

**NEC**

\$3.00

**LINEAR INTEGRATED CIRCUITS  
DATA BOOK**

Edition I

**NEC**

**NEC Electronics U.S.A. Inc.**  
Electron Division

**NEC**

# **LINEAR IC DATA BOOK**

Edition 1

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ELECTRON DIVISION

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# ORDERING INFORMATION FOR LINEAR CIRCUIT

The ordering information for NEC devices covered in this catalog is introduced as follows. Three basic units of information are contained in the code.

$\mu$ PC	151	C
DEVICE FAMILY	DEVICE NUMBER	PACKAGE

## • DEVICE FAMILY

- $\mu$ PA : Twin Transistor and Miscellaneous Device
- $\mu$ PB : Monolithic Bipolar Digital
- $\mu$ PC : Monolithic Linear
- $\mu$ PD : Monolithic MOS

## • DEVICE NUMBER

This group of alpha numeric characters denotes the device type.

Most of NEC's High Reliability linear devices employ proprietary numbering system of NEC. And the original manufacturers type number denotes the commercial temperature range of linear circuits. (For example,  $\mu$ PC151A: High Reliability 741 type of op amp.  $\mu$ PC741C: commercial temperature range of 741.)

## • PACKAGE

One letter shows the package information

- D — Ceramic DIP
- C — Plastic Molded DIP
- G — Plastic Flat Package

## • TEMPERATURE

	High Reliability/Industrial	Commercial
Operating Temperature Range		
Ceramic DIP	-20°C to +80°C	-
Plastic DIP, flat	-20°C to +70°C	0°C to +70°C
Storage Temperature Range		
Metal Can	-65°C to +175°C	-
Ceramic DIP	-55°C to +150°C	-
Plastic DIP, flat	-55°C to +125°C	-55°C to +125°C

## • EXAMPLE

- $\mu$ PC741C : 741 type of op amp in plastic molded DIP with commercial temperature rating capability.
- $\mu$ PC151G : 741 type op amp in plastic flat package with industrial temperature rating capability.
- $\mu$ PC741G : 741 type op amp in plastic flat package with commercial temperature rating capability.

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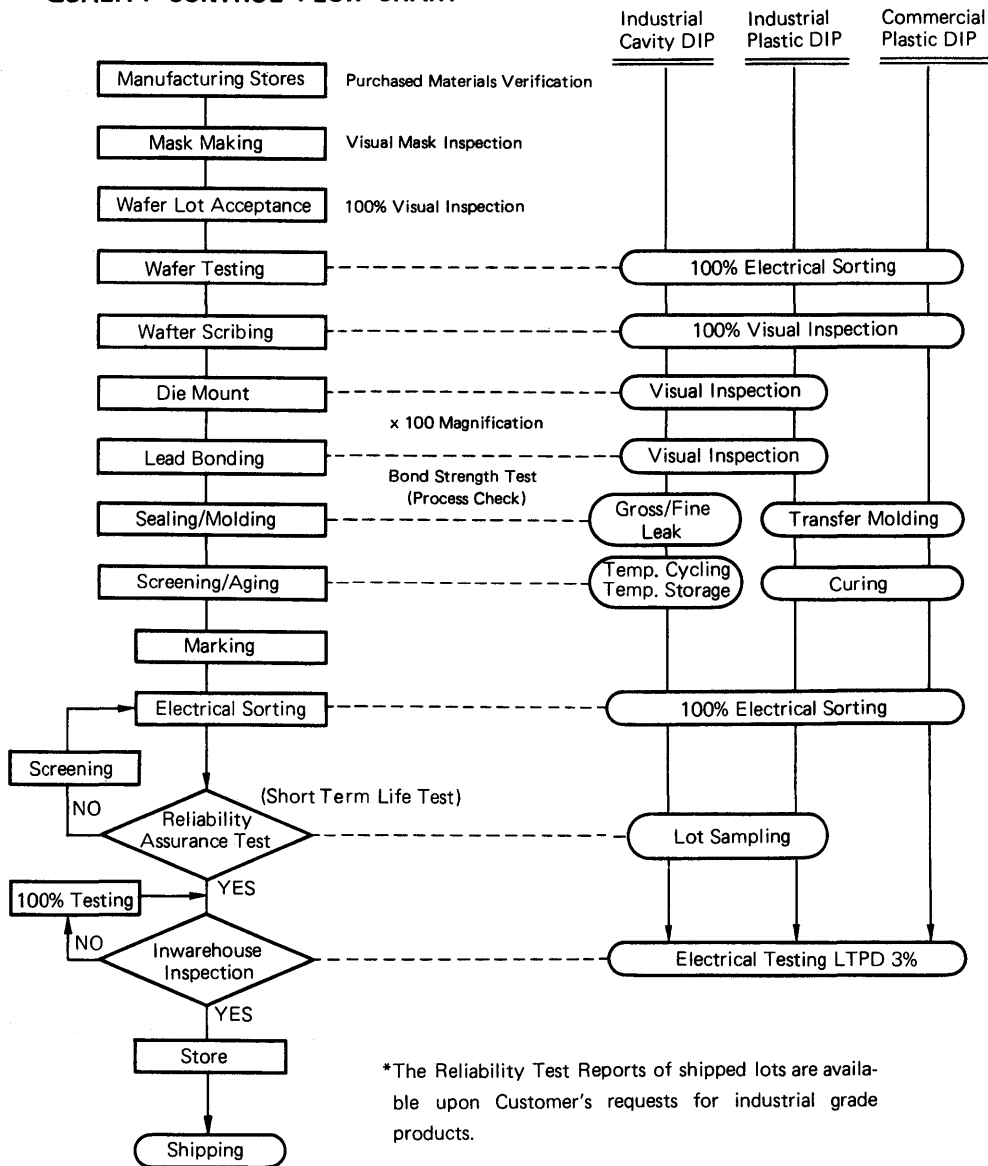
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# QUALITY & RELIABILITY

NEC's Linear Integrated Circuits are manufactured and tested by the following process flows to realize a complete quality and reliability.

## QUALITY CONTROL FLOW CHART



\*The Reliability Test Reports of shipped lots are available upon Customer's requests for industrial grade products.

## Periodical Reliability Test

### INDUSTRIAL CAVITY DIP

	Test Items	Test Condition
Environmental Test	Soldering Heat	260°C, 10 sec, once
	Temperature Cycle	-65°C to +150°C, 10 cycles, 30 min each temp.
	Thermal Shock	100°C and 0°C, 15 cycles, 5 min each temp.
	Mechanical Shock	1500G, 0.5 ms, XYZ Axis, 5 times
	Variable Frequency Vibration	100 Hz to 2000 Hz, 20G, XYZ Axis, 4 times
	Constant Acceleration	2000G, XYZ Axis, 1 min each
	Lead Fatigue	250 g, 90 degrees, 3 times, 3 or 4 leads
	Solderability	230°C, 5 sec, once, with rosin flux
Life Test	Bias Temperature Test	Ta=125°C, Maximum Rated Voltage, 1000 hours
	High Temperature Storage Test	Ta=175°C, 1000 hours

### INDUSTRIAL PLASTIC MOLDED DIP

	Test Items	Test Condition
Environmental Test	Soldering Heat	260°C, 10 sec, once
	Temperature Cycle	-65°C to +150°C, 10 cycles, 30 min each temp.
	Thermal Shock	100°C and 0°C, 15 cycles, 5 min each temp.
	Lead Fatigue	250 g, 90 degrees, 3 times, 3 or 4 leads
	Solderability	230°C, 5 sec, once, with rosin flux
Life Test	Bias Temperature Test	Ta=125°C, Maximum Rated Voltage, 1000 hours
	High Temperature Storage Test	Ta=150°C, 1000 hours
	High Temperature, High Humidity Storage Test	Ta=65°C, RH=95%, 1000 hours
	Pressure Cooker Test	Ta=125°C, RH=100%, 96 Hr

### INDUSTRIAL MINIFLAT IC

	Test Items	Test Condition
Environmental Test	Solderability	230°C, 5 sec, once
	Temperature Cycle	-65°C to +150°C, 10 cycles, 30 min each temp.
	Thermal Shock	100°C and 0°C, 15 cycles, 5 min each temp.
Life Test	Bias Temperature Test	Ta=125°C, Maximum Rated Voltage, 1000 hours
	High Temperature Storage Test	Ta=150°C, 1000 hours
	High Temperature, High Humidity Storage Test	Ta=65°C, RH=95%, 1000 hours
	Pressure Cooker Test	Ta=125°C, RH=100%, 48 Hr

\* Periodical reliability test is carried out every three months for each product. Test reports are available upon customer's requests.



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# CROSS REFERENCE GUIDE

## INDUSTRIAL TEMPERATURE RANGE

FUNCTION	NEC	FAIRCHILD	NATIONAL	MOTOROLA	T.I.
General Purpose OP Amp.	μPC55D	—	—	MC1709CU	μA709CJG
General Purpose OP Amp.	μPC151D μPC151C μPC151G	μA741RC μA741TC —	LM741CJ LM741CN —	MC1741CU MC1741CP1 —	μA741CJG μA741CP —
Instrumentation OP Amp.	μPC154D	μA725RC	LM725CJ	MC1456CU*	—
Super Beta OP Amp.	μPC156D	—	LM308J-8	LM308U	—
General Purpose OP Amp.	μPC157D μPC157C	— μA301AT	LM301AJ LM301AN	LM301AJ LM301AN	LM301AJG LM301AP
High Speed Wide Band OP Amp.	μPC159D	—	LM318J-8	—	LM318JG
Micro Power OP Amp. (Programmable)	μPC253DΔ	—	—	—	—
Instrumentation OP Amp.	μPC254A μPC254D	— Precision Monolithic Inc. OP-05CJ— * — Precision Monolithic Inc. OP-05CY—			
Instrumentation OP Amp.	μPC354D	* — Precision Monolithic Inc. OP-07CY—			
J-FET Input OP Amp.	μPC801C μPC801D	μAF771LTC* μAF771RC*	LF351N* —	MC34001P* MC34001U*	TL081C TL081CJG
Micro Power OP Amp. (Programmable)	μPC802C μPC802G	—	LM4250CN	—	—
Dual General Purpose OP Amp.	μPC251C μPC251D μPC251G	μA1458TC μA1458RC —	LM1458N LM1458J —	MC1458P1 MC1458L —	MC1458P MC1458JG —
Dual General Purpose OP Amp.	μPC258C μPC258D μPC258G	μA4558TC μA4558RC —	— — —	MC4558CP1 MC4558CU —	RC4558P RC4558JG —
Dual High Speed Wide Band OP Amp. Δ	μPC259CΔ	—	—	—	—
Dual Instrumentation OP Amp.	μPC454D	— Precision Monolithic Inc. OP-10CY—			
Dual Low Power OP Amp.	μPC1251C μPC1251D μPC1251G	— — —	LM358N — —	LM358N LM358J —	LM358P LM358JG —
Dual J-FET Input OP Amp.	μPC803C μPC803D	μAF772LTC* μAF772RC*	LF353N* —	MC34002P* MC34002U*	TL082CP TL082CJG
Quad Low Power OP Amp.	μPC451C μPC451D μPC451G	μA324P μA324D —	LM324N LM324J —	LM324N LM324J —	LM324N LM324J —
Quad General Purpose OP Amp.	μPC458C μPC458D μPC458G	HARRIS HA4741-5 — —		MC4741P — —	— — —
Quad J-FET Input OP Amp.	μPC804D μPC804C	μAF774RC* μAF774LTC*	— LF347N*	MC34004U* MC34004P*	TL084JG TL084CP

\* PMI; 14 pin Ceramic Package, NEC; 8 pin Ceramic Package

● Functional Equivalent

Δ NEC Original Device

FUNCTION	NEC	FAIRCHILD	NATIONAL	MOTOROLA	T.I.
Precision Comparator	$\mu$ PC271C $\mu$ PC271D $\mu$ PC271G	$\mu$ A311T $\mu$ A311R —	LM311N LM311J-8 —	LM311N LM311J-8 —	LM311P LM311JG —
Dual High Speed Comparator	$\mu$ PC272C $\mu$ PC272D $\mu$ PC272G	— — —	LM319N LM319J —	— — —	— — —
Dual Low Power Comparator	$\mu$ PC277C $\mu$ PC277D $\mu$ PC277G	— — —	LM393N — —	— — —	LM393P LM393JG —
Quad Low Power Comparator	$\mu$ PC177C $\mu$ PC177D $\mu$ PC177G	$\mu$ A339P $\mu$ A339D	LM339N LM339J	LM339N LM339J	LM339N LM339J
6 Bit D/A Converter	$\mu$ PC603D	— Precision Monolithic Inc. DAC-01CY —			
10 Bit D/A Converter	$\mu$ PC610D	— Precision Monolithic Inc. DAC-02CCX1 —			
8 Bit D/A Converter	$\mu$ PC624D $\mu$ PC624C	— Precision Monolithic Inc. DAC-08EQ			
4.5 Digit Integrating A/D (Analog)	$\mu$ PC646D	—	LF13300	—	—
4.5 Digit Integrating A/D (Digital)	$\mu$ PC647C $\Delta$	—	MM5330 $\circ$	—	—
Timer	$\mu$ PC617C	$\mu$ A555TC	LM555CN	MC1455L	NE555P
Precision Positive Regulator	$\mu$ PC141D $\mu$ PC141C	— $\mu$ A376TC	— LM376N	— —	— LM305P
Switching Regulator Controller	$\mu$ PC1042C	—	—	—	—
Over Voltage Protector	$\mu$ PC3423C	—	—	MC3423P1	—

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## COMMERCIAL TEMPERATURE RANGE

FUNCTION	NEC	FAIRCHILD	NATIONAL	MOTOROLA	T.I.
General Purpose OP Amp	$\mu$ PC741C $\mu$ PC741G	$\mu$ A741TC —	LM741CN —	MC1741CP1 —	$\mu$ A741CP —
General Purpose OP Amp	$\mu$ PC301AC	$\mu$ A301AT	LM301AN	LM301AN	LM301AP
J-FET Input OP Amp	$\mu$ PC4081C $\mu$ PC4081G	$\mu$ AF771LTC* —	LF351N* —	MC34001P* —	TL081C —
Micro Power OP Amp (Programmable)	$\mu$ PC4250C $\mu$ PC4250G	— —	LM4250CN —	— —	— —
Dual General Purpose OP Amp	$\mu$ PC1458C $\mu$ PC1458G	$\mu$ A1458TC —	LM1458N —	MC1458P1 —	MC1458P —
Dual Decompensated OP Amp	$\mu$ PC4556 $\Delta$	—	—	—	—
Dual Head Phone Amp	$\mu$ PC4557 $\Delta$	—	—	—	—
Dual General Purpose OP Amp	$\mu$ PC4558C $\mu$ PC4558G	$\mu$ A4558TC —	— —	MC4558CP1 —	RC4558P —
Dual General Purpose OP Amp	$\mu$ PC4559C	—RAYTHEON RC4559NB—			
Dual High Speed Wide Band OP Amp	$\mu$ PC4560C $\Delta$	—	—	—	—
Dual General Purpose OP Amp	$\mu$ PC358C $\mu$ PC358G	— —	LM358N —	LM358N —	LM358P —
Dual J-FET Input OP Amp	$\mu$ PC4082C	$\mu$ AF772LTC* —	LF353N* —	MC34002P* —	TL082CP —
Quad Low Power OP Amp	$\mu$ PC324C $\mu$ PC324G	$\mu$ A324P —	LM324N —	LM324N —	LM324N —
Quad General Purpose OP Amp	$\mu$ PC4741C $\mu$ PC4741G	HARRIS HA4741—5 —		MC4741P —	— —
Quad J-FET Input OP Amp	$\mu$ PC4084C	$\mu$ AF774LTC* —	LF347N* —	MC34004P* —	TL084CP —
Precision Comparator	$\mu$ PC311C $\mu$ PC311G	$\mu$ A311T —	LM311N —	LM311N —	LM311P —
Dual High Speed Comparator	$\mu$ PC319C $\mu$ PC319G	— —	LM319N —	— —	— —
Dual Low Power Comparator	$\mu$ PC393C $\mu$ PC393G	— —	LM393N —	— —	LM393P —
Quad Low Power Comparator	$\mu$ PC339C $\mu$ PC339G	$\mu$ A339P —	LM339N —	LM339N —	LM339N —
Timer	$\mu$ PC1555C	$\mu$ A555TC	LM555CN	MC1455CP1	NE555P
Three Terminal Positive Regulator (0.1 A)	$\mu$ PC78L05 $\mu$ PC78L08 $\mu$ PC78L12 $\mu$ PC78L15	$\mu$ A78L05AWC $\mu$ A78L08AWC $\mu$ A78L12AWC $\mu$ A78L15AWC	LM78L05CZ LM78L08CZ LM78L12CZ LM78L15CZ	MC78L05CP MC78L08CP MC78L12CP MC78L15CP	$\mu$ A78L05CLP $\mu$ A78L08CLP $\mu$ A78L12CLP $\mu$ A78L15CLP

● Functional Equivalent

$\Delta$  NEC Original Device

FUNCTION	NEC	FAIRCHILD	NATIONAL	MOTOROLA	T.I.
Three Terminal Positive Regulator (0.5 A)	$\mu$ PC78M05H	$\mu$ A78M05UC	LM341P-5.	MC78M05CP	$\mu$ A78M05CKC
	$\mu$ PC78M08H	$\mu$ A78M08UC	LM341P-8.	MC78M08CP	$\mu$ A78M08CKC
	$\mu$ PC78M10H	—	—	—	—
	$\mu$ PC78M12H	$\mu$ A78M12UC	LM341P-12	MC78M12CP	$\mu$ A78M12CKC
	$\mu$ PC78M15H	$\mu$ A78M15UC	LM341P-15	MC78M15CP	$\mu$ A78M15CKC
	$\mu$ PC78M18H	$\mu$ A78M18UC	LM341P-18	MC78M18CP	$\mu$ A78M18CKC
Three Terminal Positive Regulator (1 A)	$\mu$ PC78M24H	$\mu$ A78M24UC	LM341P-24	MC78M24CP	$\mu$ A78M24CKC
	$\mu$ PC7805H	$\mu$ A7805UC	LM340T-5	MC7805CP	$\mu$ A7805CKC
	$\mu$ PC7808H	$\mu$ A7808UC	LM340T-8	MC7808CP	$\mu$ A7808CKC
	$\mu$ PC7812H	$\mu$ A7812UC	LM340T-12	MC7812CP	$\mu$ A7812CKC
	$\mu$ PC7815H	$\mu$ A7815UC	LM340T-15	MC7815CP	$\mu$ A7815CKC
	$\mu$ PC7818H	$\mu$ A7818UC	LM340T-18	MC7818CP	$\mu$ A7818CKC
Three Terminal Negative Regulator (1 A)	$\mu$ PC7824H	$\mu$ A7824UC	LM340T-24	MC7824CP	$\mu$ A7824CKC
	$\mu$ PC7905H	$\mu$ A7905UC	LM320T-5	MC7905CP	$\mu$ A7905CKC
	$\mu$ PC7908H	$\mu$ A7908UC	LM320T-8	MC7908CP	$\mu$ A7908CKC
	$\mu$ PC7912H	$\mu$ A7912UC	LM320T-12	MC7912CP	$\mu$ A7912CKC
	$\mu$ PC7915H	$\mu$ A7915UC	LM320T-15	MC7915CP	$\mu$ A7915CKC
	$\mu$ PC7918H	$\mu$ A7918UC	LM320T-18	MC7918CP	$\mu$ A7918CKC
	$\mu$ PC7924H	$\mu$ A7924UC	LM320T-24	MC7924CP	$\mu$ A7924CKC





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$\mu$ PC803, $\mu$ PC4082 .....	J-FET Input Dual Operational Amplifier . . . . . 98
$\mu$ PC804, $\mu$ PC4084 .....	J-FET Input Quad Operational Amplifier . . . . . 101
$\mu$ PC1251, $\mu$ PC358 .....	Low Power Dual Operational Amplifier . . . . . 104
$\mu$ PC4556 .....	High Performance Dual Operational Amplifier . . . . . 108
$\mu$ PC4557 .....	High Performance Dual Operational Amplifier . . . . . 111
$\mu$ PC4559 .....	High Performance Dual Operational Amplifier . . . . . 115

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## DEFINITIONS

### Input Offset Voltage

The Input voltage required to zero the output with no load.

### Input Bias Current

The base current or gate leak of the input transistor when the output is at zero volts with no load.

### Input Offset Current

The difference between the two input bias currents when the output is at zero volts with no load.

### Average Input Offset Voltage Drift

The ratio of the change in the input offset voltage to the change in temperature producing it.

### Average Input Bias Current Drift

The ratio of the change in the input bias current to the change in temperature producing it.

### Average Input Offset Current Drift

The ratio of the change in the input offset current to the change in temperature producing it.

### Large Signal Voltage Gain

The ratio of the change in output voltage to the change in input voltage producing it.

### Common Mode Rejection Ratio (CMRR)

The ratio of the change in input offset voltage to the change in common-mode voltage producing it.

### Supply Voltage Rejection Ratio (SVRR)

The ratio of the change in input offset voltage to the change in supply voltage producing it.

### Input Voltage Range

The range of common-mode voltage on the input terminals for which the device will operate linearly.

### Input Resistance

The ratio of the small-signal change in input voltage change in input current at either input terminal with the other grounded.

### Maximum Output Voltage Swing

The peak output voltage that can be obtained without clipping.

### Supply Current

The standby current of the amplifier is measured when the output is at zero.

### Input Noise Voltage

The peak to peak noise voltage in a specified frequency band.

### Input Noise Voltage Density

The rms noise voltage in a 1 Hz band surrounding a specified value of frequency.

### Input Noise Current

The peak to peak noise current in a specified frequency band.

### Input Noise Current Density

The rms noise current in a 1 Hz band surrounding a specified value of frequency.

### Slew Rate

The ratio of a change in output voltage to the minimum time required to effect this change under large signal drive conditions.



## SELECTION GUIDE

DEVICE	ORIGINAL First Souce Number	Operating Temperature Range [°C]	DESCRIPTION	PACKAGE
Single Operational Amplifier				
μPC55D	709	-20 ~ +80	General Purpose	8 Pin Cavity DIP
μPC151D μPC151C μPC151G μPC741C μPC741G	741	-20 ~ +80 -20 ~ +70 -20 ~ +70 0 ~ +70 0 ~ +70	General Purpose	8 Pin Cavity DIP 8 Pin Modled DIP 8 Pin Molded Flat 8 Pin Molded DIP 8 Pin Molded Flat
μPC154D	725	-20 ~ +80	Instrumentation Amplifier	8 Pin Cavity DIP
μPC156D	308	-20 ~ +80	Super Beta Transistor Input	8 Pin Cavity DIP
μPC157D μPC157C μPC301AC	301	-20 ~ +80 -20 ~ +70 0 ~ +70	General Purpose	8 Pin Cavity DIP 8 Pin Molded DIP 8 Pin Molded DIP
μPC159D	318	-20 ~ +80	High Speed Wide Band	8 Pin Cavity DIP
μPC253D	NEC ORIGINAL	-20 ~ +80	Micro Power Programmable	8 Pin Cavity DIP
μPC254D	OP-05	-20 ~ +80	Instrumentation Amplifier	8 Pin Cavity DIP
μPC354D	OP-07	-20 ~ +80	Instrumentation Amplifier	8 Pin Cavity DIP
μPC801D μPC801C μPC4081C	TL-081	-20 ~ +80 -20 ~ +70 0 ~ +70	J-FET Input	8 Pin Cavity DIP 8 Pin Molded DIP 8 Pin Molded DIP
μPC802C μPC802G μPC4250C μPC4250G	4250	-20 ~ +70 -20 ~ +70 0 ~ +70 0 ~ +70	Micro Power Programmable	8 Pin Molded DIP 8 Pin Molded Flat 8 Pin Molded DIP 8 Pin Molded Flat
Dual Operational Amplifier				
μPC251C μPC251D μPC251G μPC1458C μPC1458G	1458	-20 ~ +70 -20 ~ +80 -20 ~ +70 0 ~ +70 0 ~ +70	Dual General Purpose	8 Pin Molded DIP 8 Pin Cavity DIP 8 Pin Molded Flat 8 Pin Molded DIP 8 Pin Molded Flat

ELECTRICAL CHARACTERISTICS (Ta = 25°C)									PAGE
Supply Voltage		I <sub>CC</sub> MAX. [mA]	V <sub>IO</sub> MAX. [mV]	I <sub>IO</sub> MAX. [nA]	I <sub>B</sub> MAX. [nA]	A <sub>v</sub> MIN. [dB]	f <sub>T</sub> TYP. [MHz]	Slew Rate TYP. [V/μs]	
MIN. [V]	TYP. [V]								
±9	±15	5.0	5.0	200	800	86	Programmable		24
±7*	±15	2.8	6.0	200	500	88	0.6	0.5	28
	±15	5.0	2.0	35	125	108	Programmable		32
	±15	0.8	7.5	1.0	7.5	88	Programmable		37
±5	±15	3.0	7.5	50	250	88	Programmable		41
	±15	1.0	10	200	500	88	10	70	46
±3	±15	Program- mable	5.0	50	100	90	Programmable		54
±3	±15	5.0	1.3	6.0	±7.0	100	0.5	0.15	58
±3	±15	5.0	150μV	6.0	±7.0	100	0.5	0.15	70
±4*	±15	2.8	15	200pA	400pA	88	3	11	89
±1.0	±15	Program- mable	6.0	20	75	96	Programmable		92
±7*	±15	5.6	6.0	200	500	86	0.6	0.5	50

\* Not guaranteed

DEVICE	ORIGINAL First Souce Number	Operating Temperature Range [°C]	DESCRIPTION	PACKAGE
$\mu$ PC258D $\mu$ PC258C $\mu$ PC258G $\mu$ PC4558C $\mu$ PC4558G	4558	-20 ~ +80 -20 ~ +70 -20 ~ +70 0 ~ +70 0 ~ +70	Dual General Purpose	8 Pin Cavity DIP 8 Pin Molded DIP 8 Pin Molded Flat 8 Pin Molded DIP 8 Pin Molded Flat
$\mu$ PC259C $\mu$ PC4560C	NEC ORIGINAL	-20 ~ +70 0 ~ +70	Dual High Speed Wide Band GB $\approx$ 10 MHz	8 Pin Molded DIP 8 Pin Molded DIP
$\mu$ PC454D	OP-10	-20 ~ +80	Dual Instrumentation Amplifier	14 Pin Cavity DIP
$\mu$ PC1251D $\mu$ PC1251C $\mu$ PC1251G $\mu$ PC358C $\mu$ PC358G	358	-20 ~ +80 -20 ~ +70 -20 ~ +70 0 ~ +70 0 ~ +70	Dual Low Power Single Supply Operation	8 Pin Cavity DIP 8 Pin Molded DIP 8 Pin Molded Flat 8 Pin Molded DIP 8 Pin Molded Flat
$\mu$ PC4556C	NEC ORIGINAL	0 ~ +70	Dual High Speed Wide Band GB $\approx$ 20 MHz (Decompensated)	8 Pin Molded DIP
$\mu$ PC4557C	NEC ORIGINAL	0 ~ +70	Dual Head Phone Amplifier	8 Pin Molded DIP
$\mu$ PC4559C	4559	0 ~ +70	Dual High Speed Wide Band	8 Pin Molded DIP
$\mu$ PC803D $\mu$ PC803C $\mu$ PC4082C	TL-082	-20 ~ +80 0 ~ +70 0 ~ +70	Dual J-FET Input	8 Pin Cavity DIP 8 Pin Molded DIP 8 Pin Molded DIP
Quad Operational Amplifier				
$\mu$ PC451D $\mu$ PC451C $\mu$ PC451G $\mu$ PC324C $\mu$ PC324G	324	-20 ~ +80 -20 ~ +70 -20 ~ +70 0 ~ +70 0 ~ +70	Quad Low Power Single Supply Operation	14 Pin Cavity DIP 14 Pin Molded DIP 14 Pin Molded Flat 14 Pin Molded DIP 14 Pin Molded Flat
$\mu$ PC458C $\mu$ PC458D $\mu$ PC458G $\mu$ PC4741C $\mu$ PC4741G	4741	-20 ~ +70 -20 ~ +80 -20 ~ +70 0 ~ +70 0 ~ +70	Quad General Purpose	14 Pin Molded DIP 14 Pin Cavity DIP 14 Pin Molded Flat 14 Pin Molded DIP 14 Pin Molded Flat
$\mu$ PC804D $\mu$ PC804C $\mu$ PC4084C	TL-084	-20 ~ +80 -20 ~ +70 0 ~ +70	Quad J-FET Input	14 Pin Cavity DIP 14 Pin Molded DIP 14 Pin Molded DIP

ELECTRICAL CHARACTERISTICS (Ta = 25°C)									
Supply Voltage		I <sub>CC</sub> MAX. [mA]	V <sub>IO</sub> MAX. [mV]	I <sub>IO</sub> MAX. [nA]	I <sub>B</sub> MAX. [nA]	A <sub>v</sub> MIN. [dB]	f <sub>T</sub> TYP. [MHz]	Slew Rate TYP. [V/μs]	PAGE
MIN. [V]	TYP. [V]								
±4*	±15	5.7	6.0	200	500	86	2	1	62
±4*	±15	5.7	6.0	200	500	86	GB≅10 MHz	2.8	66
±3	±15	5.0/ch	150μV	6.0	±7.0	100	0.5	0.15	78
+3	+30	1.2	7.0	50	250	88	0.5	0.25	104
±4*	±15	5.7	6.0	200	500	86	GB≅20 MHz	5	108
±4*	±15	5.7	6.0	200	500	86	2	1	111
±4*	±15	5.7	6.0	200	500	86	3	2	115
±4*	±15	5.6	15	200pA	400pA	88	3	11	98
+3	+30	2	7.0	50	500	100TYP.	0.5	0.25	74
±4*	±15	7.0	5.0	50	300	88	3	1.6	85
±4*	±15	11.2	15	200pA	400pA	88	3	11	101

\* Not guaranteed

5

# μPC55

## General Purpose Operational Amplifier

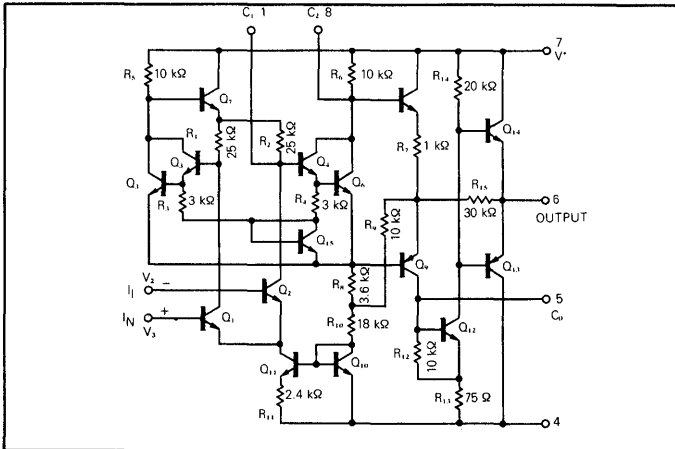
### GENERAL DESCRIPTION

The original source of the μPC55 is 709 the first general purpose monolithic operational amplifier. It features low offset voltage drift, high output swing under load and low power consumption. The device displays excellent temperature stability and will operate over a wide range of supply voltages.

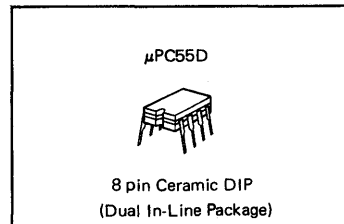
### FEATURES

- μA709 Direct Replacement

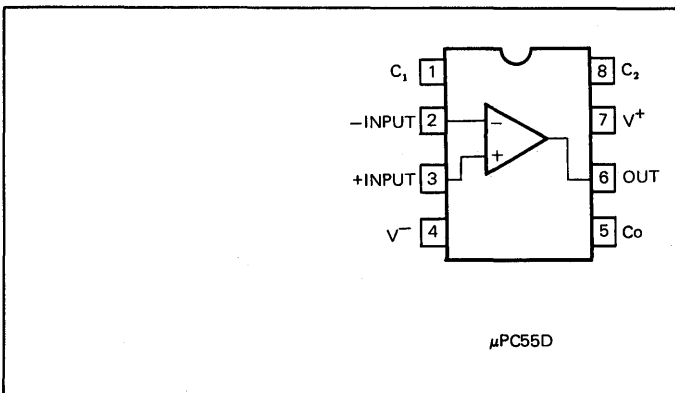
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

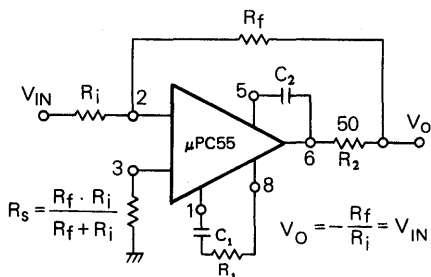
PARAMETER		μPC55	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	V
Differential Input Voltage		±6	V
Input Voltage		±10	V
Power Dissipation	D Package	300 Note 1	mW
Output Short Circuit Duration		5	s
Operating Temperature Range	D Package	-20 to +80	°C
Storage Temperature Range			°C
	D Package	-55 to +150	

Note 1 Full Temperature Range

**ELECTRICAL CHARACTERISTICS (Ta = 25°C V<sup>±</sup> = ±9V to ±18V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		0.5	5	mV	R <sub>S</sub> ≤ 10 kΩ
Average Input Offset Voltage Drift		2	20	μV/°C	R <sub>S</sub> ≤ 50 Ω
Supply Voltage Rejection Ratio		25	100	μV/V	V <sup>±</sup> = ±15V, R <sub>S</sub> ≤ 10 kΩ
Input Bias Current		180	800	nA	
Input Offset Current		20	200	nA	
Average Input Offset Current Drift		0.1		nA/°C	
Input Impedance	100	400		kΩ	
Common Mode Input Resistance		10 <sup>8</sup>		Ω	
Output Resistance		150		Ω	
Power Consumption		80	150	mW	V <sup>±</sup> = ±15 V
Large Signal Voltage Gain	20000	42000		-	V <sup>±</sup> = ±15 V, V <sub>O</sub> = ±10V
Output Voltage Swing	±12	±14		V	V <sup>±</sup> = ±15V, R <sub>L</sub> ≥ 10 kΩ
	±10	±13		V	V <sup>±</sup> = ±15V, R <sub>L</sub> ≥ 2 kΩ
Common Mode Input Voltage Range	±9	±10.3		V	V <sup>±</sup> = ±15V
Common Mode Rejection Ratio	70	90		dB	

Standard Connection Method

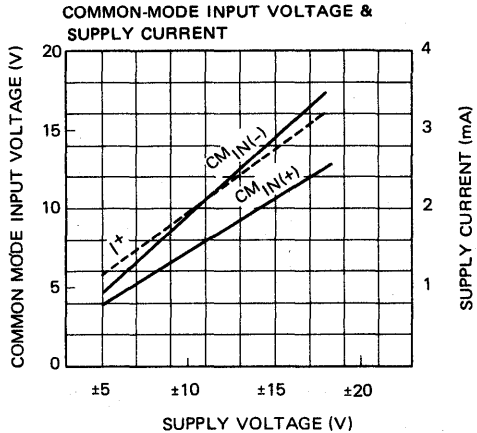
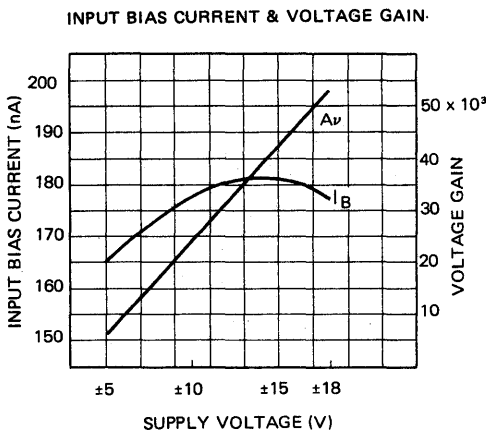
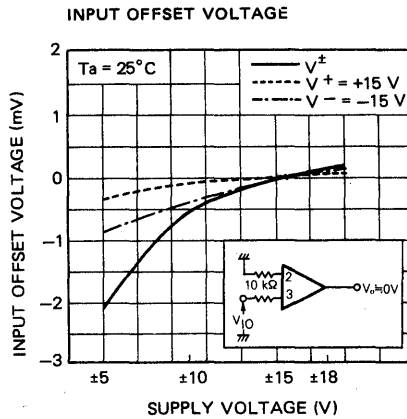
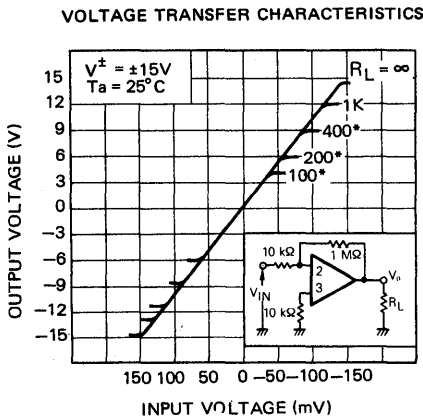
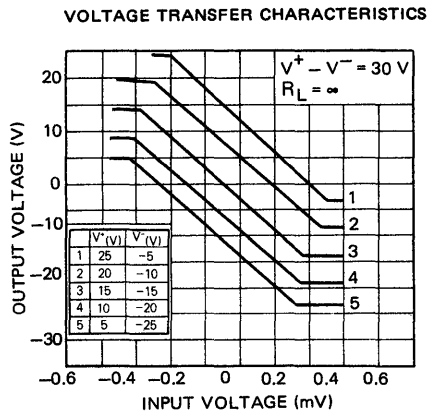
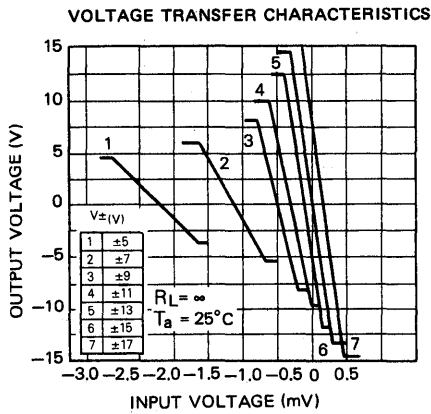


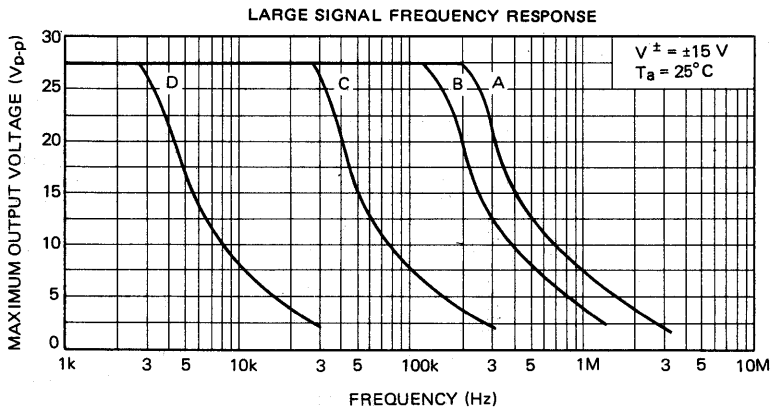
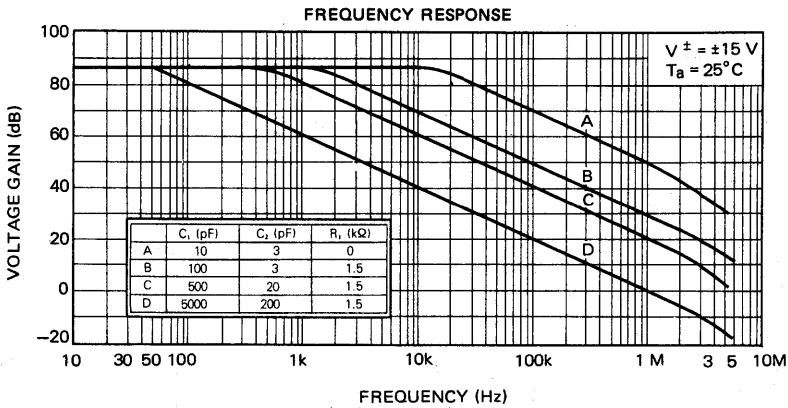
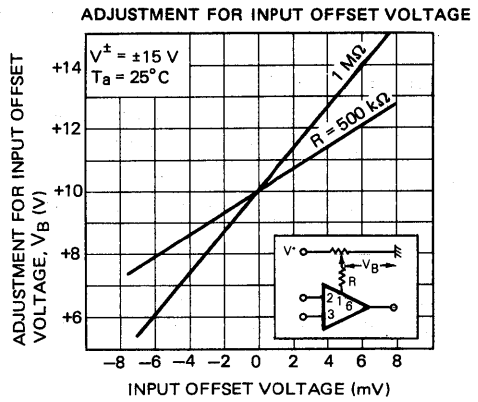
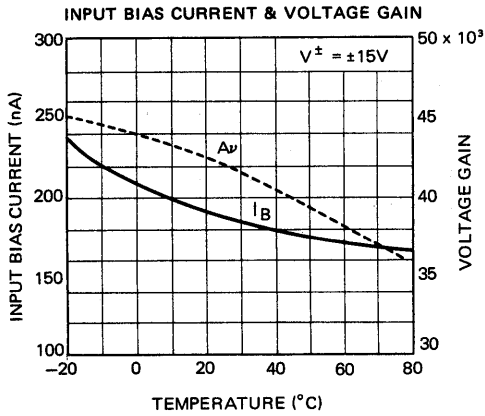
R<sub>2</sub> is necessary when the amplifier is operated with capacitive loading.

	R <sub>f</sub> /R <sub>i</sub>	C <sub>1</sub> (pF)	C <sub>2</sub> (pF)	R <sub>1</sub> (kΩ)
A	1000	10	3	0
B	100	100	3	1.5
C	10	500	20	1.5
D	1	5000	200	1.5

Each frequency characteristics is shown in Page 27.

TYPICAL PERFORMANCE CHARACTERISTICS (Ta=25°C)





5



# μPC151 / 741

## General Purpose Operational Amplifiers

### GENERAL DESCRIPTION

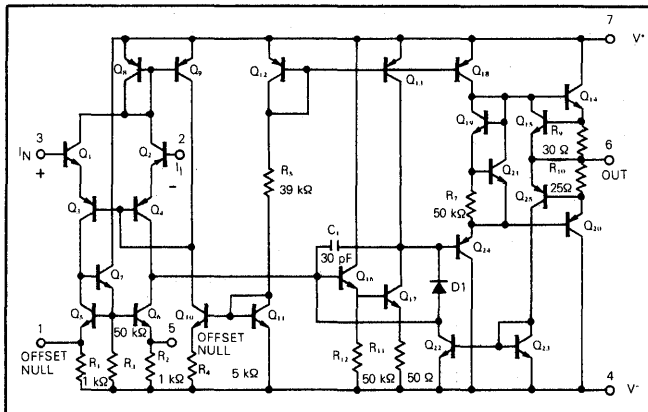
The μPC151 and 741 are general purpose operational amplifiers having internal frequency compensating circuits. It is intended for a wide range of analog applications. High common mode voltage range and no latch up tendencies make this amplifier ideal for use as a voltage follower.

Two kinds of ICs are available according to reliability, the μPC151 for industry, the μPC741 for commercial.

### FEATURES

- Internal Frequency Compensation
- Short Circuit Protection
- Offset Voltage Null Capability
- Large Common Mode and Differential Voltage Range
- No Latch Up
- μA741 Direct Replacement

### EQUIVALENT CIRCUIT



### ORDERING INFORMATION

μPC151D



8 pin Ceramic DIP  
(Dual In-Line Package)

μPC151C/μPC741C



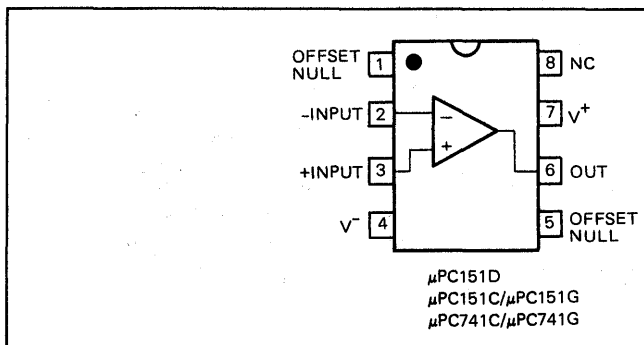
8 pin Plastic Molded DIP  
(Dual In-Line Package)

μPC151G/μPC741G



8 pin Plastic Molded Flat Package  
(MINI FLAT IC)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC151	μPC741	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	36	V
Power Dissipation *	D Package	500	—	mW
	C Package	350	350	
	G Package	440	440	
Differential Input Voltage		±30	±30	V
Input Voltage (Note 1)		±15	±15	V
Output Short Circuit Duration		Indefinite	Indefinite	s
Voltage between Offset-Null and V <sup>-</sup>		±0.5	±0.5	V
Operating Temperature Range	D Package	-20 to +80	—	°C
	C or G Package	-20 to +70	0 to +70	
Storage Temperature Range	D Package	-55 to +150	—	°C
	C or G Package	-55 to +125	-55 to +125	

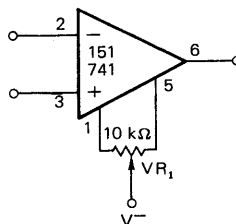
Note 1: For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

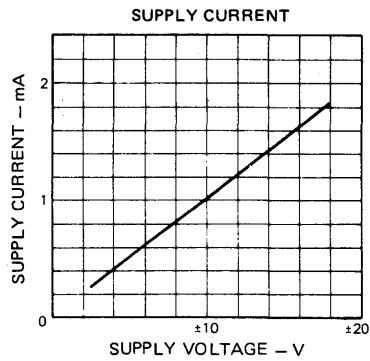
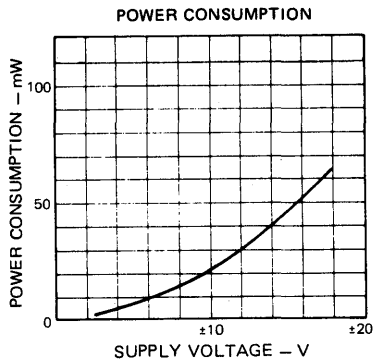
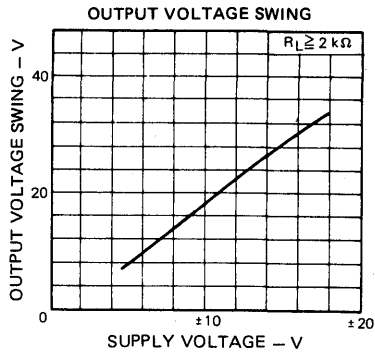
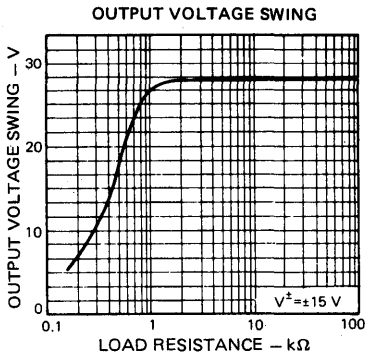
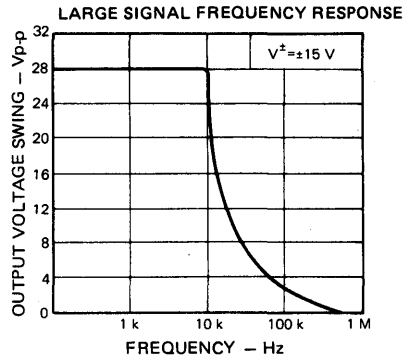
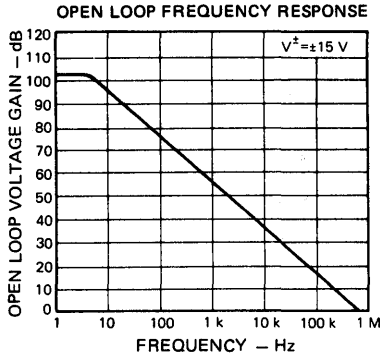
**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

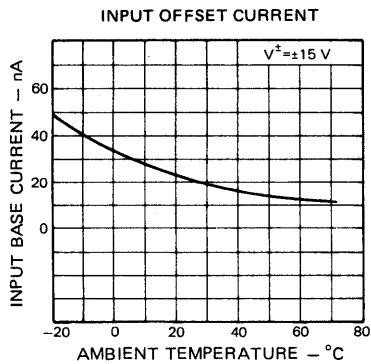
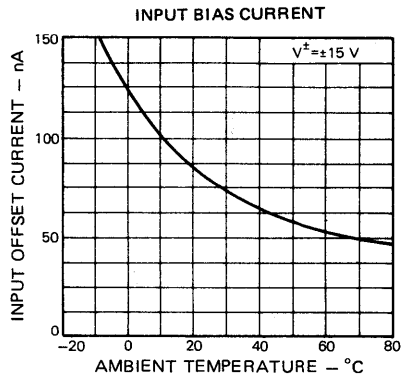
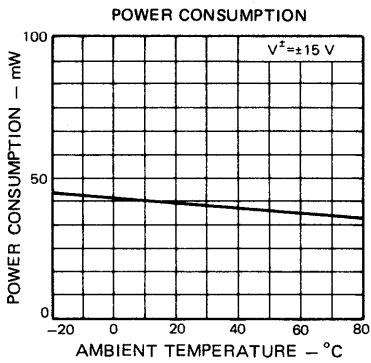
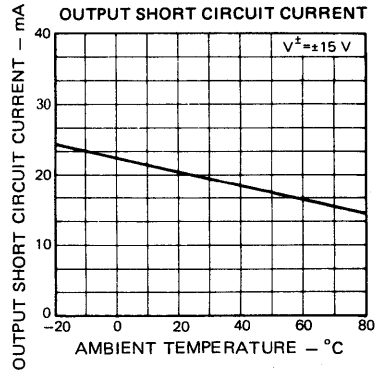
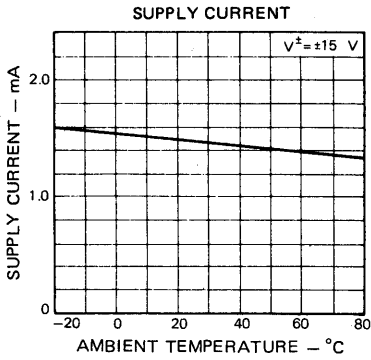
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		1.0	6.0	mV	R <sub>S</sub> ≤ 10 kΩ
Input Offset Current		20	200	nA	
Input Bias Current		80	500	nA	
Large Signal Voltage Gain	25,000	200,000			R <sub>L</sub> ≥ 2 kΩ, V <sub>O</sub> = ±10 V
Offset Voltage Adjustable Range		±15		mV	V <sub>R1</sub> = 10 kΩ
Supply Current		1.5	2.8	mA	
Power Consumption		45	85	mW	
Common Mode Rejection Ratio	70	90		dB	R <sub>S</sub> ≤ 10 kΩ
Supply Voltage Rejection Ratio		30	150	μV/V	R <sub>S</sub> ≤ 10 kΩ
Output Voltage Swing	±12	±14		V	R <sub>L</sub> ≥ 10 kΩ
Output Voltage Swing	±10	±13		V	R <sub>L</sub> ≥ 2 kΩ
Output Short Circuit Current	5	20		mA	R <sub>L</sub> = 0

Offset Voltage Null Circuit



**TYPICAL PERFORMANCE CHARACTERISTICS (Ta=25 °C)**





5

# μPC154

## Instrumentation Operational Amplifier

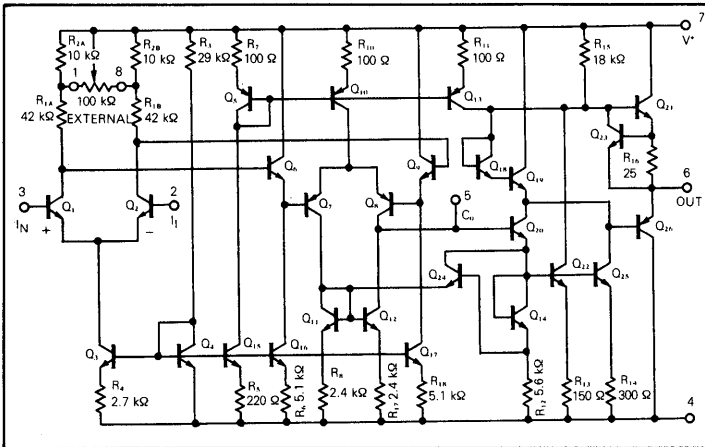
### GENERAL DESCRIPTION

The μPC154 is an operational amplifier featuring superior performance in applications where low noise, low drift and accurate closed-loop gain are required. High common mode rejection and offset null capability make this device suitable for low level instrumentation applications over a wide supply voltage range.

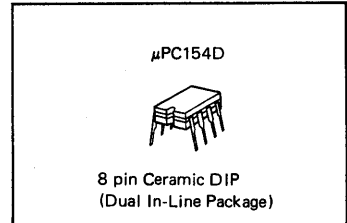
### FEATURES

- High Open Loop Gain                    3000 000 Typ.
- Low Input Voltage drift                0.5 μV/°C typ.
- Low Input Offset Current               3 nA Typ.
- High Common Mode Rejection        120 dB Typ.
- High Input Voltage Range             ±14 V Typ.
- Wide Power Supply Range            ±3 V to ±22 V
- Offset Null Capability
- μA725 Direct Replacement

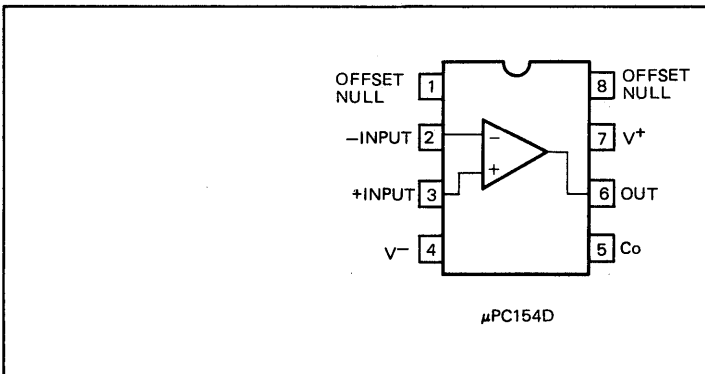
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC154	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		44	V
Power Dissipation*	D Package	500	mW
Differential Input Voltage		±5	V
Input Voltage (Note 1)		±22	V
Voltage between Offset-Null and V <sup>-</sup>		±0.5	V
Operating Temperature Range	D Package	-20 to +80	°C
Storage Temperature Range			°C
	D Package	-55 to +150	

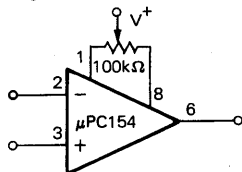
Note 1: For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

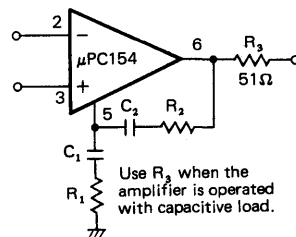
**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		0.5	2.5	mV	R <sub>s</sub> ≤ 10 kΩ
Average Input Offset Voltage Drift		0.5	3.0	μV/°C	R <sub>s</sub> ≤ 50 Ω (With external trim)
Average Input Offset Voltage Drift		2.0		μV/°C	R <sub>s</sub> ≤ 50 Ω (Without external trim)
Input Offset Current		3.0	35	nA	
Average Input Offset Current Drift		10		pA/°C	
Input Bias Current		50	125	nA	
Input Impedance		1.5		MΩ	
Large Signal Voltage Gain	250,000	3,000,000		—	R <sub>L</sub> ≥ 2 kΩ, V <sub>o</sub> = ±10 V
Power Consumption		80	150	mW	
Output Voltage Swing	±12	±13		V	R <sub>L</sub> ≥ 10 kΩ
Output Voltage Swing	±10	±13		V	R <sub>L</sub> ≥ 2 kΩ
Common-Mode Input Voltage Range	±13.5	±14		V	
Common-Mode Rejection Ratio	96	120		dB	R <sub>s</sub> ≤ 10 kΩ
Supply Voltage Rejection Ratio		2.0	35	μV/V	R <sub>s</sub> ≤ 10 kΩ
Input Noise Voltage		2		μV <sub>p-p</sub>	R <sub>s</sub> = 10 kΩ f = 0.1 ~ 10 Hz
Input Noise Voltage		0.3		μV <sub>rms</sub>	R <sub>s</sub> = 10 kΩ f = 10 Hz ~ 1 kHz

Offset Voltage Null Circuit



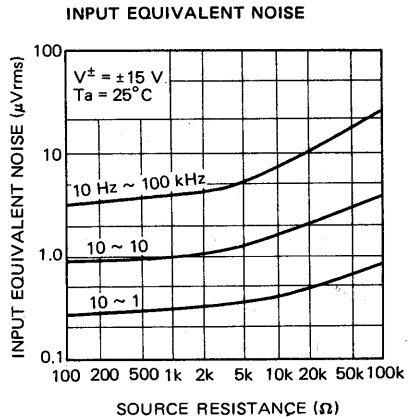
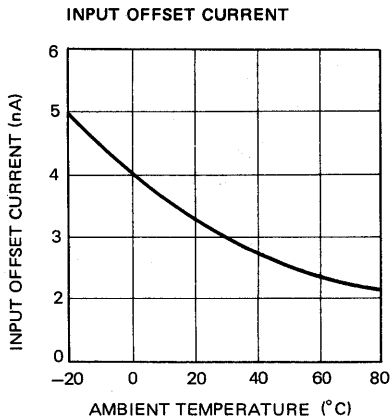
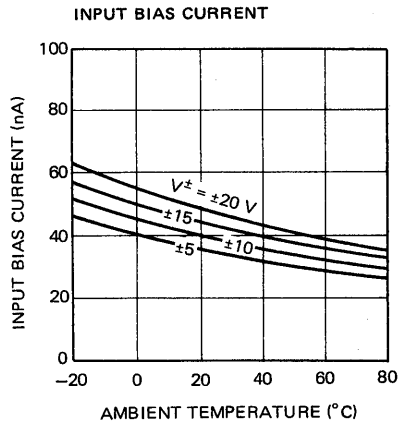
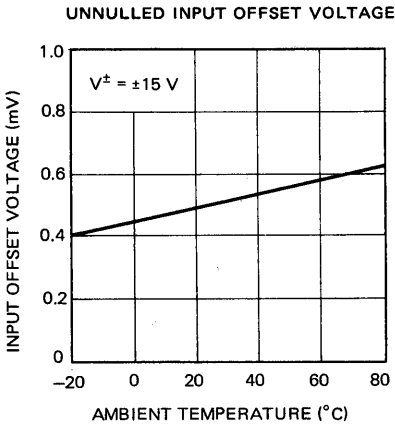
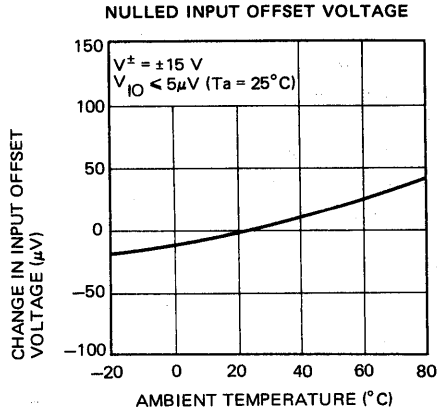
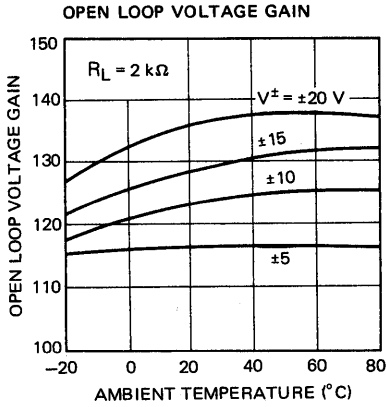
Frequency Compensation Circuit

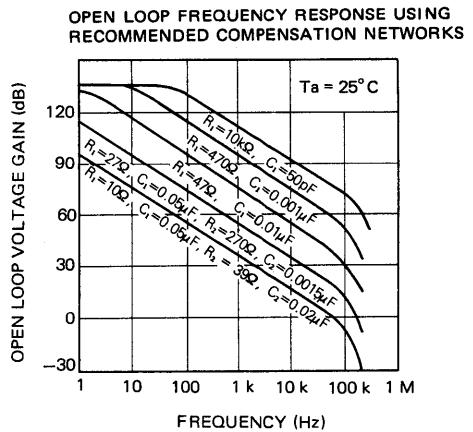
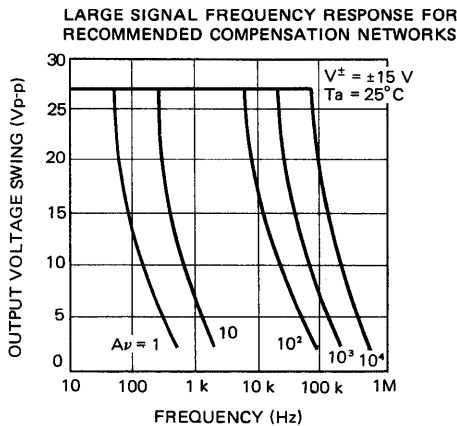
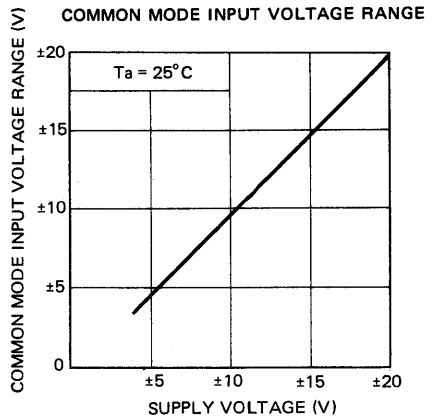
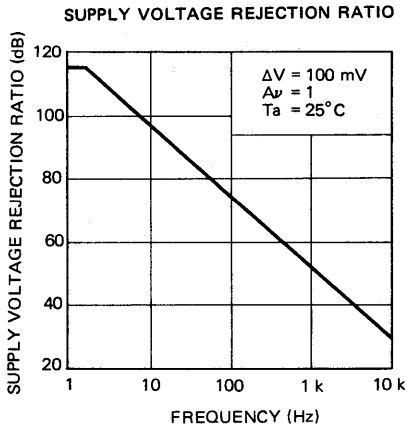
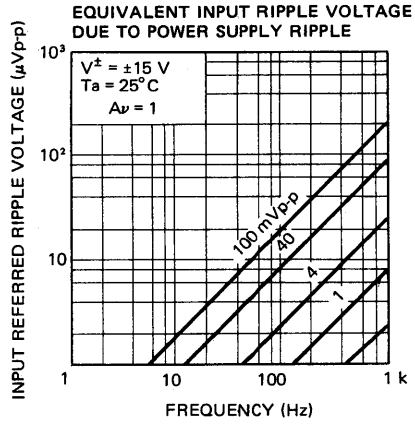
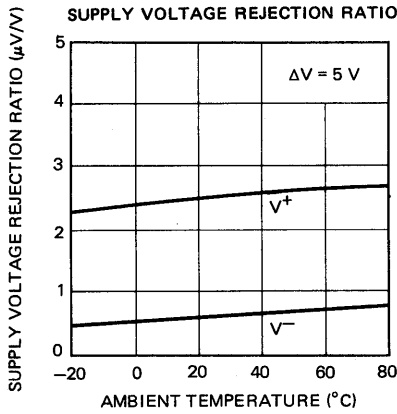


Frequency Compensation Components

GAIN	R <sub>1</sub> (Ω)	C <sub>1</sub> (μF)	R <sub>2</sub> (Ω)	C <sub>2</sub> (μF)
10,000	10 k	50 pF	—	—
1,000	470	0.001	—	—
100	47	0.01	—	—
10	27	0.05	270	0.0015
1	10	0.05	39	0.02

**TYPICAL PERFORMANCE CHARACTERISTICS (Ta = 25°C)**

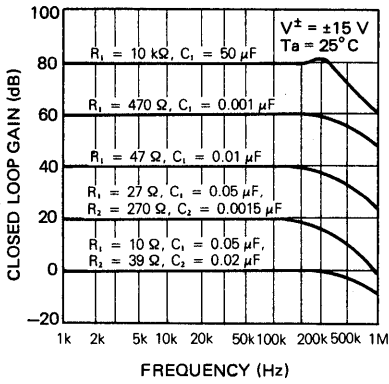




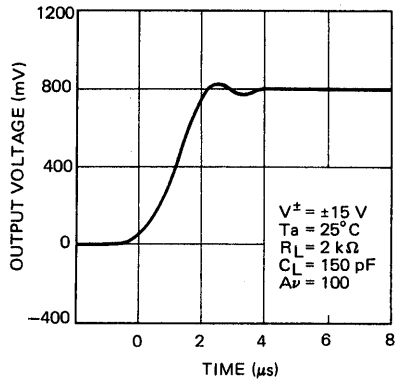
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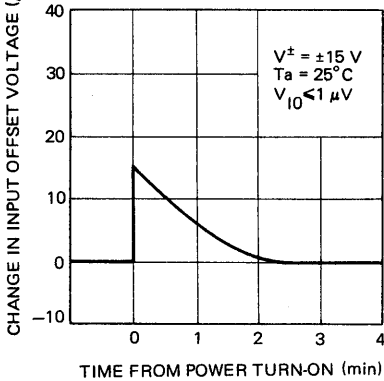
**FREQUENCY RESPONSE FOR VARIOUS CLOSED-LOOP GAINS**



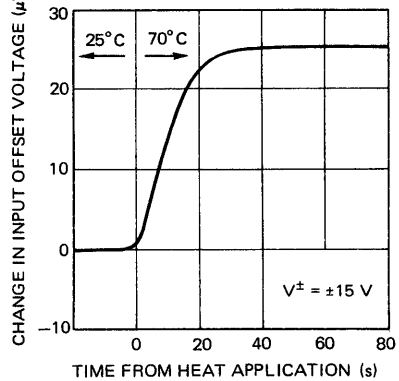
**TRANSIENT RESPONSE**



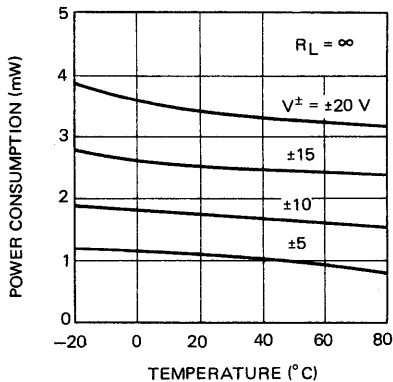
**STABILIZATION TIME OF INPUT OFFSET VOLTAGE FROM POWER TURN-ON**



**OFFSET VOLTAGE CHANGE DUE TO THERMAL SHOCK**



**POWER CONSUMPTION**





**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC156	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	V
Power Dissipation*	D Package	500	mW
Differential Input Current (Note 1)		±10	mA
Input Voltage (Note 2)		±15	V
Output Short Circuit Duration		Indefinite	s
Operating Temperature Range	D Package	-20 to +80	°C
Storage Temperature Range			°C
	D Package	-55 to +150	

Note 1: The inputs are shunted with back-to-back diode for over voltage protection. Therefore excessive current will flow if a differential input voltage in excess of 1 V is applied between the inputs unless adequate limiting resistance is used.

2: For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

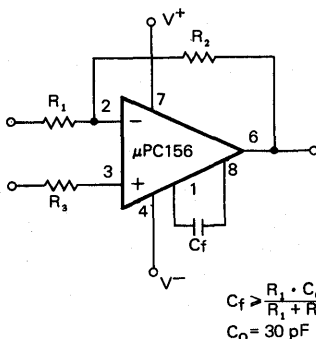
\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

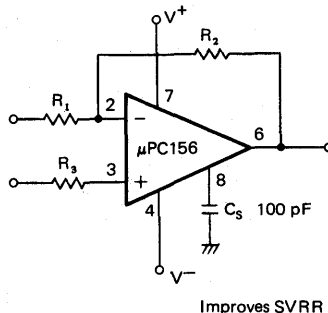
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		2	7.5	mV	R <sub>S</sub> ≤ 100 kΩ
Average Input Offset Voltage Drift		6		μV/°C	
Input Bias Current		1.5	7	nA	
Input Offset Current		0.2	1	nA	
Average Input Offset Current Drift		2		pA/°C	
Input Impedance	10	40		MΩ	
Large Signal Voltage Gain	25,000	300,000			R <sub>L</sub> ≥ 10 kΩ
Output Voltage Swing	±13	±14		V	R <sub>L</sub> ≥ 10 kΩ
Common Mode Rejection Ratio	80	100		dB	
Supply Voltage Rejection Ratio		20	100	μV/V	
Supply Current			0.8	mA	

**Compensation Circuit**

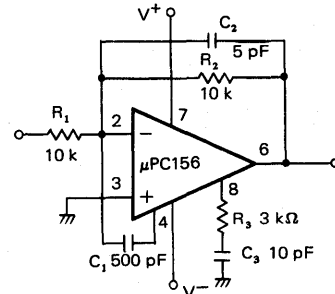
Standard Compensation



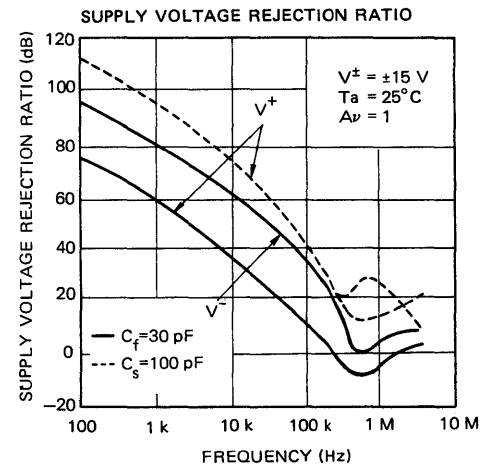
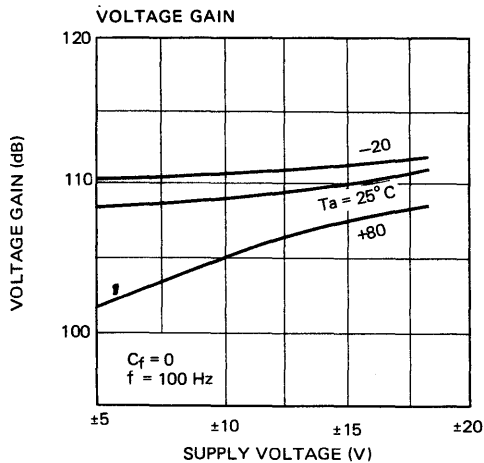
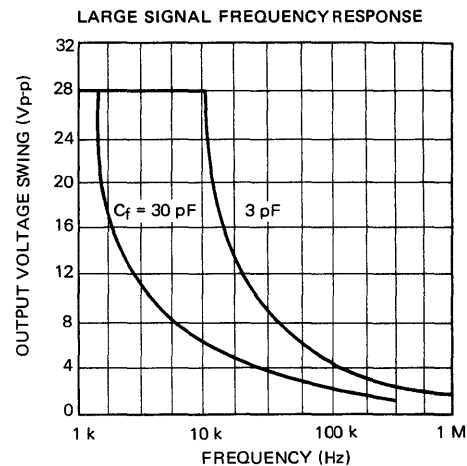
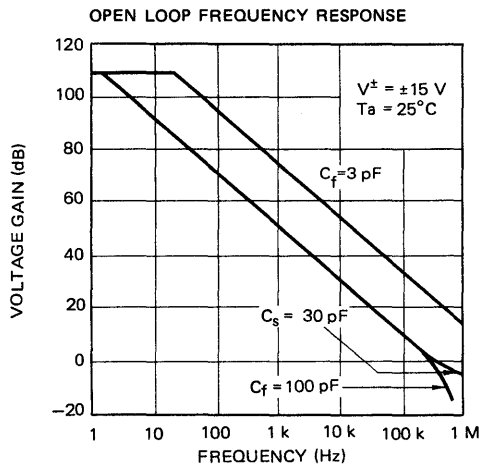
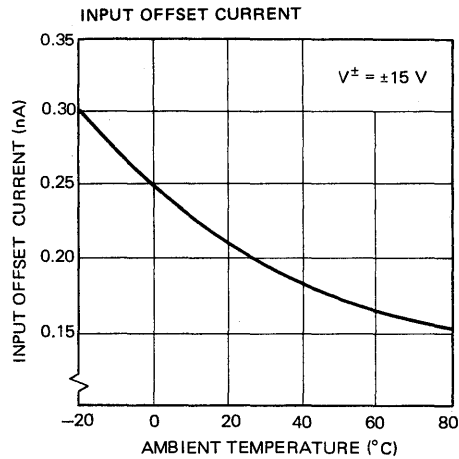
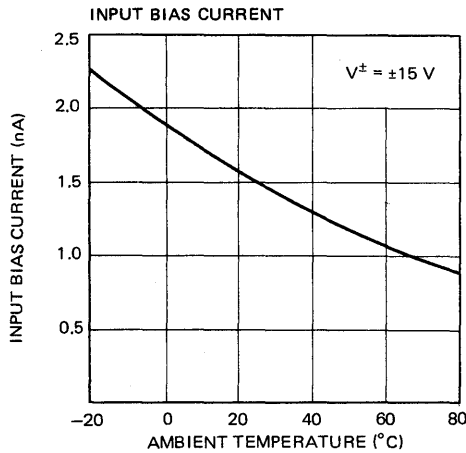
Alternate Frequency Compensation



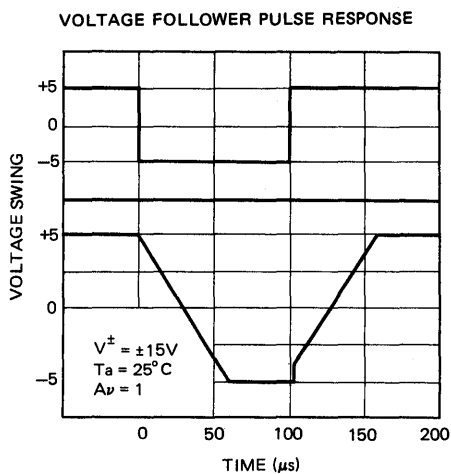
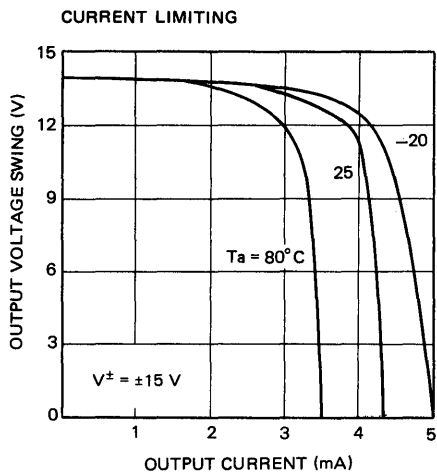
Feedforward Compensation



TYPICAL PERFORMANCE CHARACTERISTICS (Ta = 25°C)



5



### GENERAL DESCRIPTION

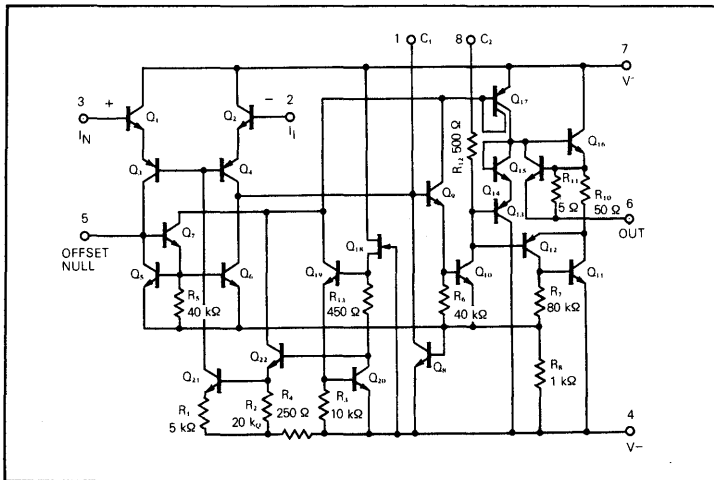
μPC157 are general purpose operational amplifiers which feature higher performance than that of 709 type. This amplifier offers many features which make its application nearly foolproof: Overload protection on the input and output, no latch up when the common mode range is exceeded, freedom from oscillations with a single 30 pF capacitor. Frequency compensation can be tailored to the individual circuit with single external capacitor.

