

## All About Minicomputers

Minicomputers are almost certainly the hottest topic in the EDP world today. And there's a good reason why. The steadily decreasing costs and increasing capabilities of these compact, versatile computers are leading nearly every wide-awake businessman and scientist to wonder whether a minicomputer might represent the key to solving some or all of his information processing problems.

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 data 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. The current offerings of 47 manufacturers are summarized in the accompanying minicomputer comparison charts.

### 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 Feature Report, *All About Small Accounting Computers*.

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

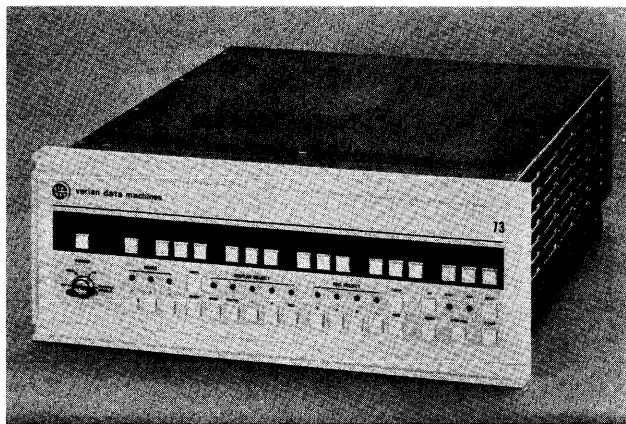
The typical minicomputer is a parallel, binary processor with a 16-bit word length (though 8-bit, 12-bit, 18-bit, and 24-bit word lengths are also common). It uses integrated circuits and is housed in a compact cabinet suitable for either tabletop use or mounting in a standard 19-inch rack. It weighs less than 50 pounds, consumes less than 500 watts of standard 115-volt electric power, and

The minicomputer revolution is hitting full stride. As prices fall and capabilities increase, this new breed of compact, low-cost computers is satisfying an ever-widening spectrum of applications. This report surveys the characteristics, features, and drawbacks of 128 current minicomputers from 47 manufacturers and summarizes users' experience with a total of 1268 machines.

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.



Compact yet powerful, the Varian 73 exemplifies many of the current trends in minicomputer design. It offers up to 65K bytes 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.

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▷ 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 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 \$350 million to \$500 million a year. These figures include peripheral equipment and software; minicomputer mainframes alone are believed to account for \$100-\$125 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 1972, more than 60,000 minicomputers were in use around the world, and about 54,000 of these were in the United States. International Data Corporation estimates that 18,800 "dedicated application computers" — mostly minis — were shipped worldwide during 1972, and looks for this figure to increase by 29% to 24,300 in 1973.

Minicomputers still represent only a small slice of the \$13 billion total U.S. market for computer-related products and services, but the minicomputer segment is expected to continue its rapid growth. Estimates of worldwide minicomputer market volume in 1975 range from \$700 million to an even \$1 billion.

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 26,000 computers to date and still commands roughly a 30 percent share of the minicomputer market. Rounding out the "big five" among the minicomputer builders are Honeywell, Hewlett-Packard, Varian, and Data General. Each of these companies has already delivered more than 3000 minicomputers—and Data General managed the unprecedented feat of delivering its 6000th 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 Computer Automation, Digital Computer Controls, General Automation, Interdata, and Microdata. Minicomputers are also being built by divisions of large, well-established companies such as General Telephone and Electronics,

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 50 companies are now marketing minicomputers in the United States. The current offerings of 41 U.S. manufacturers and 6 foreign-based companies are summarized in the accompanying comparison charts.

Minicomputer 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 systems 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. Computer Automation, Data General, Datacraft, Microdata, Modular Computer Systems, Texas Instruments, and Varian all introduced new minicomputers which are program-compatible with their earlier models and feature lower price tags and/or ▷

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- > ● 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 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.

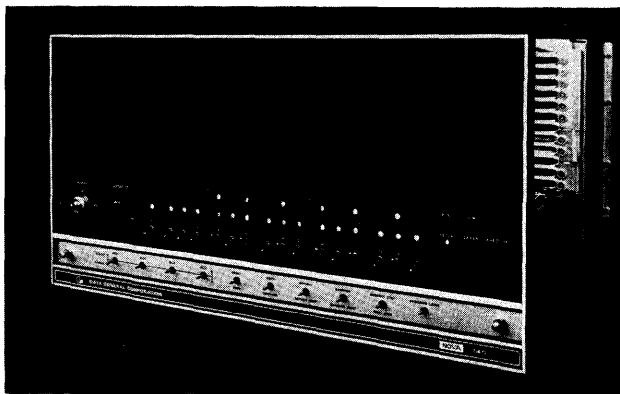
Even if small businessmen were willing to pay the price of the software required to solve their problems, they would find it hard to get from most of the current minicomputer builders. In general, the manufacturers have oriented their marketing efforts toward the comparatively sophisticated engineering 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. >



*Data General's Nova 840, newest member of the highly popular Nova line, offers up to 131K words of core storage and a new memory management and protection unit. In connection with the company's Real-Time Disk Operating System, the Nova 840 permits dual programming operation, dual processor/shared disk operation, and memory mapping within 1024-word boundaries.*

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▷ 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 pricetags of the minicomputers themselves, make it clear that the minicomputers will soon be making their presence felt 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 March 1973 supplement to DATAPRO 70 and mailed to all subscribers. By June 1, usable responses had been received from 83 users with a total of 1268 installed minicomputers. (Responses were also received from 23 users of small accounting computers such as the IBM System/3 and the Burroughs L Series, but these responses were excluded from our tabulated results; for a survey of user experience with this class of equipment, please see the companion Datapro report, *All About Small Accounting Computers*.)

The number of minicomputers installed in each respondent's organization ranged from 1 to 500. Although the average number of machines per organization was 15.3, 41% of the organizations that responded had only one minicomputer. The number of different *models* of minicomputers installed in each organization ranged from 1 to 6 and averaged 1.45.

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 23 popular minicomputers from 12 manufacturers are summarized in the accompanying table. 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:

	<u>Excellent</u>	<u>Good</u>	<u>Fair</u>	<u>Poor</u>
Overall performance	42%	46%	10%	2%
Ease of programming	19%	58%	17%	6%
Ease of operation	34%	57%	7%	2%
Hardware reliability	40%	44%	12%	4%
Maintenance service	24%	46%	23%	7%
Technical support	13%	38%	30%	19%
Manufacturer's software	16%	44%	25%	15%

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" — and it's worth nothing that some of the largest minicomputer suppliers drew some of the lowest user ratings in the areas of software and support.

The minicomputer users were asked whether they acquired their machines directly from the manufacturer or from an independent system supplier. The results were as follows:

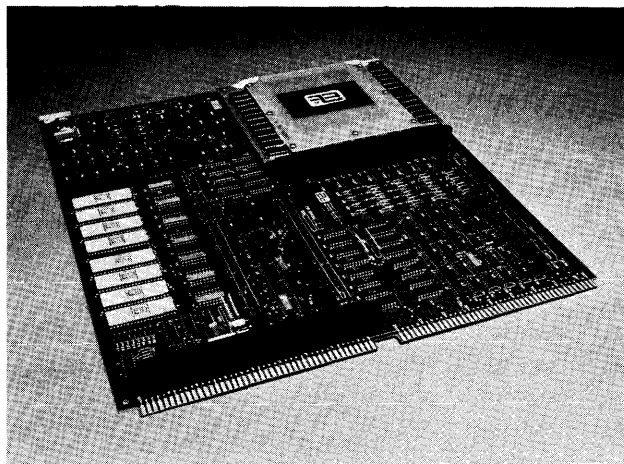
Acquired from minicomputer manufacturer:	69%
Acquired from system supplier:	31%

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

In-house personnel:	60%
Minicomputer manufacturer:	22%
System supplier:	28%
Independent software firm:	3%

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

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*Priced at under \$1,000 in OEM quantities, Computer Automation's 16-bit Naked Mini LSI is a full-fledged minicomputer on a single board that fits neatly into a pizza box. Add a chassis, power supply, and console, and you have the companion Alpha LSI at a cost of just \$1,990.*

▷ improved performance. Other minicomputer builders took an even more direct approach by reducing the prices of their current models. Though the price cuts during the last year were generally less precipitous than those of the past, there is no reason to believe that minicomputer prices have yet reached bottom. Thus, the careful buyer will almost certainly continue to get steadily increasing power per dollar.

The most dramatic recent example of increased minicomputer cost-effectiveness was the May 1973 announcement of Computer Automation's Naked Mini LSI. This 16-bit minicomputer is supplied without chassis, power supply, or console, and is designed to be "buried" within equipment produced and sold by other companies. In OEM lots of 200, the Naked Mini LSI sells for just \$990, complete with 4K words of 1.6-microsecond memory. This is by far the lowest price yet for a full-fledged computer and should open up a wide variety of new applications.

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 only \$900.

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 considerably 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.

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 6024/4, DEC PDP-11/45, Interdata Models 80 and 85, Modcomp IV, and Varian 73. Most of these systems feature large main storage capacities, fast semiconductor memory, advanced memory management facilities, multi-programming operating systems, and other "big computer" software facilities, at mainframe prices ranging from about \$15,000 upward.

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 micro-programming 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 many 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 now appears 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 ▷

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*Digital Equipment Corporation's DECgraphic-11 Laboratory System is a low-priced computer graphics system based upon the ubiquitous PDP-11 minicomputer (center). DEC offers minicomputer-based systems oriented toward a wide range of specialized applications.*

▷ technology for logic circuits is certain to continue for the same reason.

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, ac-

counting 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.

### 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

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### USERS' RATINGS OF MINICOMPUTERS

