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## All About Minicomputers

Minicomputers continue to attract more attention than any other single subject in the fast-moving world of electronic data processing. 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, and in many cases minicomputers represent the best answer.
- 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.

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 186 current minicomputers from 69 manufacturers.

- 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.

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.

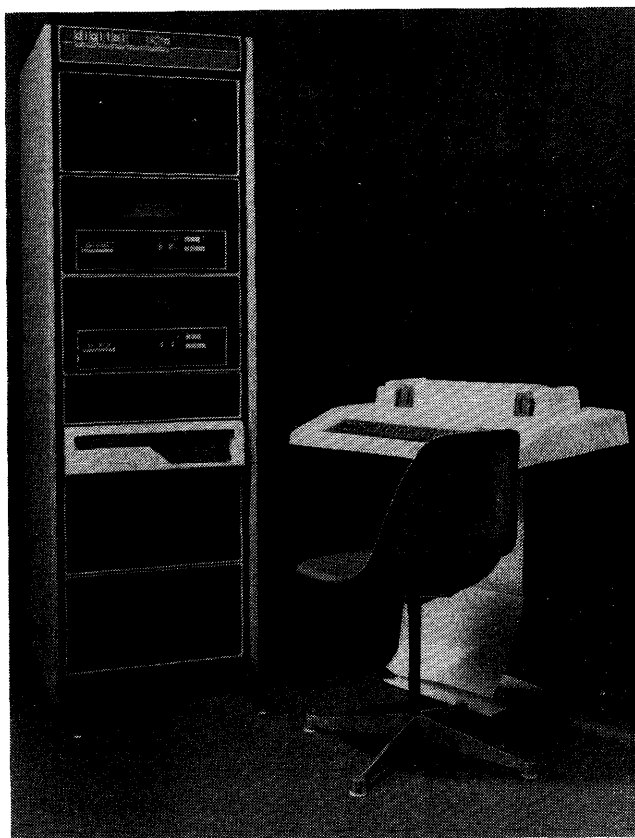
But what, exactly, is a minicomputer? Where are they being used? What are the significant features and drawbacks of these machines? How can you tell whether a minicomputer will fit into your own information processing plans? And, if so, which of the many available models represents the best overall choice 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. The current offerings of 69 manufacturers are summarized in 38 pages of detailed comparison charts.

### TODAY'S TYPICAL 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 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 many of the purely business-oriented systems which are described in our companion report, *All About Small Business Computers* (70C-010-30).



The PDP-11/34, the newest minicomputer from industry leader Digital Equipment Corporation, is shown in a packaged configuration called the PDP-11T34. This system includes the 11/34 processor with 64K bytes of core or MOS memory, dual RK05 2.4-megabyte disk drives (4.8 megabytes total), and an LA36 DECwriter II console, and sells for \$30,900. A standard feature of the 11/34 is memory management, which allows the system to address up to 248K bytes.

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▷ Although the currently available minicomputers exhibit a wide variety of characteristics and capabilities, there are enough similarities and common traits to make it possible to define a "typical minicomputer" whose characteristics are reasonably representative of most of the machines on the market today.

The typical minicomputer is a parallel, binary processor with a 16-bit word length (though 8-bit, 12-bit, 18-bit, 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 65,536 words of magnetic core or semiconductor storage with a cycle time of 0.6 to 1.2 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

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 "classical" minicomputer field (as distinguished from the small business computer market, where Burroughs, IBM, and NCR are the leaders). DEC has delivered more than 60,000 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. Although IBM is expected to unveil an important new minicomputer before this report reaches you, at this writing its only "pure" minicomputer is the System/7, a 16-bit machine, introduced in 1970, that is supported mainly for "sensor-based" applications in data acquisition and control. (The very popular IBM System/3 and System/32 fall into the small business computer category.) Data General, established in 1969, quickly earned a reputation as a supplier of reliable, low-cost minicomputers and has already delivered more than 21,000 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, Modular Computer Systems, and Prime Computer. Minicomputers are also being built by divisions of large, well-established companies such as Control Data, 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, more than 70 companies are now manufacturing minicomputers. The current offerings of 69 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.
- 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. ▷

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### ▷ MINICOMPUTER TRENDS

During the past year, new models were introduced by nearly all of the major minicomputer makers. As any veteran industry observer 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. These "packaged" configurations are described in the companion DATAPRO 70 report, *All About Small Business Computers* (70C-010-30), while the minicomputers on which they are based are covered in this report.

Having solidified their position as a cheaper alternative to the larger general-purpose computers for many 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.

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 Eclipse Series, and the Varian V75 and V76. Meanwhile, the increased computational power and flexibility made possible by the use of a 32-bit word length are being stressed in such 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, floppy disk units, 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 ▷

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▷ 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, business data processing, data communications, and education. Specific applications in which

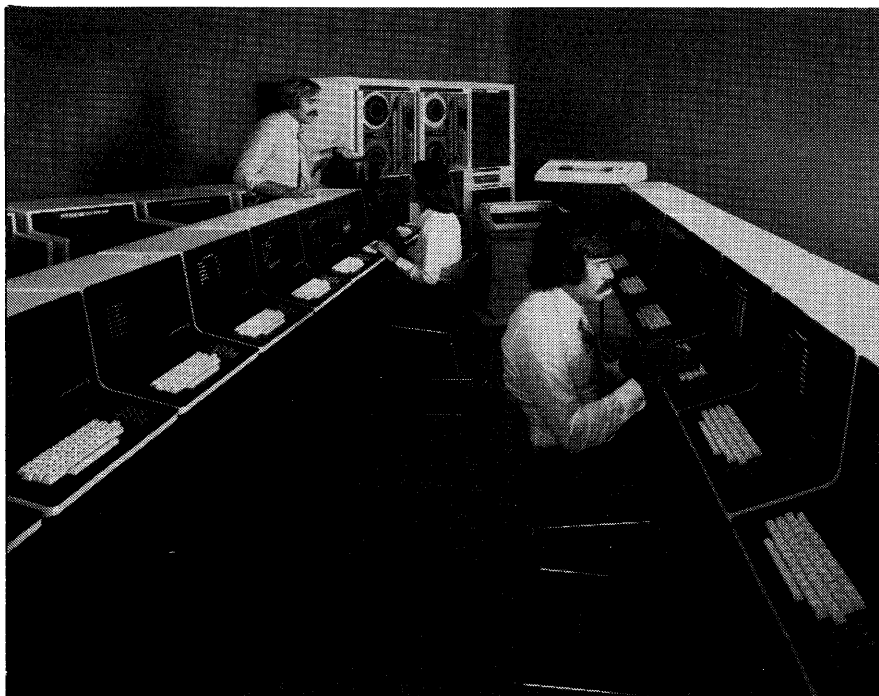
minicomputers are already being widely and successfully used include:

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

### 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. ▷

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*Minicomputers need not be mini in capabilities, size, or price, as indicated by this multi-user Eclipse C/300 system from Data General Corporation. This expanded configuration includes 512K bytes of main memory, four 92-megabyte disk drives, two 60-KBS tape drives, a 30-cps terminal console and CRT console, a 600-lpm printer, asynchronous multiplexers, and 16 CRT terminals for interactive data entry and inquiry/response. Purchase price of this configuration is approximately \$294,000—a far cry from the \$30,700 price tag on the basic, 64K-byte C/300 mainframe.*

▷ Yet true minicomputers—as distinguished from the less powerful electronic accounting machines—have only recently begun 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, a high proportion of all minicomputers are still being sold in quantity, on an OEM (original equipment manufacturer) basis, to other companies that 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 minicomputer-based systems designed primarily for business data processing applications. Most of them are included in this report, and you can find the details on dozens of other business-oriented systems in a companion DATA-PRO 70 report called *All About Small Business Computers* (Report 70C-010-30).

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 authorization, stock brokerage accounting, and many more. These systems, ▷

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▷ too, are described in Report 70C-010-30, *All About Small Business Computers*. 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 and office is still a few years away.

### USER EXPERIENCE

If you're shopping for a minicomputer, it's important to know how well the systems on the market are performing in actual user installations. In order to determine the current level of user satisfaction with specific minicomputer systems and with minicomputers in general, Datapro conducts an extensive user survey each year. Detailed results of the most recent survey, including the users' ratings of more than 60 popular minicomputer models, are presented in a companion DATAPRO 70 report, *User Ratings of Minicomputers and Small Business Computers* (70C-010-40).

### THE COMPARISON CHARTS

The key functional characteristics of 186 commercially available minicomputers from 69 manufacturers are presented in the accompanying comparison charts. Nearly all of the information in the charts was supplied and/or verified by the manufacturers during the months of September and October 1976; their close cooperation with the Datapro Research staff in the preparation of these charts is greatly appreciated.

The comparison charts can be used effectively to complete a comprehensive, first-level search of the minicomputer universe in just a few minutes. For example, if you want a minicomputer but know you can't pay more than \$5,000 for the basic CPU and memory, then you can quickly scan across the charts noting the entry "Price of CPU, power supply, front panel, and minimum memory in chassis" and jotting down the manufacturer and model number of each minicomputer that applies. Or, your requirements may be for a minicomputer that has a BASIC programming language in addition to removable disk pack storage. A similar quick scan across the entries called "Disk pack/cartridge drives" and "Compilers" will produce a complete list of those minicomputers that satisfy both requirements.

*PLEASE NOTE that a similar presentation of the characteristics of minicomputers with a strong orientation toward business data processing applications is contained in a companion DATAPRO 70 report called "All About*

*Small Business Computers" (Report 70C-010-30). Thus, to assure that your search will be complete, we suggest that you also scan that report because, as you know, categorical descriptions and definitions in the area of minicomputers can be difficult. What you may consider to be a small business computer, someone else may call a minicomputer, or the converse. To be sure, therefore, we suggest you quickly scan both sets of charts.*

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, bits*; i.e., the number of bits (binary digits) that can be stored in or retrieved from main storage during a single cycle. In general, the longer the word length, the greater the efficiency and accuracy of a computer's internal operations—and the higher its price tag. Most of the minicomputers currently on the market have a 16-bit word length; this size neatly accommodates two 8-bit bytes (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. Entries also indicate parity and error correction bits when applicable.

For most minicomputers, the *fixed-point operand length, bits* 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, bits* 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.

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### ▷ Main Storage

The *storage type* generally falls into one of two basic categories, magnetic core or semiconductor memory. Magnetic core storage has been widely used for more than a decade, and has proved to be fast, flexible, and reliable. Semiconductor memories began to appear in commercially available minicomputers late in 1970, and most minicomputer makers are now using semiconductor memory in their new products. Use of core versus semiconductor memories has almost reached a balance point this year, with approximately 50 percent of the minicomputers currently available using each type of memory. It is clear that the demand for higher performance at lower cost, together with forthcoming improvements in semiconductor technology, has accelerated the trend toward the use of semiconductor memories.

