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All About Minicomputers

Economic pressures are causing demands to do more computer work at reduced costs. Innovations in technology and manufacturing are resulting in minicomputers with steadily, increased capabilities and lower price tags. Meanwhile, increasing software consciousness on the part of both minicomputer makers and users is spurring software development along avenues undreamed of only a few years ago. These are some of the principal reasons why minicomputers continue to hold the interest of the EDP world today.

The low prices and impressive capabilities of the current minicomputers are naturally attracting the attention of the businessmen, scientists, educators, and government officials who have the responsibility for deciding what types of information processing equipment will be used in their operations.

But what, exactly, is a minicomputer? Where are they being used? What are the significant features and drawbacks of these machines? How do users rate their performance? How can you tell whether a minicomputer will fit into your own information processing plans? And, if so, which of the many available models represents the best overall choice for you?

This report is designed to answer these questions and bring you up to date on the rapidly advancing state of the art in minicomputers and microcomputers. The current offerings of 54 manufacturers are summarized in the accompanying comparison charts, and the experience of 213 minicomputer users is analyzed and tabulated.

PROFILE OF A MINICOMPUTER

There is some disagreement within the industry as to just what constitutes a minicomputer. Some insiders reserve the minicomputer designation for machines whose mainframes sell for less than \$20,000 (or some other arbitrary figure), and—in keeping with the current fashion terminology—use “midcomputer” for the machines that range from \$20,000 on up to about \$50,000 in purchase price.

Throughout this report, we'll simplify the picture by using the single term “minicomputers” for the whole class of stored-program digital computers which are suitable for general-purpose applications and are priced below \$50,000. Excluded from this survey are the general-purpose data processing systems which are described in detailed reports in the Computer section of DATAPRO 70, as well as the electronic accounting machines which are described in our companion report, *All About Small Accounting Computers* (70C-010-30).

Although the currently available minicomputers exhibit a wide variety of characteristics and capabilities, there

Compact, low-cost computers with surprisingly high speeds are proliferating as a result of continuing advances in semiconductor technology. As prices fall and capabilities increase, this new breed of computers is satisfying an ever-widening spectrum of applications. This report presents the characteristics of 167 current minicomputers and microcomputers from 54 manufacturers and summarizes the experience of 213 users with a total of 633 machines.

are enough similarities and common traits to make it possible to define a “typical minicomputer” whose characteristics are reasonably representative of most of the machines on the market today.

The typical minicomputer is a parallel, binary processor with a 16-bit word length (though 7-bit, 12-bit, 18-bit, 24-bit, and 32-bit word lengths are also common). It uses in- ➤



Digital Equipment Corporation's packaged "Standard 8" system consists of a PDP-8/E minicomputer with 8K 12-bit words of core memory, a moving-head disk drive, dual cassette drives, a DECwriter terminal, and software consisting of Digital's OS/8 system and diagnostics. The complete system is priced at \$18,000—approximately what the first PDP-8 minicomputer alone sold for when it was introduced in 1965.

All About Minicomputers

▷ Integrated circuits and is housed in a compact cabinet suitable for either tabletop use or mounting in a standard 19-inch rack. It weighs less than 50 pounds, consumes less than 500 watts of standard 115-volt electric power, and requires no special air conditioning. It offers from 4,096 to 32,768 words of magnetic core or semiconductor storage with a cycle time of 0.8 to 1.5 microseconds. Parity checking and storage protection are available as extra-cost options.

Today's typical minicomputer uses a one-address instruction format and has two accumulators, a single index register, and a multi-level indirect addressing facility. The add time for 16-bit operands is 1 to 3 microseconds. Hardware multiply/divide instructions are optional, as are power-failure protection and a real-time clock or timer. Floating-point arithmetic requires the use of software subroutines.

Input/output operations in the typical minicomputer are facilitated by an optional direct memory access (DMA) channel, which accommodates I/O data rates of up to about 1,000,000 words per second. The typical complement of standard peripheral equipment consists of a teletypewriter, disk storage unit, magnetic tape drive, card reader, paper tape reader and punch, line printer, and an assortment of interfaces for communication and control applications.

Software support for today's typical minicomputer is limited to a symbolic assembler, a Basic FORTRAN compiler, a simple batch-mode operating system or real-time monitor, and a modest assortment of utility routines. And the list purchase price of the basic system, including 4,096 words of main storage but no input/output devices, is likely to be well under the \$5,000 mark, with liberal discounts available to quantity purchasers. By all previous standards of value in the computer field, it's a truly impressive little package of computing power for the price.

THE MINICOMPUTER INDUSTRY

Estimates of the current worldwide market volume for U.S. minicomputer manufacturers range from about \$480 million to \$670 million a year. These figures include peripheral equipment and software; minicomputer mainframes alone are believed to account for about \$170 million. Precise figures are nearly impossible to obtain because of the widespread differences of opinion as to what constitutes a minicomputer.

By the end of 1973, more than 90,000 minicomputers were in use around the world, and about 84,000 of these were in the United States. International Data Corporation estimates that 33,360 "dedicated application computers"—mostly minis—were shipped worldwide during 1973, and looks for this figure to increase by 48 to 53 percent to a total of 49,300 to 51,150 units during 1974.

Minicomputers still represent only a small slice of the \$12 billion total U.S. market for computer-related products and services, but the minicomputer segment is expected to continue its rapid growth. The U.S. Department of Commerce projects a worldwide minicomputer market dollar volume of \$1.8 billion by 1977.

Digital Equipment Corporation, the company that started the minicomputer boom in the mid-sixties with its highly successful PDP-8 line, is still the undisputed king of the minicomputer field. DEC has delivered more than 34,000 computers to date and currently commands roughly a 37 percent share of the minicomputer market. Rounding out the "big five" among the minicomputer builders are Data General, Hewlett-Packard, Varian, and Computer Automation. Each of these companies has already delivered more than 4,000 minicomputers—and Data General managed the unprecedented feat of delivering its 6,000th computer less than four years after shipping its first computer, the Nova, in February 1969.

In the second echelon of minicomputer makers are aggressive, innovative young companies such as Digital Computer Controls, General Automation, Interdata, Microdata, and Modular Computer Systems. Minicomputers are also being built by divisions of large, well-established companies such as General Telephone and Electronics, Honeywell, Lockheed, Raytheon, Texas Instruments, and Westinghouse. And then there are dozens of comparatively small, unproven companies whose survival will depend upon their ability to back up their imaginative hardware ideas with effective marketing, production, software, and customer support.

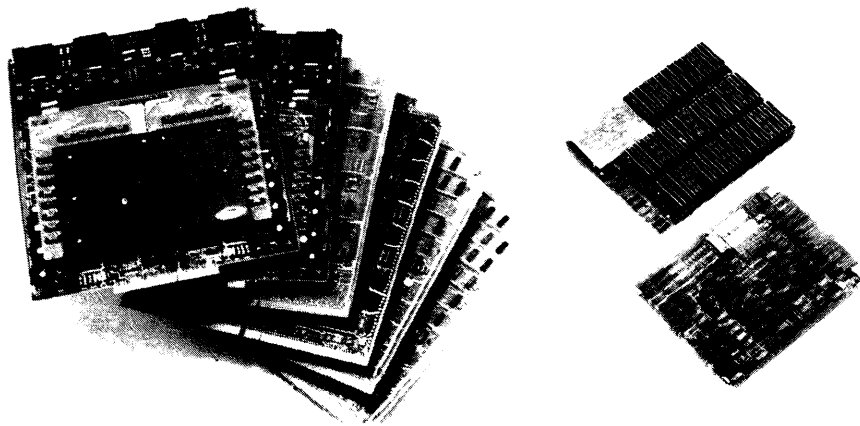
IBM—the undisputed leader in most other segments of the computer field—is still playing a comparatively minor role in the minicomputer market. The IBM System/7, announced in October 1970, is a fast 16-bit machine that features a semiconductor main memory. Although the System/7 has the hardware capabilities of typical general-purpose minicomputers, IBM is marketing it only for "sensor-based" applications in data acquisition, process control, and laboratory and plant automation. No peripheral equipment or software to support the System/7's use in general-purpose scientific or business applications has been made generally available to date.

In all, approximately 60 companies are now marketing minicomputers in the United States. The current offerings of 45 U.S. manufacturers and 9 foreign-based companies are summarized in the accompanying comparison charts.

Minicomputers builders are gradually realizing that the buyers for their wares generally fall into three basic categories:

- Original equipment manufacturers, who incorporate the minicomputers into their own products or sys- ▷

All About Minicomputers



General Automation's new LSI-16 computer, at bottom right, when combined with GA's new 32K semiconductor micromemory, offers, in two 7-3/4 by 11-inch printed circuit boards, all the power and performance previously found in the six large boards at left that make up GA's earlier SPC-16 minicomputer. This 8-to-1 area reduction is made possible by the use of SOS (silicon on sapphire) circuit technology in the LSI-16 processor chips and by GA's packaging design for the 32K micromemory.

▷ tems and are primarily interested in adequate performance at minimum cost.

- Knowledgeable end users, who demand the availability of peripheral equipment, software, and manufacturer support that will enable them to implement their own applications.
- Comparatively unsophisticated end users, who want complete systems programmed and installed on a "turnkey" basis.

Just a few years ago, nearly all minicomputer sales were to buyers in the first, or OEM, category. Now most of the minicomputer builders are placing increasing emphasis upon the end-user market, which is potentially far more lucrative—but also far more costly to enter and support.

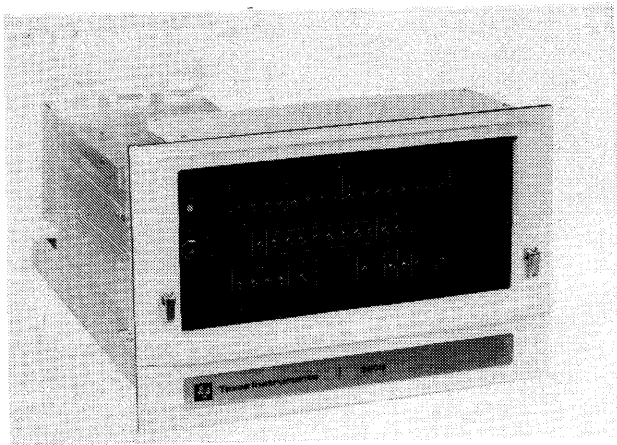
MINICOMPUTER TRENDS

Minicomputer prices continued to fall during the past year as a result of continuing technological improvements and aggressive competition. The use of semiconductor memories and MOS/LSI circuitry is spreading like wildfire among the larger minicomputer manufacturers. Texas Instruments, Microdata, Hewlett-Packard, Intel, Digital Equipment Corporation, Computer Automation, General Automation, Raytheon, and Interdata all introduced new models during the past year. Most of these additions to the minicomputer ranks are program- and hardware-compatible with earlier models, feature lower price tags, and deliver improved performance. What's more, the majority of these new minicomputers use semiconductor memories and/or are designed around microprocessors.

Having solidified their position as a cheaper alternative to the larger general-purpose computers for many types of applications, the minicomputers are in turn being threatened by a newer and still cheaper class of computers called "microcomputers" or "microprocessors." Intel Corporation pioneered the microcomputer concept in 1971 by introducing a line of standard LSI chips that can be combined to form computers which are extremely small in size and low in cost. The Intel MCS-4 Microcomputer is composed of only four kinds of chips. Three of these chips—a processor, shift register, and read/write memory—are standard designs, while the fourth—a read-only memory—is programmed to the user's specifications. Prices of the individual chips range from \$3 to \$30 each in lots of 100, and a complete microcomputer with 4K four-bit words of read/write memory lists for under \$1,200.

Intel remains the leader in microcomputers, but a number of other companies have gotten into the act—some with LSI microcomputer chips of their own, and others with specialized equipment that facilitates the development of microcomputer programs and applications. As the still-young microcomputer technology evolves, it is clear that the long-promised "computer on a chip" will soon become a practical reality. For the next few years, at least, it appears that the microcomputers will be slower than the commercially available minicomputers. Moreover, the present microcomputers are aimed almost exclusively at the large-quantity OEM market rather than at one-of-a-kind user applications. Therefore, instead of displacing large numbers of minicomputers, the microcomputers can be expected to open up vast new application areas where even the cheapest minicomputers have been economically unjustifiable. Thanks to the advent of the microcomputers, the day when there will be a computer in every car and every household may not be too far away. ▷

All About Minicomputers



Texas Instruments' 980B is a cost-effective, general-purpose minicomputer that features up to 65K words of MOS semiconductor memory in the mainframe, programmable memory protection, hardware memory address biasing, and hardware multiply and divide. It is well suited for real-time process control, scientific data processing, and communications systems.

➤ Another evident design trend is toward increasing use of microprogrammed logic, which can make it comparatively easy for the manufacturer, OEM, and/or end user to tailor a minicomputer's capabilities to fit his particular needs. Current systems that feature user-accessible microprogramming include the Hewlett-Packard 2100A and 2100S, Interdata Model 85, Microdata 3200, and Varian 73.

Semiconductor main memories are being used, as either standard or optional equipment, in most of the recently introduced minicomputers. Both the MOS and bipolar LSI memory technologies are in evidence, but the trend is clearly toward the cheaper MOS approach. Many minicomputer builders are still exhibiting an understandable reluctance to turn away from the traditional (and highly reliable) core memories. But it is now quite clear that the continuing demand for higher performance at lower cost will force most minicomputer makers to switch from core to semiconductor memories within the next few years. And the industry-wide trend toward the use of LSI technology for logic circuits is certain to continue for the same reason.

An example of current design trends is Microdata Corporation's MICRO-ONE, a fast, microprogrammable microprocessor priced at \$895 in quantities of 20. Oriented toward dedicated volume applications, the MICRO-ONE can emulate, through microprogramming, other general- or special-purpose computers. Interface hardware is available to provide plug-to-plug compatibility with other Microdata computers and most Microdata peripherals. The MICRO-ONE is an updated version of the earlier Microdata 800/1600 series computers. Its basic configuration includes 1,024 words of read-only memory (ROM) and 1,024 bytes of MOS memory, occupying

one 8-1/2-by-11-inch board. Advanced features and operating characteristics include bipolar circuitry, memory addressing to 65K bytes, compatibility with either MOS or core memory modules, 1.2-microsecond memory cycle time, and an 8-bit arithmetic/logic unit.

Running counter to the trend toward ever smaller and cheaper minicomputers is a concurrent trend toward a class of "super minicomputers" whose power and flexibility rival that of far more costly medium-scale computers. Examples are the Data General Nova 840, Datacraft Slash 4, DEC PDP-11/45, Interdata Models 80 and 85, Modcomp IV, and Varian 74. Most of these systems feature large main storage capacities, fast semiconductor memory, advanced memory management facilities, multiprogramming operating systems, and other "big computer" software facilities, at mainframe prices ranging from about \$15,000 upward.

Peripheral equipment designed specifically for use with minicomputers continues to proliferate. Nearly all of the major minicomputer builders are striving to expand their own product lines and reduce their dependence upon outside suppliers of disk storage and input/output devices. Moreover, literally hundreds of independent firms are now offering an incredible variety of disk drives, cassette tape units, printers, card readers, CRT displays, and many other products whose capabilities and prices are oriented toward the minicomputer buyer's needs and budget. Here again, the careful buyer can get more for his money than ever before.

The developers of proprietary software and systems are increasingly designing their wares around minicomputers. As a result, minicomputer-based systems are now available to handle a wide range of specialized applications in both the scientific and business fields. DEC, for example, currently offers computer-based systems to handle real-time data acquisition, message switching, line concentration, signal averaging, typesetting, chromatography, numerical control, pulse-height analysis, clinical laboratory analysis, graphic displays, vocational training, accounting for office-products distributors, etc. Other minicomputer builders and independent software firms offer other "packaged" systems designed to handle these applications and many more.

Among the most popular minicomputer-based systems are the in-house time-sharing systems. Hewlett-Packard has long been the leader in this area, but now DEC, Data General, and other suppliers are also offering economical systems designed to distribute the problem-solving capabilities of a minicomputer among a number of simultaneous users seated at individual teletypewriter or CRT terminals. Many companies are discovering that these in-house time-sharing systems can satisfy their computational needs at a substantially lower cost than the commercial time-sharing services. ➤

All About Minicomputers

▷ MINICOMPUTER APPLICATIONS

Most of the currently installed minicomputers are being used in industrial control and laboratory instrumentation. These are the areas where it all began. The minicomputer boom started when it became apparent that the impressive recent advances in semiconductor and magnetic technologies had made it possible to construct general-purpose computers at a lower cost than the single-purpose, hardwired controllers which were formerly used in these specialized applications. The added flexibility of stored-program computer control was a welcome bonus that helped to ensure the rapid acceptance of the minicomputers.

During the past five years, the capabilities of the minicomputers have been steadily increasing, while their costs have been decreasing in equally rapid fashion. The proliferation of these small, economical, and surprisingly fast computers has led to an ever-widening range of applications for them.

Among the largest current markets for minicomputers are industrial control, research, data communications, and education. Specific applications in which minicomputers are already being widely and successfully used include:

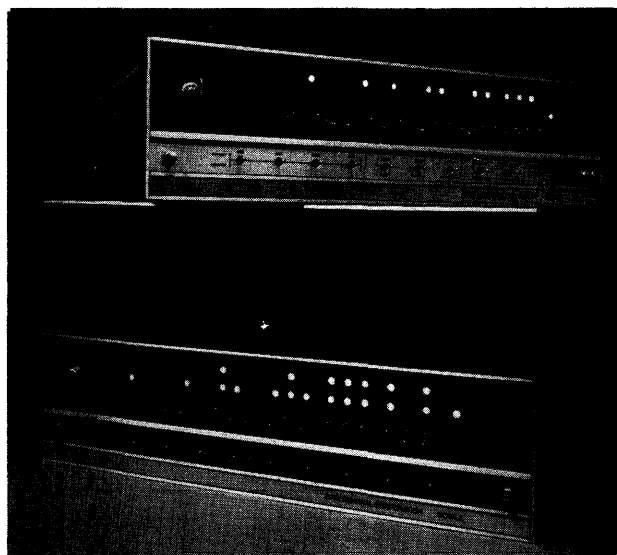
- Process control
- Numerical control of machine tools
- Direct control of machines and production lines
- Automated testing and inspection
- Telemetry
- Data acquisition and logging
- Control and analysis of laboratory experiments
- Analysis and interpretation of medical tests
- Traffic control
- Shipboard navigation control
- Message switching
- Communications controllers for larger computers
- Communications line concentrators
- Programmable communications terminals
- Peripheral controllers for larger computers
- Control of multistation key-to-tape/disk systems
- Display control

- Computer-aided design
- Typesetting and photocomposition
- Computer-assisted instruction
- Engineering and scientific computations
- Time-sharing computational services
- Business data processing

MINICOMPUTERS FOR THE BUSINESSMAN

Conventional business data processing applications, which represent by far the largest potential market for the minicomputers, have thus far proved to be an elusive target. Theoretically, the minicomputer's capabilities and economy should make it an ideal solution to the information processing needs of nearly every small business. In retail stores of all kinds, a minicomputer could handle the bookkeeping, inventory control, labeling, billing, payroll, and a variety of other useful functions—and it could do all this at roughly the cost of a single clerk. Yet minicomputers are really only beginning to make a significant impact in the business world.

The problem, of course, is software. Despite claims to the contrary, programming for the minicomputers is no easier than programming for the larger, general-purpose data processing systems. In fact, the minicomputers' short word lengths, limited storage capacities, and lack of sophisticated software aids tend to make the pro- ▷



Data General Corporation's Nova series continues to rank near the top in minicomputer sales. The current Nova 2 line includes the Nova 2/4 (top) and the Nova 2/10. The Nova 2/4 holds four standard Data General printed circuit boards, while the Nova 2/10 holds up to ten. Cycle time is either 800 or 1200 nanoseconds, depending on the memory used.

All About Minicomputers

▷ programmer's job even more difficult. As a result, it is common in minicomputer applications for programming costs to far exceed the cost of the hardware itself.

Even if small businessmen were willing to pay the price of the software required to solve their problems, they would find it hard to get from most of the current minicomputer builders. In general, the manufacturers have oriented their marketing efforts toward the comparatively sophisticated engineering and scientific markets, which are equipped to design the systems and write the programs required to accomplish their goals with a minimum of assistance from the manufacturer. In fact, the majority of minicomputers are still being sold in quantity, on an OEM (original equipment manufacturer) basis, to other companies which incorporate them into a wide variety of devices and systems for various end-user markets. It's no secret that mass production is the key to success for the minicomputer builders, and OEM sales represent the quickest route to maximum volume with a minimal investment in marketing, software development, and customer support. As a result, the businessman who is interested in buying a single minicomputer won't receive much encouragement or aid from many of the manufacturers.

But help for the poor businessman is definitely on the way, in the form of three significant recent trends.

First, a number of manufacturers have introduced minicomputer-based systems designed primarily for business data processing applications. Examples included in this report are the Basic Four, Cascade Data, Datapoint, and Qantel systems. You'll find the details on dozens of other business-oriented systems in Datapro's companion report, *All About Small Accounting Computers*.

Second, the larger minicomputer builders are directing an increasing proportion of their marketing efforts toward the end-user market. It has become clear that their potential for growth and profitability will be severely limited until they can supply the peripheral equipment, software, and service required to support individual user installations in the same manner as IBM and the other major computer makers. Therefore, DEC, Varian, Hewlett-Packard, Data General, and other manufacturers are strengthening their support staffs and developing peripheral devices and software facilities that equip their computers to serve in a variety of specific applications, including business-oriented ones.

Third, the availability of the minicomputers has led to the emergence of a new group of computer entrepreneurs: "middlemen" who use the minicomputers as the central components of integrated hardware/software systems designed to handle specific applications. Dozens of companies have entered this business within the past four years; most of them, unfortunately, are quite small, young, and unproven. They offer packaged systems to

handle a wide range of applications, such as general accounting, billing, order processing, inventory control, payroll, text editing, hospital data processing, credit authorization, stock brokerage accounting, and many more. These middlemen are accelerating the minicomputer boom by penetrating new markets and making it easier for unsophisticated users to get started in EDP.

These trends, together with the steadily decreasing prices of the minicomputers themselves, make it clear that the minicomputers will soon be making a much stronger impact in the business data processing world. At the same time, enough problems remain to be solved to make it safe to predict that the widely-discussed day when there will be a computer in every store is still quite a few years away.

USER EXPERIENCE

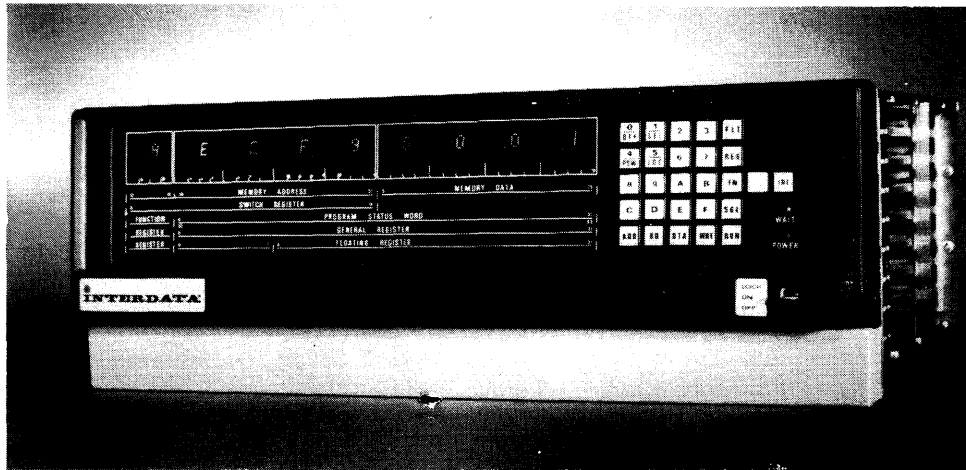
To determine the current level of user satisfaction with specific minicomputers, Datapro Research Corporation conducted an extensive user survey. A Minicomputer Reader Survey Form was included in the May 1974 supplements to DATAPRO 70 and DATAPRO REPORTS ON MINICOMPUTERS and mailed to all subscribers. By July 1, usable responses had been received from 213 users with a total of 633 installed minicomputers.