Minicomputer Manufacturer and Model	No. of User Replies	No. of Com- puters	Users' Ratings*																															
			Overall Performance				Ease of Program- ming				Ease of Operation				Hardware Reliability				Mainte- nance Service				Technical Support				Manu- facturer's Software							
			E	G	F	P	E	G	F	P	E	G	F	P	E	G	F	P	E	G	F	P	E	G	F	P	E	G	F	P				
Computer Automation (all models)	2	7	0	2	0	0	0	1	1	0	0	2	0	0	2	0	0	0	0	1	1	0	0	1	1	0	0	2	0	0	0	0	0	0
Computer Communica- tions CC-70	2	28	2	0	0	0	0	1	1	0	2	0	0	0	2	0	0	0	1	0	1	0	1	0	1	0	0	1	1	0	0	0	1	0
Data General Nova	4	6	2	1	1	0	1	1	2	0	1	1	2	0	2	2	0	0	1	2	1	0	1	3	0	0	0	1	3	0	0	0	0	0
Data Gen. Nova 800 Series	5	10	3	2	0	0	2	3	0	0	1	4	0	0	2	2	0	0	2	0	1	0	1	1	1	1	1	1	2	1	1	2	1	1
Data Gen. Nova 1200 Series	5	17	2	2	1	0	1	2	1	1	1	3	0	1	2	3	0	0	1	1	2	1	1	1	1	2	0	3	1	1	0	0	0	0
Data Gen. Supernova	4	8	0	3	1	0	0	2	0	2	1	3	0	0	0	1	2	1	0	2	1	1	0	1	1	1	0	0	1	2	0	0	0	0
Data General totals	18	41	7	8	3	0	4	8	3	3	4	11	2	1	6	8	2	1	4	5	5	2	3	6	3	4	2	8	3	4	0	0	0	0
Datapoint 2200	3	5	0	2	1	0	1	1	1	0	3	0	0	0	0	2	1	0	0	1	1	1	0	1	1	1	1	1	1	0	1	0	0	0
DEC PDP-8 Series	19	603	9	6	2	1	4	9	2	2	6	10	1	1	10	7	1	0	3	12	2	0	3	6	3	6	5	7	2	3	0	0	0	0
DEC PDP-9	1	18	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
DEC PDP-11 Series	15	61	3	10	1	0	1	7	3	0	1	12	1	0	3	10	1	0	2	7	4	1	1	4	6	3	1	5	2	1	0	0	0	0
DEC PDP-15	2	3	1	1	0	0	0	1	0	0	0	2	0	0	0	2	0	0	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0
DEC totals	37	685	13	18	3	1	5	18	5	2	8	24	2	1	13	19	3	0	5	21	6	2	4	12	9	10	6	13	6	4	0	0	0	0
Four-Phase 7000 Series	5	18	4	1	0	0	1	3	1	0	4	1	0	0	2	2	1	0	2	2	1	0	0	4	1	0	2	2	1	0	0	0	0	0
Gen. Automation SPC-12	3	259	1	1	1	0	0	1	1	1	0	1	2	0	1	1	0	1	0	1	0	2	0	0	1	2	0	0	0	1	1	0	0	1
Gen. Automation SPC-16	2	13	0	2	0	0	0	2	0	0	0	2	0	0	0	2	0	0	0	0	2	0	0	0	2	0	0	0	1	1	0	0	0	0
Gen. Automation totals	5	272	1	3	1	0	0	3	1	1	0	3	2	0	1	3	0	1	0	1	2	2	0	0	3	2	0	1	2	1	0	0	0	0
Hewlett-Packard 2100A	5	6	3	1	0	1	2	3	0	0	3	2	0	0	4	0	0	1	3	2	0	0	0	3	1	1	1	2	1	1	0	0	0	0
Hewlett-Packard 2114B	5	6	3	2	0	0	3	1	1	0	4	1	0	0	3	2	0	0	2	2	0	0	3	1	0	0	3	1	0	0	0	0	0	0
Hewlett-Packard 2116B	4	4	1	2	0	0	1	2	1	0	2	2	0	0	1	2	1	0	2	2	0	0	0	2	2	0	0	3	1	0	0	0	0	0
Hewlett-Packard totals	14	16	7	5	0	1	6	6	2	0	9	5	0	0	8	4	1	1	7	6	0	0	3	6	3	1	4	6	2	1	0	0	0	0
Honeywell 316	4	110	2	2	0	0	0	2	1	0	1	2	0	0	2	2	0	0	2	1	1	0	0	0	3	0	0	2	1	0	0	0	0	0
Honeywell 516	2	16	0	2	0	0	0	1	1	0	1	1	0	0	0	2	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Honeywell totals	6	126	2	4	0	0	0	3	2	0	2	3	0	0	2	4	0	0	2	2	1	0	0	1	3	0	0	2	1	1	0	0	0	0
IBM System/7	5	5	1	2	1	0	1	3	0	0	2	1	1	0	2	1	1	0	1	3	0	0	1	2	1	0	1	1	1	1	0	0	0	0
IBM 1130	3	4	2	1	0	0	0	2	1	0	1	2	0	0	2	1	0	0	2	0	1	0	0	2	0	1	0	0	2	0	0	0	0	0
IBM totals	8	9	3	3	1	0	1	5	1	0	3	3	1	0	4	2	1	0	3	3	1	0	1	4	1	1	1	1	3	1	0	0	0	0
Interdata Model 70\	3	4	3	0	0	0	1	2	0	0	2	1	0	0	2	1	0	0	0	2	1	0	0	1	2	0	0	3	0	0	0	0	0	0
Varian 620 Series	8	29	4	2	2	0	0	7	0	0	0	7	1	0	1	4	1	1	0	6	2	0	1	5	2	0	0	1	4	1	0	0	0	0
All others**	9	28	3	5	0	0	2	4	1	1	2	5	0	0	3	1	4	0	3	0	4	1	1	2	3	2	0	2	2	1	0	0	0	0
Totals	120	1268	49	53	11	2	21	62	19	7	39	65	8	2	46	50	14	4	27	50	26	8	14	43	33	21	16	43	25	15	0	0	0	0

\* Ratings are expressed in terms of number of user responses. The legend is E for Excellent, G for Good, F for Fair, and P for Poor.

\*\* "All others" category consists of the following computers that received only one user mention each: Cincinnati Milacron CIP/2002, Digital Computer Control D-112, Digital Scientific Meta 4, Incoterm SPD 10/20, Rolm 1601, Sanders 804, Scantlin 801, Texas Instruments 960A, and Xerox Sigma 2.

## All About Minicomputers

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

<u>Application</u>	<u>No. of user responses</u>	<u>Percent of total</u>
Data communications (remote job entry, message switching, front-end processing, etc.)	30	25%
Industrial data acquisition and control	30	25%
Laboratory automation	14	12%
Data entry	12	10%
Education	10	8%
Business data processing	7	6%
Automated testing	6	5%
Publishing and word processing	5	4%
Graphics	3	3%
Time-sharing	3	3%
Scientific calculations	2	2%
Miscellaneous	9	8%

### MINICOMPUTER CHARACTERISTICS

The key functional characteristics of 128 commercially available minicomputers from 47 manufacturers are presented in the accompanying comparison charts. Nearly all of the information in the charts was supplied and/or verified by the 47 manufacturers during May and June of 1973; 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, or 24 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

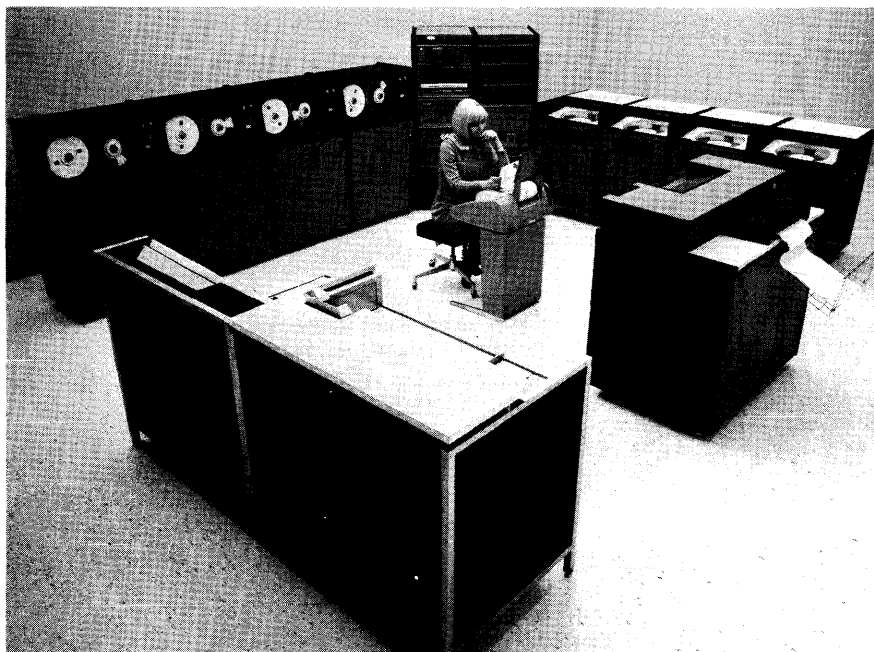
The storage type used in most of the current minicomputers is magnetic cores. Though semiconductor memories began to appear in commercially available minicomputers late in 1970, most minicomputer makers are still using core storage because of its demonstrated ability to satisfy all reasonable requirements for performance, reliability, and economy. It is clear, however, that the demand for higher performance at lower cost, together with forthcoming improvements in semiconductor technology, will accelerate 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. Where read-only memories are used, their characteristics and functions are described in the “Comments” entries at the bottom of the comparison charts.

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 ▷



## All About Minicomputers



*The Honeywell 720/01 Terminal System, shown with a large complement of peripheral equipment, is one of six systems built around the 716 minicomputer and designed for a variety of communications and control applications.*

▷ 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 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: enough 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

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, or 24 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 ▷

## All About Minicomputers

- ▷ 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 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 quite rare in 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 ▷

## All About Minicomputers

▷ 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.

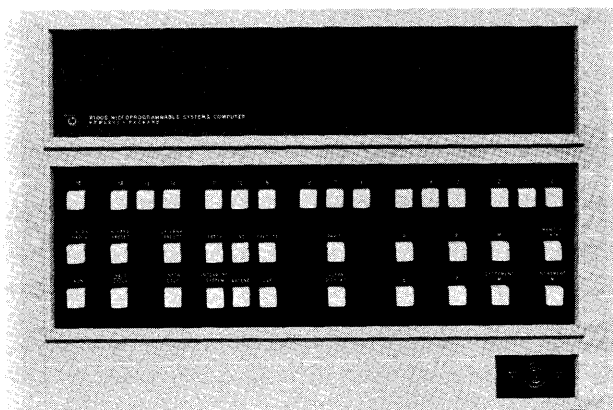
### Input/Output Control

*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 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



*Hewlett-Packard's new 2100S Microprogrammable Systems Computer features hardware and software aids that facilitate microprogramming by the user. Up to 256 24-bit microinstructions can be stored on each of three writable control store (WCS) cards. After debugging, the microprograms can be fused into read-only memory chips by the computer's PROM writer for permanent storage.*

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

FORTRAN 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. ➤

## All About Minicomputers

➤ *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 1, 1973. 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 47 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.*, 5455 Pare Street, Montreal 309, P. Quebec, Canada. Telephone (514) 735-6581.

*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.

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

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

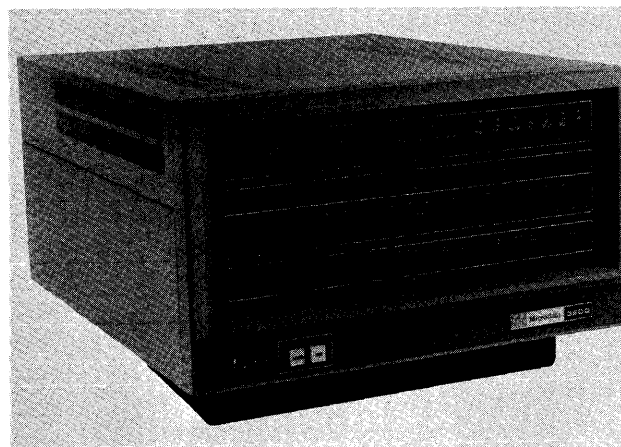
*Clary Datacomp Systems, Inc.*, 404 Junipero Serra Drive, San Gabriel, California 91776. Telephone (213) 283-9485.

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

*Computer Automation Incorporated*, 895 West Sixteenth Street, Newport Beach, California 92660. Telephone (714) 642-9630.

*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) 888-5555. ➤



*The 3200 is the latest and fastest in a long line of microprogrammable computers from Microdata Corporation. The same processor is offered in two microprogrammed adaptations: the 3230, which is program-compatible with earlier Microdata computers, and the 32/S, which features stack architecture and uses a subset of PL/I as its basic language.*

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- ▷ *Data General Corporation*, Southboro, Massachusetts 01772. Telephone (617) 485-9100.
- Datacraft Corporation*, 1200 N.W. 70th Street, P.O. Box 23550, Fort Lauderdale, Florida 33307. Telephone (305) 974-1700.
- 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*, 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.*, West Long Branch, New Jersey 07764. Telephone (201) 229-1100.
- Electronic Processors Incorporated* (a subsidiary of the Samsonite Corporation), 5050 South Federal Boulevard, Englewood, Colorado 80110. Telephone (303) 798-9305.
- Four-Phase Systems, Inc.*, 10420 N. Tantau Avenue, Cupertino, California 95014. Telephone (408) 255-0900.
- Fujitsu Limited*, 680 Fifth Avenue, New York, N.Y. 10019. Telephone (212) 265-5360.
- 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.*, Four Corporate Park Drive, White Plains, New York 10604. Telephone (914) 694-8840.
- 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.
- Nuclear Data Inc.*, P.O. Box 451, Palatine, Illinois 60067. Telephone (312) 529-4600.
- Omnus Computer Corporation*, 1538 East Chestnut Street, Suite E, Santa Ana, California 92701. Telephone (714) 547-8444.
- Philips-Electrologica B.V.*, OEM Marketing, P.O. Box 245, Apeldoorn, the Netherlands. Telephone 05760-30123.
- Prime Computer, Inc.*, 17 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.
- 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) 494-5115.
- 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-4MC	Automatic Elect. Systems AES-80	Automatic Elect. Systems AES-80C
<b>DATA FORMATS</b>					
Word length, bits	4/8	4/8	4/8	8	8
Fixed-point operand length, bits	4	4	4	8	8
Instruction length, bits	8/16	8/16	8/16	12	12
<b>MAIN STORAGE</b>					
Storage type	Semiconductor	Semiconductor	Semiconductor	Semiconductor	Semiconductor
Cycle time, microseconds/word	11.8	11.8	5	0.24	0.24
Minimum capacity, words	256	1,024	1,024	16 data/256 inst.	16 data/256 inst.
Maximum capacity, words	4,096	4,096	16,384	4K data/4K inst.	4K data/64K inst.
Parity checking	No	No	No	No	No
Storage protection	No	No	No	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	1	1	1	1
No. of index registers	16	16	1	0	0
No. of directly addressable words	4,096	4,096	8,192	2K inst./1K data	2K inst./1K data
Indirect addressing	One-level	One-level	One-level	Yes	Yes
Add time, microseconds (full word)	11.8	11.8	5	0.24	0.24
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	Optional	Optional
Real-time clock or timer	No	No	No	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	4	4	12	8	8
Direct memory access channel	No	No	Standard	No	No
Maximum I/O rate, words/sec	10,000	10,000	20,000	2,080,000	2,080,000
No. of external interrupt levels	None	None	None	Variable	Variable
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	No	No	No	Yes	Yes
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	—	—	—	75/300	75/300
High-speed paper tape output, cps	—	—	—	—	—
Other standard peripheral units	—	—	—	Modems, etc.	Modems, etc.
<b>SOFTWARE</b>					
Assembler	No	1-pass	2-pass	1 & 2-pass	1 & 2-pass
Macro assembler	No	No	No	No	No
FORTRAN compiler	No	No	No	No	No
Other compilers	No	No	No	See Comments	See Comments
Operating system	No	Yes	Yes	No	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$695	\$7,130	\$8,450	\$3,640	\$3,640
Price of basic system with 8K words	Not available	Not available	\$10,990	\$6,330	\$6,330
Date of first delivery	Feb. 1972	March 1972	June 1973	May 1972	Oct. 1972
Number installed to date	NA	NA	NA	58	5
<b>COMMENTS</b>	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 Microelectronics PPS microcomputer chips. Includes assembler/simulator and PROM programmer.	The AES Microprocessors are programmable controllers, designed mainly for logical control functions. Programming is facilitated by a Program Development and Control Console and a cross-assembler coded in FORTRAN.	