Two types of semiconductor memories appear in the charts, MOS (metal oxide semiconductor) and bipolar (bipolar transistor). MOS is decidedly more popular because of its compactness and price. However, bipolar technology, a type of transistor-transistor logic, offers a classic trade-off—higher speed at the expense of more space and greater power consumed, as well as greater cost.

The *cycle time, microseconds/word* for a storage device is the minimum time interval that must elapse between the starts of two successive accesses to any one storage location. 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.

*Access time, microseconds/word* is the actual elapsed time between the CPU's request for data and the time when that data is received (read). In core memory, the access time is usually one-half the cycle time; semiconductor memories do not display a similar relationship.

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 capabilities 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.

It is important to choose the right storage capacity; for nonmultiprogramming 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



*The Burroughs B 80, an impressive new small business computer, doesn't look like a typical minicomputer. Its processor is hidden inside the cabinetry and is part of a neatly packaged system. The entry-level configuration includes 32K bytes of MOS memory, a 60-cps printer and keyboard, two floppy disk drives (1 megabyte each), a magnetic tape cassette drive, and a 256-character visual display terminal. It can be purchased for \$19,510.*

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.

*Error correction* is a rather new feature which is beginning to appear in some of the recent minicomputer offerings from Century Computer, Hewlett-Packard, Honeywell, Texas Instruments, and others. This feature involves appending five or six check bits to each word of memory. The check bits, called a Hamming code, and special algorithms allow a system to detect and correct single-bit errors, and also to detect a fair proportion of the multiple-bit errors that occur.





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▷ *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 are parallel, binary processors with single-address instructions and fixed word lengths of 8, 12, 16, 18, 24, or 32 bits.

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

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

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

*Number of addressing modes* refers to the number of different types of additional addressing modes (other than direct) available to the user. There are many addressing modes being offered today: program-relative, base-relative, indexed, base plus displacement, auto increment/decrement, and many others. Many of these modes can also be combined with indirect addressing, the most popular of all non-direct addressing modes, to create an almost unlimited list of addressing schemes.

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

*Control storage* is an indication of the microprogrammability of the minicomputer. 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 hard-wired logic, a microprogrammed computer uses sequences of microinstructions, usually stored in a special read-only memory (ROM), programmable read-only memory (PROM), or bipolar read-only memory (BROM) 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. Entries here indicate both the type and the size of central storage.

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, microseconds* 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, ▷



## All About Minicomputers

▷ with no indexing or indirect addressing. Comparisons based on add times can easily be misleading, however, because of differences in word lengths and instruction repertoires.

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

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

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

*Battery backup* is a feature unique to minicomputers with semiconductor memory, which is volatile and requires refreshing at regular intervals to retain the data that has been written into it. In the event of a power failure, the contents of memory would be lost if the regulator power supply were not backed up by the battery pack.

An interesting solution to this problem with semiconductor memories is furnished by Computer Talk, Inc., whose battery backup feature causes the contents of memory to be recorded on the system disk if a power failure occurs. When power is restored, memory can be recreated by copying from the disk.

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

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

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

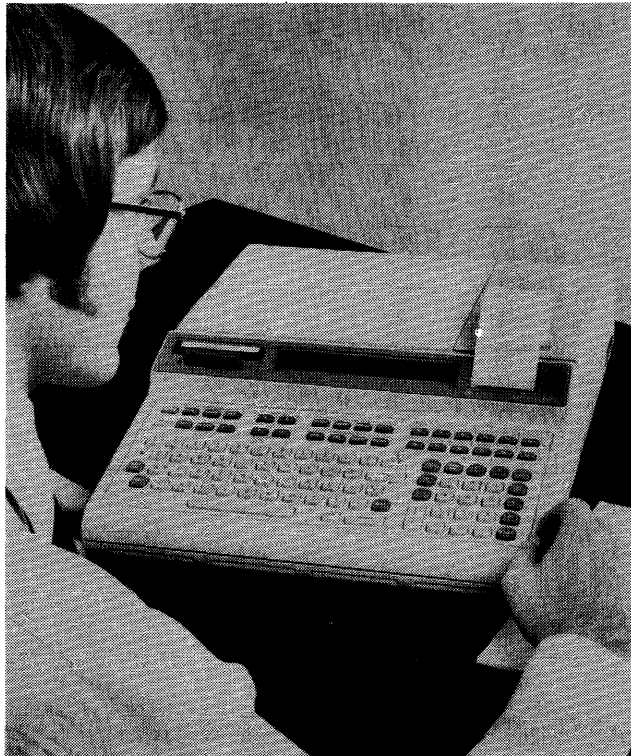
The *number of external interrupt levels* provides a reasonable indication of the power of a minicomputer's interrupt system. It shows the number of different external devices whose interrupt signals can be identified by the processor—though it should be noted that this identification process may require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

### Peripheral Equipment

The comparison charts summarize the standard peripheral devices that are available for each minicomputer.

Users who are accustomed to larger general-purpose computer systems will find that the term "standard peripheral device" often has a somewhat different ▷

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*The Hewlett-Packard 9825, though called a programmable calculator by many, truly deserves minicomputer status. A basic HP 9825 includes 6844 bytes of MOS memory, a 32-character light-emitting diode display, a 16-character alphanumeric strip printer, an integrated 2.75-KBS magnetic tape cartridge drive, interrupt capability, and an HPL high-level language compiler implemented in firmware. The base price is \$5,900, but the tariff can go much higher if additional peripherals such as up to 32 floppy disk drives (15 megabytes total), a 30-cps serial printer, a 240-lpm line printer, paper tape readers and punches, or plotters are interfaced to the system.*

▷ 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. In many instances the minicomputer manufacturer buys the peripheral device from the peripheral manufacturer and supplies an appropriate interface for his minicomputer. Datapro has made every effort to include *only* the peripheral devices that are physically supplied by the minicomputer vendors; 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 inclusion of mass storage devices (magnetic disk units) can greatly increase the data storage and processing capabilities of a minicomputer system. Disk units enable millions of characters of information to be constantly accessible to the computer. Moreover, any desired record can be retrieved, updated, and re-recorded on the disk, usually within a fraction of a second.

By replacing or augmenting slower, less flexible file storage media such as punched cards, paper tape, or magnetic ledger cards, disk units can enable small computers to handle applications and processing volumes that would otherwise be impossible. The principal disadvantages of disk units are their comparatively high costs and the software complexities that are encountered by users who attempt to harness their full potential. One or both of these considerations will make disk units impractical for many small computer buyers, despite the obvious appeal of disk-oriented data processing.

The diskette, or "floppy disk," is an innovation that can significantly reduce the cost of disk-oriented data processing. The diskette itself consists of a flexible Mylar disk, about 8 inches in diameter, that is permanently housed in a plastic envelope. It can serve as an input/output and/or random-access storage medium that is considerably smaller in capability and slower in performance than conventional disk units—but also far lower in cost. Introduced by IBM in 1972, diskettes and diskette drive units are now being produced by dozens of vendors and are finding their way into numerous small computer systems, such as the IBM System/32 and Burroughs B 80. Recent enhancements to the floppy disk concept include more concentrated data storage and "flippies" (floppy disks that utilize both sides of the diskette), allowing more data to be stored on-line.

The other, more conventional types of mass storage devices, cartridge and disk pack drives, provide access to far more data and at significantly faster rates. Unfortunately, they also carry price tags several times higher than their floppy counterparts. Most of these units employ cartridges or disk packs that can easily be removed from the drive units and interchanged in much the same manner as magnetic tape reels.

Some cartridge-type units either use nonremovable media or use two cartridges, one fixed and the other removable. Nonremovable disks impose two important limitations. First, the system's file storage capacity is effectively limited to the amount of information that can be stored on-line. Second, disk dumps to create backup files for efficient restart procedures in case of catastrophe are not available to the user.

Interchangeable disks, conversely, provide great flexibility and make it practical to use small computers effectively for both sequential and random data processing applications. In sequential applications, files of virtually unlimited size can be handled through the use of multiple disk packs or cartridges. ▷

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▷ Fixed-head (head-per-track) disk and drum units can provide much faster access to on-line data than any other type of mass storage device. The reason is that there is no loss of time due to head positioning because a head is provided for each track. The only delay is rotational delay (latency), or the time required for the desired data to move under the read/write head. But the price of this type of equipment is higher than that of the preceding varieties, and less data can be stored on-line. Fixed-head devices are used when data bases are relatively small and very rapid access to the information is required.

*Floppy disk (diskette) drives* indicates whether floppies are available for a particular minicomputer and the minimum and maximum on-line capacities that are offered.

*Disk pack/cartridge drives* signifies whether one or the other, or both, types of devices can be interfaced to the system and the minimum and maximum on-line capacities available.

*Drum/fixed-head disk storage* informs the reader as to the availability of a drum or head-per-track (fixed-head) disk drive and the minimum and maximum on-line capacities offered.

The indicated maximum storage capacities are shown in thousands (K) or millions (M) of bytes and may be the capacity of a single disk or the total capacity of two or more (typically, four to eight) drives that can be connected to one controller. It is difficult to imagine minicomputer users wanting more disk storage, but if an I/O slot is open, theoretically, another controller and its associated drives can be added to most systems.

Magnetic tape cassettes and cartridges offer increased convenience in that they can be transported and stored with little fear of damaging the data that has been recorded. What's more, price tags for cassette and cartridge drives are significantly lower than those of the more conventional reel-to-reel variety, but once again the trade-off of slower transfer rates and reduced on-line storage must be accepted. The charts indicate the availability of *magnetic tape cassettes/cartridges* and *magnetic tape, 1/2-inch* drives and their associated transfer rates in characters per second (cps) or thousands of bytes per second (KBS).

*Punched card input* informs the reader if a punched card reader is offered and its speed in cards per minute (cpm).

*Serial (character-at-a-time) printers* are enjoying increased popularity with the prolific growth of the minicomputer marketplace. The main reason is price; serial printers can provide excellent-quality hard-copy reports for far less money than the line-at-a-time printers used with larger computers. However, for users who require faster printing capabilities, *line printers* are also available for many systems. Serial printers generally range in speed from about 30 to 600 or more characters per second (cps),

while line printers operate at speeds of 100 to 2000 or more lines per minute (lpm). The user who needs faster printed output can obviously get it, but he must be willing to pay the higher price tag associated with the line printers.

*Data communications interface* describes the minicomputer's capabilities, if any, to send and receive data over a common-carrier communications link. Depending on the configuration, a minicomputer can be programmed to function as an intelligent terminal communicating with a larger host computer, or the mini can act as the host computer communicating with other terminals in a network. The chart entry indicates whether an interface is available and gives the range of data rates or the maximum data rate in bits per second (bps).

*CRT* indicates the availability of a CRT display unit and describes its standard screen size in characters per line and number of lines per screen (e.g., 80 char. x 24 lines).

