SN5325
754	National	LM1596
75450	ITT	ITT75450
	National	DS75450
	Signetics	75450
	Teledyne S	75450
	TI	SN75450
75451	ITT	ITT75451
	National	DS75451
	Signetics	75451
	Teledyne S	75451
	TI	SN75451
75452	ITT	ITT75452
	National	DS75452
	Signetics	75452
	Teledyne S	75452
	TI	SN75452
75453	National	DS75453
	Signetics	75453
	Teledyne S	75453
	TI	SN75453
75454	ITT	ITT75454
	National	DS75454
	Signetics	75454
	Teledyne S	75454
	TI	SN75454
75460	ITT	ITT75460
	National	DS75460
	Teledyne S	75460
	TI	SN75460
75461	ITT	ITT75461
	National	DS75461
	Teledyne S	75461
	TI	SN75461
75462	ITT	ITT75462
	National	DS75462
	Teledyne S	75462
	TI	SN75462
75463	National	DS75463
	Teledyne S	75463
	TI	SN75463
75464	ITT	ITT75464
	National	DS75464
	TI	SN75464
75491	National	DS75491
	TI	SN75491
75492	National	DS75492
	TI	SN75492
758	Exar	XR1800
	Sprague	ULN-2244
760	National	LM160
763	National	LM1496
	National	LM1596
767	National	LM360
	Sprague	ULN-2128
776	Harris	HA-2720
	Motorola	MC1776
	National	LM4250
	Silicon G	SG1250
777	Intersil	777
	Motorola	MLM101
	National	LM101
	Silicon G	SG777
	TI	SN52777
780	RCA	CA3070
	Sprague	ULN-2124
7800	Silicon G	SG7800
7805	Motorola	MC7805
	National	LM340-5
	Silicon G	SG7805
	TI	SN72905
7806	Motorola	MC7806
	National	LM340-6
	Silicon G	SG7806
	TI	SN72906
7808	Motorola	MC7808
	National	LM340-8
	Silicon G	SG7808
	TI	SN72908
781	RCA	CA3071
	Sprague	ULN-2127
7812	Motorola	MC7812
	National	LM340-12
	Silicon G	SG7812
	TI	SN72912
7815	Motorola	MC7815
	National	LM340-15
	Silicon G	SG7815
	TI	SN72915
7818	Motorola	MC7818
	National	LM340-18
	Silicon G	SG7818
	TI	SN72918
7824	Motorola	MC7824
	National	LM340-24
	Silicon G	SG7824
	TI	SN72924
795	Lithic Sys	LS1495
	Lithic Sys	LS1595
796	Lithic Sys	LS1496
	Lithic Sys	LS1596
	Motorola	MC1496
	National	LM1496
8T13	National	DS55121
	TI	SN55121
8T14	National	DS55122
	TI	SN55122
8T23	National	DS75123
	TI	SN75123
8T24	National	DS75124
	TI	SN75124
9H00	Motorola	MC54H00
	Motorola	MC74H00
	National	DM54H00
	National	DM74H00
	Signetics	N74H00
	Signetics	S54H00
	TI	SN54H00
	TI	SN74H00
9H01	Motorola	MC54H01
	Motorola	MC74H01
	National	DM54H01
9H01	National	DM74H01
	Signetics	N74H01
	Signetics	S54H01
	TI	SN54H01
	TI	SN74H01
9H04	Motorola	MC54H04
	Motorola	MC74H04
	National	DM54H04
	National	DM74H04
	Signetics	N74H04
	Signetics	S54H04
	TI	SN54H04
	TI	SN74H04
9H05	Motorola	MC54H05
	Motorola	MC74H05
	National	DM54H05
	National	DM74H05
	Signetics	N74H05
	Signetics	S54H05
	TI	SN54H05
	TI	SN74H05
9H08	Motorola	MC54H08
	Motorola	MC74H08
	National	DM54H08
	National	DM74H08
	Signetics	N74H08
	Signetics	S54H08
9H10	Motorola	MC54H10
	Motorola	MC74H10
	National	DM54H10
	National	DM74H10
	Signetics	N74H10
	Signetics	S54H10
9H101	Motorola	MC54H101
	Motorola	MC74H101
	Signetics	N74H101
	Signetics	S54H101
	TI	SN54H101
	TI	SN74H101
9H102	Motorola	MC54H102
	Motorola	MC74H102
	Signetics	N74H102
	Signetics	S54H102
9H103	National	DM54H103
	National	DM74H103
	TI	SN54H103
	TI	SN74H103
9H106	National	DM54H106
	National	DM74H106
	Signetics	N74H106
	Signetics	S54H106
	TI	SN54H106
	TI	SN74H106
9H108	Motorola	MC54H108
	Motorola	MC74H108
	National	DM54H108
	National	DM74H108
	Signetics	N74H108
	Signetics	S54H108
	TI	SN54H108
	TI	SN74H108
9H11	Motorola	MC54H11
	Motorola	MC74H11
	National	DM54H11
	National	DM74H11
	Signetics	N74H11
	Signetics	S54H11
	TI	SN54H11
	TI	SN74H11
9H20	Motorola	MC54H20
	Motorola	MC74H20
	National	DM54H20
	National	DM74H20
	Signetics	N74H20
	Signetics	S54H20
	TI	SN54H20
	TI	SN74H20
9H21	Motorola	MC54H21
	Motorola	MC74H21
	National	DM54H21
	National	DM74H21
9H21	TI	SN54H21
	TI	SN74H21
9H22	Motorola	MC54H22
	Motorola	MC74H22
	National	DM54H22
	National	DM74H22
	Signetics	N74H22
	Signetics	S54H22
	TI	SN54H22
	TI	SN74H22
9H30	Motorola	MC54H30
	Motorola	MC74H30
	National	DM54H30
	National	DM74H30
	Signetics	N74H30
	Signetics	S54H30
	TI	SN54H30
	TI	SN74H30
9H40	Motorola	MC54H40
	Motorola	MC74H40
	National	DM54H40
	National	DM74H40
	Signetics	N74H40
	Signetics	S54H40
	TI	SN54H40
	TI	SN74H40
9H50	Motorola	MC74H50
	National	DM54H50
	National	DM74H50
	Signetics	N74H50
	Signetics	S54H50
	TI	SN54H50
	TI	SN74H50
9H51	Motorola	MC54H51
	Motorola	MC74H51
	National	DM54H51
	National	DM74H51
	Signetics	N74H51
	Signetics	S54H51
	TI	SN54H51
	TI	SN74H51
9H52	Motorola	MC54H52
	Motorola	MC74H52
	National	DM54H52
	National	DM74H52
	TI	SN54H51
	TI	SN74H51
9H53	Motorola	MC54H53
	Motorola	MC74H53
	National	DM54H53
	National	DM74H53
	TI	SN54H53
	TI	SN74H53
9H54	Motorola	MC54H54
	Motorola	MC74H54
	National	DM54H54
	National	DM74H54
	TI	SN54H54
	TI	SN74H54
9H55	Motorola	MC54H55
	Motorola	MC74H55
	National	DM54H55
	National	DM74H55
	TI	SN54H55
	TI	SN74H55
9H60	Motorola	MC54H60
	Motorola	MC74H60
	National	DM54H60
	National	DM74H60
	TI	SN54H60
	TI	SN74H60
9H61	Motorola	MC54H61
	Motorola	MC74H61
	National	DM54H61
	National	DM74H61
	Signetics	N74H61
	Signetics	S54H61
	TI	SN54H61
	TI	SN74H61
9H62	Motorola	MC54H62
	Motorola	MC74H62

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

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Fairchild Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
9H62	National	DM54H62
	National	DM74H62
	Signetics	N74H62
	Signetics	S54H62
	TI	SN54H62
	TI	SN74H62
9H71	Motorola	MC54H71
	Motorola	MC74H71
	National	DM54H71
	National	DM74H71
	Signetics	N74H71
	Signetics	S54H71
	TI	SN54H71
	TI	SN74H71
9H72	Motorola	MC54H72
	National	DM54H72
	National	DM74H72
	Signetics	N74H72
	Signetics	S54H72
	TI	SN54H72
	TI	SN74H72
9H73	Motorola	MC54H73
	National	DM54H73
	National	DM74H73
	Signetics	N74H73
	Signetics	S54H73
9H74	Motorola	MC54H74
	Motorola	MC74H74
	National	DM54H74
	National	DM74H74
	Signetics	N74H74
	Signetics	S54H74
	TI	SN54H74
	TI	SN74H74
9H76	National	DM54H76
	National	DM74H76
	Signetics	N74H76
	Signetics	S54H76
	TI	SN54H76
	TI	SN74H76
9H78	National	DM54H78
	National	DM74H78
	TI	SN54H78
	TI	SN74H78
9LA38	Raytheon see page 282	54LS38
9LD27	Raytheon see page 282	54LS27
9LS00	Raytheon see page 282	54LS00
9LS02	Raytheon see page 282	54LS02
9LS03	Raytheon see page 282	54LS03
9LS04	Raytheon see page 282	54LS04
9LS05	Raytheon see page 282	54LS05
9LS08	Raytheon see page 282	54LS08
9LS10	Raytheon see page 282	54LS10
9LS109	Raytheon see page 282	54LS109
9LS11	Raytheon see page 282	54LS11
9LS112	Raytheon see page 282	54LS112
9LS113	Raytheon see page 282	54LS113
9LS114	Raytheon see page 282	54LS114
9LS132	Raytheon	54LS132
9LS136	Raytheon see page 282	54LS136
9LS138	Raytheon see page 282	54LS138
9LS139	Raytheon see page 282	54LS139
9LS14	Raytheon	54LS14
9LS15	Raytheon see page 282	54LS15
9LS151	Raytheon see page 282	54LS151
9LS152	Raytheon see page 282	54LS152
9LS153	Raytheon see page 282	54LS153
9LS155	Raytheon see page 282	54LS155
9LS156	Raytheon see page 282	54LS156
9LS157	Raytheon see page 282	54LS157
9LS158	Raytheon see page 282	54LS158
9LS160	Raytheon see page 282	54LS160
9LS161	Raytheon see page 282	54LS161
9LS162	Raytheon see page 282	54LS162
9LS163	Raytheon see page 282	54LS163
9LS164	Raytheon	54LS164
9LS174	Raytheon see page 282	54LS174
9LS175	Raytheon	54LS175
9LS181	Raytheon see page 282	54LS181
9LS190	Raytheon	54LS19
9LS191	Raytheon see page 282	54LS191
9LS192	Raytheon see page 282	54LS192
9LS193	Raytheon see page 282	54LS193
9LS194	Raytheon see page 282	54LS194A
9LS195	Raytheon see page 282	54LS195A
9LS196	Raytheon see page 282	54LS196
9LS20	Raytheon see page 282	54LS20
9LS21	Raytheon	54LS21
9LS22	Raytheon see page 282	54LS22
9LS251	Raytheon see page 282	54LS251
9LS253	Raytheon see page 282	54LS253
9LS257	Raytheon see page 282	54LS257
9LS258	Raytheon see page 282	54LS258
9LS266	Raytheon see page 282	54LS266
9LS283	Raytheon see page 282	54LS283
9LS295	Raytheon see page 282	54LS295A
9LS30	Raytheon see page 282	54LS30
9LS32	Raytheon see page 282	54LS32
9LS37	Raytheon see page 282	54LS37
9LS40	Raytheon see page 282	54LS40
9LS51	Raytheon see page 282	54LS51
9LS54	Raytheon see page 282	54LS54
9LS55	Raytheon see page 282	54LS55
9LS670	Raytheon	54LS670
9LS74	Raytheon see page 282	54LS74
9LS83	Raytheon	54LS83
9LS86	Raytheon see page 282	54LS86
9LS95	Raytheon see page 282	54LS95B
9N00	Motorola	MC5400
	Motorola	MC7400
	National	DM7400
	Signetics	N7400
	Signetics	S5400
	TI	SN5400
	TI	SN7400
9N01	Motorola	MC5401
	Motorola	MC7401
	National	DM7401
	Signetics	N7401
	Signetics	S5401
	TI	SN5401
	TI	SN7401
9N02	Motorola	MC7402
	National	DM7402
	Signetics	N7402
	Signetics	S5402
	TI	SN5402
	TI	SN7402
9N03	Motorola	MC5403
	Motorola	MC7403
	National	DM7403
	Signetics	N7403
	Signetics	S5403
	TI	SN5403
	TI	SN7403
9N04	Motorola	MC5404
	Motorola	MC7404
	National	DM7404
	Signetics	N7404
	Signetics	S5404
	TI	SN5404
	TI	SN7404
9N05	Motorola	MC5405
	Motorola	MC7405
	National	DM7405
	Signetics	N7405
	Signetics	S5405
	TI	SN5405
	TI	SN7405
9N06	Motorola	MC5406
	Motorola	MC7406
	National	DM7406
	Signetics	N7406
	Signetics	S5406
	TI	SN5406
	TI	SN7406
9N07	Motorola	MC5407
	Motorola	MC7407
	National	DM7407
	Signetics	N7407
	Signetics	S5407
	TI	SN5407
	TI	SN7407
9N08	Motorola	MC5408
	Motorola	MC7408
	National	DM7408
	Signetics	N7408
	Signetics	S5408
	TI	SN5408
	TI	SN7408
9N09	Motorola	MC5409
	Motorola	MC7409
	National	DM7409
	Signetics	N7409
	TI	SN5409
	TI	SN7409
9N10	Motorola	MC5410
	Motorola	MC7410
	National	DM7410
	Signetics	S5410
	TI	SN5410
	TI	SN7410
9N107	Motorola	MC54107
	Motorola	MC74H107
	National	DM74107
	Signetics	N74107
	Signetics	S54107
	TI	SN54107
	TI	SN74107
9N11	National	DM7411
	Signetics	N7411
	Signetics	S5411
9N12	Motorola	MC5412
	TI	SN5412
	TI	SN7412
9N122	National	DM74122
	TI	SN54122
	TI	SN74122
9N123	National	DM74123
	TI	SN54123
	TI	SN74123
9N13	National	DM7413
	TI	SN5413
	TI	SN7413
9N132	National	DM74132
	TI	SN54132
	TI	SN74132
9N14	National	DM7414
	TI	SN5414
	TI	SN7414
9N16	Motorola	MC5416
	Motorola	MC7416
	National	DM7416
	TI	SN5416
	TI	SN7416
9N17	Motorola	MC7417
	Motorola	MC9417
	National	DM7417
	TI	SN5417
	TI	SN7417
9N20	Motorola	MC5420
	Motorola	MC7420
	National	DM7420
	Signetics	N7420
	Signetics	S5420
	TI	SN5420
	TI	SN7420
9N23	Motorola	MC5423
	Motorola	MC7423
	National	DM7423
	TI	SN5423
	TI	SN7423
9N25	Motorola	MC5425
	Motorola	MC7425
	National	DM7425
	TI	SN5425
	TI	SN7425
9N26	Motorola	MC5426
	Motorola	MC7426
	National	DM7426
	Signetics	S5426
	TI	SN5426
	TI	SN7426
9N27	Motorola	MC5427
	Motorola	MC7427
	National	DM7427
	TI	SN5427
	TI	SN7427
9N30	Motorola	MC5430
	Motorola	MC7430
	National	DM7430
	Signetics	N7430
	Signetics	S5430
	TI	SN5430
	TI	SN7430
9N32	National	DM7432
	TI	SN5432
	TI	SN7432
9N37	Motorola	MC5437
	Motorola	MC7437
	National	DM7437
	TI	SN5437
	TI	SN7437
9N38	Motorola	MC5438
	Motorola	MC7438
	National	DM7438
	TI	SN5438
	TI	SN7438
9N40	Motorola	MC5440
	Motorola	MC7440

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Bold face device number indicates additional data is provided in Catalog section

Fairchild Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
9N40	National	DM7440
	Signetics	N7440
	Signetics	S5440
	TI	SN5440
	TI	SN7440
9N50	Motorola	MC5450
	Motorola	MC7450
	National	DM7450
	Signetics	N7450
	Signetics	S5450
	TI	SN5450
	TI	SN7450
9N51	Motorola	MC5451
	Motorola	MC7451
	National	DM7451
	Signetics	N7451
	Signetics	S5451
	TI	SN5451
	TI	SN7451
9N53	Motorola	MC5453
	Motorola	MC7453
	National	DM7453
	Signetics	N7453
	Signetics	S5453
	TI	SN5453
	TI	SN7453
9N54	Motorola	MC5454
	Motorola	MC7454
	National	DM7454
	Signetics	N7454
	Signetics	S5454
	TI	SN5454
	TI	SN7454
9N60	Motorola	MC5460
	Motorola	MC7460
	National	DM7460
	Signetics	N7460
	Signetics	S5460
	TI	SN5460
	TI	SN7460
9N70	Motorola	MC5470
	Motorola	MC7470
	National	DM7470
	Signetics	N7470
	Signetics	S5470
	TI	SN5470
	TI	SN7470
9N72	Motorola	MC5472
	Motorola	MC7472
	National	DM7472
	Signetics	N7472
	Signetics	S5472
	TI	SN5472
	TI	SN7472
9N73	Motorola	MC5473
	Motorola	MC7473
	National	DM7473
	Signetics	N7473
	Signetics	S5473
	TI	SN5473
	TI	SN7473
9N74	Motorola	MC5474
	Motorola	MC7474
	National	DM7474
	Raytheon	5474
	Signetics	N7474
	Signetics	S5474
	TI	SN5474
	TI	SN7474
9N75	Motorola	MC8375
	TI	SN5475
	TI	SN7475
9N76	Motorola	MC5476
	Motorola	MC7476
	National	DM7476
	Signetics	N7476
	Signetics	S5476
	TI	SN5476
	TI	SN7476
9N86	National	DM7486
	Raytheon	5486
	Signetics	N7486
	Signetics	S5486
	TI	SN5486
	TI	SN7486
9S00	National	DM74S00
	Signetics	N74S00
	TI	SN54S00
	TI	SN74S00
9S03	National	DM74S03
	Signetics	N74S03
	TI	SN54S03
	TI	SN74S03
9S04	National	DM74S04
	Signetics	N74S04
	TI	SN54S04
	TI	SN74S04
9S05	National	DM74S05
	Signetics	N74S05
	TI	SN54S05
	TI	SN74S05
9S10	National	DM74S10
	TI	SN54S10
	TI	SN74S10
9S11	National	DM74S11
	TI	SN54S11
	TI	SN74S11
9S112	National	DM74S112
	TI	SN54S112
	TI	SN74S112
9S113	National	DM74S113
	TI	SN54S113
	TI	SN74S113
9S114	National	DM74S114
	TI	SN54S114
	TI	SN74S114
9S140	National	DM74S140
	TI	SN54S140
	TI	SN74S140
9S15	National	DM74S15
	TI	SN54S15
	TI	SN74S15
9S20	National	DM74S20
	Signetics	N74S20
	TI	SN54S20
	TI	SN74S20
9S22	National	DM74S22
	Signetics	N74S22
	TI	SN54S22
	TI	SN74S22
9S40	National	DM74S40
	Signetics	N74S40
	TI	SN54S40
	TI	SN74S40
9S64	National	DM74S64
	Signetics	N74S64
	TI	SN54S64
	TI	SN74S64
9S65	National	DM74S65
	Signetics	N74S65
	TI	SN54S65
	TI	SN74S65
9S74	National	DM74S74
9000	ITT	ITT9000
9001	ITT	ITT9001
	Motorola	MC3052
	Motorola	MC9001
	TI	SN29001
9002	ITT	ITT9002
	Motorola	MC7400
	National	DM9002C
	TI	SN29002
9003	ITT	ITT9003
	Motorola	MC7410
	National	DM9003C
	TI	SN29003
9004	ITT	ITT9004
	Motorola	MC7420
	National	DM9004C
	TI	SN29004
9005	ITT	ITT9005
	Motorola	MC7450
	National	DM9005C
	TI	SN29005
9006	ITT	ITT9006
	Motorola	MC7460
	National	DM9006C
9007	ITT	ITT9007
	TI	SN29007
9008	ITT	ITT9008
	National	DM9008C
	TI	SN29008
9009	ITT	ITT9009
	Motorola	MC7440
	National	DM9009C
	TI	SN29009
9012	ITT	ITT9012
	National	DM9012C
	TI	SN29012
9016	ITT	ITT9016
	Motorola	MC7404
	National	DM9016C
	TI	SN29016
9017	ITT	ITT9017
9020	ITT	ITT9020
9022	ITT	ITT9022
9024	ITT	ITT9024
	National	DM74109
	Signetics	N74109
	TI	SN54109
	TI	SN74109
9031	Signetics	N8252
9033	Hitachi	HM2501
	ITT	ITT9033
	TI	SN5481A
	TI	SN7481A
9034	Fairchild	93434
	Motorola	MCM4002
	Signetics	N8224
	TI	SN5488A
	TI	SN7488A
9093	Hitachi	HD2211
	Raytheon	RM993
	SW	SW705
	TI	SN158093
	TI	SN159093
9094	Raytheon	RM994
	SW	SW708
	TI	SN158094
	TI	SN159094
9097	Raytheon	RM997
	SW	SW709
	TI	SN158097
	TI	SN159097
9099	Hitachi	HD2210
	Raytheon	RM999
	SW	SW706
	TI	SN158099
	TI	SN159099
9157	SW	SW957
9158	SW	SW958
93L00	AMD	93L00
93L01	AMD	93L01
93L08	AMD	93L08
93L10	AMD	93L10
93L11	AMD	93L11
93L12	AMD	93L12
93L14	AMD	93L14
93L16	AMD	93L16
93L18	AMD	93L18
93L21	AMD	93L21
93L22	AMD	93L22
93L24	AMD	93L24
93L28	AMD	93L28
93L34	AMD	93L34
93L38	AMD	93L38
93L40	AMD	93L40
93L41	AMD	93L41
93L60	AMD	93L60
93L66	AMD	93L66
93S10	AMD	93S10
93S12	AMD	93S12
93S153	National	DM74S153
93S157	National	DM74S157
	TI	SN54S167
	TI	SN74S167
93S16	AMD	93S16
93S21	AMD	93S21
93S22	AMD	93S22
	National	DM74S22
	TI	SN54S157
	TI	SN74S157
93S47	National	DM74S47
93S48	AMD	93S48
9300	AMD	9300
	ITT	ITT9300
	Motorola	MC9300
	National	DM9300
	Raytheon	RC9300
	Raytheon	RM9300
	TI	SN54195
	TI	SN74195
9301	AMD	9301
	ITT	ITT9301
	Motorola	MC9301
	National	DM9301
	TI	SN29301
	TI	SN39301
9304	AMD	9304
	ITT	ITT9304
	Motorola	MC9304
	Raytheon	RC9304
	Raytheon	RM9304
9306	AMD	9306
	Motorola	MC9306
9307	Motorola	MC9307
9308	AMD	9308
	ITT	ITT9308
	Motorola	MC9308
	Raytheon	RC9308
	Raytheon	RM9308
	TI	SN29308
	TI	SN39308
9309	AMD	9309
	Motorola	MC9309
	National	DM9309
	TI	SN29309
	TI	SN39309
9310	AMD	9310
	Motorola	MC8310
	Motorola	MC9310
	National	DM74160
	Raytheon	RC9310
	Raytheon	RM9310
	TI	SN54160
	TI	SN74160
9311	AMD	9311
	ITT	ITT9311
	Motorola	MC8311
	Motorola	MC9311
	Raytheon	RC9311
	Raytheon	RM9311
	TI	SN54154
	TI	SN74154
9312	AMD	9312
	ITT	ITT9312
	Motorola	MC9312
	National	DM9312
	Raytheon	RC9312
	Raytheon	RM9312
	Signetics	N8230
	TI	SN29312
	TI	SN39312
9314	AMD	9314
	Motorola	MC9314
93141	National	DM74141
	TI	SN74141
93145	ITT	ITT74145
	Motorola	MC83145
	Motorola	MC93145
	National	DM74145
	Raytheon	54145
	Raytheon	74145
	TI	SN54145

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Fairchild Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
93145	TI	SN74145
9315	Motorola	MC8315
	Motorola	MC9315
	National	DM7441A
	National	DM7741A
	Signetics	N7441
	TI	SN74141
93150	ITT	ITT74150
	Motorola	MC83150
	Motorola	MC93150
	National	DM74150
	Raytheon	54150
	Raytheon	74150
	TI	SN54150
	TI	SN74150
93151	ITT	ITT74151
	Motorola	MC83151
	Motorola	MC93151
	National	DM74151
	Raytheon	54151
	Raytheon	74151
	TI	SN54151A
	TI	SN74151A
93152	Motorola	MC83152
	Motorola	MC93152
	Raytheon	54152
	Raytheon	74152
	TI	SN54152A
93153	ITT	ITT74153
	Motorola	MC83153
	Motorola	MC93153
	National	DM74153
	Raytheon	54153
	Raytheon	74153
	TI	SN54153
	TI	SN74153
93155	National	DM74155
	Raytheon	54155
	Raytheon	74155
	TI	SN54155
	TI	SN74155
93156	National	DM74156
	Raytheon	54156
	Raytheon	74156
	TI	SN54156
	TI	SN74156
9316	AMD	9316
	ITT	ITT9316
	Motorola	MC8316
	Motorola	MC9316
	National	DM74161
	Raytheon	RC9316
	Raytheon	RM9316
	TI	SN54161
	TI	SN74161
93163	Raytheon	54163
	Raytheon	74163
	TI	SN54163
	TI	SN74163
93164	AMD	SN74164
	Motorola	MC83164
	Motorola	MC93164
	National	DM74164
	TI	SN54164
	TI	SN74164
93165	ITT	ITT74165
	Motorola	MC83165
	National	DM74165
	Raytheon	54165
	Raytheon	74165
	TI	SN54165
	TI	SN74165
93166	National	DM74166
	Raytheon	54166
	Raytheon	74166
	TI	SN54166
	TI	SN74166
9317B	National	DM7447
	TI	SN5447A
	TI	SN7447A
9317C	National	DM7446
9317C	TI	SN5446A
	TI	SN7446A
93170	National	DM74170
	Raytheon	54170
	Raytheon	74170
	TI	SN54170
	TI	SN74170
93174	AMD	SN74174
	National	DM74174
	Raytheon	54174
	Raytheon	74174
	TI	SN54174
	TI	SN74174
93175	AMD	SN74175
	National	DM74175
	Raytheon	54175
	Raytheon	74175
	TI	SN54175
	TI	SN74175
93176	Motorola	MC93176
	National	DM74176
	TI	SN54176
	TI	SN74176
93177	Motorola	MC83177
	Motorola	MC93177
	National	DM74177
	TI	SN54177
	TI	SN74177
93178	Motorola	MC83178
	Motorola	MC93178
	TI	SN54178
	TI	SN74178
93179	Motorola	MC83179
	Motorola	MC93179
	TI	SN54179
	TI	SN74179
9318	AMD	9318
	Motorola	MC9318
	TI	SN54148
	TI	SN74148
93180	ITT	ITT74180
	Motorola	MC83180
	Motorola	MC93180
	National	DM74180
	Raytheon	54180
	Raytheon	74180
	TI	SN54180
	TI	SN74180
93190	National	DM74190
	Raytheon	54190
	Raytheon	74190
	TI	SN54190
	TI	SN74190
93191	National	DM74191
	Raytheon	54191
	Raytheon	74191
	TI	SN54191
	TI	SN74191
93194	AMD	SN74194
	National	DM74194
	Raytheon	54194
	Raytheon	74194
	TI	SN54194
	TI	SN74194
93196	Motorola	MC7280
	National	DM74196
	TI	SN54196
	TI	SN74196
93197	Motorola	MC8280
	National	DM74197
	TI	SN54197
	TI	SN74197
93198	Motorola	MC8316
	National	DM74198
	Raytheon	54198
	Raytheon	74198
	Signetics	N74198
	Signetics	S54198
	TI	SN54198
	TI	SN74198
93199	National	DM74199
93199	Raytheon	54199
	Raytheon	74199
	TI	SN54199
	TI	SN74199
9321	AMD	9321
9322	AMD	9322
	ITT	ITT9322
	Motorola	MC8322
	Motorola	MC9322
	National	DM74157
	Raytheon	RC9322
	Raytheon	RM9322
	Raytheon	54157
	Raytheon	74157
	TI	SN54157
	TI	SN74157
9324	AMD	9324
	Motorola	MC9324
9325	National	DM74141
	Signetics	N74141
	Signetics	S54141
	TI	SN74141
9328	AMD	9328
	ITT	ITT9328
	Motorola	MC9328
	Signetics	N8277
9334	AMD	9334
	Motorola	MC9334
	National	DM9334
	TI	SN54259
	TI	SN74259
9338	AMD	9338
9340	AMD	9340
93400	Motorola	MCM4012
93403	AMD	93403
	Intersil	IM5501
	MMI	6560
	Motorola	MCM4064
	Motorola	MC4064
	National	DM7489
	Signetics	**N82S25**
	see page 804, 806, 814,	
	TI	SN7489
93406	Intersil	IM5603
	MMI	6200
	Motorola	MCM4006
	National	DM54187
	National	DM74187
	Signetics	N82S226
	TI	SN54187
	TI	SN74187
93407	ITT	ITT7481
	Motorola	MC4004
	Motorola	MC4304
	TI	SN5481A
	TI	SN7481A
9341	AMD	9341
	ITT	ITT74181
	Motorola	MC8341
	Motorola	MC9341
	National	DM74181
	Raytheon	RC9341
	Raytheon	RM9341
	Raytheon	54181
	Raytheon	74181
	Signetics	N74181
	Signetics	S54181
	TI	SN54181
	TI	SN74181
¶ 93410	Motorola	MCM4056
	Signetics	**N74S301**
	see page 804, 806, 815,	
	Signetics	N93410
	Signetics	**S54S301**
	see page 804, 806, 815,	
	Signetics	S93410
	TI	SN54S301
	TI	SN74S301
93411	Intersil	IM5533
	MMI	MM16531
	MMI	5530
93411	MMI	6530
	Raytheon	RC5330
	Raytheon	RM5330
	Signetics	**N74S201**
	see page 804, 806, 815,	
	Signetics	**N82S12**
	see page 804, 806, 810,	
	TI	SN54S201
	TI	SN74S201
93412	Intersil	IM5600
	TI	SN54S214
	TI	SN74S214
93415	**Intel**	**2115**
	see page 766, 769	
	Intersil	IM5508
	Raytheon	RC5500
	Raytheon	RM5500
	Signetics	**N82S10**
	see page 804, 806, 818,	
	TI	SN54S314
	TI	SN74S314
93416	Harris	HPROM-1024
	Harris	HPROM-1024A
	Intel	**3601**
	see page 772, 773	
	Intersil	IM5603
	MMI	6300
	National	DM7573
	National	DM8573
	Signetics	**N82S126**
	see page 804, 826, 835,	
93417	MMI	5300
	National	DN7573
	TI	SN54S387
	TI	SN74S387
9342	AMD	9342
	ITT	ITT74182
	Motorola	MC8342
	Motorola	MC9342
	National	DM74182
	Raytheon	RM9342
	Raytheon	54182
	Raytheon	74182
	Signetics	N74182
	Signetics	S54182
	TI	SN54182
	TI	SN74182
93421	Intersil	IM5523
	MMI	5531
	MMI	6531
	Raytheon	RC5340
	Raytheon	RM5340
	Signetics	**N82S16**
	see page 804, 806, 815,	
	TI	SN54S201
	TI	SN74S201
93425	**Intel**	**2125**
	see page 766, 769	
93426	Harris	HPROM-1024A
	Intersil	IM5623
	MMI	6301
	National	DM7574
	National	DM8574
	Signetics	N82S129
	TI	SN54S287
	TI	SN74S287
93433	Motorola	MC4004
	TI	SN83433
	TI	SN93433
93434	Intersil	IM5600
	ITT	ITT7488
	ITT	ITT7488A
	MMI	5230
	MMI	6230
	Motorola	MCM4002
	National	DM5487
	National	DM7488
	Signetics	8223
	TI	SN5488A
	TI	SN7488A
93435	MMI	5560

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

Fairchild Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
93435	MMI	6560
	Motorola	MC4064
	TI	SN7489
93436	Intel	3602
	see page 774, 775	
	Intersil	IM5604
	MMI	5205
	MMI	6205
	TI	SN54S270
	TI	SN74S270
93438	TI	SN54S475
	TI	SN74S475
93446	Intel	3622
	see page 774, 775	
93448	TI	SN54S474
	TI	SN74S474
9345	ITT	ITT7445
	Motorola	MC9345
	National	DM7445
	Raytheon	5445
	Raytheon	7445
	Signetics	N7445
	Signetics	S5445
	TI	SN5445
	TI	SN7445
9349	Raytheon	54180
	Raytheon	74180
	Signetics	N74180
	Signetics	S54180
	TI	SN54180
	TI	SN74180
9352	ITT	ITT7442
	Motorola	MC8352
	Motorola	MC9352
	National	DM7442
	Signetics	N7442
	Signetics	S5442
	TI	SN5442
	TI	SN7442
9353	ITT	ITT7443
	Motorola	MC8353
	Motorola	MC9353
	Signetics	N7443
	Signetics	S5443
	TI	SN5443
	TI	SN7443
9354	ITT	ITT7444
	Motorola	MC8354
	Motorola	MC9354
	Signetics	N7444
	Signetics	S5444
	TI	SN5444
	TI	SN7444
9355	Motorola	MC8355
9357	Motorola	MC8357
	Motorola	MC9357
9357A	ITT	ITT7446A
	Motorola	MC9357A
	National	DM7446A
	Signetics	N7446
	TI	SN5446A
	TI	SN7446A
9357B	ITT	ITT7447A
	Motorola	MC9357B
	National	DM7447A
	Signetics	N7447
	TI	SN5447A
	TI	SN7447A
9358	ITT	ITT7448
	Motorola	MC8358
	Motorola	MC9358
	National	DM7448
	Signetics	N7448
	TI	SN5448
	TI	SN7448
9359	Motorola	MC8359
	Motorola	MC9359
9360	AMD	9360
	ITT	ITT74192
	Motorola	MC8360
	Motorola	MC9360
9360	National	DM74192
	Raytheon	RC9360
	Raytheon	RM9360
	Raytheon	54192
	Raytheon	74192
	Signetics	N74192
	Signetics	S54192
	TI	SN54192
	TI	SN74192
9366	AMD	9366
	ITT	ITT74193
	Motorola	MC8366
	Motorola	MC9366
	National	DM74193
	Raytheon	RM9366
	Raytheon	54193
	Raytheon	74193
	Signetics	N74192
	Signetics	S54192
	TI	SN54193
	TI	SN74193
9375	ITT	ITT7475
	Motorola	MC9375
	National	DM7475
	Signetics	N7475
	Signetics	S5475
	TI	SN5475
	TI	SN7475
9377	Motorola	MC8377
	Motorola	MC9377
9380	ITT	ITT7480
	Motorola	MC8380
	Motorola	MC9380
	Signetics	N7480
	Signetics	S5480
	TI	SN5480
	TI	SN7480
9382	ITT	ITT7482
	Motorola	MC8382
	Motorola	MC9382
	National	DM7482
	TI	SN5482
	TI	SN7482
9383	ITT	ITT7483
	Motorola	MC8383
	Motorola	MC9383
	National	DM7483
	Signetics	N7483
	Signetics	S5483
	TI	SN5483
	TI	SN7483
9385	National	DM7485
9390	ITT	ITT7490
	Motorola	MC8390
	Motorola	MC9390
	National	DM7490
	Signetics	N7490
	Signetics	S5490
	TI	SN5490
	TI	SN7490
9391	ITT	ITT7491
	Motorola	MC8391
	Motorola	MC9391
	National	DM7491
	Signetics	N7491
	Signetics	S5491
	TI	SN5491
	TI	SN7491
9392	ITT	ITT7492
	Motorola	MC8392
	Motorola	MC9392
	National	DM7492
	Signetics	N9392
	Signetics	S9392
	TI	SN5492
	TI	SN7492
9393	ITT	ITT7493
	Motorola	MC8393
	Motorola	MC9393
	National	DM7493
	Signetics	N7493
9393	Signetics	S5493
	TI	SN5493
	TI	SN7493
9394	ITT	ITT7494
	Motorola	MC8394
	Motorola	MC9394
	Signetics	N7494
	Signetics	S5494
	TI	SN5494
	TI	SN7494
9395	ITT	ITT7495A
	Motorola	MC8395
	Motorola	MC9395
	National	DM7495
	Signetics	N7495
	Signetics	S5495
	TI	SN5495
	TI	SN7495
9396	ITT	ITT7496
	Motorola	MC8396
	Motorola	MC9396
	National	DM7496
	Signetics	N7496
	Signetics	S5496
	TI	SN5496
	TI	SN7496
95H90	Plessey	SP640
95H91	Plessey	SP641
95H92	Plessey	SP642
95H93	Plessey	SP643
9600	AMD	9600
9601	AMD	9601
	ITT	ITT9601
	Motorola	MC9601
	National	DM9601
	Raytheon	RF8601
	Raytheon	RF9601
	TI	SN29601
9602	AMD	9602
	ITT	ITT9602
	Motorola	MC9602
	National	DM9602
	Raytheon	RF8602
	Raytheon	RF9602
9603	ITT	ITT74121
	Motorola	MC8603
	Motorola	MC9603
	Signetics	N74121
	Signetics	S54121
	TI	SN54121
	TI	SN74121
9614	AMD	9614
	ITT	ITT9614
	TI	SN55114
9615	AMD	9615
	ITT	ITT9615
	TI	SN55115
9616	AMD	9616
9617	AMD	9617
9620	AMD	9620
9621	AMD	9621
	Raytheon	RC9621
	Raytheon	RM9621
9622	Raytheon	RC9622
	Raytheon	RM9622
9664	Signetics	N7524
9665	Signetics	N7525
98176	Motorola	MC83176
9930	Hitachi	HD2204
	Raytheon	RM930
	SW	SW930
	TI	SN15830
	TI	SN15930
9932	Hitachi	HD2201
	Raytheon	RM932
	SW	SW932
	TI	SN15832
	TI	SN15932
9933	Hitachi	HD2202
	Raytheon	RM933
	SW	SW933
9933	TI	SN15833
	TI	SN15933
9935	Hitachi	HD2208
	Raytheon	RM935
	SW	SW935
	TI	SN15835
	TI	SN15935
9936	Hitachi	HD2206
	Raytheon	RM936
	SW	SW936
	TI	SN15836
	TI	SN15936
9937	Raytheon	RM937
	SW	SW937
	TI	SN15839
	TI	SN15937
9941	Raytheon	RM941
	SW	SW941
	TI	SN15841
	TI	SN15941
9944	Hitachi	HD2209
	Raytheon	RM944
	SW	SW944
	TI	SN15844
	TI	SN15944
9945	Hitachi	HD2205
	Raytheon	RM945
	SW	SW945
	TI	SN15845
	TI	SN15945
9946	Hitachi	HD2203
	Raytheon	RM946
	SW	SW946
	TI	SN15846
	TI	SN15946
9948	Raytheon	RM948
	SW	SW948
	TI	SN15848
	TI	SN15948
9949	SW	SW949
	TI	SN15849
	TI	SN15949
9950	Raytheon	RM950
	SW	SW950
	TI	SN15850
	TI	SN15950
9951	Raytheon	RM951
	SW	SW951
	TI	SN15851
	TI	SN15951
9961	Raytheon	RM961
	SW	SW961
	TI	SN15861
	TI	SN15961
9962	Hitachi	HD2207
	Raytheon	RM962
	SW	SW962
	TI	SN15862
	TI	SN15962
9963	Raytheon	RM963
	SW	SW963
	TI	SN15863
	TI	SN15963

General Instrument

Manufacturer Device	Replacement Source	Replacement Device
¶ AY5-1012	TI	TMS6011
AY5-1013	AMI	S1883
	see page 533	
	TI	S1883
AY5-9100	Plessey	MP 9100
AY5-9200	Plessey	MP 9200
¶ DL9-1402	Signetics	2502
RA3-1217	EMM/Semi	1217
RA3-1218	EMM/Semi	1218
RA3-4402	EMM/Semi	4402
	see page 734	
RA3-4256	EMM/Semi	RA3-4256
¶ RA9-1101	Intersil	IM7501
	Intersil	IM7511

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Manufacturer Device	Replacement Source	Replacement Device
General Instrument (cont)		
RA9-1101	Mostek	MK4007
	Signetics	2501
¶ RA9-1103	Signetics	1103
¶ RO1-2048	AMI	S8773
RO3-16382	**AMI**	**S8996**
	see page 706	
RO3-16384	EMM/Semi	RO3-16384
RO3-4096	EMM/Semi	RO3-4096
RO3-5120	EMM/Semi	RO3-5120
RO3-8316	EMM/Semi	RO3-8316
RO5-8192	**AMI**	**S8865**
	see page 706	
¶ RO6-1024	AMI	S8773
¶ RO6-2048	AMI	S8773
SL6-2064-17	Siliconix	S12064
Harris Semiconductor		
HA-2101	Teledyne S	LM101
HA-2107	Teledyne S	LM107
HA-2111	Teledyne S	LM111
HA-2201	Teledyne S	LM201
HA-2301	Teledyne S	LM301
HA-2307	Teledyne S	LM307
HA-2311	Teledyne S	LM311
HA-2650	Teledyne S	1558
HA-2655	Teledyne S	1458
HA2520	**AD**	**AD509**
	see page 624	
HA2522	**AD**	**AD509**
	see page 624	
HA2525	**AD**	**AD509**
	see page 624	
HA2625	**AD**	**AD507**
	see page 624	
HD4000	Motorola	MC14000
	SSS	SCL4000
HD4001	Motorola	MC14001
	SSS	SCL4001
HD4002	Motorola	MC14002
	SSS	SCL4002
HD4007	Motorola	MC14007
	SSS	SCL4007
HD4009	Motorola	MC14009
	SSS	SCL4009
HD4010	Motorola	MC14010
	SSS	SCL4010
HD4011	SSS	SCL4011
HD4012	Motorola	MC14012
	SSS	SCL4012
HD4013	Motorola	MC14013
	SSS	SCL4013
HD4014	**see page 266**	
	SSS	SCL4014
HD4015	**see page 266**	
	SSS	SCL4015
HD4017	SSS	SCL4017
HD4018	**see page 266**	
	SSS	SCL4018
HD4019	**see page 266**	
	SSS	SCL4019
HD4022	**see page 266**	
	SSS	SCL4022
HD4023	Motorola	MC14023
	SSS	SCL4023
HD4024	SSS	SCL4024
HD4025	Motorola	MC14025
	SSS	SCL4025
HD4027	SSS	SCL4027
HD4029	**see page 266**	
	SSS	SCL4029
HD4030	**see page 266**	
	SSS	SCL4030
HD4040	SSS	SCL4040
HD4049	SSS	SCL4049
HD4050	SSS	SCL4050
HD4518	SSS	SCL4518
HD4520	SSS	SCL4520
HD4811	Fairchild	34811
HD54C00	National	MM54C00
HD54C00	Teledyne S	MM54C00
HD54C02	Teledyne S	MM54C02
HD54C04	National	MM54C04
	Teledyne S	MM54C04
HD54C08	National	MM54C08
HD54C10	Teledyne S	MM54C10
HD54C107	National	MM54C107
	Teledyne S	MM54C107
HD54C151	**see page 266**	
	National	MM54C151
	Teledyne S	MM54C151
HD54C154	**see page 266**	
	National	MM54C154
	Teledyne S	MM54C154
HD54C157	National	MM54C157
	Teledyne S	MM54C157
HD54C160	**see page 266**	
	National	MM54C160
	Teledyne S	MM54C160
HD54C161	**see page 266**	
	National	MM54C161
	Teledyne S	MM54C161
HD54C162	**see page 266**	
	Teledyne S	MM54C162
HD54C163	National	MM54C163
	Teledyne S	MM54C163
HD54C164	National	MM54C164
	Teledyne S	MM54C164
HD54C165	National	MM54C165
HD54C173	National	MM54C173
	Teledyne S	MM54C173
HD54C174	National	MM54C174
HD54C175	National	MM54C175
HD54C192	**see page 266**	
	National	MM54C192
	Teledyne S	MM54C192
HD54C193	**see page 266**	
	National	MM54C193
	Teledyne S	MM54C193
HD54C195	National	MM54C195
	Teledyne S	MM54C195
HD54C20	National	MM54C20
	Teledyne S	MM54C20
HD54C30	National	MM54C30
HD54C32	National	MM54C32
HD54C42	**see page 266**	
	National	MM54C42
	Teledyne S	MM54C42
HD54C48	National	MM54C48
HD54C73	National	MM54C73
	Teledyne S	MM54C73
HD54C74	National	MM54C74
	Teledyne S	MM54C74
HD54C75	Teledyne S	MM54C75
HD54C76	National	MM54C76
	Teledyne S	MM54C76
HD54C83	**see page 266**	
	National	MM54C83
HD54C85	**see page 266**	
	National	MM54C85
HD54C86	National	MM54C86
	Teledyne S	MM54C86
HD54C89	National	MM54C89
	Teledyne S	MM54C89
HD54C901	National	MM54C901
HD54C902	National	MM54C902
HD54C903	National	MM54C903
HD54C904	National	MM54C904
HD54C906	National	MM54C906
HD54C907	National	MM54C907
HD54C95	Teledyne S	MM54C95
HD70C95	National	MM70C95
HD70C97	National	MM70C97
HD74C00	National	MM54C95
	National	MM74C00
	Teledyne S	MM74C00
HD74C02	National	MM74C02
	Teledyne S	MM74C02
HD74C04	National	MM74C04
	Teledyne S	MM74C04
HD74C08	National	MM74C08
HD74C08	Teledyne S	MM74C08
HD74C10	National	MM74C10
	Teledyne S	MM74C10
HD74C107	National	MM74C107
	Teledyne S	MM74C107
HD74C14	National	MM74C14
HD74C151	**see page 266**	
	National	MM74C151
	Teledyne S	MM74C151
HD74C154	**see page 266**	
	National	MM74C154
	Teledyne S	MM74C154
HD74C157	National	MM74C157
	Teledyne S	MM74C157
HD74C160	**see page 266**	
	National	MM74C160
	Teledyne S	MM74C160
HD74C161	**see page 266**	
	National	MM74C161
	Teledyne S	MM74C161
HD74C162	**see page 266**	
	National	MM74C162
	Teledyne S	MM74C162
HD74C163	National	MM74C163
	Teledyne S	MM74C163
HD74C164	National	MM74C164
	Teledyne S	MM74C164
HD74C165	National	MM74C165
HD74C173	National	MM74C173
	Teledyne S	MM74C173
HD74C174	Fairchild	F40174
	National	MM74C174
HD74C175	Fairchild	F40175
	National	MM74C175
HD74C192	**see page 266**	
	National	MM74C192
	Teledyne S	MM74C192
HD74C193	**see page 266**	
	National	MM74C193
	Teledyne S	MM74C193
HD74C195	National	MM74C195
	Teledyne S	MM74C195
HD74C20	National	MM74C20
	Teledyne S	MM74C20
HD74C200	National	MM74C200
	Teledyne S	MM74C200
HD74C221	National	MM74C221
HD74C30	National	MM74C30
HD74C32	National	MM74C32
HD74C42	**see page 266**	
	National	MM74C42
	Teledyne S	MM74C42
HD74C48	National	MM74C48
HD74C73	National	MM74C73
	Teledyne S	MM74C73
HD74C74	National	MM74C74
	Teledyne S	MM74C74
HD74C76	National	MM74C76
	Teledyne S	MM74C76
HD74C83	**see page 266**	
	National	MM74C83
HD74C85	**see page 266**	
	Fairchild	F40085
	National	MM74C85
HD74C86	National	MM74C86
	Teledyne S	MM74C86
HD74C89	National	MM74C89
	Teledyne S	MM74C89
HD74C901	National	MM74C901
HD74C902	National	MM74C902
HD74C903	National	MM74C903
HD74C904	National	MM74C904
HD74C95	National	MM74C95
	Teledyne S	MM74C95
HD80C95	National	MM70C95
HD80C97	Fairchild	F40097
	National	MM70C97
	National	MM80C97
HI5040	Intersil	IH5040
HI5041	Intersil	IH50441
HI5042	Intersil	IH5042
HI5044	Intersil	IH5044
HI5045	Intersil	IH5045
HI5046	Intersil	IH5046
HI5047	Intersil	IH5047
HI5048	Intersil	IH5048
HI5049	Intersil	IH5049
HI5050	Intersil	IH5050
HI5051	Intersil	IH5051
HI506-2	**Siliconix**	**DG506**
	see page 561, 563, 564,	
HI506-5	**Siliconix**	**DG506**
	see page 561, 563, 564,	
HI507-2	**Siliconix**	**DG507**
	see page 561, 563, 564,	
HI507-5	**Siliconix**	**DG507**
	see page 561, 563, 564,	
HM7602	**see page 746**	
	AMD	AM27S09
	MMI	6330
	Signetics	**N82S23**
	see page 804, 826, 828,	
	TI	SN54S188
	TI	SN74S188
HM7603	**see page 746**	
	MMI	5331
	MMI	6331
	Signetics	**N82S123**
	see page 804, 826, 828,	
	TI	SN54S288
	TI	SN74S288
HM7610	**see page 746**	
	Intel	**3601-1**
	see page 772, 773	
	Intersil	IM5603
	MMI	5300
	MMI	6300
	National	DM7573
	National	DM8573
	Signetics	**N82S126**
	see page 804, 826, 835,	
	TI	SN54S387
	TI	SN74S387
HM7611	**see page 746**	
	Intel	**3621-1**
	see page 772, 773	
	Intersil	IM5603
	MMI	5301
	MMI	6301
	National	DM8574
	National	SM7574
	TI	SN54S287
	TI	SN74S287
HM7621	**see page 746**	
	MMI	5306
	MMI	6306
HM7640	**see page 746**	
	Intel	**3604**
	see page 776, 777	
	MMI	6340
HM7641	**see page 746**	
	Intel	**3624**
	see page 776, 777	
HPROM0512	TI	SN54186
	TI	SN74186
HPROM1024	**Intel**	**3621**
	see page 772, 773	
	MMI	5301
	MMI	6301
	National	DM7574
	National	DM8574
	Signetics	N82S129
	TI	SN54S287
	TI	SN74S287
HPROM1024A	Fairchild	93416
	Intersil	IM5603
	MMI	5300
	MMI	6300
	National	DM7573
	National	DM8573
	Signetics	**N82S126**
	see page 804, 826, 835,	

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

Manufacturer Device	Replacement Source	Replacement Device
Harris Semiconductor (cont)		
HPROM1024A	TI	SN54S387
	TI	SN74S387
¶ HPROM2048	Fairchild	93446
	Intersil	IM5624
	Signetics	N82S131
	see page 804, 826, 838,	
HPROM2048A	AMD	AM27S08
	Fairchild	93436
	Signetics	N82S130
	see page 804, 826, 838,	
HPROM8256	Intersil	IM5600
	MMI	5330
	MMI	6330
	National	DM7577
	National	DM8577
	Signetics	N82S23
	see page 804, 826, 828,	
	TI	SN54S188
	TI	SN54188
	TI	SN74S188
	TI	SN74188
Intel		
INL3212	TI	SN54S412
	TI	SN74S412
INT3601	MMI	5300
1101	AMD	1101
	Intersil	IM7501
	Intersil	IM7511
	Mostek	MK4007
	National	MM1101
	Signetics	1101
	Signetics	2501
1103	AMI	S1103
	see page 707	
	AMI	S1103A
	see page 712	
	AMI	S146
	Fairchild	1103
	Hitachi	HM3503
	Nortec	1103
	Rockwell	1103
	Synertek	SY1103
	TI	TMS1103
1301	AMI	S8773
1402	AMD	1402
	AMI	S2502A
	Nortec	1402
	Signetics	2502
	Synertek	SY1402
1403	AMD	1403
	Nortec	1403
	Signetics	2503
	Synertek	SY1403
1404	AMD	1404
	Nortec	1404
	Signetics	2504
	Synertek	SY1404
1405	AMD	1405
	Signetics	2505
1406	AMD	1406
1407	AMD	1407
1504	AMI	S1685
1506	AMD	1506
1507	AMD	1507
1602	AMD	1602
	National	1602
1702	AMD	1702
	National	1702
2101	AMD	2101
	EA	EA2101
	Hitachi	HM2101
	National	MM2101
	Synertek	SY2101
	TI	TMS2101
2102	AMD	2102
	AMD	9102
	EA	2102
	Fairchild	2102
2102	Intersil	IM7552
	Mostek	MK4102
	Motorola	MCM2102
	National	MM2102
	Signetics	2602
	see page 790	
	Synertek	SY2102
	TI	TMS4033
	TI	TMS4034
	TI	TMS4035
2104	see page 752, 759	
	Fairchild	4066
	Mostek	MK4096
	see page 778, 781	
2107	AMI	S4021
	see page 722	
	TI	TMS4030
	TI	TMS4060
	Western	RM1701
2107B	see page 760, 765	
	TI	TMS4060
2111	AMD	2111
	EA	EA2111
	Synertek	SY2111
	TI	TMS4042
2112	AMD	2112
	EA	EA2112
	Synertek	SY2112
	TI	TMS4043
2113	Synertek	SY2113
2146	AMI	S146
2308	EA	EA2308
2316	EMM/Semi	RO3-8316
	GI	RO3-8316
	Mostek	MK31000
	see page 783	
2401	Synertek	SY2401
2405	AMI	S1685
	Synertek	SY2405
3002	Signetics	N3002
	see page 1006	
3101	AMD	3101
	Intersil	IM5501
	MMI	5560
	MMI	6560
	Signetics	N82S25
	see page 804, 806, 814,	
3102	Fairchild	93400
3104	Fairchild	93402
3106	Fairchild	93421
	Intersil	IM5523
	MMI	6531
	Raytheon	RC5340
	Raytheon	RM5340
	Signetics	82S16
	TI	SN54S201
	TI	SN74S201
3107	Fairchild	93411
	Intersil	IM5533
	MMI	5530
	MMI	6530
	Raytheon	RC5330
	Raytheon	RM5330
	Signetics	N74S01
	Signetics	S82S17
	Signetics	82S17
	TI	SN54S301
	TI	SN74S301
3110	TI	SN74S209
3202	Fairchild	93401
3301	AMD	74186
	Fairchild	93406
	Intersil	IM5603
	MMI	H6200
	MMI	5200
	National	DM54187
	National	DM74187
	TI	SN54187
	TI	SN74187
33011	MMI	H5200
3304	MMI	6340
3601	see page 772, 773	
	Fairchild	93416
	Harris	HPROM-1024A
	Intersil	IM5603
	MMI	6300
	National	DM7573
	National	DM8573
	Signetics	N82S126
	see page 804, 826, 835,	
	TI	SN54S387
	TI	SN74S387
3602	see page 774, 775	
	Fairchild	93436
3604	see page 776, 777	
	MMI	6340
3622	see page 774, 775	
	Fairchild	93446
4001	National	INS4001
4002	National	INS4002
4003	National	INS4003
4004	National	INS4003
4008	National	INS4008
4009	National	INS4009
4702	AMD	4702
	National	4702
5201	SSS	SCL5424
5801	SSS	SCL5437
8080	see page 958	
	AMD	9080
	TI	TMS8080
8212	see page 960	
	TI	SN54S412
	TI	SN74S412
8308	see page 960	
	EA	EA8308
8316	see page 960	
	GI	RO3-8316
8702	AMD	8702
	National	8702
Intersil		
AH0126	Siliconix	DG126
	see page 551	
AH0129	Siliconix	DG129
	see page 551	
AH0133	Siliconix	DG133
	see page 551	
AH0134	Siliconix	DG134
	see page 551	
AH0139	Siliconix	DG139
	see page 551	
AH0140	Siliconix	DG140
	see page 551	
AH0141	Siliconix	DG141
	see page 551	
AH0142	Siliconix	DG142
	see page 551	
AH0143	Siliconix	DG143
	see page 551	
AH0144	Siliconix	DG144
	see page 551	
AH0145	Siliconix	DG145
	see page 551	
AH0146	Siliconix	DG146
	see page 551	
AH0151	Siliconix	DG151
	see page 551	
AH0152	Siliconix	DG152
	see page 551	
AH0153	Siliconix	DG153
	see page 551	
AH0154	Siliconix	DG154
	see page 551	
AH0161	Siliconix	DG161
	see page 551	
AH0162	Siliconix	DG162
	see page 551	
AH0163	Siliconix	DG163
	see page 551	
AH0164	Siliconix	DG164
	see page 551	
DG111	Siliconix	DGM111
	see page 557, 558	
DG116	Siliconix	DG116
DG118	Siliconix	DG172
	see page 557, 558	
DG123	Siliconix	DG123
	see page 551	
DG125	Siliconix	DG125
	see page 551	
DG126	Siliconix	DG126
	see page 551	
DG129	Siliconix	DG129
	see page 551	
DG133	Siliconix	DG133
	see page 551	
DG134	Siliconix	DG134
	see page 551	
DG139	Siliconix	DG139
	see page 551	
DG140	Siliconix	DG140
	see page 551	
DG141	Siliconix	DG141
	see page 551	
DG142	Siliconix	DG142
	see page 551	
DG143	Siliconix	DG143
	see page 551	
DG144	Siliconix	DG144
	see page 551	
DG145	Siliconix	DG145
	see page 551	
DG146	Siliconix	DG146
	see page 551	
DG151	Siliconix	DG151
	see page 551	
DG152	Siliconix	DG152
	see page 551	
DG153	Siliconix	DG153
	see page 551	
DG154	Siliconix	DG154
	see page 551	
DG161	Siliconix	DG161
	see page 551	
DG162	Siliconix	DG162
	see page 551	
DG163	Siliconix	DG163
	see page 551	
DG164	Siliconix	DG164
	see page 551	
DG182	Siliconix	DG182
	see page 552, 554	
DG185	Siliconix	DG182
	see page 552, 554	
DG188	Siliconix	DG188
	see page 552, 554	
DG191	Siliconix	DG191
	see page 552, 554	
DG426	Siliconix	DG126
	see page 551	
DG464	Siliconix	DG164
	see page 551	
D123	Siliconix	D123
D125	Siliconix	D125
G115	Siliconix	G115
G116	Siliconix	G116
G117	Siliconix	G117
G118	Siliconix	G118
G119	Siliconix	G119
G123	Siliconix	G123
G125	Siliconix	G125
G126	Siliconix	G126
G127	Siliconix	G127
G128	Siliconix	G128
G129	Siliconix	G129
G130	Siliconix	G130
G131	Siliconix	G131
G132	Siliconix	G132
IH5009	AMI	MX52
	National	AH5009

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Intersil (cont)

Manufacturer Device	Replacement Source	Replacement Device
IH5010	AMI	MX52
	National	AH5010
IH5040	Harris	HI5040
IH5042	Harris	HI5042
	Siliconix	06188
IH5043	**Siliconix**	**DG191**
	see page 552, 554	
IH5044	Harris	HI5044
IH50441	Harris	HI5041
IH5045	Harris	HI5045
	Siliconix	**DG185**
	see page 552, 554	
IH5046	Harris	HI5046
IH5047	Harris	HI5047
IH5048	**Siliconix**	**DG181**
	see page 552, 554	
IH5049	Harris	HI5049
	Siliconix	**DG184**
	see page 552, 554	
IH5050	Harris	HI5050
	Siliconix	**DG187**
	see page 552, 554	
IH5051	Harris	HI5051
	Siliconix	**DG190**
	see page 552, 554	
IH5070	**AD**	**AD7507**
	see page 548	
	Harris	HI507
	Siliconix	**DG507**
	see page 561, 563, 564,	
IM5501	AMD	IM5501
	MMI	5560
	MMI	6560
	TI	SN54S289
	TI	SN74S289
IM5502	TI	SN5481A
IM5503	MMI	6531
	Signetics	**N74S301**
	see page 804, 806, 815,	
	Signetics	**N82S17**
	see page 804, 806, 815,	
	TI	SN54S301
	TI	SN74S301
IM5508	Fairchild	93415
	Signetics	**N82S10**
	see page 804, 806, 818,	
	TI	SN74S209
IM5512	TI	SN5481A
IM5523	Fairchild	93421
	MMI	5531
	MMI	6531
	Raytheon	RC5340
	Raytheon	RC5540
	Raytheon	RM5340
	Signetics	**N82S16**
	see page 804, 806, 815,	
	Signetics	S82S16
	TI	SN54S201
	TI	SN74S201
IM5533	Fairchild	93411
	MMI	5530
	MMI	6530
	Raytheon	RC5330
	Raytheon	RM5330
	Signetics	**N82S17**
	see page 804, 806, 815,	
	TI	SN54S301
	TI	SN74S301
IM5543	Fairchild	93421
	TI	SN54S301
	TI	SN74S301
IM5553	Fairchild	93411
IM5600	Fairchild	93434
	Harris	HPROM-8256
	MMI	5330
	MMI	6330
	National	DM7577
	National	DM8577
	Signetics	**N82S23**
	see page 804, 826, 828,	
	TI	SN54S188
IM5600	TI	SN74S188
IM5602	MMI	6340
IM5603	Fairchild	93416
	Harris	HPROM-1024A
	Intel	**3601**
	see page 772, 773	
	MMI	5300
	MMI	6300
	National	DM7573
	National	DM8573
	TI	SN54S387
	TI	SN74S387
IM5604	Fairchild	93436
	Intel	**3602**
	see page 774, 775	
	MMI	5305
	MMI	6305
	Signetics	**N82S130**
	see page 804, 826, 838,	
IM5605	**Intel**	**3604**
	see page 776, 777	
	MMI	6340
	TI	SN54S475
	TI	SN74S475
IM5610	**Harris**	**HM7603**
	see page 746	
	MMI	5331
	MMI	6331
	Signetics	**N82S123**
	see page 804, 826, 828,	
	TI	SN54S288
	TI	SN74S288
IM5623	Fairchild	93426
	Harris	HPROM-1024
	Intel	**3621**
	see page 772, 773	
	MMI	5301
	MMI	6301
	National	DM7574
	National	DM8574
	Signetics	N82S129
	TI	SN54S287
	TI	SN74S287
IM5624	Fairchild	93446
	Harris	**HM7621**
	see page 746	
	Intel	**3622**
	see page 774, 775	
	MMI	5306
	MMI	6306
	Signetics	**N82S131**
	see page 804, 826, 838,	
IM5625	**Intel**	**3624**
	see page 776, 777	
	MMI	6341
	TI	SN54S474
	TI	SN745474
IM5640	**Harris**	**HM7620**
	see page 746	
IM6100	**Harris**	**HM6100**
	see page 938	
	Harris	**HM6100A**
	see page 938	
IM7051	AMD	1101
	Signetics	2501
	Signetics	**2602**
	see page 790	
IM7501	Mostek	MK4007
IM7511	Mostek	MK4007
IM7512	Mostek	MK4007
IM7552	Mostek	MK4102
	TI	TMS4033
	TI	TMS4034
	TI	TMS4035
IM7702	Nortec	1402
	Signetics	2502
IM7703	Nortec	1403
	Signetics	2503
IM7704	Nortec	1404
	Signetics	2504
IM7712	AMD	AM2806
IM7712	Nortec	2512
	Signetics	2512
IM7722	AMD	AM2808
	Signetics	2525
IM7780	Mostek	MK1007
	Signetics	2532
	TI	TMS3409
LM101	Teledyne S	LM101
LM105	Teledyne S	LM105
LM107	Teledyne S	LM107
LM111	Teledyne S	LM111
LM201	Teledyne S	LM201
LM205	Teledyne S	LM205
LM207	Teledyne S	LM207
LM211	Teledyne S	LM211
LM301	Teledyne S	LM301
LM305	Teledyne S	LM305
LM307	Teledyne S	LM307
LM311	Teledyne S	LM311
LM723	Teledyne S	723
LM741	Teledyne S	741
LM748	Teledyne S	748
MM452	Siliconix	S1452
MM455	Siliconix	S1455
MM552	Siliconix	S1552
MM555	Siliconix	S1555
NE555	Lithic Sys	LS555
	RCA	**CA555**
	see page 661	
SE555	Lithic Sys	LS555
	RCA	**CA555**
	see page 661	
SSS1458	RCA	CA1458
SSS1558	RCA	CA1558
101	AD	101A
	National	LM101
	Raytheon	LM101
	RCA	**CA101**
	see page 661	
	RCA	CA748
	Teledyne S	LM101
107	**RCA**	**CA107**
	see page 661	
108	**AD**	**AD108**
	see page 625	
	National	LM108
	Raytheon	LM108
111	**RCA**	**CA111**
	see page 661	
201	AD	201A
	National	LM201
	Raytheon	LM201
	RCA	**CA201**
	see page 661	
	RCA	CA748
	Teledyne S	LM201
207	**RCA**	**CA207**
	see page 661	
208	**AD**	**AD208**
	see page 625	
	National	LM208
	Raytheon	LM208
	RCA	CA208
211	**RCA**	**CA211**
	see page 661	
301	AD	301A
	National	LM301
	Raytheon	LM301
	RCA	**CA301**
	see page 661	
	Teledyne S	LM301
307	**RCA**	**CA307**
	see page 661	
308	**AD**	**AD308**
	see page 625	
	National	LM308
	Raytheon	LM308
	Teledyne S	LM308
311	**RCA**	**CA311**
	see page 661	
4250	National	LM4250
555	Lithic Sys	LS555
	National	LM555
	Raytheon	RC555
	Raytheon	RM555
	Teledyne S	555
723	National	LM723
	Raytheon	RC723
	Raytheon	RM723
	RCA	CA723
	Teledyne S	723
741	**AD**	**AD741**
	see page 625	
	Fairchild	741
	National	LM741
	PMI	SSS741
	Raytheon	RC741
	Raytheon	RM741
	RCA	**CA741**
	see page 661	
	Teledyne S	741
747	**RCA**	**CA747**
	see page 661	
748	Fairchild	748
	National	LM748
	Raytheon	RC748
	Raytheon	RM748
	RCA	CA748
	Teledyne S	748
8007	AD	AD8007
8013	AD	AD530
	AD	AD533
8038	Lithic Sys	LS8038
8101	RCA	CA748
8201	RCA	CA748
8741	**RCA**	**CA741**
	see page 661	

ITT Semiconductors

Manufacturer Device	Replacement Source	Replacement Device
ITT9000	Fairchild	9000
	TI	SN29000
ITT9001	Fairchild	9001
	TI	SN29001
ITT9002	Fairchild	9002
	TI	SN29002
ITT9003	Fairchild	9003
	TI	SN29003
ITT9004	Fairchild	9004
ITT9005	Fairchild	9005
	TI	SN29005
ITT9006	Fairchild	9006
ITT9007	Fairchild	9007
	TI	SN29007
ITT9008	Fairchild	9008
	TI	SN29008
ITT9009	Fairchild	9009
	TI	SN29009
ITT9014	Fairchild	9014
ITT9015	Fairchild	9015
ITT9016	Fairchild	9016
	TI	SN29016
ITT9017	Fairchild	9017
ITT9022	Fairchild	9022
ITT9024	Fairchild	9024
	TI	SN29024
ITT9033	Fairchild	9033
ITT9093	Motorola	MC853
	Motorola	MC953
	Raytheon	RM993
	SW	SW705
	TI	SN158093
	TI	SN159093
ITT9094	Motorola	MC856
	Motorola	MC956
	Raytheon	RM994
	SW	SW708
	TI	SN158094
	TI	SN159094
ITT9097	Motorola	MC855
	Motorola	MC955

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

ITT Semiconductors (cont)

Manufacturer Device	Replacement Source	Replacement Device
ITT9097	Raytheon	RM997
	SW	SW709
ITT9099	Motorola	MC852
	Motorola	MC952
	Raytheon	RM999
	SW	SW706
	TI	SN158099
	TI	SN159099
ITT930	Motorola	MC830
	Motorola	MC930
	Raytheon	RM930
	SW	SW930
	TI	SN15830
	TI	SN15930
ITT9300	AMD	9300
	Fairchild	9300
	TI	SN29300
	TI	SN39300
ITT9301	AMD	9301
	Fairchild	9301
	TI	SN29301
	TI	SN39301
ITT9304	AMD	9304
	Fairchild	9304
ITT9309	AMD	9309
	Fairchild	9309
	TI	SN29309
	TI	SN39309
ITT931	Motorola	MC831
	Motorola	MC931
	TI	SN15831
	TI	SN15931
ITT9312	AMD	9312
	Fairchild	9312
	TI	SN29312
	TI	SN39312
ITT9316	AMD	9316
	Fairchild	9316
	Raytheon	RM9316
	TI	SN29316
	TI	SN39316
ITT932	Motorola	MC832
	Motorola	MC932
	Raytheon	RM932
	SW	SW932
	TI	SN15832
	TI	SN15932
ITT933	Motorola	MC833
	Motorola	MC933
	Raytheon	RM933
	SW	SW933
	TI	SN15833
	TI	SN15933
ITT935	Motorola	MC840
	Motorola	MC940
	Raytheon	RM935
	TI	SN15835
	TI	SN15935
ITT936	Motorola	MC936
	Raytheon	RM936
	SW	SW936
	TI	SN15836
	TI	SN15936
ITT937	Motorola	MC837
	Motorola	MC937
	Raytheon	RM937
	SW	SW937
	TI	SN15837
	TI	SN15937
ITT944	Motorola	MC844
	Motorola	MC944
	Raytheon	RM944
	SW	SW944
	TI	SN15844
	TI	SN15944
ITT945	Motorola	MC845
	Motorola	MC945
	Raytheon	RM945
	SW	SW945
	TI	SN15845
	TI	SN15945
ITT946	Motorola	MC846
	Motorola	MC946
	Raytheon	RM946
	SW	SW946
	TI	SN15846
	TI	SN15946
ITT948	Motorola	MC848
	Motorola	MC948
	Raytheon	RM948
	SW	SW948
	TI	SN15848
	TI	SN15948
ITT949	Motorola	MC849
	Motorola	MC949
	Raytheon	RM949
	SW	SW949
	TI	SN15849
	TI	SN15949
ITT950	Motorola	MC850
	Motorola	MC950
	Raytheon	RM950
	SW	SW950
	TI	SN15850
	TI	SN15950
ITT951	Motorola	MC851
	Motorola	MC951
	Raytheon	RM951
	SW	SW951
	TI	SN15851
	TI	SN15951
ITT9601	AMD	9601
	Fairchild	9601
	TI	SN29601
ITT961	Motorola	MC861
	Motorola	MC961
	Raytheon	RM961
	SW	SW961
	TI	SN15861
	TI	SN15961
ITT962	Motorola	MC862
	Motorola	MC962
	Raytheon	RM962
	SW	SW962
	TI	SN15862
	TI	SN15962
ITT963	Motorola	MC1141
	Motorola	MC863
	Motorola	MC963
	Raytheon	RM963
	SW	SW963
	TI	SN5481A
	TI	SN7481A

Lithic Systems

Manufacturer Device	Replacement Source	Replacement Device
LA3018	Fairchild	μA3018
	Fairchild	CA3018
	National	LM3018
	RCA	CA3018
	Silicon G	SG3018
LA3018A	Fairchild	μA3018A
	Fairchild	CA3018A
	RCA	CA3018A
LA3026	Fairchild	μA3026
	Fairchild	CA3026
	RCA	CA3026
	Silicon G	SG3822
LA3045	Fairchild	μA3045
	Fairchild	CA3045
	Plessey	SL3045
	RCA	CA3045
	Silicon G	SG3821
LA3086	Fairchild	μA3086
	Fairchild	CA3086
	Plessey	SL3086
	RCA	CA3086
	Silicon G	SG3886
LS1495	Fairchild	μA795
	Fairchild	795
	Motorola	MC1495
	Silicon G	SG1495
LS1496	Fairchild	μA796
	Fairchild	796
	Motorola	MC1496
	National	LM1496
	Signetics	N5596
	Silicon G	SG1496
LS1595	Fairchild	μA795
	Fairchild	795
	Motorola	MC1595
	Silicon G	SG1595
LS1596	Fairchild	μA796
	Fairchild	796
	Motorola	MC1596
	National	LM1596
	Signetics	S5596
	Silicon G	SG1596
LS170	National	LM170
LS171	National	LM171
	Teledyne S	911A
LS270	National	LM270
LS271	National	LM271
	Teledyne S	911B
LS3028	National	LM3028
	RCA	CA3028
LS3053	National	LM3053
	RCA	CA3053
LS370	National	LM370
LS371	National	LM371
	Teledyne S	911C
LS555	Exar	XR555
	Intersil	NE555
	National	LM555
	Raytheon	RC555
	Signetics	NE555
	Silicon G	SG555
	Teledyne S	555
	TI	SN72555
LS8038	Intersil	8038

Mitsubishi International Corp.

Manufacturer Device	Replacement Source	Replacement Device
M58531	Mostek	MK4007

Monolithic Memories Inc.