The number of minicomputers installed in each respondent's organization ranged from 1 to 50. Although the average number of machines per organization was 2.97, 26% of the organizations that responded had only one minicomputer.

Users were asked to rate the overall performance, ease of programming, ease of operation, hardware reliability, maintenance service, technical support, and manufacturer's software for each minicomputer by assigning a rating of Excellent, Good, Fair, or Poor. The ratings for 40 popular minicomputers from 19 manufacturers are summarized in the accompanying "User Ratings" tables. Prospective buyers should note that the small sample sizes for some of these models make it unwise to draw firm conclusions from the indicated ratings. A minicomputer user's degree of satisfaction may depend heavily upon his specific application, the overall system in which the minicomputer is incorporated, and the support and service provided by his local branch office. Also, many minicomputer users get their software, technical support, and/or maintenance service from sources other than the manufacturers.

The ratings assigned by all of the responding users can be combined to form the following overall picture of user satisfaction (or dissatisfaction) with the current minicomputers: ▷

All About Minicomputers



The Interdata 7/16 is a general-purpose 16-bit minicomputer that lists for just \$3,200. This base price includes the processor, 4K words of core memory, 16 general registers, 104 instructions, hardware interrupt for up to 255 devices, 4 DMA (direct memory access) channels, and power supply.

	Excellent	Good	Fair	Poor	No Response
Overall performance	42%	50%	3%	1%	4%
Ease of programming	26%	43%	21%	4%	6%
Ease of operation	37%	51%	8%	1%	3%
Hardware reliability	38%	43%	13%	2%	4%
Maintenance service	23%	38%	25%	5%	9%
Technical support	13%	26%	35%	15%	11%
Operating systems	26%	30%	22%	8%	14%
Compilers and assemblers	19%	39%	23%	3%	16%
Applications programs	13%	23%	14%	9%	41%

Thus, it is clear that minicomputer users are generally well pleased with the reliability and effectiveness of their hardware and reasonably well satisfied with the quality of the maintenance service they are receiving. But it is equally clear that many users are far less pleased with the associated technical support and software. There appears to be more than a grain of truth in the provocative advertising claim that "most minicomputers aren't delivered, they're abandoned."

The minicomputer users were asked to specify the memory sizes of their systems. The results are tabulated below in terms of ranges of memory size.

Range	No. of Times Specified
1K to 8K	82
12K to 24K	97
32K to 64K	52
Over 64K	7

The users were also asked who wrote the programs for their applications, with the following results:

In-house personnel:	80%
Manufacturer's personnel:	13%
Used "ready made" programs:	15%
Other:	11%

The figures add up to more than 100% because a number of respondents called upon two or more sources for their applications programs.

The users reported that their minicomputers are being used in a predictably broad spectrum of applications, which can be categorized as follows:

	No. of Users	% of Total
Data communications (comprising remote job entry, message switching, front-end processing, etc.)	56	26
Industrial data acquisition and control	41	19
Business data processing	38	18
Data entry	35	16
Scientific calculations	16	8
Automated testing	14	7
Education	10	5
Time-sharing	10	5
Laboratory automation	9	4
Graphics	7	3
Miscellaneous	8	4

Here again, the figures total more than 100% because some of the respondents are using their minis in multiple applications.

The users were asked whether the minicomputers they acquire are for their own use or for resale. The following results were obtained:

	No. of Respondents	% of Total
Own use	174	82
Resale	18	8
Both of the above	16	8
No response	5	2

In reply to the question, "During the next 12 months we expect to acquire these additional minicomputers:", 105 respondents (49 percent of all the respondents) indicated they would be purchasing additional minicom- ➤

All About Minicomputers

USER RATINGS OF MINICOMPUTERS

Manufacturer and Model	No. of User Replies	No. of Computers Represented	Users' Ratings*																			
			Overall Performance					Ease of Programming					Ease of Operation					Hardware Reliability				
			WA	E	G	F	P	WA	E	G	F	P	WA	E	G	F	P	WA	E	G	F	P
Burroughs B 1700	2	7	2.5	1	0	0	1	3.5	1	1	0	0	3.5	1	1	0	0	2.0	0	1	0	1
Computer Automation:																						
Alpha-16	2	2	3.5	1	1	0	0	3.5	1	1	0	0	3.5	1	1	0	0	4.0	2	0	0	0
LSI-16	2	51	3.5	1	1	0	0	3.0	0	2	0	0	3.0	0	2	0	0	3.5	1	1	0	0
Comp. Auto. Totals	4	53	3.5	2	2	0	0	3.3	1	3	0	0	3.3	1	3	0	0	3.8	3	1	0	0
Control Data (all models)	2	3	3.0	0	2	0	0	2.5	0	1	1	0	2.5	0	1	1	0	2.5	0	1	1	0
Data General:																						
Nova	2	19	3.0	1	0	1	0	2.0	0	0	1	0	2.5	0	1	1	0	3.0	0	2	0	0
Nova 2/10	1	1	3.0	0	1	0	0	2.0	0	0	1	0	3.0	0	1	0	0	3.0	0	1	0	0
Nova 800	6	26	3.6	3	2	0	0	2.8	0	5	1	0	3.2	2	3	1	0	3.6	4	0	1	0
Nova 1200	12	42	3.5	6	4	1	0	2.6	1	5	3	1	3.1	4	4	3	0	3.2	4	5	2	0
Data General Totals	21	88	3.4	10	7	2	0	2.6	1	10	6	1	3.1	6	9	5	0	3.3	8	8	3	0
Datapoint 2200	8	17	3.6	5	3	0	0	3.5	4	4	0	0	3.9	7	1	0	0	3.6	5	3	0	0
Digital Equipment:																						
PDP-8	27	80	3.4	11	14	1	0	2.5	6	4	9	5	3.3	12	13	2	0	3.4	11	15	1	0
PDP-11	38	115	3.4	15	20	2	0	3.2	11	21	4	0	3.4	17	19	2	0	3.1	12	19	6	1
PDP-12	1	2	3.0	0	1	0	0	4.0	1	0	0	0	4.0	1	0	0	0	2.0	0	0	1	0
DEC Totals	66	197	3.4	26	35	3	0	2.9	18	25	13	5	3.4	30	32	4	0	3.2	23	34	8	1
Four-Phase:																						
IV/40	1	1	3.0	0	1	0	0	3.0	0	1	0	0	2.0	0	0	1	0	2.0	0	0	1	0
IV/70	7	26	3.0	2	4	0	1	2.5	1	1	1	1	3.2	2	3	1	0	2.9	2	3	1	1
Four-Phase Totals	8	27	3.0	2	5	0	1	2.6	1	2	1	1	3.0	2	3	2	0	2.8	2	3	2	1
General Automation (all models)	3	8	3.0	0	3	0	0	3.7	2	1	0	0	3.3	1	2	0	0	2.7	0	2	1	0
Hewlett-Packard:																						
2000 Series	3	3	3.0	0	3	0	0	3.0	1	1	1	0	3.3	1	2	0	0	2.7	0	2	1	0
2100 Series	10	37	3.6	6	4	0	0	2.7	2	3	5	0	3.0	1	8	1	0	3.5	6	3	1	0
3000 Series	3	3	3.3	1	2	0	0	4.0	3	0	0	0	3.3	1	2	0	0	4.0	3	0	0	0
HP Totals	16	43	3.4	7	9	0	0	3.0	6	4	6	0	3.1	3	12	1	0	3.4	9	5	2	0
Honeywell 316	6	37	3.5	3	3	0	0	2.8	1	3	2	0	3.2	1	5	0	0	3.6	3	2	0	0
Honeywell 516	1	2	3.0	0	1	0	0	2.0	0	0	1	0	2.0	0	1	0	0	4.0	1	0	0	0
Honeywell 716	2	2	3.0	0	2	0	0	2.0	0	0	2	0	3.0	1	0	1	0	3.0	1	0	1	0
Honeywell Totals	9	41	3.3	3	6	0	0	2.6	1	3	5	0	3.0	2	5	2	0	3.5	5	2	1	0
IBM System/3	11	13	3.7	8	3	0	0	3.5	5	6	0	0	3.8	9	2	0	0	3.6	7	4	0	0
IBM System/7	7	10	3.3	3	3	1	0	2.6	1	4	2	0	3.5	3	3	0	0	3.3	3	3	1	0
IBM 360/20	2	2	3.0	0	2	0	0	3.0	0	2	0	0	3.0	0	2	0	0	3.0	0	2	0	0
IBM 1130	3	3	3.0	1	1	1	0	3.3	1	2	0	0	3.3	1	2	0	0	3.7	2	1	0	0
IBM 1800	2	2	3.5	1	1	0	0	2.5	0	1	1	0	3.0	0	2	0	0	3.5	1	1	0	0
IBM Totals	25	30	3.4	13	10	2	0	3.2	7	15	3	0	3.5	13	11	0	0	3.5	13	11	1	0
Interdata 4	1	1	4.0	1	0	0	0	4.0	1	0	0	0	3.0	0	1	0	0	3.0	0	1	0	0
Interdata 50	2	5	3.5	1	1	0	0	3.5	1	1	0	0	3.0	0	2	0	0	3.0	1	0	1	0
Interdata 70	6	12	3.0	0	4	0	0	3.0	1	3	1	0	3.0	1	2	1	0	3.0	1	2	1	0
Interdata Totals	9	18	3.3	2	5	0	0	3.3	3	4	1	0	3.0	1	5	1	0	3.0	2	3	2	0
Modular Computer Sys.																						
Modcomp II	2	5	4.0	2	0	0	0	3.5	1	1	0	0	3.5	1	1	0	0	4.0	2	0	0	0
Modcomp III	2	6	4.0	2	0	0	0	3.5	1	1	0	0	3.5	1	1	0	0	3.5	1	1	0	0
Modcomp Totals	4	11	4.0	4	0	0	0	3.5	2	2	0	0	3.5	2	2	0	0	3.8	3	1	0	0
NCR 100	1	1	3.0	0	1	0	0	3.0	0	1	0	0	3.0	0	1	0	0	1.0	0	0	0	1
NCR 399	1	1	3.0	0	1	0	0	3.0	0	1	0	0	3.0	0	1	0	0	3.0	0	1	0	0
NCR 725	2	15	4.0	2	0	0	0	4.0	1	0	0	0	4.0	2	0	0	0	4.0	2	0	0	0
NCR Totals	4	17	3.5	2	2	0	0	3.3	1	2	0	0	3.5	2	2	0	0	3.0	2	1	0	1
Qantel (all models)	4	9	3.3	1	3	0	0	3.5	2	2	0	0	3.8	3	1	0	0	2.3	0	2	1	1
Raytheon (all models)	2	2	3.0	0	2	0	0	2.0	0	1	0	1	3.0	0	2	0	0	3.0	0	2	0	0
Singer System Ten	2	2	3.5	1	1	0	0	2.0	0	0	2	0	3.5	1	1	0	0	2.5	0	1	1	0
Texas Instruments 980A	3	6	4.0	2	0	0	0	3.0	0	2	0	0	3.0	0	2	0	0	3.5	1	1	0	0
Varian V73	2	2	3.5	1	1	0	0	3.0	1	0	1	0	3.0	0	2	0	0	3.5	1	1	0	0
Varian 620 Series	7	25	3.3	2	5	0	0	2.4	0	3	4	0	3.0	2	3	2	0	2.6	1	2	4	0
Varian Totals	9	27	3.3	3	6	0	0	2.6	1	3	5	0	3.0	2	5	2	0	2.8	2	3	4	0
All others**	12	25	3.4	6	5	1	0	3.3	4	7	1	0	3.3	3	9	0	0	3.4	4	6	0	0
Totals	213	633	3.4	90	106	8	2	3.0	55	92	44	8	3.3	80	109	18	3	3.2	82	91	27	5

* Ratings are expressed in terms of number of user responses. The legend is E for excellent, G for good, F for fair, P for poor, and WA for Weighted Average, calculated on a scale ranging from 4.0 for excellent to 1.0 for poor.

All About Minicomputers

USER RATINGS OF MINICOMPUTERS (Continued)

Manufacturer and Model	Users' Ratings*																								
	Maintenance Service					Technical Support					Operating Systems					Compilers and Assemblers					Applications Programs				
	WA	E	G	F	P	WA	E	G	F	P	WA	E	G	F	P	WA	E	G	F	P	WA	E	G	F	P
Burroughs B 1700	1.5	0	0	1	1	1.5	0	0	1	1	4.0	2	0	0	0	4.0	2	0	0	0	4.0	1	0	0	0
Computer Automation:																									
Alpha-16	3.5	1	1	0	0	3.5	1	1	0	0	4.0	1	0	0	0	3.0	0	1	0	0	—	0	0	0	0
LSI-2	2.5	0	1	1	0	2.0	0	0	1	0	2.0	0	1	0	1	2.5	0	1	1	0	1.0	0	0	0	1
Comp. Auto. Totals	3.0	1	2	1	0	3.0	1	1	1	0	2.7	1	1	0	1	2.7	0	2	1	0	1.0	0	0	0	1
Control Data (all models)	4.0	1	0	0	0	1.0	0	0	0	1	1.5	0	0	1	1	1.5	0	0	1	1	3.0	0	1	0	0
Data General:																									
Nova	2.0	0	0	2	0	2.0	0	0	1	0	2.5	0	1	1	0	2.5	0	1	1	0	2.5	0	1	1	0
Nova 2/10	2.0	0	0	1	0	2.0	0	0	1	0	3.0	0	1	0	0	4.0	1	0	0	0	1.0	0	0	0	1
Nova 800	2.2	0	2	2	1	2.4	0	2	3	0	3.5	3	0	1	0	3.2	2	2	1	0	3.0	0	2	0	0
Nova 1200	2.7	0	8	3	0	2.4	0	7	1	3	2.7	2	2	5	0	2.7	1	4	4	0	2.2	1	2	0	3
Data General Totals	2.5	0	10	8	1	2.3	0	9	6	3	2.9	5	4	7	0	2.9	4	7	6	0	2.3	1	5	1	4
Datapoint 2200	3.1	3	3	2	0	2.8	1	4	3	0	3.9	7	1	0	0	3.6	6	1	1	0	3.3	3	0	0	1
Digital Equipment:																									
PDP-8	3.1	10	7	6	1	2.6	6	6	5	5	2.7	4	9	2	4	2.8	4	9	5	1	2.4	5	2	5	5
PDP-11	2.8	5	23	7	2	2.4	5	10	14	6	2.9	9	13	9	2	3.0	7	18	6	0	2.7	5	8	4	4
PDP-12	1.0	0	0	0	1	1.0	0	0	0	1	2.0	0	0	1	0	2.0	0	0	1	0	1.0	0	0	0	1
DEC Totals	2.9	15	30	13	4	2.4	11	16	19	12	2.8	13	22	12	6	2.9	11	27	12	1	2.5	10	10	9	10
Four Phase:																									
IV/40	2.0	0	0	1	0	3.0	0	1	0	0	3.0	0	1	0	0	—	0	0	0	0	3.0	0	1	0	0
IV/70	2.3	0	2	5	0	2.0	0	1	5	1	3.4	1	3	0	1	2.4	0	3	1	1	3.3	3	2	1	0
Four Phase Totals	2.3	0	2	6	0	2.1	0	2	5	1	2.8	1	4	0	1	2.4	0	3	1	1	3.3	3	3	1	0
General Automation (all models)	2.3	0	1	2	0	3.0	1	1	1	0	2.3	0	1	2	0	2.3	0	1	2	0	2.3	0	2	0	1
Hewlett-Packard:																									
2000 Series	2.3	0	1	2	0	1.5	0	0	1	1	2.7	0	2	1	0	2.0	0	1	1	1	3.0	1	1	1	0
2100 Series	2.8	1	1	2	0	2.4	1	3	5	1	2.4	2	2	4	2	2.8	1	6	3	0	3.0	1	5	1	0
3000 Series	4.0	3	0	0	0	3.7	2	1	0	0	4.0	3	0	0	0	4.0	3	0	0	0	3.0	0	1	0	0
HP Totals	3.0	4	2	4	0	2.5	3	4	6	2	2.8	5	4	5	2	2.8	4	7	4	1	3.0	2	7	2	0
Honeywell 316	2.7	1	2	3	0	2.0	0	0	4	0	2.8	2	1	1	1	2.5	0	3	3	0	3.0	0	2	0	0
Honeywell 516	3.0	0	1	0	0	2.0	0	0	1	0	2.0	0	0	1	0	2.0	0	0	1	0	—	0	0	0	0
Honeywell 716	2.5	0	1	1	0	3.0	1	0	1	0	2.0	0	0	2	0	2.0	0	0	1	0	2.0	0	0	1	0
Honeywell Totals	2.7	1	4	4	0	2.3	1	0	6	0	2.5	2	1	4	1	2.4	0	3	5	0	2.7	0	2	1	0
IBM System/3	3.2	4	5	2	0	2.7	3	3	4	1	3.5	6	4	1	0	3.0	2	6	2	0	3.1	3	3	0	1
IBM System/7	3.0	3	2	1	1	2.6	1	3	2	1	3.5	3	3	0	0	3.0	1	5	1	0	3.0	2	1	2	0
IBM 360/20	3.0	0	2	0	0	—	0	0	0	0	4.0	2	0	0	0	4.0	2	0	0	0	—	0	0	0	0
IBM 1130	3.7	2	1	0	0	3.0	0	3	0	0	3.0	0	3	0	0	3.3	1	2	0	0	2.5	0	1	1	0
IBM 1800	3.5	1	1	0	0	3.0	0	2	0	0	2.5	0	1	1	0	2.5	0	1	1	0	3.0	1	0	1	0
IBM Totals	3.2	10	11	3	1	2.7	4	11	6	2	3.4	11	11	2	0	3.1	6	14	4	0	3.0	6	5	4	1
Interdata 4	—	0	0	0	0	—	0	0	0	0	—	0	0	0	0	—	0	0	0	0	—	0	0	0	0
Interdata 50	2.5	1	0	0	1	3.0	1	0	1	0	1.0	0	0	0	1	3.5	1	1	0	0	—	0	0	0	0
Interdata 70	2.8	1	1	2	0	1.8	0	1	1	2	2.6	1	1	3	0	2.8	1	2	2	0	2.5	0	1	1	0
Interdata Totals	2.7	2	1	2	1	2.2	1	1	2	2	2.3	1	1	3	1	3.0	2	3	2	0	2.5	0	1	1	0
Modular Computer Sys.																									
Modcomp II	3.0	0	2	0	0	2.5	0	1	1	0	3.5	1	1	0	0	3.5	1	1	0	0	2.0	0	0	1	0
Modcomp III	3.0	0	2	0	0	2.5	0	1	1	0	3.5	1	1	0	0	3.5	1	1	0	0	2.0	0	0	1	0
Modcomp Totals	3.0	0	4	0	0	2.5	0	2	2	0	3.5	2	2	0	0	3.5	2	2	0	0	2.0	0	0	2	0
NCR 100	2.0	0	0	1	0	2.0	0	0	1	0	3.0	0	1	0	0	3.0	0	1	0	0	1.0	0	0	0	1
NCR 399	3.0	0	1	0	0	2.0	0	0	1	0	3.0	0	1	0	0	—	0	0	0	0	—	0	0	0	0
NCR 725	4.0	2	0	0	0	3.0	1	0	1	0	4.0	2	0	0	0	3.5	1	1	0	0	4.0	2	0	0	0
NCR Totals	3.3	2	1	1	0	2.5	1	0	3	0	3.5	2	2	0	0	3.3	1	2	0	0	3.0	2	0	0	1
Qantel (all models)	3.0	0	4	0	0	1.5	0	1	0	3	1.7	0	1	0	2	2.8	0	3	1	0	2.3	0	1	3	0
Raytheon (all models)	2.5	0	1	1	0	2.0	0	1	0	1	3.0	0	1	0	0	3.0	0	1	0	0	3.0	0	1	0	0
Singer System Ten	1.0	0	0	0	2	1.0	0	0	0	2	2.0	0	0	2	0	2.0	0	0	2	0	2.5	0	1	1	0
Texas Instruments 980A	3.5	1	1	0	0	2.5	0	1	1	0	2.0	0	0	2	0	2.5	0	1	1	0	2.0	0	0	2	0
Varian V73	2.5	0	1	1	0	2.0	0	0	2	0	2.5	0	1	1	0	2.5	0	1	1	0	2.0	0	1	0	1
Varian 620 Series	3.0	3	1	3	0	1.8	0	0	5	1	2.2	0	1	5	0	1.8	0	0	4	1	2.9	0	6	1	0
Varian Totals	2.9	3	2	4	0	1.9	0	0	7	1	2.3	0	2	6	0	2.0	0	1	5	1	2.7	0	7	1	1
All others**	3.2	5	2	1	1	2.9	4	1	5	0	3.1	3	5	0	1	2.9	2	5	1	1	2.8	0	3	1	0
Totals	2.9	48	81	53	11	2.4	28	55	74	31	2.9	55	63	46	16	2.9	40	83	49	6	2.7	28	49	29	20

**"All others" category consists of the following minicomputers which received only one user mention each: Applied Computing Technology CBC-4, Basic Four Model 400, Comten Model 3670, Digital Scientific Corporation Meta-4, Electronic Processors EPI-118, GRI Computer System 99, Harris CSI Cope 1200, Lockheed System III, Microdata 1600/30, Mohawk 2400, Sycor 340, and Xerox Data Systems CE-16.

All About Minicomputers

puters. The form included space for indicating the manufacturer and model of equipment to be purchased. The following results were obtained from this data.

<u>Purchasers' Intentions</u>	<u>% of Respondents</u>
Buy from manufacturer of current equipment	65
Buy from a different manufacturer	22
Buy some systems from manufacturers of current equipment and other systems from different manufacturers	11
Have not decided on a manufacturer	2

MINICOMPUTER CHARACTERISTICS

The key functional characteristics of 167 commercially available minicomputers from 54 manufacturers are presented in the accompanying comparison charts. Nearly all of the information in the charts was supplied and/or verified by the 54 manufacturers during June and July of 1974; their close cooperation with the Datapro Research staff in the preparation of these charts is greatly appreciated.

The chart entries and their significance to potential minicomputer users are explained in the following paragraphs, together with some useful guidelines for selecting the most suitable minicomputer for your application.