*Other standard peripheral units* lists the additional peripheral devices that are available for each system. Typical entries include analog/digital (A/D) converters, paper tape readers, paper tape punches, plotters, etc.

### Software

A critically important area to be evaluated is *software*—the programming packages and languages used to program the computer and thereby direct its operations. It is important that you carefully investigate the available software. This investigation should include the operating systems, programming languages, preprogrammed utility packages such as sorts and file maintenance, and application packages such as payroll, inventory control, general ledger, etc. Prospective buyers should carefully note whether the software they will require is included in the cost of the system or offered at extra cost.

Vendors' claims and promises concerning the availability and capability of software should be carefully checked. This is particularly true of software that has been announced but not yet released. Vendors have frequently failed to live up to their marketing publicity.

An *assembler* is a special-purpose program that uses the computer's power to facilitate the preparation of other programs. It enables the programmer to write his own program in a simplified format that uses mnemonic operation codes and symbolic operand addresses. The assembler program then converts these symbolic instructions into their machine-language equivalents, producing computer programs ready for loading and execution. Entries here indicate the availability of an assembler or, in some cases, a macro assembler.

A macro assembler is another software tool to aid the programmer and make his job a little easier. Macro routines can be called by the programmer and copied right ▷

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▷ into his program. This saves the programmer from having to recode the routine each time it is used and also eliminates the possibility of keying errors when that part of the program is entered. As usual, there is a price to pay: the use of macros usually wastes memory space.

Entries in this section of the charts indicate whether an assembler, a macro assembler, or both are available.

A *compiler* is a software tool designed to shift part of the program preparation task from the user to the computer itself by converting programs written in a simplified, procedure-oriented language into machine-language object programs. Compilers are now used in virtually all large and medium-scale computer installations because of their demonstrated ability to slash programming costs—and they are becoming increasingly available for minicomputers. This trend is possible because of the more powerful central processors now being used, since compilation is an intricate process that requires more storage space and processing power than the earlier minicomputers provided. Where compilers are offered, however, they frequently limit the programmer to restricted subsets of the standard programming languages and/or require the use of a larger computer to perform the compilation process.

Entries in this section of the charts may include *COBOL* (COmmon Business Oriented Language), *RPG* (Report Program Generator), *FORTRAN* (FORmula TRANslator), *BASIC* (Beginners All-purpose Symbolic Instruction Code), *ALGOL* (ALGOrithmic Language), or proprietary languages that are available from a vendor for use on a particular system, and indicate the availability of those compilers for each minicomputer. The key word of warning here is that if you use a language that is unique to a vendor, you will be faced with a big problem if someday you decide to change vendors. Your investment in software will be lost, since the programs will not operate on any other system.

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.

Typical entries describing the available operating systems include “batch,” which means that the system processes one or more jobs sequentially and requires all data to be supplied before initiation (communication between operator and system is not permitted once the job has begun); “interactive,” which means that the system allows data, parameters, etc., to be entered as the job is executing; “real-time,” which means that the system responds to external demands on a priority basis; or “time-sharing,” which means that the system allows multiple users to access the system and share all its resources at the same time.

*Language implemented in firmware and operating system implemented in firmware* tell the reader whether or not the language processor and/or the operating system are contained in microcode. The entries stipulate “Fully,” “partially,” or “no” to indicate the extent of firmware implementation. An advantage to the user is that a language and/or operating system implemented in firmware frees up more memory space for the user’s programs and data. Also, the microcode is usually inaccessible to the user (generally contained in read-only memory), eliminating any possible tampering with the language processor or operating system and reducing chances for error. A third advantage derived from firmware implementation is the ability to create more sophisticated and complex system functions at the hardware level. Microcode routines can be substituted for often-used subroutines, thereby increasing system performance.

### Pricing and Availability

The comparison charts show the *price of CPU, power supply, front panel, and minimum memory in chassis* along with the memory size in parentheses. *Price of memory increment* stipulates the costs of various sizes (when available) of memory increments, with the actual sizes in parentheses.

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 systems of each type had been delivered to customers as of approximately September 30, 1976. All figures were supplied by the manufacturers themselves.

### Comments

This final entry on the comparison charts is used to explain or amplify the preceding entries and to provide other pertinent information about each system’s hardware, software, pricing, or applications.

## MINICOMPUTER MANUFACTURERS

Listed below, for your convenience in obtaining additional information, are the full names, addresses, and telephone numbers of the 69 suppliers whose products are listed in the comparison charts that follow.

*Anderson-Jacobson, Inc.*, 1065 Morse Avenue, Sunnyvale, California 94086. Telephone (408) 734-4030.

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

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

*Basic Timesharing Inc.*, 650 North Mary Avenue, Sunnyvale, California 94086. Telephone (408) 733-1122.

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

*Burroughs Corporation*, Burroughs Place, Detroit, Michigan 48232. Telephone (313) 972-7000.

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

*Century Computer*, 2339 Stanwell Circle, Concord, California 94520. Telephone (415) 798-8000.

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

*Computer Talk, Inc.*, P.O. Box 145, Idledale, Colorado 80453. Telephone (303) 697-4315.

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

*Control Data Corporation*, P.O. 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.

*Datsaab Systems Inc.*, 437 Madison Avenue, New York, New York 10022. Telephone (212) 754-0680.

*Datum, Inc.*, 1363 State College Boulevard, Anaheim, California 92806. Telephone (714) 533-6333.

*Decision Data Computer Corporation*, 100 Witmer Road, Horsham, Pennsylvania 19044. Telephone (215) 674-3300.

*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.

*Digital Systems Corporation*, 3 North Main Street, Walkersville, Maryland 21793. Telephone (301) 845-4141.

*Financial Computer Corporation*, 412 W. Redwood St., Baltimore, Maryland 21201. Telephone (301) 837-9510.

*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.

*General Automation, Inc.*, 1055 S. East Street, Anaheim, California 92805. Telephone (714) 778-4800.

*GRI Computer Corporation*, 320 Needham Street, Newton, Massachusetts 02164. Telephone (617) 969-0800.

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

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

*Hewlett-Packard, Calculator Products Division*, P.O. Box 301, Loveland, Colorado 80537. Telephone (303) 667-5000.

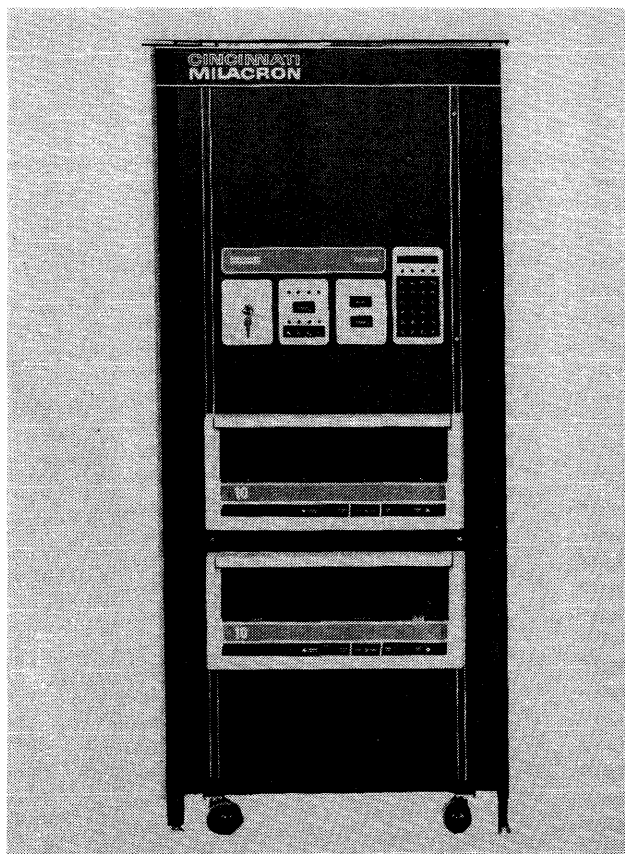
*Hewlett-Packard, Data Systems Division*, 11000 Wolfe Road, Cupertino, California 95014. Telephone (408) 257-7000.

*Hewlett-Packard, GSD Division*, 5303 Stevens Creek Road, Santa Clara, California 95050. Telephone (408) 249-7020.

*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.

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



The CIP/4400 from Cincinnati Milacron is shown with a programmer's panel/debug console and two front-loading cartridge disk drives. The CIP/4400 processor can be purchased alone with 32K bytes of main memory for \$16,100, or in a packaged version, the Model 80, with 64K bytes of memory, a CRT, 10-megabyte cartridge disk drive, printer controller, and interface for up to eight CRT's for \$42,800.

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- ▷ *International Computers (USA) Limited*, 555 Madison Avenue, New York, New York 10022. Telephone (212) 486-7400.
- Jacquard Systems*, 2502 Broadway, Santa Monica, California 90404. Telephone (213) 839-3493.
- Keronix, Inc.*, 1752 Cloverfield Blvd., Santa Monica, California 90404. Telephone (213) 829-3594.
- Litton Industries, Inc.*, Sweda International Division, 34 Maple Avenue, Pine Brook, New Jersey 07058. Telephone (201) 757-8100.
- Lockheed Electronics Company*, Data Products Division, U.S. Highway 22, Plainfield, New Jersey 07060. Telephone (201) 757-1600.
- Logical Machine Corporation*, 1294 Hammerwood Avenue, Sunnyvale, California 94086. Telephone (408) 744-1290.
- MELCO (Mitsubishi Electric Company) U.S.A., Inc.*, 3030 East Victoria Street, Compton, California 90221. Telephone (213) 636-2331.
- 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.
- Mylee Digital Sciences, Inc.*, 155 Weldon Parkway, Maryland Heights, Missouri 63043. Telephone (314) 567-3420.
- Nanodata Corporation*, 2457 Wehrle Drive, Williamsville, New York 14221. Telephone (716) 631-5880.
- NCR Corporation*, Main & K Streets, Dayton, Ohio 45409. Telephone (513) 449-2000.
- Nixdorf Computer Inc.*, O'Hara Plaza, 5725 East River Road, Chicago, Illinois 60631. Telephone (312) 693-6600.
- A/S Norsk Data-Elektronikk*, Postboks 163, Okem, Oslo, 5 Norway. Telephone 21 73 71.
- Olivetti Corporation of America*, 500 Park Avenue, New York, New York 10022. Telephone (212) 371-5500.
- Philips Business Systems, Inc.*, 175 Froelich Farm Boulevard, Woodbury, New York 11797. Telephone (516) 921-9310.
- 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.
- Randal Data Systems, Inc.*, 365 Maple Avenue, Torrance, California 90503. Telephone (213) 320-8550.
- 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.
- Roim 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.
- Tandem Computers, Inc.*, 20605 Valley Green Drive, Cupertino, California 95014. Telephone (408) 255-4800.
- Tektronix, Inc.*, P.O. Box 500, Beaverton, Oregon 97077. Telephone (503) 644-0161.
- Texas Instruments, Inc.*, Digital Systems Division, P.O. Box 1444, Houston, Texas 77001. Telephone (713) 494-5115.
- Univac (Sperry Univac Division)*, Sperry Rand Corporation, P.O. Box 500, Blue Bell, Pennsylvania 19422. Telephone (215) 542-4011.
- 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.
- Warrex Computer Corporation*, P.O. Box 943, Richardson, Texas 75080. Telephone (214) 233-8400.
- Westinghouse Electric Corporation*, Computer and Instrumentation Division, Computer Department, 1200 West Colonial Drive, Orlando, Florida 32804. Telephone (305) 843-7030.□