Manufacturer Device	Replacement Source	Replacement Device
A5240	National	DM7795
A5281	AMD	AM27581
A6240	National	DM8795
A6280	AMD	AM27S80
A6281	AMD	AM27S81
H5200	Intel	33011
H6200	Intel	3301
L5560	AMD	31L01
	National	DM54L89A
L5561	National	DM76L99
L6560	AMD	31L01
	National	DM74L89A
L6561	National	DM8699
1702	National	MM5202A
5200	Fairchild	93406
	Fairchild	93416
	Intel	3301
	Intersil	IM5603
	National	DM44187
	National	DM54187
	Signetics	**S82S226**
	see page 804, 820, 822,	
	TI	SN54187
5201	Intersil	IM5623
	National	DM7597
	Signetics	S82S229
5205	Intersil	IM5604
	TI	SN54S270
5206	TI	SN54S370
5230	Fairchild	93434
	Intersil	IM5600
	National	DM5488
	TI	SN5488
	TI	SN5488A
5231	Intersil	IM5610
	National	DM7598
5240	National	DM7795
5241	National	DM7796
5300	Fairchild	93416
	Harris	HPROM1024A
	Intel	**3601**
	see page 772, 773	
	Intersil	IM5603
	National	DM7573
	National	DM8573
	Signetics	**S82S126**
	see page 804, 826, 835,	
	TI	SN54S387
5301	Fairchild	93406
	Harris	HPROM1024
	Intersil	IM5623
	National	DM7574
	Signetics	**S82S129**
	see page 804, 826, 835,	
	TI	SN54S287
5305	Fairchild	93436
	Harris	**HM7620**
	see page 746	
	Intersil	IM5604
	Signetics	**S82S130**
	see page 804, 826, 838,	
5306	Fairchild	93446
	Harris	**HM7621**
	see page 746	
	Intersil	IM5624
	Signetics	**S82S130**
	see page 804, 826, 838,	
5330	AMD	AM24508
	AMD	AM27S09
	Harris	**HM7602**
	see page 746	
	Harris	HPROM8256
	Intel	**3604**
	see page 776, 777	
	Intersil	IM5533
	Intersil	IM5600
	National	DM7577
	Signetics	**S82S23**
	see page 804, 826, 828,	
	TI	SN54S288
	TI	SN54S475
	TI	SN54188A
5331	**Harris**	**HM7603**
	see page 746	
	Intersil	IM5610
	National	DM7578
	Signetics	**S82S123**
	see page 804, 826, 828,	
	TI	SN54S288
5340	Harris	HM7643
5341	**Intel**	**3624**
	see page 776, 777	
	TI	SN54S474
5530	Fairchild	93411
	Raytheon	RM5330
	Signetics	S82S17
	TI	SN54S301
5531	Fairchild	93421
	Intersil	IM5523
	National	DM54200
	Raytheon	RM5340
	Signetics	S82S16
	TI	SN54S201
5560	AMD	AM27S02
	Fairchild	93435
	Intersil	IM5501
	National	DM5489
	Signetics	**S3101A**
	see page 804, 806, 814,	
	TI	SN54S289
5561	AMD	AM27S03
	National	DM7599
	National	DM76L99
	TI	SN54S189
5660	Intel	3101

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Monolithic Memories Inc. (cont)

Manufacturer Device	Replacement Source	Replacement Device
6200	Fairchild	93406
	Intersil	IM5603
	National	DM74187
	Signetics	N82S226
	TI	SN74187
6201	Intersil	IM5623
	National	DM8597
	Signetics	N82S229
6205	Intersil	IM5604
	TI	SN74S270
6206	TI	SN74S370
6230	Fairchild	93434
	Intersil	IM5600
	ITT	ITT7488
	Motorola	MCM4002
	National	DM7488
	Signetics	8223
	TI	SN7488A
6231	National	DM8598
6240	National	DM8795
6241	National	DM8796
6246	Signetics	N8204
6247	Signetics	N8205
6300	Fairchild	93416
	Harris	HPROM1024A
	Intel	**3601**
	see page 772, 773	
	Intersil	IM5603
	National	DM8573
	Signetics	**N82S126**
	see page 804, 826, 835,	
	TI	SN74S387
63006	**Harris**	**HM7621**
	see page 746	
6301	Fairchild	93426
	Harris	HPROM1024
	Intersil	IM5623
	National	DM8574
	Signetics	N82S129
	TI	SN74S387
6305	Fairchild	93436
	Harris	**HM7621**
	see page 746	
	Intel	**3602**
	see page 774, 775	
	Intersil	IM5604
	Signetics	**N82S130**
	see page 804, 826, 838,	
6306	Fairchild	93446
	Intel	**3622**
	see page 774, 775	
6330	AMD	AM27S08
	Harris	HPROM8256
	Intersil	IM5600
	National	DM8577
	Signetics	**N82S23**
	see page 804, 826, 828,	
	TI	SN74188A
6331	AMD	AM27S09
	Harris	**HM7603**
	see page 746	
	Intersil	IM5610
	National	DM8578
	Signetics	**N82S123**
	see page 804, 826, 828,	
	TI	SN74S288
6335	Fairchild	93436
	Intel	**3602**
	see page 774, 775	
6340	Harris	HM7644
	Intel	**3604**
	see page 776, 777	
	Intersil	IM5605
	TI	SN74S475
6341	**Intel**	**3624**
	see page 776, 777	
	Intersil	IM5625
	TI	SN74S474
6500	Intersil	IM5501
6501	Intersil	IM5501
6523	Intersil	IM5523
6530	Fairchild	93411
	Intel	3107
	Intersil	IM5533
	National	DM8582
	Raytheon	RC5330
	Signetics	**N82S17**
	see page 804, 806, 815,	
	TI	SN74S206
6531	Fairchild	93421
	Intel	3106
	Intersil	IM5523
	National	DM74200
6560	AMD	AM27S02
	AMD	MM6560
	Fairchild	93435
	Intel	3101
	Intersil	IM5501
	National	DM7489
	Signetics	**N3101A**
	see page 804, 806, 814,	
	TI	SN74S289
6561	AMD	AM27S03
	AMD	MM6561
	National	DM8599

Mostek Corp.

Manufacturer Device	Replacement Source	Replacement Device
F8	**see page 964**	
	Fairchild	**F8**
	see page 923	
MK1002	AMD	1002
MK1007	Intersil	IM7780
	TI	TMS3409
MK2300	TI	TMS2300
MK2302	GI	RO5-2240S
MK2400	AMI	S8773
MK2500	**AMI**	**S5232**
	see page 706	
MK4006	**AMI**	**S4006**
	see page 706	
	Motorola	MCM4006
	TI	SN74S387
MK4007	Intersil	IM7501
	Intersil	IM7511
MK4008	**AMI**	**S4008**
	see page 706	
MK4096	**see page 778, 781**	
	AMI	**S4096**
	see page 728	
	EA	EA4096
	EMM/Semi	RO3-4096
	Fairchild	4096
	GI	RO3-4096
	Rockwell	1604
MK4102	Intersil	IM7552
	Signetics	**2602**
	see page 790	
	TI	TMS4033
	TI	TMS4035
3850	**see page 965**	
	Fairchild	**3850**
	see page 924	
3851	**see page 965**	
	Fairchild	**3851**
	see page 924	
3852	**see page 966**	
	Fairchild	**3852**
	see page 925	
3853	**see page 966**	
	Fairchild	**3853**
	see page 925	
3854	**see page 966**	
	Fairchild	**3854**
	see page 925	

Motorola Semiconductor

Manufacturer Device	Replacement Source	Replacement Device
MCM10140	Signetics	10140
	TI	SN10140
MCM10142	TI	SN10142
MCM10144	Fairchild	F10410
	Raytheon	RC10144
	Signetics	10144
MCM10145	Hitachi	MD10145
	Signetics	10145
	TI	SN10145
MCM10147	Fairchild	F10405
MCM10148	Signetics	10148
	TI	SN10147
	TI	SN10148
MCM1110	National	MM5231
	Nitron	NCM1110
	Signetics	2430
	TI	TMS2600
MCM1111	Nitron	NCM1111
¶ MCM1112	National	MM4230
	National	MM5230
	Nitron	NCM1112
MCM1120	Nitron	NCM1120
MCM1121	Nitron	NCM1121
MCM1122	Nitron	NCM1122
MCM1130	Nitron	NCM1130
¶ MCM1131	AMI	S8614
	Nitron	NCM1131
¶ MCM1132	AMI	S8614
	TI	TMS4103
MCM1140	Nitron	NCM1140
	TI	TMS4300
¶ MCM1173	AMI	S2103
MCM4002	Fairchild	93434
	Intersil	IM5600
	MMI	6230
	National	DM5488
	National	DM7488
	TI	SN7488
MCM4004	Fairchild	93406
	Fairchild	93407
	Intersil	IM5603
	ITT	ITT7481
	MMI	6200
	TI	SN7481A
MCM4005	Fairchild	93407
	ITT	ITT7481
	TI	SN7481A
MCM4006	TI	SN74S387
MCM4064	Fairchild	93403
	Intersil	IM5501
¶ MCM4065	Signetics	8225
¶ MCM4256	Intersil	IM5523
MCM5303	Harris	HPROM-0512
MCM6560	Nitron	NCM6560
MCM6561	Nitron	NCM6561
MCM6570	Nitron	NCM6570
MCM6571	Nitron	NCM6571
MCM6572	Nitron	NCM6572
MCM6580	Nitron	NCM6580
MCM6581	Nitron	NCM6581
MCM6583	Nitron	NCM6583
MCM6590	Nitron	NCM6590
MCM6605	Intersil	IM7505
MCM6810	**AMI**	**S6810**
	see page 884	
MCM6830	**AMI**	**S6830**
	see page 887	
MCM6832	Nitron	NCM6832
MCM7001	Nitron	7001
	TI	TMS7001
MC1004	Signetics	N1004
MC1005	Signetics	N1005
MC1006	Signetics	N1006
MC1010	Signetics	N1010
MC10101	Fairchild	F10101
	Signetics	10101
MC10102	Fairchild	F10102
	Signetics	10102
MC10103	Fairchild	F10103
	Signetics	10103
MC10104	Fairchild	F10104
	Signetics	10104
MC10105	Fairchild	F10105
	Signetics	10105
MC10106	Fairchild	F10106
	Signetics	10106
MC10107	Fairchild	F10107
	Signetics	10107
MC10109	Fairchild	F10109
	Signetics	10109
MC1011	Signetics	N1011
MC10110	Fairchild	F10110
	Signetics	10110
MC10111	Fairchild	F10111
	Signetics	10111
MC10113	Fairchild	F10113
	Signetics	10113
MC10114	Fairchild	F10114
	Signetics	10114
MC10115	Signetics	10115
MC10116	Fairchild	F10116
	Signetics	10116
MC10117	Fairchild	F10117
	Signetics	10117
MC10118	Fairchild	F10118
	Signetics	10118
MC10119	Fairchild	F10119
	Signetics	10119
MC1012	Signetics	N1012
MC10121	Fairchild	F10121
	Signetics	10121
MC10123	Motorola	F10123
	Signetics	10123
MC10124	Fairchild	F10124
	Signetics	10124
MC10125	Fairchild	F10125
	Signetics	10125
MC10128	Signetics	F10128
MC10129	Signetics	10129
MC1013	Signetics	N1013
MC10130	Fairchild	F10130
	Signetics	10130
MC10131	Fairchild	F10131
	Signetics	10131
MC10132	Fairchild	F10132
	Signetics	10132
MC10133	Fairchild	F10133
	Signetics	10133
MC10134	Fairchild	F10134
	Signetics	10134
MC10135	Fairchild	F10135
	Signetics	10135
MC10136	Fairchild	F10136
	Signetics	10136
MC10137	Fairchild	F10137
	Signetics	10137
MC10138	Signetics	10138
MC10139	Intersil	IM5600
MC1014	Signetics	N1014
MC10141	Fairchild	F10141
	Signetics	10141
MC10153	Fairchild	F10153
MC10158	Fairchild	F10158
MC10160	Signetics	10160
MC10161	Fairchild	F10161
	Signetics	10161
MC10162	Fairchild	F10162
	Signetics	10162
MC10164	Signetics	10164
MC10166	Fairchild	F10166
MC10168	Fairchild	F10168
MC10170	Fairchild	F10170
	Signetics	10170
MC10171	Fairchild	F10171
	Signetics	10171
MC10172	Fairchild	F10172
	Signetics	10172
MC10173	Fairchild	F10173
	Signetics	10173
MC10174	Signetics	10174
MC10175	Fairchild	F10175
	Signetics	10175
MC10176	Fairchild	F10176
	Signetics	10176
MC10178	Fairchild	F10178

¶ Discontinued

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Motorola Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
MC10178	Signetics	10178
MC10179	Fairchild	F10179
	Signetics	10179
MC10180	Fairchild	F10180
	Signetics	10180
MC10181	Fairchild	F10181
	Signetics	10181
MC10186	Fairchild	F10186
	Signetics	10186
MC10190	Signetics	10190
MC10191	Signetics	10191
MC10195	Signetics	10195
MC10216	Signetics	10216
MC10231	Signetics	10231
MC1068	Signetics	N1068
¶ MC1150	AMI	MX53D
¶ MC1160	TI	TMS3003
¶ MC1161	TI	TMS4062
¶ MC1180	**AMI**	**S2470**
	see page 254	
¶ MC1181	**AMI**	**S2567**
	see page 254	
	Nitron	NC1181
¶ MC1182	**AMI**	**S2566**
	see page 254	
	Nitron	NC1182
¶ MC1183	**AMI**	**S2555**
	see page 254	
	Nitron	NC1183
¶ MC1184	**AMI**	**S2556**
	see page 254	
	Nitron	NC1184
MC1303	Raytheon	RC4739
MC1304	Fairchild	μA732
	Fairchild	732
	National	LM1304
	Sprague	ULN-2120
MC1305	National	LM1305
	Sprague	ULN-2122
MC1307	Fairchild	μA767
	National	LM1307
	Sprague	ULN-2128
MC1310	Exar	XR1310
	Signetics	MC1310
	Sprague	ULN-2210
MC1324	Sprague	ULN-2224
MC1328	RCA	CA3072
	Sprague	ULN-2114
	Sprague	ULN-2228
MC1339	Signetics	PA239
	Sprague	ULN-2126
MC1351	National	LM1351
MC1357	Fairchild	2136
	RCA	CA2111
	Signetics	ULN2111
	Sprague	ULN-2111
	Sprague	ULN-2113
MC1358	Fairchild	μA3065
	RCA	CA3065
	Sprague	ULN-2165
MC1364	Fairchild	μA3064
	Sprague	ULN-2264
MC1370	Fairchild	μA780
	Sprague	ULN-2124
MC1371	Fairchild	μA781
	Sprague	ULN-2127
MC1398	RCA	CA1398
MC14000	Harris	HD4000
	National	CD4000
	RCA	**CD4000**
	see page 375	
	SSS	SCL4000
	TI	TF4000
	TI	TP4000
MC14001	Fairchild	F4001
	GI	MEM4001
	Harris	HD4001
	National	CD4001
	RCA	**CD4001**
	see page 375	
	SGS	HBF4001
MC14001	SSS	SCL4001
	SW	SN4001
	TI	TF4001
	TI	TP4001
	Toshiba	TC4001
MC14002	Fairchild	F4002
	Harris	HD4002
	National	CD4002
	RCA	**CD4002**
	see page 375	
	SGS	HBF4002
	SSS	SCL4002
	TI	TF4002
	TI	TP4002
	Toshiba	TC4002
MC14006	Fairchild	F4006
	Harris	HD4006
	National	CD4006
	RCA	**CD4006**
	see page 375	
	SSS	SCL4006
MC14007	Fairchild	F4007
	GI	MEM4007
	National	CD4007
	National	CD4008
	RCA	**CD4007**
	see page 375	
	SGS	HD4007
	SSS	SCL4007
	TI	TF4007
	TI	TP4007
	Toshiba	TC4007
MC14008	Fairchild	F4008
	Harris	HD4008
	RCA	**CD4008**
	see page 375	
	SSS	SCL4008
	TI	TF4008
	TI	TP4008
	Toshiba	TC4008
MC14009	National	CD4009
	RCA	**CD4009**
	see page 375	
	SSS	SCL4009
MC14010	National	CD4010
	RCA	**CD4010**
	see page 375	
	SSS	SCL4010
MC14011	Fairchild	F4011
	GI	MEM4011
	Harris	HD4011
	National	CD4011
	RCA	**CD4011**
	see page 375	
	SGS	HBF4011
	SSS	SCL4011
	SW	SW4011
	TI	TF4011
	TI	TP4011
	Toshiba	TC4011
MC14012	Fairchild	F4012
	Harris	HD4012
	National	CD4012
	RCA	**CD4012**
	see page 375	
	SGS	HBF4012
	SSS	SCL4012
	SW	SW4012
	TI	TF4012
	TI	TP4012
	Toshiba	TC4012
MC14013	AMI	UL51L
	Fairchild	F4013
	GI	MEM4013
	Harris	HD4013
	National	CD4013
	National	MM4613
	SGS	HBF4013
	SSS	SCL4013
	SW	SW4013
	TI	TF4013
MC14013	TI	TP4013
	Toshiba	TC4013
MC14014	National	CD4015
	RCA	**CD4014**
	see page 375	
	SSS	SCL4014
MC14015	Fairchild	F4015
	Harris	**HD4015**
	see page 266	
	RCA	**CD4015**
	see page 375	
	SGS	HBF4015
	SSS	SCL4015
	SW	SW4015
	TI	TF4015
	TI	TP4015
	Toshiba	TC4015
MC14016	National	CD4016
	RCA	**CD4016**
	see page 375	
	SSS	SCL4016
MC14017	Fairchild	F4017
	Harris	HD4017
	National	CD4017
	RCA	**CD4017**
	see page 375	
	SGS	HBF4017
	SSS	SCL4017
	SW	SW4017
	TI	TF4017
	TI	TP4017
	Toshiba	TC4017
MC14020	Fairchild	F4020
	Harris	**HD4020**
	see page 266	
	National	CD4020
	RCA	**CD4020**
	see page 375	
	SGS	HBF4020
	SSS	SCL4020
	SW	SW4020
	TI	TF4020
	TI	TP4020
	Toshiba	TC4020
MC14021	Fairchild	F4021
	Harris	**HD4021**
	see page 266	
	National	CD4021
	RCA	**CD4021**
	see page 375	
	SSS	SCL4021
	SW	SW4021
	TI	TF4021
	TI	TP4021
	Toshiba	TC4021
MC14022	Fairchild	F4022
	Harris	**HD4022**
	see page 266	
	National	CD4022
	RCA	**CD4022**
	see page 375	
	SGS	HBF4022
	SSS	SCL4022
	TI	TF4022
	TI	TP4022
	Toshiba	TC4022
MC14023	Fairchild	F4023
	Harris	HD4023
	National	CD4023
	RCA	**CD4023**
	see page 375	
	SGS	HBF4023
	SSS	SCL4023
	SW	SW4023
	TI	TF4023
	TI	TP4023
	Toshiba	TC4023
MC14024	Fairchild	F4024
	Harris	HD4024
	National	CD4024
	National	MM4624
MC14024	**RCA**	**CD4024**
	see page 375	
	SGS	HBF4024
	SSS	SCL4024
MC14025	Fairchild	F4025
	Harris	HD4025
	National	CD4025
	RCA	**CD4025**
	see page 375	
	SGS	HBF4025
	SSS	SCL4025
	SW	SW4025
	TI	TF4025
	TI	TP4025
	Toshiba	TC4025
MC14027	Fairchild	F4027
	Harris	HD4027
	National	CD4027
	RCA	**CD4027**
	see page 375	
	SGS	HBF4027
	SSS	SCL4027
	SW	SW4027
	TI	TF4027
	TI	TP4027
	Toshiba	TC4027
MC14028	Fairchild	F4028
	Harris	**HD4028**
	see page 266	
	National	CD4028
	RCA	**CD4028**
	see page 375	
	SGS	HBF4028
	SSS	SCL4028
	SW	SW4028
	TI	TF4028
	TI	TP4028
	Toshiba	TC4028
MC14032	**RCA**	**CD4032**
	see page 375	
	Toshiba	TC4032
MC14034	Fairchild	F4034
	RCA	**CD4034**
	see page 375	
	SSS	SCL4034
	Toshiba	TC4034
MC14035	Fairchild	F4035
	Harris	**HD4035**
	see page 266	
	National	CD4035
	RCA	**CD4035**
	see page 375	
	SGS	HBF4035
	SSS	SCL4035
	TI	TF4035
	TI	TP4035
	Toshiba	TC4035
MC14038	**RCA**	**CD4038**
	see page 375	
	Toshiba	TC4038
MC14040	Fairchild	F4040
	Harris	HD4040
	National	CD4040
	RCA	**CD4040**
	see page 375	
	SSS	SCL4040
	TI	TF4040
	TI	TP4040
	Toshiba	TC4040
MC14042	Fairchild	F4042
	Harris	HD4042
	National	CD4042
	RCA	**CD4042**
	see page 375	
	SGS	HBF4042
	SSS	SCL4042
	TI	TF4042
	TI	TP4042
	Toshiba	TC4042
MC14046	Fairchild	F4046
	RCA	**CD4046**
	see page 375	

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The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Motorola Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
MC14049	Fairchild	F4049
	GI	MEM4049
	Harris	HD4049
	National	CD4049
	RCA	**CD4049**
	see page 375	
	SGS	HBF4049
	SSS	SCL4049
	SW	SW4049
	Teledyne S	CD4049
	TI	TF4049
	TI	TP4049
	Toshiba	TC4049
MC14050	Fairchild	F4050
	Harris	HD4050
	National	CD4050
	RCA	**CD4050**
	see page 375	
	SGS	HBF4050
	SSS	SCL4050
	SW	SW4050
	Teledyne S	CD4050
	TI	TF4050
	TI	TP4050
	Toshiba	TC4050
MC14068	Fairchild	F4068
	RCA	**CD4068**
	see page 375	
	Toshiba	TC4068
MC14069	Fairchild	F4069
	National	CD4069
	RCA	**CD4069**
	see page 375	
	Toshiba	TC4069
MC14071	Fairchild	F4071
	RCA	**CD4071**
	see page 375	
	TI	TF4071
	TI	TP4071
	Toshiba	TC4071
MC14073	RCA	**CD4073**
	see page 375	
	Toshiba	TC4073
MC14076	Fairchild	F4076
	National	CD4076
	RCA	**CD4076**
	see page 375	
MC1408	AD	**AD559**
	see page 538	
	PMI	SSS1408
MC14081	Fairchild	F4081
	RCA	**CD4081**
	see page 375	
	TI	TF4081
	TI	TP4081
	Toshiba	TC4081
MC1414	National	LM1414
	Raytheon	RC1414
	TI	SN72514
MC1436	Harris	HA-2645
	National	LM1436
	Silicon G	SG1436
MC1437	Raytheon	RC1437
MC1441	RCA	CA1541
MC14502	RCA	CD4502
	RCA	CD4502B
	SSS	SCL4502
	Solitron	CM4508
	Toshiba	TC4508
MC14507	RCA	CD4070A
	TI	TF4507
MC14508	Harris	HD4508
MC14510	Fairchild	F4510
	Harris	HD4510
	National	CD4510
	RCA	CD4510B
	SSS	SCL4510
MC14511	National	CD4511
	RCA	CD4511B
	SSS	SCL4511
	Solitron	CM4511
MC14512	Fairchild	F4512
	Harris	HD4512
	TI	TF4512
	TI	TP4512
	Toshiba	TC4512
MC14514	Fairchild	F4514
	Harris	SIL4514
	RCA	**CD4514**
	see page 375	
	SSS	SCL4514
	Solitron	CM4514
	Toshiba	TC4514
MC14515	Fairchild	F4515
	RCA	**CD4515**
	see page 375	
	SSS	SCL4515
	Solitron	CM4515
	Toshiba	TC4515
MC14516	Fairchild	F4516
	National	CD4516
	RCA	**CD4516**
	see page 375	
	SSS	SCL4516
	Toshiba	TC4516
MC14517	SSS	SCL4517
MC14518	Fairchild	F4518
	Harris	HD4518
	National	CD4518
	RCA	**CD4518**
	see page 375	
	RCA	CD4518B
	SSS	SCL4518
	Solitron	CM4518
	TI	TF4518
	TI	TP4518
	Toshiba	TC4518
MC14519	Fairchild	F4519
	Harris	HD4519
	TI	TF4519
	TI	TP4519
MC14520	Fairchild	F4520
	Harris	HD4520
	National	CD4520
	RCA	CD4520B
	SSS	SCL4520
	Solitron	CM4520
	TI	TF4520
	TI	TP4520
	Toshiba	TC4520
MC14521	Harris	HD4521
MC14522	Fairchild	F4522
	TI	TF4522
	TI	TP4522
MC14526	Fairchild	F4526
	TI	TF4526
	TI	TP4526
MC14527	RCA	**CD4527**
	see page 375	
	RCA	CD4527B
MC14528	Fairchild	F4528
	RCA	CD4528B
	Signetics	N4528
	SSS	SCL4528
	Toshiba	TC4528
MC14529	Harris	HD4529
MC14531	Fairchild	F4531
	SSS	SC4531
	TI	TF4531
	TI	TP4531
MC14532	Fairchild	F4532
	RCA	**CD4532**
	see page 375	
	RCA	CD4532B
	Toshiba	TC4532
MC14539	Fairchild	F4539
	Toshiba	TC4539
MC14543	Harris	HD4543
MC1455	Exar	XR555
	Raytheon	RC555
	Signetics	NE555
MC14553	Fairchild	F4553
MC14555	Fairchild	F4555
	RCA	**CD4555**
	see page 375	
	RCA	CD4555B
MC14556	Fairchild	F4556
	RCA	**CD4556**
	see page 375	
	RCA	CD4556B
MC1456	Harris	HA-2605
	Raytheon	RC1556
	Signetics	MC1456
	Silicon G	SG1456
	TI	SN72771
MC14571	SSS	SCL4571
MC1458	Fairchild	µA1458
	Fairchild	1458
	Harris	HA-2655
	National	LM1458
	PMI	SSS1458
	Raytheon	RC1458
	Raytheon	**RC4558**
	see page 651	
	RCA	CA1458
	Signetics	MC1458
	Silicon G	SG1458
	Teledyne S	1458
	TI	SN72558
MC14581	SSS	SCL4581
	TI	TF4581
	TI	TP4581
MC14582	Fairchild	F4582
	TI	TF4582
	TI	TP4582
MC14583	Toshiba	TC4583
MC14585	National	MM74C85
	SSS	SCL4585
	Toshiba	TC4585
MC1468	Exar	XR1468
	Silicon G	SG1468
MC1488	AMD	MC1488
	Exar	XR1488
	ITT	ITT1488
	ITT	ITT1489
	National	DS1488
	Raytheon	RC1488
	Raytheon	RM1488
	Silicon G	SG1488
	TI	SN75188
MC1489	AMD	MC1489
	Exar	XR1489
	National	DS1489
	Raytheon	RC1489
	Raytheon	RC1489A
	Signetics	MC1489
	Silicon G	SG1489
	TI	SN75189
MC1495	Lithic Sys	LS1495
	Silicon G	SG1495
MC1496	Fairchild	µA796
	Lithic Sys	LS1496
	Signetics	MC1496
	Silicon G	SG1496
MC1508	AD	**AD559**
	see page 538	
	PMI	SSS1508
MC1510	TI	SN5510
MC1514	National	LM1514
	Raytheon	RM1514
	TI	SN52514
MC1536	Harris	HA-2640
	National	LM1536
	Silicon G	SG1536
MC1537	Raytheon	RM1537
MC1541	RCA	CA1541
MC1555	Raytheon	RM555
	Signetics	SE555
MC1556	Harris	HA-2600
	Raytheon	RM1556
	Raytheon	RM1556A
	Signetics	MC1556
	Silicon G	SG1556
MC1556	TI	SN52771
MC1558	Fairchild	µA1558
	Harris	HA-2650
	National	LM1558
	PMI	SSS1558
	Raytheon	RM1558
	Raytheon	**RM4558**
	see page 651	
	RCA	CA1558
	Signetics	MC1558
	Silicon G	SG1558
	Teledyne S	1558
	TI	SN52558
MC1568	Exar	XR1568
	Silicon G	SG1568
MC1595	Lithic Sys	LS1595
	Silicon G	SG1595
MC1596	Fairchild	µA796
	Lithic Sys	LS1596
	National	LM1596
	Signetics	MC1596
	Silicon G	SG1596
MC1648	Plessey	SP1648
MC1650	Plessey	SP1650
MC1651	Plessey	SP1651
MC1658	Fairchild	11C58
	Plessey	SP1658
MC1660	Plessey	SP1660
MC1662	Plessey	SP1662
MC1664	Plessey	SP1664
MC1666	Plessey	SP1666
MC1668	Plessey	SP1668
MC1670	Plessey	SP1670
MC1672	Plessey	SP1672
MC1674	Plessey	SP1674
MC1690	Fairchild	11C06C
	Plessey	SP1690
MC1692	Plessey	MC1692
MC1709	Fairchild	µA709
	National	LM1709
	National	LM709
	Raytheon	RC709
	Raytheon	RM709
	Signetics	µA709
	Teledyne S	709
	TI	SN52709
MC1710	Fairchild	µA710
	National	LM1710
	National	LM710
	Raytheon	RC710
	Raytheon	RM710
	Signetics	µA710
	Silicon G	SG1710
	Teledyne S	710
	TI	SN52710
MC1711	Fairchild	µA711
	Fairchild	711
	National	LM1711
	National	LM711
	Raytheon	RC711
	Raytheon	RM711
	Signetics	µA711
	Silicon G	SG1711
	Teledyne S	711
	TI	SN52711
MC1712	Fairchild	µA702
	Raytheon	RC702
	Raytheon	RM702
	TI	SN52702
MC1723	AMD	723
	Fairchild	µA723
	Intersil	723
	National	LM1723
	National	LM723
	Raytheon	RC723
	Raytheon	RM723
	RCA	CA723
	Signetics	µA723
	Silicon G	SG1723
	Teledyne S	723
	TI	SN52723

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Bold face device number indicates additional data is provided in Catalog section

Motorola Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
MC1733	AMD	733
	National	LM1733
	National	LM733
	Raytheon	RC733
	Raytheon	RM733
	Signetics	µA733
	TI	SN52733
MC1741	AMD	741
	Fairchild	µA741
	Intersil	741
	National	LM1741
	National	LM741
	PMI	SSS741
	Raytheon	RC741
	Raytheon	RM741
	RCA	**CA741**
	see page 661	
	Signetics	µA741
	Silicon G	SG1741
	Silicon G	SG741
	Teledyne S	741
	TI	SN52741
MC1747	AMD	747
	Raytheon	RC747
	Raytheon	RM747
	Signetics	µA747
	Teledyne S	747
MC1748	AMD	748
	Fairchild	µA748
	Intersil	748
	National	LM1748
	National	LM748
	Raytheon	RC748
	Raytheon	RM748
	RCA	CA748
	Signetics	µA748
	Silicon G	SG1748
	Teledyne S	748
	TI	SN52748
MC1800	SW	SW1800
	TI	SN151800
MC1801	TI	SN151801
MC1802	SW	SW1802
	TI	SN151802
MC1803	TI	SN151803
MC1804	SW	SW1804
	TI	SN151804
MC1805	TI	SN151805
MC1806	SW	SW1806
	TI	SN151806
MC1807	TI	SN151807
MC1808	SW	SW1808
	TI	SN151808
MC1809	TI	SN151809
MC1810	SW	SW1810
	TI	SN151810
MC1811	TI	SN151811
MC1812	SW	SW1812
	TI	SN151812
MC1813	SW	SW1813
MC1814	SW	SW1814
MC1900	SW	SW1900
	TI	SN151900
MC1901	TI	SN151901
MC1902	SW	SW1902
	TI	SN151902
MC1903	SW	SW1903
	TI	SN151903
MC1904	SW	SW1904
	TI	SN151904
MC1905	TI	SN151905
MC1906	SW	SW1906
	TI	SN151906
MC1907	TI	SN151907
MC1908	SW	SW1908
	TI	SN151908
MC1909	TI	SN151909
MC1910	SW	SW1910
	TI	SN151910
MC1911	TI	SN151911
MC1912	SW	SW1912
MC1912	TI	SN151912
MC1914	SW	SW1914
MC2257	Nitron	NC2257
MC2259	Nitron	NC2259
MC2260	Nitron	NC2260
MC3000	Fairchild	74H00
	Fairchild	9H00
	ITT	ITT74H00
	TI	SN74H00
MC3001	Fairchild	74H08
	Fairchild	9H08
	ITT	ITT7408
	TI	SN7408
MC3003	ITT	ITT7432
	TI	SN7432
MC3004	Fairchild	74H01
	Fairchild	9H01
	ITT	ITT74H01
	TI	SN74H01
MC3005	Fairchild	74H10
	Fairchild	9H10
	ITT	ITT74H10
	TI	SN74H10
MC3006	Fairchild	74H11
	Fairchild	9H11
	ITT	ITT74H11
	TI	SN74H11
MC3008	Fairchild	74H04
	Fairchild	9H04
	ITT	ITT74H04
	TI	SN74H04
MC3009	Fairchild	74H05
	Fairchild	9H05
	ITT	ITT74H05
	TI	SN74H05
MC3010	Fairchild	74H20
	Fairchild	9H20
	ITT	ITT74H20
	ITT	ITT74H21
	TI	SN74H20
MC3011	Fairchild	74H21
	Fairchild	9H21
	TI	SN74H21
MC3012	Fairchild	74H22
	Fairchild	9H22
	TI	SN74H22
MC3015	TI	SN74H30
MC3016	Fairchild	74H30
	Fairchild	9H30
	ITT	ITT74H30
MC3018	Fairchild	74H62
	Fairchild	9H62
	TI	SN74H62
MC3019	Fairchild	74H61
	Fairchild	9H61
	TI	SN74H61
MC3020	Fairchild	74H50
	Fairchild	9H50
	ITT	ITT74H50
	TI	SN74H50
MC3021	TI	SN74S86
MC3023	Fairchild	74H51
	Fairchild	9H51
	ITT	ITT74H51
	TI	SN74H51
MC3024	Fairchild	74H40
	Fairchild	9H40
	ITT	ITT74H40
	TI	SN74H40
MC3025	ITT	ITT74H40
	TI	SN74H40
MC3030	Fairchild	74H60
	Fairchild	9H60
	ITT	ITT74H60
	TI	SN74H60
MC3031	Fairchild	74H52
	Fairchild	9H52
	TI	SN74H52
MC3032	Fairchild	74H53
	Fairchild	9H53
	ITT	ITT74H53
MC3032	TI	SN74H53
MC3033	Fairchild	74H54
	Fairchild	9H54
	ITT	ITT74H54
	TI	SN74H54
MC3034	Fairchild	74H55
	Fairchild	9H55
	TI	SN74H55
MC3054	Fairchild	74H71
	Fairchild	9H71
	TI	SN74H71
MC3055	Fairchild	74H72
	Fairchild	9H72
	TI	SN74H72
MC3060	ITT	ITT74H74
	TI	SN74H74
MC3061	Fairchild	9S114
	TI	SN74S114
MC3062	Fairchild	9S113
	TI	SN74S113
MC3063	Fairchild	74H73
	Fairchild	9H73
	ITT	ITT74H73
	TI	SN74H73
MC3100	TI	SN54H00
MC3104	TI	SN54H01
MC3105	TI	SN54H10
MC3106	TI	SN54H11
MC3108	TI	SN54H04
MC3109	TI	SN54H05
MC3110	TI	SN54H20
MC3111	TI	SN54H21
MC3112	TI	SN54H22
MC3116	TI	SN54H30
MC3118	TI	SN54H62
MC3119	TI	SN54H61
MC3120	TI	SN54H50
MC3121	TI	SN54S86
MC3123	TI	SN54H51
MC3124	TI	SN54H40
MC3125	TI	SN54H40
MC3130	TI	SN54H60
MC3131	TI	SN54H52
MC3132	TI	SN54H53
MC3133	TI	SN54H54
MC3134	TI	SN54H55
MC3154	TI	SN54H71
MC3155	TI	SN54H72
MC3160	TI	SN54H74
MC3162	TI	SN54S113
MC3163	TI	SN54H73
MC3301	Fairchild	3301
	Raytheon	LM2900
	Raytheon	RC3301
MC3302	Raytheon	RC3302
	Teledyne S	3302
MC3401	Fairchild	3401
	Raytheon	LM3900
	Raytheon	RC3401
	RCA	CA3401
MC3403	Exar	XR3403
	Fairchild	µA3403C
	Raytheon	**RC3403**
	see page 649	
	Raytheon	RC4137
MC3503	Exar	XR3503
	Fairchild	µA3503M
	Raytheon	**RM3503**
	see page 649	
	Raytheon	RM4137
MC4005	Fairchild	93407
	ITT	ITT481
	TI	SN7481
MC4015	Raytheon	RL4015
MC4024	Fairchild	11C24C
MC4044	Fairchild	11C44C
MC4064	MMI	6560
	Signetics	**N82S16**
	see page 804, 806, 815,	
MC4304	TI	SN5481A
MC4305	TI	SN5481A
MC5003	TI	SN74186
MC5005	MMI	6300
	TI	SN74S387
MC5303	TI	SN54186
MC5400	Raytheon	5400
MC5401	Raytheon	5401
MC5403	Raytheon	5403
MC5404	Raytheon	5404
MC5405	Raytheon	5405
MC5408	Raytheon	5408
MC5409	Raytheon	5409
MC5410	Raytheon	5410
MC5411	Raytheon	5411
MC5412	Raytheon	5412
MC54123	Raytheon	54123
MC54136	Raytheon	54136
MC54145	Raytheon	54145
MC5415	Raytheon	5415
MC54150	Raytheon	54150
MC54151	Raytheon	54151
MC54152	Raytheon	54152
MC54153	Raytheon	54153
MC54154	Raytheon	54154
MC54155	Raytheon	54155
MC54156	Raytheon	54156
MC54157	Raytheon	54157
MC54158	Raytheon	54158
MC54159	Raytheon	54159
MC54160	Raytheon	54160
MC54161	Raytheon	54161
MC54162	Raytheon	54162
MC54163	Raytheon	54163
MC54164	Raytheon	54164
MC54165	Raytheon	54165
MC54166	Raytheon	54166
MC54170	Raytheon	54170
MC54174	Raytheon	54174
MC54175	Raytheon	54175
MC54181	Raytheon	54181
MC54182	Raytheon	54182
MC54190	Raytheon	54190
MC54191	Raytheon	54191
MC54193	Raytheon	54193
MC54194	Raytheon	54194
MC54195	Raytheon	54195
MC54198	Raytheon	54198
MC54199	Raytheon	54199
MC5420	Raytheon	5420
MC5421	Raytheon	5421
MC5422	Raytheon	5422
MC54283	Raytheon	54283
MC5442	Raytheon	5442
MC5443	Raytheon	5443
MC5444	Raytheon	5444
MC5445	Raytheon	5445
MC5474	Raytheon	5474
MC5481	Raytheon	5481
MC5483	Raytheon	5483
MC5486	Raytheon	5486
MC55107	AMD	SN55107B
	Fairchild	55107
	National	DS55107
	Raytheon	RM55107
	TI	SN55107
MC55108	AMD	SN55108B
	Fairchild	55108
	National	DS55108
	Raytheon	RM55108
	TI	SN55108
MC55109	AMD	SN55109
	Fairchild	55109
	National	DS55109
	Raytheon	RM55109
	TI	SN55109
MC55110	AMD	SN55110
	Fairchild	55110
	National	DS55110
	Raytheon	RM55110
	TI	SN55110
MC5520	National	DS5520
MC5521	National	DS5521

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Motorola Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
MC5522	National	DS5522
MC5523	National	DS5523
MC5524	National	DS5524
MC5525	National	DS5525
MC574	Raytheon	5474
MC6002	TI	TMS4062
MC6800	**AMI**	**S6800**
	see page 862	
MC6820	**AMI**	**S6820**
	see page 889	
MC6850	**AMI**	**S6850**
	see page 895	
MC6860	**AMI**	**S6860**
	see page 900	
MC7241	Raytheon	RC8241
	Signetics	N8241
MC7242	Fairchild	9386
	Raytheon	RC8242
	Signetics	N8242
MC7250	Raytheon	RC8250
	Signetics	N8250
MC7251	Raytheon	RC8251
	Signetics	N8251
MC7261	Raytheon	RC8261
	Signetics	N8261
MC74H00	Raytheon	74H00
MC74H01	Raytheon	74H01
MC74H04	Raytheon	74H04
MC74H05	Raytheon	74H05
MC74H10	Raytheon	74H10
MC74H11	Raytheon	74H11
MC74H20	Raytheon	74H20
MC74H22	Raytheon	74H22
MC74H40	Raytheon	74H40
MC74H74	Raytheon	74H74
MC7400	Hitachi	HD2503
	Raytheon	7400
	TI	SN7400
MC7401	Hitachi	HD2509
	Raytheon	7401
	TI	SN7401
MC7402	Hitachi	HD2511
	TI	SN7402
MC7403	Raytheon	7403
MC7404	Hitachi	HD2522
	Raytheon	7404
	TI	SN7404
MC7405	Hitachi	HD2523
	Raytheon	7405
	TI	SN7405
MC7408	Raytheon	7408
MC7409	Raytheon	7409
MC7410	Hitachi	HD2507
	Raytheon	7410
	TI	SN7410
MC74107	Hitachi	HD2530
	TI	SN74107
MC7411	Raytheon	7411
MC7412	Raytheon	7412
MC74121	Hitachi	HD2543
	TI	SN74121
MC74123	Raytheon	74123
MC74136	Raytheon	74136
MC74145	Raytheon	74145
MC7415	Raytheon	7415
MC74150	Hitachi	HD2548
	Raytheon	74150
	TI	SN74150
MC74151	Hitachi	HD2549
	Raytheon	74151
	TI	SN74151A
MC74152	Raytheon	74152
MC74153	Raytheon	74153
MC74154	Raytheon	74154
MC74155	Raytheon	74155
MC74156	Raytheon	74156
MC74157	Raytheon	74157
MC74158	Raytheon	74158
MC74159	Raytheon	74159
MC74160	Raytheon	74160
MC74161	Raytheon	74161
MC74162	Raytheon	74162
MC74163	Raytheon	74163
MC74164	Raytheon	74164
MC74165	Raytheon	74165
MC74166	Raytheon	74166
MC74170	Raytheon	74170
MC74174	Raytheon	74174
MC74181	Raytheon	74181
MC74182	Raytheon	74182
MC74190	Raytheon	74190
MC74191	Raytheon	74191
MC74192	Raytheon	74192
MC74193	Raytheon	74193
MC74194	Raytheon	74194
MC74195	Raytheon	74195
MC74198	Raytheon	74198
MC74199	Raytheon	74199
MC7420	Hitachi	HD2504
	Raytheon	7420
	TI	SN7420
MC7421	Raytheon	7421
MC7422	Raytheon	7422
MC74283	Raytheon	74283
MC7430	Hitachi	HD2508
	TI	SN7430
MC7440	Hitachi	HD2501
	TI	SN7440
MC7441	Hitachi	HD2518
	TI	SN74141
MC7442	Raytheon	7442
MC7443	Raytheon	7443
MC7444	Raytheon	7444
MC7445	Raytheon	7445
MC7450	Hitachi	HD2506
	TI	SN7450
MC7451	Hitachi	HD2505
	TI	SN7451
MC7453	Hitachi	HD2512
	TI	SN7453
MC7454	Hitachi	HD2514
	TI	SN7454
MC7460	Hitachi	HD2502
	TI	SN7460
MC7470	Signetics	N7470
	TI	SN7470
MC7472	Hitachi	HD2529
	Signetics	N7472
	TI	SN7472
MC7473	Hitachi	HD2515
	Signetics	N7473
	TI	SN7473
MC7474	Hitachi	HD2510
	Raytheon	MC7474
	TI	SN7474
MC7475	Hitachi	HD2517
	Signetics	N7475
	TI	SN7475
MC7476	Hitachi	HD2516
	Signetics	N7476
MC7480	Signetics	N7480
	TI	SN7480
MC7481	Raytheon	7481
MC7483	Raytheon	7483
	Signetics	N7483
MC7486	Raytheon	7486
MC7490	Hitachi	HD2541
	Signetics	N7490
	TI	SN7490A
MC7491	Hitachi	HD2524
	Signetics	N7491
	TI	SN7491A
MC7492	Signetics	N7492
	TI	SN7492A
MC7493	Hitachi	HD25
	Signetics	N7493
	TI	SN7493A
MC7495	Hitachi	HD2534
	Signetics	N7495
	TI	SN7495A
MC7496	Hitachi	HD2546
	TI	SN7496
MC75107	AMD	SN75107B
	Fairchild	75107
	National	DS75107
	Raytheon	RC75107A
MC75108	AMD	SN75108B
	Fairchild	75108
	National	DS75108
	Raytheon	RC75108A
MC75109	AMD	SN75109
	Fairchild	75109
	ITT	ITT75109
	National	DS75109
	Raytheon	RC75109
MC75110	AMD	SN75110
	Fairchild	75110
	ITT	ITT75110
	National	DS75110
	Raytheon	RC75110
MC7520	ITT	ITT7520
	National	DS7520
	Signetics	SN7520
	Signetics	7520
	TI	SN7520
MC7521	ITT	ITT7521
	National	DS7521
	Signetics	SN7521
	Signetics	7521
	TI	SN7521
MC7522	ITT	ITT7522
	National	DS7522
	Signetics	SN7522
	Signetics	7522
	TI	SN7522
MC7523	ITT	ITT7523
	National	DS7523
	Signetics	SN7523
	Signetics	7523
	TI	SN7523
MC75234	ITT	ITT75234
MC75235	ITT	ITT75235
MC7524	ITT	ITT7524
	National	DS7524
	Signetics	SN7524
	Signetics	7524
	TI	SN7524
MC7525	ITT	ITT7525
	National	DS7525
	Signetics	SN7525
	Signetics	7525
	TI	SN7525
MC75252	ITT	ITT75452
MC7528	ITT	ITT7528
	National	DS7528
	TI	SN7528
MC7529	ITT	ITT7529
	TI	SN7529
MC75325	Fairchild	75325
	National	DS75325
	Raytheon	RC75325
	TI	SN75325
MC7534	National	DS7534
	TI	SN7534
MC7535	National	DS7535
	TI	SN7535
MC7538	National	DS7538
	TI	SN7538
MC7539	National	DS7539
	TI	SN7539
MC75450	ITT	ITT75450
	National	DS75450
	Raytheon	RC75450
	Teledyne S	75450
	TI	SN75450
MC75451	ITT	ITT75451
	National	DS75451
	Raytheon	RC75451
	Teledyne S	75451
	TI	SN75451
MC75452	National	DS75452
	Raytheon	RC75452
	Teledyne S	75452
MC75452	TI	SN75452
MC75453	ITT	ITT75453
	National	DS75453
	Raytheon	RC75453
	Teledyne S	75453
	TI	SN75453
MC75454	ITT	ITT75454
MC75491	National	DS75490
	TI	SN75491
MC75492	National	DS75492
	TI	SN75492
MC7805	National	LM340-5
	Raytheon	RC7805
	Silicon G	SG7805
MC7806	National	LM340-6
	Raytheon	RC7806
	Silicon G	SG7806
MC7808	National	LM340-8
	Raytheon	RC7808
	Silicon G	SG7808
MC7812	National	LM340-12
	Raytheon	RC7812
	Silicon G	SG7812
MC7815	National	LM340-15
	Raytheon	RC7815
	Silicon G	SG7815
MC7818	National	LM340-18
	Raytheon	RC7818
	Silicon G	SG7818
MC7824	National	LM340-24
	Raytheon	RC7824
	Silicon G	SG7824
MC8241	Raytheon	RM8241
	Signetics	S8241
MC8242	Fairchild	9386
	Raytheon	RM8242
	Signetics	S8242
MC8250	Raytheon	RM8250
	Signetics	S8250
MC8251	Raytheon	RM8251
	Signetics	S8251
MC8260	Raytheon	RM8260
MC8261	Raytheon	RM8261
	Signetics	S8261
MC830	Hitachi	HD2204
	SW	SW930
	TI	SN15930
MC8300	AMD	9300
	Fairchild	9300
	Raytheon	RC9300
	TI	SN74195
MC8301	AMD	9301
	Fairchild	9301
	Signetics	N8252
	TI	SN29301
MC8304	AMD	9304
	Fairchild	9304
	Raytheon	RC9304
MC8308	AMD	9308
	Fairchild	9308
	Raytheon	RC9308
	TI	SN29308
MC8309	AMD	9309
	Fairchild	9309
	TI	SN29309
MC831	SW	SW931
	TI	SN15831
MC8310	AMD	9310
	Fairchild	9310
	Raytheon	RC9310
	TI	SN74160
MC8311	AMD	9311
	Fairchild	9311
	Raytheon	RC9311
	TI	SN74154
MC8312	AMD	9312
	Fairchild	9312
	Raytheon	RC9312
	Signetics	N8230
	TI	SN29312
MC8314	AMD	9314

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

Motorola Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
MC8316	AMD	9316
	Fairchild	9316
	Raytheon	RC9316
	TI	SN74161
MC8318	AMD	9318
	TI	SN29318
MC832	Hitachi	HD2201
	SW	SW932
	TI	SN15832
MC8328	AMD	9328
	Fairchild	9328
	Signetics	N82778
MC833	Hitachi	HD2202
	SW	SW933
	TI	SN15833
MC834	TI	SN15834
MC835	SW	SW936
	TI	SN15838
MC836	Hitachi	HD2206
	SW	SW936
	TI	SN15836
MC837	SW	SW937
	TI	SN15837
MC840	SW	SW935
	TI	SN15835
MC841	TI	SN15835
MC844	Hitachi	HD2209
	SW	SW844
MC845	Hitachi	HD2205
	SW	SW945
	TI	SN15845
MC846	Hitachi	HD2203
	SW	SW946
	TI	SN15846
MC848	SW	SW948
	TI	SN15848
MC849	SW	SW949
	TI	SN15849
MC850	SW	SW850
	TI	SN15850
MC851	SW	SW951
	TI	SN15851
MC852	SW	SW706
	TI	SN158099
MC853	SW	SW705
	TI	SN158093
MC855	SW	SW709
	TI	SN158097
MC856	SW	SW708
	TI	SN158094
MC857	Hitachi	HD2213
	SW	SW957
	TI	SN15857
MC858	Hitachi	HD2214
	SW	SW958
	TI	SN15858
MC8601	AMD	9601
	Fairchild	9601
	Raytheon	RF8601
	Signetics	N8T22
	TI	SN29601
MC8602	AMD	9602
	Raytheon	RF8602
MC861	SW	SW961
	TI	SN15861
MC862	Hitachi	HD2207
	SW	SW962
	TI	SN15862
MC863	SW	SW963
	TI	SN15863
MC930	Raytheon	RM930
	SW	SW930
	TI	SN15930
MC9300	AMD	9300
	Raytheon	RM9300
	TI	SN54195
MC9301	AMD	9301
	TI	SN39301
MC9304	AMD	9304
	Raytheon	RM9304
MC9308	AMD	9308

Manufacturer Device	Replacement Source	Replacement Device
MC9308	Raytheon	RM9308
	TI	SN39308
MC931	SW	SW931
	TI	SN15931
MC9310	AMD	9310
	Raytheon	RM9310
	TI	SN54160
MC9311	AMD	9311
	Raytheon	RM9311
	TI	SN54154
MC9312	AMD	9312
	Raytheon	RM9312
	Signetics	S8230
	TI	SN39312
MC9314	AMD	9314
MC9316	AMD	9316
	Raytheon	RM9316
	TI	SN54161
MC9318	AMD	9318
	TI	SN39318
MC932	Raytheon	RM932
	SW	SW932
	TI	SN15939
MC9328	AMD	9328
	Signetics	N8277
MC933	SW	SW933
	TI	SN15933
MC934	TI	SN15934
MC935	Raytheon	RM935
	SW	SW736
	TI	SN15938
MC936	Raytheon	RM936
	SW	SW936
	TI	SN15936
MC937	Raytheon	RM937
	SW	SW937
	TI	SN15937
MC940	Raytheon	RM940
	SW	SW935
	TI	SN15935
MC943	Fairchild	SH2001
MC944	Raytheon	RM944
	SW	SW944
	TI	SN15944
MC945	Raytheon	RM945
	SW	SW945
	TI	SN15945
MC946	Raytheon	RM946
	SW	SW946
	TI	SN15946
MC948	Raytheon	RM948
	SW	SW948
	TI	SN15948
MC949	Raytheon	RM949
	SW	SW949
	TI	SN15949
MC950	Raytheon	RM950
	SW	SW950
	TI	SN15950
MC951	Raytheon	RM951
	SW	SW951
	TI	SN15951
MC952	Raytheon	RM952
	SW	SW952
	TI	SN159099
MC953	SW	SW953
	TI	SN159093
MC955	TI	SN159097
MC956	TI	SN159094
MC957	Raytheon	RM957
	SW	SW957
	TI	SN15957
MC958	Raytheon	RM958
	SW	SW958
	TI	SN15958
MC9601	AMD	9601
	Raytheon	RF9601
	Signetics	S8T22
	TI	SN29601
MC9602	AMD	9602
	Raytheon	RF9602

Manufacturer Device	Replacement Source	Replacement Device
MC961	Raytheon	RM961
	SW	SW961
	TI	SN15961
MC962	Raytheon	RM962
	SW	SW962
	TI	SN15962
MC963	Raytheon	RM963
	SW	SW963
	TI	SN15963
MLM101	AMD	LM101
	Fairchild	μA101
	Intersil	LM101
	National	LM101
	Raytheon	LM101
	RCA	**CA101**
	see page 661	
	Signetics	LM101
	Teledyne S	LM101
MLM104	National	LM104
	Raytheon	LM104
	Teledyne S	LM104
MLM105	AMD	LM105
	Fairchild	μA105
	Intersil	LM105
	National	LM105
	Raytheon	LM105
	Teledyne S	LM105
MLM107	AMD	LM107
	Fairchild	μA107
	Intersil	LM107
	National	LM107
	Raytheon	LM107
	RCA	**CA107**
	see page 661	
	Teledyne S	LM107
MLM108	RCA	CA108
MLM109	Fairchild	μA109
	Fairchild	LM109
	National	LM109
	Raytheon	LM109
MLM110	AMD	LM110
	Intersil	LM110
	National	LM110
MLM111	AMD	LM111
	Harris	HA-2111
	National	LM111
	Raytheon	LM111
	RCA	**CA111**
	see page 661	
	Teledyne S	LM111
MLM201	Fairchild	μA201
	Intersil	LM201
	National	LM201
	Raytheon	LM201
	RCA	**CA201**
	see page 661	
	Signetics	LM201
	Teledyne S	LM201
MLM204	National	LM204
	Raytheon	LM204
	Teledyne S	LM204
MLM205	AMD	LM205
	Intersil	LM205
	National	LM205
	Raytheon	LM205
	Teledyne S	LM205
MLM207	AMD	LM207
	Fairchild	μA207
	Intersil	LM207
	National	LM207
	Raytheon	LM207
	Teledyne S	LM207
MLM208	RCA	CA208
MLM209	AMD	LM209
	Fairchild	μA209
	National	LM209
	Raytheon	LM209
MLM210	AMD	LM210
	Intersil	LM210
	National	LM210
MLM211	AMD	LM211

Manufacturer Device	Replacement Source	Replacement Device
MLM211	Harris	HA-2211
	Intersil	LM211
	National	LM211
	Raytheon	LM211
	RCA	**CA211**
	see page 661	
	Teledyne S	LM211
MLM301	AMD	LM301
	Fairchild	μA301
	Intersil	LM301
	National	LM301
	Raytheon	LM301
	RCA	**CA301**
	see page 661	
	Signetics	LM301
	Teledyne S	LM301
	TI	SN72301
MLM304	National	LM304
	Raytheon	LM304
	Teledyne S	LM304
MLM305	AMD	LM305
	Fairchild	μA305
	Intersil	LM305
	National	LM305
	Raytheon	LM305
	Teledyne S	LM305
MLM307	AMD	LM307
	Fairchild	μA307
	Intersil	LM307
	National	LM307
	Raytheon	LM307
	RCA	**CA307**
	see page 661	
	Signetics	LM307
	Teledyne S	LM307
MLM308	RCA	CA308
MLM309	AMD	LM309
	Fairchild	μA309
	National	LM309
	Raytheon	LM309
MLM310	AMD	LM310
	Intersil	LM310
	National	LM310
MLM311	AMD	LM311
	Harris	HA-2311
	Intersil	LM311
	National	LM311
	Raytheon	LM311
	RCA	**CA311**
	see page 661	
	Teledyne S	LM311
MV14511	Fairchild	F4511
10149	MMI	10149
	Signetics	10149

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Manufacturer Device	Replacement Source	Replacement Device
AH0126	**Siliconix**	**DG126**
	see page 551	
AH0129	**Siliconix**	**DG129**
	see page 551	
AH0133	**Siliconix**	**DG133**
	see page 551	
AH0134	**Siliconix**	**DG134**
	see page 551	
AH0139	**Siliconix**	**DG139**
	see page 551	
AH0140	**Siliconix**	**DG140**
	see page 551	
AH0141	**Siliconix**	**DG141**
	see page 551	
AH0142	**Siliconix**	**DG142**
	see page 551	
AH0143	**Siliconix**	**DG143**
	see page 551	
AH0144	**Siliconix**	**DG144**
	see page 551	
AH0145	**Siliconix**	**DG145**
	see page 551	
AH0146	**Siliconix**	**DG146**
	see page 551	

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The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

National Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
AH0151	**Siliconix**	**DG151**
	see page 551	
AH0152	**Siliconix**	**DG152**
	see page 551	
AH0153	**Siliconix**	**DG153**
	see page 551	
AH0154	**Siliconix**	**DG154**
	see page 551	
AH0161	**Siliconix**	**DG161**
	see page 551	
AH0162	**Siliconix**	**DG162**
	see page 551	
AH0163	**Siliconix**	**DG163**
	see page 551	
AH0164	**Siliconix**	**DG164**
	see page 551	
CD4001	Harris	HD4001
	RCA	**CD4001**
	see page 375	
CD4002	Harris	HD4002
	RCA	**CD4002**
	see page 375	
CD4007	Harris	HD4007
	RCA	**CD4007**
	see page 375	
CD4009	**RCA**	**CD4009**
	see page 375	
CD4010	**RCA**	**CD4010**
	see page 375	
CD4011	**RCA**	**CD4011**
	see page 375	
CD4012	Harris	HD4012
	RCA	**CD4012**
	see page 375	
CD4013	Harris	HD4013
	RCA	**CD4013**
	see page 375	
CD4014	**Harris**	**HD4014**
	see page 266	
	RCA	**CD4014**
	see page 375	
CD4015	**Harris**	**HD4015**
	see page 266	
	RCA	**CD4015**
	see page 375	
CD4016	**RCA**	**CD4016**
	see page 375	
CD4017	Harris	HD4017
	RCA	**CD4017**
	see page 375	
CD4018	**Harris**	**HD4018**
	see page 266	
	RCA	**CD4018**
	see page 375	
CD4019	**Harris**	**HD4019**
	see page 266	
	RCA	**CD4019**
	see page 375	
CD4020	**Harris**	**HD4020**
	see page 266	
	RCA	**CD4020**
	see page 375	
CD4021	**Harris**	**HD4021**
	see page 266	
	RCA	**CD4021**
	see page 375	
CD4022	**Harris**	**HD4022**
	see page 266	
	RCA	**CD4022**
	see page 375	
CD4023	Harris	HD4023
	RCA	**CD4023**
	see page 375	
CD4025	Harris	HD4025
	RCA	**CD4025**
	see page 375	
CD4027	Harris	HD4027
	RCA	**CD4027**
	see page 375	
CD4030	**Harris**	**HD4030**
	see page 266	
CD4030	**RCA**	**CD4030**
	see page 375	
CD4035	**Harris**	**HD4035**
	see page 266	
	RCA	**CD4035**
	see page 375	
CD4049	Harris	HD4049
	RCA	**CD4049**
	see page 375	
CD4050	Harris	HD4050
	RCA	**CD4050**
	see page 375	
CD4066	Harris	HD4066
	RCA	**CD4066**
	see page 375	
DM10101	Motorola	MC10101
DM10102	Motorola	MC10102
DM10105	Motorola	MC10105
DM10106	Motorola	MC10106
DM10107	Motorola	MC10107
DM10109	Motorola	MC10109
DM10110	Motorola	MC10110
DM10111	Motorola	MC10111
DM10115	Motorola	MC10115
DM10116	Motorola	MC10116
DM10117	Motorola	MC10117
DM10118	Motorola	MC10118
DM10119	Motorola	MC10119
DM10121	Motorola	MC10121
DM10124	Motorola	MC10124
DM10130	Motorola	MC10130
DM1800	Motorola	MC1800
	SW	SW1800
DM1801	Motorola	MC1801
DM54H00	Fairchild	54H00
	Fairchild	9H00
	Raytheon	54H00
DM54H01	Raytheon	54H01
DM54H04	Raytheon	54H04
DM54H05	Raytheon	54H05
DM54H10	Raytheon	54H10
DM54H11	Raytheon	54H11
DM54H20	Raytheon	54H20
DM54H22	Raytheon	54H22
DM54H40	Raytheon	54H40
DM54H74	Raytheon	54H74
DM54L187	Intersil	IM5603
DM54L89	MMI	L5560
DM54S287	MMI	5401
	TI	SN54S287
DM54S387	**Intel**	**3601**
	see page 772, 773	
	MMI	5300
	TI	SN54S387
DM5400	Fairchild	5400
	Fairchild	9N00
	Raytheon	5400
	Signetics	S5400
DM5401	Raytheon	5401
	Signetics	S5401
	TI	SN5401
DM5402	Signetics	S5402
	TI	SN5402
DM5403	Raytheon	5403
	Signetics	S5403
	TI	SN5403
DM5404	Raytheon	5404
	Signetics	S5404
	TI	SN5404
DM5405	Raytheon	5405
	Signetics	S5405
	TI	SN5405
DM5406	Signetics	S5406
	TI	SN5406
DM5408	Raytheon	5408
	Signetics	S5408
	TI	SN5408
DM5409	Raytheon	5409
	Signetics	S5409
	TI	SN5409
DM5410	Raytheon	5410
DM5410	Signetics	S5410
	TI	SN5410
DM54107	Signetics	S54107
	TI	SN54107
DM5411	Raytheon	5411
	Signetics	S5411
DM5412	Raytheon	5412
DM54123	Raytheon	54123
DM5413	Signetics	S5413
	TI	SN5413
DM54136	Raytheon	54136
DM54145	Raytheon	54145
DM5415	Raytheon	5415
DM54150	Raytheon	54150
DM54151	Raytheon	54151
DM54152	Raytheon	54152
DM54153	AMD	SN54153
	Raytheon	54153
	TI	SN54153
DM54154	AMD	SN54154
	Raytheon	54154
	TI	SN54154
DM54155	Raytheon	54155
DM54156	Raytheon	54156
DM54157	AMD	SN54157
	Raytheon	54157
	TI	SN54157
DM54158	Raytheon	54158
DM54159	Raytheon	54159
DM5416	Signetics	S5416
	TI	SN5416
DM54160	Raytheon	54160
DM54161	Raytheon	54161
DM54162	Raytheon	54162
DM54163	Raytheon	54163
DM54164	AMD	SN54164
	Raytheon	54164
	TI	SN54164
DM54165	Raytheon	54165
DM54166	Raytheon	54166
DM5417	Signetics	S5417
	TI	SN5417
DM54170	Raytheon	54170
DM54174	Raytheon	54174
DM54175	Raytheon	54175
DM54181	AMD	SN54181
	Raytheon	54181
	TI	SN54181
DM54182	Raytheon	54182
DM54187	Fairchild	93406
	Intersil	IM5603
	MMI	5200
	TI	SN54187
DM54190	Raytheon	54190
DM54191	Raytheon	54191
DM54192	AMD	SN54192
	Raytheon	54192
	TI	SN54192
DM54193	AMD	SN54193
	Raytheon	54193
	TI	SN54193
DM54194	Raytheon	54194
DM54195	AMD	SN54195
	Raytheon	54195
	TI	SN54195
DM54198	Raytheon	54198
DM54199	Raytheon	54199
DM5420	Raytheon	5420
	Signetics	S5420
	TI	SN5420
DM54200	Intersil	IM5523
	MMI	5531
	Raytheon	RM5340
	TI	SN54S201
DM5421	Raytheon	5421
DM5422	Raytheon	5422
DM54283	Raytheon	54283
DM5430	Signetics	S5420
	TI	SN5430
DM5432	Signetics	S5432
	TI	SN5432
DM5437	Signetics	S5437
	TI	SN5437
DM5438	Signetics	S5438
	TI	SN5438
DM5440	Signetics	S5440
	TI	SN5440
DM5442	Raytheon	5442
DM5443	Raytheon	5443
DM5444	Raytheon	5444
DM5445	Raytheon	5445
	Signetics	S5445
DM5450	Signetics	S5450
	TI	SN5450
DM5451	Signetics	S5451
	TI	SN5451
DM5453	Signetics	S5453
	TI	SN5453
DM5454	Signetics	S5454
	TI	SN5454
DM5460	Signetics	S5460
	TI	SN5460
DM5472	Signetics	S5472
	TI	SN5472
DM5473	Signetics	S5473
	TI	SN5473
DM5474	Raytheon	5474
	Signetics	S5474
	TI	SN5474
DM5475	Signetics	S5475
	TI	SN5475
DM5476	Signetics	S5476
	TI	SN5476
DM5481	Raytheon	5481
DM5483	Raytheon	5483
DM5486	Raytheon	5486
	Signetics	S5486
	TI	SN5486
DM5488	Fairchild	93434
	Intersil	IM5600
	MMI	5230
	TI	SN5488A
DM5489	AMD	SN5489
	AMD	31013
	Intersil	IM5501
	MMI	5560
	Raytheon	5489
DM5490	Signetics	S5490
	TI	SN5490A
DM5491	Signetics	S5491
	TI	SN5491A
DM5492	Signetics	S5492
	TI	SN5492A
DM5493	Signetics	S5493
	TI	SN5493A
DM7093	TI	SN54125
DM7094	TI	SN54126
DM7095	TI	SN54365
DM7096	TI	SN54366
DM7097	TI	SN54367
DM7098	TI	SN54368
DM71L22	TI	SN54L157
DM71S60	Fairchild	93S43
DM7121	TI	SN54251
DM74H00	Fairchild	74H00
	Fairchild	9H00
	Raytheon	74H00
	Signetics	N74H00
	TI	SN74H00
DM74H01	Raytheon	74H01
	Signetics	N74H01
DM74H04	Raytheon	74H04
	Signetics	N74H04
	TI	SN74H04
DM74H05	Raytheon	74H05
	Signetics	N74H05
	TI	SN74H05
DM74H08	Signetics	N74H08
DM74H10	Raytheon	74H10
	Signetics	N74H10
	TI	SN74H10
DM74H11	Raytheon	74H11

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Bold face device number indicates additional data is provided in Catalog section

National Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
DM74H11	Signetics	N74H11
	TI	SN74H11
DM74H20	Raytheon	74H20
	Signetics	N74H20
	TI	SN74H20
DM74H21	Signetics	N74H21
	TI	SN74H21
DM74H22	Raytheon	74H22
	Signetics	N74H22
	TI	SN74H22
DM74H30	Signetics	N74H30
	TI	SN74H30
DM74H40	Raytheon	74H40
	Signetics	N74H40
	TI	SN74H40
DM74H50	Signetics	N74H50
	TI	SN74H50
DM74H51	Signetics	N74H51
	TI	SN74H51
DM74H53	Signetics	N74H53
	TI	SN74H53
DM74H54	Signetics	N74H54
	TI	SN74H54
DM74H55	Signetics	N74H55
	TI	SN74H55
DM74H60	Signetics	N74H60
	TI	SN74H60
DM74H62	Signetics	N74H62
	TI	SN74H62
DM74H74	Raytheon	74H74
DM74L187	Intersil	IM5603
DM74L89	MMI	L6560
DM74S200	Signetics	N74S200
DM74S387	**Intel**	**3601-1**
	see page 772, 773	
	MMI	6300
	Signetics	**N82S126**
	see page 804, 826, 835,	
	TI	SN74S387
DM7400	Fairchild	7400
	Fairchild	9N00
	Hitachi	HD2503
	Raytheon	7400
	Signetics	N7400
	TI	SN7400
DM7401	Hitachi	HD2509
	Raytheon	7401
	Signetics	N7401
	TI	SN7401
DM7402	Hitachi	HD2511
	Signetics	N7402
	TI	SN7402
DM7403	Hitachi	HD2528
	Raytheon	7403
	Signetics	N7403
	TI	SN7403
DM7404	Hitachi	HD2522
	Raytheon	7404
	Signetics	N7404
	TI	SN7404
DM7405	Hitachi	HD2523
	Raytheon	7405
	Signetics	N7405
	TI	SN7405
DM7407	Signetics	N7407
	TI	SN7407
DM7408	Hitachi	HD2550
	Raytheon	7408
	Signetics	N7408
	TI	SN7408
DM7409	Hitachi	HD2551
	Raytheon	7409
	Signetics	N7409
	TI	SN7409
DM7410	Hitachi	HD2507
	Raytheon	7410
	Signetics	N7410
	TI	SN7410
DM74107	Hitachi	HD2530
	Signetics	N74107
	TI	SN74107
DM7411	Raytheon	7411
	Signetics	N7411
DM7412	Raytheon	7412
DM74121	Signetics	N74121
	TI	SN74121
DM74123	AMD	SN74123
	Raytheon	74123
	Signetics	N74123
	TI	SN74123
DM74125	Signetics	N74125
	TI	SN74425
DM74126	Signetics	N74126
	TI	SN74426
DM7413	Signetics	N7413
	TI	SN7413
DM74136	Raytheon	74136
DM74141	Signetics	N74141
	TI	SN74141
DM74145	Raytheon	74145
	Signetics	N74145
	TI	SN74145
DM7415	Raytheon	7415
DM74150	Raytheon	74150
	Signetics	N74150
	TI	SN74150
DM74151	Raytheon	74151
	Signetics	N74151
	TI	SN74151A
DM74152	Raytheon	74152
DM74153	AMD	SN74153
	Hitachi	HD2564
	Raytheon	74153
	Signetics	N74153
	TI	SN74153
DM74154	AMD	SN74154
	Hitachi	HD2580
	Raytheon	74154
	Signetics	N74154
	TI	SN74154
DM74155	Raytheon	74155
	Signetics	N74155
	TI	SN74155
DM74156	Raytheon	74156
	Signetics	N74156
	TI	SN74156
DM74157	AMD	SN74157
	Raytheon	74157
	Signetics	N74157
	TI	SN74157
DM74158	Raytheon	74158
DM74159	Raytheon	74159
DM7416	Signetics	N7416
	TI	SN7416
DM74160	AMD	SN74160
	Raytheon	74160
	Signetics	N74160
	TI	SN74160
DM74161	Raytheon	74161
DM74162	Raytheon	74162
	Signetics	N74162
	TI	SN74162
DM74163	AMD	SN74163
	Raytheon	74163
	Signetics	N74163
	TI	SN74163
DM74164	AMD	SN74164
	Raytheon	74164
	Signetics	N74164
	TI	SN74164
DM74165	Raytheon	74165
	Signetics	N74165
	TI	SN74165
DM74166	Raytheon	74166
	Signetics	N74166
	TI	SN74166
DM7417	Signetics	N7417
	TI	SN7417
DM74170	Fairchild	74170
	Hitachi	HD2540
	Raytheon	74170
	Signetics	N74170
DM74170	TI	SN74170
DM74172	Signetics	N74S172
	Signetics	N74172
	TI	SN74172
DM74174	AMD	SN74174
	Raytheon	74174
	Signetics	N74174
	TI	SN74174
DM74175	AMD	SN74175
	Raytheon	74175
	Signetics	N74175
	TI	SN74175
DM74180	Signetics	N74180
	TI	SN74180
DM74181	AMD	SN74181
	Raytheon	74181
	Signetics	N74181
	TI	SN74181
DM74182	AMD	SN74182
	Raytheon	74182
	Signetics	N74182
	TI	SN74182
DM74187	Fairchild	93406
	Intersil	IM5603
	MMI	6200
	Signetics	N82S226
	TI	SN74187
DM74190	Raytheon	74190
	Signetics	N74190
	TI	SN74190
DM74191	Raytheon	74191
	Signetics	N74191
	TI	SN74191
DM74192	AMD	SN74192
	Raytheon	74192
	Signetics	N74192
	TI	SN74192
DM74193	AMD	SN74193
	Raytheon	74193
	Signetics	N74193
	TI	SN74193
DM74194	Raytheon	74194
DM74195	AMD	SN74195
	Raytheon	74195
	Signetics	N74195
	TI	SN74195
DM74198	Raytheon	74198
	Signetics	N74198
	TI	SN74198
DM74199	Raytheon	74199
	Signetics	N74199
	TI	SN74199
DM7420	Hitachi	HD2504
	Raytheon	7420
	Signetics	N7420
	TI	SN7420
DM74200	Fairchild	93421
	Intersil	IM5523
	MMI	6531
	Raytheon	RC5340
	TI	SN74S201
DM7421	Raytheon	7421
DM7422	Raytheon	7422
DM7426	Signetics	N7426
	TI	SN7426
DM74283	Raytheon	74283
DM7430	Hitachi	HD2508
	Signetics	N7430
	TI	SN7430
DM7440	Hitachi	HD2501
	Signetics	N7440
	TI	SN7440
DM7441	Hitachi	HD2518
	Signetics	N7441
	TI	SN74141
DM7442	Hitachi	HD2536
	Raytheon	7442
	Signetics	N7442
	TI	SN7442A
DM7443	Raytheon	7443
DM7444	Raytheon	7444
DM7445	Raytheon	7445
	Signetics	N7445
	TI	SN7445
DM7446	Hitachi	HD2553
	TI	SN7446A
DM7447	Hitachi	HD2532
	Signetics	N7447
	TI	SN7447A
DM7448	Signetics	N7448
	TI	SN7448
DM7450	Hitachi	HD2506
	Signetics	N7450
	TI	SN7450
DM7451	Hitachi	HD2505
	Signetics	N7451
	TI	SN7451
DM7453	Hitachi	HD2512
	Signetics	N7453
	TI	SN7453
DM7454	Hitachi	HD2514
	Signetics	N7454
	TI	SN7452
DM7460	Signetics	N7460
	TI	SN7460
DM7472	Hitachi	HD2529
	Signetics	N7472
	TI	SN7472
DM7473	Hitachi	HD2515
	Signetics	N7473
	TI	SN7473
DM7474	Hitachi	HD2510
	Raytheon	7474
	Signetics	N7474
	TI	SN7474
DM7475	Hitachi	HD2517
	Signetics	N7475
	TI	SN7475
DM7476	Hitachi	HD2516
	Signetics	N7476
DM7481	Raytheon	7481
DM7483	Hitachi	HD2535
	Raytheon	7483
	Signetics	N7483
	TI	SN7483A
DM7486	Hitachi	HD2526
	Raytheon	7486
	Signetics	N7486
	TI	SN7486
DM7488	Intersil	IM5600
	MMI	6230
	TI	SN7488A
DM7489	AMD	C3101
	AMD	SN7489
	Intersil	IM5501
	MMI	6560
	Raytheon	7489
	TI	SN7489
DM7490	Hitachi	HD2519
	Signetics	N7490
	TI	SN7490A
DM7491	Signetics	N7491
	TI	SN7491A
DM7492	Hitachi	HD2521
	Signetics	N7492
	TI	SN7492A
	TI	SN7496
DM7493	Hitachi	HD2520
	Signetics	N7493
	TI	SN7493A
DM7495	Hitachi	HD2534
	Signetics	N7495
	TI	SN7495A
DM7496	Hitachi	HD2546
	Signetics	N7496
DM75L60	TI	SN540192
DM75L63	TI	SN54L193
DM75L70	TI	SN54L164
DM75491	TI	SN75491
DM75492	TI	SN75492
DM7551	TI	SN54173
DM7560	TI	SN54192

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The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

National Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
DM7563	TI	SN54193
DM7570	TI	SN54164
DM7573	Harris	HPROM-1024A
	Intersil	IM5603
	MMI	5300
	TI	SN54S387
DM7574	AMD	AM27S09
	Harris	**HM7602**
	see page 746	
	Harris	HPROM-1024
	Intersil	IM5623
	MMI	5301
	TI	SN54S188
	TI	SN54S287
DM7582	Intersil	IM5533
	TI	SN54S301
DM7588	Intersil	IM5600
	TI	SN54S188
DM7590	TI	SN54165
DM7597	Intersil	IM5623
	MMI	5201
	TI	SN54S287
DM7598	Intersil	IM5610
	MMI	5231
DM7599	AMD	AM27S03
	AMD	DM7599
	MMI	5561
	TI	SN54S189
DM76L97	Intersil	IM5623
DM76L99	Intersil	IM5501
	MMI	L5561
DM7795	MMI	A5240
DM7796	MMI	5241
DM7800	TI	SN55180
DM7810	TI	SN5426
DM7812	TI	SN5416
DM7860	National	DS55491
DM7862	National	DS55492
DM7893	National	DS55493
DM7894	National	DS55494
DM8093	TI	SN74125
DM8094	TI	SN74126
DM8095	TI	SN74365
DM8096	TI	SN74366
DM8097	TI	SN74367
DM8098	TI	SN74368
DM81L22	TI	SN74L157
DM81S60	Fairchild	93S47
DM8200	Signetics	N8269
DM8213	Fairchild	9311
	ITT	ITT74154
	Motorola	MC8311
	Raytheon	RC9311
	Signetics	N74154
	TI	SN74154
DM8220	Hitachi	HD2525
DM8280	Fairchild	93176
	Raytheon	RC8280
	Signetics	N8280
	TI	SN74176
DM8281	Fairchild	93177
	Raytheon	RC8281
	Signetics	N8281
	TI	SN74177
DM8283	Fairchild	9383
	Motorola	MC7483
	Signetics	N7483
	TI	SN7483A
DM8288	Signetics	N8288
DM8290	Fairchild	93196
	Raytheon	RC8290
DM8291	Fairchild	93197
	Raytheon	RC8291
	TI	SN74197
DM8296	TI	SN74196
DM8300	AMD	9300
	Fairchild	9300
	Raytheon	RC9300
	TI	SN29300
DM8301	AMD	9301
	TI	SN29301
DM8309	AMD	9309
	Fairchild	9309
	TI	SN29309
DM8310	AMD	9310
	Fairchild	9310
	Raytheon	RC9310
	TI	SN29310
DM8311	AMD	9311
	Fairchild	9311
	Raytheon	RC9311
	TI	SN29311
DM8312	AMD	9312
	Fairchild	9312
	Raytheon	RC9312
	TI	SN29312
DM8316	AMD	9316
	Fairchild	9316
	Raytheon	RC9316
	TI	SN29316
DM8322	AMD	9322
	Fairchild	9322
	Raytheon	RC9322
	Raytheon	74154
	Raytheon	74157
	TI	SN29322
DM85L60	TI	SN74L192
DM85L63	TI	SN74L193
DM85S99	AMD	SN74S189
	TI	SN74S189
DM8500	Signetics	N7476
	TI	SN7476
DM8501	Signetics	N7473
	TI	SN7473
DM8510	Signetics	N7474
	TI	SN7474
DM8530	Fairchild	9390
	Motorola	MC7490
	Signetics	N7490
	TI	SN7490A
DM8532	Fairchild	9392
	Motorola	MC7492
	Signetics	N7492
	TI	SN7492A
DM8533	Fairchild	9393
	Motorola	MC7493
	Signetics	N7493
	TI	SN7493A
DM8550	Fairchild	9375
	Motorola	MC7475
	Signetics	N7475
	TI	SN7475
DM8551	TI	SN74173
DM8560	Fairchild	9360
	Hitachi	HD2541
	ITT	ITT74192
	Motorola	MC74192
	Raytheon	74192
	Signetics	N74192
	TI	SN74192
DM8563	Fairchild	9366
	Hitachi	HD2542
	ITT	ITT74193
	Motorola	MC74193
	Raytheon	74193
	Signetics	N74193
	TI	SN74193
DM8570	Fairchild	93164
	Motorola	MC74164
	Raytheon	74164
	TI	SN74164
DM8573	Fairchild	93416
	Harris	HPROM-1024A
	Intel	**3601**
	see page 772, 773	
	Intersil	IM5603
	MMI	6300
	Signetics	**N82S126**
	see page 804, 826, 835,	
	TI	SN74S387
DM8574	Fairchild	93426
	Harris	HPROM-1024
DM8574	**Intel**	**3621**
	see page 772, 773	
	Intersil	IM5603
	Intersil	IM5623
	MMI	6301
	TI	SN74S287
DM8577	AMD	AM27S08
	Harris	**HM7602**
	see page 746	
	TI	SN74S188
DM8578	MMI	6331
	Signetics	**N82S123**
	see page 804, 826, 828,	
	TI	SN74S288
DM8579	ITT	ITT79164
DM8580	Fairchild	9395
	Motorola	MC7495
	Signetics	N7495
	TI	SN7495A
DM8582	Fairchild	93411
	Intersil	IM5533
	MMI	6530
	TI	SN74S301
DM8588	Fairchild	93434
	Intersil	IM5600
	ITT	ITT7488A
	TI	SN74S188
DM8590	Fairchild	93165
	ITT	ITT74165
	Raytheon	74165
	TI	SN74165
DM8597	Intersil	IM5623
	MMI	6201
	TI	SN74S287
	TI	SN74S370
DM8598	Intersil	IM5610
	MMI	6231
	TI	SN74S288
DM8599	AMD	AM27S03
	AMD	DM8599
	MMI	6561
	TI	SN74S189
DM86L97	Intersil	IM5623
DM86L99	Fairchild	IM5501
	Intersil	IM5501
	MMI	L6561
DM8600	Motorola	MC8300
DM8601	AMD	9601
	Fairchild	9601
	Raytheon	RF8601
	Signetics	N8T22
	TI	SN29601
DM8602	AMD	9602
	Fairchild	9602
	Raytheon	RF8602
DM8640	TI	SN74141
DM8680	Signetics	N8280
DM8681	Signetics	N8281
DM8688	Signetics	N8288
DM8795	MMI	A6240
DM8796	MMI	6241
DM8810	ITT	ITT7426
DM8840	Hitachi	HD2558
	Motorola	MC7441
	Signetics	N7441
DM8842	Motorola	MC7442
	Signetics	N7442
	TI	SN7442A
DM8846	Motorola	MC7446
	TI	SN7446A
DM8847	Motorola	MC7447
	TI	SN7447A
DM8848	Motorola	MC7448
	TI	SN7448
DM8850	Motorola	MC9601
	Signetics	N8T22
	TI	SN29601
DM8860	National	DS75491
DM8862	National	DS75492
DM8889	Motorola	MC3491
DM8893	National	DS75493
DM8894	National	DS75494
DM9093	Motorola	MC853
	Raytheon	RM993
	SW	SW9093
	TI	SN158093
DM9094	Motorola	MC856
	Raytheon	RM9094
	SW	SW9094
	TI	SN158094
DM9097	Motorola	MC855
	SW	SW9097
	TI	SN158097
DM9099	Motorola	MC852
	Raytheon	RM999
	SW	SW9099
	TI	SN158099
DM930	Motorola	MC830
	Raytheon	RM930
	SW	SW930
	TI	SN15830
DM9300	AMD	9300
	Raytheon	RM9300
	TI	SN29300
DM9301	AMD	9301
	TI	SN29301
DM9312	AMD	9312
	TI	SN29312
DM932	Motorola	MC832
	Raytheon	RM932
	SW	SW932
	TI	SN15838
DM9322	AMD	9322
	Raytheon	RM9322
	Raytheon	54157
	TI	SN29322
DM933	Motorola	MC833
	Raytheon	RM933
	SW	SW933
	TI	SN15833
DM935	Motorola	MC840
	Raytheon	RM935
	SW	SW935
	TI	SN15835
DM936	Motorola	MC836
	Raytheon	RM936
	SW	SW936
	TI	SN15836
DM937	Motorola	MC837
	Raytheon	RM937
	SW	SW937
	TI	SN15837
DM944	Motorola	MC844
	Raytheon	RM944
	SW	SW944
	TI	SN15844
DM945	Motorola	MC845
	Raytheon	RM945
	SW	SW945
	TI	SN15845
DM946	Motorola	MC846
	Raytheon	RM946
	SW	SW946
	TI	SN15846
DM948	Motorola	MC848
	Raytheon	RM948
	SW	SW948
	TI	SN15848
DM949	Motorola	MC849
	Raytheon	RM949
	SW	SW949
	TI	SN15849
DM951	Motorola	MC851
	Raytheon	RM951
	TI	SN15851
DM9567	Motorola	MC857
DM957	Raytheon	RM957
	SW	SW957
	TI	SN15857
DM958	Motorola	MC858
	Raytheon	RM958
	SW	SW958

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

National Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
DM958	TI	SN15858
DM9601	AMD	9601
	Raytheon	RF9601
	TI	SN29601
DM9602	AMD	9602
	Raytheon	RF9602
DM961	Motorola	MC861
	Raytheon	RM961
	SW	SW961
	TI	SN15861
DM962	Motorola	MC862
	Raytheon	RM962
	SW	SW962
	TI	SN15862
DM963	Motorola	MC863
	Raytheon	RM963
	SW	SW963
	TI	SN15863
DS0026	AMD	MH0026
	Intersil	IM5013
DS1488	AMD	MC1488
	Exar	XR1488
	Harris	HD1488
	ITT	ITT1488
	Raytheon	RC1488
	TI	SN75188
DS1489	AMD	MC1489
	Exar	XR1489
	Harris	HD1489
	ITT	ITT1489
	Motorola	MC1489
	Raytheon	RC1489
	Signetics	MC1489
	TI	SN75189
DS55107	AMD	SN55107B
	Raytheon	RM55107A
	TI	SN55107
DS55108	AMD	SN55108B
	Raytheon	RM55108A
	TI	SN55108
DS55109	AMD	SN55109
	Raytheon	RM55109
	TI	SN55109
DS55110	AMD	SN55110
	TI	SN55110
DS5520	TI	SN5520
DS5521	TI	SN5521
DS5522	TI	SN5522
DS5523	TI	SN5523
DS5524	TI	SN5524
DS5525	TI	SN5525
DS5528	TI	SN5528
DS5529	TI	SN5529
DS55325	TI	SN55325
DS5534	TI	SN5532
DS5535	TI	SN55235
DS75107	AMD	SN75107B
	ITT	ITT75107
	Motorola	MC75107
	Raytheon	RC75107A
	TI	SN75107
DS75108	AMD	SN75108B
	ITT	ITT75108
	Motorola	MC75108
	Raytheon	RC75108A
	TI	SN75108
DS75109	AMD	SN75109
	ITT	ITT75109
	Motorola	MC75109
	Raytheon	RC75109
	TI	SN75109
DS75110	AMD	SN75110
	ITT	ITT75110
	Motorola	MC75110
	Raytheon	RC75110
	TI	SN75110
DS7520¶	ITT	ITT7520
	Motorola	MC7520
	Signetics	SG7520
	Silicon G	SG7520
	TI	SN7520
DS75207	TI	SN75207
DS75208	TI	SN75208
DS7521	ITT	ITT7521
	Motorola	MC7521
	Signetics	SN7521
	Silicon G	SG7521
	TI	SN7521
DS7522	ITT	ITT7522
	Motorola	MC7522
	Signetics	SN7522
	Silicon G	SG7522
	TI	SN7522
DS7523	ITT	ITT7523
	Motorola	MC7523
	Signetics	SN7523
	Silicon G	SG7523
	TI	SN7523
DS7524	Fairchild	7524
	ITT	ITT7524
	Motorola	MC7524
	Signetics	SN7524
	Silicon G	SG7524
	TI	SN7524
DS7525	Fairchild	7525
	ITT	ITT7524
	Motorola	MC7525
	NPC	SFC2525
	Signetics	SN7525
	Silicon G	SG7525
	TI	SN7525
DS7528	Fairchild	7528
	ITT	ITT7528
	Motorola	MC7528
	NPC	SFC2528
	Silicon G	SG7528
	TI	SN7528
DS7529	Fairchild	7529
	ITT	ITT7529
	Motorola	MC7529
	Silicon G	SG7529
	TI	SN7529
DS75324	Raytheon	RC75324
	TI	SN75324
DS75325	Fairchild	75325
	ITT	ITT75325
	Motorola	MC75325
	Raytheon	RC75325
DS7534	Fairchild	7534
	Motorola	MC7534
	TI	SN75232
DS7535	Fairchild	7535
	Motorola	MC7535
	TI	SN75233
DS7538	Motorola	MC7538
DS7539	Motorola	MC7539
DS7540	Fairchild	75450
DS75450	Fairchild	75450
	Motorola	MC75450
	Raytheon	RM75450
	Signetics	75450
	Teledyne S	75450
	TI	SN75450
DS75451	Fairchild	75451
	Motorola	MC75451
	Raytheon	RC75451
	Signetics	75451
	Teledyne S	75451
	TI	SN75451
DS75452	Fairchild	75452
	Motorola	MC75452
	Raytheon	RC75452
	Signetics	75452
	Teledyne S	75452
	TI	SN75452
DS75453	Fairchild	75453
	Motorola	MC75453
	Raytheon	RC75453
	Signetics	75453
	Teledyne S	75453
	TI	SN75453
DS75454	Fairchild	75454
DS75454	Raytheon	RC75454
	Signetics	75454
	Teledyne S	75453
	TI	SN75454
DS75460	TI	SN75460
DS75461	TI	SN75461
DS75462	TI	SN75462
DS75463	TI	SN75463
DS75464	TI	SN75464
DS7820	AMD	DM7820
	Signetics	DM7820
	TI	SN55182
DS7830	AMD	DM7830
	Signetics	DM7830
	TI	SN55183
DS7831	AMD	DM7831
DS7832	AMD	DM7832
DS8640	Signetics	SP380
DS8820	AMD	AM8820
	AMD	DM8820
	Signetics	DM8820
	TI	SN75182
DS8830	AMD	AM8830
	AMD	DM8830
	Signetics	DM8830
	TI	SN75183
DS8831	AMD	DM8831
DS8832	AMD	DM8832
DS8880	Signetics	DM8880
INS4001	Intel	4001
INS4002	Intel	4002
INS4003	Intel	4003
INS4004	Intel	4004
INS4008	Intel	4008
INS4009	Intel	4009
LH0042	AD	AD0042
	Intersil	LH0042
	Teledyne S	2740
LH0052	**AD**	**AD506**
	see page 624	
LH0062	**AD**	**AD528**
	see page 624	
LH101	Raytheon	LH101
	TI	SN52107
LH201	Raytheon	LH201
	Siliconix	LH201
LH2101	Intersil	LH2101
LH2108	Intersil	LH2108
LH2110	Intersil	LH2110
LH2111	Intersil	LH2111
LH2301	Intersil	LH2301
LH2308	Intersil	LH2308
LH2310	Intersil	LH2310
LH2311	Intersil	LH2311
LH740	Fairchild	µA740
	Intersil	LH740
	Signetics	µA740
LM100	Intersil	LM100
	NPC	SFC2100
	Silicon G	SG100
LM101	AMD	LM101
	AD	**AD101**
	see page 625	
	Fairchild	µA101
	Intersil	LM101
	Motorola	MLM101
	NPC	SFC2101
	Raytheon	LM101
	RCA	**CA101**
	see page 661	
	RCA	CA748
	Signetics	LM101
	Silicon G	SG101
	Siliconix	LM101
	Teledyne S	LM101
	TI	SN52101
LM102	AMD	LM102
	Fairchild	µA102
	Intersil	LM102
	Motorola	MLM110
	Silicon G	SG102
LM104	Fairchild	µA104
	Motorola	MLM104
	NPC	SFC2104
	Raytheon	LM104
	Silicon G	SG104
	Teledyne S	LM104
	TI	SN52104
LM105	AMD	LM105
	Fairchild	µA105
	Intersil	LM105
	Motorola	MLM105
	NPC	SFC2105
	Raytheon	LM105
	Silicon G	SG105
	Teledyne S	LM105
	TI	SN52105
LM106	AMD	LM106
	Raytheon	LM106
	TI	SN52106
LM107	AMD	LM107
	AD	**AD741S**
	see page 625	
	Fairchild	µA107
	Intersil	LM107
	Motorola	MLM107
	NPC	SFC2107
	Raytheon	LM107
	RCA	**CA107**
	see page 661	
	Signetics	LM107
	Silicon G	SG107
	Teledyne S	LM107
	TI	SN52107
LM108	AMD	LM108
	AD	**AD108**
	see page 625	
	Fairchild	µA108
	Intersil	LM108
	Motorola	MLM108
	Raytheon	LM108
	RCA	CA108
	Signetics	LM108
	Silicon G	SG108
	TI	SN52108
LM109	Fairchild	µA109
	Motorola	MLM109
	NPC	SFC2109
	Raytheon	LM109
	Silicon G	SG109
	TI	SN52109
LM110	AMD	LM110
	Fairchild	µA110
	Intersil	LM110
	Motorola	MLM110
	Silicon G	SG110
	TI	SN52110
LM111	AMD	LM111
	Fairchild	µA111
	Harris	HA-2111
	Intersil	LM111
	Motorola	MLM111
	NPC	SFC2111
	Raytheon	LM111
	RCA	**CA111**
	see page 661	
	Signetics	LM111
	Silicon G	SG111
	Teledyne S	LM111
	TI	SN52111
LM112	AMD	LM112
	Raytheon	LM112
LM118	AMD	LM118
	AD	**AD518**
	see page 624	
	Raytheon	LM118
	TI	SN52118
LM120	Fairchild	78N00
	Silicon G	SG120
LM124	Intersil	LM124
	Raytheon	LM124
	RCA	**CA124**
	see page 661	

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The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

National Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
LM124	Signetics	LM124
	Silicon G	SG124
	Teledyne S	LM124
	TI	LM124
LM1303	Motorola	MC1303
	Raytheon	RC4739
LM1304	Motorola	MC1304
	Sprague	ULN-2120
LM1305	Motorola	MC1305
	Sprague	ULN-2122
LM1307	Motorola	MC1307
	Sprague	ULN-2128
LM1310	Exar	XR1310
	Motorola	MC1310
	Sprague	ULN-2210
LM1351	Motorola	MC1351
LM139	Raytheon	LM139
	RCA	**CA139**
	see page 661	
	Silicon G	SG139
	Teledyne S	LM139
LM140-05	Silicon G	SG140-05
LM140-06	Silicon G	SG140-06
LM140-08	Silicon G	SG140-08
LM140-12	Silicon G	SG140-12
LM140-15	Silicon G	SG140-15
LM140-18	Silicon G	SG140-18
LM140-24	Silicon G	SG140-24
LM1414	Motorola	MC1414
	Raytheon	RC1414
	TI	SN72514
LM1458	Harris	HA-2655
	Motorola	MC1458
	PMI	SSS1458
	Raytheon	RC1458
	RCA	CA1458
	Signetics	MC1458
	Silicon G	SG1458
	Teledyne S	1458
	TI	SN72558
LM148	Intersil	LM148
LM1488	National	DS1488
LM1489	National	DS1489
LM149	Intersil	LM149
LM1496	Lithic Sys	LS1496
	Motorola	MC1496
	Signetics	MC1496
	Silicon G	SG1496
LM1514	Motorola	MC1514
	Raytheon	RM1514
	TI	SN56514
LM1558	Fairchild	µA1558
	Harris	HA-2650
	Motorola	MC1558
	PMI	SSS1558
	Raytheon	RM1558
	RCA	CA1558
	Signetics	MC1558
	Silicon G	SG1558
	Teledyne S	1558
	TI	SN52558
LM158	Raytheon	LM158
	Raytheon	RM4139
LM1596	Lithic Sys	LS1596
	Motorola	MC1596
	Signetics	MC1596
	Silicon G	SG1596
LM160	Fairchild	µA760
LM1611	National	DS1611
LM1612	National	DS1612
LM1613	National	DS1613
LM1614	National	DS1614
LM1625	National	DS1615
LM163	National	DS1603
LM163A	National	DS1604
LM170	Lithic Sys	LS170
LM171	Lithic Sys	LS171
LM1800	Exar	XR1800
	Sprague	ULN-2244
LM1820	Fairchild	µA720
	Sprague	ULN-2137
LM200	Intersil	LM200
	NPC	SFC2200
	Silicon G	SG200
LM201	AMD	LM201
	AD	**AD201**
	see page 625	
	Fairchild	µA201
	Intersil	LM201
	Motorola	MLM201
	NPC	SFC2201
	Raytheon	LM201
	RCA	**CA201**
	see page 661	
	RCA	CA748
	Signetics	LM201
	Silicon G	SG201
	Teledyne S	LM201
LM202	Intersil	LM202
	Motorola	MLM210
	Silicon G	SG202
LM204	Motorola	MLM204
	NPC	SFC2204
	Raytheon	LM204
	Silicon G	SG204
	Teledyne S	LM204
LM205	AMD	LM205
	Intersil	LM205
	Motorola	MLM205
	NPC	SFC2205
	Raytheon	LM205
	Silicon G	SG205
	Teledyne S	LM205
LM207	AMD	LM207
	AD	**AD741J**
	see page 625	
	Fairchild	µA207
	Harris	HA-2207
	Intersil	LM207
	Motorola	MLM207
	NPC	SFC2207
	Raytheon	LM207
	RCA	**CA207**
	see page 661	
	Signetics	LM207
	Silicon G	SG207
	Teledyne S	LM207
LM208	AMD	LM208
	AD	**AD208**
	see page 625	
	Fairchild	µA208
	Intersil	LM208
	Motorola	MLM208
	Raytheon	LM208
	RCA	CA208
	Signetics	LM208
	Silicon G	SG208
LM209	Fairchild	µA209
	Motorola	MLM209
	NPC	SFC2209
	Raytheon	LM209
	Silicon G	SG209
LM210	AMD	LM210
	Fairchild	µA210
	Intersil	LM210
	Motorola	MLM210
LM211	AMD	LM211
	Fairchild	µA211
	Harris	HA-2211
	Intersil	LM211
	Motorola	MLM211
	NPC	SFC2211
	Raytheon	LM211
	RCA	**CA211**
	see page 661	
	Signetics	LM211
	Teledyne S	LM211
LM2111	Motorola	MC1357
	RCA	CA2111
	Signetics	ULN2111
	Sprague	ULN-2111
LM2113	Sprague	ULN-2113
LM212	AMD	LM212
	Raytheon	LM212
LM216	AMD	LM216
	Raytheon	LM216
LM218	**AD**	**AD518**
	see page 624	
	Raytheon	LM218
LM224	Intersil	LM224
	Raytheon	LM224
	RCA	LM224
	Signetics	LM224
	Silicon G	SG224
	Teledyne S	LM224
	TI	LM224
LM239	Intersil	LM248
	Motorola	MC3302
	Raytheon	LM239
	RCA	**CA239**
	see page 661	
	Silicon G	SG239
	Teledyne S	LM239
LM249	Intersil	LM249
LM258	Raytheon	LM258
LM270	Lithic Sys	LS270
LM271	Lithic Sys	LS271
LM2900	Raytheon	LM2900
LM2901	Raytheon	LM2901
	Teledyne S	LM2901
LM2902	Motorola	MLM2902
	Raytheon	LM2902
LM300	Intersil	LM300
	NPC	SFC2300
	Silicon G	SG300
LM301	AMD	LM301
	AD	**AD301**
	see page 625	
	Fairchild	µA301
	Harris	HA-2301
	Intersil	LM301
	Motorola	MLM301
	NPC	SFC2301
	Raytheon	LM301
	RCA	**CA301**
	see page 661	
	Signetics	LM301
	Silicon G	SG301
	Teledyne S	LM301
	TI	SN52301
LM3018	Lithic Sys	LA3018
LM302	AMD	LM302
	Fairchild	µA302
	Intersil	LM302
	Motorola	MLM310
	Silicon G	SG302
	TI	SN72302
LM3028	Lithic Sys	LS3028
LM304	Fairchild	µA304
	Motorola	MLM304
	NPC	SFC2304
	Raytheon	LM304
	Silicon G	SG304
	Teledyne S	LM304
	TI	SN52304
	TI	SN72304
LM305	AMD	LM305
	Fairchild	µA305
	Intersil	LM305
	Motorola	MLM305
	NPC	SFC2305
	Raytheon	LM305
	Silicon G	SG305
	Teledyne S	LM305
	TI	SN72305
LM3053	Lithic Sys	LS3053
LM306	AMD	LM306
	Raytheon	LM306
	TI	SN72306
LM3064	Motorola	MC1364
	Sprague	ULN-2264
LM3065	Motorola	MC1358
	Sprague	ULN-2165
LM3067	Sprague	ULN-2267
LM307	AMD	LM307
	AD	AD741R
	Fairchild	µA307
	Intersil	LM307
	Motorola	MLM307
	NPC	SFC2307
	Raytheon	LM307
	RCA	**CA307**
	see page 661	
	Signetics	LM307
	Silicon G	SG307
	Teledyne S	LM307
	TI	SN72307
LM3070	Motorola	MC1370
	Sprague	ULN-2124
LM3071	Motorola	MC1371
	Sprague	ULN-2127
LM3075	Motorola	MC1375
	Sprague	ULN-2129
LM308	AMD	LM308
	AD	**AD308**
	see page 625	
	Fairchild	LM308
	Intersil	LM308
	Motorola	MLM308
	Raytheon	LM308
	RCA	CA308
	Signetics	LM308
	Silicon G	SG308
	Teledyne S	LM308
	TI	SN72308
LM309	Fairchild	µA309
	Motorola	MLM309
	NPC	SFC2309
	Raytheon	LM309
	Signetics	LM309
	Silicon G	SG309
	TI	SN72309
LM310	AMD	LM310
	Fairchild	µA310
	Intersil	LM310
	Motorola	MLM310
	Silicon G	SG310
	TI	SN72310
LM311	AMD	LM311
	Fairchild	µA311
	Harris	HA-2311
	Intersil	LM311
	Motorola	MLM311
	NPC	SFC2311
	Raytheon	LM311
	RCA	**CA311**
	see page 661	
	Signetics	LM311
	Silicon G	SG311
	Teledyne S	LM311
	TI	SN72311
LM312	AMD	LM312
	Raytheon	LM312
LM316	AMD	LM316
	Raytheon	LM316
LM318	AMD	LM318
	AD	**AD518**
	see page 624	
	Raytheon	LM318
	TI	SN72318
LM320	Silicon G	SG320
LM320-05	Motorola	MC7905
LM320-12	Motorola	MC7912
LM324	Raytheon	LM324
	RCA	**CA324**
	see page 661	
	Signetics	LM324
	Silicon G	SG324
	Teledyne S	LM324
	TI	LM324
LM339	Motorola	MC3302
	Raytheon	LM339
	RCA	**CA339**
	see page 661	

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National Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
LM339	Silicon G	SG339
	Teledyne S	LM339
LM340-05	Fairchild	µA7805
	Motorola	MC7805
	Raytheon	RC7805
	Silicon G	SG340-05
	TI	SN72905
LM340-06	Fairchild	µA7806
	Motorola	MC7806
	Raytheon	RC7806
	Silicon G	SG340-06
	TI	SN72906
LM340-08	Fairchild	µA7808
	Motorola	MC7808
	Raytheon	RC7808
	Silicon G	SG340-08
	TI	SN72908
LM340-12	Fairchild	µA7812
	Motorola	MC7812
	Raytheon	RC7812
	Silicon G	SG340-12
	TI	SN72912
LM340-15	Fairchild	µA7815
	Fairchild	µA7818
	Motorola	MC7815
	Silicon G	SG340-15
	TI	SN72915
LM340-18	Motorola	MC7818
	Raytheon	RC7818
	Silicon G	SG340-18
	TI	SN72918
LM340-24	Fairchild	µA7824
	Motorola	MC7824
	Raytheon	RC7824
	Silicon G	SG340-24
	TI	SN72924
LM343	Motorola	MC1439
LM350	National	DS350
LM351	National	DS75453
LM354	NPC	SFC2524
	NPC	SFC2525
LM358	Raytheon	LM358
	Raytheon	RC4139
LM360	Fairchild	760
LM3611	National	DS3611
LM3612	National	DS3612
LM3613	National	DS3613
LM3614	National	DS3614
LM3625	National	DS3625
LM363	National	DS3603
LM363A	National	DS3604
LM370	Lithic Sys	LS370
LM371	Lithic Sys	LS371
LM376	Fairchild	µA376
	NPC	SFC2376
	Teledyne S	LM376
	TI	SN72376
LM377	Sprague	ULN-2278
LM380	Sprague	ULN-2280
LM3900	Motorola	MC3401
	Raytheon	RC3302
LM3901	Motorola	MC3302
	Raytheon	MC3302
LM4250	Fairchild	µA776
	Harris	HA-2720
	Intersil	LM4250
	Silicon G	SG4250
LM55107A	National	DS55107
LM55108A	National	DS55108
LM55109	National	DS55109
LM5520	National	DS5520
LM55207	National	DS55207
LM55208	National	DS55208
LM5521	National	DS5521
LM5522	National	DS5522
LM5523	National	DS5523
LM5524	National	DS5524
	NPC	SFC2524
LM5525	National	DS5525
	NPC	SFC2525
LM5528	National	DS5528

Manufacturer Device	Replacement Source	Replacement Device
LM5528	NPC	SFC2528
LM5529	National	DS5529
LM55324	National	DS55324
LM55325	National	DS55325
	Raytheon	RM55325
LM5534	National	DS5534
LM5535	National	DS5535
LM5539	National	DS5539
LM55450	National	DS55450
LM55451	National	DS55451
LM55452	National	DS55452
LM55454	National	DS55454
LM555	Exar	XR555
	Intersil	LM555
	Lithic Sys	LS555
	Motorola	MC1455
	Motorola	MC1555
	Raytheon	RC555
	Raytheon	RM555
	RCA	**CA555**
	see page 661	
	Signetics	NE555
	TI	SN52555
LM565	Signetics	NE565
LM566	Signetics	NE566
LM567	Exar	XR567
	Signetics	NE567
LM709	Fairchild	µA709
	Motorola	MC1709
	NPC	SFC2709
	Raytheon	RC709
	Raytheon	RM709
	Signetics	µA709
	Teledyne S	709
	TI	SN52709
LM710	Fairchild	µA710
	Motorola	MC1710
	NPC	SFC2710
	Raytheon	RC710
	Raytheon	RM710
	RCA	CA710
	Signetics	µA710
	Silicon G	SG710
	Teledyne S	710
	TI	SN52710
LM711	Fairchild	µA711
	Motorola	MC1711
	NPC	SFC2711
	Raytheon	RC711
	Raytheon	RM711
	RCA	CA711
	Signetics	µA711
	Silicon G	SG711
	Teledyne S	711
	TI	SN52711
LM723	AMD	723
	Fairchild	µA723
	Intersil	723
	Motorola	MC1723
	NPC	SFC2723
	Raytheon	RC723
	Raytheon	RM723
	RCA	CA723
	Signetics	µA723
	Silicon G	SG723
	Teledyne S	723
	TI	SN52723
LM725	AMD	725
	Fairchild	µA725
	Intersil	SSS725
	PMI	SSS725
	Raytheon	RC725
	Raytheon	RM725
LM733	AMD	733
	Fairchild	µA733
	Motorola	MC1733
	Raytheon	RC733
	Raytheon	RM733
	Signetics	µA733
	TI	SN52733
LM741	AMD	741

Manufacturer Device	Replacement Source	Replacement Device
LM741	**AD**	**AD741**
	see page 625	
	Fairchild	µA741
	Intersil	SSS741
	Intersil	741
	Motorola	MC1741
	NPC	SFC2741
	PMI	SSS741
	Raytheon	RC741
	Raytheon	RM741
	RCA	**CA741**
	see page 661	
	Signetics	µA741
	Silicon G	SG741
	Teledyne S	741
	TI	SN52741
LM746	Motorola	MC1328
	Sprague	ULN-2114
LM747	AMD	747
	Fairchild	µA747
	Intersil	SSS747
	Motorola	MC1747
	PMI	SSS747
	Raytheon	RC747
	Raytheon	RM747
	RCA	**CA747**
	see page 661	
	Signetics	µA747
	Silicon G	SG747
	Teledyne S	747
	TI	SN52747
LM748	AMD	748
	Intersil	LM748
	Motorola	MC1748
	NPC	SFC2748
	Raytheon	RC748
	Raytheon	RM748
	RCA	CA748
	Signetics	µA748
	Silicon G	SG748
	Teledyne S	748
	TI	SN52748
LM75107A	National	DS75107
LM75108A	National	DS75108
LM7520	National	DS7520
LM75207	National	DS75207
LM75208	National	DS75208
LM7521	National	DS7521
LM7522	National	DS7522
LM7523	National	DS7523
LM7524	National	DS7524
LM7525	National	DS7525
LM7528	National	DS7528
LM7529	National	DS7529
LM75324	National	DS75324
LM75325	National	DS75325
LM7534	National	DS7534
LM7535	National	DS7535
LM7538	National	DS7538
LM7539	National	DS7539
LM75450	National	DS75450
LM75451	National	DS75451
LM75452	National	DS75452
LM75454	National	DS75454
LM7805	**Signetics**	**7805**
	see page 668	
LM7806	**Signetics**	**7806**
	see page 668	
LM7808	**Signetics**	**7808**
	see page 668	
LM7812	**Signetics**	**7812**
	see page 668	
LM7815	**Signetics**	**7815**
	see page 668	
LM7818	**Signetics**	**7818**
	see page 668	
LM7824	**Signetics**	**7824**
	see page 668	
MH0013	Intersil	IM5013
MH0025	National	DS0025
MH0026	National	DS0026

Manufacturer Device	Replacement Source	Replacement Device
MH0056	National	DS0056
MH7803	National	DS7803
MH7808	National	DS7808
MH8803	National	DS8803
MH8808	National	DS8808
MMKJC904	Harris	HD54C904
MM1101	AMD	1101
	Intersil	IM7501
	Intersil	IM7511
	Intersil	IM7512
	Mostek	MK4007
	Signetics	2501
MM1103	Signetics	1103
MM1402	AMD	1402
	AD	S2502
	Signetics	2502
	Synertek	SY1402
MM1403	AMD	1403
	AMI	S2503
	Motorola	MC2385
	Synertek	SY1403
MM1404	AMD	1404
	AMI	S2504
	Motorola	MC2386
	Synertek	SY1404
MM2102	Mostek	MK4102
MM2521	AMD	AM2521
	Signetics	2521
MM2522	Signetics	2522
MM2533	AMD	AM2533
	Signetics	2533
MM2602	**Signetics**	**2602**
	see page 790	
MM4020	Intersil	IM7780
MM4060	TI	TMS3128
	TI	TMS3129
	TI	TMS3130
	TI	TMS3131
	TI	TMS3132
MM423	AMI	S8773
MM4232	Mostek	MK2500
MM4240	AMI	S8614
MM452	Siliconix	S1452
MM455	Siliconix	S1455
MM5013	AMI	S2512A
	Signetics	2512
	Signetics	2525
MM5016	AMI	S1865
MM5020	Intersil	IM7780
MM5025	Synertek	SY5025
MM5026	Synertek	SY5026
MM5027	Synertek	SY5027
MM5054	AMI	S2181
MM5055	AMD	5055
MM5056	AMD	5056
MM5057	AMD	5057
MM5058	TI	TMS3133
MM506	Signetics	2506
MM5060	AMI	S2181
MM5230	Motorola	MCM1112
	Nitron	NCM1112
MM5231	**AMI**	**S5232**
	see page 706	
	Nitron	NCM1110
MM5232	Mostek	MK2500
	Mostek	MK2600
MM5233	**AMI**	**S3514**
	see page 706	
MM5262	Nortec	6003
MM5264	Nortec	6003
MM5270	Signetics	2670
MM5316	AMI	S1998
MM54C00	Harris	HD54C00
	Teledyne S	MM54C00
MM54C02	Harris	HD54C02
	Teledyne S	MM54C02
MM54C04	Harris	HD54C04
	Teledyne S	MM54C04
MM54C08	Harris	HD54C08
MM54C10	Harris	HD54C10
	Teledyne S	MM54C10

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

National Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
MM54C107	Harris	HD54C107
	Teledyne S	MM54C107
MM54C151	**Harris**	**HD54C151**
	see page 266	
	Teledyne S	MM54C151
MM54C154	**Harris**	**HD54C154**
	see page 266	
	Teledyne S	MM54C154
MM54C157	Harris	HD54C157
	Teledyne S	MM54C157
MM54C160	**Harris**	**HD54C160**
	see page 266	
	Teledyne S	MM54C160
MM54C161	**Harris**	**HD54C161**
	see page 266	
	Teledyne S	MM54C161
MM54C162	**Harris**	**HD54C162**
	see page 266	
	Teledyne S	MM54C162
MM54C163	Harris	HD54C163
	Teledyne S	MM54C163
MM54C164	Harris	HD54C164
	Teledyne S	MM54C164
MM54C165	Harris	HD54C165
MM54C173	Harris	HD54C173
	Teledyne S	MM54C173
MM54C174	Harris	HD54C174
MM54C175	Harris	HD54C175
MM54C192	**Harris**	**HD54C192**
	see page 266	
	Teledyne S	MM54C192
MM54C193	**Harris**	**HD54C193**
	see page 266	
	Teledyne S	MM54C193
MM54C195	Harris	HD54C195
	Teledyne S	MM54C195
MM54C20	Harris	HD54C20
	Teledyne S	MM54C20
MM54C200	Teledyne S	MM54C200
MM54C221	Harris	HD54C221
MM54C30	Harris	HD54C30
MM54C32	Harris	HD54C32
MM54C42	**Harris**	**HD54C42**
	see page 266	
	Teledyne S	MM54C42
MM54C48	Harris	HD54C48
	Teledyne S	MM54C48
MM54C73	Harris	HD54C73
	Teledyne S	MM54C73
MM54C74	Harris	HD54C74
	Teledyne S	MM54C74
MM54C76	Harris	HD54C76
	Teledyne S	MM54C76
MM54C83	**Harris**	**HD54C83**
	see page 266	
MM54C85	**Harris**	**HD54C85**
	see page 266	
MM54C86	Harris	HD54C86
	Teledyne S	MM54C86
MM54C901	Harris	HD54C901
MM54C902	Harris	HD54C902
MM54C903	Harris	HD54C903
MM54C906	Harris	HD54C906
MM54C907	Harris	HD54C907
MM54C95	Harris	HD54C95
	Teledyne S	MM54C95
MM551	AMI	MX52D
MM552	Siliconix	S1552
MM555	Siliconix	S1555
MM5555	Nitron	NCM1183
MM5556	Nitron	NC1184
MM601	Motorola	MC14001
MM602	Motorola	MC14002
MM70C95	Harris	HD70C95
MM70C97	Harris	HD70C97
MM74C00	Harris	HD74C00
	Teledyne S	MM74C00
MM74C02	Harris	HD74C02
	Teledyne S	MM74C02
MM74C04	Harris	HD74C04
	Teledyne S	MM74C04

Manufacturer Device	Replacement Source	Replacement Device
MM74C08	Harris	HD74C08
MM74C10	Harris	HD74C10
	Teledyne S	MM74C10
MM74C107	Harris	HD74C107
	Teledyne S	MM74C107
MM74C151	**Harris**	**HD74C151**
	see page 266	
	Teledyne S	MM74C151
MM74C154	**Harris**	**HD74C154**
	see page 266	
	Teledyne S	MM74C154
MM74C157	Harris	HD74C157
	Teledyne S	MM74C157
MM74C160	**Harris**	**HD74C160**
	see page 266	
	Teledyne S	MM74C160
MM74C161	**Harris**	**HD74C161**
	see page 266	
	Teledyne S	MM74C161
MM74C162	**Harris**	**HD74C162**
	see page 266	
	Teledyne S	MM74C162
MM74C163	Harris	HD74C163
	Teledyne S	MM74C163
MM74C164	Harris	HD74C164
	Teledyne S	MM74C164
MM74C165	Harris	HD74C165
MM74C173	Harris	HD74C173
	Teledyne S	MM74C173
MM74C174	Fairchild	F40174
	Harris	HD74C174
MM74C175	Fairchild	F40175
	Harris	HD74C175
MM74C192	**Harris**	**HD74C192**
	see page 266	
	Teledyne S	MM74C192
MM74C193	**Harris**	**HD74C193**
	see page 266	
	Teledyne S	MM74C193
MM74C195	Harris	HD74C195
	Teledyne S	MM74C195
MM74C20	Harris	HD74C20
	Teledyne S	MM74C20
MM74C200	Harris	HD74C200
	Teledyne S	MM74C200
MM74C221	Harris	HD74C221
MM74C30	Harris	HD74C30
MM74C32	Harris	HD74C32
MM74C42	**Harris**	**HD74C42**
	see page 266	
	Teledyne S	MM74C42
MM74C48	Harris	HD74C48
	Teledyne S	MM74C48
MM74C73	Harris	HD74C73
	Teledyne S	MM74C73
MM74C74	Harris	HD74C74
	Teledyne S	MM74C74
MM74C76	Harris	HD74C76
	Teledyne S	MM74C76
MM74C83	**Harris**	**HD74C83**
	see page 266	
MM74C85	Fairchild	F40085
	Harris	**HD74C85**
	see page 266	
	SSS	SCL4585
MM74C86	Harris	HD74C86
	Teledyne S	MM74C86
MM74C89	Harris	HD74C89
	Teledyne S	MM74C89
MM74C901	Harris	HD74C901
MM74C902	Harris	HD74C902
MM74C903	Harris	HD74C903
MM74C904	Harris	HD74C904
MM74C95	Harris	HD74C95
	Teledyne S	MM74C95
MM80C95	Harris	HD80C95
MM80C97	Fairchild	F40097
	Harris	HD80C97
MM80C98	Fairchild	F40098
NH00011	Fairchild	SH2001
	Fairchild	SH2002

Manufacturer Device	Replacement Source	Replacement Device
NH00016	Fairchild	SH2200
NH00017	Fairchild	SH2200
NH00018	Fairchild	SH2200

Nitron

Manufacturer Device	Replacement Source	Replacement Device
NCM1110	Motorola	MCM1110
	National	MM5231
	Signetics	2430
	TI	TMS2600
NCM1111	Motorola	MCM1111
	Signetics	2461
NCM1112	Motorola	MCM1112
	National	MM5230
NCM1120	Motorola	MCM1120
	TI	TMS2400
NCM1121	Motorola	MCM1121
NCM1122	Motorola	MCM1122
NCM1130	Motorola	MCM1130
	TI	TMS4100
NCM1131	Motorola	MCM1131
NCM1140	Motorola	MCM1140
	TI	TMS4300
NCM6560	Motorola	MCM6560
NCM6561	Motorola	MCM6561
NCM6570	Motorola	MCM6570
NCM6571	Motorola	MCM6571
NCM6572	Motorola	MCM6572
NCM6580	Motorola	MCM6580
NCM6581	Motorola	MCM6581
NCM6583	Motorola	MCM6583
NCM6590	Motorola	MCM6590
NCM6832	Motorola	MCM6832
NC1181	**AMI**	**S2567**
	see page 254	
NC1182	**AMI**	**S2566**
	see page 254	
NC1183	**AMI**	**S2555**
	see page 254	
	National	MM5555
NC1184	**AMI**	**S2556**
	see page 254	
	National	MM5556
NC2257	Motorola	MC2257
NC2259	Motorola	MC2259
NC2260	Motorola	MC2260

Nortec Electronics

Manufacturer Device	Replacement Source	Replacement Device
2222	**AMI**	**S2222**
	see page 706	
6002	TI	TMS4062
	TI	TMS6002
6003	TI	TMS4063

Plessey Semiconductors

Manufacturer Device	Replacement Source	Replacement Device
SL3045	RCA	CA3045
SL3046	RCA	CA3046
SL3086	RCA	CA3086
SP1001	Motorola	MC1001
SP1002	Motorola	MC1002
SP1003	Motorola	MC1003
SP1004	Motorola	MC1004
SP1005	Motorola	MC1005
SP1006	Motorola	MC1006
SP1007	Motorola	MC1007
SP1008	Motorola	MC1008
SP1009	Motorola	MC1009
SP1010	Motorola	MC1010
SP1011	Motorola	MC1011
SP1012	Motorola	MC1012
SP1013	Motorola	MC1013
SP1014	Motorola	MC1014
SP1015	Motorola	MC1015

Manufacturer Device	Replacement Source	Replacement Device
SP1016	Motorola	MC1016
SP1020	Motorola	MC1020
SP1023	Motorola	MC1023
SP1026	Motorola	MC1026
SP1027	Motorola	MC1027
SP1030	Motorola	MC1030
SP1031	Motorola	MC1031
SP1032	Motorola	MC1032
SP1033	Motorola	MC1033
SP1034	Motorola	MC1034
SP1035	Motorola	MC1035
SP1039	Motorola	MC1039
SP1040	Motorola	MC1040
SP1047	Motorola	MC1047
SP1048	Motorola	MC1048
SP1201	Motorola	MC1201
SP1202	Motorola	MC1202
SP1203	Motorola	MC1203
SP1204	Motorola	MC1204
SP1205	Motorola	MC1205
SP1206	Motorola	MC1206
SP1207	Motorola	MC1207
SP1208	Motorola	MC1208
SP1209	Motorola	MC1209
SP1210	Motorola	MC1210
SP1211	Motorola	MC1211
SP1212	Motorola	MC1212
SP1213	Motorola	MC1213
SP1214	Motorola	MC1214
SP1215	Motorola	MC1215
SP1216	Motorola	MC1216
SP1220	Motorola	MC1220
SP1226	Motorola	MC1226
SP1230	Motorola	MC1226
SP1231	Motorola	MC1231
SP1233	Motorola	MC1233
SP1235	Motorola	MC1235
SP1239	Motorola	MC1239
SP1240	Motorola	MC1240
SP1247	Motorola	MC1247
SP1248	Motorola	MC1248
SP1660	Motorola	MC1660
SP1661	Motorola	MC1661
SP1662	Motorola	MC1662
SP1664	Motorola	MC1664
SP1666	Motorola	MC1666
SP1668	Motorola	MC1668
SP1669	Motorola	MC1669
SP1670	Motorola	MC1670
SP1671	Motorola	MC1671
SP1690	Motorola	MC1690
SP1692	Motorola	MC1692
SP8616	Fairchild	11C05C
SP8640	Fairchild	95H90

Precision Monolithics

Manufacturer Device	Replacement Source	Replacement Device
¶ SSS108	RCA	CA108
SSS1408	Motorola	MC1408
SSS1508	Motorola	MC1508
¶ SSS208	RCA	CA208
¶ SSS308	RCA	CA308
SSS747	AMD	SSS747

Raytheon Semiconductor

Manufacturer Device	Replacement Source	Replacement Device
LM101	AMD	LM101
	Intersil	LM101
	National	LM101
	RCA	**CA101**
	see page 661	
	Signetics	LM101
	Silicon G	SG101
	Teledyne S	LM101
	TI	SN52101
LM105	AMD	LM105
	Intersil	LM105
	National	LM105
	Silicon G	SG105
	Teledyne S	LM105

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

Raytheon Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
LM106	AMD	LM106
	TI	SN52106
LM107	AMD	LM107
	Intersil	LM107
	National	LM107
	RCA	**CA107**
	see page 661	
	Signetics	LM107
	Silicon G	SG107
	Teledyne S	LM107
	TI	SN52107
LM108	AMD	LM108
	Intersil	LM108
	National	LM108
	RCA	CA108
	Signetics	LM108
	Silicon G	SG108
	TI	SN52108
LM109	Silicon G	SG109
LM111	AMD	LM111
	Harris	HA-2111
	Intersil	LM111
	National	LM111
	RCA	**CA111**
	see page 661	
	Signetics	LM111
	Teledyne S	LM111
	TI	SN52111
LM124	Teledyne S	LM124
LM139	Teledyne S	LM139
LM201	AMD	LM201
	Intersil	LM201
	National	LM201
	RCA	**CA201**
	see page 661	
	Teledyne S	LM201
LM204	Teledyne S	LM204
LM205	AMD	LM205
	Intersil	LM205
	National	LM205
	Teledyne S	LM205
LM207	AMD	LM207
	Intersil	LM207
	National	LM207
	RCA	**CA207**
	see page 661	
	Teledyne S	LM207
LM208	AMD	LM208
	Intersil	LM208
	RCA	CA208
LM211	AMD	LM211
	Harris	HA-2211
	Intersil	LM211
	National	LM211
	RCA	**CA211**
	see page 661	
	Signetics	LM211
	Teledyne S	LM211
LM224	Teledyne S	LM224
LM239	Teledyne S	LM239
LM2900	National	LM2900
LM2902	National	LM2902
LM301	AMD	LM301
	Intersil	LM301
	National	LM301
	Signetics	LM301
	Silicon G	SG301
	Teledyne S	LM301
LM304	Teledyne S	LM304
LM305	AMD	LM305
	Intersil	LM305
	National	LM305
	Teledyne S	LM305
LM307	AMD	LM307
	Intersil	LM307
	National	LM307
	RCA	**CA307**
	see page 661	
	Signetics	LM307
	Silicon G	SG307
	Teledyne S	LM307

Manufacturer Device	Replacement Source	Replacement Device
LM308	AMD	LM308
	Intersil	LM308
	RCA	CA308
	Signetics	LM308
	Silicon G	SG308
	Teledyne S	LM308
LM309	Silicon G	SG309
LM311	AMD	LM311
	Harris	HA-2311
	Intersil	LM311
	National	LM311
	RCA	**CA311**
	see page 661	
	Signetics	LM311
	Teledyne S	LM311
	TI	SN52111
LM324	Teledyne S	LM324
LM339	**RCA**	**CA339**
	see page 661	
RC10144	Fairchild	F10410
	Signetics	10144
	TI	SN10144
RC1437	Motorola	MC1437
RC1458	Harris	HA-2655
	PMI	SSS1458
	RCA	CA1458
	Signetics	MC1458
	Silicon G	SG1458
	Teledyne S	1458
RC1488	Exar	XR1488
	Silicon G	SG1488
	TI	SN75188
RC1489	Exar	XR1489A
	Silicon G	SG1489
	TI	SN75189
RC1556	Signetics	MC1456
RC1558	RCA	CA1558
RC3403	**see page 649**	
	Exar	XR3403
	Fairchild	μA3403
	Motorola	MC3403
RC4136	**see page 647**	
	Exar	**XR4136**
	see page 640	
	Exar	**XR4212**
	see page 639	
	TI	RC4136
RC4194	**see page 655**	
	Exar	XR4194
RC4531	Signetics	NE531
RC4558	**see page 651**	
	Exar	XR4558
	TI	RC4558
RC5332	Fairchild	93411
RC5342	Fairchild	93411
RC555	Exar	XR555
	Intersil	NE555
	Lithic Sys	LS555
	RCA	**CA555**
	see page 661	
	Signetics	NE555
	Teledyne S	555
RC556	Exar	XR-556
	Signetics	NE556
	Teledyne S	556
RC709	Signetics	μA709
	Teledyne S	709
RC710	Signetics	μA710
	Teledyne S	710
RC711	Signetics	μA711
	Teledyne S	711
RC723	Intersil	723
	Signetics	μA723
	Teledyne S	723
RC733	Signetics	μA733
RC741	Intersil	741
	PMI	SSS741
	RCA	**CA741**
	see page 661	
	Signetics	μA741
	Teledyne S	741

Manufacturer Device	Replacement Source	Replacement Device
RC747	Signetics	μA747
	Teledyne S	747
RC748	AMD	748
	Intersil	748
	RCA	CA748
	Signetics	μA748
	Teledyne S	748
RC7489	Intersil	IM5501
¶ RC7520	Signetics	7520
	Silicon G	SG7520
¶ RC7521	Signetics	7521
	Silicon G	SG7521
¶ RC7522	Signetics	7522
	Silicon G	SG7522
RC7523	Signetics	7523
	Silicon G	SG7523
¶ RC7524	Signetics	7524
	Silicon G	SG7524
¶ RC7525	Signetics	7525
	Silicon G	SG7525
	TI	SN7525
RC8T09	Signetics	8T09
RC8T10	Signetics	8T10
RC8T13	Signetics	8T13
RC8T14	Signetics	8T14
RC8T23	Signetics	8T23
RC8T24	Signetics	8T24
RC8200	Signetics	N8200
RC8201	Signetics	N8201
RC8202	Signetics	N8202
RC8203	Signetics	N8203
RC8225	Intersil	IM5501
	Signetics	N8225
	TI	SN74S189
	TI	SN74S289
RC8230	Signetics	N8230
RC8231	Signetics	N8231
RC8233	Signetics	N8233
RC8234	Signetics	N8234
RC8241	Signetics	N8241
RC8242	Signetics	N8242
RC8243	Signetics	N8243
RC8250	Signetics	N8250
RC8251	Signetics	N8251
RC8252	Signetics	N8252
RC8260	Signetics	N8260
RC8261	Signetics	N8261
RC8263	Signetics	N8263
RC8264	Signetics	N8264
RC8266	Signetics	N8266
RC8267	Signetics	N8267
RC8270	Signetics	N8270
	TI	SN74178
RC8271	Signetics	N8271
	TI	SN74179
RC8273	Signetics	N8273
RC8274	Signetics	N8274
RC8280	Signetics	N8280
	TI	SN74176
RC8281	Signetics	N8281
RC8290	Signetics	N8290
	Signetics	8290
	TI	SN74196
RC8291	Signetics	N8291
	TI	SN74197
RC930	Motorola	MC830
	TI	SN15830
RC932	Motorola	MC832
	TI	SN15832
RC933	Motorola	MC933
	TI	SN15833
RC934	Motorola	MC934
	TI	SN15834
RC935	Motorola	MC835
	TI	SN15835
RC936	Motorola	MC836
RC937	Motorola	MC837
	TI	SN15837
RC940	Motorola	MC840
RC941	Motorola	MC841
RC944	Motorola	MC844

Manufacturer Device	Replacement Source	Replacement Device
RC944	TI	SN15844
RC945	Motorola	MC845
	TI	SN15845
RC946	Motorola	MC846
	TI	SN15846
RC948	Motorola	MC848
	TI	SN15848
RC949	Motorola	MC849
	TI	SN15849
RC950	Motorola	MC850
	TI	SN15850
RC951	Motorola	MC851
	TI	SN15851
RC957	Motorola	MC857
	TI	SN15857
RC958	Motorola	MC858
	TI	SN15858
RC961	Motorola	MC861
	TI	SN15861
RC962	Motorola	MC862
	TI	SN15862
RC963	Motorola	MC863
	TI	SN15863
RC993	Motorola	MC853
	TI	SN158093
RC994	Motorola	MC856
	TI	SN158094
RC997	Motorola	MC855
	TI	SN158097
RC999	Motorola	MC852
	TI	SN158092
RM1514	TI	SN52514
RM1537	Motorola	MC1537
RM1556	Signetics	MC1556
RM1558	Harris	HA-2650
	PMI	SSS1558
	RCA	CA1558
	Silicon G	SG1558
	Teledyne S	1558
	TI	SN52558
RM3503	**see page 649**	
	Exar	XR3503
	Fairchild	μA3503
	Motorola	MC3503
RM4136	**see page 647**	
	Exar	**XR4136**
	see page 640	
	TI	RM4136
RM4194	**see page 655**	
	Exar	XR4194
RM4531	Signetics	SE531
¶ RM4741	PMI	SSS4741
	Silicon G	SG747
	Teledyne S	747
RM555	AMD	SE555
	Intersil	SE555
	Lithic Sys	LS555
	Signetics	SE555
	Teledyne S	555
RM702	TI	SN52702
RM709	Signetics	μA709
	Teledyne S	709
	TI	SN52709
RM710	Signetics	μA710
	Silicon G	SG710
	Teledyne S	710
	TI	SN52710
RM711	Signetics	μA711
	Silicon G	SG711
	Teledyne S	711
	TI	SN52711
RM723	AMD	723
	Intersil	723
	RCA	CA723
	Signetics	μA723
	Silicon G	SG723
	Teledyne S	723
	TI	SN52723
RM733	AMD	733
	Signetics	μA733
	Silicon G	SG733

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Raytheon Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
RM733	TI	SN52733
RM741	AMD	741
	Intersil	741
	PMI	SSS741
	RCA	**CA741**
	see page 661	
	Signetics	μA741
	Silicon G	SG741
	Teledyne S	741
	TI	SN52741
RM747	AMD	747
	PMI	SSS747
	Signetics	μA747
	Teledyne S	747
	TI	SN52747
RM748	AMD	748
	Intersil	748
	RCA	CA748
	Signetics	μA748
	Silicon G	SG748
	Teledyne S	748
	TI	SN52748
RM930	Motorola	MC930
	TI	SN15930
RM932	Motorola	MC932
	TI	SN15932
RM933	Motorola	MC933
	TI	SN15933
RM934	Motorola	MC934
	TI	SN15934
RM935	Motorola	MC935
	TI	SN15935
RM936	Motorola	MC936
	TI	SN15936
RM937	Motorola	MC937
	TI	SN15937
RM940	Motorola	MC940
RM941	Motorola	MC941
RM944	Motorola	MC944
	TI	SN15944
RM945	Motorola	MC945
	TI	SN15945
RM946	Motorola	MC946
	TI	SN15946
RM947	TI	SN15947
RM948	Motorola	MC948
	TI	SN15948
RM949	Motorola	MC949
	TI	SN15949
RM950	Motorola	MC950
	TI	SN15950
RM951	Motorola	MC951
	TI	SN15951
RM957	Motorola	MC957
	TI	SN15957
RM958	Motorola	MC958
	TI	SN15958
RM961	Motorola	MC961
	TI	SN15961
RM962	Motorola	MC962
	TI	SN15962
RM963	Motorola	MC963
	TI	SN15963
RM993	Motorola	MC953
	TI	SN159093
RM994	Motorola	MC956
	TI	SN159094
RM997	Motorola	MC955
	TI	SN159097
RM999	Motorola	MC952
	TI	SN159099
54LS00	see page 282	
	Signetics	S54LS00
	see page 384	
54LS01	see page 282	
	Signetics	S54LS01
	see page 384	
54LS02	see page 282	
	Signetics	S54LS02
	see page 384	
54LS03	see page 282	
	Signetics	S54LS03
	see page 384	
54LS04	see page 282	
	Signetics	S54LS04
	see page 384	
54LS05	see page 282	
	Signetics	S54LS05
	see page 384	
54LS08	see page 282	
	Signetics	S54LS08
	see page 384	
54LS09	see page 282	
	Signetics	S54LS09
	see page 384	
54LS10	see page 282	
	Signetics	S54LS10
	see page 384	
54LS109	see page 282	
	Signetics	S54LS109
	see page 384	
54LS11	see page 282	
	Signetics	S54LS11
	see page 384	
54LS112	see page 282	
	Signetics	S54LS112
	see page 384	
54LS113	see page 282	
	Signetics	S54LS113
	see page 384	
54LS114	see page 282	
	Signetics	S54LS114
	see page 384	
54LS12	see page 282	
	Signetics	S54LS12
	see page 384	
54LS136	see page 282	
	Signetics	S54LS136
	see page 384	
54LS138	see page 282	
	Signetics	S54LS138
	see page 384	
54LS139	see page 282	
	Signetics	S54LS139
	see page 384	
54LS15	see page 282	
	Signetics	S54LS15
	see page 384	
54LS151	see page 282	
	Signetics	S54LS153
	see page 384	
54LS157	see page 282	
	Signetics	S54LS157
	see page 384	
54LS158	see page 282	
	Signetics	S54LS158
	see page 384	
54LS160	see page 282	
	Signetics	S54LS160
	see page 384	
54LS161	see page 282	
	Signetics	S54LS161
	see page 384	
54LS162	see page 282	
	Signetics	S54LS162
	see page 384	
54LS163	see page 282	
	Signetics	S54LS163
	see page 384	
54LS174	see page 282	
	Signetics	S54LS174
	see page 384	
54LS175	Signetics	S54LS175
	see page 384	
54LS181	see page 282	
	Signetics	S54LS181
	see page 384	
54LS190	see page 282	
	Signetics	S54LS190
	see page 384	
54LS191	see page 282	
	Signetics	S54LS191
	see page 384	
54LS192	see page 282	
	Signetics	S54LS192
	see page 384	
54LS193	see page 282	
	Signetics	S54LS193
	see page 384	
54LS194A	see page 282	
	Signetics	S54LS194A
	see page 384	
54LS195A	see page 282	
	Signetics	S54LS195A
	see page 384	
54LS196	see page 282	
	Signetics	S54LS196
	see page 384	
54LS197	see page 282	
	Signetics	S54LS197
	see page 384	
54LS20	see page 282	
	Signetics	S54LS20
	see page 384	
54LS21	Signetics	S54LS21
	see page 384	
54LS22	see page 282	
	Signetics	S54LS22
	see page 384	
54LS251	see page 282	
	Signetics	S54LS251
	see page 384	
54LS253	see page 282	
	Signetics	S54LS253
	see page 384	
54LS257	see page 282	
	Signetics	S54LS257
	see page 384	
54LS258	see page 282	
	Signetics	S54LS258
	see page 384	
54LS26	see page 282	
	Signetics	S54LS26
	see page 384	
54LS27	see page 282	
	Signetics	S54LS27
	see page 384	
54LS28	see page 282	
	Signetics	S54LS28
	see page 384	
54LS283	see page 282	
	Signetics	S54LS283
	see page 384	
54LS295A	see page 282	
	Signetics	S54LS295A
	see page 384	
54LS30	see page 282	
	Signetics	S54LS30
	see page 384	
54LS32	see page 282	
	Signetics	S54LS32
	see page 384	
54LS33	see page 282	
	Signetics	S54LS33
	see page 384	
54LS37	see page 282	
	Signetics	S54LS37
	see page 384	
54LS38	see page 282	
	Signetics	S54LS38
	see page 384	
54LS386	see page 282	
	Signetics	S54LS386
	see page 384	
54LS40	see page 282	
	Signetics	S54LS40
	see page 384	
54LS51	see page 282	
	Signetics	S54LS51
	see page 384	
54LS54	see page 282	
	Signetics	S54LS54
	see page 384	
54LS55	see page 282	
	Signetics	S54LS55
	see page 384	
54LS670	Signetics	S54LS670
	see page 384	
54LS73	see page 282	
	Signetics	S54LS73
	see page 384	
54LS74	see page 282	
	Signetics	S54LS74
	see page 384	
54LS76	see page 282	
	Signetics	S54LS76
	see page 384	
54LS78	see page 282	
	Signetics	S54LS78
	see page 384	
54LS83A	see page 282	
	Signetics	S54LS83A
	see page 384	
54LS86	see page 282	
	Signetics	S54LS86
	see page 384	
54LS95B	see page 282	
	Signetics	S54LS95B
	see page 384	
54170	Fairchild	54170
	TI	54170

RCA Solid State Division

Manufacturer Device	Replacement Source	Replacement Device
CA101	see page 661	
	AMD	LM101
	AD	**AD101**
	see page 625	
	Fairchild	μA101
	Intersil	LM101
	Motorola	MLM101
	National	LM101
	NPC	SFC2121
	Raytheon	LM101
	Signetics	LM101
	Silicon G	SG101
	Siliconix	LM101
	Teledyne S	LM101
	TI	SN52101
CA107	see page 661	
	AMD	LM107
	Intersil	LM107
	Motorola	MLM107
	National	LM107
	Raytheon	LM107
	Signetics	LM107
	Silicon G	SG107
	Teledyne S	LM107
	TI	LM107
CA108	AMD	LM108
	Fairchild	μA108
	National	LM108
	Raytheon	LM108
	Signetics	LM108
	Silicon G	SG108
CA111	see page 661	
	AMD	LM111
	Harris	HA2111
	Intersil	LM111
	Motorola	MLM111
	National	LM111
	NPC	SFC2111
	Raytheon	LM111
	Signetics	LM111
	Silicon G	SG111
	Teledyne S	LM111
	TI	SN52111
CA1310	Signetics	MC1310
CA1458	Harris	HA-2655
	National	LM1458
	PMI	SSS1458
	Raytheon	RC1458
	Signetics	MC1458
	Silicon G	SG1458
	Teledyne S	1458
	TI	SN72558
CA1558	Fairchild	μA1558
	Harris	HA-2650

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

RCA Solid State Division (cont)

Manufacturer Device	Replacement Source	Device
CA1558	National	LM1558
	PMI	SSS1558
	Raytheon	RM1558
	Signetics	MC1558
	Silicon G	SG1558
	Teledyne S	1558
	TI	SN52558
CA201	see page 661	
	AMD	LM201
	AD	**AD201**
	see page 625	
	Fairchild	µA201
	Intersil	LM201
	Motorola	MLM201
	National	LM201
	Raytheon	LM201
	Signetics	LM201
	Silicon G	SG201
	Siliconix	LM201
	Teledyne S	LM201
CA207	see page 661	
	AMD	LM207
	Fairchild	LM207
	Intersil	LM207
	Motorola	MLM207
	National	LM207
	Raytheon	LM207
	Signetics	LM207
	Teledyne S	LM207
CA208	AMD	LM208
	AD	**AD208**
	see page 625	
	Fairchild	LM208
	Intersil	LM208
	National	LM208
	NPC	SFC2208
	Raytheon	LM208
	Signetics	LM208
	Silicon G	SG208
CA211	see page 661	
	AMD	LM211
	Harris	HA-2211
	Intersil	LM211
	Motorola	MLM211
	National	LM211
	NPC	SFC2211
	Raytheon	LM211
	Signetics	LM211
	Teledyne S	LM211
CA2111	Sprague	ULN-2111
CA239	see page 661	
	Teledyne S	LM239
CA301	see page 661	
	AD	**AD301**
	see page 625	
	AD	LM301
	Fairchild	µA301
	Intersil	LM301
	Motorola	MLM301
	National	LM301
	NPC	SFC2301
	Raytheon	LM301
	Signetics	LM301
	Teledyne S	LM301
	TI	SN72301
CA3011	Motorola	MC1590
CA3012	Motorola	MC1590
CA3013	Motorola	MC1355
CA3014	Motorola	MC1357
CA3018	Fairchild	µA3018
	Lithic Sys	LA3018
	NPC	SFC2018
	Silicon G	SG3818
CA3018A	Lithic Sys	LA3018A
CA3019	Fairchild	µA3019
CA3026	Fairchild	µA3026
	Lithic Sys	LA3026
	Silicon G	SG3822
CA3028	Lithic Sys	LS3028
¶ CA3031	Motorola	MC1712
¶ CA3032	Motorola	MC1712
CA3036	Fairchild	µA3036
	NPC	SFC2036
CA3038	Motorola	MC1709
CA3039	Fairchild	µA3039
CA3045	Fairchild	µA3045
	Lithic Sys	LA3045
	National	LM3045
	Plessey	SL3045
	Silicon G	SG3821
	Sprague	ULS2045
CA3046	Fairchild	µA3046
	Lithic Sys	LA3046
	National	3046
	NPC	SFC2046
	Plessey	SL3046
	Silicon G	SG3821
CA3049	Lithic Sys	LA3049
	Silicon G	SG3822
CA3053	Lithic Sys	LS3053
CA3054	Fairchild	µA3054
	National	LM3054
	NPC	SFC2054
CA3055	Silicon G	SG300
CA3064	Fairchild	µA3064
	Motorola	MC1364
	Sprague	ULN-2264
CA3065	Fairchild	µA3065
	Motorola	MC1358
	Sprague	ULN-2165
CA3066	Fairchild	µA3066
CA3067	Fairchild	µA3067
	Sprague	ULN-2267
CA307	see page 661	
	AMD	LM307
	Fairchild	LM307
	Intersil	LM307
	Motorola	MLM307
	National	LM307
	Raytheon	LM307
	Signetics	LM307
	Silicon G	SG307
	Teledyne S	LM307
	TI	SN72307
CA3070	Fairchild	µA780
	Motorola	MC1370
	Sprague	ULN-2124
CA3071	Fairchild	µA781
	Motorola	MC1371
	Sprague	ULN-2127
CA3072	Fairchild	746
	Motorola	MC1328
	Sprague	ULN-2114
CA3075	Fairchild	µA3075
	Motorola	MC1375
	Sprague	ULN-2129
CA3076	Fairchild	µA3076
CA308	AMD	LM308
	AD	**AD308**
	see page 625	
	Fairchild	LM308
	Intersil	LM308
	Motorola	MLM308
	National	LM308
	NPC	SFC2308
	Raytheon	LM308
	Signetics	LM308
	Silicon G	SG308
	Teledyne S	LM308
	TI	SN72308
CA3081	Silicon G	SG3081
CA3082	Silicon G	SG3082
CA3086	Fairchild	µA3086
	Lithic Sys	LA3086
	National	LM3086
	Plessey	SL3086
	Silicon G	SG3086
CA3089	SGS	TDA1200
	Sprague	ULN-2289
CA311	see page 661	
	AMD	LM311
	Fairchild	µA311
CA311	Harris	HA-2311
	Intersil	LM311
	Motorola	MLM311
	National	LM311
	NPC	SFC3111
	Raytheon	LM311
	Signetics	LM311
	Silicon G	SG311
	Teledyne S	LM311
	TI	SN72311
CA3120	Sprague	ULN-2125
CA3121	Sprague	ULN-2269
CA3123	Sprague	ULN-2137
CA324	see page 661	
	National	LM324
	Signetics	LM324
	Silicon G	SG324
	Teledyne S	LM324
CA339	see page 661	
	National	LM339
	Raytheon	LM339
	Signetics	LM339
	Silicon G	SG339
	Teledyne S	LM339
CA3458	RCA	CA1458
CA3741	**RCA**	**CA741**
	see page 661	
CA3747	**RCA**	**CA747**
	see page 661	
CA3748	RCA	CA748
CA555	see page 661	
	AMD	NE555
	AMD	SE555
	Exar	XR555
	Intersil	NE555
	Lithic Sys	LS555
	Motorola	MC1455
	Motorola	MC1555
	National	LM555
	Raytheon	RC555
	Raytheon	RM555
	Signetics	NE555
	Teledyne S	555
	TI	SN72555
CA723	AMD	723
	Fairchild	µA723
	Intersil	723
	ITT	ITT723
	Motorola	MC1723
	National	LM723
	NPC	SFC2723
	Raytheon	RC723
	Signetics	UA723
	Silicon G	SG723
	Teledyne S	723
	TI	SN52723
CA741	see page 661	
	AMD	SSS741
	AMD	741
	AD	**AD741**
	see page 625	
	Fairchild	µA741
	Intersil	LM741
	Intersil	SSS741
	Intersil	741
	Motorola	MC1741
	National	LM741
	NPC	SFC2741
	PMI	SSS741
	Raytheon	RC741
	Raytheon	RM741
	Signetics	UA741
	Silicon G	SG741
	Teledyne S	741
	TI	SN52741
CA747	see page 661	
	AMD	SSS747
	AMD	747
	Fairchild	µA747
	Intersil	SSS747
	Motorola	MC1747
CA747	National	LM747
	PMI	SSS747
	Raytheon	RC747
	Raytheon	RM741
	Raytheon	RM747
	Signetics	UA747
	Silicon G	SG747
	Teledyne S	747
CA748	AMD	748
	Fairchild	µA748
	Intersil	748
	Motorola	MC1748
	National	LM748
	Raytheon	RC748
	Raytheon	RM748
	Signetics	UA748
	Silicon G	SG748
	Teledyne S	748
	TI	SN52748
CD4000	see page 375	
	Harris	HD4000
	Motorola	MC14000
	SSS	SCL4000
	Solitron	CM4000
	TI	TF4000
	TI	TP4000
CD4001	see page 375	
	Fairchild	F4001
	Fairchild	34001
	GI	MEM4001
	Harris	HD4001
	Motorola	MC14001
	National	CD4001
	SGS	HBF4001
	SSS	SCL4001
	Solitron	CM4001
	SW	SW4001
	TI	TF4001
	TI	TP4001
	Toshiba	TC4001
CD4002	see page 375	
	Fairchild	F4002
	Fairchild	34002
	Harris	HD4002
	Motorola	MC14002
	National	CD4002
	SGS	HBF4002
	SSS	SCL4002
	Solitron	CM4002
	SW	SW4002
	TI	TF4002
	TI	TP4002
	Toshiba	TC4002
CD4006	see page 375	
	Fairchild	F4006
	Harris	HD4006
	Motorola	MC14006
	National	CD4006
	SSS	SCL4006
	Solitron	CM4006
CD4007	see page 375	
	Fairchild	F4007
	GI	MEM4007
	Harris	HD4007
	Motorola	MC14007
	National	CD4007
	SGS	HBF4007
	SSS	SCL4007
	Solitron	CM4007
	TI	TF4007
	TI	TP4007
	Toshiba	TC4007
CD4008	see page 375	
	Fairchild	F4008
	Harris	HD4008
	Motorola	MC14008
	National	CD4008
	SGS	HBF4008
	SSS	SCL4008
	Solitron	CM4008
	TI	TF4008

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

RCA Solid State Division (cont)