One kind of ICs are available according to reliability, the μPC157 for industry.

### FEATURES

- Wide Common Mode and Differential Voltage Range
- Short Circuit Protection
- No Latch Up
- Offset Voltage Null Capability
- Frequency and Transient Response Characteristics Adjustable
- LM301A Direct Replacement

### EQUIVALENT CIRCUIT



### ORDERING INFORMATION

μPC157D



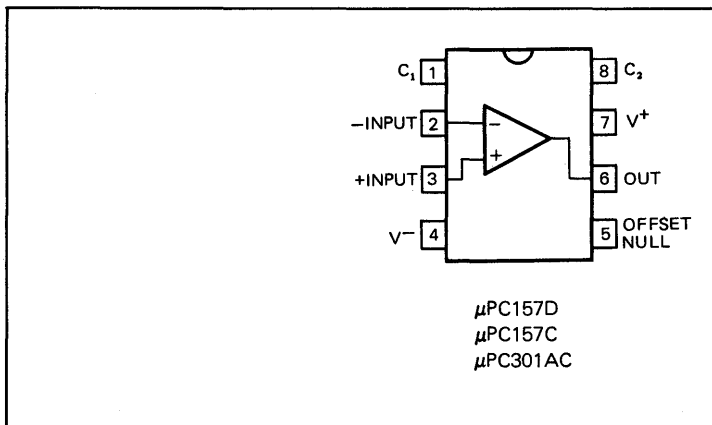
8 pin Ceramic DIP  
(Dual In-Line Package)

μPC157C/μPC301AC



8 pin Plastic Molded DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)



5

**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC157	μPC301A	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	36	V
Power Dissipation*	D Package	500	—	mW
	C Package	350	350	
Differential Input Voltage		±30	±30	V
Input Voltage (Note 1)		±15	±15	V
Output Short Circuit Duration		Indefinite	Indefinite	s
Operating Temperature Range	D Package	-20 to +80	—	°C
	C Package	-20 to +70	0 to +70	
Storage Temperature Range	D Package	-55 to +150	—	°C
	C Package	-55 to +125	-55 to +125	

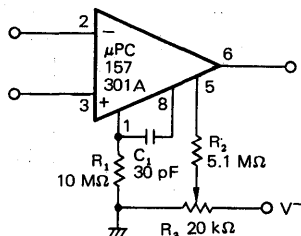
Note 1: For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in Chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±5 V to ±15 V)**

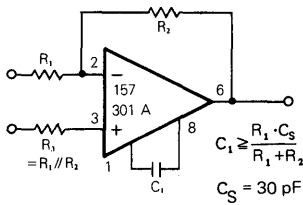
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		2.0	7.5	mV	R <sub>S</sub> ≤ 50 kΩ
Average Input Offset Voltage Drift		6.0	30	μV/°C	R <sub>S</sub> ≤ 50 kΩ, V <sup>±</sup> = ±15 V
Input Offset Current		3	50	nA	
Average Input Offset Current Drift		0.02	0.6	nA/°C	V <sup>±</sup> = ±15 V
Input Bias Current		70	250	nA	
Input Impedance	0.5	2		MΩ	
Large Signal Voltage Gain	25,000	160,000			V <sup>±</sup> = ±15 V, V <sub>O</sub> = ±10 V, R <sub>L</sub> ≥ 2 kΩ
Supply Current		1.8	3	mA	
Output Voltage Swing	±12	±14		V	V <sup>±</sup> = ±15 V, R <sub>L</sub> ≥ 10 kΩ
Output Voltage Swing	±10	±13		V	V <sup>±</sup> = ±15 V, R <sub>L</sub> ≥ 2 kΩ
Common-Mode Input Voltage Range	±12			V	V <sup>±</sup> = ±15 V
Common-Mode Rejection Ratio	70	90		dB	R <sub>S</sub> ≤ 50 kΩ
Supply Voltage Rejection Ratio	70	90		dB	R <sub>S</sub> ≤ 50 kΩ

Standard Compensation and Offset Balance Circuit

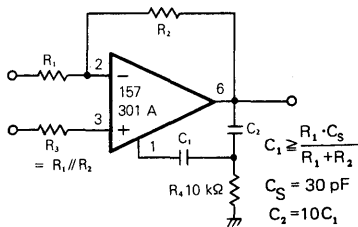


TYPICAL PERFORMANCE CHARACTERISTICS FOR VARIOUS COMPENSATION CIRCUITS (Ta = 25°C)

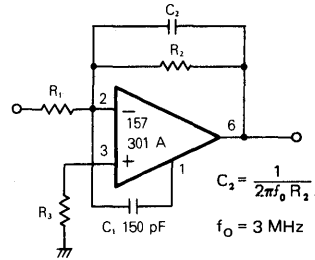
Single Pole Compensation



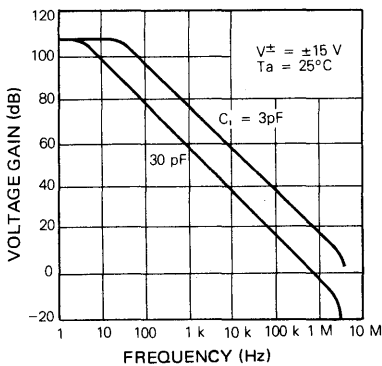
Two Pole Compensation



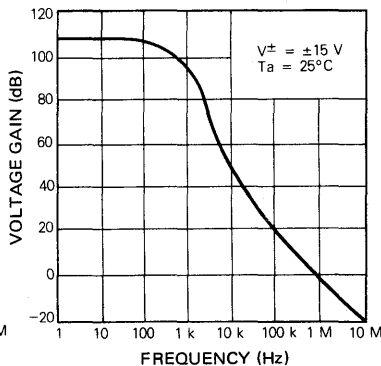
Feed Forward Compensation



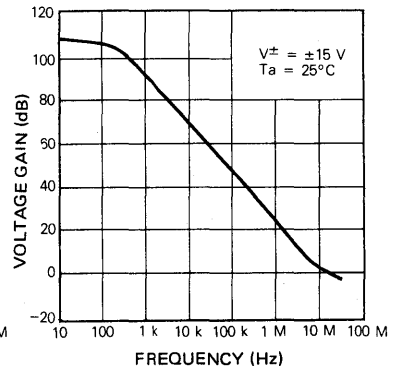
OPEN LOOP FREQUENCY RESPONSE



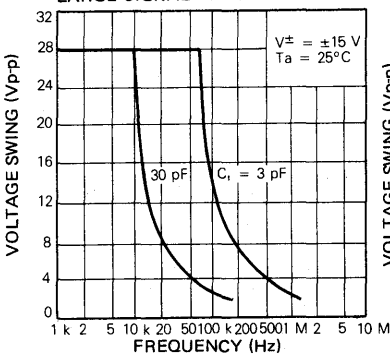
OPEN LOOP FREQUENCY RESPONSE



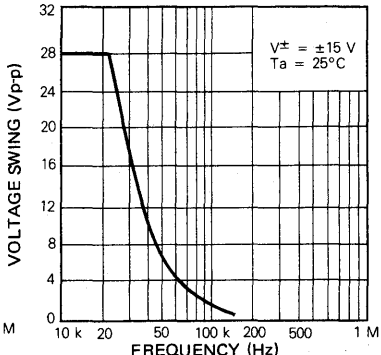
OPEN LOOP FREQUENCY RESPONSE



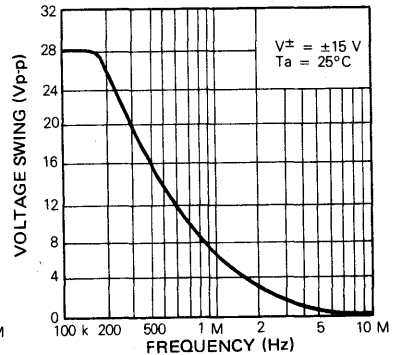
LARGE SIGNAL FREQUENCY RESPONSE



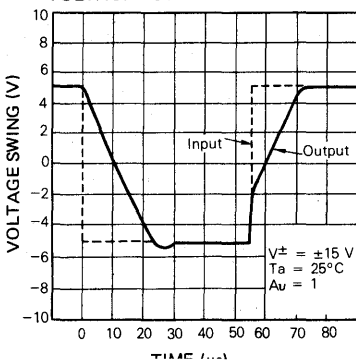
LARGE SIGNAL FREQUENCY RESPONSE



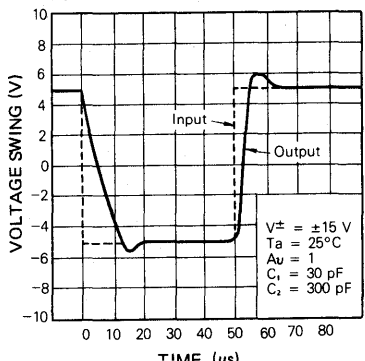
LARGE SIGNAL FREQUENCY RESPONSE



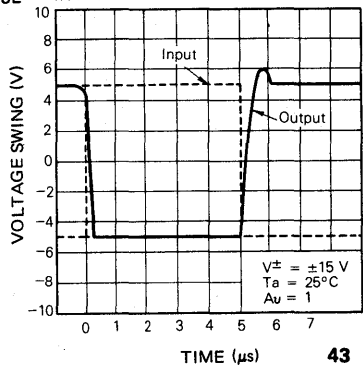
VOLTAGE FOLLOWER PULSE RESPONSE



VOLTAGE FOLLOWER PULSE RESPONSE



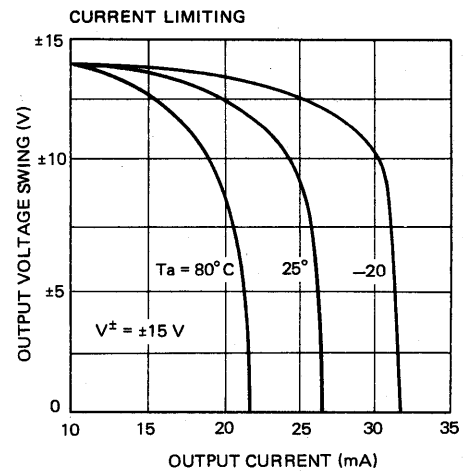
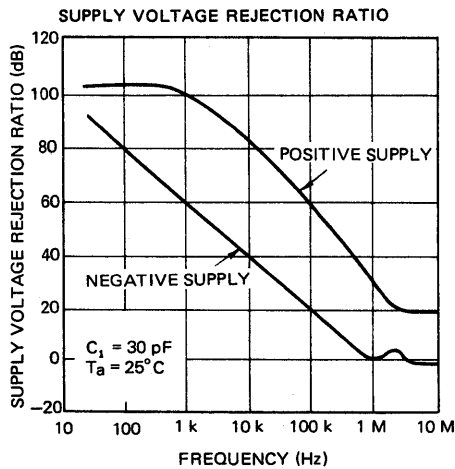
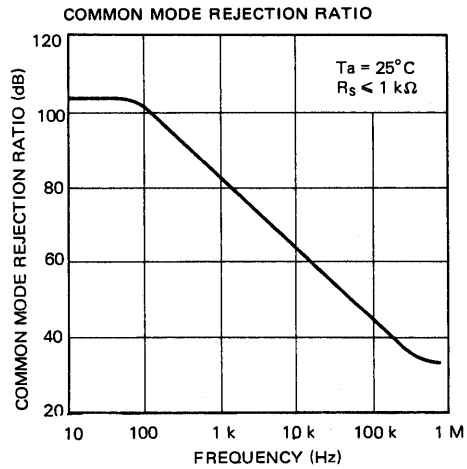
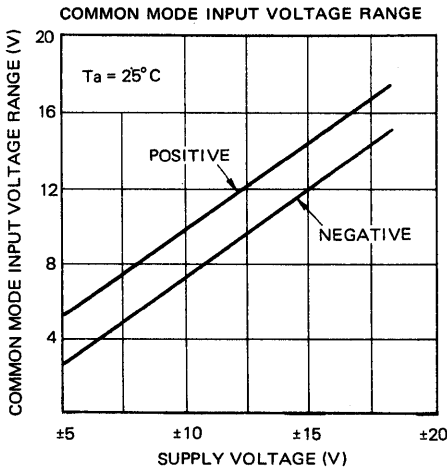
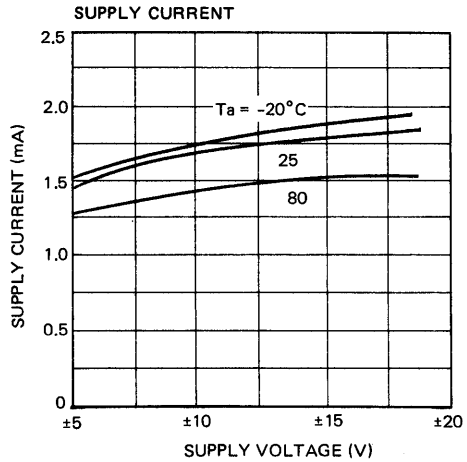
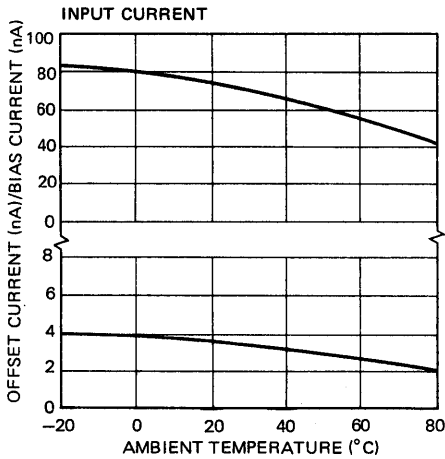
INVERTER PULSE RESPONSE

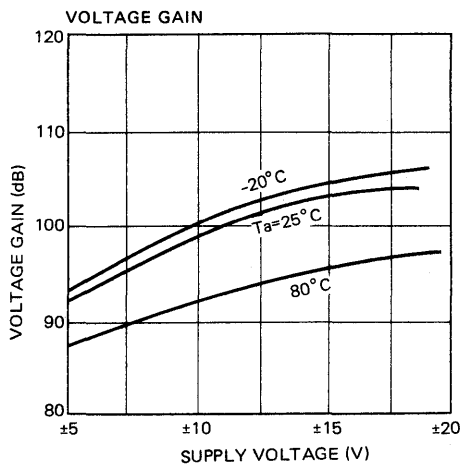


5



**TYPICAL PERFORMANCE CHARACTERISTICS (Ta = 25°C)**





# μPC159

## High Speed Operational Amplifier

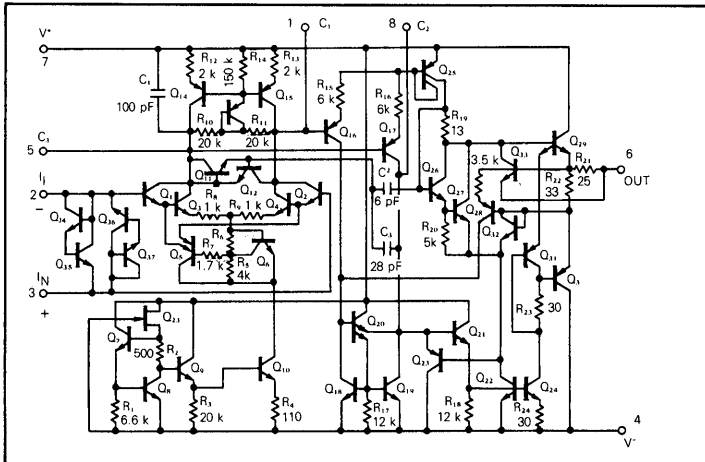
### GENERAL DESCRIPTION

The μPC159 is a precision high-speed operational amplifier designed for applications requiring wide bandwidth and high slew rate. It features a factor of ten increase in speed over general purpose devices without sacrificing DC performance. The μPC159 has internal unity gain frequency compensation. This simplifies its application since no external components are necessary for operation. The high speed and fast setting time of this device make it useful in D/A converters, oscillators and hold circuits.

### FEATURES

- Very High Slew Rate
- Maximum Bias Current of 500 nA
- Operates from Supplies of ±5 V to ±20 V
- Internal Frequency Compensation
- Input and Output Overload Protected
- LM318 Direct Replacement

### EQUIVALENT CIRCUIT



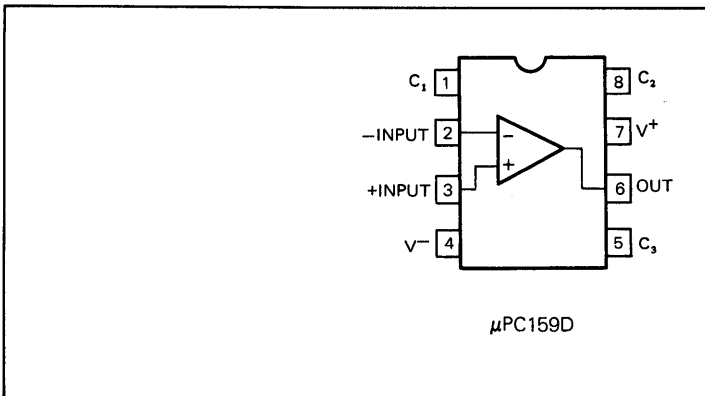
### ORDERING INFORMATION

μPC159D



8 pin Ceramic DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC159	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		40	V
Power Dissipation*	D Package	500	mW
Differential Input Current (Note 1)		±10	mA
Input Voltage (Note 2)		±15	V
Output Short Circuit Duration		Indefinite	s
Operating Temperature Range	D Package	-20 to +80	°C
Storage Temperature Range			°C
	D Package	-55 to +150	

Note 1: The Inputs are shunted with back-to-back diodes for overvoltage protection. Therefore, excessive current will flow if a differential input voltage in excess of 1 V is applied between the inputs unless some limiting resistance is used.

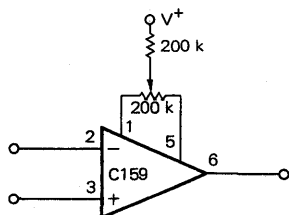
2: For supply voltages less than ±15 V, the maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

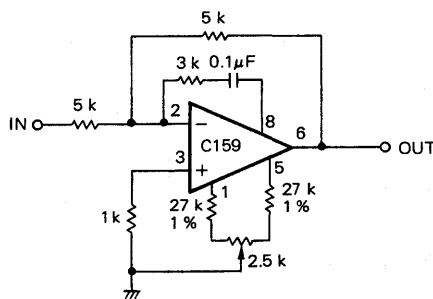
**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		4	10	mV	R <sub>s</sub> = 100 Ω
Input Offset Current		30	200	nA	
Input Bias Current		150	500	nA	
Input Impedance	0.5	3		MΩ	
Large Signal Voltage Gain	25,000	200,000			V <sub>O</sub> = ±10 V, R <sub>L</sub> ≥ 2 kΩ
Slew Rate	50	70		V/μs	A <sub>v</sub> = 1
Output Voltage Swing	±12	±13		V	R <sub>L</sub> ≥ 2 kΩ
Common Mode Input Voltage Range	±11.5			V	
Common Mode Rejection Ratio	70	100		dB	
Supply Voltage Rejection Ratio	65	80		dB	
Supply Current		5	10	mA	R <sub>L</sub> = ∞, V <sub>O</sub> = 0V

Offset Balancing Circuit

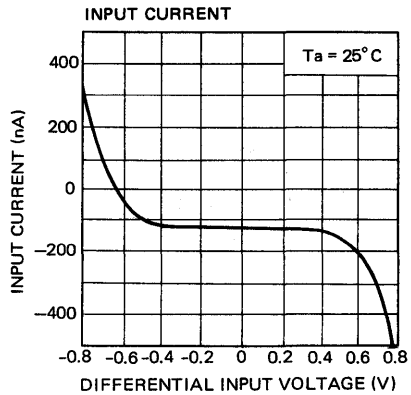
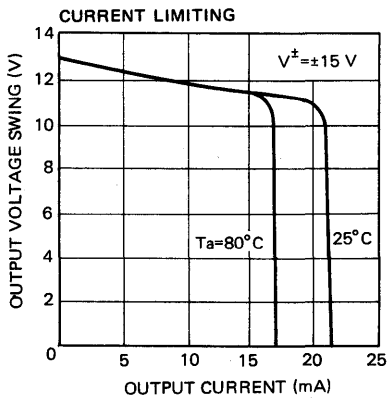
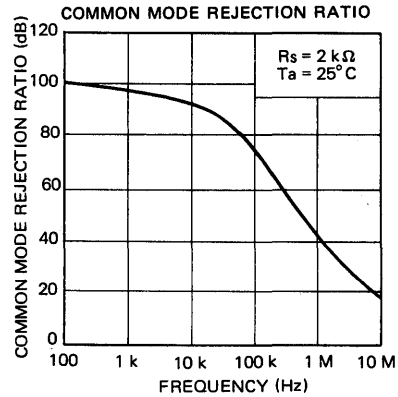
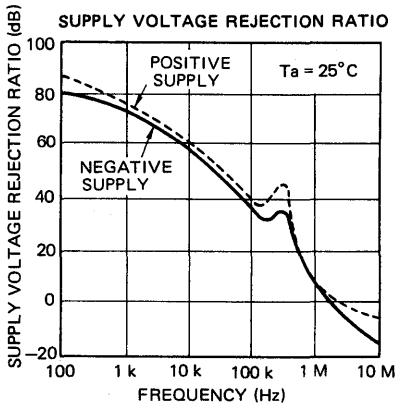
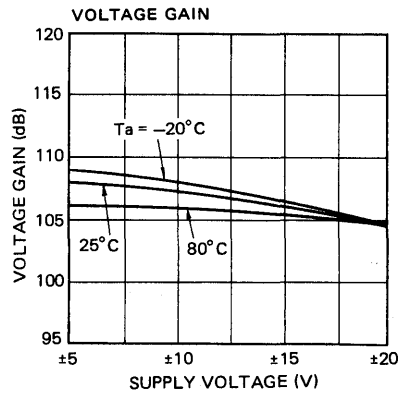
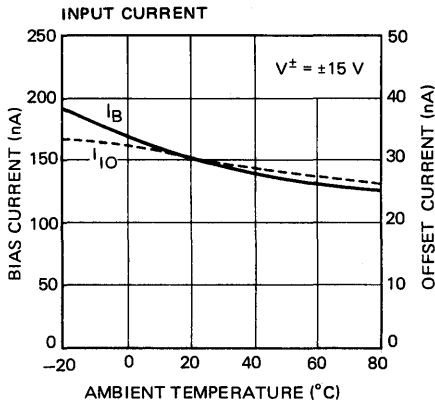


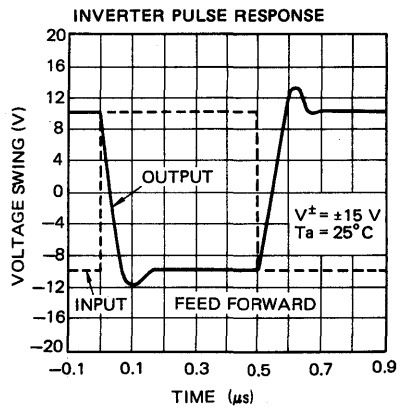
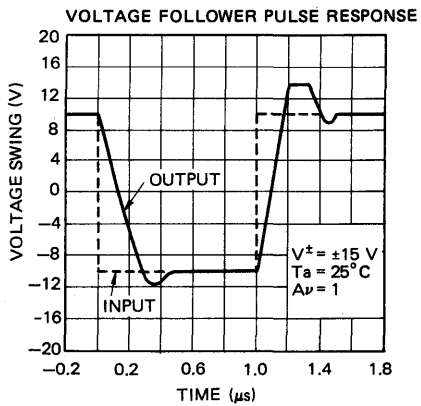
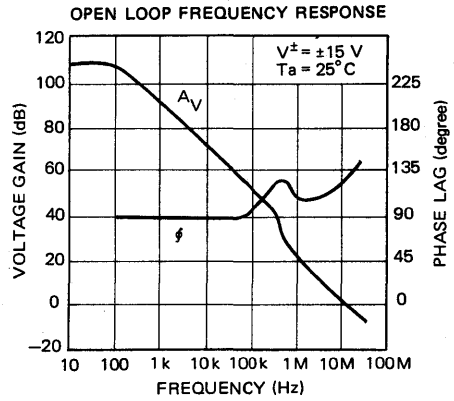
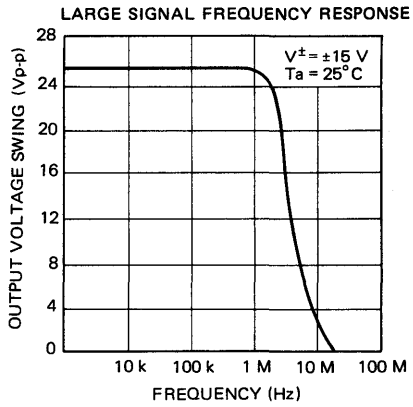
Feedforward Compensation for Greater Inverting Slew Rate



\*Slew rate typically 150 V/μs  
 \*Balance circuit necessary for increased slew

**TYPICAL PERFORMANCE CHARACTERISTICS (Ta = 25°C)**





**5**

# μPC251 / 1458

## Dual General Purpose Operational Amplifiers

### GENERAL DESCRIPTION

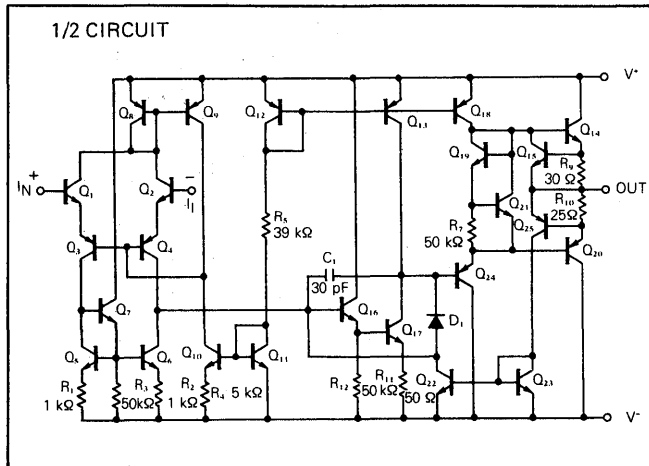
The μPC251 and 1458 are dual general purpose operational amplifiers having internal frequency compensating circuits. It is intended for a wide range of analog applications. High common mode voltage range and no latch up tendencies make this amplifier ideal for use as a voltage follower.

Two kinds of ICs are available according to reliability, the μPC251 for industry, the μPC1458 for commercial.

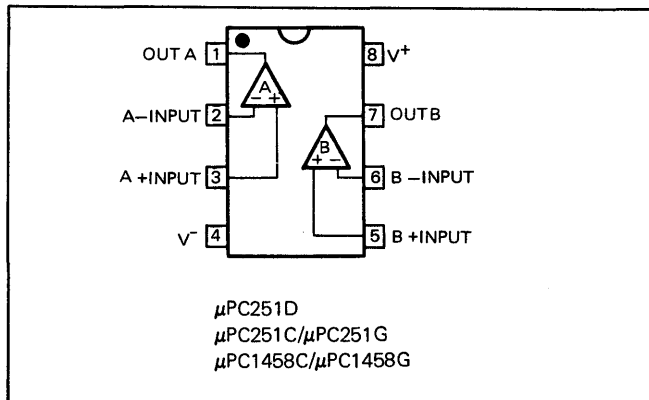
### FEATURES

- Dual μPC151/741 Internally Frequency Compensated Operational Amplifier
- Short Circuit Protection
- Large Common Mode and Differential Input Voltage
- No Latch Up
- MC1458 Direct Replacement




### EQUIVALENT CIRCUIT



### CONNECTION DIAGRAM (Top View)



### ORDERING INFORMATION

μPC251D  8 pin Ceramic DIP (Dual In-Line Package)
μPC251C/μPC1458C  8 pin Plastic Molded DIP (Dual In-Line Package)
μPC251G/μPC1458G  8 pin Plastic Molded Flat Package (MINI FLAT IC)

**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER			μPC251	μPC1458	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>			36	36	V
Power Dissipation*	D	Package	500	—	mW
	C	Package	350	350	
	G	Package	440	440	
Differential Input Voltage			±30	±30	V
Input Voltage (Note 1)			±15	±15	V
Output Short Circuit Duration			Indefinite	Indefinite	s
Operating Temperature Range	D	Package	-20 to +80	—	°C
	C or G	Package	-20 to +70	0 to +70	
Storage Temperature Range	D	Package	-55 to +150	—	°C
	C or G	Package	-55 to +125	-55 to +125	

Note 1: For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

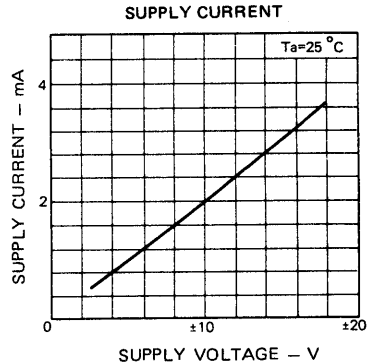
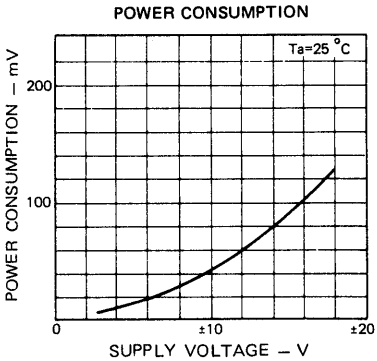
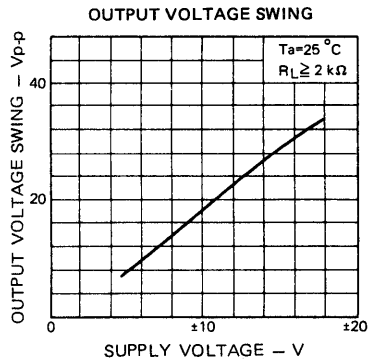
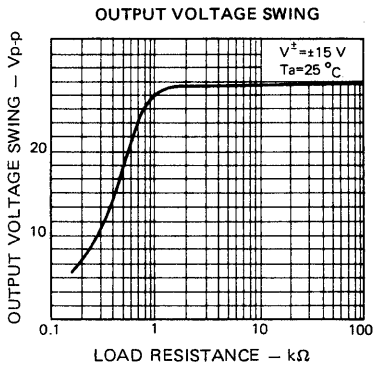
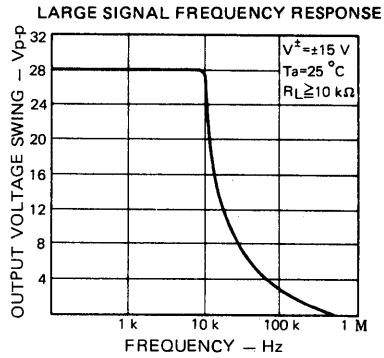
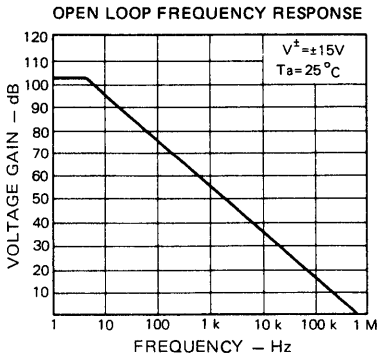
\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (V<sup>±</sup> = ±15 V, Ta = 25°C)**

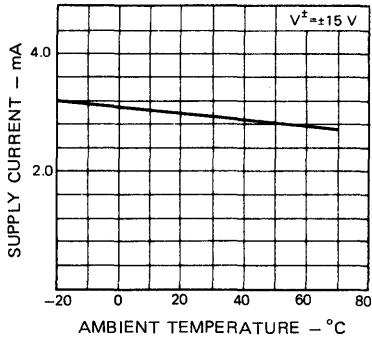
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		1.0	6.0	mV	R <sub>s</sub> ≤ 10 kΩ
Average Input Offset Voltage Drift		3		μV/°C	R <sub>s</sub> ≤ 10 kΩ
Input Offset Current		20	200	nA	
Input Bias Current		80	500	nA	
Large Signal Voltage Gain	20,000	160,000			R <sub>L</sub> ≥ 2 kΩ, V <sub>o</sub> = ±10 V
Channel Separation		120		dB	f = 10 Hz, R <sub>L</sub> = 2 kΩ
Supply Current		3.0	5.6	mA	
Power Consumption		90	170	mW	
Common Mode Rejection Ratio	70	90		dB	R <sub>s</sub> ≤ 10 kΩ
Supply Voltage Rejection Ratio		30	150	μV/V	R <sub>s</sub> ≤ 10 kΩ
Output Voltage Swing	±12	±14		V	R <sub>L</sub> ≥ 10 kΩ
Output Voltage Swing	±10	±13		V	R <sub>L</sub> ≥ 2 kΩ
Input Impedance	0.3	1.0		MΩ	



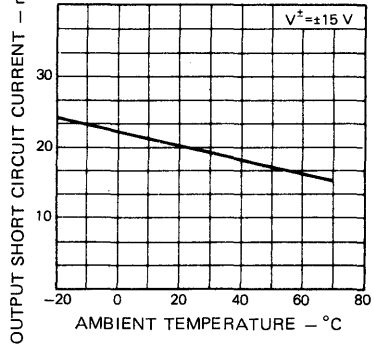
**TYPICAL PERFORMANCE CHARACTERISTICS (Ta=25 °C)**



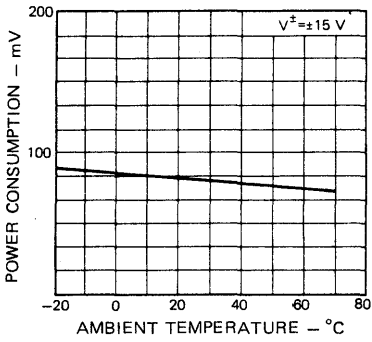
$T_{CC} - T_a$  CHARACTERISTICS



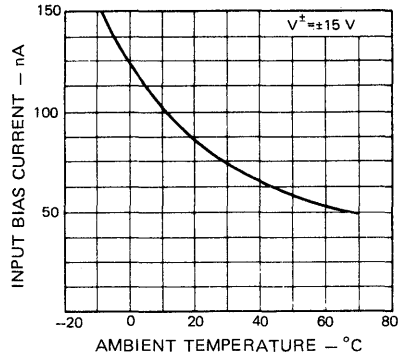
OUTPUT SHORT CIRCUIT CURRENT



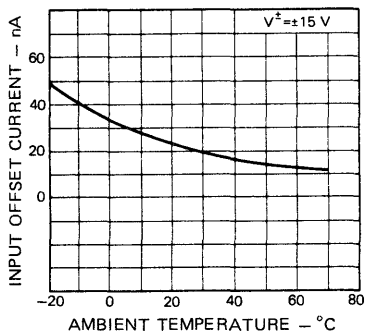
POWER CONSUMPTION



INPUT BIAS CURRENT



INPUT OFFSET CURRENT



5

# μPC253

## Programmable Operational Amplifier

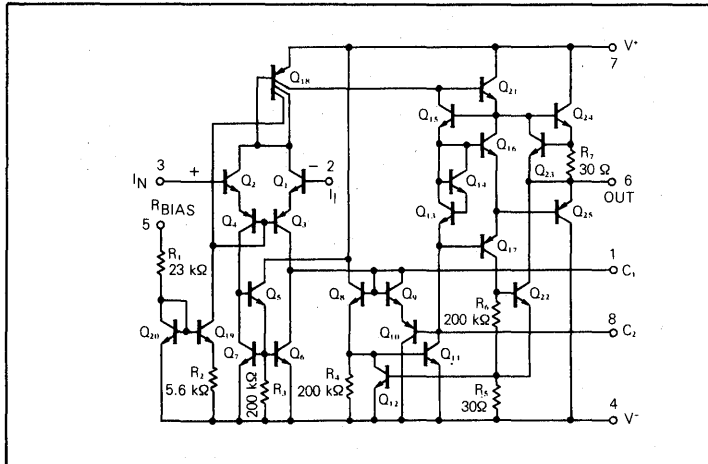
### GENERAL DESCRIPTION

μPC253 is a high performance programmable operational amplifier designed for many low power applications like handy DMM. The quiescent current can be set by a single external resistor and this feature enables micro-watt power consumption or analog gate applications.

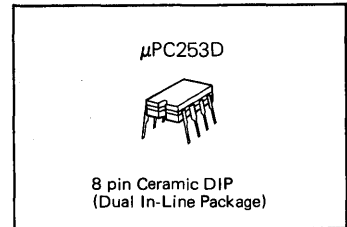
### FEATURES

- Micropower
- $\pm 3\text{ V}$  to  $\pm 18\text{ V}$  Operation
- Low Input Bias Current
- High Gain ( $V^{\pm} = \pm 3\text{ V}$ ,  $A_v = 300,000$ )
- Short Circuit Protection
- No Latch Up
- Programmable

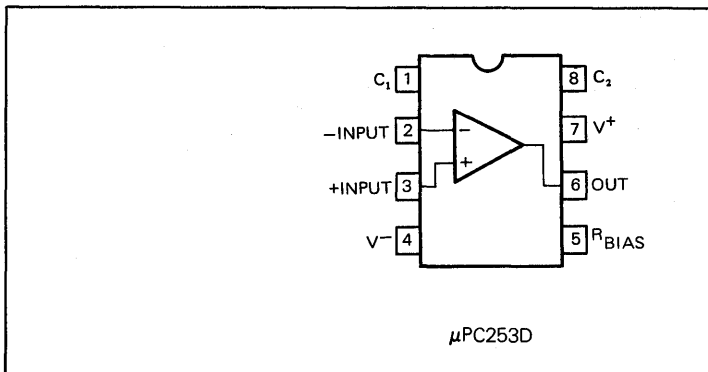
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC253	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	V
Power Dissipation*	D Package	500	mW
Differential Input Voltage		±30	V
Input Voltage (Note 1)		±15	V
Operating Temperature Range	D Package	-20 to +80	°C
Storage Temperature Range			°C
	D Package	-55 to +150	

Note 1: For supply voltage less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

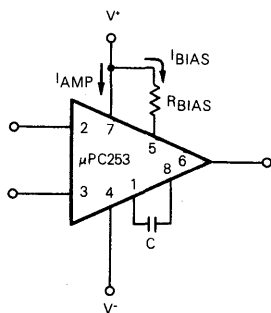
**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±3 V to ±15 V, R<sub>BIAS</sub> = 1 MΩ to V<sup>+</sup>)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		1.0	5.0	mV	R <sub>s</sub> ≤ 20 kΩ
Average Input Offset Voltage Drift		3		μV/°C	R <sub>s</sub> ≤ 20 kΩ
Input Offset Current		4	50	nA	
Input Bias Current		20	100	nA	
Input Impedance	1	6		MΩ	
Large Signal Voltage Gain	90	110		dB	
Amplifier Current		40	80	μA	
Output Voltage Swing	±10	±13.5		V	V <sup>±</sup> = ±15V, R <sub>L</sub> ≥ 2 kΩ
Output Voltage Swing		±1.5		V	V <sup>±</sup> = ±3 V, R <sub>L</sub> ≥ 2 kΩ
Common Mode Rejection Ratio	80	100		dB	
Supply Voltage Rejection Ratio		10	100	μV/V	

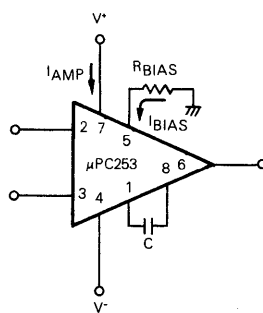
5

Supply Current = Amplifier Current (I<sub>AMP</sub>) + Bias (I<sub>BIAS</sub>) Current

Typical Connection

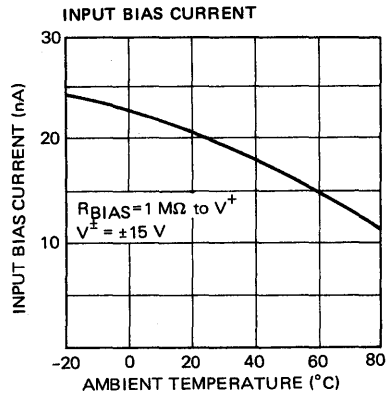
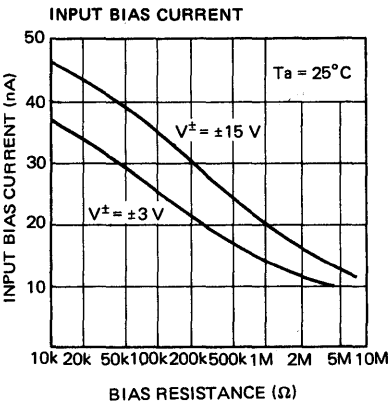
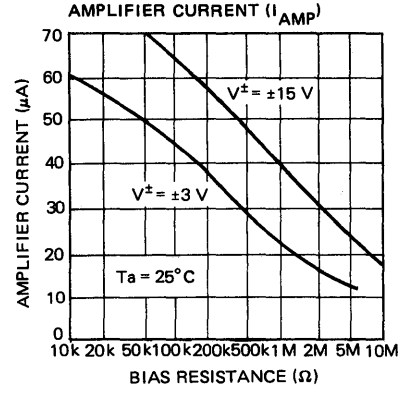
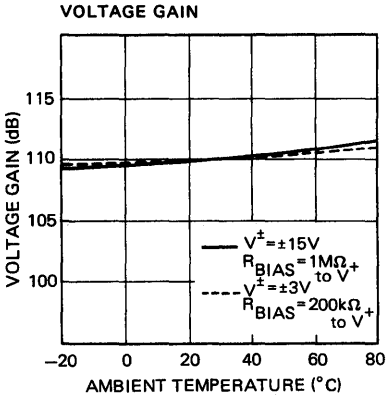
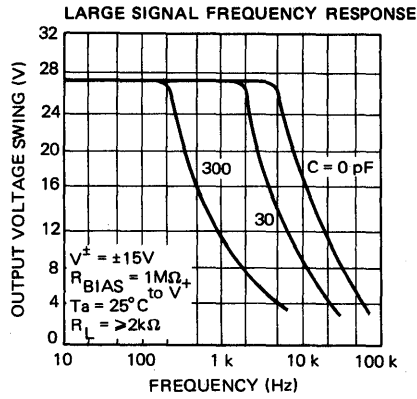
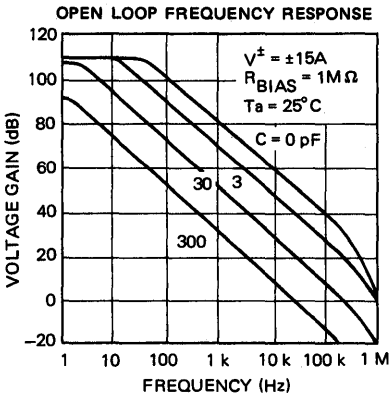


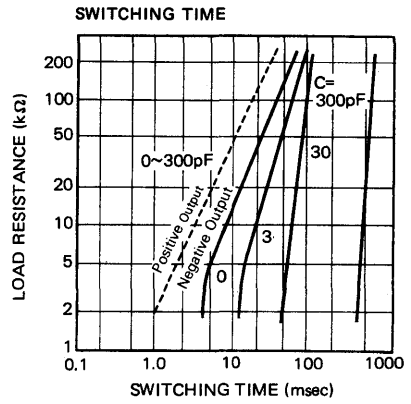
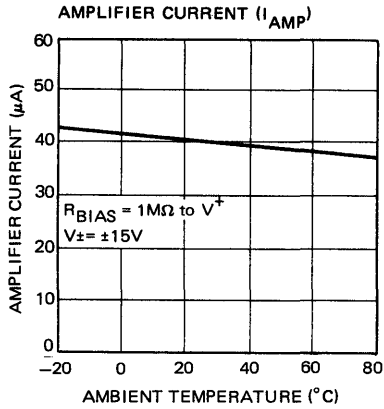
$$I_{BIAS} = \frac{|V^+ - V^-|}{R_{BIAS} + 23k\Omega}$$



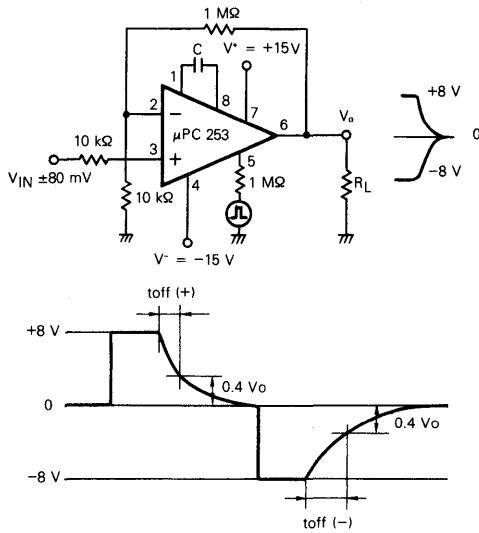
$$I_{BIAS} = \frac{|V^-|}{R_{BIAS} + 23k\Omega}$$

**TYPICAL PERFORMANCE CHARACTERISTICS**





SWITCHING TIME MEASUREMENT CIRCUIT (toff)



5

## Instrumentation Operational Amplifier

### GENERAL DESCRIPTION

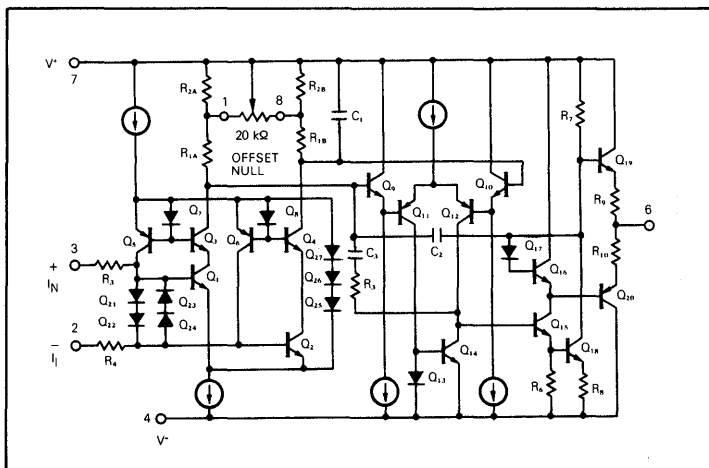
The μPC254 of Monolithic Instrumentation Operational Amplifier exhibits excellent performance in low signal level applications with the flexibility and ease of application of a fully protected, internally compensated op amp. Main features are low offset voltage, bias current and noise and high gain, input impedance, CMRR and SVRR.

The μPC254 is an optimum choice for a wide variety of applications including strain gage, thermocouple bridges, high gain active filters, buffers, integrators, and sample and hold amplifiers.

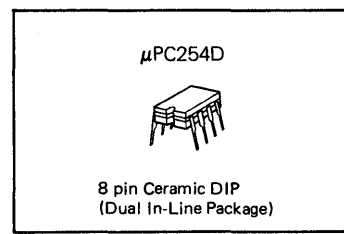
### FEATURES

- Low Input Offset Voltage Drift vs Temp . . . . .  $0.4 \mu\text{V}/^\circ\text{C}$  (Null) Typ.
- Low Input Offset Voltage Drift vs Time . . . . .  $0.4 \mu\text{V}/\text{Month}$  Typ.
- Low Input Offset Voltage . . . . .  $0.3 \text{ mV}$  Typ.
- Low Input Bias Current . . . . .  $\pm 1.8 \text{ nA}$  Typ.
- High Gain
- Low Noise
- High CMRR
- Internally Frequency Compensated.
- Easy Offset Nulling
- OP-05C Direct Replacement

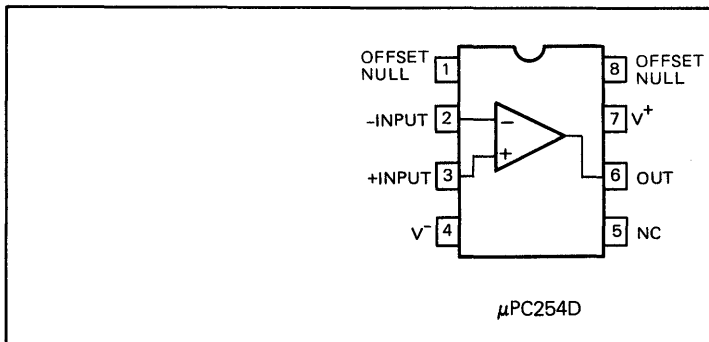
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC254	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		44	V
Power Dissipation *	D Package	500	mW
Differential Input Voltage		±30	V
Input Voltage (Note 1)		±22	V
Output Short Circuit Duration		Indefinite	s
Operating Temperature Range	D Package	-20 to +80	°C
Storage Temperature Range			°C
	D Package	-55 to +150	

Note 1: For supply voltages less than ±22 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

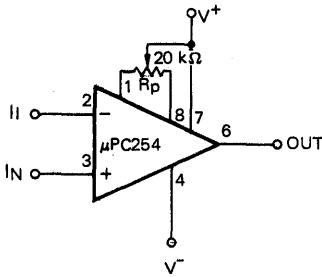
**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		0.3	1.3	mV	R <sub>s</sub> ≤ 100 Ω
Average Input Offset Voltage Drift		1.2	4.5	μV/°C	R <sub>s</sub> ≤ 100 Ω, unnull (Note 2)
Average Input Offset Voltage Drift		0.4	1.5		R <sub>s</sub> ≤ 100 Ω, null, R <sub>p</sub> = 20 kΩ (Note 2)
Input Offset Current		1.8	6.0	nA	
Average Input Offset Current Drift		12	50	pA/°C	(Note 2)
Input Bias Current		±1.8	±7.0	nA	
Average Input Bias Current Drift		18	50	pA/°C	(Note 2)
Input Resistance – Dif Mode	8	33		MΩ	
Large Signal Voltage Gain	120	500		V/mV	R <sub>L</sub> ≥ 2 kΩ, V <sub>o</sub> = ±10 V
Supply Current		3.2	5.0	mA	V <sup>±</sup> = ±3 V
		0.67	1.3		
Power Consumption		95	150	mW	
Maximum Output Voltage Swing	±12.0	±13.0		V	R <sub>L</sub> ≥ 10 kΩ
	±11.5	±12.8			R <sub>L</sub> ≥ 2 kΩ
	±1.45	±1.6			V <sup>±</sup> = ±3 V, R <sub>L</sub> ≥ 2 kΩ
Common Mode Rejection Ratio	100	120		dB	
Power Supply Rejection Ratio	90	104		dB	V <sup>±</sup> = ±3 V → ±18 V
Offset Adjustment Range		4		mV	R <sub>p</sub> = 20 kΩ
Input Noise Voltage		0.5		μV <sub>p-p</sub>	R <sub>s</sub> = 10 kΩ, f = 0.1 ~ 10 Hz (Note 2)
Input Noise Voltage Density		10.5	20.0	nV/√Hz	f <sub>o</sub> = 10 Hz (Note 2)
		10.2	13.5		f <sub>o</sub> = 100 Hz (Note 2)
		9.8	11.5		f <sub>o</sub> = 1000 Hz (Note 2)
Input Noise Current Density		0.35	0.90	pA/√Hz	f <sub>o</sub> = 10 Hz (Note 2)
		0.15	0.27		f <sub>o</sub> = 100 Hz (Note 2)
		0.13	0.18		f <sub>o</sub> = 1000 Hz (Note 2)
Long Term Input Offset Voltage Stability		0.4	2.0	μV/Mo	(Note 2)

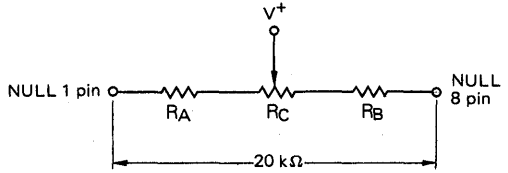
Note 2: Parameter is not 100 % tested, 90 % of units meet this specification.



**OFFSET NULLING CIRCUIT**

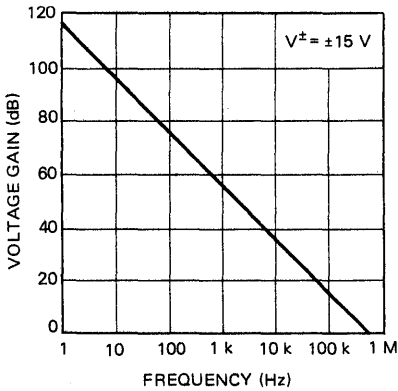


The μPC254 is designed to provide lowest drift performance when trimmed with a 20 kΩ potentiometer. When fine resolution of trimming is desired or where unwanted changes in potentiometer position with time and temperature could create unacceptable offsets, the sensitivity to offset vs potentiometer may be reduced by using the circuit shown below.

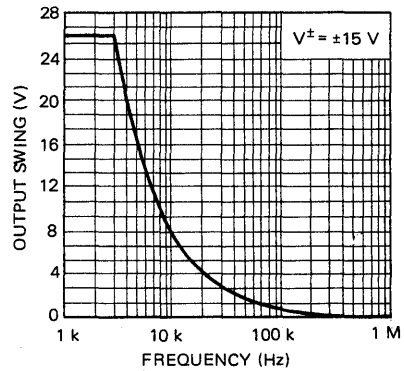


Fixed Resistor  $R_A, R_B$  5.1 kΩ  
 Potentiometer  $R_C$  10.0 kΩ  
 Null Range ±1.2 mV Typ.

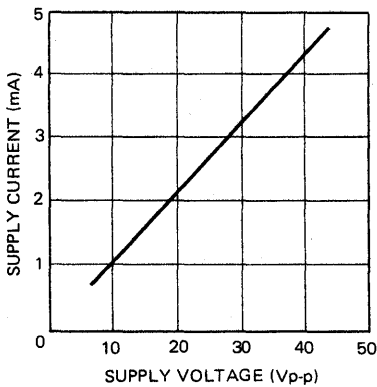
**OPEN LOOP FREQUENCY RESPONSE**



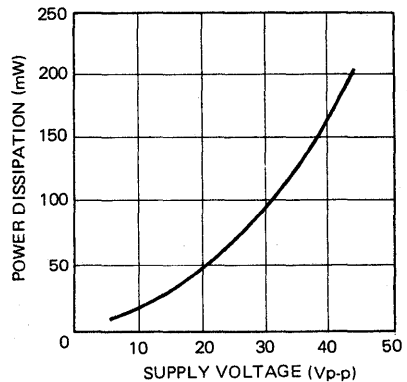
**LARGE SIGNAL FREQUENCY RESPONSE**

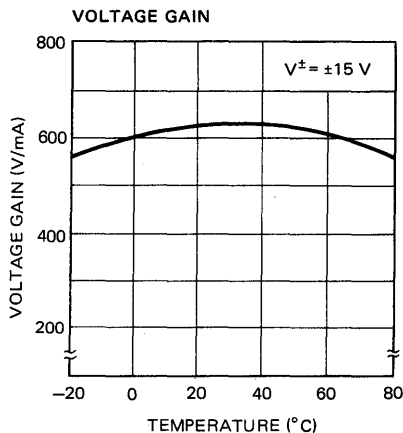
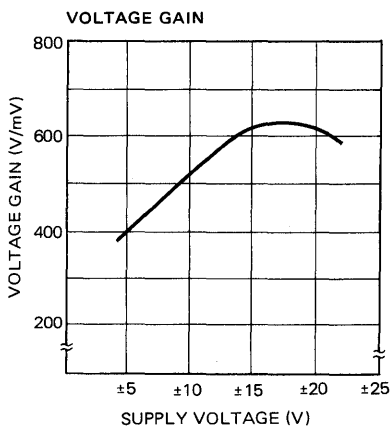
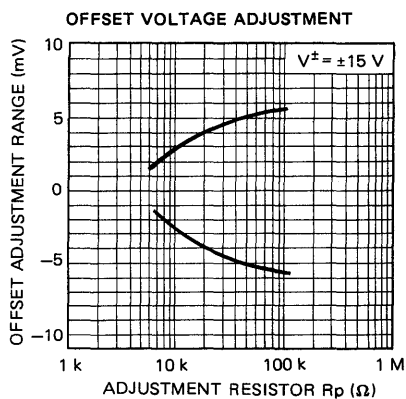
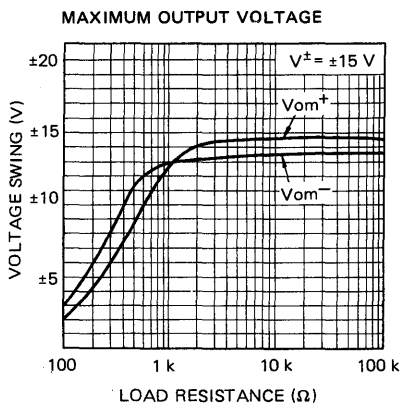
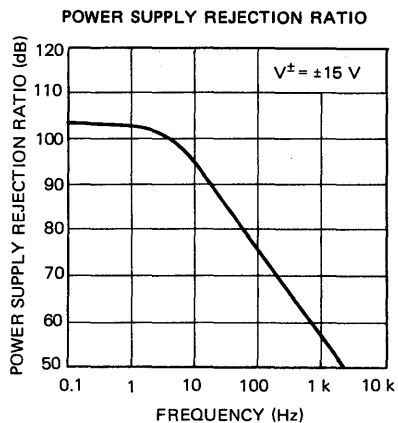
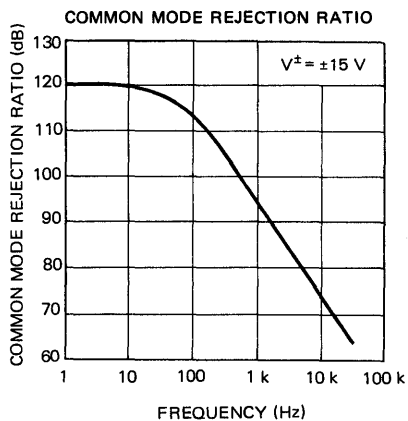


**SUPPLY CURRENT**



**POWER DISSIPATION**





5

# μPC258 / 4558

## High Performance Dual Operational Amplifiers

### GENERAL DESCRIPTION

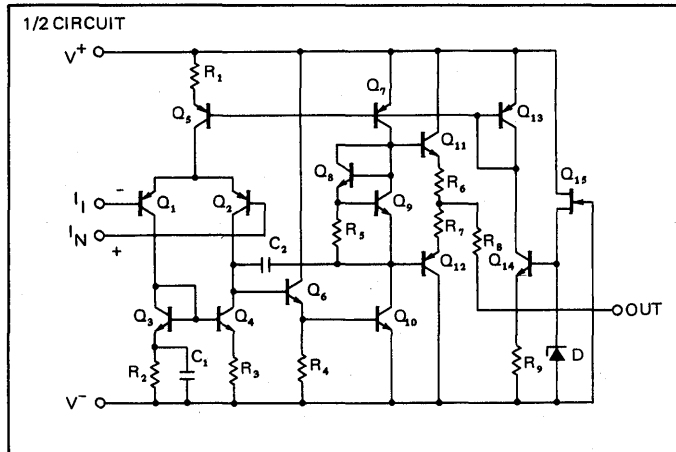
The μPC258 and μPC4558 are dual operational amplifiers having internal frequency compensating circuits. The low noise lateral pnp input transistors allow these amplifiers to be used in low noise signal processing applications such as audio preamplifiers and signal conditions. The simplified output stage completely eliminates crossover distortion under any load conditions.

Two kinds of ICs are available according to reliability, the μPC258 for industry, the μPC4558 for commercial.

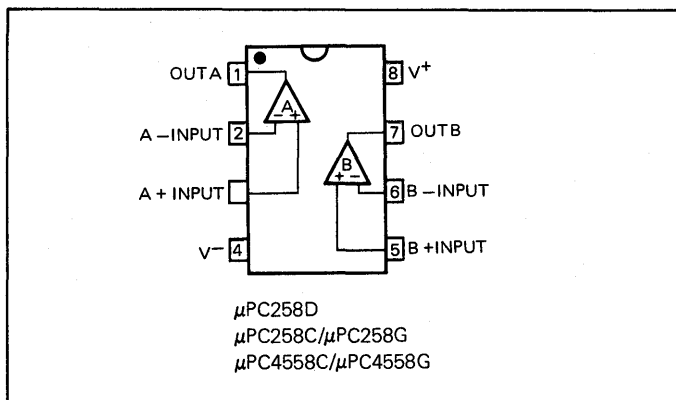
### FEATURES

- Internal Frequency Compensation
- Short Circuit Protection
- Large Common Mode and Differential Voltage Range
- No Latch Up
- Low Noise
- RC4558 Direct Replacement




### EQUIVALENT CIRCUIT



### CONNECTION DIAGRAM (Top View)



### ORDERING INFORMATION

μPC258D  8 pin Ceramic DIP (Dual In-Line Package)
μPC258C/μPC4558C  8 pin Plastic Molded DIP (Dual In-Line Package)
μPC258G/μPC4558G  8 pin Plastic Molded Flat Package (MINI FLAT IC)

**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC258	μPC4558	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	36	V
Power Dissipation *	D Package	500	—	mW
	C Package	350	350	
	G Package	440	440	
Differential Input Voltage		±30	±30	V
Input Voltage (Note 1)		±15	±15	V
Output Short Circuit Duration		Indefinite	Indefinite	s
Operating Temperature Range	D Package	-20 to +80	—	°C
	C or G Package	-20 to +70	0 to 70	
Storage Temperature Range	D Package	-55 to +150	—	°C
	C or G Package	-55 to +125	-55 to +125	

Note 1: For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		0.5	6.0	mV	R <sub>s</sub> ≤ 10 kΩ
Input Offset Current		5	200	nA	
Input Bias Current		60	500	nA	
Large Signal Voltage Gain	20,000				R <sub>L</sub> ≥ 2 kΩ, V <sub>o</sub> = ±10 V
Power Consumption		90	170	mW	Both Channel (Note 2)
Common Mode Rejection Ratio	70	90		dB	R <sub>s</sub> ≤ 10 kΩ
Supply Voltage Rejection Ratio		30	150	μV/V	R <sub>s</sub> ≤ 10 kΩ
Output Voltage Swing	±12	±14		V	R <sub>s</sub> ≤ 10 kΩ
	±10	±13		V	R <sub>s</sub> ≤ 2 kΩ
Common Mode Input Voltage Range	±12	±14		V	
Slew Rate		1.0		V/μs	A <sub>v</sub> = 1
Input Noise Voltage		6		μVp-p	R <sub>s</sub> = 1 kΩ, f = 1 Hz ~ 1 kHz
Channel Separation		105		dB	f = 1 kHz

Note. 2 The total of internal power dissipation.

Fig. 1 Noise measurement circuit

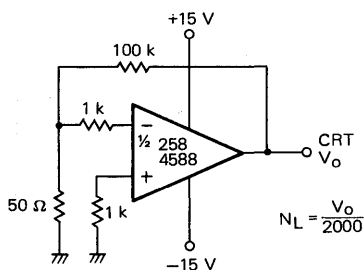
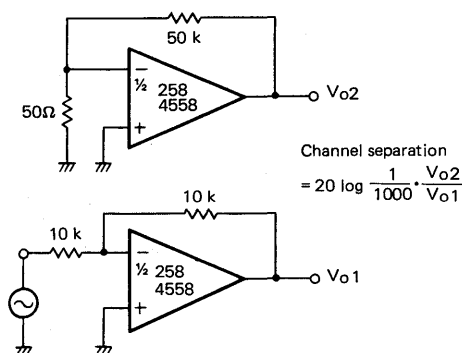
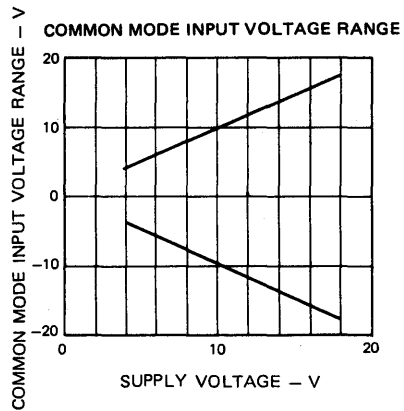
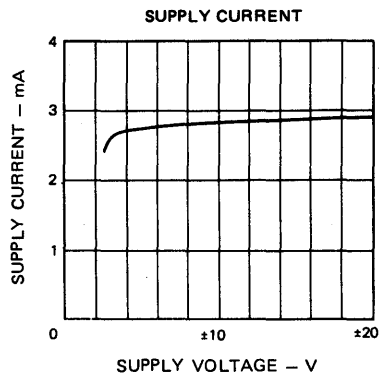
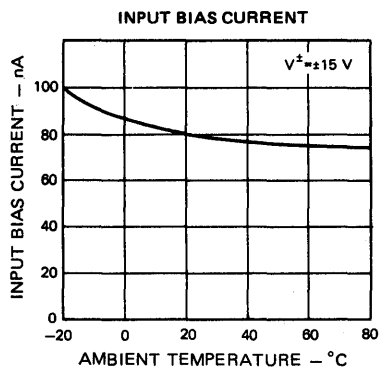
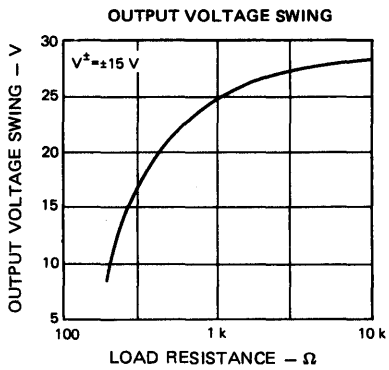
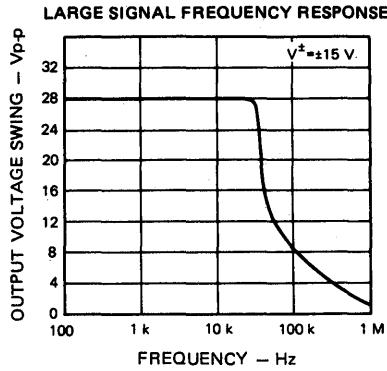
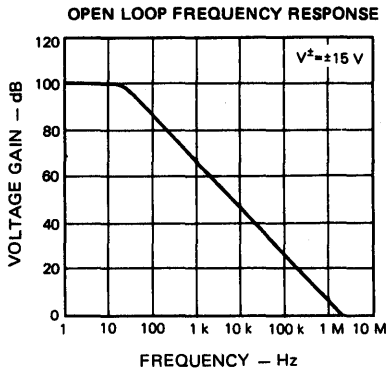
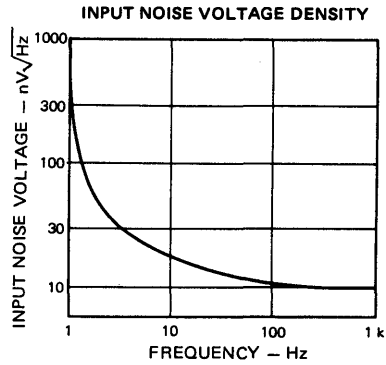
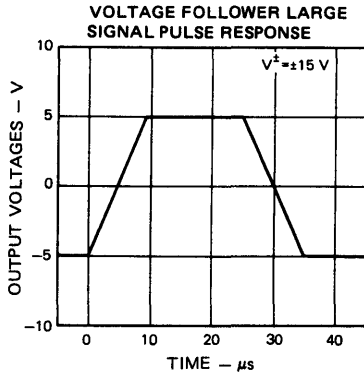


Fig. 2 Channel Separation measurement circuit

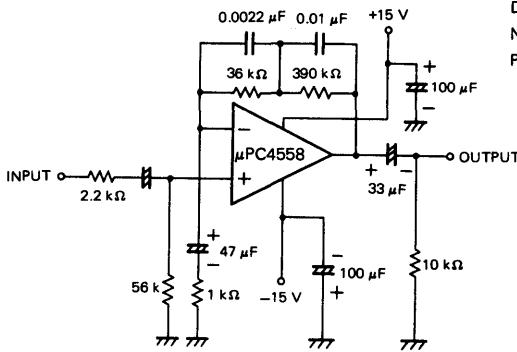


**TYPICAL PERFORMANCE CHARACTERISTICS (T<sub>a</sub>=25 °C)**

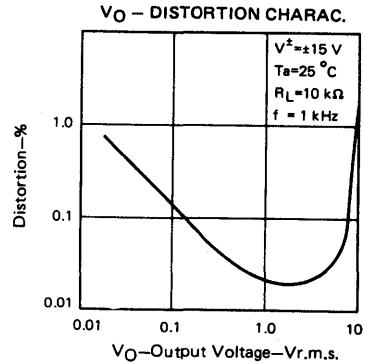




EXAMPLE OF APPLICATION CIRCUIT RIAA Preamp  $A_v=32.5$  dB



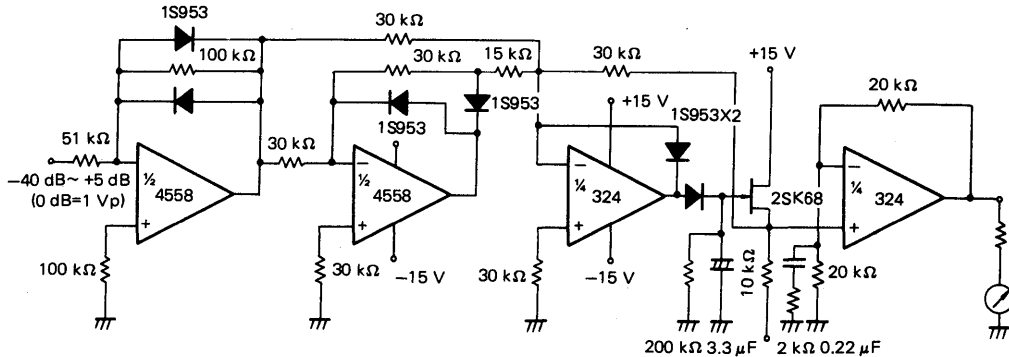
Distortion 0.03% ( $V_O=1$  Vr.m.s.,  $f=1$  kHz)  
 Noise noise 1.0 μVr.m.s. (Input EQUIV., Input EQUIV Short  
 Peak Det. Average Indication)



**PEAK LEVEL METER**

This circuit converts the peak voltage (about ±10 mV to ±10 V) of the input signal to a DC voltage (about 0.2 V to 1.3 V) and drives the meter.

Since the output voltage is proportional to the logarithmic value of the peak voltage of the input signal, indication of a much wider dynamic range can be obtained compared to conventional linear indicating methods.



Log-Compression Full-wave Rectification Peak Hold Meter Amp

NEC cannot assume any responsibility for any circuits shown or represent that they are free from patent infringement.

# μPC259 / 4560

## High Performance Dual Operational Amplifiers

### GENERAL DESCRIPTION

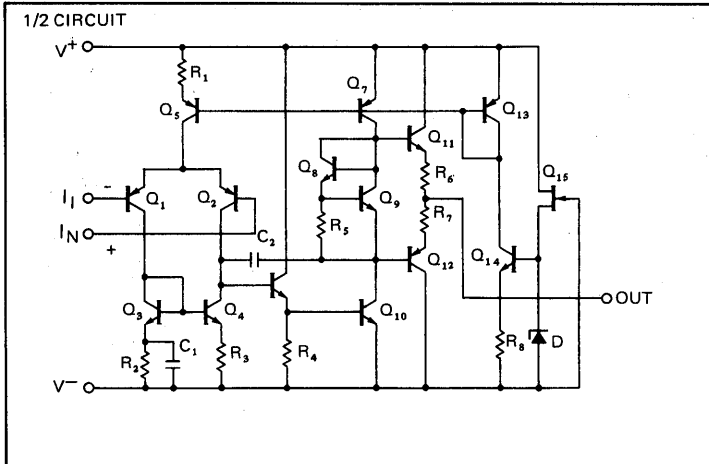
The μPC259 and 4560 are dual operational amplifiers which feature more improved slewrate and G.B. products than that of μPC4559 with unity gain frequency compensation. Also very low input noise and high output current drive capability make this device the optimum choice for audio application and active filters.

Two kinds of ICs are available according to reliability, the μPC259 for industry the μPC4560 for commercial.

