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## All About Minicomputers

For nearly a decade, minicomputers have received more attention than any other single subject in the fast-moving world of electronic data processing. Today, these compact yet surprisingly powerful computers are being delivered at an ever-increasing rate for use in a steadily broadening spectrum of applications. Here are just a few of the reasons:

- Innovations in technology and manufacturing are resulting in the availability of minicomputers with steadily lower price tags and/or increased capabilities.
- Economic pressures are forcing computer users to strive to achieve maximum performance at minimum cost.
- Increasing software consciousness on the part of both minicomputer makers and users is spurring software development along avenues undreamed of only a few years ago.
- Increasing emphasis upon distributed processing, in which large, centralized computers are augmented or replaced by multiple smaller computers located wherever there is data to be processed, is causing even the largest computer users to take a hard new look at the minicomputers.



*One of the traditional application areas for minicomputers—laboratory experiment control—is illustrated here with equipment from one of the traditional suppliers of minicomputers—Digital Equipment Corporation. In this experiment relating to the development of artificial hearing, tiny electrodes implanted in the inner ear of the man (deaf from birth) are stimulated under control of a PDP-8/F. The device in his lap is a keyboard, which enables him to respond and “control” the experiment. Without the low-cost minicomputer, many such experiments would have to share a larger computer, with the associated logistics problems, or do without computer control.*

**This report is designed to aid you in understanding the rapidly proliferating minicomputers and selecting the one that can best satisfy your requirements. You'll find detailed comparison charts covering the characteristics of 189 current minicomputers from 54 manufacturers, as well as the collective experience of 699 users with a total of 2,182 minicomputers.**

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

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

This report is designed to answer these questions and bring you up to date on the rapidly advancing state of the art in minicomputers and microcomputers. The current offerings of 54 manufacturers are summarized in the accompanying comparison charts, and the experience of 699 minicomputer users is analyzed and tabulated.

### PROFILE OF A MINICOMPUTER

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

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

Although the currently available minicomputers exhibit a wide variety of characteristics and capabilities, there are enough similarities and common traits to make it



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▷ 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, 24-bit, and 32-bit word lengths are also fairly 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 requires no special air conditioning. It offers from 4,096 to 32,768 words of magnetic core or semiconductor storage with a cycle time of 0.8 to 1.5 microseconds. Parity checking and storage protection are available as extra-cost options.

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

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

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

### THE MINICOMPUTER INDUSTRY

Estimates of the current worldwide market volume for U.S. minicomputer manufacturers range from about \$800 million to \$1.4 billion a year. These figures include peripheral equipment and software; minicomputer mainframes alone are believed to account for about \$200 to \$400 million. Precise figures are nearly impossible to obtain because of the widespread differences of opinion as to what constitutes a minicomputer.

Despite their rapid proliferation, minicomputers still represent only a small slice of the \$14 billion total U.S.

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

Digital Equipment Corporation, the company that started the minicomputer boom in the mid-sixties with its highly successful PDP-8 line, is still the undisputed king of the minicomputer field. DEC has delivered more than 47,000 computers to date and currently commands roughly a 35 percent share of the minicomputer market with its continually expanding product line.

Ranking next in minicomputer revenues, but well behind DEC, are Hewlett-Packard, IBM, and Data General. HP was another pioneer in the minicomputer field and currently offers a broad range of mini-based systems oriented toward specific applications, as well as general-purpose minicomputers. IBM, the undisputed leader in most other segments of the computer field, is currently playing a much smaller role in the minicomputer market; its only "pure" minicomputer is the System/7, a fast 16-bit machine, introduced in 1970, that is supported only for "sensor-based" applications in data acquisition and control. Data General, established in 1969, quickly earned a reputation as a supplier of reliable, low-cost minicomputers and has already delivered more than 12,000 of them.

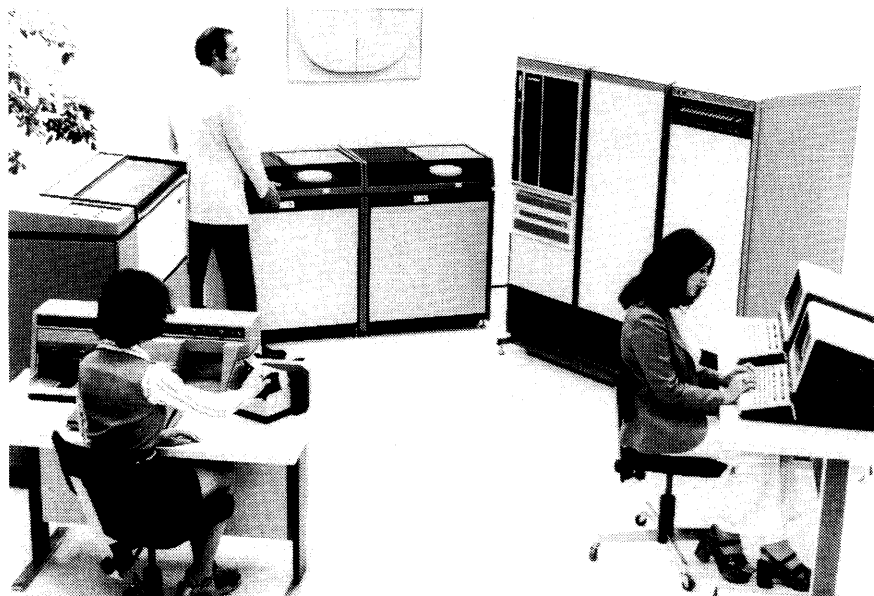
In the second echelon of minicomputer makers are aggressive, innovative young companies such as Computer Automation, Digital Computer Controls, General Automation, Interdata, Microdata, and Modular Computer Systems. Minicomputers are also being built by divisions of large, well-established companies such as Harris, Honeywell, Lockheed, Raytheon, Texas Instruments, Varian, 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.

In all, approximately 60 companies are now marketing minicomputers in the United States. The current offerings of 54 of these 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.

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*At the sophisticated end of the minicomputer applications spectrum, the Hewlett-Packard family of 3000CX Mini Data Centers provides powerful capabilities for distributed processing, data base management, time-sharing, etc. Language processors supported include COBOL, RPG, FORTRAN, and BASIC, with a common file handling arrangement to add flexibility in programming and information handling.*

- ▷ ● 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

During the past year, new models were introduced by nearly all of the major minicomputer makers, including Computer Automation, Data General, DEC, Digital Computer Controls, General Automation, Harris (formerly Datacraft), Hewlett-Packard, Interdata, Modcomp, Systems Engineering Laboratories, and Varian. As any veteran observer of the minicomputer field would expect, the great majority of these new models maintain program and hardware compatibility with earlier models from the same manufacturers, while featuring significantly increased performance and/or reduced price tags. What’s more, most of the recent arrivals continue the clear-cut industry trend toward the use of semiconductor memory and LSI (large-scale integrated) circuitry.

Many of the recently announced minicomputer systems are, in fact, special “packaged” configurations that consist of previously available minicomputer processors together with specialized peripheral equipment and software designed for specific types of applications. Examples include the various DEC Datasystems, which use the company’s popular PDP-8 or PDP-11 minicomputers in systems designed for business data processing; the General Automation DM-100 systems, which adapt GA’s SPC-16 mini to data management applications; and the Harris Series 100 systems, which use the company’s

24-bit Slash/4 computer in configurations oriented toward communications and control functions.

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 “microprocessors.” A microprocessor can be defined as a single LSI chip or set of chips that performs the basic arithmetic and logical functions of a computer central processing unit. When equipped with memory and input/output control circuitry, the microprocessor becomes a “microcomputer,” which can offer capabilities quite similar to those of the smaller minicomputers.

Intel Corporation pioneered the microprocessor concept in 1971 and remains the leader in the field. But microprocessors received such rapid acceptance that numerous other companies quickly announced competitive products, including such leading electronics firms as Fairchild, Motorola, National Semiconductor, RCA, Rockwell, Signetics, and Texas Instruments. Detailed specifications of the current microprocessors and microcomputers can be found in *DATAPRO REPORTS ON MINICOMPUTERS*, a companion looseleaf information service.

For the next few years, at least, it appears that the microcomputers will be slower than the commercially available minicomputers. Moreover, the present microcomputers are aimed almost exclusively at the large-quantity OEM market rather than at one-of-a-kind user applications. Therefore, instead of displacing large numbers of minicomputers, the microcomputers can be expected to open up vast new application areas where even the cheapest minicomputers have been economically unjustifiable. Thanks to the advent of the microcomputers, the day when there will be a computer in every car and every household may not be too far away.

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➤ Another evident design trend is toward increasing use of microprogrammed logic, which can make it comparatively easy for the manufacturer, OEM, and/or end user to tailor a minicomputer's capabilities to fit his particular needs. Current systems that feature user-accessible microprogramming include the Hewlett-Packard 21MX Series, Interdata 8/32, Microdata 3200, and Varian V70 Series.

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

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 those of far more costly medium-scale computers. Most of these systems feature large main storage capacities, fast semiconductor memory, advanced memory management facilities, multiprogramming operating systems, and other "big computer" software facilities, at mainframe prices ranging from about \$15,000 upward. Among the high-performance minicomputers that adhere to the "traditional" 16-bit word length are the DEC PDP-11/45 and PDP-11/70, the Data General Nova 830 and Eclipse Series, and the Varian V75. Meanwhile, the increased computational power and flexibility made possible by the use of a 32-bit word length are being stressed in such recently announced systems as the Interdata 8/32 Megamini and the SEL 32/50 and 32/55.

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.

Software, which had long received only cursory attention from the predominantly hardware-oriented minicomputer makers, is rapidly becoming the principal distinguishing factor between competitive product lines. Efficient compilers for programming languages such as FORTRAN, BASIC, and COBOL are becoming available

for most of the popular minicomputers from the manufacturers and/or proprietary software houses. The quality and power of the minicomputer operating systems are steadily increasing, with full-fledged multiprogramming systems now available from numerous vendors. Meanwhile, the minicomputer makers are beginning to focus their attention on more specialized software that opens up new markets for their equipment, such as data management systems and emulators for the IBM 2780 and other popular remote job entry terminals.

The developers of proprietary software and systems are increasingly designing their wares around minicomputers. As a result, minicomputer-based systems are now available, from both the minicomputer manufacturers and independent "systems houses," to handle a wide range of specialized applications in both the scientific and business fields.

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, General Automation, 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 decade, 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, engineering and scientific computation, data communications, and education. Specific applications in which minicomputers are already being widely and successfully used include: ➤

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- > ● Process control
- Numerical control of machine tools
- Direct control of machines and production lines
- Automated testing and inspection
- Telemetry
- Data acquisition and logging
- Control and analysis of laboratory experiments
- Analysis and interpretation of medical tests
- Traffic control
- Shipboard navigation control
- Message switching
- Communications controllers for larger computers
- Communications line concentrators
- Programmable communications terminals
- Peripheral controllers for larger computers
- Control of multistation key-to-tape/disk systems
- Display control
- Computer-aided design
- Typesetting and photocomposition
- Computer-assisted instruction
- Engineering and scientific computations
- Time-sharing computational services
- Business data processing

### MINICOMPUTERS FOR THE BUSINESSMAN

Conventional business data processing applications, which represent by far the largest potential market for the minicomputers, turned out to be a rather 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—as distinguished from electronic accounting machines—are really just 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 builders of "classical" minicomputers. 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 businessman is definitely on the way, in the form of three significant trends.

First, numerous manufacturers have introduced mini-computer-based systems designed primarily for business data processing applications. Many of them are included in this report, and you can find the details on dozens of other business-oriented systems in Datapro's companion report, *All About Small Business Computers*.

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

Third, the availability of the minicomputers has led to the emergence of a new group of computer entrepreneurs: "systems houses" that 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 few years. 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

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*This pair of photographs illustrates the diversity of replies one is likely to receive to the question "Okay, minicomputer manufacturers, what have you done for me lately?" On the left is the powerful (in either minicomputer or full-size computer terms) Interdata 8/32 Megamini. On the right is Digital Equipment's microcomputer in a box, the PDP-11/03. This range of equipment makes it difficult to draw a tight border around what is a minicomputer. The ready acceptance of new*



*technology and innovation in using it that is being displayed by the whole field of minicomputer manufacturers can be matched by no other field. Even software, once a major distinction between full-size, "fully supported" computers and minis, is responding to the same treatment, although somewhat more slowly. Now if they could only figure out a way to get a 100-megabyte disk drive into a shoebox . . .*

▷ authorization, stock brokerage accounting, and many more. The systems houses 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 increasing emphasis on distributed processing and the steadily decreasing price tags of the minicomputers themselves, make it clear that minicomputers will have an ever-increasing impact in the business data processing world. At the same time, enough problems remain to be solved to make it safe to predict that the widely-discussed day when there will be a computer in every store is still quite a few years away.

### USER EXPERIENCE

To determine the current level of user satisfaction with specific minicomputer systems and with minicomputers in general, Datapro Research Corporation recently conducted an extensive user survey. A Reader Survey Form was mailed to a sample of 8,200 subscribers to DATAPRO 70 and DATAPRO REPORTS ON MINI-COMPUTERS in June 1975.

By August 1, usable responses had been received from 699 users with a total of 2,182 installed minicomputers and small business computer systems. The average number of systems installed in each respondent's organization was 3.12.

The users were asked to answer a number of questions designed to characterize their method of acquisition and their applications environment. They reported that their minicomputers are being used in a predictably broad spectrum of applications, which can be categorized as follows:

	<u>No. of Users</u>	<u>% of Total</u>
Business data processing	415	59
Scientific/engineering computations	130	19
Real-time control	134	19
Data communications	171	24
Data base management	80	11
Other applications	145	21

The percentage figures add up to well over 100% because many of the respondents were using their systems in multiple applications. The comparatively high incidence of business data processing usage is due in part to the inclusion in our survey of small business computer systems such as the IBM System/3, Burroughs B 1700, Honeywell Model 58, and NCR Century Models 50 through 151.

The users were asked how they acquired their systems, and the overall results were as follows:

	<u>No. of Users</u>	<u>% of Total</u>
Outright purchase	370	53
Rental from manufacturer	290	41
Third-party lease	55	8

The great majority of users of "classical" minicomputers such as those produced by DEC and Data General had purchased their machines outright, while users of small business computers from companies such as IBM and NCR were predominantly oriented toward rental from the manufacturer. The figures make it clear that third-party leasing is not widely practiced in the minicomputer field at this time.

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

	<u>No. of Users</u>	<u>% of Total</u>
In-house personnel	589	84
Computer manufacturer's personnel	101	14
Used "ready-made" programs from manufacturer	144	21
Used proprietary packages	87	12
Contract programming house	83	12

Here again, the percentage figures total more than 100% because numerous respondents called upon two or more sources for their applications programs.

Of the 699 survey respondents, 91 reported that they were using remote batch terminals and 305 said they were using interactive terminals with their systems. Here's a breakdown of the totals:

<u>Type of Terminal</u>	<u>No. of Users</u>	<u>Total No. of Terminals in Use</u>	<u>Average No. of Terminals per User</u>
Batch	91	1,733	19.0
Interactive	305	4,241	13.9

The users were asked to report the extent of their usage of various types of "independent" peripheral devices from sources other than the minicomputer manufacturers. The overall results were as follows:

	<u>No. of Users</u>	<u>% of Total</u>
Using independent disk drives	239	34
Using independent tape drives	141	20
Using independent main memory	65	9
Using other types of independent peripherals	122	17

Finally, and most importantly, the users were asked to rate their minicomputers and the associated software and vendor support by assigning a rating of Excellent, Good, Fair, or Poor to each of 12 factors. The resulting user ratings of 57 popular minicomputers from 27 vendors are reported in Table I. All ratings are expressed in terms of Weighted Averages, which were calculated by assigning a weight of 4 to each user rating of Excellent, 3 to Good, 2 to Fair, and 1 to Poor, and then dividing the sum by the number of users who rated each factor.

Prospective buyers should note that the small sample sizes for some of the minicomputer models make it unwise to draw firm conclusions from the indicated ratings. Rather, the ratings should be used as guides to potential product strengths and weaknesses that may call for further investigation in selecting the most suitable

equipment for your needs. 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 quality of support and service provided by the vendor's nearest branch office. Also, as this survey clearly shows, many minicomputer users get their software, technical support, and/or peripheral equipment from sources other than the minicomputer makers.

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

	<u>Weighted Average User Ratings</u>
Ease of operation	3.3
Reliability of mainframe	3.5
Reliability of peripherals	3.1
Responsiveness of maintenance service	3.0
Effectiveness of maintenance service	2.9
Technical support	2.6
Manufacturer's software:	
Operating system	3.1
Compilers and assemblers	3.0
Applications programs	2.6
Ease of programming	3.1
Ease of conversion	2.9
Overall satisfaction	3.0

Thus, it is clear that minicomputer users in general are fairly well pleased with their equipment and the associated software and maintenance service. The only significant weaknesses are in the areas of applications programs and technical support—and these are precisely the areas that have been neglected by many of the minicomputer vendors until quite recently.

### MINICOMPUTER CHARACTERISTICS

The key functional characteristics of 189 commercially available minicomputers from 54 manufacturers are presented in the accompanying comparison charts. Nearly all of the information in the charts was supplied and/or verified by the 54 manufacturers during July and August 1975; 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 ➤

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TABLE I. USER RATINGS OF MINICOMPUTERS