Data Formats

Probably the single most important distinguishing characteristic of a minicomputer is its *word length*; i.e., the number of bits (binary digits) that can be stored in or retrieved from main storage during a single cycle. In general, the longer the word length, the greater the efficiency and accuracy of a computer's internal operations—and the higher its price tag. Most of the minicomputers currently on the market have a 16-bit word length; this size neatly accommodates two 8-bit characters and has been shown to yield an attractive balance between economy and performance for many applications. Other widely used models have word lengths of 8, 12, 18, 24, or 32 bits. The 8-bit minicomputers are suitable for many functions where low cost is more important than high precision or sophisticated instruction repertoires—and they can be particularly effective when extensive manipulation of 8-bit bytes must be performed.

For most minicomputers, the *fixed-point operand length* is the same as the word length. Some machines, however, have "extended precision" facilities which enable them to handle arithmetic operands two or more words in length. For many applications, extended precision arithmetic is a valuable feature that helps to overcome the limitations upon number range and accuracy which are otherwise imposed by the short word lengths used in most minicomputers. Some of the 8-bit minicomputers

are really byte-oriented machines, designed for efficient processing of variable-length operands composed of one or more 8-bit bytes.

Instruction length is one word in most computers, but some are capable of using instructions which are two or more words in length. In most two-word instruction formats, the first word defines the operation to be performed and the second word contains the address of the required operand. The use of two-word instructions greatly increases the number of storage locations that can be directly addressed. This in turn simplifies programming—but the simplification is usually gained at the expense of two words of storage space to hold each instruction and two memory cycles for each instruction retrieved for processing.

Main Storage

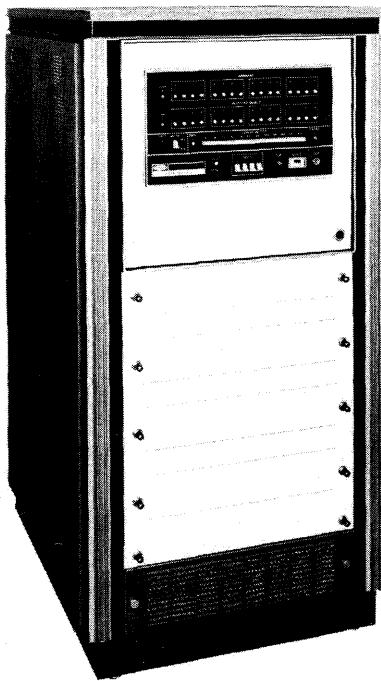
The *storage type* used in most of the current minicomputers remains magnetic cores. Though semiconductor memories began to appear in commercially available minicomputers late in 1970, many minicomputer makers are still using core storage because of its demonstrated ability to satisfy all reasonable requirements for performance, reliability, and economy. It is clear, however, that the demand for higher performance at lower cost, together with continuing improvements in semiconductor technology, is accelerating the trend toward the use of semiconductor memories.

In addition to, or in place of, their standard, alterable main storage units, some minicomputers use read-only memories for one of two functions: to provide fast-access, indestructible storage for vital programs, or to hold the microprograms which define the instruction repertoires of some machines.

The *cycle time* for a storage device is the minimum time interval that must elapse between the starts of two successive accesses to any one storage location. Main storage cycle times for the minicomputers shown in our charts span the range from approximately 0.2 to 3 microseconds. Though cycle time ranks with word length as one of the most significant individual indicators of a computer's performance potential, it is definitely *not* safe to assume that the computer with the fastest cycle time will be the best overall performer in a particular application. Other parameters that have an important effect on a minicomputer's performance include the flexibility and power of its instruction repertoire, the number of storage cycles it requires to execute each instruction, its input/output capabilities, etc.

Our comparison charts show the amount of main storage available for each computer in terms of the *minimum capacity* and *maximum capacity*, expressed in words. In the great majority of cases, storage is available in all the

All About Minicomputers



The RDS-500 "Supermini" from Raytheon Data Systems features a "Superbus" I/O system that permits simultaneous access to memory by multiple system components. This general-purpose 16-bit minicomputer boasts a 100-nanosecond CPU clock time and optional floating-point arithmetic.

➤ usual binary increments of capacity. Thus, if a computer has minimum and maximum storage capacities of 4,096 and 32,768 words, respectively, it's safe to assume that capacities of 8,192 and 16,384 words are also available.

The indicated price differentials between similar computers equipped with 4K and 8K words of storage make it clear that main storage is one of the costliest elements of the current minicomputers. Therefore, it's important to choose the right storage capacity; for non-multiprogramming systems, that usually means enough storage to hold your largest program and all associated subroutines and data, but not too much more than that. It's also wise to make sure that your computer's main storage capacity can be expanded if necessary, preferably by simply plugging in an additional storage module.

Parity checking is a standard feature of some minicomputers and an extra-cost option for others. In still other cases, the manufacturers maintain—with some justification—that the reliability of modern magnetic core and semiconductor memories is so high that parity checking is an unnecessary luxury unless absolute accuracy is a must. Parity checking requires the addition of one more bit to each main storage location. This added bit is set to the appropriate value (0 or 1) whenever a word is written into main storage and checked each time the word is read out; the technique permits detection of most, though not all, read and write errors.

Storage protection is a feature that prevents unauthorized writing in certain areas of main storage. The protection can be accomplished by hardware means, software means, or a combination of both. Though unnecessary in simple dedicated systems, an effective storage protection scheme is an essential element in multiprogramming and time-sharing environments.

Central Processor

Although there are many variations in their internal architecture, the great majority of currently available minicomputers use parallel, binary processors with single-address instructions and fixed word lengths of 8, 12, 16, 18, 24, or 32 bits.

In single-address computers, *the number of accumulators* can have a significant effect upon internal flexibility and processing power. An accumulator is a register that holds one operand and permits various arithmetic and logical operations to be performed upon it (e.g., a second operand might be added to the operand contained in the accumulator, with the sum replacing the first operand in the accumulator). In computers with multiple accumulators, instructions involving operands in two of the accumulators can often be executed more rapidly than instructions which require the retrieval of an operand from main storage.

Indexing is an important form of address modification in which the contents of a special register called an index register are added to the machine address contained in an instruction prior to its execution. An effective indexing scheme is particularly desirable in minicomputers, since it can help to compensate for their limited direct addressing capabilities. The *number of index registers* serves as an indication of a computer's programming flexibility and efficiency. Prospective buyers should note, however, that there are wide variations in the indexing schemes used in current minicomputers. It is important to determine whether the index registers are separate hardware registers or simply reserved locations in main storage, whether special instructions are provided for loading, incrementing, and testing the index registers, and how much additional time (if any) indexing adds to the instruction execution times. It should also be noted that many of the current computers use "general registers" which can serve as either accumulators or index registers.

The *number of directly addressable words* of main storage is an important characteristic that may require some explanation if you're investigating minicomputers for the first time. The problem is that the short word lengths impose serious limitations upon the number of bits that can be assigned to hold the address part of each instruction. A typical 16-bit minicomputer instruction might consist of three parts: operation code, address mode field, and the address itself. If 6 bits are assigned ➤

All About Minicomputers

▷ to hold the operation code (permitting up to 64 distinct operations) and 2 bits are used to designate the addressing mode (permitting specification of indexing and/or indirect addressing), then only 8 bits are left to hold the address field. Since these 8 bits permit direct addressing of only 256 distinct memory locations, it is clear that other means will need to be employed to access most regions of the computer's main storage. The most common solutions to the problem are the use of multi-word instructions, indexing, and/or indirect addressing.

Indirect addressing is an address modification technique in which the address part of an instruction specifies a storage location that contains another address rather than the desired operand itself. This second address may in turn be either the address of the desired operand or another indirect address; the latter case is called multi-level indirect addressing. Indirect addressing permits the use of an entire word to hold an operand address. It can also simplify programming and speed up execution times in some applications by making it possible to change the effective address of numerous instructions by altering the indirect address in a single storage location. Each level of indirect addressing, however, usually requires one additional storage cycle of execution time.

Although it is undeniably dangerous to make inferences about a computer's overall performance capability on the basis of instruction execution times, our charts show the basic *add time* to give a first-level indication of fixed-point arithmetic speeds. In general, the indicated add times are the times required to retrieve a one-word operand from main storage and add it to another operand already contained in an accumulator, with no indexing or indirect addressing. Comparisons based on add times can easily be misleading, however, because of differences in word lengths and instruction repertoires.

Hardware multiply/divide facilities are standard in some minicomputers and optional in others. When no hardware facilities are present, multiplication and division must be performed by means of programmed subroutines at a significant reduction in execution speeds. Many minicomputer applications, however, impose little or no need for multiplication or division operations, and in these cases the hardware facilities would be superfluous.

Hardware floating point facilities are not included in the standard instruction repertoires of most of the currently available minicomputers, despite the fact that floating point arithmetic is highly desirable, if not essential, in many scientific applications. Where available, these facilities can dramatically reduce the execution times for certain programs by eliminating the need for time-consuming floating point subroutines.

Hardware byte manipulation is the ability to conveniently process information expressed in the 8-bit

character codes which are rapidly becoming an industry standard. Obviously, most of the 8-bit minicomputers are effective byte manipulators, and many of the 16-bit machines offer special instructions that permit either half of a word to be addressed and processed as an 8-bit byte.

Immediate (literal) instructions in some minicomputers permit savings in both storage requirements and execution times. An immediate instruction uses its address field to hold the operand itself rather than the address of the operand, thereby saving both the storage space that would normally be required to hold the operand and the time required to access it.

Power failure protection is a vital feature in many real-time applications. This facility provides for a safe shut-down of the computer, without destruction of the contents of its main storage or hardware registers, whenever a power failure occurs. Power failure protection is often combined with an automatic restart capability that enables the computer to get back into operation without human intervention when the power supply is restored.

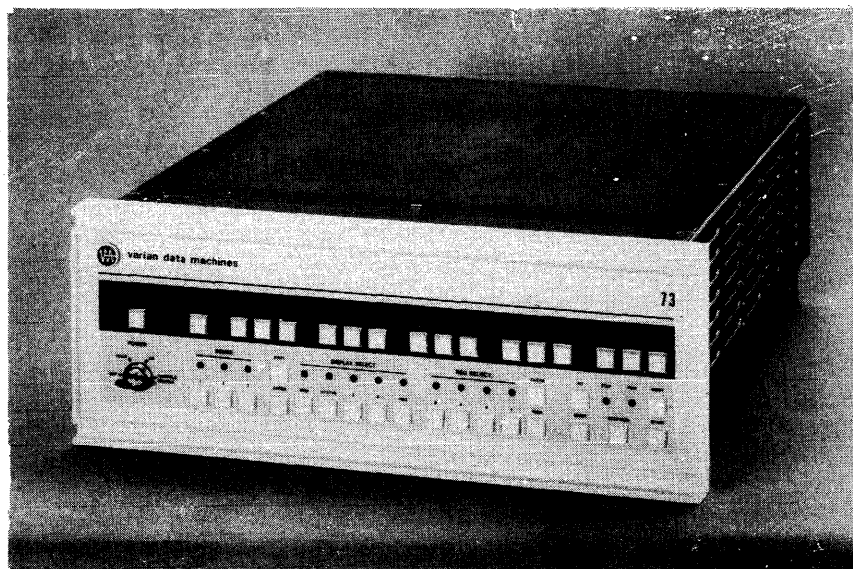
A real-time clock or timer is another essential element in most "time-conscious" systems. A real-time clock enables the program to determine the time of day, while an interval timer usually indicates the amount of time that has elapsed since the occurrence of some significant event. In many cases the timer can trigger an interrupt signal when a predetermined interval of time has elapsed.

Input/Output Control

I/O word size is the "width" of a computer's input/output data channels in terms of the number of bits of data which are transferred in parallel. In most cases this is the same as the machine's basic word length. I/O word size can have an important effect upon the cost and complexity of interfacing non-standard peripheral devices to a minicomputer. The machines with an 8-bit I/O word size can interface conveniently with most of the input and output devices on the market today.

A direct memory access channel (DMA) permits direct transfer of I/O data between main storage and a peripheral controller. When a DMA channel is used, the I/O data bypasses the computer's main hardware registers, and the I/O operation proceeds independently of program control once it has been initiated by the program. In minicomputers that lack a DMA channel, I/O data transfers are generally carried out under direct program control, with each word being transferred by way of the processor's registers. Generally speaking, the DMA channel has two significant advantages over program-controlled I/O: it can accommodate higher I/O data rates, and it causes far less interference with internal processing operations. Regardless of the type of I/O control they employ, most minicomputers can ▷

All About Minicomputers



Compact yet powerful, the Varian 73 exemplifies many of the current trends in minicomputer design. It offers a choice of 660-nanosecond core or 330-nanosecond MOS memory, is controlled by user-accessible microprograms, and is supported by three operating systems, several compilers, and a variety of peripheral and communications equipment.

- ▷ accommodate multiple I/O devices and include appropriate facilities for addressing the desired device.

Maximum I/O data rate, expressed in words per second, is a measure of each computer's potential ability to transfer data to and from peripheral devices or other external sources. In machines equipped with a DMA channel, the maximum I/O rate frequently equals the cycling rate of the main storage unit. These maximum I/O rates, however, can be quite deceptive in the case of minicomputers. In general, their storage capacities are limited, their capabilities for simultaneous input/output operations are restricted, and fairly complex programming is associated with I/O operations. For all these reasons, I/O data rates approaching the indicated maximum rates can usually be handled only in short bursts, if at all.

An effective *program interrupt* facility is a requirement for virtually all applications of a real-time nature. An interrupt is a signal that causes a temporary suspension of normal program execution so that the particular condition that caused the interrupt can be dealt with. Interrupts fall into two basic categories: internal and external. Internal interrupts are usually triggered by conditions such as a memory parity error, an illegal instruction, or a power failure. External interrupts usually indicate that a particular peripheral device requires attention or has completed an I/O operation. An interrupt usually results in automatic storage of the current contents of the instruction counter, followed by a transfer of control to a software routine that determines the cause of the interrupt and initiates the appropriate action.

The *number of external interrupt levels* provides a reasonable indication of the power of a minicomputer's interrupt system. It shows the number of different external devices whose interrupt signals can be identified by the processor—though it should be noted that this identification process may require a fairly complex and time-consuming sequence of instructions. Many of the minicomputers offer additional external interrupt levels as extra-cost options, and in these cases our charts show the available range, from minimum to maximum.

Peripheral Equipment

The comparison charts summarize the standard peripheral devices that are available for each minicomputer. (Space limitations preclude a detailed treatment of minicomputer peripheral equipment in this report; comprehensive coverage of this important area is provided by other Datapro reports.)

Users who are accustomed to larger general-purpose computer systems will find that the term "standard peripheral device" often has a somewhat different meaning when used by a minicomputer manufacturer. Since comparatively few of the minicomputer makers produce their own peripheral equipment, the indicated availability of a given type of device may simply mean that an appropriate interface is available to couple the computer with a peripheral unit supplied by some other manufacturer. Therefore, prospective buyers should ask these questions about each item of peripheral equipment they will need: ▷

All About Minicomputers

- ▷ ● Has it actually been installed and used with the computer of interest?
- If so, what has the users' experience been?
- What software support is available?
- Who will provide service for the device, and under what conditions?

The charts indicate the availability of three different types of disk and drum storage units. *Disk pack storage* is now the most popular type of random-access storage in larger computer systems; the interchangeable disk packs are suitable for either random or sequential processing. *Non-interchangeable disk storage* frequently provides larger on-line storage capacities at a lower cost per bit, though it lacks the operational flexibility of the interchangeable disk packs. *Drum storage* tends to provide faster access times and data transfer rates than the disk units, usually at a higher cost per bit.

Disk and drum storage units can greatly expand the scope of practical applications for the minicomputers by compensating for their limited main storage capacities. Cost, however, is likely to be a serious problem, since many of the currently available disk and drum units cost more than the minicomputers themselves.

Magnetic tape speed is expressed in characters per second for those minicomputers that offer magnetic tape I/O. Most of the available tape units use standard 1/2-inch tape in IBM-compatible 9-track and/or 7-track formats, though there is also a growing trend toward inexpensive cassette and cartridge units.

Punched card input and output speeds for standard 80-column cards are expressed in cards per minute. (Readers and punches for IBM's compact new 96-column cards have not yet found much acceptance among minicomputer builders or buyers.)

Where paper tape I/O devices faster than the ever-present Teletype ASR units are available, these *high-speed paper tape input and output speeds* are expressed in characters per second.

Other standard peripheral devices, such as line printers, plotters, and display units, are briefly identified on the charts. Space does not permit listings of the extensive lines of communications interfaces, real-time interfaces, and analog/digital and digital/analog converters offered by many of the minicomputer builders.

Software

This section of the comparison charts summarizes the major software items offered by the manufacturer of each minicomputer. In addition to the items listed in the charts, most manufacturers also offer utility routines to handle input/output operations, mathematical functions, program loading, and diagnostic operations. Software packages for specific applications, however, are still quite rare. Prospective buyers should carefully note whether the software they will require is included in the basic price of the computer or offered at extra cost.

An *assembler* is the one essential software item that is available for nearly every minicomputer. The assembler simplifies machine-language programming by permitting the use of mnemonic operation codes and symbolic addresses. Most assemblers also provide pseudo-instructions which control the assembly process and allocate storage space for constants and data.

One-pass and two-pass assemblers each offer certain advantages. A "pass" generally means a scan of the full source program during the assembly process. A one-pass assembler saves assembly time, but certain programming restrictions are imposed by the fact that all storage must be allocated at the beginning of the assembly process. A two-pass assembler builds a symbol table during the first pass and generates the machine-language object program during the second pass; this technique tends to be slower but more powerful. Both one- and two-pass assemblers are available for some machines.

A *macro assembler* is an assembler with the added capability to substitute a predetermined sequence of machine instructions for each "macro instruction" that appears in the source program. Macro facilities can simplify programming by making it easy to include subroutines to handle input/output, evaluation of functions, and other frequently encountered operations.

A *compiler* converts source programs written in a procedure-oriented language such as FORTRAN into machine-language object programs. Although compilers can greatly reduce programming time requirements for many applications, they are not as widely used with minicomputers as with larger computers for two principal reasons. First, most minicomputers have been used in specialized applications where relatively few programs are required but where high operational efficiency (which is difficult to achieve with compilers) is important. Second, the compilation process itself requires more storage space than many of the minicomputers provide. The trend toward ever more diversified applications for the minicomputers, however, is leading to ▷

All About Minicomputers

▷ steadily increasing use of compilers. Most of the available compilers are batch-oriented, but a few are designed for interactive, conversational-mode operation.

FORTTRAN is by far the most widely implemented compiler language for the current minicomputers. FORTRAN has been the most popular scientific programming language for more than a decade, and it has been successfully used for many business applications as well. There are many different versions of the FORTRAN language, but conversions of FORTRAN programs from one version to another are usually comparatively simple.

Other compilers, for programs written in languages such as ALGOL, BASIC, and COBOL, are listed on the charts where available.

An *operating system* facilitates the operation of a computer by handling functions such as: (1) scheduling, loading, and supervising the execution of programs; (2) allocating storage and I/O devices; (3) initiating and controlling I/O operations; (4) analyzing interrupt signals and dealing with errors; (5) handling communications between the system and its human operator; and (6) controlling multiprogramming or time-sharing operations. Most of the current minicomputer operating systems are real-time monitors, designed primarily for use in a dedicated real-time environment. Facilities for multiprogramming and/or communications control, however, are becoming fairly common.

Pricing and Availability

The comparison charts show the *prices of basic systems* equipped with 4,096 and 8,192 words of main storage but no peripheral equipment. The indicated prices for each machine include all of the features listed as "standard," but none of the "optional" features. Because of the wide variations in availability and pricing of optional features and peripheral equipment, comparisons such as these can provide only a first-level indication of the overall pricing relationships among competitive minicomputers. And, of course, prices have been falling steadily and are likely to continue to do so. Therefore, the only reliable source of detailed, up-to-date pricing information is the manufacturers themselves.

If you'll need two or more minicomputers, it's also worth noting that most of the manufacturers offer sizeable discounts from their list prices on orders for multiple computers. Discounts of up to 40 percent are not unusual on large orders.

Date of first delivery indicates when the first production model of each minicomputer was delivered (or is scheduled to be delivered) to a customer.

Number installed to date shows how many computers of each type had been delivered to customers as of June 1974. All figures were supplied by the manufacturers themselves, and the entry "NA" (Not Available) appears in all cases where the manufacturers chose not to release this information.

Comments at the bottom of the charts describe significant or unusual features, capabilities, or applications which are not reflected in the standard entries.

MINICOMPUTER MANUFACTURERS

Listed below, for your convenience in obtaining additional information, are the full names and addresses of the 54 manufacturers whose products are summarized in the comparison charts.

Applied Computing Technology, 17815 Sky Park Circle, Irvine, California 92707. Telephone (714) 549-3123.

Automatic Electronic Systems, Inc., 570 McCaffrey Street, St. Laurent H4T 1N1, P. Quebec, Canada. Telephone (514) 341-5030.

Basic/Four Corporation, 18552 MacArthur Boulevard, Santa Ana, California 92707. Telephone (714) 833-9530.

Bendix Corporation, Navigation & Control Division, Teterboro, New Jersey 07608. Telephone (201) 288-2000.

California Data Processors, 2019 S. Ritchey Street, Santa Ana, California 92705. Telephone (714) 558-8211.

Cascade Data, Inc. (a subsidiary of Syntronic Instruments, Inc.), 3000 Kraft Avenue S.E., Grand Rapids, Michigan 49508. Telephone (616) 949-8850.

Cincinnati Milacron Company, Process Controls Division, Mason Marrow Road, Lebanon, Ohio 45036. Telephone (513) 494-1200.

Compagnie Internationale pour l'Informatique (CII), 68 Route de Versailles, 78 Louveciennes, France. Telephone 951-86-00.

Computer Automation Incorporated, 18651 Von Karman Avenue, Irvine, California 92664. Telephone (714) 833-8830.

Computer Hardware, Inc., 2550 Fair Oaks Boulevard, Sacramento, California 95825. Telephone (916) 488-4614.

Computer Technology Limited, Eaton Road, Hemel Hempstead, Hertfordshire HP2 7EQ, England.

Comstar Corp., 7413 Washington Avenue S., Edina, Minnesota 55435. Telephone (612) 941-4454.

Control Data Corporation, 8100 34th Avenue South, Minneapolis, Minnesota 55440. Telephone (612) 888-5508.

Data General Corporation, Route 9, Southboro, Massachusetts 01772. Telephone (617) 485-9100.