Manufacturer Device	Replacement Source	Replacement Device
CD4008	TI	TP4008
	Toshiba	TC4008
CD4009	see page 375	
	Motorola	MC14009
	National	CD4009
	SGS	HBF4009
	SSS	SCL4009
	Solitron	CM4009
	TI	TF4009
	TI	TP4009
	Toshiba	TC4009
CD4010	see page 375	
	Motorola	MC14010
	National	CD4010
	SGS	HBF4010
	SSS	SCL4010
	Solitron	CM4010
	TI	TF4010
	TI	TP4010
	Toshiba	TC4010
CD4011	see page 375	
	Fairchild	F4011
	GI	MEM4011
	Harris	HD4011
	Motorola	MC14011
	National	CD4011
	SGS	HBF4011
	SSS	SCL4011
	Solitron	CM4011
	SW	SW4011
	TI	TF4011
	TI	TP4011
	Toshiba	TC4011
CD4012	see page 375	
	Harris	HD4012
	Motorola	MC14012
	National	CD4012
	National	MM4612
	SGS	HBF4012
	SSS	SCL4012
	Solitron	CM4012
	SW	SW4012
	TI	TF4012
	TI	TP4012
	Toshiba	TC4012
CD4013	see page 375	
	Fairchild	F4013
	GI	MEM4013
	Harris	HD4013
	Motorola	MC14013
	SGS	HBF4013
	SSS	SCL4013
	Solitron	CM4013
	SW	SW4013
	TI	TF4013
	TI	TP4013
	Toshiba	TC4013
CD4014	see page 375	
	Fairchild	F4014
	Harris	**HD4014**
	see page 266	
	Motorola	MC14014
	National	CD4014
	SGS	HBF4014
	SSS	SCL4014
	Solitron	CM4014
	TI	TF4014
	TI	TP4014
	Toshiba	TC4014
CD4015	see page 375	
	Fairchild	F4015
	Harris	**HD4015**
	see page 266	
	Motorola	MC14015
	National	CD4015
	SGS	HBF4015
	SSS	SCL4015
	Solitron	CM4015
	SW	SW4015
	TI	TF4015
	TI	TP4015
CD4016	see page 375	
	AD	AD7516
	see page 546	
	Motorola	MC14016
	National	CD4016
	SSS	SCL4016
	Solitron	CM4016
CD4017	see page 375	
	Fairchild	F4017
	Harris	HD4017
	Motorola	MC14017
	National	CD4017
	SGS	HBF4017
	SSS	SCL4017
	Solitron	CM4017
	SW	SW4017
	TI	TF4017
	TI	TP4017
	Toshiba	TC4017
CD4018	see page 375	
	Fairchild	F4018
	Harris	**HD4018**
	see page 266	
	National	CD4018
	SGS	HBF4018
	SSS	SCL4018
	Solitron	CM4018
	TI	TF4018
	TI	TP4018
	Toshiba	TC4018
CD4019	see page 375	
	Fairchild	F4019
	Harris	**HD4019**
	see page 266	
	Motorola	MC14519
	National	CD4019
	SGS	HBF4019
	SSS	SCL4019
	Solitron	CM4019
	SW	SW4019
	TI	TF4019
	TI	TP4019
	Toshiba	TC4019
CD4020	see page 375	
	Fairchild	F4020
	Harris	**HD4020**
	see page 266	
	Motorola	MC14020
	National	CD4020
	SGS	HBF4020
	SSS	SCL4020
	Solitron	CM4020
	SW	SW4020
	TI	TF4020
	TI	TP4020
	Toshiba	TC4020
CD4021	see page 375	
	Fairchild	F4021
	Harris	**HD4021**
	see page 266	
	Motorola	MC14021
	National	CD4021
	SSS	SCL4021
	Solitron	CM4021
	SW	SW4021
	SW	TF4021
	TI	TF4021
	TI	TP4021
	Toshiba	TC4021
CD4022	see page 375	
	Fairchild	F4022
	Harris	**HD4022**
	see page 266	
	Motorola	MC14022
	National	CD4022
	SGS	HBF4022
	SSS	SCL4022
	Solitron	CM4022
	TI	TF4022
	TI	TP4022
	Toshiba	TC4022
CD4023	see page 375	
	Fairchild	F4023
	Harris	HD4023
	Motorola	MC14023
	National	CD4023
	SGS	HBF4023
	SSS	SCL4023
	Solitron	CM4023
	SW	SW4023
	TI	TF4023
	TI	TP4023
	Toshiba	TC4023
CD4024	see page 375	
	Fairchild	F4024
	Harris	HD4024
	Motorola	MC14024
	National	CD4024
	SGS	HBF4024
	SSS	SCL4024
	Solitron	CM4024
	SW	SW4024
	TI	TF4024
	TI	TP4024
	Toshiba	TC4024
CD4025	see page 375	
	Fairchild	F4025
	Harris	HD4025
	Motorola	MC14025
	National	CD4025
	SGS	HBF4025
	SSS	SCL4025
	Solitron	CM4025
	SW	SW4025
	TI	TF4025
	TI	TP4025
	Toshiba	TC4025
CD4026	see page 375	
	SSS	SCL4026
	Solitron	CM4026
CD4027	see page 375	
	Fairchild	F4027
	Harris	HD4027
	Motorola	MC14027
	National	CD4027
	SGS	HBF4027
	SSS	SCL4027
	Solitron	CM4027
	SW	SW4027
	TI	TF4027
	TI	TP4027
	Toshiba	TC4027
CD4028	see page 375	
	Fairchild	F4028
	Harris	**HD4028**
	see page 266	
	Motorola	MC14028
	National	CD4028
	SGS	HBF4028
	SSS	SCL4028
	Solitron	CM4028
	SW	SW4028
	TI	TF4028
	TI	TP4028
	Toshiba	TC4028
CD4029	see page 375	
	Fairchild	F4029
	Harris	**HD4029**
	see page 266	
	Motorola	MC14029
	National	CD4029
	SGS	HBF4029
	SSS	SCL4029
	Solitron	CM4029
	SW	SW4029
	TI	TF4029
	TI	TP4029
	Toshiba	TC4029
CD4030	see page 375	
	Fairchild	F4030
	Harris	**HD4030**
	see page 266	
CD4030	Motorola	MC14030
	National	CD4030
	SGS	HBF4030
	SSS	SCL4030
	Solitron	CM4030
	SW	SW4030
	TI	TF4030
	TI	TP4030
	Toshiba	TC4030
CD4031	see page 375	
	Fairchild	F4031
	National	CD4031
CD4032	see page 375	
	Motorola	MC14032
	Solitron	CM4032
	Toshiba	TC4032
CD4033	see page 375	
	SGS	HBF4033
	SSS	SCL4033
	Solitron	CM4033
CD4034	see page 375	
	Fairchild	F4034
	Motorola	MC14034
	SSS	SCL4034
	Solitron	CM4034
	Toshiba	TC4034
CD4035	see page 375	
	Fairchild	F4035
	Harris	**HD4035**
	see page 266	
	Motorola	MC14035
	National	CD4035
	SGS	HBF4035
	SSS	SCL4035
	Solitron	CM4035
	TI	TF4035
	TI	TP4035
	Toshiba	TC4035
CD4036	see page 375	
	Solitron	CM4036
CD4037	see page 375	
	Solitron	CM4037
CD4038	see page 375	
	Motorola	MC14038
	Solitron	CM4038
	Toshiba	TC4038
CD4039	see page 375	
	Solitron	CM4039
CD4040	see page 375	
	Fairchild	F4040
	Harris	HD4040
	Motorola	MC14040
	National	CD4040
	SSS	SCL4040
	Solitron	CM4040
	TI	TF4040
	TI	TP4040
	Toshiba	TC4040
CD4041	see page 375	
	Fairchild	F4041
	SSS	SCL4041
	Solitron	CM4041
CD4042	see page 375	
	Fairchild	F4042
	Harris	HD4042
	Motorola	MC14042
	National	CD4042
	SGS	HBF4042
	SSS	SCL4042
	Solitron	CM4042
	TI	TF4042
	TI	TP4042
	Toshiba	TC4042
CD4043	see page 375	
	Fairchild	F4043
	Harris	HD4043
	Motorola	MC14043
	National	CD4043
	SSS	SCL4043
	Solitron	CM4043
	TI	TF4043

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

RCA Solid State Division (cont)

Manufacturer Device	Replacement Source	Device
CD4043	TI	TP4043
	Toshiba	TC4043
CD4044	see page 375	
	Fairchild	F4044
	Harris	HD4044
	Motorola	MC14044
	National	CD4044
	SSS	SCL4044
	Solitron	CM4044
	TI	TF4044
	TI	TP4044
	Toshiba	TC4044
CD4045	see page 375	
	SGS	HBF4045
	SSS	SCL4445
	Solitron	CM4045
CD4046	see page 375	
	Fairchild	F4046
	Motorola	MC14046
	Solitron	CM4046
CD4047	see page 375	
	Fairchild	F4047
	Solitron	CM4047
	Toshiba	TC4047
CD4048	see page 375	
	National	CD4048
	Solitron	CM4048
CD4049	see page 375	
	Fairchild	F4049
	GI	MEM4049
	Harris	HD4049
	Motorola	MC14049
	National	CD4049
	SGS	HBF4049
	SSS	SCL4049
	Solitron	CM4049
	SW	SW4049
	Teledyne S	CD4049
	TI	TF4049
	TI	TP4049
	Toshiba	TC4049
CD4050	see page 375	
	Fairchild	F4050
	GI	MEM4050
	Harris	HD4050
	Motorola	MC14050
	National	CD4050
	SGS	HBF4050
	SSS	SCL4050
	Solitron	CM4050
	SW	SW4050
	Teledyne S	CD4050
	TI	TF4050
	TI	TP4050
	Toshiba	TC4050
CD4051	see page 375	
	Fairchild	F4051
	National	CD4051
	SSS	SCL4051
	Solitron	CM4051
	TI	TF4051
	TI	TP4051
CD4052	see page 375	
	Fairchild	F4052
	National	CD4052
	SSS	SCL4052
	Solitron	CM4052
	TI	TF4052
	TI	TP4052
CD4053	see page 375	
	Fairchild	F4053
	GI	MEM4053
	National	CD4053
	SSS	SCL4053
	Solitron	CM4053
	TI	TF4053
	TI	TP4053
CD4060	see page 375	
	SSS	SCL4060
CD4061	see page 375	
	Toshiba	TC4061
CD4066	see page 375	
	Fairchild	F4066
	Harris	HD4066
	National	CD4066
	SGS	HBF4066
	SSS	SCL4066
	Solitron	CM4066
	Solitron	CM4116
	Teledyne S	CD4066
CD4067	see page 375	
	Fairchild	F4067
CD4068	see page 375	
	Fairchild	F4068
	Motorola	MC14068
	Toshiba	TC4068
CD4069	see page 375	
	Fairchild	F4069
	Harris	MM54C04
	Harris	MM74C04
	Motorola	MC14069
	National	CD4069
	National	MM54C04
	National	MM74C04
	Teledyne S	MM54C04
	Teledyne S	MM74C04
	Toshiba	TC4069
CD4070	see page 375	
	Fairchild	F4070
	National	CD4070
	National	MM74C86
	Solitron	CM4030
CD4071	see page 375	
	Fairchild	F4071
	Motorola	MC14071
	SSS	SCL4071
	TI	TF4071
	TI	TP4071
	Toshiba	TC4071
CD4072	see page 375	
	Fairchild	F4072
	Toshiba	TC4072
CD4073	see page 375	
	Fairchild	F4073
	Motorola	MC14073
	Toshiba	TC4073
CD4075	see page 375	
	Fairchild	F4075
	Motorola	MC14075
	Toshiba	TC4075
CD4076	see page 375	
	Fairchild	F4076
	Harris	MM54C173
	Harris	MM74C173
	Motorola	MC14076
	National	CD4076
	National	MM54C173
	National	MM74C173
	Teledyne S	MM54C173
	Teledyne S	MM74C173
CD4077	see page 375	
	Fairchild	F4078
	Solitron	CM4077
CD4078	see page 375	
	Fairchild	F4078
	Motorola	MC14078
	Toshiba	TC4078
CD4081	see page 375	
	Fairchild	F4081
	Motorola	MC14081
	SSS	SCL4081
	TI	TF4081
	TI	TP4081
	Toshiba	TC4081
CD4082	see page 375	
	Fairchild	F4082
	Toshiba	TC4082
CD4085	see page 375	
	Fairchild	F4085
CD4086	see page 375	
	Fairchild	F4086
CD4508	see page 375	
	Motorola	MC14508
CD4508	Solitron	CM4508
	Toshiba	TC4508
CD4510	see page 375	
	National	MM14510
CD4511	see page 375	
	Fairchild	F4511
	Motorola	MC14511
	National	MM14511
	SSS	SCL4511
	Solitron	CM4511
CD4514	see page 375	
	Fairchild	F4514
	Motorola	MC14514
	SSS	SCL4514
	Solitron	CM4514
	Toshiba	TC4514
CD4515	see page 375	
	Fairchild	F4515
	Motorola	MC14515
	Solitron	CM4515
	Toshiba	TC4515
CD4516	see page 375	
	Fairchild	F4516
	Harris	HD4516
	Motorola	MC14516
	National	CD4516
CD4518	see page 375	
	Fairchild	F4518
	Harris	HD4518
	Motorola	MC14518
	National	CD4518
	SSS	SCL4518
	TI	TF4518
	TI	TP4518
	Toshiba	TC4518
CD4520	see page 375	
	Fairchild	F4520
	Harris	HD4520
	Motorola	MC14520
	National	CD4520
	SSS	SCL4520
	TI	TF4520
	TI	TP4520
	Toshiba	TC4520
CD4527	see page 375	
	Motorola	MC14527
CD4532	see page 375	
	Fairchild	F4532
	Motorola	MC14532
	Toshiba	TC4532
CD4555	see page 375	
	Fairchild	F4555
	Motorola	MC14555
CD4556	see page 375	
	Fairchild	F4556
	Motorola	MC14556

Rockwell Microelectronic Div.

Manufacturer Device	Replacement Source	Device
1103	**AMI**	**S1103A**
	see page 712	
1604	AMI	4096
	EA	EA4096
	Mostek	4096

SGS-ATES Semiconductor

Manufacturer Device	Replacement Source	Device
HBF4001	**RCA**	**CD4001**
	see page 375	
	SSS	SCL4001
HBF4002	**RCA**	**CD4002**
	see page 375	
	SSS	SCL4002
HBF4008	**RCA**	**CD4002**
	see page 375	
	SSS	SCL4008
HBF4009	**RCA**	**CD4009**
	see page 375	
	SSS	SCL4009
HBF4010	**RCA**	**CD4010**
	see page 375	
HBF4010	SSS	SCL4010
HBF4011	**RCA**	**CD4011**
	see page 375	
	SSS	SCL4011
HBF4012	**RCA**	**CD4012**
	see page 375	
	SSS	SCL4012
HBF4016	**RCA**	**CD4016**
	see page 375	
	SSS	SCL4016
HBF4020	**RCA**	**CD4020**
	see page 375	
	SSS	SCL4020
HBF4022	SSS	SCL4022
HBF4023	**RCA**	**CD4023**
	see page 375	
	SSS	SCL4023
HBF4024	**RCA**	**CD4024**
	see page 375	
	SSS	SCL4024
HBF4025	**RCA**	**CD4025**
	see page 375	
	SSS	SCL4025
HBF4027	**RCA**	**CD4027**
	see page 375	
	SSS	SCL4027
HBF4029	**RCA**	**CD4029**
	see page 375	
	SSS	SCL4029
HBF4035	**RCA**	**CD4035**
	see page 375	
	SSS	SCL4035
HBF4040	**RCA**	**CD4040**
	see page 375	
	SSS	SCL4040

Signetics

Manufacturer Device	Replacement Source	Device
µA709	Fairchild	µA709
	Fairchild	709
	Motorola	MC1709
	National	LM709
	Raytheon	RM709
	Teledyne S	709
	TI	SN52709
µA710	Fairchild	µA710
	Motorola	MC1710
	National	LM710
	Raytheon	RM710
	Silicon G	SG710
	Teledyne S	710
	TI	SN52710
µA711	Fairchild	µA711
	Motorola	MC1711
	National	LM711
	Raytheon	RM711
	Silicon G	SG711
	Teledyne S	711
	TI	SN52711
µA723	Fairchild	µA723
	Intersil	723
	Motorola	MC1723
	National	LM723
	Raytheon	RM723
	RCA	CA723
	Silicon G	SG723
	Teledyne S	723
	TI	SN52723
µA733	AMD	733
	National	LM733
	Raytheon	RM733
	Silicon G	SG733
	TI	SN52733
µA740	Fairchild	µA740
	Intersil	740
	National	LH740
µA741	AMD	741
	AD	**AD741**
	see page 625	
	Fairchild	µA741

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Signetics (cont)

Manufacturer Device	Replacement Source	Replacement Device
μA741	Intersil	741
	Motorola	MC1741
	National	LM741
	PMI	SSS741
	Raytheon	RM741
	RCA	**CA741**
	see page **661**	
	Silicon G	SG741
	Teledyne S	741
	TI	SN52741
μA747	AMD	747
	Fairchild	μA747
	Motorola	MC1747
	National	LM747
	PMI	SSS747
	Raytheon	RM747
	RCA	**CA747**
	see page **661**	
	Silicon G	SG747
	Teledyne S	747
	TI	SN52747
μA748	AMD	748
	Fairchild	μA748
	Intersil	748
	Motorola	MC1748
	National	LM748
	Raytheon	RM748
	RCA	CA748
	Silicon G	SG748
	Teledyne S	748
	TI	SN52748
DM8880	National	DS8880
LM101	AMD	LM101
	Fairchild	μA101
	Intersil	LM101
	Raytheon	LM101
	RCA	**CA101**
	see page **661**	
	Silicon G	SG101
	Siliconix	LM101
	Teledyne S	LM101
	TI	SN52101
LM107	AMD	LM107
	Fairchild	μA107
	Intersil	LM107
	Raytheon	LM107
	RCA	**CA107**
	see page **661**	
	Silicon G	SG107
	Teledyne S	LM107
	TI	SN52107
LM108	AMD	LM108
	Fairchild	μA108
	Raytheon	LM108
	RCA	CA108
	Silicon G	SG108
LM109	Fairchild	μA109
	TI	SN52109
LM124	Teledyne S	LM124
LM201	AMD	LM201
	Fairchild	μA201
	Intersil	LM201
	Raytheon	LM201
	RCA	**CA201**
	see page **661**	
	Teledyne S	LM201
LM207	AMD	LM207
	Fairchild	μA207
	Intersil	LM207
	Raytheon	LM207
	RCA	**CA207**
	see page **661**	
	Teledyne S	LM207
LM209	Fairchild	LM209
	Raytheon	LM209
LM211	Teledyne S	LM211
LM224	Teledyne S	LM224
LM301	AMD	LM301
	Fairchild	μA301
	Intersil	LM301
	National	LM301
LM301	Raytheon	LM301
	RCA	**CA301**
	see page **661**	
	Silicon G	SG301
	Teledyne S	LM301
	TI	SN72301
LM307	AMD	LM307
	Fairchild	μA307
	Intersil	LM307
	National	LM307
	Raytheon	LM307
	RCA	**CA307**
	see page **661**	
	Silicon G	SG307
	Teledyne S	LM307
LM308	AMD	LM308
	Fairchild	μA308
	National	LM308
	Raytheon	LM308
	RCA	CA308
	Silicon G	SG308
	Teledyne S	LM308
LM309	Fairchild	μA309
	Raytheon	LM309
	TI	SN72309
LM311	AMD	LM311
	Harris	HA-2311
	Raytheon	LM311
	Teledyne S	LM311
	TI	SN72311
LM324	Teledyne S	LM324
NE529	National	LM361
NE536	Intersil	NE536
NE555	AMD	NE555
	Exar	XR555C
	Intersil	NE555
	Lithic Sys	LS555
	Raytheon	RC555
	RCA	**CA555**
	see page **661**	
	Silicon G	SG555
	Teledyne S	555
	TI	SN72555
NE556	AMD	NE556
	Exar	XR-556
	Raytheon	RC556
	Teledyne S	556
NE567	Exar	XR567
¶ N1004	Motorola	MC1004
¶ N1005	Motorola	MC1005
¶ N1006	Motorola	MC1006
¶ N1010	Motorola	MC1010
¶ N1011	Motorola	MC1011
¶ N1012	Motorola	MC1012
¶ N1013	Motorola	MC1013
¶ N1014	Motorola	MC1014
¶ N1015	Motorola	MC1015
¶ N1016	Motorola	MC1016
¶ N1017	Motorola	MC1017
¶ N1024	Motorola	MC1024
¶ N1025	Motorola	MC1025
¶ N1027	Motorola	MC1027
¶ N1033	Motorola	MC1033
¶ N1039	Motorola	MC1039
¶ N2010	Motorola	MC1160/236
N2430	Nitron	NCM1110
N2461	Nitron	NCM1111
N3002	see page **1006**	
	Intel	3002
N5065	Sprague	ULN-2165
N5070	Motorola	MC1370
	Sprague	ULN-2124
N5071	Motorola	MC1371
	Sprague	ULN-2127
N5072	Motorola	MC1328
	Sprague	ULN-2114
N5111	Motorola	MC1358
	Sprague	ULN-2111
N5556	Motorola	MC1456
	Raytheon	RC1556
	Silicon G	SG1456
N5558	Fairchild	MC1458
	Motorola	MC1458
	National	LM1458
	Raytheon	RC1458
	RCA	CA1458
	Silicon G	SG1458
	Teledyne S	1458
N5595	Motorola	MC1495
N5596	Lithic Sys	LS1496
	Motorola	MC1496
	National	LM1496
	Silicon G	SG1496
N74H00	Fairchild	74H00
	Fairchild	9H00
	Raytheon	74H00
	TI	SN74H00
N74H01	Raytheon	74H01
	TI	SN74H01
N74H04	Raytheon	74H04
	TI	SN74H04
N74H05	Raytheon	74H05
	TI	SN74H05
N74H10	Raytheon	74H10
	TI	SN74H10
N74H11	Raytheon	74H11
	TI	SN74H11
N74H20	Raytheon	74H20
	TI	SN74H20
N74H22	Raytheon	74H22
	TI	SN74H22
N74H40	Raytheon	74H40
	TI	SN74H40
N74H74	Raytheon	74H74
N74LS138	see page **384**	
	Raytheon	74LS138
N74LS139	see page **384**	
	Raytheon	74LS139
N74LS253	see page **384**	
	Raytheon	74LS253
N74S00	Fairchild	74S00
	Fairchild	9S00
	TI	SN74S00
N74S200	National	DM74S200
N74S201	see page **804, 806, 815,**	
	MMI	6531
	TI	SN74S201
N7400	Fairchild	7400
	Fairchild	9N00
	Hitachi	HD2503
	Raytheon	7400
	TI	SN7400
N7401	Hitachi	HD2509
	Raytheon	7401
	TI	SN7401
N7402	Hitachi	HD2511
	TI	SN7402
N7403	Hitachi	HD2528
	Raytheon	7403
	TI	SN7403
N7404	Hitachi	HD2522
	Raytheon	7404
	TI	SN7404
N7405	Hitachi	HD2523
	Raytheon	7405
	TI	SN7405
N7408	Hitachi	HD2550
	Raytheon	7408
	TI	SN7408
N7409	Raytheon	7409
N7410	Hitachi	HD2507
	Raytheon	7410
	TI	SN7410
N74107	Hitachi	HD2530
	TI	SN74107
N7411	Raytheon	7411
N7412	Raytheon	7412
N74123	Raytheon	74123
N74136	Raytheon	74136
N74145	Raytheon	74145
N7415	Raytheon	7415
N74150	Raytheon	74150
N74151	Raytheon	74151
N74152	Raytheon	74152
N74153	Raytheon	74153
N74154	Raytheon	74154
N74155	Raytheon	74155
N74156	Raytheon	74156
N74157	Raytheon	74157
N74158	Raytheon	74158
N74159	Raytheon	74159
N74160	Raytheon	74160
N74161	Raytheon	74161
N74162	Raytheon	74162
N74163	Raytheon	74163
N74164	Raytheon	74164
N74165	Raytheon	74165
N74166	Raytheon	74166
N74170	Raytheon	74170
N74174	Raytheon	74174
N74175	Raytheon	74175
N74181	Raytheon	74181
N74182	Raytheon	74182
N74190	Raytheon	74190
N74191	Raytheon	74191
N74192	Raytheon	74192
N74193	Raytheon	74193
N74194	Raytheon	74194
N74195	Raytheon	74195
N74198	Raytheon	74198
N74199	Raytheon	74199
N7420	Hitachi	HD2504
	TI	SN7420
N7421	Raytheon	7421
N7422	Raytheon	7422
N74283	Raytheon	74283
N7430	Hitachi	HD2508
	TI	SN7430
N7440	Hitachi	HD2501
	TI	SN7440
N7441	Hitachi	HD2518
	TI	SN74141
N7442	Raytheon	7442
N7443	Raytheon	7443
N7444	Raytheon	7444
N7445	Raytheon	7445
N7451	Hitachi	HD2505
	TI	SN7451
N7453	Hitachi	HD2512
	TI	SN7453
N7454	Hitachi	HD2514
	TI	SN7454
N7460	Hitachi	HD2502
	TI	SN7460
N7470	Hitachi	HD2539
	TI	SN7470
N7472	Hitachi	HD2529
	TI	SN7472
N7473	Hitachi	HD2515
	TI	SN7473
N7474	Hitachi	HD2510
	Raytheon	7474
	TI	SN7474
N7475	Hitachi	HD2517
	TI	SN7475
N7476	Hitachi	HD2516
	TI	SN7476
N7481	Raytheon	7481
N7483	Raytheon	7483
N7486	Raytheon	7486
N7488	Intersil	IM5600
	TI	SN7488A
N7489	Hitachi	HD2502
	Intersil	IM5501
	Raytheon	7489
	TI	SN7489
N7490	Hitachi	HD2519
	TI	SN7490A
N7491	Hitachi	HD2524
	TI	SN7491A
N7492	Hitachi	HD2521
	TI	SN7492A
N7493	Hitachi	HD2520

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

Signetics (cont)

Manufacturer Device	Replacement Source	Replacement Device
N7493	TI	SN7493A
N7494	Hitachi	HD2533
	TI	SN7494
N7495	Hitachi	HD2534
	TI	SN7495A
N7496	Hitachi	HD2546
	TI	SN7496
N7520	ITT	ITT7520
	Motorola	MC7520
	National	DS7520
	Silicon G	SG7520
N7521	ITT	ITT7521
	Motorola	MC7521
	National	DS7521
	Silicon G	SG7521
N7522	ITT	ITT7522
	Motorola	MC7522
	National	DS7522
	Silicon G	SG7522
N7523	ITT	ITT7523
	Motorola	MC7523
	National	DS7523
	Silicon G	SG7523
N7524	ITT	ITT7524
	Motorola	MC7524
	National	DS7524
	Silicon G	SG7524
N7525	ITT	ITT7525
	Motorola	MC7525
	National	DS7525
	Silicon G	SG7525
N7550	Hitachi	HD2506
N8H70	ITT	ITT74H11
	TI	SN74H11
N8H80	ITT	ITT74H00
	TI	SN74H00
N8H90	ITT	ITT74H04
	TI	SN74H04
N8T09	Raytheon	RC8T09
N8T10	National	DM8551
	Raytheon	RC8T10
	TI	SN74173
N8T13	Fairchild	8T13
	National	DS75121
	Raytheon	RC8T13
N8T14	Fairchild	8T14
	National	DS75122
	Raytheon	RC8T14
N8T22	ITT	ITT74122
	Raytheon	RC8T22
	Raytheon	RF8601
	TI	SN74122
N8T23	Fairchild	8T23
	National	DS75123
	Raytheon	RC8T23
	TI	SN75123
N8T24	Fairchild	8T24
	National	DS75124
	Raytheon	RC8T24
	TI	SN75124
N8T25	National	DS3625
N8T380	National	DS8836
N8T74	Fairchild	9374
	National	DS8674
N82S06	Intersil	IM5523
	MMI	6531
	TI	SN74S201
	TI	SN74S301
N82S07	Fairchild	93411
	Intersil	IM5533
	MMI	6530
	TI	SN74S301
N82S08	Fairchild	93415
	Fairchild	93421
N82S09	see page 804, 806, 817,	
	MMI	6555
N82S10	see page 804, 806, 818,	
	Fairchild	93415
	TI	SN74S309
N82S11	see page 804, 806, 818,	
	Fairchild	93425
N82S110	TI	SN74S309
N82S111	TI	SN74S209
N82S116	see page 804, 806, 815,	
	MMI	6531
	TI	SN74S201
N82S123	see page 804, 826, 828,	
	Harris	HM7603
	see page 746	
	Intersil	IM5610
	MMI	6331
	National	DM8598
	TI	SN74S288
	TI	54S288
N82S124	Intersil	IM5610
	TI	SN74S387
N82S126	see page 804, 826, 835,	
	Harris	HPROM-1024A
	Intel	3601
	see page 772, 773	
	MMI	5300
	MMI	6300
	National	DM7573
	National	DM8573
	TI	SN54S387
	TI	SN74S387
N82S129	Harris	HPROM-1024
	Intel	3621-1
	see page 772, 773	
	Intersil	IM5603
	MMI	5301
	MMI	6301
	National	DM7574
	National	DM8574
	TI	SN54S287
	TI	SN74S287
N82S130	see page 804, 826, 838,	
	Fairchild	93436
N82S131	see page 804, 826, 838,	
	Fairchild	93446
N82S16	see page 804, 806, 815,	
	Fairchild	93421
	Intersil	IM5523
	MMI	6531
	TI	SN54S201
	TI	SN74S201
N82S17	see page 804, 806, 815,	
	Fairchild	93411
	Intersil	IM5533
	MMI	6530
	TI	SN54S301
	TI	SN74S301
N82S226	Fairchild	93416
	Intersil	IM5603
	MMI	6300
	National	DM8573
	TI	SN54187
	TI	SN74187
N82S23	see page 804, 826, 828,	
	AMD	AM27S09
	Harris	HM7602
	see page 746	
	MMI	6330
	TI	SN54S188
	TI	SN74S188
N82S230	TI	SN54S270
	TI	SN74S270
N82S231	TI	SN54S370
	TI	SN74S370
N82S24	Intersil	IM5600
	TI	SN54S301
	TI	SN74A301
	TI	SN74S188
N82S26	Fairchild	93416
	Intersil	IM5603
	MMI	6300
	National	DM8573
	TI	SN74S387
N82S27	see page 804, 826, 832,	
	Intel	3611
N82S29	Fairchild	93426
	Intersil	IM5623
N82S29	MMI	6301
	National	DM8574
	TI	SN54S287
	TI	SN74S287
N8200	Raytheon	RC8200
N8201	Raytheon	RC8201
N8202	Raytheon	RC8202
N8203	Raytheon	RC8203
N8206	TI	SN74S201
N8207	TI	SN74S301
N8223	Harris	HPROM-8256
	Intersil	IM5600
	MMI	6330
	National	DM8577
	TI	SN74S188
N8224	Fairchild	93434
	Intersil	IM5600
	ITT	ITT7488A
	National	DM7488
	TI	SN7488
N8225	AMD	3101
	Intersil	IM5501
	MMI	6560
	Motorola	MCM4064
	Raytheon	RC8225
	TI	SN74S289
N8230	Hitachi	HD2549
	ITT	ITT9312
	Motorola	MC7230
	Raytheon	RC8230
	TI	SN29312
N8231	Motorola	MC7230
	Raytheon	RC8231
N8232	Motorola	MC7230
	Raytheon	RC8232
N8233	Motorola	MC8233
	Raytheon	RC8233
N8234	Motorola	MC8234
	Raytheon	RC8234
N8241	Hitachi	HD2526
	Motorola	MC7241/42
	Raytheon	RC8241
N8242	Motorola	MC7241/42
	Raytheon	RC8242
	TI	SN74LS266
N8250	Motorola	MC7250/51
	Raytheon	RC8250
N82506	Raytheon	RC5340
N82507	Raytheon	RC5330
N8251	Hitachi	HD2536
	Motorola	MC7250/51
	Raytheon	RC8251
N82516	Raytheon	RC5340
N82517	Raytheon	RC5330
N8252	Motorola	MC7250/51
	Raytheon	RC8252
	TI	SN29301
N8260	Motorola	MC7260
	Raytheon	RC8260
N8261	Hitachi	HD2562
	Motorola	MC7261
	Raytheon	RC8261
N8262	Raytheon	RC8262
N8263	Raytheon	RC8263
N8264	Raytheon	RC8264
N8266	Motorola	MC7266/67
	Raytheon	RC8266
N8267	Motorola	MC7266/67
	Raytheon	RC8267
N8268	ITT	ITT7480
	Motorola	MC7268
	TI	SN7480
N8269	National	DM8200
N8270	Motorola	MC7270/71
	Raytheon	RC8270
	TI	SN74178
N8271	Motorola	MC7270/71
	Raytheon	RC8271
	TI	SN74179
N8277	Motorola	MC7277
	Raytheon	RC8277
N8280	Motorola	MC7280
	National	DM8280
	Raytheon	RC8280
	TI	SN74176
N8281	Motorola	MC7281
	National	DM8281
	Raytheon	RC8281
	TI	SN54177
N8284	Motorola	MC7284
	Raytheon	RC8284
N8285	Motorola	MC7285
	Raytheon	RC8285
N8288	Motorola	MC7288
	National	DM8288
N8290	National	DM8290
	Raytheon	RC8290
	TI	SN74196
N8291	National	DM8291
	Raytheon	RC8291
	TI	SN74197
N8292	TI	SN74LS196
N8293	TI	SN74LS197
N8455	Motorola	MC7440
	TI	SN7440
N8470	ITT	ITT7410
	Motorola	MC7410
	TI	SN7410
N8471	ITT	ITT7412
	Motorola	MC7412
	TI	SN7412
N8480	ITT	ITT400
	TI	SN7400
N8481	ITT	ITT7403
	Motorola	MC7403
	TI	SN7403
N8490	ITT	ITT7404
	Motorola	MC7404
	TI	SN7404
N8555	ITT	ITT440
N8806	ITT	ITT7460
	Motorola	MC7460
	TI	SN7460
N8808	ITT	ITT7430
	Motorola	MC7430
	TI	SN7430
N8815	TI	SN7425
N8824	Motorola	MC7474
	TI	SN7474
N8825	Motorola	MC7470
	TI	SN7470
N8828	ITT	ITT7474
	Motorola	MC7479
	TI	SN7474
N8829	Motorola	MC7472
N8840	ITT	ITT7450
	Motorola	MC7450
	TI	SN7450
N8848	ITT	ITT74H74
	Motorola	MC7453
	TI	SN74H53
N8875	Motorola	MC7427
	TI	SN7427
N8881	ITT	ITT7401
	Motorola	MC7401
	TI	SN7401
N8890	ITT	ITT7404
	TI	SN7404
N8891	ITT	ITT7405
	TI	SN7405
SE529	National	LM161
SE531	Raytheon	RM4531
SE550	National	LM550
SE555	AMD	SE555
	Exar	XR555M
	Intersil	SE555
	Lithic Sys	LS555
	National	LM555
	Raytheon	RM555
	Silicon G	SG555
	Teledyne S	555
	TI	SN52555

‡ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Signetics (cont)

Manufacturer Device	Replacement Source	Replacement Device
SE556	Raytheon	RM556
SE565	National	LM565
SE566	National	LM566
SE567	National	LM567
SN75107	AMD	SN75107B
	National	DS75107
	Raytheon	RC75107A
	TI	SN75107
SN75108	AMD	SN75108B
	National	DS75108
	Raytheon	RC75108A
	TI	SN75108
SN7520	National	DS7520
	TI	SN7520
SN7521	National	DS7521
	TI	SN7521
SN7522	National	DS7522
	TI	SN7522
SN7523	National	DS7523
	TI	SN7523
SN7524	Fairchild	7524
	National	DS7524
	TI	SN7524
SN7525	Fairchild	7525
	National	DS7525
	TI	SN7525
SN75450	Fairchild	75450
	National	DS75450
	Raytheon	RC75450
	TI	SN75450
SN75451	Fairchild	75451
	National	DS75451
	Raytheon	RC75451
	TI	SN75451
SU536	Intersil	SU536
S54H00	Fairchild	54H00
	Fairchild	9H00
	TI	SN54H00
S54LS138	**see page 384**	
	Raytheon	**54LS138**
	see page 282	
S54LS139	**see page 384**	
	Raytheon	**54LS139**
	see page 282	
S54LS253	**see page 384**	
	Raytheon	**54LS253**
	see page 282	
S54S00	Fairchild	54S00
	Fairchild	9S00
	TI	SN54S00
S5400	Fairchild	5400
	Fairchild	9N00
	TI	SN5400
S5556	Motorola	MC1556
	Raytheon	RM1556
	Raytheon	RM1556A
	Silicon G	SG1556
	TI	SN52771
S5558	Motorola	MC1558
	Raytheon	RM1558
	RCA	CA1558
	Silicon G	SG1558
	TI	SN52558
S5596	Lithic Sys	LS1596
	Motorola	MC1596
	Silicon G	SG1596
S7280	National	DM7280
S7281	National	DM7281
S7290	National	DM7290
S7291	National	DM7291
S8H70	TI	SN54H11
S8H80	TI	SN54H00
S8H90	TI	SN54H04
S8T09	Raytheon	RM8T09
S8T10	Raytheon	RM8T10
	TI	SN54173
S8T13	Raytheon	RM8T13
	TI	SN55121
S8T14	Raytheon	RM8T14
	TI	SN55122
S8T22	Fairchild	9601
S8T22	Raytheon	RM8T22
	TI	SN29601
S8T23	Raytheon	RM8T23
S8T24	Raytheon	RM8T24
S82S06	TI	SN54S201
S82S07	TI	SN54S301
S82S123	**see page 804, 826, 828,**	
	Harris	**HM7603**
	see page 746	
	National	DM7578
	TI	SN54S288
S82S126	**see page 804, 826, 835,**	
	Harris	HPROM-1024A
	TI	SN54S385
	TI	SN54S387
S82S129	**see page 804, 826, 835,**	
	Harris	HPROM-1024
	TI	SN54S287
S82S17	TI	SN54S301
S82S23	**see page 804, 826, 828,**	
	Harris	**HM7602**
	see page 746	
	TI	SN54S188
S82S25	TI	SN54S289
S82S26	AMD	82S26
	National	DM7573
	TI	SN54S387
S82S29	National	DM7574
	TI	SN54S287
S82S30	Fairchild	93S12
S82S62	Fairchild	93S62
S8200	Raytheon	RM8200
S8201	Raytheon	RM8201
S8202	Raytheon	RM8202
S8203	Raytheon	RM8203
S8207	TI	SN54S301
S8223	Harris	HPROM-8256
	Intersil	IM5600
	MMI	5330
	National	DM7577
	TI	SN54S188
S8224	Fairchild	93434
	Intersil	IM5600
	National	DM5488
	TI	SN5488A
S8225	Fairchild	93403
	TI	SN54S289
S8230	Fairchild	9312
	Raytheon	RM8230
	TI	SN39312
S8231	Fairchild	9313
	Raytheon	RM8231
S8241	Raytheon	RM8241
S8242	Fairchild	9386
	Raytheon	RM8242
	TI	SN54LS266
S8250	Raytheon	RM8250
S82506	Raytheon	RM5340
S82507	Raytheon	RM5330
S8251	Raytheon	RM8251
S8252	Fairchild	9301
	Raytheon	RM8252
	TI	SN39301
S8260	Raytheon	RM8260
S8261	Raytheon	RM8261
S8262	Raytheon	RM8262
S8263	Raytheon	RM8263
S8264	Raytheon	RM8264
S8266	Raytheon	RM8266
S8267	Raytheon	RM8267
S8268	TI	SN5480
S8269	National	DM7200
S8270	Fairchild	93178
	Raytheon	RM8270
	TI	SN54178
S8271	Fairchild	93179
	Raytheon	RM8271
	TI	SN54179
S8277	Fairchild	9328
	Raytheon	RM8277
S8280	Fairchild	93176
S8280	Raytheon	RM8280
	TI	SN54176
S8281	Fairchild	93177
	Raytheon	RM8281
	TI	SN54177
S8288	National	DM7288
S8290	Fairchild	93196
	Raytheon	RM8290
	TI	SN54196
S8291	Fairchild	93197
	Raytheon	RM8291
	TI	SN54197
S8292	TI	SN54LS196
S8293	TI	SN54LS197
S8455	TI	SN5440
S8470	TI	SN5410
S8471	TI	SN5412
S8480	TI	SN5400
S8481	TI	SN5403
S8490	TI	SN5404
S8806	TI	SN5460
S8808	TI	SN5430
S8815	TI	SN5425
S8828	TI	SN5474
S8840	TI	SN5450
S8848	TI	SN54H53
S8875	TI	SN5427
S8881	TI	SN5401
S8890	TI	SN5404
S8891	TI	SN5405
S93410	Fairchild	93410
	TI	SN54S301
	TI	SN74S301
10101	Motorola	MC10101
10102	Motorola	MC10102
10105	Motorola	MC10105
10106	Motorola	MC10106
10107	Motorola	MC10107
10109	Motorola	MC10109
10110	Motorola	MC10110
10111	Motorola	MC10111
10115	Motorola	MC10115
10116	Motorola	MC10116
10117	Motorola	MC10117
10118	Motorola	MC10118
10119	Motorola	MC10119
10121	Motorola	MC10121
10124	Motorola	MC10124
10125	Motorola	MC10125
10130	Motorola	MC10130
10131	Motorola	MC10131
10132	Motorola	MC10132
10133	Motorola	MC10133
10134	Motorola	MC10134
10136	Motorola	MC10136
10137	Motorola	MC10137
10140	Motorola	MC10140
10141	Motorola	MC10141
10144	Fairchild	F10410
10145	Motorola	MCM10145
¶ 10149	Motorola	MC10149
10160	Motorola	MC10160
10161	Motorola	MC10161
10162	Motorola	MC10162
10164	Motorola	MC10164
10171	Motorola	MC10171
10172	Motorola	MC10172
10173	Motorola	MC10173
10174	Motorola	MC10174
10175	Motorola	MC10175
10176	Motorola	MC10176
10181	Motorola	MC10181
10210	Motorola	MC10210
10211	Motorola	MC10211
10212	Motorola	MC10212
1103	**AMI**	**S1103**
	see page 707	
2400	AMI	S8773
2441	AMI	S8773
2451	AMI	S8773
2461	AMI	S8773
2462	AMI	S8773
25L01	Intersil	IM7512
	Mostek	MK4007
2501	**AMI**	**S4006**
	see page 706	
	Intersil	IM7501
2502	Synertek	SY1402
2503	AMI	S2503A
	Synertek	SY1403
2504	Synertek	SY1404
2505	AMD	AM2805
	AMI	S2505A
2512	AMD	AM2806
	AMI	S2512A
	Intersil	IM7712
	Nortec	2512
2513	GI	RO3-2513
2518	TI	TMS3122
2521	AMD	AM2521
	AMI	S2181
	TI	TMS3128
2522	AMI	S2181
	TI	TMS3129
2524	AMD	AM2807
	AMI	S1685
2525	AMD	AM2808
	Intersil	IM7722
2526	AMI	S8564
2527	Synertek	SY2527
2532	AMI	S2181
	Intersil	IM7780
	TI	TMS3120
2533	AMD	AM2833
	Synertek	SY2533
	TI	TMS3133
2536	GI	AY5-1013
	TI	TMS6011
2548	Nortec	6003
2602	**see page 790**	
	Intersil	IM7752
	Mostek	MK4102
	TI	TMS4033
	TI	TMS4035
3207	ITT	ITT75361
54LS00	**Raytheon**	**54LS00**
	see page 282	
54LS01	**Raytheon**	**54LS01**
	see page 282	
54LS02	**Raytheon**	**54LS02**
	see page 282	
54LS03	**Raytheon**	**54LS03**
	see page 282	
54LS04	**Raytheon**	**54LS04**
	see page 282	
54LS05	**Raytheon**	**54LS05**
	see page 282	
54LS10	**Raytheon**	**54LS10**
	see page 282	
54LS109	**Raytheon**	**54LS109**
	see page 282	
54LS112	**Raytheon**	**54LS112**
	see page 282	
54LS113	**Raytheon**	**54LS113**
	see page 282	
54LS114	**Raytheon**	**54LS114**
	see page 282	
54LS12	**Raytheon**	**54LS12**
	see page 282	
54LS136	**Raytheon**	**54LS136**
	see page 282	
54LS138	**Raytheon**	**54LS138**
	see page 282	
54LS139	**Raytheon**	**54LS139**
	see page 282	
54LS151	**Raytheon**	**54LS151**
	see page 282	
54LS153	**Raytheon**	**54LS153**
	see page 282	
54LS158	**Raytheon**	**54LS158**
	see page 282	
54LS160	**Raytheon**	**54LS160**
	see page 282	

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Signetics (cont)

Manufacturer Device	Replacement Source	Device
54LS161	Raytheon	**54LS161**
	see page 282	
54LS162	Raytheon	**54LS162**
	see page 282	
54LS163	Raytheon	**54LS163**
	see page 282	
54LS174	Raytheon	**54LS174**
	see page 282	
54LS175	Raytheon	54LS175
54LS181	Raytheon	**54LS181**
	see page 282	
54LS190	Raytheon	**54LS190**
	see page 282	
54LS191	Raytheon	**54LS191**
	see page 282	
54LS192	Raytheon	**54LS192**
	see page 282	
54LS193	Raytheon	**54LS193**
	see page 282	
54LS194A	Raytheon	**54LS194A**
	see page 282	
54LS195A	Raytheon	**54LS195A**
	see page 282	
54LS196	Raytheon	**54LS196**
	see page 282	
54LS197	Raytheon	**54LS197**
	see page 282	
54LS20	Raytheon	**54LS20**
	see page 282	
54LS251	Raytheon	**54LS251**
	see page 282	
54LS253	Raytheon	**54LS253**
	see page 282	
54LS257	Raytheon	**54LS257**
	see page 282	
54LS26	Raytheon	**54LS26**
	see page 282	
54LS28	Raytheon	**54LS28**
	see page 282	
54LS283	Raytheon	**54LS283**
	see page 282	
54LS295A	Raytheon	**54LS295A**
	see page 282	
54LS33	Raytheon	**54LS33**
	see page 282	
54LS37	Raytheon	**54LS37**
	see page 282	
54LS38	Raytheon	**54LS38**
	see page 282	
54LS40	Raytheon	**54LS40**
	see page 282	
54LS54	Raytheon	**54LS54**
	see page 282	
54LS55	Raytheon	**54LS55**
	see page 282	
54LS73	Raytheon	**54LS73**
	see page 282	
54LS75	Raytheon	54LS75
54LS76	Raytheon	**54LS76**
	see page 282	
54LS78	Raytheon	**54LS78**
	see page 282	
54LS83	Raytheon	**54LS83A**
	see page 282	
54LS86	Raytheon	**54LS86**
	see page 282	
54LS95B	Raytheon	**54LS95B**
	see page 282	

Silicon General

Manufacturer Device	Replacement Source	Device
SG101	AMD	LM101
	Intersil	LM101
	National	LM101
	Raytheon	LM101
	RCA	CA748
	Signetics	LM101
	Teledyne S	LM101
SG105	AMD	LM105
	Intersil	LM105
	National	LM105
	Raytheon	LM105
	Teledyne S	LM105
SG107	AMD	LM107
	Intersil	LM107
	National	LM107
	Raytheon	LM107
	RCA	**CA107**
	see page 661	
	Signetics	LM107
	Teledyne S	LM107
SG108	AMD	LM108
	Intersil	LM108
	National	LM108
	Raytheon	LM108
	RCA	CA108
	Signetics	LM108
	Teledyne S	LM108
SG109	National	LM109
	Raytheon	LM109
SG110	AMD	LM110
	Intersil	LM110
	National	LM110
SG111	AMD	LM111
	Harris	HA-2111
	Intersil	LM111
	National	LM111
	Raytheon	LM111
	RCA	**CA111**
	see page 661	
	Teledyne S	LM111
SG1458	Harris	HA-2655
	PMI	SSS1458
	Raytheon	RC1458
	RCA	CA1458
	Teledyne S	1458
SG1488	AMD	MC1488
	Exar	XR1488
	National	DS1488
	Raytheon	RC1488
SG1489	AMD	MC1489
	Exar	XR1489
	National	DS1489
	Raytheon	RC1489
SG1489A	Exar	XR1489A
SG1495	Lithic Sys	LS1495
SG1496	Lithic Sys	LS1496
	Signetics	MC1496
SG1558	Harris	HA-2650
	PMI	SSS1558
	Raytheon	RM1558
	RCA	CA1558
	Teledyne S	1558
SG1595	Lithic Sys	LS1595
SG1596	Lithic Sys	LS1596
	Signetics	MC1496
SG201	AMD	LM201
	Harris	HI201
	Intersil	LM201
	National	LM201
	Raytheon	LM201
	RCA	CA748
	Signetics	LM201
	Teledyne S	748
SG205	AMD	LM205
	Intersil	LM205
	National	LM205
	Raytheon	LM205
	Teledyne S	LM205
SG207	AMD	LM207
	Intersil	LM207
	National	LM207
	Raytheon	LM207
	RCA	**CA207**
	see page 661	
	Teledyne S	LM207
SG208	AMD	LM208
	Intersil	LM208
	National	LM208
	Raytheon	LM208
	RCA	CA208
	Teledyne S	LM208
SG209	National	LM209
SG210	AMD	LM210
	Intersil	LM210
	National	LM210
SG211	AMD	LM211
	Harris	HA-2211
	Intersil	LM211
	National	LM211
	Raytheon	LM211
	RCA	**CA211**
	see page 661	
	Teledyne S	LM211
SG301	AMD	LM301
	National	LM301
	Raytheon	LM301
	RCA	**CA301**
	see page 661	
	Signetics	LM301
	Teledyne S	LM301
SG3018	Lithic Sys	LA3018
SG3026	Lithic Sys	LA3026
SG304	Raytheon	LM304
	Teledyne S	LM304
SG3045	Lithic Sys	LA3046
SG305	AMD	LM305
	National	LM305
	Raytheon	LM305
	Teledyne S	LM305
SG307	AMD	LM307
	National	LM307
	Raytheon	LM307
	RCA	**CA307**
	see page 661	
	Signetics	LM307
	Teledyne S	LM307
SG308	AMD	LM308
	National	LM308
	Raytheon	LM308
	RCA	CA308
	Teledyne S	LM308
SG3086	Lithic Sys	LA3086
SG309	National	LM309
	Raytheon	LM309
SG310	National	LM310
SG311	AMD	LM311
	Harris	HA-2311
	National	LM311
	Raytheon	LM311
	RCA	**CA311**
	see page 661	
	Teledyne S	LM311
SG3821	Lithic Sys	LA3045
SG3822	Lithic Sys	LA3026
SG3886	Lithic Sys	LA3086
SG555	Lithic Sys	LS555
	Raytheon	RC555
	Raytheon	RM555
	RCA	**CA555**
	see page 661	
SG709	National	LM709
	Raytheon	RM709
	Signetics	μA709
	Teledyne S	709
SG710	National	LM710
	Raytheon	RC710
	Raytheon	RM710
	Signetics	μA710
	Teledyne S	710
SG711	National	LM711
	Raytheon	RC711
	Raytheon	RM711
	Signetics	μA711
	Teledyne S	711
SG723	AMD	723
	Intersil	723
	National	LM723
	Raytheon	RC723
	Raytheon	RM723
	RCA	CA723
	Signetics	μA723
	Teledyne S	723
SG733	AMD	733
	Raytheon	RC733
	Raytheon	RM733
	Signetics	μA733
SG741	AMD	741
	National	LM741
	PMI	SSS741
	Raytheon	RC741
	Raytheon	RM741
	RCA	**CA741**
	see page 661	
	Signetics	μA741
	Teledyne S	741
SG747	AMD	747
	National	LM747
	PMI	SSS747
	Raytheon	RC747
	Raytheon	RM747
	RCA	**CA747**
	see page 661	
	Teledyne S	747
SG748	AMD	748
	Raytheon	RC748
	Raytheon	RM748
	RCA	CA748
	Signetics	μA748
	Teledyne S	748
SG748C	Raytheon	RC748
SG7520	National	DS7520
	Raytheon	RC7520
	Signetics	SN7520
SG7521	National	DS7521
	Signetics	SN7521
SG7522	National	DS7522
	Signetics	SN7522
SG7523	National	DS7523
	Signetics	SN7523
SG7524	National	DS7524
	Signetics	SN7524
SG7525	National	DS7525
	Signetics	SN7525

Siliconix

Manufacturer Device	Replacement Source	Device
DG126	**see page 551**	
	Intersil	DG126
	National	AH0126
DG129	**see page 551**	
	Intersil	DG129
	National	AH0129
DG133	**see page 551**	
	Intersil	DG133
	National	AH0133
DG134	**see page 551**	
	Intersil	DG134
	National	AH0134
DG139	**see page 551**	
	Intersil	DG139
	National	AH0139
DG140	**see page 551**	
	Intersil	DG140
	National	AH0140
DG142	**see page 551**	
	Intersil	DG142
	National	AH0142
DG143	**see page 551**	
	Intersil	DG143
	National	AH0143
DG144	**see page 551**	
	Intersil	DG144
	National	AH0144
DG145	**see page 551**	
	Intersil	DG145
	National	AH0145
DG146	**see page 551**	
	Intersil	DG146
	National	AH0146
DG151	**see page 551**	
	Intersil	DF151

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Siliconix (cont)

Manufacturer Device	Replacement Source	Replacement Device
DG151	National	AH0151
DG153	**see page 551**	
	Intersil	DG153
	National	AH0153
DG154	**see page 551**	
	Intersil	DG154
	National	AM0154
DG163	**see page 551**	
	Intersil	DG163
	National	AM0163
DG164	**see page 551**	
	Intersil	DG164
	National	AM0164
DG200	**see page 559, 560**	
	AD	**AD7513**
	see page 546	
DG506	**see page 561, 563, 564,**	
	AD	**AD7506**
	see page 548	
	Harris	HI506
	Intersil	IH5060
DG507	**see page 561, 563, 564,**	
	AD	**AD7507**
	see page 548	
DG509	**see page 561, 563, 564,**	
	Harris	HI509
LM101	**RCA**	**CA101**
	see page 661	
	Teledyne S	LM101

SMC Microsystems Corp.

Manufacturer Device	Replacement Source	Replacement Device
COM2017	**AMI**	**S1883**
	see page 533	
COM2505	GI	AY5-1013
KR2376	GI	AY5-2376
KR3600	GI	AY5-KR3600
SMC2376	GI	AY5-2376

Solid State Scientific

Manufacturer Device	Replacement Source	Replacement Device
SCL4000	Harris	HD4000
	Motorola	MC14000
	RCA	**CD4000**
	see page 375	
SCL4001	Harris	HD4001
	Motorola	MC14001
	National	CD4001
	RCA	**CD4001**
	see page 375	
SCL4002	Harris	HD4002
	Motorola	MC14002
	National	CD4002
	RCA	**CD4002**
	see page 375	
SCL4006	Harris	HD4006
	Motorola	MC14006
	RCA	**CD4006**
	see page 375	
SCL4007	Harris	HD4007
	Motorola	MC14007
	National	CD4007
	RCA	**CD4007**
	see page 375	
SCL4008	Harris	HD4008
	RCA	**CD4008**
	see page 375	
SCL4009	Motorola	MC14009
	National	CD4009
	RCA	**CD4009**
	see page 375	
SCL4010	Motorola	MC14010
	National	CD4010
	RCA	**CD4010**
	see page 375	
SCL4011	Harris	HD4011
	National	CD4011
	RCA	**CD4011**
	see page 375	
SCL4012	Harris	HD4012
SCL4012	Motorola	MC14012
	National	CD4012
	RCA	**CD4012**
	see page 375	
SCL4013	Harris	HD4013
	Motorola	MC14013
	National	CD4013
	RCA	**CD4013**
	see page 375	
SCL4014	**Harris**	**HD4014**
	see page 266	
	Motorola	MC14014
	RCA	**CD4014**
	see page 375	
SCL4015	**Harris**	**HD4015**
	see page 266	
	Motorola	MC14015
	National	CD4015
	RCA	**CD4015**
	see page 375	
SCL4016	Motorola	MC14016
	National	CD4016
	RCA	**CD4016**
	see page 375	
SCL4017	Harris	HD4017
	Motorola	MC14017
	National	CD4017
	RCA	**CD4017**
	see page 375	
SCL4018	**Harris**	**HD4018**
	see page 266	
	National	CD4018
	RCA	**CD4018**
	see page 375	
SCL4019	**Harris**	**HD4019**
	see page 266	
	Motorola	MC14019
	National	CD4019
	RCA	**CD4019**
	see page 375	
SCL4020	**Harris**	**HD4020**
	see page 266	
	Motorola	MC14020
	National	CD4020
	RCA	**CD4020**
	see page 375	
SCL4021	**Harris**	**HD4021**
	see page 266	
	Motorola	MC14021
	National	CD4021
	RCA	**CD4021**
	see page 375	
SCL4022	**Harris**	**HD4022**
	see page 266	
	Motorola	MC14022
	National	CD4022
	RCA	**CD4022**
	see page 375	
SCL4023	Harris	HD4023
	Motorola	MC14023
	National	CD4023
	RCA	**CD4023**
	see page 375	
SCL4024	Harris	HD4024
	Motorola	MC14024
	National	CD4024
	RCA	**CD4024**
	see page 375	
SCL4025	Harris	HD4025
	Motorola	MC14025
	National	CD4025
	RCA	**CD4025**
	see page 375	
SCL4026	**RCA**	**CD4026**
	see page 375	
SCL4027	Harris	HD4027
	Motorola	MC14027
	National	CD4027
	RCA	**CD4027**
	see page 375	
SCL4028	**Harris**	**HD4028**
	see page 266	
SCL4028	National	CD4028
	RCA	**CD4028**
	see page 375	
SCL4029	**Harris**	**HD4029**
	see page 266	
	National	CD4029
	RCA	**CD4029**
	see page 375	
SCL4030	**Harris**	**HD4030**
	see page 266	
	National	CD4030
	RCA	**CD4030**
	see page 375	
SCL4033	**RCA**	**CD4033**
	see page 375	
SCL4034	**RCA**	**CD4034**
	see page 375	
SCL4035	**Harris**	**HD4035**
	see page 266	
	RCA	**CD4035**
	see page 375	
SCL4040	Harris	HD4040
	Motorola	MC14040
	National	CD4040
	RCA	**CD4040**
	see page 375	
SCL4041	**RCA**	**CD4041**
	see page 375	
SCL4042	Harris	HD4042
	National	CD4042
	RCA	**CD4042**
	see page 375	
SCL4043	Harris	HD4043
	National	CD4043
	RCA	**CD4043**
	see page 375	
SCL4044	Harris	HD4044
	National	CD4044
	National	MM4644
	RCA	**CD4044**
	see page 375	
SCL4049	Harris	HD4049
	National	CD4049
	RCA	**CD4049**
	see page 375	
SCL4050	Harris	HD4050
	National	CD4050
	RCA	**CD4050**
	see page 375	
SCL4051	**RCA**	**CD4051**
	see page 375	
SCL4052	**RCA**	**CD4052**
	see page 375	
SCL4053	**RCA**	**CD4053**
	see page 375	
SCL4060	**RCA**	**CD4060**
	see page 375	
SCL4066	Harris	HD4066
	RCA	**CD4066**
	see page 375	
SCL4071	**RCA**	**CD4071**
	see page 375	
SCL4081	**RCA**	**CD4081**
	see page 375	
SCL4502	RCA	CD4502
SCL4510	Harris	HD4510
	National	CD4510
	RCA	**CD4510**
	see page 375	
SCL4511	National	CD4511
	RCA	**CD4511**
	see page 375	
SCL4514	**RCA**	**CD4514**
	see page 375	
SCL4515	**RCA**	**CD4515**
	see page 375	
SCL4516	Harris	HD4516
	National	CD4516
	RCA	**CD4516**
	see page 375	
SCL4518	Harris	HD4518
SCL4518	National	CD4518
	RCA	**CD4518**
	see page 375	
SCL4520	Harris	HD4520
	National	CD4520
	RCA	**CD4520**
	see page 375	
SCL5437	Mostek	MK50040

Solitron Devices

Manufacturer Device	Replacement Source	Replacement Device
CM4000	Harris	HD4000
	Motorola	MC14000
	RCA	**CD4000**
	see page 375	
	SSS	SCL4000
CM4001	Harris	HD4001
	Motorola	MC14001
	National	CD4001
	RCA	**CD4001**
	see page 375	
	SSS	SCL4001
CM4002	Harris	HD4002
	Motorola	MC14002
	National	CD4002
	RCA	**CD4002**
	see page 375	
CM4006	Harris	HD4006
	Motorola	MC14006
	RCA	**CD4006**
	see page 375	
	SSS	SCL4006
CM4007	Harris	HD4007
	Motorola	MC14007
	National	CD4007
	RCA	**CD4007**
	see page 375	
	SSS	SCL4007
CM4008	Harris	HD4008
	Motorola	MC14008
	RCA	**CD4008**
	see page 375	
	SSS	SCL4008
CM4009	Motorola	MC14009
	RCA	**CD4009**
	see page 375	
	SSS	SCL4009
CM4010	Motorola	MC14010
	National	CD4010
	RCA	**CD4010**
	see page 375	
	SSS	SCL4010
CM4011	Harris	HD4011
	Motorola	MC14011
	National	CD4011
	SSS	SCL4011
CM4012	Harris	HD4012
	Motorola	MC14012
	RCA	**CD4012**
	see page 375	
	SSS	SCL4012
CM4013	Harris	HD4013
	Motorola	MC14013
	National	CD4013
	RCA	**CD4013**
	see page 375	
	SSS	SCL4013
CM4014	**Harris**	**HD4014**
	see page 266	
	Motorola	MC14014
	RCA	**CD4014**
	see page 375	
	SSS	SCL4014
CM4015	**Harris**	**HD4015**
	see page 266	
	Motorola	MC14015
	National	CD4015
	RCA	**CD4015**
	see page 375	
	SSS	SCL4015

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Solitron Devices (cont)

Manufacturer Device	Replacement Source	Replacement Device
CM4016	Motorola	MC14015
	National	CD4016
	RCA	CD4016
	see page 375	
	SSS	SCL4016
CM4017	Harris	HD4017
	Motorola	MC14017
	National	CD4017
	RCA	CD4017
	see page 375	
	SSS	SCL4017
CM4018	Harris	HD4018
	see page 266	
	National	CD4018
	RCA	CD4018
	see page 375	
	SSS	SCL4018
CM4019	Harris	HD4019
	see page 266	
	Motorola	MC14519
	National	CD4019
	RCA	CD4019
	see page 375	
	SSS	SCL4019
CM4020	Harris	HD4020
	see page 266	
	Motorola	MC14020
	National	CD4020
	RCA	CD4020
	see page 375	
	SSS	SCL4020
CM4021	Harris	HD4021
	see page 266	
	Motorola	MC14021
	National	CD4021
	RCA	CD4021
	see page 375	
	SSS	SCL4021
CM4022	Harris	HD4022
	see page 266	
	Motorola	MC14022
	National	CD4022
	RCA	CD4022
	see page 375	
	SSS	SCL4022
CM4023	Harris	HD4023
	Motorola	MC14023
	National	CD4023
	RCA	CD4023
	see page 375	
	SSS	SCL4023
CM4024	Harris	HD4024
	Motorola	MC14024
	National	CD4024
	RCA	CD4024
	see page 375	
	SSS	SCL4024
CM4025	Harris	HD4025
	Motorola	MC14025
	National	CD4025
	RCA	CD4025
	see page 375	
	SSS	SCL4025
CM4026	RCA	CD4026
	see page 375	
	SSS	SCL4026
CM4027	Harris	HD4027
	Motorola	MC14027
	National	CD4027
	RCA	CD4027
	see page 375	
	SSS	SCL4027
CM4028	Harris	HD4028
	see page 266	
	Motorola	MC14028
	National	CD4028
	RCA	CD4028
	see page 375	
CM4029	Harris	HD4029
	see page 266	
	National	CD4029
CM4029	RCA	CD4029
	see page 375	
	SSS	SCL4029
CM4030	Harris	HD4030
	see page 266	
	National	CD4030
	RCA	CD4030
	see page 375	
	SSS	SCL4030
CM4032	Motorola	MC14032
	RCA	CD4032
	see page 375	
CM4033	RCA	CD4033
	see page 375	
	SSS	SCL4033
CM4034	RCA	CD4034
	see page 375	
	SSS	SCL4034
CM4035	Harris	HD4035
	see page 266	
	RCA	CD4035
	see page 375	
	SSS	SCL4035
CM4036	RCA	CD4036
	see page 375	
CM4037	RCA	CD4037
	see page 375	
CM4038	Motorola	MC14038
	RCA	CD4038
	see page 375	
CM4039	RCA	CD4039
	see page 375	
CM4040	Harris	HD4040
	Motorola	MC14040
	National	CD4040
	RCA	CD4040
	see page 375	
	SSS	SCL4040
CM4041	RCA	CD4041
	see page 375	
	SSS	SCL4041
CM4042	Harris	HD4042
	Motorola	MC14042
	National	CD4042
	RCA	CD4042
	see page 375	
	SSS	SCL4042
CM4043	Harris	HD4043
	National	CD4043
	RCA	CD4043
	see page 375	
	SSS	SCL4043
CM4044	Harris	HD4044
	National	CD4044
	RCA	CD4044
	see page 375	
	SSS	SCL4044
CM4045	RCA	CD4045
	see page 375	
CM4046	RCA	CD4046
	see page 375	
CM4047	RCA	CD4047
	see page 375	
CM4048	RCA	CD4048
	see page 375	
CM4049	Harris	HD4049
	National	CD4049
	RCA	CD4049
	see page 375	
	SSS	SCL4049
CM4050	Harris	HD4050
	National	CD4050
	RCA	CD4050
	see page 375	
	SSS	SCL4050
CM4051	RCA	CD4051
	see page 375	
	SSS	SCL4051
CM4052	RCA	CD4052
	see page 375	
	SSS	SCL4052
CM4053	RCA	CD4053
	see page 375	
	SSS	SCL4053
CM4066	Harris	HD4066
	RCA	CD4066
	see page 375	
	SSS	SCL4066
CM4510	National	CD4510
CM4511	National	CD4511
	RCA	CD4511
	see page 375	
CM4514	RCA	CD4514
	see page 375	
CM4515	RCA	CD4515
	see page 375	
CM4516	National	CD4516
CM4518	Harris	HD4518
	National	CD4518
	RCA	CD4518
	see page 375	
	SSS	SCL4518
CM4520	Harris	HD4520
	National	CD4520
	RCA	CD4520
	see page 375	
MA2556	Mostek	MK4007
MA2656	Mostek	MK4007
MA3556	Mostek	MK4007
MA3656	Mostek	MK4007
UC4250	Silicon G	SG4250
UC4741	PMI	SSS741
	RCA	CA741
	see page 661	
	Teledyne S	741

Sprague Electric Co.