Manufacturer and Model	No. of User Replies	No. of Computers Represented	Average Length of Time in Use, Months	Average Memory Size, K Words or Bytes	Weighted Average User Ratings*											
					Ease of Operation	Reliability of Mainframe	Reliability of Peripherals	Responsiveness of Maintenance Service	Effectiveness of Maintenance Service	Technical Support	Operating System	Compilers and Assemblers	Applications Programs	Ease of Programming	Ease of Conversion	Overall Satisfaction
Basic Four (all models)	8	8	10	38	3.9	3.7	3.4	3.7	3.6	2.9	3.8	3.6	2.4	4.0	3.1	3.6
Burroughs:																
B 1700 Series	22	38	16	61	3.9	3.0	2.4	2.8	2.3	2.1	3.6	3.2	2.7	3.4	2.9	2.8
L Series	8	10	40	8	3.5	2.9	2.9	2.5	2.3	2.0	3.0	2.7	2.0	2.8	2.8	2.8
TC Series	3	16	6	34	3.3	3.3	2.7	2.0	2.0	1.7	3.0	3.0	3.0	2.7	2.5	3.0
Burroughs Totals	33	64	19	52	3.7	3.0	2.5	2.7	2.3	2.0	3.5	3.1	2.5	3.2	2.8	2.8
Computer Automation Alpha 16 & LSI-2	5	7	19	16	3.0	3.4	2.5	2.7	3.0	2.8	2.7	3.0	2.5	3.0	3.0	3.0
Control Data 1700	3	5	42	22	3.0	3.5	2.3	3.3	2.7	2.3	3.0	3.0	3.0	2.7	3.0	3.0
Data General:																
Nova 2 Series	12	76	12	19	3.1	3.5	2.8	2.8	2.5	2.5	2.9	2.8	2.2	2.9	3.3	3.0
Nova 800 Series	18	177	23	32	3.3	3.2	2.6	2.4	2.3	2.1	3.1	2.8	2.0	2.6	2.2	2.7
Nova 1200 Series	17	126	26	21	3.2	3.7	2.6	2.5	2.3	2.3	3.3	3.3	2.7	2.8	2.8	2.8
Other models	6	9	28	39	3.3	3.4	3.0	2.7	2.7	2.0	3.0	3.0	2.5	3.2	3.0	3.2
Data General Totals	53	388	22	33	3.2	3.5	2.7	2.6	2.4	2.2	3.1	3.0	2.3	2.8	2.7	2.9
Datapoint:																
Datapoint 1100	3	3	4	13	4.0	3.7	3.5	3.3	3.0	3.5	3.7	2.0	4.0	4.0	4.0	4.0
Datapoint 2200	12	40	22	14	3.6	3.3	2.8	2.3	2.6	2.5	3.1	3.1	3.0	3.5	2.6	3.0
Datapoint Totals	15	43	18	14	3.7	3.3	2.9	2.5	2.7	2.6	3.2	2.8	3.1	3.6	2.9	3.2
Digital Computer Controls D-116	4	7	22	19	3.0	2.8	3.0	1.0	1.0	1.3	1.7	2.3	1.0	2.0	1.3	2.5
Digital Equipment Corp:																
PDP-8 Series	30	120	46	26	2.6	3.4	3.7	2.7	2.8	2.7	3.2	3.2	2.9	2.9	3.0	3.0
PDP-11/04 thru 11/20	28	44	22	19	3.3	3.4	3.0	2.8	2.9	2.8	3.3	3.1	2.8	3.0	2.8	3.1
PDP-11/35 thru 11/50	48	86	14	54	3.3	3.4	3.0	2.9	2.9	2.4	3.2	3.0	2.5	3.2	2.7	3.2
PDP-15 Series	6	7	51	23	3.8	3.3	3.3	2.3	3.2	3.8	3.0	3.0	4.0	3.7	3.7	3.8
Other models	3	12	66	20	3.7	3.7	2.7	3.0	3.0	3.5	3.3	3.0	3.0	3.0	2.0	3.0
DEC Totals	115	269	27	35	3.2	3.4	3.2	2.8	2.9	2.7	3.2	3.1	2.7	3.1	2.9	3.2
Digital Scientific META 4	5	6	33	26	3.4	3.0	3.4	3.4	3.4	3.2	3.5	3.8	3.7	3.8	4.0	4.0
Four-Phase Systems (all models)	11	24	19	65	3.5	3.5	3.3	2.7	2.8	2.6	3.0	3.1	2.9	3.3	3.1	3.0
General Automation:																
SPC-16 Series	15	21	15	56	3.4	3.7	3.1	3.1	3.0	2.7	2.8	3.0	2.8	2.7	3.1	3.1
System 18/30	8	11	35	24	3.5	3.4	3.4	3.3	3.3	2.6	3.3	3.5	3.0	3.4	3.5	3.5
Other models	4	9	39	40	3.5	3.5	2.3	2.3	2.0	1.7	1.5	2.7	3.0	3.3	2.0	2.0
Gen. Automation Totals	27	41	24	44	3.4	3.6	3.1	3.1	3.0	2.5	2.8	3.1	2.9	2.9	3.1	3.0
Hewlett-Packard:																
HP 2000 Series	13	19	24	40	3.6	3.8	3.4	3.2	3.2	2.8	3.5	3.3	2.8	3.4	2.6	3.3
HP 2100 Series	13	313	30	32	3.2	3.3	3.0	3.0	2.9	2.7	3.1	3.1	2.4	2.4	2.4	2.9
HP 21MX Series	3	17	8	17	3.3	3.0	3.0	2.7	3.0	2.7	2.0	2.0	3.0	3.0	3.0	2.7
HP 3000	5	7	5	122	3.4	3.2	3.4	3.4	3.4	3.0	3.4	3.0	2.6	3.6	2.8	3.4
Hewlett-Packard Totals	34	356	22	50	3.4	3.5	3.2	3.1	3.1	2.8	3.1	3.0	2.7	3.1	2.7	3.1
Honeywell:																
Honeywell Model 58	4	5	32	10	3.8	3.3	3.5	3.3	2.8	2.3	3.0	3.3	3.0	3.0	2.5	2.8
Honeywell 316	3	9	38	9	3.0	3.7	3.3	2.0	2.0	2.0	3.0	3.0	3.0	2.7	3.0	3.0
Honeywell 700 Series	5	8	12	36	2.8	3.3	3.3	3.0	3.3	1.8	1.0	1.7	1.3	2.3	2.5	2.5
Other models	3	4	52	53	4.0	4.0	3.7	3.7	3.0	2.7	3.5	3.5	3.0	3.0	3.0	3.3
Honeywell Totals	15	26	17	24	3.4	3.5	3.4	3.0	2.8	2.2	2.7	2.8	2.4	2.7	2.8	2.9
IBM:																
System/3 (all models)	115	133	26	37	3.6	3.7	3.4	3.5	3.5	3.0	3.3	3.3	2.7	3.5	3.1	3.4
System/7	35	49	22	19	2.9	3.3	2.8	3.1	2.9	2.4	2.3	2.1	2.3	2.2	2.3	2.5
System/32	5	6	2	22	3.3	3.3	3.3	3.3	3.3	2.3	2.7	2.7	2.0	3.0	3.0	2.7

\*Weighted Average User Ratings are calculated on a scale of 4 for each user response of Excellent, 3 for Good, 2 for Fair, and 1 for Poor.



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TABLE I. USER RATINGS OF MINICOMPUTERS (Continued)

Manufacturer and Model	No. of User Replies	No. of Computers Represented	Average Length of Time in Use, Months	Average Memory Size, K Words or Bytes	Weighted Average User Ratings*													
					Ease of Operation	Reliability of Mainframe	Reliability of Peripherals	Responsiveness of Maintenance Service	Effectiveness of Maintenance Service	Technical Support	Operating System	Compilers and Assemblers	Applications Programs	Ease of Programming	Ease of Conversion	Overall Satisfaction		
IBM (continued):																		
System/360 Model 20	26	40	70	16	3.1	3.5	3.2	3.2	3.1	2.5	2.7	2.8	2.7	3.2	3.7	3.2		
IBM 1130	33	39	79	16	3.3	3.8	3.2	3.4	3.3	2.6	3.1	2.8	2.5	3.0	2.3	3.2		
IBM 1180	10	14	72	40	3.1	3.9	3.1	3.6	3.2	2.8	3.4	2.9	2.3	3.2	2.0	3.4		
IBM Totals	224	281	44	30	3.4	3.7	3.2	3.4	3.3	2.8	3.1	2.9	2.6	3.2	2.8	3.2		
Intel (all models)	4	73	8	25	3.3	3.8	3.7	3.7	3.7	3.5	1.8	3.0	3.3	3.0	3.3	3.3		
Interdata:																		
Interdata 7/16	9	13	9	38	3.1	3.1	2.6	2.6	2.6	2.8	2.5	2.8	2.0	3.3	3.0	3.0		
Interdata 7/32	3	6	3	19	3.3	3.7	3.0	3.0	3.0	3.0	2.7	2.7	1.5	2.7	2.5	3.0		
Interdata Model 70	5	4	25	55	3.2	3.2	3.0	2.3	2.0	2.3	2.8	2.6	2.5	3.4	2.0	2.8		
Other models	7	20	30	45	3.6	3.4	3.2	3.7	3.7	3.0	3.0	2.5	1.8	3.1	3.2	3.4		
Interdata Totals	24	43	17	63	3.3	3.3	2.9	3.0	2.9	2.7	2.8	2.6	1.9	3.2	2.8	3.1		
Lockheed System III	2	2	1	27	4.0	4.0	3.0	3.0	3.0	2.5	3.5	3.5	4.0	4.0	4.0	3.0		
Microdata:																		
1600 Series	3	102	19	60	3.0	2.7	2.7	3.0	3.0	2.7	2.3	2.0	2.0	3.0	3.0	3.0		
REALITY	8	10	11	44	4.0	3.9	3.6	3.9	3.5	3.1	3.8	3.8	3.5	3.9	3.8	3.8		
Microdata Totals	11	112	13	49	3.7	3.5	3.4	3.7	3.4	3.0	3.4	3.3	2.8	3.6	3.7	3.6		
Modcomp (all models)	3	3	17	70	3.7	3.7	3.0	2.7	3.3	2.7	3.7	3.7	3.0	3.0	—	3.7		
NCR:																		
Century 50 & 100	6	6	44	24	3.5	3.8	3.5	3.8	3.5	3.2	3.6	3.2	3.0	3.2	3.5	3.8		
Century 101 & 151	19	20	23	49	3.4	3.7	3.6	3.4	3.5	2.5	3.3	3.2	2.9	3.3	3.5	3.4		
NCR 399	3	3	41	12	2.0	3.0	3.0	3.0	2.7	2.0	—	—	2.0	2.5	2.5	2.3		
NCR 725	2	3	13	143	4.0	4.0	4.0	3.0	3.0	3.5	2.0	2.5	3.5	3.0	—	3.5		
Other models	3	4	51	64	3.0	1.5	1.0	1.5	2.5	2.0	4.0	—	4.0	2.0	2.0	1.5		
NCR Totals	33	36	29	40	3.3	3.5	3.5	3.3	3.3	2.6	3.1	3.1	3.0	3.2	3.3	2.5		
Prime Computer (all models)	3	16	17	96	3.7	2.3	3.0	2.7	2.3	3.0	3.7	3.3	2.5	2.7	2.0	2.7		
Qantel (all models)	2	4	7	36	3.5	4.0	3.5	3.5	4.0	4.0	4.0	3.5	3.0	3.5	4.0	3.5		
Singer System Ten	13	34	20	59	3.8	3.4	3.0	2.8	2.8	2.9	3.1	3.0	3.1	2.9	3.3	3.1		
Sweda-Litton 1200 Series	2	2	48	12	4.0	3.0	3.0	3.0	3.0	1.0	3.5	4.0	3.0	2.5	4.0	3.5		
Texas Instruments:																		
960A	2	1	18	8	2.5	3.5	3.0	2.5	3.0	2.0	1.0	1.0	1.0	1.5	—	3.0		
980 Series	6	9	18	65	3.0	3.0	2.5	2.5	2.3	1.8	1.8	2.3	2.0	3.0	3.3	3.5		
Texas Instr. Totals	8	10	17	49	2.9	3.1	2.6	2.5	2.6	1.8	1.6	2.0	1.7	2.5	3.3	3.3		
UNIVAC:																		
9200	8	8	44	14	3.1	3.5	2.7	3.1	3.0	2.8	3.0	3.2	2.2	2.9	2.9	2.9		
9300	12	12	46	—	3.0	3.3	2.6	3.3	2.8	2.1	2.8	2.9	2.0	2.8	2.6	2.7		
UNIVAC Totals	20	20	45	14	3.1	3.4	2.6	3.3	2.9	2.4	2.9	3.0	2.1	2.8	2.7	2.8		
Varian Data Machines:																		
620 Series	2	4	13	24	3.5	3.5	3.0	2.0	3.0	3.0	3.0	2.5	3.0	3.5	1.0	3.0		
V 70 Series	3	2	15	48	3.7	3.7	3.7	2.0	2.5	2.0	2.7	2.3	1.0	2.7	2.3	2.5		
Varian Totals	5	6	9	38	3.6	3.6	3.4	2.0	2.6	2.0	2.8	2.4	2.0	3.0	2.0	2.8		
Wang Laboratories:																		
2200 Series	10	12	12	14	3.6	3.8	3.3	2.9	2.7	2.1	3.4	3.3	2.0	3.8	2.6	3.0		
Other models	2	4	30	—	3.5	4.0	3.0	3.0	3.5	2.0	—	—	2.0	2.5	2.0	4.0		
Wang Totals	12	16	15	14	3.5	3.8	3.3	2.9	2.8	2.1	3.4	3.3	2.0	3.5	2.5	3.2		
All Other Manufacturers	18	180	21	45	3.5	3.7	2.9	3.0	2.8	2.4	3.2	3.0	2.4	3.1	3.2	3.2		
GRAND TOTALS	699	2,182	32	—	3.3	3.5	3.1	3.0	2.9	2.6	3.1	3.0	2.6	3.1	2.9	3.0		

\*Weighted Average User Ratings are calculated on a scale of 4 for each user response of Excellent, 3 for Good, 2 for Fair, and 1 for Poor.

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▷ general, the longer the word length, the greater the efficiency and accuracy of a computer's internal operations—and the higher its price tag. Most of the minicomputers currently on the market have a 16-bit word length; this size neatly accommodates two 8-bit characters and has been shown to yield an attractive balance between economy and performance for many applications. Other widely used models have word lengths of 8, 12, 18, 24, or 32 bits. The 8-bit minicomputers are suitable for many functions where low cost is more important than high precision or sophisticated instruction repertoires—and they can be particularly effective when extensive manipulation of 8-bit bytes must be performed.

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

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

### Main Storage

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

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

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

Our comparison charts show the amount of main storage available for each computer in terms of the *minimum capacity* and *maximum capacity*, expressed in words. In the great majority of cases, storage is available in all the usual binary increments of capacity. Thus, if a computer has minimum and maximum storage capacities of 4,096 and 32,768 words, respectively, it's safe to assume that capacities of 8,192 and 16,384 words are also available.

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

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

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

### Central Processor

Although there are many variations in their internal architecture, the great majority of currently available minicomputers use parallel, binary processors with ▷

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- ▷ single-address instructions and fixed word lengths of 8, 12, 16, 18, 24, or 32 bits.

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

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

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



*Another of the many faces of the world of minicomputers is illustrated by the Datapoint 5500 processor running a software package called Datashare. The combination supports up to 16 users simultaneously and provides each with the apparent full facilities of the computer. Not too many years ago, time-sharing was considered the province of large, highly specialized computer systems.*

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.

*Microprogrammability* is a trait that enables the vendor and/or the user to tailor a minicomputer's internal processing capabilities to suit his particular needs. In place of conventional hardwired logic, a microprogrammed computer uses sequences of microinstructions, usually stored in a special read-only memory (ROM) unit, to define the effects of each instruction in its repertoire. In some cases the microprograms can be altered by the user himself, while in others they are accessible only to the vendor. Microprogrammability can greatly increase the flexibility of a minicomputer, but its presence may involve a trade-off in terms of reduced performance or increased price.

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. ▷

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

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

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

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

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

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

### Input/Output Control

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

I/O word size can interface conveniently with most of the input and output devices on the market today.

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

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

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

The *number of external interrupt levels* provides a reasonable indication of the power of a minicomputer's interrupt system. It shows the number of different external devices whose interrupt signals can be identified by the processor—though it should be noted that this identification process may require a fairly complex and time-consuming sequence of instructions. Many of the minicomputers offer additional external ▷

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▷ 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 in addition to the almost universally available teletypewriters.

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

- 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 important types of disk storage units. *Floppy disk (diskette) drives* provide relatively low-cost data storage on flexible Mylar disks which are housed in thin plastic envelopes; the diskettes are readily interchangeable and convenient to use, but their storage capacity is limited (typically to about 300,000 characters). *Disk pack or cartridge drives*, the most popular types of random-access storage in larger computer systems, store considerably larger quantities of data in interchangeable packs (usually containing from 6 to 12 disks on a common vertical spindle) or cartridges (usually containing a single disk). *Non-interchangeable disk storage* units store the data on nonremovable disks, which reduces operating flexibility but tends to result in higher reliability and a lower cost per character stored.

Disk storage can greatly expand the scope of practical applications for a minicomputer by augmenting its limited main storage capacity. Cost, however, can be a serious problem, since a high-performance disk unit can easily cost more than the minicomputer itself.

*Magnetic tape units* of two basic types are commonly used with minicomputers. *Cassette or cartridge drives* use magnetic tape housed in Philips-style cassettes or various types of cartridges to provide relatively low-cost, low-speed input and output capabilities. By contrast,

*1/2-inch tape drives* use standard 1/2-inch-wide computer tape, housed on reels and recorded in industry-compatible 7-track or 9-track formats, to provide higher input/output speeds at a substantially higher cost.

*Punched card input speed* and *line printer speed*, where these well-known types of peripheral devices are available from the minicomputer vendor, are expressed in cards per minute (cpm) and lines per minute (lpm), respectively.

*Data communications interfaces* make it possible to link a minicomputer to remote terminals, other minicomputers, and/or larger computer systems. The charts indicate whether the minicomputer vendor offers one or more communications interfaces; space limitations preclude a full description of the available interfaces and the supporting software.

*Other standard peripheral devices*, such as plotters and display units, are briefly identified on the charts. Space does not permit listings of the extensive lines of real-time interfaces and analog/digital and digital/analog converters offered by many of the minicomputer builders. Moreover, it should be noted that nearly every minicomputer vendor makes Teletype ASR and or KSR teletypewriters available; the ASR models include low-speed paper tape readers and punches.

### Software

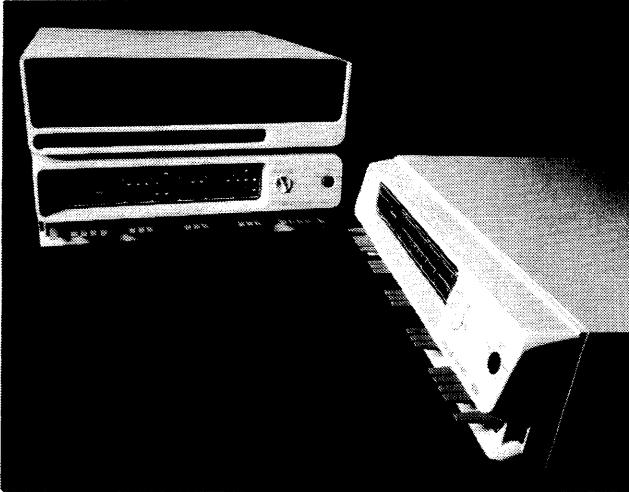
This section of the comparison charts summarizes the major software items offered by the manufacturer of each minicomputer. In addition to the items listed in the charts, most manufacturers also offer utility routines to handle input/output operations, mathematical functions, program loading, and diagnostic 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.

▷

## All About Minicomputers



The Data General Eclipse family of minicomputers carries on the company's tradition of providing a lot of computer for the dollar. With a main memory capacity of up to 256K, the S/200 on the left will support applications once reserved for the big guys. The S/100 on the right is intended for OEM sales, so you will see it in a lot of different skins in the future. These computers, along with the business-oriented Eclipse C/300, use the latest architectural concepts to achieve those favorable price/performance ratios.

▷ 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.

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

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

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

### Pricing and Availability

The comparison charts show the *prices of basic systems* equipped with the minimum available amount of main storage and with 8,192 words, 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 completely reliable source of detailed, up-to-date pricing information is the manufacturers themselves.

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

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

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

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

### MINICOMPUTER MANUFACTURERS

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



## All About Minicomputers

▷ *Artronix Inc.*, 1314 Hanely Industrial Court, St. Louis, Missouri 63144. Telephone (314) 968-4740.

*Basic/Four Corporation*, P.O. Box 11383, Santa Ana, California 92711. Telephone (714) 833-9530.

*Bendix Corporation*, Executive Office Building, Bendix Center, Southfield, Michigan 48076. Telephone (313) 352-5000.

*BSL Northrop*, One Research Park, Palos Verdes Peninsula, California 90274. Telephone (213) 532-1510.

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

*Cascade Data, Inc.*, 3000 Kraft Ave. S.E., Grand Rapids, Michigan 49508. Telephone (616) 942-1420.

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

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

*Computer Automation, Inc.*, 18651 Von Karman Ave., Irvine, California 92664. Telephone (714) 835-8830.

*Computer Development*, 13500 Midway Road, Suite 112, Dallas, Texas 75240. Telephone (214) 233-3238.

*Computer Hardware, Inc.*, 2424 Arden Way, Sacramento, California 95825. Telephone (916) 929-8731.

*Computer Technology Limited*, Eaton Road, Hemel Hempstead, Hertfordshire HP2 7EQ, England. Telephone Hemel Hempstead (0442) 3272.

*Control Data Corporation*, PO Box 0, Minneapolis, Minnesota 55440. Telephone (612) 853-4656.

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

*Datapoint Corporation*, 9725 Datapoint Drive, San Antonio, Texas 78284. Telephone (512) 690-7000.

*Digital Computer Controls, Inc.*, 12 Industrial Road, Fairfield, New Jersey 07006. Telephone (201) 575-9100.

*Digital Equipment Corporation*, 146 Main Street, Maynard, Massachusetts 01754. Telephone (617) 897-5111.

*Digital Scientific Corporation*, 11455 Sorrento Valley Road, San Diego, California 92121. Telephone (714) 453-6050.

*Electronic Processors*, 1265 West Dartmouth, Englewood, Colorado 80110. Telephone (303) 761-8540.

*Fedder Data Centers Inc.*, 412 W. Redwood St., Baltimore, Maryland 21201. Telephone (301) 685-6773.