### All About Minicomputers

MANUFACTURER & MODEL	Basic/Four Model 350	Basic/Four Model 400	Basic/Four Model 500	Bendix BDX6200	Bendix BDX9000
<b>DATA FORMATS</b>					
Word length, bits	8	8	8	20	16
Fixed-point operand length, bits	Variable	Variable	Variable	20/40	16
Instruction length, bits	16	16	16	20	16
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	1.0	1.0	1.0	2.0	2.0
Minimum capacity, words	8,192	8,192	8,192	4,096	4,096
Maximum capacity, words	65,536	65,536	65,536	16,384	32,768
Parity checking	No	No	No	Optional	Optional
Storage protection	No	No	No	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	2	2	2	3	16
No. of index registers	1	1	1	3	2
No. of directly addressable words	65,536	65,536	65,536	4,096	256
Indirect addressing	One-level	One-level	One-level	Multi-level	Multi-level
Add time, microseconds (full word)	7.0	7.0	7.0	4.0	4.0
Hardware multiply/divide	No	No	No	Standard	Standard
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	Standard	Standard	Standard	No	No
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
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	8	8	20	16
Direct memory access channel	Standard	Standard	Standard	Optional	Optional
Maximum I/O rate, words/sec	1,000,000	1,000,000	1,000,000	500,000	500,000
No. of external interrupt levels	2-32	2-32	2-32	1-64	1-64
<b>PERIPHERAL EQUIPMENT</b>					
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	10K	10K	Not specified	Not specified
Punched card input speed, cpm	300	300	300	200	200
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	120	120
Other standard peripheral units	CRT displays, acctg. machine terminals, printers	CRT displays, acctg. machine terminals, printers	CRT displays, acctg. machine terminals, printers	A/D and D/A interfaces	A/D and D/A interfaces
<b>SOFTWARE</b>					
Assembler	No	No	No	2-pass	2-pass
Macro assembler	No	No	No	No	No
FORTRAN compiler	No	No	No	No	No
Other compilers	BASIC interp.	BASIC interp.	BASIC interp.	ATLAS	No
Operating system	Yes	Yes	Yes	No	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	Not available	Not available	Not available	On request	On request
Price of basic system with 8K words	\$30,900	\$31,900	\$32,900	On request	On request
Date of first delivery	Sept. 1971	Aug. 1971	May 1972	May 1970	1971
Number installed to date	See Comments	See Comments	See Comments	40	8
<b>COMMENTS</b>	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 approximately 400 systems installed to date.			Features 10 hardware registers and 131 register change instructions.	



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MANUFACTURER & MODEL	Cascade Data Concept II	CII Mitra 15/20	CII Mitra 15/30	Cincinnati Milacron CIP/2200	Clary Datacomp 404
<b>DATA FORMATS</b>					
Word length, bits	16(2 bytes)	16	16	8	16
Fixed-point operand length, bits	16-32	16	16	8/16/24/32	16/32/48/64
Instruction length, bits	16-40	16	16	Variable	16/32
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	0.9	0.8	0.8	1.1	2.2
Minimum capacity, words	4,096	4,096	4,096	8,192	1,024
Maximum capacity, words	32,768	32,768	32,768	32,768	65,536
Parity checking	Optional	Standard	Standard	Optional	No
Storage protection	No	Standard	Standard	No	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	16	2	2	2	4
No. of index registers	3	1 (+2 base)	1 (+2 base)	1	2
No. of directly addressable words	1,024	768	768	32,768	1,024
Indirect addressing	One-level	One-level	One-level	One-level	Multi-level
Add time, microseconds (full word)	8.8	2.3	2.3	Not specified	98 (15 digits)
Hardware multiply/divide	Standard	Optional	Standard	No	Standard
Hardware floating point	No	Optional	Optional	No	No
Hardware byte manipulation	Standard	Optional	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	No	Optional	Standard	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	8/16	8/16	8	16
Direct memory access channel	Standard	Optional	Optional	Optional	Optional
Maximum I/O rate, words/sec	416,000	300,000	1,200,000	909,000	250,000
No. of external interrupt levels	Variable	1-100	1-100	32 max.	16-256
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	Yes	Yes	Yes	Yes	No
Non-interchangeable disk storage	Yes	Yes	Yes	No	No
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	50K max.	20K/40K	20K-120K	25K	25K
Punched card input speed, cpm	300	300/600	300/600/1200	600	—
Punched card output speed, cpm	120	50	50/200/300	—	—
High-speed paper tape input, cps	300	300	300/2500	300	150/300
High-speed paper tape output, cps	75	60	60	150	—
Other standard peripheral units	Line printers, mark readers, communications, displays, etc.	Line printers, CRT display, comm. and A/D interfaces, etc.	Line printers, CRT display, comm. and A/D interfaces, etc.	Line printers, real-time and communications interfaces	Line printer, CRT display, magnetic card unit
<b>SOFTWARE</b>					
Assembler	2-pass	1-pass	1-pass	2-pass	1-pass
Macro assembler	Yes	Yes	Yes	No	No
FORTRAN compiler	No	Yes	Yes	No	No
Other compilers	RPG	LP15, LPG	LP15, LPG	RPG	RPG II, BASIC
Operating system	Yes	Yes (4)	Yes (4)	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	On request	\$13,200	\$17,200	Not available	\$6,475
Price of basic system with 8K words	On request	\$18,600	\$22,500	On request	\$8,825
Date of first delivery	Jan. 1970	June 1972	June 1972	Feb. 1972	Oct. 1969
Number installed to date	NA	See Comments	See Comments	NA	NA
<b>COMMENTS</b>	Byte-oriented; designed for business applications. Supported by extensive applications software.	Systems are organized around a 4-port core memory. One port is used by the CPU and the others by Input/Output Processors and/or Direct Memory Access. Over 250 systems have been installed to date. Prices are based upon 4.30 Francs per Dollar.		Features decimal arithmetic, string moves, translate, and edit instructions.	Performs both decimal and binary arithmetic. Can be used as an "intelligent terminal."

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MANUFACTURER & MODEL	Computer Automation Alpha 16	Computer Automation Naked Mini 16	Computer Automation Alpha LSI	Computer Automation Naked Mini LSI
<b>DATA FORMATS</b>				
Word length, bits	16	16	16	16
Fixed-point operand length, bits	16	16	16/32	16/32
Instruction length, bits	16	16	16	16
<b>MAIN STORAGE</b>				
Storage type	Core	Core	Core/semicond.	Core/semicond.
Cycle time, microseconds/word	1.6	1.6	1.6/1.6	1.6/1.6
Minimum capacity, words	2,048	2,048	4,096/1,024	4,096/1,024
Maximum capacity, words	32,768	32,768	262,144	262,144
Parity checking	Optional	Optional	Optional	Optional
Storage protection	Optional	Optional	No	No
<b>CENTRAL PROCESSOR</b>				
No. of accumulators	2	2	2	2
No. of index registers	1	1	1	1
No. of directly addressable words	1,024	1,024	1,024	1,024
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	3.2	3.2	9.2	9.2
Hardware multiply/divide	Standard	Standard	Standard	Standard
Hardware floating point	No	No	No	No
Hardware byte manipulation	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>				
I/O word size, bits	16	16	8/16	8/16
Direct memory access channel	Optional	Optional	Standard	Standard
Maximum I/O rate, words/sec	700,000	700,000	1,250,000	1,250,000
No. of external interrupt levels	3-unlimited	3-unlimited	3-unlimited	3-unlimited
<b>PERIPHERAL EQUIPMENT</b>				
Disk pack storage	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes
Drum storage	Yes	Yes	No	No
Magnetic tape speed, cps	10K-96K	10K-96K	10K-96K	10K-96K
Punched card input speed, cpm	300	300	300	300
Punched card output speed, cpm	—	—	—	—
High-speed paper tape input, cps	300/1000	300/1000	300/1000	300/1000
High-speed paper tape output, cps	75/120	75/120	75/120	75/120
Other standard peripheral units	Line printer, A/D converter, communications, plotter, etc.	Line printer, A/D converter, communications, plotter, etc.	Line printer, CRT display, communications, plotter, etc.	Line printer, CRT display, communications, plotter, etc.
<b>SOFTWARE</b>				
Assembler	1 & 2-pass	1 & 2-pass	2-pass	2-pass
Macro assembler	No	No	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes
Other compilers	BASIC	BASIC	BASIC	BASIC
Operating system	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>				
Price of basic system with 4K words	\$3,550	\$2,500 in lots of 10-19	\$1,990	\$990 in lots of 200
Price of basic system with 8K words	\$4,750	\$3,740 in lots of 10-19	\$2,990	\$1,815 in lots of 200
Date of first delivery	Oct. 1971	Oct. 1971	Dec. 1973	Dec. 1973
Number installed to date	Over 1000	Over 1000	0	0
<b>COMMENTS</b>	Program compatible with the earlier 116 and 216 computers. Has 156 instructions plus microcodes.	Low-cost OEM version of the Alpha 16, less chassis, power supply, and console. Sold only in quantities of 10 or more.	Permits intermixing of core and semiconductor memory. Control console features a hexadecimal data input keyboard.	Low-cost OEM version of the Alpha LSI, less chassis, power supply, and console. Consists of a single board 15" wide by 16.9" deep by 1.1" high.