Manufacturer Device	Replacement Source	Replacement Device
ULN-2111	National	LM2111
	RCA	CA2111
ULN-2114	Fairchild	µA746
	RCA	CA3072
ULN-2120	Fairchild	µA732
ULN-2124	Fairchild	µA780
	RCA	CA3070
ULN-2126	Fairchild	µA739
	Fairchild	739
ULN-2127	Fairchild	µA781
	RCA	CA3071
ULN-2128	Fairchild	µA767
ULN-2131	Fairchild	µA753
ULN-2136	Fairchild	2136
ULN-2165	Fairchild	µA3065
ULN-2210	RCA	CA1310
ULN-2262	RCA	CA3126
ULN-2266	RCA	CA3066
ULN-2298	RCA	CA1398
ULN-2741	National	LM741
	RCA	CA741
	see page 661	
	Teledyne S	741
¶ ULN-2747	RCA	CA747
	see page 661	
	Teledyne S	747
ULN-2778	Fairchild	µA705

Stewart-Warner Microcircuits

Manufacturer Device	Replacement Source	Replacement Device
SW1800	Motorola	MC1800
	TI	SN151800
¶ SW1801	Motorola	MC1801
	TI	SN151801
SW1802	Motorola	MC1802
	TI	SN151802
¶ SW1805	Motorola	MC1805
	TI	SN15805
SW1806	Motorola	MC1806
	TI	SN151806
¶ SW1807	Motorola	MC1807
	TI	SN151807
SW1808	Motorola	MC1808
SW1808	TI	SN151808
SW1810	Motorola	MC1810
	TI	SN151810
SW1812	Motorola	MC1812
	TI	SN151812
SW1814	Motorola	MC1814
SW1900	Motorola	MC1900
	TI	SN151900
¶ SW1901	Motorola	MC1901
	TI	SN151901
SW1902	Motorola	MC1902
	TI	SN151902
¶ SW1905	Motorola	MC1905
	TI	SN151905
SW1906	Motorola	MC1906
	TI	SN151906
¶ SW1907	Motorola	MC1907
	TI	SN151907
SW1908	Motorola	MC1908
	TI	SN151908
SW1910	Motorola	MC1910
	TI	SN151910
SW1912	Motorola	MC1912
	TI	SN151912
SW1914	Motorola	MC1914
¶ SW301	Motorola	MC301
¶ SW302	Motorola	MC302
¶ SW303	Motorola	MC303
¶ SW304	Motorola	MC304
¶ SW305	Motorola	MC305
¶ SW306	Motorola	MC306
¶ SW307	Motorola	MC307
¶ SW308	Motorola	MC308
¶ SW309	Motorola	MC309
¶ SW310	Motorola	MC310
¶ SW311	Motorola	MC311
¶ SW351	Motorola	MC351
¶ SW352	Motorola	MC352
¶ SW353	Motorola	MC353
¶ SW354	Motorola	MC354
¶ SW355	Motorola	MC355
¶ SW356	Motorola	MC356
¶ SW357	Motorola	MC357
¶ SW358	Motorola	MC358
¶ SW359	Motorola	MC359
¶ SW360	Motorola	MC360
¶ SW361	Motorola	MC361
SW705-1	Motorola	MC953
	TI	SN159093
SW705-2	Motorola	MC853
	TI	SN158093
SW706-1	Motorola	MC952
	TI	SN15952
SW706-2	Motorola	MC852
	TI	SN15852
SW708-1	Motorola	MC956
	TI	SN15956
SW708-2	Motorola	MC856
	TI	SN15856
SW709-1	Motorola	MC955
	TI	SN15955
SW709-2	Motorola	MC855
	TI	SN15855
SW930-1	Motorola	MC930
	TI	SN15930
SW930-2	Motorola	MC830
	TI	SN15830
SW932-1	Motorola	MC932
	TI	SN15932
SW932-2	Motorola	MC832
	TI	SN15832
SW933-1	Motorola	MC933
	TI	SN15933
SW933-2	Motorola	MC833
	TI	SN15833
SW935-1	Motorola	MC940
	TI	SN15935
SW935-2	Motorola	MC840
	TI	SN15835
SW936-1	Motorola	MC936
	TI	SN15936

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Stewart-Warner Microcircuits (cont)

Manufacturer Device	Replacement Source	Replacement Device
SW936-2	Motorola	MC836
	TI	SN15836
SW937-1	Motorola	MC937
	TI	SN15937
SW937-2	Motorola	MC837
	TI	SN15837
SW941-1	Motorola	MC941
	TI	SN15941
SW941-2	Motorola	MC841
	TI	SN15841
SW944-1	Motorola	MC944
	TI	SN15944
SW944-2	Motorola	MC844
	TI	SN15844
SW945-1	Motorola	MC945
	TI	SN15945
SW945-2	Motorola	MC845
	TI	SN15845
SW946-1	Motorola	MC946
	TI	SN15946
SW946-2	Motorola	MC846
	TI	SN15846
SW948-1	Motorola	MC948
	TI	SN15948
SW948-2	Motorola	MC848
	TI	SN15848
SW949-1	Motorola	MC949
	TI	SN15949
SW949-2	Motorola	MC849
	TI	SN15849
SW950-1	Motorola	MC950
	TI	SN15950
SW950-2	Motorola	MC850
	TI	SN15850
SW951-1	Motorola	MC951
	TI	SN15951
SW951-2	Motorola	MC851
	TI	SN15851
SW957-1	Motorola	MC957
	TI	SN15957
SW957-2	Motorola	MC857
	TI	SN15857
SW958-1	Motorola	MC958
	TI	SN15958
SW958-2	Motorola	MC858
	TI	SN15858
SW961-1	Motorola	MC961
	TI	SN15961
SW961-2	Motorola	MC861
	TI	SN15861
SW962-1	Motorola	MC962
	TI	SN15962
SW962-2	Motorola	MC862
	TI	SN15862
SW963-1	Motorola	MC963
	TI	SN15963
SW963-2	Motorola	MC863
	TI	SN15863
¶ 1001	Motorola	MC1001
¶ 1002	Motorola	MC1002
¶ 1003	Motorola	MC1003
¶ 1004	Motorola	MC1004
¶ 1005	Motorola	MC1005
¶ 1006	Motorola	MC1006
¶ 1007	Motorola	MC1007
¶ 1008	Motorola	MC1008
¶ 1009	Motorola	MC1009
¶ 1010	Motorola	MC1010
¶ 1011	Motorola	MC1011
¶ 1013	Motorola	MC1013
¶ 1014	Motorola	MC1014
¶ 1015	Motorola	MC1015
¶ 1016	Motorola	MC1016
¶ 1017	Motorola	MC1017
¶ 1018	Motorola	MC1018
¶ 1019	Motorola	MC1019
¶ 1020	Motorola	MC1020
¶ 1021	Motorola	MC1021
¶ 1024	Motorola	MC1024
¶ 1025	Motorola	MC1025
¶ 1029	Motorola	MC1029
¶ 1030	Motorola	MC1030
¶ 1031	Motorola	MC1031
¶ 1033	Motorola	MC1033
¶ 1201	Motorola	MC1201
¶ 1202	Motorola	MC1202
¶ 1203	Motorola	MC1203
¶ 1204	Motorola	MC1204
¶ 1205	Motorola	MC1205
¶ 1206	Motorola	MC1206
¶ 1207	Motorola	MC1207
¶ 1208	Motorola	MC1208
¶ 1209	Motorola	MC1209
¶ 1210	Motorola	MC1210
¶ 1211	Motorola	MC1211
¶ 1213	Motorola	MC1213
¶ 1214	Motorola	MC1214
¶ 1215	Motorola	MC1215
¶ 1216	Motorola	MC1216
¶ 1217	Motorola	MC1217
¶ 1218	Motorola	MC1218
¶ 1219	Motorola	MC1219
¶ 1220	Motorola	MC1220
¶ 1221	Motorola	MC1221
¶ 1224	Motorola	MC1224
¶ 1225	Motorola	MC1225
¶ 1229	Motorola	MC1229
¶ 1230	Motorola	MC1230
¶ 1231	Motorola	MC1231
¶ 1233	Motorola	MC1233

Synertek

Manufacturer Device	Replacement Source	Replacement Device
SY1103	**AMI**	**S1103A**
	see page 712	
2670	National	MM5270

Teledyne Crystalonics

Manufacturer Device	Replacement Source	Replacement Device
CDR125	Siliconix	D125

Teledyne Semiconductor

Manufacturer Device	Replacement Source	Replacement Device
LM101	AMD	LM101
	AD	**AD101**
	see page 625	
	Fairchild	μA101
	Harris	HA-2101
	Intersil	LM101
	National	LM101
	Raytheon	LM101
	RCA	**CA101**
	see page 661	
	Signetics	LM101
	Silicon G	SG101
	Siliconix	LM101
LM104	Silicon G	SG104
LM105	AMD	LM105
	Fairchild	μA105
	Intersil	LM105
	National	LM105
	Raytheon	LM105
	Silicon G	SG105
LM107	AMD	LM107
	Fairchild	μA107
	Harris	HA-2107
	Intersil	LM107
	National	LM107
	Raytheon	LM107
	RCA	**CA107**
	see page 661	
	Signetics	LM107
	Silicon G	SG107
LM108	**AD**	**AD108**
	see page 625	
	RCA	CA108
LM111	AMD	LM111
	Fairchild	μA111
	Harris	HA-2111
	Intersil	LM111
	Raytheon	LM111
	RCA	**CA111**
	see page 661	
	Signetics	LM111
	Silicon G	SG111
LM124	Raytheon	LM124
	RCA	**CA124**
	see page 661	
	Signetics	LM124
	Silicon G	SG124
LM139	Raytheon	LM139
	RCA	**CA139**
	see page 661	
	Silicon G	SG139
LM201	AMD	LM201
	AD	**AD201**
	see page 625	
	Fairchild	μA201
	Harris	HA-2201
	Intersil	LM201
	National	LM201
	Raytheon	LM201
	RCA	**CA201**
	see page 661	
	Signetics	LM201
LM204	Fairchild	μA204
	Raytheon	LM204
LM205	AMD	LM205
	Fairchild	μA205
	Intersil	LM205
	National	LM205
	Raytheon	LM204
	Raytheon	LM205
LM207	AMD	LM207
	Fairchild	μA207
	Harris	HA-2207
	Intersil	LM207
	Raytheon	LM207
	RCA	**CA207**
	see page 661	
	Signetics	LM207
LM208	National	CA208
	RCA	CA208
LM211	AMD	LM211
	Fairchild	μA211
	Harris	HA-2211
	Intersil	LM211
	National	CA211
	Raytheon	LM211
	RCA	**CA211**
	see page 661	
	Signetics	LM211
LM224	Raytheon	LM224
	RCA	**CA224**
	see page 661	
	Signetics	LM224
LM239	Raytheon	LM239
	RCA	**CA239**
	see page 661	
LM301	AMD	LM301
	AD	**AD301**
	see page 625	
	Fairchild	μA301
	Harris	HA-2301
	Intersil	LM301
	National	CA301
	National	LM301
	RCA	**CA301**
	see page 661	
	Signetics	LM301
	Silicon G	SG301
LM304	Fairchild	μA304
	Raytheon	LM304
	Silicon G	SG304
LM305	AMD	LM305
	Fairchild	μA305
	Intersil	LM305
	National	LM305
	Silicon G	SG305
LM307	AMD	LM307
	Fairchild	μA307
	Harris	HA-2307
	Intersil	LM307
	National	CA307
	Raytheon	LM307
	RCA	**CA307**
	see page 661	
	Signetics	LM307
	Silicon G	SG307
LM308	AMD	LM308
	Fairchild	μA308
	National	CA308
	National	LM308
	Signetics	LM308
LM311	AMD	LM311
	Fairchild	μA311
	Harris	HA-2311
	Intersil	LM311
	National	CA311
	Raytheon	LM311
	RCA	**CA311**
	see page 661	
	Signetics	LM308
	Signetics	LM311
LM324	National	CA324
	Raytheon	LM324
	RCA	**CA324**
	see page 661	
	Signetics	LM324
LM339	National	CA339
	RCA	**CA339**
	see page 661	
LM376	Fairchild	μA376
MM54C00	Harris	HD54C00
MM54C02	Harris	HD54C02
	National	MM54C02
MM54C04	Harris	HD54C04
	National	MM54C04
MM54C10	Harris	HD54C10
	National	MM54C10
MM54C107	Harris	HD54C107
	National	HD54C107
MM54C151	**Harris**	**HD54C151**
	see page 266	
	National	MM54C151
MM54C154	**Harris**	**HD54C154**
	see page 266	
	National	MM54C154
MM54C157	Harris	HD54C157
	National	MM54C157
MM54C160	**Harris**	**HD54C160**
	see page 266	
	National	MM54C160
MM54C161	**Harris**	**HD54C161**
	see page 266	
	National	MM54C161
MM54C162	**Harris**	**HD54C162**
	see page 266	
	National	MM54C162
MM54C163	Harris	HD54C163
	National	MM54C163
MM54C164	Harris	HD54C164
	National	MM54C164
MM54C173	Harris	HD54C173
	National	MM54C173
MM54C192	**Harris**	**HD54C192**
	see page 266	
	National	MM54C192
MM54C193	**Harris**	**HD54C193**
	see page 266	
	National	MM54C193
MM54C195	Harris	HD54C195
MM54C20	Harris	HD54C20
	National	MM54C20
MM54C200	National	MM54C200
MM54C42	**Harris**	**HD54C42**
	see page 266	
	National	MM54C42
MM54C48	National	MM54C48
MM54C73	Harris	HD54C73
	National	MM54C73
MM54C74	Harris	HD54C74

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

Teledyne Semiconductor (cont)

Manufacturer Device	Replacement Source	Replacement Device
MM54C74	National	MM54C74
MM54C76	Harris	HD54C76
	National	MM54C76
MM54C86	Harris	HD54C86
	National	MM54C86
MM54C89	Harris	HD54C89
	National	MM54C89
MM54C95	Harris	HD54C95
	National	MM54C95
MM74C00	Harris	HD74C00
	National	MM74C00
MM74C02	Harris	HD74C02
	National	MM74C02
MM74C04	Harris	HD74C04
	National	MM74C04
MM74C10	Harris	HD74C10
	National	MM74C10
MM74C107	Harris	HD74C107
	National	MM74C107
MM74C14	National	MM74C14
MM74C151	**Harris**	**HD74C151**
	see page 266	
	National	MM74C151
MM74C154	**Harris**	**HD74C154**
	see page 266	
	National	MM74C154
MM74C157	Harris	HD74C157
	National	MM74C157
MM74C160	**Harris**	**HD74C160**
	see page 266	
	National	MM74C160
MM74C161	**Harris**	**HD74C161**
	see page 266	
	National	MM74C161
MM74C162	**Harris**	**HD74C162**
	see page 266	
	National	MM74C162
MM74C163	Harris	HD74C163
	National	MM74C163
MM74C164	Harris	HD74C164
	National	MM74C164
MM74C173	Harris	HD74C173
	National	MM74C173
MM74C192	**Harris**	**HD74C192**
	see page 266	
	National	MM74C192
MM74C193	**Harris**	**HD74C193**
	see page 266	
	National	MM74C193
MM74C195	Harris	HD74C195
	National	MM74C195
MM74C20	Harris	HD74C20
	National	MM74C20
MM74C200	Harris	HD74C200
	National	MM74C200
MM74C42	**Harris**	**HD74C42**
	see page 266	
	National	MM74C42
MM74C48	Harris	HD74C48
	National	MM74C48
MM74C73	Harris	HD74C73
	National	MM74C73
MM74C74	Harris	HD74C74
	National	MM74C74
MM74C76	Harris	HD74C76
	National	MM74C76
MM74C86	Harris	HD74C86
	National	MM74C86
MM74C89	Harris	HD74C89
	National	MM74C89
MM74C95	Harris	HD74C95
	National	MM74C95
TP1301	**AD**	**AD509**
	see page 624	
TP1322	**AD**	**AD509**
	see page 624	
TP301	**AD**	**AD507**
	see page 624	
TP321	**AD**	**AD507**
	see page 624	
1458	Fairchild	μA1458

Manufacturer Device	Replacement Source	Replacement Device
1458	Harris	HA-2655
	National	LM1458
	Raytheon	RC1458
	RCA	CA1458
	Signetics	MC1458
	Silicon G	SG1458
1558	Fairchild	μA1558
	Harris	HA-2650
	Motorola	MC1558
	National	LM1558
	RCA	CA1458
	Signetics	MC1558
	Silicon G	SG1558
555	Exar	XR555
	Lithic Sys	LS555
	National	CA555
556	Exar	XR556
709	Fairchild	μA709
	Raytheon	RC709
	Signetics	MA709
710	Fairchild	μA710
	National	LM710
	Raytheon	RC710
	RCA	CA710
	Signetics	MA710
	Silicon G	SG710
711	Fairchild	μA711
	National	LM711
	Raytheon	RC711
	RCA	CA711
	Signetics	MA723
	Silicon G	SG711
723	AMD	723
	Fairchild	μA723
	Intersil	LM723
	Intersil	MA723
	National	CA723
	National	LM723
	Raytheon	RC723
	Silicon G	SG723
741	AMD	741
	AD	**AD741**
	see page 625	
	Fairchild	μA741
	Intersil	LM741
	Intersil	MA741
	National	LM741
	Raytheon	RC741
	RCA	**CA741**
	see page 661	
	Signetics	MA741
	Silicon G	SG741
747	AMD	747
	National	LM747
	Raytheon	RC747
	RCA	**CA747**
	see page 661	
	Signetics	MA747
	Silicon G	SG747
748	Intersil	LM748
	Intersil	MA748
	National	LM748
	Raytheon	RC748
	RCA	CA748
	Signetics	MA748
75450	Fairchild	75450
75451	Fairchild	75451
75452	Fairchild	75452
75453	Fairchild	75453
75454	Fairchild	75454
75460	Fairchild	75460
75461	Fairchild	75461
75462	Fairchild	75462
75463	Fairchild	75463
75464	Fairchild	75464
911A	Lithic Sys	LS171
911B	Lithic Sys	LS271
911C	Lithic Sys	LS371

Texas Instruments

Manufacturer Device	Replacement Source	Replacement Device
RC4136	**Exar**	**XR4136**
	see page 640	
	Raytheon	**RC4136**
	see page 647	
RC4558	Exar	XR4558
	Raytheon	**RC4558**
	see page 651	
RM4136	**Exar**	**XR4136**
	see page 640	
	Raytheon	**RC4136**
	see page 647	
SN10101	Motorola	MC10101
SN10102	Motorola	MC10102
SN10104	Motorola	MC10104
SN10105	Motorola	MC10105
SN10106	Motorola	MC10106
SN10107	Motorola	MC10107
SN10109	Motorola	MC10109
SN10110	Motorola	MC10110
SN10111	Motorola	MC10111
SN10115	Motorola	MC10115
SN10116	Motorola	MC10116
SN10117	Motorola	MC10117
SN10118	Motorola	MC10118
SN10119	Motorola	MC10119
SN10121	Motorola	MC10121
SN10130	Motorola	MC10130
SN10131	Motorola	MC10131
SN10133	Motorola	MC10133
SN10147	Fairchild	F10405
SN10160	Motorola	MC10160
SN10161	Motorola	MC10161
SN10175	Motorola	MC10175
SN10179	Motorola	MC10179
SN10181	Motorola	MC10181
SN151800	Motorola	MC1800
	SW	SW1800
SN151801	Motorola	MC1801
SN151802	Motorola	MC1802
	SW	SW1802
SN151803	Motorola	MC1803
SN151804	Motorola	MC1804
	SW	SW1804
SN151805	Motorola	MC1805
SN151806	Motorola	MC1806
	SW	SW1806
SN151807	Motorola	MC1807
SN151808	Motorola	MC1808
	SW	SW1808
SN151809	Motorola	MC1809
SN151810	Motorola	MC1810
	SW	SW1810
SN151811	Motorola	MC1811
SN151812	Motorola	MC1812
	SW	SW1812
SN151900	Motorola	MC1900
	SW	SW1900
SN151901	Motorola	MC1901
SN151902	Motorola	MC1902
	SW	SW1902
SN151903	SW	SW1903
SN151904	Motorola	MC1904
	SW	SW1904
SN151905	Motorola	MC1905
SN151906	Motorola	MC1906
	SW	SW1906
SN151907	Motorola	MC1907
SN151908	Motorola	MC1908
	SW	SW1908
SN151909	Motorola	MC1909
SN151910	Motorola	MC1910
	SW	SW1910
SN151911	Motorola	MC1911

Manufacturer Device	Replacement Source	Replacement Device
SN151912	Motorola	MC1912
	SW	SW1912
SN158093	Motorola	MC853
	SW	SW705
	SW	SW8093
SN158094	Motorola	MC856
	SW	SW708
SN158097	Motorola	MC855
	SW	SW709
	SW	SW8097
SN158099	Motorola	MC852
	SW	SW706
	SW	SW9099
SN15830	Hitachi	HD2204
	Motorola	MC830
	SW	SW930
SN15831	Motorola	MC831
	SW	SW931
SN15832	Hitachi	HD2201
	Motorola	MC832
	SW	SW932
SN15833	Hitachi	HD2202
	Motorola	MC833
	SW	SW933
SN15834	Motorola	MC834
SN15835	Motorola	MC840
	SW	SW935
SN15836	Hitachi	HD2206
	Motorola	MC836
	SW	SW936
SN15837	Motorola	MC837
	SW	SW937
SN15838	Motorola	MC835
	SW	SW938
SN15844	Hitachi	HD2209
	Motorola	MC844
	SW	SW844
	SW	SW944
SN15845	Hitachi	HD2205
	Motorola	MC845
	SW	SW945
SN15846	Hitachi	HD2203
	Motorola	MC846
	SW	SW946
SN15848	Motorola	MC848
	SW	SW948
SN15849	Motorola	MC849
	SW	SW949
SN15850	Motorola	MC850
	SW	SW950
SN15851	Motorola	MC851
	SW	SW951
SN15857	Motorola	MC857
	SW	SW957
SN15858	Motorola	MC858
	SW	SW958
SN15861	Motorola	MC861
	SW	SW961
SN15862	Hitachi	HD2207
	Motorola	MC862
	SW	SW962
SN15863	Motorola	MC863
	SW	SW963
SN159093	Motorola	MC953
	Raytheon	RM993
	SW	SW705
SN159094	Motorola	MC956
	Raytheon	RM994
	SW	SW708
SN159097	Motorola	MC955
	Raytheon	RM997
	SW	SW709
SN159099	Motorola	MC952
	Raytheon	RM999
	SW	SW706
SN15930	Motorola	MC930
	Raytheon	RM930
	SW	SW930
SN15931	Motorola	MC931
	Raytheon	RM931
	SW	SW931

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Texas Instruments (cont)

Manufacturer Device	Replacement Source	Replacement Device
SN15932	Motorola	MC932
	Raytheon	RM932
	SW	SW932
SN15933	Motorola	MC933
	Raytheon	RM933
	SW	SW933
SN15934	Motorola	MC934
	Raytheon	RM934
SN15935	Motorola	MC940
	Raytheon	RM935
	SW	SW935
SN15936	Motorola	MC936
	Raytheon	RM936
	SW	SW936
SN15937	Motorola	MC937
	Raytheon	RM937
	SW	SW937
SN15938	Motorola	MC935
SN15941	SW	SW941
SN15944	Motorola	MC944
	Raytheon	RM944
	SW	SW944
SN15945	Motorola	MC945
	Raytheon	RM945
	SW	SW945
SN15946	Motorola	MC946
	Raytheon	RM946
	SW	SW946
SN15948	Motorola	MC948
	Raytheon	RM948
	SW	SW948
SN15949	Motorola	MC949
	Raytheon	RM949
	SW	SW949
SN15950	Motorola	MC950
	Raytheon	RM950
	SW	SW950
SN15951	Motorola	MC951
	Raytheon	RM951
	SW	SW951
SN15957	Motorola	MC957
	SW	SW957
SN15958	Motorola	MC958
	SW	SW958
SN15961–	Motorola	MC961
	Raytheon	RM961
	SW	SW961
SN15962	Motorola	MC962
	Raytheon	RM962
	SW	SW962
SN15963	Motorola	MC963
	Raytheon	RM963
	SW	SW963
SN29000	Fairchild	9000
	ITT	ITT74104
	ITT	ITT9000
SN29001	Fairchild	9001
	ITT	ITT74105
	ITT	ITT9001
SN29002	ITT	ITT9002
	National	DM9002
SN29003	ITT	ITT9003
	National	DM9003
SN29004	National	DM9004
SN29005	ITT	ITT9005
	National	DM9005
SN29008	ITT	ITT9008
	National	DM9008
SN29009	ITT	ITT9009
	National	DM9009
SN29012	ITT	ITT9012
SN29016	ITT	ITT9016
	National	DM9016
SN29300	AMD	9300
	Raytheon	RM9300
SN29301	AMD	9301
	Fairchild	9301
	National	DM9301
SN29308	AMD	9308
	Fairchild	9308
	Raytheon	RC9308
SN29308	Raytheon	RM9308
SN29309	AMD	9309
	Fairchild	9309
	National	DM9309
SN29310	AMD	9310
	Raytheon	RM9310
SN29311	AMD	9311
	Raytheon	RM9311
SN29312	AMD	9312
	ITT	ITT9312
	National	DM9312
	Raytheon	RC9312
	Raytheon	RM9312
SN29316	AMD	9316
	Raytheon	RM9316
SN29318	AMD	9318
SN29322	AMD	9322
	Raytheon	RM9322
SN29601	AMD	9601
	ITT	ITT93601
	Motorola	MC9601
	National	DM9601
	Raytheon	RF9601
SN39000	Fairchild	9000
SN39001	Fairchild	9001
SN39301	Fairchild	9301
SN39308	Fairchild	9308
SN39309	Fairchild	9309
SN39312	Fairchild	9312
SN52101	AMD	LM101
	Fairchild	μA101
	Intersil	LM101
	Motorola	MLM101
	National	LM101
	Raytheon	LM101
	RCA	**CA101**
	see page 661	
	Signetics	LM101
	Teledyne S	LM101
SN52105	Intersil	LM105
	National	LM105
	Raytheon	LM105
	Teledyne S	LM105
SN52107	AMD	LM107
	Fairchild	μA107
	Intersil	LM107
	Motorola	MLM107
	National	LM107
	Raytheon	LM107
	RCA	**CA107**
	see page 661	
	Signetics	LM107
	Silicon G	SG107
	Teledyne S	LM107
SN52108	AMD	LM108
	Intersil	LM108
	National	LM108
	Raytheon	LM108
	RCA	CA108
	Silicon G	SG108
	Teledyne S	LM108
SN52110	AMD	LM110
	Intersil	LM110
	National	LM110
SN52111	AMD	LM111
	Harris	HA-2111
	Intersil	LM111
	National	LM111
	Raytheon	LM111
	RCA	**CA111**
	see page 661	
	Signetics	LM111
	Teledyne S	LM111
SN52197	Signetics	S8291
SN52514	Raytheon	RM1514
SN52555	Intersil	SE555
	Lithic Sys	LS555
	Raytheon	RM555
SN52558	Fairchild	μA1558
	Harris	HA-2650
	Motorola	MC1558
SN52558	National	LM1558
	PMI	SSS1558
	Raytheon	RM1558
	RCA	CA1558
	Teledyne S	1558
SN52702	Fairchild	μA702
	Motorola	MC1712
	Raytheon	RM702
SN52709	Motorola	MC1709
	National	LM709
	Raytheon	RM709
	Signetics	μA709
	Teledyne S	709
SN52710	Fairchild	μA710
	Motorola	MC1710
	National	LM710
	Raytheon	RM710
	Signetics	μA710
	Silicon G	SG710
	Teledyne S	710
SN52711	Fairchild	μA711
	Motorola	MC1711
	National	LM711
	Raytheon	RM711
	Signetics	μA711
	Silicon G	SG711
	Teledyne S	711
SN52723	AMD	723
	Intersil	723
	National	LM723
	Raytheon	RM923
	Signetics	μA723
	Teledyne S	723
SN52733	AMD	733
	Fairchild	μA733
	Motorola	MC1733
	National	LM733
	Raytheon	RM733
	Signetics	μA733
	Silicon G	SG733
SN52741	AMD	741
	Fairchild	μA741
	Intersil	741
	Motorola	MC1741
	National	LM741
	PMI	SSS741
	Raytheon	RM741
	RCA	**CA741**
	see page 661	
	Signetics	μA741
	Silicon G	SG741
	Teledyne S	741
SN52747	AMD	747
	Fairchild	μA747
	Motorola	MC1747
	National	LM747
	PMI	SSS747
	Raytheon	RM747
	RCA	**CA747**
	see page 661	
	Silicon G	SG747
	Teledyne S	747
SN52748	AMD	748
	Fairchild	μA748
	Intersil	748
	Motorola	MC1748
	National	LM748
	Raytheon	RM748
	RCA	CA748
	Signetics	μA748
	Silicon G	SG748
	Teledyne S	748
SN52771	Signetics	MC1556
SN52777	Intersil	777
SN54H00	Fairchild	54H00
	Fairchild	9H00
	National	DM54H00
	Raytheon	54H00
	Signetics	S54H00
SN54H01	Fairchild	54H01
	Fairchild	9H01
SN54H01	National	DM54H01
	Raytheon	54H01
	Signetics	S54H01
SN54H04	Fairchild	54H04
	Fairchild	9H04
	National	DM54H04
	Raytheon	54H04
	Signetics	S54H04
SN54H05	Fairchild	54H05
	Fairchild	9H05
	National	DM54H05
	Raytheon	54H05
	Signetics	S54H05
SN54H10	Fairchild	54H10
	Fairchild	9H10
	National	DM54H10
	Raytheon	54H10
	Signetics	S54H10
SN54H101	Fairchild	54H101
	Fairchild	9H101
	Signetics	S54H101
SN54H102	Fairchild	54H102
	Fairchild	9H102
	Signetics	S54H102
SN54H103	Fairchild	54H103
	Fairchild	9H103
	National	DM54H103
SN54H106	Fairchild	54H106
	Fairchild	9H106
	National	DM54H106
	Signetics	S54H106
SN54H108	Fairchild	54H108
	Fairchild	9H108
	National	DM54H108
	Signetics	S54H108
SN54H11	National	DM54H11
	Raytheon	54H11
	Signetics	S54H11
SN54H183	Fairchild	54H183
	Fairchild	93H183
SN54H20	Fairchild	54H20
	Fairchild	9H20
	National	DM54H20
	Raytheon	54H20
	Signetics	S54H20
SN54H21	Fairchild	54H21
	Fairchild	9H21
	National	DM54H21
	Signetics	S54H21
SN54H22	Fairchild	54H22
	Fairchild	9H22
	National	DM54H22
	Raytheon	54H22
	Signetics	S54H22
SN54H30	Fairchild	54H30
	Fairchild	9H30
	National	DM54H30
	Signetics	S54H30
SN54H40	Fairchild	54H40
	Fairchild	9H40
	National	DM54H40
	Raytheon	54H40
	Signetics	S54H40
SN54H50	Fairchild	54H50
	Fairchild	9H50
	National	DM54H50
	Signetics	S54H50
SN54H51	Fairchild	54H51
	Fairchild	9H51
	National	DM54H51
	Signetics	S54H51
SN54H52	Fairchild	54H52
	Fairchild	9H52
	National	DM54H52
	Signetics	S54H52
SN54H53	Fairchild	54H53
	Fairchild	9H53
	National	DM54H53
	Signetics	S54H53
SN54H54	Fairchild	54H54
	Fairchild	9H54

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Bold face device number indicates additional data is provided in Catalog section

Texas Instruments (cont)

Manufacturer Device	Replacement Source	Replacement Device
SN54H54	National	DM54H54
	Signetics	S54H54
SN54H55	Fairchild	54H55
	Fairchild	9H55
	National	DM54H55
	Signetics	S54H55
SN54H60	Fairchild	54H60
	Fairchild	9H60
	National	DM54H60
	Signetics	S54H60
SN54H61	Fairchild	54H61
	Fairchild	9H61
	National	DM54H61
	Signetics	S54H61
SN54H62	Fairchild	54H62
	Fairchild	9H62
	National	DM54H62
	Signetics	S54H62
SN54H71	Fairchild	54H71
	Fairchild	9H71
	National	DM54H71
	Signetics	S54H71
SN54H72	Fairchild	54H72
	Fairchild	9H72
	National	DM54H72
	Signetics	S54H72
SN54H73	Fairchild	54H73
	Fairchild	9H73
	National	DM54H73
	Signetics	S54H73
SN54H74	Fairchild	54H74
	Fairchild	9H74
	National	DM54H74
	Raytheon	54H74
	Signetics	S54H74
SN54H76	Fairchild	54H76
	Fairchild	9H76
	National	DM54H76
	Signetics	S54H76
SN54H78	Fairchild	54H78
	Fairchild	9H78
	National	DM54H78
SN54H87	Fairchild	54H87
	Fairchild	93H87
SN54LSI60	Fairchild	54LS260
	Signetics	S54LS260A
	see page 384	
SN54LS00	Fairchild	54LS00
	National	DM54LS00
	Raytheon	54LS00
	see page 282	
	Signetics	S54LS00
	see page 384	
SN54LS01	National	DM54LS01
	Raytheon	54LS01
	see page 282	
	Signetics	S54LS01
	see page 384	
SN54LS02	Fairchild	54LS02
	Raytheon	54LS02
	see page 282	
	Signetics	S54LS02
	see page 384	
SN54LS03	Fairchild	54LS03
	National	DM54LS03
	Raytheon	54LS03
	see page 282	
	Signetics	S54LS03
	see page 384	
SN54LS04	Fairchild	54LS04
	National	DM54LS04
	Raytheon	54LS04
	see page 282	
	Signetics	S54LS04
	see page 384	
SN54LS05	Fairchild	54LS05
	Raytheon	54LS05
	see page 282	
	Signetics	S54LS05
	see page 384	
SN54LS08	Fairchild	54LS08
SN54LS08	Raytheon	54LS08
	see page 282	
	Signetics	S54LS08
	see page 384	
SN54LS10	Fairchild	54LS10
	National	DM54LS10
	Raytheon	54LS10
	see page 282	
	Signetics	S54LS10
	see page 384	
SN54LS107	Raytheon	54LS107
	see page 282	
	Signetics	S54LS107
	see page 384	
SN54LS109	Fairchild	54LS109
	Raytheon	54LS109
	see page 282	
	Signetics	S54LS109
	see page 384	
SN54LS11	Fairchild	54LS11
	Raytheon	54LS11
	see page 282	
	Signetics	S54LS11
	see page 384	
SN54LS112	Fairchild	54LS112
	Raytheon	54LS112
	see page 282	
	Signetics	S54LS112
	see page 384	
SN54LS113	Fairchild	54LS113
	Raytheon	54LS113
	see page 282	
	Signetics	S54LS113
	see page 384	
SN54LS114	Fairchild	54LS114
	Raytheon	54LS114
	see page 282	
	Signetics	S54LS114
	see page 384	
SN54LS12	National	DM54LS12
	Raytheon	54LS12
	see page 282	
	Signetics	S54LS12
	see page 384	
SN54LS123	AMD	SN54LS123
SN54LS125	Fairchild	54LS125
SN54LS126	Fairchild	54LS126
SN54LS132	Fairchild	54LS132
	Signetics	S54LS132
	see page 384	
SN54LS136	Fairchild	54LS136
	Raytheon	54LS136
	see page 282	
	Signetics	S54LS136
	see page 384	
SN54LS138	AMD	SN54LS138
	Fairchild	54LS138
	Raytheon	54LS138
	see page 282	
	Signetics	S54LS138
	see page 384	
SN54LS139	AMD	SN54LS139
	Fairchild	54LS139
	Raytheon	54LS139
	see page 282	
	Signetics	S54LS139
	see page 384	
SN54LS14	Fairchild	54LS14
	Signetics	S54LS14
	see page 384	
SN54LS145	Signetics	S54LS145
	see page 384	
SN54LS15	Fairchild	54LS15
	Raytheon	54LS15
	see page 282	
	Signetics	S54LS15
	see page 384	
SN54LS151	AMD	SN54LSU51
	Fairchild	54LS151
	Raytheon	54LS151
	see page 282	
SN54LS151	Signetics	S54LS151
	see page 384	
SN54LS152	Fairchild	54LS152
	Raytheon	54LS152
	see page 282	
SN54LS153	AMD	SN54LS153
	Fairchild	54LS153
	Raytheon	54LS153
	see page 282	
	Signetics	S54LS153
	see page 384	
SN54LS155	Fairchild	54LS155
	Raytheon	54LS155
	see page 282	
SN54LS156	Fairchild	54LS156
	Raytheon	54LS156
	see page 282	
SN54LS157	AMD	SN54LS157
	Fairchild	54LS157
	Raytheon	54LS157
	see page 282	
	Signetics	S54LS157
	see page 384	
SN54LS158	AMD	SN54LS158
	Fairchild	54LS158
	Raytheon	54LS158
	see page 282	
	Signetics	S54LS158
	see page 384	
SN54LS160	AMD	SN54LS160
	Fairchild	54LS160
	Raytheon	54LS160
	see page 282	
	Signetics	S54LS160
	see page 384	
SN54LS161	AMD	SN54LS161
	Fairchild	54LS161
	Raytheon	54LS161
	see page 282	
	Signetics	S54LS161
	see page 384	
SN54LS162	AMD	SN54LSX62
	AMD	SN54LS162
	Fairchild	54LS162
	Raytheon	54LS162
	see page 282	
	Signetics	S54LS162
	see page 384	
SN54LS163	AMD	SN54LS163
	Fairchild	54LS163
	Raytheon	54LS163
	see page 282	
	Signetics	S54LS163
	see page 384	
SN54LS164	AMD	AM54LS164
	Fairchild	54LS164
	Signetics	S54LS164
	see page 384	
SN54LS170	Fairchild	54LS170
	Signetics	S54LS170
	see page 384	
SN54LS174	AMD	SN54LS174
	Fairchild	54LS174
	Raytheon	54LS174
	see page 282	
	Signetics	S54LS174
	see page 384	
SN54LS175	AMD	SN54LS175
	Fairchild	54LS175
	Raytheon	54LSX75
	Raytheon	54LS175
	Signetics	S54LS175
	see page 384	
SN54LS181	AMD	SN54LS181
	Fairchild	54LS181
	Raytheon	54LS181
	see page 282	
SN54LS190	AMD	SN54LS190
	Fairchild	54LS190
	Raytheon	54LS190
	see page 282	
SN54LS190	Signetics	S54LS190
	see page 384	
SN54LS191	AMD	SN54LS191
	Fairchild	54LS191
	Raytheon	54LS191
	see page 282	
	Signetics	S54LS191
	see page 384	
SN54LS192	Fairchild	54LS192
SN54LS193	AMD	SN54LS193
	Fairchild	54LS193
	Raytheon	54LS193
	see page 282	
	Signetics	S54LS193
	see page 384	
SN54LS194A	AMD	SN54LS194A
	Fairchild	54LS194
	Raytheon	54LS194A
	see page 282	
	Signetics	S54LS194A
	see page 384	
SN54LS195A	AMD	SN54LS195A
	Fairchild	54LS195
	Raytheon	54LS195A
	see page 282	
	Signetics	S54LS195A
	see page 384	
SN54LS196	Fairchild	54LS196
	Raytheon	54LS196
	see page 282	
	Signetics	S54LS196
	see page 384	
SN54LS197	Fairchild	54LS197
	Raytheon	54LS197
	see page 282	
	Signetics	S54LS197
	see page 384	
SN54LS20	Fairchild	54LS20
	National	DM54LS20
	Raytheon	54LS20
	see page 282	
	Signetics	S54LS20
	see page 384	
SN54LS21	Fairchild	54LS21
	Raytheon	54LS21
	Signetics	S54LS21
	see page 384	
SN54LS22	Fairchild	54LS22
	National	DM54LS22
	National	54LS22
	Raytheon	54LS22
	see page 282	
	Signetics	S54LS22
	see page 384	
SN54LS221	Signetics	54LS221
SN54LS251	AMD	SN54LS251
	Fairchild	54LS251
	Raytheon	54LS251
	see page 282	
	Signetics	S54LS251
	see page 384	
SN54LS253	AMD	SN54LS253
	Fairchild	54LS253
	Raytheon	54LS253
	see page 282	
	Signetics	S54LS253
	see page 384	
SN54LS257	AMD	SN54LS257
	Fairchild	54LS257
	Raytheon	54LS257
	see page 282	
	Signetics	S54LS257
	see page 384	
SN54LS258	AMD	SN54LS258
	Fairchild	54LS258
	Raytheon	54LS258
	see page 282	
	Signetics	S54LS258
	see page 384	
SN54LS259	Fairchild	54LS259
SN54LS26	Fairchild	54LS26

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The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

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Manufacturer Device	Replacement Source	Replacement Device
SN54LS26	Raytheon	**54LS26**
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	Signetics	**S54LS26**
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SN54LS261	Signetics	**S54LS261**
	see page 384	
SN54LS266	Fairchild	54LS266
	Raytheon	**54LS266**
	see page 282	
	Signetics	**S54LS266**
	see page 384	
SN54LS27	Fairchild	54LS27
	Raytheon	**54LS27**
	see page 282	
	Signetics	**S54LS27**
	see page 384	
SN54LS279	Fairchild	54LS279
SN54LS28	Raytheon	**54LS28**
	see page 282	
	Signetics	**S54LS28**
	see page 384	
SN54LS283	Fairchild	54LS283
	Raytheon	**54LS283**
	see page 282	
	Signetics	**S54LS283**
	see page 384	
SN54LS290	Fairchild	54LS290
	Signetics	**S54LS290**
	see page 384	
SN54LS293	Fairchild	54LS293
	Signetics	**S54LS293**
	see page 384	
SN54LS295A	Fairchild	54LS295
	Raytheon	**54LS295A**
	see page 282	
	Signetics	**S54LS295A**
	see page 384	
SN54LS298	Fairchild	54LS298
SN54LS30	Fairchild	54LS30
	National	DM54LS30
	Raytheon	**54LS30**
	see page 282	
	Signetics	**S54LS30**
	see page 384	
SN54LS32	Fairchild	54LS32
	Raytheon	**54LS32**
	see page 282	
	Signetics	**S54LS32**
	see page 384	
SN54LS33	Raytheon	**54LS33**
	see page 282	
	Signetics	**S54LS33**
	see page 384	
SN54LS368	Fairchild	54LS368
SN54LS37	Fairchild	54LS37
	Raytheon	**54LS37**
	see page 282	
	Signetics	**S54LS37**
	see page 384	
SN54LS378	AMD	SN54LS378
SN54LS38	Fairchild	54LS38
	Raytheon	**54LS38**
	see page 282	
	Signetics	**S54LS38**
	see page 384	
SN54LS386	Raytheon	**54LS386**
	see page 282	
	Signetics	**S54LS386**
	see page 384	
SN54LS40	Fairchild	54LS40
	Raytheon	**54LS40**
	see page 282	
	Signetics	**S54LS40**
	see page 384	
SN54LS42	Fairchild	54LS42
	Signetics	**S54LS42**
	see page 384	
SN54LS51	Fairchild	54LS51
	Raytheon	**54LS51**
	see page 282	
	Signetics	**S54LS51**
	see page 384	
SN54LS54	Fairchild	54LS54
	Raytheon	**54LS54**
	see page 282	
	Signetics	**S54LS54**
	see page 384	
SN54LS55	Fairchild	54LS55
	Raytheon	**54LS55**
	see page 282	
	Signetics	**S54LS55**
	see page 384	
SN54LS670	Fairchild	54LS670
	Raytheon	54LS670
	Signetics	**S54LS670**
	see page 384	
SN54LS73	Fairchild	54LS73
	Raytheon	**54LS73**
	see page 282	
	Signetics	**S54LS73**
	see page 384	
SN54LS74	Fairchild	54LS74
	National	DM54LS74
	Raytheon	**54LS74**
	see page 282	
	Signetics	**S54LS74**
	see page 384	
SN54LS75	Signetics	**S54LS75**
	see page 384	
SN54LS76	Raytheon	**54LS76**
	see page 282	
	Signetics	**S54LS76**
	see page 384	
SN54LS78	Raytheon	**54LS78**
	see page 282	
	Signetics	**S54LS78**
	see page 384	
SN54LS83A	Fairchild	54LS83
	Raytheon	**54LS83A**
	see page 282	
	Signetics	**S54LS83A**
	see page 384	
SN54LS85	Signetics	**S54LS85**
	see page 384	
SN54LS86	Fairchild	54LS86
	Raytheon	**54LS86**
	see page 282	
	Signetics	**S54LS86**
	see page 384	
SN54LS90	Fairchild	54LS90
	Signetics	**S54LS90**
	see page 384	
SN54LS92	Fairchild	54LS92
	Signetics	**S54LS192**
	see page 384	
SN54LS95B	Fairchild	54LS95
	Signetics	**S54LS95B**
	see page 384	
SN54LS96	Signetics	**S54LS96**
	see page 384	
SN54L00	National	DM54L00
SN54L01	National	DM54L01
SN54L02	National	DM54L02
SN54L03	National	DM54L03
SN54L04	National	DM54L04
SN54L10	National	DM54L10
¶ SN54L123	National	DM54L123
SN54L154	National	DM54L154A
SN54L157	National	DM54L157A
SN54L161	National	DM54L161
SN54L164	National	DM54L164
SN54L187	National	DM54L187
SN54L192	National	DM54L192
SN54L193	National	DM54L193
SN54L20	National	DM54L20
SN54L26	National	DM54L26
SN54L30	National	DM54L30
SN54L42A	National	DM54L42A
SN54L51	National	DM54L51
SN54L54	National	DM54L54
SN54L55	National	DM54L55
SN54L71	National	DM54L71
SN54L72	National	DM54L72
SN54L73	National	DM54L73
SN54L74	National	DM54L74
¶ SN54L75	National	DM54L75
SN54L78	National	DM54L78
SN54L85	National	DM54L85
SN54L86	National	DM54L86
SN54L90	National	DM54L90
SN54L91	National	DM54L91
SN54L93	National	DM54L93
SN54L95	National	DM54L95
SN54L98	National	DM54L98
SN54S00	Fairchild	54S00
	Fairchild	9S00
	National	DM54S00
SN54S03	Fairchild	54S03
	Fairchild	9S03
	National	DM54S03
SN54S04	Fairchild	54S04
	Fairchild	9S04
	National	DM54S04
SN54S05	Fairchild	54S05
	Fairchild	9S05
	National	DM54S05
SN54S10	National	DM54S10
SN54S11	National	DM54S11
SN54S112	Fairchild	54S112
	Fairchild	9S112
	National	DM54S112
SN54S113	Fairchild	54S113
	Fairchild	9S113
	National	DM54S113
SN54S114	Fairchild	54S114
	Fairchild	9S114
	National	DM54S114
SN54S133	Fairchild	9S133
SN54S134	Fairchild	9S134
SN54S138	AMD	SN54S138
SN54S139	AMD	SN54S139
SN54S140	Fairchild	54S140
	Fairchild	9S140
	National	DM54S140
SN54S15	National	DM54S15
SN54S151	AMD	SN54S151
	National	DM54S151
SN54S153	AMD	SN54S153
	National	DM54S153
SN54S157	AMD	SN54S157
	National	DM54S157
SN54S158	AMD	SN54S158
SN54S174	AMD	SN54S174
SN54S175	AMD	SN54S175
SN54S181	AMD	SN54S181
	Fairchild	54S181
	Fairchild	93S41
SN54S182	Fairchild	54S182
	Fairchild	93S42
SN54S188	AMD	AM27S09
	Harris	**HM7602**
	see page 746	
SN54S188A	MMI	5330
SN54S189	AMD	AM27S/O
	AMD	SN54S189
SN54S194	AMD	SN54S194
SN54S195	AMD	SN54S195
	Fairchild	93S00
SN54S20	Fairchild	54S20
	Fairchild	9S20
	National	DM54S20
¶ SN54S200	Intersil	IM5523
	MMI	5531
	National	DM54S200
	Raytheon	RM5340
	Signetics	**S54S200**
	see page 804, 806, 815,	
	TI	SN54S201
SN54S206	Fairchild	93411
	Intersil	IM5533
	MMI	5205
	Raytheon	RM5330
	TI	SN74S301
SN54S22	Fairchild	54S22
SN54S22	Fairchild	9S22
	National	DM54S22
SN54S251	AMD	SN54S251
SN54S257	AMD	SN54S257
SN54S258	AMD	SN54S258
SN54S270	MMI	5205
SN54S287	MMI	5301
	National	DM7574
	National	DM8574
SN54S288	MMI	5331
SN54S289	AMD	AM27S02
	AMD	SN54S289
SN54S370	MMI	5206
SN54S387	Intel	**3601**
	see page 772, 773	
	MMI	5300
	MMI	6300
	National	DM54S387
	National	DM7573
	Signetics	**N82S126**
	see page 804, 826, 835,	
SN54S40	Fairchild	54S40
	Fairchild	9S40
	National	DM54S40
SN54S64	Fairchild	54S64
	Fairchild	9S64
	National	DM54S64
SN54S65	Fairchild	54S65
	Fairchild	9S65
	National	DM54S65
SN54S74	Fairchild	54S74
	Fairchild	9S74
	National	DM54S74
SN54S86	National	DM54S86
SN5400	Fairchild	5400
	Fairchild	9N00
	National	DM5400
	Raytheon	5400
	Signetics	S5400
	Signetics	8889
SN5401	Fairchild	5401
	Fairchild	9N01
	National	DM5401
	Raytheon	5401
	Signetics	S5401
	Signetics	8881
SN5402	Fairchild	5402
	Fairchild	9N02
	National	DM5402
	Signetics	S5402
SN5403	Fairchild	5403
	Fairchild	9N03
	National	DM5403
	Raytheon	5403
	Signetics	S5403
SN5404	Fairchild	5404
	Fairchild	9N04
	National	DM5404
	Raytheon	5404
	Signetics	S5404
	Signetics	8890
SN5405	Fairchild	5405
	Fairchild	9N05
	National	DM5405
	Raytheon	5405
	Signetics	S5405
	Signetics	8891
SN5406	Fairchild	5406
	Fairchild	9N06
	National	DM5406
	Signetics	S5406
SN5407	Fairchild	5407
	Fairchild	9N07
	National	DM5407
	Signetics	S5407
SN5408	Fairchild	5408
	Fairchild	9N08
	National	DM5408
	Raytheon	5408
	Signetics	S5408
SN5409	Fairchild	5409

¶ Discontinued

Bold face device number indicates additional data is provided in Catalog section

Texas Instruments (cont)

Manufacturer Device	Replacement Source	Replacement Device
SN5409	Fairchild	9N09
	National	DM5409
	Raytheon	5409
	Signetics	S5409
SN5410	Fairchild	5410
	Fairchild	9N10
	National	DM5410
	Raytheon	5410
	Signetics	S5410
	Signetics	8879
SN54107	AMD	SN54107
	Fairchild	54107
	Fairchild	9N107
	National	DM54107
	Signetics	S54107
SN54109	National	DM54109
	Signetics	S54109
SN5412	Fairchild	5412
	Fairchild	9N12
	Raytheon	5412
SN54121	Fairchild	54121
	Fairchild	9603
	Motorola	MC9603
	National	DM54121
	Signetics	S54121
SN54123	AMD	AM26123
	AMD	SN54123
	National	DM54123
	Raytheon	54123
	Signetics	S54123
SN54125	National	DM7093
SN54126	National	DM7094
SN5413	Fairchild	5413
	Fairchild	9N13
	National	DM5413
	Signetics	S5413
SN54132	National	DM54132
	Signetics	S54132
SN54136	Raytheon	54136
SN5414	National	DM5414
	Signetics	S5414
SN54141	National	DM54141
	Signetics	S54141
SN54145	Fairchild	54145
	Fairchild	93145
	National	DM54145
	Raytheon	54145
	Signetics	S54145
SN54150	Fairchild	54150
	Fairchild	93150
	National	DM54150
	Raytheon	54150
	Signetics	S54150
¶ SN54151	Fairchild	54151
	Fairchild	93151
	National	DM54151
	Raytheon	54151
	Signetics	S54151
	TI	SN54151A
¶ SN54152	Fairchild	54152
	Fairchild	93152
	Raytheon	54152
	Signetics	S54152
	TI	SN54152A
SN54153	AMD	SN54153
	Fairchild	54153
	Fairchild	93153
	National	DM54153
	Raytheon	54153
	Signetics	S54153
SN54154	AMD	SN54154
	Fairchild	9311
	National	DM54154
	Raytheon	54154
	Signetics	S54154
SN54155	Fairchild	93155
	National	DM54155
	Raytheon	54155
	Signetics	S54155
SN54156	Fairchild	93156
	National	DM54156
SN54156	Raytheon	54156
	Signetics	S54156
SN54157	AMD	SN54157
	Fairchild	9322
	National	DM9322
	Raytheon	54157
	Signetics	S54157
SN54159	Raytheon	54159
SN5416	Fairchild	5416
	Fairchild	9N16
	National	DM5416
	Signetics	S5416
SN54160	AMD	SN54160
	Fairchild	9310
	National	DM54160
	Raytheon	54160
	Signetics	S54160
SN54161	AMD	SN54161
	Fairchild	9316
	National	DM54161
	Raytheon	54161
	Signetics	S54161
SN54162	AMD	SN54162
	National	DM54162
	Raytheon	54162
	Signetics	S54162
SN54163	AMD	SN54163
	National	DM54163
	Raytheon	54163
	Signetics	S54163
SN54164	AMD	SN54164
	Fairchild	54164
	Fairchild	93164
	National	DM7570
	Raytheon	54164
	Signetics	S54164
SN54165	Fairchild	54165
	Fairchild	93165
	National	DM7590
	Raytheon	54165
	Signetics	S54165
SN54166	Fairchild	54166
	Fairchild	93166
	National	DM54166
	Raytheon	54166
	Signetics	S54166
SN5417	Fairchild	5417
	Fairchild	9N17
	National	DM5417
	Signetics	S5417
SN54170	Fairchild	54170
	Raytheon	54170
SN54173	National	DM7551
SN54174	AMD	SN54174
	Fairchild	93174
	National	DM54174
	Raytheon	54174
	Signetics	S54174
SN54175	AMD	SN54175
	Fairchild	93175
	National	DM54175
	Raytheon	54175
	Signetics	S54175
SN54176	Fairchild	54176
	Fairchild	93176
	National	DM7280
	Signetics	S8280
SN54177	Fairchild	54177
	Fairchild	93177
	National	DM7281
	Signetics	S8281
SN54178	Fairchild	54178
	Fairchild	93178
	Signetics	S8270
SN54179	Fairchild	54179
	Fairchild	93179
SN54180	Fairchild	54180
	Fairchild	93180
	National	DM54180
	Raytheon	54180
	Signetics	S54180
SN54181	AMD	SN54181
	AMD	9341
	Fairchild	54181
	Fairchild	9341
	National	DM54181
	Raytheon	54181
	Signetics	S54181
SN54182	AMD	SN54182
	AMD	9342
	Fairchild	54182
	Fairchild	9342
	National	DM54182
	Raytheon	54182
	Signetics	S54182
SN54184	National	DM54184
SN54185A	Fairchild	93434
	National	DM54185A
SN54186	Harris	HPROM-0512
SN54187	Fairchild	93406
	Intersil	IM5603
	MMI	5200
	National	DM54187
SN54188	Harris	MM7602
SN54188A	MMI	5330
	National	DM7577
SN54190	Fairchild	54190
	Fairchild	93190
	National	DM54190
	Raytheon	54190
SN54191	Fairchild	54191
	Fairchild	93191
	National	DM54191
	Raytheon	54191
SN54192	AMD	SN54192
	AMD	9360
	Fairchild	54192
	Fairchild	9360
	National	DM7560
	Raytheon	54192
	Signetics	S54192
SN54193	AMD	SN54193
	AMD	9366
	Fairchild	54193
	Fairchild	9366
	National	DM7563
	Raytheon	54193
	Signetics	S54193
SN54194	AMD	SN54194
	National	DM54194
	National	DM8300
	Raytheon	54194
SN54195	AMD	SN54195
	Fairchild	9300
	National	DM9300
	Raytheon	54195
	Signetics	S54195
SN54196	Fairchild	54196
	Fairchild	93196
	National	DM54196
	Signetics	S8290
SN54197	Fairchild	54197
	Fairchild	93197
	National	DM54197
SN54198	Fairchild	54198
	Fairchild	93198
	National	DM54198
	Raytheon	54198
	Signetics	S54198
SN54199	National	DM54199
	Raytheon	54199
	Signetics	S54199
SN5420	Fairchild	5420
	Fairchild	9N20
	National	DM5420
	Raytheon	5420
	Signetics	S5420
	Signetics	S8819
¶ SN54200	MMI	5531
	National	DM54200
	TI	SN54S201
SN54206	MMI	5530
SN54206	TI	SN54S301
SN5422	Raytheon	5422
SN54221	AMD	SN54221
SN5423	Fairchild	5423
	Fairchild	9N23
	National	DM5423
SN5425	Fairchild	5425
	Fairchild	9N25
	National	DM5425
SN54251	National	DM7121
SN5426	Fairchild	5426
	Fairchild	9N26
	National	DM5426
	Signetics	S5426
	Signetics	S8T18
SN5427	Fairchild	5427
	Fairchild	9N27
	National	DM5427
	SW	SW5427
SN54270	MMI	5205
SN54278	Motorola	MC54278
SN54279	Motorola	MC54279
SN54280	Raytheon	54280
SN54283	Raytheon	54283
SN54284	National	DM7875A
SN54285	National	DM7875B
SN5430	Fairchild	5430
	Fairchild	9N30
	National	DM5430
	Signetics	S5430
	Signetics	S8808
SN5432	Fairchild	5432
	Fairchild	9N32
	National	DM5432
	Signetics	S5432
	SW	SW5432
SN54365	National	DM7095
SN54366	National	DM7096
SN54367	National	DM7097
SN54368	National	DM7098
SN5437	Fairchild	5437
	Fairchild	9N37
	National	DM5437
	Signetics	S5437
SN54370	MMI	5206
SN5438	Fairchild	5438
	Fairchild	9N38
	National	DM5438
	Signetics	S5438
SN5440	Fairchild	5440
	Fairchild	9N40
	National	DM5440
	Signetics	S5440
¶ SN5442	Fairchild	5442
	Fairchild	9352
	National	DM5442
	Raytheon	5442
	Signetics	S5442
	TI	SN5442A
SN54425	National	DM7093
SN54426	National	DM7094
¶ SN5443	Fairchild	5443
	Fairchild	9353
	Raytheon	5443
	Signetics	S5443
	TI	SN5443A
¶ SN5444	Fairchild	5444
	Fairchild	9354
	Raytheon	5444
	Signetics	S5444
	TI	SN5444A
SN5445	Fairchild	5445
	Fairchild	9345
	National	DM5445
	Raytheon	5445
	Signetics	S5445
¶ SN5446	Fairchild	5446
	Fairchild	9357
	National	DM5446
	TI	SN5446A
¶ SN5447	Fairchild	5447

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Texas Instruments (cont)

Manufacturer Device	Replacement Source	Replacement Device
¶ SN5447	Fairchild	9357
	National	DM5447
	TI	SN5447A
SN5448	Fairchild	5448
	Fairchild	9358
	National	DM5448
	Signetics	S5448
SN5449	Fairchild	5449
	Fairchild	9359
SN5450	Fairchild	5450
	Fairchild	9N50
	National	DM5450
	Signetics	S5450
	Signetics	8859
SN5451	Fairchild	5451
	Fairchild	9N51
	National	DM5451
	Signetics	S5451
SN5453	Fairchild	5453
	Fairchild	9N53
	National	DM5453
	Signetics	S5453
SN5454	Fairchild	5454
	Fairchild	9N54
	National	DM5454
	Signetics	S5454
SN5460	Fairchild	5460
	Fairchild	9N60
	National	DM5460
	Signetics	S5460
SN5470	Fairchild	5470
	Fairchild	9N70
	National	DM5470
	Signetics	S5470
SN5472	Fairchild	9N72
	National	DM5472
	Signetics	S5472
SN5473	Fairchild	5473
	Fairchild	9N73
	National	DM5473
	Signetics	S5473
SN5474	Fairchild	5474
	Fairchild	9N74
	National	DM5474
	Raytheon	5474
	Signetics	S5474
SN5475	Fairchild	5475
	Fairchild	9375
	National	DM5475
	Signetics	S5475
SN5476	Fairchild	5476
	Fairchild	9N76
	Motorola	MC5476
	National	DM5476
	Signetics	S5476
SN5477	Fairchild	5477
	Fairchild	9377
	Signetics	S5477
SN5480	Fairchild	5480
	Fairchild	9380
	Signetics	S5480
¶ SN5481	Fairchild	93407
	Raytheon	5481
	TI	SN5481A
SN5482	Fairchild	5482
	Fairchild	9382
¶ SN5483	Fairchild	5483
	Fairchild	9383
	National	DM5483
	Raytheon	5483
	Signetics	S5483
	TI	SN5483A
SN5485	National	DM5485
SN5486	Fairchild	5486
	Fairchild	9N86
	National	DM5486
	Raytheon	5486
	Signetics	S5486
¶ SN5488	Fairchild	93434
	Intersil	IM5600
	MMI	5230
¶ SN5488	National	DM5488
	TI	SN5488A
¶ SN5489	AMD	SN5489
	Fairchild	93403
	MMI	5560
	National	DM5489
	Raytheon	5489
	Signetics	S8225
	TI	SN54S189
¶ SN5490	Fairchild	5490
	Fairchild	9390
	National	DM5490
	Signetics	S5490
	TI	SN5490A
¶ SN5491	Fairchild	5491
	Fairchild	9391
	National	DM5491
	Signetics	S5491
	TI	SN5491A
¶ SN5492	Fairchild	5492
	Fairchild	9392
	National	DM5492
	Signetics	S5492
	TI	SN5492A
¶ SN5493	Fairchild	5493
	Fairchild	9393
	National	DM5493
	Signetics	S5493
	TI	SN5493A
SN5494	Fairchild	5494
	Fairchild	9394
	Signetics	S5494
¶ SN5495	Fairchild	5495
	Fairchild	9395
	National	DM5495
	Signetics	S5495
	TI	SN5495A
SN5496	Fairchild	5496
	Fairchild	9396
	National	DM5496
	Signetics	S5496
SN5510	Motorola	MC1510
SN55107	AMD	SN55107B
	Fairchild	55107
	Motorola	MC55107
	National	DS55107
	Raytheon	RM55107
	Raytheon	55107
SN55108	AMD	SN55108B
	Fairchild	55108
	Motorola	MC55108
	National	DS55108
	Raytheon	RM55108
	Raytheon	55108
SN55109	AMD	SN55109
	Fairchild	55109
	National	DS55109
	Raytheon	RM55109
SN55110	AMD	SN55110
	Fairchild	55110
	National	DS55110
	Raytheon	RM55110
SN55114	ITT	ITT9614
SN55115	ITT	ITT9615
SN55182	National	DS7820
SN55183	National	DS7830
	Signetics	DM7830
SN5520	ITT	ITT5520
	National	DS5520
SN5521	National	DS5521
SN5522	National	DS5522
SN5523	National	DS5523
SN5524	National	DS5524
SN5525	National	DS5525
SN55325	Raytheon	RM55325
SN55450	National	DS55450
	Raytheon	RM55450
	Silicon G	SG55450
SN55451	National	DS55451
	Raytheon	RM55451
SN55452	National	DS55452
SN55452	Raytheon	RM55452
SN55453	National	DS55453
	Raytheon	RM55453
SN55454	National	DS55454
	Raytheon	RM55454
SN55460	ITT	ITT55460
	National	DS55460
	Silicon G	SG55460
SN555	**RCA**	**CA555**
	see page 661	
SN55702	Motorola	MC1712
SN5830	SW	SW930
SN72301	AMD	LM301
	Fairchild	LM301
	Intersil	LM301
	Motorola	MLM301
	National	LM301
	Raytheon	LM301
	RCA	**CA301**
	see page 661	
	Signetics	LM301
	Silicon G	SG301
	Teledyne S	LM301
SN72305	AMD	LM305
	Intersil	LM305
	Raytheon	LM305
	Teledyne S	LM305
SN72307	Fairchild	LM307
	Intersil	LM307
	Motorola	MLM307
	National	LM307
	Raytheon	LM307
	RCA	**CA307**
	see page 661	
	Signetics	LM307
	Silicon G	SG307
	Teledyne S	LM307
SN72308	AMD	LM308
	Intersil	LM308
	Raytheon	LM308
	RCA	CA308
	Silicon G	SG308
	Teledyne S	LM308
SN72310	AMD	LM310
	Intersil	LM310
SN72311	AMD	LM311
	Harris	HA-2311
	Intersil	LM311
	Raytheon	LM311
	RCA	**CA311**
	see page 661	
	Signetics	LM311
	Teledyne S	LM311
SN72514	Raytheon	RC1414
SN72555	AMD	NE555
	Intersil	NE555
	Lithic Sys	LS555
	Raytheon	RC555
	RCA	**CA555**
	see page 661	
	Teledyne S	555
SN72558	Fairchild	1458
	Harris	HA-2655
	Motorola	MC1458
	National	LM1458
	PMI	SSS1458
	Raytheon	RC1458
	Raytheon	**RC4558**
	see page 651	
	RCA	CA1458
	Signetics	MC1458
	Teledyne S	1458
SN72702	Fairchild	702
	Motorola	MC1712
	Raytheon	RC1458
	Raytheon	**RC4558**
	see page 651	
	Raytheon	RC556
SN72709	Fairchild	709
	Motorola	MC1709
	Raytheon	RC709
SN72709	Signetics	μA709
	Teledyne S	709
SN72710	Fairchild	710
	Motorola	MC1710
	National	LM710
	Raytheon	RC710
	Signetics	μA710
	Silicon G	SG710
	Teledyne S	710
SN72711	Fairchild	711
	Motorola	MC1711
	National	LM711
	Raytheon	RC711
	Signetics	μA711
	Silicon G	SG711
	Teledyne S	711
SN72720	National	LM1414
SN72723	AMD	723
	Intersil	723
	Raytheon	RC723
	Signetics	μA723
	Teledyne S	723
SN72733	AMD	733
	Fairchild	733
	Motorola	MC1733
	Raytheon	RC733
	Signetics	μA733
	Silicon G	SG733
SN72741	AMD	741
	Fairchild	741
	Intersil	741
	Motorola	MC1741
	National	LM741
	PMI	SSS741
	Raytheon	RC741
	RCA	**CA741**
	see page 661	
	Signetics	μA741
	Silicon G	SG741
	Teledyne S	741
SN72747	AMD	747
	Fairchild	747
	Motorola	MC1747
	PMI	SSS747
	Raytheon	RC747
	RCA	**CA747**
	see page 661	
	Silicon G	SG747
	Teledyne S	747
SN72748	AMD	748
	Fairchild	748
	Intersil	748
	Motorola	MC1748
	Raytheon	RC748
	RCA	CA748
	Signetics	μA748
	Silicon G	SG748
	Teledyne S	748
SN72777	Intersil	777
SN74H00	Fairchild	74H00
	Fairchild	9H00
	ITT	ITT74H00
	Motorola	MC74H00
	National	DM74H00
	Raytheon	74H00
	Signetics	N74H00
SN74H01	Fairchild	74H01
	Fairchild	9H01
	ITT	ITT74H01
	Motorola	MC74H01
	National	DM74H01
	Raytheon	74H01
	Signetics	N74H01
SN74H04	Fairchild	74H04
	Fairchild	9H04
	ITT	ITT74H04
	Motorola	MC74H04
	National	DM74H04
	Raytheon	74H04
	Signetics	N74H04
SN74H05	Fairchild	74H05

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Bold face device number indicates additional data is provided in Catalog section

Texas Instruments (cont)

Manufacturer Device	Replacement Source	Replacement Device
SN74H05	Fairchild	9H05
	ITT	ITT74H05
	Motorola	MC74H05
	National	DM74H05
	Raytheon	74H05
	Signetics	N74H05
SN74H10	Fairchild	74H10
	Fairchild	9H10
	ITT	ITT74H10
	Motorola	MC74H10
	National	DM74H10
	Raytheon	74H10
	Signetics	N74H10
SN74H101	Motorola	MC74H101
	Signetics	N74H101
SN74H102	Motorola	MC74H102
	Signetics	N74H102
SN74H103	National	DM74H103
	Signetics	N74H103
SN74H106	Fairchild	74H106
	Fairchild	9H106
	National	DM74H106
	Signetics	N74H106
SN74H108	Fairchild	74H108
	Fairchild	9H108
	Motorola	MC74H108
	National	DM74H108
	Signetics	N74H108
SN74H11	Fairchild	74H11
	Fairchild	9H11
	ITT	ITT74H11
	Motorola	MC74H11
	National	DM74H11
	Raytheon	74H11
	Signetics	N74H11
SN74H183	Fairchild	74H183
	Fairchild	93H183
	Hitachi	HD2563
SN74H20	Fairchild	74H20
	Fairchild	9H20
	ITT	ITT74H20
	Motorola	MC74H20
	National	DM74H20
	Raytheon	74H20
	Signetics	N74H20
SN74H21	Fairchild	74H21
	Fairchild	9H21
	ITT	ITT74H21
	Motorola	MC74H21
	National	DM74H21
	Signetics	N74H21
SN74H22	Fairchild	74H22
	Fairchild	9H22
	Motorola	MC74H22
	National	DM74H22
	Raytheon	74H22
	Signetics	N74H22
SN74H30	Fairchild	74H30
	Fairchild	9H30
	ITT	ITT74H30
	Motorola	MC74H30
	National	DM74H30
	Signetics	N74H30
SN74H40	Fairchild	74H40
	Fairchild	9H40
	ITT	ITT74H40
	Motorola	MC74H40
	National	DM74H40
	Raytheon	74H40
	Signetics	N74H40
SN74H50	Fairchild	74H50
	Fairchild	9H50
	ITT	ITT74H50
	Motorola	MC74H50
	National	DM74H50
	Signetics	N74H50
SN74H51	Fairchild	74H51
	Fairchild	9H51
	ITT	ITT74H51
	Motorola	MC74H51
	National	DM74H51
SN74H51	Signetics	N74H51
SN74H52	Fairchild	74H52
	Fairchild	9H52
	Motorola	MC74H52
	National	DM74H52
	Signetics	N74H52
SN74H53	Fairchild	74H53
	Fairchild	9H53
	ITT	ITT74H53
	Motorola	MC74H53
	National	DM74H53
	Signetics	N74H53
SN74H54	Fairchild	74H54
	Fairchild	9H54
	ITT	ITT74H54
	Motorola	MC74H54
	National	DM74H54
	Signetics	N74H54
SN74H55	Fairchild	74H55
	Fairchild	9H55
	Motorola	MC74H55
	National	DM74H55
	Signetics	N74H55
SN74H60	Fairchild	74H60
	Fairchild	9H60
	ITT	ITT74H60
	Motorola	MC74H60
	National	DM74H60
	Signetics	N74H60
SN74H61	Fairchild	74H61
	Fairchild	9H61
	Motorola	MC74H61
	National	DM74H61
	Signetics	N74H61
SN74H62	Fairchild	74H62
	Fairchild	9H62
	Motorola	MC74H62
	National	DM74H62
	Signetics	N74H62
SN74H71	Fairchild	74H71
	Fairchild	9H71
	Motorola	MC74H71
	National	DM74H71
	Signetics	N74H71
SN74H72	Fairchild	74H72
	Fairchild	9H72
	ITT	ITT74H72
	Motorola	MC74H72
	National	DM74H72
	Signetics	N74H72
SN74H73	Fairchild	74H73
	Fairchild	9H73
	ITT	ITT74H73
	Motorola	MC74H73
	National	DM74H73
	Signetics	N74H73
SN74H74	Fairchild	74H74
	Fairchild	9H74
	ITT	ITT74H74
	Motorola	MC74H74
	National	DM74H74
	Raytheon	74H74
	Signetics	N74H74
SN74H76	Fairchild	74H76
	Fairchild	9H76
	ITT	ITT74H76
	Motorola	MC74H76
	National	DM74H76
	Signetics	N74H76
SN74H78	Fairchild	74H78
	Fairchild	9H78
	National	DM74H78
SN74H87	Fairchild	74H87
	Fairchild	93H87
	Motorola	MC74H87
SN74LS00	Fairchild	74LS00
	National	DM74LS00
	Signetics	N74LS00
	see page 384	
SN74LS01	National	DM74LS01
	Signetics	N74LS01
	see page 384	
SN74LS02	Fairchild	74LS02
	Signetics	N74LS02
	see page 384	
SN74LS03	Fairchild	74LS03
	National	DM74LS03
	Signetics	N74LS03
	see page 384	
SN74LS04	Fairchild	74LS04
	National	DM74LS04
	Signetics	N74LS04
	see page 384	
SN74LS05	Fairchild	54LS05
	Signetics	N74LS05
	see page 384	
SN74LS08	Fairchild	74LS08
	Signetics	N74LS08
	see page 384	
SN74LS09	Fairchild	74LS09
	Signetics	N74LS09
	see page 384	
SN74LS10	Fairchild	74LS10
	National	DM74LS10
	Signetics	N74LS10
	see page 384	
SN74LS107	Signetics	N74LS107
	see page 384	
SN74LS109	Fairchild	74LS109
	Signetics	N74LS109
	see page 384	
SN74LS11	Fairchild	74LS11
	Signetics	N74LS11
	see page 384	
SN74LS112	Fairchild	74LS112
	Signetics	N74LS112
	see page 384	
SN74LS113	Fairchild	74LS113
	Signetics	N74LS113
	see page 384	
SN74LS114	Fairchild	74LS114
	Signetics	N74LS114
	see page 384	
SN74LS12	National	DM74LS12
	Signetics	N74LS12
	see page 384	
SN74LS123	AMD	SN74LS123
SN74LS125	Fairchild	74LS125
SN74LS126	Fairchild	74LS126
SN74LS13	Signetics	N74LS13
	see page 384	
SN74LS132	Fairchild	74LS132
	Signetics	N74LS132
	see page 384	
SN74LS136	Fairchild	74LS136
	Signetics	N74LS136
	see page 384	
SN74LS138	AMD	SN74LS138
	Fairchild	74LS138
	Signetics	N74LS138
	see page 384	
SN74LS139	AMD	SN74LS139
	Fairchild	74LS139
	Signetics	N74LS139
	see page 384	
SN74LS14	Fairchild	74LS14
	Signetics	N74LS14
	see page 384	
SN74LS145	Signetics	N74LS145
	see page 384	
SN74LS15	Fairchild	74LS15
	Signetics	N74LS15
	see page 384	
SN74LS151	AMD	SN74LS151
	Fairchild	74LS151
	Signetics	N74LS151
	see page 384	
SN74LS152	Fairchild	74LS152
SN74LS153	AMD	SN74LS153
	Fairchild	74LS153
	Signetics	N74LS153
	see page 384	
SN74LS155	Fairchild	74LS155
SN74LS156	Fairchild	74LS156
SN74LS157	AMD	SN74LS157
	Fairchild	74LS157
	Signetics	N74LS157
	see page 384	
SN74LS158	AMD	SN74LS158
	Fairchild	74LS158
	Signetics	N74LS158
	see page 384	
SN74LS160	AMD	SN74LS160
	Fairchild	74LS160
	Signetics	N74LS160
	see page 384	
SN74LS161	AMD	SN74LS161
	Fairchild	74LS161
	Signetics	N74LS161
	see page 384	
SN74LS162	AMD	SN74LS162
	Fairchild	74LS162
	Signetics	N74LS162
	see page 384	
SN74LS163	AMD	SN74LS163
	Fairchild	74LS163
	Signetics	N74LS163
	see page 384	
SN74LS164	AMD	AM74LS164
	Fairchild	74LS164
	Signetics	N74LS164
	see page 384	
SN74LS170	Fairchild	74LS170
	Signetics	N74LS170
	see page 384	
SN74LS174	AMD	SN74LS174
	Fairchild	74LS174
	Signetics	N74LS174
	see page 384	
SN74LS175	AMD	SN74LS175
	Fairchild	74LS175
	Signetics	N74LS175
	see page 384	
SN74LS181	AMD	SN74LS181
	Fairchild	74LS181
	Signetics	N74LS181
	see page 384	
SN74LS190	AMD	SN74LS190
	Fairchild	74LS190
	Signetics	N74LS190
	see page 384	
SN74LS191	AMD	SN74LS191
	Fairchild	74LS191
	Signetics	N74LS191
	see page 384	
SN74LS192	AMD	SN74LS192
	Fairchild	74LS192
	Signetics	N74LS192
	see page 384	
SN74LS193	AMD	SN74LS193
	Fairchild	74LS193
	Signetics	N74LS193
	see page 384	
SN74LS194A	AMD	SN74LS194
	Fairchild	74LS194
	Signetics	N74LS194A
	see page 384	
SN74LS195	AMD	SN74LS195
	Fairchild	74LS195
	Signetics	N74LS195A
	see page 384	
SN74LS196	Fairchild	74LS196
	Signetics	N74LS196
	see page 384	
SN74LS197	Fairchild	74LS197
	Signetics	N74LS197
	see page 384	
SN74LS20	Fairchild	74LS20
	National	DM74LS20
	Signetics	N74LS20
	see page 384	
SN74LS21	Fairchild	74LS21
	Signetics	N74LS21
	see page 384	

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The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Texas Instruments (cont)

Manufacturer Device	Replacement Source	Replacement Device
SN74LS22	Fairchild	74LS22
	National	DM74LS22
	Signetics	**N74LS22**
	see page 384	
SN74LS221	Signetics	**N74LS221**
	see page 384	
SN74LS251	AMD	SN74LS251
	Fairchild	74LS251
	Signetics	**N74LS251**
	see page 384	
SN74LS253	AMD	SN74LS253
	Fairchild	74LS253
	Signetics	**N74LS253**
	see page 384	
SN74LS257	AMD	SN74LS257
	Fairchild	74LS257
SN74LS258	AMD	SN74LS258
	Fairchild	74LS258
	Signetics	**N74LS258**
	see page 384	
SN74LS259	Fairchild	74LS259
SN74LS26	Fairchild	74LS26
	Signetics	**N74LS26**
	see page 384	
SN74LS260	Fairchild	74LS260
	Signetics	**N74LS260A**
	see page 384	
SN74LS261	Signetics	**N74LS261**
	see page 384	
SN74LS266	Fairchild	74LS266
	Signetics	**N74LS266**
	see page 384	
SN74LS27	Fairchild	74LS27
	Signetics	N74LS27
SN74LS279	Fairchild	74LS279
SN74LS28	Signetics	**N74LS28**
	see page 384	
SN74LS283	Fairchild	74LS283
	Signetics	**N74LS283**
	see page 384	
SN74LS290	Fairchild	74LS290
	Signetics	**N74LS290**
	see page 384	
SN74LS293	Fairchild	74LS293
	Signetics	**N74LS293**
	see page 384	
SN74LS295A	Fairchild	74LS295
	Signetics	**N74LS295A**
	see page 384	
SN74LS298	Fairchild	74LS298
SN74LS30	Fairchild	74LS30
	National	DM74LS30
	Signetics	**N74LS30**
	see page 384	
SN74LS32	Fairchild	74LS32
	Signetics	**N74LS32**
	see page 384	
SN74LS33	Signetics	**N74LS33**
	see page 384	
SN74LS368	Fairchild	74LS368
	Signetics	N74LS368
SN74LS37	Fairchild	74LS37
	Signetics	**N74LS37**
	see page 384	
SN74LS38	Fairchild	74LS38
	Signetics	**N74LS38**
	see page 384	
SN74LS40	Fairchild	74LS40
	Signetics	**N74LS40**
	see page 384	
SN74LS42	Fairchild	74LS42
	Signetics	**N74LS42**
	see page 384	
SN74LS51	Fairchild	74LS51
	Signetics	**N74LS51**
	see page 384	
SN74LS54	Fairchild	74LS54
	Signetics	**N74LS54**
	see page 384	
SN74LS670	Fairchild	74LS670
	Signetics	**N74LS670**
	see page 384	

Manufacturer Device	Replacement Source	Replacement Device
SN74LS73	Fairchild	74LS73
	Signetics	**N74LS73**
	see page 384	
SN74LS74	Fairchild	74LS74
	Signetics	**N74LS74**
	see page 384	
SN74LS76	Signetics	**N74LS76**
	see page 384	
SN74LS78	Signetics	**N74LS78**
	see page 384	
SN74LS83A	Signetics	**N74LS83A**
	see page 384	
SN74LS86	Fairchild	74LS86
	Signetics	**N74LS86**
	see page 384	
SN74LS90	Fairchild	74LS90
	Signetics	**N74LS90**
	see page 384	
SN74LS92	Fairchild	74LS92
	Signetics	**N74LS92**
	see page 384	
SN74LS93	Fairchild	74LS93
	Signetics	**N74LS93**
	see page 384	
SN74LS95B	Fairchild	74LS95
	Signetics	**N74LS95B**
	see page 384	
SN74LS96	Signetics	**N74LS96**
	see page 384	
SN74L00	National	DM74L00
SN74L01	National	DM74L01
SN74L02	National	DM74L02
SN74L03	National	DM74L03
SN74L04	National	DM74L04
SN74L10	National	DM74710
SN74L123	National	DM74L123
SN74L154	National	DM74L154A
SN74L157	National	DM74L157A
SN74L164	National	DM74L164
SN74L192	National	DM74L192
SN74L193	National	DM74L193
SN74L20	National	DM74L20
SN74L30	National	DM74L30
SN74L42	National	DM74L42A
SN74L51	National	DM74L51
SN74L54	National	DM74L54
SN74L55	National	DM74L55
SN74L71	National	DM74L71
SN74L72	National	DM74L72
SN74L73	National	DM74L73
SN74L74	National	DM74L74
¶ SN74L75	National	DM74L75
SN74L78	National	DM74L78
SN74L85	National	DM74L85
SN74L86	National	DM74L86
SN74L90	National	DM74L90
SN74L91	National	DM74L91
SN74L93	National	DM74L93
SN74L95	National	DM74L95
SN74L98	National	DM74L98
SN74S00	Fairchild	74S00
	Fairchild	9S00
	National	DM74S00
	Signetics	N74S00
SN74S03	Fairchild	74S03
	Fairchild	9S03
	National	DM74S03
	Signetics	N74S03
SN74S04	Fairchild	74S04
	Fairchild	9S04
	National	DM74S04
	Signetics	N74S04
SN74S05	Fairchild	74S05
	Fairchild	9S05
	National	DM74S05
	Signetics	N74S05
SN74S10	National	DM74S10
	Signetics	N74S10
SN74S109	Fairchild	9S109
SN74S11	Fairchild	9S11
	National	DM74S11

Manufacturer Device	Replacement Source	Replacement Device
SN74S11	Signetics	N74S11
SN74S112	Fairchild	74S112
	Fairchild	9S112
	National	DM74S112
SN74S113	Fairchild	74S113
	Fairchild	9S113
	National	DM74S113
SN74S114	Fairchild	74S114
	Fairchild	9S114
	National	DM74S114
SN74S133	Fairchild	9S133
SN74S134	Fairchild	9S134
SN74S138	AMD	SN54S138
SN74S139	AMD	SN74S139
SN74S140	Fairchild	74S140
	Fairchild	9S140
	National	DM74S140
SN74S15	National	DM74S15
	Signetics	N74S15
SN74S151	AMD	SN74S151
	National	DM74S151
	Signetics	N74S151
SN74S153	AMD	SN74S153
	Fairchild	93S153
	National	DM74S153
	Signetics	N74S153
SN74S157	AMD	SN74S157
	Fairchild	93S157
	National	DM74S157
	Signetics	N74S157
SN74S158	AMD	SN74S158
	Fairchild	93S158
	Signetics	N74S158
SN74S174	AMD	SN74S174
	Signetics	N74S174
SN74S175	AMD	SN74S175
	Fairchild	93S175
	Signetics	N74S175
SN74S181	AMD	SN74S181
	Fairchild	74S181
	Fairchild	93S41
	Signetics	N74S181
SN74S188	AMD	AM27S09
	Harris	**HM7602**
	see page 746	
	MMI	6330
	Signetics	**N82S23**
	see page 804, 826, 828,	
SN74S189	AMD	AM27S03
	AMD	SN74S189
	Fairchild	93405
SN74S194	AMD	SN74S194
	Fairchild	93S194
	Signetics	N74S194
SN74S195	AMD	SN74S195
	Fairchild	93S00
SN74S196	Fairchild	82S90
SN74S197	Fairchild	82S91
SN74S20	Fairchild	74S20
	Fairchild	9S20
	National	DM74S20
	Signetics	N74S20
SN74S200	Fairchild	93421
	Intersil	IM5523
	MMI	6531
	National	DM74S200
	Raytheon	RC5340
	Signetics	N74S200
	TI	SN74S201
SN74S201	MMI	6531
	Signetics	**N74S201**
	see page 804, 806, 815,	
SN74S206	Fairchild	93411
	Intersil	IM5533
	MMI	6205
	Raytheon	RC5330
	Signetics	**N82S17**
	see page 804, 806, 815,	
	TI	SN74S301
SN74S22	Fairchild	74S22
	Fairchild	9S22