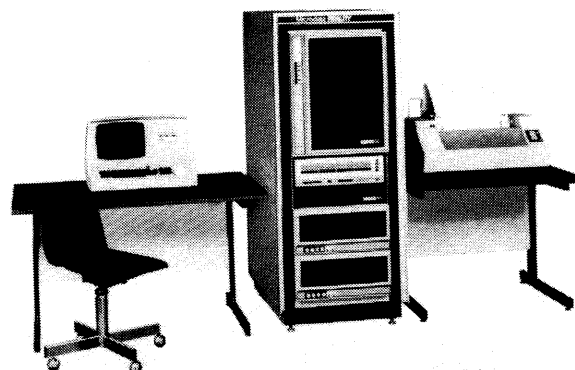
*Four-Phase Systems, Inc.*, 19333 Vallco Parkway, Cupertino, California 95014. Telephone (408) 255-0900.

*Fujitsu Limited*, 6-1 Marunouchi 2-chome, Chiyoda-ku, Tokyo 100, Japan. Telephone 03-216-3211.

*GEC Computers Limited*, Elstree Way, Borehamwood, Hertfordshire WD6 1RX, England. Telephone 01-953-2030.

*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.



*Microdata*, an early proponent of the microprogramming approach to computer architecture, operated for a long time in the OEM market segment. Its computers show up in the products of a number of systems houses. The company recently approached the end-user market by offering its innovative Reality system through an authorized dealer arrangement. The Reality system uses the Microdata 1600 minicomputer as its central component. It uses the microprogrammability to implement the operating system and other "software" elements in read-only memory. This tailors the system to the specialized area of transaction processing and information management. Microprogrammability introduces a potential problem for buyers of packaged turnkey systems: It is no longer enough to know the model number and option list of the processor to know whether you can run software developed by someone else for the "same" processor.

*GTE Information Systems, Inc.*, One Stamford Forum, Stamford, Connecticut 06904. Telephone (203) 357-2000.

*Harris Corporation*, Computer Systems Division, 1200 Gateway Drive, Fort Lauderdale, Florida 33309. Telephone (305) 974-1700.

*Hewlett-Packard Company*, 1501 Page Mill Road, Palo Alto, California 94304. Telephone (415) 493-1501.

*Hitachi, Ltd.*, New Marunouchi Building, 5-1-1-chome, Marunouchi Chiyoda-ku, Tokyo, Japan 100. Telephone Tokyo 212-1111.

*Honeywell Information Systems Inc.*, 200 Smith Street, Waltham, Massachusetts 02154. Telephone (617) 890-8400.

*IBM Corporation*, General Systems Division, 875 Johnson Ferry Road N.E., Atlanta, Georgia 30342.

*Information Computer Systems, Ltd.*, Heron House, 19 Marylebone Road, London NW1, England. Telephone (01) 486-4635.

*Interdata, Inc.*, 2 Crescent Place, Oceanport, New Jersey 07757. Telephone (201) 229-4040.

*Keronix, Inc.*, 1752 Cloverfield Blvd., Santa Monica, California 90404. Telephone (213) 829-3594.

*Linolex Systems, Inc.*, 5 Esquire Road, North Billerica, Massachusetts 01862. Telephone (617) 667-4151.

*Lockheed Electronics Company*, Data Products Division, 6201 E. Randolph Street, Los Angeles, California 90022. Telephone (213) 722-6810.



## All About Minicomputers

- ▷ *Martin, Wolfe Inc.*, 8369 Vickers St., San Diego, California 92111. Telephone (714) 277-3700.
- Micro Computer Machines Inc.*, 133 Dalton Street, Kingston, Ontario, Canada K7L 4W2. Telephone (613) 544-9860.
- Microdata Corporation*, 17481 Red Hill Ave., Irvine, California 92705. Telephone (714) 540-6730.
- Modular Computer Systems, Inc.*, 1650 West McNab Road, Fort Lauderdale, Florida 33309. Telephone (305) 974-1380.
- Nanodata Corporation*, 2457 Wehrle Drive, Williamsville, New York 14221. Telephone (716) 631-5880.
- A/S Norsk Data-Elektronikk*, Postboks 163, Okem, Oslo, 5 Norway. Telephone 21 73 71.
- Philips-Electrologica B.V.*, P.O. Box 245, Apeldoorn, Netherlands. Telephone 05760-30123.
- North American Philips Corp.*, Dept. 007, 100 E. 42nd Street, New York, New York 10017. Telephone (212) 697-3600.
- Prime Computer, Inc.*, 145 Pennsylvania Ave., Framingham, Massachusetts 01701. Telephone (617) 879-2960.
- Qantel Corporation*, 3525 Breakwater Avenue, Hayward, California 94545. Telephone (415) 783-3410.
- Raytheon Data Systems Company*, 1415 Boston-Providence Turnpike, Norwood, Massachusetts 02062. Telephone (617) 762-6700.
- A/S Regnecentralen*, Falkoner Alle 1-DK 2000, Copenhagen, Denmark. Telephone (01) 10-53-66.
- 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.
- Ultimacc Systems, Inc.*, 9 Brook Ave., Maywood, New Jersey 07607. Telephone 845-0500.
- Varian Data Machines*, 2722 Michelson Drive, Irvine, California 92664. Telephone (714) 833-2400.
- Wang Laboratories Inc.*, 836 North St., Tewksbury, Massachusetts 08176. Telephone (617) 851-4111.
- Westinghouse Electric Corporation*, Computer and Instrumentation Division Computer Department, 1200 West 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	Artronix PC-12/730	Artronix PC-12/770	Artronix PC-16	Basic/Four Model 350	Basic/Four Model 400
<b>DATA FORMATS</b>					
Word length, bits	12	12	16	8	8
Fixed-point operand length, bits	12	12	16	Variable	Variable
Instruction length, bits	12/60	12/60	16/32	16	16
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core/semi.	Core	Core
Cycle time, microseconds/word	1.2	0.7	0.8/0.2	1.0	1.0
Minimum capacity, words	4,096	16,384	8,192	8,192	8,192
Maximum capacity, words	65,536	131,072	131,072	65,536	65,536
Parity checking	No	No	Optional	No	No
Storage protection	No	No	Optional	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	1	8	2	2
No. of index registers	64	64	8	1	1
No. of directly addressable words	4,096	4,096	32,768	65,536	65,536
Indirect addressing	One-level	One-level	Multi-level	One-level	One-level
Microprogrammable	No	No	By vendor only	No	No
Add time, microseconds (full word)	2.4	1.4	2.4	7.0	7.0
Hardware multiply/divide	No	No	Optional	No	No
Hardware floating point	Optional	Standard	Optional	No	No
Hardware byte manipulation	No	Optional	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Optional	Standard	Standard	Standard	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	12/24	12/24	8/16	8	8
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	833,000	1,250,000	4,800,000	1,000,000	1,000,000
No. of external interrupt levels	1-256	1-256	Variable	2-32	2-32
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	No	No
Disk pack/cartridge drives	Yes	Yes	Yes	Cartridge	Cartridge
Non-interchangeable disk storage	Yes	Yes	No	Yes	Yes
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	No	No
Magnetic tape, 1/2-inch	No	Yes	Yes	Yes	Yes
Punched card input speed, cpm	300	300	600	300	300
Line printer speeds, lpm	60-300	60-300	600	200	200
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Graphics, plotter, instrumentation	CRTs or TTY terminals	Graphics	CRTs; serial printer	CRTs; serial printer
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	1- & 2-pass	No	No
Macro assembler	No	No	Yes	No	No
FORTRAN compiler	Yes	Yes	Yes	No	No
Other compilers	Comfort	MUMPS-PC	MUMPS, RPG-II	BASIC interp.	BASIC interp.
Operating system	Interactive, batch, real-time	Batch, time-sharing	Batch, real-time, time-sharing	Time-sharing	Time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	Approx. \$20,000 (16K)	Approx. \$76,000 (64K)	Approx. \$15,000 (16K)	\$32,400	\$34,900
Price of basic system with 8K words	NA	NA	NA	\$32,400	\$34,900
Date of first delivery	Sept. 1971	Feb. 1974	July 1975	Sept. 1971	Aug. 1971
Number installed to date	Over 150	Over 20	NA	See Comments	See Comments
<b>COMMENTS</b>	Primarily sold as integrated turnkey systems for the medical field; PC-12/730 provides extensive clinical and laboratory software; PC-12/770 provides data base management facilities; prices above are for basic operational systems		Highly modular; operating system handles up to 4 processors per system	Small business computer systems; Models 350, 400, and 500 can have 1, 4, or 8 CRT terminals per system. Total of over 1800 systems installed to date. Also used for scientific processing	

### All About Minicomputers

MANUFACTURER & MODEL	Basic/Four Model 500	Basic/Four Model 600	Bendix BDX6200	Bendix BDX9000	BSL Northrop BDS-1000
<b>DATA FORMATS</b>					
Word length, bits	8	8	20	16	8
Fixed-point operand length, bits	Variable	Variable	20/40	16	8-32
Instruction length, bits	16	Variable	20	16	8-40
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	1.0	1.0	2.0	1.0	1.0
Minimum capacity, words	8,192	32,768	4,096	4,096	16,384
Maximum capacity, words	65,536	65,536	16,384	32,768	16,384
Parity checking	No	No	Optional	Optional	No
Storage protection	No	No	Optional	Optional	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	2	2	3	16	2
No. of index registers	1	1	3	2	1
No. of directly addressable words	65,536	65,536	4,096	512	32,768
Indirect addressing	One-level	One-level	Multi-level	Multi-level	One-level
Microprogrammable	No	No	NA	NA	By vendor only
Add time, microseconds (full word)	7.0	7.0	4.0	2.0	4.6
Hardware multiply/divide	No	No	Standard	Standard	No
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	Standard	Standard	No	No	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	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	8	20	16	8
Direct memory access channel	Standard	Standard	Optional	Optional	Standard
Maximum I/O rate, words/sec	1,000,000	1,000,000	500,000	500,000	1,000,000
No. of external interrupt levels	2-32	2-32	1-64	1-64	1
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	No
Disk pack/cartridge drives	Cartridge	Cartridge	Pack	Pack	Cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	No
Magnetic tape cassettes/cartridges	No	No	No	No	No
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	300	300	200	200	300
Line printer speeds, lpm	200	200	NA	NA	200-600
Data communications interface	Yes	Yes	NA	NA	Yes
Other standard peripheral units	CRTs; serial printer	CRTs; serial printer	A/D and D/A interfaces; punched tape units	A/D and D/A interfaces; punched tape units	Thermal printer, CRTs
<b>SOFTWARE</b>					
Assembler	No	No	2-pass	2-pass	Yes
Macro assembler	No	No	No	No	No
FORTRAN compiler	No	No	No	No	No
Other compilers	BASIC interp.	BASIC interp.	ATLAS	No	No
Operating system	Time-sharing	Time-sharing	No	No	Batch, real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$36,900	\$54,400	On request	On request	\$69,300
Price of basic system with 8K words	\$36,900	Not available	On request	On request	Not available
Date of first delivery	May 1972	NA	May 1970	1971	1972
Number installed to date	See Comments	12	120	25	8
<b>COMMENTS</b>	See Comments on previous page	Small business computer system; basic system includes printer and 12 MB disk; up to 8 CRTs can be accommodated	These minicomputers are sold exclusively for aerospace and ground support systems and are not usually available commercially		See Comments next page

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MANUFACTURER & MODEL	BSL Northrop BDS-2000	BSL Northrop BDS-3000	California Data Processors Cal Data 4/I	California Data Processors Cal Data 4I	California Data Processors Cal Data 5/1130
<b>DATA FORMATS</b>					
Word length, bits	8	8	16/8	8	16/8
Fixed-point operand length, bits	8-32	8-32	32	16	16
Instruction length, bits	8-40	8-40	16	16/32	16/32
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	1.0	1.0	0.675/0.85	0.675/0.85	0.675/0.85
Minimum capacity, words	16,384	24,576	8,192/16,384	8,192/16,384	8,192/16,384
Maximum capacity, words	24,576	32,768	131,072	65,536	65,536
Parity checking	No	No	No	No	No
Storage protection	No	Standard	Optional	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	2	2	8	8	8
No. of index registers	1	1	8	8	8
No. of directly addressable words	32,768	32,768	32,768	65,536	65,536
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Microprogrammable	By vendor only	By vendor only	By user	By user	By user
Add time, microseconds (full word)	4.6	4.6	2.0	1.2	2.8
Hardware multiply/divide	No	No	Optional	Standard	Standard
Hardware floating point	No	No	Optional	No	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Standard	Standard	Standard	Standard	No
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	8	8/16	8/16	16
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1,000,000	1,000,000	3,000,000	3,000,000	235,000
No. of external interrupt levels	1	1	4	4	9
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	See Comments	See Comments
Disk pack/cartridge drives	Cartridge	Cartridge	Pack, cartridge	—	—
Non-interchangeable disk storage	No	No	No	—	—
Magnetic tape cassettes/cartridges	No	No	No	—	—
Magnetic tape, 1/2-inch	Yes	Yes	Yes	—	—
Punched card input speed, cpm	300	300	300-1000	—	—
Line printer speeds, lpm	200-600	200-600	125-1000	—	—
Data communications interface	Yes	Yes	Yes	—	—
Other standard peripheral units	Thermal printer, CRTs	Thermal printer, CRTs	—	—	—
<b>SOFTWARE</b>					
Assembler	Yes	Yes	2-pass	See Comments	See Comments
Macro assembler	No	No	Yes	—	—
FORTAN compiler	No	No	Yes	—	—
Other compilers	No	BASIC	BASIC	—	—
Operating system	Batch, real-time	Batch, real-time	Batch, real-time	—	—
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$100,700	\$216,700	\$9,000	Contact vendor	Contact vendor
Price of basic system with 8K words	Not available	Not available	\$9,000	—	—
Date of first delivery	1973	—	Nov. 1973	Oct. 1974	NA
Number installed to date	13	—	150	NA	NA
<b>COMMENTS</b>	Turnkey multi-user systems for furniture manufacturer or medical billing application; prices include disk, 1 CRT, line printer, and applications software. BDS-1000 can accommodate up to 4 CRTs; BDS-2000, up to 6; BDS-3000, up to 12		Emulates Digital Equipment PDP-11	The 4/I emulates the GTE Tempo, and the 5/1130 emulates the IBM 1130. No peripherals or software available directly	

## All About Minicomputers

MANUFACTURER & MODEL	Cascade Data Concept II	CII Mitra 15/30 (15/20)	Cincinnati Milacron CIP/2200B	Computer Automation Naked Milli LSI-3/05
<b>DATA FORMATS</b>				
Word length, bits	16 (2 bytes)	16 + 2	8	16
Fixed-point operand length, bits	16-32	16	8/16/24/32	8/16/32
Instruction length, bits	16-40	16	8/16/24/32	16/32
<b>MAIN STORAGE</b>				
Storage type	Core	Core	Core/MOS	Core/MOS
Cycle time, microseconds/word	1.2 (per byte)	0.8	1.1	See Comments
Minimum capacity, words	4,096	4,096	8,192	256
Maximum capacity, words	32,768	32,768 (8,192)	65,536	262,144
Parity checking	Standard	Standard	Optional	No
Storage protection	No	Standard	Yes	No
<b>CENTRAL PROCESSOR</b>				
No. of accumulators	15	2	3	2
No. of index registers	3	1 (+2 base)	1	1
No. of directly addressable words	32,768	768	32,768	384
Indirect addressing	No	One-level	Multi-level	Multi-level
Microprogrammable	No	NA	By vendor only	By vendor only
Add time, microseconds (full word)	8.8	2.3	110	6.25
Hardware multiply/divide	Standard	Standard (opt.)	Standard	No
Hardware floating point	No	Optional	No	No
Hardware byte manipulation	Standard	Standard (opt.)	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard
Power failure protection	No	Standard (opt.)	Standard	Standard
Real-time clock or timer	Optional	Optional	Standard	Standard
<b>INPUT/OUTPUT CONTROL</b>				
I/O word size, bits	16	8/16	8	8/16
Direct memory access channel	Standard	Optional	Optional	Standard
Maximum I/O rate, words/sec	413,000	1,200,300 (300K)	909,000	1,176,000
No. of external interrupt levels	0	1-100	32 max.	1-unlimited
<b>PERIPHERAL EQUIPMENT</b>				
Floppy disk (diskette) drives	No	No	Yes	Yes
Disk pack/cartridge drives	Pack	Pack	Pack	No
Non-interchangeable disk storage	No	Yes	Yes	No
Magnetic tape cassettes/cartridges	No	No	Yes	No
Magnetic tape, 1/2-inch	Yes	Yes	Yes	No
Punched card input speed, cpm	300	300-1200	600	285
Line printer speeds, lpm	125-600	NA	125-600	150
Data communications interface	Yes	Yes	Yes	Yes
Other standard peripheral units	CRT terminals	Line printers, CRTs, A/D interfaces, etc.	CRTs; 96-column card units	CRTs, TTY, punched tape units
<b>SOFTWARE</b>				
Assembler	2-pass	1-pass	2-pass	See Comments
Macro assembler	Yes	Yes	Yes	See Comments
FORTRAN compiler	No	Yes	No	No
Other compilers	RPG	LP15, LPG, BASIC	RPG II	No
Operating system	Batch, real-time, time-sharing	Yes (4)	Batch (fore/back- ground)	Real-time
<b>PRICING &amp; AVAILABILITY</b>				
Price of basic system with minimum main storage	\$29,500	\$15,800 (\$12,200)	\$5,220	\$465
Price of basic system with 8K words	Not available	\$20,700 (\$17,000)	\$5,220	\$1,075
Date of first delivery	April 1970	June 1972	Feb. 1972 (2200)	March 1975
Number installed to date	140	Over 750	1700	NA
<b>COMMENTS</b>	Byte-oriented; de- signed for business applications; turnkey systems; extensive applications software	System uses 4-port core memory; 1 for the CPU, the I/O processors and DMA. Information furnished in June 1974	Features multiple CRT units under RPG II	2-pass macro assembler runs on LSI-2; See Comments on next page for memory speeds and family relationships

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MANUFACTURER & MODEL	Computer Automation Naked Mini LSI-2/10	Computer Automation Naked Mini LSI-2/20	Computer Automation Megabyte LSI-2/60	Computer Development Opus III	Computer Development Century 400
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	8	16
Fixed point operand length, bits	8/16/32	8/16/32	8/16/32	8	16
Instruction length, bits	16/32	16/32	16/32	8/16/24	8/16/24
<b>MAIN STORAGE</b>					
Storage type	Core/MOS	Core/MOS	Core/MOS	MOS	MOS
Cycle time, microseconds/word	See Comments	See Comments	See Comments	1.3	0.86
Minimum capacity, words	4,096	4,096	8,192	NA	NA
Maximum capacity, words	262,144	262,144	524,288	65,536	65,536
Parity checking	Optional	Optional	Optional	No	No
Storage protection	No	No	No	No	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	2	2	2	1	1
No. of index registers	1	1	1	15	15
No. of directly addressable words	768	768	768	65,536	65,536
Indirect addressing	Multi-level	Multi-level	Multi-level	One-level	Multi-level
Microprogrammable	By vendor only	By vendor only	By vendor only	No	By vendor only
Add time, microseconds (full word)	4.12	2.06	2.06	1.3	NA
Hardware multiply/divide	Standard	Standard	Standard	Optional	Optional
Hardware floating point	No	No	No	Standard	Standard
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Optional	No	No
Real-time clock or timer	Optional	Optional	Optional	No	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8/16	8/16	8/16	Variable	Variable
Direct memory access channel	Standard	Standard	Standard	Optional	Standard
Maximum I/O rate, words/sec	1,666,000	1,666,000	1,666,000	1,000,000	1,000,000
No. of external interrupt levels	3-unlimited	3-unlimited	3-unlimited	15-120	120
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	Yes	Yes
Disk pack/cartridge drives	Cartridge	Cartridge	Cartridge		Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	No	No	No	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	285	285	285	NA	NA
Line printer speeds, lpm	150	150	150	Approx. 100	600
Data communications interface	CRTs, TTY, punched tape units	CRTs, TTY, punched tape units	CRTs, TTY, punched tape units	CRTs, typewriter	CRTs, typewriter
Other standard peripheral units					
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	1-pass	1-pass
Macro assembler	Yes	Yes	Yes	No	No
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC	BASIC	BASIC	BASIC, COBOL	BASIC, COBOL
Operating system	Batch and real-time	Batch and real-time	Batch and real-time	Batch/real-time	Batch/real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$1,750	\$2,300	\$6,850	\$5,000	\$5,000
Price of basic system with 8K words	\$2,120	\$2,695	\$6,850	\$6,500	\$6,500
Date of first delivery	May 1974	Sept. 1973	March 1975	Feb. 1971	March 1975
Number installed to date	NA	NA	NA	Over 500	43
<b>COMMENTS</b>	All models in the LSI family are program and I/O compatible. The same memory bus (asynchronous) is used throughout the family, providing interchangeability among 0.98, 1.2, and 1.6 usec core and 0.85 usec MOS modules			Turnkey system oriented toward the business market; systems are sold primarily to dealers and system houses	