## All About Minicomputers

MANUFACTURER & MODEL	Computer Automation Alpha 8	Computer Automation Naked Mini 8	Comstar 1	Comstar 2	Comstar 4
<b>DATA FORMATS</b>					
Word length, bits	8	8	8	8	4
Fixed-point operand length, bits	8	8	8	Variable	Variable
Instruction length, bits	8/16/24/32	8/16/24/32	8/16	16	8/16
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Semiconductor
Cycle time, microseconds/word	1.6	1.6	1.6	1.1	12.5
Minimum capacity, words	4,096	4,096	1,024	1,024	80
Maximum capacity, words	32,768	32,768	32,768	32,768	1,280
Parity checking	Optional	Optional	No	No	No
Storage protection	Optional	Optional	No	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	1	1	15	1
No. of index registers	0	0	1 (2 optional)	0	16
No. of directly addressable words	512	512	4,096	32,768	1,280
Indirect addressing	Multi-level	Multi-level	No	No	No
Add time, microseconds (full word)	3.2	3.2	1.6	0.22	12.5
Hardware multiply/divide	No	No	No	No	No
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	No	No	No	Standard	Standard
Power failure protection	Optional	Optional	Optional	Optional	No
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	8	8	8	4
Direct memory access channel	Optional	Optional	Optional	Optional	No
Maximum I/O rate, words/sec	120,000	120,000	625,000	910,000	80,000
No. of external interrupt levels	3-64	3-64	1-64	1-64	1
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	No	No	No	No	No
Non-interchangeable disk storage	No	No	Yes	No	No
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	10K-25K	10K-25K	240	240	240
Punched card input speed, cpm	300	300	150	—	150
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	400	400	120	300	120
High-speed paper tape output, cps	75/120	75/120	70	70	70
Other standard peripheral units	Line printer, A/D converter, data sets, etc.	Line printer, A/D converter, data sets, etc.	CRT displays, communications	Cassette tape, communications	CRT display, communications, digital I/O interfaces
<b>SOFTWARE</b>					
Assembler	1 & 2-pass	1 & 2-pass	2-pass	2-pass	No
Macro assembler	No	No	No	No	No
FORTRAN compiler	No	No	No	No	No
Other compilers	No	No	Process Control	Process Control	Process Control
Operating system	No	No	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$2,800	\$1,975 in lots of 10-19	\$3,500	\$3,500	\$1,580 (with 1280 words)
Price of basic system with 8K words	\$3,300	\$2,275 in lots of 10-19	\$5,400	\$5,400	Not available
Date of first delivery	May 1972	May 1972	June 1972	Jan. 1971	Feb. 1972
Number installed to date	NA	NA	10	6	300
<b>COMMENTS</b>	Program compatible with the earlier 108, 208, and 808 computers. Has 76 instructions plus microcodes.	Low-cost OEM version of Alpha 8, less chassis, power supply, and console. Sold only in quantities of 10 or more.	Special-purpose computer for warehouse control, data concentration, and process control. Has compiler for Process Control Language.	Special-purpose computer for process control and machine tool control applications.	Microcomputer, based on Intel MCS-4, for process control, industrial automation, and special OEM systems.

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MANUFACTURER & MODEL	Control Data 1700	Control Data SC-1700	Data General Nova 800	Data General Nova 820	Data General Nova 840
<b>DATA FORMATS</b>					
Word length, bits	16 + 2	16 + 2	16	16	16
Fixed-point operand length, bits	16	16	16	16	16
Instruction length, bits	16/32	16/32	16	16	16
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	1.1	1.5	0.8	0.8	0.8
Minimum capacity, words	4,096	4,096	2,048	2,048	2,048
Maximum capacity, words	32,768	32,768	32,768	32,768	131,072
Parity checking	Standard	Standard	No	No	No
Storage protection	Standard	Standard	No	No	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	2	2	4	4	4
No. of index registers	2	2	2	2	2
No. of directly addressable words	256	256	1,024	1,024	1,024
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	2.2	3.0	0.8	0.8	0.8
Hardware multiply/divide	Standard	Standard	Optional	Optional	Optional
Hardware floating point	No	No	Optional	Optional	Optional
Hardware byte manipulation	No	Optional	Standard	Standard	Standard
Immediate (literal) instructions	No	No	No	No	No
Power failure protection	Standard	Standard	Optional	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
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	900,000	650,000	1,250,000	1,250,000	1,250,000
No. of external interrupt levels	2-16	2-16	16	16	16
<b>PERIPHERAL EQUIPMENT</b>					
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	30K max.	30K max.	30K max.	30K max.	30K max.
Punched card input speed, cpm	330-1600	330-1600	225/400	225/400	225/400
Punched card output speed, cpm	100-460	100-460	—	—	—
High-speed paper tape input, cps	400	400	300	300	300
High-speed paper tape output, cps	120/150	120/150	63	63	63
Other standard peripheral units	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.	Line printer, A/D converters, communications, plotter, etc.	Line printer, A/D converters, communications, plotter, etc.
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	No	No	No
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	No	No	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$20,000	\$15,900	\$6,600	\$6,100	NA
Price of basic system with 8K words	\$26,500	\$20,400	\$8,000	\$7,500	\$16,530 (with 16K words)
Date of first delivery	1966	1972	March 1971	NA	June 1973
Number installed to date	See Comments	See Comments	485	170	NA
<b>COMMENTS</b>	18-bit word includes parity and storage protection bits. The CDC 1714 Computer System uses a CPU similar to the 1700. More than 500 of the 1700 Series systems have been installed.		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.

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MANUFACTURER & MODEL	Data General Nova 1200	Data General Nova 1210	Data General Nova 1220	Data General Nova 1230	Data General Supernova
<b>DATA FORMATS</b>					
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
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core/semicond.
Cycle time, microseconds/word	1.2	1.2	1.2	1.2	0.8/0.3
Minimum capacity, words	2,048	2,048	2,048	2,048	1,024
Maximum capacity, words	32,768	24,576	32,768	32,768	32,768
Parity checking	No	No	No	No	No
Storage protection	No	No	No	No	Optional
<b>CENTRAL PROCESSOR</b>					
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)	1.35	1.35	1.35	1.35	0.8/0.3
Hardware multiply/divide	Optional	Optional	Optional	Optional	Optional
Hardware floating point	Optional	No	Optional	No	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
<b>INPUT/OUTPUT CONTROL</b>					
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	833,000	833,000	833,000	833,000	1,250,000
No. of external interrupt levels	16	16	16	16	16
<b>PERIPHERAL EQUIPMENT</b>					
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	30K max.	30K max.	30K max.	30K max.	30K max.
Punched card input speed, cpm	225/400	225/400	225/400	225/400	225/400
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	300	300	300	300	300
High-speed paper tape output, cps	63	63	63	63	63
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, plotters, etc.	Line printer, A/D converters, communications, plotters, etc.
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	No	No	No	No	No
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$5,100	\$4,000	\$4,900	NA	\$9,250
Price of basic system with 8K words	\$6,500	\$5,400	\$6,300	\$7,100	\$10,500
Date of first delivery	Dec. 1970	Feb. 1972	Feb. 1972	NA	April 1970
Number of installed to date	2700	1540 (Nova 1210) & 1220 combined)	1540 (Nova 1210) & 1220 combined)	NA	215
<b>COMMENTS</b>	All Nova-line computers are program compatible. Semiconductor read-only memory is interchangeable with core.	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 semiconductor, or 300-nsec read-only semiconductor memory.

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MANUFACTURER & MODEL	Datacraft 6024/1	Datacraft 6024/3	Datacraft 6024/4 (Slash 4)	Datacraft 6024/5	Datapoint 2200 Version 1
<b>DATA FORMATS</b>					
Word length, bits	24	24	24	24	8
Fixed-point operand length, bits	24/48	24/48	24/48	24/48	8
Instruction length, bits	24	24	24	24	8/16/24
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core/semicond.	Core	Semiconductor
Cycle time, microseconds/word	0.6	1.0	0.75/0.20	0.95	8.0
Minimum capacity, words	8,192	8,192	8,192/8,192	4,096	2,048
Maximum capacity, words	65,536	65,536	262,144/16,384	65,536	8,192
Parity checking	Standard	Standard	Standard	Standard	No
Storage protection	Optional	Optional	Optional	Optional	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	5 or 6	5 or 6	5 or 6	5 or 6	1
No. of index registers	3	3	3	3	0
No. of directly addressable words	65,536	65,536	65,536	65,536	8,192
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level	No
Add time, microseconds (full word)	1.2	2.0	1.5	1.9	16
Hardware multiply/divide	Standard	Standard	Standard	Standard	No
Hardware floating point	Optional	Optional	Optional	No	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	No
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Optional	Optional	Standard
Real-time clock or timer	Optional	Optional	Optional	Optional	No
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	24 or 8	24 or 8	24 or 8	24 or 8	8
Direct memory access channel	Optional	Optional	Optional	Optional	No
Maximum I/O rate, words/sec	1,667,000	1,000,000	1,300,000	1,000,000	2,000
No. of external interrupt levels	4-72	4-24	4-48	4-24	0
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	No
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	320K max.	320K max.	320K max.	320K max.	10K
Punched card input speed, cpm	300/600/1000	300/600/1000	300/600/1000	300/600/1000	—
Punched card output speed, cpm	35-100	35-100	35-100	35-100	—
High-speed paper tape input, cps	300/600	300/600	300/600	300/600	—
High-speed paper tape output, cps	75/110	75/110	75/110	75/110	—
Other standard peripheral units	CRT display, plotter, A/D converter, com- munications	CRT display, plotter, A/D converter, com- munications	Line printers, CRT display, plotter, A/D converter, com- munications	CRT display, plotter, A/D converter, com- munications	CRT display, printers, com- munications interfaces
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	No
FORTRAN compiler	Yes	Yes	Yes	Yes	No
Other compilers	BASIC, RPG	BASIC, RPG	BASIC, RPG	BASIC, RPG	BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	Not available	Not available	Not available	\$10,900	\$6,630
Price of basic system with 8K words	\$51,400	\$32,800	\$19,900	\$13,400	\$7,800
Date of first delivery	May 1969	Feb. 1970	Aug. 1973	May 1972	April 1972
Number installed to date	20	125	0	75	Over 2000 total
<b>COMMENTS</b>	All four Datacraft models are program-compatible. The quoted prices include a basic software package; other software is available at extra cost. Models 6024/4 and 6024/5 fit into a standard 19" rack. The 6024/5 is also available in a ruggedized version called the 6024/5R, which is priced at \$27,000 with 8K words of core storage.				Processor in- cludes a CRT display and 2 cassette tape drives. See Report 70D- 315-01 for more information.

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MANUFACTURER & MODEL	Datapoint 2200 Version II	Digital Com- puter Control D-112	Digital Com- puter Control D-112H	Digital Com- puter Control D-116	Digital Com- puter Control D-116H
<b>DATA FORMATS</b>					
Word length, bits	8	12	12	16	16
Fixed-point operand length, bits	8	12	12	16	16
Instruction length, bits	8/16/24	12/24	12/24	16	16
<b>MAIN STORAGE</b>					
Storage type	Semiconductor	Core	Core/semicond.	Core	Core
Cycle time, microseconds/word	1.6	1.2	0.9/0.2	1.2	0.96
Minimum capacity, words	4,096	4,096	256	4,096	1,024
Maximum capacity, words	16,384	32,768	32,768	131,072	131,072
Parity checking	No	Optional	Optional	No	No
Storage protection	No	Standard	Standard	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	1	1	4	4
No. of index registers	0	8	24	2	2
No. of directly addressable words	16,384	256	256	1,024	1,024
Indirect addressing	No	One-level	One-level	Multi-level	Multi-level
Add time, microseconds (full word)	4.8	2.4	2.4	1.35	Not specified
Hardware multiply/divide	No	Optional	Optional	Optional	Optional
Hardware floating point	No	Optional	Optional	No	No
Hardware byte manipulation	No	Optional	Standard	Standard	Standard
Immediate (literal) instructions	Standard	No	No	No	No
Power failure protection	Standard	Optional	Optional	Standard	Standard
Real-time clock or timer	Standard	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	12	12	16	16
Direct memory access channel	No	Optional	Optional	Standard	Standard
Maximum I/O rate, words/sec	30,000	833,000	833,000	833,000	1,040,000
No. of external interrupt levels	0	1-64	1-64	16	16
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	No	Yes	Yes	Yes	Yes
Drum storage	No	Yes	Yes	No	No
Magnetic tape speed, cps	10K	30K	30K	30K	30K
Punched card input speed, cpm	400/600	200	200	225/400	225/600
Punched card output speed, cpm	—	100	100	100	100
High-speed paper tape input, cps	—	300	300	300	300
High-speed paper tape output, cps	—	110	110	110	110
Other standard peripheral units	CRT display, printers, communications interfaces	Line printer, communications interfaces, A/D converters, etc.	Line printers, communications interfaces, A/D converters, etc.	Line printer, communications interfaces, A/D converters, etc.	Line printer, communications interfaces, A/D converters, plotters, etc.
<b>SOFTWARE</b>					
Assembler	2-pass	1 & 2-pass	1 & 2-pass	2-pass	2-pass
Macro assembler	No	Yes	Yes	Yes	Yes
FORTRAN compiler	No	Yes	Yes	Yes	Yes
Other compilers	BASIC	BASIC	BASIC	BASIC	BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$8,571	\$3,390	\$5,600	\$3,800	\$4,000
Price of basic system with 8K words	\$10,003	\$5,390	\$7,700	\$5,130	\$5,400
Date of first delivery	March 1972	Aug. 1970	April 1971	Nov. 1971	Dec. 1972
Number installed to date	Over 2000 total	NA	NA	718	NA
<b>COMMENTS</b>					
	Processor includes a CRT display and 2 cassette tape drives. See Report 70D-315-01 for more information.	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.	Designed to be fully compatible with the Data General Nova 1200 series computers. Offers 16K memory on single board.	Designed to be fully compatible with the D-116 and the Data General Nova 1200 series computers.