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MANUFACTURER & MODEL	Anderson Jacobson 1500	Artronix PC-12/730	Artronix PC-12/770	Artronix Modulex	Basic Four 350
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte 8, 16 8, 24	12 12 12, 60	12 12 12, 60	16 16 16, 32	8-bit byte 16, 32 8, 16, 24, 32
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core 1.2 0.6 16K bytes 64K bytes Optional No Standard	Core 1.2 0.7 4K 64K No No No	Core 0.7 0.4 16K 128K No No No	Core, MOS 0.8, 0.5 0.46, 0.25 8K 512K Optional No Optional	MOS 0.60 0.40 24K bytes 64K bytes Standard No No
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	128 3 64K 2 ROM; 4K bytes  4 No No Standard No Standard	1 64 4K 8 No  2.4 No Optional No — Optional	1 64 4K 8 No  1.4 No Standard Optional — Standard	8 8 32K 8 ROM; 512 bytes  1.4 Optional Optional Standard Optional Standard	2 1 64K 8 ROM; 1K x 16 bits  7.4 No No Standard Standard Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 606K 15	Standard 883K 1-256	Standard 1.25M 1-256	Standard 4.8M Variable	Standard 1M 8
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives Drum/fixed-head disk storage Magnetic tape cassettes/cartridges  Magnetic tape, ½-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	600K-2.4M bytes Cartridge; 10-40M bytes No No  No No 45 cps 200-600 lpm 1200 bps; asynch. 80 char. x 24 lines —	315-1260K bytes Cartridge; 3.2-13.7M bytes Fixed-head; 0.5-2M bytes Cartridge; 10 KBS  No 300 cpm 100 cps 210 lpm 110-9600 bps 80 char. x 24 lines Graphics, plotter, instrumentation	315-1260K bytes Cartridge; 3.2-13.7M bytes Fixed-head; 0.5-2M bytes Cartridge; 10 KBS  No 300 cpm 100 cps 210 lpm 110-9600 bps 80 char. x 24 lines Graphics, plotter, instrumentation	315K-unlimited Cartridge; 2.5M-unlimited No No  72 KBS 600 cpm 100 cps 210, 400 lpm 110-9600 bps 80 char. x 24 lines Graphics, plotter, instrumentation	No Cartridge; 5M bytes No No  10 KBS No 165 cps 300, 600 lpm 1200 bps 80 char. x 24 lines —
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler  ESP  Batch  Partially Partially	Assembler  Comfort, FORTRAN  Batch, Real-time, Time-sharing No No	Assembler  FORTRAN, Mumps  Batch, Real-time Time-sharing No No	Assembler & macro assembler FORTRAN, RPG II, MUMPS  Batch, Real-time, Time-sharing Optional Optional	No  Business BASIC  Single-user inter- active No Partially
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$19,500 (16K bytes) \$4,400 (16K bytes)  December 1976 NA	\$20,000 (16K words) \$2,700 (4K words)  September 1971 Over 150	\$76,000 (64K words) \$2,700 (4K words)  February 1974 Over 20	\$8,300 (8K words)   July 1975 NA	\$34,400 (24K bytes) \$3,000 (8K bytes); \$3,500 (16K bytes) 1971 3000 (all models)
<b>COMMENTS</b>	System price also includes two diskettes, paper tape, reader, and serial printer			Highly modular; operating system handles multiple processors	Available as pack- aged systems only; system price also includes cartridge disk subsystem, serial or line print- er, and CRT termi- nal



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MANUFACTURER & MODEL	Basic Four 400	Basic Four 600	Basic Four 700	Basic Timesharing 4000 Series	Bendix BDX9000
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte 16, 32 8, 16, 24, 32	8-bit byte 16, 32 8, 16, 24, 32	8-bit byte 16, 32 8, 16, 24, 32	16 16, 32 16	16 16 16
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 0.60 0.40 24K bytes 64K bytes Standard No No	MOS 0.60 0.40 32K bytes 64K bytes Standard No No	MOS 0.60 0.40 64K bytes 128K bytes Standard No No	MOS 0.65 0.3 64K bytes 64K bytes Standard No Standard	Core 1.0 0.5 4K 32K Optional No Optional
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	2 1 64K 8 ROM; 1K x 16 bits  7.4 No No Standard Standard Standard	2 1 64K 8 ROM; 1K x 16 bits  7.4 No No Standard Standard Standard	2 1 64K 8 ROM; 1K x 16 bits  7.4 No No Standard Standard Standard	2; not user-access. 2; not user-access. — — PROM, WCS; 98K bits  — Standard Standard Standard Standard	16 2 512 — No  2.0 Standard No No No Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1M 8	Standard 1M 8	Standard 1M 8	Standard 616,666 60	Standard 500K 1-64
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives  Drum/fixed-head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	No Cartridge; 10-20M bytes No  No  10 KBS No 165 cps 300, 600 lpm 1200 bps 80 char. x 24 lines —	No Cartridge; 10-40M bytes No  No  10 KBS No 165 cps 300, 600 lpm 1200 bps 80 char. x 24 lines —	No Cartridge; 100-400M bytes No  No  10 KBS No 165 cps 300, 600 lpm 1200 bps 80 char. x 24 lines —	No Pack & cartridge; 7.5-389M bytes No  No  To 72 KBS No No 300-900 lpm 2500 bps; asynch. No —	No Pack  Fixed-head  No  Yes 200 cpm No No No No A/D & D/A con- verters, paper tape units
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	No  Business BASIC  Multi-user  No Partially	No  Business BASIC  Multi-user  No Partially	No  Business BASIC  Multi-user  No Partially	No  BASIC X  Time-sharing  Partially Partially	Yes  —  No  No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$36,900 (24K bytes) \$3,000 (8K bytes); \$3,500 (16K bytes) 1971 3000 (all models)	\$51,400 (32K bytes) \$3,000 (8K bytes); \$3,500 (16K bytes) 1975 3000 (all models)	\$115,000 (64K bytes) \$3,000 (8K bytes); \$3,500 (16K bytes) 1975 3000 (all models)	\$35,950-\$56,300 — — January 1976 NA	— — — 1971 Over 25
<b>COMMENTS</b>	Available as packaged systems only; system price also includes cartridge disk subsystem, serial or line printer, and CRT terminal	Available as packaged systems only; system price also includes cartridge disk subsystem, serial or line printer, and CRT terminal	Available as packaged systems only; system price also includes cartridge disk subsystem, serial or line printer, and CRT terminal	Based on a modified HP 21MX; packaged system for up to 32 users includes pack or cartridge disk, magnetic tape drive, and eight terminal ports	Sold exclusively for ground support systems and not usually available commercially

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MANUFACTURER & MODEL	Burroughs L 9000 Series	Burroughs B 80	Burroughs B 730/B 720	Burroughs B 770 Series	Burroughs B 1700 Series
<b>DATA FORMATS</b>					
Word length, bits	64	8-bit byte	64	16	8-bit byte
Fixed-point operand length, bits	—	—	—	—	—
Instruction length, bits	Variable	Variable	Variable	Variable	Variable
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	MOS	Core, MOS	MOS
Cycle time, microseconds/word	1.5	1.0	1.0	1	1.5
Access time, microseconds/word	1.2	0.5	0.5	0.4; 0.63	1.0
Minimum capacity, words	4K bytes	32K bytes	32K bytes	16K bytes	24K bytes
Maximum capacity, words	48K bytes	60K bytes	80K bytes	48K; 98K bytes	128K bytes
Parity checking	Standard	Standard	Standard	Standard	Standard
Error correction	No	No	No	No	No
Storage protection	Standard	Standard	Standard	Standard	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	None to user	None to user	None to user	None to user	None to user
No. of index registers	4	None to user	None to user	None to user	None to user
No. of directly addressable words	—	—	—	—	—
No. of addressing modes	—	—	—	—	—
Control storage	RAM; 8K bytes	ROM; 4K bytes	ROM; 3584 bytes	RAM; 32K bytes	No
Add time, microseconds	—	—	0.43	—	—
Hardware multiply/divide	—	—	No	—	—
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	Standard	Standard	Standard	—	—
Battery backup	—	—	—	—	—
Real-time clock or timer	—	—	—	Standard	—
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	—	—	—	Standard	—
Maximum I/O rate, words/sec	—	—	—	Standard	—
No. of external interrupt levels	—	—	—	—	—
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	243K-6M bytes	243K-1.5M bytes	243K bytes	No
Disk pack/cartridge drives	No	Cartridge; 4.6-27.6M bytes	Cartridge; 4.6-36.8M bytes	Cartridge; 4.6-36.8M bytes	Pack & cartridge; 2.3-697.6M bytes
Drum/fixed-head disk storage	No	No	No	No	Fixed-head disk; 1.9M bytes
Magnetic tape cassettes/cartridges	Cassette; 1 KBS	Cassette; 1 KBS	Cassette; 1 KBS	Cassette; 1 KBS	Cassette; 1 KBS
Magnetic tape, ½-inch	10 KBS	No	10 KBS	10 KBS	10-120 KBS
Punched card input	480 cpm	No	600 cpm	300-800 cpm	300-1400 cpm
Serial printer	60, 90 cps	60, 180 cps	60 cps	No	No
Line printer	90-250 lpm	160, 250 lpm	85-400 lpm	85-750 lpm	85-1040 lpm
Data communications interface	9600 bps	9600 bps	9600 bps	9600 bps	9600 bps
CRT	32 char. x 8 lines	32 char. x 8 lines	80 char. x 24 lines	No	80 char. x 24 lines
Other standard peripheral units	Mag. ledger card reader	—	Card punch, card reader/punch	Up to 2 data communications processors; reader/punch/data record.	Card punch, card reader/punch
<b>SOFTWARE</b>					
Assembler	Assembler	No	No	Assembler	No
Compilers	COBOL	COBOL, RPG	COBOL, RPG, AEL	COBOL, RPG, NDL, MPL	COBOL, FORTRAN, RPG, BASIC, UPL, NDL
Operating system	—	Batch	Real-time	Batch, real-time	Batch, real-time, time-sharing
Language implemented in firmware	Fully	Fully	Fully	Fully	Fully
Operating system implemented in firmware	—	Fully	Fully	Fully	Fully
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$16,490 (4K bytes)	\$19,510 (32K bytes)	\$20,900 (32K bytes)	\$17,600-\$23,500	\$22,225
Price of memory increment	\$800 (2K bytes); \$1,400 (4K bytes)	\$900 (4K bytes)	\$2,280 (8K bytes)	\$2,800 (8K bytes)	\$3,000 (32K bytes)
Date of first delivery	June 1975	April 1976	March 1973	1974	3rd qtr. 1972
Number installed to date	Thousands	5500 on order	NA	NA	Over 1300 total
<b>COMMENTS</b>	Six models: L 9300, L 9400, and L 9500 with 60-cps printer, L 9700, L 9800, and L 9900 with 90-cps printer; L 9500 and L 9900 have mag. ledger capability	Offers the technology of Burroughs' larger computers	System price includes console printer; AEL and COBOL or RPG programs can run concurrently	Systems and communications processors; not all models allow all features presented	See Report 70C-112-04 for more details