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MANUFACTURER & MODEL	Computer Hardware CHI 2120	Computer Hardware CHI 2130	Computer Technology Modular One 1.11	Computer Technology Modular One 1.12	Computer Technology Modular One 1.15
<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	MOS	Core	Core/MOS	MOS	Core/MOS
Cycle time, microseconds/word	1.6	0.8	0.75	0.9	0.75
Minimum capacity, words	16,384	8,192	8,192	8,192	8,192
Maximum capacity, words	16,384	65,536	57,324	57,324	229,376
Parity checking	Standard	Standard	No	No	No
Storage protection	No	Optional	Standard	Standard	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	1	2	2	2
No. of index registers	6	6	8	8	8
No. of directly addressable words	16,384	16,384	57,324	57,324	229,376
Indirect addressing	2-level	2-level	Multi-level	Multi-level	Multi-level
Microprogrammable	No	No	No	No	No
Add time, microseconds (full word)	1.6	3.2	1.6	1.8	1.6
Hardware multiply/divide	Standard	Standard	Standard	Standard	Standard
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	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	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	625,000	1,250,000	1,000,000	1,000,000	1,000,000
No. of external interrupt levels	8	8	8-96	8-96	8-96
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	No
Disk pack/cartridge drives	Cartridge	Cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	No	No	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	No	No	No	No	No
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	200-1000	200-1000	600	600	600
Line printer speeds, lpm	300-1100	300-1100	100-600	100-600	100-600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Plotter; punched tape units	Plotter; punched tape units	Punched tape units, plotter, CRTs, etc.	Punched tape units, plotter, CRTs, etc.	Punched tape units, plotter, CRTs, etc.
<b>SOFTWARE</b>					
Assembler	1- & 2-pass	1- & 2-pass	1- & 2-pass	No	1- & 2-pass
Macro assembler	Yes	Yes	Yes	No	Yes
FORTRAN compiler	Yes	Yes	Yes	No	Yes
Other compilers	RPG, COBOL, BASIC, SL1	RPG, COBOL, BASIC, SL1	COBOL, BASIC, ALGOL, FTS, etc.	No	COBOL, BASIC, ALGOL, FTS, etc.
Operating system	Batch	Batch, time-sharing	Batch/real-time/time-sharing	RJE only	Batch/real-time/time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$26,400	\$30,000	On request	On request	On request
Price of basic system with 8K words	Not available	\$30,000	On request	On request	On request
Date of first delivery	July 1975	July 1974	NA	NA	1975
Number installed to date	4	53	See Comments	See Comments	See Comments
<b>COMMENTS</b>	Compatible with IBM 1130	Compatible with IBM 1130	All systems are fully compatible; over 400 systems have been delivered; 1.11 and 1.15 are available in versions specialized for commercial teaching, scientific, and other applications; 1.12 is used as a satellite network processor under HASP and emulates CDC 200, ICL 7020/7905, or IBM 2780		

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MANUFACTURER & MODEL	Control Data System 17	Data General Eclipse S/100	Data General Eclipse S/200	Data General Eclipse C/300	Data General Nova 2/4
<b>DATA FORMATS</b>					
Word length, bits	16 + 2	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
<b>MAIN STORAGE</b>					
Storage type	MOS	Core/MOS	Core/MOS	Core/MOS	Core
Cycle time, microseconds/word	0.6/0.9	0.2-0.8 (eff.)	0.2-0.8 (eff.)	0.2-0.8 (eff.)	1.0/0.8
Minimum capacity, words	4,096	8,192	16,384	32,768	4,096
Maximum capacity, words	65,536	131,072	131,072	131,072	32,768
Parity checking	Standard	See Comments	See Comments	See Comments	No
Storage protection	Standard	Standard	Standard	Standard	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	2	4	4	4	4
No. of index registers	2	2	2	2	2
No. of directly addressable words	256	1,024	1,024	1,024	1,024
Indirect addressing	No	Multi-level	Multi-level	Multi-level	Multi-level
Microprogrammable	No	By user, opt.	By user, opt.	By vendor only	No
Add time, microseconds (full word)	1.2/1.8	0.6	0.6	0.6	0.8/1.0
Hardware multiply/divide	Standard	Standard	Standard	Standard	Optional
Hardware floating point	Optional	No	Optional	Standard	No
Hardware byte manipulation	Optional	Standard	Standard	Standard	Standard
Immediate (literal) instructions	No	NA	NA	NA	No
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	16	16	16
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1,600,000	733,000	733,000	733,000	1.25/.833M
No. of external interrupt levels	2-16	16	16	16	16
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	Yes	Yes	Yes	Yes
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	No	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	No	Yes	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	330	150-1000	150-1000	150-1000	150-1000
Line printer speeds, lpm	300-1200	240-300	240-300	240-300	240-300
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Punched tape units, CRTs, A/D units	CRTs, punched tape units, plotter	CRTs, punched tape units, plotter	CRTs, punched tape units, plotter	CRTs, punched tape units, plotter
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes (3)
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	No	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC, RPG II	ALGOL, BASIC
Operating system	Batch, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$14,175 (0.9 usec)	\$9,200	\$16,300	\$30,700	\$3,500
Price of basic system with 8K words	\$17,325 (0.6 usec) \$17,325 (0.9 usec) \$21,525 (0.6 usec)	\$9,200	Not available	Not available	\$4,000
Date of first delivery	1973	Feb. 1975	March 1975	August 1975	Oct. 1973
Number installed to date	Over 200	NA	NA	NA	NA
<b>COMMENTS</b>	Compatible with predecessor CDC 1700 models	Memory modules can be 800-nsec core or 700-nsec MOS; 200-nsec bipolar cache memory is used to enhance effective memory speed. Error checking and correcting memory modules are available optionally. INFOS data base oriented file management software is available for C/300. Instruction set is upward-compatible with Nova line			Nova 2 uses a 1-microsecond, 16K-word memory or an 800-nanosecond 4K- or 8K-word memory; 2/4 has 4 slots

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MANUFACTURER & MODEL	Data General Nova 2/10	Data General Nova 800	Data General Nova 820	Data General Nova 830	Data General Nova 840
<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
Cycle time, microseconds/word	1.0/0.8	0.8	0.8	1.0	0.8
Minimum capacity, words	4,096	4,096	4,096	16,384	16,384
Maximum capacity, words	32,768	32,768	32,768	131,072	131,072
Parity checking	No	No	No	No	No
Storage protection	No	No	No	Optional	Standard
<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
Microprogrammable	No	No	No	No	No
Add time, microseconds (full word)	0.8/1.0	0.8	0.8	1.0	0.8
Hardware multiply/divide	Optional	Optional	Optional	Optional	Optional
Hardware floating point	Optional	Optional	Optional	Optional	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	No	No	No	No	No
Power failure protection	Optional	Optional	Optional	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<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	1.25/.833M	1,250,000	1,250,000	833,000	1,250,000
No. of external interrupt levels	16	16	16	16	16
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	Yes	Yes
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	150-1000	150-1000	150-1000	150-1000	150-1000
Line printer speeds, lpm	240-300	240-300	240-300	240-300	240-300
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRTs, punched tape units, plotter	CRTs, punched tape units, plotter	CRTs, punched tape units, plotter	CRTs, punched tape units, plotter	CRTs, punched tape units, plotter
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC
Operating system	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$4,400	\$6,600	\$6,100	\$12,650	\$16,530
Price of basic system with 8K words	\$4,900	\$8,000	\$7,500	Not available	Not available
Date of first delivery	Oct. 1973	March 1971	Apr. 1972	Dec. 1974	June 1973
Number installed to date	NA	NA	NA	NA	NA
<b>COMMENTS</b>					
	Nova 2 uses a 1-microsecond, 16K-word memory or an 800-nanosec., 4K- or 8K-word memory; 2/10 has 10 slots	All Nova-line computers are program compatible. Semiconductor read-only memory is interchangeable with core	Housed in a 10.5-inch-high "jumbo" chassis that contains 10 subassembly slots for expansion	Feature memory management and protection unit that provides memory expansion to 131K	



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MANUFACTURER & MODEL	Data General Nova 1200	Data General Nova 1210	Data General Nova 1220	Datapoint 1100 Cassette	Datapoint 1100 Diskette
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	8	8
Fixed-point operand length, bits	16	16	16	8	8
Instruction length, bits	16	16	16	8/16/24	8/16/24
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	MOS	MOS
Cycle time, microseconds/word	1.2	1.2	1.2	1.6	1.6
Minimum capacity, words	4,096	4,096	4,096	4,096	16,384
Maximum capacity, words	32,768	32,768	32,768	8,192	16,384
Parity checking	No	No	No	No	No
Storage protection	No	No	No	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	4	4	4	2	2
No. of index registers	2	2	2	14	14
No. of directly addressable words	1,024	1,024	1,024	8,192	16,384
Indirect addressing	Multi-level	Multi-level	Multi-level	No	No
Microprogrammable	No	No	No	No	No
Add time, microseconds (full word)	1.35	1.35	1.35	4.8	4.8
Hardware multiply/divide	Optional	Optional	Optional	No	No
Hardware floating point	Optional	No	Optional	No	No
Hardware byte manipulation	Standard	Standard	Standard	No	No
Immediate (literal) instructions	No	No	No	Standard	Standard
Power failure protection	Optional	Optional	Optional	Standard	Standard
Real-time clock or timer	Optional	Optional	Optional	Standard	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	16	8	8
Direct memory access channel	Standard	Standard	Standard	No	No
Maximum I/O rate, words/sec	833,000	833,000	833,000	350	40,000
No. of external interrupt levels	16	16	16	0	0
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	No	Yes
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Pack, cartridge	No	No
Non-interchangeable disk storage	Yes	Yes	Yes	No	No
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	Yes	No
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	No
Punched card input speed, cpm	150-1000	150-1000	150-1000	300	300
Line printer speeds, lpm	240-300	240-300	240-300	300	300
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRTs, punched tape units, plotter	CRTs, punched tape units, plotter	CRTs, punched tape units, plotter	—	—
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	No	No
FORTRAN compiler	Yes	Yes	Yes	No	No
Other compilers	ALGOL, BASIC	ALGOL, BASIC	ALGOL, BASIC	BASIC, Databus, Dataform	BASIC, Databus, RPG II, Dataform
Operating system	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Real-time	Real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$5,100	\$4,000	\$4,900	\$7,200	\$12,880
Price of basic system with 8K words	\$5,950	\$5,400	\$6,300	\$8,040	Not available
Date of first delivery	Dec. 1970	Feb. 1972	Feb. 1972	Jan. 1974	Feb. 1975
Number installed to date	NA	NA	NA	Over 1,500	Over 500
<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	Include 960-character CRT and dual cassettes or floppy disk (diskette) as standard equipment	

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MANUFACTURER & MODEL	Datapoint 2200	Datapoint 5500	Digital Computer Controls D-116S	Digital Computer Controls D-116H	Digital Computer Controls D-216
<b>DATA FORMATS</b>					
Word length, bits	8	8	16	16	16
Fixed-point operand length, bits	8	8	16	16	16
Instruction length, bits	8/16/24	8/16/24	16	16	16
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	Core	Core	MOS
Cycle time, microseconds/word	1.6	0.8	1.2	0.96	1.6
Minimum capacity, words	4,096	40,960	4,096	1,024	1,024
Maximum capacity, words	16,384	65,536	131,072	131,072	16,384
Parity checking	No	Standard	No	No	No
Storage protection	No	Standard	Optional	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	2	2	4	4	8
No. of index registers	14	16	2	2	2 + 2
No. of directly addressable words	16,384	65,536	1,024	1,024	1,024
Indirect addressing	No	One-level	Multi-level	Multi-level	Multi-level
Microprogrammable	No	No	No	No	By vendor only
Add time, microseconds (full word)	4.8	1.4	1.35	1.0	1.6
Hardware multiply/divide	No	No	Optional	Optional	No
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	No	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	No	No	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
Direct memory access channel	No	No	Standard	Standard	Standard
Maximum I/O rate, words/sec	195,000	312,500	833,000	1,040,000	625,000
No. of external interrupt levels	0	0	1-16	1-16	1-16
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	Yes	Yes
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	No	No	No
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	300	300	150-600	150-600	150-600
Line printer speeds, lpm	125-600	125-600	60-600	60-600	60-600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRT terminals	CRT terminals	Punched tape units, CRTs, plotter, A/D and D/A units, TTY, etc.	Punched tape units, CRTs, plotters, A/D and D/A units, TTY, etc.	Punched tape units, CRTs, plotters, A/D and D/A units, TTY, etc.
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	No	Yes	Yes	Yes	Yes
FORTRAN compiler	No	No	Yes	Yes	Yes
Other compilers	BASIC, Databus, RPG II, Dataform	BASIC, Databus, RPG II, Dataform	BASIC, IRIS	BASIC, IRIS	BASIC, IRIS
Operating system	Batch, real-time, time-sharing	Batch-real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$8,571	\$22,500	\$2,975	\$3,075	\$1,800 (board); \$2,700 (full)
Price of basic system with 8K words	\$10,003	Not available	\$3,365	\$3,465	\$2,700 (board); \$3,600 (full)
Date of first delivery	April 1972	Feb. 1975	Nov. 1971	Dec. 1972	NA
Number installed to date	Over 6000	Over 200	NA	NA	NA
<b>COMMENTS</b>	Include 960-character CRT and dual cassettes standard. Databus is a business oriented language; Dataform is an input editing/forms processing-oriented language		All DCC 16 Series members are fully compatible with Data General Nova 1200 Series minis and with each other. Also see Comments on next page		

## All About Minicomputers

MANUFACTURER & MODEL	Digital Computer Controls D-316	Digital Computer Controls D-416	Digital Computer Controls D-616	Digital Computer Controls PDP-8/A	Digital Computer Controls PDP-8/E
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	12	12
Fixed-point operand length, bits	16	16	16	12	12
Instruction length, bits	16	16	16	12	12
<b>MAIN STORAGE</b>					
Storage type	MOS	Core	Core/MOS	Core/MOS	Core
Cycle time, microseconds/word	1.6	1.6	0.66	1.5-3.4	1.2
Minimum capacity, words	4,096	4,096	4,096	1K-8K	1,024
Maximum capacity, words	32,768	32,768	1,048,576	32,768	32,768
Parity checking	Standard	No	See Comments	No	Optional
Storage protection	Optional	Optional	Optional	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	8	8	8	1	1
No. of index registers	2 + 2	2 + 2	2 + 2	8 (4K mem.)	8 (4K mem.)
No. of directly addressable words	1,024	1,024	1,024	256	256
Indirect addressing	Multi-level	Multi-level	Multi-level	One-level	One-level
Microprogrammable	By vendor only	By vendor only	By vendor only	No	No
Add time, microseconds (full word)	1.6	1.6	0.66	3.0-3.8	2.6
Hardware multiply/divide	No	No	Optional	No	Optional
Hardware floating point	No	No	Optional	Optional	Optional
Hardware byte manipulation	Standard	Standard	Standard	No	No
Immediate (literal) instructions	Standard	Standard	Standard	No	Standard
Power failure protection	Standard	Standard	Standard	Optional	Standard
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	16	12	12
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	625,000	625,000	0.833/1.25/1.515M	526K-667K	833,000
No. of external interrupt levels	1-16	1-16	1-16	1-64	1-64
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	Yes	Yes
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Pack, cartridge	Cartridge	Cartridge
Non-interchangeable disk storage	No	No	No	Yes	Yes
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	150-600	150-600	150-600	300	300
Line printer speeds, lpm	60-600	60-600	60-600	300	300
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Punched tape units, CRTs, plotters, A/D and D/A units, TTY, etc.	Punched tape units, CRTs, plotters, A/D and D/A units, TTY, etc.	Punched tape units, CRTs, plotters, A/D and D/A units, TTY, etc.	DECtape, CRTs, plotter, punched tape units, etc.	DECtape, CRTs, plotter, punched tape units, etc.
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	1- and 2-pass	1- and 2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC, IRIS	BASIC, IRIS	BASIC, IRIS	BASIC, ALGOL, DIBOL, FOCAL	BASIC, ALGOL, DIBOL, FOCAL
Operating system	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$2,000 (board) \$2,900 (full)	\$2,400 (board) \$3,400 (full)	\$5,660	\$1,745-\$3,795	\$4,490
Price of basic system with 8K words	\$2,600 (board) \$3,500 (full)	\$2,800 (board) \$3,800 (full)	\$6,060	\$3,935-\$3,795	\$5,300
Date of first delivery	NA	NA	NA	Dec. 1974	March 1971
Number installed to date	NA	NA	NA	NA	See Comments
<b>COMMENTS</b>	216/316/416 are available with CPU, memory, and TTY interface mounted on single 15-inch board or as a "full" minicomputer. The 616 offers dual ported memory with CORE and MOS modules intermixed if desired; memory modules with error detection and correction capabilities are optional. Previous DCC 12 Series, compatible with DEC PDP-8 has been discontinued			Family of 4 microcomputers program compatible with PDP-8E. Battery power back up. Range of memory options and configuration rules results in ranges given above	Most expansion capability of PDP-8 family; for OEM and end user. Also see Comments on next page.