Manufacturer Device	Replacement Source	Replacement Device
SN74S22	National	DM74S22
	Signetics	N74S22
SN74S251	AMD	SN74S25
	Signetics	N74S251
SN74S257	AMD	SN74S257
	Signetics	N74S257
SN74S258	AMD	SN74S258
	Fairchild	93S258
	Signetics	N74S258
SN74S270	Intersil	IM5604
	MMI	6205
SN74S287	Intel	**3621-1**
	see page 772, 773	
	Intersil	IM5603
	MMI	6301
	National	DM74S287
	National	7574
	Signetics	N82S129
SN74S288	MMI	6331
	Signetics	**N82S123**
	see page 804, 826, 828,	
SN74S289	AMD	SN74S289
	Fairchild	93404
	Signetics	**N82S25**
	see page 804, 806, 814,	
SN74S301	Signetics	**N74S301**
	see page 804, 806, 815,	
SN74S370	MMI	6206
SN74S371	MMI	H6236
SN74S387	Intel	**3601-1**
	see page 772, 773	
	MMI	6300
	National	DM74S387
	National	DM8573
	Signetics	**N82S126**
	see page 804, 826, 835,	
SN74S40	Fairchild	74S40
	Fairchild	9S40
	National	DM74S40
	Signetics	N74S40
SN74S64	Fairchild	74S64
	Fairchild	9S64
	National	DM74S64
	Signetics	N74S64
SN74S65	Fairchild	74S65
	Fairchild	9S65
	National	DM74S65
	Signetics	N74S65
SN74S74	Fairchild	74S74
	Fairchild	9S74
	National	DM74S74
	Signetics	N74S74
SN74S86	National	DM74S86
SN7400	Fairchild	7400
	Fairchild	9N00
	Hitachi	HD2503
	ITT	ITT7400
	Motorola	MC7400
	National	DM7400
	Raytheon	7400
	Signetics	N7400
	Signetics	8889
	SW	SW7400
	TRW	7400
SN7401	Fairchild	7401
	Fairchild	9N01
	Hitachi	HD2509
	ITT	ITT7401
	Motorola	MC7401
	National	DM7401
	Raytheon	7401
	Signetics	N7401
	SW	SW7401
	TRW	7401
SN7402	Fairchild	7402
	Fairchild	9N02
	Hitachi	HD2511
	ITT	ITT7402
	Motorola	MC7402
	National	DM7402
	Signetics	N7402

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Manufacturer Device	Replacement Source	Replacement Device
SN7402	SW	SW7402
	TRW	7402
SN7403	Fairchild	7403
	Fairchild	9N03
	Hitachi	HD2528
	ITT	ITT7403
	Motorola	MC7403
	National	DM7403
	Raytheon	7403
	Signetics	N7403
	SW	SW7403
	TRW	7403
SN7404	Fairchild	7404
	Fairchild	9N04
	Hitachi	HD2522
	ITT	ITT7404
	Motorola	MC7404
	National	DM7404
	Raytheon	7404
	Signetics	N7404
	SW	SW7404
	TRW	7404
SN7405	Fairchild	7405
	Fairchild	9N05
	Hitachi	HD2523
	ITT	ITT7405
	Motorola	MC7405
	National	DM7405
	Raytheon	7405
	Signetics	N7405
	Signetics	8891
	SW	SW7405
	TRW	7405
SN7406	Fairchild	7406
	Fairchild	9N06
	ITT	ITT7406
	Motorola	MC7406
	National	DM7406
	Signetics	N7406
	SW	SW7406
	TRW	7406
SN7407	Fairchild	7407
	Fairchild	9N07
	ITT	ITT7407
	Motorola	MC7407
	National	DM7407
	Signetics	N7407
	SW	SW7407
	TRW	7407
SN7408	Fairchild	7408
	Fairchild	9N08
	Hitachi	HD2550
	ITT	ITT7408
	Motorola	MC7408
	National	DM7408
	Raytheon	7408
	Signetics	N7408
	SW	SW7408
	TRW	7408
SN7409	Fairchild	7409
	Fairchild	9N09
	Hitachi	HD2551
	ITT	ITT7409
	Motorola	MC7409
	National	DM7409
	Raytheon	7409
	Signetics	N7409
	SW	SW7409
	TRW	7409
SN7410	Fairchild	7410
	Fairchild	9N10
	Hitachi	HD2507
	ITT	ITT7410
	Motorola	MC7410
	National	DM7410
	Raytheon	7410
	Signetics	N7410
	Signetics	8879
	SW	SW7410
	TRW	7410
SN74100	Motorola	MC74100
SN74100	Signetics	N74100
	SW	SW74100
¶ SN74104	ITT	ITT74104
	SW	SW74104
	TI	SN29000
¶ SN74105	ITT	ITT74105
	SW	SW74105
	TI	SN29001
SN74107	AMD	SN74107
	Fairchild	74107
	Fairchild	9N107
	Hitachi	HD2530
	ITT	ITT74107
	Motorola	MC74107
	National	DM74107
	Signetics	N74107
	SW	SW74107
SN74109	ITT	ITT74109
	ITT	ITT9024
	National	DM74109
	Signetics	N74109
SN74111	TRW	74111
SN7412	Fairchild	7412
	Fairchild	9N12
	ITT	ITT7412
	Motorola	MC7412
	Raytheon	7412
	TRW	7412
SN74121	Fairchild	74121
	Fairchild	9603
	Hitachi	HD2543
	ITT	ITT74121
	Motorola	MC74121
	National	DM74121
	Signetics	N74121
	SW	SW74121
	TRW	74121
SN74122	ITT	ITT74122
	Motorola	MC74122
	National	DM74122
	Signetics	N74122
	Signetics	8T22
	SW	SW74122
SN74123	AMD	AM26123
	AMD	SN74123
	Hitachi	HD2561
	ITT	ITT74123
	Motorola	MC74123
	National	DM74123
	Raytheon	74123
	Signetics	N74123
	SW	SW74123
	TRW	74123
SN74125	National	DM8093
	National	DM8094
	Signetics	N74125
SN74126	Signetics	N74126
SN74129	National	DM74193
SN7413	Fairchild	7413
	Fairchild	9N13
	Hitachi	HD2545
	ITT	ITT7413
	National	DM7413
	Signetics	N7413
	SW	SW7413
	TRW	7413
SN74132	National	DM74132
SN74136	Motorola	MC74136
	Raytheon	74136
	TRW	74136
SN7414	National	DM7414
SN74141	Fairchild	74141
	Fairchild	93141
	Hitachi	HD2558
	ITT	ITT74141
	National	DM74141
	National	DM7441
	Signetics	N74141
	Signetics	N7441
	SW	SW74141
SN74145	Fairchild	74145
SN74145	Fairchild	93145
	Hitachi	HD2555
	ITT	ITT74145
	Motorola	MC74145
	National	DM74145
	Raytheon	74145
	Signetics	N74145
	SW	SW74145
	TRW	74145
SN74150	Fairchild	74150
	Fairchild	93150
	Hitachi	HD2548
	ITT	ITT74150
	Motorola	MC74150
	National	DM74150
	Raytheon	74150
	Signetics	N74150
	SW	SW74150
	TRW	74150
¶ SN74151	Fairchild	74151
	Fairchild	93151
	Hitachi	HD2549
	ITT	ITT74151
	Motorola	MC74151
	National	DM74151
	Raytheon	74151
	Signetics	N74151
	SW	SW74151
	TI	SN74151A
	TRW	74151
¶ SN74152	Fairchild	74152
	Fairchild	93152
	Motorola	MC74152
	Raytheon	74152
	TRW	74152
SN74153	AMD	SN74153
	Fairchild	74153
	Fairchild	93153
	Hitachi	HD2564
	ITT	ITT74153
	Motorola	MC74153
	National	DM74153
	Raytheon	74153
	Signetics	N74153
	SW	SW74153
	TRW	74153
SN74154	AMD	SN74154
	Fairchild	9311
	Hitachi	HD2580
	ITT	ITT74154
	Motorola	MC74154
	National	DM74154
	Raytheon	74154
	Signetics	N74154
	SW	SW74154
	TRW	74154
SN74155	Fairchild	93155
	ITT	ITT74155
	Motorola	MC74155
	National	DM74155
	Raytheon	74155
	Signetics	N74155
	SW	SW74155
	TRW	74155
SN74156	Fairchild	93156
	ITT	ITT74156
	Motorola	MC74156
	National	DM74156
	Raytheon	74156
	Signetics	N74156
	SW	SW74156
	TRW	74156
SN74157	AMD	SN74157
	Fairchild	9322
	ITT	ITT74157
	ITT	ITT9322
	Motorola	MC74157
	National	DM74157
	National	DM8322
	Raytheon	74157
	Signetics	N74157
SN74157	SW	SW74157
SN74159	Raytheon	74159
SN7416	Fairchild	7416
	Fairchild	9N16
	ITT	ITT7416
	Motorola	MC7416
	National	DM7416
	Signetics	N7416
	SW	SW7416
	TRW	7416
SN74160	AMD	SN74160
	Fairchild	9310
	ITT	ITT74160
	Motorola	MC74160
	National	DM74160
	Raytheon	74160
	Signetics	N74160
	TRW	74160
SN74161	AMD	SN74161
	Fairchild	9316
	ITT	ITT74161
	ITT	ITT9316
	Motorola	MC74161
	National	DM74161
	Raytheon	74161
	Signetics	N74161
	TRW	74161
SN74162	AMD	SN74162
	ITT	ITT74162
	National	DM74162
	Raytheon	74162
	Signetics	N74162
	TRW	74162
SN74163	AMD	SN74163
	ITT	ITT74163
	National	DM74163
	Raytheon	74163
	Signetics	N74163
	TRW	74163
SN74164	AMD	SN74164
	Fairchild	74164
	Fairchild	93164
	ITT	ITT74164
	Motorola	MC74164
	National	DM74164
	National	DM8570
	Raytheon	74164
	Signetics	N74164
SN74165	Fairchild	74165
	Fairchild	93165
	ITT	ITT74165
	Motorola	MC74165
	National	DM74165
	National	DM8590
	Raytheon	74165
	Signetics	N74165
SN74166	Fairchild	74166
	Fairchild	93166
	ITT	ITT74166
	Motorola	MC74166
	National	DM74166
	Raytheon	74166
	Signetics	N74166
SN7417	Fairchild	7417
	Fairchild	9N17
	ITT	ITT7417
	Motorola	MC7417
	National	DM7417
	Signetics	N7417
	TRW	7417
SN74170	Fairchild	74170
	Hitachi	HD2540
	National	DM74170
	Raytheon	74170
	Signetics	N74170
SN74172	Signetics	N74172
SN74173	National	DM8551
SN74174	AMD	SN74174
	Fairchild	93174
	ITT	ITT74174
	National	DM74174

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Texas Instruments (cont)

Manufacturer Device	Replacement Source	Replacement Device
SN74174	Raytheon	74174
	Signetics	N74174
SN74175	AMD	SN74175
	Fairchild	93175
	ITT	ITT74175
	National	DM74175
	Raytheon	74175
	Signetics	N74175
SN74176	Fairchild	74176
	Fairchild	82S90
	Fairchild	93176
	Motorola	MC74176
	National	DM74176
	National	DM8280
	Signetics	N8280
SN74177	Fairchild	74177
	Fairchild	82S91
	Fairchild	93177
	Motorola	MC74177
	National	DM74177
	National	DM8281
	Signetics	N8281
SN74178	Fairchild	74178
	Fairchild	82S70
	Fairchild	93178
	Motorola	MC74178
	Signetics	N8270
SN74179	Fairchild	74179
	Fairchild	82S72
	Fairchild	93179
	Motorola	MC74179
	Signetics	N8271
SN74180	Fairchild	74180
	Fairchild	93180
	Hitachi	HD2525
	ITT	ITT74180
	Motorola	MC74180
	National	DM74180
	Raytheon	74180
	Signetics	N74180
	SW	SW74180
	TRW	74180
SN74181	AMD	SN74181
	AMD	9341
	Fairchild	74181
	Fairchild	9341
	Hitachi	HD2547
	ITT	ITT74181
	Motorola	MC74181
	National	DM74181
	Raytheon	74181
	Signetics	N74181
	SW	SW74181
SN74182	AMD	SN74182
	AMD	9342
	Fairchild	74182
	Fairchild	9342
	Hitachi	HD2562
	ITT	ITT74182
	Motorola	MC74182
	National	DM74182
	Raytheon	74182
	Signetics	N74182
	SW	SW74182
SN74184	National	DM74184
SN74185A	National	DM74185A
SN74186	Harris	HPROM-0512
SN74187	Fairchild	93406
	Intersil	IM5603
	MMI	6200
	National	DM74187
	Signetics	N82S226
SN74188	Harris	HPROM-8256
	Intersil	IM5600
	Signetics	**N82S23**
	see page 804, 826, 828,	
	TI	SN74188A
SN74188A	MMI	6330
	National	DM8577
SN74190	Fairchild	74190
	Fairchild	93190
SN74190	ITT	ITT74190
	Motorola	MC74190
	National	DM74190
	Raytheon	74190
	Signetics	N74190
SN74191	Fairchild	74191
	Fairchild	93191
	ITT	ITT74191
	Motorola	MC74191
	National	DM74191
	Raytheon	74191
	Signetics	N74191
SN74192	AMD	SN74192
	AMD	9360
	Fairchild	74192
	Fairchild	9360
	ITT	ITT74192
	Motorola	MC74192
	National	DM74192
	National	DM8560
	Raytheon	74192
	Signetics	N74192
	SW	SW74192
SN74193	AMD	SN74193
	AMD	9366
	Fairchild	74193
	Fairchild	9366
	ITT	ITT74193
	Motorola	MC74193
	National	DM8563
	Raytheon	74193
	Signetics	N74193
	SW	SW74193
SN74194	AMD	SN74194
	ITT	ITT74194
	Motorola	MC74194
	National	DM74194
	Raytheon	74194
	Signetics	N74194
SN74195	AMD	SN74195
	Fairchild	9300
	ITT	ITT74195
	ITT	ITT9300
	Motorola	MC74195
	National	DM8300
	Raytheon	74195
	Signetics	N74195
SN74196	Fairchild	74196
	Fairchild	82S90
	Fairchild	93196
	Motorola	MC74196
	National	DM74196
	Signetics	N8290
SN74197	Fairchild	74197
	Fairchild	82S91
	Fairchild	93197
	Motorola	MC74197
	National	DM74197
	Signetics	N8291
SN74198	Fairchild	74198
	Fairchild	93198
	Motorola	MC74198
	National	DM74198
	Raytheon	74198
	Signetics	N74198
SN74199	Fairchild	93199
	Motorola	MC74199
	National	DM74199
	Raytheon	74199
	Signetics	N74199
SN7420	Fairchild	7420
	Fairchild	9N20
	Hitachi	HD2504
	ITT	ITT7420
	Motorola	MC7420
	National	DM7420
	Raytheon	7420
	Signetics	N7420
	Signetics	N8819
	SW	SW7420
	TRW	7420
SN74200	Fairchild	93421
	Intersil	IM5523
	MMI	6531
	National	DM74200
	Raytheon	RC5340
	Signetics	N82S06
	TI	SN74S201
SN74206	Intersil	IM5533
	MMI	6530
	Raytheon	RC5330
	TI	SN74S301
SN7422	Raytheon	7422
SN74221	AMD	SN74221
SN7423	Fairchild	7423
	Fairchild	9N23
	Motorola	MC7423
	National	DM7423
	SW	SW7423
SN7425	Fairchild	7425
	Fairchild	9N25
	Motorola	MC7425
	National	DM7425
	SW	SW7425
SN74251	National	DM8121
SN7426	Fairchild	7426
	Fairchild	9N26
	Hitachi	HD2560
	ITT	ITT7426
	Motorola	MC7426
	National	DM7426
	Signetics	N7426
	Signetics	N8T18
	SW	SW7426
	TRW	7426
SN7427	Fairchild	7427
	Fairchild	9N27
	Motorola	MC7427
	National	DM7427
	SW	SW7427
SN74270	MMI	6205
SN7428	ITT	ITT7428
SN74283	Raytheon	74283
SN74284	National	DM8875A
SN74285	National	DM8875B
SN74287	Fairchild	93426
SN74290	TRW	74290
SN74293	TRW	74293
SN7429301	ITT	ITT9301
SN7430	Fairchild	7430
	Fairchild	9N30
	Hitachi	HD2508
	ITT	ITT7430
	Motorola	MC7430
	National	DM7430
	Signetics	N7430
	SW	SW7430
	TRW	7430
SN7432	Fairchild	7432
	Fairchild	9N32
	ITT	ITT7432
	National	DM7432
	Signetics	N7432
	SW	SW7432
SN7433	ITT	ITT7433
SN74365	National	DM8095
SN74366	National	DM8096
SN74367	National	DM8097
SN74368	National	DM8098
SN7437	Fairchild	7437
	Fairchild	9N37
	Hitachi	HD2552
	ITT	ITT7437
	Motorola	MC7437
	National	DM7437
	Signetics	N7437
	SW	SW7437
	TRW	7437
SN74370	MMI	6206
SN7438	Fairchild	7438
	Fairchild	9N38
	Hitachi	HD2544
SN7438	ITT	ITT7438
	Motorola	MC7438
	National	DM7438
	Signetics	N7438
	SW	SW7438
	TRW	7438
SN74387	Fairchild	93416
SN7440	Fairchild	7440
	Fairchild	9N40
	Hitachi	HD2501
	ITT	ITT7440
	Motorola	MC7440
	National	DM7440
	Signetics	N7440
	SW	SW7440
	TRW	7440
¶ SN7441A	National	DM7441A
	TI	SN74141
¶ SN7442	Fairchild	7442
	Fairchild	9352
	Hitachi	HD2536
	ITT	ITT7442
	Motorola	MC7442
	National	DM7442
	Raytheon	7442
	Signetics	N7442
	SW	SW7442
	TI	SN7442A
SN74425	National	DM8083
SN74426	National	DM8094
¶ SN7443	Fairchild	7443
	Fairchild	9353
	Hitachi	HD2537
	ITT	ITT7443
	Motorola	MC7443
	Raytheon	7443
	Signetics	N7443
	SW	SW7443
	TI	SN7443A
¶ SN7444	Fairchild	7444
	Fairchild	9354
	Hitachi	HD2538
	ITT	ITT7444
	Motorola	MC7444
	Raytheon	7444
	Signetics	N7444
	SW	SW7444
	TI	SN7444A
SN7445	Fairchild	7445
	Fairchild	9345
	Hitachi	HD2531
	ITT	ITT7445
	Motorola	MC7445
	National	DM7445
	Raytheon	7445
	Signetics	N7445
	SW	SW7445
	TRW	7445
¶ SN7446	Fairchild	7446
	Fairchild	9357
	Hitachi	HD2553
	ITT	ITT7446
	Motorola	MC7446
	National	DM7446
	Signetics	N7446
	SW	SW7446
	TI	SN7446A
¶ SN7447	Fairchild	7447
	Hitachi	HD2532
	ITT	ITT7447
	Motorola	MC7447
	National	DM7447
	Signetics	N7447
	SW	SW7447
	TI	SN7447A
SN7448	Fairchild	7448
	Fairchild	9358
	ITT	ITT7448
	Motorola	MC7448
	National	DM7448
	Signetics	N7448

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Bold face device number indicates additional data is provided in Catalog section

Texas Instruments (cont)

Manufacturer Device	Replacement Source	Replacement Device
SN7448	Signetics	N8T04
	Signetics	N8T05
	SW	SW7448
SN7449	Fairchild	7449
	Fairchild	9359
	Motorola	MC7449
SN7450	Fairchild	7450
	Fairchild	9N50
	Hitachi	HD2506
	ITT	ITT7450
	Motorola	MC7450
	National	DM7450
	Signetics	N7450
	Signetics	N8859
	SW	SW7450
	TRW	7450
SN7451	Fairchild	7451
	Fairchild	9N51
	Hitachi	HD2505
	ITT	ITT7451
	Motorola	MC7451
	National	DM7451
	Signetics	N7451
	SW	SW7451
	TRW	7451
SN7453	Fairchild	7453
	Fairchild	9N53
	Hitachi	HD2512
	ITT	ITT7453
	Motorola	MC7453
	National	DM7453
	Signetics	N7453
	SW	SW7453
	TRW	7453
SN7454	Fairchild	7454
	Fairchild	9N54
	Hitachi	HD2514
	ITT	ITT7454
	Motorola	MC7454
	National	DM7454
	Signetics	N7454
	SW	SW7454
	TRW	7454
SN7460	Fairchild	7460
	Fairchild	9N60
	Hitachi	HD2502
	ITT	ITT7460
	Motorola	MC7460
	National	DM7460
	Signetics	N7460
	SW	SW7460
	TRW	7460
SN7470	Fairchild	7470
	Fairchild	9N70
	Hitachi	HD2539
	ITT	ITT7470
	Motorola	MC7470
	National	DM7470
	Signetics	N7470
SN7472	Fairchild	7472
	Fairchild	9N72
	Hitachi	HD2529
	ITT	ITT7472
	Motorola	MC7472
	National	DM7472
	Signetics	N7472
	SW	SW7472
	TRW	7472
SN7473	Fairchild	7473
	Fairchild	9N73
	Hitachi	HD2515
	ITT	ITT7473
	National	DM7473
	Signetics	N7473
	SW	SW7473
SN7474	Fairchild	7474
	Fairchild	9N74
	Hitachi	HD2510
	ITT	ITT7474
	Motorola	MC7474
	National	DM7474
SN7474	Raytheon	7474
	Signetics	N7474
	SW	SW7474
	TRW	N7474
SN7475	Fairchild	7475
	Fairchild	9375
	Hitachi	HD2517
	ITT	ITT7475
	Motorola	MC7475
	National	DM7475
	Signetics	N7475
	SW	SW7475
	TRW	7475
SN7476	Fairchild	7476
	Fairchild	9N76
	Hitachi	HD2516
	ITT	ITT7476
	Motorola	MC7476
	National	DM7476
	Signetics	N7476
	SW	SW7476
	TRW	7476
¶ SN7477	Fairchild	7477
	Fairchild	9377
	Motorola	MC7477
¶ SN7480	Fairchild	7480
	Fairchild	9380
	ITT	ITT7480
	Motorola	MC7480
	Signetics	N7480
	Signetics	8268
	SW	SW7480
¶ SN7481	Fairchild	93407
	Hitachi	HM2501
	ITT	ITT7481
	Motorola	MC4004
	Raytheon	7481
	TI	SN7481A
	TRW	7481
SN7482	Fairchild	7482
	Fairchild	9382
	Hitachi	HD2513
	ITT	ITT7482
	National	DM7482
	SW	SW7482
¶ SN7483	Fairchild	7483
	Fairchild	9383
	Hitachi	HD2535
	ITT	ITT7483
	Motorola	MC7483
	National	DM7483
	Raytheon	7483
	Signetics	N7483
	TI	SN7483A
¶ SN7484	ITT	ITT7484
	Motorola	MC7484
	TI	SN7484A
SN7485	Motorola	MC7485
	National	DM7485
	Signetics	N7485
	SW	SW7485
	TRW	7485
SN7486	Fairchild	7486
	Fairchild	9N86
	Hitachi	HD2526
	ITT	ITT7486
	Motorola	MC7486
	National	DM7486
	Raytheon	7486
	Signetics	N7486
	SW	SW7486
	TRW	7486
¶ SN7488	Fairchild	93434
	Intersil	IM5600
	ITT	ITT7488
	MMI	6230
	Motorola	MCM4002
	National	DM7488
	TI	SN7488A
SN7489	AMD	SN7489
	Fairchild	7489
SN7489	Hitachi	HM2502
	Intersil	IM5501
	National	DM7489
	Raytheon	7489
	Signetics	**N82S25**
	see page 804, 806, 814,	
	TRW	7489
¶ SN7490	Fairchild	7490
	Fairchild	9390
	Hitachi	HD2519
	ITT	ITT7490
	Motorola	MCM4023
	Motorola	MC7490
	National	DM7490
	Signetics	N7490
	SW	SW7490
	TI	SN7490A
	TRW	7490
¶ SN7491	Fairchild	7491
	Fairchild	9391
	Hitachi	HD2524
	ITT	ITT7491
	Motorola	MC7491
	National	DM7491
	Signetics	N7491
	SW	SW7491
	TI	SN7491A
¶ SN7492	Fairchild	7492
	Fairchild	9392
	Hitachi	HD2521
	ITT	ITT7492
	Motorola	MC7492
	National	DM7492
	Signetics	N7492
	SW	SW7492
	TI	SN7492A
	TRW	7492
¶ SN7493	Fairchild	7493
	Fairchild	9392
	Hitachi	HD2520
	ITT	ITT7493
	Motorola	MC7493
	National	DM7493
	Signetics	N7493
	SW	SW7493
	TI	SN7493A
	TRW	7493
SN7494	Fairchild	7494
	Fairchild	9394
	Hitachi	HD2533
	ITT	ITT7494
	Motorola	MC7494
	Signetics	N7494
	SW	SW7494
¶ SN7495	Fairchild	7495
	Fairchild	9395
	Hitachi	HD2534
	ITT	ITT7495
	Motorola	MC7495
	National	DM7495
	Signetics	N7495
	SW	SW7495
	TI	SN7495A
SN7496	Fairchild	7496
	Fairchild	9396
	Hitachi	HD2546
	ITT	ITT7496
	Motorola	MC7496
	National	DM7496
	Signetics	N7496
	SW	SW7496
	TRW	7496
SN7510	Motorola	MC1410
SN75107	AMD	SN75107B
	Fairchild	75107
	ITT	ITT75107
	Motorola	MC75107
	National	DS75107
	Raytheon	RC75107
SN75108	AMD	SN75108B
	Fairchild	75108
SN75108	ITT	ITT75108
	Motorola	MC75108
	National	DS75108
	Raytheon	RC75108
SN75109	AMD	SN75109
	Fairchild	75109
	ITT	ITT75109
	Motorola	MC75109
	National	DS75109
	Raytheon	RC75109
SN75110	AMD	SN75110
	Fairchild	75110
	ITT	ITT75110
	Motorola	MC75110
	National	DS75110
	Raytheon	RC75110
SN75114	Fairchild	9614
SN75115	Fairchild	9615
SN75121	National	DS75121
SN75122	National	DS75122
SN75123	National	DS75123
SN75124	National	DS75124
SN75140	Motorola	MC75140
SN75150	National	DS75150
	Raytheon	RC75150
SN75152	Fairchild	9627
SN75154	ITT	ITT9311
	National	DS75154
	Raytheon	RC75154
SN75182	AMD	8820
	National	DS8820
	Signetics	DM8820
SN75183	AMD	8830
	National	DS8830
	Signetics	DM8830
SN75188	ITT	ITT1448
	Signetics	MC1488
SN75189	ITT	ITT1449
	Signetics	MC1489
SN7520	ITT	ITT7520
	Motorola	MC7520
	National	DS7520
	Signetics	7520
	Silicon G	SG7520
SN75207	National	DS75207
SN7521	ITT	ITT7521
	Motorola	MC7521
	National	DS7521
	Signetics	7521
	Silicon G	SG7521
SN7522	ITT	ITT7522
	Motorola	MC7522
	National	DS7522
	Signetics	7522
	Silicon G	SG7522
SN7523	ITT	ITT7523
	Motorola	MC7523
	National	DS7523
	Signetics	7523
	Silicon G	SG7523
SN75234	Fairchild	75234
	ITT	ITT75234
	Motorola	MC75234
SN75235	Fairchild	75235
	ITT	ITT75235
	Motorola	MC75235
SN75236	ITT	ITT75236
SN75238	Motorola	MC75238
SN75239	Motorola	MC75239
SN7524	Fairchild	7524
	ITT	ITT7524
	Motorola	MC7524
	National	DS7524
	Signetics	7524
	Silicon G	SG7524
SN7525	Fairchild	7525
	ITT	ITT7525
	Motorola	MC7525
	National	DS7525
	Silicon G	SG7525
SN7528	ITT	ITT7528

¶ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Texas Instruments (cont)

Manufacturer Device	Replacement Source	Replacement Device
SN7528	Motorola	MC7528
	National	DS7528
	Silicon G	SG7528
SN7529	ITT	ITT7529
	Motorola	MC7529
	National	DS7529
	Silicon G	SG7529
SN75324	National	DS75324
	Raytheon	RC75324
SN75325	ITT	ITT75325
	Motorola	MC75325
	National	DS75325
	Raytheon	RC75325
SN75326	ITT	ITT75326
SN75327	ITT	ITT75327
SN7534	ITT	ITT7534
	National	DS7534
	Silicon G	SG7534
SN7535	ITT	ITT7535
	National	DS7535
	Silicon G	SG7535
SN75361	ITT	ITT75361
	National	DS75361
SN75365	ITT	ITT75365
	National	DS75365
SN75370	ITT	ITT75370
SN7538	Silicon G	SG7538
SN7539	Silicon G	SG7539
SN75450	Hitachi	HD2574
	ITT	ITT75450
	Motorola	MC75450
	National	DS75450
	Raytheon	RC75450
	Signetics	75450
	Silicon G	SG75450
	Teledyne S	75450
SN75451	Hitachi	HD2575
	ITT	ITT75451
	Motorola	MC75451
	National	DS75451
	Raytheon	RC75451
	Signetics	75451
	Teledyne S	75451
SN75452	Fairchild	75452
	Hitachi	HD2577
	ITT	ITT75452
	Motorola	MC75452
	National	DS75452
	Raytheon	RC75452
	Signetics	75452
	Teledyne S	75452
SN75453	Fairchild	75453
	Hitachi	HD2578
	ITT	ITT75453
	Motorola	MC75453
	National	DS75453
	Raytheon	RC75453
	Signetics	75453
	Teledyne S	75453
SN75454	Fairchild	75454
	Hitachi	HD2579
	ITT	ITT75453
	Motorola	MC75454
	National	DS75454
	Raytheon	RC75454
	Signetics	75454
	Teledyne S	75454
SN75460	Fairchild	75460
	ITT	ITT75460
	National	DS75460
	Silicon G	SG75460
	Teledyne S	75460
SN75461	Fairchild	75461
	ITT	ITT75461
	National	DS75461
	Teledyne S	75461
SN75462	Fairchild	75462
	ITT	ITT75462
	National	LM75462
	Teledyne S	75462
SN75463	Fairchild	75463

Manufacturer Device	Replacement Source	Replacement Device
SN75463	ITT	ITT75463
	National	DS75463
	Teledyne S	75463
SN75464	Fairchild	75464
	ITT	ITT75464
	National	DS75464
	Teledyne S	75464
SN75491	Motorola	MC75491
	National	DS75491
SN75492	Motorola	MC75492
	National	DS75492
SN75493	National	DS75493
SN75494	National	DS75494
SN76104	Fairchild	732
	Motorola	MC1304
	Sprague	ULN-2120
SN76105	Motorola	MC1305
	Sprague	ULN-2122
SN76107	Fairchild	767
	Motorola	MC1370
SN76111	Sprague	ULN-2121
SN76113	Sprague	ULN-2128
SN76115	RCA	CA1310
	Sprague	ULN-2210
SN76131	Fairchild	739
SN76149	Fairchild	749
SN76177	Fairchild	705
	Sprague	ULN-2277
SN76242	Fairchild	780
	Motorola	MC1370
	RCA	CA3070
	Sprague	ULN-2124
SN76243	Fairchild	781
	Motorola	MC1371
	Sprague	ULN-2127
SN76246	Fairchild	746
	Motorola	MC1328
	RCA	CA3071
	Sprague	ULN-2114
SN76266	Fairchild	3066
	RCA	CA3066
SN76267	Fairchild	3067
	RCA	CA3067
	Sprague	ULN-2267
SN76530	Motorola	MC1330
SN76564	Fairchild	3064
	Motorola	MC1364
	RCA	CA3064
	Sprague	ULN-2264
SN76600	Motorola	MC1350
SN76603	Fairchild	703
SN76630	Fairchild	786
SN76642	Motorola	MC1357
	Sprague	ULN-2113
SN76643	Fairchild	2136
	Signetics	ULN2111
	Sprague	ULN-2111
SN76650	Motorola	MC1352
	RCA	CA1352
SN76651	Motorola	MC1351
SN76653	Motorola	MC1353
SN76665	Fairchild	3065
	Motorola	MC1353
	RCA	CA3065
	Sprague	ULN-2165
SN76666	Fairchild	3066
SN76675	Fairchild	3075
	Motorola	MC1375
	Sprague	ULN-2129
SN76676	Fairchild	3076
S54LS192	AMD	SN54LS192
	Fairchild	54LS192
	Raytheon	**54LS192**
	see page 282	
	Signetics	**S54LS192**
	see page 384	
TF4000	Motorola	MC14000
TF4001	Motorola	MC14001
TF4002	Motorola	MC14002
TF4007	Motorola	MC14007
TF4009	Motorola	MC14009

Manufacturer Device	Replacement Source	Replacement Device
TF4010	Motorola	MC14010
TF4011	Motorola	MC14011
TF4012	Motorola	MC14012
TF4013	Motorola	MC14013
TF4023	Motorola	MC14023
TF4025	Motorola	MC14025
TF4027	Motorola	MC14027
TMS1101	Intersil	IM7501
	Signetics	1101
TMS1103	Signetics	1103
¶ TMS2102	Intersil	IM7552
¶ TMS2300	AMI	S8773
¶ TMS2500	AMI	S8773
¶ TMS2600	AMI	S8773
	National	MM4230
	National	MM5230
	Nitron	NCM1110
¶ TMS2800	National	MM4210
¶ TMS2900	AMI	S8773
TMS3112	Fairchild	3348
TMS3113	AMI	S2181A
TMS3114	AMD	3114
	AMI	S2181A
TMS3120	Signetics	2532
TMS3121	Fairchild	3342
TMS3122	Signetics	2518
TMS3126	National	MM4060
TMS3127	National	MM4060
TMS3128	National	MM4060
TMS3129	National	MM4060
TMS3130	National	MM4060
TMS3131	National	MM4060
TMS3132	National	MM4060
TMS3133	Fairchild	3355
¶ TMS3304	Motorola	MC1141
TMS3409	Intersil	IM7780
TMS3412	AMI	S1685
	Signetics	S2502
	Signetics	S2532
¶ TMS3414	AMI	S1685
TMS3417	Fairchild	3342
TMS4000	GI	RO5-8192
TMS4024	Signetics	2535
TMS4030	Intel	2107A
	Western	RM1701
TMS4033	**Signetics**	**2602-1**
	see page 790	
	Signetics	**2602-2**
	see page 790	
TMS4034	**Signetics**	**2602**
	see page 790	
TMS4050	MMI	2150
TMS4060	**AMI**	**S4021**
	see page 722	
	EA	EA4060
	Intel	2107
	Signetics	**2604**
	see page 793	
	Western	RM1701
TMS4062	Nortec	6002
	Western	RM1701
TMS4100	Motorola	MCM1130
	Nitron	NCM1130
TMS4103	Motorola	MCM1131/32
	Motorola	MCM1132
TMS4300	Nitron	NCM1140
¶ TMS4400	Motorola	MCM1140
¶ TMS4401	Motorola	MCM1141
TMS4800	EA	EA4800
	EA	EA4900
TMS5000	GI	AY5-3600
TMS6010	**AMI**	**S1757**
	see page 532	
	GI	AY5-1013
TMS6011	**AMI**	**S1883**
	see page 533	
TMS7001	AMS	AMS7001
	Motorola	MCM7001
	Nitron	7001
	RCA	MW7001
TMS8080	AMD	9080

Manufacturer Device	Replacement Source	Replacement Device
TMS8080	**Intel**	**8080**
	see page 958	
TM54060	**Intel**	**2107B**
	see page 760, 765	
TP4000	Motorola	MC14000
TP4001	Motorola	MC14001
TP4002	Motorola	MC14002
TP4007	Motorola	MC14007
TP4009	Motorola	MC14009
TP4010	Motorola	MC14010
TP4011	Motorola	MC14011
TP4012	Motorola	MC14012
TP4013	Motorola	MC14013
TP4023	Motorola	MC14023
TP4025	Motorola	MC14025
TP4027	Motorola	MC14027

Western Digital

Manufacturer Device	Replacement Source	Replacement Device
RM1701	Intel	2107
	TI	TMS4030
	TI	TMS4060
TR1402A	GI	AY5-1013
TR1602	**AMI**	**S1883**
	see page 533	

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Santa Clara, California 95051
(408) 246-0330
TWX: 910-338-0018

Product Information:
Memory Products
Frank Rittiman, Manager .... ext. 688
CMOS RAMs .... Les Brock
1103 RAM Family .... Jim Dodson
4006 RAM Family .... Les Brock
4K RAMs
Raju Shah, Manager .... ext. 747
ROMs .... Les Brock
Microprocessors
Dave Gellatly, Manager .... ext. 743
Consumer Products
Dick Barck, Manager .... ext. 695

Literature:
Data Room, ... ext. 189
Or write:
Data Room
American Microsystems, Incorporated
3800 Homestead Road
Santa Clara, California 95051

Price and delivery:
See Product Information above

To plan an order:
Memories
Bill Mathewson .... ext. 563/564
ROMs
Leslie Menster .... ext. 662/577
Microprocessors
Bob McClaflin .... ext. 451/452
Interface (Communication) Ckts.
Bob McClaflin .... ext. 451/452

Follow-up an order:
See Product Information above

All other information:
Barbara Hilgers .... ext. 539

Sales Offices & Representatives

Ariz Phoenix
Hecht, Henschen & Assoc. Inc., (602) 275-4411
Cal Manhattan Beach
AMI, (213) 379-2452
San Diego
Haddon Associates, (714) 565-9444
San Jose
AMI, (408) 249-4550
Colo Denver
Barnhill Five, (303) 426-0222
Fla Altamonte Springs
AMI, (305) 830-8889
Ill Elk Grove Village
AMI, (312) 437-6496
Mass Norwood
AMI, (617) 762-0726
Mich Brighton
Lowrey & Associates, (313) 227-7067
Livonia
AMI, (313) 478-9339
Minn Minneapolis
AMI, (612) 559-9004
NY Monsey
AMI, (914) 352-5333
Syracuse
Precision Sales Company, (315) 458-2223
OH Cleveland
AMI, (216) 292-6850
Ore Beaverton
Arneson Associates, (503) 643-5745
Pa Ambler
AMI, (215) 643-0217
Pittsburgh
Compu Graphs, Inc., (412) 366-5056
Tex Richardson
AMI, (214) 231-5721

American Microsystems Inc. (cont)

Utah Salt Lake City
Simpson Associates, Inc., (801) 486-3731
Wash Edmonds
E. S. Chase Company, (206) 744-3586
Seattle
Arneson Associates, (206) 762-7664
Can Barnaby, B.C.
E. S. Chase Company, (604) 298-4515
R. V. Weatherford Co., (602) 272-7144
Can Ottowa, Ont.
Cantec, (613) 828-1390
Intl England
Swindon, Wiltshire
AMI Microsystems, Ltd., (0793) 31345
Intl France, Vincennes
AMI Microsystems S.A.R.L., (01) 374-0090
Intl Italy, Milan
AMI Microsystems, (02) 29 37 45
Intl Japan, Tokyo
AMI Japan Ltd., (501) 2241
Intl West Germany, Munich
AMI Microsystems GmbH, (089) 48 30 81

Distributors

Ariz Phoenix
R. V. Weatherford Company, (602) 272-7144
Sterling Electronics, (602) 258-4531
Cal Anaheim
R. V. Weatherford Company, (714) 547-0891
Costa Mesa
Schweber Electronics, (213) 924-5594, (714) 556-3880
Glendale
R. V. Weatherford Company, (213) 849-3451
Newport Beach
Semicomp Corp., (714) 833-3070 (213) 971-5253
Palo Alto
R. V. Weatherford Company, (415) 493-5373
Pomona
R. V. Weatherford Company, (714) 623-1261
San Diego
R. V. Weatherford Company, (714) 278-7400
Colo Englewood
R. V. Weatherford Company, (303) 761-5432
Conn Danbury
Schweber Electronics, (203) 792-3500
Fla Hollywood
Schweber Electronics, (305) 927-0511
Ga Atlanta
Schweber Electronics, (404) 449-9170
Ill Elk Grove Village
Schweber Electronics, (312) 593-2740
Iowa Cedar Rapids
Schweber Electronics, (319) 393-0100
La Metairie
Sterling Electronics, (504) 887-7610
Md Rockville
Schweber Electronics, (301) 881-3300
Mass Waltham
Schweber Electronics, (617) 890-8484
Watertown
Sterling Electronics, (617) 926-9720
Mich Troy
Schweber Electronics, (313) 583-9242
Minn Bloomington
Arrow Electronics, (612) 888-5522
Edina
Schweber Electronics, (612) 941-5280
NJ Perth Amboy
Sterling Electronics, (201) 442-8000
Somerset
Schweber Electronics, (201) 469-6008
NM Albuquerque
Century Electronics, (505) 292-2700
R. V. Weatherford, (505) 842-0868
Sterling Electronics, (505) 345-6601
NY Rochester
Schweber Electronics, (716) 461-4000
Westbury
Schweber Electronics, (516) 334-7474
Ohio Beachwood
Schweber Electronics, (216) 464-2970
Tex Austin
Schweber Electronics, (512) 837-2890
Dallas
R. V. Weatherford Company, (214) 243-1571
Schweber Electronics, (214) 661-5010
Sterling Electronics, (214) 357-9131
Houston
R. V. Weatherford Company, (713) 688-7406
Schweber Electronics, (713) 784-3600
Sterling Electronics, (713) 627-9800
Utah Salt Lake City
ALTA Electronics, (801) 486-7227
Century Electronics, (801) 487-8551
Va Richmond
Meridian, (804) 355-6521
Wash Seattle
Intermark Electronics, (206) 767-3160
R. V. Weatherford, (206) 243-6340
Can Mississauga, Ont.
Schweber Electronics, (416) 678-9050

Analog Devices

For data on selected products see page:

Analog Devices, Inc.
P. O. Box 280
Route 1 Industrial Park
Norwood, Massachusetts 02062
(617) 329-4700
TWX: (710) 394-6577
Cable: Analog Norwood Mass
Telex: 924-491

Specific product information:
Regional Offices
Massachusetts, Keith Rutherford (617) 329-4700 .... ext. 302
Illinois, Edward Grokulsky, (312) 894-3300
California, Walter Borlase, (213) 595-1783

Literature:
Joseph Chelluk, Direct Mail Supervisor .... ext. 391

Price and delivery:
See Product Information

Place an order:
Regional Offices
Massachusetts, Keith Rutherford (617) 329-4700 .... ext. 302
Illinois,
Edward Grokulsky, (312) 894-3300
California, Walter Borlase, (213) 595-1783

Follow-up an order:
Peter Bosworth Manager of Customer Service .... ext. 311

All other information:
James Hackbush, Director of Human Resources .... ext. 210

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Ala Huntsville
Currie, Peak, & Frazier, Inc., (205) 536-5650
Ariz Tuscon
Grady Moore Associates, (602) 795-3176
Cal Los Altos
Analog Devices, (415) 941-4874
Long Beach
Analog Devices, (213) 595-1783
Colo Boulder
Grady Moore Associates, (303) 494-3351
Fla Orlando
Currie, Peak & Frazier, Inc., (305) 855-0843
Ill Northfield
Torkelson Associates, (312) 446-9085
Bloomingdale
Analog Devices, (312) 894-3300
Ind Indianapolis
Torkelson Associates, (317) 244-7867
Kans Shawnee Mission
Technical Sales Assoc., Inc., (913) 888-3330
Md Columbia
Rep-Tron, Inc., (301) 465-6433
Mass Norwood
Analog Devices, (617) 329-4700
Mich Detroit
Electro Sales Assoc., (313) 526-8800
Minn Minneapolis
Torkelson Associates, (612) 835-2414
Mo Ferguson
Technical Sales Assoc., (314) 725-5361
NM Albuquerque
Grady Moore Associates, (505) 292-3322
NY Buffalo
Labtronics, Inc., (716) 685-4111
Syracuse
Labtronics, Inc., (315) 454-9314
NY Ulster Park
Labtronics, Inc., (518) 372-6649
Woodbury
Harwood-Sandler Assoc., (516) 692-6100
NC Greensboro
Currie, Peak & Frazier, Inc., (919) 273-3040
Ohio Cleveland
Electro Sales Assoc., (216) 261-5440
Dayton
Electro Sales Assoc., (513) 426-5551
Pa Ambler
Wyncote Inst. Co., (215) 643-2440
Pittsburgh
Electro Sales Assoc., (412) 371-9449
Tex Houston
Analog Devices, (713) 644-6704
Richardson
Analog Devices, (214) 231-5094
San Antonio
Data Applications Corp., (512) 732-7176
Wash Seattle
Avionics Liaison, Inc., (206) 767-3870
Can Downsview, Ontario
Tracan Electronics Corporation, (416) 638-0052
Ottawa, Ontario
Tracan Electronics Corporation, (613) 820-0269
Montreal
Tracan Electronics Corporation, (514) 341-4163
West Vancouver, B.D.
Tracan Electronics western Ltd., (604) 926-3411
Intl Argentina, Buenos Aires
Rayo Electronica S.R.L., Tel: 38 17 79
Rodar S.A.C.I.,
Intl Australia
Mordialloc, Victoria
Parameters Pty. Ltd., Tel: 90 76 13
Intl Crow's Nest, N.S.W.
Parameters Pty. Ltd., Tel: 43 65 77
Intl Austria, Wien
International Engineering Service,
Tel: 02 22/829 366, /829 367
Intl Belgium, Antwerp
Klaasing Benelux N.V., Tel: 03 38 27 07
Intl Brazil, Sao Paulo
Artimar Ltd., Tel: 35 07 47; 35 24 52
Electronic Associates Ind.,
Intl Denmark, Ballerup
Analog Devices A/S, Tel: 97 95 99 (AC:02)
Intl Finland, Helsinki
SW-Instruments, Tel: 90 73 82 65
Intl France
Alencon
Analog Devices S.A. (Bretagne) Tel: 34 26 07 61
Rungis
Analog Devices S.A., (Centre d'Affaires SILIC) Tel: 686-7905, 686-7760, 686-7802
Seysses
Analog Devices S.A. Tel: 61 51 10 46
Seyssinet Pariset
Analog Devices S.A. Tel: 76 96 96 86
Intl W. Germany
Berlin
Analog Devices Tel: 0311/31 64 41
Donen
Analog Devices GmbH, Tel: 023/83 73 55
Karlsruhe
Analog Devices Tel: 0721/69 46 00
Munich
Analog Devices GmbH, Tel: 089/53 03 19
Intl Greece, Athens
George D. Chryssos, Tel: 021/89 43 77 7
Intl Holland, Breda
Klaasing-Reuvers B.V., Tel: 01600-22555
Intl India, Allahabad
Darbari Industries, Tel: 33 85
Intl Israel, Tel Aviv
STG International Ltd., Tel: 53 45 9
Intl Italy
Banchette
Dott. Ing. Guiseppe de Mico, Tel: 01 25 23 00
Bologna
Dott. Ing. Giuseppe de Mico, Tel: 22 97 51
Milano
Dott. Ing. Giuseppe de Mico, Tel: 65 31 31
Padova
Dott. Ing. Giuseppe de Mico, Tel: 65 29 09
Rome
Dott. Ing. Giuseppe de Mico, Tel: 31 62 04

Analog Devices (cont)

Intl **Torino**
Dott. Ing. Giuseppe de Mico, Tel: 87 41 37

Intl **Japan**
Osaka
Analog Devices of Japan, Inc., Tel: 06/37 21 81 4
Tokyo
Analog Devices of Japan, Inc., Tel: 03/26 36 82 6

Intl **Malaysia, Selangor**
General Engineers (Electr.) Corp.,

Intl **Mexico, Mexico, D.F.**
Nucleoelectronics S.A. Tel: 915/59 36 04 3

Intl **New Zealand**
Auckland
W. Arthur Fisher Ltd., Tel: 59 55 27; 59 82 02
Christchurch
W. Arthur Fisher Ltd.,
Wellington
W. Arthur Fisher Ltd., Tel: 55 59 50 12

Intl **Norway, Hvalstad**
EStronic, Tel: 78 24 10

Intl **Pakistan, Karachi**
Superior Electronic Associates

Intl **Singapore, Singapore**
General Engineers (Electr.) Corp., Tel: 33 36 41; 33 36 51

Intl **South Africa, Pretoria**
Electronic Building Elements (Pty) Ltd., Tel: 78-9221/6

Intl **Spain, Madrid**
Belport Electronica de Madrid, Tel: 234-6262, 254-2916

Intl **Sweden, Solna**
NAXAB, Tel: 08/98 51 40

Intl **Switzerland, Zurich**
Megex Electronic AG, Tel: 01/98 4171

Intl **Taiwan, Taipei**
Yuan Kong Enterprises Ltd., Tel: 33 88 33; 33 54 00

Intl **Thailand, Bangkok**
Dynamic Supply Engineering, Tel: 91 44 34

Intl **Turkey**
Ankara
Simsel Limited, Tel: 18 87 74; 18 21 76
Istanbul
Simsel Limited, Tel: 43 07 83

Intl **United Kingdom**
East Molesey, Surrey
Analog Devices Ltd., (also Memory Devices) Tel: 01/94 10 46 6

Analogic

Analogic Corporation
Audubon Road
Wakefield, Massachusettes 01880
(617) 246-0300
TWX: (710) 348-0425

Beckman Instruments

Beckman Instruments
Helipot Division
2500 Harbor Blvd.
Fullerton, California 92634
(714) 871-4848
TWX: (910) 592-1260

Sales Offices & Representatives

Ala **Huntsville**
Murcota Corporation, (205) 539-8476

Ariz **Scottsdale**
Barnhill Five, Inc., (602) 947-5745

Cal **Fullerton**
Beckman Instruments, Inc., (714) 871-4848
Mountain View
Beckman Instruments, Inc., (415) 961-6817
San Diego
Beckman Instruments, Inc., (714) 565-6244

Colo **Denver**
Barnhill Five, Inc., (303) 462-0222

Fla **Clearwater**
Lynch-Gentry Associates, Inc., (813) 443-2697
Ft. Lauderdale
Lynch-Gentry Assoc., Inc., (305) 763-5374

Ill **Chicago**
Carlson Electronic Sales Co., (312) 774-9022

Iowa **Cedar Rapids**
Comstrand, Inc., (319) 363-4905

Md **Silver Spring**
Beckman Instruments, Inc., (301) 622-2500

Mass **Needham Heights**
Beckman Instruments, Inc., (617) 444-9010

Mich **Farmington**
Sheridan Associates, Inc., (313) 477-3800

Minn **Minneapolis**
Comstrand, Inc., (612) 560-5300

Mo **Florissant**
Sheridan Associates, Inc., (314) 837-5200

NJ **Clifton**
Beckman Instruments, Inc., (201) 778-8888
Mt. Laurel
Beckman Instruments, Inc., (609) 235-3314

NM **Albuquerque**
Barnhill Five, Inc., (505) 293-5955

NY **Buffalo**
Ossmann Component Sales Corp., (716) 832-4271
Kingston
Ossmann Component Sales Corp., (914) 338-5505
Rochester
Ossmann Component Sales Corp., (716) 442-3290
Syracuse
Ossmann Component Sales Corp., (315) 454-4477
Vestal
Ossmann Component Sales Corp., (607) 785-9949

NC **Winston-Salem**
Murcota Corporation, (919) 723-1001

Ohio **Cincinnati**
Sheridan Associates, Inc., (513) 761-5432
Cleveland
Sheridan Associates, Inc., (216) 524-8120
Dayton
Sheridan Associates, Inc., (513) 277-8911

Okla **Tulsa**
Norvell Associates, Inc., (918) 663-1247

Ore **Portland**
Almac/Stroum Electronics, (503) 292-3534

Pa **Pittsburgh**
Sheridan Associates, Inc., (412) 244-1640

Tex **Dallas**
Norvell Associates, Inc., (214) 350-6771
Houston
Norvell Associates, Inc., (713) 774-2568

Wash **Seattle**
Almac/Stroum Electronics, (206) 763-2300

Can **Toronto**
Beckman Instruments, Inc., (416) 251-5251

Intl **Scotland**
Glenrothes, Fife
Bechman Instruments, Ltd.,

Distributors

Ala **Huntsville**
M &C Sales, (205) 539-8476
Powell Electronics, (205) 539-2731

Ariz **Phoenix**
Liberty Electronics, (602) 257-1272
Tempe
Marshall Industries, (602) 968-6181

Cal **El Monte**
Marshall Industries, (213) 686-0141
El Segundo
Liberty Electronics, (213) 322-8100
Irvine
Marshall Industries, (714) 556-6400
Mountain View
Elmar Electronics, (415) 961-3611
San Diego
Liberty Electronics, (714) 565-9171
Marshall Industries, (714) 278-6350
Sunnyvale
Marshall Industries, (408) 732-1100

Colo **Arvada**
Marshall Industries, (303) 423-9670
Commerce City
Elmar Electronics, (303) 287-9611

Conn **Hamden**
Arrow Electronics, Inc., (203) 248-3801
North Branford
Marshall Industries, (203) 484-0488

Fla **Clearwater**
Lynch-Gentry Associates, Inc., (813) 443-2697
Miami Springs
Powell Electronics, (305) 885-8761
Orlando
Powell Electronics, (305) 859-1450

Ill **Mount Prospect**
Magnuson Electronics, (312) 956-0700
Rosemont
Advent Electronics, (312) 298-4210

Ind **Indianapolis**
Advent Electronics, (317) 297-4910

Iowa **Cedar Rapids**
Advent Electronics, (319) 393-8811

Md **Baltimore**
Arrow Electronics, Inc., (301) 247-5200, (202) 737-1700
Beltsville
Powell Electronics, (301) 937-4030

Mass **Lexington**
Harvey/r&D Electronics, (617) 861-9200
Newton Highlands
Marshall Industries, (617) 965-5115

Mich **Farmington**
Advent Electronics, (313) 477-1650
Sheridan Sales Company (313) 477-3800

Minn **Bloomington**
Arrow Electronics, Inc., (612) 888-5522
St. Paul
Magnuson Electronics, (612) 227-8495

Mo **Florissant**
Sheridan Sales Company, (314) 837-5200

NJ **Moorestown**
Arrow/Angus, Inc., (609) 235-1900, (215) 928-1800
Saddle Brook
Arrow Electronics, Inc., (201) 797-5800
Rutherford
Kierulff Electronics, Inc., (201) 935-2120

NM **Albuquerque**
Elmar Electronics, (505) 292-1111

NY **Buffalo**
Ossmann Component Sales Corp., (716) 832-4271
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Arrow Electronics, Inc., (516) 694-6800
Marshall Industries, (516) 293-4141
Kingston
Ossmann Component Sales Corp., (914) 338-5505
Rochester
Ossmann Component Sales Corp., (716) 442-3290
Syracuse
Ossman Component Sales Corp., (315) 454-4477
Vestal
Ossmann Component Sales Corp., (607) 785-9949

NC **Winston-Salem**
M&C Sales, (919) 723-1001

Ohio **Cincinnati**
Sheridan Sales Company, (513) 761-5432
Cleveland
Arrow Electronics, (216) 464-2000
Sheridan Sales Company, (216) 831-0130
Dayton
Kettering
Arrow Electronics, (513) 253-9176
Sheridan Sales Company, (513) 277-8911

Okla **Tulsa**
Norvell Electronics, (918) 663-1247

Ore **Portland**
Almac/Stroum Electronics, (503) 292-3534

Pa **Philadelphia**
Powell Electronics, (215) 365-1900
Pittsburgh
Sheridan Sales Company,
(412) 244-1640

Tex **Dallas**
Norvell Electronics, (214) 350-6771
Houston
Norvell Electronics, (713) 774-2568

Wash **Seattle**
Almac/Stroum Electronics, (206) 763-2300
Liberty Electronics, (206) 763-8200

Can **Toronto, Ont.**
Semad Electronics, (416) 635-9880
Vancouver
Bowtek Electronics, (604) 736-7677

Beckman Instruments (cont)

Can Mississauga, Ontario
Specialty Electronics Ltd., (416) 678-2104
Montreal, Quebec
Specialty Electronics Ltd., (514) 336-4500
Semad Electronics, (514) 636-4614

Burr-Brown Research

Burr-Brown Research Corp.
International Airport Industrial Park
Tucson, Arizona 85734
(602) 294-1431
TWX: (910) 952-1111

Sales Offices and Representatives

Ala Huntsville
BCS Assocs., (205) 881-6220
Ariz Tucson
Burr-Brown Research Corp., (602) 294-1431
Cal San Jose
Burr-Brown Research Corp., (408) 984-7700
Santa Ana
Burr-Brown Research Corp., (714) 835-0712
Conn Enfield
Meas. Equip. Co., (203) 745-9050
Fla Orlando
BCS Assocs., (305) 896-4881
Ill Addison
Burr-Brown Research Corp., (312) 832-6520
Ind Indianapolis
Sheridan Assocs., (317) 547-7777
Kan Overland Park
Sheridan Assocs., (913) 383-1636
Md Silver Spring
QED Elctrns., (301) 588-8134
Mass Wakefield
Meas. Equip. Co., (617) 245-4870
Mich Farmington
Sheridan Assocs., (313) 477-3800
Grand Rapids
Sheridan Assocs., (616) 942-2504
Minn Minneapolis
E.C. Electronic Sales, Inc., (612) 831-0229
Mo Florissant
Sheridan Assocs., (314) 837-5200
NJ Camden
QED Elctrns., Inc., (215) 925-8711
NY Cicero
Advanced Comps. Corp., (315) 699-2671
Clinton
Advanced Comps. Corp., (315) 853-6438
Endicott
Advanced Comps. Corp., (607) 785-3191
Great Neck, LI
Burr-Brown Research Corp., (516) 466-2650
Scottsville
Advanced Comps. Corp., (716) 889-1429
NC Greensboro
BCS Assocs., (919) 273-1918
Ohio Cincinnati
Sheridan Assocs., (513) 761-5432
Cleveland
Sheridan Assocs., (216) 831-0130
Dayton
Sheridan Assocs., (513) 277-8911
Okla Tulsa
Norvell Assocs., (918) 663-1247
Pa Pittsburgh
Sheridan Assocs., (412) 244-1640
Tex Dallas
Norvell Assocs., (214) 350-6771
Houston
Norvell Assocs., (713) 774-2568
Wash Seattle
Hayes Tech., (206) 763-2210
Can Calgary, Alberta
Allan Crawford Assocs., (403) 276-9658
Darmouth, Nova Scotia
Allan Crawford Assocs., (902) 469-7865
Longueuil, Quebec
Allan Crawford Assocs.,
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Ottawa, Ontario
Allan Crawford Assocs.,
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Allan Crawford Assocs.,
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Intl Australia
Burwood, Victoria
Kenelec Systems (Pty.) Ltd.,
Tel: (03) 288 7100
Intl Austria, Wein
Dipl. Ing. Peter Marchetti, Tel: 57 82 30
Intl Belgium, Brussels
BETA, Tel: (02) 49 99 00
Intl Colombia, Bogota, D.E.
Instrumentacion Henrik A. Langebaek & Kier, Ltd., Tel: 45 78 06
Intl Denmark, Glostrup
Prins Electronic, Tel: (01) 96 88 44
Intl Equador, Guayaquil
Suministros Tecnicos Ltd., Tel: 301419
Intl England, Watford
Burr-Brown International Ltd., Tel: (923) 33837
Intl Finland, Helsinki
Nores & Company OY, Tel: 13360
Intl France, Le Chesnay
Burr-Brown International S.A., Tel: 954 3558
Intl Germany
Leinfelden Bei Stuttgart
Burr-Brown International GMBH, Tel: (711) 75 10 21
Intl Greece, Athens
Hellenci Scientific Representations Ltd., Tel: 7705 960
Intl Holland, Breda
Datron B.V., Tel: 076-141152
Intl India, Bombay
Vibronics Private Limited, Tel: 551973
Intl Israel, Tel-Aviv
Racom Electronics Co., Ltd., Tel: 443126
Intl Italy, Milano
Metroelettronica, Tel: 546 26 41
Intl Japan
Chiyoda-ku, Tokyo
Kyokuto Boeki Kaisha Ltd., Tel: 03 244 3784 8
Intl New Zealand, Auckland
W. & K. McLean Ltd., Tel: 587 037
Intl Norway, Oslo
Bugo Riso A/S, Tel: 23 2580
Intl Pakistan, Karachi
I & S Corporation, Tel: 223322
Intl Portugal, Lisbon
Tleectra, Tel: 686072
Intl So. Africa
Johannesburg
David Pollock (Pty.) Ltd., Tel: 724 8274
Intl Spain, Madrid
Distesa, Tel: 457 28 00
Intl Sweden, Vallingby
Teleinstrument AB, Tel: 08 38 03 70
Intl Switzerland, Zurich
Telemeter Electronic AG, Tel: 01 25 78 72
Intl Turkey, Istanbul
Telekom, Tel: 49 40 40

Cermetek, Inc.

Cermetek, Inc.
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Mountain View, Ca. 94043
(415) 969-9433

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Cal Marina del Rey
Relcom, (213) 822-1187
Col Boulder
R.G. Enterprises, (303) 447-9211
Fla Ft. Lauderdale
Reynolds & Associates, (305) 581-6611, (305) 565-2369
Hollywood
Reynolds & Associates, (305) 987-6720
Satellite Beach
Reynolds & Associates, (305) 773-4700
St. Petersburg
Reynolds & Associates, (813) 360-1484
Ga Atlanta
Reynolds & Associates, (404) 252-5360, (205) 536-1941
Ill Chicago
Reynolds & Associates, (312) 647-7755
Mass Burlington
Contact Sales, Inc., (617) 273-1520
Md Florissant
Mid West Marketing, (301) 922-2092
Randallstown
C.L. Malinow & Co., (301) 922-2092
NJ Cherry Hill
J.M. Barrett Associates, Inc., (609) 429-1551
Clifton
Compar New York, Inc., (201) 546-3660
NM Albuquerque
Tritronix/Albuquerque, (505) 265-5400
Oh Dayton
Compass Associates, (513) 252-9939
Tx Houston
Data Aid Associates, (713) 862-6685
Can Richmond Hill, Ontario
Ferritronics Ltd., (416) 889-7313
Intl Israel, Tel Aviv
STG International, (03) 534598 523648 523658 53115

Collins Radio

Collins Radio Group
4311 Jamboree Road
Newport Beach, California 92663
(714) 833-4661
TWX: (910) 959-1705

Specific product information:
Don Gibson .... ext. 4637

Application engineering:
Don Gibson .... ext. 4637
Charlene Root .... ext. 4630
Mike Kilgore .... ext. 4590
Mike Kilgore .... ext. 4590
Charlene Root .... ext. 4630

Sales Offices & Representatives

Ala Huntsville
Gentry Associates, Inc., (205) 534-9771
Ariz Scottsdale
Williams Associates, (602) 947-4297
Cal Burlingame
Jack Logan Associates, (415) 697-6377
Garden Grove
Impact Electronics, Inc., (714) 893-8551

Collins Radio (cont)

Colo Denver
Williams Associates, (303) 373-4730
Fla Orlando
Gentry Associates, Inc., (305) 894-4401
Ga Atlanta
Gentry Associates, Inc., (404) 448-2365
Ind Ft. Wayne
Walter W. Bierberich, Inc., (219) 432-2537
New Albany
Walter W. Bierberich, Inc., (812) 945-3187
Iowa Cedar Rapids
Engineering Services Co., (913) 649-4000
Mass Lexington
Circuit Sales, Inc., (617) 861-0567
Mich Grosse Pointe Park
Greiner Associates, Inc., (313) 499-0188
Mo St. Louis
Engineering Services Co., (314) 977-1515
NC Burlington
Gentry Associates, Inc98 (919) 227-3639
NM Albuquerque
Williams Associates, (602) 947-4297
NY Pittsford
T² Electronics Co., (716) 381-2551
Plainview
E.R.A., (516) 822-9890
Syracuse
T² Electronics Co., (315) 463-8592
Ohio Cleveland
Arthur H. BAIER Co., (216) 461-6161
Dayton
Arthur H. Bair CO., (513) 276-4128
Tex Dallas
J Clay Company, (214) 350-1281
Wash Redmond
Desco Northwest, (206) 455-9325
Wisc Milwaukee
J M Sales Company, (414) 546-0040
Can Toronto, Ontario
Norgay Enterprises, LTD., (416) 233-2930

Consumer Microcircuits of America

Consumer Microcircuits of America
114 E Simmons St.
Galesburg, Illinois 61401
(309) 342-5311

Datel Systems

Datel Systems
1020 Turnpike St.
Canton, Massachusettes 02021
(617) 828-8000
TWX: (710) 348-0135
Telex: 924461
Regional Offices
Santa Ana, Calif. (714) 835-2751
Sunnyvale, Calif. (408) 733-2424
Canton, Mass (617) 828-8000
Home office, Canton, Mass. (617) 828-8000
Ala Huntsville
Intn'l Scientific Instruments, (205) 533-6880
Ariz Phoenix
Cleveland Enterprises, (602) 996-6130
Cal Los Angeles-Santa Ana
Western Regional Office (213) 933-72568 (714) 835-2751
Sunnyvale
NO. Calif Sales Office, (408) 733-2424
Fla Lighthouse Point
Saber Assoc., (305) 943-3076
Longwood
Saber Assoc., (305) 422-3686
St. Petersburg
Saber Assoc., (813) 441-1301
Haw Honolulu
Hawaii Data Systems, (808) 946-1533
Ill Chicago
Carter Electronics, Inc., (312) 585-5486
Ind Indianapolis
Carter Electronics, (317) 293-0696
Iowa Cedar Rapids
Technical Representatives, Inc., (319) 363-2489
Kan Olathe
Technical Representatives, (913) 782-1177
Mich Troy
George R. Peters, Assoc., (313) 362-1220
Minn Minneapolis
Carter Electronics, Inc., (612) 544-9393
Mo Hazelwood
Technical Representatives, Inc., (314) 731-5200
NC Raleigh
Saber Associates, (919) 834-3961
NJ Fort Lee
Technical Marketing Assoc., (201) 224-6911
NM Albuquerque
Cleveland Enterprises, (505) 345-2481
NY Liverpool
R. &D. Associates, Inc., (315) 622-2350
Ohio Cleveland
Instrumentation Systems, Inc., (216) 486-0782
Dayton
Instrumentation Systems, Inc., (513) 294-2838
Penn King of Prussia
Rivco, (215) 265-5211
Pittsburgh
Instrumentation Systems, Inc., (412) 243-1111
Tex Dallas
Evans-McDowell, (214) 238-7157
Houston
Evans-McDowell, (713) 783-2900
Va Arlington
J.H. Heffernan Co., (703)522-6666
Wash Seattle
Jon B. Jolly Inc, (206) 938-4166
Wisc Milwaukee
Carter Electronics, Inc., (414) 464-5555
Can Montreal, Quebec
Prelco Electronics, Ltd. (514) 389-8051
Ottawa, Ontario
Prelco Electronics, Ltd., (613) 237-6150
Rexdale, Ontario
Prelco Electronics, Ltd., (416) 678-0401
Intl Australia, Artarmon, NSW
Digital Electronics (Marketing) Pty. Ltd. Tel: 43 6668
Intl Austria, Vienna
Bacher Elektronische Gerate Tel: 83 63 96 0
Intl Belgium, Brussels
Sotronic A.A. Tel: 736.10.07
Intl Denmark, Valby
Paratron A/S Tel: (01) 74 44 66
Intl Finland, Helsinki
Havulinna Oy Tel: (90) 661451
Intl France, Paris
Datel Systems Snarl Tel: 603-06-74
Intl India, Bombay
Smita Electronics Tel: 40 542 564
Intl Israel, Tel Aviv
MTI Engineering Ltd. Tel: 244090, 236334
Intl Italy, Milano
3G Electronics s.r.l. Tel: 5442918 543096
Intl Japan, Tokyo
Datel KK Tel: 499-0631
Intl Netherlands, Amsterdam
Techmation Tel: 020-456995
Intl New Zealand, Auckland
David J. Reid (N.Z.) Ltd. Tel: 492-189
Intl Norway, Oslo
Morgenstierne & Co., A/S Tel: 37 29 40
Intl So. Africa, Johannesburg
Peter Jones Electronic Equipment PTY, Ltd., Tel: 22-3658
Intl Spain, Madrid
Aupoca Electronica Y Sistemes Tel: 457 53 12
Intl Sweden, Stockholm
AB Nordqvist & Berg Tel: 08-69 04 001
Intl Switzerland, Zurich
Traco Electronic Co., Ltd. Tel: 01/3607 11
Intl U.K.
Basingstoke, Hampshire
Datel (UK) Ltd. Tel: Basingstoke (0256) 66721
Intl W. Germany, Munich
Datelek Systems GmbH Tel: 089/78 4045

Data Device

Data Device Corporation
Airport Industrial Plaza
Bohemia, New York 11716
(516) 567-5600
TWX: (510) 221-1874

Electronic Arrays

Electronic Arrays, Inc.
550 East Middlefield Road
Mountain View, California 94043
(415) 964-4321
TWX: (910) 379-6985
Advanced Products .... Dick Eiler
Memory Products .... Bob Cushman
Consumer Products .... Dick Eiler
Literature:
Marketing Services .... Ed Meagher
Price and delivery:
Local Field Sales Offices (preferred), or Customer Service
Follow-up an order:
Customer Service
All other information:
Marketing Service .... Ed Meagher

Sales Offices & Representatives

Ariz Phoenix
Dorton Enterprises, Inc., (602) 263-0414
Cal Huntington beach
Electronic Arrays, Regional Office, (714) 968-3775
Los Angeles
Black, Ekizian & Strong, Inc., (213) 870-9191
Mountain View
Caltron/Pyle, Inc., (415) 964-3244
Electronic Arrays Regional Office, (415) 964-4321
San Diego
Bestronics, (714) 278-2150
Colo Denver
The Thorson Co., (303) 759-0809
Conn Wallingford
Com-Sale, Inc., (203) 269-7964
Fla Largo
Col-Ins-Co., (813) 343-0978
Orlando
Col-Ins-Co., Inc., (305) 423-7615
Ill Westchester
Gassner & Clark Company, (312) 345-4245
Ind Indianapolis
Ihrig Associates, (317) 783-7630
Iowa Cedar Rapids
Engineering Services Co., (319) 362-0503
Kan Prarie Village
Engineering Services Co., (913) 649-4000
Mass Waltham
Com-Sale, Inc., (617) 890-0011
Minn Minneapolis
Electronic Innovators, Inc., (612) 884-7471
Mo. St. Louis
Electronic Arrays, Regional Office, (314) 878-6446
Engineering Services Co., (314) 997-1515
NH Manchester
Com-Sale, Inc., (603)688-8500
N J Cherry Hill
Electronic Arrays, Inc., (609) 795-5066
NM Albuquerque
The Thorson Company, (505) 265-5655
NY Elmont
Crane & Egert Corp., (516) 488-2100
Ohio Cleveland
K.W. Electronic Sales, Inc., (216) 831-8292
Dayton
K.W. Electronic Sales, Inc., (513)890-2150

Electronic Arrays (cont)

Ore Beaverton
N. R. Schultz Co., (503) 643-1644

Pa Allison Park
K.W. Electronic Sales, Inc., (412) 487-3636
Willow Grove
Harry Nash Associates, (215) 657-2213

Tex Dallas
The Thorson Company, (214) 233-5744
Houston
The Thorson Company, (713) 771-3504

Va Reston
Boyle Associates (703) 620-9558

Wash Bellevue
N. R. Schultz Co., (206) 454-0300

Intl Netherlands, Amsterdam
Electronic Arrays, European Sales, (020) 712560

Intl Far East, MT View Ca
Electronic Arrays, Far East Sales, (415) 964-4321

Intl Germany, Munich
Electronic Arrays, GmbH, (089) 7853168

Intl Japan, Tokyo
Electronic Arrays Sales Office, 03-403-9061

Distributors

Intl Australia, Prospect, SA
A J. Ferguson, 269-1244

Intl Belgium, Brusselles
Betea Sprl., 02 49-80-85

Intl France, Paris
Technology Resources S.A., 747-4717

Intl Holland, Breda
Famatra Benelux, 01600-33457

Intl India, Bombay
Hinditron Services Pvt. Ltd., 36-5-3-44

Intl Israel, Tel-Aviv
Israel Radio Company, 50156

Intl Italy, Milan
Memos Italiana, 02-871353 or 867589
Philips Sezione Elcoma, 02-6994

Intl Norway, Lillestrom
Kjell Bakke & Co., 711-872

Intl So. Amer. Mt View Ca
Intectra, (415) 967-8818

Intl Sweden, Vallingb'
Svensk Teleindrustri, 08/89 04 35

Intl Switzerland, Zurich
Dimos AG, 08/89 04 35

Intl U.K., East Molesey, Eng
Analog Devices, Ltd., 941-0466

EMM/Semi

For data on selected products see page 734.

EMM/SEMI
Subsidiary of Electronic Memories
and Magnetics Corporation
3883 North 28th Avenue
Phoenix, Arizona 85017
(602) 263-0202
TWX: (910) 951-1383

Sales Offices & Representatives

Ala Huntsville
Gentry Associates, (205) 543-9771

Ariz Tempe
EMM, (602) 968-2492

Cal Hawthorne
EMM, (213) 644-9881
Orange
EMM, (714) 639-5811
Santa Clara
EMM, (408) 247-9711

Fla Orlando
Gentry Associates, (305) 894-9180

Ga Atlanta
Gentry Associates, (404) 448-2365

Ill Des Plains
EMM, (312) 297-7090

Mass Lexington
EMM, (617) 861-9650

NY Melville
EMM, (516) 423-5800

NC Burlington
EMM, (919) 227-3639

Ohio Akron
EMM, (216) 867-5435

Wash Bellvue
Thorson Company, (206) 455-9180

Can Montreal
Cantec, (514) 620-3121
Ottawa
Cantec, (613) 225-0363
Toronto
Cantec, (416) 457-4455

Distributors

Cal Newport Beach
Semicomp Corporation, (213) 971-5253

Minn Bloomington
Arrow Electronics, (612) 888-5521

NM Albuquerque
Century Electronics, (505) 292-2700

Exar Integrated Systems

For data on selected products see page 630.