Datacraft Corporation, 1200 Gateway Drive, P.O. Box 23550, Fort Lauderdale, Florida 33309. Telephone (305) 974-1700. ▷

All About Minicomputers

- ▷ *Datapoint Corporation*, 9725 Datapoint Drive, San Antonio, Texas 78284. Telephone (512) 696-4520.
- Digital Computer Controls, Inc.*, 12 Industrial Road, Fairfield, New Jersey 07006. Telephone (201) 227-4861.
- Digital Equipment Corporation*, 146 Main Street, Maynard, Massachusetts 01754. Telephone (617) 897-5111.
- Digital Scientific Corporation*, 11455 Sorrento Valley Road, San Diego, California 92121. Telephone (714) 453-6050.
- Electronic Associates, Inc.*, 185 Monmouth Parkway, West Long Branch, New Jersey 07764. Telephone (201) 229-1100.
- Electronic Processors Incorporated* (a subsidiary of the Samsonite Corporation), 1265 W. Dartmouth, Englewood, Colorado 80110. Telephone (303) 761-8540.
- Four-Phase Systems, Inc.*, 19333 Valco Parkway, Cupertino, California 95014. Telephone (408) 255-0900.
- Fujitsu Limited*, 680 Fifth Avenue, New York, New York 10019. Telephone (212) 265-5360.
- GEC Computers Limited*, Elstree Way, Borehamwood, Hertfordshire WD6 1RX, England.
- General Automation, Inc.*, 1055 S. East Street, Anaheim, California 92805. Telephone (714) 778-4800.
- GRI Computer Corporation*, 320 Needham Street, Newton, Massachusetts 02164. Telephone (617) 969-0800.
- GTE Information Systems, Inc.*, One Stamford Forum, Stamford, Connecticut 06904. Telephone (203) 357-2000.
- Hewlett-Packard Company*, Cupertino Division, 11000 Wolfe Road, Cupertino, California 95014. Telephone (213) 877-1282.
- Hitachi, Ltd.* 23-15 6-chrome, Minamiohi, Shinagawa-ku, Tokyo 140, Japan. Telephone (765) 3111.
- Honeywell Information Systems Inc.*, (a subsidiary of Honeywell Inc.), 200 Smith Street, Waltham, Massachusetts 02154. Telephone (617) 237-4100.
- Information Computer Systems Ltd.*, Heron House, 19 Marylebone Road, London NW1, England. Telephone (01) 486-4635.
- Intel Corporation*, 3065 Bowers Avenue, Santa Clara, California 95051. Telephone (408) 246-7501.
- Interdata, Inc.*, 2 Crescent Place, Oceanport, New Jersey 07757. Telephone (201) 229-4040.
- IBM Corporation*, Data Processing Division, 1133 Westchester Avenue, White Plains, New York 10604. Telephone (213) 376-9763.
- Linolex Systems, Inc.*, 5 Esquire Road, North Billerica, Massachusetts 01862. Telephone (617) 667-4151.
- Lockheed Electronics Company* (a subsidiary of Lockheed Aircraft Corporation), Data Products Division, 6201 E. Randolph Street, Los Angeles, California 90022. Telephone (213) 722-6810.
- Microdata Corporation*, 17481 Red Hill Avenue, Irvine, California 92705. Telephone (714) 540-6730.
- Modular Computer Systems, Inc.*, 1650 West McNab Road, Fort Lauderdale, Florida 33309. Telephone (305) 974-1380.
- Nanodata Corporation*, 7457 Wehrle Drive, Williamsville, New York 14221. Telephone (716) 631-5880.
- National Semiconductor Corporation*, 2900 Semiconductor Drive, Santa Clara, California 95051. Telephone (408) 732-5000.
- Nuclear Data Inc.*, Golf & Meacham Road, Schaumburg, Illinois 60172. Telephone (315) 885-4700.
- Omnus Computer Corporation*, 1310 E. Edinger "B", Santa Ana, California 92705. Telephone (714) 547-8444.
- Philips-Electrologica B.V.*, OEM Marketing, P.O. Box 245, Apeldoorn, the Netherlands. Telephone 05760-30123.
- Prime Computer, Inc.*, 23 Strathmore Road, Natick, Massachusetts 01760. Telephone (617) 655-6988.
- Qantel Corporation*, 3474 Investment Boulevard, Hayward, California 94545. Telephone (415) 783-3410.
- Raytheon Data Systems Company* (a division of Raytheon Company), 1415 Boston-Providence Turnpike, Norwood, Massachusetts 02062. Telephone (617) 762-6700.
- Rolm Corporation*, 18922 Forge Drive, Cupertino, California 95014. Telephone (408) 257-6440.
- R2E Micro-Computers* (a subsidiary of Realisations Etudes Electroniques), 38 Garden Road, Wellesley Hills, Massachusetts 02181. Telephone (617) 235-8830.
- Systems Engineering Laboratories, Inc.*, 6901 West Sunrise Boulevard, Fort Lauderdale, Florida 33313. Telephone (305) 587-2900.
- Texas Instruments Inc.*, Digital Systems Division, P.O. Box 1444, Houston, Texas 77001. Telephone (713) 777-1623.
- UNIVAC* (a division of Sperry Rand Corporation), UNIVAC Park, P.O. Box 3525, St. Paul, Minnesota 55165. Telephone (612) 456-2222.
- Varian Data Machines* (a subsidiary of Varian Associates), 2722 Michelson Drive, Irvine, California 92664. Telephone (714) 833-2400.
- Westinghouse Electric Corporation*, Computer Department, 1200 W. Colonial Drive, Orlando, Florida 32804. Telephone (305) 843-7030.
- Xerox Corporation*, 701 South Aviation Boulevard, El Segundo, California 90245. Telephone (213) 679-4511. □

All About Minicomputers

MANUFACTURER & MODEL	Applied Comp. Technology CBC-4N	Applied Comp. Technology CBC-4	Applied Comp. Technology PPS-4ME	Applied Comp. Technology PPS-4MP	Applied Comp. Technology UMPS-4
DATA FORMATS					
Word length, bits	4/8	4/8	4/8	4/8	4/8
Fixed-point operand length, bits	4	4	4	4	4
Instruction length, bits	8/16	8/16	8/16	8/16	8/16
MAIN STORAGE					
Storage type	Semiconductor	Semiconductor	Semiconductor	Semiconductor	Semiconductor
Cycle time, microseconds/word	11.8	11.8	5	5	5
Minimum capacity, words	256	1,024	1,024	1,024	256
Maximum capacity, words	4,096	4,096	16,384	16,384	16,384
Parity checking	No	No	No	No	No
Storage protection	No	No	No	No	No
CENTRAL PROCESSOR					
No. of accumulators	1	1	1	1	1
No. of index registers	16	16	1	16	1
No. of directly addressable words	4,096	4,096	4,096	4,096	4,096
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Add time, microseconds (full word)	11.8	11.8	No	5	No
Hardware multiply/divide	No	No	No	No	No
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	No	No	No	No	No
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	No	No	No	No	No
Real-time clock or timer	No	No	No	No	No
INPUT/OUTPUT CONTROL					
I/O word size, bits	4	4	12	12	12
Direct memory access channel	No	No	Standard	Standard	Standard
Maximum I/O rate, words/sec	10,000	10,000	20,000	20,000	20,000
No. of external interrupt levels	None	None	None	None	None
PERIPHERAL EQUIPMENT					
Disk pack storage	No	No	No	No	No
Non-interchangeable disk storage	No	No	No	No	No
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	—	—	—	—	—
Punched card input speed, cpm	—	—	—	—	—
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	—	—	120	—	—
High-speed paper tape output, cps	—	—	—	—	—
Other standard peripheral units	—	Teletypewriter	Teletypewriter	Teletypewriter	—
SOFTWARE					
Assembler	No	1-pass	No	No	No
Macro assembler	No	No	No	No	No
FORTRAN compiler	No	No	No	No	No
Other compilers	No	No	No	No	No
Operating system	No	Yes	Yes	Yes	No
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$495	\$4,950	\$2,950	\$6,950	Not available
Price of basic system with 8K words	Not available	Not available	Not available	\$9,950	Not available
Date of first delivery	Feb. 1972	March 1972	June 1973	June 1973	May 1974
Number installed to date	NA	NA	NA	NA	NA
COMMENTS	Complete micro-computer on a single card; based on Intel's MCS-4 chips.	Development tool for use of Intel MCS-4 microcomputers in OEM products. Includes assembler/simulator and PROM programmer.	Design aid for applications of Rockwell PPS-4 microprocessor. Includes real-time program emulation and resident utility system.	Design aid for applications of Rockwell PPS microcomputer chips. Includes assembler/simulator and PROM programmer.	Prototyping system for Rockwell's PPS-4 microprocessor.

All About Minicomputers

MANUFACTURER & MODEL	Automatic Elect. Systems AES-80	Automatic Elect. Systems AES-80C	Basic/Four Model 350	Basic/Four Model 400	Basic/Four Model 500
DATA FORMATS					
Word length, bits	8	8	8	8	8
Fixed-point operand length, bits	8	8	Variable	Variable	Variable
Instruction length, bits	12	12	16	16	16
MAIN STORAGE					
Storage type	Semiconductor	Semiconductor	Core	Core	Core
Cycle time, microseconds/word	0.24	0.24	1.0	1.0	1.0
Minimum capacity, words	16 data/256 inst.	16 data/256 inst.	8,192	8,192	8,192
Maximum capacity, words	4K data/4K inst.	4K data/32K inst.	65,536	65,536	65,536
Parity checking	No	No	No	No	No
Storage protection	No	No	Yes	Yes	Yes
CENTRAL PROCESSOR					
No. of accumulators	1	1	2	2	2
No. of index registers	0	0	1	1	1
No. of directly addressable words	2K inst./1K data	2K inst./1K data	65,536	65,536	65,536
Indirect addressing	Yes	Yes	One-level	One-level	One-level
Add time, microseconds (full word)	0.24	0.24	7.0	7.0	7.0
Hardware multiply/divide	No	No	No	No	No
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	No	No	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Standard	Standard	Standard
Real-time clock or timer	Optional	Optional	Standard	Standard	Standard
INPUT/OUTPUT CONTROL					
I/O word size, bits	8	8	8	8	8
Direct memory access channel	No	No	Standard	Standard	Standard
Maximum I/O rate, words/sec	131,072	1,048,576	1,000,000	1,000,000	1,000,000
No. of external interrupt levels	Variable	Variable	2-32	2-32	2-32
PERIPHERAL EQUIPMENT					
Disk pack storage	Optional*	Optional*	Yes	Yes	Yes
Non-interchangeable disk storage	Optional*	Optional*	Yes	Yes	Yes
Drum storage	—	—	No	No	No
Magnetic tape speed, cps	—	—	10K	10K	10K
Punched card input speed, cpm	—	—	300	300	300
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	75/300	75/300	300	300	300
High-speed paper tape output, cps	—	—	75	75	75
Other standard peripheral units	Modems, etc.	Modems, etc.	CRT displays, acctg. machine terminals, printers	CRT displays, acctg. machine terminals, printers	CRT displays, acctg. machine terminals, printers
SOFTWARE					
Assembler	1 & 2-pass	1 & 2-pass	No	No	No
Macro assembler	No	No	No	No	No
FORTRAN compiler	No	No	No	No	No
Other compilers	See Comments	See Comments	BASIC interp.	BASIC interp.	BASIC interp.
Operating system	No	No	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$3,640**	\$3,640**	Not available	Not available	Not available
Price of basic system with 8K words	Not available	Not available	\$32,400	\$34,900	\$36,900
Date of first delivery	May 1972	Oct. 1972	Sept. 1971	Aug. 1971	May 1972
Number installed to date	Over 100	Over 200	See Comments	See Comments	See Comments
COMMENTS	*AES supplies interfaces and devices on request. **Price depends on system complexity and quantity purchased. AES microprocessors are microprogrammable controllers.		Small business computer systems; printer and disk drive are standard. Models 350, 400, and 500 can have 1, 4, or 8 CRT display terminals per system, respectively. Total of over 1,200 systems installed to date. Also used in scientific processing.		

All About Minicomputers

MANUFACTURER & MODEL	Bendix BDX6200	Bendix BDX9000	California Data Processors CAL DATA-1	Cascade Data Concept II	CHI 2130 (Computer Hardware)
DATA FORMATS					
Word length, bits	20	16	16	16 (2 bytes)	16
Fixed-point operand length, bits	20/40	16	16	16-32	16
Instruction length, bits	20	16	48	16-40	32
MAIN STORAGE					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	2.0	2.0	0.675	1.2 (per byte)	0.8
Minimum capacity, words	4,096	4,096	8,192	4,096	8,192
Maximum capacity, words	16,384	32,768	131,072	16,384	65,536
Parity checking	Optional	Optional	Optional	Standard	Standard
Storage protection	Optional	Optional	Standard	No	No
CENTRAL PROCESSOR					
No. of accumulators	3	16	16	15	1
No. of index registers	3	2	16	3	3
No. of directly addressable words	4,096	256	131,072	16,384	65,536
Indirect addressing	Multi-level	Multi-level	Multi-level	No	One-level
Add time, microseconds (full word)	4.0	4.0	2	8.8	2.8-4.4
Hardware multiply/divide	Standard	Standard	Optional	Standard	Standard
Hardware floating point	No	No	Optional	No	Optional
Hardware byte manipulation	No	No	Standard	Standard	No
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Standard	No	No
Real-time clock or timer	Optional	Optional	Standard	No	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	20	16	16	16	16
Direct memory access channel	Optional	Optional	Optional	Standard	Optional
Maximum I/O rate, words/sec	500,000	500,000	3,000,000	413,000	1,250,000
No. of external interrupt levels	1-64	1-64	Variable	0	6-28
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	See Comments	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	—	Yes	No
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	Not specified	Not specified	—	60K	75K
Punched card input speed, cpm	200	200	—	300	1,000
Punched card output speed, cpm	—	—	—	—	160
High-speed paper tape input, cps	300	300	—	150	300
High-speed paper tape output, cps	120	120	—	75	110
Other standard peripheral units	A/D and D/A interfaces	A/D and D/A interfaces	I/O controller, line printers, memory management units, etc.	Line printers, mark readers, communications, displays, etc.	Line printers, plotters, async. & BSC communications
SOFTWARE					
Assembler	2-pass	2-pass	2-pass	2-pass	No
Macro assembler	No	No	Yes	Yes	Yes
FORTRAN compiler	No	No	—	No	Yes
Other compilers	ATLAS	No	—	RPG	COBOL, BASIC, SNOBOL, SL1
Operating system	No	No	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	On request	On request	On request	On request	Not available
Price of basic system with 8K words	On request	On request	On request	On request	\$28,000
Date of first delivery	May 1970	1971	July 1972	April 1970	July 1974
Number installed to date	40	8	Over 10	130	NA
COMMENTS	These minicomputers are sold exclusively for aerospace and ground support systems and are not usually available commercially.		CAL DATA-1 emulates the DEC PDP-11 and supports the same complement of peripherals and software as the PDP-11.	Byte-oriented; also designed for business applications. Extensive applications software. Models 80/20, 80/30, 80/40 are no longer manufactured.	System is completely software-compatible with the IBM 1130.

All About Minicomputers

MANUFACTURER & MODEL	CII Mitra 15/30 (15/20)	Cincinnati Milacron CIP/2200	Computer Automation Alpha-16	Computer Automation Alpha LSI-1	Computer Automation Alpha LSI-2/10
DATA FORMATS					
Word length, bits	16 + 2	8	16	16	16
Fixed-point operand length, bits	16	8/16/24/32	16	16/32	16/32
Instruction length, bits	16	Variable	16	16/32	16/32
MAIN STORAGE					
Storage type	Core	Core	Core	Core/semicond.	Core/semicond.
Cycle time, microseconds/word	0.8	1.1	1.6	1.6/1.2/0.98	1.6/1.2/0.98
Minimum capacity, words	4,096	8,192	2,048	1,024	4,096
Maximum capacity, words	32,768 (8,192)	65,536	32,768	262,144	262,144
Parity checking	Standard	Optional	Optional	Optional	Optional
Storage protection	Standard	No	Optional	Optional	Optional
CENTRAL PROCESSOR					
No. of accumulators	2	3	2	2	2
No. of index registers	1 (+2 base)	1	1	1	1
No. of directly addressable words	768	32,768	1,024	1,024	1,024
Indirect addressing	One-level	One-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	2.3	12-13	3.2	9.2	4.12
Hardware multiply/divide	Standard (opt.)	Standard	Standard	Standard	Standard
Hardware floating point	Optional	No	No	No	No
Hardware byte manipulation	Standard (opt.)	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard (opt.)	Standard	Optional	Optional	Optional
Real-time clock or timer	Optional	Standard	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	8/16	8	16	8/16	8/16
Direct memory access channel	Optional	Optional	Optional	Standard	Standard
Maximum I/O rate, words/sec	1,200,300 (300K)	909,000	700,000	1,666,000	1,666,000
No. of external interrupt levels	1-100	32 max.	3-unlimited	3-unlimited	3-unlimited
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	20K-120K	20K	20K	20K	20K
Punched card input speed, cpm	300/600/1200	600	300	300	300
Punched card output speed, cpm	50/200/300	—	—	—	—
High-speed paper tape input, cps	300/1200	300	300	300	300
High-speed paper tape output, cps	60	75	75	75	75
Other standard peripheral units	Line printers, CRT display, comm. and A/D interfaces, etc.	Line printers, real-time and communications interfaces, CRT display, TTY	Line printer, communications	Line printer, CRT, cassette, communications	Line printer, CRT, cassette, communications
SOFTWARE					
Assembler	1-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	No	Yes	Yes	Yes
Other compilers	LP15, LPG, BASIC	RPG	BASIC	BASIC	BASIC
Operating system	Yes (4)	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$15,800 (\$12,200)	Not available	\$3,550	\$2,390	\$2,440
Price of basic system with 8K words	\$20,700 (\$17,000)	\$5,220	\$4,750	\$2,760	\$2,810
Date of first delivery	June 1972	Feb. 1972	Oct. 1971	NA	May 1974
Number installed to date	Over 750	575	Over 3,000	NA	NA
COMMENTS	System uses 4- port core memory: 1 for the CPU, the I/O processors and DMA.	Features decimal arithmetic, string moves, translate, and edit instruc- tions.	Program compati- ble with the earlier 116 and 216 computers. Has 156 instruc- tions plus micro- codes.	LSI-1 has 168 instructions in- cluding hardware multiple/divide and memory scan.	LSI-2/10 has 188 instructions including the LSI-1 set plus multiple stack handling instruc- tions.

All About Minicomputers

MANUFACTURER & MODEL	Computer Automation Alpha LSI-2/20	Computer Automation Naked Mini-16	Computer Automation Naked Mini LSI-1	Computer Automation Naked Mini LSI-2/10	Computer Automation Naked Mini LSI-2/20
DATA FORMATS					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16/32	16	16/32	16/32	16/32
Instruction length, bits	16/32	16	16	16/32	16/32
MAIN STORAGE					
Storage type	Core/semicond.	Core	Core/semicond.	Core/semicond.	Core/semicond.
Cycle time, microseconds/word	1.6/1.2/0.98	1.6	1.6/1.2/0.98	1.6/1.2/0.98	1.6/1.2/0.98
Minimum capacity, words	4,096	2,048	1,024	4,096	4,096
Maximum capacity, words	262,144	32,768	262,144	262,144	262,144
Parity checking	Optional	Optional	Optional	Optional	Optional
Storage protection	Optional	Optional	Optional	Optional	Optional
CENTRAL PROCESSOR					
No. of accumulators	2	2	2	2	2
No. of index registers	1	1	1	1	1
No. of directly addressable words	1,024	1,024	1,024	1,024	1,024
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	2.06	3.2	9.2	4.12	2.06
Hardware multiply/divide	Standard	Standard	Standard	Standard	Standard
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Optional	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	8/16	16	8/16	8/16	8/16
Direct memory access channel	Standard	Optional	Standard	Standard	Standard
Maximum I/O rate, words/sec	1,666,000	700,000	1,666,000	1,666,000	1,666,000
No. of external interrupt levels	3-unlimited	3-unlimited	3-unlimited	3-unlimited	3-unlimited
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	20K	20K	20K	20K	20K
Punched card input speed, cpm	300	300	300	300	300
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	300	300	300	300	300
High-speed paper tape output, cps	75	75	75	75	75
Other standard peripheral units	Line printer, CRT, cassette, communications	Line printer, communications	Line printer, CRT, cassette, communications	Line printer, CRT, cassette, communications	Line printer, CRT, cassette, communications
SOFTWARE					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC	BASIC	BASIC	BASIC	BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$2,765	\$2,500 in lots of 10-19	\$1,650	\$1,750	\$2,300
Price of basic system with 8K words	\$3,060	\$3,740 in lots of 10-19	\$2,020	\$2,120	\$2,595
Date of first delivery	Sept. 1973	Oct. 1971	NA	May 1974	Sept. 1973
Number installed to date	Over 1,000	Over 3,000	NA	NA	Over 1,000
COMMENTS	LSI-2/20 has 188 instructions including the LSI-1 set plus multiple stack handling instructions.	Low-cost OEM version of the Alpha 16, less chassis, power supply, and console. Sold only in quantities of 10 or more.	Low-cost OEM version of the Alpha LSI-1, less chassis, power supply, and console.	Low-cost OEM version of the Alpha LSI-2/10, less chassis, power supply, and console.	Low-cost OEM version of the Alpha LSI-2/20, less power supply and console.

All About Minicomputers

MANUFACTURER & MODEL	Computer Technology Modular One 1.11	Computer Technology Modular One 1.12	Computer Technology Modular One 1.14	Comstar System M1	Comstar System M8
DATA FORMATS					
Word length, bits	16	16	16	8	8
Fixed-point operand length, bits	16	16	16	8	8
Instruction length, bits	16	16	16	8/24	8/48
MAIN STORAGE					
Storage type	Core	MOS	MOS	Semiconductor	Semiconductor
Cycle time, microseconds/word	0.75	1.5 or 0.75	1.5 or 0.75	1	0.4
Minimum capacity, words	8,192	8,192	12,288	256	4,096
Maximum capacity, words	57,324	57,324	24,556	65,536	65,536
Parity checking	No	No	No	No	No
Storage protection	Standard	Standard	Standard	No	No
CENTRAL PROCESSOR					
No. of accumulators	2	2	2	1	1
No. of index registers	2, 3	2, 3	2, 3	251	64
No. of directly addressable words	57,324	32,768	24,556	65,536	65,536
Indirect addressing	Multi-level	Multi-level	Multi-level	6.0	No
Add time, microseconds (full word)	1.6	1.8 or 2.4	1.8 or 2.4	Multi-level	0.9
Hardware multiply/divide	Standard	Standard	Standard	No	Standard
Hardware floating point	No	No	No	No	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Optional	Optional
Real-time clock or timer	Standard	Standard	Standard	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	16	8	8
Direct memory access channel	Optional	Optional	Optional	No	Optional
Maximum I/O rate, words/sec	156,000	156,000	156,000	100,000	2,000,000
No. of external interrupt levels	32	32	32	1	7
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	—	Yes
Drum storage	No	No	No	—	—
Magnetic tape speed, cps	556/800	556/800	556/800	—	1,000
Punched card input speed, cpm	400/600	400/600	400/600	—	150
Punched card output speed, cpm	No	No	No	—	50
High-speed paper tape input, cps	500	500	500	—	120
High-speed paper tape output, cps	75	75	75	—	75
Other standard peripheral units	Printer, plotter	Printer	Printer, plotter	TTY, 120-cps printer	TTY, 120-cps printer
SOFTWARE					
Assembler	1-pass or 2-pass	No	1-pass or 2-pass	No	2-pass
Macro assembler	Yes	No	Yes	No	No
FORTRAN compiler	Yes	No	Yes	No	No
Other compilers	CORAL 66, BASIC	No	CORAL 66, BASIC	No	Process Control
Operating system	MODUS 4	No	MODUS 4	No	No
PRICING & AVAILABILITY					
Price of basic system with 4K words	On request	On request	On request	\$1,495 (with 1,024 words)	\$1,585
Price of basic system with 8K words	On request	On request	On request	\$1,880	\$1,975
Date of first delivery	NA	NA	NA	June 1974	NA
Number installed to date	250	NA	NA	1	NA
COMMENTS	Multiprogramming system; CORAL 66 language is based upon ALGOL 60.	For use as a satellite (HASP) processor in a computer network at up to 9,600 bps; also emulates CDC 200, ICL 7020.	Program compatible with Modular One (MOS Version); CORAL 66 language is based upon ALGOL 60.	Microprogrammable; has 200-nanosecond minor cycle; 68 instructions.	Microprogrammable; 100-nanosec. minor cycle; 110 instructions; multiprocessor capability.