## All About Minicomputers

MANUFACTURER & MODEL	Digital Equipment PDP-8/F	Digital Equipment PDP-8/M	Digital Equipment LSI-11	Digital Equipment PDP-11/03	Digital Equipment PDP-11/04
<b>DATA FORMATS</b>					
Word length, bits	12	12	16	16	16
Fixed-point operand length, bits	12	12	16	16	16
Instruction length, bits	12	12	16/32/48	16/32/48	16/32/48
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core/MOS	Core/MOS	MOS
Cycle time, microseconds/word	1.2	1.2	1.2	1.2	0.725
Minimum capacity, words	1,024	1,024	4,096	4,096	4,096
Maximum capacity, words	32,768	32,768	32,768	32,768	32,768
Parity checking	Optional	Optional	No	No	Optional
Storage protection	No	No	No	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	1	8	8	8
No. of index registers	8 (4K mem.)	8 (1K of mem.)	8 min.	8 min.	8 min.
No. of directly addressable words	256	256	32,768	32,768	32,768
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Microprogrammable	No	No	By vendor only	By vendor only	By vendor only
Add time microseconds (full word)	2.6	2.6	3.5	3.5	3.17
Hardware multiply/divide	Optional	Optional	Optional	Optional	Optional
Hardware floating point	Optional	Optional	Optional	Optional	No
Hardware byte manipulation	No	No	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	12	12	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	2,000,000
No. of external interrupt levels	1-64	1-64	Variable	Variable	Variable
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	Yes	Yes
Disk pack/cartridge drives	Cartridge	Cartridge	Cartridge	Cartridge	Cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	300	300	1200	1200	1200
Line printer speeds, lpm	300	300	1200	1200	1200
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	DEctape, CRTs, plotter, punched units, etc.	DEctape, CRTs, plotter, punched tape units, etc.	CRTs, A/D units, etc.	CRTs, A/D units, etc.	CRTs, A/D units, punched tape units, etc.
<b>SOFTWARE</b>					
Assembler	1- & 2-pass	1- & 2-pass	1- & 2-pass	1- & 2-pass	1- & 2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	ALGOL, BASIC, DIBOL, FOCAL	ALGOL, BASIC, DIBOL, FOCAL	BASIC	BASIC	BASIC
Operating system	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time	Batch, real-time	Batch, real time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$3,200	\$3,200	\$990	\$2,495	\$2,495
Price of basic system with 8K words	\$3,600	\$4,000	\$1,615	\$3,120	\$3,295
Date of first delivery	Dec. 1971	Dec. 1971	May 1975	NA	August 1975
Number installed to date	See Comments	See Comments	NA	NA	See Comments
<b>COMMENTS</b>	Over 25,000 PDP-8 systems have been delivered since 1965. All models are program-compatible. Extensive software is available, as well as integrated systems for specific applications. A host of earlier-model PDP-8's are now called "traditional products" with continuing support. 8F is for end user; 8M is for OEM		Microcomputers compatible with PDP-11 series; LSI-11 is intended for OEM sale only; PDP-11/03, a packaged version, is intended for OEM or end user		See Comments on next page

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MANUFACTURER & MODEL	Digital Equipment PDP-11/05	Digital Equipment PDP-11/10	Digital Equipment PDP-11/35	Digital Equipment PDP-11/40	Digital Equipment PDP-11/45
<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/MOS/Bipolar
Cycle time, microseconds/word	0.98	0.98	0.98	0.98	0.98/0.5/0.3
Minimum capacity, words	4,096	8,192	8,192	16,384	16,384
Maximum capacity, words	32,768	32,768	131,072	131,072	131,072
Parity checking	No	No	Optional	Standard	Standard
Storage protection	No	No	Optional	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	8	8	8	8	16
No. of index registers	8 min.	8 min.	8 min.	8 min.	16 min.
No. of directly addressable words	32,768	32,768	32,768	32,768	131,072
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Microprogrammable	By vendor only	By vendor only	By vendor only	By vendor only	By vendor only
Add time, microseconds (full word)	3.7	3.7	0.99	0.99	0.9/0.45/0.3
Hardware multiply/divide	Optional	Optional	Optional	Optional	Standard
Hardware floating point	No	No	Optional	Optional	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	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
No. of external interrupt levels	Variable	Variable	Variable	Variable	Variable
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	Yes	Yes
Disk pack/cartridge drives	Cartridge	Cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	1200	1200	1200	1200	1200
Line printer speeds, lpm	1200	1200	1200	1200	1200
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRTs, A/D units, punched tape units, etc.	CRTs, A/D units, punched tape units, graphics display, etc.	CRTs, A/D units, punched tape units, graphics display, etc.	CRTs, A/D units, punched tape units, graphics display, etc.	CRT; A/D units, punched tape units, graphics display, etc.
<b>SOFTWARE</b>					
Assembler	1- & 2-pass	1- & 2-pass	1- & 2-pass	1- & 2-pass	1- & 2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC	BASIC	BASIC, COBOL	BASIC, COBOL	BASIC, COBOL
Operating system	Batch, real-time	Batch, real-time	Batch, real-time, time sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$4,395	\$5,995	\$9,495	\$16,800	\$25,300
Price of basic system with 8K words	\$4,995	\$5,995	\$9,495	Not available	Not available
Date of first delivery	Feb. 1972	March 1973	Sept. 1973	Jan. 1973	April 1972
Number installed to date	See Comments	See Comments	See Comments	See Comments	See Comments
<b>COMMENTS</b>	Over 15,000 PDP-11 systems have been installed. PDP-11/50 is a packaged version of the PDP-11/45 with mixed MOS and core memory. LSI-11, PDP-11/04, 11/05, and 11/35 are intended for OEM use; PDP-11/10 and 11/40 are intended for end users; PDP-11/03, 11/45, and 11/70 are for either. PDP-11/04 through PDP-11/45 reserve upper 4K of memory for I/O control and transfer. The 11-series models up through the 11/10 are generally used in dedicated applications.				

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MANUFACTURER & MODEL	Digital Equipment PDP-11/70	Digital Equipment PDP-12	Digital Equipment PDP-15/76 & 78	Digital Equipment XVM	Digital Scientific Meta 4/1130
<b>DATA FORMATS</b>					
Word length, bits	16	12	18	18	16 + 2
Fixed-point operand length, bits	16	12	18	18	16/32
Instruction length, bits	16/32/48	12	18	18	16
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	1.02	1.6	0.98	0.98 or less	0.9
Minimum capacity, words	65,536	4,096	32,768/24,576	32,768	8,192
Maximum capacity, words	1,048,576	32,768	131,072	131,072	65,536
Parity checking	Standard	No	Optional	No	Standard
Storage protection	Standard	No	Optional	Standard	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	16	1	1	1	Up to 28
No. of index registers	16 min.	15/4K of mem.	1 + 8 auto ind.	1	3
No. of directly addressable words	131,072	1,024	8,192	8,192	65,536
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Microprogrammable	By vendor only	No	No	No	By user
Add time, microseconds (full word)	0.3	3.2	1.78	1.78	2.9
Hardware multiply/divide	Standard	Standard	Optional	Standard	Standard
Hardware floating point	Optional	Optional	Optional	Optional	Optional
Hardware byte manipulation	Standard	No	No	No	No
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Optional	Optional	Standard	Standard
Real-time clock or timer	Standard	Optional	Optional	Standard	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	12	18	18	16
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	2,900,000	660,000	1,000,000	1,000,000	1,000,000
No. of external interrupt levels	Variable	1-64	4	4	16
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	No	No	No	No
Disk pack/cartridge drives	Pack, cartridge	Cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	Yes	No
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	1200	300	300-1000	300-1000	1000
Line printer speeds, lpm	1200	300	300-1200	300-1200	300-600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRTs, A/D units, punched tape units, graphics display, etc.	DECTape, A/D converters, plotters, etc.	DECTape, A/D converters, real-time interfaces, graphic displays	DECTape, A/D converters, real-time interfaces, graphics unit	Punched tape units
<b>SOFTWARE</b>					
Assembler	1- & 2-pass	2-pass	2-pass	2-pass	1-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC, COBOL	BASIC, FORTRAN	FOCAL, ALGOL	FOCAL, ALGOL	COBOL, RPG
Operating system	Batch, real-time, time-sharing	Real-time	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$54,600	\$17,170	\$68,500/\$35,000	\$37,500	\$33,850
Price of basic system with 8K words	Not available	\$21,170	Not available	Not available	\$33,850
Date of first delivery	April 1975	April 1969	Fall 1969 (1st 15)	NA	Jan. 1970
Number installed to date	See Comments	Over 600	Over 700 (all 15's)	NA	Over 150
<b>COMMENTS</b>	Uses 2048-word, 0.3-usec bipolar cache memory. Also see Comments on previous page	Designed for laboratory applications; can execute PDP-8 programs; built-in CRT display	Family uses upgraded instruction set of PDP-9. Many previous PDP-15 models are no longer marketed. Any PDP-15 with 32K memory can be upgraded to an XVM. The PDP-15/76 uses a PDP-11/05 or 11/10 peripheral processor, the XVM an 11/10; XVM includes instruction look-ahead		Emulates IBM 1130; time-sharing system can accommodate up to 16 users

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MANUFACTURER & MODEL	Digital Scientific Meta 4/1800	Electronic Processors EPI-118	Electronic Processors EPI-218	Fedder System III 03/03B	Fedder System III 10
<b>DATA FORMATS</b>					
Word length, bits	16 + 2	18	18	16	16
Fixed-point operand length, bits	16	18	18	32	32
Instruction length, bits	16	18	18/36	8	8
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	MOS	MOS
Cycle time, microseconds/word	0.9	1.0	1.2	1.0	1.0
Minimum capacity, words	8,192	4,096	4,096	8,192	16,384
Maximum capacity, words	65,536	32,768	32,768	65,536	65,536
Parity checking	Standard	No	No	No	No
Storage protection	Standard	No	Optional	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	Up to 28	2	3	16	16
No. of index registers	3	0	3	48	48
No. of directly addressable words	65,536	32,768	32,768	32,768	32,768
Indirect addressing	One-level	No	Multi-level	Multi-level	Multi-level
Microprogrammable	By user	NA	NA	No	No
Add time, microseconds (full word)	2.9	2.5	2.4	5.0	5.0
Hardware multiply/divide	Standard	No	Optional	No	No
Hardware floating point	Optional	No	No	No	No
Hardware byte manipulation	No	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	No	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	No	No
Real-time clock or timer	Standard	Optional	Optional	No	No
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	21	21	8	8
Direct memory access channel	Standard	Optional	Optional	Optional	Optional
Maximum I/O rate, words/sec	1,000,000	900,000	900,000	10,000	500,000
No. of external interrupt levels	Up to 32	0-18	0-18	0-16	0-16
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	No
Disk pack/cartridge drives	Pack, cartridge	Pack	Pack	Cartridge	Cartridge
Non-interchangeable disk storage	Yes	No	No	Yes	Yes
Magnetic tape cassettes/cartridges	No	Yes	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	No	No
Punched card input speed, cpm	1000	300	300	Not available	Not available
Line printer speeds, lpm	300-600	Yes	Yes	200-600	200-600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Punched tape units	CRTs, A/D units	CRTs, A/D units	TTY, CRTs	TTY, CRTs
<b>SOFTWARE</b>					
Assembler	1-pass	2-pass	2-pass	1-pass	1-pass
Macro assembler	Yes	No	No	Yes	Yes
FORTRAN compiler	Yes	No	No	No	No
Other compilers	COBOL, RPG	BASIC	BASIC	BASIC	BASIC
Operating system	Batch, real-time, time-sharing	Yes	Yes	Batch	Batch, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$49,285	\$2,790	\$3,490	\$24,950/\$29,500	\$37,500
Price of basic system with 8K words	\$49,285	\$3,990	\$4,690	\$24,950/\$29,500	Not available
Date of first delivery	1971	Nov. 1970	Jan. 1973	1973/1974	1975
Number installed to date	Over 30	Over 700	Over 90	200	50
<b>COMMENTS</b>	Emulates IBM 1800; can have up to 65K auxiliary core storage	Basic 118 add-time is 2 used per octal digit; faster 18-bit arithmetic processor is optional for 118 and standard on 218. Prices quoted are to "qualified OEM users." Information provided in August 1974		System oriented toward business data processing; extensive library of application programs; III 03 includes I/O typewriter; III 03B replaces this with CRT and serial printer; III 10 can accommodate up to 4 users	

### All About Minicomputers

MANUFACTURER & MODEL	Four-Phase Systems, Inc. System IV/40	Four-Phase Systems, Inc. System IV/70	Fujitsu Facom R-E	Fujitsu Panafacom U-100	Fujitsu Panafacom U-200
<b>DATA FORMATS</b>					
Word length, bits	24	24	16	16	16
Fixed-point operand length, bits	24	24	16	8/16/32	8/16/32
Instruction length, bits	24	24	16	16/32/48	16/32/48
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	Core	Core/MOS	Core/MOS
Cycle time, microseconds/word	2.0	2.0	1.5	1.5/0.6	0.65/0.75
Minimum capacity, words	24,576	12,288	4,096	4,096	4,096
Maximum capacity, words	73,728	98,304	32,768	32,768	32,768
Parity checking	Standard	Standard	Standard	Standard	Standard
Storage protection	No	No	No	No	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	5	5	1	8	8
No. of index registers	3	3	4	7	7
No. of directly addressable words	73,728	98,304	512	32,768	32,768
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Microprogrammable	No	No	No	By vendor only	No
Add time, microseconds (full word)	16.0	16.0	6.0	2.8/4.4	1.58/3.15
Hardware multiply/divide	Standard	Standard	No	Standard	Optional
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	Standard
Real-time clock or timer	Standard	Standard	Optional	Standard	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	24	24	16	8/16	8/16
Direct memory access channel	No	No	Standard	Standard	Standard
Maximum I/O rate, words/sec	125,000	125,000	400,000	1,000,000	1,000,000
No. of external interrupt levels	8	8	1	4	4
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	No	Yes	Yes
Disk pack/cartridge drives	No	Pack, cartridge	Cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	No	No	No	Yes	Yes
Magnetic tape cassettes/cartridges	No	No	Yes	Yes	Yes
Magnetic tape, 1/2-inch	No	Yes	Yes	Yes	Yes
Punched card input speed, cpm	Not available	300-600	300	100-600	100-600
Line printer speeds, lpm	300	245-1100	440	160-900	160-900
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRTs, serial printer	CRTs, serial printer	CRTs, punched tape units, optical mark reader, etc.	Drum, punched tape units, CRTs, optical mark reader, optical char. reader, etc.	Drum, punched tape units, CRTs, optical mark reader, optical char. reader, etc.
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	1- & 2-pass	1- & 2-pass
Macro assembler	No	No	No	Yes	Yes
FORTRAN compiler	No	No	Yes	Yes	Yes
Other compilers	COBOL, RPG	COBOL, RPG	No	No	No
Operating system	See Comments	See Comments	No	Batch, real-time	Batch, real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$15,750	\$16,000	On request	On request	On request
Price of basic system with 8K words	Not available	Not available	On request	On request	On request
Date of first delivery	June 1973	Feb. 1971	March 1969	August 1975	Oct. 1972
Number installed to date	Over 100	Over 1000	Over 1000	—	Over 1000
<b>COMMENTS</b>	Specifically designed for distributed processing, remote data entry, and inquiry/retrieval	Supports up to 32 interactive CRT terminals	Has 28 basic instructions and 5 addressing modes		



## All About Minicomputers

MANUFACTURER & MODEL	Fujitsu Panafacom U-300	Fujitsu Panafacom U-400	GEC Computers 2050	GEC Computers 4080	General Automation SPC-16
<b>DATA FORMATS</b>					
Word length, bits	16	16	8	8	16
Fixed-point operand length, bits	8/16/32	8/16/32	8/16/24/32	8/16/24/32	16
Instruction length, bits	16/32/48	16/32/48	8 or 16	8 or 16	16
<b>MAIN STORAGE</b>					
Storage type	Core/MOS	Core/MOS	Core	Core	Core
Cycle time, microseconds/word	0.65/0.75	0.65/0.75	0.950	0.550	0.80/0.96/1.44
Minimum capacity, words	4,096	32,768	4,096	32,768	4,096
Maximum capacity, words	32,768	131,072	196,608	131,072	131,072
Parity checking	Standard	Standard	No	Yes	No
Storage protection	Standard	Standard	No	Standard	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	8	8	1	2	16
No. of index registers	7	7	3	1	6
No. of directly addressable words	32,768	32,768	128	32,768	32,768
Indirect addressing	One-level	One-level	Yes	Yes	One-level
Microprogrammable	By vendor only	By vendor only	No	No	
Add time, microseconds (full word)	0.8/1.8	0.8/1.8	3.4	1.1	0.80/0.96/1.44
Hardware multiply/divide	Standard	Standard	Standard	Standard	Standard
Hardware floating point	Optional	Optional	No	Standard	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	No	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	8/16	8/16	8	16	16
Direct memory access channel	Standard	Standard	Optional	Standard	Standard
Maximum I/O rate, words/sec	1,000,000	1,000,000	512,000	1,536,000	1,040,000
No. of external interrupt levels	8	8	255	256	64-unlimited
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	No	No	Yes
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Yes	Yes	Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	No	Yes	Yes
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	100-600	100-600	400-600	400-600	200-1000
Line printer speeds, lpm	160-900	160-900	300-1250	300-1250	600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Drum, punched tape units, CRTs, optical mark reader, optical char. reader, etc.	Drum, punched tape units, CRTs, optical mark reader, optical char. reader, etc.	Plotter	Plotter	A/D converters, punched tape units, CRTs, TTY, plotter, etc.
<b>SOFTWARE</b>					
Assembler	1- & 2-pass	1- & 2-pass	Symbolic	BABBAGE	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	No	No	CORAL 66	CORAL 66	BASIC, COBOL
Operating system	Batch, real-time	Batch, real-time	Yes	NUCLEUS, COS, DOS	Batch, real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	On request	On request	\$13,000	\$50,000	\$3,950
Price of basic system with 8K words	On request	Not available	\$15,000	Not available	\$5,350
Date of first delivery	June 1975	August 1975	May 1973	Oct. 1973	May 1970
Number installed to date	Over 50	—	180	55	5,000
<b>COMMENTS</b>	Dual/duplex system available	Dual/duplex system available			

### All About Minicomputers

MANUFACTURER & MODEL	General Automation GA-8/55	General Automation GA-16/110	General Automation GA-16/220	General Automation GA-16/330	General Automation GA-16/340
<b>DATA FORMATS</b>					
Word length, bits	8	16	16	16	16
Fixed-point operand length, bits	8	16	16	16	16
Instruction length, bits	8	16	16	16	16
<b>MAIN STORAGE</b>					
Storage type	NMOS	NMOS	NMOS	Core	Core
Cycle time, microseconds/word	0.5	0.5	0.5	NA	NA
Minimum capacity, words	1,024	1,024	1,024	16,384	16,384
Maximum capacity, words	57,344	65,536	65,536	65,536	65,536
Parity checking	No	Optional	Optional	Optional	Optional
Storage protection	No	Optional	Optional	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	7	16	16	16	16
No. of index registers	4	8	8	8	8
No. of directly addressable words	65,536	65,536	65,536	65,536	65,536
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Microprogrammable	No	By user	By user	By user	By user
Add time, microseconds (full word)	2.0	2.0	2.0	1.4	1.4
Hardware multiply/divide	No	Standard	Standard	Standard	Standard
Hardware floating point	No	Optional	Optional	Optional	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	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	16	16	16	16	16
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	2,000,000	2,000,000	2,000,000	1,000,000	1,000,000
No. of external interrupt levels	64-unlimited	64-unlimited	64-unlimited	64-unlimited	64-unlimited
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	Yes	Yes	Yes
Disk pack/cartridge drives	No	No	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	No	No	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	Yes	No	Yes	Yes	Yes
Magnetic tape, 1/2-inch	No	No	Yes	Yes	Yes
Punched card input speed, cpm	Not available	Not available	400-1000	200-1000	200-1000
Line printer speeds, lpm	Not available	Not available	200-600	600	600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	—	See Comments	See Comments	See Comments	See Comments
<b>SOFTWARE</b>					
Assembler	Cross assemb.	Cross assemb.	2-pass	2-pass	2-pass
Macro assembler	No	No	Yes	Yes	Yes
FORTRAN compiler	No	No	Yes	Yes	Yes
Other compilers	PL/M	No	COBOL, BASIC	COBOL, BASIC	COBOL, BASIC
Operating system	No	Real-time	Batch, real-time	Batch, real-time	Batch, real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	Contact vendor	Contact vendor	Contact vendor	Contact vendor	Contact vendor
Price of basic system with 8K words	Contact vendor	Contact vendor	Contact vendor	Contact vendor	Contact vendor
Date of first delivery	May 1975	NA	NA	NA	NA
Number installed to date	NA	NA	NA	NA	NA
<b>COMMENTS</b>	Single PC board OEM configuration; intended for dedicated applications	Fully compatible with SPC-16 software and I/O family. 16/110 is on a single board; 16/220 is on two boards; both are OEM configurations intended for dedicated applications; 16/330 is an OEM configuration; 16/340 is a low-cost development system			