### FEATURES

- Internal Frequency Compensation
- Large Common Mode and Differential Input Voltage
- No Latch Up
- Gain-bandwidth products = 10 MHz Typ.
- Low Input Noise Voltage = 6μVp-p Typ.

### EQUIVALENT CIRCUIT



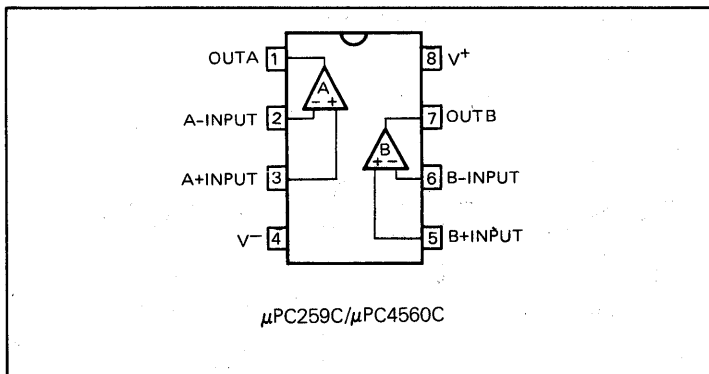
### ORDERING INFORMATION

μPC259C/μPC4560C



8 pin Plastic Molded DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC259	μPC4560	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	36	V
Power Dissipation (Note 1)	C Package	700	700	mW
Differential Input Voltage		±30	±30	V
Input Voltage (Note 2)		±15	0	V
Output Short Circuit Duration		0	0	s
Operating Temperature Range	C Package	-20 to +70	0 to +70	°C
Storage Temperature Range	C Package	-55 to +125	-55 to +125	°C

Note 1: When the ambient temperature is more than 25°C, derate linearly at RmW/°C (Tj MAX = 125°C).

See thermal information in chapter 11.

Note 2: For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		0.5	6.0	mV	Rs ≤ 10 kΩ
Input Offset Current		5	200	nA	
Input Bias Current		60	500	nA	
Large Signal Voltage Gain	20,000	180,000			RL ≥ 2 kΩ, Vo = ±10 V
Power Consumption		120	170	mW	Both Channel
Common Mode Rejection Ratio	70	100		dB	Rs ≤ 10 kΩ
Supply Voltage Rejection Ratio		10	150	μV/V	Rs ≤ 10 kΩ
Output Voltage Swing	±12	±14		V	Rs ≥ 2 kΩ
	±10	±13		V	Io = ±25 mA
Common Mode Input Voltage Range	±12	±14		V	
Slew Rate		2.8		V/μs	Av = 1
Input Noise Voltage		6		μVp-p	Rs = 1 kΩ, f = 1 Hz ~ 1 kHz
Channel Separation		105		dB	f = 1 kHz

Fig. 1 Noise Measurement Circuit

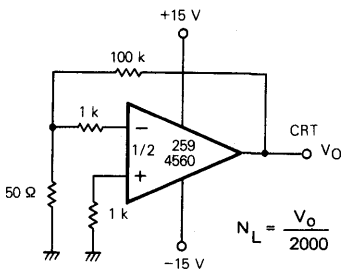
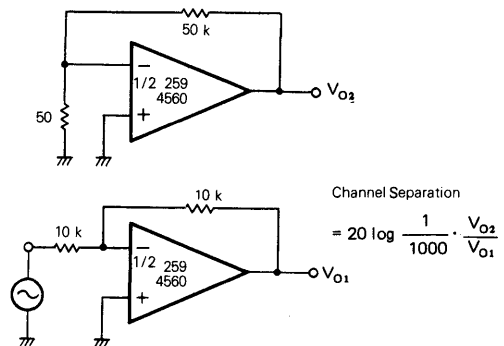
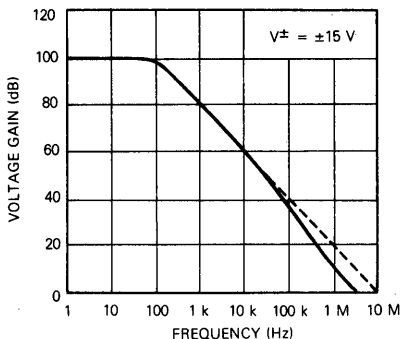


Fig. 2 Channel Separation Circuit

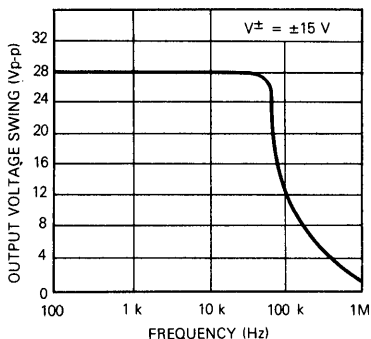




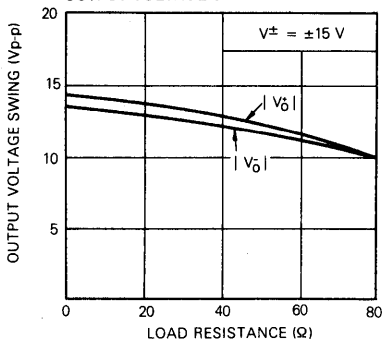
**OPEN LOOP FREQUENCY RESPONSE**



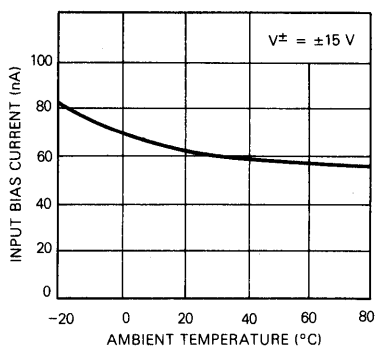
**LARGE SIGNAL FREQUENCY RESPONSE**



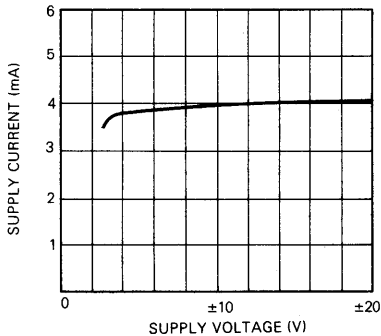
**OUTPUT VOLTAGE SWING**



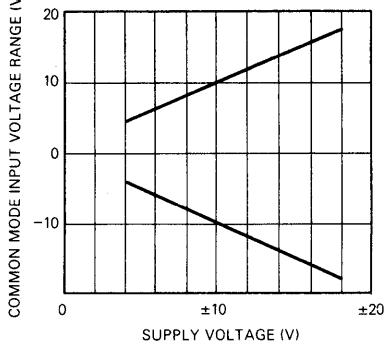
**INPUT BIAS CURRENT**



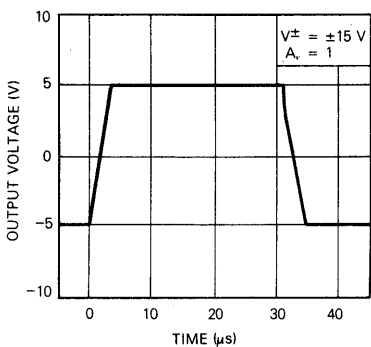
**SUPPLY CURRENT**



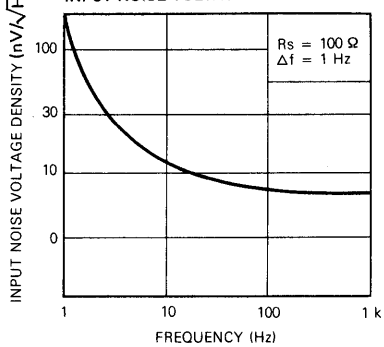
**COMMON MODE INPUT VOLTAGE RANGE**



**PULSE RESPONSE**

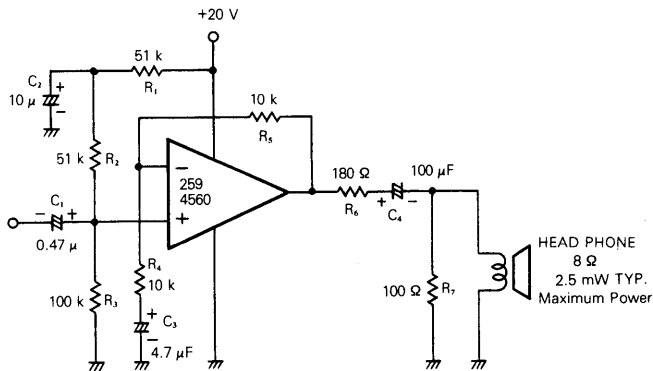


**INPUT NOISE VOLTAGE DENSITY**



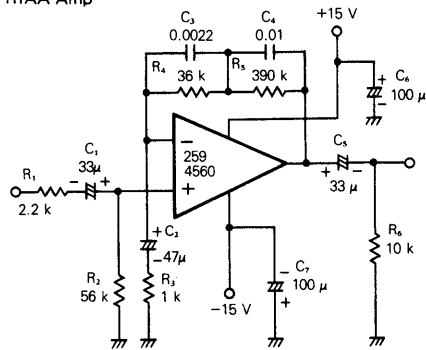
APPLICATION CIRCUITS

Head Phone Amp

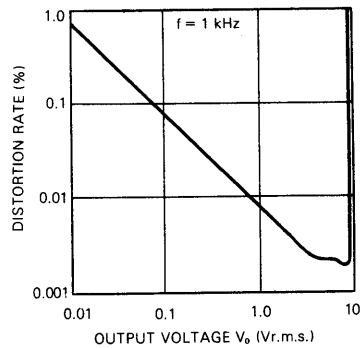


HEAD PHONE  
8 Ω  
2.5 mW TYP.  
Maximum Power

RIAA Amp



DISTORTION CHARACTERISTICS



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# μPC354

## Ultra Low Offset Voltage Instrumentation Operational Amplifier

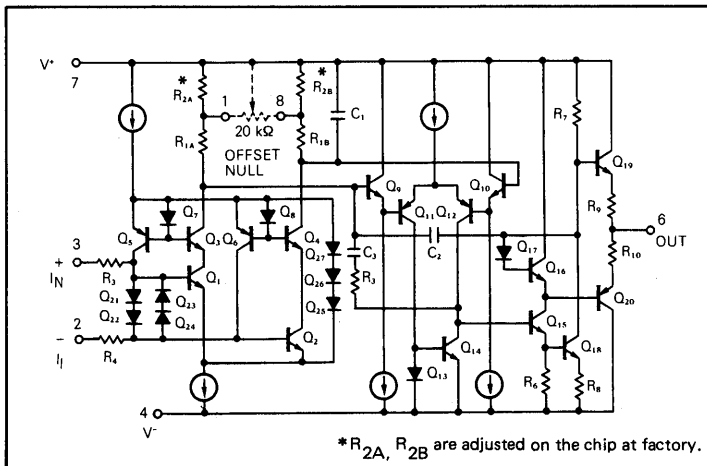
### GENERAL DESCRIPTION

The μPC354 is a monolithic instrumentation amplifier which has an offset trimming network on the conventional μPC254 chip. By this feature, very low offset voltage of typ. 60μV is achieved during initial factory testing. The other excellent characteristics like low noise, low drift vs. temperature and time, low bias current, and high input impedance are almost similar to the μPC254. The μPC354 is recommended as a replacement for modular and monolithic chopper stabilized amplifiers where reductions in cost, noise, size, and power consumption are required.

### FEATURES

- Very low Input offset Voltage . . . . . 60 μV Typ.
- Low Input Offset Voltage Drift vs Temp. . . . .  
0.4 μV/°C Typ. (Null), 0.5 μV/°C Typ. (Unnull)
- Low Input Offset Voltage Drift vs. Time . . . . .  
0.4 μV/Month Typ.
- Low Input Bias Current . . . . . ±1.8 nA Typ.
- High Gain
- Low Noise
- Internally Frequency Compensated
- OP-07C Direct Replacement

### EQUIVALENT CIRCUIT

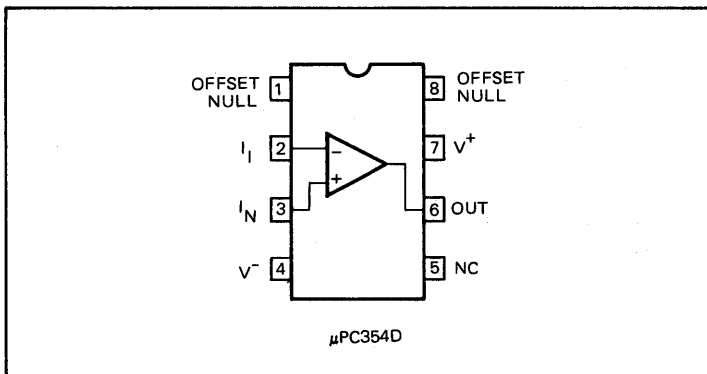


### ORDERING INFORMATION

μPC354D

8 pin Ceramic DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC354	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		44	V
Power Dissipation*	D Package	500	mW
Differential Input Voltage		±30	V
Input Voltage (Note 1)		±22	V
Output Short Circuit Duration		Indefinite	s
Operating Temperature Range	D Package	-20 to +80	°C
Storage Temperature Range	D Package	-55 to +150	°C

Note 1: For supply voltages less than ±22 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

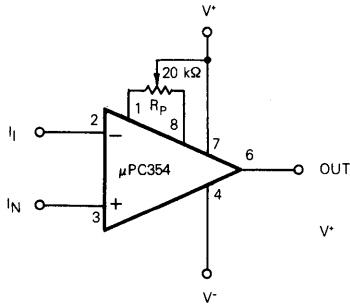
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		60	150	μV	Rs ≤ 100 Ω
Input Offset Current		0.8	6.0	nA	
Input Bias Current		±1.8	±7.0	nA	
Input Resistance – Dif Mode	8	33		MΩ	
Input Resistance – Common Mode		120		GΩ	
Input Voltage Range	±13.0	±14.0		V	
Large Signal Voltage Gain	120	400		V/mV	RL ≥ 2 kΩ, Vo = ±10 V
Supply Current		3.2	5.0	mA	
		0.67	1.3	mA	V <sup>±</sup> = ±3 V
Power Consumption			150	mW	
Maximum Output Voltage Swing	±12.0	±13.0		V	RL ≥ 10 kΩ
	±11.5	±12.8			RL ≥ 2 kΩ
Common Mode Rejection Ratio	100	120		dB	
Power Supply Rejection Ratio	90	104		dB	V <sup>±</sup> = ±3 V → ±18 V
Slewing Rate		0.17		V/μs	
Bandwidth		500		kHz	
Input Noise Voltage		0.38	0.65	μVp-p	Rs = 100 Ω, f = 0.1 ~ 10 Hz (Note 2)
Input Noise Voltage Density		10.5	20.0	n√/Hz	f0 = 10 Hz (Note 2)
		10.2	13.5		f0 = 100 Hz (Note 2)
		9.8	11.5		f0 = 1 000 Hz (Note 2)
Input Noise Current			35	pAp-p	f0 = 0.1 ~ 10 Hz (Note 2)
Input Noise Current Density		0.35	0.90	pA/√Hz	f0 = 10 Hz (Note 2)
		0.15	0.27		f0 = 100 Hz (Note 2)
		0.13	0.18		f0 = 1 000 Hz (Note 2)
Offset Adjustment Range		±4		mV	Rp = 20 kΩ
Long Term Input Offset Voltage Stability		0.4	2.0	μV/Mo	(Note 2)

0 ≤ Ta ≤ 70°C

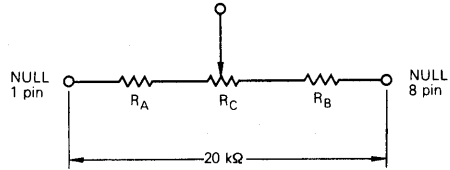
Input Offset Voltage		85	250	μV	Rs ≤ 100 Ω
Average Input Offset Voltage Drift		0.5	1.8	μV/°C	Rs ≤ 100 Ω, unnull (Note 2)
		0.4	1.5		Rs ≤ 100 Ω, null, Rp = 20 kΩ (Note 2)
Average Input Offset Current Drift		12	50	pA/°C	(Note 2)
Average Input Bias Current Drift		18	50	pA/°C	(Note 2)

Note 2: Parameter is not 100 % tested, 90 % of units meet this specification.

**OFFSET NULLING CIRCUIT**

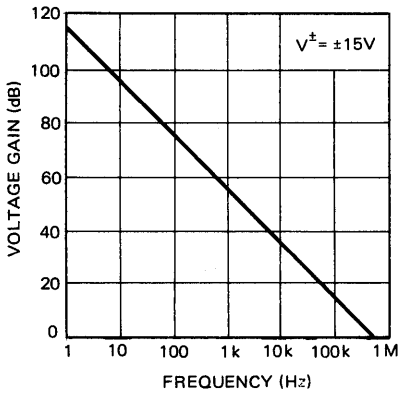


The μPC354 is designed to provide lowest drift performance when trimmed with a 20 kΩ potentiometer. When fine resolution of trimming is desired or where unwanted changes in potentiometer position with time and temperature could create unacceptable offsets, the sensitivity to offset vs. potentiometer may be reduced by using the circuit shown below.

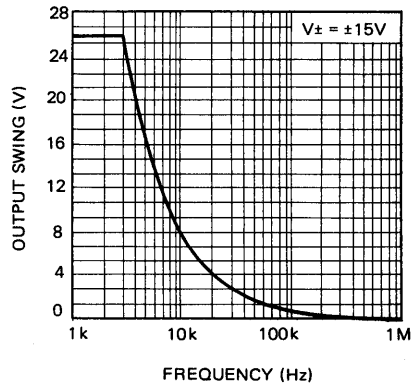


Fixed Resistor  $R_A, R_B$  7.5kΩ  
 Potentiometer  $R_C$  5kΩ  
 Null Range ±0.8mV Typ.

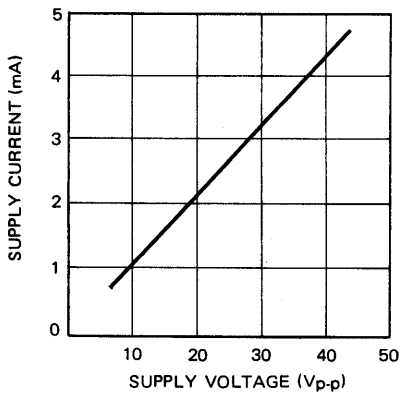
**OPEN LOOP FREQUENCY RESPONSE**



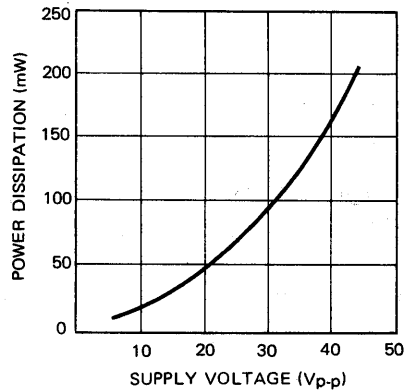
**LARGE SIGNAL FREQUENCY RESPONSE**



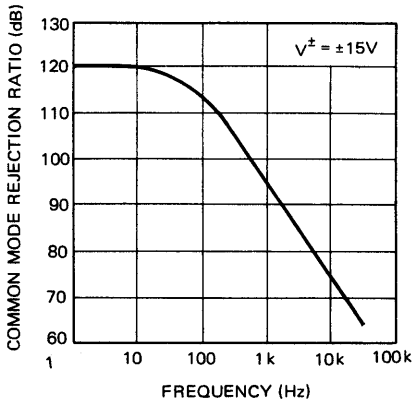
**SUPPLY CURRENT**



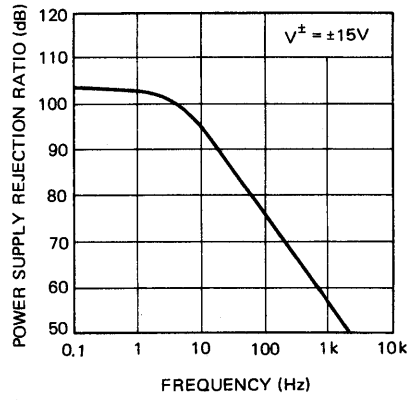
**POWER DISSIPATION**



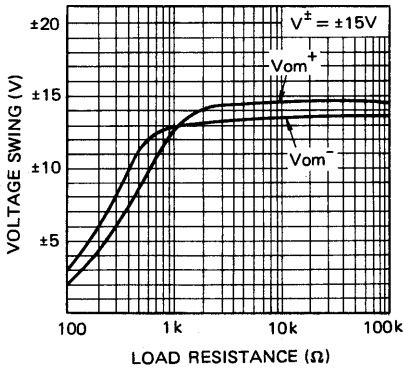
COMMON MODE REJECTION RATIO



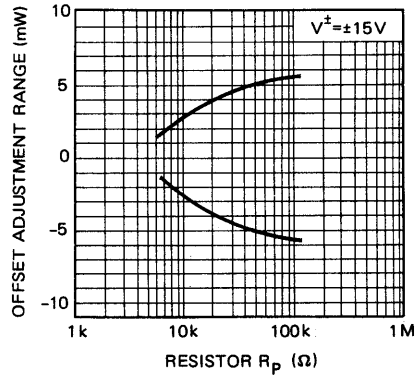
POWER SUPPLY REJECTION RATIO



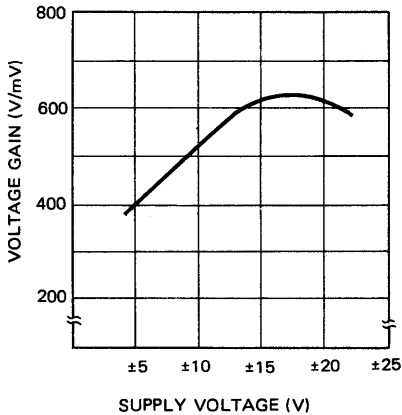
MAXIMUM OUTPUT VOLTAGE



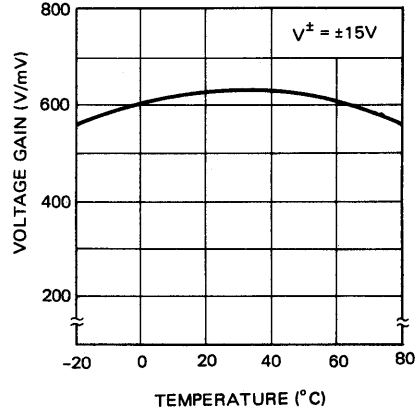
OFFSET VOLTAGE ADJUSTMENT



VOLTAGE GAIN



VOLTAGE GAIN



5

# μPC451 / 324

## Low Power Quad Operational Amplifiers

### GENERAL DESCRIPTION

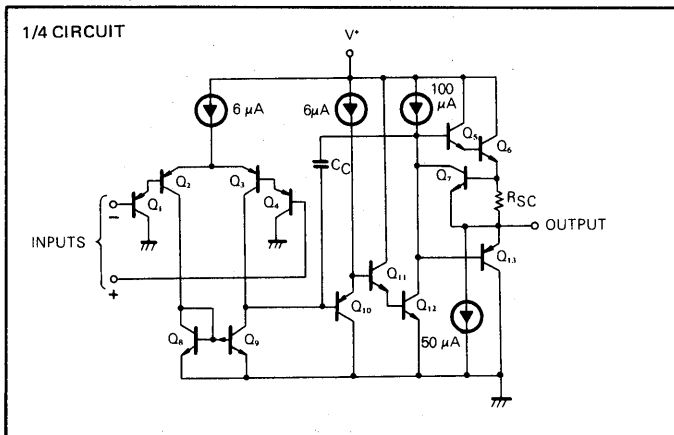
The μPC451/324 are quad operational amplifiers which are designed to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the power supply current drain is very low. Further advantage, the input common-mode voltage can also swing to ground in the linear mode.

Two kinds of ICs are available according to reliability, the μPC451 for industry, the μPC324 for commercial.

### FEATURES

- Internal Frequency Compensation
- Large Output Voltage Swing  
0V to  $V^+$  -1.5 V DC
- Input Common-Mode Voltage Range Includes Ground
- Wide Power Supply Range  
Single Supply 3 V to 30 V DC  
Dual Supplies  $\pm 1.5$  V to  $\pm 15$  V DC
- LM324 Direct Replacement

### EQUIVALENT CIRCUIT



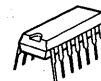
### ORDERING INFORMATION

μPC451D



14 pin Ceramic DIP  
(Dual In-Line Package)

μPC451C/μPC324C



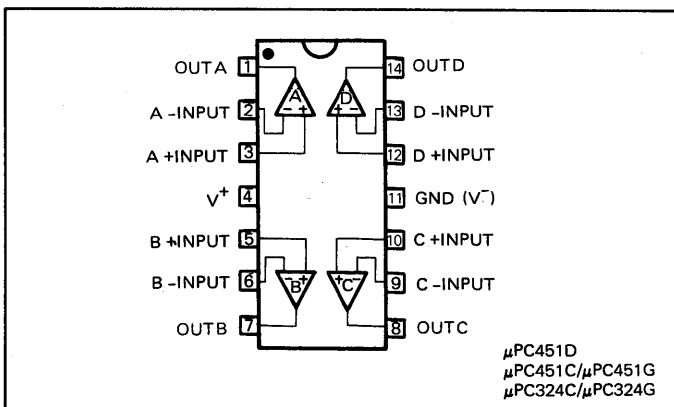
14 pin Plastic Molded DIP  
(Dual In-Line Package)

μPC451G/μPC324G



14 pin Plastic Molded Flat Package  
(MINI FLAT IC)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC451	μPC324	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		32	32	V
Differential Input Voltage		32	32	V
Input Voltage		-0.3 to +32	-0.3 to +32	V
Power Dissipation*	D Package	900	-	mW
	C Package	570	570	
	G Package	550	550	
Operating Temperature Range	D Package	-20 to +80	-	°C
	C or G Package	-20 to +70	0 to +70	
Storage Temperature Range	D Package	-55 to +150	-	°C
	C or G Package	-55 to +125	-55 to +125	

\* See thermal information in chapter 11.

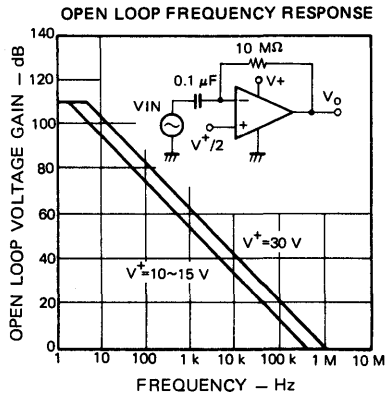
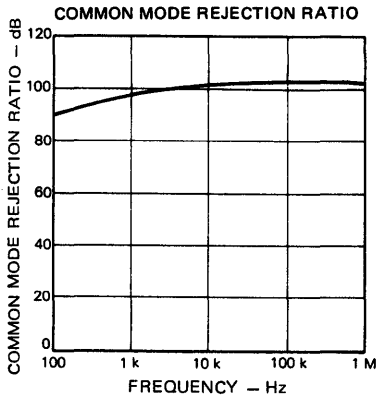
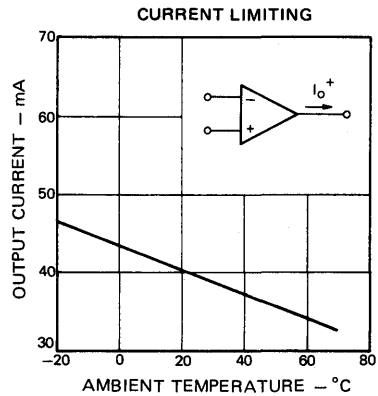
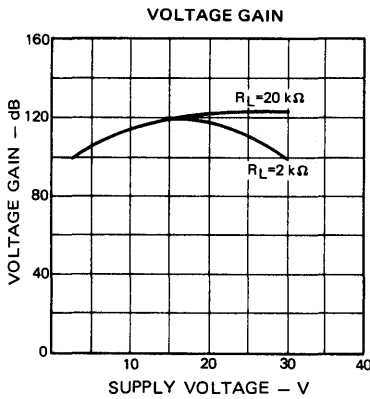
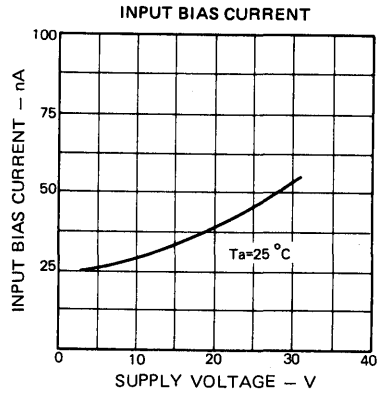
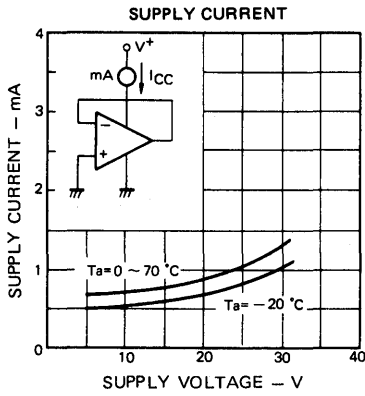
**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>+</sup> = +5 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		2	7	mV	Rs = 0 Ω
Input Bias Current		45	500	nA	
Input Offset Current		5	50	nA	
Common Mode Input Voltage Range	0		V <sup>+</sup> - 1.5	V	
Supply Current		0.8	2	mA	RL = ∞ on All Op Amps
Large Singal Voltage Gain		100		V/mV	RL ≥ 2 kΩ
Output Voltage Swing	0		V <sup>+</sup> - 1.5	V	RL = 2 kΩ
Common Mode Rejection Ratio		85		dB	
Supply Voltage Rejection Ratio		100		dB	
Channel Separation		120		dB	f = 1 kHz to 20 kHz
Output Current (Source)	20	40		mA	VIN <sup>+</sup> = +1 V, VIN <sup>-</sup> = 0 V
Output Current (Sink)	10	20		mA	VIN <sup>-</sup> = 1 V, VIN <sup>+</sup> = 0 V

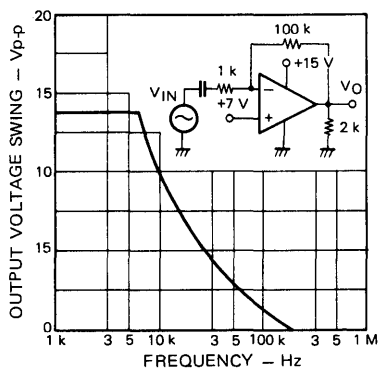
**5**



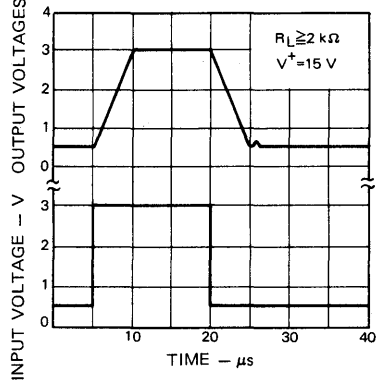
**TYPICAL PERFORMANCE CHARACTERISTICS (Ta=25 °C)**



LARGE SIGNAL FREQUENCY RESPONSE



VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



# μPC454

## Dual Matched Instrumentation Operational Amplifier

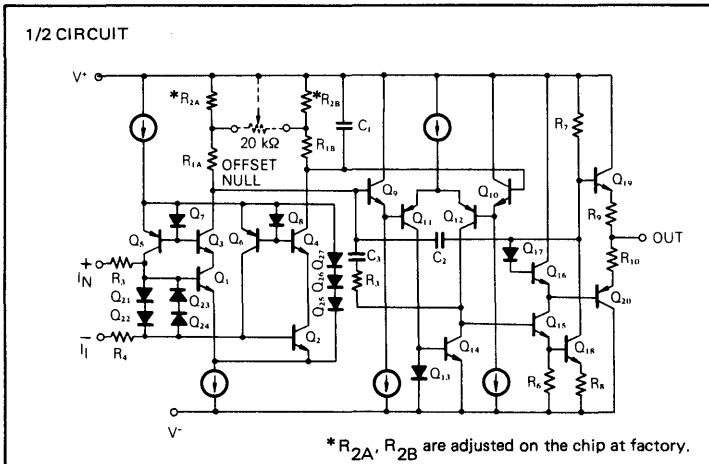
### GENERAL DESCRIPTION

The μPC454 of Dual Matched Instrumentation Operational Amplifier consists of two independent monolithic high performance operational amplifiers (μPC354) in a single 14 pin Dual in Line package. The advantage of common package is the elimination of the unavoidable temperature differentials. The tight matching of critical parameters and temperature tracking between channels enables realization of extremely high performance instrumentation amplifier designs.

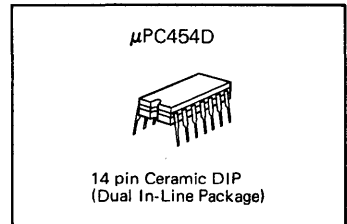
### FEATURES

- Extremely Tight Matching
- Individual Amplifier Parameters Equal to μPC354
- Tight Offset Voltage Match . . . . . 0.1 mV Typ.
- Tight Offset Voltage Match vs Temp. . . . . 0.5-μ V/°C Typ. (Unnull)
- Low Noise
- Low Bias Current
- High Channel Separation
- Internally Frequency Compensated
- Improved Pin Compatible Device for OP-10 Sockets

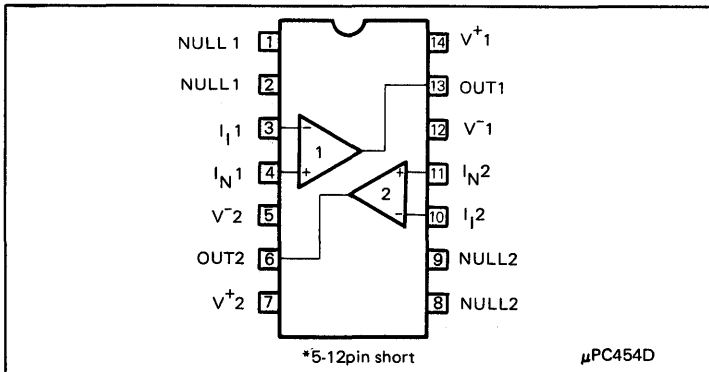
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC454	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		44	V
Power Dissipation*	D Package	900	mW
Differential Input Voltage		±30	V
Input Voltage (Note 1)		±22	V
Output Short Circuit Duration		Indefinite	s
Operating Temperature Range	D Package	-20 to +80	°C
Storage Temperature Range	D Package	-55 to +150	°C

Note 1: For supply voltages less than ±22 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V, Each Amplifier)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		60	150	μV	Rs ≤ 100 Ω
Input Offset Current		0.8	6.0	nA	
Input Bias Current		±1.8	±7.0	nA	
Input Resistance – Dif Mode	8	33		MΩ	
Input Resistance – Common Mode		120		GΩ	
Input Voltage Range	±13.0	±14.0		V	
Large Signal Voltage Gain	120	400		V/mV	RL ≥ 2 kΩ, Vo = ±10 V
Supply Current		3.2	5.0	mA	
		0.67	1.3	mA	V <sup>±</sup> = ±3 V
Power Consumption			150	mW	
Maximum Output Voltage Swing	±12.0	±13.0		V	RL ≥ 10 kΩ
	±11.5	±12.8			RL ≥ 2 kΩ
Common Mode Rejection Ratio	100	120		dB	
Power Supply Rejection Ratio	90	104		dB	V <sup>±</sup> = ±3 V → ±18 V
Slewing Rate		0.17		V/μs	
Bandwidth		500		kHz	
Input Noise Voltage		0.38	0.65	μVp-p	Rs = 100 Ω, f = 0.1 ~ 10 Hz (Note 2)
Input Noise Voltage Density		10.5	20.0	nV/√Hz	fo = 10 Hz (Note 2)
		10.2	13.5		fo = 100 Hz (Note 2)
		9.8	11.5		fo = 1 000 Hz (Note 2)
Input Noise Current			35	pAp-p	fo = 0.1 ~ 10 Hz (Note 2)
Input Noise Current Density		0.35	0.90	pA/√Hz	fo = 10 Hz (Note 2)
		0.15	0.27		fo = 100 Hz (Note 2)
		0.13	0.18		fo = 1 000 Hz (Note 2)
Offset Adjustment Range		±4		mV	Rp = 20 kΩ
Long Term Input Offset Voltage Stability		0.4	2.0	μV/Mo	(Note 2)

0 ≤ Ta ≤ 70°C

Input Offset Voltage		85	250	μV	Rs ≤ 100 Ω
Average Input Offset Voltage Drift		0.5	1.8	μV/°C	Rs ≤ 100 Ω, unnull (Note 2)
		0.4	1.5		Rs ≤ 100 Ω, null, Rp = 20 kΩ (Note 2)
Average Input Offset Current Drift		12	50	pA/°C	(Note 2)
Average Input Bias Current Drift		18	50	pA/°C	(Note 2)

Note 2: Parameter is not 100 % tested, 90 % of units meet this specification.

**MATCHING CHARACTERISTICS (Ta = 25°C, V± = ±15 V)**

PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Input Offset Voltage Match		100	300	μV	Rs ≤ 100 Ω
Average Non-Inverting Bias Current		±2.0	±7.0	nA	
Non-Inverting Input Offset Current	–	1.8	–	nA	
Inverting Input Offset Current	–	1.8	–	nA	
Common Mode Rejection Ratio Match	–	117	–	dB	
Power Supply Rejection Ratio Match	–	106	–	dB	
Channel Separation	120	137		dB	f = 100 Hz, RL = ∞

0 ≤ Ta ≤ 70°C

Input Offset Voltage Match		150	600	μV	Rs ≤ 100 Ω
Input Offset Voltage Tracking	–	0.5	–	μV/°C	Rs ≤ 100 Ω, unnl
	–	0.4	–		Rs ≤ 100 Ω, null, Rp = 20 kΩ, CH1 only
Average Drift of Non-Inverting Bias Current	–	18	–	pA/°C	
Average Drift of Non-Inverting Offset Current	–	20	–	pA/°C	

**MATCHING PARAMETER DEFINITIONS**

- Input Offset Voltage Match ( $\Delta V_{IO}$ ) . . . The difference between the offset voltage of CH1 and CH2 ( $V_{IO1} - V_{IO2}$ ). In Fig. 1 if  $V_{IO1} = V_{IO2}$ , the net differential offset voltage at the output of amplifier pair equals zero.
- Input Offset Voltage Tracking . . . The ratio of the change in  $\Delta V_{IO}$  to the change in temperature producing it.
- Average Non-Inverting Bias Current . . . The average of the CH1 and CH2 non-inverting input bias currents.

$$\frac{I_{B1}^+ + I_{B2}^+}{2}$$

- Non-Inverting Input Offset Current . . . The difference between the non-inverting input bias currents of CH1 and CH2.
- Inverting Input Offset Current . . . The difference between the inverting input bias currents of CH1 and CH2.
- Average Drift of Non-Inverting Bias Current . . . The ratio of the change in non-inverting bias current to the change in temperature producing it.
- Average Drift of Non-Inverting Offset Current . . . The ratio of the change in non-inverting offset current to the change in temperature producing it.
- Common Mode Rejection Ratio Match . . . The difference between the common-mode rejection ratios of CH1 and CH2.
- Supply Voltage Rejection Ratio Match . . . The difference between the power supply rejection ratios of CH1 and CH2.
- Channel Separation . . . The ratio of the change in input offset voltage of one channel to the change in output voltage in the second channel producing it.

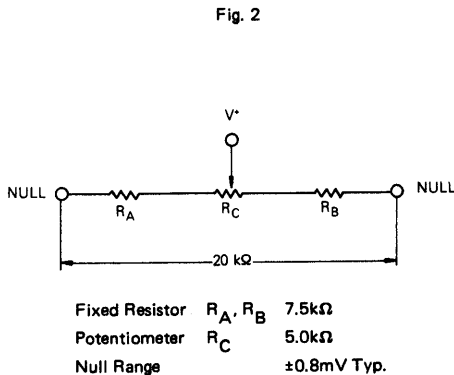
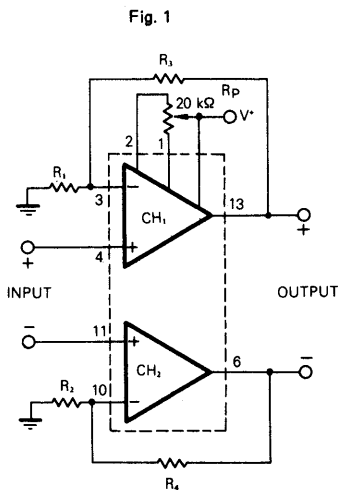
**POWER SUPPLIES**

The  $V^+$  supply terminals are completely independent and may be powered by separate supplies if desired. (This approach however, would sacrifice the advantage of the power supply rejection ratio matching.) The  $V^-$  supply terminals are both connected to the common substrate and must be tied to the same voltage.

**OFFSET TRIMMING**

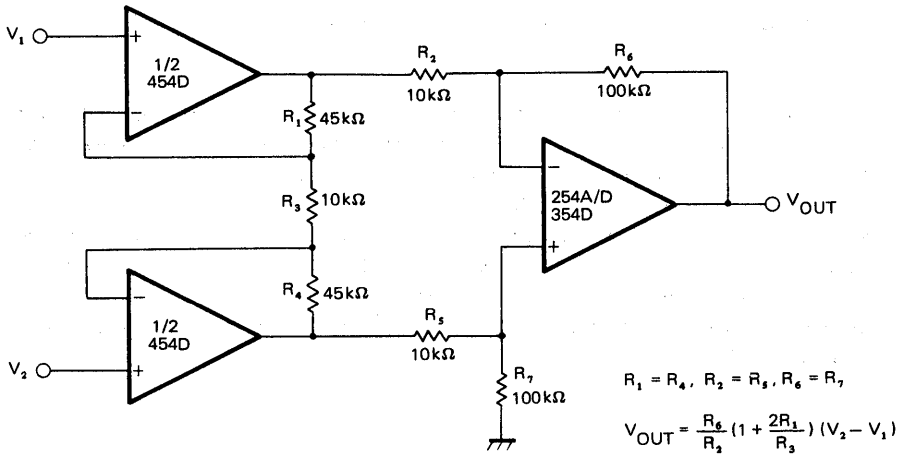
Offset trimming terminals are provided for each amplifier of the μPC454D—however, guaranteed performance over temperature can be obtained by trimming only one side (CH1) to match the offset of the other for a net differential offset of zero. (See Fig. 1) However results which are essentially the same may be obtained by trimming CH2 to match CH1, or by nulling each side individually.

The μPC454D is designed to provide lowest drift performance when trimmed with a 20 kΩ potentiometer; this value provides about ±4 mV of adjustment range which should be considerably more than adequate for most applications. Where finer resolution of trimming is desired, or where unwanted changes in potentiometer position with time and temperature could create unacceptable offsets, the sensitivity to offset vs potentiometer position may be reduced by using the circuit of Fig. 2.



APPLICATION CIRCUITS

• TRIPLE OP AMP INSTRUMENTATION AMPLIFIER

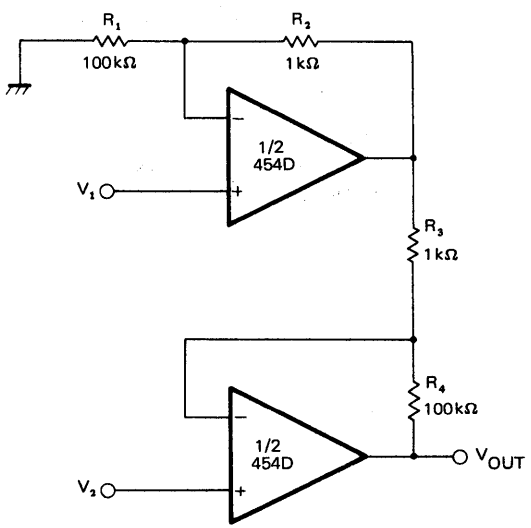


$R_1 = R_4, R_2 = R_3, R_6 = R_7$

$V_{OUT} = \frac{R_6}{R_2} \left( 1 + \frac{2R_1}{R_3} \right) (V_2 - V_1)$

Resistor accuracy should be better than 1%.

• INSTRUMENTATION AMPLIFIER 2 OP AMP DESIGN

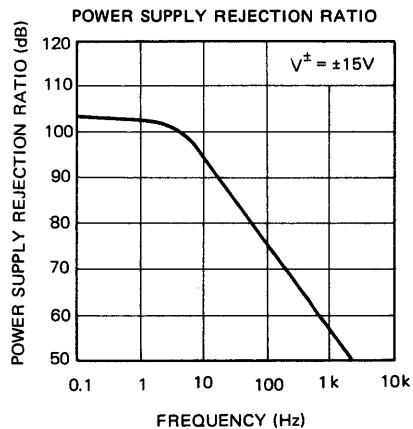
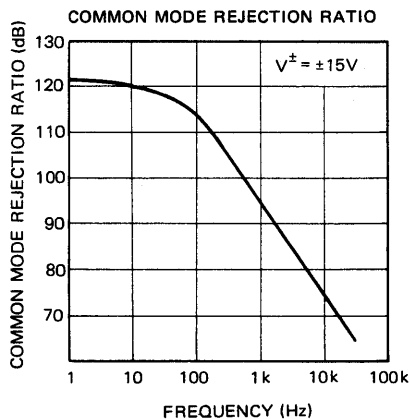
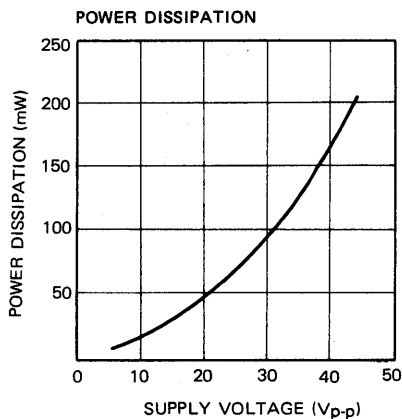
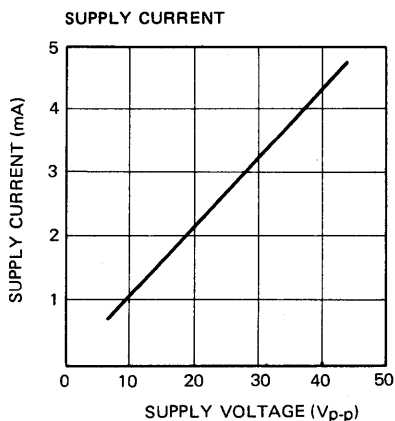
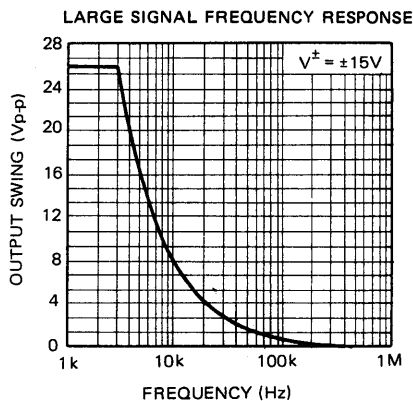
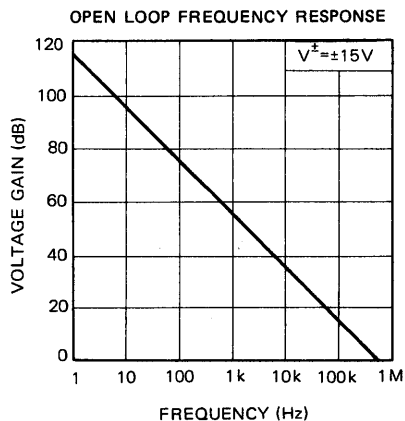


$R_3 = R_2, R_1 = R_4$

$V_{OUT} = \left( 1 + \frac{R_2}{R_3} \right) (V_2 - V_1)$

Resistor accuracy should be better than 1%.

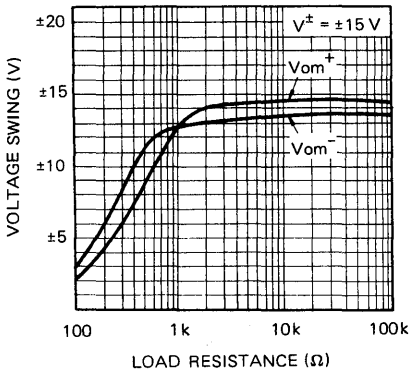
TYPICAL PERFORMANCE CHARACTERISTICS (Ta = 25°C)



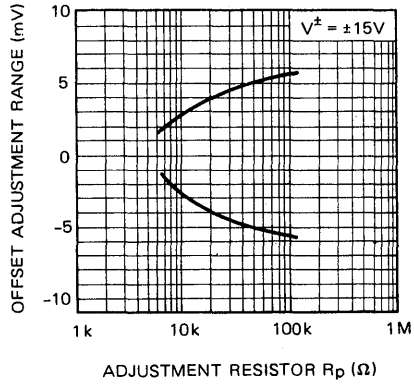
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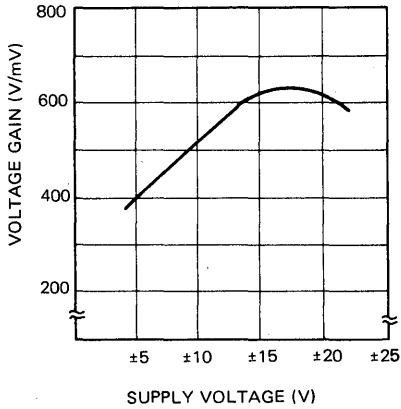
**MAXIMUM OUTPUT VOLTAGE**



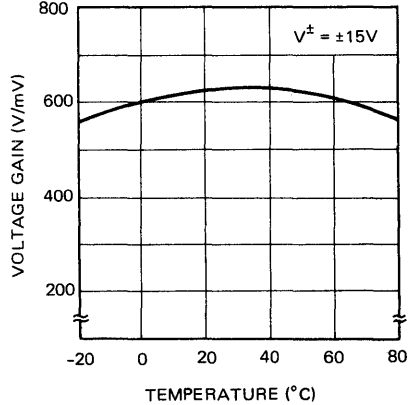
**OFFSET VOLTAGE ADJUSTMENT RANGE**



**VOLTAGE GAIN**



**VOLTAGE GAIN**



## High Performance Quad Operational Amplifiers

### GENERAL DESCRIPTION

The μPC458/4741 are quad operational amplifiers which consist of four independent internally frequency compensated operational amplifiers.

These amplifiers feature AC and DC performance which exceed that of the 741 type amplifiers.

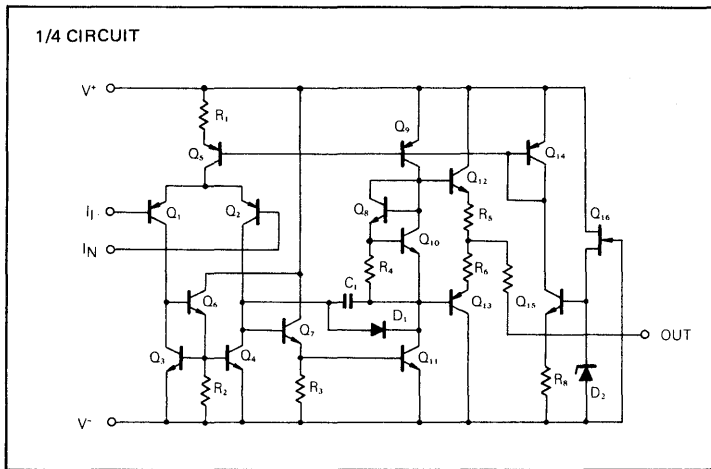
Its superior bandwidth, slewrate and noise characteristics make it an excellent choice for active filter or audio amplifier applications.

Two kinds of ICs are available according to reliability, the μPC458 for industry, the μPC4741 for commercial.

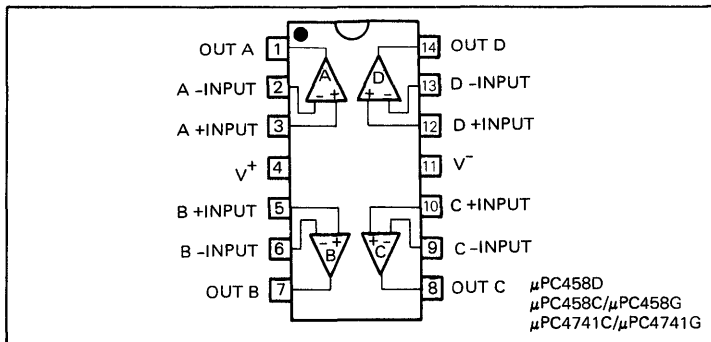
### FEATURES

- Internal Frequency Compensation
- Output Short Circuit Protection
- Large Common Mode and Differential Input Voltage Range
- No Latch Up
- No Crossover Distortion
- Wide Power Supply Range  $\pm 2\text{ V}$  to  $\pm 20\text{ V}$
- HA4741 Direct Replacement

### EQUIVALENT CIRCUIT



### CONNECTION DIAGRAM (Top View)



### ORDERING INFORMATION

μPC458D



14 pin Ceramic DIP  
(Dual In-Line Package)

μPC458C/μPC4741C



14 pin Plastic Molded DIP  
(Dual In-Line Package)

μPC458G/μPC4741G



14 pin Plastic Molded Flat Package  
(MINI FLAT IC)

**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC458	μPC4741	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		40	40	V
Power Dissipation*	D Package	900	—	mW
	C Package	570	570	
	G Package	550	550	
Differential Input Voltage		±30	±30	V
Input Voltage (Note 1)		±15	±15	V
Output Short Circuit Duration (Note 2)		Indefinite	Indefinite	s
Operating Temperature Range	D Package	-20 to +80	—	°C
	C or G Package	-20 to +70	0 to 70	
Storage Temperature Range	D Package	-55 to +150	—	°C
	C or G Package	-55 to +125	-55 to +125	

Note 1 For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

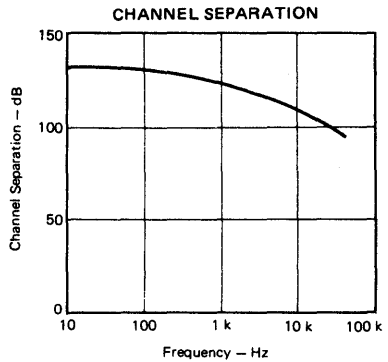
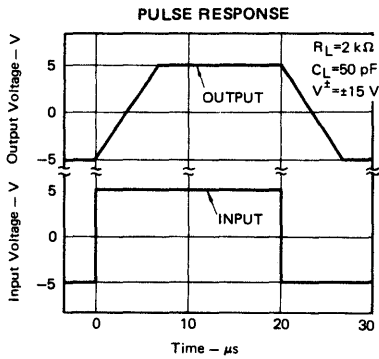
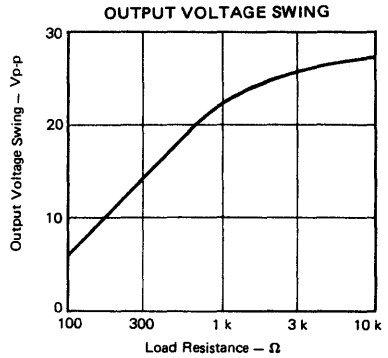
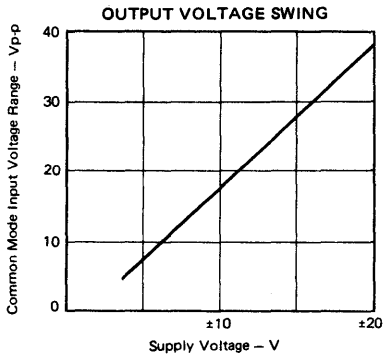
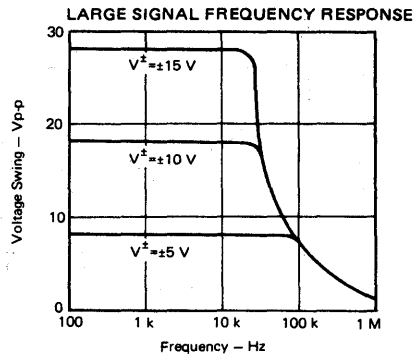
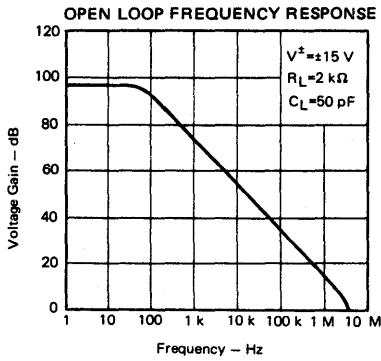
Note 2 Short circuit to ground on one amplifier only.

\* See thermal information in chapter 11.

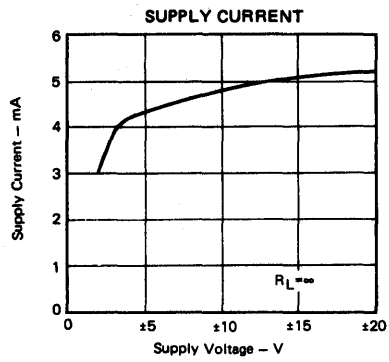
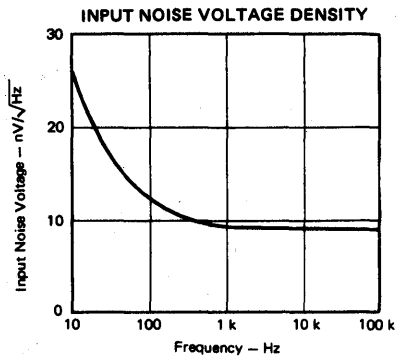
**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		1.0	5.0	mV	R <sub>s</sub> ≤ 100 Ω
Input Offset Current		30	50	nA	
Input Bias Current		100	300	nA	
Large Singal Voltage Gain	25,000	50,000			R <sub>L</sub> ≥ 2 kΩ, V <sub>o</sub> = ±10 V
Power Consumption		150	210	mW	
Common Mode Rejection Ratio	80	90		dB	
Supply Voltage Rejection Ratio		50	100	μV/V	
Output Voltage Swing	±12	±13.7		V	R <sub>L</sub> ≥ 10 kΩ
Output Voltage Swing	±10	±12.5		V	R <sub>L</sub> ≥ 2 kΩ
Common Mode Input Voltage	±12	±14		V	
Slew Rate		1.6		V/μs	A <sub>v</sub> = 1
Input Noise Voltage		9		nV/√Hz	f = 1 kHz
Channel Separation		108		dB	f = 10 kHz

TYPICAL PERFORMANCE CHARACTERISTICS (T<sub>a</sub>=25 °C)



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## J-FET Input Operational Amplifiers

### GENERAL DESCRIPTION

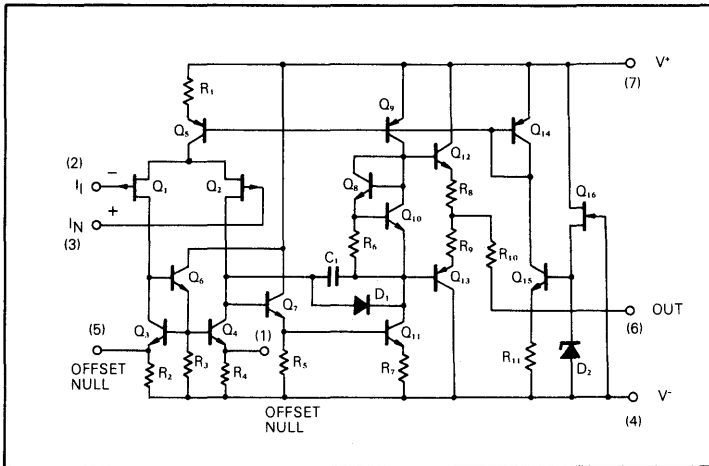
The μPC801/4081, are single operational amplifiers incorporating well matched ion implant P-channel JFET or the same chip with standard bipolar transistors. The key feature of these op amps are very low input bias current and high slew rate ten times faster than conventional general purpose op amps. By these features μPC801/4081 are excellent choice for wide variety of applications including integrator, active filter, pulse amp etc.

Two kinds of ICs are available according to reliability, the μPC801 for industry, the μPC4081 for commercial.



### FEATURES

- Wide Common-Mode and Differential Input Voltage Range
- Low Input Bias and Offset Currents
- Output Short-Circuit Protection
- High Input Impedance . . . . . J-FET INPUT Stage
- Internal Frequency Compensation
- High Slew Rate . . . . . 11 V/μs Typ.
- Latch Up Free Operation
- TL081 Direct Replacement

### EQUIVALENT CIRCUIT

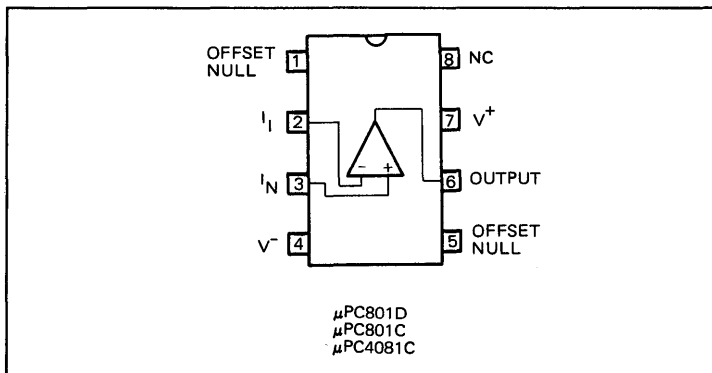


### ORDERING INFORMATION

<p>μPC801D</p>  <p>8 pin Ceramic DIP (Dual In-Line Package)</p>
<p>μPC801C/μPC4081C</p>  <p>8 pin Plastic Molded DIP (Dual In-Line Package)</p>

5

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC801	μPC4081	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	36	V
Power Dissipation*	D Package	500	—	mW
	C Package	350	350	
Differential Input Voltage		±30	±30	V
Input Voltage (Note 1)		±15	±15	V
Output Short Circuit Duration		Indefinite	Indefinite	s
Operating Temperature Range	D Package	-20 to +80	—	°C
	C Package	-20 to +70	0 to 70	
Storage Temperature Range	D Package	-55 to +150	—	°C
	C Package	-55 to +125	-55 to +125	

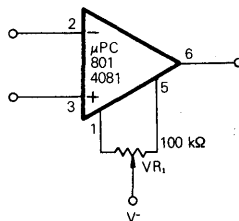
Note 1: For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

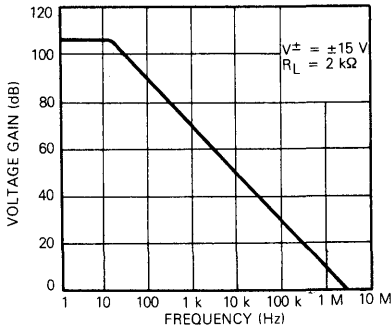
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		5.0	15.0	mV	R <sub>s</sub> ≤ 50Ω
Input Offset Current		5	200	pA	
Input Bias Current		30	400	pA	
Large Signal Voltage gain	25	200		V/mV	R <sub>L</sub> ≥ 2 kΩ, V <sub>o</sub> = ±10 V
Supply Current		2.0	2.8	mA	
Common Mode Rejection Ratio	70	76		dB	
Supply Voltage Rejection Ratio	70	76		dB	
Output Voltage Swing	±12	±13.5		V	R <sub>L</sub> ≥ 10 kΩ
Output Voltage Swing	±10	±12		V	R <sub>L</sub> ≥ 2 kΩ
Common Mode Input Voltage Range	±10			V	
Slew Rate		11		V/μs	A <sub>v</sub> = 1
Input Equivalent Noise Voltage		25		nV/√Hz	f = 1 kHz, R <sub>s</sub> = 100Ω
Unity Gain Bandwidth		3		MHz	
Input Offset Voltage			20	mV	R <sub>s</sub> ≤ 50 Ω Ta = T <sub>opt</sub>
Temperature Coefficient of Input Offset Voltage		10		μV/°C	Ta = T <sub>opt</sub>
Input Bias Current			10	nA	Ta = T <sub>opt</sub>
Input Offset Current			5	nA	Ta = T <sub>opt</sub>
Channel Separation		120		dB	

Input Offset Voltage Null Circuit

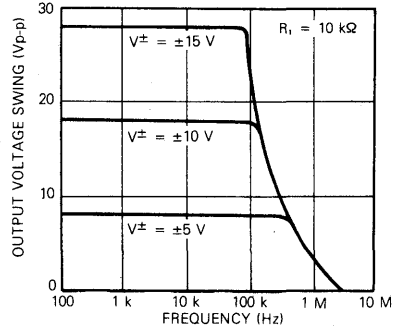


TYPICAL PERFORMANCE CHARACTERISTICS (Ta = 25°C)

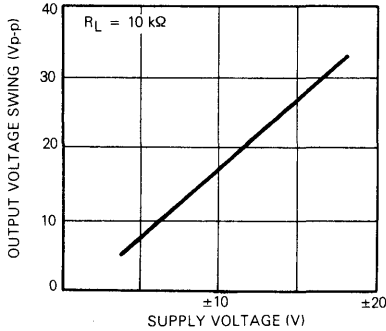
OPEN LOOP FREQUENCY RESPONSE



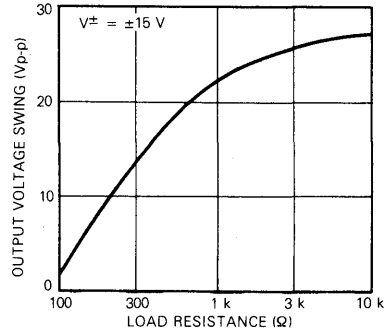
LARGE SIGNAL FREQUENCY RESPONSE



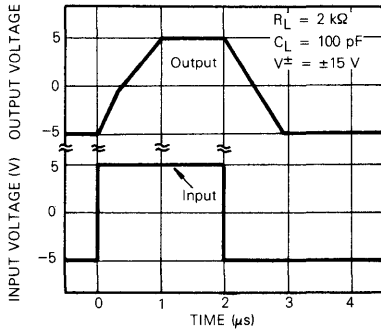
OUTPUT VOLTAGE SWING



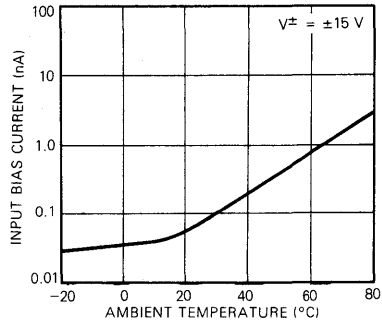
OUTPUT VOLTAGE SWING



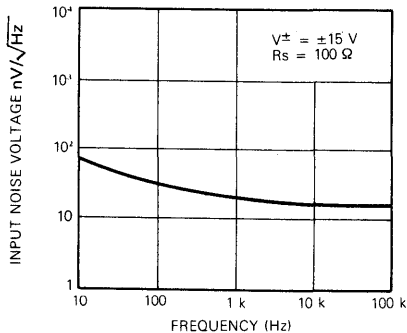
VOLTAGE FOLLOWER PULSE RESPONSE



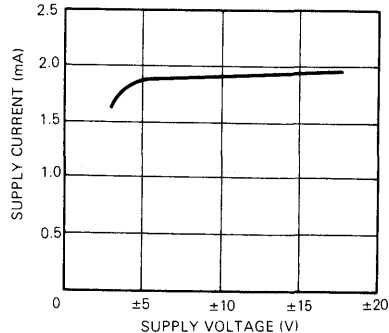
INPUT BIAS CURRENT



INPUT EQUIVALENT NOISE VOLTAGE



SUPPLY CURRENT



5



# μPC802 / 4250

## Programmable Operational Amplifiers

### GENERAL DESCRIPTION

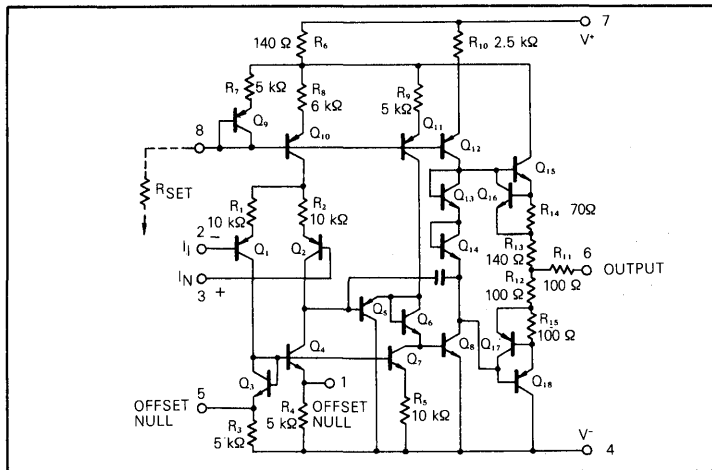
The μPC802/4250 are highly versatile monolithic operational amplifiers. The quiescent power dissipation, input offset and bias current, slew rate and gain-bandwidth product are determined by a single external programming resistor. Since μPC802/4250 are in effect different op amps for each externally programmed set current, it is possible to use a single stock item for a variety of circuit function in a system.

Two kinds of ICs are available according to reliability, the μPC802 for industry, the μPC4250 for commercial.