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MANUFACTURER & MODEL	Digital Equipment PDP-8/E	Digital Equipment PDP-8/F	Digital Equipment PDP-8/M	Digital Equipment PDP-12	Digital Equipment PDP-15
<b>DATA FORMATS</b>					
Word length, bits	12	12	12	12	18
Fixed-point operand length, bits	12	12	12	12	18
Instruction length, bits	12/24	12/24	12/24	12/24	18
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	1.2	1.2	1.2	1.6	0.8
Minimum capacity, words	4,096	4,096	4,096	4,096	4,096
Maximum capacity, words	32,768	16,384	32,768	32,768	131,072
Parity checking	Optional	Optional	Optional	Optional	Optional
Storage protection	Optional	Optional	Optional	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	1	1	1	1
No. of index registers	8	6	6	8	1
No. of directly addressable words	256	256	256	1,024	4,096
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Add time, microseconds (full word)	2.6	2.6	2.6	3.2	1.6
Hardware multiply/divide	Optional	Optional	Optional	Optional	Optional
Hardware floating point	Optional	Optional	Optional	Optional	No
Hardware byte manipulation	Yes	Yes	Yes	No	No
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
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	12	12	12	12	18
Direct memory access channel	Standard	Optional	Optional	Standard	Standard
Maximum I/O rate, words/sec	833,000	833,000	833,000	625,000	1,000,000
No. of external interrupt levels	1-64	1-64	1-64	1-64	28-64
<b>PERIPHERAL EQUIPMENT</b>					
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	Yes
Magnetic tape speed, cps	36K max.	36K max.	36K max.	36K max.	60K max.
Punched card input speed, cpm	300	300	300	200	200
Punched card output speed, cpm	275 max.	275 max.	275 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, plotter, CRT displays, comm., printers, etc.	DEctape, plotter, CRT displays, comm., printers, etc.	DEctape, plotters, A/D converters, printers, etc.	DEctape, A/D converters, real-time interfaces
<b>SOFTWARE</b>					
Assembler	1 & 2-pass	1 & 2-pass	1 & 2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	No	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	ALGOL, BASIC, DIBOL, FOCAL	ALGOL, BASIC, DIBOL, FOCAL	ALGOL, BASIC, DIBOL, FOCAL	BASIC	FOCAL
Operating system	Yes	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$4,990	\$3,990	\$3,990	\$13,400	\$15,000
Price of basic system with 8K words	\$7,740	\$6,740	\$6,395	\$17,400	\$21,000
Date of first delivery	Dec. 1970	May 1972	Jan. 1972	April 1969	Fall 1969
Number installed to date	8,300	2,840	360	Over 600	Over 500
<b>COMMENTS</b>	Over 21,000 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. The PDP-8/M is intended for OEM's. 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.			Designed for laboratory applications; can execute PDP-8 programs; built-in CRT display.	Program compatible with the PDP-9, and has 17 new instructions.



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MANUFACTURER & MODEL	Digital Equipment PDP-11/05	Digital Equipment PDP-11/10	Digital Equipment PDP-11/15	Digital Equipment PDP-11/20	Digital Equipment PDP-11/40
<b>DATA FORMATS</b>					
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	16/32/48
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	0.9	0.9	0.9	0.9	0.85
Minimum capacity, words	4,096	8,192	4,096	4,096	8,192
Maximum capacity, words	28,672	28,672	32,768	124K	124K
Parity checking	Optional	Optional	Optional	Optional	Optional
Storage protection	No	No	No	No	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	8	8	8	8	8
No. of index registers	Up to 8	Up to 8	Up to 8	Up to 8	Up to 8
No. of directly addressable words	28,672	28,672	32,768	32,768	32,768
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Add time, microseconds (full word)	2.3	2.3	2.3	2.3	2.3
Hardware multiply/divide	Optional	Optional	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	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Standard	Standard	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
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	833,000	833,000	1,110,000	1,110,000	1,150,000
No. of external interrupt levels	Variable	Variable	Variable	Variable	Variable
<b>PERIPHERAL EQUIPMENT</b>					
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 max.	36K max.	36K max.	36K max.	36K max.
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	50	50	50	50	50
Other standard peripheral units	Communications interface, CRT displays, printers, etc.	Communications interface, CRT displays, 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.
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Runs on 11/20	Runs on 11/20	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC	BASIC	BASIC	BASIC	BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$4,795	Not available	\$6,200	\$9,300	Not available
Price of basic system with 8K words	\$6,495	\$6,995	\$8,100	\$12,900	\$12,995
Date of first delivery	Feb. 1972	March 1973	April 1971	March 1970	Jan. 1973
Number installed to date	300	15	Over 1000	Over 2500	30
<b>COMMENTS</b>	The PDP-11 systems form an upward-compatible family. The PDP-11/05 and 11/15 are designed for OEM use; the 11/10 is an end-user version of the 11/05. Not shown in the charts are the PDP-11/R20, a ruggedized version of the 11/20 with a \$13,900 base price, and the PDP-11/50, which is exactly like the 11/45 (next page) except for a limitation to 32K words of semiconductor-only main memory. Many turnkey systems are available for specialized applications. 500-nsec read-only memory is available in 1024-word increments.				

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MANUFACTURER & MODEL	Digital Equipment PDP-11/45	Digital Scientific META 4	Electronic Associates PACER	Electronic Processors EPI-118	Electronic Processors EPI-218
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	18	18
Fixed-point operand length, bits	16	16	16	18	18
Instruction length, bits	16/32/48	32	16	18	18/36
<b>MAIN STORAGE</b>					
Storage type	Core/semicond.	Core	Core	Core	Core
Cycle time, microseconds/word	0.85 (core)	0.90	1.0	1.0	1.2
Minimum capacity, words	4,096	4,096	8,192	4,096	4,096
Maximum capacity, words	124K	65,536	32,768	32,768	32,768
Parity checking	Standard	Standard	No	No	No
Storage protection	Optional	Standard	Standard	No	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	8	32	1	2	3
No. of index registers	Up to 8	Variable	1	0	3
No. of directly addressable words	32,768	65,536	512	32,768	32,768
Indirect addressing	One-level	One-level	Multi-level	No	Multi-level
Add time, microseconds (full word)	2.3	2.14	2.0	2.5	2.4
Hardware multiply/divide	Standard	Standard	Standard	No	Optional
Hardware floating point	Optional	Optional	Optional	No	No
Hardware byte manipulation	Standard	Standard	No	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	No	Standard
Power failure protection	Standard	Optional	Standard	Standard	Standard
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	16	21	21
Direct memory access channel	Standard	9 standard	Optional	Optional	Optional
Maximum I/O rate, words/sec	1,180,000	1,100,000	1,000,000	900,000	900,000
No. of external interrupt levels	Variable	16	64	0 to 18	0 to 18
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	No	Yes	No	No
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	36K max.	60K max.	120K max.	10K-30K	10K-30K
Punched card input speed, cpm	300	1000 max.	300	300	300
Punched card output speed, cpm	—	160 max.	—	100	100
High-speed paper tape input, cps	300	400	300	300	300
High-speed paper tape output, cps	50	50	120	75	75
Other standard peripheral units	DECtape, CRT displays A/D converters, printers, etc.	Line printers, plotter, communications	Line printers, cartridge tape, CRT displays, communications, plotters, etc.	Line printers, CRT display, cassette tape, A/D and comm. interfaces, etc.	Line printers, CRT display, cassette tape, A/D and comm. interfaces, etc.
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	No	No	No
FORTRAN compiler	Yes	Yes	Yes	No	No
Other compilers	BASIC	Yes	Op. Interpreter	BASIC	BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$19,400	\$29,475	Not available	\$2,790	\$3,490
Price of basic system with 8K words	\$23,900	\$33,175	\$15,200	\$3,990	\$4,690
Date of first delivery	May 1972	Jan. 1970	May 1972	Nov. 1970	Jan. 1973
Number installed to date	200	NA	NA	NA	NA
<b>COMMENTS</b>	Includes 2 Unibus structures for increased data handling capability. Main memory can include up to 32K of 450-nsec MOS and/or 300-nsec bipolar memory.	Controlled by 1K to 4K words of 90-nsec read-only memory. One version, META 4/1130, emulates the IBM 1130 and 1800.	PACER is fully compatible with the earlier EAI 640, which it replaces. Uses MSI and LSI technology.	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."

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MANUFACTURER & MODEL	Four-Phase Systems, Inc. System IV/40	Four-Phase Systems, Inc. System IV/70	Fujitsu FACOM R-E	Fujitsu FACOM U-200	General Automation SPC-12
<b>DATA FORMATS</b>					
Word length, bits	24	24	16	8	8
Fixed-point operand length, bits	24	24	16	8/16/32	8/12
Instruction length, bits	24	24	16	16/32/48	8/16
<b>MAIN STORAGE</b>					
Storage type	Semiconductor	Semiconductor	Core	Core/semicond.	Core
Cycle time, microseconds/word	2.0	2.0	1.5	0.65/0.75	2.16
Minimum capacity, words	8,192	4,096	4,096	4,096	4,096
Maximum capacity, words	24,576	32,768	32,768	32,768	16,384
Parity checking	Standard	Standard	Standard	Standard	Optional
Storage protection	No	No	No	Optional	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	5	5	1	8	4
No. of index registers	3	3	4	7	3
No. of directly addressable words	24,576	32,768	512	32,768	4,096
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Add time, microseconds (full word)	16	16	6.0	1.58/1.93	6.48
Hardware multiply/divide	Standard	Standard	No	Optional	No
Hardware floating point	Standard	Standard	No	No	No
Hardware byte manipulation	Standard	Standard	None	Standard	Standard
Immediate (literal) instructions	No	No	No	Standard	Standard
Power failure protection	No	No	Optional	Standard	Optional
Real-time clock or timer	Standard	Standard	Optional	Optional	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	24	24	16	8/16	8/12
Direct memory access channel	Standard	Standard	Standard	Standard	Optional
Maximum I/O rate, words/sec	125,000	125,000	400,000	1,000,000	460,000
No. of external interrupt levels	8	8	1	4	2-256
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	No	No	No	Yes	Yes
Drum storage	No	No	Yes	Yes	Yes
Magnetic tape speed, cps	—	60K max.	21.6K	9.6K	60K max.
Punched card input speed, cpm	—	300	300	100/300/600	400/1000
Punched card output speed, cpm	—	—	30	30	100
High-speed paper tape input, cps	—	—	200/400	300/600	400
High-speed paper tape output, cps	—	—	50/100/200	50/100/200	75
Other standard peripheral units	CRT displays, character printer, comm. controller	CRT displays, line printer, Data-Phone interface, IBM channel adapter	Line printer, plotter, optical mark reader	Cassette tape, line printer, communications, displays, etc.	A/D converters, communications interfaces
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	1 & 2-pass	1-pass
Macro assembler	No	No	No	Yes	No
FORTRAN compiler	No	No	Yes	Yes	No
Other compilers	COBOL	COBOL	No	No	No
Operating system	Yes	Yes	No	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	Not available	\$16,000	On request	\$8,036	\$2,980 to \$3,980
Price of basic system with 8K words	\$15,750	\$22,600	On request	\$10,179	\$3,850 to \$4,850
Date of first delivery	June 1973	Feb. 1971	Not specified	Oct. 1972	Jan. 1968
Number installed to date	NA	NA	Over 750	Over 250	1700
<b>COMMENTS</b>	Specifically de- signed for data entry and remote inquiry use. Price includes 290K-byte diskette drive.	Specifically de- signed to sup- port up to 32 interactive CRT terminals. MOS/LSI CP consists of 12 chips on 1 card.	Has 28 basic instructions and 5 addressing modes.	Processor, memory, and peripheral de- vices share a single high-speed bus. Offers wide range of peripherals.	Available in three models; SPC-12/10, 12/15, and 12/20.