## All About Minicomputers

MANUFACTURER & MODEL	General Automation GA-16/440	GRI Computer GRI-99 Model 10	GRI Computer GRI-99 Model 30	GRI Computer GRI-99 Model 40	GRI Computer GRI-99 Model 50
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16	16/32	16/32	16/32	16/32
Instruction length, bits	16	16/32	16/32	16/32	16/32/48
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	0.8	1.76	1.76	1.76	1.76
Minimum capacity, words	16,384	4,096	4,096	4,096	8,192
Maximum capacity, words	1,048,576	32,768	32,768	32,768	32,768
Parity checking	Optional	No	No	No	No
Storage protection	Optional	No	No	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	16	2	2	8	8
No. of index registers	8	1	1	1	1
No. of directly addressable words	1M w/mem. mgt.	32,768	32,768	32,768	32,768
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Microprogrammable	By user	By user	By user	By user	By user
Add time, microseconds (full word)	0.78	1.76	1.76	1.76	1.76
Hardware multiply/divide	Standard	Optional	Optional	Standard	Optional
Hardware floating point	Optional	No	No	No	No
Hardware byte manipulation	Standard	Optional	Optional	Optional	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Standard	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	1,100,000	568,000	568,000	568,000	568,000
No. of external interrupt levels	64-unlimited	Unlimited	Unlimited	Unlimited	Unlimited
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	Yes	Yes
Disk pack/cartridge drives	Pack, cartridge	Cartridge	Cartridge	Cartridge	Cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	200-1000	300	300	300	300
Line printer speeds, lpm	600	Up to 600	Up to 600	Up to 600	Up to 600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	A/D converters, punched tape units, CRTs, TTY, plotter, etc.	CRTs, TTY, extensive A/D units, punched tape units	CRTs, TTY, extensive A/D units, punched tape units	CRTs, TTY, extensive A/D units, punched tape units	CRTs, TTY, extensive A/D units, punched tape units
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	1- & 2-pass
Macro assembler	Yes	No	No	No	No
FORTRAN compiler	Yes	No	No	No	No
Other compilers	COBOL, BASIC	BASIC interp.	BASIC interp.	BASIC interp.	RPG II, BASIC interpreter
Operating system	Batch, real-time, time-sharing	Real-time, multi-user	Real-time, multi-user	Real-time, multi-user	Real-time, multi-user
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	Contact vendor	\$4,670	\$5,060	\$5,725	\$6,300
Price of basic system with 8K words	Contact vendor	\$5,115	\$5,505	\$6,170	\$6,300
Date of first delivery	May 1975	June 1972	June 1972	June 1972	Aug. 1974
Number installed to date	NA	NA	Over 900	Over 400	NA
<b>COMMENTS</b>	Software and I/O compatible, with SPC-16; oriented toward multi-user environment	Based on a Universal Bus System, in which all system elements share common data busses and communicate in direct, parallel fashion. Designed mainly for real-time applications. Model 50 is used in the company's System 99 small business computer			

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MANUFACTURER & MODEL	GTE IS/1000	Harris S110	Harris S120	Harris S210	Harris S220
<b>DATA FORMATS</b>					
Word length, bits	16	24	24	24	24
Fixed-point operand length, bits	16	24	24	24	24
Instruction length, bits	16	24	24	24	24
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core/MOS	Core/MOS
Cycle time, microseconds/word	0.75	0.75	0.75	0.425/0.2	0.425/0.2
Minimum capacity, words	8,192	32,768	49,152	65,536	98,304
Maximum capacity, words	262,144	65,536	65,536	131,072	131,072
Parity checking	Optional	Standard	Standard	Standard	Standard
Storage protection	Optional	Standard	Standard	Standard	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	16	5	5	5	5
No. of index registers	16	4	4	4	4
No. of directly addressable words	65,536	262,144	262,144	262,144	262,144
Indirect addressing	Multi-level	No	No	No	No
Microprogrammable	No	No	No	No	No
Add time, microseconds (full word)	0.75	0.75	0.75	0.425	0.425
Hardware multiply/divide	Optional	Standard	Standard	Standard	Standard
Hardware floating point	No	Optional	Optional	Standard	Standard
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Optional	Standard	Standard	Standard	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	24	24	24	24
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1,000,000	1,333,333	1,333,333	1,900,000	1,900,000
No. of external interrupt levels	8-16	10-48	10-48	14-48	14-48
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	Yes	Yes
Disk pack/cartridge drives	Pack, cartridge	Pack	Pack	Pack	Pack
Non-interchangeable disk storage	Yes	No	No	Yes	Yes
Magnetic tape cassettes/cartridges	No	Cartridge	Cartridge	No	No
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	200-1000	Not available	600-1000	600-1000	1000
Line printer speeds, lpm	200-600	Not available	200-600	200-600	600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Channel interfaces	Printer/plotter	Printer/plotter	Printer/plotter	Printer/plotter
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	COBOL, PL	COBOL, BASIC, RPG II, SNOBOL	COBOL, BASIC, RPG II, SNOBOL	COBOL, BASIC, RPG II, SNOBOL	COBOL, BASIC, RPG II, SNOBOL
Operating system	Real-time	See Comments	See Comments	See Comments	See Comments
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$6,500	\$85,000	\$119,000	\$159,000	\$189,000
Price of basic system with 8K words	\$6,500	Not available	Not available	Not available	Not available
Date of first delivery	Jan. 1972	3rd Q 1975	4th Q 1975	4th Q 1975	4th Q 1975
Number installed to date	NA	-	-	-	-
<b>COMMENTS</b>	Designed for communications and control applications. Features 16-general-purpose registers	Systems are based on Slash 4 processor, but with virtual memory hardware and software; VULCAN operating system provides concurrent multi-batch, real-time, and time-sharing operation; language processors include FORGO		Systems are based on Slash 7 processor, but with virtual memory hardware and software; VULCAN operating system provides concurrent multi-batch, real-time, and time-sharing operation; language processors include FORGO	

## All About Minicomputers

MANUFACTURER & MODEL	Harris S230	Harris S240	Harris Slash 5	Harris Slash 4	Harris Slash 7
<b>DATA FORMATS</b>					
Word length, bits	24	24	24	24	24
Fixed-point operand length, bits	24	24	24	24	24
Instruction length, bits	24	24	24	24	24
<b>MAIN STORAGE</b>					
Storage type	Core/MOS	Core/MOS	Core	Core/MOS	Core/MOS
Cycle time, microseconds/word	0.425/0.2	0.425/0.2	0.95	0.75/0.2	0.425/0.2
Minimum capacity, words	98,304	163,840	8,192	8,192	32,768
Maximum capacity, words	131,072	196,608	65,536	262,144	262,144
Parity checking	Standard	Standard	Standard	Standard	Standard
Storage protection	Standard	Standard	Optional	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	5	5	5	5	5
No. of index registers	4	4	3	3	3
No. of directly addressable words	262,144	262,144	32,768	32,768	32,768
Indirect addressing	No	No	One-level	One-level	One-level
Microprogrammable	No	No	No	No	No
Add time, microseconds (full word)	0.425	0.425	0.95	0.75	0.425
Hardware multiply/divide	Standard	Standard	Standard	Standard	Standard
Hardware floating point	Standard	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	Optional
Real-time clock or timer	Standard	Standard	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	24	24	24	24	24
Direct memory access channel	Standard	Standard	Optional	Optional	Optional
Maximum I/O rate, words/sec	1,900,000	1,900,000	1,052,631	1,333,333	1,900,000
No. of external interrupt levels	14-48	14-48	4-24	4-48	4-48
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	Yes	Yes
Disk pack/cartridge drives	Pack	Pack	Pack	Pack	Pack
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	No	No	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	1000	1000	200-1000	200-1000	200-1000
Line printer speeds, lpm	600	600	200-600	200-600	200-600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Printer/plotter	Printer/plotter	Printer/plotter	Printer/plotter	Printer/plotter
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	COBOL, BASIC, RPG II, SNOBOL	COBOL, BASIC, RPG II, SNOBOL	COBOL, BASIC, RPG II, SNOBOL	COBOL, BASIC, RPG II, SNOBOL	COBOL, BASIC, RPG II, SNOBOL
Operating system	See Comments	See Comments	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$280,000	\$400,000	\$16,500	\$24,000	\$45,000
Price of basic system with 8K words	Not available	Not available	\$16,500	\$24,000	Not available
Date of first delivery	4th Q 1975	4th Q 1975	Feb. 1972	Sept. 1973	3rd Q 1975
Number installed to date	—	—	234	61	—
<b>COMMENTS</b>	Systems are based on Slash 7 processor, but with virtual memory hardware and software; VULCAN operating system provides concurrent multi-batch, real-time, and time-sharing operation; language processors include FORGO		Formerly known as Datacraft 6024/5; language processors include FORGO	Formerly known as Datacraft 6024/4; language processors include FORGO	Language processors include FORGO

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MANUFACTURER & MODEL	Hewlett-Packard 2100R	Hewlett-Packard 2100S	Hewlett-Packard 2105A (21-M/101)	Hewlett-Packard 2108A (21-M/20)	Hewlett-Packard 2112A (21-M/30)
<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	MOS	MOS	MOS
Cycle time, microseconds/word	0.98	0.98	0.65	0.65	0.65
Minimum capacity, words	8,192	8,192	4,096	4,096	4,096
Maximum capacity, words	32,768	32,768	32,768	65,536	131,072
Parity checking	Standard	Standard	Standard	Standard	Standard
Storage protection	Standard	Standard	No	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	2	2	2	2	2
No. of index registers	0	0	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
Microprogrammable	By user	By user	By user	By user	By user
Add time, microseconds (full word)	1.96	1.96	1.94	1.94	1.94
Hardware multiply/divide	Standard	Standard	Standard	Standard	Standard
Hardware floating point	Standard	Standard	Standard	Standard	Standard
Hardware byte manipulation	No	No	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Optional	Optional	Optional
Real-time clock or timer	Optional	Standard	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	Optional	Standard	Optional	Optional	Optional
Maximum I/O rate, words/sec	1,000,000	1,000,000	617,000	617,000	617,000
No. of external interrupt levels	60	60	60	60	60
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	No
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	No	No	No	No	No
Magnetic tape cassettes/cartridges	No	No	No	No	No
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	600	600	600	600	600
Line printer speeds, lpm	200-1200	200-1200	200-1200	200-1200	200-1200
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Plotters	Plotters	Plotters	Plotters	Plotters
<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	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$11,400	\$14,400	\$5,550	\$6,700	\$7,600
Price of basic system with 8K words	\$11,400	Not available	\$6,150	\$7,300	\$8,200
Date of first delivery	June 1971	May 1973	May 1974	May 1974	Sept. 1975
Number installed to date	7500	1000	400	1200	—
<b>COMMENTS</b>	The 2100A is an OEM configuration; 2100S, end user. These models are the last remaining of the family that began with Hewlett-Packard's first minicomputer in 1968. Over 11,000 of all models have been installed.		The 21MX Series is used in numerous packaged systems by Hewlett-Packard, such as time-sharing, data base management, distributed processing networks, processor/disk combinations (DISComputers), inventory management, order processing, etc.		

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MANUFACTURER & MODEL	Hewlett-Packard 3000CX	Hewlett-Packard 9600MX	Hitachi Hitac 10-11	Hitachi Hitac 20	Honeywell System 700
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16/32	16	8/16/32	1/8/16/32	16/32
Instruction length, bits	16	16	16	16/32	16
<b>MAIN STORAGE</b>					
Storage type	Core	MOS	Core	Core	Core
Cycle time, microseconds/word	0.9	0.65	0.9	0.65	0.775
Minimum capacity, words	49,152	16,384	4,096	8,192	8,192
Maximum capacity, words	65,536	262,144	32,768	65,536	65,536
Parity checking	Standard	Standard	Standard	Standard	Optional
Storage protection	Standard	Standard	Optional	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	Stack	2	1	16	1
No. of index registers	1	2	1	15	2
No. of directly addressable words	524,288	2,048	512	65,536	1,024
Indirect addressing	One-level	Multi-level	One-level	No	Multi-level
Microprogrammable	By vendor	By user	No	By vendor only	No
Add time, microseconds (full word)	1.05	1.94	1.8	2.2	1.55
Hardware multiply/divide	Standard	Standard	Optional	Optional	Standard
Hardware floating point	Standard	Standard	Optional	Optional	No
Hardware byte manipulation	Standard	Standard	No	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	No
Power failure protection	Standard	Standard	Optional	Optional	Standard
Real-time clock or timer	Standard	Standard	Optional	Optional	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	16	8/16	16
Direct memory access channel	Standard	Standard	Optional	Optional	Standard
Maximum I/O rate, words/sec	1,400,000	617,000	833,000	1,200,000	1,000,000
No. of external interrupt levels	253	60	1-4	4	63
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	Yes	No
Disk pack/cartridge drives	Pack, cartridge	Cartridge	Cartridge	Cartridge	Cartridge
Non-interchangeable disk storage	Yes	No	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	No	No	Yes	No	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	75	600	310	310	300-600
Line printer speeds, lpm	200-1250	200-1200	150-300	100-430	200-1100
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRTs, punched tape units, plotter	Measurement and control units, CRTs, TV monitors, plotter	Punched tape units, mark reader, CRTs, serial printer, plotter, etc.	Punched tape units, mark reader, CRTs, serial printer, plotter, etc.	Punched tape units, TTY
<b>SOFTWARE</b>					
Assembler	1- & 2-pass	2-pass	1- & 2-pass	2-pass	2-pass
Macro assembler	Yes	No	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	COBOL, RPG, BASIC	ALGOL, BASIC	BASIC	PLUS	BASIC
Operating system	Batch, real-time, time-sharing	Real-time	Batch, real-time	Batch, real-time	Batch, real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$99,500	\$16,800	\$7,100	\$12,700	\$10,800
Price of basic system with 8K words	Not available	Not available	\$11,300	\$12,700	\$10,800
Date of first delivery	Nov. 1972 (3000)	April 1975	Nov. 1972	Oct. 1975	June 1972
Number installed to date	150	50	1500	—	Over 1,000 (9/74)
<b>COMMENTS</b>	Includes capability for running IMAGE data base management software package, which includes QUERY language	Dedicated system package built around 21MX; designed for distributed networks for local and remote measurement and control	Prices are based upon conversion ratio of 300 Yen per dollar	PLUS language is similar to PL/1. Prices are based upon conversion ratio of 300 Yen per dollar	Type 716 CPU is incorporated into G systems designed for a variety of sensor-based and communications applications

## All About Minicomputers

MANUFACTURER & MODEL	IBM System/7	IBM 1130	IBM System/32	Information Comp. Systems ALP-1	Information Comp Systems ALP2/ALP3
<b>DATA FORMATS</b>					
Word length, bits	16 + 2	16 + 2	8	16	16
Fixed-point operand length, bits	16	16/32	1-16 digits	16/32	16/32
Instruction length, bits	16/32	16/32	24-48	16	16
<b>MAIN STORAGE</b>					
Storage type	Bipolar	Core	MOS	Core/semicond.	Core/semicond.
Cycle time, microseconds/word	0.4	3.6/2.2	0.6	0.65/0.33	0.65/0.33
Minimum capacity, words	2,048	4K/8K	16,384	4,096	4,096
Maximum capacity, words	65,536	32,768	32,768	65,536	262,144
Parity checking	Standard	Standard	Standard	Standard	Standard
Storage protection	Standard (Mdl. E)	No	No	No	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	4 sets of 1	2	NA	2	2
No. of index registers	4 sets of 7	3	2	0	2
No. of directly addressable words	65,536	32,768	32,768	256	256
Indirect addressing	No	One-level	No	Multi-level	Multi-level
Microprogrammable	No	No	Yes	NA	NA
Add time, microseconds (full word)	0.8	8.0/4.9	72 (5 bytes)	2.25	2.25
Hardware multiply/divide	No	Standard	No	Standard	Standard
Hardware floating point	No	No	No	No	No/Standard
Hardware byte manipulation	No	No	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	—	Standard	Standard
Power failure protection	Optional	No	No	Standard	Standard
Real-time clock or timer	Standard	No	No	Standard	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	8	16	16
Direct memory access channel	Standard	Optional	Standard	Standard	Standard
Maximum I/O rate, words/sec	2,000,000	278K/455K	889,000	1,500,000	6,000,000
No. of external interrupt levels	64	6	4	64	64
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	Yes	No	No
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Cartridge	Pack	Pack
Non-interchangeable disk storage	Yes	No	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	No	No	No	No	No
Magnetic tape, 1/2-inch	No	Yes	No	Yes	Yes
Punched card input speed, cpm	300	100-600	Not available	300-600	300-600
Line printer speeds, lpm	155	40-1100	50-155	Yes	Yes
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Extensive A/D and sensor units, TTY	Punched tape units, plotter, mark reader	CRT, serial printer	CRTs, punched tape units	CRTs, punched tape units
<b>SOFTWARE</b>					
Assembler	1-pass	Yes	No	2-pass	2-pass
Macro assembler	No	Yes	No	Yes	Yes
FORTRAN compiler	Yes	Yes	No	Yes	Yes
Other compilers	No	RPG, COBOL	RPG II	ALGOL, BASIC	ALGOL, BASIC
Operating system	Batch, real-time	Batch	No	Multiprocessing	Multiprocessing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$8,670	\$16,640/\$31,720	\$33,100	\$11,100	\$13,700/\$14,600
Price of basic system with 8K words	\$19,900	\$21,840/\$31,720	Not available	\$11,800	\$14,400/\$15,300
Date of first delivery	1971	1965	March 1975	Aug. 1972	Jan. 1973
Number installed to date	NA	4,000 (est.)	NA	NA	NA
<b>COMMENTS</b>	The S/7 forms the base for many "RPQ" systems for voice response, Touch-Tone data entry, communications processing, etc.	IBM 1800 is similar, with storage protection, real-time operating system, and extensive A/D and sensor units	Price includes diskette, fixed disk, display, keyboard, and printer; applications programs are available	The Multum family of multiprocessor systems can interconnect up to 8 processors and up to 4 4K- to 64K-word storage blocks with up to 4 simultaneous memory accesses. Prices are based on \$2.57 per British pound. Information furnished in August 1974	



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MANUFACTURER & MODEL	Interdata 7/16	Interdata 7/16 (HSALU)	Interdata Model 50	Interdata Model 55	Interdata Model 60
<b>DATA FORMATS</b>					
Word length, bits	8/16/32	8/16/32	8/16/32	8/16/32	8/16/32
Fixed-point operand length, bits	8/16/32	8/16/32	8/16/32	8/16/32	8/16/32
Instruction length, bits	16/32	16/32	16/32	16/32	16/32
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	MOS
Cycle time, microseconds/word	1.0	0.75/1.0	1.0	1.0	0.270
Minimum capacity, words	4,096	4,096	4,096	8,192	8,192
Maximum capacity, words	32,768	32,768	32,768	57,344	32,768
Parity checking	Optional	Optional	Optional	Optional	Optional
Storage protection	No	Optional	Optional	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	16	16	16	16	16
No. of index registers	15	15	15	15	15
No. of directly addressable words	32,768	32,768	32,768	57,344	32,768
Indirect addressing	No	No	No	No	No
Microprogrammable	By vendor only	By vendor only	By vendor only	By vendor only	By vendor only
Add time, microseconds (full word)	1.50	0.75	1.0	1.0	0.530
Hardware multiply/divide	Optional	Standard	Standard	Standard	Standard
Hardware floating point	Optional	Standard	Standard	Standard	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Optional	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8/16	8/16	8/16	8/16	8/16
Direct memory access channel	Optional	Optional	Standard	Standard	Optional
Maximum I/O rate, words/sec	1,000,000	1,000,000	1,000,000	2,000,000	1,575,000
No. of external interrupt levels	255	255	255	255	255
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	No
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	Cassette	Cassette	Cassette	Cassette	Cassette
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	1000	1000	1000	1000	1000
Line printer speeds, lpm	600	600	600	600	600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	A/D units, punched tape units, serial printer	A/D units, punched tape units, serial printer	A/D units, punched tape units, serial printer	A/D units, punched tape units, serial printer	A/D units, punched tape units, serial printer
<b>SOFTWARE</b>					
Assembler	1- & 2-pass	1- & 2-pass	1- & 2-pass	1- & 2-pass	1- & 2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC interp.	BASIC interp.	BASIC interp.	BASIC interp.	BASIC interp.
Operating system	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$3,200	\$8,100	\$7,800	\$15,900	\$14,900
Price of basic system with 8K words	\$3,700	\$8,600	\$10,200	\$15,900	\$14,900
Date of first delivery	March 1974	July 1974	Apr. 1972	Aug. 1972	June 1973
Number installed to date	Over 1000	Over 300	Over 130	Over 230	Over 10
<b>COMMENTS</b>	Designed for OEM use, the system is software and in- terface compatible with other Inter- data systems	Designed for OEM use, the system is upgradable to a 7/32	Model 50 is a modified Model 70 with about 20 instructions added for com- munications applications; Model 55 is a dual-processor system made up of a Model 50 and a Model 70		Model 60 is a data communications system