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MANUFACTURER & MODEL	Burroughs B 1720 Series	Cascade Data Concept II	Century Computer 200	Century Computer 400	CII Mitra 15-35
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	64 — Variable	16 16-32 16-40	8-bit byte 8 8, 16, 24	16 + 5 16 8, 16, 24	16 + 2 16 16
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 1.0 0.67 48K bytes 378K bytes Standard No Standard	Core 1.2 0.35 16K 64K Standard No No	MOS 0.6 0.2 32K bytes 64K bytes No No No	MOS 0.6 0.2 32K bytes 512K bytes Optional Optional Optional	Core 0.8 0.3 16K 64K Standard No Standard
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	None to user None to user — — ROM; to 8K bytes  — — No — — —	16 3 32K 2 No  8.8 Standard No Standard No Optional	16 16 64K bytes 17 PROM; to 2K bytes  2.6 Optional Standard Standard No No	16 16 64K bytes 17 PROM; to 2K bytes  2.6 Optional Standard Standard Optional Optional	32 — — — —  2.3 Standard No Standard — Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	— — —	Standard 413K 0	Optional 1M 15; 120	Standard 1M 120	Optional — —
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives  Drum/fixed-head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, ½-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	No Pack & cartridge; 2.3-697.6M bytes Fixed head disk; 1.9-70M bytes Cassette; 1 KBS  10-120 KBS 300-1400 cpm No 85-1040 lpm 9600 bps 80 char. x 24 lines Card punch, card reader/punch	No Cartridge; 40M bytes No  No 30, 60 KBS 300 cpm 55 cps 125-600 lpm 9600 bps 80 char. x 16 lines Paper tape reader, paper tape punch	No Pack & cartridge; 10-1200M bytes No  Cassette; 300 cps  120 KBS 300, 600 cpm 165 cps 300, 600 lpm Up to 9600 bps 80 char. x 24 lines Paper tape reader	No Pack & cartridge; 10-1200M bytes No  Cassette; 300 cps  120 KBS 300, 600 cpm 165 cps 300, 600 lpm Up to 9600 bps 80 char. x 24 lines Paper tape reader	4M bytes Pack & cartridge; 40-600M bytes Fixed-head; 1.6M bytes Cassette  40 KBS 300, 600 cpm 180 cps 200-400 lpm 19.2K bps; synch 80 char. x 24 lines Card punch
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	No  COBOL, FORTRAN, RPG, BASIC, UPL, NDL Batch, real-time, time-sharing Fully Fully	Macro assembler  RPG  Batch, real-time, time sharing No No	Yes  BASIC, CPL  Batch, real-time  No No	Yes  BASIC, CPL  Batch, real-time  No Partially	Macro assembler  COBOL, FORTRAN, PROCOL Batch, real-time  Partially Partially
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$87,300 \$3,000 (32K bytes)  2nd qtr. 1973 Over 1300 total	\$22,200 (16K bytes) \$1,200 (16K bytes) \$2,700 (32K bytes) January 1970 150	\$13,070 (32K bytes) \$5,300 (32K bytes) February 1971 Over 600	\$15,070 (32K bytes) \$5,300 (32K bytes) March 1975 117	\$28,000 NA  1972 (Europe) 425 (Europe)
<b>COMMENTS</b>	See Report 70C-112-04 for more details	Operating system provides two parti- tions; system price includes CRT and cartridge disk	System price also includes RS-232C interface; system is intended pri- marily for sys- tem/turnkey houses and deal- ers; volume dis- counts available	System price also includes RS-232C interface; system is intended pri- marily for sys- tem/turnkey houses and deal- ers; volume dis- counts available	Asynchronous communications at up to 1200 bps

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MANUFACTURER & MODEL	CII Mitra 105	CII Mitra 125	Cincinnati Milacron CIP/2200B	Cincinnati Milacron CIP/4400	Computer Automation Naked Milli LSI-3/05
<b>DATA FORMATS</b>					
Word length, bits	16 + 1	16 + 2	16	16	16
Fixed-point operand length, bits	16	16	8-32	8-32	8, 16, 32
Instruction length, bits	16	16	8-64	8-64	16, 32, 48
<b>MAIN STORAGE</b>					
Storage type	MOS, Core	Core	MOS	MOS	Core, MOS
Cycle time, microseconds/word	0.85; 0.6	0.9	1.1	0.9	0.98-1.6
Access time, microseconds/word	0.4; 0.35	0.35	0.66	0.6	0.5-0.8
Minimum capacity, words	4K	32K	32K bytes	32K bytes	512
Maximum capacity, words	32K	1024K	64K bytes	96K bytes	8K
Parity checking	—	—	Optional	Standard	No
Error correction	—	—	No	No	No
Storage protection	—	—	Standard	Standard	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	6	64	3	3	2
No. of index registers	—	—	1	1	1
No. of directly addressable words	—	—	32K	32K	128
No. of addressing modes	—	—	9	9	8
Control storage	—	—	ROM; 3590 bytes	ROM	ROM; 512 x 24 bits
Add time, microseconds	1.75	1.9	12.43	12.43	6.25 (2 digits)
Hardware multiply/divide	—	—	No	Standard	No
Hardware floating point	—	—	No	No	No
Hardware byte manipulation	—	—	Standard	Standard	Standard
Battery backup	—	—	No	Standard	Optional
Real-time clock or timer	—	—	Standard	Standard	Optional
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	—	—	Optional	Optional	Standard
Maximum I/O rate, words/sec	—	—	909K	1.2M	250K
No. of external interrupt levels	—	—	64	64	1
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	1M bytes	512K bytes	630K-2.5M bytes	630K-2.5M bytes	243-972K bytes
Disk pack/cartridge drives	No	Pack & cartridge; 40-600M bytes	Cartridge; to 160M bytes	Cartridge; to 160M bytes	Cartridge; 4.92-19.68M bytes
Drum/fixed-head disk storage	No	Fixed-head; 1.6M bytes	No	No	No
Magnetic tape cassettes/cartridges	Cassette	Cassette	No	No	No
Magnetic tape, 1/2-inch	No	120 KBS	No	20 KBS	20 KBS
Punched card input	No	300, 600 cpm	600 cpm	600 cpm	285 cpm
Serial printer	180 cps	180 cps	165, 330 cps	165, 330 cps	100, 165 cps
Line printer	No	200-600 lpm	300, 600 lpm	300, 600 lpm	No
Data communications interface	1000 bps; synch.	100K bps; synch.	9600 bps	9600 bps	To 9600 bps
CRT	80 char. x 24 lines	80 char. x 24 lines	80 char. x 12 lines	80 char. x 12 lines	80 char. x 24 lines
Other standard peripheral units	—	Card punch	Card reader/punch	Card reader/punch	Paper tape reader, paper tape reader/ punch
<b>SOFTWARE</b>					
Assembler	Assembler	Assembler	Macro assembler	Macro assembler	Macro assembler
Compilers	FORTTRAN, LP 15	COBOL, FORTTRAN, PROCOL	RPG	RPG	FORTTRAN
Operating system	Batch	—	Batch, real-time	Batch, real-time	Real-time
Language implemented in firmware	Partially	Partially	Fully	Fully	No
Operating system implemented in firmware	Partially	Partially	No	No	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$7,000	\$35,000	\$5,400 (32K bytes)	\$16,100 (32K bytes)	\$725 (4K MOS)
Price of memory increment	NA	NA	\$2,250 (8K bytes)	\$2,250 (8K bytes) \$3,500 (16K bytes)	\$550 (4K MOS)
Date of first delivery	June 1976 (Eur.)	1st qtr. 1976 (Eur.)	June 1973	July 1976	January 1975
Number installed to date	75 (Europe)	185 (Europe)	NA	NA	NA
<b>COMMENTS</b>	Asynchronous communications at up to 1200 bps	Cartridge disk and serial printer are included in basic price; asynchronous communications at up to 9600 bps	See Report M11-168-201 for more details	Packaged system including CPU with 32K bytes, 60-cps printer, dual floppy disk drives, CRT display console, and 30-inch desk; accounting software available	ROM/EPROM & RAM/ROM/PROM are available in combination; ROM, PROM, EROM available in max. capacities of 8K, 2K, & 4K words, respectively