All About Minicomputers

MANUFACTURER & MODEL	Comstar System 4	Control Data 1700	Control Data SC-1700	Control Data System 17	Data General Nova 2/4
DATA FORMATS					
Word length, bits	4	16 + 2	16 + 2	16 + 2	16
Fixed-point operand length, bits	4	16	16	16	16
Instruction length, bits	8/16	16/32	16/32	16/32	16
MAIN STORAGE					
Storage type	Semiconductor	Core	Core	MOS	Core
Cycle time, microseconds/word	10.8	1.1	1.5	0.6/0.9	1.0/0.8
Minimum capacity, words	256	4,096	4,096	4,096	4,096
Maximum capacity, words	4,096	32,768	32,768	16,384	32,768
Parity checking	No	Standard	Standard	Standard	No
Storage protection	No	Standard	Standard	Standard	No
CENTRAL PROCESSOR					
No. of accumulators	1	2	2	2	4
No. of index registers	16	2	2	2	2
No. of directly addressable words	256	256	256	256	1,024
Indirect addressing	No	Multi-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	10.8	2.2	3.0	1.2/1.8	0.8/1.0
Hardware multiply/divide	No	Standard	Standard	Standard	Optional
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	No	No	Optional	Optional	Standard
Immediate (literal) instructions	Standard	No	No	No	No
Power failure protection	Optional	Standard	Standard	Standard	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	4	16	16	16	16
Direct memory access channel	No	Optional	Optional	Standard	Standard
Maximum I/O rate, words/sec	10,000	900,000	650,000	1,600,000	1.25/.833M
No. of external interrupt levels	—	2-16	2-16	2-16	16
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	—	Yes	Yes	Yes	Yes
Drum storage	—	Yes	Yes	Yes	No
Magnetic tape speed, cps	1,000	30K max.	30K max.	60K max.	60K max.
Punched card input speed, cpm	150	330-1600	330-1600	300-1600	225/1,000
Punched card output speed, cpm	—	100-460	100-460	100-460	—
High-speed paper tape input, cps	120	400	400	400	400
High-speed paper tape output, cps	75	120/150	120/150	120/150	63.3
Other standard peripheral units	TTY, 120-cps printer	Line printer, CRT displays, A/D converters, data sets, OCR	Line printer, CRT displays, A/D converters, data sets, OCR	Line printer, CRT displays, A/D converters, data sets, OCR	Line printer, A/D converters, communications, plotter, etc.
SOFTWARE					
Assembler	No	2-pass	2-pass	2-pass	2-pass
Macro assembler	No	Yes	Yes	Yes	Yes (3)
FORTRAN compiler	No	Yes	Yes	Yes	Yes
Other compilers	Process Control	No	No	No	ALGOL, BASIC
Operating system	No	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$665 (with 1,024 words)	\$20,000	\$15,900	\$14,175* \$17,325**	\$3,500
Price of basic system with 8K words	Not available	\$26,500	\$20,400	\$17,325* \$21,525**	\$4,000
Date of first delivery	NA	1966	1972	1973	Oct. 1973
Number installed to date	NA	See Comments	See Comments	NA	NA
COMMENTS	LSI processor; 45 instructions; over 100 special interfaces available.	These systems are no longer produced; an extensive base of over 600 systems exists.		Program/peripheral/operator panel-compatible with earlier 1700's. *900-nanosec. **600-nanosec.	Nova 2 uses a 1-microsec., 16K-word memory or an 800-nanosec., 4K- or 8K-word memory; 2/4 has 4 slots.

All About Minicomputers

MANUFACTURER & MODEL	Data General Nova 2/10	Data General Nova 800	Data General Nova 820	Data General Nova 840	Data General Nova 1200
DATA FORMATS					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16	16	16	16	16
Instruction length, bits	16	16	16	16	16
MAIN STORAGE					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	1.0/0.8	0.8	0.8	0.8	1.2
Minimum capacity, words	4,096	4,096	4,096	16,384	4,096
Maximum capacity, words	32,768	32,768	32,768	131,072	32,768
Parity checking	No	No	No	No	No
Storage protection	No	No	No	Standard	No
CENTRAL PROCESSOR					
No. of accumulators	4	4	4	4	4
No. of index registers	2	2	2	2	2
No. of directly addressable words	1,024	1,024	1,024	1,024	1,024
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	0.8/1.0	0.8	0.8	0.8	1.35
Hardware multiply/divide	Optional	Optional	Optional	Optional	Optional
Hardware floating point	Optional	Optional	Optional	Optional	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	No	No	No	No	No
Power failure protection	Optional	Optional	Optional	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1.25/.833M	1,250,000	1,250,000	1,250,000	833,000
No. of external interrupt levels	16	16	16	16	16
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	60K max.	60K max.	60K max.	60K max.	60K max.
Punched card input speed, cpm	225/1,000	225/1,000	225/1,000	225/1,000	225/1,000
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	400	400	400	400	400
High-speed paper tape output, cps	63.3	63.3	63.3	63.3	63.3
Other standard peripheral units	Line printer, A/D converters, communications, plotter, etc.	Line printer, A/D converters, communications, plotter, etc.	Line printer, A/D converters, communications, plotter, etc.	Line printer, A/D converters, communications, plotter, etc.	Line printer, A/D converters, communications, plotter, etc.
SOFTWARE					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC
Operating system	Yes (3)	Yes (3)	Yes (3)	Yes (3)	Yes (3)
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$4,400	\$6,600	\$6,100	Not available	\$5,100
Price of basic system with 8K words	\$4,900	\$8,000	\$7,500	\$16,530 (with 16K words)	\$5,950
Date of first delivery	Oct. 1973	March 1971	Apr. 1972	June 1973	Dec. 1970
Number installed to date	NA	NA	NA	NA	NA
COMMENTS					
	Nova 2 uses a 1-microsec., 16K-word memory or an 800-nanosec., 4K- or 8K-word memory; 2/10 has 10 slots.	All Nova-line computers are program compatible. Semiconductor read-only memory is interchangeable with core.	Housed in a 10.5-inch-high "jumbo" chassis that contains 10 subassembly slots for expansion.	Features memory management and protection unit that provides for memory expansion to 131K.	All Nova-line computers are program compatible. Semiconductor read-only memory is interchangeable with core.

All About Minicomputers

MANUFACTURER & MODEL	Data General Nova 1210	Data General Nova 1220	Data General Nova 1230	Data General Supernova	Datacraft Slash 4
DATA FORMATS					
Word length, bits	16	16	16	16	24
Fixed-point operand length, bits	16	16	16	16	24
Instruction length, bits	16	16	16	16	24
MAIN STORAGE					
Storage type	Core	Core	Core	Core/semicond.	Core
Cycle time, microseconds/word	1.2	1.2	1.2	0.8/0.3	0.75
Minimum capacity, words	4,096	4,096	4,096	1,024/4,096	8,192
Maximum capacity, words	32,768	32,768	32,768	32,768	65,536
Parity checking	No	No	No	No	Standard
Storage protection	No	No	No	Optional	Optional
CENTRAL PROCESSOR					
No. of accumulators	4	4	4	4	2
No. of index registers	2	2	2	2	3
No. of directly addressable words	1,024	1,024	1,024	1,024	32,768
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	1.35	1.35	1.35	0.8/0.3	1.5
Hardware multiply/divide	Optional	Optional	Optional	Optional	Standard
Hardware floating point	No	Optional	No	Optional	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	No	No	No	No	Standard
Power failure protection	Optional	Optional	Optional	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	16	15	24 or 8
Direct memory access channel	Standard	Standard	Standard	Standard	Optional
Maximum I/O rate, words/sec	833,000	833,000	833,000	1,250,000	5,000,000
No. of external interrupt levels	16	16	16	16	4-48
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	60K max.	60K max.	60K max.	60K max.	320K max.
Punched card input speed, cpm	225/1,000	225/1,000	225/1,000	225/1,000	300/600/1,000
Punched card output speed, cpm	—	—	—	—	47-100
High-speed paper tape input, cps	400	400	400	400	300
High-speed paper tape output, cps	63.3	63.3	63.3	63.3	75
Other standard peripheral units	Line printer, A/D converters, communications, plotter, etc.	Line printer, A/D converters, communications, plotter, etc.	Line printer, A/D converters, communications, plotters, etc.	Line printer, A/D converters, communications, plotters, etc.	CRT, TTY, line printers, communications
SOFTWARE					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC	BASIC, RPG
Operating system	Yes (3)	Yes (3)	Yes (3)	Yes (3)	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$4,000	\$4,900	Not available	\$9,250	Not available
Price of basic system with 8K words	\$5,400	\$6,300	\$7,100	\$10,500	\$24,000
Date of first delivery	Feb. 1972	Feb. 1972	Dec. 1971	April 1970	Aug. 1973
Number installed to date	NA	NA	NA	NA	30
COMMENTS					
	Economy-model Nova processor, designed mainly for OEM use.	Housed in a 10.5-inch-high chassis that contains 10 subassembly slots for expansion.	Housed in a 10.5-inch-high chassis that contains 17 subassembly slots for expansion.	Offers choice of 800-nsec core, 300-nsec read/write semi- conductor, or 300-nsec read- only semiconductor memory.	See Comments on next page.

All About Minicomputers

MANUFACTURER & MODEL	Datacraft Slash 4 VM	Datacraft Slash 5	Datapoint 2200	Digital Computer Controls D-112	Digital Computer controls D-112H
DATA FORMATS					
Word length, bits	24	24	8	12	12
Fixed-point operand length, bits	24	24/48	8	12	12
Instruction length, bits	24	24	8/16/24	12/24	12/24
MAIN STORAGE					
Storage type	Core	Core	Semiconductor	Core	Core/semicond.
Cycle time, microseconds/word	0.75	0.95	1.6	1.2	0.9/0.2
Minimum capacity, words	32,768	4,096	4,096	4,096	256
Maximum capacity, words	262,144	65,536	16,384	32,768	32,768
Parity checking	Standard	Standard	No	Optional	Optional
Storage protection	Standard	Optional	No	Standard	Standard
CENTRAL PROCESSOR					
No. of accumulators	2	5 or 6	1	1	1
No. of index registers	3	3	0	8	24
No. of directly addressable words	262,144	65,536	16,384	256	256
Indirect addressing	Multi-level	Multi-level	No	One-level	One-level
Add time, microseconds (full word)	1.5	1.9	4.8	2.4	2.4
Hardware multiply/divide	Standard	Standard	No	Optional	Optional
Hardware floating point	Optional	No	No	Optional	Optional
Hardware byte manipulation	Standard	Standard	No	Optional	Standard
Immediate (literal) instructions	Standard	Standard	Standard	No	No
Power failure protection	Optional	Optional	Standard	Optional	Optional
Real-time clock or timer	Standard	Optional	Standard	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	24 or 8	24 or 8	8	12	12
Direct memory access channel	Optional	Optional	No	Optional	Optional
Maximum I/O rate, words/sec	5,000,000	1,000,000	30,000	833,000	833,000
No. of external interrupt levels	4-48	4-24	0	1-64	1-64
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	No	Yes	Yes
Drum storage	No	No	No	Yes	Yes
Magnetic tape speed, cps	320K max.	320K max.	10K	30K	30K
Punched card input speed, cpm	300/600/1,000	300/600/1,000	400/600	200	200
Punched card output speed, cpm	47-100	35-100	—	100	100
High-speed paper tape input, cps	300	300/600	—	300	300
High-speed paper tape output, cps	75	75/110	—	110	110
Other standard peripheral units	CRT, TTY, line printers, communications	CRT display, plotter, A/D converter, com- munications	CRT display, printers, com- munications inter- faces	Line printer, com- munications inter- faces, A/D con- verters, etc.	Line printers, com- munications inter- faces, A/D con- verters, etc.
SOFTWARE					
Assembler	2-pass	2-pass	2-pass	1 & 2-pass	1 & 2-pass
Macro assembler	Yes	Yes	No	Yes	Yes
FORTRAN compiler	Yes	Yes	No	Yes	Yes
Other compilers	BASIC, RPG	BASIC, RPG	BASIC, RPG II	BASIC	BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	Not available	Not available	\$8,571	\$3,490	\$4,095
Price of basic system with 8K words	\$89,600	\$16,500	\$10,003	\$4,550	\$5,150
Date of first delivery	March 1974	May 1972	April 1972	Aug. 1970	April 1971
Number installed to date	1	143	Over 2000 total	NA	NA
COMMENTS	All Datacraft models are program compatible. The quoted prices include a basic software package. Other software is available at extra cost.		Processor includes CRT display and 2 cassette tape drives. Also available in smaller Datapoint 1100 and larger 5500 models.	Designed to be fully compatible with the DEC PDP-8 series computers.	Has expanded PDP-8 series instruction set. Offers either core or 200-nanosecond semiconductor memory.

All About Minicomputers

MANUFACTURER & MODEL	Digital Computer Controls D-116H	Digital Computer Controls D-116S	Digital Equipment PDP-8/A	Digital Equipment PDP-8/E	Digital Equipment PDP-8/F
DATA FORMATS					
Word length, bits	16	16	12	12	12
Fixed-point operand length, bits	16	16	12	12	12
Instruction length, bits	16	16	12	12	12
MAIN STORAGE					
Storage type	Core	Core	Semiconductor	Core	Core
Cycle time, microseconds/word	0.96	1.2	1.5	1.2	1.2
Minimum capacity, words	1,024	4,096	1,024	1,024	1,024
Maximum capacity, words	131,072	131,072	32,768	32,768	32,768
Parity checking	No	No	Optional	Optional	Optional
Storage protection	Optional	Optional	No	No	No
CENTRAL PROCESSOR					
No. of accumulators	4	4	1	1	1
No. of index registers	2	2	8/4K mem.	8/4K mem.	8/4K mem.
No. of directly addressable words	1,024	1,024	256	256	256
Indirect addressing	Multi-level	Multi-level	One-level	One-level	One-level
Add time, microseconds (full word)	1.0	1.35	3.25	2.6	2.6
Hardware multiply/divide	Optional	Optional	No	Optional	Optional
Hardware floating point	No	No	Optional	Optional	Optional
Hardware byte manipulation	Standard	Standard	No	No	No
Immediate (literal) instructions	No	No	No	Standard	Standard
Power failure protection	Optional	Optional	Standard	Standard	Standard
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	12	12	12
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1,040,000	833,000	666,400	833,000	833,000
No. of external interrupt levels	16	16	1-64	1-64	1-64
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	Special order	Special order	Special order
Magnetic tape speed, cps	30K	30K	36K max.	36K max.	36K max.
Punched card input speed, cpm	300/600	300/600	300	300	300
Punched card output speed, cpm	100	100	75 max.	75 max.	75 max.
High-speed paper tape input, cps	300	300	300	300	300
High-speed paper tape output, cps	75	75	50	50	50
Other standard peripheral units	Line printer, communications interfaces, A/D converters, plotters, etc.	Line printer, communications interfaces, A/D converters, etc.	DECtape, plotter, CRT displays, comm., printers, etc.	DECtape, plotter, CRT displays, comm., printers, etc.	DECtape, plotter, CRT displays, comm., printers, etc.
SOFTWARE					
Assembler	2-pass	2-pass	1 & 2-pass	1 & 2-pass	1 & 2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC, IRIS	BASIC, IRIS	ALGOL, BASIC, DIBOL, FOCAL	ALGOL, BASIC, DIBOL, FOCAL	ALGOL, BASIC, DIBOL, FOCAL
Operating system	Yes	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$3,036	\$2,975	\$2,600	\$4,490	\$3,200
Price of basic system with 8K words	\$3,432	\$3,365	Not available	\$5,000	\$3,600
Date of first delivery	Dec. 1972	Nov. 1971	Dec. 1974	March 1971	Dec. 1971
Number installed to date	NA	2,600	NA	NA	NA
COMMENTS	Designed to be fully compatible with the other D-116 and D-112 minicomputers.	Designed to be fully compatible with the Data General Nova 1200 series computers. Offers 16K memory on single board.	PDP-8A microcomputer is program-compatible with PDP-8/E. Power fail battery ensures uninterrupt processing.	Over 25,000 PDP-8 systems have been delivered since 1965. All models are program-compatible. Extensive software is available, as well as integrated systems for specific applications. A host of earlier-model PDP-8's are now called "traditional products" with continuing support. The PDP-8/E includes built-in hardware for expansion.	

All About Minicomputers

MANUFACTURER & MODEL	Digital Equipment PDP-8/M	Digital Equipment PDP-12	Digital Equipment PDP-15	Digital Equipment PDP-11/05	Digital Equipment PDP-11/10
DATA FORMATS					
Word length, bits	12	12	18	16	16
Fixed-point operand length, bits	12	12	18	16	16
Instruction length, bits	12	12	18	16/32/48	16/32/48
MAIN STORAGE					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	1.2	1.6	0.8	0.9	0.9
Minimum capacity, words	1,024	4,096	8,192	4,096	8,192
Maximum capacity, words	32,768	32,768	131,072	28,672	28,672
Parity checking	Optional	No	Optional	No	No
Storage protection	No	No	Optional	No	No
CENTRAL PROCESSOR					
No. of accumulators	1	1	1	8	8
No. of index registers	8/4K of mem.	15/4K of mem.	1 + 8 auto ind.	8 min.	8 min.
No. of directly addressable words	256	1,024	8,192	32,768*	32,768*
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Add time, microseconds (full word)	2.6	3.2	1.6	3.7	3.7
Hardware multiply/divide	Optional	Standard	Optional	Optional	Optional
Hardware floating point	Optional	Optional	Optional	No	No
Hardware byte manipulation	No	No	No	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Optional	Optional	Standard	Standard
Real-time clock or timer	Optional	Optional	Optional	Standard	Standard
INPUT/OUTPUT CONTROL					
I/O word size, bits	12	12	18	16	16
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	833,000	660,000	1,000,000	2,000,000	2,000,000
No. of external interrupt levels	1-64	1-64	28-64	Variable	Variable
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	Special order	Special order	Special order	Special order	Special order
Magnetic tape speed, cps	36K max.	36K max.	60K max.	36K max.	36K max.
Punched card input speed, cpm	300	300	300	300	300
Punched card output speed, cpm	75 max.	75 max.	75 max.	75 max.	75 max.
High-speed paper tape input, cps	300	300	300	300	300
High-speed paper tape output, cps	50	50	50	50	50
Other standard peripheral units	DECtape, plotter, CRT displays, comm., printers, etc.	DECtape, plotters, A/D converters, printers, etc.	DECtape, A/D converters, real-time interfaces	Communications interface, CRT displays, printers, etc.	Communications interface, CRT displays, printers, etc.
SOFTWARE					
Assembler	1 & 2-pass	2-pass	2-pass	1 & 2-pass	1 & 2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	ALGOL, BASIC, DIBOL, FOCAL	BASIC, FORTRAN	FOCAL, ALGOL	BASIC	BASIC
Operating system	Yes	Yes	Yes (3)	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$3,200	\$17,170	Not available	\$4,795	Not available
Price of basic system with 8K words	\$3,600	\$21,170	\$21,000	\$6,495	\$7,295
Date of first delivery	Dec. 1971	April 1969	Fall 1969	Feb. 1972	March 1973
Number installed to date	See 8/E	Over 600	Over 700	See Comments on next page.	See Comments on next page.
COMMENTS	See comments under PDP-8/E. The PDP-8/M is a slower (3.4 microsec.), low-cost version of the -8/M.	Designed for laboratory applications; can execute PDP-8 programs; built-in CRT display.	Program compatible with the PDP-9, and has 17 new instructions.	*28K is main memory; 4K is I/O device addresses implemented in IC's.	*28K is main memory; 4K is I/O device addresses implemented in IC's.

All About Minicomputers

MANUFACTURER & MODEL	Digital Equipment PDP-11/35	Digital Equipment PDP-11/40	Digital Equipment PDP-11/45	Digital Equipment PDP-11/50	Digital Scientific META 4
DATA FORMATS					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16	16	16	16	16
Instruction length, bits	16/32/48	16/32/48	16/32/48	16/32/48	32
MAIN STORAGE					
Storage type	Core	Core	Core/semicond.	Core/semicond.	Core
Cycle time, microseconds/word	0.90	0.90	0.90 (core)	0.45/0.30 (semi.)	0.90
Minimum capacity, words	8,192	8,192	1,028 (bipolar)	1,028 (bipolar)	8,192
Maximum capacity, words	131,072	131,072	124K (core)	124K (core)	65,536
Parity checking	Optional	Optional	Optional	Optional	Standard
Storage protection	Optional	Optional	Optional	Optional	Standard
CENTRAL PROCESSOR					
No. of accumulators	8	8	16	16	32
No. of index registers	8 min.	8 min.	16 min.	16 min.	Variable
No. of directly addressable words	32,768	32,768	32,768	32,768	65,536
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Add time, microseconds (full word)	0.99	0.99	0.90	0.45/0.30	2.14
Hardware multiply/divide	Optional	Optional	Standard	Standard	Standard
Hardware floating point	Optional	Optional	Optional	Optional	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	—	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	Standard	Standard	Standard	Standard	9 standard
Maximum I/O rate, words/sec	2,000,000	2,000,000	2,000,000	2,000,000	1,100,000
No. of external interrupt levels	Variable	Variable	Variable	Variable	16
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	Special order	Special order	Special order	Special order	No
Magnetic tape speed, cps	36K max.	36K max.	36K max.	36K max.	60K max.
Punched card input speed, cpm	300	300	300	300	1000 max.
Punched card output speed, cpm	75	75 max.	75 max.	75 max.	160 max.
High-speed paper tape input, cps	300	300	300	300	400
High-speed paper tape output, cps	50	50	50	50	50
Other standard peripheral units	DECTape, CRT displays, A/D converters, printers, etc.	DECTape, CRT displays, A/D converters, printers, etc.	DECTape, CRT displays, A/D converters, printers, etc.	DECTape, CRT displays, A/D converters, printers, etc.	Line printers, plotter, communications
SOFTWARE					
Assembler	1 & 2-pass	1 & 2-pass	1 & 2-pass	1 & 2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC	BASIC	BASIC	BASIC	Yes
Operating system	Yes	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	Not available	Not available	Not available	Not available	Not available
Price of basic system with 8K words	\$9,495	\$12,995	\$23,900 (16K core)	\$32,000 (16K MOS)	\$33,175
Date of first delivery	Sept. 1973	Jan. 1973	April 1972	May 1972	Jan. 1970
Number installed to date	See Comments	See Comments	See Comments	See Comments	NA
COMMENTS	Over 11,000 PDP-11's have been installed. PDP-11/35, a new entry, is an improved version of the 11/15 and 11/20 (still available). PDP-11/05 and 11/35 are for OEM use, while the 11/40 is the end-user 11/35 version. PDP-11/45 and 11/50 semiconductor memories can mix 450-nsec. MOS (to 32K words) with 300-nsec. bipolar memory to 8K words (mix and match). The 11/45 and 11/50 include 2 Unibus structures for increased data handling.				Controlled by 1K to 4K words of 90-nsec read-only memory. One version, META 4/1130, emulates the IBM 1130, and META 4/1800 emulates the IBM 1800.