### FEATURES

- ±1 V to ±18 V Power Supply Operation
- Standby Power Consumption As Low As 500 nW
- Programmable Electrical Characteristics
- Internal Frequency Compensation
- Offset Voltage Nulling Capability
- Short Circuit Protection
- LM4250 Direct Replacement

### EQUIVALENT CIRCUIT



### ORDERING INFORMATION

μPC802C/μPC4250C



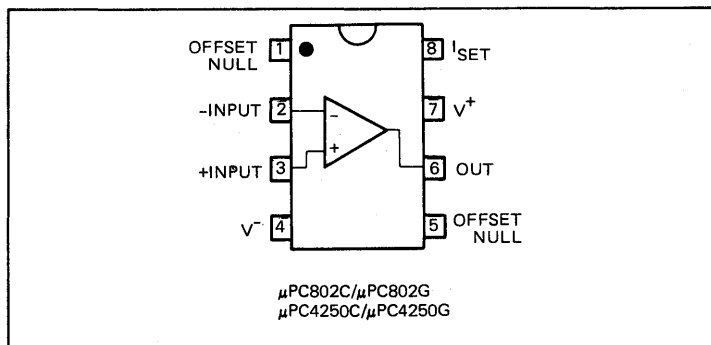
8 pin Plastic Molded DIP  
(Dual In-Line Package)

μPC802G/μPC4250G



8 pin Plastic Molded Flat Package  
(MINI FLAT IC)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC802	μPC4250	UNIT	
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	36	V	
Power Dissipation*	C Package	350	350	mW	
	G Package	440	440		
Differential Input Voltage		±30	±30	V	
Input Voltage (Note 1)		±15	±15	V	
I <sub>SET</sub> Current		150	150	μA	
Output Short Circuit Duration		Indefinite	Indefinite	s	
Operating Temperature Range		C or G Package	-20 to +70	0 to +70	°C
Storage Temperature Range		C or G Package	-55 to +125	-55 to +125	°C

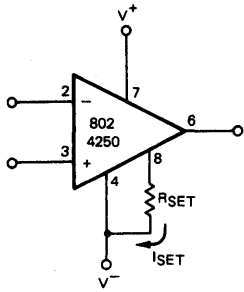
Note 1: For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

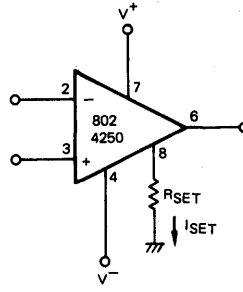
**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	I <sub>SET</sub> = 1 μA		I <sub>SET</sub> = 10 μA		UNIT	CONDITIONS
	MIN.	MAX.	MIN.	MAX.		
Input Offset Voltage		5		6	mV	R <sub>s</sub> ≤ 100 kΩ
		5		6		V <sup>±</sup> = ±1.5 V, R <sub>s</sub> ≤ 100 kΩ
Input Offset Current		6		20	nA	
Input Bias Current		10		75	nA	V <sup>±</sup> = ±1.5 V
		10		75		
Voltage Gain	60,000					V <sub>o</sub> = ±10 V, R <sub>L</sub> = 100 kΩ
			60,000			V <sub>o</sub> = ±10 V, R <sub>L</sub> = 10 kΩ
Supply Current		11		100	μA	V <sup>±</sup> = ±1.5 V
		8		90		
Power Dissipation		330		3,000	μW	V <sup>±</sup> = ±1.5 V
		24		270		
Input Voltage Range	±13.5		±13.5		V	V <sup>±</sup> = ±1.5 V
	±0.6		±0.6			
Output Voltage Swing	±12				V	R <sub>L</sub> = 100 kΩ
	±0.6					V <sup>±</sup> = ±1.5 V, R <sub>L</sub> = 100 kΩ
Output Voltage Swing			±12		V	R <sub>L</sub> = 10 kΩ
			±0.6			V <sup>±</sup> = ±1.5 V, R <sub>L</sub> = 10 kΩ
Common Mode Rejection Ratio	70		70		dB	R <sub>s</sub> ≤ 10 kΩ
Supply Voltage Rejection Ratio	74		74		dB	R <sub>s</sub> ≤ 10 kΩ

**TYPICAL CONNECTIONS**

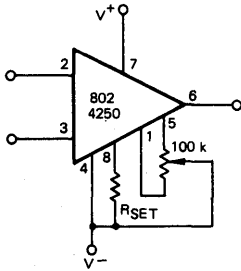


$$I_{SET} = \frac{V^+ + |V^-| - 0.5}{R_{SET}}$$

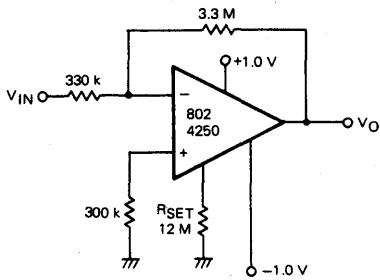


$$I_{SET} \approx \frac{V^+ - 0.5}{R_{SET}}$$

**Offset Null Circuit**

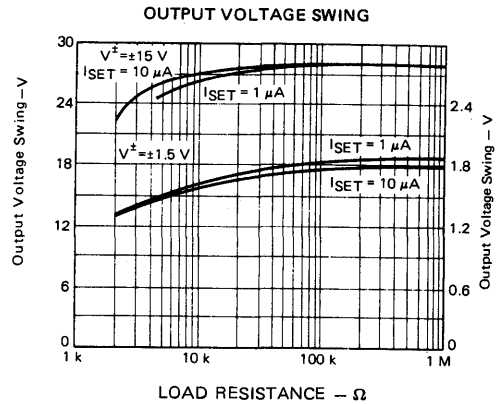
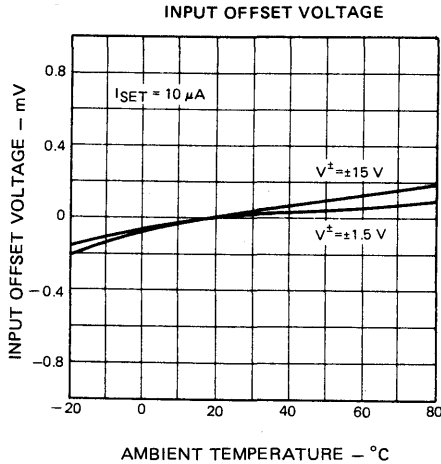
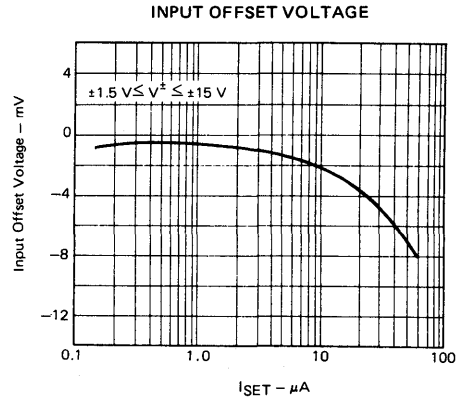
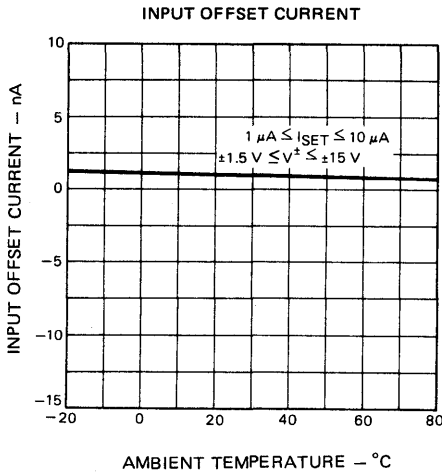
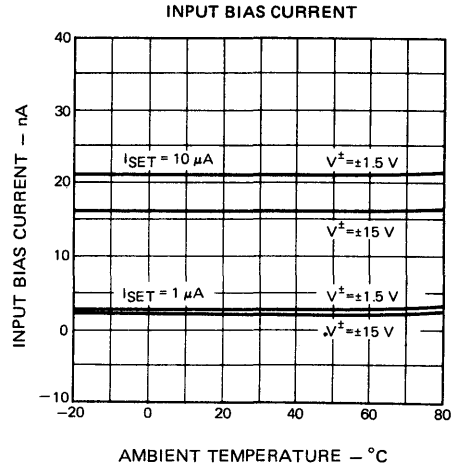
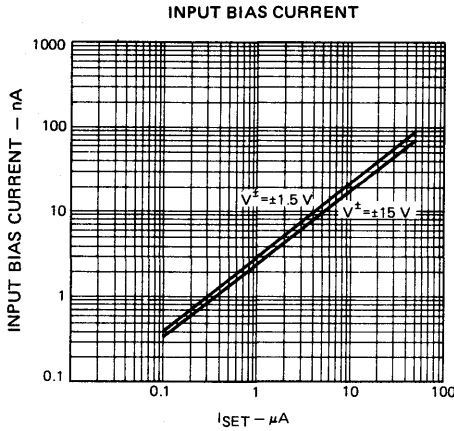


**TYPICAL APPLICATION**



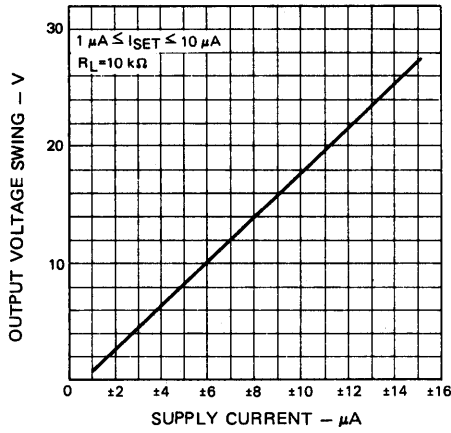
500 Nano-Watt x 10 Amplifier

TYPICAL PERFORMANCE CHARACTERISTICS (Ta=25 °C)

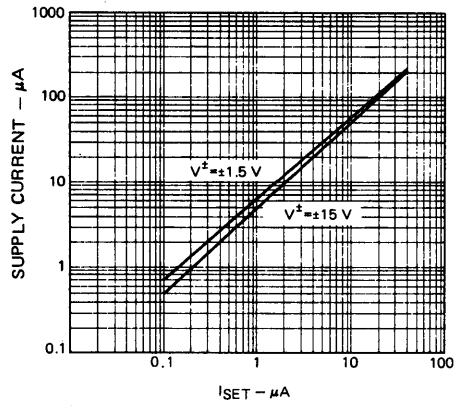


5

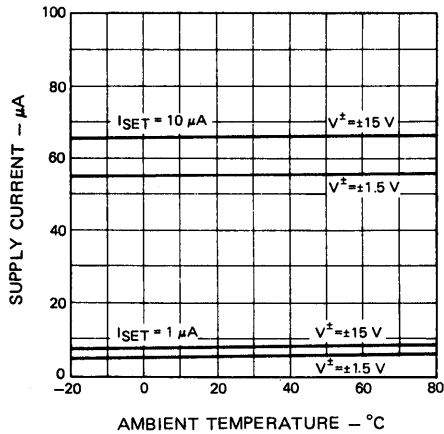
**OUTPUT VOLTAGE SWING**



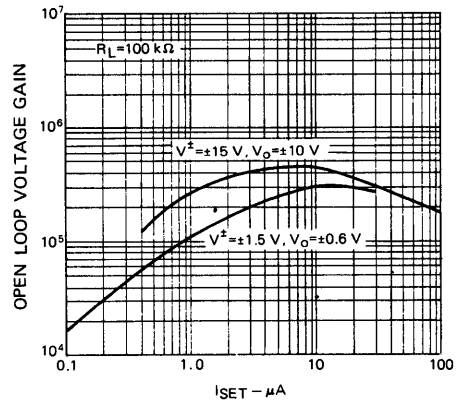
**SUPPLY CURRENT**



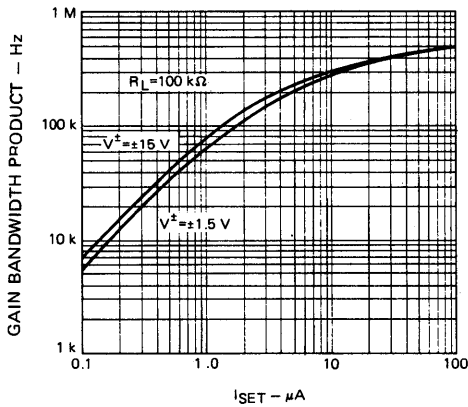
**SUPPLY CURRENT**



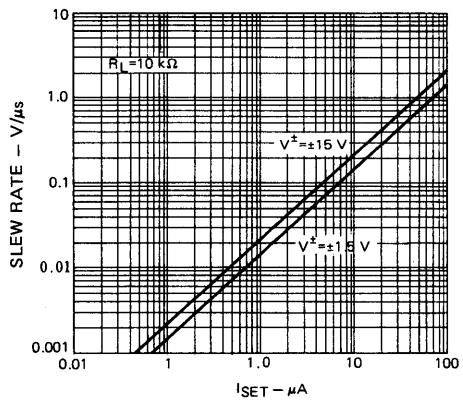
**OPEN LOOP VOLTAGE GAIN**

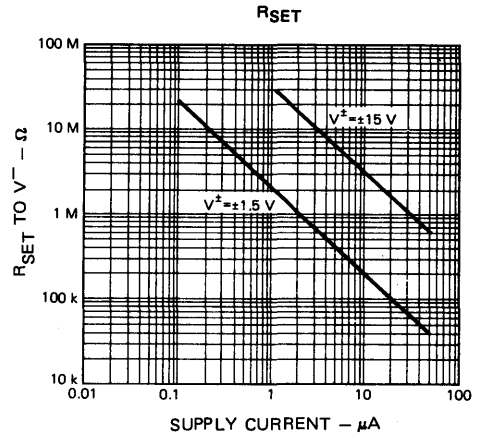
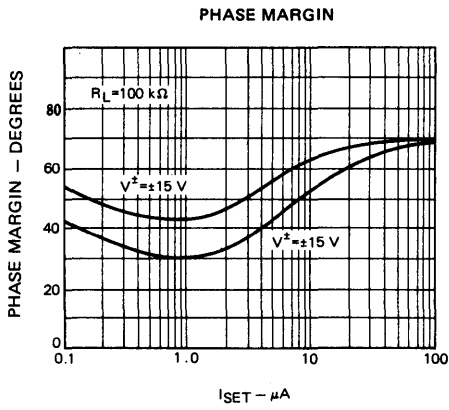


**GAIN BANDWIDTH PRODUCT**



**SLEW RATE**





# μPC803 / 4082

## J-FET Input Dual Operational Amplifiers

### GENERAL DESCRIPTION

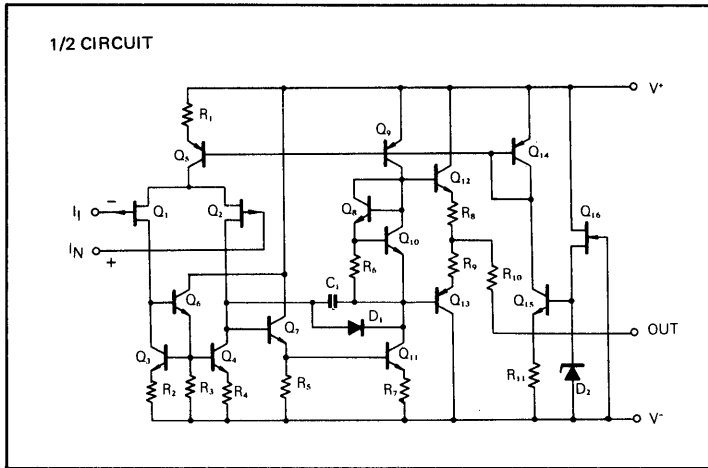
The μPC803, 4082, are dual operational amplifiers incorporating well matched ion implant P-channel JFET on the same chip with standard bipolar transistors. The key feature of these op amps are very low input bias current and high slew rate for 10 times faster than conventional general purpose op amps. By these features the μPC803, 4082 are excellent choice for wide variety of applications including integrator, active filter, pulse amp etc.

The kinds of ICs are available according to reliability, the μPC803 for industry, the μPC4082 for commercial.

### FEATURES

- Wide Common-Mode and Differential Input Voltage Ranges
- Low Input Bias and Offset Currents
- Output Short-Circuit Protection
- High Input Impedance . . . . . J-FET INPUT Stage
- Internal Frequency Compensation
- High Slew Rate . . . . . 11 V/μs Typ.
- Latch Up Free Operation
- TL082 Direct Replacement

### EQUIVALENT CIRCUIT



### ORDERING INFORMATION

μPC803D



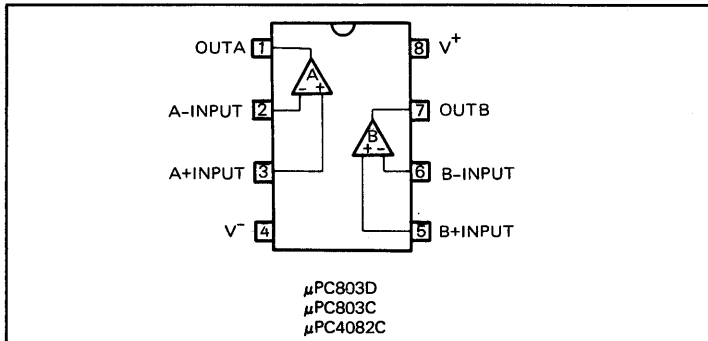
8 pin Ceramic DIP  
(Dual In-Line Package)

μPC803C/μPC4082C



8 pin Plastic Molded DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC803	μPC4082	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	36	V
Power Dissipation *	D Package	500	—	mW
	C Package	350	350	
Differential Input Voltage		±30	±30	V
Input Voltage (Note 1)		±15	±15	V
Output Short Circuit Duration		Indefinite	Indefinite	s
Operating Temperature Range	D Package	-20 to +80	—	°C
	C Package	-20 to +70	0 to +70	
Storage Temperature Range	D Package	-55 to +150	—	°C
	C Package	-55 to +125	-55 to +125	

Note 1: For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

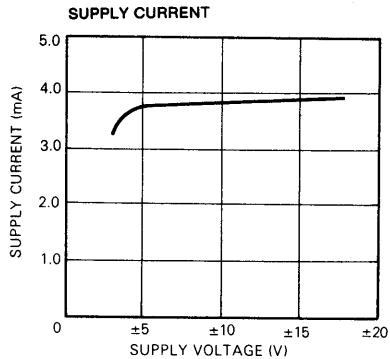
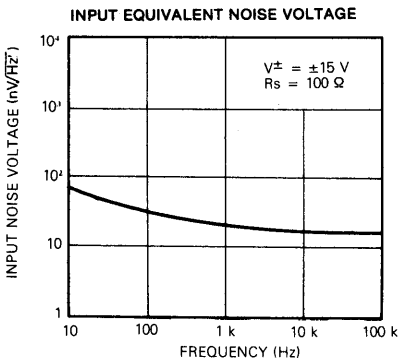
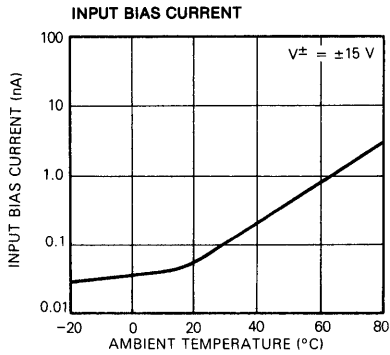
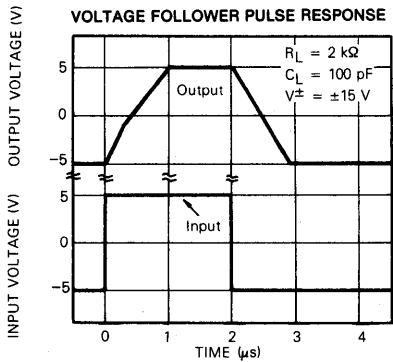
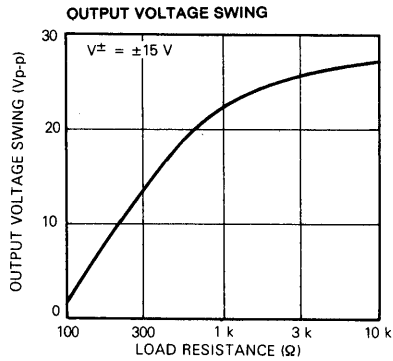
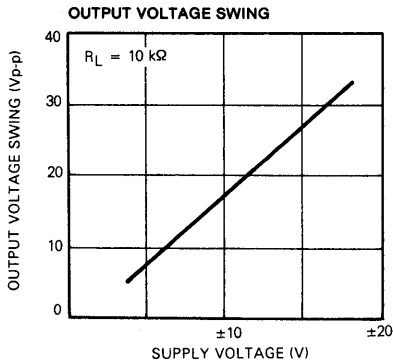
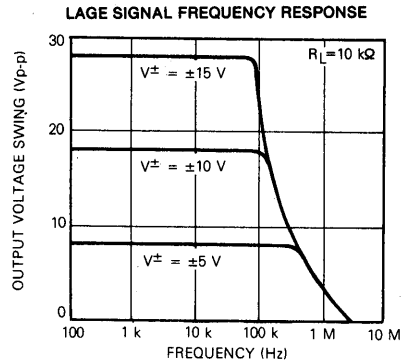
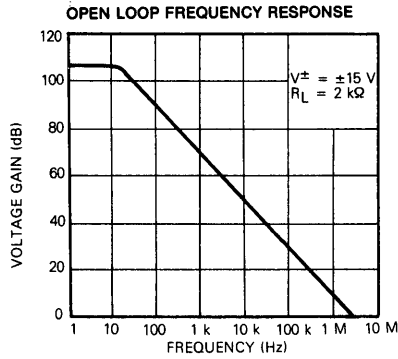
\* See package information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		5.0	15.0	mV	R <sub>s</sub> ≤ 50
Input Offset Current		5	200	pA	
Input Bias Current		30	400	pA	
Large Signal Voltage gain	25	200		V/mA	R <sub>L</sub> ≥ 2 kΩ, V <sub>o</sub> = ±10 V
Supply Current		4.0	5.6	mA	Both Amplifiers
Common Mode Rejection Ratio	70	76		dB	
Supply Voltage Rejection Ratio	70	76		dB	
Output Voltage Swing	±12	±13.5		V	R <sub>L</sub> ≥ 10 kΩ
Output Voltage Swing	±10	±12		V	R <sub>L</sub> ≥ 2 kΩ
Common Mode Input Voltage Range	±10			V	
Slew Rate		11		V/μs	A <sub>v</sub> = 1
Input Equivalent Noise Voltage		25		nV/√Hz	f = 1 kHz, R <sub>s</sub> = 100 Ω
Unity Gain Bandwidth		3		MHz	
Input Offset Voltage			20	mV	R <sub>s</sub> ≤ 50 Ω, Ta = T <sub>opt</sub>
Temperature Coefficient of Input Offset Voltage		10		μV/°C	Ta = T <sub>opt</sub>
Input Bias Current			10	nA	Ta = T <sub>opt</sub>
Input Offset Current			5	nA	Ta = T <sub>opt</sub>
Channel Separation		120		dB	



**TYPICAL PERFORMANCE CHARACTERISTICS (Ta = 25°C)**



## J-FET Input Quad Operational Amplifiers

### GENERAL DESCRIPTION

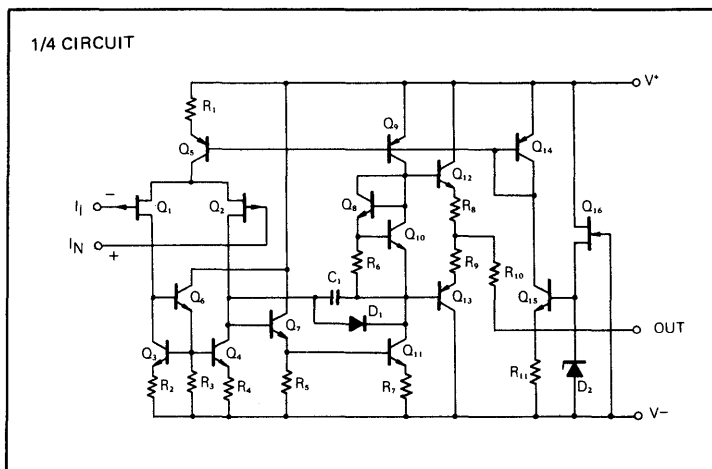
The μPC804, 4084, are quad operational amplifiers incorporating well matched ion implant P-channel JFET on the same chip with standard bipolar transistors. The key features of these op amps are very low input bias current and high slew rate ten times faster than conventional general purpose op amps. By these features μPC804, 4084, are excellent choices for wide variety of applications including integrator, active filter, pulse amp, etc.

Two kinds of ICs are available according to reliability, the μPC804 for industry, the μPC4084 for commercial.

### FEATURES

- Wide Common-Mode and Differential Input Voltage Ranges
- Low Input Bias and Offset Currents
- Output Short-Circuit Protection
- High Input Impedance . . . J-FET INPUT Stage
- Internal Frequency Compensation
- High Slew Rate . . . 11 V/μs Typ.
- Latch Up Free Operation
- TL 084 Direct Replacement

### EQUIVALENT CIRCUIT



### ORDERING INFORMATION

μPC804D



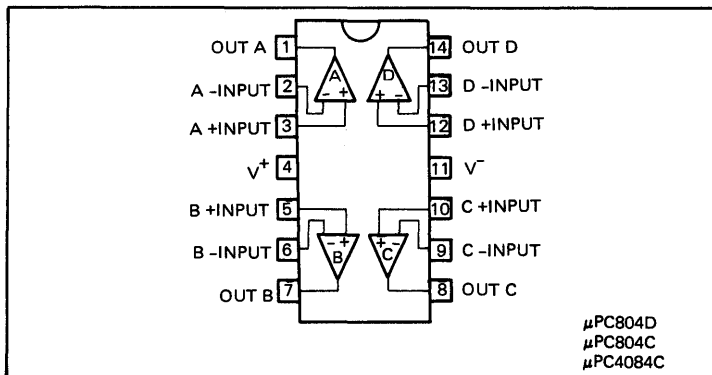
14 pin Ceramic DIP  
(Dual In-Line Package)

μPC804C/μPC4084C



14 pin Plastic Molded DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER			μPC804	μPC4084	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>			36	36	V
Power Dissipation*	D Package		900	—	mW
	C Package		570	570	
Differential Input Voltage			±30	±30	V
Input Voltage (Note 1)			±15	±15	V
Output Short Circuit Duration			Indefinite	Indefinite	s
Operating Temperature Range	D Package		-20 to +80	—	°C
	C Package		-20 to +70	0 to +70	
Storage Temperature Range	D Package		-55 to +150	—	°C
	C Package		-55 to +125	-55 to +125	

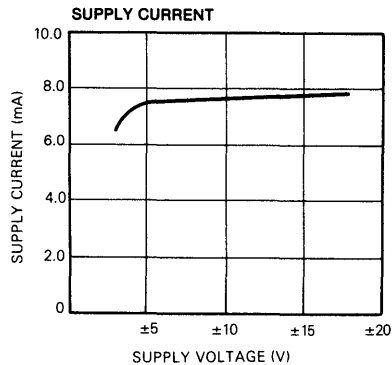
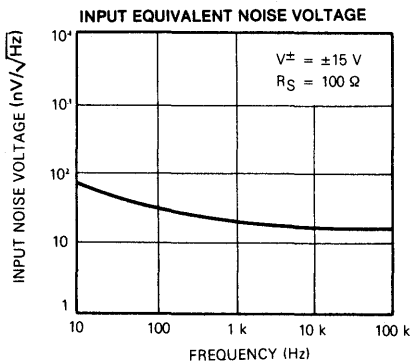
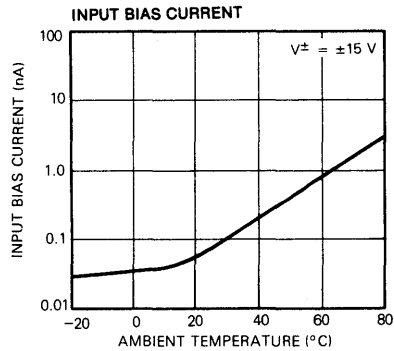
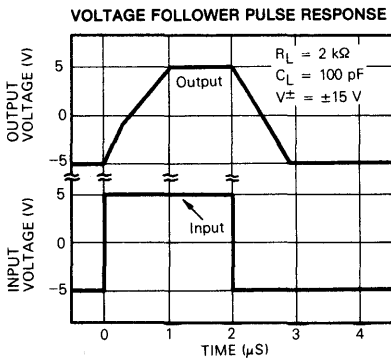
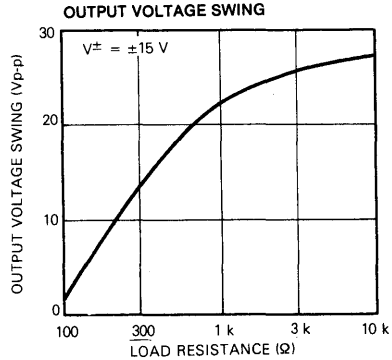
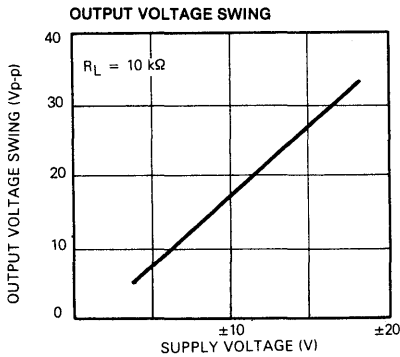
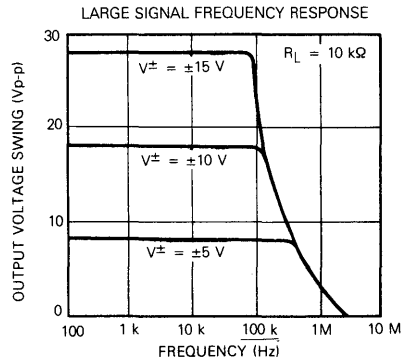
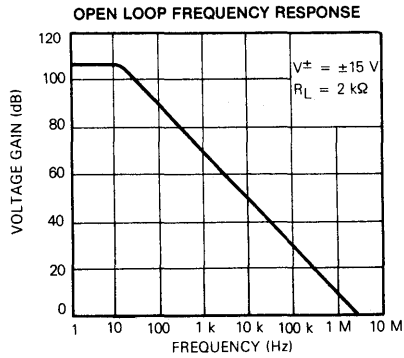
Note 1. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		5.0	15.0	mV	Rs ≤ 50Ω
Input Offset Current		5	200	pA	
Input Bias Current		30	400	pA	
Large Signal Voltage Gain	25	200		V/mV	RL ≥ 2 kΩ, Vo = ±10 V
Supply Current		8.0	11.2	mA	All Amplifiers
Common Mode Rejection Ratio	70	76		dB	
Supply Voltage Rejection Ratio	70	76		dB	
Output Voltage Swing	±12	±13.5		V	RL ≥ 10 kΩ
Output Voltage Swing	±10	±12		V	RL ≥ 2 kΩ
Common Mode Input Voltage Range	±10			V	
Slew Rate		11		V/μs	Av = 1
Input Equivalent Noise Voltage		25		nV√Hz	f = 1 kHz, Rs = 100 Ω
Unity Gain Bandwidth		3		MHz	
Input Offset Voltage			20	mV	Rs ≤ 50Ω Ta = Topt
Temperature Coefficient of Input Offset Voltage		10		μV/°C	Ta = Topt
Input Bias Current			10	nA	Ta = Topt
Input Offset Current			5	nA	Ta = Topt
Channel Separation		120		dB	

TYPICAL PERFORMANCE CHARACTERISTICS ( $T_a = 25^\circ\text{C}$ )



5

# μPC1251 / 358

## Low Power Dual Operational Amplifiers

### GENERAL DESCRIPTION

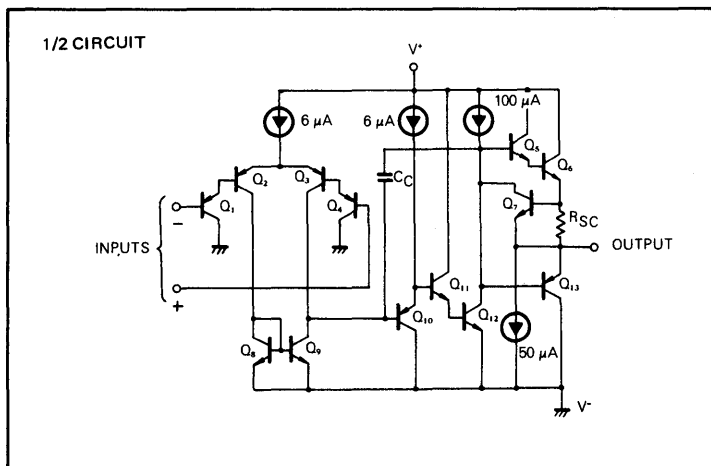
The μPC1251/358 are dual operational amplifiers which are designed to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the power supply current drain is very low. Further advantage, the input common-mode voltage includes ground and the output voltage can also swing to ground in the linear mode.

Two kinds of ICs are available according to reliability, the μPC1251 for industry, the μPC358 for commercial.

### FEATURES

- Internal Frequency Compensation
- Large Output Voltage Swing  
0 V to  $V^+ - 1.5$  V DC
- Input Common-Mode Voltage Range Includes Ground
- Wide Power Supply Range  
Single Supply 3 V to 30 V DC
- Dual Supplies  $\pm 1.5$  V to  $\pm 15$  V DC
- Low Power Consumption
- LM358 Direct Replacement

### EQUIVALENT CIRCUIT



### ORDERING INFORMATION

μPC1251D



8 pin Ceramic DIP  
(Dual In-Line Package)

μPC1251C/μPC358C



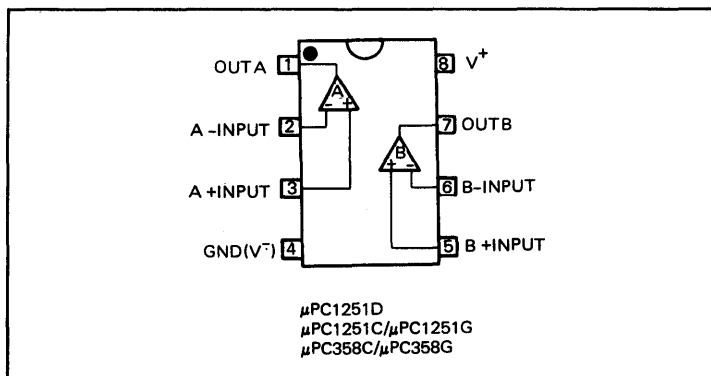
8 pin Plastic Molded DIP  
(Dual In-Line Package)

μPC1251G/μPC358G



8 pin Plastic Molded Flat Package  
(MINI FLAT IC)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC1251	μPC358	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		32	32	V
Differential Input Voltage		32	32	V
Input Voltage		-0.3 to +32	-0.3 to +32	V
Power Dissipation*	D Package	500	-	mW
	C Package	350	350	
	G Package	440	440	
Output Short Circuit Duration		Indefinite	Indefinite	s
Operating Temperature Range	D Package	-20 to +80	-	°C
	C or G Package	-20 to +70	0 to +70	
Storage Temperature Range	D Package	-55 to +150	-	°C
	C or G Package	-55 to +125	-55 to +125	

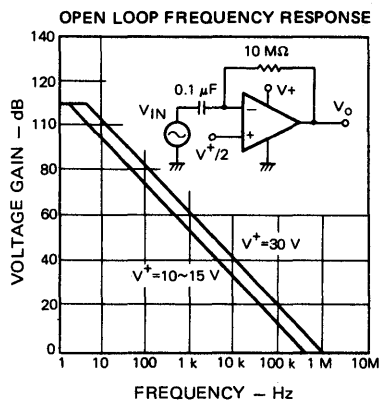
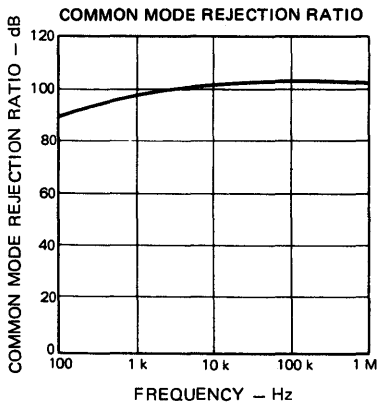
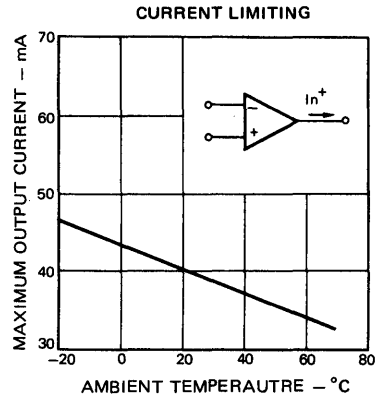
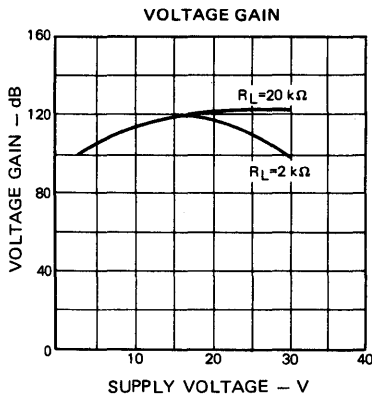
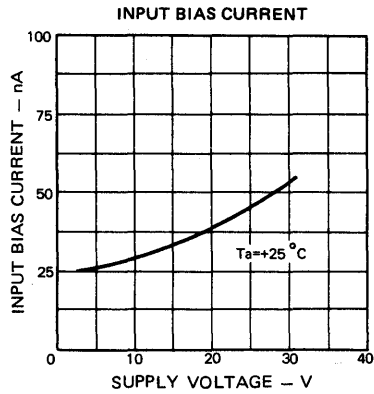
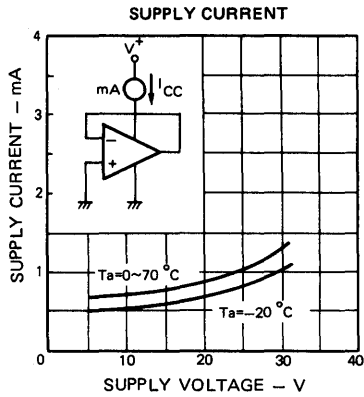
\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>+</sup> = +5 V)**

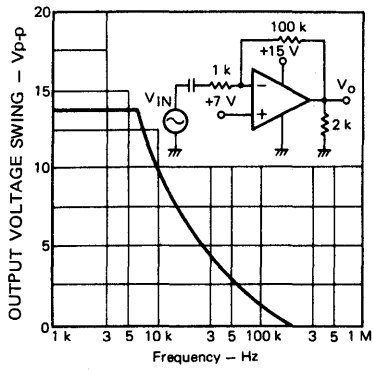
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		2	7	mV	Rs = 0 Ω
Input Bias Current		45	250	nA	
Input Offset Current		5	50	nA	
Common Mode Input Voltage Range	0		V <sup>+</sup> - 1.5	V	
Supply Current		0.7	1.2	mA	RL = ∞ on All Op Amps
Voltage Gain	25	100		V/mV	RL ≥ 2k Ω
Output Voltage Swing	0		V <sup>+</sup> - 1.5	V	RL = 2 kΩ
Common Mode Rejection Ratio	65	70		dB	
Supply Voltage Rejection Ratio	65	100		dB	
Channel Separation		120			f = 1 kHz to 20 kHz
Output Current (SOURCE)	20	40		mA	V <sub>IN<sup>+</sup></sub> = 1 V, V <sub>IN<sup>-</sup></sub> = 0 V
Output Current (SINK)	10	20		mA	V <sub>IN<sup>-</sup></sub> = 1 V, V <sub>IN<sup>+</sup></sub> = 0 V
	12	50		μA	V <sub>IN<sup>-</sup></sub> = 1 V, V <sub>IN<sup>+</sup></sub> = 0 V, Vo = 200 mV



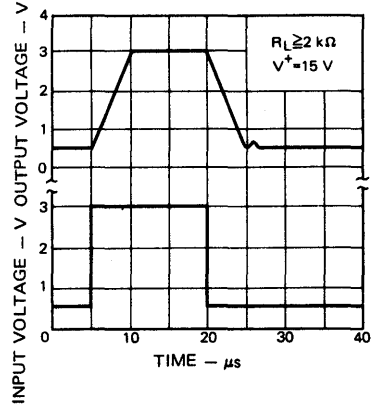
**TYPICAL PERFORMANCE CHARACTERISTICS (T<sub>a</sub>=25 °C)**



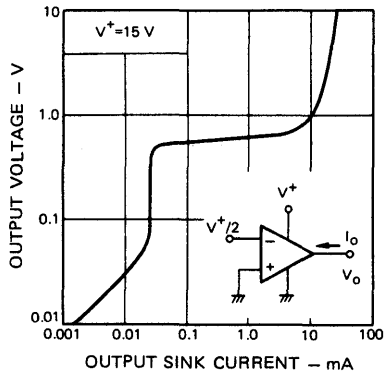
LARGE SIGNAL FREQUENCY RESPONSE



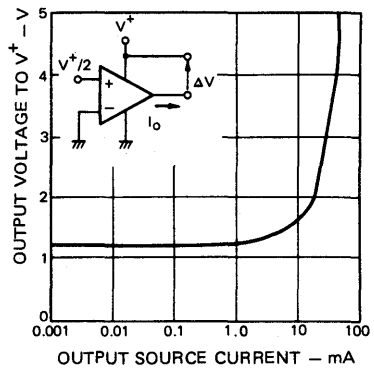
VOLTAGE FOLLOWER PULSE RESPONSE



CURRENT SINKING



CURRENT SOURCING



5



# μPC4556

## High Performance Dual Decompensated Operational Amplifier

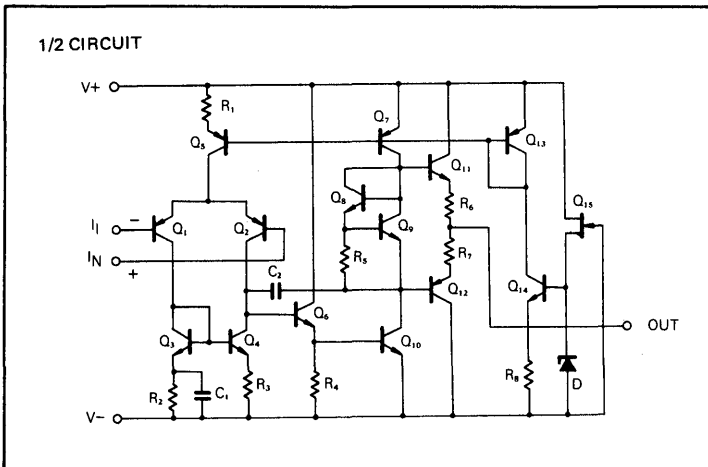
### GENERAL DESCRIPTION

The μPC4556 is a dual operational amplifier which features further advanced A.C. performance than that of the 4558 type. Decompensation characteristic guarantees 20 MHz G.B. product higher than 20 dB. Low input noise and high output current drive capability also make this device the optimum choice for audio application.

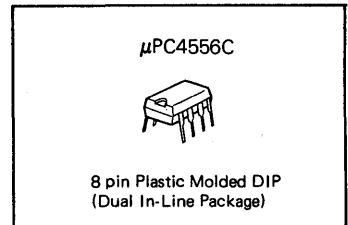
### FEATURES

- Gain-bandwidth products = 20 MHz ( $A_v \geq 20$  dB)
- High slew rate 5 V/μs
- Low input noise voltage 6 μVp-p
- Decompensated frequency characteristics
- Large Common Mode and Differential Input Voltages.

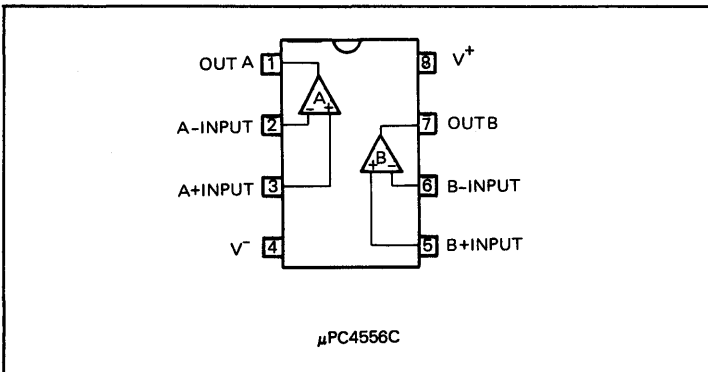
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC4556	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	V
Power Dissipation (Note 1)	C Package	700	mW
Differential Input Voltage		±30	V
Input Voltage (Note 2)		±15	V
Output Short Circuit Duration		5	s
Operating Temperature Range	C Package	0 to +70	°C
Storage Temperature Range	C Package	-55 to +125	°C

Note 1. When the ambient temperature is more than 25°C, derate linearly at 7mW/°C (Tj MAX = 125°C).

See thermal information in chapter 11.

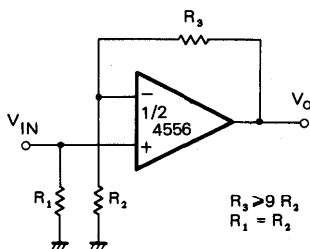
Note 2. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

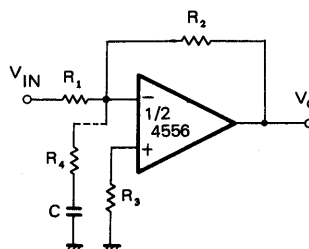
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		0.5	6.0	mV	Rs ≤ 10 kΩ
Input Offset Current		5	200	nA	
Input Bias Current		180	500	nA	
Voltage Gain	20,000	100,000			RL ≥ 2 kΩ, Vo = ±10 V
Power Dissipation		90	170	mW	Both Channel
Common Mode Rejection Ratio	70	90		dB	Rs ≤ 10 kΩ
Supply Voltage Rejection Ratio		30	150	μV/V	Rs ≤ 10 kΩ
Output Voltage Swing	±12	±14		V	RL ≥ 2 kΩ
Output Voltage Swing	±10	±11.5		V	Io = ±25 mA
Common Mode Input Voltage Range	±12	±14		V	
Slew Rate		5		V/s	Av ≥ 10 (20 dB)
Input Noise Voltage		6		μVp-p	Rs = 1 kΩ, f = 1 Hz ~ 1 kHz
Channel Separation		105		dB	f = 1 kHz

**TYPICAL APPLICATION**

Noninverting Amplifier



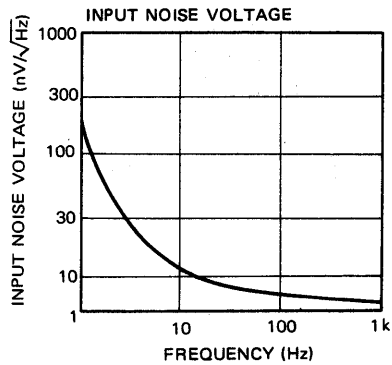
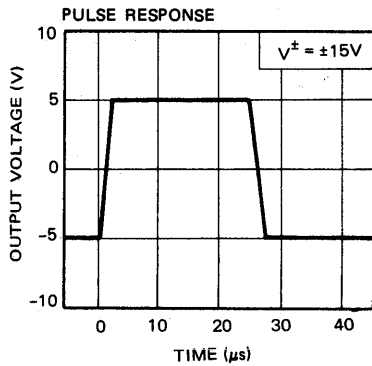
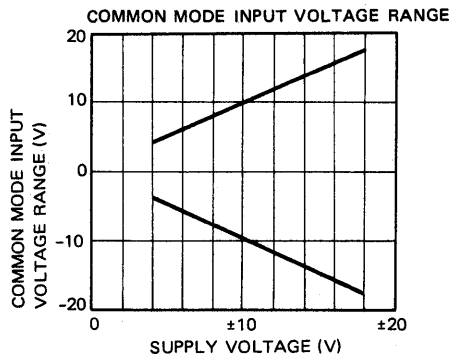
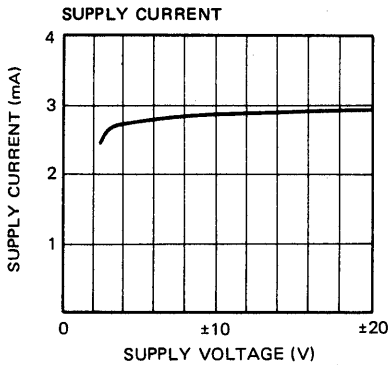
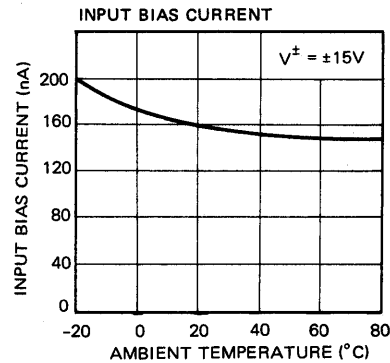
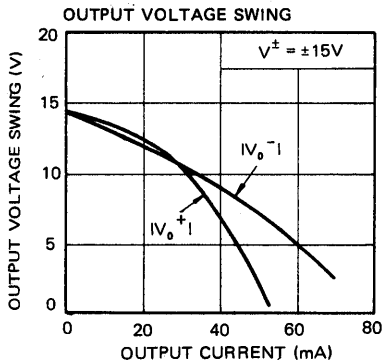
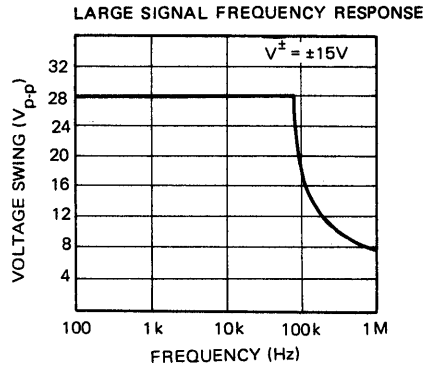
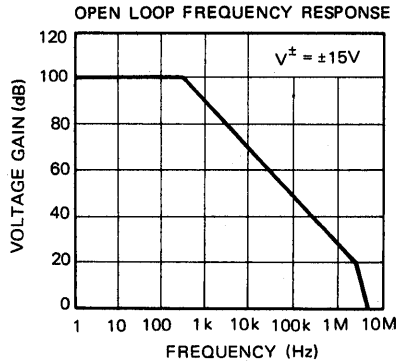
Inverting Amplifier



R<sub>4</sub>, C are necessary when R<sub>2</sub> < 10R<sub>1</sub>  
 $R_4 < \frac{1}{9} R_2$   
 $C > \frac{R_2/R_4}{2 R_4 \cdot 5\text{MHz}}$

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**TYPICAL PERFORMANCE CHARACTERISTICS (T<sub>a</sub> = 25°C)**



## High Performance Dual Operational Amplifier

### GENERAL DESCRIPTION

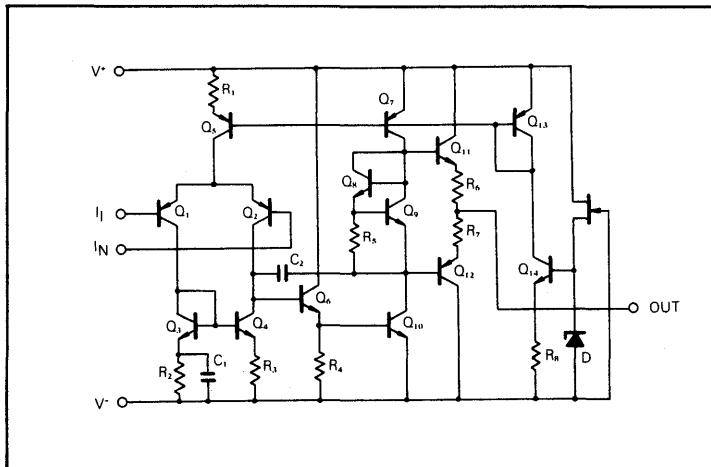
The μPC4557 is a dual operational amplifier which features higher output current drive capability than that of the μPC4558.

For this feature, this device can drive head phone speaker directly. The other characteristic like low noise and no cross over distortion make this device the optimum choice for audio applications.

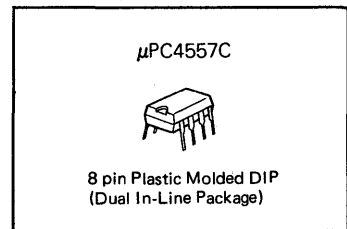
### FEATURES

- Internal Frequency Compensation
- Large Common-Mode and Differential Input Voltage Ranges
- No Latch up
- Low Noise

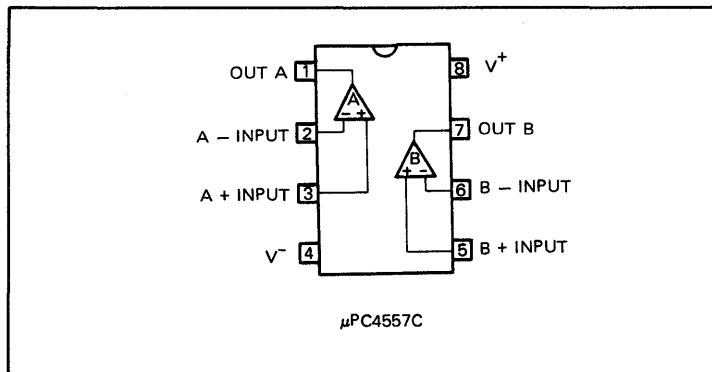
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC4557	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	V
Power Dissipation (Note 1)	C Package	700	mW
Differential Input Voltage		±30	V
Input Voltage (Note 2)		±15	V
Output Short Circuit Duration		5	s
Operating Temperature Range	C Package	0 to +70	°C
Storage Temperature Range	C Package	-55 to +125	°C

Note 1. When the ambient temperature is more than 25°C, derate linearly at 7mW/°C, (Ti MAX = 125°C).

See thermal information in chapter 11.

Note 2. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		0.5	6.0	mV	Rs ≤ 10 kΩ
Input Offset Current		5	200	nA	
Input Bias Current		60	500	nA	
Large Signal Voltage Gain	20,000	100,000			RL ≥ 2 kΩ, Vo = ±10 V
Power Consumption		90	170	mW	Both Channel
Common Mode Rejection Ratio	70	90		dB	Rs ≤ 10 kΩ
Supply Voltage Rejection Ratio		30	150	μV/V	Rs ≤ 10 kΩ
Output Voltage Swing	±12	±14		V	Rs ≥ 2 kΩ
	±10	±11.5		V	Io = ±25 mA
Common-Mode Input Voltage Range	±12	±14		V	
Slew Rate		1.0		V/μs	Av = 1
Input Noise Voltage		6		μVp-p	Rs = 1 kΩ, f = 1 Hz ~ 1 kHz
Channel Separation		105		dB	f = 1 kHz

Fig. 1 Noise Measurement Circuit

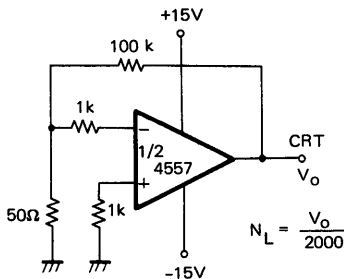
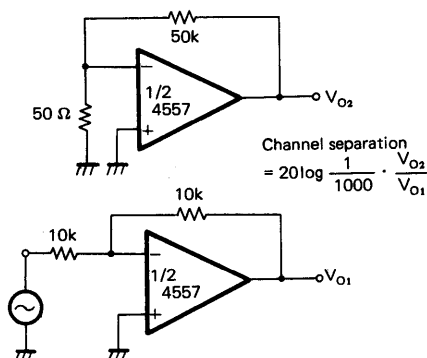
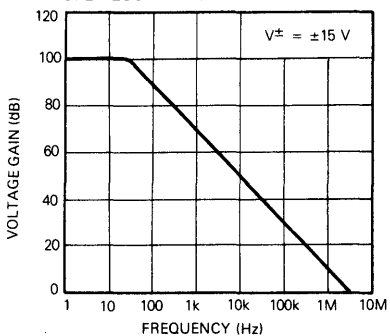


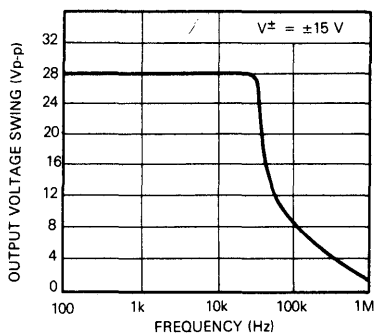
Fig. 2 Channel Separation Measurement Circuit



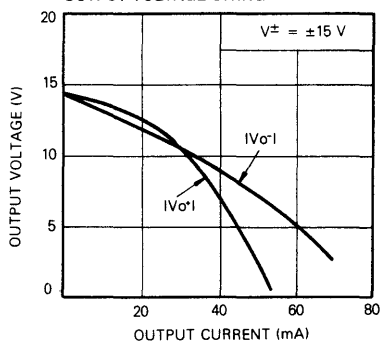
OPEN LOOP FREQUENCY RESPONSE



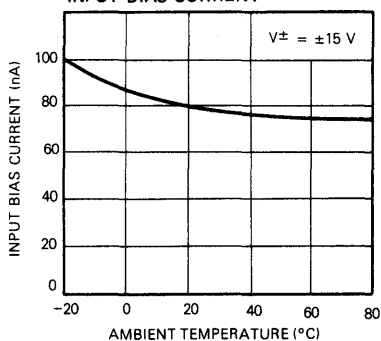
LARGE SIGNAL FREQUENCY RESPONSE



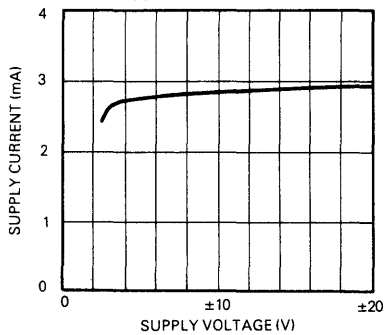
OUTPUT VOLTAGE SWING



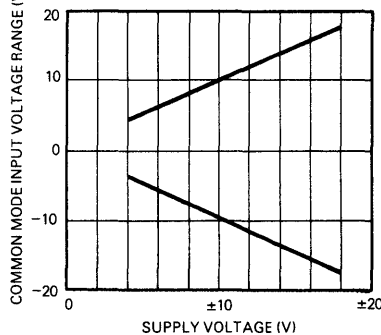
INPUT BIAS CURRENT



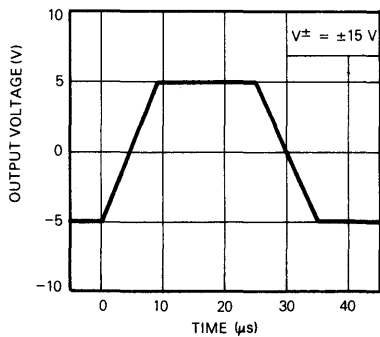
SUPPLY CURRENT



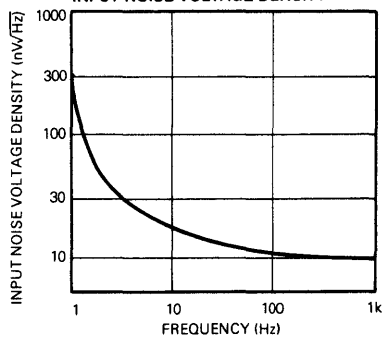
COMMON MODE INPUT VOLTAGE RANGE



VOLTAGE FOLLOWER PULSE RESPONSE

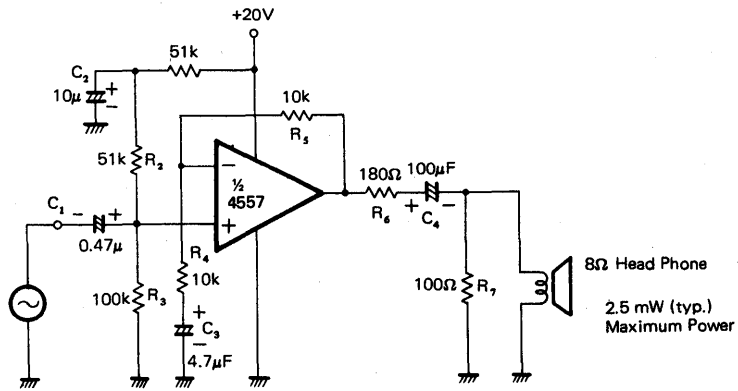


INPUT NOISE VOLTAGE DENSITY



5

**HEAD PHONE AMP CIRCUIT**



Input		Output
dBm	Vr.m.s.	mW
+6	1.55	2.0
0	0.775	0.5
-6	0.388	0.125

Sine Wave

8Ω Head Phone  
2.5 mW (typ.)  
Maximum Power

NEC cannot assume any responsibility for any circuits shown or represent that they are free from patent infringement.

## High Performance Dual Operational Amplifier

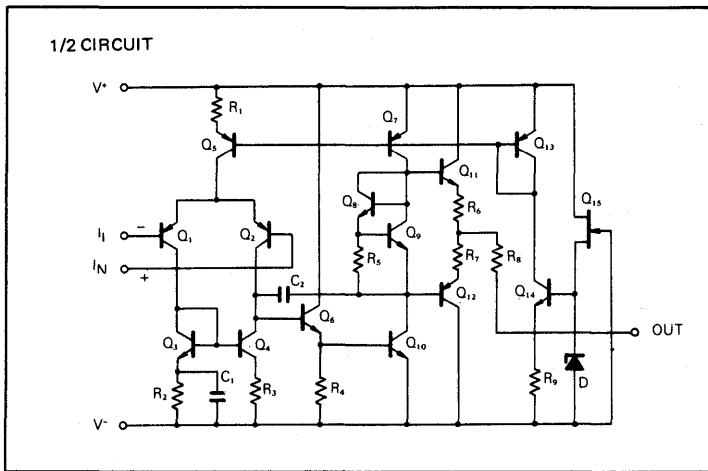
### GENERAL DESCRIPTION

The μPC4559 is a dual operational amplifier having better slewrate and bandwidth than the μPC 4558C with satisfying unity gain frequency compensation. Having low noise characteristics, this device is very convenient to make active filters and other audio application circuits.

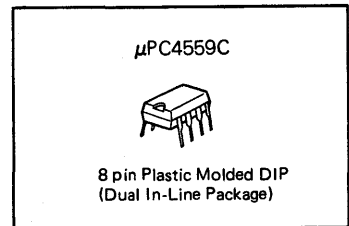
### FEATURES

- Internal Frequency Compensation
- Large Common Mode and Differential Input Voltage Range
- No Latch up
- Low Noise
- Output Short Circuit Protection
- RC4559 Direct Replacement

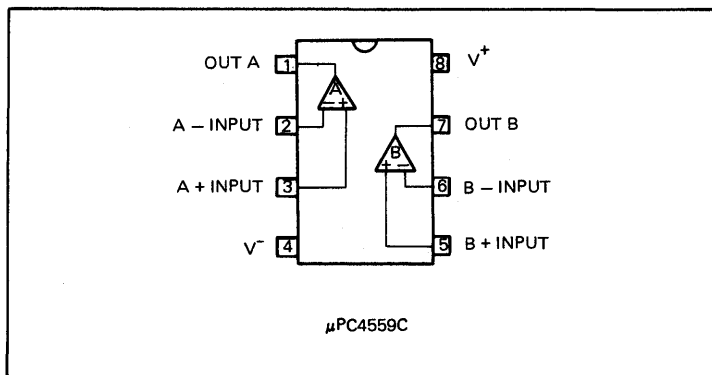
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



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**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC4559	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	V
Power Dissipation *	C Package	350	mW
Differential Input Voltage		±30	V
Input Voltage (Note 1)		±15	V
Output Short Circuit Duration		Indefinite	s
Operating Temperature Range	C Package	0 to +70	°C
Storage Temperature Range	C Package	-55 to +125	°C

Note 1. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		0.5	6.0	mV	Rs ≤ 10 kΩ
Input Offset Current		5	200	nA	
Input Bias Current		60	500	nA	
Large Signal Voltage Gain	20,000	100,000			RL ≥ 2 kΩ, Vo = ±10 V
Power Consumption		90	170	mW	
Common Mode Rejection Ratio	70	90		dB	Rs ≤ 10 kΩ
Supply Voltage Rejection Ratio		30	150	μV/V	Rs ≤ 10 kΩ
Output Voltage Swing	±12	±14		V	Rs ≥ 10 kΩ
	±10	±13		V	Rs ≥ 2 kΩ
Common-Mode Input Voltage Range	±12	±14		V	
Slew Rate		2.0		V/μs	Av = 1
Input Noise Voltage		6		μVp-p	Rs = 1 kΩ, f = 1 Hz ~ 1 kHz
Channel Separation		105		dB	f = 1 kHz

Fig. 1 Noise Measurement Circuit

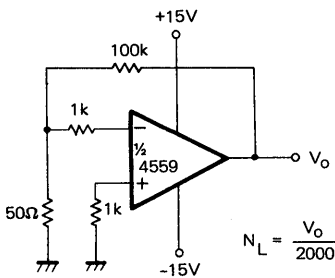
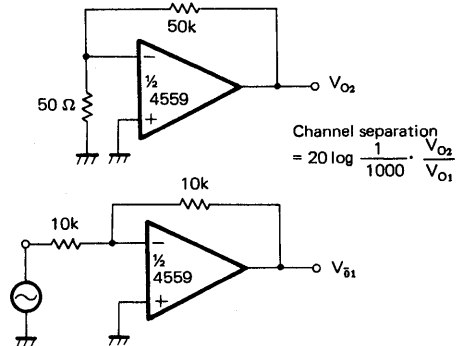
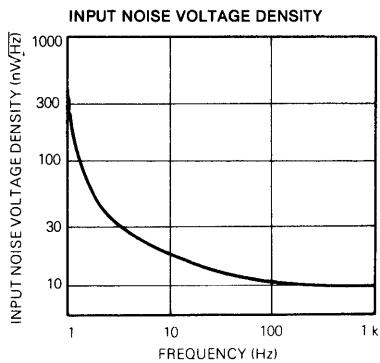
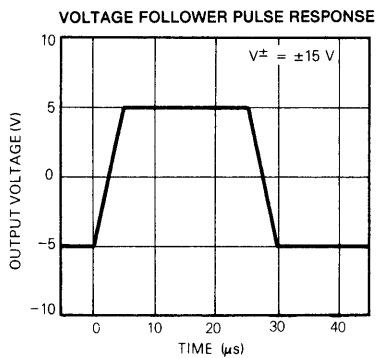
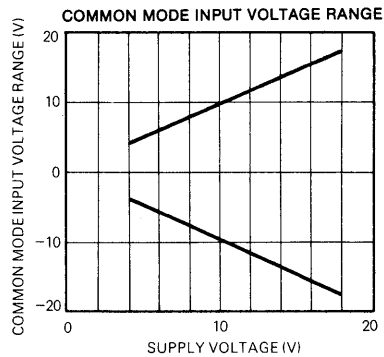
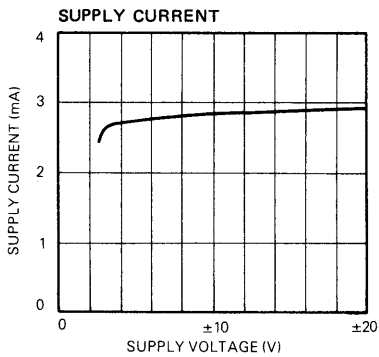
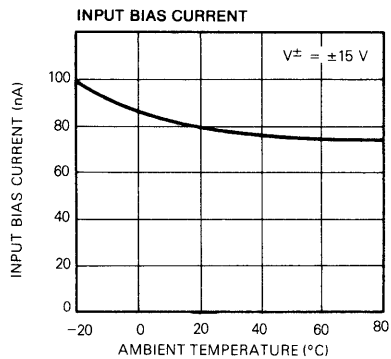
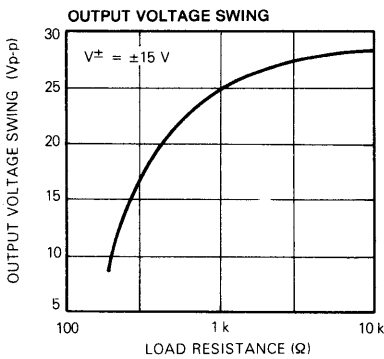
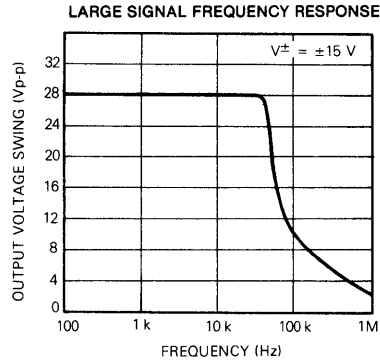
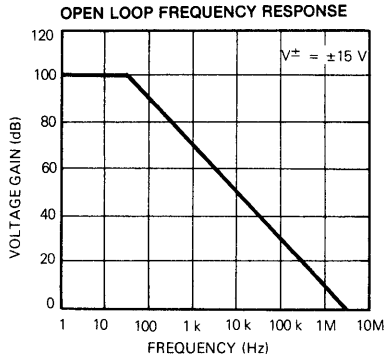


Fig. 2 Channel Separation Measurement Circuit





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$\mu$ PC177, $\mu$ PC339 ..... Low Power Quad Comparator .....	137

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## DEFINITIONS

### Input Offset Voltage

The voltage between the input terminals when the output is within a specified voltage range.

### Input Bias Current

The base current of the input transistor.

### Input Offset Current

The difference in the currents into the two input terminals when the output is within a specified voltage range.

### Voltage Gain

The ratio of the change in output voltage to the change in input voltage producing it.

### Common Mode Rejection Ratio

The ratio of the input voltage range to the maximum change in input offset voltage over this range.

### Supply Voltage Rejection Ratio

The ratio of the change in input offset voltage to the change in supply voltage producing it.

### Input Voltage Range

The range of common mode voltage on the input terminals for which operation within specifications is assured.

### Output Leakage Current

The current into the output terminal with a given output voltage and input drive equal to or greater than a specified value.

### Output Sink Current

The maximum negative current that can be delivered by the comparator.

### Saturation Voltage

The low output voltage level with a given sink current.

### Overdrive

The input step voltage of specified size drives the comparator from some initial input voltage to an input level just barely in excess of that required to bring the output from its high or low state to the logic threshold voltage.

## SELECTION GUIDE

DEVICE	ORIGINAL	Operating Temperature Range [°C]	DESCRIPTION	PACKAGE
$\mu$ PC271C $\mu$ PC271ED $\mu$ PC271G $\mu$ PC311C $\mu$ PC311G	311	-20 ~ +70 -20 ~ +80 -20 ~ +70 0 ~ +70 0 ~ +70	Single High Speed Precision	8 Pin Molded DIP 8 Pin Cavity DIP 8 Pin Molded Flat 8 Pin Molded DIP 8 Pin Molded Flat
$\mu$ PC272C $\mu$ PC272D $\mu$ PC272G $\mu$ PC319C $\mu$ PC319G	319	-20 ~ +70 -20 ~ +80 -20 ~ +70 0 ~ +70 0 ~ -70	Dual High Speed	14 Pin Molded DIP 14 Pin Cavity DIP 14 Pin Molded Flat 14 Pin Molded DIP 14 Pin Molded Flat
$\mu$ PC277C $\mu$ PC277D $\mu$ PC277G $\mu$ PC393C $\mu$ PC393G	393	-20 ~ +70 -20 ~ +80 -20 ~ +70 0 ~ +70 0 ~ +70	Dual Low Power Single Supply Operation	8 Pin Molded DIP 8 Pin Cavity DIP 8 Pin Molded Flat 8 Pin Molded DIP 8 Pin Molded Flat
$\mu$ PC177C $\mu$ PC177ED $\mu$ PC177G $\mu$ PC339C $\mu$ PC339G	339	-20 ~ +70 -20 ~ +80 -20 ~ +70 0 ~ +70 0 ~ +70	Quad Low Power Single Supply Operation	14 Pin Molded DIP 14 Pin Cavity DIP 14 Pin Molded Flat 14 Pin Molded DIP 14 Pin Molded Flat

ELECTRICAL CHARACTERISTICS									PAGE
Supply Voltage		I <sub>CC</sub> MAX. [mA]	V <sub>IO</sub> MAX. [mV]	I <sub>IO</sub> MAX. [nA]	I <sub>B</sub> MAX. [nA]	A <sub>v</sub> TYP. [dB]	t <sub>d</sub> TYP. [ns]	V <sub>OL</sub> MAX. [V]	
MIN. [V]	TYP. [V]								
+5	+30	7.5	7.5	50	250	106	200	0.4	124
+5	+30	12.5	8.0	200	1000	92	80	0.4	129
+2*	+30	1.0	5.0	50	250	106	1300	0.4	134
+2*	+30	2.0	5.0	50	250	106	1300	0.4	137

\* Not guaranteed



# μPC271 / 311

## Precision Voltage Comparators

### GENERAL DESCRIPTION

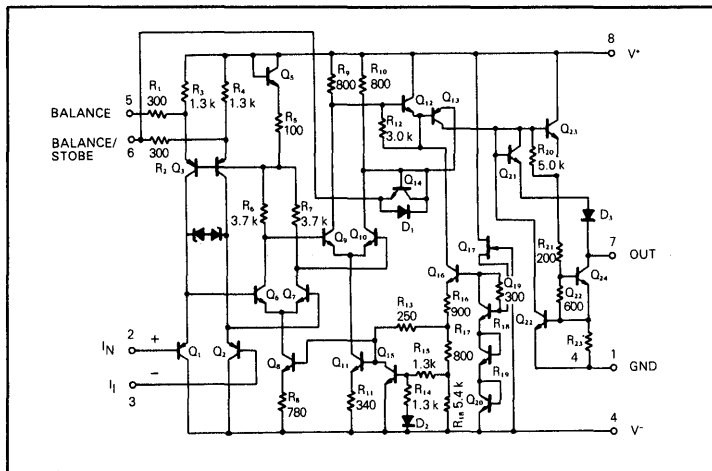
The μPC271/311 are voltage comparators that has input currents more than a hundred times lower than device like conventional standard type of 710. It is also designed to operate over a wide range of supply voltages; from ±15 V op amp supplies down to the single 5 V supply used for IC logic. Its output is compatible with HNIL, DTL and TTL as well as MOS circuits.

Two kinds of ICs are available according to reliability, the μPC271 for industry, the μPC311 for commercial.