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MANUFACTURER & MODEL	General Automation SPC-16	General Automation System 18/30	GRI Computer GRI-99 Model 30	GRI Computer GRI-99 Model 40	GTE IS/1000
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16	16/32	16	16	16
Instruction length, bits	16	16/32	16	16	16
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	0.80/0.96/1.44	0.96	1.2	1.2	0.75
Minimum capacity, words	4,096	4,096	4,096	4,096	4,096
Maximum capacity, words	65,536	32,768	32,768	32,768	32,768
Parity checking	No	Standard	No	No	Optional
Storage protection	No	Standard	Optional	Optional	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	16	2	1	1	16
No. of index registers	6	3	1; up to 32K	1; up to 32K	15
No. of directly addressable words	32,768	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)	0.80/0.96/1.44	2.4	0.88/1.76	0.88/1.76	0.75
Hardware multiply/divide	Optional	Standard	Optional	Standard	Optional
Hardware floating point	Optional	No	Optional	Standard	No
Hardware byte manipulation	Standard	No	Optional	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Optional	Optional	Standard
Real-time clock or timer	Standard	Standard	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	Standard	5 standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1,040,000	960,000	568,000	568,000	1,100,000
No. of external interrupt levels	64-unlimited	6-59	Unlimited	Unlimited	8
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	Yes	Yes	Special order	Special order	Yes
Magnetic tape speed, cps	60K max.	60K max.	310	310	30K/40K
Punched card input speed, cpm	400/1000	400/1000	300	300	200 to 1000
Punched card output speed, cpm	100	100	Special order	Special order	200
High-speed paper tape input, cps	400	400	300	300	400
High-speed paper tape output, cps	75	75	50	50	120
Other standard peripheral units	A/D converters, communications interfaces	A/D converters, communications interfaces	Cassette tape, line printers, displays, etc.	Cassette tape, line printers, displays, etc.	Line printers, communications interfaces
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	No	No	No	Yes
FORTRAN compiler	Yes	Yes	No	No	Yes
Other compilers	BASIC	RPG	No	No	No
Operating system	Yes	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$3,950 to \$8,550	\$18,950	\$5,060	\$5,725	\$5,700
Price of basic system with 8K words	\$5,350 to \$10,150	\$22,950	\$5,505	\$6,170	\$7,500
Date of first delivery	May 1970	July 1969	June 1972	June 1972	1st qtr. 1972
Number installed to date	1100	300	Over 200	Over 50	NA
<b>COMMENTS</b>	Available in six models, offering choice of core speeds and I/O packaging. Read-only memory is interchangeable with core.	Instruction set is fully compatible with the IBM 1130 and 1800. SPC-18 is an OEM version of the 18/30.	Based on a Universal Bus System, in which all system elements share common data buses 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.

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MANUFACTURER & MODEL	Hewlett-Packard 2100A	Hewlett-Packard 2100S	Hewlett-Packard 3000	Hitachi HITAC 10-II	Honeywell System 700
<b>DATA FORMATS</b>					
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
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	0.98	0.98	0.90	0.9	0.775
Minimum capacity, words	4,096	4,096	32,768	4,096	4,096
Maximum capacity, words	32,768	32,768	65,536	32,768	65,536
Parity checking	Standard	Standard	Standard	Standard	Optional
Storage protection	Standard	Standard	Standard	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	2	2	Stack	1	1
No. of index registers	0	0	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)	1.96	1.96	1.05	1.8	1.55
Hardware multiply/divide	Standard	Standard	Standard	Optional	Standard
Hardware floating point	No	Standard	Standard	No	No
Hardware byte manipulation	No	No	Standard	No	Standard
Immediate (literal) instructions	No	No	Standard	Standard	No
Power failure protection	Standard	Standard	Standard	Optional	Standard
Real-time clock or timer	Optional	Standard	Standard	Optional	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	Optional (2)	Standard (2)	Standard	Optional	Standard
Maximum I/O rate, words/sec	1,000,000	1,000,000	1,400,000	833,000	1,000,000
No. of external interrupt levels	Up to 56	Up to 56	253	1-4	63
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	Yes	Yes	Yes	Yes	No
Magnetic tape speed, cps	72K max.	72K max.	72K max.	19.2K/40K	112K max.
Punched card input speed, cpm	200/600	200/600	600/1200	310	300 to 1050
Punched card output speed, cpm	—	—	200	No	100
High-speed paper tape input, cps	500	500	500	240/600	300
High-speed paper tape output, cps	75/120	75/120	75	110	110
Other standard peripheral units	Line printers, communications interfaces, plotters	Line printers, communications interfaces, plotters	Line printers, CRT displays, communications interfaces	Line printer, cassette tape, mark readers, plotter, etc.	6 line printers, cassette tape, A/D and comm. interfaces, etc.
<b>SOFTWARE</b>					
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
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$6,900	Not available	Not available	\$8,038	\$12,265 (\$363/month)
Price of basic system with 8K words	\$8,400	\$16,000 (with 16K words)	Not available	\$10,830	\$16,300 (\$483/month)
Date of first delivery	1971	1973	Nov. 1972	Nov. 1972	June 1972
Number installed to date	Over 500	0	NA	Over 90	150
<b>COMMENTS</b>	Controlled by semiconductor read-only memory. User-micro-programmable; supports writable control store.	User-micro-programmable systems computer. Compatible with earlier HP mini-computers at the macro program level.	Features stack architecture and 170 instructions. System prices range from about \$150,000 to \$300,000.	Prices are based upon conversion ratio of 265 Yen per Dollar.	Type 716 CPU is incorporated into 6 systems designed for a variety of sensor-based and communications applications.

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MANUFACTURER & MODEL	Honeywell 316	Honeywell 516	Information Comp. Systems ALP1	Information Comp. Systems ALP2	Information Comp. Systems ALP3
<b>DATA FORMATS</b>					
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
<b>MAIN STORAGE</b>					
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
<b>CENTRAL PROCESSOR</b>					
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
<b>INPUT/OUTPUT CONTROL</b>					
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
<b>PERIPHERAL EQUIPMENT</b>					
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, displays, etc.	Line printers, communications interfaces, displays, etc.	Printers, CRT displays, communications interfaces	Printers, CRT displays, communications interfaces	Printers, CRT displays, communications interfaces
<b>SOFTWARE</b>					
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
<b>PRICING &amp; AVAILABILITY</b>					
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	2500	1400	2	3	1
<b>COMMENTS</b>	The 316 and 516 are logically identical. They form the basis of Honeywell's Series 1600 data acquisition and data communications systems. Ruggedized models, 316R and 516R are also available.		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 inter-connected, and up to 4 store-processor transfers can proceed simultaneously. Prices are based upon 2.57 Dollars per British Pound.		

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MANUFACTURER & MODEL	Intel MCS-4 Microcomputer	Intel MCS-8 Microcomputer	Intel Intellec 4 Microcomputer	Intel Intellec 8 Microcomputer	Intel SIM8-01 Microcomputer
<b>DATA FORMATS</b>					
Word length, bits	4/8	8	4	8	8
Fixed-point operand length, bits	4	8	4	8	8
Instruction length, bits	8/16	8/16/24	8/16	8/16/24	8/16/24
<b>MAIN STORAGE</b>					
Storage type	Semiconductor	Semiconductor	Semiconductor	Semiconductor	Semiconductor
Cycle time, microseconds/word	10.8	12.5	10.8	12.5	20
Minimum capacity, words	256	256	4,096	4,096	1,024
Maximum capacity, words	5,376	16,384	8,192	16,384	3,072
Parity checking	No	No	No	No	No
Storage protection	No	No	Monitor in PROM	Monitor in PROM	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	1	1	1	1
No. of index registers	16 (4-bit)	6 (8-bit)	16	6	6
No. of directly addressable words	4,096	16,384	8,192	16,384	16,384
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Add time, microseconds (full word)	10.8	10 to 20	10.8	12.5	20
Hardware multiply/divide	No	No	No	No	No
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	No	Standard	No	Standard	Standard
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
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	4	8	4	8	8
Direct memory access channel	No	No	Standard	Standard	No
Maximum I/O rate, words/sec	10,000	5,000	11,500	12,500	7,800
No. of external interrupt levels	None	1	None	1	1
<b>PERIPHERAL EQUIPMENT</b>					
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	—	—	—	—	—
High-speed paper tape output, cps	—	—	—	—	—
Other standard peripheral units	—	—	Teletypewriter	Teletypewriter	Teletypewriter
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	No	No	No	No	No
FORTRAN compiler	No	No	No	No	No
Other compilers	No	INTERP/8	No	PL/M	PL/M
Operating system	No	No	No	No	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$900	\$900	\$2,195	\$2,395	\$900 (with 1024 words)
Price of basic system with 8K words	Not available	\$1,400	\$3,065	\$3,145	Not available
Date of first delivery	June 1971	Jan. 1972	Sept. 1973	Sept. 1973	May 1972
Number installed to date	NA	NA	0	0	NA
<b>COMMENTS</b>	Consists of 4 kinds of LSI chips: processor, shift register, R/W memory, and ROM. The ROM modules are programmed to user spec's.	CPU is a single MOS chip that can be combined with various R/W memory, ROM, and shift register modules.	Facilitates development of programs for the MCS-4 by providing random access memory (RAM) plus a control panel and display.	Facilitates development of programs for the MCS-8 by providing random access memory (RAM) plus a control panel and display.	Prototyping board to facilitate design of MCS-8 programs. Uses electrically programmed PROM's in place of mask programmed ROM's.

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MANUFACTURER & MODEL	Interdata Model 70	Interdata Model 74	Interdata Model 80	Interdata Model 85	IBM System/7
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16	16	16	16	16
Instruction length, bits	16/32	16/32	16/32	16/32	16/32
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Semiconductor	Semiconductor	Semiconductor
Cycle time, microseconds/word	1.0	1.0	0.24	0.27	0.4
Minimum capacity, words	4,096	4,096	8,192	8,192	2,048
Maximum capacity, words	32,768	32,768	32,768	32,768	16,384
Parity checking	Optional	Optional	Optional	Optional	Standard
Storage protection	Optional	Optional	Optional	Optional	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	16	16	16	16	4 groups of 1
No. of index registers	15	15	15	15	4 groups of 7
No. of directly addressable words	32,768	32,768	32,768	32,768	16,384
Indirect addressing	No	No	No	No	No
Add time, microseconds (full word)	1.0	1.5	0.45	0.53	0.8
Hardware multiply/divide	Standard	Standard	Standard	Standard	No
Hardware floating point	Standard	No	Standard	Standard	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	No
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	Standard (2)
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8/16	8/16	8/16	8/16	16
Direct memory access channel	Optional	Standard	Optional	Standard	Standard
Maximum I/O rate, words/sec	1,000,000	1,000,000	4,500,000	2,000,000	500,000
No. of external interrupt levels	256	256	256	256	64
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	Yes	Yes	Yes	Yes	No
Magnetic tape speed, cps	36K	36K	36K	36K	RPQ
Punched card input speed, cpm	300	300	300	300	RPQ
Punched card output speed, cpm	—	—	—	—	RPQ
High-speed paper tape input, cps	300	300	300	300	RPQ
High-speed paper tape output, cps	60	60	60	60	RPQ
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, comm. and A/D interfaces	Analog and digital I/O interfaces, communications interface
<b>SOFTWARE</b>					
Assembler	1 & 2-pass	1 & 2-pass	1 & 2-pass	1 & 2-pass	1-pass
Macro assembler	No	No	No	No	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Runs on S/360
Other compilers	No	No	No	No	No
Operating system	Yes (3)	Yes (3)	Yes (3)	Yes (3)	Limited
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$6,800	\$3,600	Not available	Not available	\$16,795
Price of basic system with 8K words	\$9,500	\$5,900	\$14,900	\$22,800	\$27,820
Date of first delivery	Dec. 1971	March 1973	July 1972	July 1973	Nov. 1971
Number installed to date	Over 200	Over 50	NA	—	1500 (est.)
<b>COMMENTS</b>	Controlled by microprograms in 80-nanosecond bipolar read-only memory. Compatible with earlier Interdata computers.	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 sensor-based applications. Can be used on-line with IBM 1130, 1800, 360, and 370 computers. Disk pack is System/3-compatible.