All About Minicomputers

MANUFACTURER & MODEL	Electronic Associates PACER	Electronic Processors EPI-118	Electronic Processors EPI-218	Four-Phase Systems, Inc. System IV/40	Four-Phase Systems, Inc. System IV/70
DATA FORMATS					
Word length, bits	16	18	18	24	24
Fixed-point operand length, bits	16	18	18	24	24
Instruction length, bits	16	18	18/36	24	24
MAIN STORAGE					
Storage type	Core	Core	Core	Semiconductor	Semiconductor
Cycle time, microseconds/word	1.0	1.0	1.2	2.0	2.0
Minimum capacity, words	8,192	4,096	4,096	8,192	4,096
Maximum capacity, words	65,536	32,768	32,768	24,576	32,768
Parity checking	No	No	No	Standard	Standard
Storage protection	Standard	No	Optional	No	No
CENTRAL PROCESSOR					
No. of accumulators	†	2	3	5	5
No. of index registers	1	0	3	3	3
No. of directly addressable words	512	32,768	32,768	24,576	32,768
Indirect addressing	Multi-level	No	Multi-level	One-level	One-level
Add time, microseconds (full word)	2.0	2.5	2.4	16	16
Hardware multiply/divide	Standard	No	Optional	Standard	Standard
Hardware floating point	Optional	No	No	Standard	Standard
Hardware byte manipulation	No	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	No	Standard	No	No
Power failure protection	Standard	Standard	Standard	No	No
Real-time clock or timer	Optional	Optional	Optional	Standard	Standard
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	21	21	24	24
Direct memory access channel	Optional	Optional	Optional	No	No
Maximum I/O rate, words/sec	1,000,000	900,000	900,000	125,000	125,000
No. of external interrupt levels	64	0 to 18	0 to 18	8	8
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	No	No	No	No
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	120K max.	10K-30K	10K-30K	—	60K max.
Punched card input speed, cpm	300	300	300	—	300
Punched card output speed, cpm	—	100	100	—	—
High-speed paper tape input, cps	300	300	300	—	—
High-speed paper tape output, cps	120	75	75	—	—
Other standard peripheral units	Line printers, cartridge tape, CRT displays, comm., plotters, etc.	Line printers, CRT display, cassette tape, A/D & comm. interfaces, etc.	Line printers, CRT display, cassette tape, A/D & comm. interfaces, etc.	CRT displays, character printer, comm. controller	CRT displays, line printer, comm. controller, IBM channel adapter
SOFTWARE					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	No	No	No	No	No
FORTRAN compiler	Yes	No	No	No	No
Other compilers	Op. Interpreter	BASIC	BASIC	COBOL, RPG	COBOL, RPG
Operating system	Yes	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	Not available	\$2,790	\$3,490	Not available	\$16,000
Price of basic system with 8K words	\$15,200	\$3,990	\$4,690	\$15,750	\$22,600
Date of first delivery	May 1972	Nov. 1970	Jan. 1973	June 1973	Feb. 1971
Number installed to date	150	Over 700	Over 90	100	1,000
COMMENTS	PACER is compatible with EIA's earlier 640, which it replaces. Uses MSI and LSI technology. EIA supports interprocessor communications.	Basic add time is 2.0 microseconds per octal digit. Faster, 18-bit arithmetic unit is optional. Prices listed are to "qualified OEM users."	18-bit arithmetic unit is standard. Prices listed are to "qualified OEM users."	Specifically designed for distributed processing, remote data entry, and retrieval. Price includes 290K-byte diskette drive.	Specifically designed to support up to 32 interactive video terminals and associated peripherals. MOS/LSI CPU & memory.

All About Minicomputers

MANUFACTURER & MODEL	Fujitsu FACOM R-E	Fujitsu FACOM U-200	GEC Computers 2050	GEC Computers 4080	General Automation SPC-12
DATA FORMATS					
Word length, bits	16	8	8	8	8
Fixed-point operand length, bits	16	8/16/32	8/16/24/32	8/16/24/32	8/12
Instruction length, bits	16	16/32/48	8 or 16	8 or 16	8/16
MAIN STORAGE					
Storage type	Core	Core/semicond.	Core	Core	Core
Cycle time, microseconds/word	1.5	0.65/0.75	0.950	0.550	2.16
Minimum capacity, words	4,096	4,096	4,096	32,768	4,096
Maximum capacity, words	32,768	32,768	65,536	262,144	16,384
Parity checking	Standard	Standard	No	No	Optional
Storage protection	No	Optional	No	Standard	No
CENTRAL PROCESSOR					
No. of accumulators	1	8	1	1	4
No. of index registers	4	7	6	8	3
No. of directly addressable words	512	32,768	—	—	4,096
Indirect addressing	One-level	One-level	Yes	Yes	One-level
Add time, microseconds (full word)	6.0	1.58/1.93	3.4	1.1	6.48
Hardware multiply/divide	No	Optional	Standard	Standard	No
Hardware floating point	No	No	No	Standard	No
Hardware byte manipulation	None	Standard	Standard	Standard	Standard
Immediate (literal) instructions	No	Standard	No	Standard	Standard
Power failure protection	Optional	Standard	Standard	—	Optional
Real-time clock or timer	Optional	Optional	Standard	Standard	Standard
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	8/16	8	8	8/12
Direct memory access channel	Standard	Standard	Optional	Standard	Optional
Maximum I/O rate, words/sec	400,000	1,000,000	1,200,000	—	460,000
No. of external interrupt levels	1	4	64	256	2-256
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	No	Yes	No	Yes	Yes
Drum storage	Yes	Yes	No	No	Yes
Magnetic tape speed, cps	21.6K	9.6K	Yes	Yes	60K max.
Punched card input speed, cpm	300	100/300/600	400	400	400/1000
Punched card output speed, cpm	30	30	No	No	100
High-speed paper tape input, cps	200/400	300/600	500	500	400
High-speed paper tape output, cps	50/100/200	50/100/200	110	110	75
Other standard peripheral units	Line printer, plotter, optical mark reader	Cassette tape, line printer, communications, displays, etc.	Printer, console, cassette, plotter	Printer, console, plotter	A/D converters, communications interfaces
SOFTWARE					
Assembler	2-pass	1 & 2-pass	Symbolic	BABBAGE	1-pass
Macro assembler	No	Yes	Yes	Yes	No
FORTRAN compiler	Yes	Yes	Yes	Yes	No
Other compilers	No	No	CORAL 66	CORAL 66	No
Operating system	No	Yes	No	NUCLEUS, COS, DOS	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	On request	\$8,036	Not available	Not available	\$2,980 to \$3,980
Price of basic system with 8K words	On request	\$10,179	\$12,000	\$35,000	\$3,850 to \$4,850
Date of first delivery	Not specified	Oct. 1972	May 1973	Oct. 1973	Jan. 1968
Number installed to date	Over 750	Over 300	170	35	Over 2,000
COMMENTS	Has 28 basic instructions and 5 addressing modes.	Processor, memory, and peripheral devices share a single high-speed bus. Offers wide range of peripherals.	Forms basis of GEC 2050 RJE terminal for IBM and ICL systems; typical system costs about \$20,000.	Modular Multi-processor (up to 4) with built-in Multiprogramming for real-time operations; typical system costs about \$95,000.	Available in three models; SPC-12/10, 12/15, and 12/20. Replaced by LSI-12/16.

All About Minicomputers

MANUFACTURER & MODEL	General Automation LSI-12/16	General Automation LSI-16	General Automation SPC-16	General Automation System 18/30	GRI Computer GRI-99 Model 10
DATA FORMATS					
Word length, bits	8	16	16	16	16
Fixed-point operand length, bits	8/12	16	16	16/32	16/32
Instruction length, bits	8/16	16	16	16/32	16/32
MAIN STORAGE					
Storage type	Semiconductor	Core/semicond.	Core	Core	Core
Cycle time, microseconds/word	2.64	1.8	0.80/0.96/1.44	0.96	1.76
Minimum capacity, words	1,024	1,024	4,096	4,096	4,096
Maximum capacity, words	32,768	32,768	65,536	32,768	32,768
Parity checking	No	Optional	No	Standard	No
Storage protection	No	No	No	Standard	—
CENTRAL PROCESSOR					
No. of accumulators	4	18	16	2	2
No. of index registers	3	6	6	3	1
No. of directly addressable words	4,096	32,768	32,768	32,768	32,768
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Add time, microseconds (full word)	10.56	1.2	0.80/0.96/1.44	2.4	1.76
Hardware multiply/divide	No	Standard	Optional	Standard	Optional
Hardware floating point	No	Optional	Optional	Yes	No
Hardware byte manipulation	Standard	Standard	Standard	No	Optional
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Standard	Standard	Standard	Standard	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	No	Standard	Standard	5 standard	Standard
Maximum I/O rate, words/sec	27,000	185,000	1,040,000	960,000	568,000
No. of external interrupt levels	2-256	64-unlimited	64-unlimited	6-59	Unlimited
PERIPHERAL EQUIPMENT					
Disk pack storage	No	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	No	Yes	Yes	Yes	Yes
Drum storage	No	Yes	Yes	Yes	No
Magnetic tape speed, cps	350	60K max.	60K max.	60K max.	—
Punched card input speed, cpm	—	400/1000	400/1000	400/1000	300
Punched card output speed, cpm	—	100	100	100	120
High-speed paper tape input, cps	400	400	400	400	300
High-speed paper tape output, cps	75	75	75	75	75
Other standard peripheral units	A/D converters, communications interfaces, TTY, CRT, printers	A/D converters, communications interfaces	A/D converters, communications interfaces, CRT, printer, plotter	A/D converters, communications interfaces, printer	Cassette tape, line printers, displays, etc.
SOFTWARE					
Assembler	2-pass (cross assy.)	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	No	No
FORTRAN compiler	No	Yes	Yes	Yes	No
Other compilers	No	BASIC	BASIC	RPG	BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	Not available	Not available	\$3,950 to \$8,550	\$18,950	\$4,670
Price of basic system with 8K words	Not available	Not available	\$5,350 to \$10,150	\$22,950	\$5,115
Date of first delivery	March 1974	Late 1974	May 1970	July 1969	June 1972
Number installed to date	20	NA	1,900	Over 500	NA
COMMENTS	Available in three models; a board-only configuration with 1K words of memory costs \$495 in quantities of 1,000.	Packaged on a single PCB, this microcomputer uses two SOS chips in its processor section.	Available in six models, offering choice of core size, speeds, and I/O packaging. Read-only memory is interchangeable with core. Replaced by LSI-16.	Instruction set is fully compatible with the IBM 1130 and 1800. SPC-18 is an OEM version of the 18/30.	See Comments on next page.

All About Minicomputers

MANUFACTURER & MODEL	GRI Computer GRI-99 Model 30	GRI Computer GRI-99 Model 40	GRI Computer GRI-99 Model 50	GTE IS/1100	Hewlett- Packard 2100
DATA FORMATS					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16/32	16/32	16/32	16	16
Instruction length, bits	16/32	16/32	16/32/48	16	16
MAIN STORAGE					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	1.76	1.76	1.76	0.75	0.98
Minimum capacity, words	4,096	4,096	8,192	4,096	8,192
Maximum capacity, words	32,768	32,768	131,072	262,144	32,768
Parity checking	No	No	No	Optional	Standard
Storage protection	—	—	Optional	Standard	Standard
CENTRAL PROCESSOR					
No. of accumulators	2	8	8	16	2
No. of index registers	1	1	1	15	0
No. of directly addressable words	32,768	32,768	32,768	65,536	2,048
Indirect addressing	One-level	One-level	One-level	Multi-level	Multi-level
Add time, microseconds (full word)	1.76	1.76	1.76	2.25	1.96
Hardware multiply/divide	Optional	Standard	Optional	Optional	Standard
Hardware floating point	No	No	No	Standard	Standard
Hardware byte manipulation	Optional	Optional	Standard	Standard	No
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	Standard	Standard	Standard	Standard	Optional
Maximum I/O rate, words/sec	568,000	568,000	568,000	650,000	1,000,000
No. of external interrupt levels	Unlimited	Unlimited	Unlimited	8-16	60
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	No	Yes	No
Magnetic tape speed, cps	—	—	—	120K	72K
Punched card input speed, cpm	300	300	—	200 to 1,000	600
Punched card output speed, cpm	120	120	—	—	45
High-speed paper tape input, cps	300	300	300	300	500
High-speed paper tape output, cps	75	75	75	125	75
Other standard peripheral units	Cassette tape, line printers, displays, etc.	Cassette tape, line printers, displays, etc.	Cassette tape, line printers, displays, etc.	Line printers, communications interfaces	Line printers, communications interfaces, plotters
SOFTWARE					
Assembler	2-pass	2-pass	1 & 2-pass	2-pass	2-pass
Macro assembler	No	No	No	Yes	No
FORTRAN compiler	No	No	No	Yes	Yes
Other compilers	BASIC	BASIC	RPG II	BASIC, COBOL	ALGOL, BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$5,060	\$5,725	Not available	\$5,700	Not available
Price of basic system with 8K words	\$5,505	\$6,170	\$6,300	\$7,500	\$9,015
Date of first delivery	June 1972	June 1972	Aug. 1974	Jan. 1972	June 1971
Number installed to date	Over 900	Over 400	NA	500	5,500 (all mod.)
COMMENTS	Based on a Universal Bus System, in which all system elements share common data busses and communicate in direct, parallel fashion. Designed mainly for OEM use, as central control computers in larger systems.			Designed for communications and control applications. Features 16-general-purpose registers.	Controlled by semiconductor read-only memory. User-micro-programmable; supports writable control store.

All About Minicomputers

MANUFACTURER & MODEL	Hewlett-Packard 2105A (21-M/10)	Hewlett-Packard 2108A (21-M/20)	Hewlett-Packard 3000	Hitachi HITAC 10-II	Honeywell System 700
DATA FORMATS					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16	16	16/32	8/16/32	16/32
Instruction length, bits	16	16	16	16	16
MAIN STORAGE					
Storage type	Semiconductor	Semiconductor	Core	Core	Core
Cycle time, microseconds/word	0.650	0.650	0.90	0.9	0.775
Minimum capacity, words	4,096	4,096	32,768	4,096	8,192
Maximum capacity, words	32,768	65,536	65,536	32,768	65,536
Parity checking	Standard	Standard	Standard	Standard	Optional
Storage protection	No	Optional	Standard	Optional	Optional
CENTRAL PROCESSOR					
No. of accumulators	2	2	Stack	1	1
No. of index registers	2	2	1	1	2
No. of directly addressable words	2,048	2,048	512	512	1,024
Indirect addressing	Multi-level	Multi-level	One-level	One-level	Multi-level
Add time, microseconds (full word)	1.94	1.94	1.05	1.8	1.55
Hardware multiply/divide	Standard	Standard	Standard	Optional	Standard
Hardware floating point	Standard	Standard	Standard	No	No
Hardware byte manipulation	Standard	Standard	Standard	No	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	No
Power failure protection	Optional	Optional	Standard	Optional	Standard
Real-time clock or timer	Optional	Optional	Standard	Optional	Standard
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	Optional	Optional	Standard	Optional	Standard
Maximum I/O rate, words/sec	617,000	617,000	1,400,000	833,000	1,000,000
No. of external interrupt levels	60	60	253	1-4	63
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	Yes	Yes	No
Magnetic tape speed, cps	72K max.	72K max.	72K max.	19.2K/40K	112K max.
Punched card input speed, cpm	600	600	600/1200	310	300 to 1050
Punched card output speed, cpm	45	45	200	No	100
High-speed paper tape input, cps	500	500	500	240/600	300
High-speed paper tape output, cps	75	75	75	110	110
Other standard peripheral units	Line printers, communications interfaces, plotters	Line printers, communications interfaces, plotters	Line printers, CRT displays, communications interfaces	Line printers, cassette tape, mark readers, plotter, etc.	6 line printers, cassette tape, A/D and comm. interfaces, etc.
SOFTWARE					
Assembler	2-pass	2-pass	Yes	1 & 2-pass	2-pass
Macro assembler	No	No	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	ALGOL, BASIC	ALGOL, BASIC	BASIC, COBOL	BASIC	BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$5,950	\$7,100	Not available	\$7,607	Not available
Price of basic system with 8K words	\$6,800	\$7,950	Not available	\$10,250	\$10,800 (\$330/month)
Date of first delivery	Aug. 1974	Aug. 1974	Nov. 1972	Nov. 1972	June 1972
Number installed to date	NA	NA	50 (est.)	Over 600	Over 1,000
COMMENTS	Controlled by semiconductor read-only memory. User-micro-programmable; supports writable control store.	Controlled by semiconductor read-only memory. User-micro-programmable; supports writable control store.	Features stack architecture and 170 instructions. System prices range from about \$150,000 to \$300,000.	Priced are based upon conversion ratio of 280 Yen per dollar.	Type 716 CPU is incorporated into G systems designed for a variety of sensor-based and communications applications.

All About Minicomputers

MANUFACTURER & MODEL	Honeywell 316	Honeywell 516	Information Comp. Systems ALP1	Information Comp. Systems ALP2	Information Comp. Systems ALP3
DATA FORMATS					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16/32	16/32	16/32	16/32	16/32
Instruction length, bits	16	16	16	16	16
MAIN STORAGE					
Storage type	Core	Core	Core/semicond.	Core/semicond.	Core/semicond.
Cycle time, microseconds/word	1.6	0.96	0.65/0.33	0.65/0.33	0.65/0.33
Minimum capacity, words	4,096	4,096	4,096	4,096	4,096
Maximum capacity, words	32,768	32,768	65,536	262,144	262,144
Parity checking	Optional	Optional	Standard	Standard	Standard
Storage protection	Optional	Optional	No	Standard	Standard
CENTRAL PROCESSOR					
No. of accumulators	1	1	2	2	2
No. of index registers	1	1	0	2	2
No. of directly addressable words	1,024	1,024	256	256	256
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	3.2	1.92	2.25	2.25	2.25
Hardware multiply/divide	Optional	Optional	Standard	Standard	Standard
Hardware floating point	Special order	Special order	No	No	Standard
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	No	No	Standard	Standard	Standard
Power failure protection	Optional	Optional	Standard	Standard	Standard
Real-time clock or timer	Optional	Optional	Standard	Standard	Standard
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	Optional	Optional	Standard	Standard	Standard
Maximum I/O rate, words/sec	313,000	1,040,000	1,500,000	6,000,000	6,000,000
No. of external interrupt levels	1-65	1-65	64	64	64
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape speed, cps	64K max.	64K max.	60K/120K	60K/120K	60K/120K
Punched card input speed, cpm	800	800	300/600	300/600	300/600
Punched card output speed, cpm	100	100	—	—	—
High-speed paper tape input, cps	300	300	500	500	500
High-speed paper tape output, cps	110	110	75/150	75/150	75/150
Other standard peripheral units	Line printers, communications interfaces, dis- plays, etc.	Line printers, communications interfaces, dis- plays, etc.	Printers, CRT displays, com- munications interfaces	Printers, CRT displays, com- munications interfaces	Printers, CRT displays, communications interfaces
SOFTWARE					
Assembler	1 & 2-pass	1 & 2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC	BASIC	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$8,400	\$23,800	\$11,100	\$13,700	\$14,600
Price of basic system with 8K words	\$11,900	\$31,800	\$11,800	\$14,400	\$15,300
Date of first delivery	June 1969	Oct. 1966	Aug. 1972	Jan. 1973	March 1973
Number installed to date	Over 2,500	Over 1,400	NA	NA	NA
COMMENTS	The 316 and 516 are logically identical and form the basis of the Series 1600 data acquisition/data communications systems. These 2 systems are mature machines on which changes are no longer expected.		The ICS Multum line is a family of multi-memory, multi-processor systems. Up to 8 processors and 4 store blocks (each with 4K to 64K words) can be interconnected, and up to 4 store-processor transfers can proceed simultaneously. Prices are based upon \$2.57 per British pound.		

All About Minicomputers

MANUFACTURER & MODEL	Intel MCS-4 Microcomputer Set	Intel Intellec 4 Microcomputer	Intel MCS-8 Microcomputer Set	Intel Intellec 8/Mod 8 Microcomputer	Intel MCS-80 Microcomputer Set
DATA FORMATS					
Word length, bits	4/8	4/8	8	8	8
Fixed-point operand length, bits	4	4	8	8	8/16
Instruction length, bits	8/16	8/16	8/16/24	8/16/24	8/16/24
MAIN STORAGE					
Storage type	Semiconductor	Semiconductor	Semiconductor	Semiconductor	Semiconductor
Cycle time, microseconds/word	10.8	10.8	12.5	12.5	2.0
Minimum capacity, words	256	4,096	256	4,096	256
Maximum capacity, words	8,192	8,192	16,384	16,384	65,536
Parity checking	No	No	No	No	No
Storage protection	No	No	No	No	No
CENTRAL PROCESSOR					
No. of accumulators	1	1	1	1	1
No. of index registers	16 (4-bit)	16	6	6	6
No. of directly addressable words	4,096	8,192	16,384	16,384	65,536
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Add time, microseconds (full word)	10.8	10.8	12.5	12.5	2.0
Hardware multiply/divide	No	No	No	No	No
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	No	No	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	No	Optional	No	Optional
Real-time clock or timer	Optional	No	Optional	No	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	4	4	8	8	8
Direct memory access channel	Optional	No	Optional	No	Optional
Maximum I/O rate, words/sec	100,000	100,000	80,000	80,000	500,000
No. of external interrupt levels	None	None	1	1	1
PERIPHERAL EQUIPMENT					
Disk pack storage	No	No	No	No	No
Non-interchangeable disk storage	No	No	No	No	No
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	—	—	—	—	—
Punched card input speed, cpm	—	—	—	—	—
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	—	150	—	150	—
High-speed paper tape output, cps	—	—	—	—	—
Other standard peripheral units	—	—	—	—	—
SOFTWARE					
Assembler	2-pass	2-pass	2-pass	3-pass	2-pass
Macro assembler	No	No	Yes	Yes	Yes
FORTRAN compiler	No	No	No	No	No
Other compilers	No	No	PL/M	PL/M	PL/M
Operating system	No	No	No	Yes	No
PRICING & AVAILABILITY					
Price of basic system with 4K words	Not available	\$2,545	Not available	Not available	Not available
Price of basic system with 8K words	Not available	\$3,340	Not available	\$3,540	Not available
Date of first delivery	June 1971	Nov. 1973	Jan. 1972	Nov. 1973	Dec. 1973
Number installed to date	NA	NA	NA	NA	NA
COMMENTS	Consists of 4 kinds of LSI chips; processor, shift register, R/W memory and ROM. ROM modules are programmed to user spec's. CPU chip price is \$60 in quantity.	Facilitates development of programs for the MCS-4 by providing random access memory (RAM) plus a control panel and display.	CPU is a single MOS chip that can be combined with various R/W memory, ROM, and shift register modules. Chip price is \$180 in quantity.	Facilitates development of programs for the MCS-8 by providing random access memory (RAM) plus a control panel and display.	CPU is a single MOS chip that can be combined with various R/W memory, ROM, and shift register modules. CPU chip price is \$360 in quantity.