### FEATURES

- Operates from single 5 V supply
- Maximum input current: 250 nA
- Maximum offset current: 50 nA
- Fast transient response: 200 ns TYP.
- LM311 Direct Replacement

### EQUIVALENT CIRCUIT



### ORDERING INFORMATION

μPC271ED



8 pin Ceramic DIP  
(Dual In-Line Package)

μPC271C/μPC311C



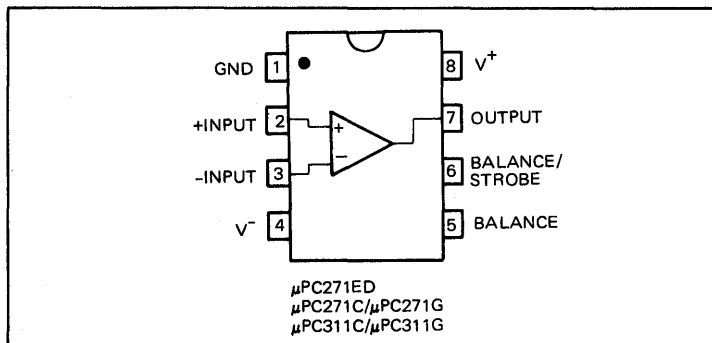
8 pin Plastic Molded DIP  
(Dual In-Line Package)

μPC271G/μPC311G



8 pin Plastic Molded Flat Package  
(MINI FLAT IC)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

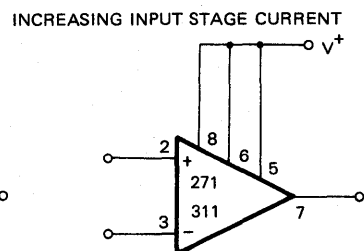
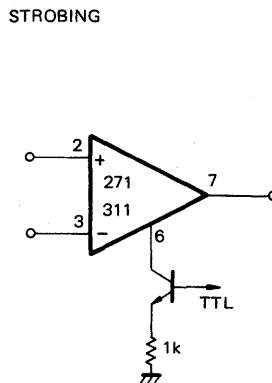
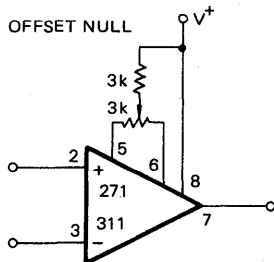
PARAMETER		μPC271	μPC311	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	36	V
Output to Negative Supply Voltage		40	40	V
Ground to Negative Supply Voltage		30	30	V
Differential Input Voltage		±30	±30	V
Input Voltage (Note 1)		±15	±15	V
Power Dissipation *	D Package	500	—	mW
	C Package	350	350	
	G Package	440	440	
Output Short Circuit Duration		10	10	s
Operating Temperature Range	D Package	-20 to +80	—	°C
	C or G Package	-20 to +70	0 to 70	
Storage Temperature Range	D Package	-55 to +150	—	°C
	C or G Package	-55 to +125	-55 to +125	

Note 1. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

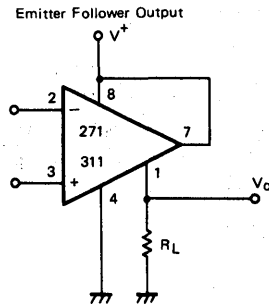
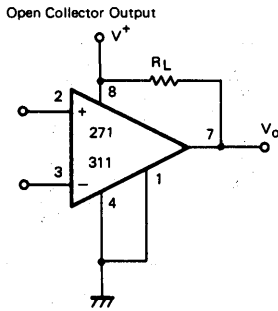
\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		2.0	7.5	mV	V <sup>+</sup> - V <sup>-</sup> = 5 V ~ 30 V, R <sub>s</sub> ≤ 50 kΩ
Input Offset Current		6.0	50	nA	"
Input Bias Current		100	250	nA	"
Voltage Gain		200		V/mV	R <sub>L</sub> = 1.0 kΩ
Response Time		200		ns	Input step 100 mV, Overdrive 5 mV
Saturation Voltage		0.75	1.5	V	V <sub>IN</sub> ≥ 10 mV, I <sub>o</sub> = 50 mA
Strobe ON Current		3.0		mA	
Output Leakage Current		0.2	50	nA	V <sub>IN</sub> ≥ 10 mV, V <sub>o</sub> = 35 V
Positive Supply Current		5.1	7.5	mA	
Negative Supply Current		4.1	5.0	mA	
Input Offset Voltage			10	mV	V <sup>+</sup> - V <sup>-</sup> = 5 ~ 30 V, R <sub>s</sub> ≤ 50 kΩ, TA = 0 ~ 70°C
Input Offset Current			70	nA	"
Input Bias Current			300	nA	"
Input Voltage Range		±14		V	
Saturation Voltage		0.23	0.4	V	V <sup>+</sup> ≥ 4.5 V, V <sup>-</sup> = 0 V, V <sub>IN</sub> ≤ -10 mV, I <sub>o</sub> = 8 mA

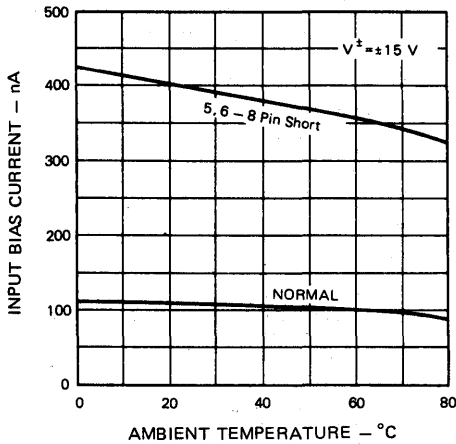


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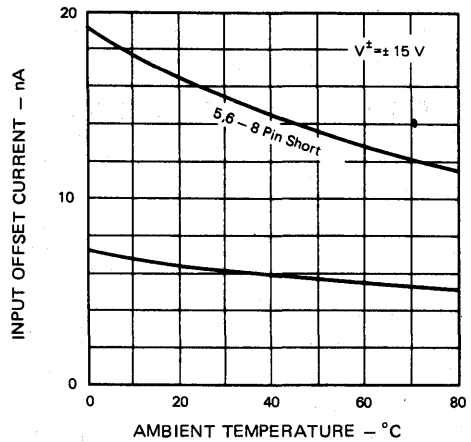


**TYPICAL PERFORMANCE CHARACTERISTICS (Ta=25 °C)**

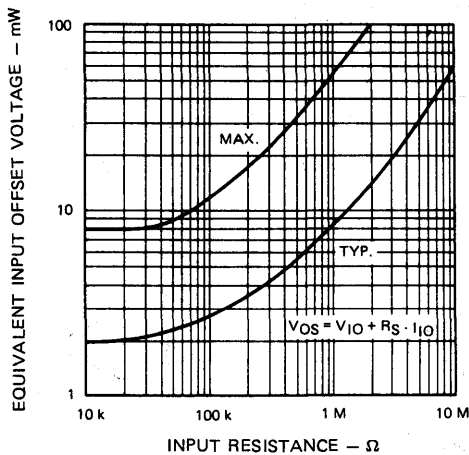
**INPUT BIAS CURRENT**



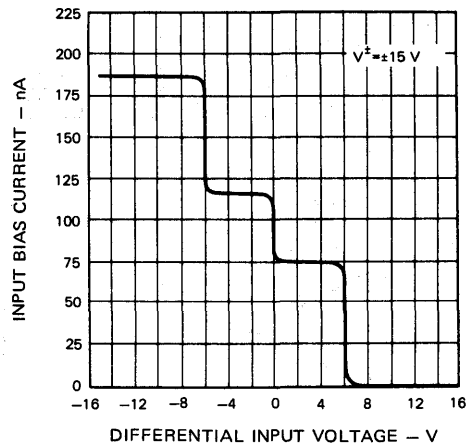
**INPUT OFFSET CURRENT**

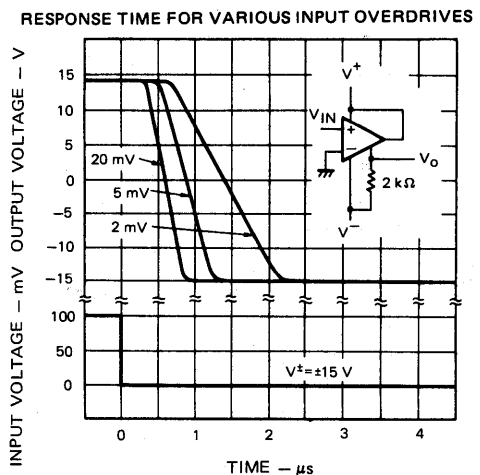
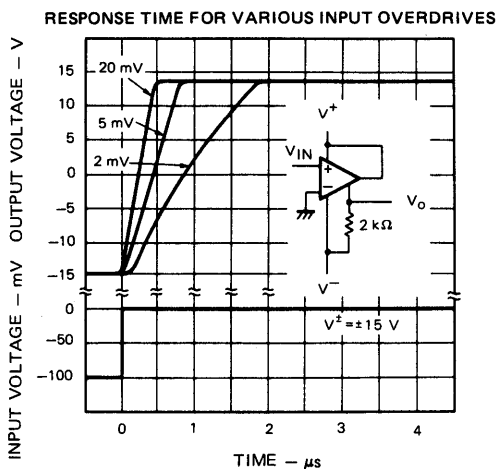
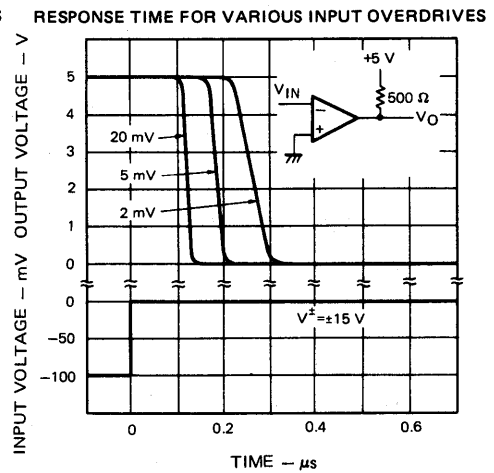
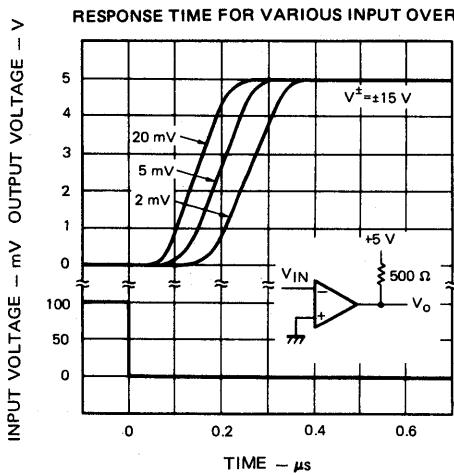
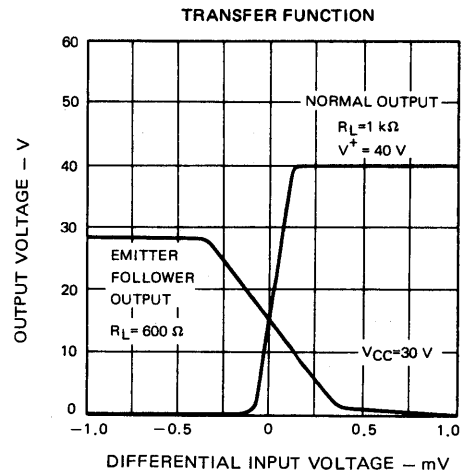
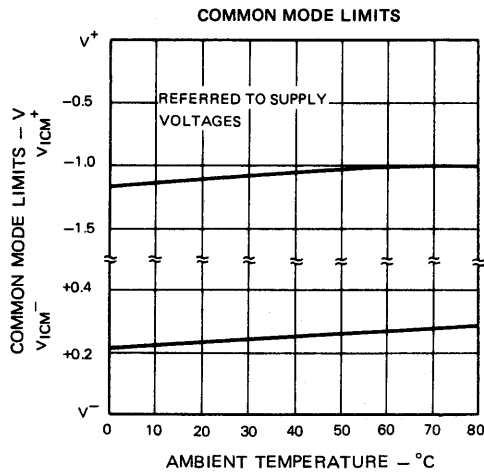


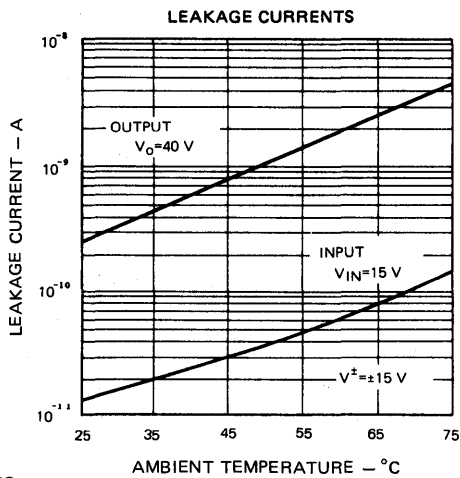
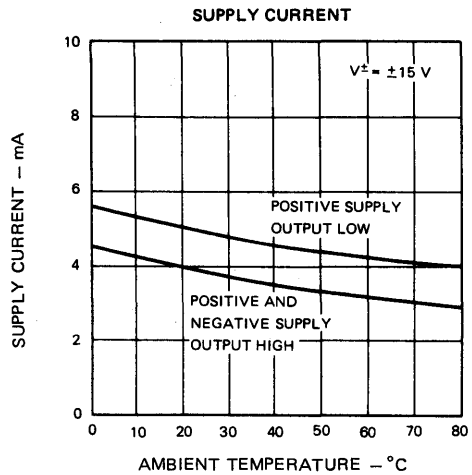
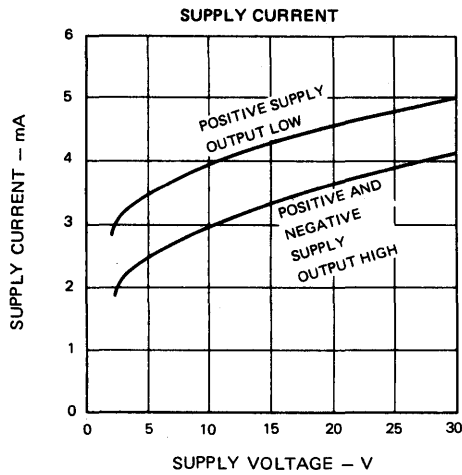
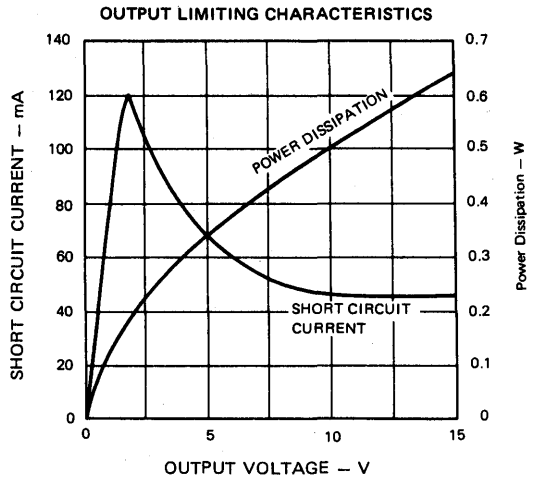
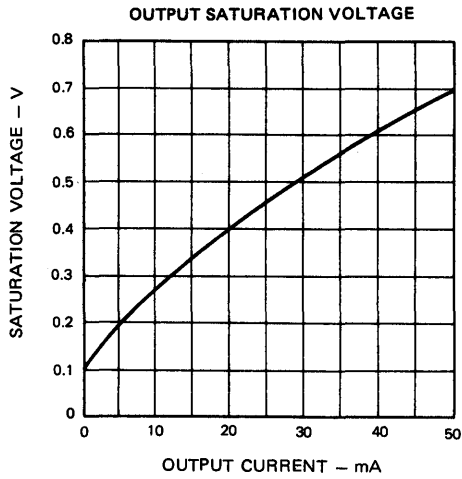
**OFFSET ERROR**



**INPUT CHARACTERISTICS**







### GENERAL DESCRIPTION

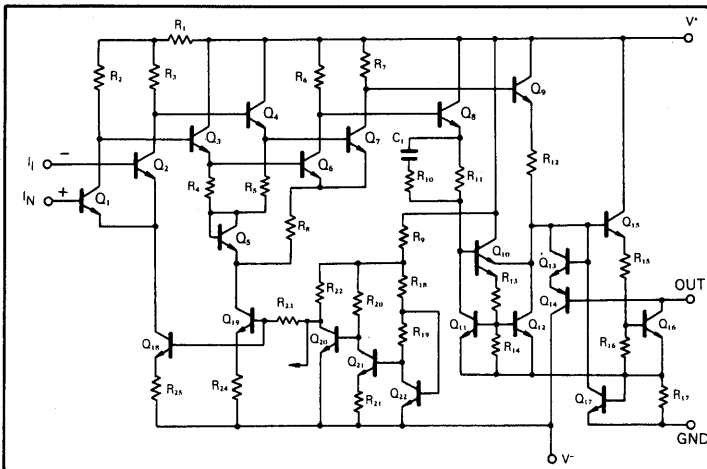
The μPC272/319 are precision high speed dual comparators designed to operate over a wide range of supply voltage down to a 5 V logic supply and ground. Further advantage, they have excellent input characteristics and direct drive capability to all the popular logic families.

Two kinds of ICs are available according to the reliability, the μPC272 for industry, the μPC319 for commercial.

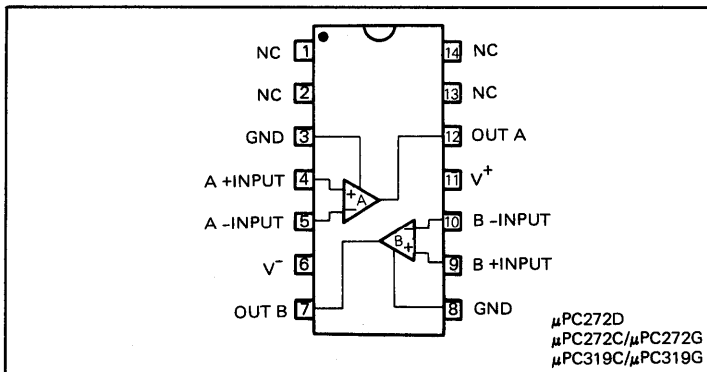
### FEATURES

- Operate from Single 5 V Supply
- Typically 80 ns Response Time at ±15 V
- Open Collector Output
- Minimum Fan-Out of 2 Each Side (TTL)
- High Common Mode Slew Rate
- LM319 Direct Replacement

### EQUIVALENT CIRCUIT



### CONNECTION DIAGRAM (Top View)



### ORDERING INFORMATION

μPC272D



14 pin Ceramic DIP  
(Dual In-Line Package)

μPC272C/μPC319C



14 pin Plastic Molded DIP  
(Dual In-Line Package)

μPC272G/μPC319G



14 pin Plastic Molded Flat Package  
(MINI FLAT IC)

**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC272	μPC319	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	36	V
Output to Negative Supply Voltage		36	36	V
Ground to Negative Supply Voltage		25	25	V
Ground to Positive Supply Voltage		18	18	V
Differential Input Voltage		±5	±5	V
Input Voltage (Note 1)		±15	±15	V
Power Dissipation*	D Package	900	—	mW
	C Package	500	500	
	G Package	550	550	
Output Short Circuit Duration		10	10	s
Operating Temperature Range	D Package	-20 to +80	—	°C
	C or G Package	-20 to +70	0 to 70	
Storage Temperature Range	D Package	-55 to +150	—	°C
	C or G Package	-55 to +125	-55 to +125	

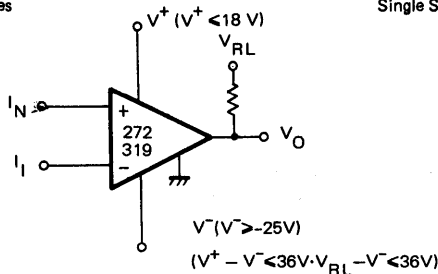
Note 1. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

\* See thermal information in chapter 11.

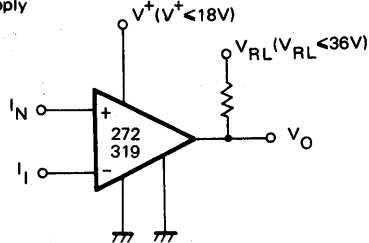
**ELECTRICAL CHARACTERISTICS (V<sup>±</sup> = ±15 V, Ta = 25°C)**

CARACTERISTIC	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Input Offset Voltage		2.0	8.0	mV	V <sup>±</sup> = +5 V ~ ±15 V, R <sub>s</sub> ≤ 50 kΩ
Input Offset Current		80	200	nA	"
Input Bias Current		400	1 000	nA	"
Voltage Gain	8	40		V/mV	
Response Time		80		ns	Input 100 mV, Overdrive 5 mV
Saturation Voltage		0.75	1.5	V	V <sub>IN</sub> ≤ -10 mV, I <sub>o</sub> = 25 mA
Output Leakage Current		0.2	10	μA	V <sub>IN</sub> ≥ 10 mV, V <sub>o</sub> = 35 V
Positive Supply Current		4.3		mA	V <sup>+</sup> = +5 V, V <sup>-</sup> = 0V
Positive Supply Current		8.0	12.5	mA	V <sup>±</sup> = ±15 V
Positive Supply Current		3.0	5.0	mA	V <sup>±</sup> = ±5V
Input Offset Voltage			10	mV	V <sup>+</sup> = +5 V ~ ±15 V, R <sub>s</sub> ≤ 5 kΩ, Ta = 0 ~ +70°C
Input Offset Current			300	nA	"
Input Bias Current			1 200	nA	"
Input Voltage Range		±13		V	V <sup>±</sup> = ±15 V
Saturation Voltage		0.23	0.4	V	V <sup>+</sup> ≥ 4.5 V, V <sup>-</sup> = 0 V, V <sub>IN</sub> ≤ -10 mV, I <sub>o</sub> ≤ 3.2 mA

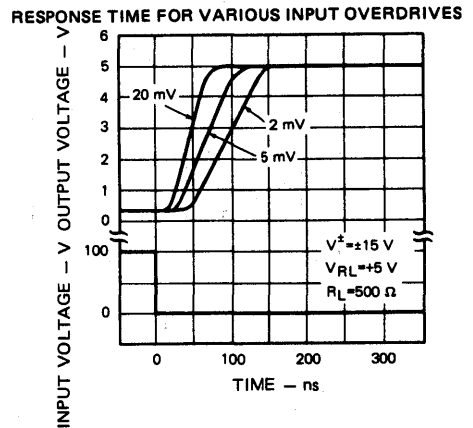
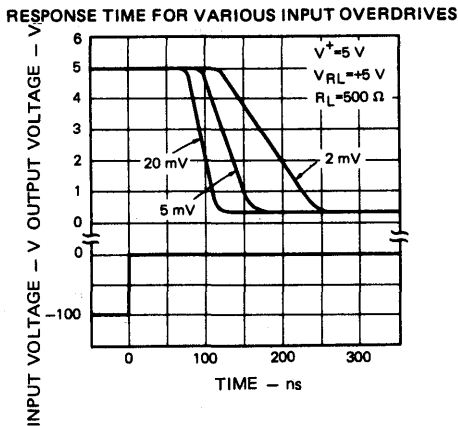
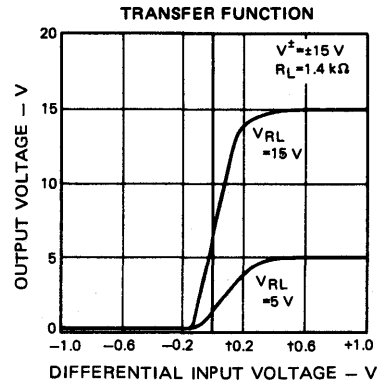
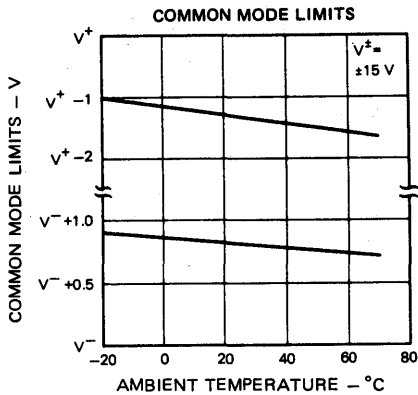
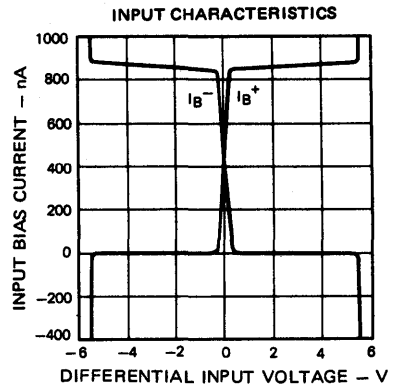
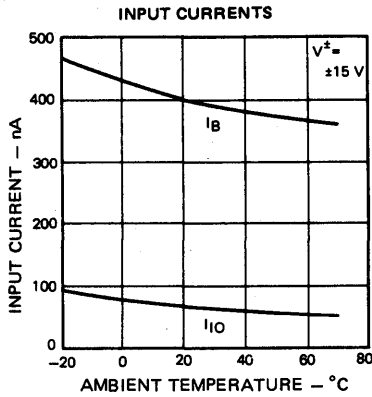
Split Supplies



Single Supply



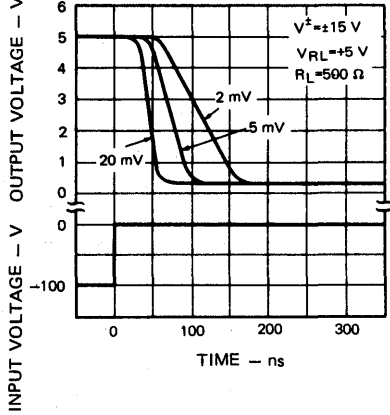
TYPICAL PERFORMANCE CHARACTERISTICS ( $T_a=25^\circ\text{C}$ )



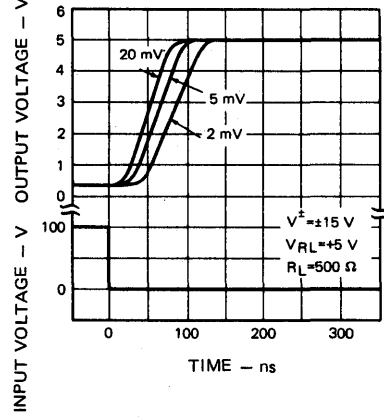
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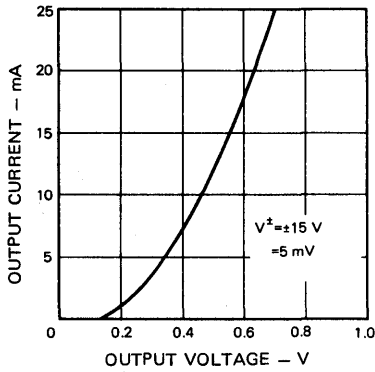
**RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES**



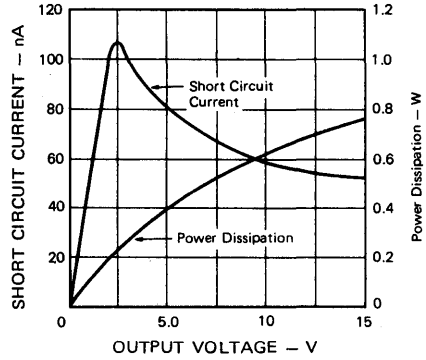
**RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES**



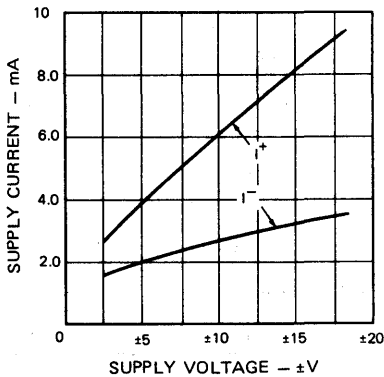
**OUTPUT SATURATION VOLTAGE**



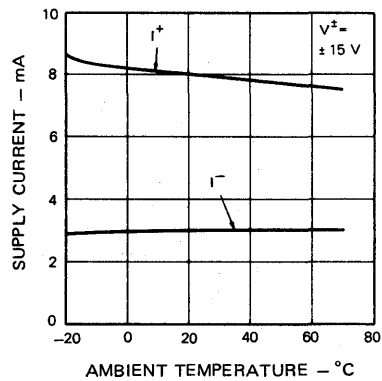
**OUTPUT LIMITING CHARACTERISTICS**

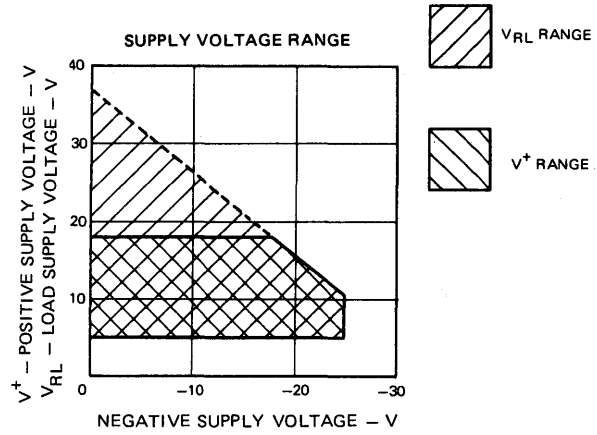
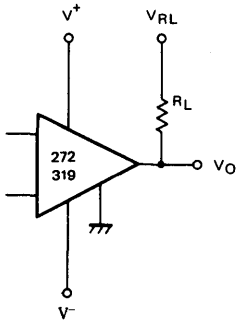


**SUPPLY CURRENT**



**SUPPLY CURRENT**





# μPC277 / 393

## Low Power Dual Comparators

### GENERAL DESCRIPTION

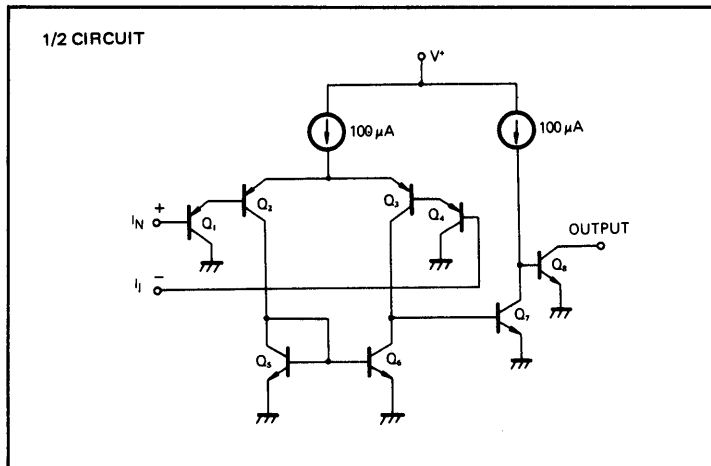
The μPC277/393 are dual comparators which are designed to operate from a single power supply over a wide range of voltage. Operation from split power supplies is also possible and the power supply current drain is very low. Further advantage, the input common-mode voltage includes ground, even though operated from a single power supply voltage.

Two kinds of ICs are available according to reliability, the μPC277 for industry, the μPC393 for commercial.

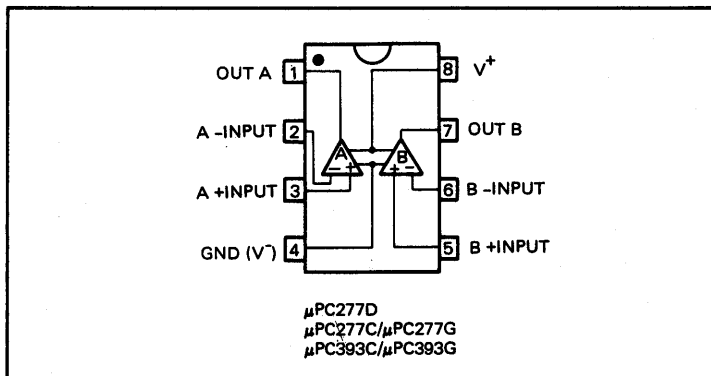
### FEATURES

- Input Common-Mode Voltage Range Includes Ground
- Wide Power Supply Range  
Single Supply 2 V to 36 V DC  
Dual Supplies ±1 V to ±18 V DC
- Low Power Consumption
- Compatible with All Forms Logic
- LM393 Direct Replacement

### EQUIVALENT CIRCUIT



### CONNECTION DIAGRAM (Top View)



### ORDERING INFORMATION

<p>μPC277D</p> <p>8 pin Ceramic DIP (Dual In-Line Package)</p>
<p>μPC277C/μPC393C</p> <p>8 pin Plastic Molded DIP (Dual In-Line Package)</p>
<p>μPC277G/μPC393G</p> <p>8 pin Plastic Molded Flat Package (MINI FLAT IC)</p>

**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC277	μPC393	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	36	V
Differential Input Voltage		36	36	V
Common Mode Input Voltage		-0.3 to +36	-0.3 to +36	V
Power Dissipation*	D Package	500	-	mW
	C Package	350	350	
	G Package	440	440	
Output Short Circuit to Ground		Indefinite	Indefinite	s
Operating Temperature Range	D Package	-20 to +80	-	°C
	C or G Package	-20 to +70	0 to +70	
Storage Temperature Range	D Package	-55 to +150	-	°C
	C or G Package	-55 to +125	-55 to +125	

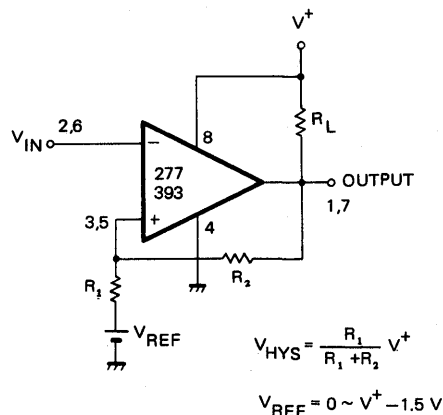
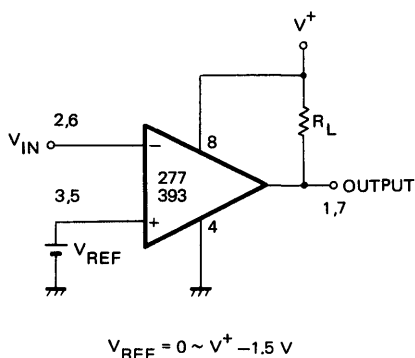
\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>+</sup> = 5V)**

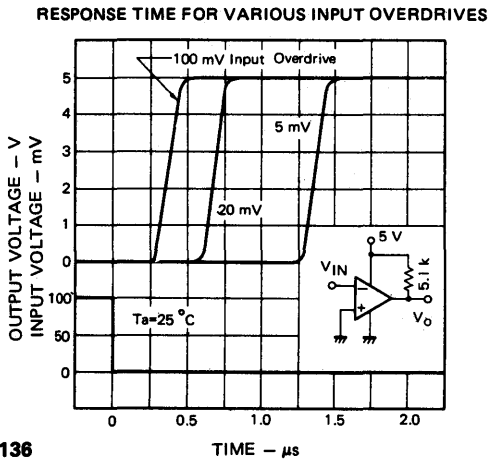
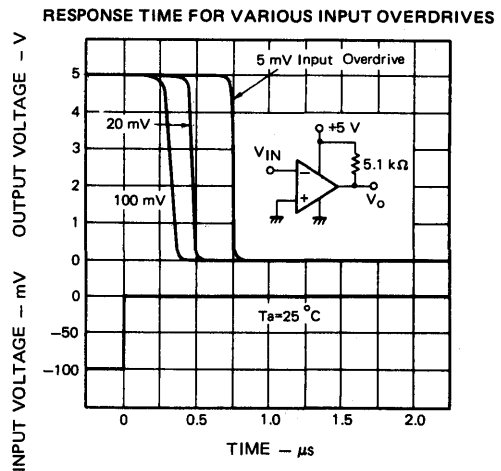
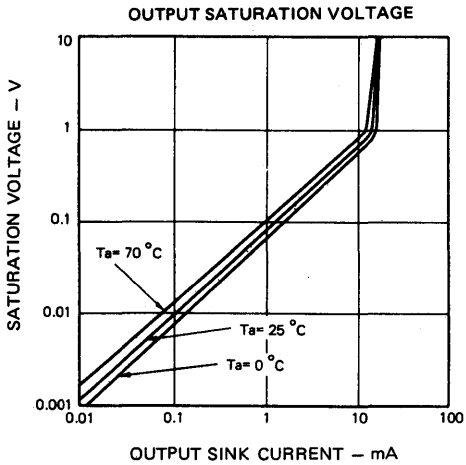
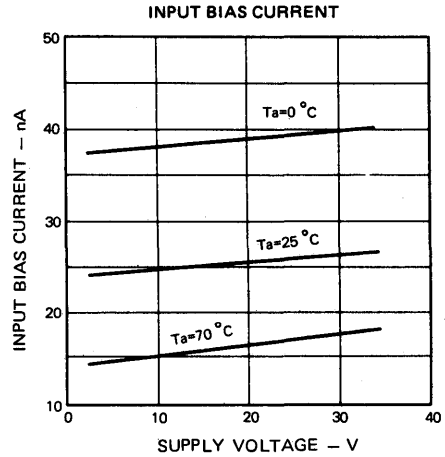
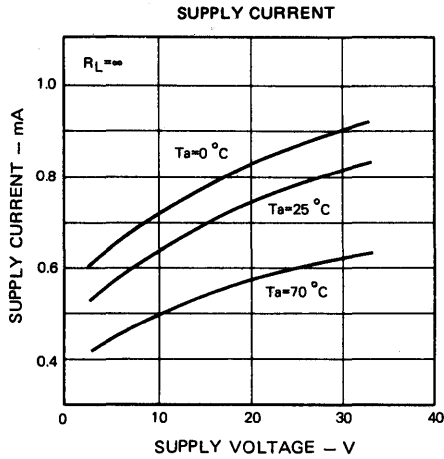
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		2	5	mV	Vo = 1.4 V, VREF = 1.4 V, Rs = 0 Ω
Input Bias Current		25	250	nA	Vo ≈ 1.4 V
Input Offset Current		5	50	nA	Vo ≈ 1.4 V
Common Mode Input Voltage Range	0		V <sup>+</sup> -1.5	V	
Supply Current		0.6	1	mA	RL = ∞
Voltage Gain		200		V/mV	RL = 15 kΩ
Large Signal Response Time		1.3		μs	RL = 5.1 kΩ, VRL = 5 V
Output Sink Current	6	16		mA	VIN(-) = 1 V, VIN(+) = 0 V, Vo ≤ 1.5 V
Saturation Voltage		0.2	0.4	V	VIN(-) = 1 V, VIN(+) = 0 V, Isink = 3 mA
Output Leakage Current		0.1		nA	VIN(+) = 1 V, VIN(-) = 0 V, Vo = 5 V



**TYPICAL APPLICATIONS**



TYPICAL PERFORMANCE CHARACTERISTICS ( $T_a=25^\circ\text{C}$ )



### GENERAL DESCRIPTION

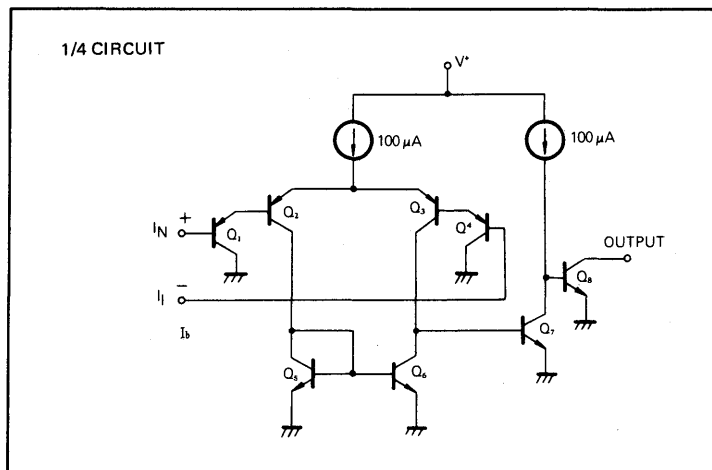
The μPC177/339 are quad comparators which are designed to operate from a single power supply over a wide range of voltages. Operation from split power supplies, is also possible and the power supply current drain is very low. Further advantage, the input common-mode voltage includes ground, even though operated from a single power supply voltage.

Two kinds of ICs are available according to reliability, the μPC177 for industry, the μPC339 for commercial.

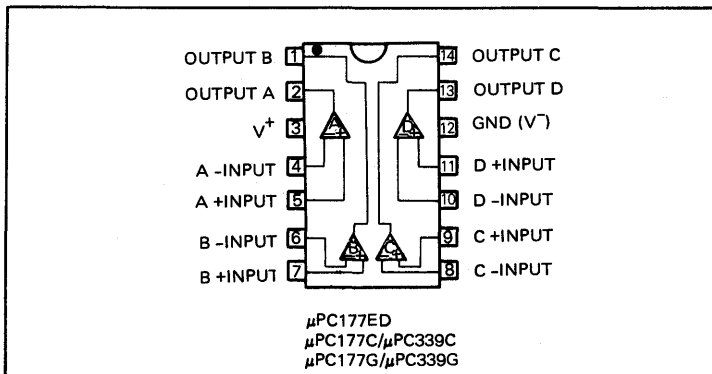
### FEATURES

- Input Common-Mode Voltage Range Includes Ground
- Wide Power Supply Range  
Single Supply 2 V to 36 V DC  
Dual Supplies ±1 V to ±18 V DC
- Low Power Consumption
- Compatible with All Forms Logic.
- Open Collector Output
- LM339 Direct Replacement

### EQUIVALENT CIRCUIT



### CONNECTION DIAGRAM (Top View)



### ORDERING INFORMATION

<p>μPC177ED</p> <p>14 pin Ceramic DIP (Dual In-Line Package)</p>
<p>μPC177C/μPC339C</p> <p>14 pin Plastic Molded DIP (Dual In-Line Package)</p>
<p>μPC177G/μPC339G</p> <p>14 pin Plastic Molded Flat Package (MINI FLAT IC)</p>

**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

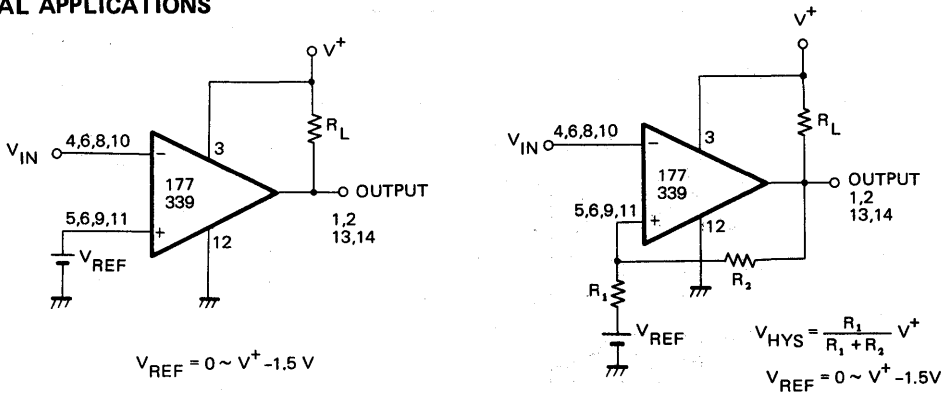
PARAMETER		μPC177	μPC339	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	36	V
Differential Input Voltage		36	36	V
Common Mode Input Voltage		-0.3 to +36	-0.3 to +36	V
Power Dissipation *	D Package	900	-	
	C Package	570	570	mW
	G Package	550	550	
Output Short Circuit to Ground		Indefinite	Indefinite	s
Operating Temperature Range	D Package	-20 to +80	-	°C
	C or G Package	-20 to +70	0 to +70	
Storage Temperature Range	D Package	-20 to +80	-	°C
	C or G Package	-55 to +125	-55 to +125	

\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>+</sup> = 5 V)**

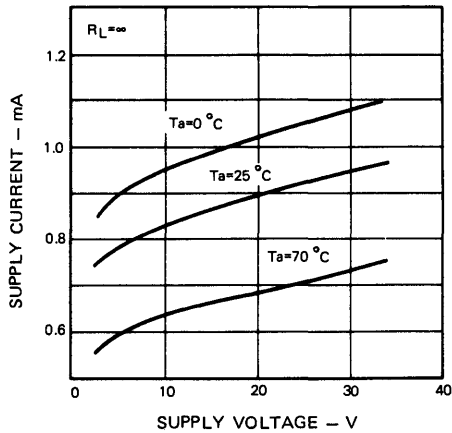
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		2	5	mV	Vo = 1.4 V, VREF = 1.4 V, Rs = 0 Ω
Input Bias Current		25	250	nA	Vo ≈ 1.4 V
Input Offset Current		5	50	nA	Vo ≈ 1.4 V
Common Mode Input Voltage Range	0		V <sup>+</sup> -1.5	V	
Supply Current		0.8	2	mA	RL = ∞
Voltage Gain		200		V/mV	RL = 15 kΩ
Large Signal Response Time		1.3		μs	RL = 5.1 kΩ, VRL = 5V
Output Sing Current	6	16		mA	VIN(-) = 1 V, VIN(+)= 0 V, Vo ≤ 1.5 V
Saturation Voltage		0.2	0.4	V	VIN(-) = 1 V, VIN(+)= 0V, Isink = 3 mA
Output Leakage Current		0.1		nA	VIN(+)= 1 V, VIN(-)= 0 V, Vo = 5 V

**TYPICAL APPLICATIONS**

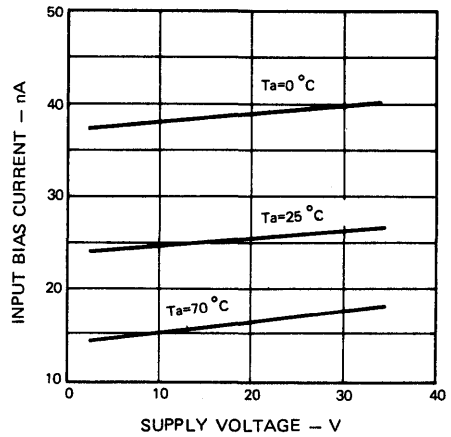


TYPICAL PERFORMANCE CHARACTERISTICS (Ta=25 °C)

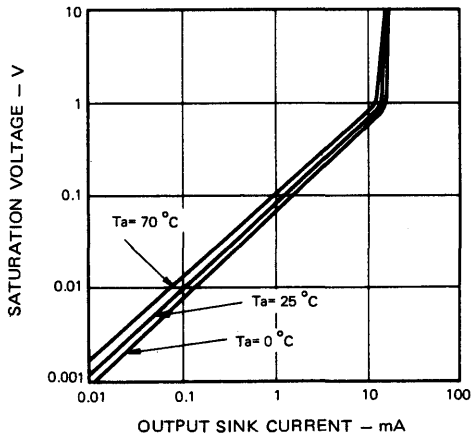
SUPPLY CURRENT



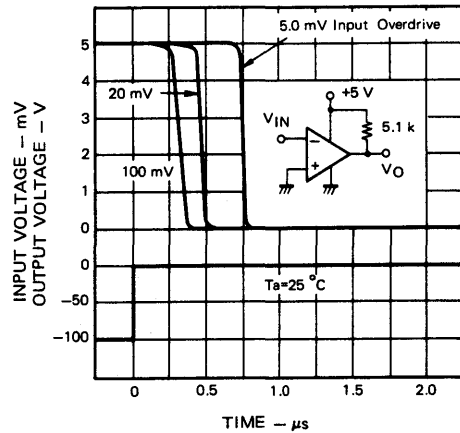
INPUT BIAS CURRENT



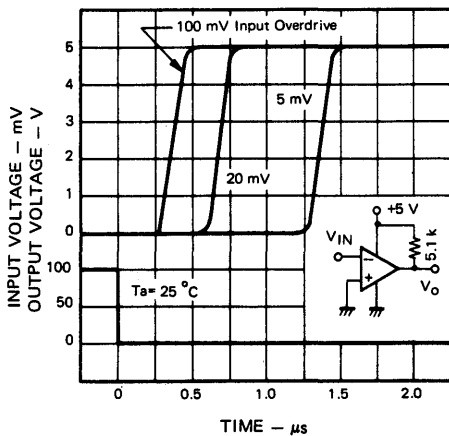
OUTPUT SATURATION VOLTAGE



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES



6





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## High Performance 6 Bit D/A Converter

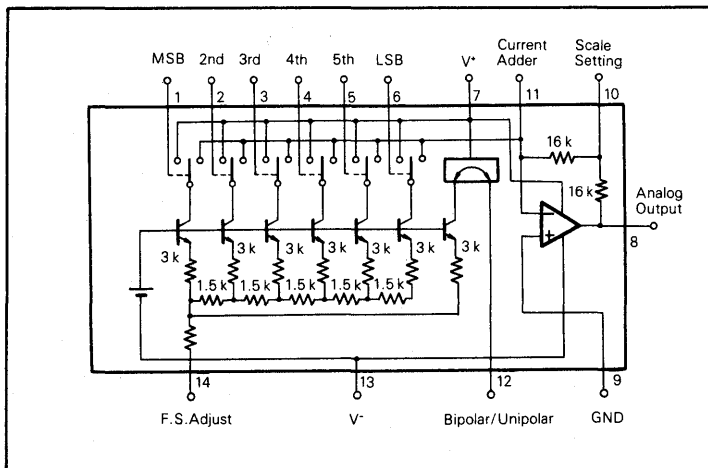
### GENERAL DESCRIPTION

The μPC603D is a monolithic D/A converter for converting 6 bit binary coded digital signal into an analog output voltage signal. The reference voltage, weighted current source, current switch, output operational amplifier etc. are integrated in the chip, making the composing of D/A or A/D conversion systems easy.

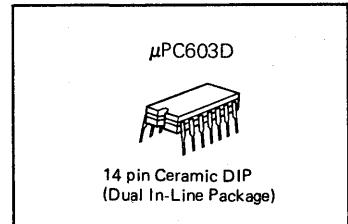
### FEATURES

- Linearity Error 0.4% (¼ LSB of 6 Bit) MAX.
- Response Speed 3 μs MAX.
- Temp. Coef. at F. S. 160 ppm/°C MAX.
- Input Level TTL, DTL Level, Active Low
- The output voltage range can be applied to any of the 3 following ranges:  
0 to 10 V, -5 to +5 V, -10 V to +10 V
- A built-in output short-circuit protection circuit is provided.
- Possesses a linearity equivalent to that of a 7 bit converter, and can be used as a 7 bit D/A converter by the addition of external circuits.
- Pin for Pin compatible with PMI'S "DAC-01C".

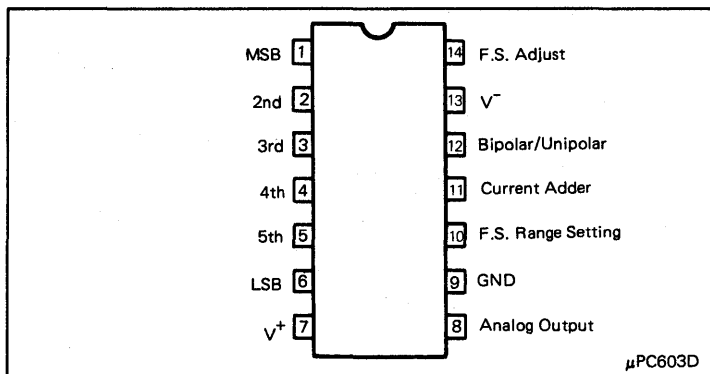
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



7

**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC603	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		±18	V
Power Dissipation	D Package	500	mW
Input Voltage		-0.7 to +6	V
Output Short Circuit Duration		Indefinite	s
Operating Temperature Range	D Package	-20 to +80	°C
Storage Temperature Range	D Package	-55 to +150	°C

**ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

CHARACTERISTIC		MIN.	TYP.	MAX.	UNIT	CONDITIONS
Linearity Error				0.4	%FSR	Fig. 1, 2, 3
				0.45	%FSR	Fig. 1, 2, 3 Ta = -20 ~ +80°C
F.S. Temperature Coef. (Note 2)			80	160	ppm/°C FSR	Fig. 1 each Bit "ON" after full scale adjust Ta = -20 ~ +80°C
Analog Output Offset Voltage	Unipolar			25	mV	Fig. 1 each Bit "OFF" without F.S. adjust Ta = -20 ~ +80°C
	Bipolar (Note 3)		50		mV	Fig. 2; ±5 V output without F.S. adjust
			100		mV	Fig. 3; ±10 V output without F.S. adjust
Low Level Input Voltage (Note 4)				0.5	V	Bit "ON"
High Level Input Voltage (Note 4)		2.1			V	Bit "OFF"
Input Terminal Current				5.0	μA	0 V ≤ V <sub>IN</sub> ≤ 5 V
Analog Output Full Scale Voltage	Unipolar	+10.00		+11.75	V	R <sub>L</sub> = 2 kΩ Fig. 1; without F.S. adjust
	Bipolar	+4.93		+5.94	V	Fig. 2; ±5 V Range R <sub>L</sub> = 2 kΩ without Offset adjust and F.S. adjust
		-5.94		-4.93	V	
		+9.86		+11.89	V	Fig. 3; ±10 V Range R <sub>L</sub> = 2 kΩ without Offset adjust and F.S. adjust
-11.89		-9.86	V			
PS. Voltage Suppression Ratio				0.15	%FSR/V	±12 V ≤ V <sup>±</sup> ≤ ±18 V
Setting Time (Note 5)				3	μsec	Error ≤ ½ LBS, R <sub>L</sub> /C <sub>L</sub> = 5 k//30 pF
Power Consumption				250	mW	

Note 1. %FSR and ppm FSR are the percentage and parts per million against full scale, respectively.

Note 2. The average value of the differential coefficient at T<sub>c</sub> = -20 to +80°C.

Note 3. Care should be taken, since the temperature drift after bipolar offset adjustment has been made will become larger for ICs in which the offset voltage of the bipolar analog output is larger than the LSB value.

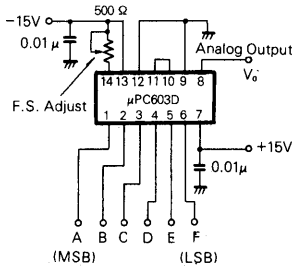
Note 4. The input is active "Low".

Note 5. When the load capacitance exceeds 30 pF there is a possibility of oscillation.

STANDARD CONNECTION

1. Unipolar Operation

Fig. 1 Output 0 to 10V Range

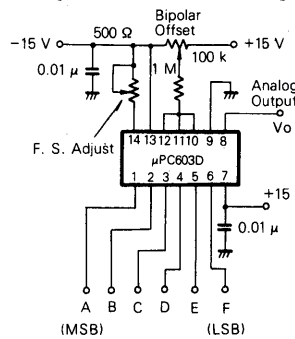


Digital Input  
6 Bit Binary Code  
Active Low

Example  
Input    Output  
111111 = 0.00V  
100000 ≐ 4.92V  
011111 ≐ 5.08V  
000000 = 10.00V

2. Bipolar Operation (1)

Fig. 2 Output -5V to +5V Range

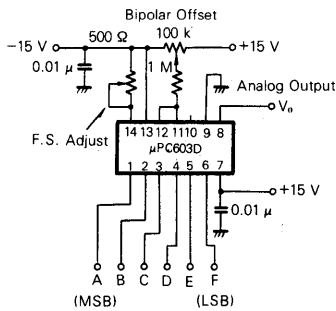


Digital Input  
6 Bit Offset  
Binary Code  
Active Low

Example  
Input    Output  
111111 = -5.00V  
100000 ≐ -0.08V  
011111 ≐ +0.08V  
000000 = +5.00V

3. Bipolar Operation (2)

Fig. 3 -10V to +10V Output

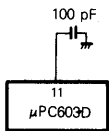


Input 6 Bit Offset  
Binary Code  
Active Low

Example  
Input    Output  
111111 = -10.00V  
100000 ≐ -0.16V  
011111 ≐ +0.16V  
000000 = +10.00V

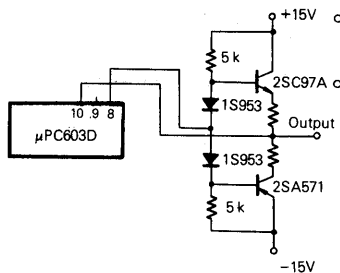
OTHER EXAMPLES OF APPLICATION

Fig. 4 Compensation against Capacitive Loads (1)



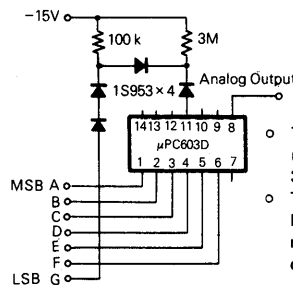
- The IC is stable against capacitive loads of less than 100 pF.
- Care should be taken, since the settling time will increase to about 5 μsec.

Fig. 5 Compensation against Capacitive Loads (2)



○ This method can be applied only to the 0 to 10V and ±5V output ranges. It is possible to connect such operational amplifier as μPC159A, etc. to the 8 pin as a voltage follower.

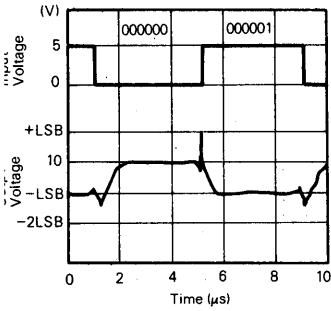
Fig. 6 7 Bit D/A Converter



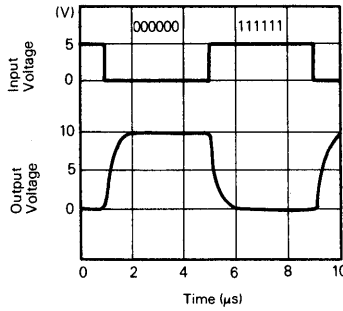
- The linearity error can be reduced by adjusting the 3MΩ resistor.
- The output voltage may be set to any of the 3 ranges, with the circuits of Fig. 1, 2, and 3.

**CHARACTERISTIC CURVES**

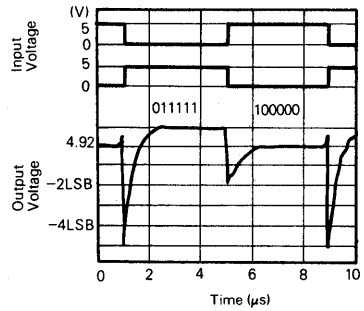
**Fig. 7 Output Response (1)**



**Fig. 8 Output Response (2)**

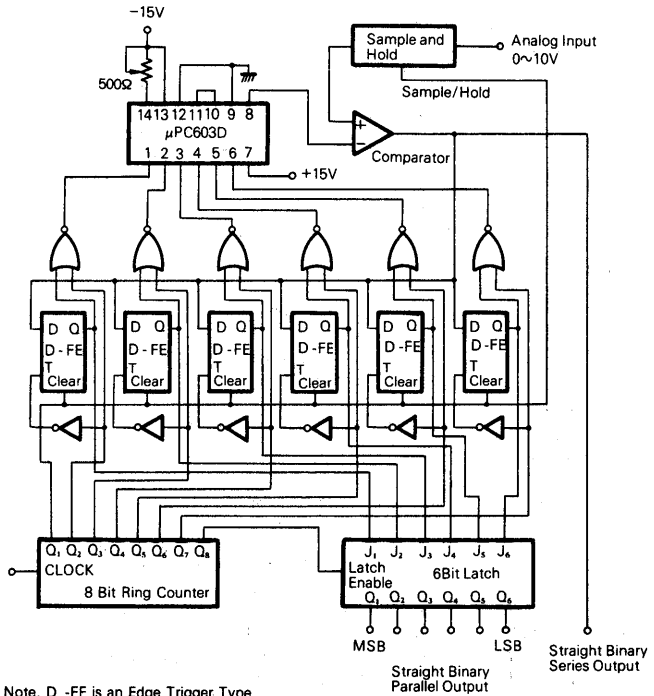


**Fig. 9 Glitch Waveform at 1/4 Scale**



**APPLICATION CIRCUIT**

- 1. Progressive comparison type A/D Converter
- Input : 0 to 10V
- Output : 6 bit straight binary (parallel, serial)

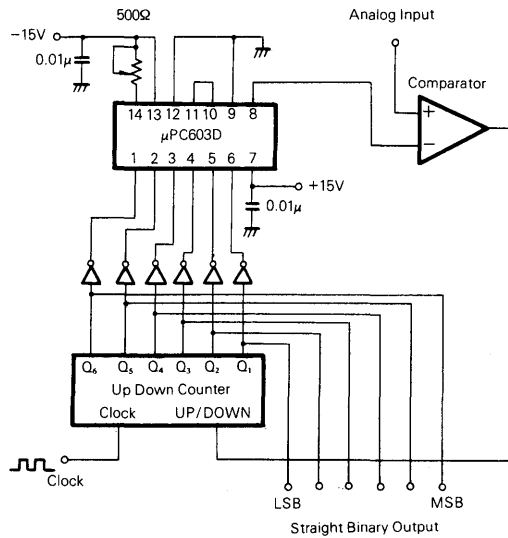


Note. D -FF is an Edge Trigger Type

2. Tracking Type A/D Converter

Input : 0 to 10V

Output : 6 Bit Straight Binary





# μPC610

## Polarized 10 Bit D/A Converter

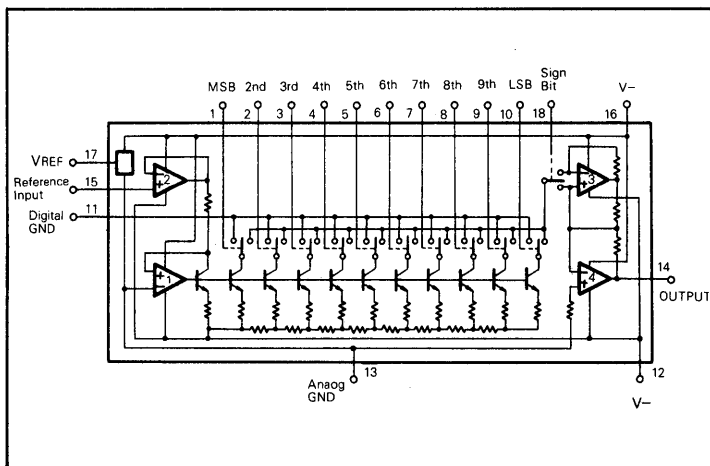
### GENERAL DESCRIPTION

The μPC610 is a high performance precision monolithic D/A converter for converting 10 bit binary coded digital signal into an analog DC output voltage. All circuit blocks required for a D/A conversion system are integrated on a single chip, making the composing of a D/A system easy. Furthermore, since the IC is provided with reference voltage and reference input terminals, multiplier type operation is also possible.

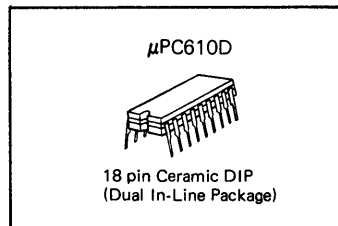
### FEATURES

- Full Scale Temp. 100 ppm/°C MAX.
- Linearity Error 0.2% (1/4 of 8th Bit) MAX.
- Setting Time 1.5 μs TYP.
- Built-in band-gap reference voltage source.
- Multiplying type.
- Sign-Magnitude binary code.
- Low noise.
- Low power dissipation.

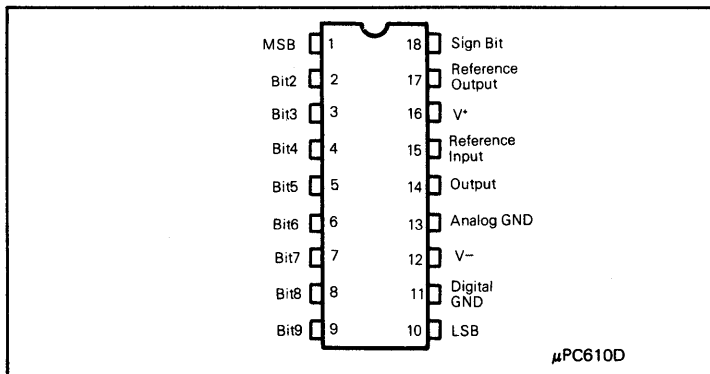
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC610	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		±18	V
Power Dissipation*	D Package	500	mW
Analog Ground to Digital Ground		±0.5	V
Logic Input Voltage		-5 to +15	V
Reference Input Voltage		0 to +7	V
Reference Voltage Source Output Current		1.0	mA
Output Short Circuit Duration		Indefinite	s
Operating Temperature Range	D Package	-20 to +80	°C
Storage Temperature Range	D Package	-55 to +150	°C

\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (V<sup>±</sup> = ±15 V, Ta = 25°C)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Resolution (Note 1)			11	Bit	Bipolar Operation
			10	Bit	Unipolar Operation
Linearity Error (Note 1)		0.1	0.2	%FSR	Ta = -20 ~ +80°C
Setting Time		1.5	6.0	μs	Final Value ±20 mV
Full Scale Temperature Coefficient (Note 2)		50	100	ppm/°C	Using internal reference voltage source
		30	60	ppm/°C	Using external reference voltage source
Reference Input Bias Current		100	500	nA	
Reference Input Slew Rate		1.5		V/μs	
Reference Voltage	2.2	2.4	2.6	V	R <sub>L</sub> ≥ 20 kΩ
Zero Scale Offset Voltage		±5	±10	mV	Signbit "ON" Other bits "OFF"
Zero Scale Offset Symmetry		±1	±5	mV	
F.S. Output Offset		±10	±80	mV	
Supply V. Suppression Ratio		0.015	0.15	%FSR/V	±12 V ≤ V <sup>±</sup> ≤ ±18 V
Power Dissipation			300	mW	
Logic Input Terminal Current			10	μA	V <sub>IN</sub> = -5 V ~ +15 V
High Level Input V. (Note 3)	2.0			V	
Low Level Input V. (Note 3)			0.8	V	
Full Scale Output Voltage (Note 4)	10.0		11.0	V	All bits "ON" R <sub>L</sub> ≥ 2 kΩ
	-11.0		-10.0	V	Signbit "OFF" Other bits "ON" R <sub>L</sub> ≥ 2 kΩ

Note 1. Though the IC possesses a resolution of 10 or 11 bits, the linearity error is equivalent to 9 bits. In applications where perfect monotonicity is expected, employ the IC as an 8 bit D/A converter.

Note 2. The average value of the differential coefficient at Ta = -20°C to +80°C.

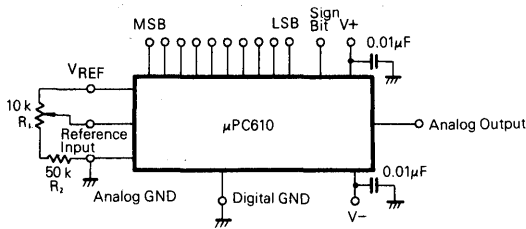
Note 3. The digital input is active "High" binary code.

Note 4. The value when the internal reference voltage is directly applied to the reference input terminals.



**TYPICAL APPLICATIONS**

**1. Using internal reference voltage source**



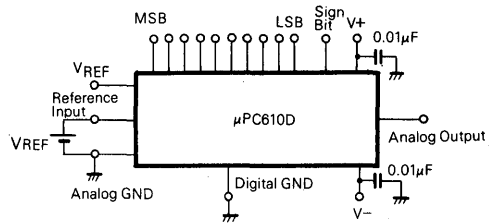
Note: Use resistors with good stability for  $R_1$  and  $R_2$

o Sign + 10 Bit Binary code

Input Output

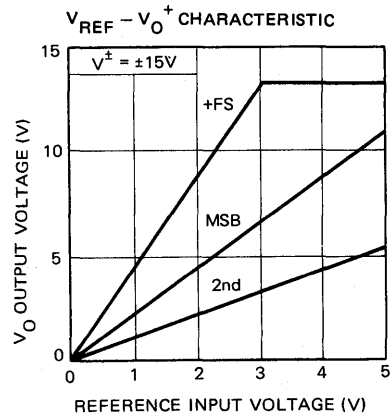
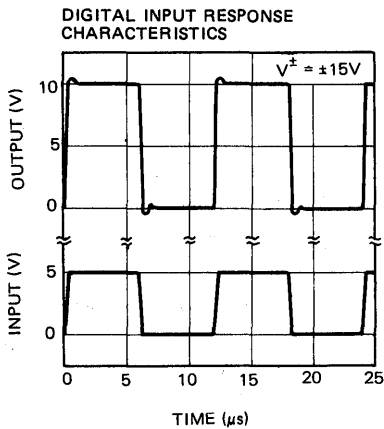
Sign	Magnitude
1	1111111111 = 10V
1	0000000000 = 0V
0	0000000000 = 0V
0	1111111111 = -10V

**2. External reference and multiplier type**

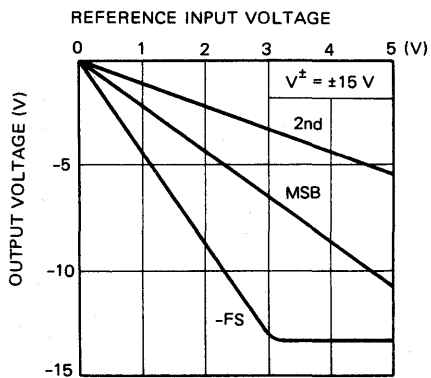


- o Multiplying coefficient  $\approx 4.4$   
 $V_{FS} \approx 4.4 \times V_{REF}$ ,  $V_{MSB} \approx 2.2 \times V_{REF}$   
 $V_{LSB} \approx 2.2 \times 2^{-9} \times V_{REF}$

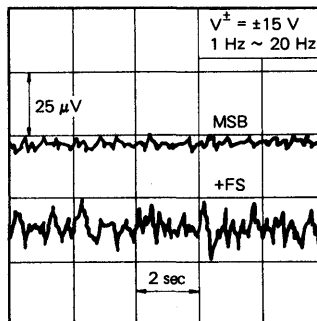
**TYPICAL PERFORMANCE CHARACTERISTICS (Ta = 25°C)**



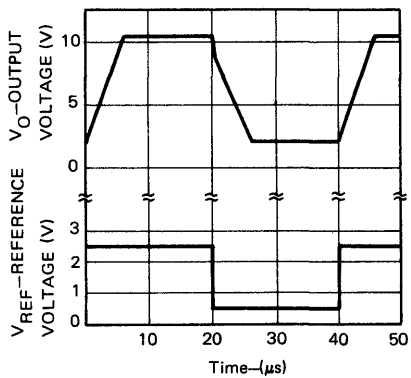
$V_{REF} - V_O$ -CHARACTERISTIC



OUTPUT NOISE VOLTAGE

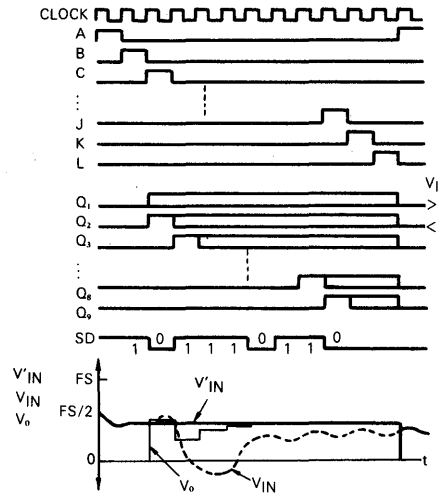
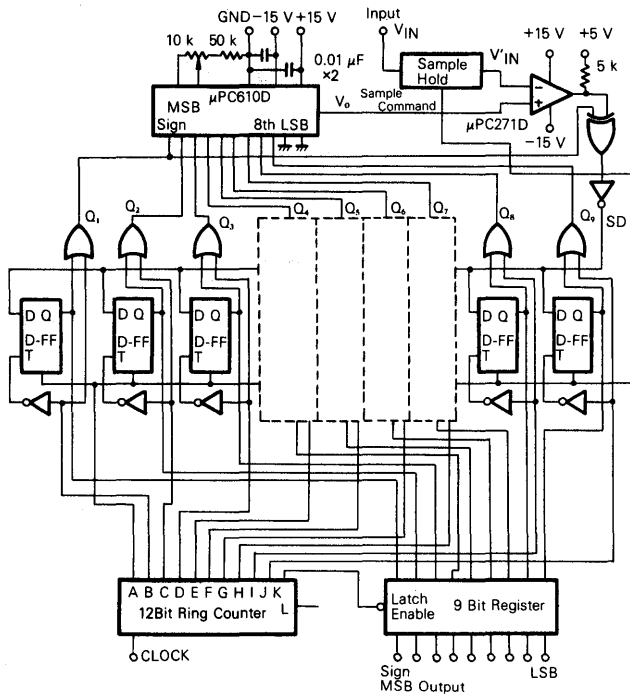


REFERENCE INPUT RESPONSE CHARACTERISTIC



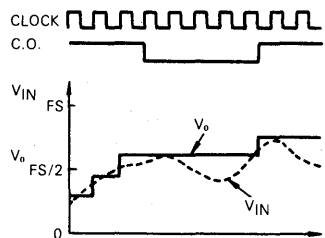
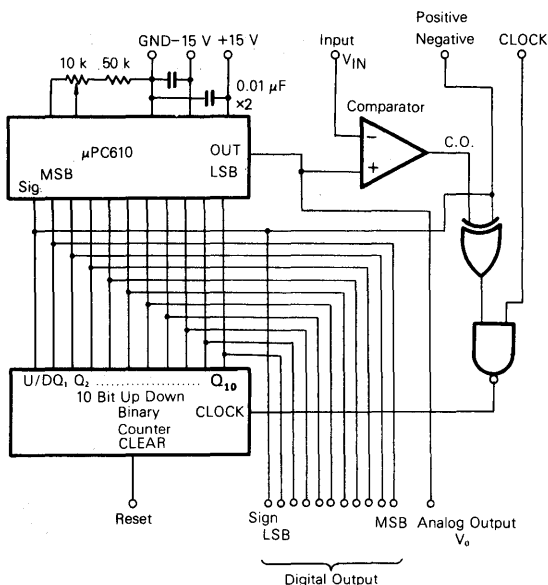
**APPLICATION CIRCUIT**

**1. 8 Bit + Sign A/D Converter**  
Successive Approximation Type



\* D, V<sub>IN</sub>, V'<sub>IN</sub> and V<sub>0</sub> show in case when an input equivalent to an output of "101110110".

2. Peak Detector (Positive/Negative)



- Sign High
- o In case of Sign "H" (Positive)
  - o The steps at analog outputs are exaggerated from the actual ones.

PRECAUTIONS FOR USAGE

- (1) In order to absorb surges and prevent oscillation, bypass the power supply terminals with a capacitor of about 0.01 μF.
- (2) In order to utilize the characteristics of the μPC610D in full, employ components of good stability for the full-scale adjustment resistor and the trimmer.
- (3) In the case of capacitive loads, since the settling time may increase or oscillation may occur, the μPC610D should be used with load capacitance of 100 pF or less.
- (4) In the case of multiplier type operation, the output amplifier will saturate at:  $|V_{REF}| \geq 3V$ .  
In this case the response time and power supply current will increase.
- (5) Since the reference potential inside the μPC610D is connected to the analog GND, common mode noise in regards to analog GND will present a direct error.  
Since analog GND and digital GND have independent circuits within the IC, when using, (if required), these should be connected together outside the IC.

# μPC624

## 8 Bit High Speed Multiplying D/A Converter

### GENERAL DESCRIPTION

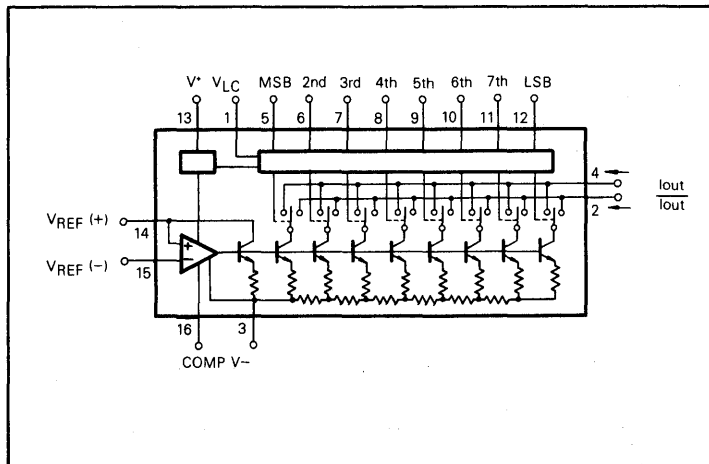
The μPC624 is a monolithic multiplying Digital to Analog converter featuring very high speed performance with outstanding applications flexibility.

Advanced circuit design achieves settling time of 85 ns. High impedance dual complementary current output allows simple resistor loads, voltage conversion circuit by op amp, and other applications. Further advantage, direct interface to all the popular logic families is available by adjustable threshold logic inputs.

### FEATURES

- Wide range multiplying capability
- Wide power supply range  $\pm 5$  V to  $\pm 18$  V
- High output impedance and compliance
- Variable logic threshold
- Direct interface to TTL, CMOS, PMOS
- Differential current outputs
- Pin to pin compatible with PMI'S DAC-08

### EQUIVALENT CIRCUIT



### ORDERING INFORMATION

μPC624D



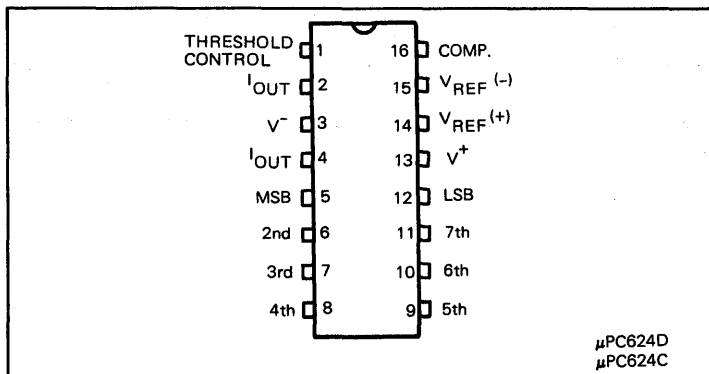
16 pin Ceramic DIP  
(Dual In-Line Package)

μPC624C



16 pin Plastic Molded DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC624	UNIT
Supply Voltage		36	V
Logic Inputs		V <sup>-</sup> to V <sup>-</sup> +36	V
Logic Threshold Control Voltage		V <sup>-</sup> to V <sup>+</sup>	V
Analog Current Outputs		4.2	mA
Reference Inputs		V <sup>-</sup> to V <sup>+</sup>	V
Reference Input Differential Voltage		±18	V
Reference Input Current		5.0	mA
Power Dissipation*	D or C Package	500	mW
Operating Temperature Range	D Package	-20 to +80	°C
	C Package	-20 to +70	
Storage Temperature Range	D Package	-55 to +150	°C
	C Package	-55 to +125	

\* See thermal information in chapter 11.