Exar Integrated Systems, Inc.
750 Palomar Ave.
Sunnyvale, California 94086
(408) 733-7700
TWX: (910) 339-9233

Specific product information:
Product Marketing

Application engineering:
Applications Engineering

Literature:
Local Representative or Distributor

Price and delivery:
Local Representative or Distributor

Place an order:
Less than 1000 pcs .... Local Distributor
Larger Orders .... Local Representative

Follow-up an order:
Local Representative or Exar Customer Service, (408) 733-7700

Sales Offices & Representatives

Ariz Scottsdale
Summit Sales, (602) 994-4587

Cal Culver City
DeAngelo, Rothman & Co., Inc., (213) 398-6239
Redwood City
Logan Sales, (415) 369-6726
San Diego
DeAngelo, Rothman & Co., Inc. (714) 560-5707

Conn Wallingford
Com-Sale, (203) 269-7964

Fla Miami
Reptronics, Inc., (305) 251-5478
St. Petersburg
Reptronics, Inc., (813) 522-8220

Ga Atlanta
Electro-Mech, (404) 449-6337

Ill Chicago
M & S Sales, (312) 992-1053

Kan Wichita
Dy-Tronix, Inc., (316) 943-6221

Md Baltimore
Component Sales, Inc., (301) 484-3647

Mass Waltham
Com-Sale, (617) 890-0011

Mich Warren
DEM Electronic Sales, (313) 755-6660

Minn Minneapolis
Electronic Innovators, (612) 884-7471

Mo Hazelwood
Dy-Tronix, Inc., (314) 731-5799

Mo Kansas City
Dy-Tronix, Inc., (816) 761-6543

NM Albuquerque
Tri-Tronix, (505) 265-8409

NY Buffalo
Quality Components, Inc., (716) 839-2044
Manlius
Quality Components, Inc., (315) 682-8885
Rochester
Quality Components, Inc., (716) 889-1919
Williston Park, N.Y.C.
ABC Electronic Sales, (516) 747-6610

NC Raleigh
Component Sales, Inc., (919) 782-8433

Ohio Columbus
McFadden Sales, (614) 221-3363

Penn Erie
ECCO Electronic Sales, (814) 452-3762
Huntingdon Valley
ABC Electronic Sales, (215) 947-6960

Tenn Nashville
Electro-Mech, (615) 883-1490

Tex Dallas
Technical Marketing, Inc., (214) 387-3601
Houston
Technical Marketing, Inc., (713) 777-9228

Wash Bellevue
SE-R² Products & Sales, (206) 747-9424

Can Mississauga Ont.
R.F.Q. Limited, (416) 625-8874
Quebec, PQ
R.F.Q. Limited, (514) 626-8324

Distributors

Ala Huntsville
Hall-Mark Electronics Corp., (205) 837-8700

Ariz Phoenix
MIRCO Electronic Dist., (602) 944-2281

Cal Newport Beach
Semicomp Corp., (714) 833-3070 (213) 971-5253
San Diego
Intermark Electronics, (714) 279-5200
Santa Ana
Intermark Electronics, (714) 540-1322
Sunnyvale
Intermark Electronics, (408) 738-1111
Semicomp Corp, (408) 736-2330
Woodland Hills
Semiconductor Concepts, Inc., (213) 884-4560

Fla Ft. Lauderdale
Hall-Mark Electronics Corp, (305) 971-9280
Orlando
Hall-Mark Electronics Corp, (305) 855-4020

Ga Lawrenceville
Hall-Mark Electronics Corp, (404) 963-9728

Ill Elk Grove Village
Hall-Mark Electronics Corp, (312) 437-8800
Westmont
Bodelle Co. Inc., (312) 323-9670

Ind Ft. Wayne
Graham Electronics, (219) 423-3422
Indianapolis
Graham Electronics, (317) 634-8486
Lafayette
Graham Electronics, (317) 742-4006

Iowa Cedar Rapids
Hall-Mark Electronics Corp., (319) 393-3556

Kan Lenexa
Hall-Mark Electronics, (913) 888-4747
Wichita
Hall-Mark Electronics Corp., (316) 682-2073
Radio Supply, (316) 267-5214

Md Baltimore
Hall-Mark Electronics Corp., (301) 265-8500
Gaithersburg
Pioneer, (301) 948-0710

Mass Dedham
Gerber Electronics, (617) 329-2400

Mich Ann Arbor
Wedemeyer Electronics, Inc., (313) 665-8611

Minn Bloomington
Hall-Mark Electronics, (612) 884-9056
Minneapolis
Cassidy Electronics, (612) 835-7744

MO Earth City
Hall-Mark Electronic, (314) 291-5350

Exar Integrated Systems (cont)

MO **St. Louis**
Olive Industrial Elec., (314) 863-7800
NH **Londonderry**
Yankee Electronics Supply, (603) 625-9746
NY **Hauppauge**
Hall-Mark Electronics, (516) 273-0030
Semiconductor Concepts, Inc., (516) 273-1234
NC **Raleigh**
Hall-Mark Electronics, (919) 832-4465
Ohio **Cincinnati**
Graham Electronics, (513) 733-1661
Dayton
Hall-Mark Electronics, (513) 294-0437
Okla **Tulsa**
Component Specialties, Inc., (918) 664-2820
Hall-Mark Electronics, (918) 835-8458
Penn **Horsham**
Pioneer, (215) 674-5710
Huntingdon Valley
Hall-Mark Electronics, (215) 355-7300
Tex **Austin**
Component Specialties, Inc., (512) 459-3307
Hall-Mark Electronics, (512) 837-2814
Dallas
Component Specialties Inc., (214) 357-4576
Hall-Mark Electronics, (214) 231-6111
El Paso
Hall-Mark Electronics, (915) 545-1763
Houston
Component Specialties Inc., (713) 771-7237
Hall-Mark Electronics, (713) 781-6100
Utah **Salt Lake City**
Intermark Electronics, (801) 426-5600
Wash **Seattle**
Intermark Electronics, (206) 767-3160
Wisc **Mequon**
Taylor Electric Co., (414) 241-4321
West Allis
Hall-Mark Electronics, (414) 476-1270
Can **Montreal, Quebec**
Future Electronics, (514) 735-5775
Vancouver, B.C.
R-A-E Industrial Electronics, (604) 687-2621
Intl **Australia, Prospect**
A.J. Ferguson (Adelaide) Pty. Ltd., 269-1244
Intl **India, Bombay**
Zenith Electronics Jaikishan Nivas 36-7717
Intl **New Zealand, Auckland**
Professional Electronics Ltd., 469-450

Hobbyist Distributor

Cal **Belmont**
James Electronics, (415) 592-8097

Fairchild Semiconductor

For data on selected products see page 923.

Fairchild Camera and Instrument Corp.
Integrated Circuits Group
464 Ellis Street
Mountain View, California 94042
(415) 962-5011
TWX: (910) 379-6435

Specific product information:
Local field sales office or franchised distributor, or specific product marketing department at 464 Ellis Street, Mountain View, Ca.
Request through main switchboard:
- Linear Integrated Circuit Product Mktg.
- Bipolar Memory Product Mktg.
- Digital Product Mktg. (Bipolar and CMOS)
- Diode Product Marketing
- MOS Product Marketing
- Optoelectronic Product Marketing
- Transistor Product Marketing

Application engineering:
See Product Information

Literature:
Local field office or specific product marketing group in Mountain View.

Price and delivery:
Local field sales office or franchised distributor.

Place an order:
Local field sales office or franchised distributor.

Follow-up an order:
Customer Service Center, 401 Ellis Street, Mountain View, Calif. 94042 (415) 962-3424

All other information:
Fairchild Information Line, (415) 962-4401

Sales Offices & Representatives

Ala **Huntsville**
Field Sales Office, (205) 883-7020
Cartwright & Bean, Inc., (205) 533-3509
Ariz **Phoenix**
Field Sales Office, (602) 264-4948
Cal **Irvine**
Celtec Company, (714) 752-6111
Los Angeles
Field Sales Office, (213) 466-8393
Celtec Company, (213) 874-6002
San Diego
Field Sales Office, (714) 279-6021
Celtec Company, (714) 279-7961
Santa Ana
Field Sales Office, (714) 558-1881
Santa Clara
Field Sales Office, (408) 244-1400
Magna Sales, Inc., (408) 985-1750
Colo **Denver**
Field Sales Office, (303) 234-9292
Littleton
Simpson Associates, Inc., (303) 794-8381
Conn **Stamford**
Field Sales Office, (203) 348-7701
Lorac Sales, Inc., (203) 327-6238
Fla **Altamonte Springs**
WMM Associates, Inc., (305) 862-4700
Clearwater
WMM Associates, Inc., (813) 447-2533
Orlando
Field Sales Office, (305) 834-7000
Pompano Beach
WMM Associates, Inc., (305) 943-3091
Tampa
Field Sales Office, (813) 585-3892
Ga **Atlanta**
Cartwright & Bean, Inc., (404) 255-5262
Ill **Schiller Park**
Field Sales Office, (312) 671-4660
Ind **Fort Wayne**
Field Sales Office, (219) 483-6453
Indianapolis
Field Sales Office, (317) 849-5412
Leslie M. Devoe Company, (317) 257-1227
Kan **Olathe**
B.C. Electronic Sales, Inc., (913) 782-6696
Wichita
B.C. Electronic Sales, Inc., (316) 686-3394
Md **Bladensburg**
Field Sales Office, (301) 779-0954
L D Lowery, (301) 277-6565
Mass **Wellesley Hills**
Field Sales Office, (617) 237-3400
Spectrum Associates, Inc., (617) 237-2796
Mich **Detroit**
Rathsburg Associates, (313) 882-1717
Westland
Field Sales Office, (313) 425-3250
Minn **Edina**
Field Sales Office, (612) 835-3322
Minneapolis
PSI Company, (612) 835-1777
Miss **Jackson**
Cartwright & Bean, Inc., (601) 981-1368
Mo Hazelwood
B.C. Electronic Sales, Inc., (314) 731-1255
NJ **Wayne**
Field Sales Office, (201) 696-7070
Lorac Sales Inc., (201) 696-8815
NM **Albuquerque**
Field Sales Office, (505) 265-5601
NY **Endwell**
Field Sales Office, (607) 754-1094
Fairport
Field Sales Office, (716) 223-7700
Melville
Field Sales Office, (516) 293-2900
293-29 **Lorac Sales, Inc., (516) 696-8815**
North Syracuse
Advanced Components, Inc., (315) 699-2671
Poughkeepsie
Field Sales Office, (914) 452-4200
293-29 **Tuckahoe**
Spectrum Sales, Inc., (914) 793-1660
NC **Charlotte**
Cartwright & Bean, Inc., (704) 333-6457
Raleigh
Cartwright & Bean, Inc., (919) 834-1186
Ohio **Cleveland**
Components, Inc., (216) 243-9200
Dayton
Field Sales Office, (513) 278-8278
Highland Heights
Field Sales Office, (216) 461-8288
West Carrollton
Components, Inc., (513) 866-0661
Okla **Tulsa**
Field Sales Office, (918) 663-7131
Pa **Broomall**
L.D. Lowery, (215) 356-5300 or 528-5170
Fort Washington
Field Sales Office, (215) 886-6623
BGR Associates, (215) 643-4111
SC **Seneca**
Field Sales Office, (803) 882-1760
Tenn **Knoxville**
Cartwright & Bean, Inc., (615) 693-7450
Memphis
Cartwright & Bean, Inc., (901) 276-4442
Tex **Dallas**
Field Sales Office, (214) 234-3391
Technical Marketing, 7214) 387-3601
Houston
Field Sales Office, (713) 771-3547
Technical Marketing, (713) 777-9228
Wash **Bellevue**
Quadra Corporation, (206) 454-4946
Wisc **Greenfield**
Field Sales Office, (414) 282-5260
Wauwatosa
Larsen Associates, (414) 258-0529
Can **Mississauga, Ont.**
Toronto Regional Office, (416) 625-7070
Willowdale, Ont.
Avotronics Limited, (416) 493-9711
Montreal, PQ
Fairchild Semiconductor, (514) 382-2552
Pointe Claire, PQ
Avotronics Limited, (514) 697-2135
Intl **Australia, North Sydney**
Fairchild Australia Pty, Ltd., Tel: 929-6711
Intl **Austria, Vienna**
Fairchild Electronics, Tel: 0222 635821
Intl **Brazil, Sao Paulo**
Fairchild Electronica Ltd., Tel: 81-6168
Intl **France, Paris**
Fairchild Semiconducteurs S.A., Tel: 580 5566
Intl **Germany, Hanover**
Fairchild Halbleiter GmbH, Tel: 0511 17844
Intl **Leonberg**
Fairchild Halbleiter GmbH, Tel: 07152 41026
Intl **Munich**
Fairchild Halbleiter GmbH, Tel: (0 89) 4 701091
Intl **Nuernberg**
Fairchild Halbleiter GmbH, Tel: 0911 407005
Intl **Weisbaden**
Fairchild Halbleiter GmbH, Tel: 06121 2051
Intl **Hong Kong, Kowloon**
Fairchild Semiconductor HK Ltd., Tel: K 890271
Intl **Italy**
Milan
Fairchild Semiconduttori S.p.A., Tel: 00392 6887451
Rome
Fairchild Semiconduttori S.p.A., Tel: 00386 3274006
Intl **Japan, Tokyo**
TDK Fairchild, Tel: 03-400-8351
Intl **Mexico, Mexico, D.F.**
Fairchild Mexicana S.A., Tel: 905-563-5411
Intl **Scotland, West Lothian**
Fairchild Semiconductor Ltd., Tel: 00445 8932891
Intl **Sweden, Stockholm**
Fairchild Semiconductor AB, Tel: 00468-449255
Intl **Taiwan, Taipei**
Fairchild Semiconductor (Taiwan) Ltd., Tel: 573205
Intl **Netherlands, Eindhoven**
Fairchild Semiconductor, Tel: 0031-4067727
Intl **United Kingdom, Herts**
Fairchild Semiconductor Ltd., Tel: 00441 4407311

Fairchild Semiconductor (cont)

Distributors

Ala. Huntsville
Hallmark Electronics, (205) 837-8700
Hamilton/Avnet Electronics, (205) 533-1170

Ariz Phoenix
Hamilton/Avnet Electronics, (602) 275-7851
Liberty Electronics/Arizona, (602) 257-1272
Mirco Electronic Distributors, (602) 944-2201

Cal Culver City
Avnet Electronics, (213) 836-7200
Hamilton Electro Sales, (213) 870-7171
El Monte
G.S. Marshall Company, (213) 686-0141
El Segundo
Liberty Electronics, (213) 322-8100
Irvine
G.S. Marshall Company, (714) 556-6400
Mountain View
Elmar Electronics, (415) 961-3611
Hamilton/Avnet Electronics, (415) 961-7000
San Diego
G.S. Marshall Company, (714) 278-6350
Hamilton/Avnet Electronics, (714) 279-2421
Liberty Electronics/San Diego, (714) 565-9171
Sunnyvale
Bell Industries, (408) 734-8570

Colo Arvada
G.S. Marshall Company, (303) 423-9670
Commerce City
Elmar Electronics, (303) 287-9611
Denver
Hamilton/Avnet Electronics, (303) 534-1212

Conn Danbury
Schweber Electronics, (203) 792-3500
Georgetown
Hamilton/Avnet Electronics, (203) 762-0361
Norwalk
Harvey Electronics, (203) 853-1515

Fla Ft. Lauderdale
Hallmark Electronics, (305) 971-9280
Hollywood
Hamilton/Avnet Electronics, (305) 925-5401
Schweber Electronics, (305) 927-0511
Orlando
Hallmark Electronics, (305) 855-4020
Tampa
Lykes electronics Corp., (404) 355-2223

Ga Atlanta
Schweber Electronics, (404) 449-9170
Norcross
Hamilton/Avnet Electronics, (404) 448-0800

Ill Elgin
Allied Electronics, (312) 697-8200
Elk Grove
Schweber Electronics, (312) 593-2740
Elmhurst
Semiconductor Specialists, Inc., (312) 279-1000
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Ariz **Phoenix**
Toward Engineering Assoc., Inc., (602) 277-1453
Cal **Mountain View**
Caltron-Pyle, (415) 964-3244
Van Nuys
Wes-K Associates, (213) 989-3070
Colo **Golden**
A-G Electronics, (303) 279-7815
Conn **New Haven**
Kitchen & Kutchin, (203) 239-0212
Fla **Oldsmar**
The Nickerson Co., (813) 855-4209
Tampa
The Nickerson Co., (813) 885-1416
Ill **Des Plaines**
Coombs Associates, (312) 298-4830
Md **Baltimore**
Robert L. Wilkinson, Inc., (301) 377-7800
Mass **Lexington**
Kitchen & Kutchin, (617) 862-8230
Mo **Grandview**
Beneke & McCaul, Inc., (816) 765-2998
St. Louis
Beneke & McCaul, Inc., (314) 434-6242
Minn **St. Paul**
Northport Engineering, Inc., (612) 698-3841
NC **Franklin**
The Nickerson Co., (704) 524-6363
Kannapolis
The Nickerson Co., (704) 932-6772
NY **Bayside**
Robert Diamond, Inc., (212) 423-7330
Dewitt
Tri-Tech Electronics, Inc., (315) 446-2881
East Rochester
Tri-Tech Electronics, Inc., (716) 381-2722
Great Neck, L.I.,
Cooper-Simon & Co., Inc., (516) 487-1142
Larchmont
Tri-Tech Electronics, Inc., (914) 834-4423
Ohio **Dayton**
R.G. Sidnell Company, Inc., (513) 433-7761
Mentor
R.G. Sidnell Company, Inc., (216) 255-6969
Penn **Narberth**
Electro-Comp Sales, Inc., (215) 664-3576
Tex **Dallas**
Ralph Matthews & Associates, (214) 233-0363
Houston
Ralph Matthews & Associates, (713) 664-7131
Wash **Seattle**
Underwood & Underwood, Inc., (206) 243-2133
Wisc **Greendale**
Coombs Associates, (414) 421-2300

Hybrid Systems

Hybrid Systems Corp.
Crosby Drive
Bedford, Mass 01730
(617) 275-1570
TWX: (710) 326-7584

Intech

Intech, Inc.
1220 Coleman Avenue
Santa Clara, Ca. 95050
(408) 244-0500
TWX: (910) 338-0254

Specific product information:
Jack Murray, East Coast ....ext. (617) 535-3058
Harry Douglas, West Coast ....ext. (408) 244-0500, Ext. 48
Robert Burkett, Sales Manager ....ext. (408) 244-0500, Ext. 45

Application engineering:
See Product Information

Literature:
282 Brokaw Rd. Santa Clara, California 95050, (408) 244-0500, Ext. 49

Price and delivery:
Customer Service .... ext. 49

Place an order:
Customer Service .... ext. 49

Follow-up an order:
Customer Service .... ext. 49

All other information:
Public Relations, Bobbie Fikes ....ext. (408) 244-0500, Ext. 51

Sales Offices and Representatives

Ariz **Scottsdale**
Summit Sales, (602) 994-4587
Cal **Lawndale**
Group Three, (213) 542-7391
Santa Clara
Intech, Inc., (408) 244-0500
Sunnyvale
RDP Instruments, Inc., (408) 735-9040
San Diego
Mesa Engineering & Sales Associates, (714) 278-8021
Colo **Arvada**
Figaro Kleffa Associates, (303) 424-0108
Fla **Clearwater**
Brennan Associates, Inc., (813) 446-5006
Ill **Elk Grove Village**
L.F.Green & Assocs., (312) 593-0282
Ind **Indianapolis**
Loren Green, (317) 293-9827
Mass **Peabody**
Murray Sales, (617) 535-3058
Mich **Ann Arbor**
AP Assoc., Inc., (313) 971-8870
Minn **Minneapolis**
L.F. Green & Assocs, (612) 781-1611
NJ **Clifton**
Compar N.Y., (201) 546-3660
NM **Albuquerque**
Tri Tronix, (505) 265-0172
NY **Buffalo**
Ossmann Component Sales, (716) 832-4271
Rochester
Ossmann Component Sales, (716) 442-3290
NC **Greensboro**
DMI, Inc., (919) 885-4634
Ohio **Dayton**
Bear Marketing, (513) 299-3566
West Richfield
Bear Marketing, (216) 659-3131

Intech (cont)

Ore Portland
Western Technical Sales, (503) 297-1711
Penn Ambler
(FMI Products only)
WM Associates, (215) 643-4119
Delmont
T. F. Laslo & Associates, (412) 468-5045
Tex Houston
The Cunningham Company, (713) 461-4197
Richardson
The Cunningham Company, (214) 231-2686
Va Falls Church
Scientific Associates, Inc., (703) 573-8787
Wash Bellevue
Western Technical Sales, (206) 641-3900
Intl Australia, Sydney
Ampec Engineering Co., (02) 747-2731
Intl Austria, Salzburg
Schock Electro-Optic, 06222/85264
Intl Belgium, Bruxelles
C.M. Rood b.v., 02-35.21.35
Intl Denmark, Naerum
SC Metric A/S, (02) 80 42 00
Intl Finland, Tapiola
Finn Metric Oy, 460 844
Intl France, Paris
Septa, 206-16-59
Intl Germany
Munich
Niederlassung Munchen, 089/182339
Sprendlingen
Newport Laboratories GmbH, 06103/63041/42
Stuttgart
Stahl Elektronik, 0711/724 903
Intl Israel, Tel Aviv
MADAA & Mabada, (03) 47 07 84
Intl Italy, Milan
Nuclear Milano, 738 359
Intl Japan, Tokyo
Microtek, Inc., (03) 369-1101
Intl Netherlands, Rijswijk
C.M. Rood b.v., 07-99 63 60
Intl Norway, Oslo
Metric A.S., (02) 28 26 24
Intl Republic of South Africa Cape Town
Eagle Electric Co., (Pty.) Ltd., 45-1421
Intl Sweden, Solna
Scandia Metric AB, 08/82 04 10
Intl Switzerland, Geneva
Electronic Components Geneva, (022) 43 15 31
Intl U.K., England
Slough, Bucks
Teknis Limited, (0753) 44712

Distribution

Cal San Diego
Intermark Electronics, (714) 279-5200
Santa Ana
Intermark Electronics, (714) 540-1322
Sunnyvale
Intermark Electronics, (408) 738-1111
Woodland Hills
Semiconductor Concepts, (213) 884-4560
Colo Denver
Intermark Electronics, (303) 936-8284
Ind Indiana
Ra-Dis-Co., Inc., (317) 637-5571
Mass Framingham
Cadence, (617) 879-3000
NM Albuquerque
Century Electronics, (505) 292-2700
NY Hauppage
Semiconductor Concepts, Inc., (516) 273-1234
Woodbury
C. Tennant, (516) 364-9071
Oh Dayton
WKM Associates, Inc., (513) 434-7500
Ore Portland
Almac/Stroum Electronics, (503) 292-3634
Tex Dallas
Component Specialties, Inc., (214) 357-4576
Houston
Component Specialties, Inc., (713) 771-7237
Wash Seattle
Almac/Stroum Electronics, (206) 854-4991
Intermark Electronics, (206) 767-3160

Integrated Photomatrix Inc.

Integrated Photomatrix, Inc.
1101 Bristol Road
Mountainside, New Jersey 07092
(201) 233-7200

Intel

For data on selected products see page:

Memory 752
Microprocessor 958

Intel Corporation
3065 Bowers Avenue
Santa Clara, California 95051
(408) 246-7501
TWX: (910) 338-0026

Sales Offices and Representatives

Ala Huntsville
Barnhill & Associates, (205) 883-9394
Ariz Scottsdale
Sales Engineering, Inc., (602) 945-5781
Cal Cupertino
Mac-1 (408) 257-9880
San Diego
Earle Associates, Inc., (714) 278-5441
Santa Ana
Intel Corp., (714) 835-9642
Santa Clara
Intel Corp., (408) 985-5781
Col Denver
Intel Corp., (303) 373-4920
Fla Orlando
Intel Corp., (305) 628-2393
Pompano Beach
Intel Corp., (305) 781-7450
Ill Oakbrook
Intel Corp., (312) 325-9510
Kan Olathe
Technical Representatives, Inc., (913) 782-1177
Md Timonium
Barnhill & Associates, (301) 252-7742
Intel Corp., (301) 252-7742
Ma Chelmsford
Intel Corp., (617) 861-1136
Waltham
Datcom, (617) 891-4600
Mich Birmingham
Intel Corp., (313) 642-7018
Farmington Hills
Sheridan Associates, Inc., (313) 477-3800
Minn Bloomington
Intel Corp., (612) 835-6722
Mo Hazelwood
Technical Representatives, Inc., (314) 731-5200
NJ Edison
Intel Corp., (201) 985-9100
NY Buffalo
Ossmann Components Sales Corp., (716) 832-4271
Kingston
Ossmann Components Sales Corp., (914) 338-5505
Rochester
Ossmann Components Sales Corp., (716) 442-3290
Syosset
Intel Corp., (516) 364-9860
Syracuse
Ossmann Components Sales Corp., (315) 454-4477
Vestal
Ossmann Components Sales Corp., (607) 785-9949
NC Raleigh
Barnhill & Associates, (919) 876-5617
Ohio Beachwood
Sheridan Associates, Inc., (216) 831-0130
Cincinnati
Sheridan Associates, Inc., (513) 761-5432
Ohio Dayton
Intel Corp., (513) 890-5250
Sheridan Associates, Inc., (513) 277-8911
Pa Bala Cynwyd
Vantage Sales Company, (215) 667-0990
Fort Washington
Intel Corp., (215) 542-9444
Pittsburg
Sheridan Associates, Inc., (412) 244-1640
Tenn Johnson City
Barnhill & Associates, (615) 928-0184
Tex Dallas
Evans & McDowell Associates, (214) 238-7157
Intel Corp., (214) 661-8829
Houston
Evans & McDowell Associates, (713) 783-2900
Va Lynchburg
Barnhill & Associates, (804) 846-4624
Wash Seattle
E.S. Chase Co., (206) 762-4824
Can Ottawa, Ontario
Multilek, Inc., (613) 825-4695
Intl Belgium, Brussels
Intel International, Tel: (02) 660 30 10
Intl Denmark, Copenhagen East
Intel Scandinavia A/S, Tel: (01) 18 20 00
Intl England, Cowley, Oxford
Intel Corporation, Tel: (0865) 77 14 31
Intl France, Rungis Cedex
Intel Corporation S.A.R.L., Tel: (1) 677 60 75
Intl Germany
Munich
Intel Semiconductor, Tel: (089) 79 89 23
Wiesenweg
Intel Semiconductor, Tel: (0) 6127/2314
Intl Japan, Tokyo
Intel Japan Corp., Tel: (03) 295-5441
Intl Sweden, Vallingby
Intel Sweden AB, Tel: (08) 37 53 70

Distributors

Ala Huntsville
Hamilton/Avnet Electronics, (205) 533-1170
Ariz Phoenix
Cramer/Arizona, (602) 263-1112
Hamilton/Avnet Electronics, (602) 275-7851
Liberty/Arizona, (602) 257-1272
Cal Culver City
Hamilton Electro Sales, (213) 558-2121
El Segundo
Liberty Electronics, (213) 332-8100
Irvine
Cramer/Los Angeles, (714) 979-3000
Mountain View
Elmar Electronics, (415) 961-3611
Hamilton/Avnet Electronics, (415) 961-7000
San Diego
Cramer/San Diego, (714) 565-1881
Hamilton/Avnet Electronics, (714) 297-2421
Liberty/San Diego, (714) 565-9171
Sunnyvale
Cramer/San Francisco, (408) 739-3011
Col Commerce City
Elmar/Denver, (303) 287-9611
Denver
Cramer/Denver, (303) 758-2100
Hamilton/Avnet Electronics, (303) 534-1212
Conn Georgetown
Hamilton/Avnet Electronics, (203) 762-0361
North Haven
Cramer/Connecticut, (203) 239-5841
Fla Hollywood
Cramer/E.W. Hollywood, (305) 923-8181
Hamilton/Avnet Electronics, (305) 925-5401
Orlando
Cramer/E.W. Orlando, (305) 894-1511
Ga Atlanta
Cramer/E.W. Atlanta, (404) 448-9050
Norcross
Hamilton/Avnet Electronics, (404) 448-0800
Ill Mt. Prospect
Cramer/Chicago, (312) 593-8230
Schiller Park
Hamilton/Avnet Electronics, (312) 678-6310
Ind Indianapolis
Pioneer/Indiana, (317) 849-7300
Sheridan Associates, Inc., (317) 547-7777

Intel (cont)

Kan **Lexena**
Hamilton/Avnet Electronics, (913) 888-8900
Overland Park
Sheridan Associates, Inc., (913) 383-1636
Mass **Burlington**
Hamilton/Avnet Electronics, (617) 273-2120
Newton
Cramer Electronics Inc., (617) 969-7700
Md **Gaithersburg**
Cramer/EW Washington, (301) 948-0110
Hanover
Cramer/EW Baltimore, (301) 796-5790
Hamilton/Avnet Electronics, (301) 796-5000
Mich **Farmington Hills**
Sheridan Sales Co., (313) 477-3800
Livonia
Hamilton/Avnet Electronics, (313) 522-4700
Pioneer/Michigan, (313) 525-1800
Minn **Edina**
Cramer/Bonn, (612) 835-7811
Hamilton/Avnet Electronics, (612) 941-3801
Minneapolis
Industrial Components, Inc., (612) 831-2666
Mo **Florissant**
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Hazelwood
Hamilton/Avnet Electronics, (314) 731-1144
NJ **Cedar Grove**
Hamilton/Avnet Electronics, (201) 239-0800
Cherry Hill
Cramer/Pennsylvania, Inc., (609) 424-5993
Moonachie
Cramer/New Jersey, (201) 935-5600
Mt. Laurel
Hamilton/Avnet Electronics, (609) 234-2133
NM **Albuquerque**
Cramer/New Mexico, (505) 265-5767
Hamilton/Avnet Electronics, (505) 765-1500
NY **East Syracuse**
Cramer/Syracuse, (315) 437-6671
Hamilton/Avnet Electronics, (315) 437-2642
Hauppauge
Cramer/Long Island, (516) 231-5600
Rochester
Cramer/Rochester, (716) 275-0300
Hamilton/Avnet Electronics, (716) 442-7820
Westbury
Hamilton/Avnet Electronics, (516) 333-5800
NC **Winston Salem**
Cramer Electronics, (919) 725-8711
Ohio **Beachwood**
Sheridan Sales, (216) 831-0130
Cincinnati
Sheridan Sales, (513) 761-5432
Cleveland
Hamilton/Avnet Electronics, (216) 461-1400
Pioneer/Cleveland, (216) 587-3600
Dayton
Hamilton/Avnet Electronics, (513) 433-0610
Pioneer/Dayton, (513) 236-9900
Sheridan Sales Co., (513) 277-8911
Okla **Tulsa**
Components Specialties, Inc., (918) 664-2820
Ore **Portland**
Almac/Stroum Electronics, (503) 292-3534
Pa **Pittsburgh**
Pioneer/Pittsburgh, (412) 782-2300
Sheridan Sales Co., (412) 244-1640
Tex **Dallas**
Cramer Electronics, (214) 350-1355
Component Specialties, Inc., (214) 357-4576
Hamilton/Avnet Electronics, (214) 661-8661
Houston
Component Specialties, Inc., (713) 771-7237
Hamilton/Avnet Electronics, (713) 526-4661
Utah **Salt Lake City**
Cramer/Utah, (801) 487-4131
Hamilton/Avnet Electronics, (801) 262-8451
Wash **Bellevue**
Almac/Stroum Electronics, (206) 746-8750
Seattle
Almac/Stroum Electronics, (206) 763-2300
Cramer/Seattle, (206) 762-5755
Can **Calgary, Alberta**
L.A. Varah Ltd., (403) 276-8818
Vancouver, B.C.
L.A. Varah Ltd., (604) 873-3211
Mississauga, Ont
Hamilton/Avnet Electronics, (416) 677-7432
Ottawa, Ont.
Hamilton/Avnet Electronics, (613) 226-1700
Can **Toronto, Ont.**
Cramer/Canada, (416) 661-9222
St. Laurent, Que.
Hamilton/Avnet Electronics, (514) 331-6443
Intl **Australia, Prospect,**
A.J. Ferguson (Adelaide) PTY, Ltd., Tel: 269-1244
Intl **Austria, Vienna**
Bacher Elektronische Gerate GmbH, Tel: (0222) 83 63 96
Intl **Belgium, Brussels**
Inelco Belgium S.A., Tel: (02) 660 00 12
Intl **Denmark, Copenhagen**
Scandinavian Semiconductor, Tel: (01) 93 50 90
Intl **Finland, Helsinki**
Havulinna Oy, Tel: (90) 66 44 51
Intl **France, Sevres**
Tekelec Airtronic Tel: (01) 626 02 35
Intl **Germany, Quickborn-Hmbrg**
Alfred Neye Enatachnik GmbH, Tel: (041 06) 612-1
Intl **Hong Kong, Hong Kong**
Q1 Far East Ltd.,
Intl **Israel, Ramat-Gan**
Telsys Ltd., Tel: (3) 73 98 65
Intl **Italy, Viale Elvezia**
Eldra S.P.A., Tel: (02) 34 93 014
Intl **Japan, Yokohama**
Pan Electron, Tel: (045) 471-8321
Intl **Netherlands, Amsterdam**
Inelco Nederland, Tel: (02) 93 48 24
Intl **Norway, Oslo**
Nordisk Elektronik (Norge) A/S, Tel: (02) 55 38 93
Intl **So. Africa, Pretoria**
Electronic Building Elements,
Tel: 78 92 21
Spain, Barcelona
Interface, Tel: (93) 203 53 30
Intl **Sweden, Stockholm**
Nordisk Electronik AB, Tel: (08) 24 83 40
Intl **Switzerland, Zurich**
Industrade AG, Tel: (01) 60 22 30
Taiwan, Taipei
Asionics-Taiwan 75 55 82
Taiwan Automation 391-09-69
Intl **United Kingdom**
London
Rapid Recall, Ltd., Tel: (01) 379-6741
Wembley
G.E.C. Semiconductors Ltd., Tel: (01) 904-9303

Interdesign

Interdesign
1255 Reamwood Avenue
Sunnyvale, California 94086
(408) 734-8666
TWX: (910) 339-9374

International Microcircuits Inc.

International Microcircuits Inc.
3000 Lawrence Expressway
Santa Clara, California 95051
(408) 735-9370

Sales Offices and Representatives

Conn **Hamden**
Impact Sales, (203) 281-1331
Mass **Waltham**
Impact Sales, (617) 893-2850
Minn **Minneapolis**
Quantum Sales, (612) 831-8583
Wash **Redmonds**
Desco-NW, (206) 455-9325

Intersil

Intersil, Inc.
10900 N. Tantau Avenue
Cupertino, California 95014
(408) 996-5000
TWX: (910) 338-0228

Specific product information:
Memory .... ext. (408) 996-5120
Analog
Linear .... ext. (408) 996-5264
Analog Devices .... ext. (408) 996-5152
Discretes
FETs, Duals, Bipolar .... ext. (408) 996-5273
Timing Devices .... ext. (408) 996-5255

Application engineering:
Contact Appropriate Product Marketing Department

Literature:
Marketing Services Department .... ext. (408) 996-5406

Price and delivery:
Sales Department

Place an order:
Distributors, Representatives, Field Sales Offices or Sales Department .... ext. (408) 996-5257, (408) 996-5275

Follow-up an order:
Sales Department .... ext. (408) 996-5278

All other information:
Marketing Services Department .... ext. (408) 996-5406

Sales Offices and Representatives

Ariz **Phoenix**
Shefler-Kahn Co., (602) 258-7893
Cal **Carson**
Field Sales Office, (213) 532-3544
Cupertino
Field Sales Office, (408) 984-5000
San Diego
Daniels & Doty Sales Co., (714) 560-6266
Fla **Casselberry**
E.I.R., Inc., (305) 830-9600
Margate
Intersil, Inc., (305) 971-6160
Ill **Franklin Park**
Dekotech, Inc., (312) 455-5100
Hinsdale
Intersil, Inc., (910) 651-0859
Ind **Ft. Wayne**
Delesa Sales, (219) 483-9537
Indianapolis
Delesa Sales, (317) 257-4683
Kan **Olathe**
Electronic Sales, (913) 782-2850
Md **Glen Bernie**
New Era Sales, (301) 768-6666
Mass **Burlington**
New England Technical Sales, (617) 272-0434
Field Sales Office, (617) 273-2055
Mich **Grand Rapids**
J.L. Montgomery Asso., (616) 774-9308
Southfield
J.L. Montgomery Asso., (313) 358-2616
Minn **Minneapolis**
Field Sales Office, (612) 925-1844
NC **High Point**
Remco, (704) 738-4716
NJ **Cherry Hill**
Barrett Associates, (609) 429-1551
Englewood Cliffs
Field Sales Office, (201) 567-5585
Irvington
M.G.I., (201) 399-4350 (505) 265-7077
NM **Albuquerque**
Shefler-Kahn Co.
NY **Ithaca**
Bob Dean, Inc., (607) 272-2187
Syracuse
Field Sales Office, (315) 463-3368
Ohio **Cincinnati**
Giesting & Assoc., (513) 931-0812
Cleveland
Giesting & Assoc., (216) 621-4240
Dayton
Giesting & Assoc., (513) 293-4044
Intersil, Inc., (513) 278-4837

Intersil (cont)

Ore Portland
Earl & Brown, Inc., (503) 245-2283
Tenn Bristol
Remco, (615) 968-4716
Tex Dallas
Bonser-Philhower Sales, (214) 272-0666
Field Sales Office, (214) (214)6387-0539
Wash Seattle
Earl & Brown Co. Inc., (206) 284-1121
Can Vancouver, B. C.
Deskin Sales, (604) 324-6331
Malton, Ont.
Deskin Sales, (416) 677-5517
Montreal, Quebec
Deskin Sales, (514) 331-2860

Distributors

Ariz Phoenix
Liberty Electronics, (602) 257-1272
R.V. Weatherford Co., (602) 272-7144
Cal Anaheim
R.V. Weatherford Co., (714) 547-0891
Cal Costa Mesa
Schweber Electronics, (714) 556-3880
El Segundo
Liberty Electronics, (213) 322-8100
Glendale
R.V. Weatherford Co., (213) 849-3451
Mt. View
Elmar Electronics, (415) 961-3611
Palo Alto
R.V. Weatherford Co., (415) 493-5373
Pomona
R.V. Weatherford Co., (714) 623-1261
San Diego
Liberty Electronics, (714) 565-9171
R.V. Weatherford Co., (714) 278-7400
Colo Commerce City
Elmar Electronics, (303) 287-9611
Englewood
R.V. Weatherford Co., (303) 761-5432
Conn Danbury
Schweber Electronics, (203) 792-3500
Conn Hamden
Arrow Electronics, (203) 248-3801
Fla Clearwater
Southland, Inc., (813) 443-4514
Hollywood
Schweber Electronics, (305) 927-0511
Ga Atlanta
Schweber Electronics, (404) 449-9170
Ill Chicago
Semiconductor Spec., (312) 279-1000
Elk Grove Village
Schweber Electronics, (312) 593-2740
Ind Indianapolis
Semiconductor Spec., (317) 243-8271
Iowa Cedar Rapids
Schweber Electronics, (319) 393-9125
MD Baltimore
Arrow Electronics, (301) 247-5200
Rockville
Schweber Electronics, (301) 881-2970
Mass Billerica
Kierulff Electronics, (617) 667-8331
Waltham
Schweber Electronics, (617) 890-8484
Mich Farmington
Semiconductor Specialists, (313) 478-2700
Troy
Schweber Electronics, (313) 583-9242
Minn Bloomington
Arrow Electronics, (612) 888-5522
Edina
Schweber Electronics, (612) 941-5280
Minneapolis
Semiconductor Spec., (612) 854-8841
Mo Hazelwood
Semiconductor Spec., (314) 731-2400
Kansas City
Semiconductor Spec., (816) 452-3900
NJ Moorestown
Arrow Electronics, (609) 235-1900
Saddlebrook
Arrow Electronics, (201) 797-5800
Somerset
Schweber Electronics, (201) 469-6008
NM Albuquerque
Century Electronics, (505) 292-2700
R.V. Weatherford Co., (505) 842-0868
NY Farmingdale
Arrow Electronics, (516) 694-6800
Rochester
Schweber Electronics, (716) 461-4000
Westbury
Schweber Electronics, (516) 334-7474
Ohio Beachwood
Schweber Electronics, (216) 464-2970
Dayton
Arrow Electronics, (513) 253-9176
Semiconductor Spec., (513) 278-9455
Pa Pittsburgh
Semiconductor Spec., (412) 781-8120
Tex Austin
Schweber Electronics, (512) 837-2890
Dallas
Schweber Electronics, (214) 661-5010
Semiconductor Spec., (214) 358-5211
R.V. Weatherford Co., (214) 243-1571
Houston
R. V. Weatherford, (713) 688-7406
Schweber Electronics, (713) 784-3600
Wash Seattle
Earl & Brown Co. Inc., (206) 284-1121
Liberty Electronics, (206) 763-8200
R.V. Weatherford Co., (206) 243-6340
Wisc New Berlin
Arrow Electronics, (414) 782-2801
Wauwatosa
Semiconductor Spec., (414) 257-1330
Can Malton, Ontario
Deskin Sales, (416) 677-5517
Montreal, Quebec
Deskin Sales, (514)331-2860
Vancouver, B.C.
Deskin Sales, (604) 324-6331

ITT Semiconductors

ITT Semiconductors
U.S. Division
74 Commerce Way
Woburn, Mass 01801
(617) 935-7910
TWX: 710-342-0764

Specific product information:
Product Marketing
Digital ... ext. 247
Consumer ... ext. 247
Linear ... ext. 233
Automotive ... ext. 233

Application engineering:
Contact appropriate Product Marketing Department

Literature:
Use address above for mail inquiries ... ext. 218

Price and delivery:
See list for sales offices

Place an order:
See list for sales offices

Follow-up an order:
Customer Service ... ext. 254

All other information:
Public Relations ... ext. 218

Sales Offices & Representatives

Ala Huntsville
Rep, Incorporated, (205) 881-9270
Ariz Phoenix
ITT, (602) 968-2497
Tempe
Argus Sales, (602) 967-8709
Cal Inglewood
ITT, (213) 649-4644
Mountain View
Nor-Cal Associates, (415) 961-8121
Palo Alto
ITT, (415) 961-5265
San Diego
JTL Associates, (714) 277-8044
Cal Woodland Hills
Interstate Marketing Associates, (213) 883-7606
Colo Englewood
Checkmate Sales Corporation, (303) 771-0666
Fla North Palm Beach
Lectromech, Incorporated, (305) 842-2458
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ITT, (404) 939-6715
Ill Elk Grove Village
Centronics, (312) 956-0963
Schaumburg
ITT, (312) 884-0990
Iowa Cedar Rapids
S & O Sales Company, (319) 393-1845
Kan Shawnee Mission
Mid-America Electronics Marketing, (913) 236-4800
Md Baltimore
Colbourn-DeGrief, Incorporated, (311) 247-4646
Mass Lexington
ITT, (617) 861-0880
Waltham
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Mich Livonia
Giesting Associates, (313) 477-6060
Minn Minneapolis
ITT, (612) 835-5311
Nortec Sales, Incorporated, (612) 835-7414
NM Albuquerque
Cleveland Enterprises, (505) 345-2481
NY Fayetteville
ITT, (315) 445-0560
Huntington
Caravan Sales Corporation, (516) 692-2839
Jericho
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LRC Associates, (914) 634-7973
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Can Toronto, Ont.
ITT, (416) 625-9022

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Hamilton/Avnet Electronics, (205) 533-1170
Ariz Phoenix
Cramer/Arizona, (602) 267-7321
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Cal Chatsworth
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Avnet Electronics, (213) 558-2345, (714) 522-8220
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Irvine
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Hamilton/Avnet Electronics, (415) 961-7000
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Sterling Electronics, (415) 592-2353
San Diego
Cramer/San Diego, (714) 565-1881
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Cramer/Electronics, (408) 739-3011
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Cramer/Denver, (303) 758-2100
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Conn Georgetown
Hamilton/Avnet Electronics, (203) 762-0361
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Cramer/Connecticut, (203) 239-5641
Fla Clearwater
Diplomat/Southland, (813) 443-4514
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Cramer/Hollywood, (305) 923-8181
Hamilton/Avnet Sales, (305) 925-5401

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Fla **Orlando**
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Mt. Prospect
Cramer/Chicago, (312) 593-8230
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Hamilton/Avnet Electronics, (312) 678-6310

Kans **Lenexa**
Hamilton/Avnet Electronics, (913) 888-8900

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Cramer/Washington, (301) 948-0110
Hanover
Cramer/Baltimore, (301) 796-5790
Hamilton/Avnet Electronics, (301) 796-5000

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Cramer Electronics, Inc., (617) 969-7700
Cramer Electronics, (617) 969-7700
Cramer/International, (617) 969-7700
Greene-Shaw Co., Inc., (617) 969-8900

Mich **Livonia**
Hamilton/Avnet Electronics, (313) 522-4700

Minn **Edina**
Cramer/Minnesota, (612) 835-7811
Hamilton/Avnet Electronics, (612) 941-3801

Mo **Hazelwood**
Hamilton/Avnet Electronics, (314) 731-1144

NJ **Cedar Grove**
Hamilton/Avnet Electronics, (201) 239-0800
Cherry Hill
Cramer/Pennsylvania, (609) 424-5993
Moonachie
Cramer/New Jersey, (201) 935-5600
Mt. Laurel
Hamilton/Avnet Electronics, (609) 234-2133

NM **Albuquerque**
Cramer/New Mexico, (505) 265-5767
Hamilton/Avnet Electronics, (505) 765-1500

NY **East Syracuse**
Cramer/Syracuse, (315) 437-6671
Hamilton/Avnet Electronics, (315) 437-2642
Freeport
Milgray Electronics, (516) 546-6000
Hauppauge
Cramer/Long Island, (516) 231-5600
Rochester
Cramer/Rochester, (716) 275-0300
Hamilton/Avnet Electronics, (716) 442-7820
Westbury, L.I.
Hamilton/Avnet Electronics, (516) 333-5800

NC **Winston-Salem**
Cramer/Winston-Salem, (919) 725-8711

Ohio **Cleveland**
Cramer/Cleveland, (216) 248-8400
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Dayton
Hamilton/Avnet Electronics, (513) 433-0610

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Cramer/Texas, (214) 661-9300
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Sterling Electronics, (214) 357-9131
Houston
Hamilton/Avnet Electronics, (713) 526-4661
Sterling Electronics, (713) 627-9800

Utah **Salt Lake City**
Cramer/Utah, (801) 487-4131
Hamilton/Avnet Electronics, (801) 262-8451

Wash **Bellevue**
Hamilton/Avnet Electronics, (206) 746-8750
Seattle
Cramer/Seattle, (206) 762-5755

Can **Downsview, Ont.**
Cramer/Canada Ltd., (416) 661-9222
Mississauga, Ont.
Hamilton/Avnet Electronics, (416) 677-7432
Montreal, Quebec
Hamilton/Avnet Electronics, (514) 331-6443
Ottawa
Hamilton/Avnet Electronics, (613) 725-3071
Toronto, Ont.
Westburne Industrial Enterprises, (416) 789-4181

Can **Vancouver, B.C.**
Cam Gard Supply, Ltd., (604) 291-1441
Winnepeg, Man.
Cam-Gard Supply, Ltd., (204) 786-8481

Lithic Systems

Lithic Systems, Inc.
15800 Sanborn Road
P. O. Box 478
Saratoga, Ca. 95070
(408) 867-5600

Litronix

Litronix, Inc.
19000 Homestead Road
Cupertino, California 95014
(408) 257-7910
TWX: (910) 338-0022

LSI Computer Systems

LSI Computer Systems
22 Cain Drive
Plainview, New York 11803
(516) 293-3850

Micro Networks

Micro Networks Corporation
324 Clark Street
Worchester, Massachusetts 01606
(617) 852-5400

Sales Offices & Representatives

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Cal **Burlingame**
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Santa Ana
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Colo **Parker**
Technology Marketing Associates, (303) 841-3435

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John E. Boeing, Inc., (203) 632-1892

Fla **Winter Park**
Young & Lawrence Associates, (305) 647-6929

Hi **Honolulu**
Aloha Associates, (808) 941-1575

Ill **Chicago**
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Kans **Overland Park**
Ensco-Rep, Inc., (913) 381-7557

Md **Lutherville**
Houck Associates, (301) 296-6021

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John E. Boeing, Inc., (617) 862-2500

Mass **Worcester**
Micro Networks Corporation, (617) 852-5400

Mich **Detroit**
Rathsburg Associates, Inc., (313) 882-1717

Minn **Minneapolis**
Beta Engineering Corp. (612) 546-2215

Mo **St. Louis**
Ensco-Rep, Inc., (314) 567-3935

NM **Albuquerque**
Technology Marketing Associates, (505) 298-4321

NY **Jamaica**
S-J Sales Associates, Inc., (212) 291-3232
Syracuse
Nycom, Incorporated, (315) 437-8343

Ohio **Chagrin Falls**
Midwest Marketing Associates, (216) 247-6655
Dayton
Midwest Marketing Associates, (513) 433-2511

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Tucker Associates, (215) 644-0142

Tex **Dallas**
J. Clay Company, (214) 350-1281

Wash **Seattle**
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Can **Oakville, Ontario**
Haltronics Ltd., (416) 844-2121

Micro Power Systems

Micro Power Systems
3100 Alfred Street
Santa Clara, California 95050
(408) 247-5350
TWX: (910) 338-0154

Micropac Industries

Micropac Industries, Incorporated
905 East Walnut Street
Garland, Texas 75040
(214) 272-3571
TWX: (910) 860-5186

All other information:
All Inquiries: Marketing Department .... ext. 20, 21, 24

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Ariz **Tempe**
Argus Sales, (602) 967-8709

Cal **Los Altos**
Cain, White & Company, (415) 948-6533
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Cain Technology, (213) 476-2251
Palo Alto
Western International Trade Corporation, (415) 321-1240

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Coombs Associates, (312) 298-4830

Md **Baltimore**
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Mass **Medford**
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Bitronics Sales Co., (612) 835-7744

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Instrumentation Sales Co., (201) 445-5210

NY **Syracuse**
T-2 Electronics, (315) 463-8592

NC **Winston-Salem**
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Ohio **Cleveland**
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Dayton
Del Steffen & Associates, (513) 293-3146

Micropac Industries (cont)

Ore Beaverton
ES/Chase Company, (503) 649-6177

Va Lynchburg
Burgin-Kreh, (703) 845-5600

Wash Edmonds
ES/Chase Company, (206) 774-3586

Wisc Greendale
Coombs Associates, (414) 421-2300

Mitsubishi International Corp.

Melco Sales, Inc.
7045 North Ridgeway Ave.
Lincolnwood, Illinois 60645
(312) 973-2000
Melco Sales, Inc.
3030 East Victoria Street
Compton, California 90221
(213) 537-7132

Monolithic Memories Inc.

Monolithic Memories, Inc.
1165 East Arques Avenue
Sunnyvale, Ca. 94086
(408) 739-3535
TWX: (910) 339-9229

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Ariz Phoenix
Howe & Howe Sales, (602) 264-7971

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Mountain View
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San Diego
JTL Associates, (714) 277-8044
Sunnyvale
MMI Regional Office, (408) 739-3535

Colo Wheatridge
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Fla Clearwater
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Ft. Lauderdale
Dyne-A-Mark, (305) 771-6501, 944-5031
Orlando
Dyne-A-Mark, (305) 299-5303

Ga Tucker
Rep. Incorporated, (404) 938-4358

Ill Chicago
Carlson Electronic Sales, (312) 774-9022
Rolling Meadows
Sumer, Inc., (312) 394-4900

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Mass Andover
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MMI Regional Office, (617) 655-7070
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CompRep & Assoc., (617) 444-2484

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R. T. Reid Associates, (201) 692-0200

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Makin Associates, (216) 464-4330

Ore Beverton
Arneson & Associates, (503) 643-5754

Pa Horsham
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MMI Regional Office, (215) 643-0883

Tex Houston
Jackson Arnold Associates, (713) 783-9522

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Sterling Electronics, (602) 258-4531

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Palo Alto
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Intermark Electronics, (213) 436-5275
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Sterling Electronics, (415) 592-2353
San Diego
Intermark Electronics, (714) 279-5200
Kierulff Electronics, (714) 278-2112
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Colo Denver
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Wheatridge
Century Electronics, (303) 343-1985

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Arrow Electronics, (203) 248-3801

Fla Ft. Lauderdale
Hall-Mark Electronics, (305) 971-9280
Orlando
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Ind Indianapolis
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Kierulff Electronics, (301) 948-0250

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Pioneer/Michigan, (313) 525-1800

Minn Bloomington
Hall-Mark Electronics, (612) 884-9056
Minneapolis
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Mo Earth City
Hall-Mark Electronics, (314) 291-5350

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Arrow Electronics, (609) 235-1900
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Kierulff Electronics, (201) 935-2120
Saddlebrook
Arrow Electronics, (201) 797-5800

NM Albuquerque
Century Electronics, (505) 292-2700

NY Buffalo
Summit Distributors, (716) 884-3450
Farmingdale
Arrow Electronics, (516) 694-6800
Rochester
Summit Distributors, (716) 334-8110

NC Raleigh
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Ohio Cleveland
Arrow Electronics, (216) 464-2000
Pioneer/Cleveland, (216) 587-3600
Dayton
Arrow Electronics, (513) 253-9176
Pioneer/Dayton, (513) 236-9900

Okla Tulsa
Hall-Mark Electronics, (918) 835-8458

Ore Portland
Almac/Stroum Elect., (503) 292-3534

Penn Horsham
Pioneer/Delaware Valley, (215) 674-5710
Pittsburgh
Pioneer/Pittsburgh, (412) 782-2300

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Hall-Mark Electronics, (214) 231-6111
Houston
Hall-Mark Electronics, (713) 781-6100

Utah Salt Lake City
Century Electronics, (801) 487-8551

Wash Seattle
Almac/Stroum Elect., (206) 763-2300
Intermark Electronics, (206) 767-3160

Wisc Milwaukee
Hall-Mark Electronics, (414) 476-1270

Can Montreal, 307 Quebec
Future Electronics, (514) 735-5775
Toronto, Rexdale Ont.
Future Electronics, (416) 677-7820
Vancouver, B. C.
Future Electronics, (604) 261-1335

MOS Technology

MOS Technology, Inc.
Valley Forge Corporate Center
950 Rittenhouse Road
Norristown, Pennsylvania 19401
(215) 666-7950
TWX: (510) 660-4033

Specific product information:
Local Representative or Regional Sales Director ext. 220, 294, 212, 201, 205, 217

Literature:
Local Representative or Regional Sales Director, written inquiries to above address, Attn: Marketing Department ext. 294, 212, 220, 217

Price and delivery:
Local Representative or Regional Sales Director ext. 220, 294, 212, 201

Place an order:
Local Representative or Regional Sales Director ext. 220, 299, 294, 201, 212, 217

All other information:
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Sales Offices and Representatives

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Currie, Peak & Frazier, Inc., (205) 536-5650

Ariz Phoenix
Howard Engineering Associates, (602) 955-3193

Cal Hayward
MOS Technology, (415) 881-8080

Colo Boulder
R.G. Enterprises, Inc., (303) 447-9211

Fla Orlando
Currie, Peak & Frazier, Inc., (305) 855-0843

Mass Waltham
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Md Baltimore
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Falk Baker Associates, (201) 661-2430

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MOS Technology, (516) 822-4240
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McShane, Inc., (513) 298-3441
Medina
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Norvell Associates, (918) 663-1247

Ore Eugene
J.A. Tudor & Associates, (503) 686-1252
Portland
J.A. Tudor & Associates, (503) 288-5154

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Rivco, (215) 265-5211

Tex Dallas
Norvell Associates, (214) 350-6771

MOS Technology (cont)

Tex Houston
Norvell Associates, (714) 774-2568

Wash Seattle
J.A. Tudor & Associates, (206) 682-7444

Spokane
J.A. Tudor & Associates, (509) 327-3328

Mostek Corp.

For data on selected products see page:

Mostek Corporation
1215 West Crosby Road
Carrollton, Texas 75006
(214) 242-0444
TWX: (910) 860-5945
TELEX: 730423

Sales Office and Representatives

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Ariz Phoenix
Howe & Howe Sales, Inc., (602) 264-7971

Cal Irvine
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Los Altos
Field Sales Office, (415) 941-3030

Redwood City
James Heaton Co., (415) 4671

San Diego
Harvey King, Inc., (714) 566-5252

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Fla Clearwater
Dyne-A-Mark Corp., (813) 441-4702
Field Sales Office, (813) 441-9671

Ft. Lauderdale
Dyne-A-Mark Corp., (305) 771-6501

Ill Rolling Meadows
Sumer, Inc., (312) 394-4900

Ind Indianapolis
Electro Reps, (317) 255-4147

Mass Burlington
New England Technical Sales, (617) 272-0434

Waltham
Field Sales Office, (617) 899-9107

Mich Grosse Point Park
Greiner Associates, (313) 499-1088

Minn Minneapolis
Field Sales Office, (612) 566-5810
HMR Inc., (612) 920-8200

Miss Hernando
Beacon Assoc., (601) 369-9008

NC Greensboro
Beacon Assoc., (919) 674-9432

NJ East Hanover
HLM Associates, (201) 386-0794

NY Liverpool
James Semple Associates, (315) 458-4775

Northport
HLM Associates, (516) 757-1606

Rochester
James Semple Associates, (716) 544-8582

Ohio Brecksville
Field Sales Office, (216) 526-6747

Cincinnati
R. O. Whitesell & Associates, (513) 521-2290

Penn Ft. Washington
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SC Spartanburg
Beacon Assoc., (803) 582-4613

Tex Fort Worth
W. Pat Fralia Co., (817) 738-2394

Houston
W. Pat Fralis Co., (713) 772-1572

Utah Salt Lake City
Waugaman Assoc., (801) 277-8911

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General Electronics, (206) 243-5141

Distributors

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Kierulff Electronics, (602) 273-7331

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Los Angeles
Kierulff Electronics, (213) 685-5511

Palo Alto
Kierulff Electronics, (415) 968-3475

San Diego
Cramer Electronics, (714) 585-1881
Kierulff Electronics, (714) 278-2112

Sunnyvale
Cramer Electronics, (408) 739-3011

Colo Commerce City
Elmar Electronics, (303) 287-9611

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Kierulff Electronics, (303) 371-6500

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North Haven
Cramer Electronics, (203) 239-5641

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Southland Inc., (813) 443-4514

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Cramer Electronics, (305) 923-8181

Orlando
Cramer Electronics, (305) 923-8181

Ga Atlanta
Cramer Electronics, (404) 448-9050

Ill Elmhurst
Semiconductor Specialist, (312) 279-1000

Mt. Prospect
Cramer Electronics, (312) 593-8230

Skokie
Bell Industries, (312) 965-7500

Ind Anderson
Graham Electronics Supply, (317) 644-8837

Indianapolis
Graham Electronics Supply, (317) 634-8202
Semiconductor Specialist, (317) 243-8271

Lafayette
Graham Electronics Supply, (317) 423-5564

Md Baltimore
Arrow Electronics, (202) 737-1700

Gaithersburg
Cramer Electronics, (301) 948-0110

Hanover
Cramer Electronics, (301) 796-5790

Mass Billerica
Kierulff Electronics, (617) 667-8331

Newton
Cramer Electronics, (617) 969-7700

Minn Edina
Cramer Electronics, (612) 835-7811

Minneapolis
Semiconductor Specialist, (612) 854-8841
Stark Electronics, (612) 333-3361

Mich Farmington
Semiconductor Specialist, (313) 478-2700

Mo Hazelwood
Semiconductor Specialist, (314) 731-2400

Kansas City
Semiconductor Specialist, (816) 452-3900

St. Louis
Olive Industrial Electronics, Inc., (314) 863-7800

NJ Cherry Hill
Cramer Electronics, (609) 424-5993

Moonachie
Cramer Electronics, (201) 935-5600

Morrestown
Arrow Electronics, (609) 235-1900

Saddlebrook
Arrow Electronics, (201) 797-5800

NC Winston-Salem
Cramer Electronics, (919) 265-8711

NM Albuquerque
Cramer Electronics, (505) 265-5767

NY East Syracuse
Cramer Electronics, (315) 437-6671

Farmingdale
Arrow Electronics, (516) 694-6800

Hauppauge
Cramer Electronics, (516) 231-5600

NY Rochester
Cramer Electronics, (716) 275-0300

Ohio Cleveland
Cramer Electronics, (216) 248-8400

Dayton
Arrow Electronics, (513) 253-9176
Semiconductor Specialist, (513) 278-9455

Penn Pittsburg
Semiconductor Specialist, (412) 781-8120

Tex Dallas
Cramer Electronics, (214) 350-1355

Utah Salt Lake City
Alta Electronics, (801) 486-7227
Cramer Electronics, (801) 487-4131

Wash Seattle
Cramer Electronics, (206) 763-1550
Kierulff Electronics, (206) 763-1550
Liberty Electronics, (206) 763-8200

Can Downsview, Ont.
Cramer Electronics, (416) 389-9222

Montreal, P.Q.
Prelco Electronics, (514) 389-8051

Motorola Semiconductor

Motorola Semiconductor Products
5005 East McDowell Road
Phoenix, Arizona 85008

Specific product information:
Contact nearest district sales office or franchised distributor

Application engineering:
See Product Information

Literature:
See above

Price and delivery:
Direct contact with the proper people in the factory, if required, can be made through one of the sales offices or distributors.

Place an order:
See Price & Delivery

Follow-up an order:
See above

Sales Offices and Representatives

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Field Sales Office, (205) 533-1650

Ariz Phoenix
Field Sales Office, (602) 244-6900

Ariz Scottsdale
Field Sales Office, (602) 244-6364

Cal Encino
Field Sales Office, (213) 986-6850

La Jolla
Field Sales Office, (714) 459-4217

Menlo Park
Field Sales Office, (415) 854-1910

San Diego
Field Sales Office, (714) 560-4644

Santa Ana
Field Sales Office, (714) 558-2601

Colo Denver
Field Sales Office, (303) 770-2122

Conn Hamden
Field Sales Office, (203) 281-0771

Fla Ft. Lauderdale
Field Sales Office, (305) 584-6000

Maitland
Field Sales Office, (305) 644-3422

Pompano Beach
Field Sales Office, (305) 782-4464

St. Petersburg
Field Sales Office, (813) 576-6030

Ga Atlanta
Field Sales Office, (404) 255-2043

Ill Chicago
Field Sales Office, (312) 992-2320

Schiller Park
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Ind Ft. Wayne
Field Sales Office, (219) 485-1691

Indianapolis
Field Sales Office, (317) 849-7060

Iowa Cedar Rapids
Field Sales Office, (319) 393-8632

Motorola Semiconductor (cont)

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Field Sales Office, (913) 384-3050
Md Hyattsville
Field Sales Office, (301) 779-1100
Mass Lexington
Field Sales Office, (617) 861-1350
Mich Garden City
Field Sales Office, (313) 261-6200
Saugatuck
Field Sales Office, (616) 857-2159
Minn Minneapolis
Field Sales Office, (612) 545-0251
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Field Sales Office, (201) 488-1200
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Field Sales Office, (914) 896-8970
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Hamilton/Avnet Electronics, (801) 262-8451
Wash **Bellevue**
Hamilton/Avnet Electronics, (206) 746-8750
Seattle
Almac/Stroum Electronics, (206) 763-2300
Liberty Electronics Northwest, (206) 763-8200
Wisc **Milwaukee**
Taylor Electric Company, (414) 241-4321
Can **Dorval, Quebec**
Semad Electronics, Ltd.,
Downsview, Ont.
Semad Electronics, Ltd., (416) 635-9880
Mississauga
Hamilton/Avnet Electronics, Ltd., (416) 677-7432
Montreal, Quebec
Prelco Electronics, Ltd., (514) 389-8051
Ottawa
Hamilton/Avnet Electronics, (613) 725-3071

National Semiconductor (cont)

Can **St. Laurent, Quebec**
Hamilton/Avnet Electronics, (514) 331-6443
Willowdale, Ontario
Electro SONIC, Inc., (416) 494-1666

NEC Microcomputers

NEC Microcomputers
5 Militia Drive
Lexington, Mass 02173
TWX: 92-3434
(617) 862-6410

Sales Offices and Representatives

Ariz **Scottsdale**
Summit Sales, (602) 994-4587
Cal **El Toro**
Electronic Component Marketing, (714) 830-3939
Mountain View
Trident Associates, (415) 967-7031
San Diego
Electronic Component Marketing, (714) 295-6122
Woodland Hills
Electronic Component Marketing, (213) 340-1745
Fla **Clearwater**
Perrott Associates, Inc., (813) 726-1549
Orlando
Perrott Associates, Inc., (305) 275-1132
Ill **Park Ridge**
R.F. Specialists, 7312) 698-2044
Mass **Lexington**
Circuit Sales Company, (617) 861-0567
Minn **Minneapolis**
Bitronics Sales Company, (612) 835-7744
NM **Albuquerque**
Tri-Tronix, (505) 265-8400
NY **Great Neck**
TRIONIC Associates, Inc., (516) 466-2300
Ohio **Columbus**
McFadden Sales, Inc., (614) 221-3363
Penn **Hershey**
C.A. Newson & Associates, (717) 233-8576, (301) 825-0001
Philadelphia
C.H. Newson & Associates, (215) 248-3377
Tex **Dallas**
Merino Sales Company, (214) 233-6002
Wash **Bellevue**
Tri-tronix N.E., 7206) 454-0940
Can **Mississauga, Ontario**
R.F.Q. Ltd., (514) 626-8324
Dollrd Ds Ormeaux, Que
R.F.Q. Ltd., (416) 625-8874

Nippon Electric Co.

NEC America
Nippon Electric Ltd.
277 Park Avenue
New York, N.Y. 10017
(212) 758-1666

Nitron

Nitron
A Division of McDonnell Douglas
Corporation
10420 Bubb Road
Cupertino, California 95014
(408) 255-7550
TWX: (910) 338-0222

Specific product information:
ROMS .... ext. 208
MNOS .... ext. 203

Application engineering:
.... ext. 217

Literature:
.... ext. 218

Price and delivery:
.... ext. 218

Place an order:
.... ext. 218

Follow-up an order:
.... ext. 218

Sales Offices & Representatives

Ala **Huntsville**
Technology Marketing Assoc., (205) 883-7893
Scottsdale
Carter Associates, Inc., (602) 947-4355
Cal **Glendale**
Orion Sales, Inc., (213) 240-3151
Palo Alto
R. W. Thompson Assoc., Inc., (415) 494-7516
Tustin
Orion Sales, Inc., (714) 832-9687
Colo **Denver**
Omega Ltd., (303) 758-1508
Conn **Guilford**
R. H. Sturdy Company, Inc., (203) 453-5424
Fla **Ormond Beach**
Technology Marketing Assoc., (904) 672-2314
Pompano Beach
Technology Marketing Assoc., (305) 942-0774
Ill **Chicago**
Carlson Electronic Sales Co., (312) 774-9022, (312) 774-4812
Md **Glen Burnie**
New Era Sales, Inc., (301) 768-6666
Mass **Wellesley Hills**
R. H. Sturdy Co., Inc., (617) 235-2330
Mich **Warren**
Dem Electronic Sales, (313) 755-6660
Minn **Minneapolis**
S & R Component Sales, Inc., (612) 544-3022
NY **Jericho**
Electro Rep Inc., (516) 938-0540
Ore **Portland**
C.K. Shanks & Associates, Inc., (503) 292-5656
Penn **Birchrunville**
Jadelectronic Associates, Inc., (215) 647-5151
Tex **Addison**
Robert R. Thomas Co., (214) 233-8235
Utah **Salt Lake City**
Omega Ltd., (801) 266-9617
Wash **Seattle**
C.K. Shanks & Associates, Inc., (206) 632-4290
Wisc **Milwaukee**
Carlson Electronic Sales Co., (414) 476-2790
Can **Mississauga, Ont.**
Munro Electronic Components Ltd., (416) 676-1042
Ottawa, Ont.
Munro Electronic Components Ltd., (613) 749-0740
Dollard des Ormeaux, PQ
Munro Electronic Components Ltd., (514) 626-6723
Intl **Denmark, lyngby**
Knud Kamuk A/S, (01) 88 38 33
Intl **England, Oxfordshire**
Peter Gray Electronics Ltd., (Henley 6543)
Intl **France, Sevres**
Tekelec Airtronic, 626 02 35
Intl **Germany**
Hamburg
Infratron Ing., 040-81 75 78
Intl **Munich**
Infratron Ing., 089-52 41 81
Intl **Holland, Breda**
Klaasing Electronics B.V. 01600-48457
Intl **Italy, Milan**
Silverstar, Ltd., 4996
Intl **Japan, Tokyo**
Kyokuto Boeki Kaisha, Ltd., 244-3511
Intl **Sweden, Solna**
Johan Lagercrantz KB 08-83 07 90
Intl **Switzerland, Mutschellen**
W. Stolz AG, 057-5 46 55

Nortec Electronics

Nortec Electronics Corporation
3697 Tahoe Way
Santa Clara, California 95051
(408) 732-2204
Telex: 348359

Specific product information:
Joel Scheinberg .... ext. 201

Application engineering:
Joel Scheinberg .... ext. 201
Candi Harrell

Price and delivery:
Joel Scheinberg .... ext. 201

Place an order:
Joel Scheinberg .... ext. 201
Judy Rowan .... ext. 209

Follow-up an order:
Joel Scheinberg .... ext. 201

All other information:
Dick Kors .... ext. 207

Sales Offices and Representatives

Ariz **Scottsdale**
Summit Sales, (602) 994-4587
Cal **Pasedena**
Micronics, (216) 449-0075
Colo **Denver**
James S. Heaton Co., Inc., (303) 758-5130
Ill **Park Ridge**
R. R. Specialists, (312) 698-2044
Ind **Ft. Wayne**
R.R. Specialists, (219) 485-8982
Md **Towson**
Newson & Associates, (301) 825-0001
Mass **Lexington**
Circuit Sales Company, Inc., (617) 861-0567
Mich **New Baltimore**
Tek-Tron Engineering, (313) 725-4600
NJ **Ft. Lee**
Tech Sales, (201) 944-3642
Pa **Philadelphia**
Newson & Associates, Inc., (215) 248-3377
Tex **Richardson**
Semiconductro Sales, (214) 231-6181
Wash **Bellevue**
Tri-Tronix, 7206) 454-0940
Can **Mississauga, Ont.**
Semicon Electronics Limited, (416) 678-9225
Point Claire, Quebec
Semicon Electronics Limited, (514) 697-9970

Nucleonic Products Co.