All About Minicomputers

MANUFACTURER & MODEL	Intel Intellec 8/Mod 80 Microcomputer	Interdata Model 50	Interdata Model 55	Interdata Model 60	Interdata Model 70
DATA FORMATS					
Word length, bits	8	16	16	16	16
Fixed-point operand length, bits	8/16	16	16	16	16
Instruction length, bits	8/16/24	16/32	16/32	16/32	16/32
MAIN STORAGE					
Storage type	Semiconductor	Core	Core	Semiconductor	Core
Cycle time, microseconds/word	2.0	1.0	1.0	0.270	1.0
Minimum capacity, words	4,096	4,096	8,192	8,192	4,096
Maximum capacity, words	16,384	32,768	57,344	32,768	32,768
Parity checking	No	Optional	Optional	Optional	Optional
Storage protection	No	Optional	Optional	Optional	Optional
CENTRAL PROCESSOR					
No. of accumulators	1	16	32	16	16
No. of index registers	6	15	30	15	15
No. of directly addressable words	65,536	32,768	57,344	32,768	32,768
Indirect addressing	One-level	No	No	No	No
Add time, microseconds (full word)	2.0	1.0	1.0	0.530	1.0
Hardware multiply/divide	No	Standard	Standard	Standard	Standard
Hardware floating point	No	Standard	Standard	No	Standard
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	No	Optional	Optional	Optional	Optional
Real-time clock or timer	No	Optional	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	8	8/16	8/16	8/16	8/16
Direct memory access channel	No	Optional	Optional	Optional	Optional
Maximum I/O rate, words/sec	500,000	1,000,000	2,000,000	1,575,000	1,000,000
No. of external interrupt levels	1	256	512	255	256
PERIPHERAL EQUIPMENT					
Disk pack storage	No	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	No	Yes	Yes	Yes	Yes
Drum storage	No	Yes	Yes	Yes	Yes
Magnetic tape speed, cps	—	36K	36K	28K/56K	36K
Punched card input speed, cpm	—	300	300	400/1,000	300
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	150	300	300	300	300
High-speed paper tape output, cps	—	60	60	75	60
Other standard peripheral units	—	Cassette tape, comm. and A/D interfaces	Cassette tape, comm. and A/D interfaces	Line printers, VDT, TTY, communications	Cassette tape, comm. and A/D interfaces
SOFTWARE					
Assembler	3-pass	1 & 2-pass	1 & 2-pass	1 & 2-pass	1 & 2-pass
Macro assembler	Yes	No	No	No	No
FORTRAN compiler	No	Yes	Yes	Yes	Yes
Other compilers	PL/M	No	No	BASIC	No
Operating system	Yes	Yes (3)	Yes (3)	Yes	Yes (3)
PRICING & AVAILABILITY					
Price of basic system with 4K words	Not available	\$6,800	Not available	Not available	\$6,800
Price of basic system with 8K words	\$3,340	\$9,200	\$15,900	\$14,900	\$9,200
Date of first delivery	June 1974	Apr. 1972	Aug. 1972	June 1973	Dec. 1971
Number installed to date	NA	114	231	10	Over 600
COMMENTS					
	Facilitates development of programs for the MCS-80 by providing random access memory (RAM) plus a control panel and display.	Model 50 is a modified Model 70 with about 20 instructions added for communications applications; Model 55 is a dual processor system made up of a Model 50 and a Model 70.		Model 60 is a data communications system.	Controlled by microprograms in 80-nanosecond bipolar read-only memory. Compatible with earlier Interdata computers.

All About Minicomputers

MANUFACTURER & MODEL	Interdata Model 74	Interdata Model 80	Interdata Model 85	Interdata 7/16	Interdata 7/16 (HSALU)
DATA FORMATS					
Word length, bits	16	16	16	8/16/32	8/16/32
Fixed-point operand length, bits	16	16	16	8/16/32	8/16/32
Instruction length, bits	16/32	16/32	16/32	16/32	16/32
MAIN STORAGE					
Storage type	Core	Semiconductor	Semiconductor	Core	Core
Cycle time, microseconds/word	1.0	0.24	0.27	1.0	0.75/1.0
Minimum capacity, words	4,096	8,192	8,192	4,096	4,096
Maximum capacity, words	32,768	32,768	32,768	32,768	32,768
Parity checking	Optional	Optional	Optional	Optional	Optional
Storage protection	Optional	Optional	Optional	Optional	Optional
CENTRAL PROCESSOR					
No. of accumulators	16	16	16	16	16
No. of index registers	15	15	15	15	15
No. of directly addressable words	32,768	32,768	32,768	32,768	32,768
Indirect addressing	No	No	No	No	No
Add time, microseconds (full word)	1.5	0.45	0.53	1.50	0.75
Hardware multiply/divide	Standard	Standard	Standard	Optional	Standard
Hardware floating point	No	Standard	Standard	Optional	Standard
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Optional	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	8/16	8/16	8/16	8/16	8/16
Direct memory access channel	Standard	Optional	Standard	Optional	Optional
Maximum I/O rate, words/sec	1,000,000	4,500,000	2,000,000	33,000	120,000
No. of external interrupt levels	256	256	256	255	255
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape speed, cps	36K	36K	36K	72K	72K
Punched card input speed, cpm	300	300	300	1,000	1,000
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	300	300	300	300	300
High-speed paper tape output, cps	60	60	60	60	60
Other standard peripheral units	Cassette tape, comm. and A/D interfaces	Cassette tape, comm. and A/D interfaces	Cassette tape, comm. and A/D interfaces	Cassette tape, line printer, A/D, CRT display	Cassette tape, line printer, A/D, CRT display
SOFTWARE					
Assembler	1 & 2-pass	1 & 2-pass	1 & 2-pass	1 & 2-pass	1 & 2-pass
Macro assembler	No	No	No	No	No
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	No	No	No	No	No
Operating system	Yes (3)	Yes (3)	Yes (3)	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$3,600	Not available	Not available	\$3,200	\$8,100
Price of basic system with 8K words	\$5,300	\$14,900	\$22,800	\$3,700	\$8,600
Date of first delivery	March 1973	July 1972	July 1973	March 1974	July 1974
Number installed to date	Over 100	30 (est.)	NA	72	NA
COMMENTS	Designed for OEM customers; upward-compatible with other Interdata computers.	Features 240-nanosecond MOS main memory. Controlled by microprograms in 60-nanosecond bipolar read-only memory.	Controlled by user-alterable microprograms in a 4K-byte Dynamic Control Store; features dual banks of 24 16-bit micro registers.	Designed for OEM use, the system is software and interface compatible with other Interdata systems.	Designed for OEM use, the system is upgradable to a 7/32.

All About Minicomputers

MANUFACTURER & MODEL	Interdata 7/32	IBM System/7	Linolex Model 1203	Lockheed Electronics MAC 16	Lockheed Electronics MAC Jr.
DATA FORMATS					
Word length, bits	8/16/32	16	8	16	16
Fixed-point operand length, bits	8/16/32	16	Variable	16	16
Instruction length, bits	16/32/48	16/32	Variable	16	16
MAIN STORAGE					
Storage type	Core	Semiconductor	Semiconductor	Core	Core
Cycle time, microseconds/word	0.75/1.0	0.4	1.2	1.0	1.0
Minimum capacity, words	4,096 (32-bit)	2,048	8,192	4,096	4,096
Maximum capacity, words	262,144 (32-bit)	65,536	32,768	65,536	65,536
Parity checking	Optional	Standard	No	Optional	Optional
Storage protection	Optional	No	No	Optional	Optional
CENTRAL PROCESSOR					
No. of accumulators	32	4 groups of 1	All of memory	1	1
No. of index registers	30	4 groups of 7	All of memory	8-64	4-16
No. of directly addressable words	262,144	16,384	32,768	1,024	1,024
Indirect addressing	No	No	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	1.0	0.8	22	2.0	2.0
Hardware multiply/divide	Standard	No	Mult. standard	Optional	Optional
Hardware floating point	Optional	No	No	No	No
Hardware byte manipulation	Standard	No	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	No	Standard	Optional
Real-time clock or timer	Optional	Standard (2)	Standard	Standard	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	8/16	16	8	8/16	8/16
Direct memory access channel	Optional	Standard	No	Standard	Optional
Maximum I/O rate, words/sec	350,000	500,000	10,000	1,000,000	1,000,000
No. of external interrupt levels	1,024	64	0	8-64	4-16
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	In dev'tment	No	No
Non-interchangeable disk storage	Yes	Yes	No	Yes	Yes
Drum storage	Yes	No	No	No	No
Magnetic tape speed, cps	72K	RPQ	10K	20K	20K
Punched card input speed, cpm	1,000	RPQ	400	300	300
Punched card output speed, cpm	—	RPQ	—	—	—
High-speed paper tape input, cps	300	RPQ	150	300	300
High-speed paper tape output, cps	60	RPQ	75	75	75
Other standard peripheral units	Cassette tape, line printer, A/D, CRT display	Analog and digital I/O interfaces, communications interface	Printers, communications interfaces	Line printer, cassette tape, communications, displays	Line printer, cassette tape, communications, displays
SOFTWARE					
Assembler	1 & 2-pass	1-pass	6-pass	2-pass	2-pass
Macro assembler	No	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Runs on S/360	No	Yes	Yes
Other compilers	No	No	BASIC, DEGEN	No	No
Operating system	Yes	Limited	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	Not available	\$16,400	Not available	\$11,040	\$7,810
Price of basic system with 8K words	Not available	\$23,800	\$12,900	\$13,515	\$10,285
Date of first delivery	July 1974	Nov. 1971	Aug. 1972	Feb. 1969	Jan. 1971
Number installed to date	NA	2,500 (est.)	350	350	1,637
COMMENTS	Hardware and software com- patible with 7/16. Price of 7/32 with 32KB memory is \$9,950.	Designed for sen- sor-based applica- tions. Can be used on-line with IBM 1130, 1800, 360, and 370 com- puters. Disk pack is System/3-com- patible.	Price includes integral 1600- character CRT, keyboard, and three cassette tape drives. The 4K-word model 1103 is no longer available.	Optional Multiplex Data Channel handles up to 16 concurrent I/O operations.	Program-com- patible with MAC 16. Op- tional channel handles up to 16 concurrent I/O operations.

All About Minicomputers

MANUFACTURER & MODEL	Lockheed Electronics SUE	Microdata MICRO-ONE	Microdata 400/10	Microdata 1600/30	Microdata 1600/40
DATA FORMATS					
Word length, bits	16	8	8	8	8
Fixed-point operand length, bits	16	8/16/24/32	8	8/16/24/32	8/16/24/32
Instruction length, bits	16/32	8/16/24/32	8/16	8/16/24/32	8/16/24/32
MAIN STORAGE					
Storage type	Core/ROM/RAM	Core/Semicond.	Core	Core	Core
Cycle time, microseconds/word	0.85/0.20/0.25	1.2/0.8	1.6	1.0	1.0
Minimum capacity, words	4K/1K/1K	1,024	1,024	4,096	8,192
Maximum capacity, words	32K/30K/30K	65,536	65,536	65,536	65,536
Parity checking	Optional	No	No	No	No
Storage protection	Optional	No	No	No	No
CENTRAL PROCESSOR					
No. of accumulators	7	3	2	3	2
No. of index registers	7	1	1 or 2	1	1
No. of directly addressable words	32,768	32,768	4,096	32,768	65,536
Indirect addressing	Multi-level	One-level	No	One-level	One-level
Add time, microseconds (full word)	2.79	4.8	1.6	4.0	5.0
Hardware multiply/divide	Optional	Standard	No	Standard	Standard
Hardware floating point	No	No	No	Optional	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	No	Standard	Standard
Power failure protection	Optional	Optional	Standard	Standard	Standard
Real-time clock or timer	Optional	Standard	Standard	Standard	Standard
INPUT/OUTPUT CONTROL					
I/O word size, bits	8/16	8	8	8	8
Direct memory access channel	Standard	Optional	Standard	Optional	Optional
Maximum I/O rate, words/sec	5,000,000	833,000	625,000	1,000,000	1,000,000
No. of external interrupt levels	4-64	2-128	1-64	2-128	2-64
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	36K	36K	20K	36K	36K
Punched card input speed, cpm	600	300	300	300	300
Punched card output speed, cpm	35	—	—	—	—
High-speed paper tape input, cps	300	300	300	300	300
High-speed paper tape output, cps	75	75	75	75	75
Other standard peripheral units	Line printer, cassette tape, communications, displays	CRT, line printers, comm., I/O interfaces	Communications interfaces	Line printer, communications interfaces	CRT displays
SOFTWARE					
Assembler	1-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	No	No	No	No
FORTRAN compiler	Yes	Yes	No	Yes	No
Other compilers	RPG-II	BASIC	No	PL-1	BASIC
Operating system	Yes	Yes	No	Yes	Yes (special purpose)
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$4,270	Not available	\$2,250 (100-unit quantities) NA	\$6,075	Not available
Price of basic system with 8K words	\$5,870	\$2,300 (20-unit quantity)	NA	\$6,400	\$6,900
Date of first delivery	Sept. 1972	Nov. 1974	Jan. 1973	Jan. 1973	Nov. 1972
Number installed to date	400	NA	NA	Over 1,250 for these & earlier 1600 sys.	
COMMENTS	Highly modular packaging; core and semiconductor memory can be inter-mixed. Up to 4 processors can be used in a system.	Microprogram-mable system; compatible with the other Micro-data systems.	Repackaged, program-compatible version of the earlier Micro 400. Model 400/10 has been replaced by MICRO-ONE.	Microprogrammed; features stack processing and character/string manipulation; compatible with the earlier Micro.1600/20 & 1600/21.	Interactive BASIC system; handles up to 32 user terminals.

All About Minicomputers

MANUFACTURER & MODEL	Microdata 1600/60	Microdata 3200	Microdata 3230	Microdata REALITY	Microdata 32/S
DATA FORMATS					
Word length, bits	8	16	8	16	16
Fixed-point operand length, bits	8/16/24/32	8/16	8/16/24/32	8/16/32/48	1/2/4/8/16/32
Instruction length, bits	8/16/24/32	32 (micro)	8/16/24/32	8/16/32/48	8/16/24/32/40
MAIN STORAGE					
Storage type	Core	Semiconductor	Semiconductor	Core	Semiconductor
Cycle time, microseconds/word	1.0	0.3	0.3	2.0	0.3
Minimum capacity, words	4,096	4,096	8,192	8,192	4,096
Maximum capacity, words	65,536	131,072	65,536	32,768	131,072
Parity checking	No	Optional	No	No	Optional
Storage protection	No	No	No	Standard	Optional
CENTRAL PROCESSOR					
No. of accumulators	3	32	3	32/terminal	5 (stack)
No. of index registers	1	32	1	17/terminal	5 (stack)
No. of directly addressable words	65,536	131,072	65,536	See Comments	131,072
Indirect addressing	One-level	No	One-level	Multi-level	Multi-level
Add time, microseconds (full word)	4.0	0.135	1.5	NA	0.405
Hardware multiply/divide	Standard	No	Standard	Standard	Standard
Hardware floating point	Optional	No	Optional	No	Standard
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Standard	Standard	Standard	Standard	Standard
INPUT/OUTPUT CONTROL					
I/O word size, bits	8	8/16	8	8	8/16
Direct memory access channel	Optional	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1,000,000	2,500,000	2,500,000	500,000	2,500,000
No. of external interrupt levels	4-128	4	2-64	64	4-1024
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	36K	36K	36K	25K	36K
Punched card input speed, cpm	300	300	300	300	300
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	300	300	300	—	300
High-speed paper tape output, cps	75	75	75	—	75
Other standard peripheral units	Line printer, communications interfaces	Line printer, CRT displays, communications interfaces	Line printer, CRT display, communications interfaces	Line printer, CRT display	Line printer, CRT display, communications interfaces
SOFTWARE					
Assembler	2-pass	Cross-assembly	2-pass	2-pass	No
Macro assembler	No	Yes	No	Yes	No
FORTRAN compiler	Yes	No	Yes	No	No
Other compilers	PL-1	No	BASIC	RPG II, ENGLISH	MPL
Operating system	Yes	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$10,575	\$8,000	Not available	Not available	\$9,450
Price of basic system with 8K words	\$10,900	\$9,200	\$8,450	\$47,500	\$10,650
Date of first delivery	March 1973	Oct. 1973	Oct. 1973	Nov. 1973	March 1974
Number installed to date	Over 50	NA	NA	35	NA
COMMENTS	Communications system based upon the dual- processor Micro 1600D; handles up to 256 lines and 40K char/ sec.	Microprogram- mable processor; 135-nsec control memory holds up to 4K 32-bit microinstructions.	Program-com- patible with, and 5 to 10 times faster than, the Micro.820, 821, 1600/20, 1600/21, & 1600/30.	REALITY im- plements a micro- code virtual mem- ory system. All of virtual mem- ory (disc storage) is addressable.	Features stack architecture, fundamental language is MPL, a subset of PL/1.

All About Minicomputers

MANUFACTURER & MODEL	Modular Comp. Systems Modcomp I	Modular Comp. Systems Modcomp II	Modular Comp. Systems Modcomp III	Modular Comp. Systems Modcomp IV/10	Modular Comp. Systems Modcomp IV/25
DATA FORMATS					
Word length, bits	16	16	16	16/32	16/32
Fixed-point operand length, bits	16	16/32	16/32/48	16/32	16/32
Instruction length, bits	16/32	16/32	16/32	16/32	16/32
MAIN STORAGE					
Storage type	Core, semicond.	Core, semicond.	Core, semicond.	Core, semicond.	Core, semicond.
Cycle time, microseconds/word	0.8	0.8	0.8	0.64 (16-bit)	0.64 (16-bit)
Minimum capacity, words	512	4,096	4,096	16,384 (16-bit)	16,384 (16-bit)
Maximum capacity, words	32,768	65,536	65,536	65,536	262,144
Parity checking	Optional	Optional	Standard	Standard	Standard
Storage protection	No	Optional	Optional	Optional	Standard
CENTRAL PROCESSOR					
No. of accumulators	3	15	15	15	240
No. of index registers	3	7	7	7	112
No. of directly addressable words	32,768	65,536	65,536	65,536	131,072
Indirect addressing	No	One-level	One-level	One-level	One-level
Add time, microseconds (full word)	0.8	0.8	0.8	0.8 (32 bits)	0.8 (32 bits)
Hardware multiply/divide	Optional	Optional	Optional	Standard	Standard
Hardware floating point	No	Optional	Optional	Optional	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Standard	Standard	Standard
Real-time clock or timer	Optional	Optional	Optional	Standard	Standard
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	Standard	Optional	Optional	Optional	Optional
Maximum I/O rate, words/sec	1,250,000	1,250,000	1,250,000	1,560,000	1,560,000
No. of external interrupt levels	1-16	3-16	4-32	8-16	8-16
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	10K/60K	10K/60K	10K/60K	10K/120K	10K/120K
Punched card input speed, cpm	300/1000	300/1000	300/1000	300/1000	300/1000
Punched card output speed, cpm	100	100	100	100	100
High-speed paper tape input, cps	625	625	625	625	625
High-speed paper tape output, cps	110	110	110	110	110
Other standard peripheral units	Line printers, A/D converters, communications multiplexers	Line printers, A/D converters, communications multiplexers	Line printers, A/D converters, communications multiplexers	Line printers, A/D converters, communications multiplexers	Line printers, A/D converters, communications multiplexers
SOFTWARE					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	No	Yes	Yes	Yes	Yes
FORTRAN compiler	No	Yes	Yes	Yes	Yes
Other compilers	No	BASIC	BASIC	BASIC, RPG	BASIC, RPG
Operating system	No	Yes (3)	Yes (3)	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$4,400	\$7,400	\$9,850	Not available	Not available
Price of basic system with 8K words	\$6,200	\$9,200	\$11,650	\$18,500 (with 16K 16-bit words)	\$23,500 (with 16K 16-bit words)
Date of first delivery	Oct. 1971	March 1971	Dec. 1970	4th qtr. 1974	June 1974
Number installed to date	Over 500	Over 400	Approx. 100	0	NA
COMMENTS	A DMA with extended control capabilities is standard.	4-port memory is available for multiprocessor and I/O processor configurations. A high-throughput comm. processor is also available.	200-nsec read-only control memory consists of 256 to 1024 40-bit words. This system has been replaced by Modcomp II.	Features 32-bit parallel internal operation and 15 general purpose registers. Upward-compatible with Modcomp I, II, III.	Features 32-bit parallel internal operation, 16 sets of general-purpose registers, and 1,024 memory mapping registers.

All About Minicomputers

MANUFACTURER & MODEL	Nanodata OM-1A (OM-1B)	National Semiconductor IMP-8 Microprocessor	National Semiconductor IMP-16P(L) Microprocessor	Nuclear Data ND812	Omnus Computer Corp. Omnus-1
DATA FORMATS					
Word length, bits	18	8	16	12	16
Fixed-point operand length, bits	Variable	8	16	12	16
Instruction length, bits	Variable	8/16	16/32	12/24	16/32
MAIN STORAGE					
Storage type	Core	Semiconductor	Semiconductor	Semiconductor	Core/ROM
Cycle time, microseconds/word	0.75 (1.25)	1.4	1.4	1.0	0.65
Minimum capacity, words	16,384	8,192	4,096	8,192	8,192
Maximum capacity, words	262,144	32,768	32,768	16,384	131,072
Parity checking	Standard	No	No	No	No
Storage protection	Standard	No	No	No	Optional
CENTRAL PROCESSOR					
No. of accumulators	32	4	4	2	2,049
No. of index registers	12	1	2	2	2,049
No. of directly addressable words	262,144	256	256	16,384	32,768
Indirect addressing	Multi-level	One-level	One-level	One-level	No
Add time, microseconds (full word)	1.5 (2.5)	4.55	4.55	2/4	2.0
Hardware multiply/divide	Standard	No	Standard	Standard	Optional
Hardware floating point	Standard	No	No	No	Optional
Hardware byte manipulation	Standard	Standard	Standard	No	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	No	No	Standard	Standard
Real-time clock or timer	Optional	No	No	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	18	8	16	12/24	16
Direct memory access channel	Optional	No	No (Standard)	Standard	Standard
Maximum I/O rate, words/sec	—	27K	35K (1M)	500,000	1,250,000
No. of external interrupt levels	2,048	1	2 (4)	256-4,096	32-256
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	No	No	Yes	Yes
Non-interchangeable disk storage	Yes	No	No	Yes	Yes
Drum storage	Yes	No	No	No	Yes
Magnetic tape speed, cps	160K (max.)	—	—	36K	40K
Punched card input speed, cpm	1,000 (max.)	300	300	300	300
Punched card output speed, cpm	200 (max.)	—	—	—	75
High-speed paper tape input, cps	750	—	—	125/300	300
High-speed paper tape output, cps	150	—	—	50/110	72
Other standard peripheral units	Line printers, CRT display	TTY	TTY	Line printer, cassette tape, A/D converters	Line printer, communications interfaces
SOFTWARE					
Assembler	1 & 2-pass	3-pass	3-pass	2-pass	1 & 2-pass
Macro assembler	Yes	No	No	Limited	No
FORTRAN compiler	Yes	No	No	No	No
Other compilers	BASIC, ALGOL, COBOL, RPG, PL/1	No	No	NUTRAN	No
Operating system	Yes	No	No	Limited	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	Not available	Not available	\$3,850 (\$3,950)	Not available	Not available
Price of basic system with 8K words	\$96,000* (\$89,000*)	\$3,750	\$5,150 (\$5,250)	\$9,600	Not available
Date of first delivery	April 1974	Feb. 1974	Mar. 1974 (9/73)	Nov. 1970	Aug. 1971
Number installed to date	NA	NA	NA	Over 500	NA
COMMENTS	Fully micropro- grammable sys- tems using two levels of micro- programming. *16K	These processors are available as packaged systems or on single cards. They are designed for use as hardware/ software development tools. Prices given include CPU, memory, console, interfaces, and support software.		Now being built only for Nuclear Data's own use and for certain special customers.	Omnus-1 is available only as a part of Omnus-1/C and -1/CU communication systems.