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MANUFACTURER & MODEL	Linolex Model A.	Lockheed Electronics MAC 16	Lockheed Electronics MAC Jr.	Lockheed Electronics SUE
<b>DATA FORMATS</b>				
Word length, bits	8	16	16	16
Fixed-point operand length, bits	Variable	16	16	16
Instruction length, bits	Variable	16	16	16/32
<b>MAIN STORAGE</b>				
Storage type	Semiconductor	Core	Core	Core/ROM/RAM
Cycle time, microseconds/word	1.2	1.0	1.0	0.85/0.20/0.25
Minimum capacity, words	4,096	4,096	4,096	4K/1K/1K
Maximum capacity, words	32,768	65,536	65,536	32K/30K/30K
Parity checking	No	Optional	Optional	Optional
Storage protection	No	Optional	Optional	Optional
<b>CENTRAL PROCESSOR</b>				
No. of accumulators	All of memory	1	1	7
No. of index registers	All of memory	8-64	4-16	7
No. of directly addressable words	32,768	1,024	1,024	32,768
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	22	2.0	2.0	2.79
Hardware multiply/divide	Mult. standard	Optional	Optional	Optional
Hardware floating point	No	No	No	No
Hardware byte manipulation	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard
Power failure protection	No	Standard	Optional	Optional
Real-time clock or timer	Standard	Standard	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>				
I/O word size, bits	8	8/16	8/16	8/16
Direct memory access channel	No	Standard	Optional	Standard
Maximum I/O rate, words/sec	20,000	1,000,000	1,000,000	5,000,000
No. of external interrupt levels	0	8-64	4-16	4-64
<b>PERIPHERAL EQUIPMENT</b>				
Disk pack storage	In dev'tment	No	No	Yes
Non-interchangeable disk storage	No	Yes	Yes	Yes
Drum storage	No	No	No	No
Magnetic tape speed, cps	10K	20K	20K	36K
Punched card input speed, cpm	400	300	300	600
Punched card output speed, cpm	150	—	—	35
High-speed paper tape input, cps	150	300	300	300
High-speed paper tape output, cps	75	75	75	75
Other standard peripheral units	Printers, communications interfaces	Line printer, cassette tape, communications, displays	Line printer, cassette tape, communications, displays	Line printer, cassette tape, communications, displays
<b>SOFTWARE</b>				
Assembler	6-pass	2-pass	2-pass	1-pass
Macro assembler	Yes	Yes	Yes	Yes
FORTRAN compiler	No	Yes	Yes	Yes
Other compilers	BASIC, DEGEN	No	No	RPG II
Operating system	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>				
Price of basic system with 4K words	\$9,900	\$9,500	\$6,500	\$3,975
Price of basic system with 8K words	\$12,900	\$11,750	\$8,750	\$5,575
Date of first delivery	Aug. 1972	Feb. 1969	Jan. 1971	Sept. 1972
Number installed to date	50	350	1200	250
<b>COMMENTS</b>	Prices include integral 1600-character CRT, keyboard, and three cassette tape drives.	Optional Multiplex Data Channel handles up to 16 concurrent I/O operations.	Program-compatible with MAC 16. Optional channel handles up to 16 concurrent I/O operations.	Highly modular packaging; core and semiconductor memory can be intermixed. Up to 4 processors can be used in a system.

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MANUFACTURER & MODEL	Microdata 400/10	Microdata 1600/30	Microdata 1600/40	Microdata 1600/60	Microdata 3200
<b>DATA FORMATS</b>					
Word length, bits	8	8	8	8	16
Fixed-point operand length, bits	8	8/16/24/32	8/16/24/32	8/16/24/32	8/16
Instruction length, bits	8/16	8/16/24/32	8/16/24/32	8/16/24/32	32 (micro)
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Semiconductor
Cycle time, microseconds/word	1.6	1.0	1.0	1.0	0.3
Minimum capacity, words	1,024	4,096	8,192	4,096	4,096
Maximum capacity, words	65,536	65,536	65,536	65,536	131,072
Parity checking	No	No	No	No	Optional
Storage protection	No	No	No	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	2	3	2	3	32
No. of index registers	1 or 2	1	1	1	32
No. of directly addressable words	4,096	32,768	65,536	65,536	131,072
Indirect addressing	No	One-level	One-level	One-level	No
Add time, microseconds (full word)	1.6	4.0	5.0	4.0	0.135
Hardware multiply/divide	No	Standard	Standard	Standard	No
Hardware floating point	No	Optional	No	Optional	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	No	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Standard	Standard	Standard	Standard	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	8	8	8	8/16
Direct memory access channel	Standard	Optional	Optional	Optional	Standard
Maximum I/O rate, words/sec	625,000	1,000,000	1,000,000	1,000,000	2,500,000
No. of external interrupt levels	1-64	2-128	2-64	4-128	4
<b>PERIPHERAL EQUIPMENT</b>					
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	36K	36K	36K	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	300
High-speed paper tape output, cps	75	75	75	75	75
Other standard peripheral units	Communications interfaces	Line printer, communications interfaces	CRT displays	Line printer, communications interfaces	Line printer, CRT displays, communications interfaces
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	Cross-assembly
Macro assembler	No	No	No	No	Yes
FORTRAN compiler	No	Yes	No	Yes	No
Other compilers	No	PL-1	BASIC	PL-1	No
Operating system	No	Yes	Yes (special purpose)	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$2,250 (100-unit quantities)	\$6,075	Not available	\$10,575	\$8,000
Price of basic system with 8K words	NA	\$6,400	\$6,900	\$10,900	\$9,200
Date of first delivery	Jan. 1973	Jan. 1973	Nov. 1972	March 1973	Oct. 1973
Number installed to date	NA	10	15	4	—
<b>COMMENTS</b>	Repackaged, program-compatible version of the earlier Micro 400.	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.	Communications system based upon the dual-processor Micro 1600D; handles up to 256 lines and 40K char/sec.	Microprogrammable processor; 135-nsec control memory holds up to 4K 32-bit microinstructions.

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MANUFACTURER & MODEL	Philips P855M	Philips P860M	Prime 100	Prime 200	Prime 300
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16	16	16	16	16
Instruction length, bits	16/32	16/32	16	16	16
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Semiconductor	Semiconductor	Semiconductor
Cycle time, microseconds/word	1.2	0.84	1.0	0.75	0.6
Minimum capacity, words	4,096	4,096	4,096	4,096	8,192
Maximum capacity, words	32,768	32,768	32,768	65,536	262,144
Parity checking	No	No	No	Standard	Standard
Storage protection	Optional	Optional	No	No	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	16	16	1	1	1
No. of index registers	Up to 14	Up to 14	1	1	1
No. of directly addressable words	32,768	32,768	32,768	65,536	65,536
Indirect addressing	One-level	One-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	3.6	2.52	Not specified	1.96	1.4 (est.)
Hardware multiply/divide	Optional	Optional	Optional	Optional	Standard
Hardware floating point	No	No	No	No	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	No	No	No
Power failure protection	Optional	Optional	Optional	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
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	833,000	1,200,000	500,000	1,000,000	1,250,000
No. of external interrupt levels	3-48	3-48	64	64	64
<b>PERIPHERAL EQUIPMENT</b>					
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/36K	20K/36K	36K	36K	36K
Punched card input speed, cpm	250	250	150	150	150
Punched card output speed, cpm	—	—	—	—	—
High-speed paper tape input, cps	333/600	333/600	200	200	200
High-speed paper tape output, cps	75/150	75/150	75	75	75
Other standard peripheral units	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	Printer, CRT display, comm. and A/D interfaces
<b>SOFTWARE</b>					
Assembler	1-pass	1-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	No	No	No	No	No
Operating system	Yes	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$4,743	\$5,983	\$4,600	\$5,900	Not available
Price of basic system with 8K words	\$6,757	\$7,997	\$5,500	\$7,100	\$12,500
Date of first delivery	Oct. 1972	April 1972	Feb. 1973	Oct. 1972	Aug. 1973
Number installed to date	29	60	NA	NA	0
<b>COMMENTS</b>	The Philips minicomputer line includes extensive peripheral, data communications, and analog and digital interfacing equipment. Quantity discounts up to 41% are available.			Microprogrammed logic uses 64-bit microinstruction word format. Has flexible memory addressing facilities.	Features virtual memory, supported by up to 50 million bytes of disk storage, plus repertoire of 164 instructions.

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MANUFACTURER & MODEL	Qantel Answer	Raytheon 704	RoIm 1601 Ruggednova	RoIm 1602 Ruggednova	SYSTEMS 71
<b>DATA FORMATS</b>					
Word length, bits	8	16	16	16	16
Fixed-point operand length, bits	Variable	16	16	16	16/32
Instruction length, bits	24 or 48	16	16	16/32	16
<b>MAIN STORAGE</b>					
Storage type	Semiconductor	Core	Core/semicond.	Core/semicond.	Core
Cycle time, microseconds/word	1.5	1.0	2.6	1.0	0.85
Minimum capacity, words	4,096	4,096	256	256	8,192
Maximum capacity, words	32,768	32,768	32,768	65,536	65,536
Parity checking	No	Optional	No	No	Optional
Storage protection	No	Optional	No	No	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	Program-controlled	1	4	4	8
No. of index registers	-	1	2	2	2
No. of directly addressable words	32,768	2,048	1,024	1,024	256
Indirect addressing	Multi-level	No	Multi-level	Multi-level	One-level
Add time, microseconds (full word)	58	2.0	5.9	1.0	3
Hardware multiply/divide	Standard	Optional	Optional	Standard	Optional
Hardware floating point	No	No	No	Optional	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	No	Standard	No	Standard	Standard
Power failure protection	Standard	Optional	Standard	Standard	Standard
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	16	16	16	8/16
Direct memory access channel	Std. (up to 9)	Optional	Standard	Standard	Optional
Maximum I/O rate, words/sec	666,000	1,000,000	285,500	1,000,000	1,000,000
No. of external interrupt levels	1	1-16	16-256	16-256	0-384
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	Yes	Yes	No	No	Yes
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Drum storage	No	No	No	No	Yes
Magnetic tape speed, cps	10K-60K	120K max.	60K max.	60K max.	45 ips
Punched card input speed, cpm	500	300/1000	400	400	300
Punched card output speed, cpm	-	100-400	-	-	-
High-speed paper tape input, cps	50	300	300	300	300
High-speed paper tape output, cps	50	110	63	63	120
Other standard peripheral units	Line printers, CRT displays, communications & voice response controllers	Line printers, cassette tape, A/D converters, communications	Line printers, LINC tape, A/D and data comm. interfaces	Line printers, LINC tape, A/D and data comm. interfaces	Line printers, analog and digital interfaces, communications
<b>SOFTWARE</b>					
Assembler	2-pass	1 & 2-pass	2-pass	2-pass	1-pass
Macro assembler	No	Yes	No	No	No
FORTRAN compiler	No	Yes	Yes	Yes	Yes
Other compilers	No	No	ALGOL, BASIC	ALGOL, BASIC	BASIC
Operating system	Yes	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$12,315	\$7,200	\$13,500	Not available	Not available
Price of basic system with 8K words	\$14,465	\$9,200	\$19,500	\$18,500	\$15,000
Date of first delivery	June 1970	March 1970	March 1970	Feb. 1973	Aug. 1972
Number installed to date	150	Over 250	Over 400	50	NA
<b>COMMENTS</b>	Controlled by microprograms in 50-nsec read-only memory. Prices include I/O type-writer and desk.	Optional Array Transform Processor facilitates signal processing. Software library contains over 600 routines.	Ruggedized version of the Data General Nova, designed for military and other severe environments.	Ruggedized, microprogrammable processor; upward compatible with RoIm 1601 and Data General Nova series.	All-core-memory version of the SYSTEMS 72.