**ELECTRICAL CHARACTERISTICS (V<sup>±</sup> = 15 V, I<sub>REF</sub> = 2.0 mA, Ta = 25°C)**

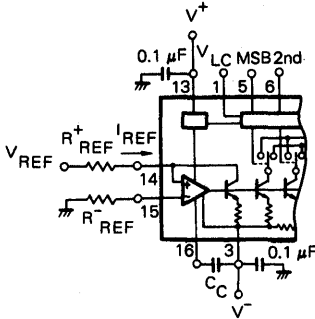
CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Resolution	8	8	8	Bit	
Monotonicity	8	8	8	Bit	
Nonlinearity			0.19	%FSR	
Settling Time		85	150	ns	±½ LSB, R <sub>L</sub> ≤ 50 Ω ON/OFF
Full Scale Temp. Coeff.		10	50	ppm/°C	
Output Voltage Compliance	-10		+18	V	ΔI <sub>FS</sub> ≤ ½ LSB
Full Scale Current	1.94	1.99	2.04	mA	V <sub>REF</sub> = 10.000 V, R <sub>REF</sub> <sup>+</sup> = 5.000 kΩ
Full Scale Symmetry		±1.0	±8.0	μA	
Zero Scale Offset Current		0.2	2.0	μA	
Output Current Range	0	2.0	2.1	mA	V <sup>-</sup> = 5.0 V
	0	2.0	4.2	mA	V <sup>-</sup> = 8.0 V to -18 V
Low Level Input Voltage			0.8	V	V <sub>LC</sub> = 0 V, Bit "OFF"
High Level Input Voltage	2.0			V	V <sub>LC</sub> = 0 V, Bit "ON"
Low Level Input Current		-2.0	-10	μA	V <sub>LC</sub> = 0 V, V <sub>IN</sub> = -10 V to +0.8 V
High Level Input Current		0.002	10	μA	V <sub>LC</sub> = 0 V, V <sub>IN</sub> = 2.0 V to 18 V
Logic Input Swing	-10		+18	V	
Logic Threshold Range	-10		+13.5	V	V <sub>TH</sub> ≈ V <sub>LC</sub> + 1.3 V
Reference Bias Current			-3	μA	
Reference Input Slew Rate	4.0	8.0		mA/μs	R <sub>REF</sub> ≤ 200 Ω, C <sub>c</sub> = 0 pF
Power Supply Rejection	SVR <sup>+</sup>	0.0003	0.01	%FSR/%	V <sup>+</sup> = 4.5 to 18 V, I <sub>REF</sub> = 1 mA
	SVR <sup>-</sup>	0.002	0.01	%FSR/%	V <sup>-</sup> = -4.5 V to -18 V, I <sub>REF</sub> = 1 mA
Power Supply Current	I <sup>+</sup>	2.5	3.8	mA	
	I <sup>-</sup>	-6.5	-7.8	mA	
	I <sup>+</sup>	2.4	3.8	mA	V <sup>+</sup> = 5 V, V <sup>-</sup> = -15 V, I <sub>REF</sub> = 2 mA
	I <sup>-</sup>	-6.4	-7.8	mA	V <sup>+</sup> = 5 V, V <sup>-</sup> = -15 V, I <sub>REF</sub> = 2 mA
	I <sup>+</sup>	2.3	3.8	mA	V <sup>±</sup> = ±5 V, I <sub>REF</sub> = 1 mA
	I <sup>-</sup>	-4.3	-5.8	mA	V <sup>±</sup> = ±5 V, I <sub>REF</sub> = 1 mA



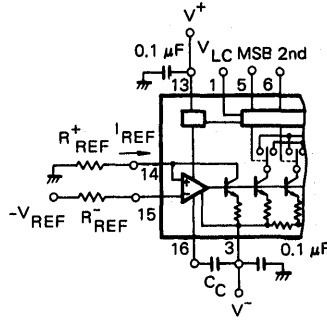


**TYPICAL APPLICATIONS**

Basic Positive Reference Operation



Basic Negative Reference Operation



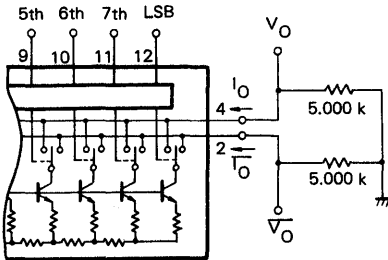
$R^+_{REF} = R^-_{REF}$

$C = 0.01 \mu F$  (Standard Value)

\*Minimum capacitor value for stable operation is given by

$C_C = R_{REF} (k\Omega) \times 15 (pF)$ .

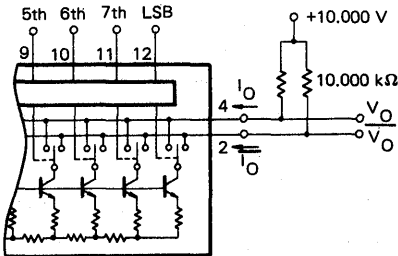
Basic Unipolar Negative Operation



$I_{REF} = 2.000 \text{ mA}$

INPUT	$I_O$ (mA)	$\bar{I}_O$ (mA)	$V_O$ (V)	$\bar{V}_O$ (V)
11111111	1.992	0.000	-9.96	0.000
11111110	1.984	0.008	-9.92	-0.04
10000001	1.008	0.984	-5.04	-4.92
10000000	1.000	0.992	-5.00	-4.96
01111111	0.992	1.000	-4.96	-5.00
00000001	0.008	1.984	-0.04	-9.92
00000000	0.000	1.992	0.00	-9.96

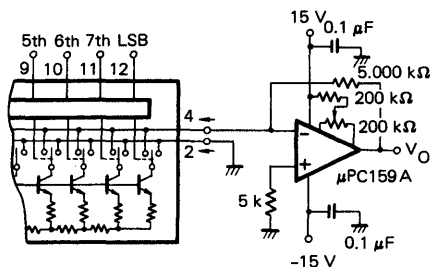
Basic Bipolar Output Operation



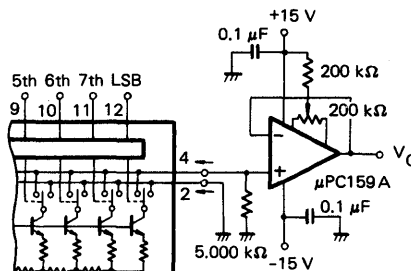
$I_{REF} = 2.000 \text{ mA}$

INPUT	$I_O$ (mA)	$\bar{I}_O$ (mA)	$V_O$ (V)	$\bar{V}_O$ (V)
11111111	1.992	0.000	-9.92	+10.00
11111110	1.984	0.008	-9.84	+9.92
10000001	1.008	0.984	-0.08	+0.16
10000000	1.000	0.992	0.00	+0.08
01111111	0.992	1.000	+0.08	0.00
00000001	0.008	1.984	+9.92	-9.84
00000000	0.000	1.992	+10.00	-9.92

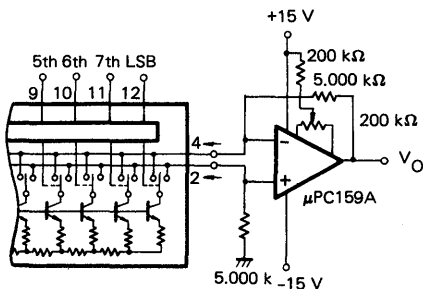
Positive Low Impedance Output Operation



Negative Low Impedance Output Operation



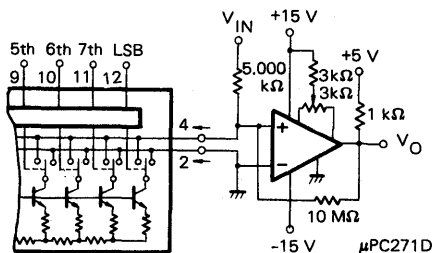
Low Impedance Output Operation (Both Outputs)



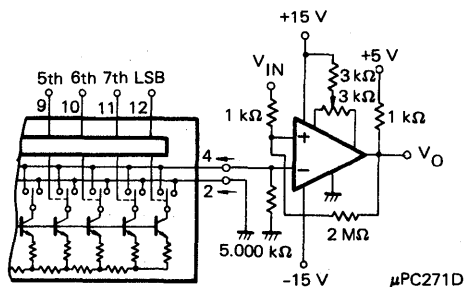
\* For buffer amplifier, high slew rate op amp is recommended to obtain fast settling time.

Comparator Connection Method for A/D Conversion

Positive Analog Input



Negative Analog Input



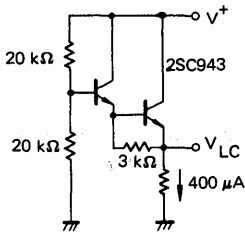
$V_{\pm} = \pm 15V, I_{REF} = 2mA$

**Interfacing with Various Logic Families**

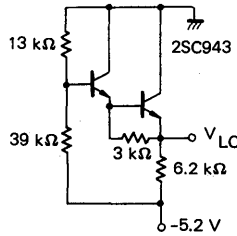
The logic threshold is set about 1.4 V above  $V_{LC}$ . This enables TTL levels acceptance with simply pin 1 grounded. By placing an appropriate voltage at the logic threshold control pin (pin 1), various threshold values are available for the other logic families.

TTL interface permission gives the interval logic threshold  $-4 \text{ mV}/^\circ\text{C}$  temperature coefficient.  $V_{TH} = V_{LC} + 1.4 \text{ V} - 0.004 \text{ V} \times (T_a - 25^\circ\text{C})$

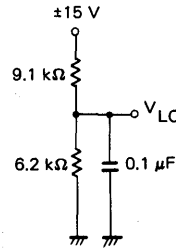
Anti-temp. coef. circuits are shown as follows.



CMOS, HN1L, NMOS

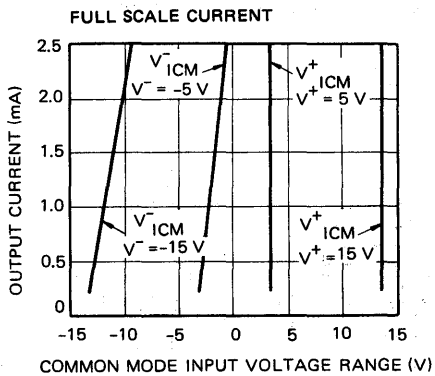
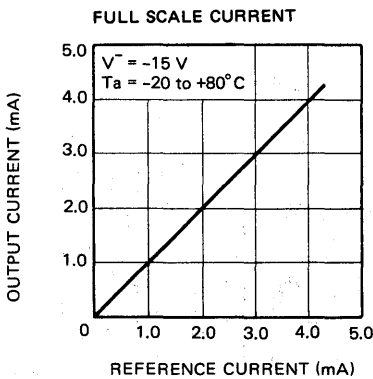


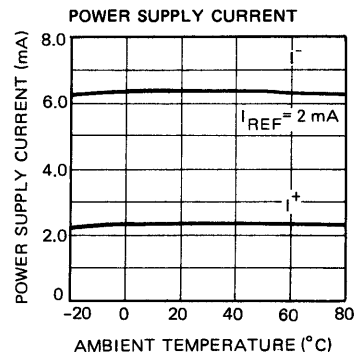
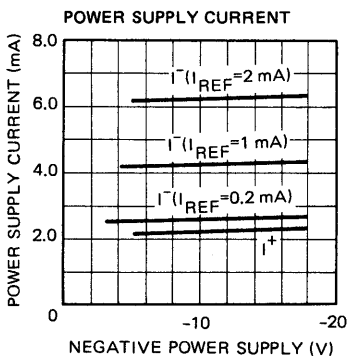
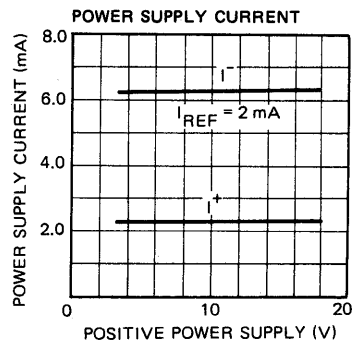
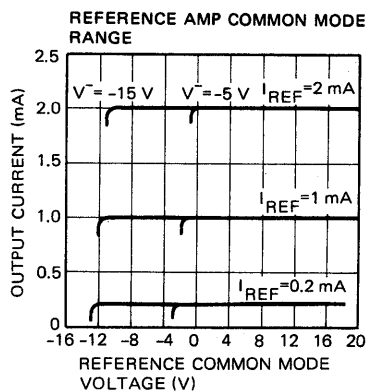
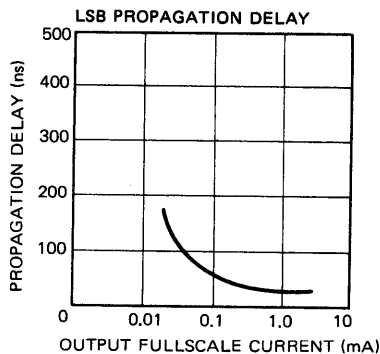
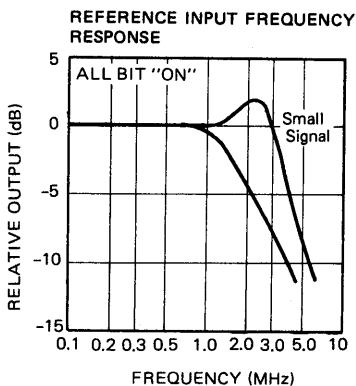
ECL



CMOS, HN1L (15 V)

**TYPICAL CHARACTERISTICS ( $T_a = 25^\circ\text{C}$ )**





**A/D CONVERSION PROGRAM LIST**

0000	MVI	A, 89H	: CONTROL WORD FOR 8255
0002	OUT	(8255)	: PROGRAM TO 8255
0004	MVI	B, 80H	: BIT POINTER INITIALIZE
0006	MOV	A, B	: BIT SET WORD
0007 BIT TEST	OUT	(PORT B)	: BIT SET OUTPUT TO PB OF 8255
0009	MOV	C, A	
000A	NOP		
000B	IN	(PORT C)	: READ COMPARATOR
000D	RRC		: A <sub>0</sub> → CARRY FLG
000E	JC	DEC POINTER	: COMPARATOR TEST
0011	MOV	A, C	
0012	SUB	B	: BIT RESET
0013	MOV	C, A	
0014 DEC POINTER	MOV	A, B	
0015	RRC		: DECREMENT BIT POINTER
0016	JC	RETURN	: LSB WAS TESTED ?
0019	MOV	B, A	
001A	ORA	C	: NEW BIT SET WORD
001B	JMP	BIT TEST	
001E RETURN	RET	(MAIN PROGRAM)	: CONVERSION END & RETURN TO MAIN PROGRAM

PROGRAM MEMORY : 31 BYTE  
CONVERSION TIME : 371 μs (741STATE) MAX, 323 μs (645STATE) MIN (@ φ = 2 MHz)  
WORKING REGISTER : B & C (C REGISTER; FINAL ANSWER MEMORY)

## Precision 4 1/2 Digit Integrating A/D Pair

### GENERAL DESCRIPTION

The μPC646D is the analog section of a precision integrating analog-to-digital (A/D) system.

J-FET and bipolar transistors are combined on the same chip to provide a high input impedance unity gain buffer, comparator and integrator, along with J-FET analog switches.

The μPC646D has sufficient resolution to construct up to a 4½-digit DPM is specifically designed for use with either the μPC647C BCD digital building block.

The μPC647C is the control section of μPC646D internally 4½-digit up counter, decoder, data latches and BCD output circuit.

### FEATURES

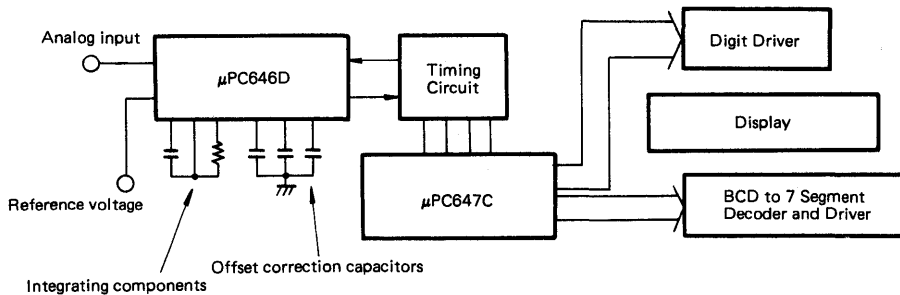
μPC646D Analog section

- High input impedance 10,000 MΩ typ.
- Automatic offset correction
- Analog input range of ±11 V with ±15 V supplies
- Wide power supply voltage range ±15 V to ±18 V
- TTL and CMOS compatible logic

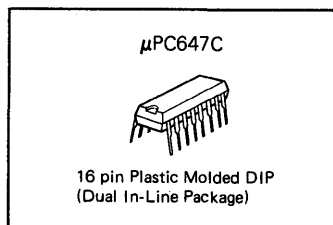
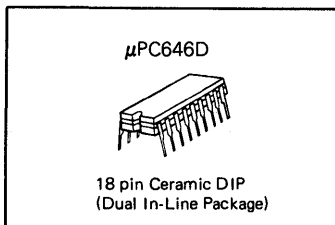
μPC647C Digital section

- +5 V single supply operation
- TTL compatible input and output
- BCD dynamic scan output

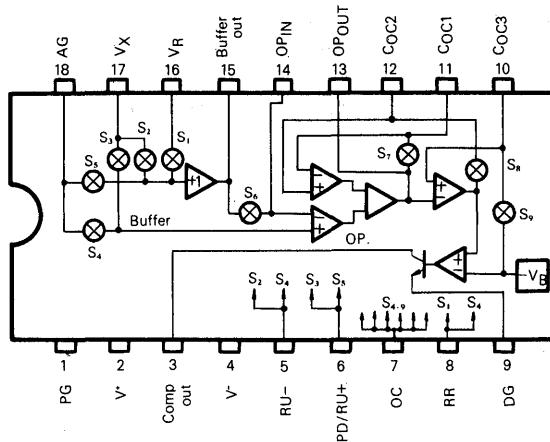
### SYSTEM BLOCK DIAGRAM



### ORDERING INFORMATION



**μPC646D BLOCK DIAGRAM**



**μPC646D**

**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

Power Supply Voltage Range	V <sup>±</sup>	±18	V
Reference Input Voltage Range	V <sub>R</sub>	0 ~ V <sup>+</sup>	V
Analog Input Voltage Range	V <sub>A</sub>	V <sup>-</sup> ~ V <sup>+</sup>	V
Control Input Voltage Range	V <sub>C</sub>	-2 ~ +6	V
Comparator Sink Current	I <sub>SINK</sub>	10	mA
Total Power Dissipation	P <sub>D</sub>	500	mW
Operating Temperature Range	T <sub>opt</sub>	-20 ~ +70	°C
Storage Temperature Range	T <sub>stg</sub>	-55 ~ +150	°C

**μPC646D RECOMMENDED OPERATIONAL CONDITIONS (Ta = 25°C, V<sup>±</sup> = ±15 V)**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Power Supply Voltage	V <sup>±</sup>	±4.75	±15	±16	V
Reference Voltage	V <sub>R</sub>	PG + 1		V <sup>+</sup> - 3	V
Analog Input Voltage	V <sub>A</sub>	-10		+10	V
Low Level Logic Input Voltage	V <sub>IL</sub>	-2.0		0.8	V
High Level Logic Input Voltage	V <sub>IH</sub>	2.0		5.0	V
Comparator Sink Current	I <sub>SINK</sub>		2.0	5.0	mA
Operating Temperature	T <sub>opt</sub>	0	25	50	°C

μPC646D ELECTRICAL CHARACTERISTICS (T<sub>s</sub> = 25°C, V<sup>±</sup> = ±15 V)

CHARACTERISTIC	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Analog Input Current	I <sub>IN</sub>	V <sub>X</sub> = 0		300	500	pA
		-20°C ≤ T <sub>a</sub> ≤ 70°C			5	nA
		V <sub>X</sub> = ±11 V			10	nA
Analog Input Resistance	R <sub>i</sub>	V <sub>X</sub> = 0	10 000			MΩ
Reference Input Current	I <sub>R</sub>	V <sub>R</sub> = 10 V		1.0	100	nA
		-20°C ≤ T <sub>a</sub> ≤ 70°C, V <sub>R</sub> = 10 V			10	μA
		V <sub>R</sub> = 11 V			10	μA
Reference Input Resistance	R <sub>i</sub>	V <sub>R</sub> = PG + 1 ~ 11 V	1 000			MΩ
Offset Correction Voltage	-V <sub>B</sub>		-12			V
Offset Correction Current	I <sub>OC</sub>	Coc <sub>1</sub> , Coc <sub>2</sub> , Coc <sub>3</sub>		20	2 000	pA
		-20°C ≤ T <sub>a</sub> ≤ 70°C			20	nA
OP Amp Slew Rate	SR <sub>1</sub>			10		V/μs
OP Amp Bandwidth	GB			3		MHz
Buffer Slew Rate	SR <sub>2</sub>			25		V/μs
Comparator Response Time		200 μV step, 100 μV		2.5		μs
Comparator Saturation	V <sub>OL</sub>	V <sub>CC</sub> = 5 V, R <sub>L</sub> = 2 kΩ, -20°C ≤ T <sub>a</sub> ≤ 70°C	0.25	0.4		V
Logic Input Current	I <sub>IC</sub>	0 ≤ V <sub>I</sub> ≤ 5 V, -20°C ≤ T <sub>a</sub> ≤ 70°C		15	50	μA
Power Supply Current	I <sup>+</sup>			3		mA
	I <sup>-</sup>			-5.5		mA
	I <sup>±</sup>	-20°C ≤ T <sub>a</sub> ≤ 70°C		±4	±11	mA

**Functional Description**

The μPC646D goes through the following 5 states during normal cycle: 1) Offset Correction; 2) Polarity Determination; 3) Initialization; 4) Ramp Unknown; 5) Ramp Reference.

Offset Correction Description (Figure 1)

The Offset Correction scheme will drive the input of the comparator to its switching threshold when the analog input is zero and the timing components, RC, are bypassed.

The Offset Correction input (OC) is driven high, closing switches S4–S9.

The offset voltages are assigned as follows: V<sub>OS1</sub> – the input offset voltage of the buffer; V<sub>OS2</sub> – the input offset voltage of A1; V<sub>OS3</sub> – the input offset voltage of A2; V<sub>OS4</sub> – the input offset voltage of the comparator.

S5 grounds the input of the buffer so that its output voltage is simply V<sub>OS1</sub>. S6 bypasses R to keep the integration time constant, RC, from affecting the circuit operation. S4 makes the total equivalent input voltage to A1 be -V<sub>OS1</sub> - V<sub>OS2</sub>. S7 puts the op amp in a unity gain configuration with respect to the input of A2. S8 keeps the output voltage of the op amp at -V<sub>B</sub> + V<sub>OS4</sub> = -V<sub>B</sub> (the Offset Correction potential) since the comparator is placed inside the loop. C3 samples the output of the -V<sub>B</sub> generator. The voltage at the non-inverting input of A2 is -V<sub>B</sub> - V<sub>OS1</sub> -

V<sub>OS2</sub> - V<sub>OS3</sub> + V<sub>OS4</sub> = V1. Thus, the sum of the offsets is stored on C1, and the differential voltage across the comparator is zero.

Polarity Determination (Figure 2)

The simplified diagram of the μPC646D in the Polarity Determination state is shown in Figure 2. S5 and S3 are closed during this period. S5 grounds the buffer input and V<sub>X</sub> (the unknown voltage) is applied through S3 to the non-inverting input of A1. The equation that describes the op amp output voltage is given in Figure 2. When V<sub>X</sub> is applied to A1 at t<sub>1</sub>, the output of the op amp slews to V<sub>X</sub> and is integrated until t<sub>2</sub>, when S3 opens and S4 closes. At t<sub>2</sub>, V<sub>OUT</sub>

slews down by -V<sub>X</sub> leaving  $\frac{1}{RC} \int_{t_1}^{t_2} V_X dt - V_B$  at the op amp output.

Just before t<sub>2</sub>, the comparator senses the op amp output with respect to -V<sub>B</sub>; the comparator output goes high if V<sub>X</sub> > 0 and remains low if V<sub>X</sub> ≤ 0.

Initialization (Figure 1)

During initialization, the configuration is the same way as it is in the Offset Correction state and the op amp output is brought back to the Offset Correction potential -V<sub>B</sub>.





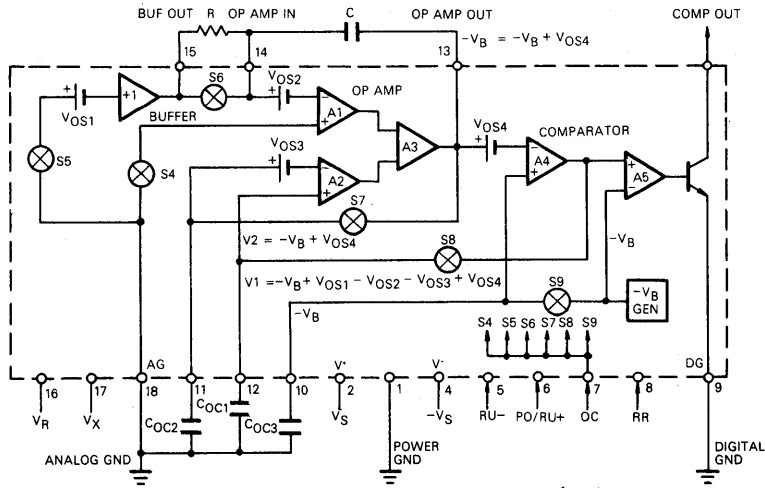


Fig. 1 Offset Correction Circuit

$$-V_B + V_X + \frac{1}{RC} \int_{t_3}^{t_4} V_X dt : \text{Ramp Unknown for } V_X > 0$$

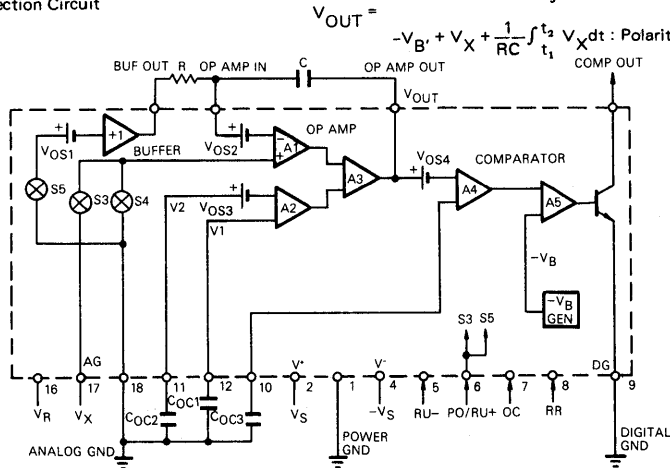


Fig. 2 Polarity Determination Circuit or Ramp Unknown Circuit for  $V_X > 0$

$$V_{OUT} = -V_B + V_X + \frac{1}{RC} \int_{t_1}^{t_2} V_X dt : \text{Polarity Determination}$$

Ramp Unknown (Figure 2 and 3)

In the Ramp Unknown state if  $V_X \geq 0$ , S3 and S5 are closed, as shown in Figure 2, and  $V_X$  is applied to the + input of the integrator. If  $V_X < 0$ , the device is connected as in Figure 3 with S2 and S4 closed.  $V_X$  is now applied through the buffer to the - input of the integrator. In either Ramp Unknown case, the op amp output ramps in the positive direction and  $V_X$  is applied to a high impedance J-FET input.

Ramp Reference (Figure 4)

In this state, the μPC646D is configured with switches S1 and S4 closed. The reference voltage,  $V_R$ , a positive voltage, is applied to the buffer input and the op amp

output ramps down until  $V_{OUT} = -V_B$ , where the comparator will trip.

If  $V_X$  and  $V_R$  are assumed to be constant over their respective integration periods, the integrals of Figure 4 are reduced to,

$$\frac{V_X (t_4 - t_3)}{RC} = \frac{V_R (t_5 - t_4)}{RC}$$

or

$$\frac{V_X}{V_R} = \frac{t_5 - t_4}{t_4 - t_3}$$

Since  $t_4 - t_3 = 4096$  clock periods and  $t_5 - t_4$  can be measured in clock periods,  $V_X/V_R = X/2^{12}$ , where X is a digital binary output representing an analog input  $V_X$  with respect to  $V_R$ .

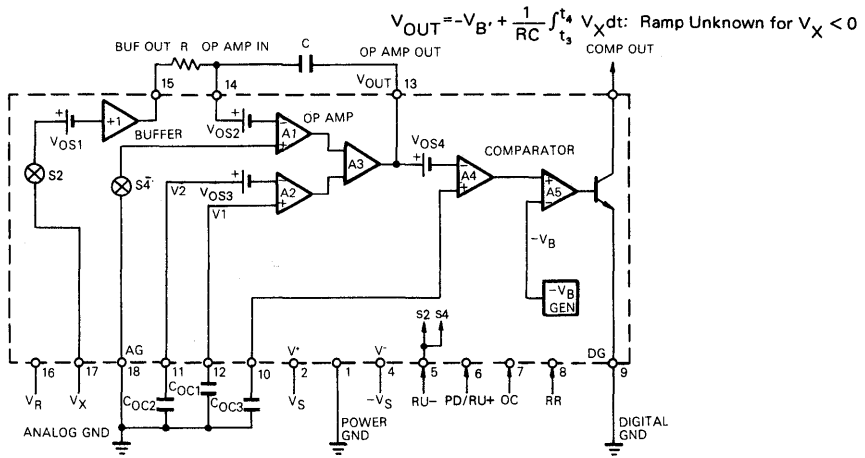
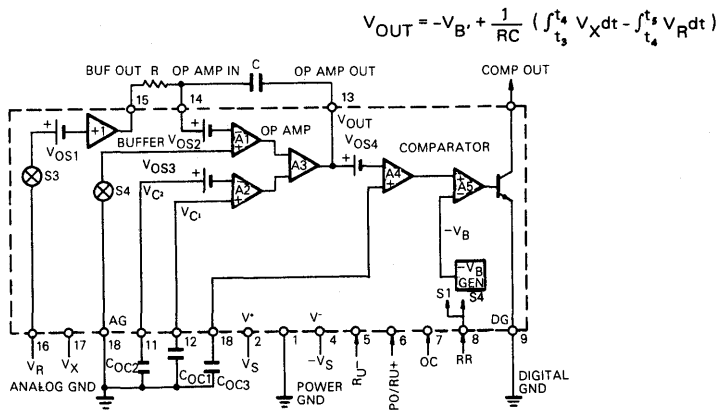


Fig. 3 Ramp Unknown for  $V_X < 0$



\*More accurately

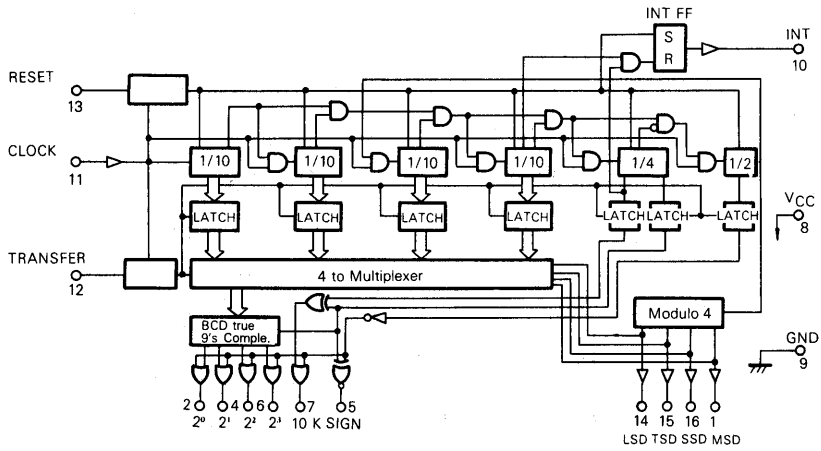
$$V_{OUT} = V_B + \frac{1}{RC} (\int_{t_3}^{t_4+\Delta} V_R dt + \int_{t_3}^{t_4} V_X dt) + \delta$$

Where  $\delta$  is the incremental voltage overdrive needed to fully switch the comparator and  $\Delta$  is the sum of the additional time required to develop  $\delta$  and the comparator propagation delay.

Fig. 4 Ramp Reference Circuit



μPC647C BLOCK DIAGRAM



μPC647C ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)

PARAMETER	SYMBOL	μPC647C	UNIT
Power Supply Voltage	V <sub>cc</sub>	6.0	V
Input Voltage Range	V <sub>I</sub>	-0.5 ~ +6.0	V
Total Power Dissipation	P <sub>D</sub>	300	mW
Operating Temperature Range	T <sub>opt</sub>	-20 ~ +70	°C
Storage Temperature Range	T <sub>stg</sub>	-55 ~ +125	°C

μPC647C RECOMMENDED OPERATING CONDITIONS (Ta = 25°C, Vcc = +5 V)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Power Supply Voltage	V <sub>cc</sub>	4.75	5.0	5.25	V
Low Level Logic Input Voltage	V <sub>IL</sub>	0		0.8	V
High Level Logic Input Voltage	V <sub>IH</sub>	3		V <sub>cc</sub> +0.3	V
High Level Clock Input Voltage	V <sub>ICLH</sub>	4.0		V <sub>cc</sub> +0.3	V
Clock Frequency	f <sub>CL</sub>	DC		400	kHz
Input Pulse Width	PW	200			ns
Operating Temperature	T <sub>opt</sub>	0	25	50	°C



μPC647C ELECTRICAL CHARACTERISTICS (Ta = 25°C, Vcc = +5 V)

CHARACTERISTIC	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Power Supply Current	I <sub>CC</sub>	I <sub>O</sub> = 0, V <sub>CC</sub> = +5 ±0.2 V			35	mA
High Level Output Voltage	V <sub>OH</sub>	I <sub>O</sub> SOURCE = 100 μA	4.75			V
		I <sub>O</sub> SOURCE = 100 μA	3.0			
Output Sink Current	I <sub>O</sub> SINK	V <sub>O</sub> = 4.5 V	5.0			mA
Low Level Output Voltage	V <sub>OL</sub>	I <sub>O</sub> SINK = 2 mA			0.4	V
		I <sub>O</sub> SINK = 2 mA			0.4	
Logic Input Current	I <sub>I</sub>				50	μA
Comparator Delay Time	t <sub>d</sub>		0.1		5	μs

**Functional Description**

**Counters:** The μPC647C has four ÷10 counters, one ÷4 counter, and one ÷2 for a counter of 80,000 clock pulses. A ripple carry is provided and all counter flip-flops are synchronous with the negative transition of the input clock. The last flip-flop in the divider chain (÷2 in the block diagram) triggers with the "0" to "1" transition of the previous flip-flop. The count sequence is shown in the first column of the count diagram.

**Reset:** All counter stages are reset to "0" and the INT flip-flop (driving the INT output) is set to "1" on the first negative clock transition after a "0" is applied to the Reset input. The internal reset is removed on the first negative clock transition after the internal reset has occurred and a "1" has been applied to the Reset input. This timing provides an on-chip reset at least one clock cycle wide and a one cycle delay to remove reset before counting begins.

**Transfer:** Data in the counters is transferred to the latches when the Transfer input is at "0". If the Transfer input is held low the state of the counters is continuously displayed (see count diagram). Data will cease to transfer to the latches on the first positive clock transition after the first negative clock transition after a "1" is applied to the Transfer input. This provides a transfer pulse at least one half clock cycle wide and a half clock cycle delay to remove the transfer signal before the counters change state.

**INT:** The integrate output is used to set the charge time on a dual slope integrator. INT is "1" from reset

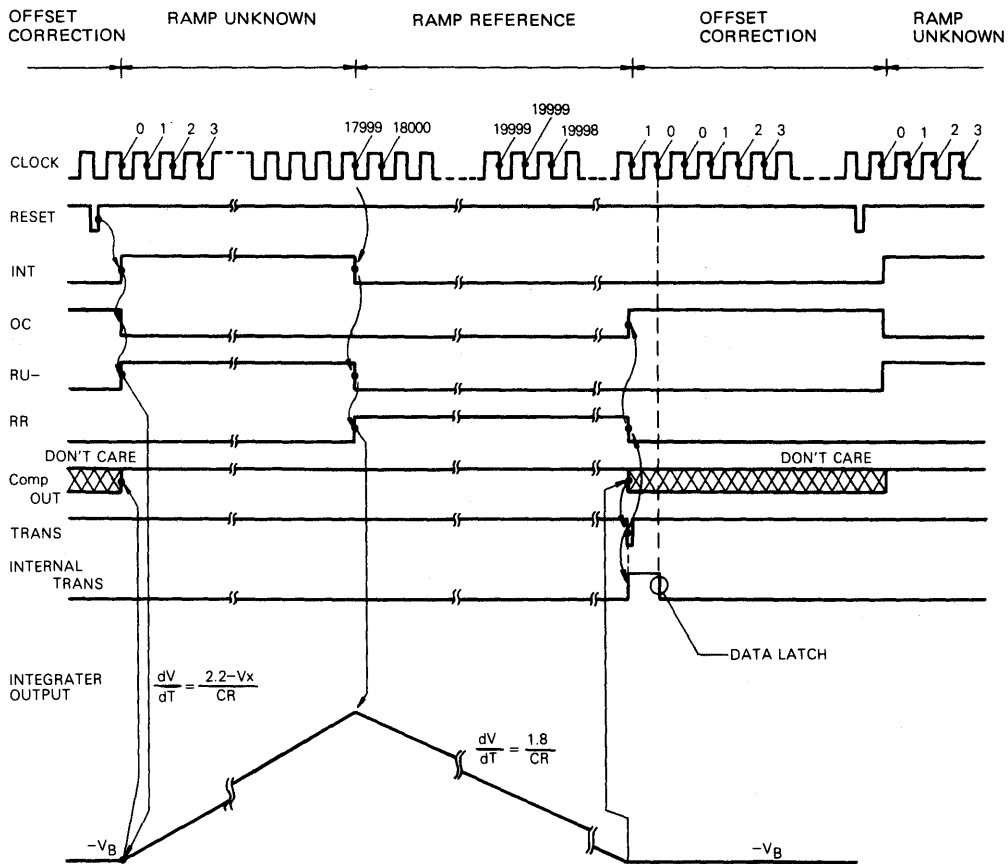
to the 18,000th clock pulse, then "0" until the next reset. The dual slope integrator is the voltage monitoring part of the external circuitry needed for a DPM. It charges a capacitor at a rate proportional to the measured voltage while INT is "1", then discharges at a rate proportional to a fixed reference as shown in the dual slope diagram. When the output of the integrator reaches 0V a pulse is generated and fed into the Transfer input of the chip. As the dual slope diagram indicates, the number in the latches is proportional to the measured voltage.

**Multiplexing:** The module 4 multiplex counter is triggered by the carry from the second decade counter, making the multiplex rate one hundredth the counting rate (4 KHz for a 400 kHz clock). The LSD, TSD, SSD and MSD (least significant, third significant, second significant and most significant digits) outputs indicate by a low level which decade latch is displayed at the BCD outputs.

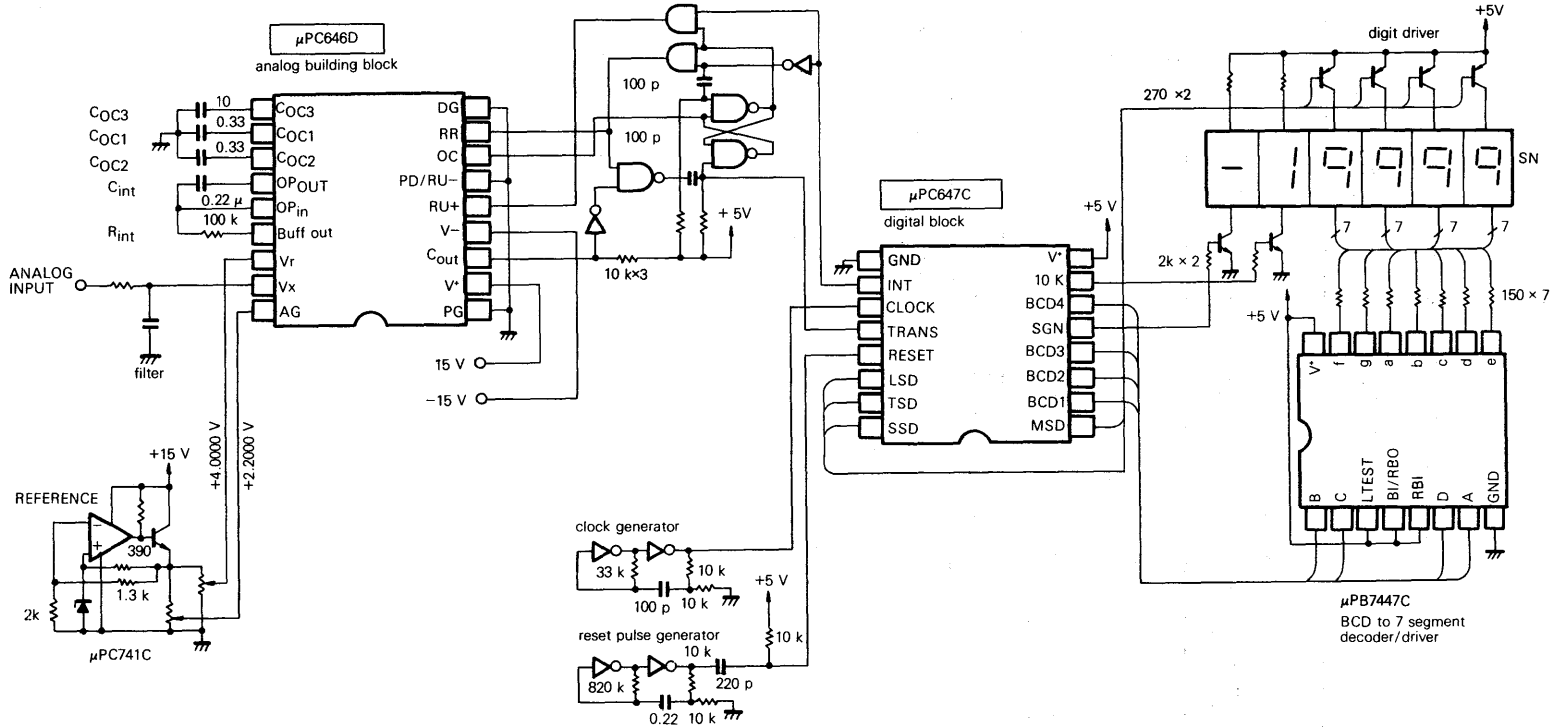
**Overrange Blanking and Sign:** The data in the latch for the ÷2 counter is used to detect an out-of-range voltage. If this latch is "0" the BCD and 10 k outputs are forced to all "1's" and the SGN output is inverted. When the data in the overrange latch and the sign bit latch are "1" the sign bit generates the 9's complement of the decade latches and the complement of the 10 k latch at the respective outputs. When the overrange bit is "1" and the sign bit is "0" true BCD of the decade latches and the uncomplemented 10 k latch appear at the outputs.



4½ DIGIT INTEGRATING A/D CONVERTER TIMING



**μPC646D, 647C 4½ DIGIT INTEGRATING A/D CONVERTER**



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## SELECTION GUIDE

DEVICE	ORIGINAL	OPERATING TEMPERATURE RANGE (°C)	V <sub>OUT</sub> (V)	V <sub>IN</sub> (V)		I <sub>O</sub> MAX. (A)	P <sub>T</sub> MAX. (W)	PACKAGE	
				MIN.	MAX.				
μPC141C	305	-20~+80/-20~+70	4.5 ~ 30	8.0	40	0.05	0.5/0.35	8 pin DIP	
μPC305C	305	0~+70	4.5~30	8.0	40	0.05	0.35	8 pin DIP	
μPC78L05	78L05	* -20~+150	☆ 5	7	30	0.1	0.8		
μPC78L08	78L08	* -20~+150	☆ 8	10.5	30	0.1	0.8		
μPC78L12	78L12	* -20~+150	☆ 12	14.5	35	0.1	0.8		
μPC78L15	78L15	* -20~+150	☆ 15	17.5	35	0.1	0.8		
μPC78M05H	78M05	-20~+80	★ 5	7	35	0.5	20		
μPC78M08H	78M08	-20~+80	★ 8	10.5	35	0.5	20	TO-220AB	
μPC78M10H	—	-20~+80	★ 10	12.5	35	0.5	20	TO-220AB	
μPC78M12H	78M12	-20~+80	★ 12	14.5	35	0.5	20	TO-220AB	
μPC78M15H	78M15	-20~+80	★ 15	17.5	35	0.5	20	TO-220AB	
μPC78M18H	78M18	-20~+80	★ 18	21	35	0.5	20	TO-220AB	
μPC78M24H	78M24	-20~+80	★ 24	27	40	0.5	20	TO-220AB	
μPC7805H	7805	-20~+80	★ 5	7	35	1.0	20	TO-220AB	
μPC7808H	7808	-20~+80	★ 8	10.5	35	1.0	20	TO-220AB	
μPC7812H	7812	-20~+80	★ 12	14.5	35	1.0	20	TO-220AB	
μPC7815H	7815	-20~+80	★ 15	17.5	35	1.0	20	TO-220AB	
μPC7818H	7818	-20~+80	★ 18	21	35	1.0	20	TO-220AB	
μPC7824H	7824	-20~+80	★ 24	27	40	1.0	20	TO-220AB	
μPC7905H	7905	-20~+80	★ -5	-7	-35	1.0	20	TO-220AB	
μPC7908H	7908	-20~+80	★ -8	-10.5	-35	1.0	20	TO-220AB	
μPC7812H	7912	-20~+80	★ -12	-14.5	-35	1.0	20	TO-220AB	
μPC7915H	7915	-20~+80	★ -15	-17.5	-35	1.0	20	TO-220AB	
μPC7918H	7918	-20~+80	★ -18	-21	-35	1.0	20	TO-220AB	
μPC7924H	7924	-20~+80	★ -24	-27	-40	1.0	20	TO-220AB	
μPC1042C	—	-20~+85	Values depend on application circuits						16 pin DIP

\* Junction temperature

☆ Output Voltage accuracy ±10%

★ Output Voltage accuracy ±5%

# μPC141 / 305

## Precision Positive Voltage Regulator

### GENERAL DESCRIPTION

The μPC141/305 are precision Voltage Regulator for a wide range of applications from digital power supplies to high stability analog circuitry.

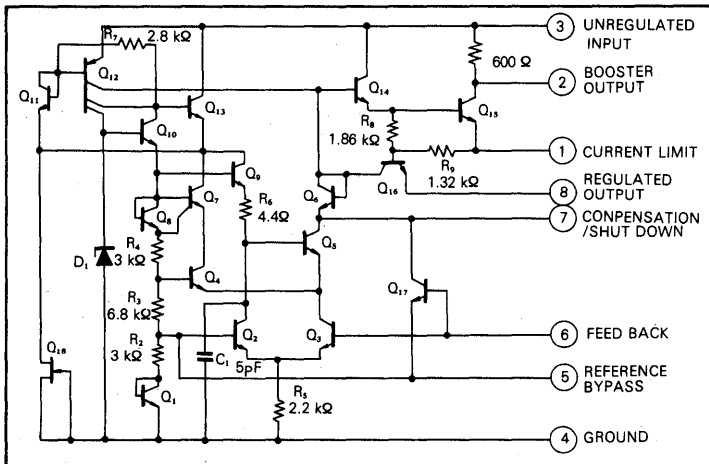
Fast response to both load and line transients, small standby power dissipation and freedom from oscillations with varying resistive load and reactive load make this type of regulator ideal for general purpose power supply systems.

Two kinds of ICs are available according to reliability the μPC141 for industry, the μPC305 for commercial.

### FEATURES

- Output Voltage adjustable from 4.5 V to 30 V
- Output Currents in excess of 10 A possible by adding external transistors
- Load Regulation better than 0.1% full load with current Limiting
- DC Line Regulation guaranteed at 0.03%/V
- LM305 Direct Replacement

### EQUIVALENT CIRCUIT



### ORDERING INFORMATION

μPC141D



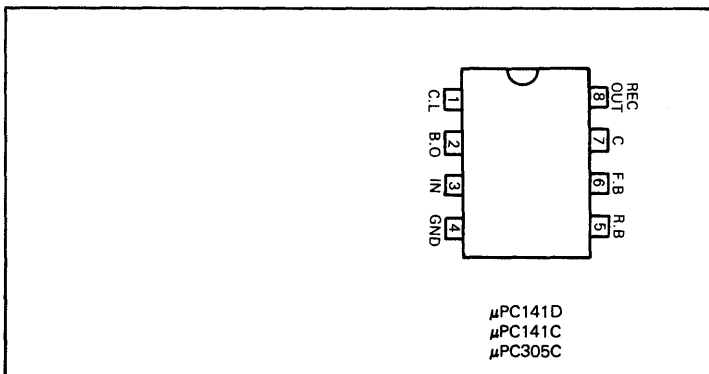
8 pin Ceramic DIP  
(Dual In-Line Package)

μPC141C/μPC305C



8 pin Plastic Molded DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER		μPC141	μPC305	UNIT
Input Voltage		40	40	V
Input Output Voltage Differential		40	40	V
Peak Output Current		50	50	mA
Power Dissipation*	D Package	500	—	mW
	C Package	350	350	
Operating Temperature Range	D Package	-20 to +80	—	°C
	C Package	-20 to +70	0 to 70	
Storage Temperature Range	D Package	-55 to +150	—	°C
	C Package	-55 to +125	-55 to +125	

\* See thermal information in chapter 11.

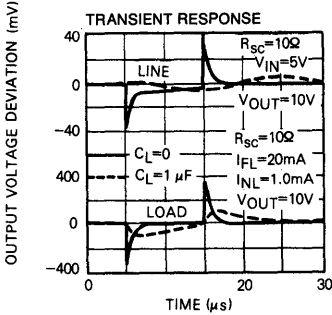
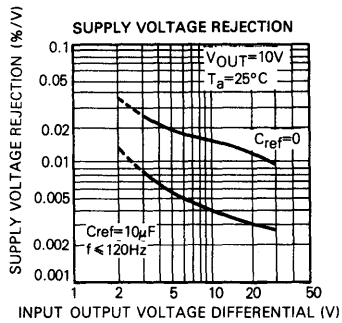
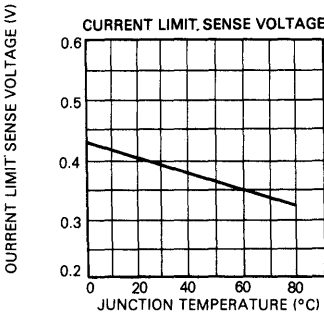
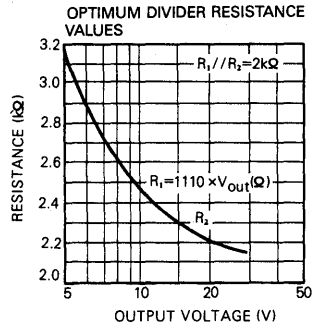
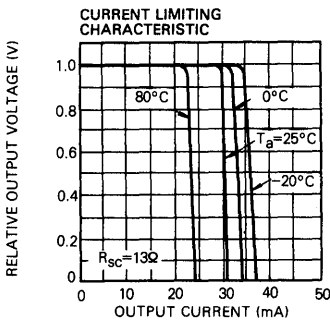
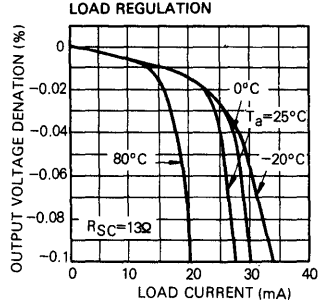
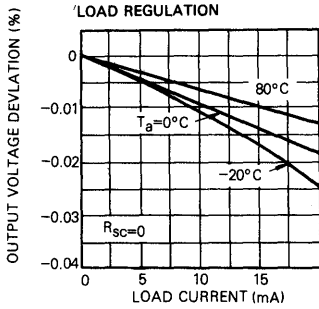
**ELECTRICAL CHARACTERISTICS**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS	
Input Voltage Range	8.0		40	V		
Output Voltage Range	4.5		30	V		
Input Output Voltage Differential	3.0		30	V		
Load Regulation		0.02	0.05	%	$0 \leq I_o \leq 12 \text{ mA}$ , $R_{sc} = 18 \Omega$	
Line Regulation		0.025	0.06	%/V	$V_{IN} - V_{OUT} \leq 5 \text{ V}$	
		0.015	0.03	%/V	$V_{IN} - V_{OUT} > 5 \text{ V}$	
Ripple Rejection		0.003		%/V	$C_{REF} = 10 \mu\text{F}$ , $f = 120 \text{ Hz}$	
Temperature Stability	141 A/D		0.3	1.0	%	$-20^\circ\text{C} \leq T_a \leq 80^\circ\text{C}$
	141 C		0.3	1.0	%	$-20^\circ\text{C} \leq T_a \leq 70^\circ\text{C}$
	305C		0.3	1.0	%	$0^\circ\text{C} \leq T_a \leq 70^\circ\text{C}$
Feedback Sense Voltage	1.65	1.8	1.90	V		
Standby Current Drain		0.005		%	$10 \text{ Hz} \leq f \leq 10 \text{ kHz}$ , $C_{REF} = 0$	
		0.002		%	$C_{REF} = 0.1 \mu\text{F}$	
Long Term Stability		0.1		%		
Standby Current Drain		1.0	2.0	mA	$V_{IN} = 40 \text{ V}$	

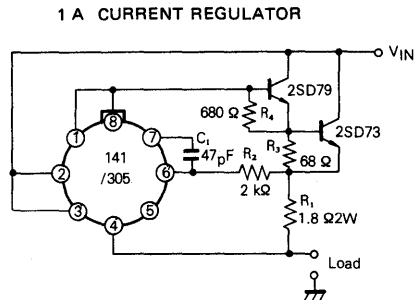
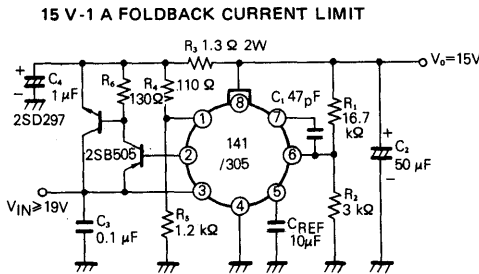
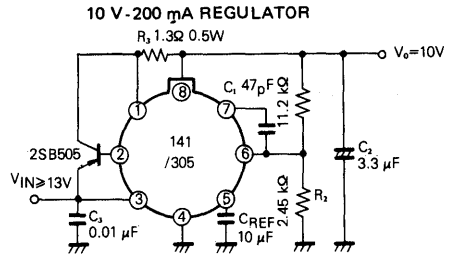
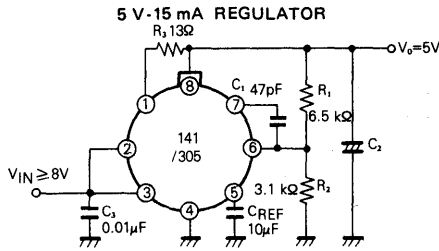
C<sub>REF</sub> : Bypass capacitor of Pin 5

R<sub>sc</sub> : Output current sense resistor

TYPICAL PERFORMANCE CHARACTERISTICS ( $T_a = 25^\circ\text{C}$ )



APPLICATIONS



NEC cannot assume any responsibility for any circuits shown or represent that they are free from patent infringement.

# $\mu$ PC78L00 SERIES

## Three Terminal Positive Regulators

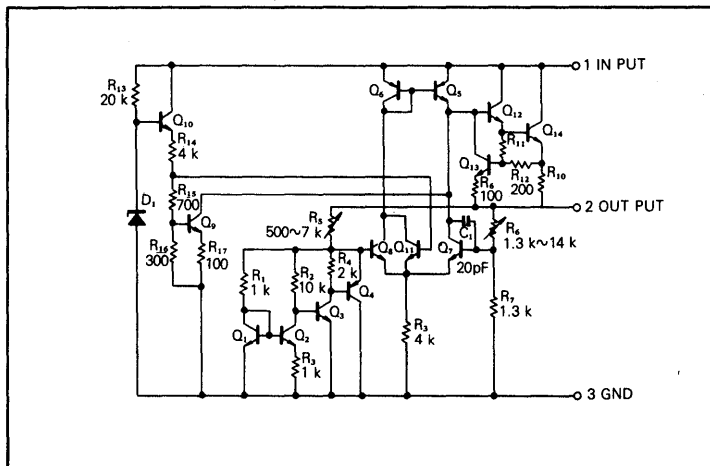
### GENERAL DESCRIPTION

The  $\mu$ PC78L00 series are monolithic three terminal positive regulators which employ internally current limiting, thermal shut down, make them essentially indestructible. They are intended as fixed voltage regulators in a wide range of application including local on card regulation for elimination of distribution problems associated with single point regulation.

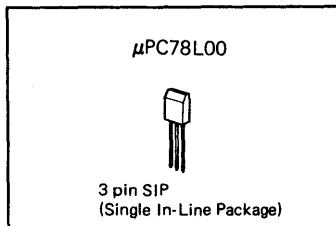
### FEATURES

- Output current in excess of 100 mA
- No external component required
- Internal thermal overload protection
- Internal short circuit current limiting

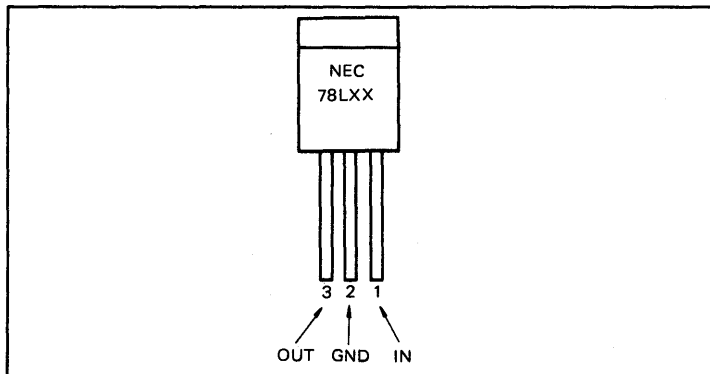
### EQUIVALENT CIRCUIT



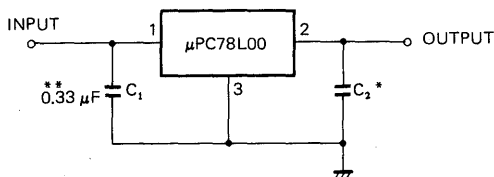
### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



**TYPICAL APPLICATION**



Notes: \* Although no output capacitor is needed for stability, it does improve transient response.  
 \*\* Required if regulator is located an appreciable distance from power supply filter.

**ABSOLUTE MAXIMUM RATINGS**

Input Voltage	(μPC78L05/78L08) 30	V
	(μPC78L12/78L15) 35	V
Internal Power Dissipation	800	mW
Operating Temperature Range	-20 to +80	°C
Storage Temperature Range	-55 to +150	°C
Lead Temperature	Soldering 10 sec 260	°C
Operating Junction Temperature Range	-20 to 150	°C

**ELECTRICAL CHARACTERISTICS μPC78L05**

( $V_{IN} = 10\text{ V}$ ,  $I_{OUT} = 40\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\ \mu\text{F}$ ,  $C_{OUT} = 0.1\ \mu\text{F}$ )

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	4.6	5.0	5.4	V	$T_j = 25^\circ\text{C}$
Line Regulation	$REG_{IN}$		55	200	mV	$T_j = 25^\circ\text{C}$ $7\text{ V} \leq V_{IN} \leq 20\text{ V}$
			45	150	mV	
Load Regulation	$REG_L$		11	60	mV	$T_j = 25^\circ\text{C}$ $1\text{ mA} \leq I_{OUT} \leq 100\text{ mA}$
			5.0	30	mV	
Output Voltage	$V_o$	4.5		5.5	V	$7\text{ V} \leq V_{IN} \leq 20\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 40\text{ mA}$
		4.5		5.5	V	$V_{IN} = 10\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 70\text{ mA}$
Quiescent Current	$I_{BIAS}$		3.8	6.0	mA	$T_j = 25^\circ\text{C}$
				5.5	mA	$T_j = 125^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.5	mA	$8\text{ V} \leq V_{IN} \leq 20\text{ V}$ , $I_{OUT} = 40\text{ mA}$
				0.2	mA	$V_{IN} = 10\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 40\text{ mA}$
Output Noise Voltage	NL		30		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		40	50		dB	$f = 120\text{ Hz}$ , $8\text{ V} \leq V_{IN} \leq 18\text{ V}$ , $T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$V_o/\Delta T$		-0.65		$\text{mV}/^\circ\text{C}$	$I_{OUT} = 5\text{ mA}$
Dropout Voltage			1.7		V	$T_j = 25^\circ\text{C}$
Short Circuit Current	$I_{short}$		150		mA	$T_j = 25^\circ\text{C}$



# μPC78L00 SERIES

## ELECTRICAL CHARACTERISTICS μPC78L08

( $V_{IN} = 14\text{ V}$ ,  $I_{OUT} = 40\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ )

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	7.36	8.0	8.64	V	$T_j = 25^\circ\text{C}$
Line Regulation	$REG_{IN}$		80	200	mV	$T_j = 25^\circ\text{C}$ $10.5\text{ V} \leq V_{IN} \leq 23\text{ V}$
			70	150	mV	
Load Regulation	$REG_L$		15	80	mV	$T_j = 25^\circ\text{C}$ $1\text{ mA} \leq I_{OUT} \leq 100\text{ mA}$
			8.0	40	mV	
Output Voltage	$V_o$	7.2		8.8	V	$10.5\text{ V} \leq V_{IN} \leq 23\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 40\text{ mA}$
		7.2		8.8	V	$V_{IN} = 14\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 70\text{ mA}$
Quiescent Current	$I_{BIAS}$		3.9	6.0	mA	$T_j = 25^\circ\text{C}$
				5.5	mA	$T_j = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.5	mA	$12\text{ V} \leq V_{IN} \leq 23\text{ V}$ , $I_{OUT} = 40\text{ mA}$
				0.2	mA	$V_{IN} = 14\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 40\text{ mA}$
Output Noise Voltage	NL		60		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		38	45		dB	$f = 120\text{ Hz}$ , $12\text{ V} \leq V_{IN} \leq 22\text{ V}$ , $T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$V_o/\Delta T$		-0.8		$\text{mV}/^\circ\text{C}$	$I_{OUT} = 5\text{ mA}$
Dropout Voltage			1.7		V	$T_j = 25^\circ\text{C}$
Short Circuit Current	$I_{o\text{ short}}$		150		mA	$T_j = 25^\circ\text{C}$

## ELECTRICAL CHARACTERISTICS μPC78L12

( $V_{IN} = 19\text{ V}$ ,  $I_{OUT} = 40\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\text{ }\mu\text{F}$ ,  $C_{OUT} = 0.1\text{ }\mu\text{F}$ )

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	11.1	12	12.9	V	$T_j = 25^\circ\text{C}$
Line Regulation	$REG_{IN}$		120	250	mV	$T_j = 25^\circ\text{C}$ $14.5\text{ V} \leq V_{IN} \leq 27\text{ V}$
			100	200	mV	
Load Regulation	$REG_L$		20	100	mV	$T_j = 25^\circ\text{C}$ $1\text{ mA} \leq I_{OUT} \leq 100\text{ mA}$
			10	50	mV	
Output Voltage	$V_o$	10.8		13.2	V	$14.5\text{ V} \leq V_{IN} \leq 27\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 40\text{ mA}$
		10.8		13.2	V	$V_{IN} = 19\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 70\text{ mA}$
Quiescent Current	$I_{BIAS}$		4.2	6.5	mA	$T_j = 25^\circ\text{C}$
				6.0	mA	$T_j = 125^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.5	mA	$16\text{ V} \leq V_{IN} \leq 27\text{ V}$ , $I_{OUT} = 40\text{ mA}$
				0.2	mA	$V_{IN} = 19\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 40\text{ mA}$
Output Noise Voltage	NL		80		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		36	42		dB	$f = 120\text{ Hz}$ , $15\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$V_o/\Delta T$		-1.0		$\text{mV}/^\circ\text{C}$	$I_{OUT} = 5\text{ mA}$
Dropout Voltage			1.7		V	$T_j = 25^\circ\text{C}$
Short Circuit Current	$I_{o\text{ short}}$		150		mA	$T_j = 25^\circ\text{C}$

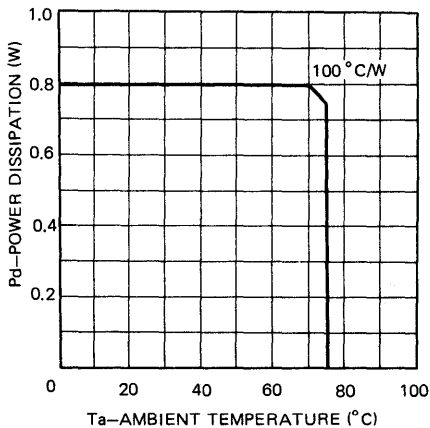
**ELECTRICAL CHARACTERISTICS μPC78L15**

( $V_{IN} = 23\text{ V}$ ,  $I_{OUT} = 40\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ ,  $C_{IN} = 0.33\ \mu\text{F}$ ,  $C_{OUT} = 0.1\ \mu\text{F}$ )

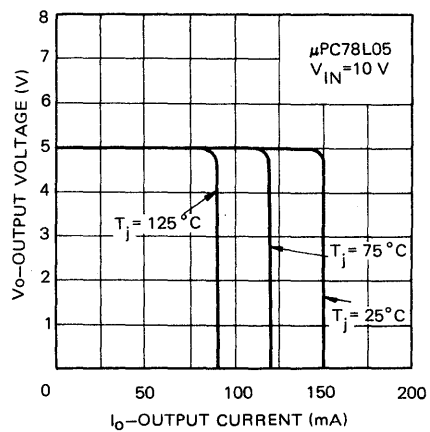
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	13.8	15	16.2	V	$T_j = 25^\circ\text{C}$
Line Regulation	$REG_{IN}$		130	300	mV	$T_j = 25^\circ\text{C}$ , $17.5\text{ V} \leq V_{IN} \leq 30\text{ V}$
			110	250	mV	$20\text{ V} \leq V_{IN} \leq 30\text{ V}$
Load Regulation	$REG_L$		25	150	mV	$T_j = 25^\circ\text{C}$ , $1\text{ mA} \leq I_{OUT} \leq 100\text{ mA}$
			12	75	mV	$1\text{ mA} \leq I_{OUT} \leq 40\text{ mA}$
Output Voltage	$V_o$	13.5		16.5	V	$17.5\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 40\text{ mA}$
		13.5		16.5	V	$V_{IN} = 23\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 70\text{ mA}$
Quiescent Current	$I_{BIAS}$		4.4	6.5	mA	$T_j = 25^\circ\text{C}$
				6.0	mA	$T_j = 125^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.5	mA	$20\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $I_{OUT} = 40\text{ mA}$
				0.2	mA	$V_{IN} = 23\text{ V}$ , $1\text{ mA} \leq I_{OUT} \leq 40\text{ mA}$
Output Noise Voltage	NL		90		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		33	39		dB	$f = 120\text{ Hz}$ , $18.5\text{ V} \leq V_{IN} \leq 28.5\text{ V}$ ; $T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$V_o/\Delta T$		-1.3		$\text{mV}/^\circ\text{C}$	$I_{OUT} = 5\text{ mA}$
Dropout Voltage			1.7		V	$T_j = 25^\circ\text{C}$
Short Circuit Current	$I_{o\text{ short}}$		150		mA	$T_j = 25^\circ\text{C}$

**TYPICAL CHARACTERISTICS ( $T_a = 25^\circ\text{C}$ )**

**WORST CASE POWER DISSIPATION vs. AMBIENT TEMPERATURE**

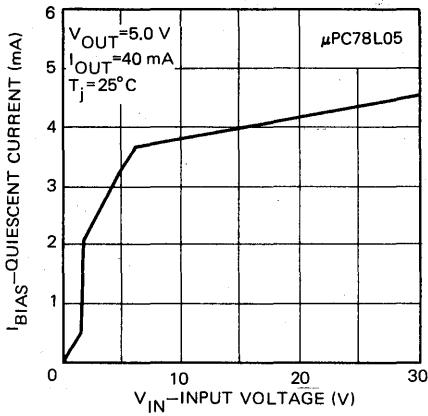


**CURRENT LIMITING CHARACTERISTICS**

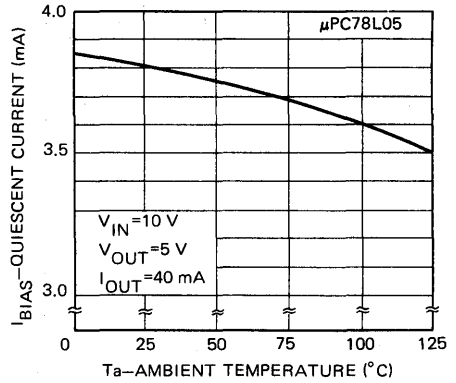


# μPC78L00 SERIES

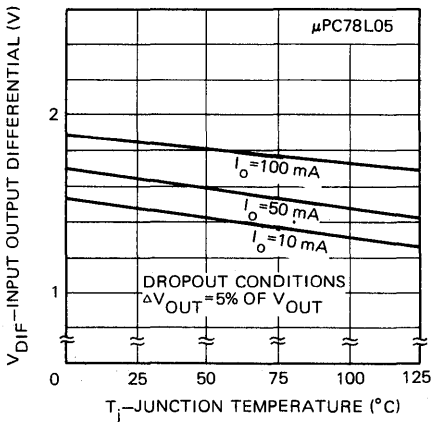
QUIESCENT CURRENT AS A FUNCTION OF INPUT VOLTAGE



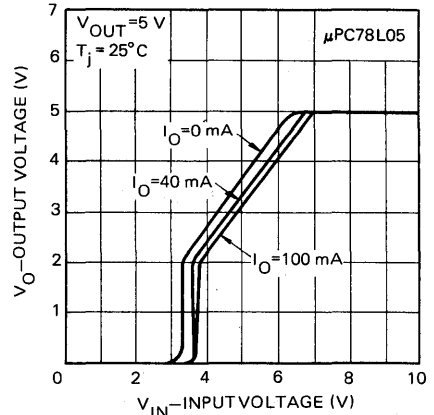
QUIESCENT CURRENT AS A FUNCTION OF TEMPERATURE



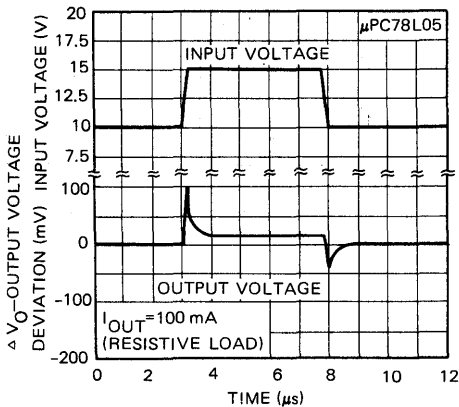
DROPOUT VOLTAGE AS A FUNCTION OF JUNCTION TEMPERATURE



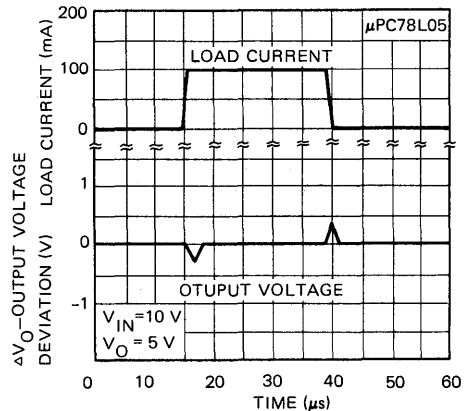
DROPOUT CHARACTERISTICS



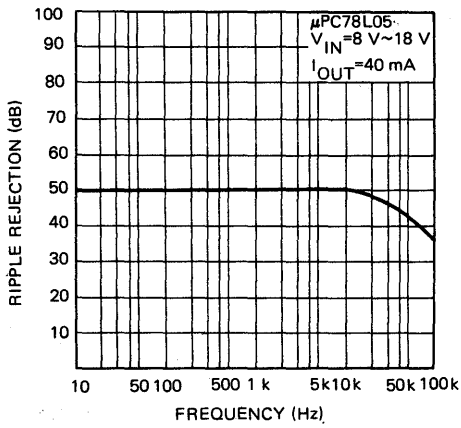
LINE TRANSIENT RESPONSE



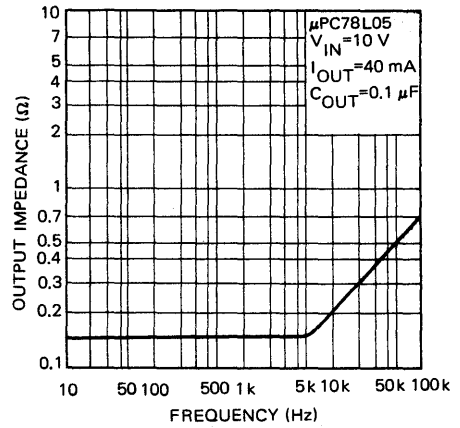
LOAD TRANSIENT RESPONSE



**RIPPLE REJECTION AS A FUNCTION OF FREQUENCY**



**OUTPUT IMPEDANCE AS A FUNCTION OF FREQUENCY**



# μPC78M00H SERIES

## Three Terminal Positive Regulators

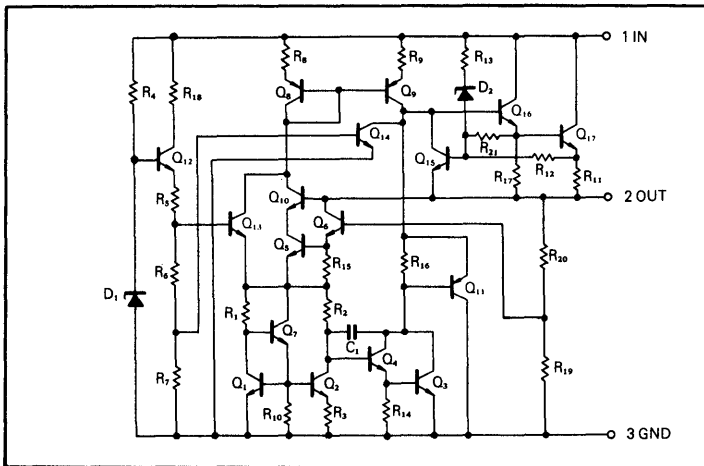
### GENERAL DESCRIPTION

The μPC78M00H series are monolithic three terminal positive regulators which employ internally current limiting, thermal shut down, and safe-area compensation, make them essentially indestructible. They are intended as fixed-voltage regulators in a wide range of application including local on card regulation for elimination of distribution problems associated with single point regulation.