All About Minicomputers

MANUFACTURER & MODEL	Philips P850M	Philips P852M	Philips P855M	Prime 100	Prime 200
DATA FORMATS					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16	16	16	16/32	16/32
Instruction length, bits	16/32	16/32	16/32	16/32	16/32
MAIN STORAGE					
Storage type	Core	Core	Core	Semiconductor	Semiconductor
Cycle time, microseconds/word	3.2	1.2	0.84	1.0	0.75
Minimum capacity, words	512	4,096	4,096	4,096	4,096
Maximum capacity, words	2,048	32,768	32,768	65,536	65,536
Parity checking	No	No	No	No	Standard
Storage protection	No	No	Optional	No	No
CENTRAL PROCESSOR					
No. of accumulators	16	16	16	1	1
No. of index registers	Up to 14	Up to 14	Up to 14	1	1
No. of directly addressable words	2,048	32,768	32,768	32,768	65,536
Indirect addressing	One-level	One-level	One-level	Multi-level	Multi-level
Add time, microseconds (full word)	6.4	2.3	1.56	2.44	1.96
Hardware multiply/divide	No	No	Optional	Optional	Optional
Hardware floating point	No	No	No	No	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	No	No
Power failure protection	Optional	Optional	Optional	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	No	Optional	Optional	Standard	Standard
Maximum I/O rate, words/sec	10,500	833,000	1,190,000	694,444	1,000,000
No. of external interrupt levels	1	63	8-48	64	64
PERIPHERAL EQUIPMENT					
Disk pack storage	No	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	No	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	—	20K/36K	20K/36K	36K	36K
Punched card input speed, cpm	285	285	285	400	400
Punched card output speed, cpm	—	—	—	285	285
High-speed paper tape input, cps	333/600	333/600	333/600	200	200
High-speed paper tape output, cps	75/150	75/150	75/150	75	75
Other standard peripheral units	Line printer, cassette tape, plotter, communications	Line printer, cassette tape, plotter, communications	Line printer, cassette tape, plotter, communications	Printer, CRT display, comm. and A/D interfaces	Printer, CRT display, comm. and A/D interfaces
SOFTWARE					
Assembler	1-pass	1-pass	1-pass	2-pass	2-pass
Macro assembler	No	Yes	Yes	Yes	Yes
FORTRAN compiler	No	Yes	Yes	Yes	Yes
Other compilers	No	BASIC	BASIC	BASIC	BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	\$3,100 (with 2K words)	\$4,002	\$4,300	\$4,600	\$5,600
Price of basic system with 8K words	Not available	\$4,521	\$4,936	\$5,500	\$6,800
Date of first delivery	April 1971	March 1974	Oct. 1972	Feb. 1973	Oct. 1972
Number installed to date	NA	NA	NA	See Comments	See Comments
COMMENTS	The Philips minicomputer line includes extensive peripheral, data communications, and analog and digital interfacing equipment. Quantity discounts up to 41% are available. Prices are based upon 2.66 Guilders per dollar.			Microprogrammed logic uses 64-bit microinstruction word format. Has flexible memory addressing facilities. Approximately 250 Prime 100, 200, and 300 systems have been sold to date.	

All About Minicomputers

MANUFACTURER & MODEL	Prime 300	Qantel System 1100 (System 1200)	Raytheon RDS-500	Raytheon 704	Roim 1601 Ruggednova
DATA FORMATS					
Word length, bits	16	8	16	16	16
Fixed-point operand length, bits	16/32	Variable	16	16	16
Instruction length, bits	16/32	24 or 48	16	16	16
MAIN STORAGE					
Storage type	Semiconductor	Semiconductor	Core	Core	Core/semicond.
Cycle time, microseconds/word	0.60/0.75	1.5	0.8/0.9	1.0	2.6
Minimum capacity, words	8,192	4,096	8,192	4,096	256
Maximum capacity, words	262,144	32,768	65,536	32,768	32,768
Parity checking	Standard	No	Optional	Optional	No
Storage protection	Standard	No	Optional	Optional	No
CENTRAL PROCESSOR					
No. of accumulators	1	—	8 (Gen. purpose)	1	4
No. of index registers	1	—	8	1	2
No. of directly addressable words	65,536	32,768	65,536	32,768	1,024
Indirect addressing	Multi-level	Multi-level	No	No	Multi-level
Add time, microseconds (full word)	1.56	58	1.6/1.8	2.0	5.9
Hardware multiply/divide	Standard	Standard	Optional	Optional	Optional
Hardware floating point	Optional	No	Optional	No	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	No	No	Standard	Standard	No
Power failure protection	Optional	Standard	Optional	Optional	Standard
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	8	16	16	16
Direct memory access channel	Standard	Std. (up to 9)	Optional	Optional	Standard
Maximum I/O rate, words/sec	1,136,363	666,000	2,500,000	1,000,000	285,500
No. of external interrupt levels	64	Variable	16	1-16	16-256
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	No
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	36K	20K/40K	30K/60K/120K	120K max.	60K max.
Punched card input speed, cpm	400	500	300/1000	300/1000	400
Punched card output speed, cpm	285	—	100-400	100-400	—
High-speed paper tape input, cps	200	50	300	300	300
High-speed paper tape output, cps	75	50	110	110	63
Other standard peripheral units	Printer, CRT display, comm. and A/D interfaces	Line printers, CRT displays, comm. & voice response con- trollers	Line printers, plotters, process I/O, array proc- essors, comm- unications	Line printers, A/D converters, communications	Line printers, LINC tape, A/D and data comm. interfaces
SOFTWARE					
Assembler	2-pass	2-pass	2-pass	1 & 2-pass	2-pass
Macro assembler	Yes	No	Yes	Yes	No
FORTRAN compiler	Yes	No	Yes	Yes	Yes
Other compilers	BASIC	QIC	COBOL	COBOL	ALGOL, BASIC
Operating system	Yes	Yes	Yes	Yes (5)	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	Not available	\$30,975 (\$32,445)	Not available	\$7,200	\$13,500
Price of basic system with 8K words	\$11,700	\$33,925 (\$35,395)	\$8,000	\$9,200	\$19,500
Date of first delivery	Aug. 1973	June 1970	Feb. 1974	March 1970	March 1970
Number installed to date	See Prime 200	Over 200	NA	Over 250	Over 400
COMMENTS	Features virtual memory, sup- ported by up to 50 million bytes of disk storage, plus repertoire of 164 instruc- tions.	System 1100 supports two terminals; the 1200 supports up to six termi- nals.	Optional Array Transform Proc- essor facilitates signal processing Software library contains over 600 routines.	Optional Array Transform Proc- essor facilitates signal processing Software library contains over 600 routines.	Ruggedized ver- sion of the Data General Nova, designed for military and other severe en- vironments.

All About Minicomputers

MANUFACTURER & MODEL	Rolm 1602 Ruggednova	Rolm 1603 Ruggednova	R2E Microcomputer MICRAL B	R2E Microcomputer MICRAL G	R2E Microcomputer MICRAL S
DATA FORMATS					
Word length, bits	16	16	8	8	8
Fixed-point operand length, bits	16	16	8	8	8
Instruction length, bits	16/32	16	8/16/24	8/16/24	8/16/24
MAIN STORAGE					
Storage type	Core/semicond.	Core/semicond.	Semiconductor	Semiconductor	Core/semicond.
Cycle time, microseconds/word	1.0	1.2	24	12	2
Minimum capacity, words	256	256	256	256	256
Maximum capacity, words	262,144	32,768	16,384	16,384/49,152	65,536
Parity checking	No	No	No	No	No
Storage protection	Yes	No	No	No	No
CENTRAL PROCESSOR					
No. of accumulators	4	4	1	1	1
No. of index registers	2	2	6	6	6
No. of directly addressable words	1,024	1,024	16,384	16,384	65,536
Indirect addressing	Multi-level	Multi-level	One-level	One-level	One-level
Add time, microseconds (full word)	1.0	5.9	24	12	4
Hardware multiply/divide	Standard	Optional	No	No	Optional
Hardware floating point	Optional	No	Optional (BCD)	Optional (BCD)	Optional (BCD)
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	No	Standard	Standard	Standard
Power failure protection	Standard	Standard	Battery	Battery	Battery
Real-time clock or timer	Optional	Optional	Standard	Standard	Standard
INPUT/OUTPUT CONTROL					
I/O word size, bits	16	16	8	8	8
Direct memory access channel	Standard	Standard	No	No	Optional
Maximum I/O rate, words/sec	1,000,000	285,500	1,000,000	1,000,000	1,000,000
No. of external interrupt levels	16-256	16-256	64-stack	64-stack	64-stack
PERIPHERAL EQUIPMENT					
Disk pack storage	No	No	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	60K max.	60K max.	20K	20K	20K
Punched card input speed, cpm	400	400	200	200	200
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	300	300	120	120	120
High-speed paper tape output, cps	63	63	70	70	70
Other standard peripheral units	Line printers, LINC tape, A/D and data comm. interfaces	Line printers, LINC tape, A/D and data comm. interfaces	Floppy disc, A/D converter, relay optoelectronics	Floppy disc, A/D converter, relay optoelectronic	Floppy disc, A/D converter, relay optoelectronic
SOFTWARE					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	No	No	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Cross assembly	Cross assembly	Cross assembly
Other compilers	ALGOL, BASIC	ALGOL, BASIC	BASIC	MICRO-CTL	BASIC, MICRO-CTL
Operating system	Yes	Yes	No	No	Yes
PRICING & AVAILABILITY					
Price of basic system with 4K words	Not available	Not available	\$1,470	\$1,520	\$1,670
Price of basic system with 8K words	\$18,500	\$9,950	\$2,470	\$2,500	\$2,600
Date of first delivery	Feb. 1973	Aug. 1974	Jan. 1973	Jan. 1974	July 1974
Number installed to date	50	NA	250	20	NA
COMMENTS	Ruggedized, microprogram- mable processor; upward com- patible with Rolm 1601 and Data General Nova series.	The 1603 is a smaller, faster, lower-priced version of the 1601.	MICRAL Microcomputer processors are all compatible with a standard PLURIBUS architecture. Editor software plus complete control console facilities are included. Available in individual board form or as integrated systems.		

All About Minicomputers

MANUFACTURER & MODEL	SYSTEMS 85	SYSTEMS 86	Texas Instruments Model 960A	Texas Instruments Model 960B	Texas Instruments Model 980A
DATA FORMATS					
Word length, bits	32	32	16	16	16
Fixed-point operand length, bits	32	32	16	16/32	16
Instruction length, bits	32	32	32	32	16/32
MAIN STORAGE					
Storage type	Core	Core	Semiconductor	Semiconductor	Semiconductor
Cycle time, microseconds/word	0.85	0.60	0.75	0.75	0.75
Minimum capacity, words	8,192	8,192	4,096	8,192	4,096
Maximum capacity, words	131,072	131,072	65,536	65,536	65,536
Parity checking	Standard	Standard	Standard	Standard	Standard
Storage protection	Standard	Standard	Standard	Standard	Standard
CENTRAL PROCESSOR					
No. of accumulators	8	8	Up to 16	Up to 16	2
No. of index registers	3	3	Up to 16	Up to 16	1
No. of directly addressable words	131,072	131,072	65,536	65,536	65,536
Indirect addressing	Multi-level	Multi-level	One-level	One-level	One-level
Add time, microseconds (full word)	1.7	1.2	3.2	3.6	1.75
Hardware multiply/divide	Standard	Standard	Optional	Optional	Standard
Hardware floating point	Optional	Optional	No	No	No
Hardware byte manipulation	Standard	Standard	Standard	No	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Optional	Standard
Real-time clock or timer	Standard	Standard	Optional	Optional	Optional
INPUT/OUTPUT CONTROL					
I/O word size, bits	16/32	16/32	1 to 16	1 to 16	16
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1,176,470	1,666,666	1,300,000	1,000,000	1,300,000
No. of external interrupt levels	6-112	6-112	2	2	2-64
PERIPHERAL EQUIPMENT					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	Yes	Yes	No	No	No
Magnetic tape speed, cps	36K-320K	36K-320K	300K max.	30K	300K max.
Punched card input speed, cpm	100	100	300	300	300
Punched card output speed, cpm	300	300	100	No	100
High-speed paper tape input, cps	600	600	300	300	300
High-speed paper tape output, cps	110	110	60	60	60
Other standard peripheral units	Line printers, analog and digital interfaces, communications	Line printers, analog and digital interfaces, communications	Line printers, communications interfaces, A/D converters, etc.	Line printers, communications interfaces, A/D converters, etc.	Line printers, communications interfaces, A/D converters, etc.
SOFTWARE					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	No*	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	No	No	No	No	No
Operating system	Yes	Yes	Yes	Yes	Yes (tape only)
PRICING & AVAILABILITY					
Price of basic system with 4K words	Not available	Not available	\$2,850	Not available	\$3,475
Price of basic system with 8K words	\$80,000	\$104,000	\$4,350	\$4,350	\$4,975
Date of first delivery	Dec. 1972	Aug. 1970	Nov. 1971	NA	May 1972
Number installed to date	30	50	450	NA	75
COMMENTS	These medium-scale computer systems are used in high-volume data entry and acquisition. Software is bundled in system prices. Systems 71 and 72 are no longer produced.		Has 2 processor modes, each with 8 general registers. Real-time monitor system handles multiprogramming.	*Separate macro processor and cross assemblers are available.	Hardware and software support bit/byte/word or byte string manipulation. General purpose.

All About Minicomputers

MANUFACTURER & MODEL	Texas Instruments Model 980B	UNIVAC 1616	UNIVAC 1816	Varian V72
DATA FORMATS				
Word length, bits	16	16+2	16+2	16
Fixed-point operand length, bits	16/32	8/16/32	8/16/32	16
Instruction length, bits	16/32	16/32	16/32	16/32
MAIN STORAGE				
Storage type	Semiconductor	Core	Core	Core
Cycle time, microseconds/word	0.75	0.75	1.0	0.66/1.2
Minimum capacity, words	8,192	8,192	16,384	8,192/16,384
Maximum capacity, words	65,536	65,536	65,536	32,768/262,144
Parity checking	Standard	Optional	Optional	Optional
Storage protection	Standard	Standard	Standard	Standard
CENTRAL PROCESSOR				
No. of accumulators	2	16-64	16-64	Up to 16
No. of index registers	1	—	—	Up to 16
No. of directly addressable words	65,536	65,536	65,536	32,768
Indirect addressing	One-level	One-level	One-level	Multi-level
Add time, microseconds (full word)	1.75	0.75	1.0	1.32/2.4
Hardware multiply/divide	Standard	Standard	Optional	Standard
Hardware floating point	No	No	No	Optional
Hardware byte manipulation	Standard	Standard	Standard	Optional
Immediate (literal) instructions	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Optional	Standard
Real-time clock or timer	Optional	Optional	Optional	Standard
INPUT/OUTPUT CONTROL				
I/O word size, bits	16	8/16/32	8/16/32	16
Direct memory access channel	Standard	Optional	Optional	Standard
Maximum I/O rate, words/sec	1,000,000	1,300,000	1,300,000	1,200,000
No. of external interrupt levels	2-32	8	8	0-64
PERIPHERAL EQUIPMENT				
Disk pack storage	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No
Magnetic tape speed, cps	30K	200K	200K	120K max.
Punched card input speed, cpm	300	200	200	300/600/1,000
Punched card output speed, cpm	No	75	75	35/100
High-speed paper tape input, cps	300	200	200	300
High-speed paper tape output, cps	60	75	75	75
Other standard peripheral units	Line printers, communications interfaces, A/D converters, etc.	CRT, ASR-33 teletypewriter	CRT, ASR-33 teletypewriter	Line printers, CRT displays, A/D converters, plotters, etc.
SOFTWARE				
Assembler	2-pass	1-pass	1-pass	2-pass
Macro assembler	No*	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes
Other compilers	BASIC	Host 1108	Host 1108	BASIC, RPG
Operating system	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY				
Price of basic system with 4K words	Not available	Not available	Not available	Not available
Price of basic system with 8K words	\$4,975	\$23,100	\$65,000 (16K mem.)	\$10,500
Date of first delivery	NA	Sept. 1971	June 1973	Jan. 1974
Number installed to date	NA	See Comments	See Comments	59 as of 5/74
COMMENTS	*Separate macro processor and cross assemblers are available.	Over 100 systems have been sold to date. These systems are commercial versions of AN/UJK-15, -20, and MPC-16 military systems.		See Comments on next page.

All About Minicomputers

MANUFACTURER & MODEL	Varian V73	Varian V74	Varian 620/f-100	Varian 620/L
DATA FORMATS				
Word length, bits	16	16	16	16
Fixed-point operand length, bits	16	16	16	16
Instruction length, bits	16/32	16/32	16/32	16/32
MAIN STORAGE				
Storage type	Core/semicond.	Core/semicond.	Core	Core
Cycle time, microseconds/word	0.66/0.33	0.66/0.33	0.75	1.8
Minimum capacity, words	8,192	32,768	4,096	4,096
Maximum capacity, words	32,768/262,144	262,144	32,768	32,768
Parity checking	Optional	Optional	No	No
Storage protection	Standard	Standard	Standard	Optional
CENTRAL PROCESSOR				
No. of accumulators	Up to 16	Up to 16	2	2
No. of index registers	Up to 16	Up to 16	2	2
No. of directly addressable words	32,768	32,768	2,048	2,048
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	1.32/0.66	1.32/0.66	1.5	3.6
Hardware multiply/divide	Standard	Standard	Standard	Standard
Hardware floating point	Optional	Optional	No	No
Hardware byte manipulation	Optional	Standard	No	No
Immediate (literal) instructions	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard
Real-time clock or timer	Standard	Standard	Standard	Standard
INPUT/OUTPUT CONTROL				
I/O word size, bits	16	16	16	16
Direct memory access channel	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1.2/1.35M	1.2/1.35M	1,330,000	200,000
No. of external interrupt levels	0-64	0-64	0-64	0-64
PERIPHERAL EQUIPMENT				
Disk pack storage	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes
Drum storage	No	No	Yes	Yes
Magnetic tape speed, cps	120K max.	120K max.	20K max.	20K max.
Punched card input speed, cpm	300/600/1,000	300/600/1,000	300	300
Punched card output speed, cpm	35/100	35/100	35	35
High-speed paper tape input, cps	300	300	150/300	150/300
High-speed paper tape output, cps	75	75	75	75
Other standard peripheral units	Line printers, CRT displays, A/D converters, plotters, etc.	Line printer, CRT displays, A/D converters, plotters, etc.	Line printer, CRT displays, A/D converters, plotters, etc.	Line printer, CRT displays, A/D converters, plotters, etc.
SOFTWARE				
Assembler	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	No	No
FORTRAN compiler	Yes	Yes	Yes	Yes
Other compilers	BASIC, RPG	BASIC, RPG	BASIC, RPG	BASIC, RPG
Operating system	Yes	Yes	Yes	Yes
PRICING & AVAILABILITY				
Price of basic system with 4K words	Not available	Not available	\$10,500	Not available
Price of basic system with 8K words	\$14,500/13,000	Not available	\$13,000	\$7,700
Date of first delivery	Nov. 1972	May 1974	June 1972	May 1971
Number installed to date	170 as of 5/74	NA	200 as of 1/74	750 as of 1/74
COMMENTS	The Varian V72, V73, V74 and all 620 Series computers are program compatible with one another and with the original Varian 602/i.			

All About Minicomputers

MANUFACTURER & MODEL	Varian 620/L-100	Varian R-620/i	Westinghouse 2500	Xerox 530
DATA FORMATS				
Word length, bits	16	16 (18 opt.)	16	16
Fixed-point operand length, bits	16	16	16	16/32
Instruction length, bits	16/32	16/32	16	16/32
MAIN STORAGE				
Storage type	Core	Core	Core	Core
Cycle time, microseconds/word	0.95	1.8	0.75	0.8
Minimum capacity, words	4,096	4,096	8,192	8,192
Maximum capacity, words	32,768	32,768	65,536	65,536
Parity checking	No	No	Optional	Standard
Storage protection	No	No	Optional	Standard
CENTRAL PROCESSOR				
No. of accumulators	2	2	2	6
No. of index registers	2	2	2	2
No. of directly addressable words	2,048	2,048	256	1,024
Indirect addressing	Multi-level	Multi-level	One-level	One-level
Add time, microseconds (full word)	1.9	3.6	1.7	1.92
Hardware multiply/divide	Standard	Optional	Standard	Standard
Hardware floating point	No	No	Optional	Optional
Hardware byte manipulation	No	No	No	Optional
Immediate (literal) instructions	Standard	Standard	No	No
Power failure protection	Standard	Optional	Standard	Standard
Real-time clock or timer	Standard	Optional	Optional	Standard (2)
INPUT/OUTPUT CONTROL				
I/O word size, bits	16	16	16	16
Direct memory access channel	Standard	Optional	Optional	Optional (2)
Maximum I/O rate, words/sec	383,000	200,000	1,000,000	850,000 each
No. of external interrupt levels	0-64	0-64	120	6-30
PERIPHERAL EQUIPMENT				
Disk pack storage	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes
Drum storage	Yes	Yes	No	Yes
Magnetic tape speed, cps	20K max.	20K max.	20K/40K	20.8K/30K/60K
Punched card input speed, cpm	300	300	285/600/1000	200/400/1500
Punched card output speed, cpm	35	35	35/100	100
High-speed paper tape input, cps	150/300	150/300	300	300
High-speed paper tape output, cps	75	75	110	75
Other standard peripheral units	Line printer, CRT displays, A/D converters, plotters, etc.	Line printer, CRT displays, A/D converters, plotters, etc.	Line printer, CRT display, communications, A/D converters	Line printers, plotters, comm. and A/D interfaces
SOFTWARE				
Assembler	2-pass	2-pass	2-pass	Yes
Macro assembler	No	No	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes
Other compilers	BASIC, RPG	BASIC, RPG	BASIC, RPG	COBOL, RPG II
Operating system	Yes	Yes	Yes	Yes (2)
PRICING & AVAILABILITY				
Price of basic system with 4K words	Not available	\$16,900	Not available	Not available
Price of basic system with 8K words	\$7,700	\$23,300	\$11,500	\$20,000 (\$700/month)
Date of first delivery	June 1972	June 1969	June 1971	3rd qtr. 1973
Number installed to date	500 as of 1/74	200 as of 1/74	150	NA
COMMENTS	See Comments on preceding page.		Features 16-high speed IC registers. Used in Westinghouse 2550 programmable terminal, 2515 power control system, and 2530 data management system.	Uses multi-bus architecture and micro-programming techniques. Bit-string manipulation facilities are optional.