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MANUFACTURER & MODEL	Computer Automation Naked Milli LSI-2/10 & 2/20	Computer Automation MegaByter LSI-2/60	Computer Hardware Inc. 2120	Computer Hardware Inc. 2130	Computer Hardware Inc. 3230
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 2 8, 16, 32 16, 32, 48	16 + 2 8, 16, 32 16, 32	16 16 16-64	16 16 16-64	16 16 16-64
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core, MOS 0.85-1.2 0.4-0.6 8K 262K Optional No No	Core, MOS 0.85-1.2 0.4-0.6 8K 512K Optional No No	MOS 1.8 0.35 8K 16K Standard No No	MOS 0.8 0.25 8K 64K Standard No Optional	MOS 0.8 0.25 8K 256K Standard No Optional
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	2 1 32K 8 ROM; 256 x 56 bits 4.12, 2.06 Standard No Standard Optional Optional	2 1 32K 8 ROM; 512 x 56 bits 2.06 Standard No Standard Optional Optional	8 6 16K — — 3.6 Standard No No No Optional	8 6 16K — — 1.6 Standard Optional No No Optional	8 6 16K — — 1.6 Standard Optional No No Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1M 3	Standard 1M 3	Standard 625K 8	Standard 1.25M 8	Standard 1.25M 8
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives  Drum/fixed-head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, ½-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	243-972K bytes Cartridge; 4.92-19.68M bytes No  No  20 KBS 285 cpm 100, 165 cps No 110-50K bps 80 char. x 24 lines Paper tape reader, paper tape reader/ punch	243-972K bytes Cartridge; 4.92-19.68M bytes No  No  20 KBS 285 cpm 100, 165 cps No 110-50K bps 80 char. x 24 lines Paper tape reader, paper tape reader/ punch	No Pack; 20M bytes  No  No  Yes 300-1000 cpm No 300, 600 lpm To 4800 bps; synch. 80 char. x 24 lines Card reader/punch, paper tape reader, paper tape punch, plotter	No Pack; 320M bytes  No  No  Yes 300-1000 cpm No 300, 600 lpm To 4800 bps; synch. 80 char. x 24 lines Card reader/punch, paper tape reader, paper tape punch, plotter	No Pack; 460M bytes  Fixed-head; 2M bytes No  Yes 300-1000 cpm No 300, 600 lpm To 4800 bps; synch. 80 char. x 24 lines Card reader/punch, paper tape reader, paper tape punch, plotter
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Macro assembler  FORTRAN, BASIC  Batch, real-time, multi-tasking No No	Macro assembler  FORTRAN, BASIC  Batch, real-time, multi-tasking No No	Assembler & macro assembler RPG, COBOL, FORTRAN  Batch  No No	Assembler & macro assembler RPG, COBOL, FORTRAN  Batch, time-sharing  No No	Assembler & macro assembler RPG, COBOL, FORTRAN  Batch, time-sharing  No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$1,750 (4K 2/10); \$2,765 (4K 2/20) \$985 (4K words core) July 1973 NA	\$6,850 (8K core)  \$1,950 (8K core) \$550 (4K RAM) NA NA	\$29,000  — 1975 NA	\$60,000  — 1974 NA	\$77,000  — 1976 NA
<b>COMMENTS</b>	ROM/EPROM & RAM/ROM/PROM are available in combination; ROM, PROM, EROM available in max. capacities of 8K, 2K, & 4K words respectively; 2/20 is identical to 2/10 but twice as fast	Used as basis for SyFA business sys- tem	Asynchronous communications to 9600 bps; sys- tem price also in- cludes CRT and disk pack drive	Asynchronous communications to 9600 bps; sys- tem price also in- cludes CRT and disk pack drive	Asynchronous communications to 9600 bps; sys- tem price also in- cludes disk pack drive

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MANUFACTURER & MODEL	Computer Talk Model CT-400	Computer Technology CTL 8010	Computer Technology CTL 8030	Computer Technology CTL 8050	Control Data Cyber 18-17
<b>DATA FORMATS</b>					
Word length, bits	16 + 2	16	16	16 + 1	16 + 1
Fixed-point operand length, bits	16, 32	16	16	16	16
Instruction length, bits	16	16	16	16	16, 32
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	MOS	Core	MOS
Cycle time, microseconds/word	0.5; 0.3	—	—	0.7	0.6, 0.9
Access time, microseconds/word	0.3; 0.15	—	—	0.4	—
Minimum capacity, words	4K	16K bytes	56K bytes	96K bytes	4K
Maximum capacity, words	512K	112K bytes	112K bytes	448K bytes	64K
Parity checking	Optional	No	No	Standard	Standard
Error correction	Optional	No	No	No	No
Storage protection	See comments	Standard	Standard	Standard	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	12 (4 more opt.)	5	5	5	2
No. of index registers	2	0	0	0	2 (1 in memory)
No. of directly addressable words	32K	112K bytes	112K bytes	—	256
No. of addressing modes	—	—	22	22	7
Control storage	PROM; 512 words	No	No	No	No
Add time, microseconds	1	2.0	1.3	1.2	1.8
Hardware multiply/divide	Standard	Standard	Standard	Standard	Standard
Hardware floating point	Standard	No	No	No	Optional
Hardware byte manipulation	Standard	No	No	Optional	Optional
Battery backup	Standard	—	—	—	Optional
Real-time clock or timer	Standard	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1M	450K	600K	1.3M	1.6M
No. of external interrupt levels	1-16	8; 96	8; 96	8; 96	2-16
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	10M bytes	No	No	No	262-520K bytes
Disk pack/cartridge drives	Pack & cartridge; 145K-50M bytes	No	Pack & cartridge; 9.6-192M bytes	Pack & cartridge; 9.6-384M bytes	Pack; 25-400M bytes
Drum/fixed-head disk storage	Fixed-head; 1.2-50M bytes	No	No	No	No
Magnetic tape cassettes/cartridges	Cassette & cartridge; 30-800 cps & 4 KBS	No	No	No	No
Magnetic tape, ½-inch	5-120 KBS	No	No	120 KBS	20 KBS
Punched card input	200-1000 cpm	400 cpm	400 cpm	400, 600 cpm	400, 600 cpm
Serial printer	10-200 cps	165 cps	165 cps	165 cps	No
Line printer	125-600 lpm	300, 600 lpm	300, 600 lpm	300, 600 lpm	300, 600 lpm
Data communications interface	50-9600 bps	Up to 9600 bps	Up to 9600 bps	Up to 9600 bps	Up to 9600 bps
CRT	64 char. x 20 lines	80 char. x 25 lines	80 char. x 25 lines	80 char. x 25 lines	80 char. x 24 lines
Other standard peripheral units	Card punch, card reader/punch, A/D & D/A converters, plotter	Paper tape reader, paper tape punch	Paper tape reader, paper tape punch, plotter	Paper tape reader, paper tape punch, plotter	A/D & D/A converters
<b>SOFTWARE</b>					
Assembler	Assembler & macro assembler	No	No	Yes	Assembler & macro assembler
Compilers	BASIC, FORTRAN IV	FORTRAN, BASIC	COBOL, FOR- TRAN, BASIC, CORAL, RPG	COBOL, FOR- TRAN, BASIC, CORAL, RPG	FORTRAN, BASIC, AUTRAN
Operating system	Batch, real-time, time-sharing	Batch, time-sharing	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time
Language implemented in firmware	Part; all opt.	No	No	No	No
Operating system implemented in firmware	Partially	No	No	No	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$24,950 (4K MOS)	\$23,140 (16K bytes)	\$44,500 (56K bytes)	\$80,100 (96K bytes)	About \$15,000
Price of memory increment	\$1,600 (4K MOS)	—	—	—	—
Date of first delivery	May 1975	NA	NA	May 1976	July 1973
Number installed to date	NA	NA	NA	NA	Over 300
<b>COMMENTS</b>	Storage protection std. by memory partition and opt. by page; mapping to 512K opt.; 4K PROM opt.; on power failure, memory is dumped to protected disk; price includes CRT, light pen, modem, 1.2M-byte disk, & arith. & I/O processors		System price also includes 500-cps paper tape reader	System price also includes 500-cps paper tape reader	

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MANUFACTURER & MODEL	Control Data Cyber 18 Series	Data General Nova 3/4	Data General Nova 3/12, 3-D	Data General Eclipse S/100	Data General Eclipse S/200
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 5 or + 1 16 16, 32	16 + 1 16 16	16 + 1 16 16	16 + 5 16 16, 32	16 + 5 16 16, 32
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 0.75 0.3 16K 128K Standard Optional Standard	Core, MOS 0.7 0.35 4K 32K Optional No No	Core, MOS 0.7 0.35 4K 32K Optional No No; see comments	Core, MOS 0.8, 0.7 0.4, 0.5 8K 32K No Optional No	Core, MOS 0.8, 0.7 0.4, 0.5 16K 128K No Optional Optional
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	6 6 64K 8 ROM; 8K bytes  1.76 Standard No Standard Optional Optional	4 2 256 6 No  0.7 Optional No No Optional Optional	4 2 256 6 No  0.7 Optional Optional No Optional Optional	4 2 32K 7 See comments  0.6 Standard No Standard No Optional	4 2 32K 7 ROM; 256 x 56 bits 0.6 Standard Optional Standard No Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1.2M 2-16	Standard 1.10M 16	Standard 1.10M 16	Standard 1.25M 16	Standard 1.25M 16
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives  Drum/fixed head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	560K bytes Pack; 25-400M bytes No  No  20 KBS 300, 600 cpm No 300, 600 lpm Up to 9600 bps 80 char. x 24 lines None	315K-1.25M bytes Cartridge; 2.5-10M bytes Fixed-head; 256K-1M bytes Cassette; 1.6 KBS  10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm Up to 9600 bps 80 char. x 24 lines Modular digital & analog data control & acquisition sub-system optional	315K-2.5M bytes Pack & cartridge; 2.5-736M bytes Fixed-head; 256K-2M bytes Cassette; 1.6 KBS  10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm Up to 9600 bps 80 char. x 24 lines Modular digital & analog data control & acquisition sub-system optional	315K-2.5M bytes Pack & cartridge; 2.5-736M bytes Fixed-head; 256K-2M bytes Cassette; 1.6 KBS  10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm Up to 9600 bps 80 char. x 24 lines Modular digital & analog data control & acquisition sub-system optional	315K-2.5M bytes Pack & cartridge; 2.5-736M bytes Fixed-head; 256K-2M bytes Cassette; 1.6 KBS  10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm Up to 9600 bps 80 char. x 24 lines Modular digital & analog data control & acquisition sub-system optional
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Macro assembler  FORTRAN, BASIC  Batch, real-time, time-sharing No No	Assembler & macro assembler FORTRAN, BASIC, ALGOL  Real-time No No	Assembler & macro assembler FORTRAN, BASIC, ALGOL  Batch, real-time, time-sharing No No	Assembler & macro assembler FORTRAN, BASIC, ALGOL  Batch, real-time, time-sharing No No	Assembler & macro assembler FORTRAN, BASIC, ALGOL  Batch, real-time, time-sharing No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$27,840 (16K words) — May 1976 NA	\$2,600 (4K MOS) — April 1976 NA	\$3,600 (4K MOS) — April 1976 NA	\$9,200 (8K core) \$4,500 (16K core); \$8,500 (32K MOS) February 1975 1000+ (all models)	\$16,300 (16K core) \$4,500 (16K core); \$8,500 (32K MOS) February 1975 1000+ (all models)
<b>COMMENTS</b>	System price also includes card reader & CRT	4-slot chassis; auto program load and power monitor/ auto restart opt.	12-slot chassis; memory management unit standard; memory allocation and protection unit standard on 3-D	256 56-bit words of writable control store optionally available	256 56-bit words of writable control store, memory allocation and protection unit optionally available