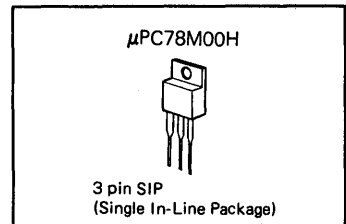
### FEATURES

- Output current in excess of 0.5 A
- No external component required
- Internal thermal overload protection
- Internal short circuit current limiting

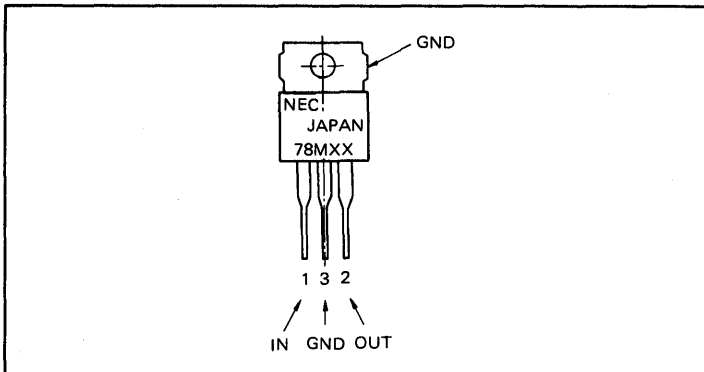
### EQUIVALENT CIRCUIT



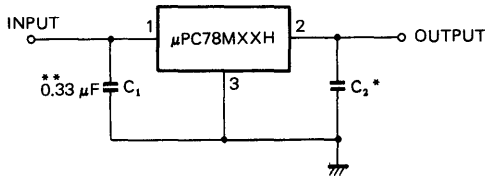
### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



TYPICAL APPLICATION



- Notes:**
- \* Although no output capacitor is needed for stability, it does improve transient response.
  - \*\* Required if regulator is located an appreciable distance from power supply filter.

ABSOLUTE MAXIMUM RATINGS

Input Voltage	(μPC78M05H/08H/12H/15H/18H)35	V
	(μPC78M24H) 40	V
Internal Power Dissipation	Internally Limited	
Operating Temperature Range	-20 to +80	°C
Storage Temperature Range	-55 to +150	°C
Lead Temperature	Soldering 10 sec 230	°C
Operating Junction Temperature Range	0 to 125	°C (Continuous)
Operating Junction Temperature Range	0 to 200	°C (short term, 30 min. MAX.)

ELECTRICAL CHARACTERISTICS μPC78M05H (V<sub>IN</sub> = 10 V, I<sub>o</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V <sub>o</sub>	4.8	5.0	5.2	V	T <sub>j</sub> = 25°C
		4.75		5.25		7 V ≤ V <sub>IN</sub> ≤ 20 V, 5 mA ≤ I <sub>o</sub> ≤ 350 mA
Line Regulation	REG <sub>IN</sub>		3	100	mV	T <sub>j</sub> = 25°C, 7 V ≤ V <sub>IN</sub> ≤ 25 V, I <sub>o</sub> = 200 mA
			1	50		T <sub>j</sub> = 25°C, 8 V ≤ V <sub>IN</sub> ≤ 25 V, I <sub>o</sub> = 200 mA
Load Regulation	REG <sub>L</sub>		20	100	mV	T <sub>j</sub> = 25°C, 5 mA ≤ I <sub>o</sub> ≤ 500 mA
			10	50		T <sub>j</sub> = 25°C, 5 mA ≤ I <sub>o</sub> ≤ 200 mA
Quiescent Current	I <sub>BIAS</sub>		4.5	6.0	mA	T <sub>j</sub> = 25°C
Quiescent Current Change	ΔI <sub>BIAS</sub>			0.8	mA	8 V ≤ V <sub>IN</sub> ≤ 25 V, I <sub>o</sub> = 200 mA
				0.5		5 mA ≤ I <sub>o</sub> ≤ 350 mA
Output Noise Voltage	N <sub>L</sub>		40		μV	T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz
Ripple Rejection		62	80		dB	T <sub>j</sub> = 25°C, f = 120 Hz, 8 V ≤ V <sub>IN</sub> ≤ 18 V, I <sub>o</sub> = 300 mA
Dropout Voltage			2.0		V	T <sub>a</sub> = 25°C
Short Circuit Current	I <sub>o short</sub>		250		mA	T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V
Peak Output Current	I <sub>o peak</sub>		1.0		A	T <sub>j</sub> = 25°C
Temperature Coefficient of Output Voltage	ΔV <sub>o</sub> /ΔT		-1.0		mV/°C	I <sub>o</sub> = 5 mA

# μPC78M00H SERIES

## ELECTRICAL CHARACTERISTICS μPC78M08H ( $V_{IN} = 14\text{ V}$ , $I_o = 350\text{ mA}$ , $0^\circ\text{C} < T_j < 125^\circ\text{C}$ )

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	7.7	8.0	8.3	V	$T_j = 25^\circ\text{C}$
		7.6		8.4		$10.5\text{ V} \leq V_{IN} \leq 23\text{ V}$ , $5\text{ mA} \leq I_o \leq 350\text{ mA}$
Line Regulation	$REG_{IN}$		6.0	100	mV	$T_j = 25^\circ\text{C}$ , $10.5\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_o = 200\text{ mA}$
			2.0	50		$T_j = 25^\circ\text{C}$ , $11\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_o = 200\text{ mA}$
Load Regulation	$REG_L$		25	160	mV	$T_j = 25^\circ\text{C}$ , $5\text{ mA} \leq I_o \leq 500\text{ mA}$
			10	80		$T_j = 25^\circ\text{C}$ , $5\text{ mA} \leq I_o \leq 200\text{ mA}$
Quiescent Current	$I_{BIAS}$		4.6	6.0	mA	$T_j = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			0.8	mA	$10.5\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_o = 200\text{ mA}$
				0.5		$5\text{ mA} \leq I_o \leq 350\text{ mA}$
Output Noise Voltage	$N_L$		52		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		56	80		dB	$T_j = 25^\circ\text{C}$ , $f = 120\text{ Hz}$ , $11.5\text{ V} \leq V_{IN} \leq 21.5\text{ V}$ , $I_o = 300\text{ mA}$
Dropout Voltage			2.0		V	$T_a = 25^\circ\text{C}$
Short Circuit Current	$I_o$ short		250		mA	$T_j = 25^\circ\text{C}$ , $V_{IN} = 35\text{ V}$
Peak Output Current	$I_o$ peak		1.0		A	$T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$\Delta V_o / \Delta T$		-1.0		$\text{mV}/^\circ\text{C}$	$I_o = 5\text{ mA}$

## ELECTRICAL CHARACTERISTICS μPC78M12H ( $V_{IN} = 19\text{ V}$ , $I_o = 350\text{ mA}$ , $0^\circ\text{C} < T_j < 125^\circ\text{C}$ )

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	11.5	12.0	12.5	V	$T_j = 25^\circ\text{C}$
		11.4		12.6		$14.5\text{ V} \leq V_{IN} \leq 27\text{ V}$ , $5\text{ mA} \leq I_o \leq 350\text{ mA}$
Line Regulation	$REG_{IN}$		8.0	100	mV	$T_j = 25^\circ\text{C}$ , $14.5\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $I_o = 200\text{ mA}$
			2.0	50		$T_j = 25^\circ\text{C}$ , $16\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $I_o = 200\text{ mA}$
Load Regulation	$REG_L$		25	240	mV	$T_j = 25^\circ\text{C}$ , $5\text{ mA} \leq I_o \leq 500\text{ mA}$
			10	120		$T_j = 25^\circ\text{C}$ , $5\text{ mA} \leq I_o \leq 200\text{ mA}$
Quiescent Current	$I_{BIAS}$		4.8	6.0	mA	$T_j = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			0.8	mA	$14.5\text{ V} \leq V_{IN} \leq 30\text{ V}$ , $I_o = 200\text{ mA}$
				0.5		$5\text{ mA} \leq I_o \leq 350\text{ mA}$
Output Noise Voltage	$N_L$		75		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		55	80		dB	$T_j = 25^\circ\text{C}$ , $f = 120\text{ Hz}$ , $15\text{ V} \leq V_{IN} \leq 25\text{ V}$ , $I_o = 300\text{ mA}$
Dropout Voltage			2.0		V	$T_a = 25^\circ\text{C}$
Short Circuit Current	$I_o$ short		250		mA	$T_j = 25^\circ\text{C}$ , $V_{IN} = 35\text{ V}$
Peak Output Current	$I_o$ peak		1.0		A	$T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$\Delta V_o / \Delta T$		-1.0		$\text{mV}/^\circ\text{C}$	$I_o = 5\text{ mA}$

**ELECTRICAL CHARACTERISTICS μPC78M15H (V<sub>IN</sub> = 23 V, I<sub>o</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C)**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V <sub>o</sub>	14.4	15	15.6	V	T <sub>j</sub> = 25°C
		14.25		15.75		17.5 V ≤ V <sub>IN</sub> ≤ 30 V, 5 mA ≤ I <sub>o</sub> ≤ 350 mA
Line Regulation	REG <sub>IN</sub>		10	100	mV	T <sub>j</sub> = 25°C, 17.5 V ≤ V <sub>IN</sub> ≤ 30 V, I <sub>o</sub> = 200 mA
			3.0	50		T <sub>j</sub> = 25°C, 20 V ≤ V <sub>IN</sub> ≤ 30 V, I <sub>o</sub> = 200 mA
Load Regulation	REG <sub>L</sub>		25	300	mV	T <sub>j</sub> = 25°C, 5 mA ≤ I <sub>o</sub> ≤ 500 mA
			10	150		T <sub>j</sub> = 25°C, 5 mA ≤ I <sub>o</sub> ≤ 200 mA
Quiescent Current	I <sub>BIAS</sub>		4.8	6.0	mA	T <sub>j</sub> = 25°C
Quiescent Current Change	ΔI <sub>BIAS</sub>			0.8	mA	17.5 V ≤ V <sub>IN</sub> ≤ 30 V, I <sub>o</sub> = 200 mA
				0.5		5 mA ≤ I <sub>o</sub> ≤ 350 mA
Output Noise Voltage	N <sub>L</sub>		90		μV	T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz
Ripple Rejection		54	70		dB	T <sub>j</sub> = 25°C, f = 120 Hz, 18.5 V ≤ V <sub>IN</sub> ≤ 28.5 V, I <sub>o</sub> = 300 mA
Dropout Voltage			2.0		V	T <sub>a</sub> = 25°C
Short Circuit Current	I <sub>o</sub> short		250		mA	T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V
Peak Output Current	I <sub>o</sub> peak		1.0		A	T <sub>j</sub> = 25°C
Temperature Coefficient of Output Voltage	ΔV <sub>o</sub> /ΔT		-1.0		mV/°C	I <sub>o</sub> = 5 mA

**ELECTRICAL CHARACTERISTICS μPC78M18H (V<sub>IN</sub> = 27 V, I<sub>o</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C)**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V <sub>o</sub>	17.3	18.0	18.7	V	T <sub>j</sub> = 25°C
		17.1		18.9		21 V ≤ V <sub>IN</sub> ≤ 33 V, 5 mA ≤ I <sub>o</sub> ≤ 350 mA
Line Regulation	REG <sub>IN</sub>		10	100	mV	T <sub>j</sub> = 25°C, 21 V ≤ V <sub>IN</sub> ≤ 33 V, I <sub>o</sub> = 200 mA
			4.0	50		T <sub>j</sub> = 25°C, 24 V ≤ V <sub>IN</sub> ≤ 30 V
Load Regulation	REG <sub>L</sub>		30	360	mV	T <sub>j</sub> = 25°C, 5 mA ≤ I <sub>o</sub> ≤ 500 mA
			10	180		T <sub>j</sub> = 25°C, 5 mA ≤ I <sub>o</sub> ≤ 200 mA
Quiescent Current	I <sub>BIAS</sub>		4.8	6.0	mA	T <sub>j</sub> = 25°C
Quiescent Current Change	ΔI <sub>BIAS</sub>			0.8	mA	27 V ≤ V <sub>IN</sub> ≤ 38 V
				0.5		5 mA ≤ I <sub>o</sub> ≤ 350 mA
Output Noise Voltage	N <sub>L</sub>		100		μV	T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz
Ripple Rejection		53	70		dB	T <sub>j</sub> = 25°C, f = 120 Hz, 22 V ≤ V <sub>IN</sub> ≤ 32 V, I <sub>o</sub> = 300 mA
Dropout Voltage			2.0		V	T <sub>a</sub> = 25°C
Short Circuit Current	I <sub>o</sub> short		250		mA	T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V
Peak Output Current	I <sub>o</sub> peak		1.0		A	T <sub>j</sub> = 25°C
Temperature Coefficient of Output Voltage	ΔV <sub>o</sub> /ΔT		-1.0		mV/°C	I <sub>o</sub> = 5 mA

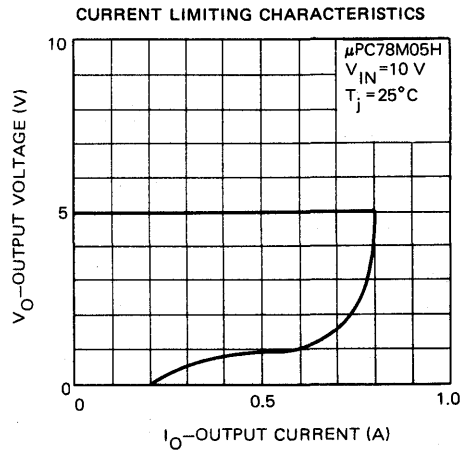
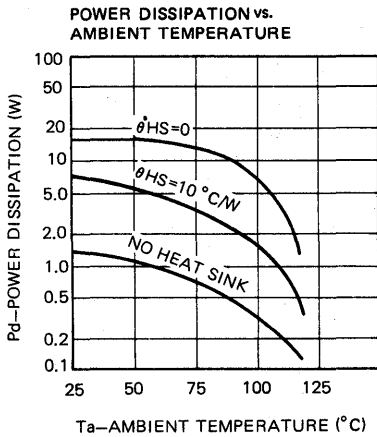




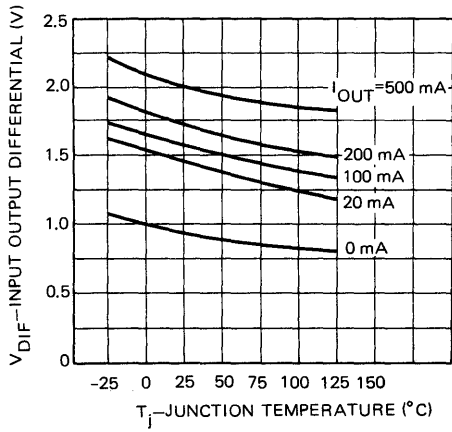
**ELECTRICAL CHARACTERISTICS μPC78M24H (V<sub>IN</sub> = 33 V, I<sub>o</sub> = 350 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C)**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V <sub>o</sub>	23	24	25	V	T <sub>j</sub> = 25°C
		22.8		25.2		27 V ≤ V <sub>IN</sub> ≤ 38 V, 5 mA ≤ I <sub>o</sub> ≤ 350 mA
Line Regulation	REG <sub>IN</sub>		10	100	mV	T <sub>j</sub> = 25°C, 27 V ≤ V <sub>IN</sub> ≤ 38 V, I <sub>o</sub> = 200 mA
			5.0	50		T <sub>j</sub> = 25°C, 28 V ≤ V <sub>IN</sub> ≤ 38 V, I <sub>o</sub> = 200 mA
Load Regulation	REG <sub>L</sub>		30	480	mV	T <sub>j</sub> = 25°C, 5 mA ≤ I <sub>o</sub> ≤ 500 mA
			10	240		T <sub>j</sub> = 25°C, 5 mA ≤ I <sub>o</sub> ≤ 200 mA
Quiescent Current	I <sub>BIAS</sub>		5.0	6.0	mA	T <sub>j</sub> = 25°C
Quiescent Current Change	ΔI <sub>BIAS</sub>			0.8	mA	27 V ≤ V <sub>IN</sub> ≤ 38 V, I <sub>o</sub> = 200 mA
				0.5		5 mA ≤ I <sub>o</sub> ≤ 350 mA
Output Noise Voltage	N <sub>L</sub>		170		μV	T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 Hz
Ripple Rejection		50	70		dB	T <sub>j</sub> = 25°C, f = 120 Hz, 28 V ≤ V <sub>IN</sub> ≤ 38 V, I <sub>o</sub> = 300 mA
Dropout Voltage			2.0		V	T <sub>a</sub> = 25°C
Short Circuit Current	I <sub>o short</sub>		250		mA	T <sub>j</sub> = 25°C, V <sub>IN</sub> = 35 V
Peak Output Current	I <sub>o peak</sub>		1.0		A	T <sub>j</sub> = 25°C
Temperature Coefficient of Output Voltage	ΔV <sub>o</sub> /ΔT		-1.2		mV/°C	I <sub>o</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C

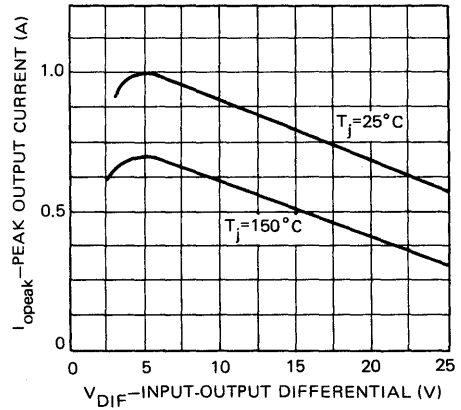
**TYPICAL CHARACTERISTICS (T<sub>a</sub> = 25°C)**



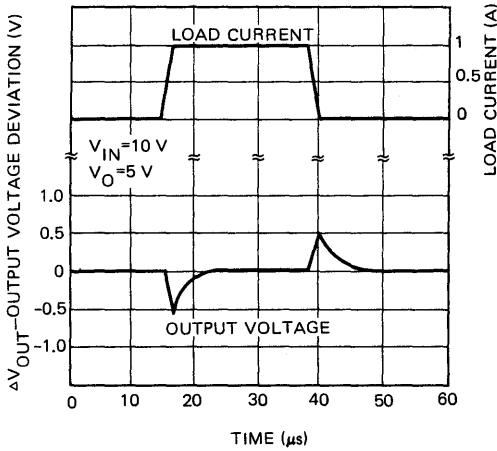
**DROPOUT VOLTAGE AS A FUNCTION OF JUNCTION TEMPERATURE**



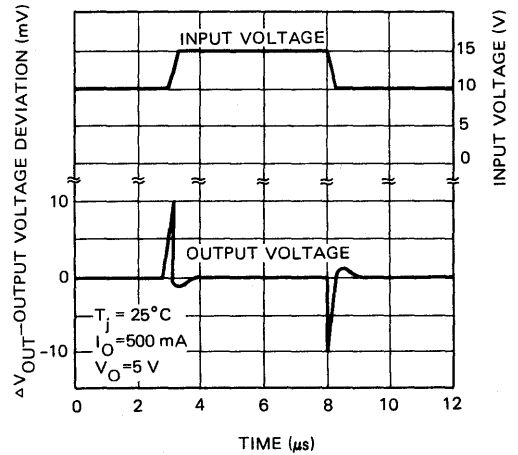
**PEAK OUTPUT CURRENT AS A FUNCTION OF INPUT/OUTPUT DIFFERENTIAL VOLTAGE**



**LOAD TRANSIENT RESPONSE (μPC78M05H)**



**LINE TRANSIENT RESPONSE (μPC78M05H)**



# μPC7800H SERIES

## Three Terminal Positive Voltage Regulators

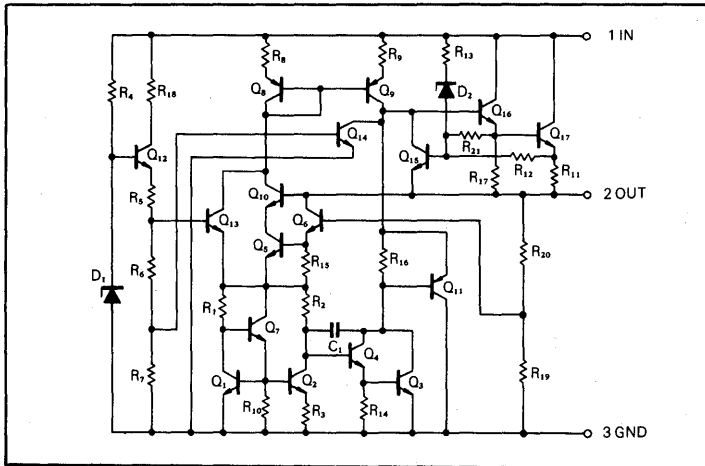
### GENERAL DESCRIPTION

The μPC7800H series are monolithic three terminal positive regulators which employ internally current limiting, thermal shut down, and safe-area compensation, make them essentially indestructible. They are intended as fixed-voltage regulators in a wide range of application including local on card regulation for elimination of distribution problems associated with single point regulation.

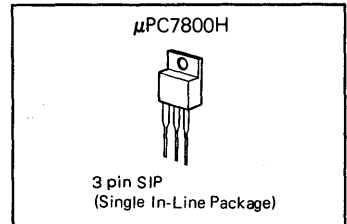
### FEATURES

- Output current in excess of 1 A
- No external component required
- Internal thermal overload protection
- Internal short circuit current limiting
- Low output resistance 17 mΩ

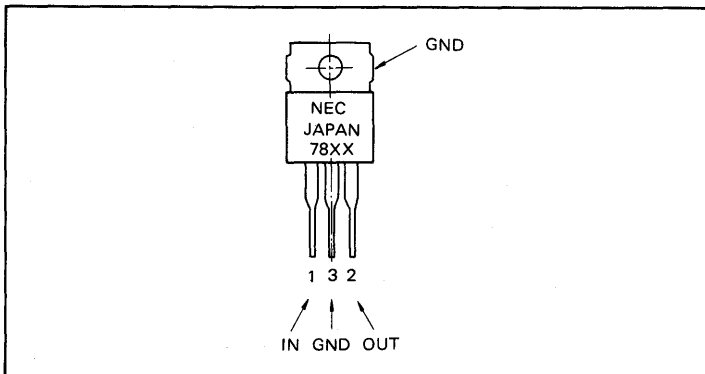
### EQUIVALENT CIRCUIT



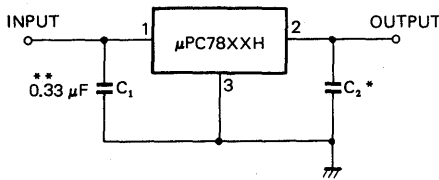
### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



**TYPICAL APPLICATION**



- Notes:**
- \* Although no output capacitor is needed for stability, it does improve transient response.
  - \*\* Required if regulator is located an appreciable distance from power supply filter.

**ABSOLUTE MAXIMUM RATINGS**

Input Voltage	(μPC7805H/08H/12H/15H/18H)35	V
	(μPC7824H) 40	V
Internal Power Dissipation	Internally Limited	
Operating Temperature Range	-20 to +80	°C
Storage Temperature Range	-55 to +150	°C
Lead Temperature	Soldering 10 sec 230	°C
Operating Junction Temperature Range	0 to 125	°C (Continuous)
Operation Junction Temperature Range	0 to 200	°C (short term, 30 min. MAX.)

**ELECTRICAL CHARACTERISTICS μPC7805H (V<sub>IN</sub> = 10 V, I<sub>o</sub> = 500 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C)**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V <sub>o</sub>	4.8	5.0	5.2	V	T <sub>j</sub> = 25°C
		4.75		5.25		7 V ≤ V <sub>IN</sub> ≤ 20 V, 5 mA ≤ I <sub>o</sub> ≤ 1.0 A, P <sub>T</sub> ≤ 15 W
Line Regulation	REG <sub>IN</sub>		3	100	mV	T <sub>j</sub> = 25°C, 7 V ≤ V <sub>IN</sub> ≤ 25 V
			1	50		T <sub>j</sub> = 25°C, 8 V ≤ V <sub>IN</sub> ≤ 12 V
Load Regulation	REG <sub>L</sub>		15	100	mV	T <sub>j</sub> = 25°C, 5 mA ≤ I <sub>o</sub> ≤ 1.5 A
			5	50		T <sub>j</sub> = 25°C, 250 mA ≤ I <sub>o</sub> ≤ 750 mA
Quiescent Current	I <sub>BIAS</sub>		4.2	8.0	mA	T <sub>j</sub> = 25°C
Quiescent Current Change	ΔI <sub>BIAS</sub>			1.3	mA	7 V ≤ V <sub>IN</sub> ≤ 25 V
				0.5		5 mA ≤ I <sub>o</sub> ≤ 1.0 A
Output Noise Voltage	N <sub>L</sub>		40		μV	T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz
Ripple Rejection		62	78		dB	f = 120 Hz, 8 V ≤ V <sub>IN</sub> ≤ 18 V
Dropout Voltage			2.0		V	I <sub>o</sub> = 1.0 A, T <sub>j</sub> = 25°C
Output Resistance	R <sub>o</sub>		17		mΩ	f = 1 kHz
Short Circuit Current	I <sub>oshort</sub>		750		mA	T <sub>j</sub> = 25°C
Peak Output Current	I <sub>opeak</sub>		2.2		A	T <sub>j</sub> = 25°C
Temperature Coefficient of Output Voltage	ΔV <sub>o</sub> /ΔT		-1.1		mV/°C	I <sub>o</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C



# μPC7800H SERIES

## ELECTRICAL CHARACTERISTICS μPC7808H ( $V_{IN} = 14\text{ V}$ , $I_o = 500\text{ mA}$ , $0^\circ\text{C} < T_j < 125^\circ\text{C}$ )

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	7.7	8.0	8.3	V	$T_j = 25^\circ\text{C}$
		7.6		8.4		$10.5\text{ V} \leq V_{IN} \leq 23\text{ V}$ , $5\text{ mA} \leq I_o \leq 1.0\text{ A}$ , $P_T \leq 15\text{ W}$
Line Regulation	$REG_{IN}$		6.0	160	mV	$T_j = 25^\circ\text{C}$ , $10.5\text{ V} \leq V_{IN} \leq 25\text{ V}$
			2.0	80		$T_j = 25^\circ\text{C}$ , $11\text{ V} \leq V_{IN} \leq 17\text{ V}$
Load Regulation	$REG_L$		12	160	mV	$T_j = 25^\circ\text{C}$ , $5\text{ mA} \leq I_o \leq 1.5\text{ A}$
			4.0	80		$T_j = 25^\circ\text{C}$ , $250\text{ mA} \leq I_o \leq 750\text{ mA}$
Quiescent Current	$I_{BIAS}$		4.3	8.0	mA	$T_j = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.0	mA	$10.5\text{ V} \leq V_{IN} \leq 25\text{ V}$
				0.5		$5\text{ mA} \leq I_o \leq 1.0\text{ A}$
Output Noise Voltage	$N_L$		52		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		56	72		dB	$f = 120\text{ Hz}$ , $11.5\text{ V} \leq V_{IN} \leq 21.5\text{ V}$
Dropout Voltage			2.0		V	$I_o = 1.0\text{ A}$ , $T_j = 25^\circ\text{C}$
Output Resistance	$R_o$		16		$\text{m}\Omega$	$f = 1\text{ kHz}$
Short Circuit Current	$I_{short}$		450		mA	$T_j = 25^\circ\text{C}$
Peak Output Current	$I_{peak}$		2.2		A	$T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$\Delta V_o/\Delta T$		-0.8		$\text{mV}/^\circ\text{C}$	$I_o = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

## ELECTRICAL CHARACTERISITCS μPC7812H ( $V_{IN} = 19\text{ V}$ , $I_o = 500\text{ mA}$ , $0^\circ\text{C} < T_j < 125^\circ\text{C}$ )

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	11.5	12.0	12.5	V	$T_j = 25^\circ\text{C}$
		11.4		12.6		$14.5\text{ V} \leq V_{IN} \leq 27\text{ V}$ , $5\text{ mA} \leq I_o \leq 1.0\text{ A}$ , $P_T \leq 15\text{ W}$
Line Regulation	$REG_{IN}$		10	240	mV	$T_j = 25^\circ\text{C}$ , $14.5\text{ V} \leq V_{IN} \leq 30\text{ V}$
			3.0	120		$T_j = 25^\circ\text{C}$ , $16\text{ V} \leq V_{IN} \leq 22\text{ V}$
Load Regulation	$REG_L$		12	240	mV	$T_j = 25^\circ\text{C}$ , $5\text{ mA} \leq I_o \leq 1.5\text{ A}$
			4.0	120		$T_j = 25^\circ\text{C}$ , $250\text{ mA} \leq I_o \leq 750\text{ mA}$
Quiescent Current	$I_{BIAS}$		4.3	8.0	mA	$T_j = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.0	mA	$14.5\text{ V} \leq V_{IN} \leq 30\text{ V}$
				0.5		$5\text{ mA} \leq I_o \leq 1.0\text{ A}$
Output Noise Voltage	$N_L$		75		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		55	71		dB	$f = 120\text{ Hz}$ , $15\text{ V} \leq V_{IN} \leq 25\text{ V}$
Dropout Voltage			2.0		V	$I_o = 1.0\text{ A}$ , $T_j = 25^\circ\text{C}$
Output Resistance	$R_o$		18		$\text{m}\Omega$	$f = 1\text{ kHz}$
Short Circuit Current	$I_{short}$		350		mA	$T_j = 25^\circ\text{C}$
Peak Output Current	$I_{peak}$		2.2		A	$T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$\Delta V_o/\Delta T$		-1.0		$\text{mV}/^\circ\text{C}$	$I_o = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

**ELECTRICAL CHARACTERISTICS μPC7815H (V<sub>IN</sub> = 23 V, I<sub>o</sub> = 500 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C)**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V <sub>o</sub>	14.4	15.0	15.6	V	T <sub>j</sub> = 25°C
		14.25		15.75		17.5 V ≤ V <sub>IN</sub> ≤ 30 V, 5 mA ≤ I <sub>o</sub> ≤ 1.0 A, P <sub>T</sub> ≤ 15 W
Line Regulation	REG <sub>IN</sub>		11	300	mV	T <sub>j</sub> = 25°C, 17.5 V ≤ V <sub>IN</sub> ≤ 30 V
			3.0	150		T <sub>j</sub> = 25°C, 20 V ≤ V <sub>IN</sub> ≤ 26 V
Load Regulation	REG <sub>L</sub>		12	300	mV	T <sub>j</sub> = 25°C, 5 mA ≤ I <sub>o</sub> ≤ 1.5 A
			4.0	150		T <sub>j</sub> = 25°C, 250 mA ≤ I <sub>o</sub> ≤ 750 mA
Quiescent Current	I <sub>BIAS</sub>		4.4	8.0	mA	T <sub>j</sub> = 25°C
Quiescent Current Change	ΔI <sub>BIAS</sub>			1.0	mA	17.5 V ≤ V <sub>IN</sub> ≤ 30 V
				0.5		5 mA ≤ I <sub>o</sub> ≤ 1.0 A
Output Noise Voltage	N <sub>L</sub>		90		μV	T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz
Ripple Rejection		54	70		dB	f = 120 Hz, 18.5 V ≤ V <sub>IN</sub> ≤ 28.5 V
Dropout Voltage			2.0		V	I <sub>o</sub> = 1.0 A, T <sub>j</sub> = 25°C
Output Resistance	R <sub>o</sub>		19		mΩ	f = 1 kHz
Short Circuit Current	I <sub>oshort</sub>		230		mA	T <sub>j</sub> = 25°C
Peak Output Current	I <sub>opeak</sub>		2.1		A	T <sub>j</sub> = 25°C
Temperature Coefficient of Output Voltage	ΔV <sub>o</sub> /ΔT		-1.0		mV/°C	I <sub>o</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C

**ELECTRICAL CHARACTERISTICS μPC7818H (V<sub>IN</sub> = 27 V, I<sub>o</sub> = 500 mA, 0°C ≤ T<sub>j</sub> ≤ 125°C)**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	V <sub>o</sub>	17.3	18.0	18.7	V	T <sub>j</sub> = 25°C
		17.1		18.9		21 V ≤ V <sub>IN</sub> ≤ 33 V, 5 mA ≤ I <sub>o</sub> ≤ 1.0 A, P <sub>T</sub> ≤ 15 W
Line Regulation	REG <sub>IN</sub>		15	360	mV	T <sub>j</sub> = 25°C, 21 V ≤ V <sub>IN</sub> ≤ 33 V
			5.0	180		T <sub>j</sub> = 25°C, 24 V ≤ V <sub>IN</sub> ≤ 30 V
Load Regulation	REG <sub>L</sub>		12	360	mV	T <sub>j</sub> = 25°C, 5 mA ≤ I <sub>o</sub> ≤ 1.5 A
			4.0	180		T <sub>j</sub> = 25°C, 250 mA ≤ I <sub>o</sub> ≤ 750 mA
Quiescent Current	I <sub>BIAS</sub>		4.5	8.0	mA	T <sub>j</sub> = 25°C
Quiescent Current Change	ΔI <sub>BIAS</sub>			1.0	mA	21 V ≤ V <sub>IN</sub> ≤ 33 V
				0.5		5 mA ≤ I <sub>o</sub> ≤ 1.0 A
Output Noise Voltage	N <sub>L</sub>		110		μV	T <sub>a</sub> = 25°C, 10 Hz ≤ f ≤ 100 kHz
Ripple Rejection		53	69		dB	f = 120 Hz, 22 V ≤ V <sub>IN</sub> ≤ 32 V
Dropout Voltage			2.0		V	I <sub>o</sub> = 1.0 A, T <sub>j</sub> = 25°C
Output Resistance	R <sub>o</sub>		22		mΩ	f = 1 kHz
Short Circuit Current	I <sub>oshort</sub>		200		mA	T <sub>j</sub> = 25°C
Peak Output Current	I <sub>opeak</sub>		2.1		A	T <sub>j</sub> = 25°C
Temperature Coefficient of Output Voltage	ΔV <sub>o</sub> /ΔT		-1.0		mV/°C	I <sub>o</sub> = 5 mA, 0°C ≤ T <sub>j</sub> ≤ 125°C

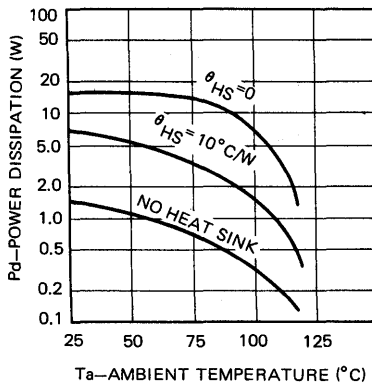
# μPC7800H SERIES

## ELECTRICAL CHARACTERISTICS μPC7824H ( $V_{IN} = 33\text{ V}$ , $I_o = 500\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ )

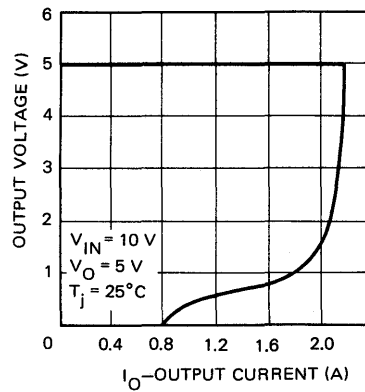
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	23.0	24.0	25.0	V	$T_j = 25^\circ\text{C}$
		22.8		25.2		$27\text{V} \leq V_{IN} \leq 38\text{ V}$ , $5\text{ mA} \leq I_o \leq 1.0\text{ A}$
Line Regulation	$REG_{IN}$		18	480	mV	$T_j = 25^\circ\text{C}$ , $27\text{ V} \leq V_{IN} \leq 38\text{ V}$
			6	240		$T_j = 25^\circ\text{C}$ , $30\text{ V} \leq V_{IN} \leq 36\text{ V}$
Load Regulation	$REG_L$		12	480	mV	$T_j = 25^\circ\text{C}$ , $5\text{ mA} \leq I_o \leq 1.5\text{ A}$
			4.0	240		$T_j = 25^\circ\text{C}$ , $250\text{ mA} \leq I_o \leq 750\text{ mA}$
Quiescent Current	$I_{BIAS}$		4.6	8.0	mA	$T_j = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.0	mA	$27\text{ V} \leq V_{IN} \leq 38\text{ V}$
				0.5		$5\text{ mA} \leq I_o \leq 1.0\text{ A}$
Output Noise Voltage	$N_L$		170		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		50	66		dB	$f = 120\text{ Hz}$ , $28\text{ V} \leq V_{IN} \leq 38\text{ V}$
Dropout Voltage			2.0		V	$I_o = 1.0\text{ A}$ , $T_j = 25^\circ\text{C}$
Output Resistance	$R_o$		28		$\text{m}\Omega$	$f = 1\text{ kHz}$
Short Circuit Current	$I_{short}$		150		mA	$T_j = 25^\circ\text{C}$
Peak Output Current	$I_{opeak}$		2.1		A	$T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$\Delta V_o/\Delta T$		-1.5		$\text{mV}/^\circ\text{C}$	$I_o = 5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

## TYPICAL CHARACTERISTICS ( $T_a = 25^\circ\text{C}$ )

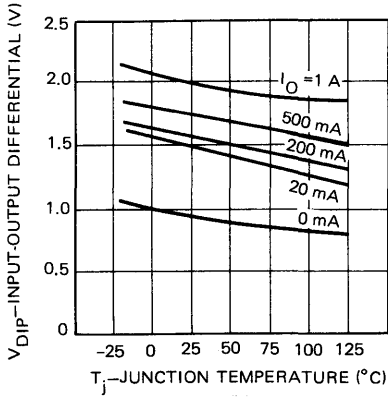
POWER DISSIPATION VS. AMBIENT TEMPERATURE



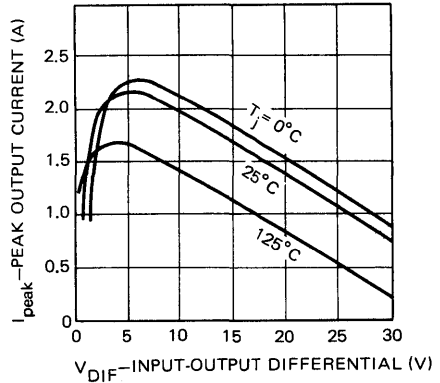
CURRENT LIMITING CHARACTERISTICS



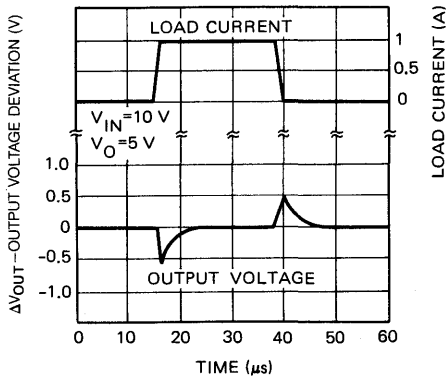
**DROPOUT VOLTAGE AS A FUNCTION OF JUNCTION TEMPERATURE**



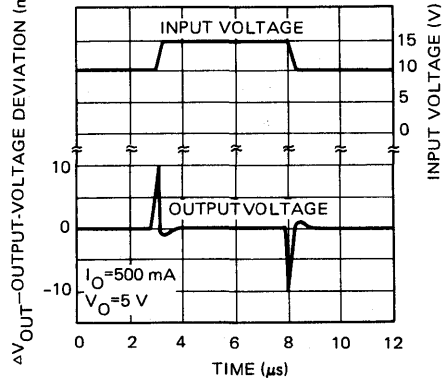
**PEAK OUTPUT CURRENT AS A FUNCTION OF INPUT/OUTPUT DIFFERENTIAL VOLTAGE**



**LOAD TRANSIENT RESPONSE**



**LINE TRANSIENT RESPONSE**





# μPC7900H SERIES

## Three Terminal Negative Regulators

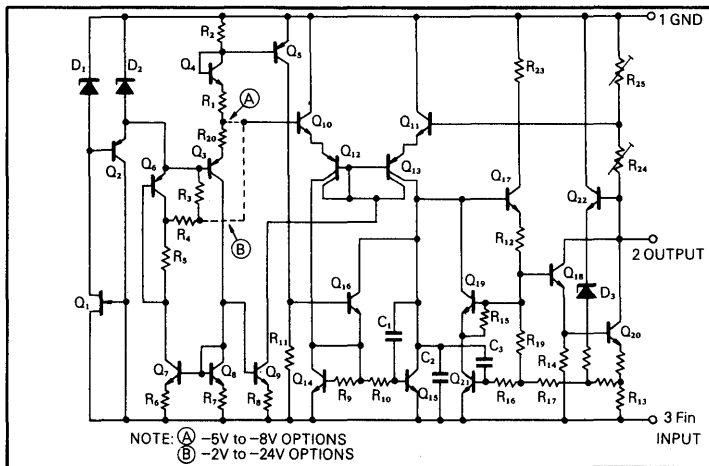
### GENERAL DESCRIPTION

The μPC7900H series are monolithic three terminal negative regulators which employ internally current limiting, thermal shut down, and safe-area compensation, make them essentially indestructible. They are intended as fixed-voltage regulators in a wide range of application including local on card regulation for elimination of distribution problems associated with single point regulation.

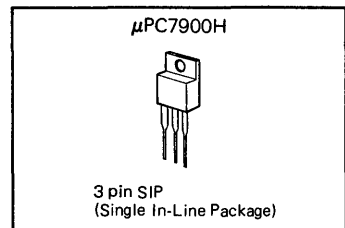
### FEATURES

- Output current in excess of 1 A
- No external component required
- Internal thermal overload protection
- Internal short circuit current limiting
- Low output resistance 70 mΩ

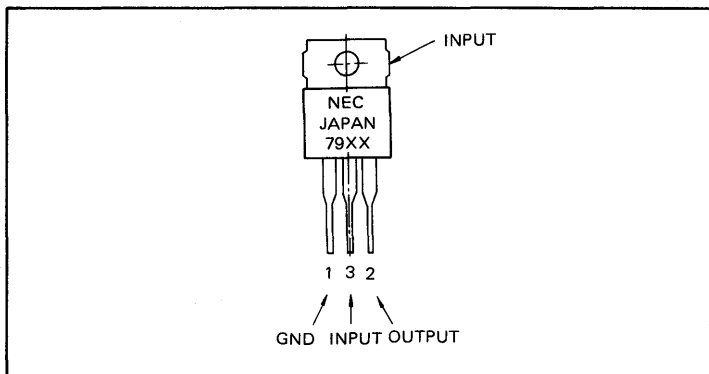
### EQUIVALENT CIRCUIT



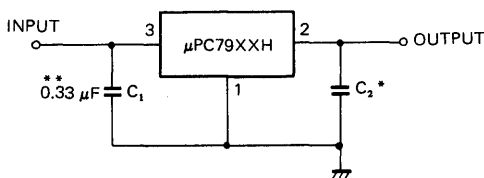
### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



TYPICAL APPLICATION



- Notes:** \* Although no output capacitor is needed for stability, it does improve transient response.  
 \*\* Required if regulator is located an appreciable distance from power supply filter.

ABSOLUTE MAXIMUM RATINGS

Input Voltage	(μPC7905H/08H/12H/15H/18H)–35	V
	(μPC7924H) –40	V
Internal Power Dissipation	Internally Limited	
Operating Temperature Range	–20 to +80	°C
Storage Temperature Range	–55 to +150	°C
Lead Temperature	Soldering 10 s 230	°C
Operating Junction Temperature Range	0 to 125	°C (Continuous)
Operating Junction Temperature Range	0 to 200	°C (short term, 30 min. MAX.)

ELECTRICAL CHARACTERISTICS μPC7905H ( $V_{IN} = -10\text{ V}$ ,  $I_o = -500\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ$ )

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	–4.8	–5.0	–5.2	V	$T_j = 25^\circ\text{C}$
		–4.75		–5.25		$-7\text{ V} \leq V_{IN} \leq -20\text{ V}$ , $-5\text{ mA} \leq I_o \leq -1.0\text{ A}$ , $P_T \leq 15\text{ W}$
Line Regulation	$REG_{IN}$		3	100	mV	$T_j = 25^\circ\text{C}$ , $-7\text{ V} \leq V_{IN} \leq -25\text{ V}$
			1	50		$T_j = 25^\circ\text{C}$ , $-8\text{ V} \leq V_{IN} \leq -12\text{ V}$
Load Regulation	$REG_L$		70	150	mV	$T_j = 25^\circ\text{C}$ , $-5\text{ mA} \leq I_o \leq -1.5\text{ A}$
			20	80		$T_j = 25^\circ\text{C}$ , $-250\text{ mA} \leq I_o \leq -750\text{ mA}$
Quiescent Current	$I_{BIAS}$		1.0	2.0	mA	$T_j = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.3	mA	$-7\text{ V} \leq V_{IN} \leq -25\text{ V}$
				0.5		$-5\text{ mA} \leq I_o \leq -1.0\text{ A}$
Output Noise Voltage	$N_L$		100		μV	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		54	62		dB	$f = 120\text{ Hz}$ , $-8\text{ V} \leq V_{IN} \leq -18\text{ V}$ , $I_o = -500\text{ mA}$
Dropout Voltage			1.1		V	$I_o = -1.0\text{ A}$ , $T_j = 25^\circ\text{C}$
Peak Output Current	$I_{opeak}$		–2.1		A	$T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$\Delta V_o/\Delta T$		–0.4		mV/°C	$I_o = -5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

# μPC7900H SERIES

## ELECTRICAL CHARACTERISTICS μPC7908H ( $V_{IN} = -14\text{ V}$ , $I_o = -500\text{ mA}$ , $0^\circ\text{C} < T_j < 125^\circ\text{C}$ )

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	-7.7	-8.0	-8.3	V	$T_j = 25^\circ\text{C}$
		-7.6		-8.4		$-10.5\text{ V} \leq V_{IN} \leq -23\text{ V}$ , $-5\text{ mA} \leq I_o \leq -1.0\text{ A}$ , $P_T \leq 15\text{ W}$
Line Regulation	$REG_{IN}$		6.0	160	mV	$T_j = 25^\circ\text{C}$ , $-10.5\text{ V} \leq V_{IN} \leq -25\text{ V}$
			2.0	80		$T_j = 25^\circ\text{C}$ , $-11\text{ V} \leq V_{IN} \leq -17\text{ V}$
Load Regulation	$REG_L$		80	200	mV	$T_j = 25^\circ\text{C}$ , $-5\text{ mA} \leq I_o \leq -1.5\text{ A}$
			30	100		$T_j = 25^\circ\text{C}$ , $-250\text{ mA} \leq I_o \leq -750\text{ mA}$
Quiescent Current	$I_{BIAS}$		1.0	2.0	mA	$T_j = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.0	mA	$-10.5\text{ V} \leq V_{IN} \leq -25\text{ V}$
				0.5		$-5\text{ mA} \leq I_o \leq -1.0\text{ A}$
Output Noise Voltage	$N_L$		200		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		54	62		dB	$f = 120\text{ Hz}$ , $-11.5\text{ V} \leq V_{IN} \leq -21.5\text{ V}$ $I_o = -500\text{ mA}$
Dropout Voltage			1.1		V	$I_o = -1.0\text{ A}$ , $T_j = 25^\circ\text{C}$
Peak Output Current	$I_{opeak}$		-2.1		A	$T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$\Delta V_o/\Delta T$		-0.6		$\text{mV}/^\circ\text{C}$	$I_o = -5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

## ELECTRICAL CHARACTERISTICS μPC7912H ( $V_{IN} = -19\text{ V}$ , $I_o = -500\text{ mA}$ , $0^\circ\text{C} < T_j < 125^\circ\text{C}$ )

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	-11.5	-12.0	-12.5	V	$T_j = 25^\circ\text{C}$
		-11.4		-12.6		$-14.5\text{ V} \leq V_{IN} \leq -27\text{ V}$ , $-5\text{ mA} \leq I_o \leq -1.0\text{ A}$ , $P_T \leq 15\text{ W}$
Line Regulation	$REG_{IN}$		10	240	mV	$T_j = 25^\circ\text{C}$ , $-14.5\text{ V} \leq V_{IN} \leq -30\text{ V}$
			3.0	120		$T_j = 25^\circ\text{C}$ , $-16\text{ V} \leq V_{IN} \leq -22\text{ V}$
Load Regulation	$REG_L$		85	240	mV	$T_j = 25^\circ\text{C}$ , $-5\text{ mA} \leq I_o \leq -1.5\text{ A}$
			30	120		$T_j = 25^\circ\text{C}$ , $-250\text{ mA} \leq I_o \leq -750\text{ mA}$
Quiescent Current	$I_{BIAS}$		1.5	3.0	mA	$T_j = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.0	mA	$-14.5\text{ V} \leq V_{IN} \leq -30\text{ V}$
				0.5		$-5\text{ mA} \leq I_o \leq -1.0\text{ A}$
Output Noise Voltage	$N_L$		300		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		54	62		dB	$f = 120\text{ Hz}$ , $-15\text{ V} \leq V_{IN} \leq -25\text{ V}$ , $I_o = -500\text{ mA}$
Dropout Voltage			1.1		V	$I_o = -1.0\text{ A}$ , $T_j = 25^\circ\text{C}$
Peak Output Current	$I_{opeak}$		-2.1		A	$T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$\Delta V_o/\Delta T$		-0.8		$\text{mV}/^\circ\text{C}$	$I_o = -5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

**ELECTRICAL CHARACTERISTICS μPC7915H ( $V_{IN} = -23\text{ V}$ ,  $I_o = -500\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ )**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	-14.4	-15.0	-15.6	V	$T_j = 25^\circ\text{C}$
		-14.25		-15.75		$-17.5\text{ V} \leq V_{IN} \leq -30\text{ V}$ , $-5\text{ mA} \leq I_o \leq -1.0\text{ A}$ , $P_T \leq 15\text{ W}$
Line Regulation	$REG_{IN}$		11	300	mV	$T_j = 25^\circ\text{C}$ , $-17.5\text{ V} \leq V_{IN} \leq -30\text{ V}$
			3.0	150		$T_j = 25^\circ\text{C}$ , $-20\text{ V} \leq V_{IN} \leq -26\text{ V}$
Load Regulation	$REG_L$		90	300	mV	$T_j = 25^\circ\text{C}$ , $-5\text{ mA} \leq I_o \leq -1.5\text{ A}$
			30	150		$T_j = 25^\circ\text{C}$ , $-250\text{ mA} \leq I_o \leq -750\text{ mA}$
Quiescent Current	$I_{BIAS}$		1.5	3.0	mA	$T_j = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.0	mA	$-17.5\text{ V} \leq V_{IN} \leq -30\text{ V}$
				0.5		$-5\text{ mA} \leq I_o \leq -1.0\text{ A}$
Output Noise Voltage	$N_L$		375		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		54	60		dB	$f = 120\text{ Hz}$ , $-18.5\text{ V} \leq V_{IN} \leq -28.5\text{ V}$ , $I_o = -500\text{ mA}$
Dropout Voltage			1.1		V	$I_o = -1.0\text{ A}$ , $T_j = 25^\circ\text{C}$
Peak Output Current	$I_{opeak}$		-2.1		A	$T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$\Delta V_o/\Delta T$		-1.0		$\text{mV}/^\circ\text{C}$	$I_o = -5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

**ELECTRICAL CHARACTERISTICS μPC7918H ( $V_{IN} = -27\text{ V}$ ,  $I_o = -500\text{ mA}$ ,  $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$ )**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	-17.3	-18.0	-18.7	V	$T_j = 25^\circ\text{C}$
		-17.1		-18.9		$-21\text{ V} \leq V_{IN} \leq -33\text{ V}$ , $-5\text{ mA} \leq I_o \leq -1.0\text{ A}$ , $P_T \leq 15\text{ W}$
Line Regulation	$REG_{IN}$		15	360	mV	$T_j = 25^\circ\text{C}$ , $-21\text{ V} \leq V_{IN} \leq -33\text{ V}$
			5.0	180		$T_j = 25^\circ\text{C}$ , $-24\text{ V} \leq V_{IN} \leq -30\text{ V}$
Load Regulation	$REG_L$		90	360	mV	$T_j = 25^\circ\text{C}$ , $-5\text{ mA} \leq I_o \leq -1.5\text{ A}$
			30	180		$T_j = 25^\circ\text{C}$ , $-250\text{ mA} \leq I_o \leq -750\text{ mA}$
Quiescent Current	$I_{BIAS}$		1.5	3.0	mA	$T_j = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.0	mA	$-21\text{ V} \leq V_{IN} \leq -33\text{ V}$
				0.5		$-5\text{ mA} \leq I_o \leq -1.0\text{ A}$
Output Noise Voltage	$N_L$		450		$\mu\text{V}$	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		54	60		dB	$f = 120\text{ Hz}$ , $-22\text{ V} \leq V_{IN} \leq -32\text{ V}$ , $I_o = -500\text{ mA}$
Dropout Voltage			1.1		V	$I_o = -1.0\text{ A}$ , $T_j = 25^\circ\text{C}$
Peak Output Current	$I_{opeak}$		-2.1		A	$T_j = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$\Delta V_o/\Delta T$		-1.0		$\text{mV}/^\circ\text{C}$	$I_o = -5\text{ mA}$ , $0^\circ\text{C} \leq T_j \leq 125^\circ\text{C}$

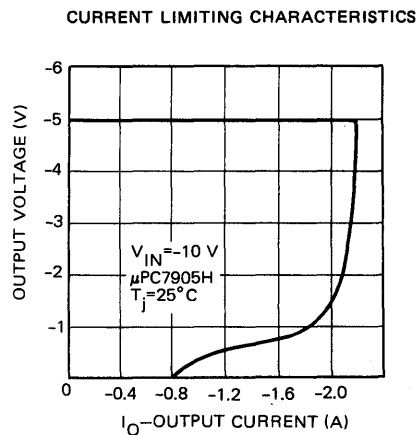
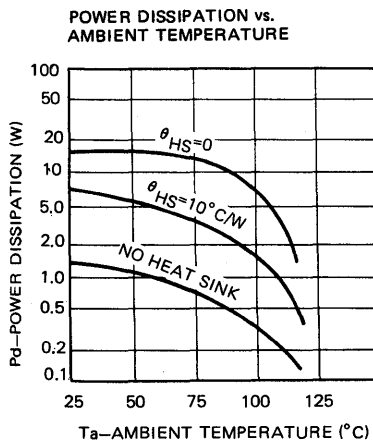


# μPC7900H SERIES

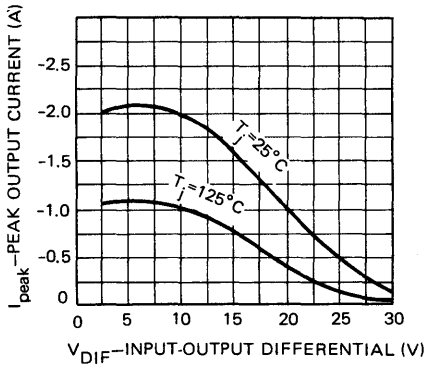
## ELECTRICAL CHARACTERISTICS μPC7924H ( $V_{IN} = -33\text{ V}$ , $I_O = -500\text{ mA}$ , $0^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$ )

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_O$	-23.0	-24.0	-25.0	V	$T_J = 25^\circ\text{C}$
		-22.8		-25.2		$-27\text{ V} \leq V_{IN} \leq -38\text{ V}$ , $-5\text{ mA} \leq I_O \leq -1.0\text{ A}$
Line Regulation	$REG_{IN}$		18	480	mV	$T_J = 25^\circ\text{C}$ , $-27\text{ V} \leq V_{IN} \leq -38\text{ V}$
			6	240		$T_J = 25^\circ\text{C}$ , $-30\text{ V} \leq V_{IN} \leq -36\text{ V}$
Load Regulation	$REG_L$		90	480	mV	$T_J = 25^\circ\text{C}$ , $-5\text{ mA} \leq I_O \leq -1.5\text{ A}$
			30	240		$T_J = 25^\circ\text{C}$ , $-250\text{ mA} \leq I_O \leq -750\text{ mA}$
Quiescent Current	$I_{BIAS}$		1.5	3.0	mA	$T_J = 25^\circ\text{C}$
Quiescent Current Change	$\Delta I_{BIAS}$			1.0	mA	$-27\text{ V} \leq V_{IN} \leq -38\text{ V}$
				0.5		$-5\text{ mA} \leq I_O \leq -1.0\text{ A}$
Output Noise Voltage	$N_L$		600		μV	$T_a = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 100\text{ kHz}$
Ripple Rejection		51	59		dB	$f = 120\text{ Hz}$ , $-28\text{ V} \leq V_{IN} \leq -38\text{ V}$ , $I_O = -500\text{ mA}$
Dropout Voltage			1.1		V	$I_O = -1.0\text{ A}$ , $T_J = 25^\circ\text{C}$
Peak Output Current	$I_{OPEAK}$		-2.1		A	$T_J = 25^\circ\text{C}$
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$		-1.0		mV/°C	$I_O = -5\text{ mA}$ , $0^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$

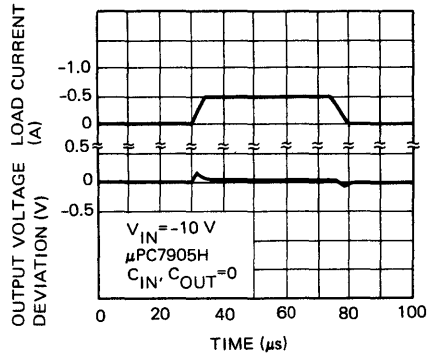
## TYPICAL CHARACTERISTICS ( $T_a = 25^\circ\text{C}$ )



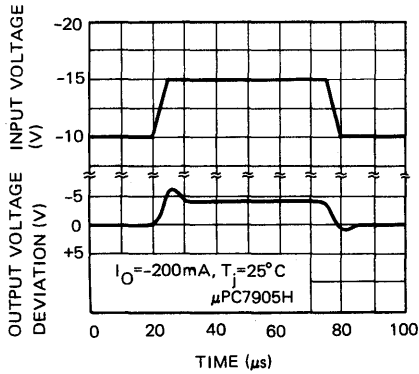
**PEAK OUTPUT CURRENT AS A FUNCTION OF INPUT/OUTPUT DIFFERENTIAL VOLTAGE**



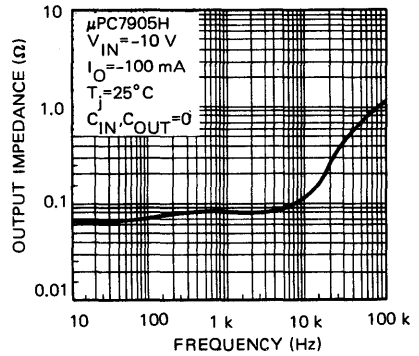
**LOAD TRANSIENT RESPONSE**



**LINE TRANSIENT RESPONSE**



**OUTPUT IMPEDANCE AS A FUNCTION OF FREQUENCY**



# μPC1042

## Switching Regulator Control Circuit

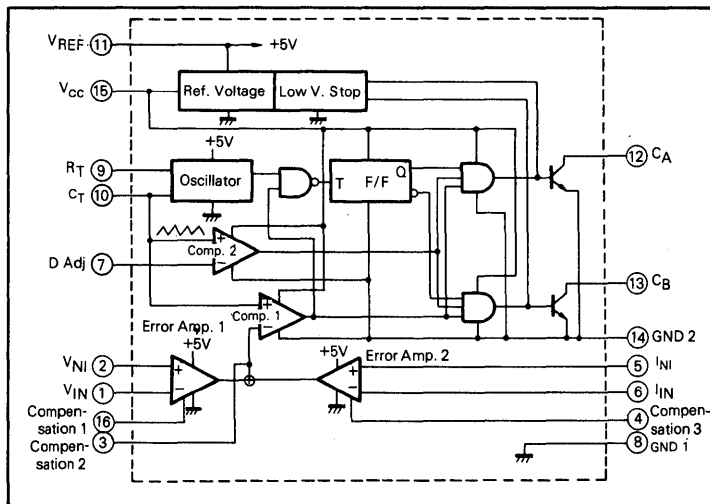
### GENERAL DESCRIPTION

The μPC1042 is an inverter control unit which provides all the control circuitry for PWM type switching regulators. The voltage reference, dual error amplifiers, oscillator, voltage comparator for pulse width modulation, pulse steering flip-flop, dual alternating output switches, and dead time adjustment are all included in this device. It can be used for fixed-frequency switching regulators such as forward type and push-pull type SMPS.

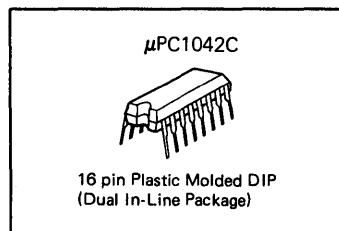
### FEATURES

- Internal Oscillator has symmetrical triangular wave-form
- Adjustable dead time (0 ~ 100%)
- Includes a Mis-Operation preventing circuit at low input voltage
- No double pulsing of each outputs,  $C_A$  and  $C_B$
- Error Amp. II can operate 0 V input voltage level

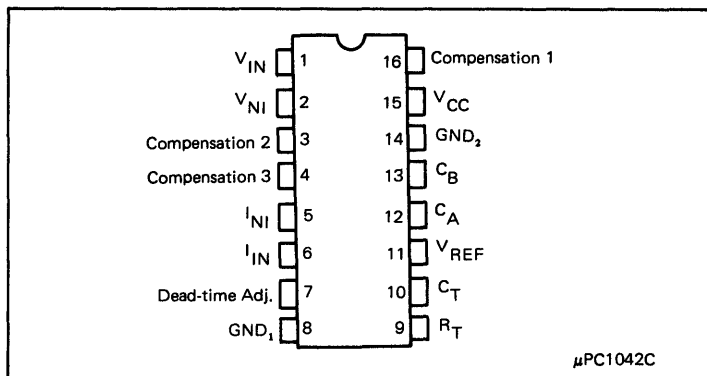
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER	SYMBOL	μPC1042C	UNIT
Supply Voltage	V <sub>CC</sub>	30	V
Output Voltage	V <sub>CER</sub>	40	V
Output Current (each output)	I <sub>C</sub>	100	mA
Reference Output Current	I <sub>REF</sub>	40	mA
Total Power Dissipation (Ta = 25°C)	P <sub>T</sub>	800	mW
Operating Temperature Range	T <sub>opt</sub>	-20 to +85	°C
Storage Temperature Range	T <sub>stg</sub>	-40 to +125	°C

**RECOMMENDED OPERATING CONDITIONS**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V <sub>CC</sub>	8	12	16	V
Output Voltage	V <sub>CER</sub>		24	32	V
Output Current	I <sub>C</sub>	5	20	40	mA
Reference Output Current	I <sub>REF</sub>	0	3	5	mA
Oscillation Frequency	f <sub>OSC</sub>	20	40	100	kHz

**ELECTRICAL CHARACTERISTICS (V<sub>CC</sub> = 12 V, Ta = 25°C unless otherwise noted)**

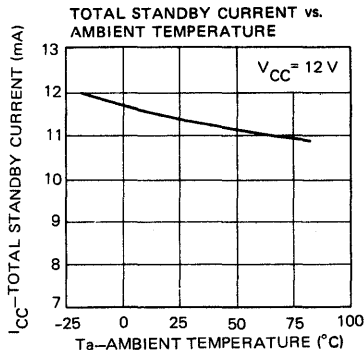
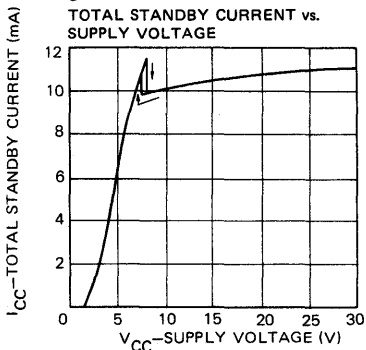
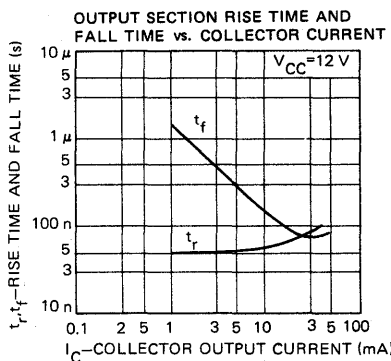
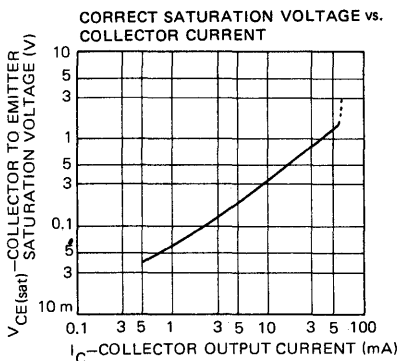
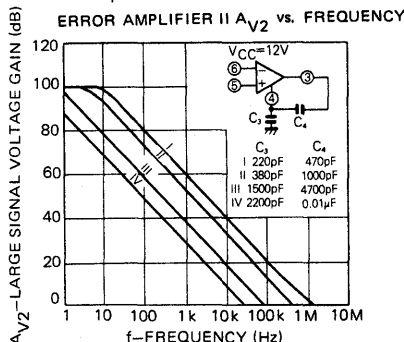
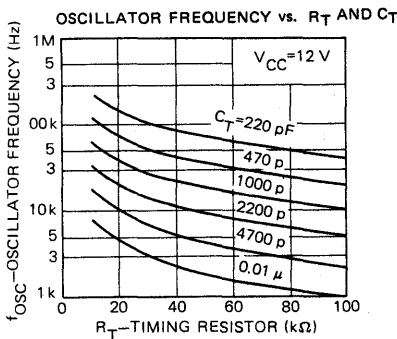
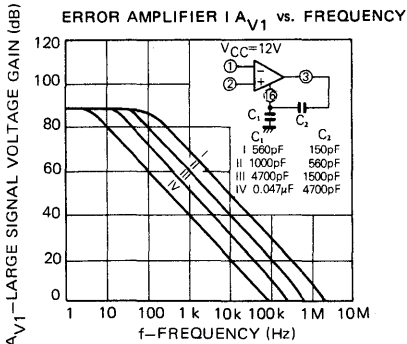
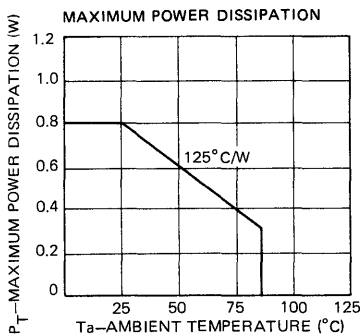
BLOCK	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Reference Section	Output Voltage	V <sub>REF</sub>	4.6	5.0	5.4	V	I <sub>REF</sub> =0
	Line Regulation	REG <sub>IN</sub>		13	35	mV	8V ≤ V <sub>CC</sub> ≤ 20V, I <sub>REF</sub> =0
	Load Regulation	REG <sub>L</sub>		-2.5	-10	mV	0 ≤ I <sub>REF</sub> ≤ 20mA
	Ripple Rejection			60		dB	f=120 Hz
	Temperature Coefficient	ΔV <sub>REF</sub> /ΔT		200	750	μV/°C	-20°C ≤ T <sub>opt</sub> ≤ +85°C
Low Voltage Stop Sec.	Start-up Voltage	V <sub>CC</sub> (L to H)		7.5		V	0 ≤ V <sub>CC</sub> ≤ 12 V
	Hysteresis Voltage	V <sub>H</sub>		0.5		V	0 ≤ V <sub>CC</sub> ≤ 12 V
Oscillator Section	Maximum Oscillation Frequency	f <sub>max</sub>	100			kHz	
	Initial Accuracy			±5	±10	%	R <sub>T</sub> , C <sub>T</sub> constant
	Temperature Stability			-6	-10	%	-20°C ≤ T <sub>opt</sub> ≤ +85°C
	Output Voltage (Hight)	V <sub>O(H)</sub>		4		V	
	Output Voltage (Low)	V <sub>O(L)</sub>		2		V	
	Line Frequency Stability			±1	±2	%	8 V ≤ V <sub>CC</sub> ≤ 20 V



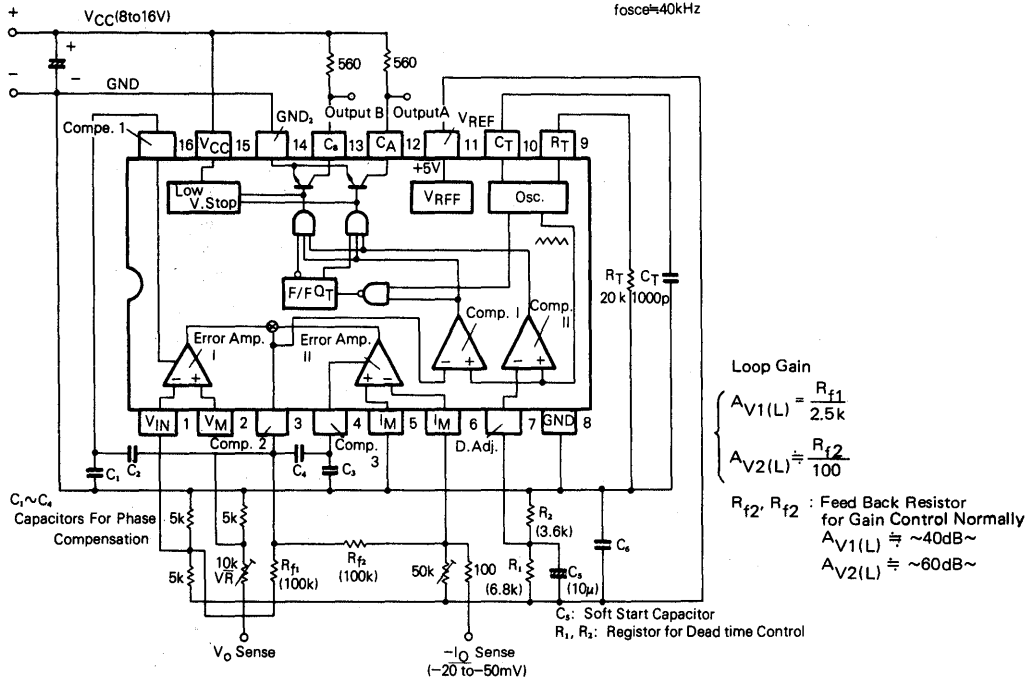


BLOCK	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Error Amp. 1 Section	Input Offset Voltage	$V_{IO(1)}$		±2	±10	mV	
	$V_{IO(1)}$ Temperature Coefficient	$\Delta V_{IO(1)}/\Delta T$		±4	±10	$\mu V/^{\circ}C$	$-20^{\circ}C \leq T_{opt} \leq +85^{\circ}C$
	Input Bias Current	$I_{B1}$		+1.3	+10	$\mu A$	
	Large Signal Voltage Gain	$A_{V1}$	72	87		dB	
	Common Mode Input Voltage		1.2		4.0	V	
	Common Mode Rejection Ratio	$CMR_1$		70		dB	
	Small Signal Bandwidth	$f_{01}$		2		MHz	$A_{V1}=0 \text{ dB}, C_1=560 \text{ pF}, C_2=150 \text{ pF}$
Error Amp. 2 Section	Input Offset Voltage	$V_{IO(2)}$		±3	±10	mV	
	$V_{IO(2)}$ Temperature Coefficient	$\Delta V_{IO(2)}/\Delta T$		±3	±10	$\mu V/^{\circ}C$	$-20^{\circ}C \leq T_{opt} \leq +85^{\circ}C$
	Input Bias Current	$I_{B2}$		-1.5	-10	$\mu A$	
	Large Signal Voltage Gain	$A_{V2}$	72	100		dB	
	Common Mode Input Voltage		0		3	V	
	Common Mode Rejection Ratio	$CMR_2$		70		dB	
	Small Signal Bandwidth	$f_{02}$		1.2		MHz	$A_{V2}=0 \text{ dB}, C_3=220 \text{ pF}, C_4=470 \text{ pF}$
Dead time Adj. Section	Maximum Output Current	$I_{O(AMP)}$			1.0	mA	
	Input Bias Current	$I_{B3}$		-4.5		$\mu A$	
	Input Voltage (0% duty)	$V_{D(0)}$		1.35		V	
Output Section	Input Voltage (100% duty)	$V_{D(100)}$		3.3		V	
	Collector to Emitter Voltage	$V_{CER}$	40			V	$I_C=1 \text{ mA}$
	Collector to Emitter Cutoff Current	$I_{CER}$			10	$\mu A$	$V_{CE}=40 \text{ V}$
	Collector Saturation Voltage	$V_{CE(sat)}$		0.55	0.7	V	$I_C=20 \text{ mA}$
	Rise Time	$t_r$		80		ns	$I_C=20 \text{ mA}$
Fall Time	$t_f$		70		ns	$V_{CC}=12 \text{ V}, R_L \approx 560 \Omega$	
Total Standby Current	$I_{CC}$		12	15	mA	$V_{CC}=20 \text{ V}, I_{REF}=0$	

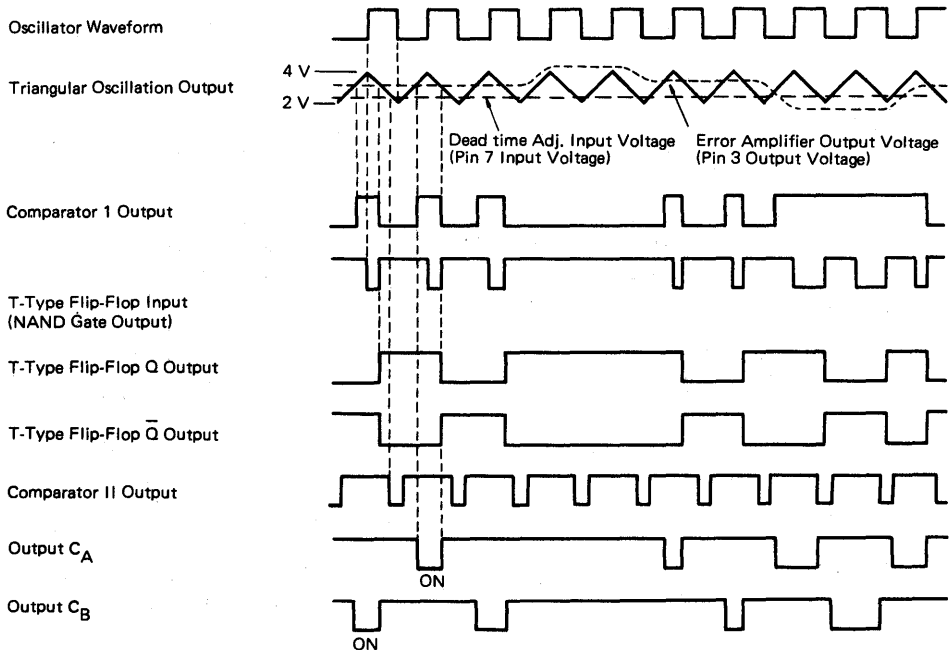
TYPICAL PERFORMANCE CHARACTERISTICS (Ta = 25±2°C)



APPLICATION



INTERNAL WAVEFORMS (TIMING CHARTS)



**PRECAUTIONS FOR OPERATION**

1. Common Mode Input Voltage Range of Error Amp. I  
C.M. voltage range of the Error Amp. I is from 1.2 V to 4.0 V.  
Input terminals of the Error Amp. I (pin 1 or 2) must be given bias voltage in this range even if the Error Amp. I is not in use. (When the bias voltage is not given to them, the oscillator stops.)
2. Dead-time Adjustment Terminal (pin 7)  
If dead-time adjust terminal is not in use, it must be connected to GND1 (pin 8).
3. Phase Compensation of Error Amplifiers.  
Error Amp. I and II do not have internal phase compensation. So, when these Amps are used, external capacitors ( $C_1 \sim C_4$ ) are necessary. (Without them, the Amp. will cause high frequency oscillation.)