Nucleonic Products Co.
6660 Variel Avenue
Canoga Park, California 91303
(213) 887-1010
TWX: (910) 494-1954

Sales Offices and Representatives

Ariz **Phoenix**
Chaparral-Dorton, (602) 263-0414
Cal **Los Angeles**
NPC, (213) 887-1010
Newbury Park
Astralonics, (805) 498-2183
Redwood City
Logan Sales, (415) 367-6726
San Diego
Earle Associates, (714) 278-5441
Colo **Denver**
Eggeman Assoc., (303) 423-3707
Conn **Fairfield**
Hingston-Walsh, (914) 834-4423
Fla **Miami**
Component Engr. Sales Co., (305) 922-5230
Ill **Chicago**
R.H. Dutton & Assoc., (312) 297-3365
Franklin Park
Dekotech, Inc., (312) 455-5100
Ind **Indianapolis**
Technical Reps., (317) 849-6454
Iowa **Cedar Rapids**
J.R. Sales, (319) 377-8211
Kan **Kansas City**
CenTech Sales, (816) 358-8100
Md **Baltimore**
Component Sales, (301) 484-3647
Mass **Waltham**
Ranteck, Inc., (617) 890-5110
Mich **Farmington**
Davis & Martensen, (313) 474-8300
Minn **Minneapolis**
Quantum Sales, (612) 831-8583
Mo **St. Louis**
CenTech Sales, (314) 731-4220
NY **New York City**
Kahgan Sales, (516) 538-2300
De Ruyter
R.P. Kennedy Co., (315) 662-3996
Red Hook
R.P. Kennedy Co., (914) 876-2700
Rochester
R.P. Kennedy Co., (716) 271-6322
NC **Raleigh**
Component Sales, (919) 782-8433
Ohio **Cincinnati**
GH Sales Co., (513) 771-8231
Cleveland
GH Sales Co., (216) 248-8490
Ore **Portland**
Freed Assoc., (503) 223-3374
Penn **Willow Grove**
Harry Nash Assoc., (215) 657-2213
Tex **Dallas**
Bonser-Philhower Sales, (214) 234-8438
Houston
Bonser-Philhower Sales, (713) 467-4373
Wash **Seattle**
Freed Assoc., (206) 822-8223

OKI Electronics of America

OKI Electronics of America
4031 N.E. 12th Terrace
P. O. Box 24260
Fort Lauderdale, Florida 33307
(305) 563-6234
TWX: (510) 955-9837

Panasonic

Panasonic
Matsushita Electric Corporation Industrial Division
1 Panasonic Way
Secaucus, New Jersey 07094
(201) 348-7267

Specific product information:
IC's and Solid State Products Product Manager, Bob Zolkowski

Application engineering:
Chicago, Arthur Suyama ....ext. (312) 455-3105
New Jersey, M. Toyoscu
(201) 348-7275

Price and delivery:
See Local Representatives

Place an order:
See Local Representatives

Follow-up an order:
See Local Representatives

Sales Offices & Representatives

Ala **Huntsville**
Rep, Inc., (205) 881-9270
Ariz **Phoenix**
Arrowhead Sales Corporation, (602) 277-7148
Cal **Los Angeles**
West Inc., (213) 625-1868, (714) 540-9040
San Jose
Allgood-North, (408) 288-6731
Col **Arvada**
Arrowhead Sales Corporation, (303) 423-5556
Conn **Bridgeport**
Vector Sales, (203) 366-2506
Fla **Casselberry**
EIR, Incorporated, (305) 830-9600
Palm Beach
EIR, Incorporated, (305) 585-6689
Plantation
EIR, Incorporated, (305) 791-6390
Ga **Tucker**
Rep, Inc., (404) 938-4358
Ill **Chicago**
Brock & Cushman, (312) 622-4110
Iowa **Des Moines**
B.E.A.M.S., Inc., (515) 282-0292
Kans **Overland Park**
B.E.A.M.S., Inc., (913) 341-7744
Mass **Allston**
Vector Sales, Inc., (617) 787-2790
Mich **Detroit**
NICON Associates, (313) 341-7688
Minn **St. Paul**
SKOR, (614) 645-6461
Mo **St. Louis**
B.E.A.M.S., Inc., (314) 781-6855
NJ **Plainfield**
Meg Electronic Sales, (201) 757-4332, (212) 233-9059
NY **Ontario Center**
Kehoe Elec., (315) 524-2491
NC **Charlotte**
Anthom Inc., (704) 527-1515
Ohio **Columbus**
Tom Mulligan & Associates, (614) 457-2242
Ore **Portland**
Almac/Stroum Electronics, (503) 292-3534
Pa **King of Prussia**
Monteiro Associates, Inc., (215) 265-0634
Tex **Addison**
Dunbar Associates, Inc., (214) 239-7151
Va **Alexandria**
Dyna Rep. Co., (703) 354-1222
Wash **Seattle**
Almac/Stroum Electronics, (206) 763-2300, (206) 243-2301
Can **Quebec**
R F Q Ltd., (514) 626-8324
Ontario
R F Q Ltd., (416) 625-8874
Intl **Japan, Kyoto**
Matsushita Electronics, Tel: (075) 921-8151

Plessey Semiconductors

Plessey Semiconductors
1674 McGaw Avenue
Santa Ana, California 92705
(714) 540-9979or 540-9945
TWX: (910) 595-1930

Application engineering:
Walt Boris .... ext. 49

Literature:
Donna Clark .... ext. 35

Price and delivery:
Donna Clark .... ext. 35

Follow-up an order:
Donna Clark .... ext. 35

Sales Offices & Representatives

Ariz **Phoenix**
The Thorson Company, (602) 956-5300
Cal **Los Altos**
Cain-White, (415) 948-6533
Los Angeles
The Thorson Company, (213) 476-1241
Tustin
The Thorson Company, (714) 544-5121
Colo **Denver**
West Mark Associates, (303) 433-7181
Ill **Park Ridge**
R. F. Specialists, (219) 485-8982
Ind **Fort Wayne**
R. F. Specialists, (219) 485-8982
Iowa **Cedar Rapids**
Glassner & Clark Co., (319) 393-5763
Kan **Prairie Village**
Engineering Services, (913) 649-4000
Mass **Natick**
Wayland Engineering Sales, (617) 655-6080
Mo **Saint Louis**
Engineering Services, (314) 997-1515
NM **Albuquerque**
The Thorson Company, (505) 265-5655
NY **Plainview**
Erde Associates, Inc., (516) 822-5357
Syracuse
Syracuse Technical Reps, (315) 488-0222
Ohio **Cincinnati**
Luebbe Sales, (513) 871-4211
Pa **Easton**
Megargel/Himmelstein, (609) 622-3081
Tenn **Bristol**
Remco, (615) 968-4195
Tex **Dallas**
W. Pat Fraua Co., (817) 738-2394
Wash **Olympia**
Bergford and Associates, (206) 866-2001

Power Monolithics

Power Monolithics
121 International Drive
Corpus Christi, Texas 78401
(512) 883-6251

Precision Monolithics

Precision Monolithics, Inc.
1500 Space Park Drive
Santa Clara, California 95050
(408) 246-9222
TWX: (910) 338-0528

Specific product information:
Local Field Sales Office

Literature:
Local Field Sales Office

Follow-up an order:
Customer Service .... ext. 171

Sales Offices & Representatives

Ala **Huntsville**
W. A. Brown Components, (205) 539-4411

Ariz **Tempe**
Argus Sales Inc., (602) 967-8709

Cal **El Toro**
ECM, (714) 830-3939

Mt. View
Thresum Assoc., (408) 965-9180

Newport Beach
PMI, (714) 752-1760

San Diego
ECM, (714) 295-6122

Woodland Hills
ECM, (213) 340-1745

Colo **Denver**
Thorson Company, (303) 759-0809

Conn **Wallingford**
Com-Sale, (203) 269-7964

Fla **Clearwater**
DYNE-A-MARK, (813) 441-4702

Ft. Lauderdale
DYNE-A-MARK, (305) 771-6501, (305) 944-5031 (Miami)

Ga **Atlanta**
W. A. Brown Components, (404) 455-0405

Ill **Arlington Heights**
PMI, (312) 437-6697

Rolling Meadows
Sumer Inc., (312) 394-4900

Ind **Indianapolis**
Jerry Ihrig Assoc. Inc., (317) 783-7630

Iowa **Cedar Rapids**
Comstrand, Inc., (319) 363-7495

Kan **Olathe**
Technical Representatives, Inc., (913) 782-1177

Md **Baltimore**
Stemler Assoc, Inc, (301) 944-8262

Mass **Waltham**
COM-SALE, (617) 890-0011

Mich **Detroit**
A. Blumenberg Assoc., (313) 557-1934

Minn **Minneapolis**
Comstrand, Inc., (612) 571-0000

Mo **Hazelwood**
Technical Representatives, (314) 731-5200

NJ **Cherry Hill**
Stemler Assoc., (609) 966-4070

Laurel Springs
Stemler Assoc. Inc., (215) 644-3477

NM **Albuquerque**
Thorson Company, (505) 265-5655

NY **Jericho**
J-Square Marketing, Inc., (516) 433-5330

Rochester
Ontec Associates, (716) 464-8636

Wantagh
PMI, (516) 785-3331

NC **Raleigh**
W. A. Brown Components, (919) 876-9601

Winston-Salem
W.A. Brown Components, (919) 725-5384

Ohio **Cleveland**
Del Steffen & Associates, (216) 461-8333

Dayton
Del Steffen & Associates, (513) 293-3145

Lexington
Del Steffen & Assoc., (419) 884-2313

Ore **Portland**
SJI, (206) 224-0344

Tex **Houston**
Oeler & Menelaides, Inc., (713) 772-0730

Richardson
Oeler & Menelaides, Inc., (214) 234-6334

Va **Alexandria**
Stemler Associates, Inc., (703) 548-7818

Wash **Seattle**
SJI, (206) 624-9020

Can **Mississauga, Ontario**
RFQ Limited, (416) 625-8874

Distributors

Ariz **Phoenix**
Sterling Electronics, (602) 258-4531

Cal **Chatsworth**
Westates Electronics Corp., (213) 341-4411

Cal **San Diego**
Intermark Electronics, (714) 279-5200

Santa Ana
Intermark Electronics, (714) 540-1322

Sunnyvale
Intermark Electronics, (408) 738-1111
Westates Electronics Corp., (408) 733-8383

Colo **Denver**
Intermark Electronics, (303) 936-8284

Ill **Elk Grove Village**
Hallmark Electronics, (312) 437-8800

Ind **Indianapolis**
Pioneer Electronics, (317) 849-7300

Md **Baltimore**
Whitney Distributors, (301) 944-8080

Mass **Dedham**
Gerber Electronics, (617) 329-2400

Woburn
Newark Electronics, (617) 935-8350

Mich **Detroit**
R.S. Electronics, (313) 491-1000

Minn **Bloomington**
Hallmark Electronics, (612) 884-9056

Mo **Garth City**
Hallmark Electronics, (314) 291-5350

NM **Albuquerque**
Sterling Electronics, (505) 345-6601

NY **Binghamton**
Harvey Electronics

Vestal
Shipping Address, (607) 748-8211

Woodbury
Harvey Electronics, (516) 921-8700

NC **Winston-Salem**
Kirkman Electronics, (919) 724-0541

Ohio **Cleveland**
Pioneer Electronics, (216) 587-3600

Columbus
Pioneer Electronics, (800) 362-2274

Dayton
Pioneer Electronics, (513) 236-9900

Ore **Portland**
Almac/Stroum Electronics, (503) 292-3534

Pa **Huntington Valley**
Hallmark Electronics, (215) 355-7300

Pittsburgh
Pioneer Electronics, (412) 391-4846

Tex **Dallas**
Sterling Electronics, (214) 357-9131

Houston
Sterling Electronics, (713) 627-9800

Wash **Seattle**

Can **Vancouver, B. C.**
Intek Electronics, Ltd., (604) 736-7677
Almac/Stroum Electronics, (206) 763-2300

Ragen Semiconductor

Ragen Semiconductor
53 South Jefferson Road
Whippany, New Jersey 07981
(201) 887-4141

Information:
F. Jack Hartley
Joseph Larkin

Raytheon Semiconductor

For data on selected products see page:
Digital 282
Linear 647

Raytheon Semiconductor
350 Ellis St.
Mt. View, California 94042
(415) 968-9211
TWX: (910) 379-6481

Specific product information:
Linear .... Al Borken, Nik Raines
Digital .... Steve Fry
Discrete .... John Norton, Larry Collins
Microprocessors .... Paul Sullivan

Price and delivery:
Local Field Sales Office

Place an order:
Local Field Sales Office

Follow-up an order:
Customer Service

Sales Offices & Representatives

Ariz **Scottsdale**
Gleason Sales, (602) 946-3992

Cal **Irvine**
Raytheon Semiconductor, (714) 833-9042

Los Altos
P M Sales, (415) 941-4444

Mountain View
Raytheon Semiconductor, (415) 964-4754

Colo **Denver**
Straube Associates, (303) 426-0890

Fla **Clearwater**
Perrott Associates, (813) 726-1549

Fort Lauderdale
Raytheon Semiconductor, (305) 792-8400

Orlando
Perrott Associates, (305) 275-1132

Ill **Chicago**
Carlson Electronic Sales, (312) 774-9022

Des Plaines
Raytheon Semiconductor, (312) 297-5540

Kan **Overland Park**
Electri-Rep, (913) 649-2168

Mass **Burlington**
Raytheon Semiconductor, (617) 272-8500

Mich **Birmingham**
J.C. Hofstetter Co., (313) 643-7203

Grand Rapids
J.C. Hofstetter Co., (616) 942-0650

Minn **New Brighton**
Raytheon Semiconductor, (612) 636-7696

Mo **St. Louis**
Kebco, (314) 569-2660

NJ **Pennsauken**
Raytheon Semiconductor, (609) 663-4066

NY **Baldwin (NY Metro Area)**
R.O.M.E. Inc., (516) 623-3344

Melville
Raytheon Semiconductor, (516) 420-0700

North Syracuse
Precision Sales, (315) 458-2223

Orchard Park
Precision Sales, (716) 648-5450

Raytheon Semiconductor (cont)

NY Oswego
Precision Sales, (607) 687-2893
Ohio Dayton
J.C. Hofstetter Co., (513) 296-1010
Medina
J.C. Hofstetter Co., (216) 241-4880
Ore Beaverton
E.S. Chase Co., (503) 649-6177
Tex Dallas
Kruvand Associates, (214) 691-4592
Mark Kruvand Co., Inc., (214) 827-8043
Houston
Kruvand Associates, (713) 661-3007
Mark Kruvand Co., Inc., (713) 661-3007
Wash Seattle
E.S. Chase Co., Inc., (206) 762-4324
Wisc Milwaukee
Carlson Electronic Sales, (414) 476-2790
Can
Massachusetts Office
Intl Germany, Munich
Raytheon Halbleiter GmbH, 089/539 693
Intl Japan, Tokyo
New Japan Radio Co., Ltd., (591) 3451
Intl Switzerland, Zurich
Transistor AG-Raytheon 01 625611
Intl All other Overseas Areas
Lexington, Mass
Raytheon Co., International (617) 862-6600

Distributors

Ala Huntsville
Hallmark Electronics, (205) 837-8700
Ariz Phoenix
Cramer Electronics, (602) 267-7321
Kierulff Electronics, (602) 273-7331
Ark Fort Smith
Carlton Bates, (501) 646-8201, (800) 362-9009
Cal Culver City
Avnet Electronics, (213) 559-4111
Irvine
Cramer/Los Angeles, (213) 771-8300, (714) 979-3000
Los Angeles
Kierulff Electronics, (213) 685-5511
Newport Beach
Semicomp, (714) 833-3070 (213) 581-7201
Palo Alto
Kierulff Electronics, (415) 968-6292
San Diego
Cramer/San Diego, (714) 565-1881
Intermark Electronics, (714) 279-5200
Kierulff Electronics, (714) 278-2112
Santa Ana
Intermark Electronics, (714) 540-1322, (213) 436-5275
Sunnyvale
Bell Industries, (408) 734-8570
Cramer/San Francisco, (408) 739-3011
Intermark Electronics, (408) 738-1111
Colo Denver
Cramer/Denver, (303) 758-2100
Wheatridge
Century Electronics, (303) 424-1985
Conn North Haven
Cramer/Connecticut, (203) 239-5641
Fla Clearwater
Diplomat/Southland, (813) 443-4514
Hollywood
Cramer/EW Hollywood, (305) 923-8181
Orlando
Cramer/EW Orlando, (305) 894-1511
Ga Atlanta
Cramer/EW Atlanta, (404) 448-9050
Lykes Electronics, (404) 355-2223
Ill Elk Grove Village
Hallmark Electronics, (312) 437-8800
Diplomat/Lakeland, (312) 595-1000
Mt. Prospect
Cramer/Chicago, (312) 593-8230
Ind Indianapolis
Graham Electronics Supply, Inc., (317) 635-5453
Md Baltimore
Radio Electric Service Co., (301) 823-0070
Technico, (301) 828-6416
Gaithersburg
Cramer/Washington, (301) 948-0110
Pioneer Washington Elect., (301) 948-0710
Hanover
Cramer/Baltimore, (301) 796-5790
Mass Billerica
Kieruff Electronics, (617) 667-8331,
Framingham
Future Electronics, (617) 879-0860, (800) 225-0380-Toll Free
Newton
Cramer Electronics, (617)
Mich Farmington
Diplomat/Northland, (313) 477-3200
Minn Minneapolis
Diplomat/Electro Com., (612) 788-8601
Hallmark Electronics, (612) 884-9056
Stark Electronic Supply, (612) 332-1325
Mo Earth City
Hallmark Electronics, (314) 291-5350
St. Louis
Diplomat/St. Louis, (314) 645-8550
NJ Cherry Hill
Cramer/Pennsylvania, (609) 424-5993
Hackensack
Components Plus, (201) 487-0565
Moonachie
Cramer Electronics, (201) 935-5600
Moorestown
Arrow/Angus, (609) 235-1900
NM Albuquerque
Centruy Electronics, (505) 292-2700
Cramer/New Mexico, (505) 265-5767
Kierulff Electronics, (505) 247-1055
NY East Syracuse
Cramer/Syracuse, (315) 437-6671
Elmsford
Zeus Components, Inc., (914) 592-4120
Hauppauge
Components Plus, (516) 231-9200
Cramer/Long Island, (516) 231-5600
Semiconductor Concepts, (516) 273-1234
New Hyde Park
Lafayette Industrial Elect., (516) 488-6600
Plainview
ACI Electronics Corp., (513) 293-6630
Rochester
Cramer/Rochester, (716) 275-0300
NC Winston-Salem
Cramer/EW Winston-Salem, (919) 725-8711
Ohio Cleveland
Cramer/Cleveland, (216) 248-8400
Dayton
Diplomat/Ohio, (513) 228-1080
Okla Tulsa
Component Specialties, (918) 664-2820
Pa Braddock
Leff Radio Parts, (412) 271-7100
Tex Austin
Components Specialties, (512) 459-3307
Dallas
Components Specialties, (214) 357-4576
Cramer/Texas, (214) 661-9300
Houston
Component Specialties, (713) 771-7237
Utah Salt Lake City
Diplomat/Altaland, (801) 486-7227
Cramer/Utah, (801) 487-4131
Wash Bellevue
Bell Industries, (206) 747-1515
Seattle
Cramer/Seattle, (206) 762-5755
Intermark Electronics, (206) 767-3160
Wisc West Allis
Hallmark Electronics, (414) 476-1270
Can Calgary, Alberta
PAAR Industrial Electronics (408) 287-2840
Downsview, Ont.
Cramer/Canada, (416) 661-9222
Ottawa, Ont.
Wackid Radio & Television Labs, (613) 728-1821
Montreal, P.Q.
Future Electronics, (514) 735-5775
Prelco Electronics, Ltd., (514) 389-8051
Rexdale, Ont.
Future Electronics, (416) 677-7820
Vancouver, B.C.
RAE Industrial Electronics, Ltd., (604) 687-2621

RCA Solid State Division

For data on selected products see page:

Digital 375
Linear 661
Memory 784
Microprocessor 993

RCA Solid State Division
Rte. 202
Somerville, N.J. 08876
(201) 685-6000
TWX: 710-480-9333

Sales Offices and Representatives

Ala Huntsville
Field Sales Office, (205) 881-4100
Ariz Scottsdale
Field Sales Office, (602) 947-7235
Cal Hollywood
Field Sales Office, (213) 461-9171
Los Altos
Field Sales Office, (415) 948-8996
San Diego
Field Sales Office, (714) 279-0420
Tustin
Field Sales Office, (714) 832-5302
Colo Denver
Field Sales Office, (303) 433-8841
Conn Stamford
Field Sales Office, (203) 329-2041
Fla Riveria Beach
Field Sales Office, (305) 842-1577
Ga Atlanta
Field Sales Office, (404) 634-6131
Ill Des Plaines
Field Sales Office, (312) 827-0033
Ind Fort Wayne
Field Sales Office, (219) 432-9461
Indianapolis
Field Sales Office, (317) 546-4001
Kans Overland Park
Field Sales Office, (913) 642-7656
Mass Needham Heights
Field Sales Office, (617) 444-7200
Mich Birmingham
Field Sales Office, (313) 644-1151
Minn Minneapolis
Field Sales Office, (612) 929-0676
NJ Cherry Hill
Field Sales Office, (609) 424-3650
Edison
Field Sales Office, (201) 485-3900
NY Long Island
Field Sales Office, (516) 293-0180
Fairport
Field Sales Office, (716) 223-5240
Syracuse
Field Sales Office, (315) 474-8221
Ohio Dayton
Field Sales Office, (513) 253-1133
Pepper Pike
Field Sales Office, (216) 831-0030
Tex Dallas
Field Sales Office, (214) 638-6200
Va Arlington
Field Sales Office, (703) 558-4161
Wash Bellevue
Field Sales Office, (206) 747-8534
Can Rexdale (Toronto), Ont.
Field Sales Office, (416) 247-5491
Ste. Anne de Bellevue
Field Sales Office, (514) 457-9000
Intl Eng., Sunbury-on-Thames
RCA Ltd. for Europe, Middle East, Africa & U.K., SUN 85511
Intl Latin America
Somerville, NJ
International Sales, (201) 722-3200
Intl Japan, Tokyo
RCA Purchasing Co., 581-2311
Intl Taiwan, Taipei
RCA 579171

RCA Solid State Division (cont)

Distributors

Ala **Huntsville**
Hamilton/Avnet Electronics, (205) 533-1170

Ariz **Phoenix**
Hamilton/Avnet Electronics, (602) 275-7851
Kierulff Electronics, (602) 272-7331
Liberty Electronics/Arizona, (602) 257-1272

Cal **Culver City**
Hamilton Electro Sales, (213) 558-2020
El Monte
G.S. Marshall Co., (213) 686-0141
El Segundo
Liberty Electronics, (213) 322-8100
Irvine
Cramer/Los Angeles, (213) 771-8300
Los Angeles
Kierulff Electronics, (213) 685-5511
RPS Electronics, Inc., (213) 748-1271
Mt. View
Elmar Electronics, Inc., (415) 961-3611
Hamilton-Avnet Elect., (415) 961-7000
Palo Alto
Kierulff Electronics, (415) 968-6292
Riverside
Electronic Supply Corp., (714) 683-7300
San Diego
Hamilton/Avnet Electronics, (714) 279-2421
Kierulff Electronics, (714) 278-2112
Liberty/San Diego, (714) 565-9171
Sunnyvale
Cramer/San Francisco, (408) 739-3011

Colo **Commerce City**
Elmar Electronics/Denver, (303) 287-9611
Denver
Kierulff Electronics, (303) 343-7090

Conn **Danbury**
Schweber Electronics Corp., (203) 792-3500
North Haven
Cramer Electronics, Inc., (203) 239-5641

Fla **Hollywood**
Cramer/EW, Hollywood, (305) 945-4176
Hamilton/Avnet Electronics, (305) 927-0511
Schweber Electronics, (305) 927-0511
Orlando
Cramer/EW, Orlando, (305) 894-1511

Ga **Atlanta**
Schweber Electronics Corp., (404) 449-9170
Doraville
Cramer/EW, Atlanta, (404) 451-5241
Norcross
Hamilton/Avnet Electronics, (404) 448-0800

Ill **Chicago**
Newark Electronics, (312) 638-4411
Elmhurst
Semiconductor Specialist, (312) 279-1000
Mt. Prospect
Cramer/Chicago, (312) 593-8230

Ind **Indianapolis**
Graham Electronics Supply, Inc., (317) 634-8202

Iowa **Cedar Rapids**
Deeco Inc., (319) 365-7551
Schweber Electronics Corp., (319) 393-9125

Kans **Lenexa**
Hamilton/Avnet Electronics, (913) 888-8900
Wichita
Radio Supply Co., (316) 267-5214

Md **Gaithersburg**
Cramer/EW Washington, (301) 948-0110
Hanover
Hamilton/Avnet Electronics, (301) 796-7000
Rockville
Schweber Electronics, (301) 881-3300
Savage
Pyttronic Industries, (301) 792-7000

Mass **Burlington**
Wilshire Electronics/New England, (617) 272-8200
Newton
Cramer Electronics, (617) 969-7700
Waltham
Schweber Electronics, (617) 890-8484
Watertown
Sterling Electronics, (617) 926-9720
West Newton
A.W. Mayer Co., Inc., (617) 965-1111

Mich **Troy**
Schweber Electronics Corp., (313) 583-9242

Mich **Detroit**
RS Electronics, Inc., (313) 491-1000
Oak Park
Newark Electronics, (313) 548-0250

Minn **Edina**
Cramer/Minnesota, (612) 941-4860
Minneapolis
Newark Electronics, (612) 331-6350
Semiconductor Specialists, Inc., (612) 854-8841

Mo **Hazelwood**
Hamilton/Avnet Electronics, (314) 731-1144
Semiconductor Specialists, Inc., (314) 731-2400
Kansas City
Semiconductor Specialists, Inc., (816) 452-3900

NJ **Clifton**
Wilshire Electronics/N.J., (201) 365-2600
Mount Laurel
Hamilton-Avnet Elect., (609) 234-2133
Pennsauken
Resco Electronics, Div. of Astrex, (609) 662-4000
Perth Amboy
Sterling Electronics, (201) 442-8000
Rutherford
Kierulff Electronics, (201) 935-2120
Somerset
Schweber/NJ Electronics, (201) 469-6008

NM **Albuquerque**
Cramer/New Mexico, (505) 265-5767
Hamilton/Avnet Electronics, (505) 765-1500

NY **Buffalo**
Summit Distributors, (716) 884-3450
Farmingdale
Arrow Electronics, Inc., (516) 694-6800
Freeport
Milgray Electronics, Inc., (516) 546-6000
Hauppauge
Cramer/Long Island, (516) 231-5600
Rochester
Cramer/Rochester, (716) 275-0300
Rochester Radio Supply, (716) 454-7800
Schweber Electronics Corp., (716) 328-4180
Rome
Rome Electronics, Inc., (315) 337-5400
Westbury
Schweber Electronics, (516) 334-7474

NC **Greenboro**
Hammond Electronics of Carolina, Inc., (919) 275-6391
Winston Salem
Cramer/EW, Winston Salem, (919) 725-8711

Ohio **Beachwood**
Schweber Electronics, (216) 464-2970
Solon
Cramer Electronics, Inc., (216) 248-8400
Columbus
Hughes-Peters, Inc., (614) 294-5351
Dayton
Hamilton/Avnet Electronics, (513) 433-0610
The Stotts Friedman Co., (513) 224-1111

Okla **Tulsa**
Radio, Inc., (918) 587-9127

Pa **Philadelphia**
Herbach & Rademan, Inc., (215) 426-1700
Pittsburgh
Semiconductor Specialists, Inc., (412) 781-8120

Tenn **Memphis**
Bluff City Distributing, (901) 725-9500

Tex **Austin**
Schweber Electronics Corp., (512) 837-2890
Dallas
Hamilton-Avnet Elect., (214) 661-8661
Schweber Electronics Corp., (214) 661-5010
Sterling Electronics, (214) 357-9131
Houston
Hamilton-Avnet Elect., (713) 526-4661
Schweber Electronics Corp., (713) 784-3600
Sterling Electronics, (713) 623-6600

Utah **Salt Lake City**
Cramer/Utah, (801) 487-3681

Wash **Seattle**
Liberty Electronics/Northwest, (206) 763-8200
Robert E. Priebe Co., (206) 682-8242

Wisc **Mequon**
Taylor Electric Co., (414) 241-4321

Reticon

Reticon Corp.
910 Benicia Avenue
Sunnyvale, California 94086
(408) 738-4266
TWX: (910) 339-9343

Sales Offices & Representatives

Colo **Wheatridge**
Waugaman Associates, Inc., (303) 423-1020

Conn **Stratford**
Gerald Rosen Company, Inc., (203) 375-5456

Ill **Schaumburg**
Carvel Engineering Company, (312) 885-8800

Kans **Prairie Villiage**
Engineering Services, Inc., (913) 649-4000

Md **Baltimore**
Component Sales, Inc., (301) 484-3647

Mass **Framingham**
Gerald Rosen Company, Inc., (617) 879-5505

Mich **Birmingham**
J. C. Hofstetter Company, (313) 643-7203

Minn **Minneapolis**
Arjay Sales, Inc., (612) 854-4972

Mo **St. Louis**
Engineering Services, Inc., (314) 997-1515

NJ **Pennsauken**
Megargel/Himmelstein Assoc, Inc., (609) 662-3081

NY **Buffalo**
Ossman Component Sales Corp., (716) 832-4271
Huntington
CBD Enterprises, Inc., (516) 692-5200
Kingston
Ossman Component Sales Corp., (914) 338-5505
Rochester
Ossman Component Sales Corp., (716) 442-3290
Syracuse
Ossman Component Sales Corp., (315) 454-4477
Vestal
Ossman Component Sales Corp., (607) 785-9949

NC **Raleigh**
Component Sales, Inc., (919) 782-8433

Ohio **Dayton**
J. C. Hofstetter Company, (513) 296-1010
Medina
J. C. Hofstetter Company, (216) 725-4477

Tex **Dallas**
Evans & McDowell Assoc., Inc., (214) 238-7157
Houston
Evans & McDowell, (713) 783-2900

Intl **Australia, prospect**
A.J. Ferguson (Adelaide) Pty., Ltd., 269 1244

Intl **Austria, Wein**
Bacher Elektronische, Gerate G.m.b.H (0222) 83 63 96

Intl **Belgium, Bruxelles**
Inelco, (02) 660 00 12

Intl **Denmark, Copenhagen**
Scandinavian Semiconductor Supply A/S, (01) 93/Aegir 5090

Intl **England, Letchworth**
Herbert Control & Instruments Ltd., 3841 (Std Code 04626)
London
Rapid Recall, (01) 379674

Intl **Finland, Helsinki**
Havulinna Oy, (090) 661 451

Intl **France, Sevres**
Tekelec Airtronic, (01) 626 02 35

Intl **Germany, Frankfurt**
Ing Erich Sommer Elektronik G.m.b.H., (0611) 55 02 89
Munich
Opteltec, Div. Neumuller G.m.b.H., (089) 59911
Wolfratshausen
Ing Erich Sommer G.m.b.H., (08171) 15 15

Intl **Israel, Ramat-Gan**
Telsys Ltd., Electronic Engineering, 739865

Intl **Italy, Milan**
Eledra 3S SPA, (02) 34 93 041

Intl **Japan, Yokohama**
Pan Electron, Inc., 045-471-8811

Reticon (cont)

Intl Netherlands, Amsterdam
Inelco, (020) 93 4824

Intl Norway, Oslo
Nordisk Elektronik (Norge) A/S, (02) 55 38 93

Intl South Africa, Transvaal
Electronic Building Elements Pty. Ltd., 78-9221/6

Intl Sweden, Stockholm
Nordisk Elektronik AB, (08) 24 83 40

Intl Switzerland, Zurich
Industrade AG, (01) 60 22 30

Rockwell Microelectronic Div.

Rockwell International
Microelectronic Device Division
P. O. Box 3669
3430 Miraloma Avenue
Anaheim, California 92803
(714) 632-3729

Sales Offices & Representatives

Cal **Anaheim**
Field Sales office, (714) 632-3729

Ga **Atlanta**
Field Sales Office, (404) 469-7571

Ill **Elk Grove Village**
Field Sales Office, (312) 439-1713

Mich **Troy**
Field Sales Office, (313) 576-5116

NY **Smithtown**
Field Sales Office (516) 979-0183

Sanken Electric Co.

Sanken Electric Company
1-22-8 Nishi-Ikebukuro
Toshima-ku, Tokyo, Japan
Cable: SANKELE TOKYO
U. S. Agent:
American Data Corp
PO Box 5228
401 Wynn Drive, N.W.
Huntsville, Alabama 35805
(205) 837-5180

SGS-ATES Semiconductor

SGS-ATES Semiconductor Corporation
435 Newtonville Avenue
Newtonville, Massachusetts 02160
(617) 969-1610
Telex: 92-2482

Specific product information:
Product Marketing .... Umberto Broggi

Application engineering:
Product Marketing .... Umberto Broggi

Literature:
Sales Department .... Marilyn Schribman

Place an order:
Sales Department .... Anne Girolamo

Follow-up an order:
Customer Service .... Anne Girolamo

Sales Offices & Representatives

Ala **Huntsville**
Rep. Inc. (205) 881-9270

Ariz **Tempe**
J. F. Hurlbut Co., (602) 968-5962

Cal **Santa Ana**
Rical Associates, (714) 557-6543
Mountain View
Caltron/Pyle, (415) 964-3244

Colo **Golden**
J. F. Hurlbut (303) 279-7138

Fla **Clearwater**
Dyne-A-Mark, (813) 441-4702
Ft. Lauderdale
Dyne-A-Mark, (305) 771-6501

Ga **Tucker**
Rep. Inc., (404) 938-4358

Ill **Bellwood**
Fiat Engineering, (312) 547-6200

Ind **Indianapolis**
Lattronics, (317) 846-5788

Mass **Waltham**
Conti-Younger, (617) 890-4582

Mich **Grosse Pointe Park**
Greiner Associates, (313) 499-0188

Minn **Minneapolis**
Loren F. Green Associates, (612) 781-1611

Mo **Grandview**
Beneke & McCaul, Inc., (816) 765-2998
St. Louis
Beneke & McCaul, Inc., (314) 434-6242

NJ **Ridgefield**
Rical Associates, (201) 945-5250

NY **Pompey**
S. F. Foster Co., (315) 677-3333
Webster
S. F. Foster Co., (716) 265-2072

Ohio **Cleveland**
Imtech Inc., (216) 826-3400
Englewood
Imtech Inc., (513) 836-0600

Pa **Philadelphia**
C.H. Newson & Associates Inc., (215) 248-3377

Tex **Dallas**
Blackburn Associates, (214) 692-8885

Va **Reston**
Boyle Associates, (703) 620-9558

Wash **Seattle**
Ray Johnston Co., Inc., (206) 524-5170

Can **Ottawa**
Multilek Inc., (613) 825-4695
Toronto
Multilek Inc., (416) 429-1269

Intl **Mexico, Mexico City**
Mexel (905) 575-7868

Distributors

Cal **Los Angeles**
Energy Electronic Products, (213) 670-7880
Santa Clara
Re-Coil Electronics, Inc., (408) 984-0400

Fla **Pompano Beach**
Zeus Components Inc., (305) 942-4312

Ill **Des Plains**
Edmar Electronics Co., 7312) 298-8580

Mass **Burlington**
Wilshire Electronics, (617) 272-8200
Zeus Components Inc., (617) 273-0750

NY **Bayshore**
Rosyl Electronics, (516) 586-1800
Elmsford
Zeus Components Inc., (914) 592-4120

Ohio **Dayton**
Esco Inc., (513) 226-1133

Tex **Dallas**
KA Electronic Sales, (214) 634-7870

Wash **Seattle**
Radar Electric Co., (206) 282-2511

Can **Montreal**
Prelco Electronics Ltd., (514) 389-8051

Intl **Mexico, Mexico City**
Mexel (905) 575-7868

Signetics

For data on selected products see page:

Digital 384
Linear 668
Memory 787
Microprocessor 997

Signetics Corporation
811 East Arques Avenue
Sunnyvale, California 94086
(408) 739-7700
TWX: (910) 339-9283

Specific product information:
Digital
Memory .... ext. 2430
CMOS .... ext. 2353
TTL .... ext. 2968
ECL .... ext. 2968
Analog .... ext. 2460
DMOS .... ext. 2748
MOS .... ext. 2580
CMOS .... ext. 2968

Application engineering:
DMOS
Rus Hansen .... ext. 2746
Digital
Clement Lee .... ext. 2511
MOS
Hal Hall .... ext. 3047
Chuck Mernitz .... ext. 2731
Dave Uimari .... ext. 2439
Analog
Ted Veeches .... ext. 2746

Literature:
Information Services .... ext. 2982

Price and delivery:
Sales Service
Commercial .... ext. 2236
Distributor .... ext. 2667
Military .... ext. 2156

Place an order:
Sales Service
Commercial .... ext. 2236
Distributor .... ext 2667
Military .... ext. 2156

Follow-up an order:
Customer Sales Service .... ext. 2236
NY Metropolitan Region .... ext. 2623
Northeast Region
Jim Gremmell .... ext. 2623
South Atlantic
Midwest Region
George Schweizer .... ext. 2538
Southwest Region
Northwest Region
Dave Young .... ext. 2612

All other information:
Customer Service .... ext. 2236

Sales Offices and Representatives

Ala **Huntsville**
20th Century Marketing Inc., (205) 772-9237

Ariz **Phoenix**
Signetics, (602) 971-2517

Cal **Encino**
Signetics, (213) 990-2610
Irvine
Signetics, (714) 833-8980
San Diego
Mesa Engineering, (714) 278-8021
Signetics, (714) 560-0242
Sunnyvale
Signetics, (408) 736-7565

Colo **Denver**
Parker/Webster Co., (303) 770-1972

Conn **Washington Depot**
Kanan Associates, (203) 868-0513

Fla **Altamonte Springs**
Semtronic Associates, (305) 831-8233
Ft. Lauderdale
Semtronic Associates, (305) 771-0010
Largo
Semtronic Associates, (813) 586-1404
Pompano Beach
Signetics, (305) 782-8225

Ga **Douglasville**
20th Century Marketing Inc., (404) 942-6483

Ill **Rolling Meadows**
Signetics, (312) 259-8300

Signetics (cont)

Ind Indianapolis
Signetics, (317) 293-4777

Kans Shawnee
Signetics, (913) 384-1711

Shawnee Mission
Buckman & Associates, (913) 722-5210

Wichita
Buckman & Associates, (316) 267-3655

Md Glen Burnie
Microcomp, Inc., (301) 761-4600

Rockville
Signetics, (301) 881-5710

Mass Lexington
Signetics, (617) 861-0840

Reading
Kanan Associates, (617) 944-8484

Mich Southfield
Signetics, (313) 559-9166 - (313) 559-9167

Minn Minneapolis
Signetics, (612) 884-7451

Mo St. Charles
Buckman & Associates, (314) 724-6690

NH Portsmouth
J.J. Theobald, Inc., (603) 731-8450

NJ Bayonne
J.J. Theobald, Inc., (201) 823-2866

Cherry Hill
Signetics, (609) 665-5071

Piscataway
Signetics, (201) 981-0123

NM Albuquerque
The Staley Co., Inc., (505) 294-2660

NY DeWitt
Tri-Tech Electronics, Inc., (315) 446-2881

East Rochester
Tri-Tech Electronics, Inc., (716) 381-2722

Great Neck
Pacent/DiBlasi - c/o J.J. Theobald, Inc. (516) 482-4040

Larchmont
Tri-Tech Electronics, Inc., (914) 834-4423

Wappingers Falls
Signetics, (914) 297-4074

Woodbury, L.I.
Signetics, (516) 364-9100

Ohio Fairview Park
Norm Case Associates, (216) 333-4120

Centerville
Norm Case Associates, (513) 443-0966

Ore Portland
Western Technical Sales, (503) 297-1711

Tex Dallas
Signetics, (214) 661-1296

Utah Salt Lake City
Parker/Webster Co., (801) 486-3737

Wash Bellevue
Western Technical Sales, (206) 641-3900

Can Downsview, Ont.
Kaytronics Ltd., (416) 638-5511

Montreal, P.Q.
Kaytronics Ltd., (514) 487-3434

Intl Argentina/Chile,
Buenos Aires
Electronica del Atlantico SRL, 35-2624

Intl AUSTRALIA
Melbourne
Tecnico Electronics, 489-9322

Sydney
Tecnico Electronics, 550 411

Intl Brazil, Sao Paulo
Teleimport Eletronica Ltd., 221-3296/221-3943

Intl Finland, Helsinki
AB Kuno Kallman Oy, 575231/575362

Intl France, Boulogne
Signetics S A R L , 604-8127

Intl Germany
Dusseldorf
Signetics GmbH, (0211) 244238

Hamburg
Signetics GmbH, (040) 60-35-242

Munchen
Signetics GmbH, (089) 15-20-20/15-20-29

Stuttgart
Signetics GmbH, (0711) 73-50-61

Intl Hong Kong, Aberdeen
Enterprise Systems (Hong Kong) Ltd., 5-530141/5-531845

Intl India/Ceylon
(Sri-Lanka)/Bangladesh
Bombay
Semiconductors Limited, 293 667

Intl Iran, Tehran
Berkeh Company Ltd., 831564/828294

Intl Israel, Tel Aviv
RAPAC Electronics Ltd., 477 115/116/117

Intl Japan, Tokyo
Asahi Glass Co. Ltd., 218-5536

Intl Korea, Seoul
Kumho & Co., Inc., 28-5271/24-3241/22-0404

Intl Philippines, Manila
Edgeworth Marketing Corp., 406227/406569/406663

Intl Scandinavia, Stockholm
Signetics AB, (08) 29-31-00/29-95-95

Intl Singapore/Malaysia
Singapore
General Engineers Corp. Pte. Ltd., 333641/333651/321791

Intl Sweden
Gothenburg
AB Kuno Kallman, 80-30-20

Stockholm
AB Kuno Kallman, (08) 67-17-11/67-15-95

Intl Switzerland, Zurich
Omni Ray AG, (01) 34-07-66

Intl Taiwan R.O.C., Taipei
Dynatek Corporation, 713-362

Intl Thailand/Laos,
Bangkok
Saeng Thong Radio L.P., 527195/519763

Intl United Kingdom, London
Signetics International Corp., 01-659 2111

Intl Venezuela/Panama
Caracas
Instrulab C.A., 614138/614558

Distributors

Ala Huntsville
Hamilton/Avnet Electronics, (205) 533-1170

Ariz Phoenix
Hamilton/Avnet Electronics, (602) 275-7851
Kierulff Electronics, (602) 273-7331

Cal Culver City
Hamilton Electro Sales, (213) 558-2131

El Segundo
Liberty Electronics, (213) 322-8100

Los Angeles
Kierulff Electronics, (213) 685-5511

Mt. View
Hamilton/Avnet Electronics, (415) 961-7000

Palo Alto
Kierulff Electronics, (415) 968-6292

San Diego
Hamilton/Avnet Electronics, (714) 279-2421
Kierulff Electronics, (714) 278-2112

Colo Denver
Hamilton/Avnet Electronics, (303) 534-1212

Colo Lakewood
Acacia Sales, Inc., (303) 232-2882

Conn Danbury
Schweber Electronics, (203) 792-3500

Georgetown
Hamilton/Avnet Electronics, (203) 762-0361

Hamden
Arrow Electronics, (203) 248-3801

Fla Hollywood
Hamilton/Avnet Electronics, (305) 925-5401
Schweber Electronics, (305) 922-4506

Orlando
Hammond Electronics, (305) 241-6601

Ga Atlanta
Schweber Electronics, (404) 449-9170

Norcross
Hamilton/Avnet Electronics, (404) 448-0800

Ill Elk Grove
Schweber Electronics, (312) 593-2740

Elmhurst
Semiconductor Specialists, (312) 279-1000

Schiller Park
Hamilton/Avnet Electronics, (312) 678-6310

Ind Indianapolis
Pioneer Standard Electronics, (317) 849-7300
Semiconductor Specialists, (317) 243-8271

Kans Lenexa
Hamilton/Avnet Electronics, (913) 888-8900

Md Baltimore
Arrow Electronics, (301) 247-5200

Gaithersburg
Pioneer Washington Electronics, (301) 948-0710

Hanover
Hamilton/Avnet Electronics, (301) 796-5000

Rockville
Schweber Electronics, (301) 881-2970

Mass Burlington
Arrow Electronics, (617) 273-0100
Hamilton/Avnet Electronics, (617) 273-2120

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Siliconix

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Sheridan Sales, (314) 837-5200
NY **Buffalo**
Ossman Component Sales, (607) 785-9949
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Nasco, (212) 793-6500
Kingston
Ossman Component, (914) 338-5505
Rochester
Ossman Component Sales, (716) 442-3290
Syracuse
Ossman Component Sales, (315) 454-4477
Vestal
Ossman Component Sales, (607) 785-9949
Ohio **Cincinnati**
Sheridan Sales, (800) 582-7027
Penn **Pittsburgh**
Sheridan Sales, (412) 294-1640
Toronto, Ont. Can
Westburne, (416) 789-4181
Montreal, P Q
Future Electronics, (514) 735-5775
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A.J. Ferguson Pty Ltd., 516895
Intl **France, Sevres**
Tekelec-Airtronic
Intl **Japan, Tokyo**
Teijin Tapco, (506) 4670-3
Intl **W. Germany, Frankfurt**
EEP, 0611-550289

Solid State Scientific

Solid State Scientific, Inc.
Montgomeryville Industrial Center
Montgomeryville, Pennsylvania 18936
(215) 855-8400
TWX: (510) 661-7267

All other information:
All inquiries: Sales Department

Sales Offices & Representatives

Cal **El Segundo**
Varigon Assoc. (213) 679-0621
Mountain View
Thresum Assoc., (415) 965-9180
San Diego
Littlefield & Smith Assoc., (714) 277-8044
Colo **Denver**
Lindberg, Co., (303) 758-9033
Fla **Casselberry**
EIR Inc., (305) 830-9600
Maitland
Delmac Sales, (305) 644-2526
Ill **Rolling Meadows**
Solid State Scientific, (312) 253-2390
Sumer Inc., (312) 394-4900
Ind **Indianapolis**
Delesa, (317) 894-3778
Kan **Lenexa**
Palatine Sales, Inc., (913) 492-7020
NY **Pittsford**
T-Squared Electronics, (716) 381-2551
Syracuse
T-Squared Electronics, (315) 463-8592
Tex **Richardson**
Semiconductor Sales Inc., (214) 231-6181
Utah **Salt Lake City**
Lindberg Co., (801) 534-1500
Can **Montreal, Quebec**
Penryn Electronics, (514) 735-2107

Distributors

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Sterling Electronics, (602) 258-4531
Cal **Fullerton**
Zeus Components, (714) 871-0391
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Sterling Electronics, (415) 592-2353
San Diego
Sterling Electronics, (714) 565-2441
Santa Clara
Re:Coil, (408) 984-0400
Sun Valley
Sterling Electronics, (213) 767-5030
Woodland Hills
Semiconductor Concepts, (213) 884-4560
Colo **Wheatridge**
Century Electronics, (303) 424-1985
Ind **Indianapolis**
Advent Electronics, (317) 297-4910
Pioneer/Indiana, (317) 849-7300
Md **Baltimore**
Hallmark Electronics, (301) 365-8500
Gaithersburg
Pioneer/Washington, (301) 948-0710
Mass **Burlington**
Zeus/New England, (617) 273-0750
Holliston
Diplomat/New England, (617) 429-4120
Minn **Bloomington**
Hallmark Electronics, (612) 884-9056
NM **Albuquerque**
Sterling Electronics, (505) 345-6601
Pa **Erie**
Advacom Inc., (814) 455-8110
Horsham
Pioneer/Philadelphia, (215) 674-7510
Utah **Salt Lake City**
Century Electronics, (801) 487-8551
Wash **Seattle**
Sterling Electronics, (206) 762-9100

Solitron Devices

Solitron Devices, Inc.
Semiconductor Division
8808 Balboa Avenue
San Diego, California 92123
(714) 278-8780
TWX: (910) 335-1221

Sprague Electric Co.

Sprague Electric Company
Semiconductor Division
115 Northeast Cutoff
Worcester, Massachusetts 01606
(617) 853-5000
Telex: 920467

Specific product information:
(413) 664-4411 .... ext. 2424
Automotive .... B. Marshall
Consumer .... R. Milewski
Camera .... B. Marshall
Digital .... G. Tully
Transistor Arrays .... G. Tully
Operational Amplifiers .... G. Tully
Display Drivers .... P. Emerald
Mos .... G. Tully

Application engineering:
Same as Above

Literature:
647 Marshall Street, North Adams, Massachusetts 01247, (413) 664-4411 .... ext. 2572

Price and delivery:
Same as Product Information

Place an order:
Same as Above

Follow-up an order:
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Contact these offices for names of distributors

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Southeastern Distributors Supply Co., (205) 353-3615
Huntsville
Sprague Electric Co., (205) 883-0520
Ariz **Phoenix**
Zeus/KCE, (602) 951-1362
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Sprague Electric Co., (602) 279-5435
Cal **Burlingame**
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Encino
KCE Corporation, (213) 990-0511
Inglewood
Sprague E6ectric Co., (213) 649-2600
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KCE Corporation, (213) 649-2622
Sacramento
William J. Purdy Company, (916) 422-0128
San Diego
KCE Corporation, (714) 278-7640
Colo **Denver**
William J. Purdy Co., (303) 777-1411
Conn **Trumbull**
Sprague Electric Co., (203) 261-2551
D.C. **Washington,**
Sprague Electric Co., (Gov't sales only) (202) 244-6006
Fla **Ft. Lauderdale**
UniRep, Inc., (305) 527-1556
Longwood
Sprague Electric Co., (305) 831-3636
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Hawaii Electronics Sales, (808) 845-8207
Ill **Chicago**
D. Dolin Sales Co., (312) 286-6200
Schiller Park
Sprague Electric Co., (312) 678-2262
Ind **Indianapolis**
Sprague Electric Co., (317) 253-4247
Mulberry
Maish Sales, (317) 638-8484 (For Indianapolis)
Maish Sales, (317) 296-2322 (For Mulberry Area)
Mass **North Adams**
Sprague Electric Co., (413) 664-4411
Waltham
Sprague Electric Co., (617) 899-9840
Mich **Jackson**
Sprague Electric Co., (517) 787-3934
Minn **Minneapolis**
HMR, Inc., (612) 920-8200
Mo **Kansas City**
Nevco, Inc., (816) 421-1751
St. Louis
Nevco, Inc., (314) 843-7406
NJ **Cherry Hill**
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Trinkle Sales Inc., (609) 795-4200
Cranford
G. G. Burnett, (914) 698-8600
Wayne
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NM **Albuquerque**
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NY **Mamaroneck**
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Syracuse
Mar-Com Associates, (315) 437-2843
Paston-Hunter Co., Inc., (315) 437-2992
Sprague Electric Co., (315) 437-7311
NC **Winston-Salem**
Electronic Marketing Asso., (919) 722-5151
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Electronic Salesmasters, Inc., (216) 831-9555
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Sprague Electric Co., (513) 278-0781
SC **Greenville**
Electronic Marketing Assoc. Inc., (803) 268-1125
Tex **Arlington**
EMC, Inc., (817) 261-8424
Dallas
Lund & Company, Inc., (214) 387-4634
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Sprague Electric Co., (214) 235-1256
Va **Lexington**
Sprague Electric Co., (703) 463-9161
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Fleehart & Sullivan, Inc., (206) 522-1533
Sprague Electric Co., (206) 632-7761
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Sprague Electric of Canada, (514) 747-7811
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Intl **England, Yiewsley**
Sprague Electric (U.K.) Ltd., 44627
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Sprague France S.A.R.L., 1-655 19 19
Intl **Germany, Frankfurt**
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Milan
Sprague-Italiana, S.p.A., 02-47 91 21
Rome
Sprague-Italiana S.p.A., 06-83 33 69
Intl **Switzerland, Geneva**
Sprague World Trade Corp., 98-4021
Intl **Taiwan, Taipei**
Sprague Taiwan Corp., 7310748

Stewart-Warner Microcircuits

Stewart-Warner Microcircuits
730 East Evelyn Avenue
Sunnyvale, California 94086
(408) 245-9200
TWX: (910) 339-9210

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Varigon Associates, (213) 679-0621
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PM Sales, (415) 941-4444
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Varigon Associates, (714) 299-5413
Colo Wheatridge
Waugaman Associates, Inc., (303) 432-1020
Conn Meriden
Com-Sale, (203) 634-0179
Ill Chicago
LGS Electronics, (312) 456-9616
Ind Fort Wayne
G&D Electronic Sales, Inc., (219) 432-5585
Mass Waltham
Com-Sale, (617) 890-0011
Mich Farmington
Carter McCormic & Pierce, Inc., (313) 477-7700
Minn Minneapolis
S&R Component Sales, (612) 544-3022
Mo Hazelwood
Dy-Tronix, Inc., (314) 731-5799
NY Jamaica
SJ Sales Associates, (212) 291-3232
Ohio Chagrin Falls
Crest Component Sales, (216) 543-9808
Pa King of Prussia
Monteiro Associates, Inc., (215) 265-0634
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Evans McDowell Associates, (214) 238-7157
Houston
Evans McDowell Associates (713) 783-2900
Wash Bellevue
SD-R², (206) 747-9424

Distributors

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Intermark, (714) 540-1322, (213) 436-5275
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Fla Miami
Lykes Electronics, (305) 633-8535
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Powell Electronics, (305) 592-3260
Orlando
Powell Electronics, (305) 859-1450
Tampa
Lykes Electronics, (813) 886-6646
Ga Atlanta
Lykes Electronics, (404) 355-2223
Ill Skokie
Bell Electronics, (312) 965-7500
Ill Westmont
Bodelle Co., Inc., (312) 323-9670
La New Orleans
Lykes Electronics, (504) 486-7441
Md Beltsville
Powell Electronics, (301) 937-4030
Mass Burlington
Wilshire Electronics, (617) 272-8200
Dedham
Gerber Electronics, (617) 329-2400
West Newton
A. W. Mayer, (617) 965-1111
Mich Ann Arbor
Wedemeyer Electronic Supply, (313) 665-8611
Farmington
Diplomat/Northland Electronics, (313) 477-3200
Minn Minneapolis
Electro-Com Corporation, (612) 788-8601
Industrial Components, Inc., (612) 831-2666
NJ Cinnaminson
Wilshire Electronics, (609) 786-8990
NY Elmsford
Zeus Components, (914) 592-4120
Farmingdale
Harrison Electronics Corporation, (516) 293-7990
Johnson City
Wilshire Electronics, (607) 797-1236
NC Winston Salem
Kirkman Electronics, (919) 724-0541
Ohio Dayton
Stotts Freidman, (513) 224-1111
Pa Philadelphia
Powell Electronics, (215) 365-1900
Pittsburgh
RPC, (412) 782-3770
Tex Dallas
KA Electronic Sales, (214) 634-7870
Houston
Lenert Company, (713) 225-1465
Utah Salt Lake City
Alta-Land Electronics, (801) 486-7227
Wash Seattle
Intermark, (206) 767-3160
Zepher Electronics, (206) 242-2517, (206) 243-0224

Synertek

Synertek
3050 Coranado Drive
Santa Clara, California 95051
(408) 241-4300
All other information:
All Information: Jack Balletto

Sales Offices & Representatives

Ariz Phoenix
R.R. Sales, (602) 959-5150
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Relcom, (213) 822-1187
Mountain View
Thresum Associates, (415) 965-9180
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C.P.S. Corporation, (203) 795-3515
Fla Hollywood
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Ill Chicago
Professional Sales, (312) 359-2253
Mass Waltham
Synasel Assoc., (617) 890-6777
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Kent & Associates, (313) 651-1006
Minn Bloomington
Electronic Innovators, (612) 884-7471
NJ Camden
Sunday O'Brien, (609) 429-4013
NY Garden City
Comtronic Assoc., (516) 741-8966
Syracuse
Honsinger Assoc., (315) 463-5718
Tex Dallas
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Mark Kruvand Co., (713) 661-3007

Teledyne Crystalonics

Teledyne Crystalonics
147 Sherman Street
Cambridge, Mass. 02140
(617) 491-1670

Teledyne Philbrick

Teledyne Philbrick
Allied Drive at Route 128
Dedham, Massachusetts 02026
(617) 329-1600
TWX: (710) 348-6726

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Zeus, Inc., (602) 258-7519
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T. Louis Snitzer Co., (714) 454-2191
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T. Louis Snitzer Co., (213) 836-6170
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Colo Denver
PLS Associates, Inc., (303) 773-1218
Fla Largo
Col-Ins-Co., (813) 581-8233
Orlando
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Hawaii Kailua
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Ill Chicago
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Md Kensington
Electronic Marketing Associates, (301) 881-5300
Mass Burlington
Tekdata Manufacturer's Rep., (617) 273-0198
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Carter, McCormic & Peirce, Inc., (313) 477-7700
Minn Minneapolis
Electronic Innovators, Inc., (612) 884-7471
Mo Florissant
Mid-West Marketing, (314) 831-0342
NM Albuquerque
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NY Elmont
Crane & Egert Corp., (516) 488-2100
N. Syracuse
KLM Associates, (315) 458-6214
Rochester
KLM Associates, (716) 442-0820
Utica
KLM Associates, (315) 735-8525
NC Raleigh
The Candor Company, Inc., (919) 876-4999
Ohio Cleveland
Carter, McCormic & Peirce, Inc., (216) 333-5650
Dayton
Carter, McCormic & Peirce, Inc., (513) 278-5873
Okla Norman
Data Marketing Associates, (405) 364-8320
Pa King of Prussia
Electronic Marketing Associates, (215) 265-1600, (215) 248-5050

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SC **Myrtle Beach**
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Tenn **Chattanooga**
The Candor Company, Inc., (615) 894-7454
Tex **Dallas**
Data Marketing Associates, (214) 661-0300
Houston
Data Marketing Associates, (713) 686-9627
San Antonio
Data Marketing Associates, (512) 828-0937
Utah **Salt Lake City**
Zeus, Inc., (801) 486-2317
Wash **Seattle**
Seatronics, (206) 767-4330
Can **Downsview, Ont.**
Cesco Electronics Ltd., (416) 661-0220
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Cesco Electronics, Ltd., (514) 735-5511
Ottawa, Ont.
Cesco Electronics, Ltd., (613) 729-5118
Quebec, P.Q.
Cesco Electronics, Ltd., (418) 524-4641
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Intek Electronics, Ltd., (604) 324-6831
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Sirex 42-1927, 44-5781
Intl **Australia**
Brookvale, N.S.W
Elmeasco Instruments Pty. Ltd., 939 7944
Victoria
Elmeasco Instruments Pty. Ltd., 266 658
Intl **Austria, Vienna**
Kontron GmbH & Co. KG, 94 56 46
Intl **Belgium, Brussels**
Simac Electronics SPRL, (6) 72.45.56
Teledyne Philbrick, 673 99 88
Intl **Brazil, Sao Paulo**
Setpoint S/A Comercio E Importacao, 288-3834
Intl **Chile, Santiago**
Sirex, 39-5752, 3-4455
Intl **Denmark, Lyngby**
Knud Kamuk A/S, (01) 88 38 33
Intl **Finland, Kauniainen**
Findip A.B., 90-502255
Intl **France, Paris**
Teledyne Philbrick France, (1) 577 95 69
Intl **Germany, Wiesbaden**
Teledyne GmbH, (06121)-39171
Intl **Greece, Athens**
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Electronic Enterprises, 353069, 375376
Intl **Ireland**
Belfast
Neltronic Ltd., 36521/2
Dublin
Neltronic Ltd., 501845
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Intl **Japan**
Osaka
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Tokyo
Teledyne Philbrick Japan, 403-8921
Intl **Korea, Seoul**
Korea Uni[illegible]Trading Corp., 76-2502, 76-2501
Intl **Netherlands, Steensel**
Simac Electronics b.v., (04970)-2011
Intl **New Zealand, Auckland**
Professional Electronics, Ltd., 491-609
Intl **Nigeria, Lagos**
DeeMTee Electronics, Ltd.,
Intl **Iran, Tehran**
Berkeh Company, Ltd., 828294, 831564
Intl **Norway, Oslo**
Scancopter a.s., 69-44-90, 55-11-96
Intl **Pakistan, Karachi**
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Intl **Portugal, Lisbon**
Ditram Components e Electronica, Lda., 45313
Intl **South Africa, Transvaal**
K. Baker Associates Pty. Ltd., 42-1939, 42-2043
Intl **Spain, Madrid**
Hispano Electronica S.A., 233 1601 T
Intl **Sweden, Jarfalla**
Scancopter AB, 0758-37440
Intl **Switzerland, Zurich**
Kontron Electronic Ltd., 01/62 82 82
Intl **Taiwan, Taipei**
Industrial Electronics, 774 257
Intl **U.K., Cranford**
Teledyne Philbrick U.K., (01) 897-2501
Intl **West Indies,**
Miami, Fla
West Indies Sales Co., Ltd., (305) 592-8188

Teledyne Semiconductor

Teledyne Semiconductor
1300 Terra Bella Avenue
Mountain View, California 94043
(415) 968-9241
TWX: (910) 379-6494

Specific product information:
Digital Marketing
Linear Marketing
Application engineering:
See Product Information
Literature:
Literature Center
Price and delivery:
See Product Information
Place an order:
Local Field Sales Office or Order Entry
Follow-up an order:
Customer Service for (Product)
All other information:
Marketing Services

Sales Offices and Representatives

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EMA, (205) 837-6061
Ariz **Tempe**
Sedco Sales, Inc., (602) 968-7791
Cal **Escondido**
Cirolia Electronic Sales, (714) 743-3015
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Teledyne Semiconductor, (213) 826-6639
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Hutto Hawkins Peregoy, Inc., (305) 943-9593
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Penzner-Mankus Corp., (913) 381-0004
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NH **Salem**
Teledyne Semiconductor, (603) 893-9551
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Sunday-O'Brien, (609) 429-4013
NM **Albuquerque**
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NY **Buffalo**
Bowser & Sapecky Associates, (716) 839-4170
Manlius
Bowser & Sapecky Associates, (315) 682-8885
Mount Vernon
Friedman-Smith Electronic Sales, Inc., (914) 664-4866
Stony Brook
Teledyne Semiconductor, (516) 751-5640
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Burgin-Kreh Associates, (919) 768-4174
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Neal Bear Corp. - Bear Marketing, (513) 299-3566
Richfield
Neal Bear Corp. - Bear Marketing, (216) 659-3131
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Houston
Evans-McDowell Associates, (713) 783-2900
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Waugaman Associates, Inc., (801) 277-8911
Va **Lynchburg**
Burgin-Kreh Associates, (804) 845-5600
Wash **Bellevue**
SD.R^2, (206) 747-9424
PR **Santurce**
E. Franceschini Associates, (809) 726-0225
Can **Ottawa, Ont.**
Cantec Representatives, (613) 225-0363
Intl **England,**
Hounslow, Middlesex
Teledyne Semiconductor (44) 01-897-2503
Intl **Hong Kong, Kowloon**
Teledyne Semiconductor, 3-240122
Intl **Japan, Tokyo**
Teledyne Semiconductor, 03-405-5738
Intl **Singapore**
Kallang Bahru Ind. Est
Teledyne Semiconductor, 2582811
Intl **West Germany**
Tiengen
Teledyne Semiconductor, 7741-5066
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Teledyne Semiconductor, 06121-39171

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Cal **Chatsworth**
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Kierulff Electronics Co., Inc., (213) 685-5511
Newport Beach
SemiComp Corporation, (714) 833-3070
Riverside
Electronic Supply, (714) 683-8110
San Diego
Intermark Electronics, (714) 279-5200
Kierulff Electronics Co., Inc., (714) 278-2122
Santa Ana
Intermark Electronics, (714) 540-1322
Sunnyvale
Intermark Electronics, (408) 738-1111
Woodland Hills
Semiconductor Concepts, (213) 884-4560
Colo **Wheat Ridge**
Century Electronics, (303) 424-1985
Conn **Norwalk**
Harvey Electronics, (203) 853-1515
Fla **Clearwater**
Diplomat/Southland Electronics, Inc., (813) 443-4514
Ft. Lauderdale
Newark Electronics, (305) 587-2372
Orlando
Hammond Electronics, (305) 849-6060
Pompano Beach
Zeus Components, Inc., (305) 942-4312
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Advent Electronics, (312) 298-4210

Teledyne Semiconductor (cont)

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Gaithersburg
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Pyttronic Industries, Inc., (301) 792-7000
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Dedham
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Framingham
Future Electronics, (617) 879-0860
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Cadence Electronics, (617) 879-3000
Advent Electronics, (313) 769-8650
Farmington
Diplomat/Northland, (313) 477-3200
Mich Livonia
Rep-tron, Inc., (313) 525-2700
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Electro-Com Corp., (612) 788-8601
NJ Clifton
Wilshire Electronics, (201) 365-2600
Moorestown
Arrow/Angus, (609) 235-1900
NM Albuquerque
Century Electronics, (505) 292-2700
NY Buffalo
Summit Distributors, Inc., (716) 884-3450
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Zeus Components, Inc., (914) 592-4120
Hauppauge, L.I.
Semiconductor Concepts, (516) 273-1234
Johnson City
Wilshire Electronics, (607) 797-1236
New Hyde Park, L.I.
Lafayette Industrial Elec., (516) 488-6600
Rochester
Summit Electronics of Rochester, Inc., (716) 334-8110
Ohio Cleveland
Pioneer/Cleveland, (216) 587-3600
Columbus
Electronics Marketing Corp., (614) 299-4161
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Pioneer/Dayton, (513) 236-9900
Pa Montgomeryville
Pyttronic Industries, Inc., (215) 643-2850
Philadelphia
Almo Electronics, (215) 698-4021
Tex Dallas
Component Specialties, (214) 357-4576
Solid State Electronics, (214) 352-2601
Houston
Component Specialties, (713) 771-7237
Solid State Electronics, (713) 785-5205
Utah Salt Lake City
Diplomat/Alta Electronics, (801) 486-7227
Wash Seattle
Intermark Electronics, (206) 767-3160
Can Montreal, P.Q.
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Future Electronics, (416) 677-7820
Scarborough, Ont.
Carsten Electronics, (416) 751-5095
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Bowtek Electric Co. Ltd., (604) 736-1141
R-A-E, (604) 687-2621
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Victoria
Austronic Engineering Labs, Pty. Ltd., 387-1477
Prospect
A.J. Ferguson (Adelaide) Pty. Ltd., 269-1244
Intl Belgium, Brussels
Sobelab Electronics S.A., 673-9055
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A/S Nordisk Elektronik (45) (1) 969596
Intl Finland, Helsinki
Yleiselektroniikka Oy, 578922
Intl France, Sevres
Tekelec Airtronic, (8) 626-0235
Intl Germany
Bremen
Arthur Behren VDI, (49) (410) 343022
Intl Hannover
Theo Henskes,
(49) (511) 440213
Nettetal
Omni Ray GmbH, (49) (2153) 4548
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Hot Electronic
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Unterhaching
Metronik GmbH, (49) (811) 615560
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Ritro Electronics N.V. 03420 5041
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Continental Device India, Ltd., 392784
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Milan
Mesa, S.P.A., (39) (2) 3491040
Tekelec Airtronic S.P.A., (39) (2) 738.56.74
Intl Japan
Tokyo
KH Electronics Corporation, 584-6395, 584-7111
O.S. Seidi Company , Ltd., 255-6051
Takachiho Koheki Company, 263-3211
Teijin Advance Products Corporation, (506) 4670-3
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Intl Singapore, Singapore
Techco (Private) Ltd., 2588663, 2587390
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Intl Spain, Madrid
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Intl Sweden, Stockholm
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Mardel 563155-6
Intl United Kingdom
Hitchin
Double R. Electronics
Slough
G.D.S. Sales, Ltd., Slough
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Texas Instruments

Texas Instruments Incorporated
Semiconductor Group
P.O. Box 5012
Dallas, Texas 75222
(214) 238-2011
TWX: (910) 867-4702

Specific product information:
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Houston, Texas (713) 494-5115 .... ext. 2734
MOS
Houston, Texas (713) 494-5115 .... ext. 2821
Special Products
Dallas, Texas
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Low Power Schottky
CMOS (214) 238-2011 .... ext. 4841
Consumer Circuits
Lubbock, Texas (806) 762-8831 .... ext. 51
Linear Circuits
Dallas, Texas (214) 238-2011 .... ext. 3865
Advanced Circuits
ECL
Sherman, Texas (214) 893-5166 .... ext. 303

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Field Sales Office, (408) 732-1840
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Field Sales Office, (303) 750-4100
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Field Sales Office, (203) 281-0074
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Field Sales Office, (404) 458-7791
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Field Sales Office, (219) 484-0606
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Field Sales Office, (617) 890-7400
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R. V. Weatherford Co., (213) 849-3451
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Radio Product Sales, (213) 748-1271
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Arrow Electronics, (617) 273-0100
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Lcomp-St. Louis, (314) 647-5505
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Arrow Electronics, (201) 797-5800
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Cramer Binghamton, (607) 754-6661, Ext. 389
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Cramer Electronics, (516) 231-5600
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TI Supply Company, (516) 293-2660
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Rochester Radio Supply Co., (716) 454-7800
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Cramer Winston/Salem, (919) 725-8711, Ext. 550
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Arrow Electronics, (513) 253-9176
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TI Supply Company, (918) 437-4555
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TI Supply Company, (214) 238-6823
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TI Supply Company, (713) 785-4800
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Wash **Seattle**
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Wisc **Milwaukee**
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Cesco Electronics, Ltd., (613) 729-5118
Future Electronics, (613) 232-7757
Rexdale (Toronto)
Future Electronics, (416) 677-7820
Montreal, P.Q.
Cesco Electronics, Ltd., (514) 735-5511
Future Electronics, (514) 735-5775
Quebec City
Cesco Electronics, Ltd., (418) 524-4641
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Canadian Electronics, Ltd., (403) 287-1800
Edmonton
Canadian Electronics, Ltd., (403) 452-9393
Vancouver, B.C.
Canadian Electronics, Lt., (604) 685-9311
Winnipeg, Man.
Canadian Electronics, Ltd., (204) 943-0763

TMX, Inc.

TMX Incorporated
250 Park Avenue
New York, New York 10017
(212) 661-9400

Sales Offices and Representatives

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Interstate Marketing Assoc., (213) 883-7670
Mass **Burlington**
Tritek, (617) 272-4550
Ohio **Centerville**
Micro Sales Corporation, (513) 433-8171

Toshiba

Toshiba America
Chicago Office
5235 N. Elston Ave.
Chicago, Illinois 60630
(312) 545-5123
New York Office
280 Park Avenue
New York, New York 10017
(212) 557-0407
Main Office
Toshiba Semiconductor Division
1 Komukai-Toshiba-choo, Saiwai-ku'
Kawasaki City, Kanagawa 210, Japan

Transitron Electronic

Transitron Electronics Corp.
168 Albion Street
Wakefield, Mass. 01880
(617) 245-4500
TWX: (710) 643-6708

TRW

trw Semiconductors
14520 Aviation Blvd.
Lawndale, California 90260
(213) 679-4561
TWX: (910) 325-6206
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Western Digital Corporation
3128 Red Hill Avenue
P. O. Box 2180
Newport Beach, California 92663
(714) 557-3550
TWX: (910) 595-1139

Specific product information:
Product Marketing .... ext. 243, 250

Application engineering:
.... ext. 292

Literature:
Marketing Services .... ext. 241

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Spartan Test Systems - SPARTAN Sales .... ext. 208

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All other information:
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Ft. Lauderdale
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Iowa **Cedar Rapids**
S & O Sales, (319) 393-1845

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Timonium
Marktron, Inc., (301) 252-7111

Mass **Medford**
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Mich **Detroit**
A. Blumberg Associates, (313) 557-1934
St. Joseph
A. Blumenberg Assoc. Inc., (616) 983-0481

Minn **Edina**
Wagner Consultants Corp., (612) 941-6310

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Nevco, Incorporated, (816) 421-1751

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Ontec, (315) 466-2580
Rochester
Ontec, (716) 464-8636
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LRC Associates, Inc., (914) 634-7973

Ohio **Aurora**
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Engineering Marketing Assoc., (513) 433-2800

Ore **Portland**
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Huntington Valley
Knowles Associates, (215) 947-5641

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Houston
Bonser-Philhower Sales, (713) 467-4373

Va **Charlottesville**
Marktron, Inc., (301) 762-6210

Wash **Seattle**
SJI Corp., (206) 624-9020

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D. Dolin Sales Co., (414) 355-9100

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ITT Cannon Electric/Canada, (514) 336-7660
Whitby, Ontario
ITT Cannon Electric/Canada, (416) 668-8881

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Sims-Worms International Ltd., 01-572-0393

Intl **France**
Neuilly-Sur-Seine
Technology Resources, 747-4717

Intl **Hong Kong, Hong Kong**
Power Corporation, 3-637656

Intl **Japan, Yokohama**
Pan Electron, Inc., 045-471-8811

Intl **Latin America, Africa,**
India
Los Altos Cal
Row International Inc., (415) 941-6730

Intl **Sweden, Vallingby**
Svensk Teleindustri VX08-89 04 35

Intl **Taiwan, Taipei**
Sinoca Enterprises Co., Tlx 22-112

Intl **West Germany, Munich**
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Distributors

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Westates Electronics, (213) 341-4411
Costa Mesa
Westates Electronics Corp., (714) 549-8401
Sunnyvale
Bell Industries, (408) 734-8570
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Fla **Clearwater**
Diplomat Southland, (813) 443-4514

Ill **Elk Grove Village**
Diplomat/Lakeland, (312) 595-1000

Mass **Woburn**
Time Electronics/New England, (617) 935-8080

Mich **Farmington**
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Minn **Minneapolis**
Diplomat/Electro-Com Corp., (612) 788-8601

NY **Woodbury**
Diplomat/Long Island, (516) 921-9373

Ohio **Dayton**
Diplomat/Ohio, (513) 228-1080

Okla **Tulsa**
Component Specialties, Inc., (918) 664-2820

Pa **Clifton Heights**
Time Mid Atlantic, (215) 622-2500

Tex **Dallas**
Component Specialties, Inc., (214) 357-4576
Houston
Component Specialties, Inc., (713) 771-7237

Utah **Salt Lake City**
Diplomat/Salt Lake City, (801) 486-7227

Can **Whitby, Ontario**
ITT Cannon Electric/Canada, (416) 668-8881

PRODUCT INDEX

This index shows the page and the line on that page of every device in the Master Selection Guide and the Application Note Directory. It is organized alphabetically by manufacturer and for each manufacturer, alpha-numerically by device. Bold face listings lead to data on important products which has been supplied for you by the manufacturers. If you want to determine which products are in the book from a given manufacturer, simply check the Product Index.

how to use the product index

The Product Index contains the same references as the Part Number Index, but in this case the listings are sorted by manufacturer.

As in the Part Number Index, the model numbers are sorted alpha-numerically from **left** to **right**. Here the manufacturer's prefixes are included so that devices with alphabetic prefixes appear before those without them (i.e., LM101 would be before 1101). Application note pages are indicated by a ¶ sign and data by a ★ sign. The numbers preceding the dash are the page numbers, while those following the dash indicate the location on the device on the page.

When you use the Master to find data on a particular manufacturer's products, this index provides the fastest way to find all the information.

Arranged alphanumerically from left to right

IC UPDATE MASTER

¶ Indicates page number in Application Note Directory
★ Indicates additional data is provided on the page noted.

Arranged alphanumerically from left to right

¶ Indicates page number in Application Note Directory
★ Indicates additional data is provided on the page noted.

Fairchild Semiconductor (cont)

Arranged alphanumerically from left to right

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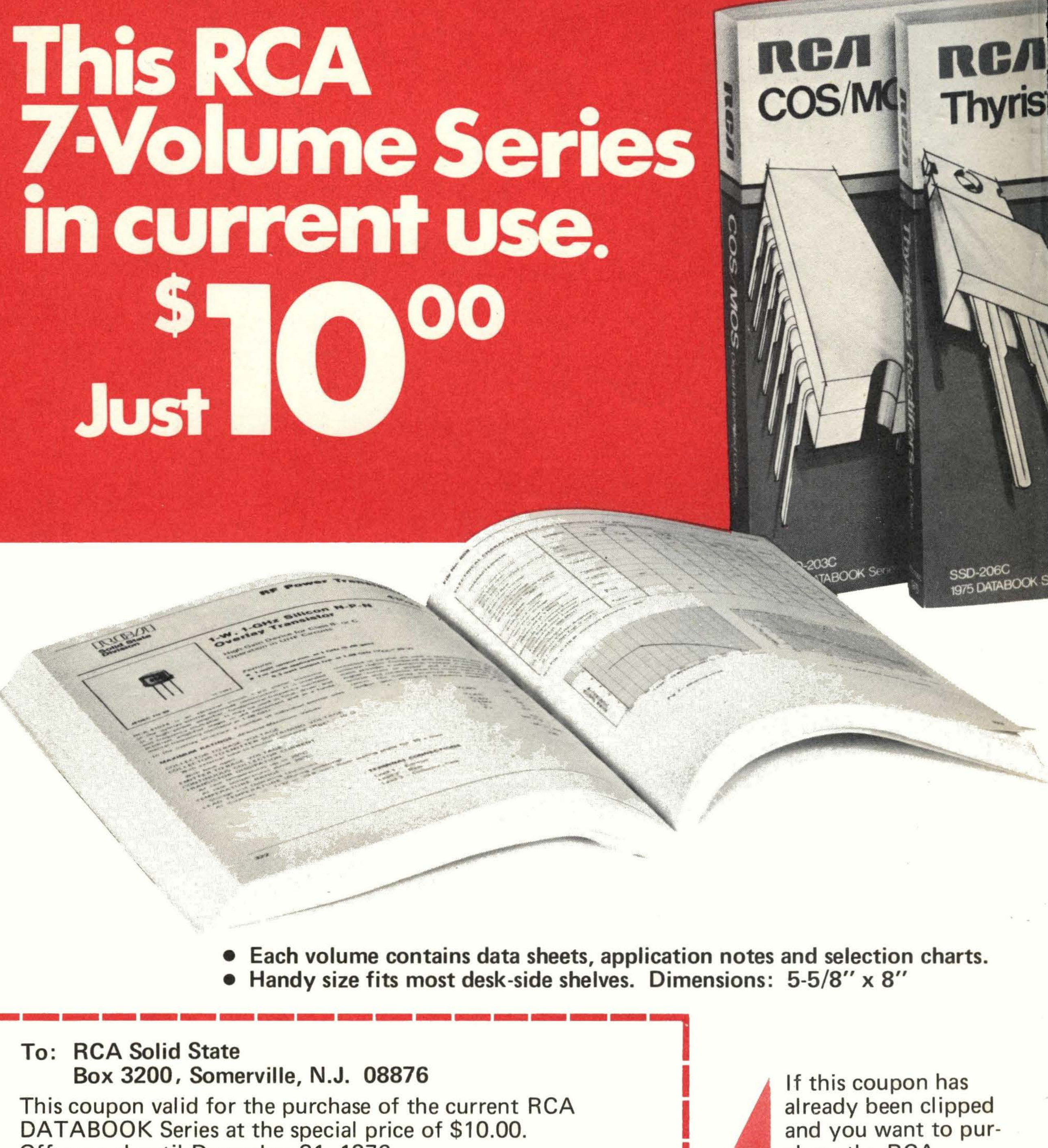

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