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MANUFACTURER & MODEL	Interdata Model 70	Interdata Model 74	Interdata Model 80	Interdata Model 85	Interdata 7/32
<b>DATA FORMATS</b>					
Word length, bits	8/16/32	8/16/32	8/16/32	8/16/32	8/16/32
Fixed-point operand length, bits	8/16/32	8/16/32	8/16/32	8/16/32	8/16/32
Instruction length, bits	16/32	16/32	16/32	16/32	16/32/48
<b>MAIN STORAGE</b>					
Storage type	Core	Core	MOS	MOS	Core
Cycle time, microseconds/word	1.0	1.0	0.27	0.27	0.75/1.0
Minimum capacity, words	4,096	4,096	8,192	8,192	4,096 (32-bit)
Maximum capacity, words	32,768	32,768	32,768	32,768	262,144 (32-bit)
Parity checking	Optional	Optional	Optional	Optional	Optional
Storage protection	Optional	No	Optional	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	16	16	16	16	32
No. of index registers	15	15	15	15	30
No. of directly addressable words	32,768	32,768	32,768	32,768	262,144
Indirect addressing	No	No	No	No	No
Microprogrammable	By vendor only	By vendor only	By vendor only	By user	By vendor only
Add time, microseconds (full word)	1.0	1.5	0.53	0.53	1.0
Hardware multiply/divide	Standard	Standard	Standard	Standard	Standard
Hardware floating point	Standard	No	Standard	Standard	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Optional	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8/16	8/16	8/16	8/16	8/16
Direct memory access channel	Optional	Standard	Standard	Standard	Optional
Maximum I/O rate, words/sec	1,000,000	1,000,000	1,575,000	1,575,000	2,000,000
No. of external interrupt levels	255	255	255	255	1,024
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	No
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	Cassette	Cassette	Cassette	Cassette	Cassette
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	1000	1000	1000	1000	1000
Line printer speeds, lpm	600	600	600	600	600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	A/D units, punched tape units, serial printer	A/D units, punched tape units, serial printer	A/D units, punched tape units, serial printer	A/D units, punched tape units, serial printer	A/D units, punched tape units, serial printer
<b>SOFTWARE</b>					
Assembler	1- & 2-pass	1- & 2-pass	1- & 2-pass	1- & 2-pass	1- & 2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC interp.	BASIC interp.	BASIC interp.	BASIC interp.	BASIC interp.
Operating system	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$7,800	\$4,150	\$14,900	\$22,800	\$9,950
Price of basic system with 8K words	\$10,200	\$5,850	\$14,900	\$22,800	Not available
Date of first delivery	Dec. 1971	March 1973	July 1972	July 1973	July 1974
Number installed to date	Over 900	Over 200	30 (est.)	20 (est.)	NA
<b>COMMENTS</b>		Designed for OEM customers; up- ward-compatible with other Inter- data computers			Hardware and software com- patible with Interdata 7/16

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MANUFACTURER & MODEL	Interdata 8/32	Keronix IDS 16/12	Keronix IDS 16/10	Keronix IDS 16/8	Linolex Model 1203
<b>DATA FORMATS</b>					
Word length, bits	32	16	16	16	8
Fixed-point operand length, bits	8/16/32	16	16	16	Variable
Instruction length, bits	32	16	16	16	Variable
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Semiconductor
Cycle time, microseconds/word	0.75	1.2	1.0	0.8	1.2
Minimum capacity, words	32,768	4,096	4,096	4,096	8,192
Maximum capacity, words	262,144	262,144	262,144	262,144	32,768
Parity checking	Optional	No	No	No	No
Storage protection	Standard	Standard	Standard	Standard	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	32-128	4	4	4	All of memory
No. of index registers	30-120	2	2	2	All of memory
No. of directly addressable words	262,144	65,536	65,536	65,536	32,768
Indirect addressing	No	Multi-level	Multi-level	Multi-level	Multi-level
Microprogrammable	By vendor only	No	No	No	By vendor only
Add time, microseconds (full word)	1.25	1.2	1.0	0.8	22
Hardware multiply/divide	Standard	Optional	Optional	Optional	Mult. standard
Hardware floating point	Optional	Optional	Optional	Optional	No
Hardware byte manipulation	Standard	Optional	Optional	Optional	Standard
Immediate (literal) instructions	Standard	No	No	No	Standard
Power failure protection	Standard	Standard	Standard	Standard	No
Real-time clock or timer	Standard	Optional	Optional	Optional	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8/16	16	16	16	8
Direct memory access channel	Standard	Standard	Standard	Standard	No
Maximum I/O rate, words/sec	3,200,000	830,000	1,000,000	1,250,000	32,000
No. of external interrupt levels	1,024	1	1	1	0
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	Yes	Yes	Yes	Yes
Disk pack/cartridge drives	Cartridge	Yes	Yes	Yes	No
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	No
Magnetic tape cassettes/cartridges	Cassette	Yes	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	400-1000	Yes	Yes	Yes	300
Line printer speeds, lpm	60-600	Up to 1000	Up to 1000	Up to 1000	300
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	A/D units, punched tape units, CRTs, TTY, serial printer	—	—	—	CRTs
<b>SOFTWARE</b>					
Assembler	1- & 2-pass	1- & 2-pass	1- & 2-pass	1- & 2-pass	2-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	No
Other compilers	BASIC	BASIC	BASIC	BASIC	BASIC, DEGEN
Operating system	Batch, real-time, time-sharing	Yes	Yes	Yes	Batch
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$51,900	\$2,900	\$2,900	\$3,400	\$9,900
Price of basic system with 8K words	Not available	\$3,300	\$3,300	\$3,800	\$9,900
Date of first delivery	June 1975	June 1974	Nov. 1974	April 1974	Aug. 1972
Number installed to date	NA	30	25	5	700
<b>COMMENTS</b>	Memory inter- leaving can re- duce effective memory cycle to 0.3 usec. Pro- cessor has instruc- tion look-ahead	Processors are software, I/O, and memory compatible with Data General Nova series			Price includes integral 1600- character CRT, keyboard, and three cassette tape drives

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MANUFACTURER & MODEL	Lockheed Electronics LEC 16	Lockheed Electronics SUE	Martin, Wolfe Mesa Two Model 5000	Martin, Wolfe Mesa Two Model 7000	Micro Computer Machines MCM/70
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	16	8
Fixed-point operand length, bits	16	16	16/32	16/32	8 to 64
Instruction length, bits	16/32	16/32	16	16	—
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	MOS
Cycle time, microseconds/word	1.0	0.8/1.1	1.0	1.0	—
Minimum capacity, words	4,096	4,096	16,384	16,384	2,048
Maximum capacity, words	65,536	65,536	16,384	32,768	8,192
Parity checking	Optional	Optional	No	No	No
Storage protection	Optional	Optional	Standard	Standard	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	8	4	4	—
No. of index registers	1	7	2	2	—
No. of directly addressable words	65,536	32,768	16,384	32,768	—
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level	—
Microprogrammable	No	By vendor only	No	No	By vendor only
Add time, microseconds (full word)	2.0	2.5	1.35	1.35	—
Hardware multiply/divide	Optional	Standard	No	No	No
Hardware floating point	Optional	Optional	No	No	No
Hardware byte manipulation	Standard	Standard	No	No	Standard
Immediate (literal) instructions	Standard	Standard	No	No	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Standard	Standard	Optional	Optional	No
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	16	16	8
Direct memory access channel	Standard	Standard	Standard	Standard	—
Maximum I/O rate, words/sec	800,000	5,000,000	600,000	600,000	—
No. of external interrupt levels	8-64	4-64	16	16	—
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	Yes
Disk pack/cartridge drives	Yes	No	Cartridge	Cartridge	No
Non-interchangeable disk storage	Yes	No	No	No	No
Magnetic tape cassettes/cartridges	Yes	Yes	No	No	Yes
Magnetic tape, 1/2-inch	Yes	Yes	No	Yes	No
Punched card input speed, cpm	Yes	Yes	Not available	300	100
Line printer speeds, lpm	Yes	Yes	100	100-600	30 cps
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRT, punched tape units	CRT, punched tape units	CRTs	CRTs	Display
<b>SOFTWARE</b>					
Assembler	1-pass	1-pass	No	No	No
Macro assembler	No	Yes	No	No	No
FORTRAN compiler	Yes	Yes	No	No	No
Other compilers	No	RPG	Mesa-RPG	Mesa-RPG	APL
Operating system	Batch, real-time	Batch	Batch, multi-terminal control	Batch, multi-terminal control	Real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$3,450	\$3,950	\$39,000	\$54,000	\$4,970
Price of basic system with 8K words	\$7,500	\$5,950	Not available	Not available	\$8,400
Date of first delivery	Feb. 1969	Nov. 1972	June 1973	Feb. 1972	Nov. 1974
Number installed to date	2000	2000	20	80	100
<b>COMMENTS</b>	LEC 16 replaces NAC 16 and MAC Jr.; systems are principally sold through distributors, who may make additional peripherals and software available		System includes processor, CRT, disk, and printer; extensive application software for small business accounting functions		Single-user, APL-based, desk-top computer with virtual memory operating system; 8K price above includes 1 cassette drive

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MANUFACTURER & MODEL	Microdata Micro-One	Microdata 1600/21	Microdata 1600/30	Microdata 32/S	Microdata 3200
<b>DATA FORMATS</b>					
Word length, bits	8	8	8	16	16
Fixed-point operand length, bits	8/16/24/32	8/16/24/32	8/16/24/32	1/2/4/8/16/32	8/16
Instruction length, bits	8/16/24/32	8/16/24/32	8/16/24/32	8/16/24/32/40	32 (micro)
<b>MAIN STORAGE</b>					
Storage type	Core/MOS	Core	Core	MOS	MOS
Cycle time, microseconds/word	1.1	1.0	1.0	0.35	0.35
Minimum capacity, words	4,096	4,096	4,096	4,096	4,096
Maximum capacity, words	32,768	32,768	32,768	131,072	131,072
Parity checking	No	No	No	Standard	Standard
Storage protection	No	No	No	Optional	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	3	3	3	5 (stack)	32
No. of index registers	1	1	1	5 (stack)	32
No. of directly addressable words	32,768	32,768	32,768	131,072	131,072
Indirect addressing	One-level	One-level	One-level	Multi-level	No
Microprogrammable	By user	By user	By user	By user	By user
Add time, microseconds (full word)	6.38	6.38	5.40	0.405	0.135
Hardware multiply/divide	Standard	Standard	Standard	Standard	No
Hardware floating point	No	No	No	Optional	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Standard	Standard	Standard	Standard	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	8	8	8/16	8/16
Direct memory access channel	Optional	Optional	Optional	Standard	Standard
Maximum I/O rate, words/sec	1,000,000	1,000,000	1,000,000	2,500,000	2,500,000
No. of external interrupt levels	2-128	2-128	2-128	4-1,024	4
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	No
Disk pack/cartridge drives	Pack	Pack	Pack	Cartridge	Cartridge
Non-interchangeable disk storage	No	No	No	No	No
Magnetic tape cassettes/cartridges	No	No	No	No	No
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	300	300	300	200	200
Line printer speeds, lpm	60-300	60-300	60-300	300	300
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRTs	CRTs	CRTs	CRTs	CRTs
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	No	Cross-assembler
Macro assembler	No	No	No	No	Yes
FORTRAN compiler	Yes	Yes	Yes	No	No
Other compilers	BASIC	BASIC	BASIC	MPL	No
Operating system	No	No	No	Batch	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$2,415	\$5,200	\$5,800	\$11,380	\$9,630
Price of basic system with 8K words	\$3,265	\$6,400	\$7,000	\$12,760	\$11,010
Date of first delivery	Dec. 1974	Nov. 1971	Jan. 1973	March 1974	Oct. 1973
Number installed to date	75	See Comments	See Comments	16	3
<b>COMMENTS</b>	Single-board processor; compatible with Microdata 800 and 1600 computers	About 2800 Series 16 computers (all models) have been installed; this series features stack processing and character string manipulation		Software-level emulator that runs on 3200 for implementing MPL, a subset of PL/1	General-purpose system for emulation of specialized architecture (such as 32/S); features stack processing

## All About Minicomputers

MANUFACTURER & MODEL	Microdata Reality	Modular Computer Systems Modcomp I	Modular Computer Systems Modcomp II	Modular Computer Systems Modcomp IV	Nanodata QM-1
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	16	18
Fixed-point operand length, bits	8/16/32/48	16	16/32	16/32	Variable
Instruction length, bits	8/16/32/48	16/32	16/32	16/32	Variable
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	2.0	0.8	0.8	0.5 (effective)	0.75/1.25
Minimum capacity, words	8,192	8,192	16,384	16,384	16,384
Maximum capacity, words	32,768	32,768	65,536	262,144	262,144
Parity checking	No	Optional	Standard	Standard	Standard
Storage protection	Standard	No	Optional	Standard	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	32/terminal	3	15	240	32
No. of index registers	17/terminal	3	7	112	12
No. of directly addressable words	See Comments	32,768	65,536	131,072	262,144
Indirect addressing	Multi-level	No	One-level	One-level	Multi-level
Microprogrammable	No	By user	By user	By user	By user
Add time, microseconds (full word)	NA	0.8	0.8	0.56	1.5/2.5
Hardware multiply/divide	Standard	Optional	Standard	Standard	Standard
Hardware floating point	No	No	Optional	Optional	Standard
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Optional	Optional	Standard	Optional
Real-time clock or timer	Standard	Optional	Optional	Standard	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	16	16	16	18
Direct memory access channel	Standard	No	Optional	Optional	Optional
Maximum I/O rate, words/sec	500,000	600,000	1,930,000	2,400,000	NA
No. of external interrupt levels	64	Up to 128	Up to 128	Up to 128	2,048
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	Yes	Yes	No
Disk pack/cartridge drives	Pack, cartridge	No	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	No	No	No	No	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	300	300-1000	300-1000	300-1000	600
Line printer speeds, lpm	300	50-600	50-600	50-600	400-1000
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRTs, serial printer	-	Printer/plotter	Printer/plotter	CRTs, punched tape units
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	1- & 2-pass
Macro assembler	Yes	No	Yes	Yes	Yes
FORTRAN compiler	No	No	Yes	Yes	Yes
Other compilers	ENGLISH	No	BASIC	BASIC	BASIC, ALGOL, COBOL, RPG, PL/1
Operating system	Multi-user	Real-time	Batch, real-time	Real-time	Batch, real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	Not available	\$6,200	\$11,500	\$19,500	\$96,000
Price of basic system with 8K words	\$47,500	\$6,200	Not available	Not available	Not available
Date of first delivery	Nov. 1973	Oct. 1971	March 1971	June 1974	April 1974
Number installed to date	130	See Comments	See Comments (I)	See Comments (I)	6
<b>COMMENTS</b>	Utilizes a micro-code program to address all of virtual memory (disk storage) directly; system is marketed through a dealer network	A total of about 1680 systems (all models) have been delivered	4-port memory is available for multiprocessor and I/O processor configurations. A high-throughput communications processor is also available	Features 32-bit parallel internal operation, 16 sets of general-purpose registers, and 1,024 memory mapping registers	Oriented toward emulation; emulators available for IBM S/360 and Data General Nova; also, a microinstruction set for developing emulators

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MANUFACTURER & MODEL	A/S Norsk Nord-10	A/S Norsk Nord-12	Philips P852M	Philips P856M	Philips P857M
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	16	16	16	16/32	16/32
Instruction length, bits	16	16	16/32	16/32	16/32
<b>MAIN STORAGE</b>					
Storage type	Core/MOS	MOS	Core	Core	Core
Cycle time, microseconds/word	0.9/0.5	0.5	1.2	0.72/1.2	0.72
Minimum capacity, words	8,192	4,096	4,096	8,192	16,384
Maximum capacity, words	262,144	65,536	32,768	32,768	131,072
Parity checking	Optional	No	No	No	No
Storage protection	Optional	No	No	No	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	4	4	16	16	16
No. of index registers	2	2	14	14	14
No. of directly addressable words	1,024	1,024	32,768	32,768	32,768
Indirect addressing	One-level	One-level	One-level	One-level	One-level
Microprogrammable	Optional	Optional	By vendor only	By vendor only	By vendor only
Add time, microseconds (full word)	1.8/1.2	2.3	2.3	1.305	1.305
Hardware multiply/divide	Standard	Standard	No	Standard	Standard
Hardware floating point	Standard	Standard	No	No	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Optional	Optional	Optional	Standard	Standard
Real-time clock or timer	Optional	Optional	Optional	Standard	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	16	16	16
Direct memory access channel	Standard	Standard	Optional	Optional	Optional
Maximum I/O rate, words/sec	4,800,000	1,200,000	833,000	1,400,000	1,400,000
No. of external interrupt levels	2,048	2,048	63	63	63
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	No
Disk pack/cartridge drives	Cartridge	Cartridge	Cartridge	Cartridge	Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	300-600	300-600	300	300	300
Line printer speeds, lpm	200-1000	200-1000	200-670	200-670	200-670
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Plotters, CRTs, real-time interfaces	Plotters, CRTs, real-time interfaces	Punched tape equipment, typewriter	Punched tape equipment, typewriter	Punched tape equipment, typewriter
<b>SOFTWARE</b>					
Assembler	1- & 2-pass	1- & 2-pass	1-pass	1-pass	1-pass
Macro assembler	Yes	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC NORD-PL	BASIC, NORD-PL	BASIC	BASIC	BASIC
Operating system	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time	Batch, real-time	Batch, real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$20,000	\$11,000	\$4,260	\$8,200	\$15,860
Price of basic system with 8K words	\$20,000	\$12,500	\$4,810	\$8,200	Not available
Date of first delivery	June 1973	May 1975	1974	1975	1975
Number installed to date	About 150	About 20	NA	NA	NA
<b>COMMENTS</b>	These program-compatible computers are used principally in real-time systems, local/remote batch and time-sharing systems, data-base systems, and combinations		Prices given are at Paris; quantity discounts to OEMs. Price for 857M includes Memory Management Unit to permit addressing beyond 32K		

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MANUFACTURER & MODEL	Prime 100	Prime 200	Prime 300	Qantel 800	Qantel 900
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	8	8
Fixed-point operand length, bits	16/32	16/32	16/32	Variable	Variable
Instruction length, bits	16/32	16/32	16/32	24/48	24/48
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	MOS	MOS	MOS
Cycle time, microseconds/word	1.0	0.75	0.60/0.75	1.5	1.5
Minimum capacity, words	4,096	4,096	8,192	32,768	32,768
Maximum capacity, words	65,536	65,536	262,144	32,768	32,768
Parity checking	No	Standard	Standard	No	No
Storage protection	No	No	Standard	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	1	1	—	—
No. of index registers	1	1	1	—	—
No. of directly addressable words	32,768	65,536	65,536	32,768	32,768
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level	Multi-level
Microprogrammable	No	No	By user	By vendor	By vendor
Add time, microseconds (full word)	2.44	1.96	1.56	58	58
Hardware multiply/divide	Optional	Optional	Standard	Standard	Standard
Hardware floating point	No	Optional	Optional	No	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Immediate (literal) instructions	No	No	No	No	No
Power failure protection	Optional	Optional	Optional	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	8	8
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	694,444	1,000,000	1,136,363	666,000	666,000
No. of external interrupt levels	64	64	64	Variable	Variable
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	No	No
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Pack, cartridge	Cartridge	Cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	No	No
Magnetic tape cassettes/cartridges	No	No	No	No	No
Magnetic tape, ½-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	400	400	400	500	500
Line printer speeds, lpm	300	300	300	60-1800	60-1800
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRT, punched tape units, A/D units	CRT, punched tape units, A/D units	CRT, punched tape units, A/D units	CRT typewriter	CRT typewriter
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	Yes	No	No
FORTRAN compiler	Yes	Yes	Yes	No	No
Other compilers	BASIC	BASIC	BASIC	QIC	QIC
Operating system	Batch, interactive	Batch, interactive	Batch, real-time, time-sharing	Real-time, time-sharing	Real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$4,600	\$5,600	\$11,700	\$19,500	\$24,900
Price of basic system with 8K words	\$5,500	\$6,800	\$11,700	Not available	Not available
Date of first delivery	Feb. 1973	Oct. 1972	Aug. 1973	March 1975	March 1975
Number installed to date	See Comments	See Comments	See Comments	See Comments	See Comments
<b>COMMENTS</b>	Prime has delivered about 600 computer systems (all models) to date. Prime 300 supports virtual memory operating system for up to 31 simultaneous users. The systems are sold for time-sharing, communications, data acquisition, and business data processing. Company provides a guaranteed two-year trade-in policy for upgrading			Include disk and typewriter (800) or CRT/printer (900); operating system uses up to 24K and supports 8 stations performing 2 jobs simultaneously. Over 300 systems (all models) have been delivered	