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### GENERAL DESCRIPTION

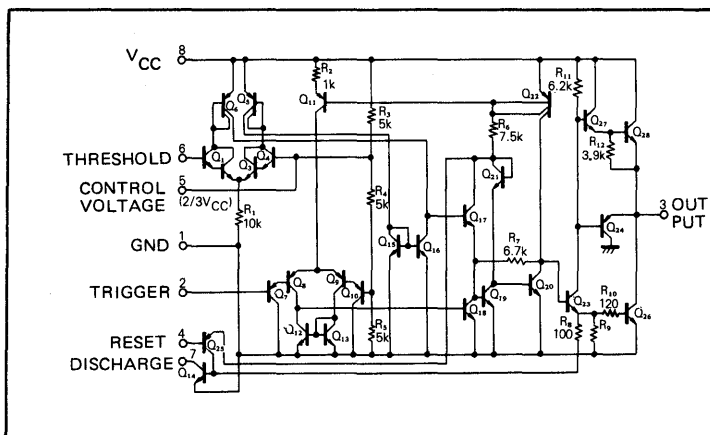
The μPC617/1555 TIMER is a highly stable controller, capable of producing accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the Time Delay Mode Operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA or drive TTL circuits.

Two kinds of ICs are available according to reliability, the μPC617 for industry, the μPC1555 for commercial.

### FEATURES

- Operates in both a stable and monostable modes
- Output can drive TTL
- Adjustable duty cycle
- NE555 Direct Replacement

### EQUIVALENT CIRCUIT



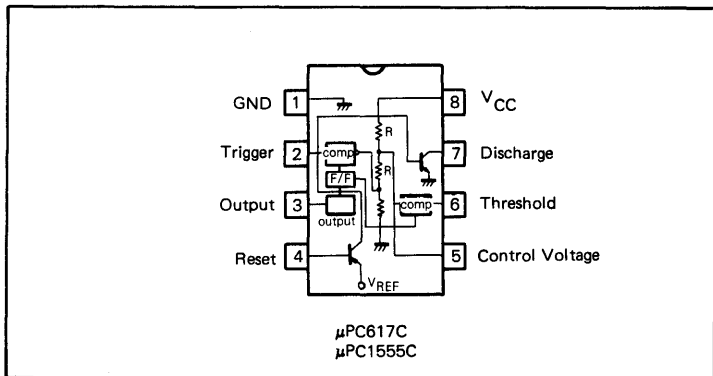
### ORDERING INFORMATION

μPC617C/μPC1555C



8 pin Plastic Molded DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)





**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER	μPC617	μPC1555	UNIT
Voltage between V <sup>+</sup> and GND	18	18	V
Power Dissipation*	600	600	mW
Operating Temperature Range	-20 to +70	0 to +70	°C
Storage Temperature Range	-55 to +125	-55 to +125	°C

\* See thermal information in chapter 11.

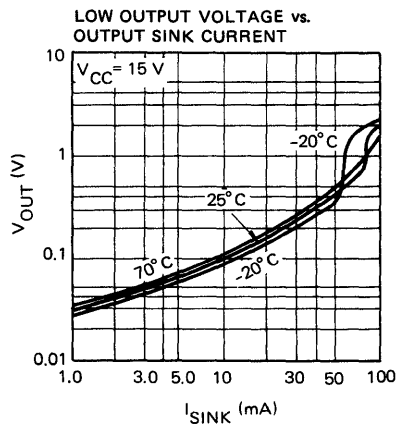
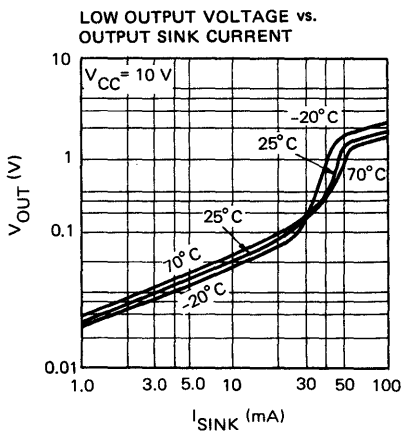
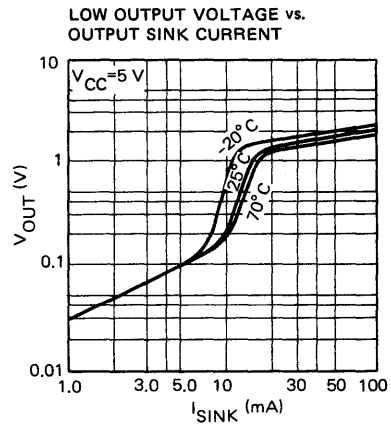
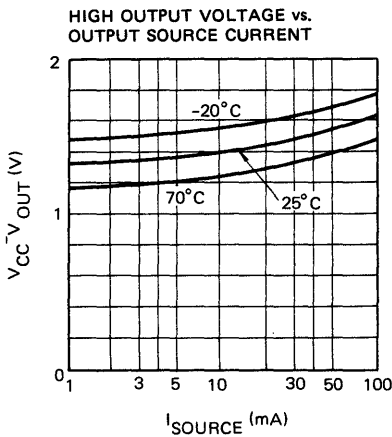
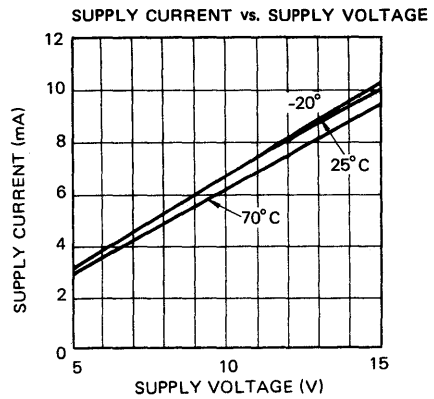
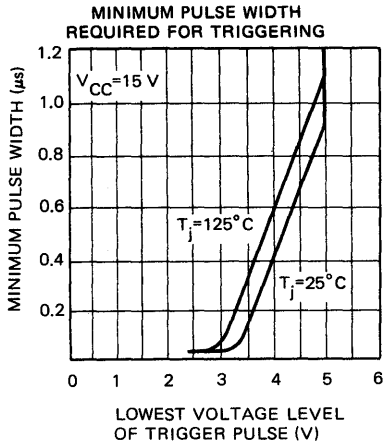
**ELECTRICAL CHARACTERISTICS (Ta=25°C V<sup>+</sup>= +5V to +15 V)**

CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Supply Voltage	4.5		16	V	
Supply Current		3	6	mA	Vcc=5 V, RL=∞, Vo="L" (Note 1)
		10	15	mA	Vcc=15V, RL=∞, Vo="L" (Note 1)
Threshold Voltage		2/3 Vcc		V	
Threshold Current		0.1	0.25	μA	(Note 2)
Trigger Voltage		5		V	Vcc=15 V
		1.67		V	Vcc=5 V
Trigger Current		0.5		μA	
Reset Voltage	0.4	0.7	1.0	V	
Reset Current		0.1		mA	
Control Voltage Level	9.0	10	11	V	Vcc=15 V
	2.6	3.33	4	V	Vcc=5 V
Output Voltage Drop (Low)		0.1	0.25	V	Vcc=15 V, ISINK=10 mA
		0.4	0.75	V	Vcc=15 V, ISINK=50 mA
		2.0	2.5	V	Vcc=15 V, ISINK=100 mA
		2.5		V	Vcc=15 V, ISINK=200 mA
Output Voltage Drop (High)		0.1	0.35	V	Vcc=5 V, ISINK=5 mA
		12.5		V	Vcc=15 V, ISOURCE=200 mA
	12.75	13.3		V	Vcc=15 V, ISOURCE=100 mA
Rise Time Output		2.75	3.3	V	Vcc=5 V, ISOURCE=100 mA
Rise Time Output		100		ns	
Fall Time Output		100		ns	
Timing Error, Astable					
Initial Accuracy		1		%	RA, RB=1 k to 100 kΩ
Drift with Temperature		50		ppm/°C	C=0.1 μF
Drift with Supply		0.01		%/V	

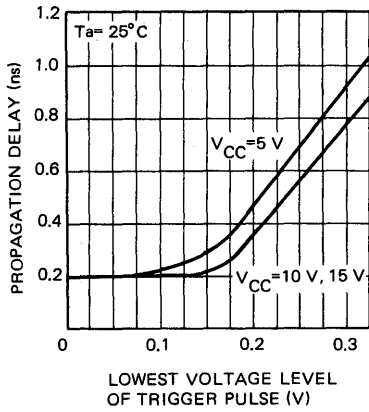
Note 1 Supply current when output high typically 1 mA less at 5 V.

Note 2 This will determine the maximum value of RA + RB for 15 V operation.  
The maximum total (RA + RB) is 20 MΩ.

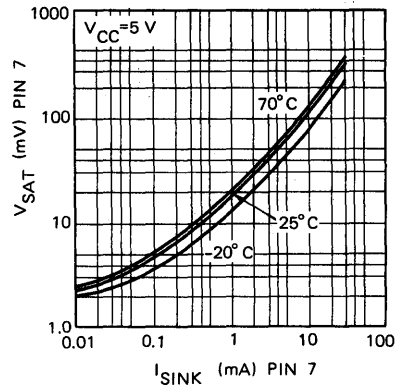
TYPICAL PERFORMANCE CHARACTERISTICS



**OUTPUT PROPAGATION DELAYS vs.  
VOLTAGE LEVEL OF TRIGGER PULSE**



**DISCHARGE TRANSISTOR (PIN 7)  
VOLTAGE vs. SINK CURRENT**



APPLICATIONS

1. Monostable Operation

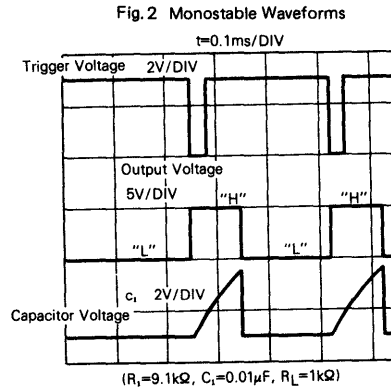
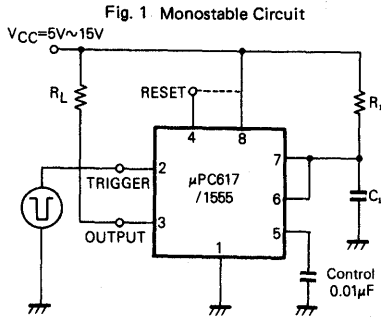
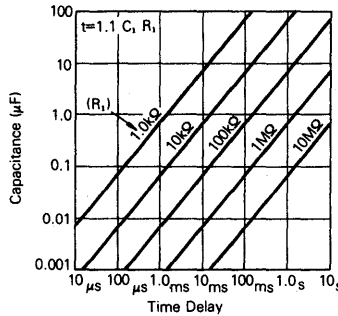


Fig. 3 Time Delay



When the timer is operated as a monostable multivibrator, one external capacitor,  $C_1$ , and one external resistor,  $R_1$ , are used as shown in Figure 1. When the trigger input is reduced below  $1/3 V_{CC}$ , the timer internal flip-flop is set. This releases the short circuit across the external capacitor and the Q output goes HIGH. The voltage across the capacitor reaches  $2/3 V_{CC}$ , the internal comparator resets the flip-flop and the external capacitor,  $C_1$ , is rapidly discharged provided the trigger voltage is returned above  $1/3 V_{CC}$ . The output is now in LOW state and a new timing cycle may be initiated. The time that the output is in the HIGH state is given by  $1.1 R_1 C_1$  or can be taken directly from Fig. 3. Both the charge rate and internal threshold are directly proportional to the  $V_{CC}$  supply voltage. Thus, the timer output pulse width is independent of the power supply voltage. If a LOW is applied to the reset input, the output is forced LOW and the external capacitor discharged regardless of the other inputs.

2. Astable Operation

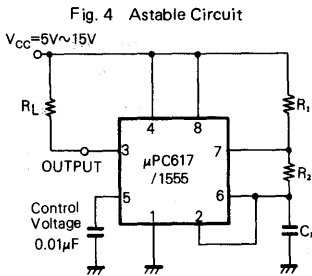


Fig. 5 Astable Wave Form  
t=0.5ms/DIV

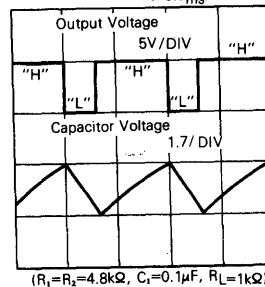
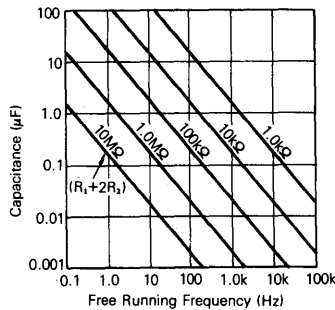


Fig. 6 Free Running Frequency



When the timer is operated in the astable mode, two external resistors,  $R_1$  and  $R_2$ , and one external capacitor,  $C_1$ , are used as shown in Fig. 4. With this connection scheme, the external capacitor,  $C_1$ , charges and discharges between  $1/3 V_{cc}$  and  $2/3 V_{cc}$ . The charge time (output HIGH) is:  $t = 0.693 (R_1 + R_2) C_1$

The discharge time (output LOW) is:  $t_2 = 0.693 R_2 C_1$ . The total period for one cycle of output HIGH and output LOW is:  $T = t_1 + t_2 = 0.693 (R_1 + 2R_2) C_1$ . The frequency for this period,  $T$  is

$$f = \frac{1}{T} = \frac{1}{0.693 (R_1 + 2R_2) C_1}$$

The astable free running frequency can also be found from the graph shown in Fig. 6. The duty cycle, time the output is LOW divided by the period, is given by:

$$D = \frac{t_2}{t_1 + t_2} = \frac{R_2}{R_1 + R_2}$$

## Overvoltage "Crowbar" Sensing Circuit

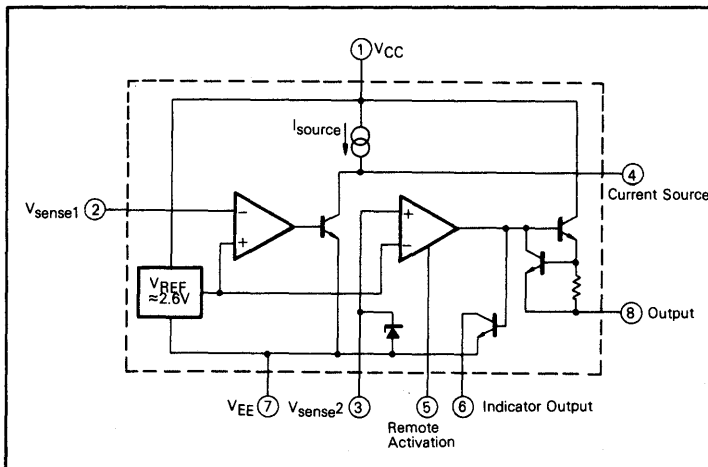
### GENERAL DESCRIPTION

The μPC3423 is an overvoltage protection circuit (OVP) and protect sensitive electronic circuitry from overvoltage transients or regulator failures when used in conjunction with an external "crowbar" SCR.

### FEATURES

- Threshold voltage can be programmed by external resistors.
- Duration of overvoltage condition before tripping can be programmed
- Output Transistor can drive 100 A class "Crowbar" SCR. ( $I_o = 300 \text{ mA MAX.}$ )
- Equivalent to MC3423

### EQUIVALENT CIRCUIT



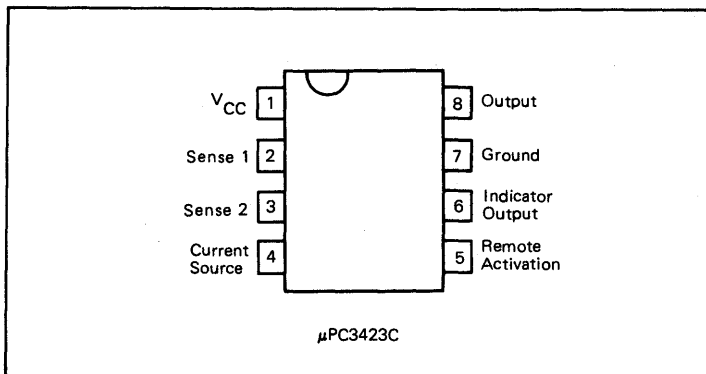
### ORDERING INFORMATION

μPC3423C



8 pin Plastic Molded DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER	SYMBOL	μPC3423	UNIT
Differential Power Supply Voltage	$V_{CC} - V_{EE}$	45	V
Sense Voltage (1)	$V_{sense 1}$	6.8	V
Sense Voltage (2)	$V_{sense 2}$	6.8	V
Remote Activation Input Voltage	$V_{act}$	7.0	V
Output Current	$I_o$	300	mA
Total Power Dissipation	$P_T (T_a=25^\circ C)$	600	mW
Operating Temperature Range	$T_{opt}$	-20 to +85	°C
Storage Temperature Range	$T_{stg}$	-40 to +125	°C

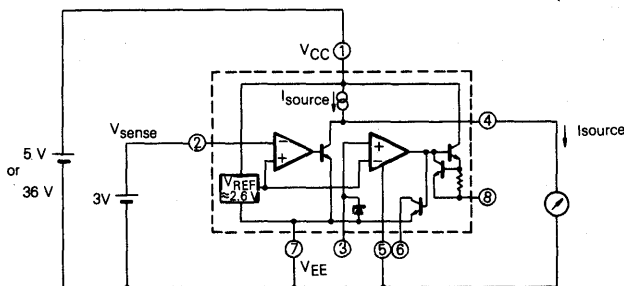
**RECOMMENDED OPERATING CONDITIONS**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage Range	$V_{CC} - V_{EE}$	4.5		36	V
Output Current	$I_o$	0		200	mA
Indication Output Current	$I_o(I_{nd})$	0		10	mA

**ELECTRICAL CHARACTERISTICS (V<sub>CC</sub>-V<sub>EE</sub> = 5.0 V, Ta = 25°C)**

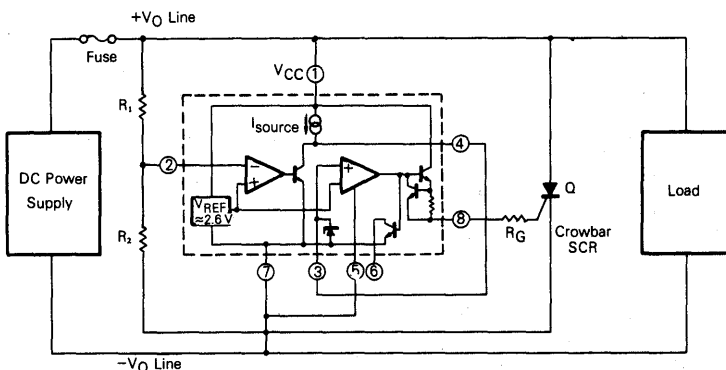
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Output Voltage	$V_o$	$V_{CC}-2.2$	$V_{CC}-1.8$		V	$I_o = 100 \text{ mA}$
Indication Output Voltage	$V_{OL}(I_{nd})$		0.2	0.4		$I_o(I_{nd}) = 8.0 \text{ mA}$
Sense Voltage (1), (2)	$V_{sense 1}$ $V_{sense 2}$	2.4	2.6	2.8	V	
Temperature Coefficient of Sense Voltage	TC V sense		-0.04		%/°C	$-20^\circ C \leq T_a \leq +80^\circ C$
Remote Activation Input Current	$I_{IH}$		0.1	40	μA	$V_{IH} = 2.0 \text{ V}$
Remote Activation Input Current	$I_{IL}$		-250		μA	$V_{IL} = 0.8 \text{ V}$
Source Current	$I_{source}$		300		μA	See Test Circuit
Output Current Rise Time	$t_r$		400		mA/μs	$I_o = 100 \text{ mA}$
Propagation Delay	$t_{pd}$		0.5		μs	
Supply Current	$I_D$		5.0	8.0	mA	pin 5 connect to pin 7 (V <sub>EE</sub> ), other terminals open

$I_{source}$  Test Circuit

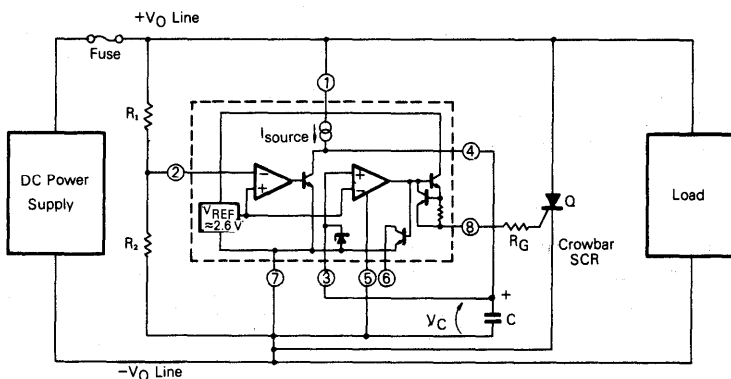


**APPLICATIONS**

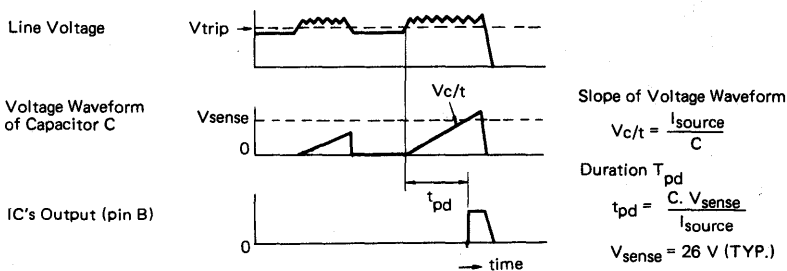
**1. BASIC APPLICATION**



**2. APPLICATION WHEN PROGRAMMABLE DURATION OF OVERVOLTAGE CONDITION BEFORE TRIP IS NEEDED**

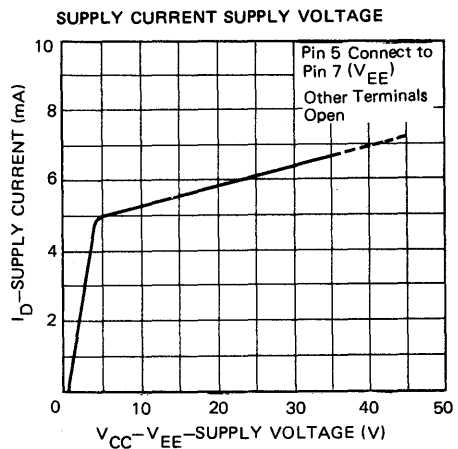
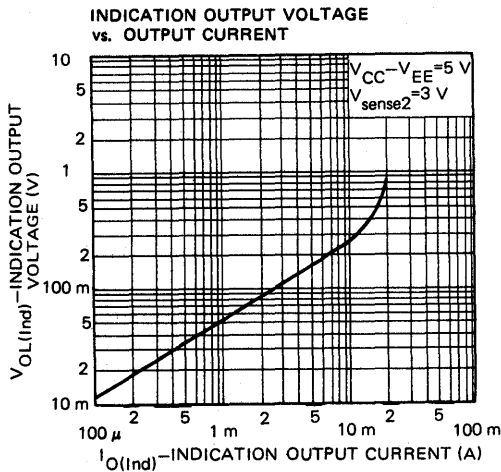
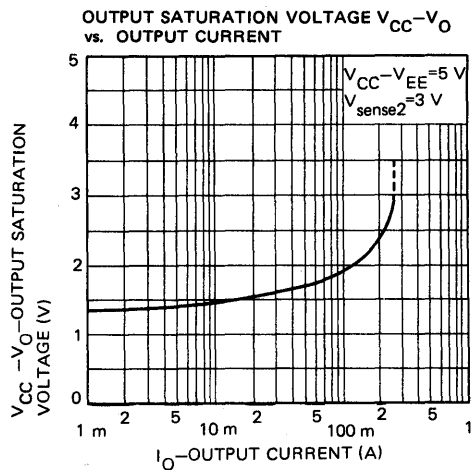
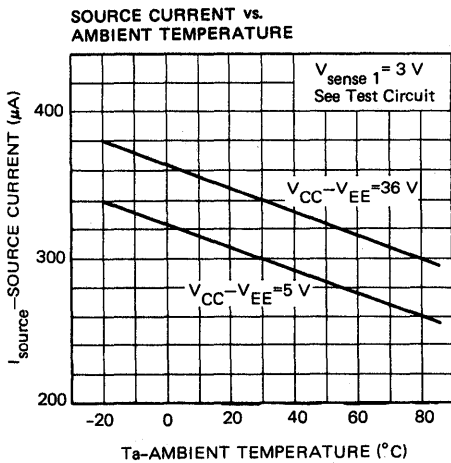
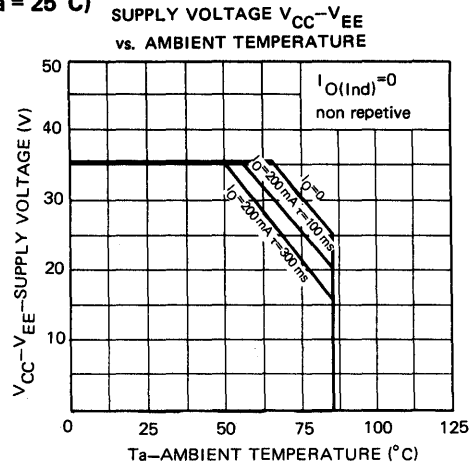
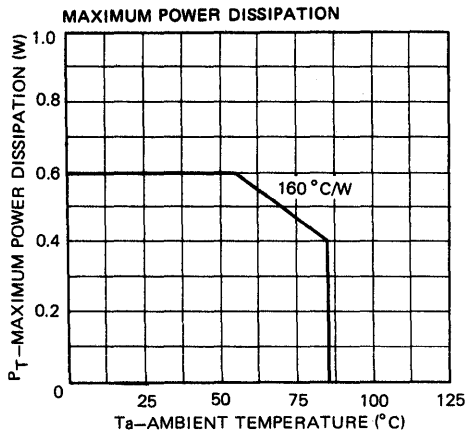


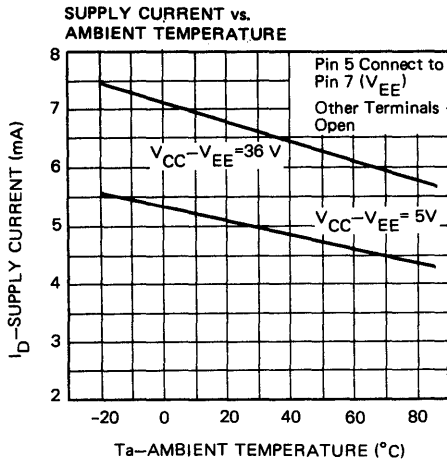
**TIMING CHART**





**TYPICAL PERFORMANCE CHARACTERISTICS (Ta = 25°C)**







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$\mu$ PC649 . . . . .	Monolithic Sample and Hold Circuit . . . . . 233

## Dual High Speed Programmable Current Mode Amplifiers

### GENERAL DESCRIPTION

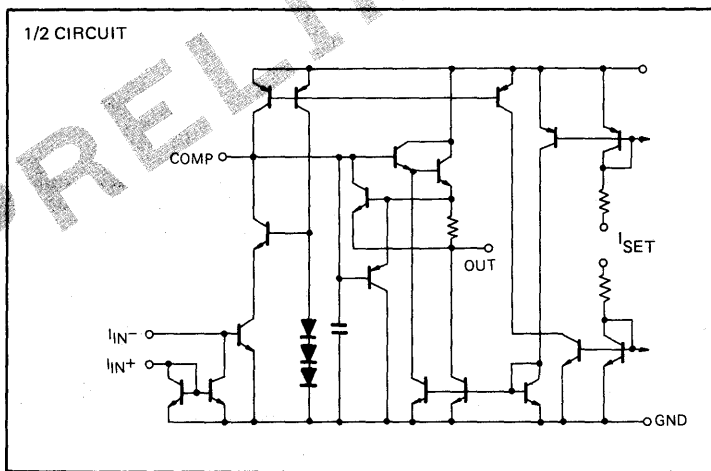
The μPC209/4359 consist of two current differencing input amplifiers. Design emphasis has been placed on obtaining high frequency performance and providing use programmable amplifier operating characteristics.

Two kinds of ICs are available according to reliability, the μPC209 for industry, the μPC4359 for commercial.

### FEATURES

- User Programmable Gain Bandwidth Product, Slew Rate, Input Bias Current, Output Stage Current
- High Gain Bandwidth Product  
400 MHz for  $A_v = 10$  to 100  
30 MHz for  $A_v = 1$
- High Slew Rate  
60 V/μs for  $A_v = 10$  to 100  
30 V/μs for  $A_v = 1$
- Operates from a single 5 V to 22 V supply
- LM359 Direct Replacement

### EQUIVALENT CIRCUIT



### ORDERING INFORMATION

μPC209D



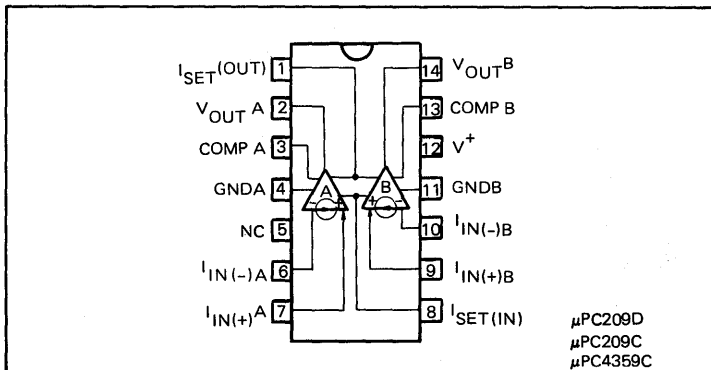
14 pin Ceramic DIP  
(Dual In-Line Package)

μPC209C/μPC4359C



14 pin Plastic Molded DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)



# μPC452 / 3403

## High Performance Quad Operational Amplifier

### GENERAL DESCRIPTION

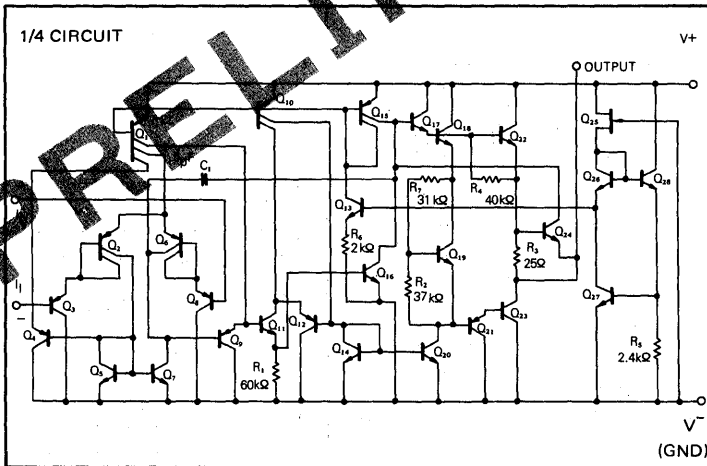
The μPC452/3403 are monolithic Quad Operational Amplifiers consisting of four independent high-gain, internally frequency-compensated operational amplifiers designed to operate from a single power supply or split power supplies over a wide range of voltages. The common mode input range includes the negative supply thereby eliminating the necessity for external biasing components in many applications.

Two types of ICs are available according to reliability, the μPC452 for industry, the μPC3403 for commercial.

### FEATURES

- Input Common Mode Voltage Range Includes Ground or Negative Supply
- Output Voltage Capable of Sourcing to Ground or Negative Supply
- Wide Power Supply Range:
  - Single Supply of 5.0 to 36 V
  - Split Supplies of ±1.5 to 18 V
- Class AB Output Stage for Minimal Crossover Distortion
- Short Circuit Protected Outputs
- MC3403 Direct Replacement

### EQUIVALENT CIRCUIT



### ORDERING INFORMATION

μPC452C/μPC3403C



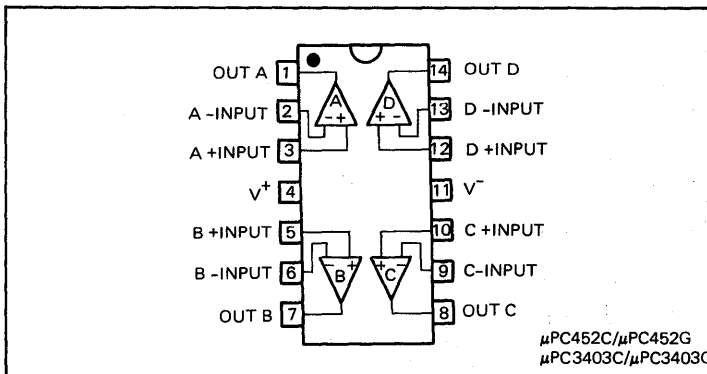
14 pin Plastic Molded DIP  
(Dual In-Line Package)

μPC452G/μPC3403G



14 pin Plastic Molded Flat Package  
(MINI FLAT IC)

### CONNECTION DIAGRAM (Top View)



## Switching Regulator Control Circuit

### GENERAL DESCRIPTION

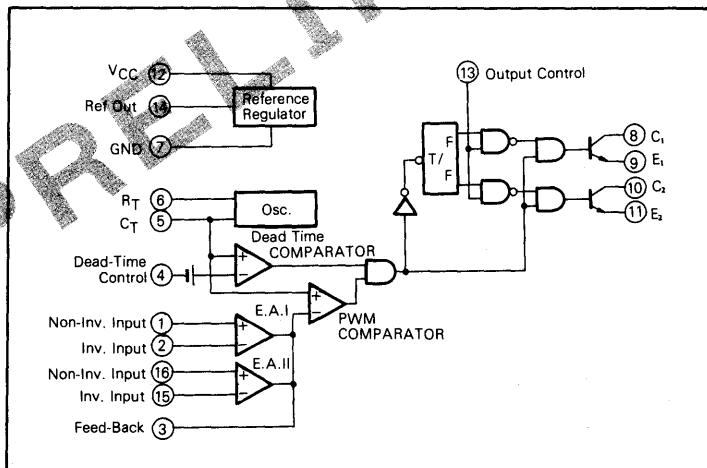
The μPC494C is an inverter control unit which provides all the control circuitry for PWM type switching regulators.

The voltage reference, dual error amplifiers, oscillator, pulse width modulator, pulse steering flip-flop, dual alternating output switches and dead time control are all included in this device.

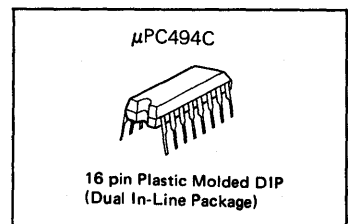
### FEATURES

- Complete PWM power control circuit
- Adjustable dead-time (0 to 100%)
- No double pulsing of same output during load transient condition
- Dual amplifiers have wide common mode input voltage capability ( $-0.3\text{ V}$  to  $V_{CC} - 2\text{ V}$ )
- Circuit architecture provides easy synchronization
- Uncommitted outputs for 250 mA sink or source
- Equivalent to TL494

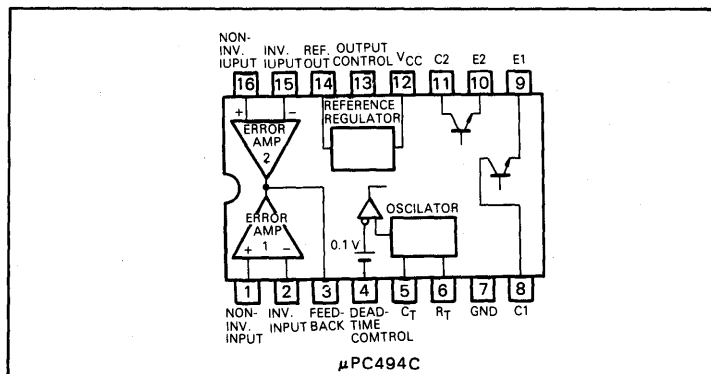
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)





**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

RATING	SYMBOL	μPC494	UNIT
Supply Voltage	V <sub>CC</sub>	41	V
Error Amplifier Input Voltage	V <sub>ICM</sub>	V <sub>CC</sub> -0.3	V
Output Voltage	V <sub>CER</sub>	41	V
Output Current	I <sub>C</sub>	250	mA
Total Power Dissipation	P <sub>T(Ta=25°C)</sub>	1,000	mW
Operating Temperature Range	T <sub>opt</sub>	-20 to +85	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +125	°C

**RECOMMENDED OPERATING CONDITIONS**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V <sub>CC</sub>	7	12	40	V
Output Voltage	V <sub>CER</sub>	-0.3		40	V
Output Current	I <sub>C</sub>			200	mA
Error Amplifier Sink Current	I <sub>OAMP</sub>			-0.3	mA
Timing Capacitor	C <sub>T</sub>	0.47		10,000	nF
Timing Resistance	R <sub>T</sub>	1.8		500	kΩ
Oscillation Frequency	f <sub>osc</sub>	1	40	500	kHz
Operating Temperature	T <sub>opt</sub>	-20		+70	°C

**ELECTRICAL CHARACTERISTICS (V<sub>CC</sub> = 15 V, f = 10 kHz, -20 ≤ T<sub>opt</sub> < +70°C, unless otherwise noted)**

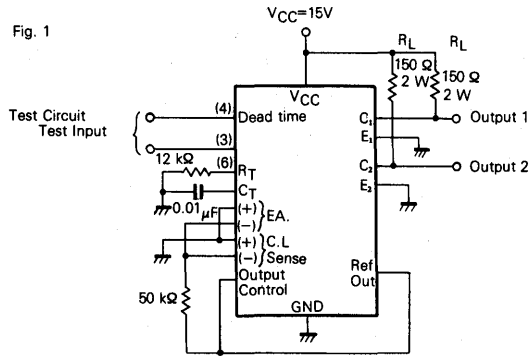
BLOCK	CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Reference Section	Output Voltage	V <sub>ref</sub>	4.75	5	5.25	V	I <sub>ref</sub> =1 mA, Ta=25°C
	Line Regulation	REG <sub>IN</sub>		2	25	mV	7 V ≤ V <sub>CC</sub> ≤ 40 V I <sub>ref</sub> =1 mA, Ta = 25°C
	Load Regulation	REG <sub>L</sub>		1	15	mV	1 mA ≤ I <sub>ref</sub> ≤ 10 mA, Ta=25°C
	Temperature Coefficient	TCV <sub>ref</sub>		0.01	0.03	%/°C	-20°C ≤ Ta ≤ +85°C, I <sub>ref</sub> = 1 mA
	Short Circuit Output Current	I <sub>short</sub>		35		mA	V <sub>ref</sub> =0
Oscillator Section	Frequency	f		10		kHz	C <sub>T</sub> =0.01 μF, R <sub>T</sub> =12 kΩ
	Standard Deviation of Frequency (Note 1)			10		%	7 V ≤ V <sub>CC</sub> ≤ 40 V, C <sub>T</sub> , R <sub>T</sub> , const. Ta = 25°C
	Frequency Change with Temperature				2	%	0°C ≤ Ta ≤ 70°C, C <sub>T</sub> = 0.01 μF R <sub>T</sub> = 12 kΩ
	Frequency Change with Voltage				1	%	7 V ≤ V <sub>CC</sub> ≤ 40 V, C <sub>T</sub> = 0.01 μF Ta = 25°C, R <sub>T</sub> = 12 kΩ
Dead-time Control Section	Input Bias Current			-2	-10	μA	0 ≤ V <sub>I</sub> ≤ 5.25 V
	Maximum Duty Cycle (Each Output)		45			%	V <sub>I</sub> =0
	Input Threshold Voltage	V <sub>th</sub>	0	3	3.3	V	Zero duty cycle Maximum duty cycle

BLOCK	CHARACTERISTIC		SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS	
Error Amplifier Section	Input Offset Voltage		$V_{IO1,2}$		2	10	mV	$V_{OAMP}=2.5\text{ V}$	
	Input Offset Current		$I_{IO1,2}$		25	250	nA	$V_{OAMP}=2.5\text{ V}$	
	Input Bias Current				0.2	1	μA	$V_{OAMP}=2.5\text{ V}$	
	Common Mode Input Voltage	Low	$V_{ICM}$	-0.3				V	$7\text{ V} \leq V_{CC} \leq 40\text{ V}$
		High		$V_{CC}-2$					
	Open-loop Voltage Amplification		$A_v$	60	74			dB	$V_{OAMP}=3\text{ V}$
	Unity Gain Bandwidth				500	650		kHz	
	Common Mode Rejection Ratio		CMR	65	80			dB	$V_{CC}=40\text{ V}$ , $T_a = 25^\circ\text{C}$
	Output Sink Current			0.3	0.6			mA	$V_{OAMP}=0.7\text{ V}$
Output Source Current			-2				mA	$V_{OAMP}=3.5\text{ V}$	
PWM Section	Input Threshold Voltage				4	4.5	V	Zero Duty Cycle	
	Input Sink Current			0.3	0.6		mA	$V_{(pin\ 3)}=0.7\text{ V}$	
Output Section	Collector Cutoff Current		$I_{CER}$		2	100	μA	$V_{CE}=40\text{ V}$ , $V_{CC}=40\text{ V}$	
	Emitter Cutoff Current					-100	μA	$V_{CC}=V_C=40\text{ V}$	
	Collector Saturation Voltage		$V_{CE(sat)}$		1.1	1.3		V	$I_C=200\text{ mA}$ , $V_E=0$ , common Emitter
			$V_{CE(ON)}$		1.5	2.5		V	$I_E=200\text{ mA}$ , $V_C=15\text{ V}$ Emitter follower
	Output Voltage	common Emitter	$t_r$		100	200		ns	$V_{CC}=15\text{ V}$ , $R_L \neq 150\Omega$ $I_O=100\text{ mA}$ $T_a = 25^\circ\text{C}$
	Rise Time	Emitter follower			100	200		ns	
	Output Voltage	common Emitter	$t_f$		70	200		ns	
Fall Time	Emitter follower			70	200		ns		
Total Device	Standby Current		$I_{CC(SB)}$		8	12.5	mA	$V_{CC}=15\text{ V}$ all other inputs and outputs open	
	Bias Current		$I_{CC(BI)}$		10			mA	$V_{(pin\ 4)}=2\text{ V}$ , see fig.1

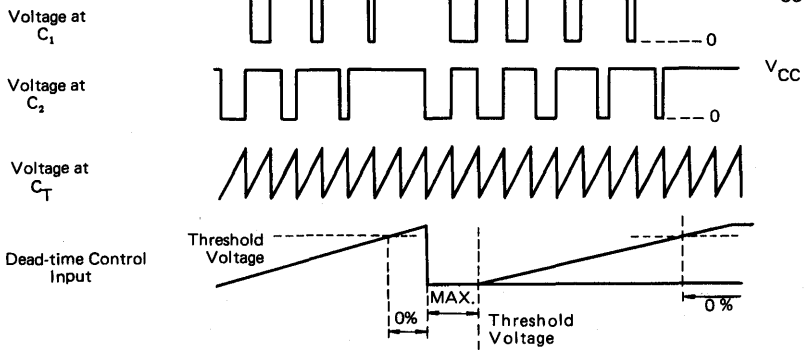
Note 1: Standard deviation is a measure of the statistical distribution about the mean as derived from the formula;

$$\sigma = \sqrt{\frac{\sum_{n=1}^N (X_n - \bar{X})^2}{N - 1}}$$

Fig. 1



**VOLTAGE WAVEFORM**



## 12 Bit High Speed Multiplying D/A Converter

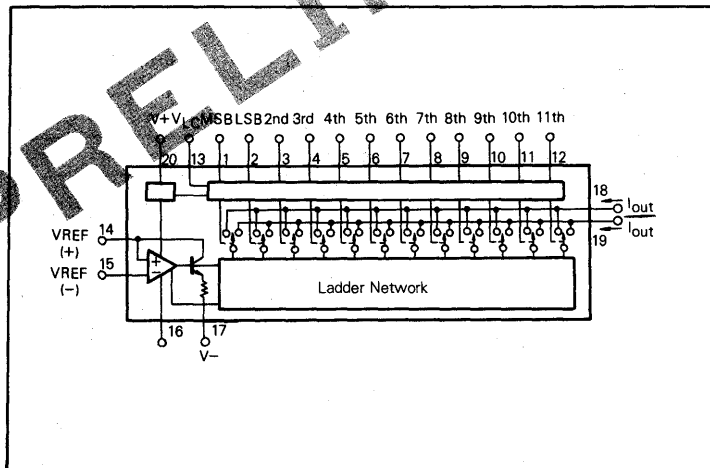
### GENERAL DESCRIPTION

The μPC648 is 12 bit monolithic multiplying D/A converter represent a new level of high speed and accuracy. The μPC648 is the first 12 bit D/A converter ever built using standard processing without the requirement of thin film resistors and or active trimming of individual devices.

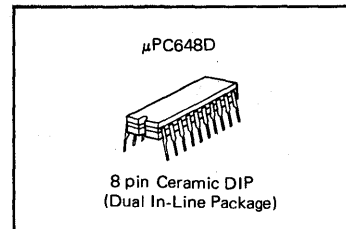
### FEATURES

- All grades 12 bit monotonic over temperature
- Differential nonlinearity to  $\pm 0.025\%$ FS max.
- Trimless design
- Fast settling output current: 400 ns Typ.
- Direct interface to TTL, CMOS, ECL, NMOS
- Am6012 Direct Replacement

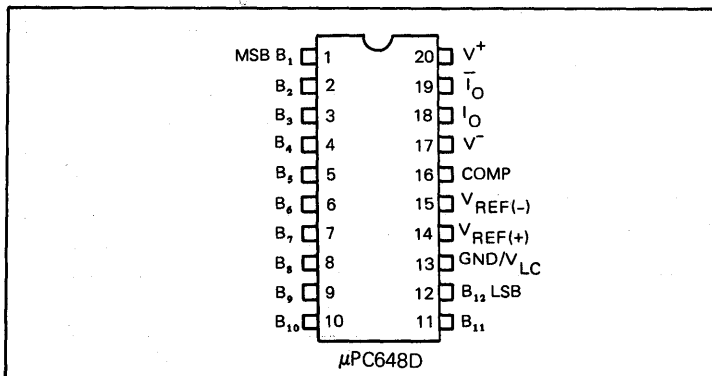
### EQUIVALENT CIRCUIT



### ORDERING INFORMATION



### CONNECTION DIAGRAM (Top View)



10

**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

PARAMETER	SYMBOL	μPC648D	UNIT
Power Supply Voltage Range	V <sup>+</sup> - V <sup>-</sup>	36	V
Logic Input Voltage Range	V <sub>I</sub>	-5 ~ +18	V
Output Voltage Range	V <sub>O</sub>	-8 ~ +12	V
Reference Input Voltage Range	V <sub>REF</sub>	V <sup>-</sup> ~ V <sup>+</sup>	V
Reference input differential Voltage Range	V <sup>+</sup> <sub>REF</sub> - V <sup>-</sup> <sub>REF</sub>	±18	V
Reference Input Current Range	I <sub>REF</sub>	1.25	mA
Total Power Dissipation	P <sub>T</sub>	500	mW
Operating Temperature Range	T <sub>opt</sub>	0 ~ +70	°C
Storage Temperature Range	T <sub>stg</sub>	-55 ~ +125	°C

**RECOMMENDED OPERATING CONDITIONS (V<sup>±</sup> = ±15 V, Ta = 0 ~ 70°C)**

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Power Supply Voltage	V <sup>+</sup>		+4.5	+15	+18	V
	V <sup>-</sup>		-18	-15	-10.8	
Ambient Temperature	T <sub>a</sub>		0	+25	+70	°C
Reference Input Current	I <sub>REF</sub>		0.2	1.0	1.1	mA
High level Input Voltage	V <sub>IH</sub>	V <sub>LC</sub> = 0 V	+2.0		+18	V
Low Level Input Voltage	V <sub>IL</sub>	V <sub>LC</sub> = 0 V	-5.0		+0.8	V
Output Voltage	V <sub>oc</sub>	D.N.L. ≤ ±0.025% FSR	-5.0	0	+10	V

**ELECTRICAL CHARACTERISTICS (V<sup>±</sup> = ±15 V, I<sub>REF</sub> & 1.0000 mA, 0°C ≤ Ta ≤ 70°C)**

CHARACTERISTIC	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Resolution			12	12	12	Bit
Monotonicity			12	12	12	Bit
Differential Nonlinearity	D.N.L.				±0.025	%FSR
Non Linearity	N.L.				±0.05	%FSR
Full Scale Current	I <sub>FS</sub>	V <sub>REF</sub> = 10.000 V, Ta = 25°C R <sub>14</sub> = R <sub>15</sub> = 10,000 kΩ	3.935	3.999	4.063	mA
Full Scale Tempco	$\left  \frac{\Delta I_{FS}}{I_{FS} \cdot \Delta T} \right $				±40	ppm/°C
Full Scale Symmetry	I <sub>FS</sub> - I <sub>FS</sub>				±2.0	μA
Zero Scale Current	I <sub>ZS</sub>				0.10	μA
Settling Time	T <sub>s</sub>	To ±½ LSB, Ta = 25°C all bits ON or OFF		400		ns
Propagation Delay	t <sub>PLH</sub>	50 % to 50 %			50	ns
	t <sub>PHL</sub>					
Output Capacitance	C <sub>o</sub>			35		pF
Logic Input Current	I <sub>I</sub>	-5 V < V <sub>I</sub> < +18 V			40	μA
Reference Bias Current	I <sub>B</sub> <sup>+</sup>				-2.0	μA
Reference Input Slew Rate	ΔI <sub>REF</sub> /ΔT	C <sub>c</sub> = 0 R <sub>14</sub> = 800 Ω	4.0	8.0		mA/μs
Supply Voltage Rejection	ISVR <sup>+</sup>	V <sup>+</sup> = +13.5 ~ +16.5 V, V <sup>-</sup> = -15 V			±0.001	%FSR/%
	ISVR <sup>-</sup>	V <sup>-</sup> = -13.5 ~ -16.5 V, V <sup>+</sup> = +15 V			±0.001	
Power Supply Current	I <sup>+</sup> <sub>1</sub>	V <sup>+</sup> = +5 V			8.5	mA
	I <sup>-</sup> <sub>1</sub>	V <sup>-</sup> = -15 V			-18.0	
	I <sup>+</sup> <sub>2</sub>	V <sup>+</sup> = +15 V			8.5	
	I <sup>-</sup> <sub>2</sub>	V <sup>-</sup> = -15 V			-18.0	
Power Dissipation	P <sub>D1</sub>	V <sup>+</sup> = +5 V, V <sup>-</sup> = -15 V			312	mW
	P <sub>D2</sub>	V <sup>+</sup> = +15 V, V <sup>-</sup> = -15 V			397	

## Monolithic Sample and Hold Circuit

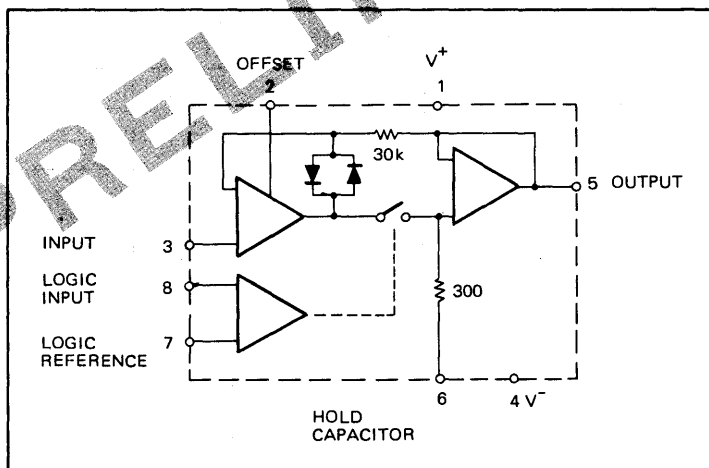
### GENERAL DESCRIPTION

μPC649 is monolithic sample and hold circuit. JFET and bipolar transistors are combined on the same chip to provide a high input impedance output buffer and high speed input buffer. Operating as a unity gain input buffer, dc accuracy 0.004 % typical and acquisition time is as low as 6 μs to 0.01 %.

### FEATURES

- Fast acquisition time
- Gain accuracy 0.004 % typ.
- Input offset Voltage 2 mV typ.
- Direct interface to TTL, CMOS
- LF398 Direct Replacement

### EQUIVALENT CIRCUIT



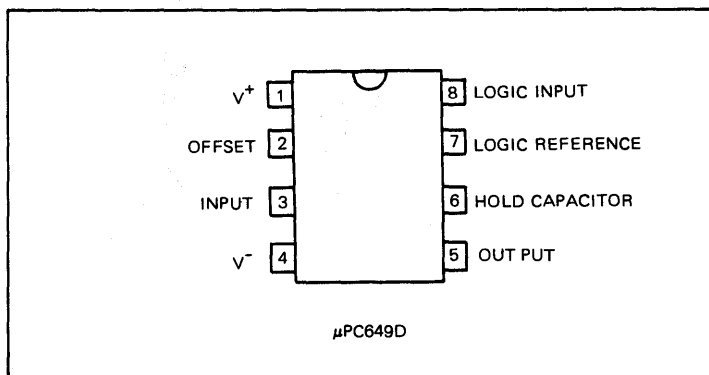
### ORDERING INFORMATION

μPC649D



8 pin Ceramic DIP  
(Dual In-Line Package)

### CONNECTION DIAGRAM (Top View)



**ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

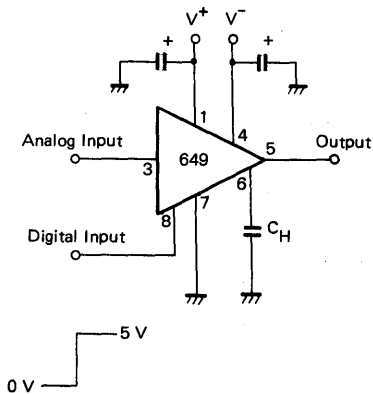
PARAMETER		μPC649	UNIT
Voltage between V <sup>+</sup> and V <sup>-</sup>		36	V
Input Voltage Range (Note 1)		±15	V
Logic to Logic Reference Differential Voltage		-30 to +7.0	V
Output Short Circuit Duration		Indefinite	S
Hold Capacitor Short Circuit Duration		10	S
Power Dissipation	D Package	500	mW
Operating Temperature Range	D Package	-20 to +80	°C
Storage Temperature Range	D Package	-55 to +150	°C

Note 1: For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

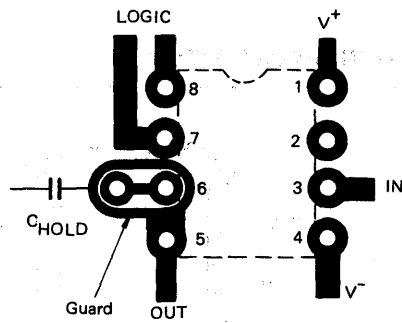
**RECOMMENDED OPERATING CONDITIONS (V<sup>±</sup> = ±15 V, Ta = 25°C)**

PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Power Supply Voltage		±5	±15	±16.5	V
Analog Input Voltage		-11.5		+11.5	V
Sample Mode Logic Input Voltage	V <sub>REF</sub> = 0	2.7		5.25	V
Hold Mode Logic Input Voltage	V <sub>REF</sub> = 0	-15		0.5	V
Logic Input Voltage Slew Rate		0.2			V/μs
Hold Capacitor		0.001		0.1	μF

**TYPICAL CONNECTION**



**GUARDING TECHNIQUE (Bottom View)**



**ELECTRICAL CHARACTERISTICS** $(V^{\pm} = \pm 15 \text{ V}, T_a = 25^{\circ}\text{C}, -11.5 \text{ V} \leq V_{IN} \leq +11.5 \text{ V}, C_H = 0.01 \mu\text{F}, R_L = 10 \text{ k}\Omega)$ 

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage			7.0	mV	
Input Bias Current			50	nA	
Input Impedance		$10^{10}$		$\Omega$	
Gain Error			0.01	%	
Feed through Attenuation Ratio	80			dB	$f = 1 \text{ kHz}$
Output Impedance			4.0	$\Omega$	
Hold Step Voltage			2.5	mV	$V_{out} = 0$
Leakage Current Into Hold Capacitor			200	pA	$V^{\pm} = \pm 5 \text{ V to } \pm 18 \text{ V}$
Acquisition Time		4		$\mu\text{s}$	$\Delta V_{out} = 10 \text{ V}, 0.1 \% \text{ Error}, C_H = 1,000 \text{ pF}$
		20		$\mu\text{s}$	$\Delta V_{out} = 10 \text{ V}, 0.1 \% \text{ Error}, C_H = 0.01 \mu\text{F}$
Hold Capacitor Charging Current		5		mA	$V_{IN} - V_{out} = 2 \text{ V}$
Logic Input Current			10	$\mu\text{A}$	
Logic Threshold	0.8		2.4	V	
Supply Voltage Rejection Ratio	80			dB	
Supply Current			6.5	mA	$V^{\pm} = \pm 15 \text{ V to } \pm 18 \text{ V}$





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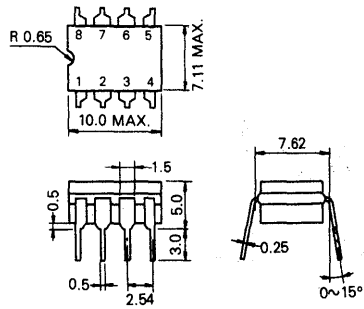
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# CASE OUTLINE DIMENSIONS

D Suffix



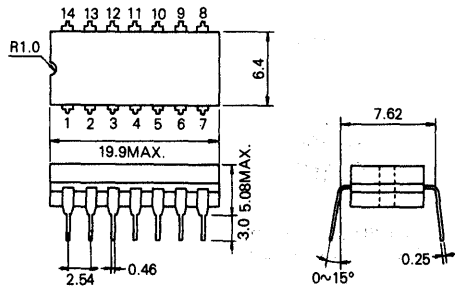
8 pin Ceramic DIP  
(Dual In-Line Package)



D Suffix



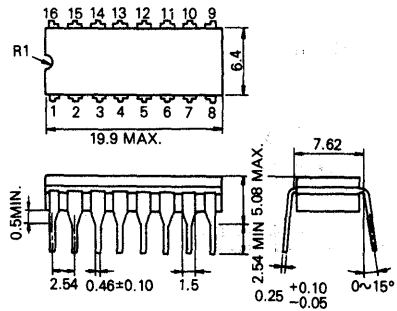
14 pin Ceramic DIP  
(Dual In-Line Package)



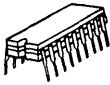
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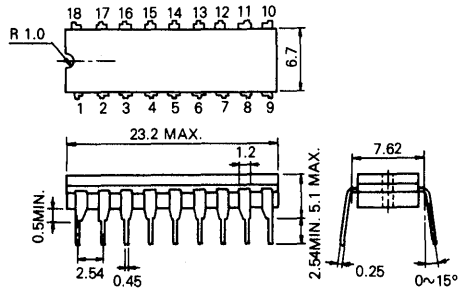
16 pin Ceramic DIP  
(Dual In-Line Package)



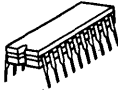
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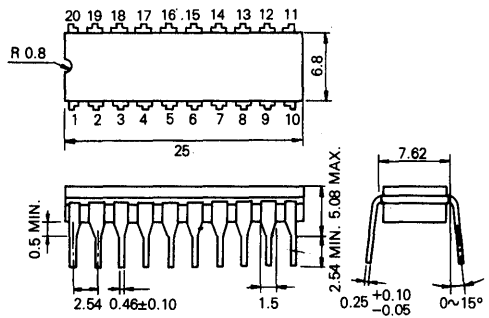
18 pin Ceramic DIP  
(Dual In-Line Package)



D Suffix



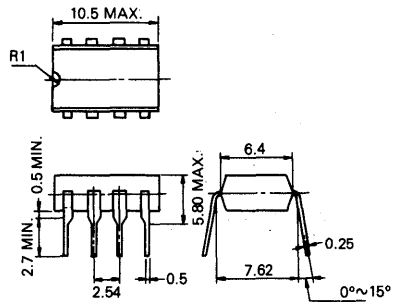
20 pin Ceramic DIP  
(Dual In-Line Package)



C Suffix



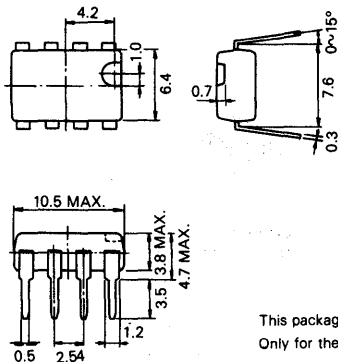
8 pin Plastic Molded DIP  
(Dual In-Line Package)



C Suffix



8 pin Plastic Molded DIP  
(Dual In-Line Package)

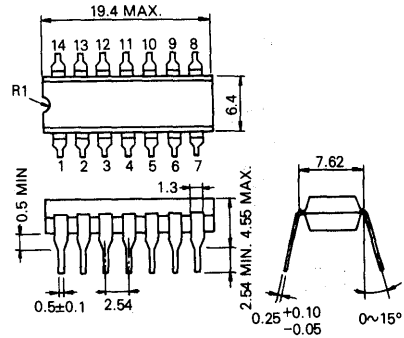


This package is used  
Only for the  $\mu$ PC3423C

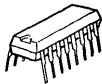
C Suffix



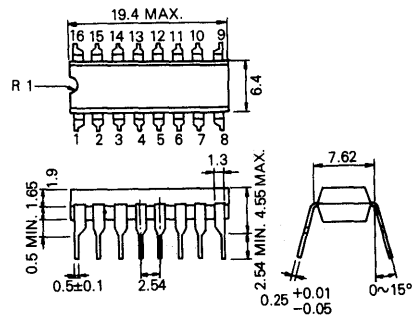
14 pin Plastic Molded DIP  
(Dual In-Line Package)



C Suffix



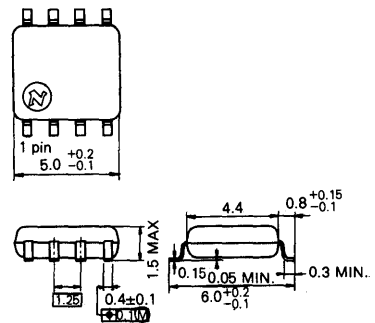
16 pin Plastic Molded DIP  
(Dual In-Line Package)



G Suffix



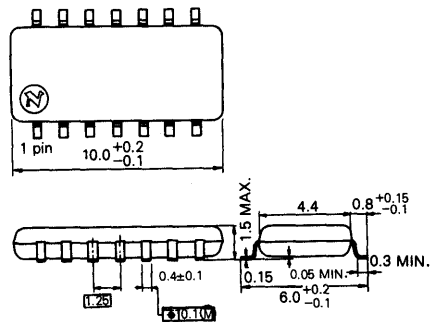
8 pin Plastic Molded Flat Package  
(MINI FLAT IC)



G Suffix



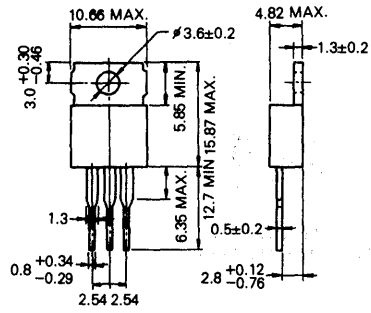
14 pin Plastic Molded Flat Package  
(MINI FLAT IC)



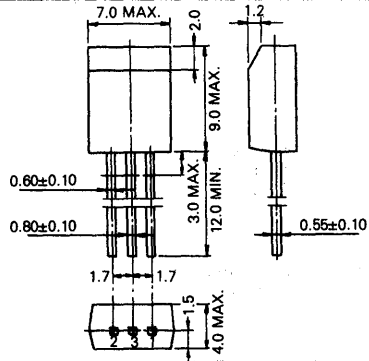
H Suffix



3 pin SIP  
(Single In-Line Package)



3 pin SIP  
(Single In-Line Package)



# THERMAL INFORMATION

The power dissipation capability of semiconductor devices is limited by the maximum allowable junction temperature, the ambient temperature, and the thermal resistance between the junction and the ambient environment.

The temperature difference between the junction and the ambient environment is determined by the following equation.

$$T_j - T_A = P_D \Theta_{JA}$$

where  $T_j$  = junction temperature, °C

$T_A$  = ambient temperature, °C

$P_D$  = power dissipation, W

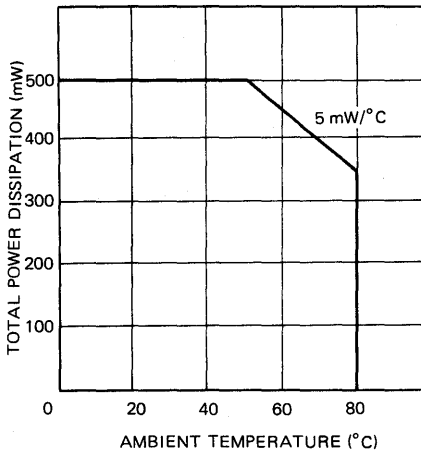
$\Theta_{JA}$  = thermal resistance, junction to ambient, °C/W

The maximum allowable junction temperature is 150°C, however, the maximum junction temperature of plastic package IC's should be 125°C because of the storage temperature range limitation.

The dissipation derating curves that follow assume the ambient environment is still air, and that no heat sink is used.

## 1. 8 Pin Metal Can Package and Cavity DIP

DISSIPATION DERATING CURVE

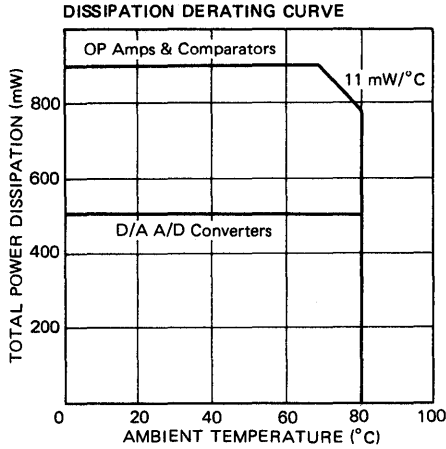


$$\Theta_{JA} = 200 \text{ } ^\circ\text{C/W typ. } T_j \text{ max} = 150 \text{ } ^\circ\text{C}$$

The maximum power dissipation value of 500 mW has been fixed considering the practical applications of op amps and comparators.



2. 14 Pin Through 20 Pin Cavity DIP

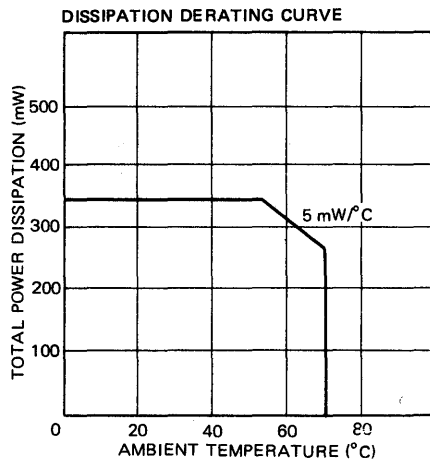


$\Theta_{JA} = 90 \text{ } ^\circ\text{C/W typ. } T_j \text{ max} = 150 \text{ } ^\circ\text{C}$

The maximum power dissipation value has been fixed considering the practical applications.

Op Amps & Comparators	900 mW
D/A A/D converters	500 mW

3. 8 Pin Plastic Molded DIP

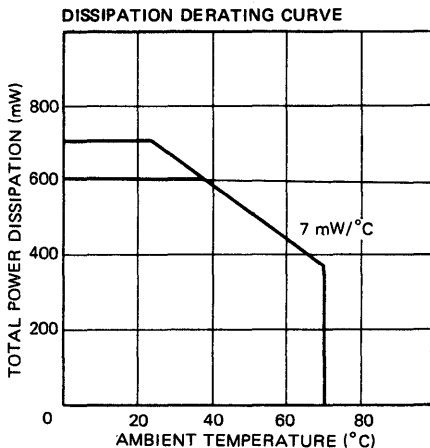


(except for  $\mu\text{PC4556C}$ ,  $\mu\text{PC4557C}$ ,  $\mu\text{PC259C/4560C}$ ,  $\mu\text{PC617C/1555C}$ )

$\Theta_{JA} = 200 \text{ } ^\circ\text{C/W typ. } T_j \text{ max} = 125 \text{ } ^\circ\text{C}$

The maximum power dissipation value of 350 mW has been fixed considering the practical applications of op amps and comparators.

4. 8 Pin Plastic Molded DIP



(For  $\mu\text{PC4556C}$ ,  $\mu\text{PC4557C}$ ,  $\mu\text{PC259C/4560C}$ ,  $\mu\text{PC617C/1555C}$ )

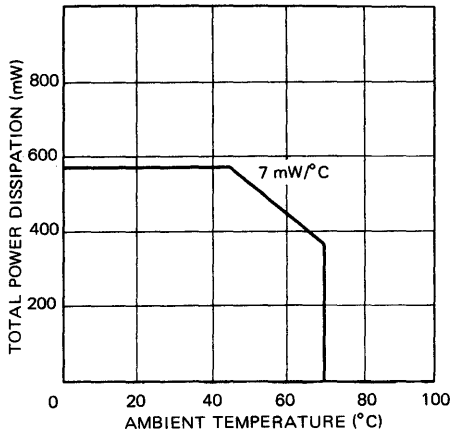
$\Theta_{JA} = 140 \text{ } ^\circ\text{C/W typ. } T_j \text{ max} = 125 \text{ } ^\circ\text{C}$

The maximum power dissipation value has been fixed considering the maximum junction temperature and the practical applications of those IC's.

$\mu\text{PC4556}$ , $\mu\text{PC4557}$ , $\mu\text{PC259C/4560C}$	700 mW
$\mu\text{PC617C/1555C}$	600 mW

5. 14 Pin Plastic Molded DIP

DISSIPATION DERATING CURVE



$\Theta_{JA} = 140\text{ }^{\circ}\text{C/W typ. } T_j \text{ max} = 125\text{ }^{\circ}\text{C}$

The maximum power dissipation value of 570 mW has been fixed considering the practical applications of op amps and comparators.

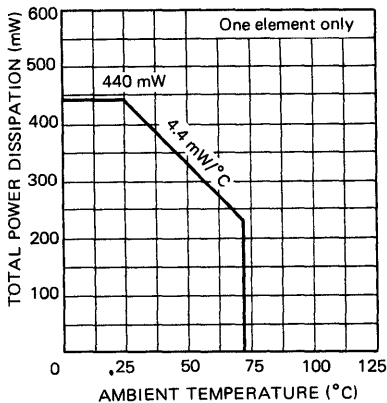
6. MINI FLAT Package

When the MINI FLAT IC's are mounted on a hybrid IC, the heat radiation through the leads is increased. When resin coated, the heat radiation through the resin to the environment is further increased. As a result, the thermal resistance in the mounted state is much smaller than in element form alone.

It is suggested that the heat dissipation in actually mounted condition is fully investigated.

6-A 8 Pin MINI FLAT Package

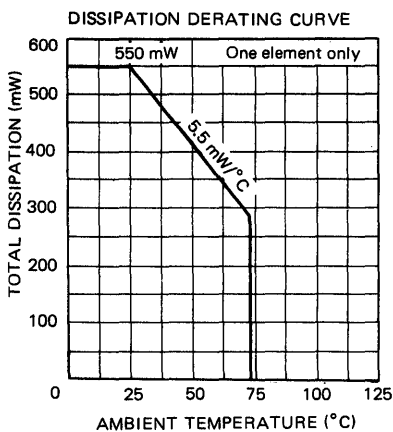
DISSIPATION DERATING CURVE



$\Theta_{JA} = 220\text{ }^{\circ}\text{C/W } T_j \text{ max} = 125\text{ }^{\circ}\text{C}$

The maximum power dissipation value of 440 mW has been fixed considering the maximum junction temperature and the practical applications of MINI FLAT IC's.

6-B 14 Pin MINI FLAT Package



$$\Theta_{JA} = 180^{\circ}\text{C/W } T_{j \text{ max}} = 125^{\circ}\text{C}$$

The maximum power dissipation value of 550 mW has been fixed considering the maximum junction temperature and the practical applications of MINI FLAT IC's.



# **NEC**

## **NEC Electronics U.S.A. Inc.**

### **Electron Division**

**252 Humboldt Court  
Sunnyvale, CA 94085  
TEL: 408-745-6520  
TWX: 910-339-9530**

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4699 North Federal Highway  
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TWX: 510-956-9722