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MANUFACTURER & MODEL	Microdata 3230	Microdata 32/S	Modular Comp. Systems Modcomp I	Modular Comp. Systems Modcomp II	Modular Comp. Systems Modcomp III
<b>DATA FORMATS</b>					
Word length, bits	8	16	16	16	16
Fixed-point operand length, bits	8/16/24/32	1/2/4/8/16/32	16	16/32	16/32/48
Instruction length, bits	8/16/24/32	8/16/24/32/40	16/32	16/32	16/32
<b>MAIN STORAGE</b>					
Storage type	Semiconductor	Semiconductor	Core, semicond.	Core, semicond.	Core, semicond.
Cycle time, microseconds/word	0.3	0.3	0.8	0.8	0.8
Minimum capacity, words	8,192	4,096	512	4,096	4,096
Maximum capacity, words	65,536	131,072	32,768	65,536	65,536
Parity checking	No	Optional	Optional	Optional	Standard
Storage protection	No	Optional	No	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	3	5 (stack)	3	15	15
No. of index registers	1	5 (stack)	3	7	7
No. of directly addressable words	65,536	131,072	32,768	65,536	65,536
Indirect addressing	One-level	Multi-level	No	One-level	One-level
Add time, microseconds (full word)	1.5	0.405	0.8	0.8	0.8
Hardware multiply/divide	Standard	Standard	Optional	Optional	Optional
Hardware floating point	Optional	Standard	No	Optional	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Optional	Optional	Standard
Real-time clock or timer	Standard	Standard	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	8/16	16	16	16
Direct memory access channel	Standard	Standard	Standard	Optional	Optional
Maximum I/O rate, words/sec	2,500,000	2,500,000	1,250,000	1,250,000	1,250,000
No. of external interrupt levels	2-64	4-1024	1-5	3-16	4-32
<b>PERIPHERAL EQUIPMENT</b>					
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	10K/60K	10K/60K	10K/60K
Punched card input speed, cpm	300	300	300/1000	300/1000	300/1000
Punched card output speed, cpm	—	—	100	100	100
High-speed paper tape input, cps	300	300	625	625	625
High-speed paper tape output, cps	75	75	110	110	110
Other standard peripheral units	Line printer, CRT display, communications interfaces	Line printer CRT display, communications interfaces	Line printers, A/D converters, communications multiplexers	Line printers, A/D converters, communications multiplexers	Line printers, A/D converters, communications multiplexers
<b>SOFTWARE</b>					
Assembler	2-pass	No	2-pass	2-pass	2-pass
Macro assembler	No	No	No	Yes	Yes
FORTRAN compiler	Yes	No	No	Yes	Yes
Other compilers	BASIC	MPL	No	BASIC	BASIC
Operating system	Yes	Yes	No	Yes (3)	Yes (3)
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	Not available	\$9,450	\$4,400	\$7,400	\$9,850
Price of basic system with 8K words	\$8,450	\$10,650	\$6,200	\$9,200	\$11,650
Date of first delivery	Oct. 1973	March 1974	Oct. 1971	March 1971	Dec. 1970
Number installed to date	—	—	Over 50	Over 15	Over 40
<b>COMMENTS</b>	Program-compatible with, and 5 to 10 times faster than, the Micro 820, 821, 1600/20, 1600/21, & 1600/30.	Features stack architecture; fundamental language is MPL, a subset of PL/1.	A DMA with extended control capabilities is standard.	4-port memory is available for multiprocessor and I/O processor configurations.	200-nsec read-only control memory consists of 256 to 1024 40-bit words.

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MANUFACTURER & MODEL	Modular Comp. Systems Modcomp IV/10	Modular Comp. Systems Modcomp IV/25	Nuclear Data ND812	Omnus Computer Corp. Omnus-1	Philips P850M
<b>DATA FORMATS</b>					
Word length, bits	16/32	16/32	12	16	16
Fixed-point operand length, bits	16/32	16/32	12	8/16	16
Instruction length, bits	16/32	16/32	12/24	16/32	16/32
<b>MAIN STORAGE</b>					
Storage type	Core, semicond.	Core, semicond.	Core	Core	Core
Cycle time, microseconds/word	0.64 (16-bit)	0.64 (16-bit)	2.0	1.2	3.2
Minimum capacity, words	16,384 (16-bit)	16,384 (16-bit)	4,096	2,048	512
Maximum capacity, words	65,536	262,144	16,384	131,072	2,048
Parity checking	Standard	Standard	No	No	No
Storage protection	Optional	Standard	No	Optional	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	15	240	2	2,049	16
No. of index registers	7	Not specified	2 (core)	2,049	Up to 14
No. of directly addressable words	65,536	Not specified	16,384	32,768	2,048
Indirect addressing	One-level	One-level	One-level	No	One-level
Add time, microseconds (full word)	0.8 (32 bits)	0.8 (32 bits)	2/4	2.4	11.2
Hardware multiply/divide	Standard	Standard	Standard	Optional	No
Hardware floating point	Optional	Optional	No	Optional	No
Hardware byte manipulation	Standard	Standard	No	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	12/24	8/16	16
Direct memory access channel	Optional	Optional	Standard	Standard	No
Maximum I/O rate, words/sec	1,560,000	1,560,000	500,000	833,000	10,500
No. of external interrupt levels	8-16	8-16	256-4,096	32-256	1
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	Yes	Yes	Yes	Yes	No
Non-interchangeable disk storage	Yes	Yes	Yes	No	No
Drum storage	No	No	No	No	No
Magnetic tape speed, cps	10K/60K	10K/60K	36K	20K	—
Punched card input speed, cpm	300/1000	300/1000	—	300	250
Punched card output speed, cpm	100	100	—	—	—
High-speed paper tape input, cps	625	625	125/300	300	333/600
High-speed paper tape output, cps	110	110	50/110	72	75/150
Other standard peripheral units	Line printers, A/D converters, communications multiplexers	Line printers, A/D converters, communications multiplexers	Line printer, cassette tape, A/D converters	Line printer, communications interfaces	Line printer, cassette tape, plotter, communications
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	1 & 2-pass	1-pass
Macro assembler	Yes	Yes	Limited	Yes	No
FORTRAN compiler	Yes	Yes	No	No	No
Other compilers	BASIC, RPG	BASIC, RPG	NUTRAN	No	No
Operating system	Yes	Yes	Limited	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	Not available	Not available	\$6,950	\$8,500	\$3,100 (with 2K words)
Price of basic system with 8K words	\$18,500 (with 16K 16-bit words)	\$23,500 (with 16K 16-bit words)	\$9,600	\$11,950	Not available
Date of first delivery	1st qtr. 1974	1st qtr. 1974	Nov. 1970	Aug. 1971	April 1971
Number installed to date	0	0	Over 200	2	102
<b>COMMENTS</b>	Features 32-bit parallel internal operation and 15 general purpose registers. Up- ward compatible with Modcomp I, II, III.	Features 32-bit parallel internal operation, 16 sets of 15 general purpose registers, and 1024 mem- ory mapping registers.	Now being built only for Nuclear Data's own use and for certain special customers.	Features 2,048 general registers in core memory and single-bus architecture. Read-only mem- ory is optional.	

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MANUFACTURER & MODEL	SYSTEMS 72	Texas Instruments Model 960A	Texas Instruments Model 980A	Westinghouse 2500	Xerox 530
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16/32	16	16	16	16/32
Instruction length, bits	16	32	16/32	16	16/32
<b>MAIN STORAGE</b>					
Storage type	Core/disk	Semiconductor	Semiconductor	Core	Core
Cycle time, microseconds/word	0.85	0.75	0.75	0.75	0.8
Minimum capacity, words	8,192 (core)	4,096	4,096	4,096	8,192
Maximum capacity, words	65,536 (core)	65,536	65,536	65,536	65,536
Parity checking	Optional	Standard	Standard	Optional	Standard
Storage protection	Standard	Standard	Standard	Optional	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	8	Up to 16	2	2	6
No. of index registers	2	Up to 16	1	2	2
No. of directly addressable words	256	65,536	65,536	256	1,024
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Add time, microseconds (full word)	3	3.2	1.75	1.5	1.92
Hardware multiply/divide	Optional	Optional	Standard	Standard	Standard
Hardware floating point	No	No	No	Optional	Optional
Hardware byte manipulation	Standard	Standard	Standard	No	Optional
Immediate (literal) instructions	Standard	Standard	Standard	No	No
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Optional	Optional	Optional	Optional	Standard (2)
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8/16	1 to 16	16	16	16
Direct memory access channel	Optional	Standard	Standard	Optional	Optional (2)
Maximum I/O rate, words/sec	1,000,000	1,300,000	1,300,000	1,000,000	850,000 each
No. of external interrupt levels	0-384	2	2-64	120	6-30
<b>PERIPHERAL EQUIPMENT</b>					
Disk pack storage	Yes	Yes	Yes	Yes	Yes
Non-interchangeable disk storage	Standard	Yes	Yes	Yes	Yes
Drum storage	Yes	No	No	No	Yes
Magnetic tape speed, cps	45 ips	300K max.	300K max.	2.5K	20.8K/30K
Punched card input speed, cpm	300	300	300	300/600/1000	200/400
Punched card output speed, cpm	—	100	100	35/100	100
High-speed paper tape input, cps	300	300	300	300	300
High-speed paper tape output, cps	120	60	60	110	120
Other standard peripheral units	Line printers, analog and digital interfaces, communications	Line printers, communications interfaces, A/D converters, etc.	Line printers, communications interfaces, A/D converters, etc.	Line printer, CRT display, communications, A/D converters	Line printers, plotters, comm. and A/D interfaces
<b>SOFTWARE</b>					
Assembler	1-pass	2-pass	2-pass	2-pass	Yes
Macro assembler	No	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC	No	No	BASIC, RPG	No
Operating system	Yes	Yes	Yes	Yes	Yes (2)
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	Not available	\$2,850	\$3,475	\$9,950	Not available
Price of basic system with 8K words	\$23,500	\$4,350	\$4,975	\$13,350	\$20,000
Date of first delivery	Aug. 1970	Nov. 1971	May 1972	April 1971	3rd qtr. 1973
Number installed to date	NA	NA	NA	Over 120	0
<b>COMMENTS</b>	Features virtual memory; quoted prices include memory map and 65K memory expansion disk.	Has 2 processor modes, each with 8 general registers. Real-time monitor system handles multi-programming.	Hardware and software support bit/byte/word or byte string manipulation.	Features 16-high speed IC registers. Used in Westinghouse 2550 programmable terminal system.	Uses multi-bus architecture and microprogramming techniques. Bit-string manipulation facilities are optional.

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MANUFACTURER & MODEL	Varian 73	Varian 620/f-100	Varian 620/L	Varian 620/L-100	Varian R-620/i
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	16	16 (18 opt.)
Fixed-point operand length, bits	16	16	16	16	16
Instruction length, bits	16/32	16/32	16/32	16/32	16/32
<b>MAIN STORAGE</b>					
Storage type	Core/semicond.	Core	Core	Core	Core
Cycle time, microseconds/word	0.66/0.33	0.75	1.8	0.95	1.8
Minimum capacity, words	4,096/1,024	4,096	4,096	4,096	4,096
Maximum capacity, words	65,536	32,768	32,768	32,768	32,768
Parity checking	Optional	No	No	No	No
Storage protection	Optional	Standard	Optional	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	Up to 16	2	2	2	2
No. of index registers	Up to 16	2	2	2	2
No. of directly addressable words	2,048	2,048	2,048	2,048	2,048
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level	Multi-level
Add time, microseconds (full word)	1.32/0.66	1.5	3.6	1.9	3.6
Hardware multiply/divide	Standard	Standard	Standard	Standard	Optional
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	Standard	Standard	Standard	Standard	Optional
Real-time clock or timer	Standard	Standard	Standard	Standard	Optional
<b>INPUT/OUTPUT CONTROL</b>					
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	Up to 3,030,000	1,330,000	200,000	383,000	200,000
No. of external interrupt levels	0-64	0-64	0-64	0-64	0-64
<b>PERIPHERAL EQUIPMENT</b>					
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	20K or 30K	20K max.	20K max.	20K max.	20K max.
Punched card input speed, cpm	300	300	300	300	300
Punched card output speed, cpm	35	35	35	35	35
High-speed paper tape input, cps	150/300	150/300	150/300	150/300	150/300
High-speed paper tape output, cps	75	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.	Line printer, CRT displays, A/D converters, plotters, etc.
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	No	No	No	No
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC, RPG	BASIC, RPG	BASIC, RPG	BASIC, RPG	BASIC, RPG
Operating system	Yes	Yes	Yes	Yes	Yes
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with 4K words	\$13,000/14,500	\$10,500	\$5,400	\$6,400	\$16,900
Price of basic system with 8K words	\$15,000/18,000	\$13,000	\$7,700	\$8,700	\$23,300
Date of first delivery	Nov. 1972	June 1972	May 1971	June 1972	June 1969
Number installed to date	40 as of 3/73	100 as of 3/73	740 as of 3/73	200 as of 3/73	80 as of 3/73
<b>COMMENTS</b>	The Varian 73 and all 620 Series computers are program-compatible with one another and with the original Varian 620/i. The R-620/i is a ruggedized version designed for reliable operation in severe environments. Varian offers three operating systems: BEST is a real-time monitor and scheduler, MOS is a batch-processing monitor, and VORTEX is a separately priced multiprogramming system with real-time capabilities. The Varian 73 features 660-nanosecond core and/or 330-nanosecond MOS storage, as well as user-accessible microprogramming with a 64-bit microinstruction word length and a 165-nanosecond microinstruction time. Extensive data communications hardware and software are available.				