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MANUFACTURER & MODEL	Qantel 950	Qantel 1200	Raytheon RDS-500	Raytheon 704	A/S Regnecentralen RC 6000
<b>DATA FORMATS</b>					
Word length, bits	8	8	16	16	24
Fixed-point operand length, bits	Variable	Variable	16	16	24/48
Instruction length, bits	24/48	24/48	16	16	12
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	Core	Core	Core
Cycle time, microseconds/word	1.5	1.5	0.8/0.9	1.0	20
Minimum capacity, words	40,960	40,960	8,192	4,096	16,384
Maximum capacity, words	49,152	65,536	65,536	32,768	16,384
Parity checking	No	No	Optional	Optional	No
Storage protection	No	No	Optional	Optional	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	—	—	8	1	4
No. of index registers	—	—	1	1	3
No. of directly addressable words	32,768	65,536	65,536	32,768	4,096
Indirect addressing	Multi-level	Multi-level	One-level	No	One-level
Microprogrammable	By vendor	By vendor	No	No	By vendor
Add time, microseconds (full word)	58	58	1.6/1.8	2.0	50
Hardware multiply/divide	Standard	Standard	Optional	Optional	No
Hardware floating point	No	No	Optional	Optional	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	No
Immediate (literal) instructions	No	No	Standard	Standard	Standard
Power failure protection	Standard	Standard	Optional	Optional	Standard
Real-time clock or timer	Optional	Optional	Optional	Optional	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	8	16	16	16
Direct memory access channel	Standard	Standard	Optional	Optional	Standard
Maximum I/O rate, words/sec	666,000	666,000	2,500,000	2,500,000	500,000
No. of external interrupt levels	Variable	Variable	16	1-16	1-14
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	Yes
Disk pack/cartridge drives	Cartridge	Pack, cartridge	Pack, cartridge	Pack	Cartridge
Non-interchangeable disk storage	No	No	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	No	No	No	No	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	500	500	300-1000	300-1000	600
Line printer speeds, lpm	60-1800	60-1800	300-1250	300-1250	Up to 600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRT, typewriter	CRT, typewriter	Printer/plotter, CRT, punched tape units, card punch	Printer/plotter, CRT, punched tape units, card punch	Card punch
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	1- & 2-pass	2-pass
Macro assembler	No	No	Yes	Yes	No
FORTRAN compiler	No	No	Yes	Yes	Yes
Other compilers	QIC	QIC	No	No	ALGOL
Operating system	Real-time, time-sharing	Real-time, time-sharing	Real-time	Real-time	Batch, real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$29,500	\$35,500	\$7,000	\$7,200	\$18,000
Price of basic system with 8K words	Not available	Not available	\$7,000	\$9,200	Not available
Date of first delivery	June 1975	June 1970	Feb. 1974	March 1970	May 1975
Number installed to date	See Comments	See Comments	500	Over 250	2
<b>COMMENTS</b>	Includes disk and CRT/printer; 950 replaces previous 1100. Operating system uses up to 24K and supports 8 stations performing 4 jobs simul- taneously. Over 300 systems (all models) have been delivered		Optional Array Transform Pro- cessor facilitates signal processing	Optional Array Transform Pro- cessor facilitates signal processing	Based on RC 3600 and emulates RC 8000

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MANUFACTURER & MODEL	A/S Regnecentralen RS 8000	A/S Regnecentralen RS 3600	Rolm 1602 Ruggednova	Rolm 1603 Ruggednova	Systems Engineering Laboratories SEL 32
<b>DATA FORMATS</b>					
Word length, bits	24	16	16	16	32
Fixed-point operand length, bits	24/48	16	16	16	32
Instruction length, bits	12	8	16/32	16	32
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core/CMOS	Core/CMOS	Core
Cycle time, microseconds/word	0.8	1.0	1.0	1.2	0.6
Minimum capacity, words	4,096	8,192	8,192	8,192	8,192
Maximum capacity, words	32,768	32,768	262,144	32,768	262,144
Parity checking	Standard	No	No	No	Standard
Storage protection	Standard	No	Optional	No	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	4	4	4	4	8
No. of index registers	3	2	2	2	3
No. of directly addressable words	4,096	256	1,024	1,024	131,072
Indirect addressing	One-level	Multi-level	Multi-level	Multi-level	Multi-level
Microprogrammable	By vendor	No	By vendor only	No	By vendor only
Add time, microseconds (full word)	1.8	1.4	1.0	5.9	1.2
Hardware multiply/divide	Standard	No	Standard	Optional	Standard
Hardware floating point	Standard	No	Optional	No	Standard
Hardware byte manipulation	Standard	No	Standard	Standard	Standard
Immediate (literal) instructions	Standard	No	Standard	No	Standard
Power failure protection	Standard	Standard	Standard	Standard	Standard
Real-time clock or timer	Standard	Standard	Optional	Optional	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	24	16	16	16	16/32
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1,000,000	500,000	1,000,000	285,500	6,500,000
No. of external interrupt levels	1-256	1-14	16-256	16-256	16-128
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	No	No	Yes
Disk pack/cartridge drives	Pack, cartridge	Cartridge	Cartridge	Cartridge	Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	No	No	Yes
Magnetic tape cassettes/cartridges	Yes	Yes	Line tape	Line tape	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	600	600	300	300	285-1000
Line printer speeds, lpm	Up to 1800	Up to 1800	60-1100	60-1100	125-600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Card punch	Card punch	CRT, TTY, punched tape units, A/D units, NTDS interfaces	CRT, TTY, punched tape units, A/D units, NTDS interfaces	TTY, extensive communications equipment, array processors, CRTs, etc.
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	No	No	No	No	Yes
FORTRAN compiler	Yes	No	Yes	Yes	Yes
Other compilers	ALGOL	MUSIL	ALGOL, BASIC	ALGOL, BASIC	RPG
Operating system	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time	Batch, real-time	Batch, real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$68,500	\$35,000	\$18,750	\$9,950	\$18,000
Price of basic system with 8K words	Not available	\$35,000	\$18,750	\$9,950	\$18,000
Date of first delivery	April 1976	June 1971	Dec. 1972	Oct. 1974	Aug. 1975
Number installed to date	—	150	180	15	—
<b>COMMENTS</b>	Designed for mul- tiprocessor opera- tion; minimum configuration in- cludes RC 3600 front end	Principally a satellite system for RJE, front end, data entry, data collection, and media con- version	Ruggedized; up- ward compatible with Rolm 1601 and Data General Nova; smaller, ROM-only con- figurations avail- able	The 1603 is a smaller, faster, lower-priced version of the previously of- fered 1601	

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MANUFACTURER & MODEL	Systems Engineering Laboratories 85	Systems Engineering Laboratories 86	Texas Instruments Model 960B	Texas Instruments Model 980B	Ultimacc 2000
<b>DATA FORMATS</b>					
Word length, bits	32	32	16	16	16
Fixed-point operand length, bits	32	32	16/32	16/32	Variable
Instruction length, bits	32	32	32	16/32	16
<b>MAIN STORAGE</b>					
Storage type	Core	Core	MOS	MOS	Core
Cycle time, microseconds/word	0.85	0.60	0.75	0.75	1.2
Minimum capacity, words	8,192	8,192	8,192	8,192	NA
Maximum capacity, words	131,072	131,072	65,536	65,536	65,536
Parity checking	Standard	Standard	Standard	Standard	Standard
Storage protection	Standard	Standard	Standard	Standard	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	8	8	Up to 16	2	2
No. of index registers	3	3	Up to 16	1	18
No. of directly addressable words	131,072	131,072	65,536	65,536	1,024
Indirect addressing	Multi-level	Multi-level	One-level	One-level	Multi-level
Microprogrammable	No	No	No	No	No
Add time, microseconds (full word)	1.7	1.2	3.6	1.75	1.2
Hardware multiply/divide	Standard	Standard	Optional	Standard	Optional
Hardware floating point	Optional	Optional	No	No	Optional
Hardware byte manipulation	Standard	Standard	No	Standard	Optional
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	Standard	Optional	Optional	Optional
Real-time clock or timer	Standard	Standard	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16/32	16/32	1 to 16	16	16
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1,176,470	1,666,666	1,000,000	1,000,000	833,000
No. of external interrupt levels	6-112	6-112	2	2-32	16
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	Yes
Disk pack/cartridge drives	Both	Pack, cartridge	Cartridge	Cartridge	Pack
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	No
Magnetic tape cassettes/cartridges	No	No	Yes (700 term.)	Yes (700 term.)	No
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	200-1000	200-1000	300	300	Yes
Line printer speeds, lpm	200-600	200-600	356	356	300-600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Punched tape units, printer/plotters, TTY, A/D units, CRT, etc.	Punched tape units, printer/plotters, TTY, A/D units, CRT, etc.	A/D units, type-writer terminals, CRTs, punched tape units	A/D units, type-writer terminals, CRTs, punched tape units	CRT/printer
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	Yes	Yes	See Comments	See Comments	No
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	RPG	RPG	No	BASIC	BASIC
Operating system	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time	Batch, real-time	Real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$80,000	\$104,000	Not available	Not available	\$60,000
Price of basic system with 8K words	\$80,000	\$104,000	\$4,350	\$4,975	—
Date of first delivery	Dec. 1972	Aug. 1970	May 1974	May 1974	Aug. 1971
Number installed to date	30	50	NA	NA	85
<b>COMMENTS</b>	These medium-scale computer systems are used in high-volume data entry and acquisition. Software is bundled in system prices. A packaged 85 with 32K memory costs \$98,000		Separate macro processor and cross assemblers are available	Separate macro processor and cross assemblers are available	Turnkey business system including disk, CRT, and programming; based on Data General Nova 1200

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MANUFACTURER & MODEL	Ultimacc 3000	Varian V 71	Varian V 72	Varian V 73	Varian V 74
<b>DATA FORMATS</b>					
Word length, bits	16	16	16	16	16
Fixed-point operand length, bits	Variable	16	16	16	16
Instruction length, bits	16	16/32	16/32	16/32	16/32
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	MOS/core/core	MOS/core/core
Cycle time, microseconds/word	1.0	0.9/1.2	0.66/1.2	0.33/0.66/1.2	0.33/0.66/1.2
Minimum capacity, words	NA	16,384	8,192	8,192	32,768
Maximum capacity, words	262,144	32,768	262,144	262,144	262,144
Parity checking	Standard	Optional	Optional	Optional	Optional
Storage protection	Standard	Optional	Standard	Standard	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	4	2-16	2-16	2-16	2-16
No. of index registers	18	2-16	2-16	2-16	2-16
No. of directly addressable words	1,024	32,768	32,768	32,768	32,768
Indirect addressing	Multi-level	Multi-level	Multi-level	Multi-level	Multi-level
Microprogrammable	No	By user	By user	By user	By user
Add time, microseconds (full word)	1.0	1.8/2.4	1.22/2.4	0.66/1.32/2.4	0.66/1.32/2.4
Hardware multiply/divide	Optional	Standard	Standard	Standard	Standard
Hardware floating point	Optional	No	Optional	Optional	Optional
Hardware byte manipulation	Optional	Optional	Optional	Optional	Optional
Immediate (literal) instructions	Standard	Standard	Standard	Standard	Standard
Power failure protection	Standard	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	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	833,000	330,000	1,200,000	1,350,000	1,350,000
No. of external interrupt levels	16	0-64	0-64	0-64	0-64
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	No	No	No	No
Disk pack/cartridge drives	Pack	Pack, cartridge	Pack, cartridge	Pack, cartridge	Pack, cartridge
Non-interchangeable disk storage	No	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	No	No	No	No	No
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	Yes	300-600	300-600	300-600	300-600
Line printer speeds, lpm	300-600	300-600	300-600	300-600	300-600
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	CRT/printer	Punched tape units, CRT, analog plotter	Punched tape units, CRT, analog plotter	Punched tape units, CRT, analog plotter	Punched tape units, CRT, analog plotter
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	2-pass	2-pass
Macro assembler	No	Yes	Yes	Yes	Yes
FORTRAN compiler	Yes	Yes	Yes	Yes	Yes
Other compilers	BASIC	BASIC, RPG II	COBOL, BASIC, RPG II	COBOL, BASIC, RPG II	COBOL, BASIC, RPG II
Operating system	Real-time	Real-time	Real-time, time-sharing	Real-time, time-sharing	Real-time, time-sharing
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$75,000	\$7,200	\$10,500	\$14,500	\$35,900
Price of basic system with 8K words	—	Not available	\$10,500	\$14,500	Not available
Date of first delivery	Jan. 1975	Jan. 1975	Jan. 1974	Sept. 1972	May 1974
Number installed to date	5	50	250	270	30
<b>COMMENTS</b>	Turnkey business system, including disk, CRT, and programming; based on Data General/Nova 830	V 70 Series computers are program-compatible with Varian 620 line. V73, 74, and 75 have dual port memory with two memory busses for multi-processor capability; V 75 extended instruction set is optional for all other V 70 Series models			

## All About Minicomputers

MANUFACTURER & MODEL	Varian V 75	Varian 620/L-100	Varian 600/L-100C	Wang WCS-10	Wang WCS-20
<b>DATA FORMATS</b>					
Word length, bits	8/16/32	16	16	8	8
Fixed-point operand length, bits	16/32	16	16	—	—
Instruction length, bits	16/32	16/32	16/32	—	—
<b>MAIN STORAGE</b>					
Storage type	MOS/core/core	Core	Core	MOS	MOS
Cycle time, microseconds/word	0.33/0.45/0.8	0.95	1.8	1.6	1.6
Minimum capacity, words	65,536	8,192	8,192	4,096	8,192
Maximum capacity, words	262,144	32,768	32,768	32,768	32,768
Parity checking	Optional	Optional	Optional	No	No
Storage protection	Standard	Optional	Optional	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	8-16	2	2	—	—
No. of index registers	7-16	2	2	—	—
No. of directly addressable words	32,768	32,768	32,768	—	—
Indirect addressing	Multi-level	Multi-level	Multi-level	—	—
Microprogrammable	By user	No	No	By vendor	By vendor
Add time, microseconds (full word)	0.66/0.9/1.6	1.9	3.6	—	—
Hardware multiply/divide	Standard	Standard	Standard	—	—
Hardware floating point	Optional	No	No	—	—
Hardware byte manipulation	Standard	No	No	—	—
Immediate (literal) instructions	Standard	Standard	Standard	—	—
Power failure protection	Standard	Standard	Standard	No	No
Real-time clock or timer	Standard	Standard	Standard	No	No
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	16	16	16	8	8
Direct memory access channel	Standard	Standard	Standard	No	No
Maximum I/O rate, words/sec	6,000,000	383,000	200,000	10,000	10,000
No. of external interrupt levels	0-64	8-64	8-64	0	0
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	Yes	Yes
Disk pack/cartridge drives	Pack, cartridge	Pack, cartridge	Pack, cartridge	Cartridge	Cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	No	No
Magnetic tape cassettes/cartridges	No	No	No	Yes	Yes
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	300-600	300	300	300	300
Line printer speeds, lpm	300-600	300-600	300-600	300	300
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Punched tape units, CRT, analog plotter	Punched tape units, CRT, analog plotter	Punched tape units, CRT, analog plotter	Plotters, digitizers, punched tape units	Plotters, digitizers, punched tape units
<b>SOFTWARE</b>					
Assembler	2-pass	2-pass	2-pass	No	No
Macro assembler	Yes	No	No	No	No
FORTRAN compiler	Yes	Yes	Yes	No	No
Other compilers	COBOL, BASIC, RPG II	BASIC, RPG IV	BASIC, RPG IV	BASIC (see Comments)	BASIC (see Comments)
Operating system	Batch, real-time, time-sharing	Batch	Batch	Batch, real-time	Batch, real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$35,000	\$9,800	\$9,800	\$5,700	\$10,000
Price of basic system with 8K words	Not available	\$9,800	\$9,800	—	—
Date of first delivery	July 1975	June 1972	June 1972	NA	NA
Number installed to date	—	1,400	1,000	NA	NA
<b>COMMENTS</b>	See previous page	R620/L-100, a ruggedized version with the same specifications, costs \$19,500 (8K) and was first delivered in May 1975		Packaged systems, based on Wang 2200, include CRT, cassette drive (-10), floppy disk (-20, -30), cartridge disk (-30), and printer (-30). BASIC is implemented in separate 24K (-10) or 42.5K (-20, -30) ROM	

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MANUFACTURER & MODEL	Wang WCS-30	Wang 2200-T	Wang 2200-S	Westinghouse 2500	Xerox 530
<b>DATA FORMATS</b>					
Word length, bits	8	8	8	16	16
Fixed-point operand length, bits	—	—	—	16	16/32
Instruction length, bits	—	—	—	16	16/32
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	MOS	Core	Core
Cycle time, microseconds/word	1.6	1.6	1.6	0.75	0.8
Minimum capacity, words	16,384	4,096	4,096	8,192	8,192
Maximum capacity, words	32,768	32,768	32,768	65,536	65,536
Parity checking	No	No	No	Standard	Standard
Storage protection	No	No	No	Optional	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	—	—	—	2	6
No. of index registers	—	—	—	2	2
No. of directly addressable words	—	—	—	256	1,024
Indirect addressing	—	—	—	One-level	One-level
Microprogrammable	By vendor	By vendor	By vendor	No	By vendor only
Add time, microseconds (full word)	—	—	—	1.7	1.92
Hardware multiply/divide	—	—	—	Standard	Standard
Hardware floating point	—	—	—	Optional	Optional
Hardware byte manipulation	—	—	—	No	Optional
Immediate (literal) instructions	—	—	—	No	No
Power failure protection	No	No	No	Standard	Standard
Real-time clock or timer	No	No	No	Optional	Standard
<b>INPUT/OUTPUT CONTROL</b>					
I/O word size, bits	8	8	8	16	16
Direct memory access channel	No	No	No	Standard	Optional (2)
Maximum I/O rate, words/sec	10,000	10,000	10,000	1,000,000	850,000 each
No. of external interrupt levels	0	0	0	16-1,920	6-30
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	Yes	No	No
Disk pack/cartridge drives	Cartridge	Cartridge	Cartridge	Pack	Pack, cartridge
Non-interchangeable disk storage	Yes	Yes	Yes	Yes	Yes
Magnetic tape cassettes/cartridges	Yes	Yes	Yes	No	No
Magnetic tape, 1/2-inch	Yes	Yes	Yes	Yes	Yes
Punched card input speed, cpm	300	300	300	300-600	200-400
Line printer speeds, lpm	300	300	300	200-600	350-1100
Data communications interface	Yes	Yes	Yes	Yes	Yes
Other standard peripheral units	Plotters, digitizers, punched tape units	Plotters, digitizers, punched tape units, instru- mentation inter- faces	Plotters, digitizers, punched tape units, instru- mentation inter- faces	Punched tape units, plotter, CRT, TTY	Punched tape units, plotters, TTY
<b>SOFTWARE</b>					
Assembler	No	No	No	2-pass	Yes
Macro assembler	No	No	No	Yes	Yes
FORTRAN compiler	No	No	No	Yes	Yes
Other compilers	BASIC (see Comments)	BASIC (see Comments)	BASIC (see Comments)	BASIC, RPG	COBOL, RPG II
Operating system	Batch, real-time	Batch, real-time	Batch, real-time	Batch, real-time	Batch, real-time
<b>PRICING &amp; AVAILABILITY</b>					
Price of basic system with minimum main storage	\$29,100	\$4,000	\$2,400	\$10,000	See Comments
Price of basic system with 8K words	—	\$5,200	\$3,600	\$10,000	See Comments
Date of first delivery	NA	NA	NA	June 1971	1973
Number installed to date	NA	NA	NA	250	NA
<b>COMMENTS</b>	See Comments on previous page	BASIC is implemented in separate 24K (-5) or 42.5K (-T) ROM; Wang declined to provide internal specifi- cations of these microprogrammed units; the systems interpretively execute stored BASIC statements			Xerox recently announced its withdrawal from the computer mainframe busi- ness