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MANUFACTURER & MODEL	Data General Eclipse S/230	Data General Eclipse C/300	Data General Eclipse C/330	Datapoint 1100	Datapoint 2200
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 5 16 16, 32	16 + 5 16 16, 32	16 + 5 16 16, 32	8-bit byte 8 8-24	8-bit byte 8 8-24
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core, MOS 0.8, 0.7 0.4, 0.5 16K 256K No Optional Optional	Core, MOS 0.8, 0.7 0.4, 0.5 16K 128K No Optional Optional	Core, MOS 0.8, 0.7 0.4, 0.5 16K 256K No Optional Optional	MOS 3.2 1.6 4K bytes 16K bytes No No No	MOS 3.2 1.6 4K bytes 16K bytes No No No
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	4 2 32K 7 ROM; 256 x 56 bits 0.6 Standard Optional Standard No Optional	4 2 32K 7 ROM; 2K x 56 bits 0.6 Standard Standard Standard No Optional	4 2 32K 7 ROM; 2K x 56 bits 0.6 Standard Standard Standard No Optional	5 9 16K bytes 2 No 4.8 No No Standard No Optional	5 9 16K bytes 2 No 4.8 No No Standard No Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1.25M 16	Standard 1.25M 16	Standard 1.25M 16	No 195K 1	No 195K 1
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives Drum/fixed-head disk storage Magnetic tape cassettes/cartridges Magnetic tape, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	315K-2.5M bytes Pack & cartridge; 2.5-736M bytes Fixed-head; 256K-2M bytes Cassette; 1.6 KBS 10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm Up to 9600 bps 80 char. x 24 lines Modular digital & analog data control & acquisition sub- system optional	315K-2.5M bytes Pack & cartridge; 2.5-736M bytes Fixed-head; 256K-2M bytes Cassette; 1.6 KBS 10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm Up to 9600 bps 80 char. x 24 lines Modular digital & analog data control & acquisition sub- system optional	315K-2.5M bytes Pack & cartridge; 2.5-736M bytes Fixed-head; 256K-2M bytes Cassette; 1.6 KBS 10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm Up to 9600 bps 80 char. x 24 lines Modular digital & analog data control & acquisition sub- system optional	256K-1M bytes No No Cassette; 352 cps 9.6-20 KBS 300 cpm 120 cps 300, 600 lpm Up to 9600 bps 80 char. x 12 lines —	256K-1M bytes Pack & cartridge; 2.4-50M bytes No Cassette; 352 cps 9.6-20 KBS 300 cpm 120 cps 300, 600 lpm Up to 9600 bps 80 char. x 12 lines —
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler FORTRAN, BASIC, ALGOL Batch, real-time time-sharing No No	Assembler & macro assembler FORTRAN, BASIC, ALGOL Batch, real-time, time-sharing No No	Assembler & macro assembler FORTRAN, BASIC, ALGOL Batch, real-time, time-sharing No No	Yes BASIC, RPG II, SCRIBE, DATA- BUS, DATAFORM Batch No No	Yes BASIC, RPG II, SCRIBE, DATA- BUS, DATAFORM Batch, time-sharing No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min mem. in chassis Price of memory increment Date of first delivery Number installed to date	\$15,000 (16K core) \$4,500 (16K core); \$8,500 (32K MOS) November 1976 1000+ (all models)	\$30,700 (32K core) \$4,500 (16K core); \$8,500 (32K MOS) August 1975 1000+ (all models)	\$30,000 (32K core) \$4,500 (16K core); \$8,500 (32K MOS) October 1976 1000+ (all models)	\$7,200 (4K bytes) \$840 (4K bytes) January 1974 6000	\$8,571 (4K bytes) \$1,432 (4K bytes); \$1,647 (8K bytes) April 1972 9000
<b>COMMENTS</b>	256 56-bit words of writable control store, extended memory allocation and protection unit optionally available; error correction std. on MOS, opt. on core	Extended arithmetic processor standard; memory allocation and protection unit optional; error correction std. on MOS, opt. on core	Extended arithmetic processor standard; extended memory allocation and protection unit optional; error correction std. on MOS, opt. on core; IDEA software	System price also includes integral CRT/keyboard and dual cassette tape drives; diskette-based system also available with 16K bytes of memory for \$12,880; the 1150 is an augmented 1100 with a 5500 instruction set for \$14,480	System price also includes integral CRT/keyboard and dual cassette tape drives

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MANUFACTURER & MODEL	Datapoint 5500	Datsaab Systems 5051 & 5052	Datsaab Systems 5020	Datum Enhancer	Decision Data System/4
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte 8 8-24	16 1-255 digits 16-128	16 + 2 8, 16 16	16 16 16, 32	8-bit byte 8 16-32
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 1.6 0.8 48K bytes 48K bytes Standard No Standard	Core 0.98; 1.2 — 4K; 8K 32K No No Standard	Core 1.2 — 4K 32K Standard No Standard	Core 0.80 0.20 16K 64K No No Optional	MOS 1 0.5 32K bytes 64K bytes Standard No No
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	5 11 48K bytes 2 ROM; 4K bytes 1.4 No No Standard No Optional	7 7 32K 8 — 3.2 Standard No Standard No Optional	8 3 256 3 — 7.2 No No Standard No Optional	6 4 16K 3 ROM & WCS; 4.6K 0.8 Standard Optional Standard No Standard	6 6 64K 3 ROM; 2K — Standard No Standard No Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	No 195K 9	Standard 1M 5	Optional — —	Standard 1.2M 64	Standard 400K 8
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives Drum/fixed-head disk storage Magnetic tape cassettes/cartridges Magnetic tape, ½-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	256K-1M bytes Pack & cartridge; 2.4-200M bytes No Cassette; 352 cps 9.6-20 BKS 300 cpm 120 cps 300, 600 lpm Up to 9600 bps 80 char. x 12 lines —	No Cartridge; 5-40M bytes No Cassette; 756 cps 10 KBS No 15-330 cps 200 lpm To 9600 bps 64 char. x 16 lines Paper tape reader, paper tape punch	256K-1M bytes No No Cassette; 756 cps No No 15-330 cps 200 lpm To 9600 bps 40 char. x 12 lines Paper tape reader, paper tape punch	No Cartridge; 2.5-100M bytes No Cassette & car- tridge; 1 KBS 10-240 KBS 285-1000 cpm No 300-1200 lpm 100-9600 bps —	1-3M bytes Cartridge; 5-40M bytes No No No 300-1200 cpm 120 cps 300 lpm Up to 9600 bps 80 char. x 24 lines None
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	Yes BASIC, RPG II, SCRIBE, DATA- BUS, DATAFORM Batch, time- sharing No No	No Logic-3/MALL Time-sharing No No	Yes DIL-5 Time-sharing No No	Micro assembler No No No	No RPG, Phrase Batch, interac- tive No Partially
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment Date of first delivery Number installed to date	\$33,888 (48K bytes) CPU cannot be expanded December 1974 500	\$45,000 (8K words) \$2,000 (8K words) NA NA	— — 1971 3000	\$12,975 (16K words) \$3,400 (16K words) March 1976 15	\$20,000 (32K bytes) \$1,450 (16K bytes) July 1975 15
<b>COMMENTS</b>	System price also includes integral CRT/ keyboard and dual cassette tape drives	Basis for Datsaab D15 business minicomputer system; interpreter-based system for up to 16 simultaneous users; system price also includes 10-mega-byte disk drive, CRT workstation, and serial printer	Basis for Datsaab D5/20 business minicomputer system; terminal oriented system for data collection and on-line data entry; intelligent terminals can process data locally	Microcomputer-based emulator of General Automation SPC-16; user-microprogrammable; can support all GA software; GA 16/440 emulator is also available	System price also includes CRT, floppy disk drive, and serial printer

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MANUFACTURER & MODEL	Digital Computer Controls D-216	Digital Computer Controls D-316	Digital Computer Controls D-416	Digital Computer Controls D-616	Digital Computer Controls Mod 5
<b>DATA FORMATS</b>					
Word length, bits	16 + 2 or + 5	16 + 2 or + 5	16	16 + 2 or + 5	16 + 2 or + 5
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	MOS	Core	Core, MOS	Core, MOS
Cycle time, microseconds/word	1.6	1.6	1.6	0.66	0.8; 1.0; 1.2
Access time, microseconds/word	0.6	0.6	0.6	0.3	0.4; 0.5
Minimum capacity, words	1K	4K	4K	4K	4K
Maximum capacity, words	32K	32K	32K	1024K	128K
Parity checking	Optional	Optional	No	Optional	Optional
Error correction	Optional	Optional	No	Optional	Optional
Storage protection	No	No	No	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	8	8	8	8	8
No. of index registers	2 + 16 in memory	2 + 16 in memory	2 + 16 in memory	4 + 16 in memory	2 + 16 in memory
No. of directly addressable words	256	256	256	256	256
No. of addressing modes	6	6	6	6	6
Control storage	PROM; 512 x 33 bits	PROM; x 512 x 33 bits	PROM; 512 x 33 bits	See Comments	PROM; 512 x 48 bits
Add time, microseconds	1.57	1.57	1.57	0.66	0.8, 1.0, 1.2
Hardware multiply/divide	Standard	Standard	Standard	Optional	Optional
Hardware floating point	No	No	No	Optional	Optional
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Battery backup	Optional	Optional	No	Optional	Optional
Real-time clock or timer	Optional	Optional	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	625K	625K	625K	1.5M	1.25M
No. of external interrupt levels	16	16	16	16	16
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	256K-2.08M bytes	256K-2.08M bytes	256K-2.08M bytes	256K-2.08M bytes	256K-2.08M bytes
Disk pack/cartridge drives	Pack & cartridge; 2.4-640M bytes	Pack & cartridge; 2.4-640M bytes	Pack & cartridge; 2.4-640M bytes	Pack & cartridge; 2.4-640M bytes	Pack & cartridge; 2.4-640M bytes
Drum/fixed-head disk storage	No	No	No	No	No
Magnetic tape cassettes/cartridge	Cassette; 1.5 KBS	Cassette; 1.5 KBS	Cassette; 1.5 KBS	Cassette; 1.5 KBS	Cassette; 1.5 KBS
Magnetic tape, ½-inch	2.5-120 KBS	2.5-120 KBS	2.5-120 KBS	2.5-120 KBS	2.5-120 KBS
Punched card input	150-600 cpm	150-600 cpm	150-600 cpm	150-600 cpm	150-600 cpm
Serial printer	30 cps	30 cps	30 cps	30 cps	30 cps
Line printer	60-600 lpm	60-600 lpm	60-600 lpm	60-600 lpm	60-600 lpm
Data communications interface	250K bps; synch.	250K bps; synch.	250K bps; synch.	250K bps; synch.	250K bps; synch.
CRT	80 char. x 24 lines	80 char. x 24 lines	80 char. x 24 lines	80 char. x 24 lines	80 char. x 24 lines
Other standard peripheral units	Paper tape units, A/D & D/A converters, card punch, plot., TTY	Paper tape units, A/D & D/A converters, card punch, plot., TTY	Paper tape units, A/D & D/A converters, card punch, plot., TTY	Paper tape units, A/D & D/A converters, card punch, plot., TTY	Paper tape units, A/D & D/A converters, card punch, plot., TTY
<b>SOFTWARE</b>					
Assembler	Macro assembler	Macro assembler	Macro assembler	Macro assembler	Macro assembler
Compilers	FORTRAN & BASIC	FORTRAN & BASIC	FORTRAN & BASIC	FORTRAN & BASIC	FORTRAN & 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
Language implemented in firmware	No	No	No	No	No
Operating system implemented in firmware	No	No	No	No	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$2,700 (1K words)	\$2,900 (4K words)	\$3,400 (4K words)	\$7,260 (4K words)	\$3,075 (4K words)
Price of memory increment	—	—	\$1,110 (4K words)	\$1,860 (4K words)	\$1,800 (4K words)
Date of first delivery	NA	NA	September 1975	September 1975	February 1976
Number installed to date	NA	NA	50-75	25	25-50
<b>COMMENTS</b>					
	CPU, power fail/ auto restart, TTY interface, & up to 32K words of memory on one PC board; asynch. communications to 19.2K bps	CPU, power fail/ auto restart, TTY interface, & up to 32K words of memory on one PC board; asynch. communications to 19.2K bps	CPU, power fail/ auto restart, TTY interface, & up to 32K words of memory on one PC board; asynch. communications to 19.2K bps	512 x 50-bit PROM std.; 1K x 33 bits of WCS optional; dual ported asynchronous memory; 2-speed DMA; memories can be mixed; asynch. communications to 19.2K bps	Two software-selectable interrupt modes; mixed core and MOS memories allowed; asynch. communications to 19.2K bps

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MANUFACTURER & MODEL	Digital Equipment PDP-8/A	Digital Equipment PDP-11/03	Digital Equipment PDP-11/04	Digital Equipment PDP-11/34	Digital Equipment PDP-11/35 & 11/40
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	12 12 12	16 16 16, 32, 48	16 + 2 16 16, 32, 48	16 + 2 16 16, 32, 48	16 + 2 16 16, 32, 48
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core; MOS 1.2; 1.5; 2.4 0.6; 0.75; 2.4 1K 32K No No No	Core; MOS 1.2; 1.2 — 4K 32K No No No	Core; MOS 0.98; 0.725 0.51; 0.635 16K 32K Standard No No	Core; MOS 0.98; 0.725 0.51; 0.635 16K 124K Standard No Standard	Core 0.98 0.36 8K 124K Optional No Optional
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	1 8 per 4K (in mem.) 256 4 — 3.0-3.8 Optional Optional No Optional Optional	6 6 32K 8 ROM; PROM; 1K 3.5 Optional Optional Standard No Optional	6 6 32K 8 — 3.17 Optional Optional Standard No Standard	6 6 32K 8 — 2.03 Optional Optional Standard Optional Standard	6 6 32K 8 No 1.07 Optional Optional Standard No Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 526-667K 1-64	Standard 833K Variable	Standard 2M Variable	Standard — Variable	Standard 2M Variable
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives Drum/fixed-head disk storage Magnetic tape cassettes/cartridges Magnetic tape, ½-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	128K-2M (6-bit) Cartridge; 3.2-12.8M (6-bit) No Cassette; 562 cps 10-36 KBS 300 cpm 180 cps 230 lpm 110-71K bps 80 char. x 24 lines DECtape, 8325 words/sec; A/D converter, paper tape reader, paper tape punch	256-512K bytes No No No No 50-56,000 bps 80 char. x 24 lines Serial line and parallel line controllers	256-512K bytes Cartridge & pack; 2.5-1408M bytes Fixed-head; 512K-8M bytes Cassette; 562 cps 10-72 KBS 285-1200 cpm 30-180 cps 230-1200 lpm 50-56,000 bps 80 char. x 24 lines DECtape, 8325 words/sec.; paper tape reader, paper tape punch	256-512K bytes Cartridge & pack; 2.5-1408M bytes Fixed-head; 512K-8M bytes Cassette; 562 cps 10-72 KBS 285-1200 cpm 30-180 cps 230-1200 lpm 50-56,000 bps 80 char. x 24 lines DECtape, 8325 words/sec.; paper tape reader, paper tape punch	256-512K bytes Cartridge & pack; 2.5-1408M bytes Fixed-head; 512K-8M bytes Cassette; 562 cps 10-72 KBS 285-1200 cpm 30-180 cps 230-1200 lpm 50-56,000 bps 80 char. x 24 lines DECtape, 8325 words/sec.; paper tape reader, paper tape punch
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler BASIC, DIBOL, ALGOL, FOCAL Batch, real-time, time-sharing No No	Assembler & macro assembler BASIC, FORTRAN Batch, real-time No No	Assembler & macro assembler BASIC, FORTRAN, FOCAL Batch, real-time, time-sharing No No	Assembler & macro assembler BASIC, FORTRAN, COBOL, FOCAL Batch, real-time, time-sharing No No	Assembler & macro assembler BASIC, FORTRAN, COBOL, FOCAL Batch, real-time, time-sharing No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment Date of first delivery Number installed to date	\$1,835-\$8,295 \$2,850 (8K core); \$1,230 (4K MOS) December 1974 Over 30,000	\$1,995 \$895 (4K core); \$625 (4K MOS) NA NA	\$7,695 (16K MOS) \$8,195 (16K core) \$1,700 (8K MOS); \$2,000 (8K core) NA NA	\$11,190 (16K core or MOS) \$1,700 (8K MOS); \$2,000 (8K core) NA NA	\$17,800 (16K 11/40) \$8,000 (32K core); \$4,400 (4K bipol.) NA NA
<b>COMMENTS</b>	Also available in packaged version called Datasystem 310	Packaged version of LSI-11 micro-computer; instruction set equivalent to PDP-11/40	Successor to PDP-11/05 and 11/10; upgradable to PDP-11/34 status	Uses similar technology to PDP-11/04; includes memory management for greater addressing capability; packaged version called Datasystem 530 is also available	PDP-11/35 is an OEM version of the PDP-11/40; packaged version is called Datasystem 350 based on PDP-11/40

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MANUFACTURER & MODEL	Digital Equipment PDP-11/45	Digital Equipment PDP-11/55	Digital Equipment PDP-11/70	Digital Equipment XVM	Digital Scientific Meta 4
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 2 16 16, 32, 48	16 + 2 16 16, 32, 48	16 + 2 16 16, 32, 48	18 18, 36 18	16 + 2 parity 16-32 16-32
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core;MOS;bipolar 0.98; 0.50; 0.30 — 32K 124K Standard No Standard	Core; bipolar 0.98; 0.30 — 16K 124K Standard No Standard	Core 0.98 0.36 64K 1024K Standard No Standard	Core 0.98 — 32K 128K No No Standard	Core 0.9 0.5 8K 128K Standard No Std. on 4/1800; Opt. on 4/1130
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	12 12 32K 8 — 0.30-0.97 Standard Optional Standard No Standard	12 12 32K 8 — 0.30-0.97 Standard Optional Standard No Standard	12 12 32K 8 — 0.30-1.20 Standard Optional Standard No Standard	1 1 8K 4 No 1.78 Standard Optional No No Standard	Up to 28 3 64K — ROM; to 4K words 2.9 Standard Optional No No Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 2M(core);4M(bi.) Variable	Standard 2M(core); 4m(bi.) Variable	Standard 2.9M Variable	Standard 1M Variable	Standard 1M Up to 32
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives Drum/fixed-head disk storage Magnetic tape cassettes/cartridges Magnetic tape, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	256-512K bytes Cartridge & pack; 2.5-1408M bytes Fixed-head; 512K-8M bytes Cassette; 562 cps 10-72 KBS 285-1200 cpm 30-180 cps 280-1200 lpm 50-56,000 bps 80 char. x 24 lines DEctape, 8325 words/sec.; paper tape reader, paper tape punch	256-512K bytes Cartridge & pack; 2.5-1408M bytes Fixed-head; 512K-8M bytes Cassette; 562 cps 10-72 KBS 285-1200 cpm 30-180 cps 230-1200 lpm 50-56,000 bps 80 char. x 24 lines DEctape, 8325 words/sec.; paper tape reader, paper tape punch	256-512K bytes Cartridge & pack; 2.5-1408M bytes Fixed-head; 512K-8M bytes Cassette; 562 cps 10-72 KBS 285-1200 cpm 30-180 cps 230-1200 lpm 50-56,000 bps 80 char. x 24 lines DEctape, 8325 words/sec.; paper tape reader, paper tape punch	No Cartridge & pack; 2.5-320M bytes No No 9-36 KBS 300, 1000 cpm 30-180 cps 300, 1200 lpm To 9600 bps 80 char. x 24 lines Graphics units, laboratory inter- faces	No Pack & cartridge; 1.2-160M bytes Fixed-head; 1-2M bytes No 30, 60 KBS 600, 1000 cpm No 300, 600 lpm Up to 9600 bps No Paper tape reader; paper tape punch
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler BASIC, FORTRAN, COBOL, FOCAL Batch, real-time, time-sharing No No	Assembler & macro assembler BASIC, FORTRAN, COBOL, FOCAL Batch, real-time, time-sharing No No	Assembler & macro assembler BASIC, FORTRAN, COBOL, FOCAL Real-time, interac- tive, time-sharing No No	Macro assembler FORTRAN, ALGOL, FOCAL Batch, real-time, multi-user No No	Assembler & macro assembler COBOL, RPG, FORTRAN, BA- SIC, APL, S11 Batch, real-time, time-sharing Partially No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment Date of first delivery Number installed to date	\$37,975 (32K core) \$8,000 (32K core); \$4,400 (4K bipol.) NA NA	\$48,000 (32K bipolar) \$8,000 (32K core); \$4,400 (4K bipol.) NA NA	\$60,000 (128K core) \$17,700 (64K core) NA NA	\$42,000 (32K) \$10,000 (32K) — 1200	\$33,850 (4/1130); \$39,360 (4/1800) \$9,925 (8K words); \$17,325 (16K words) 1970 230+ (both models)
<b>COMMENTS</b>	PDP-11/45 features two internal Uni- buses, one nor- mal-speed and one high-speed	PDP-11/55 is based on a PDP-11/45 with core and bipolar memory; designed for applications re- quiring high-speed calculations	Uses same tech- nology as PDP- 11/45 and in- cludes 2048 bytes of cache memory for in- creased perform- ance; disk stor- age & mag. tape periphs. avail. in packaged system called Datasystem 570	XVM systems are enhanced PDP-15 systems featuring a memory proces- sor that per- forms instruc- tion "look-ahead" using a 4-word instruction stack and a PDP-11/05 CPU as a front- end I/O pro- cessor	Can run most IBM 1130 and 1800 programs

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MANUFACTURER & MODEL	Digital Systems Galaxy/5	Financial Computer System III/10	Four Phase IV/40	Four Phase IV/70	Fujitsu Panafacom U-100
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte 8-2048 16, 32, 48	8-bit byte 8 8	24 15 24	24 15 24	16 + 2 8, 16, 32 16, 32, 48
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 0.75 0.50 32K bytes 1024K bytes Standard Standard No	MOS 0.6 0.2 4K bytes 256K bytes Optional Optional Optional	MOS 2 — 24K bytes 72K bytes Standard No No	MOS 2 — 24K bytes 96K bytes Standard No No	Core, MOS 1.5, 0.7 0.5, 0.53 4K 32K Standard No No
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	7 7 1M 2 ROM; 512 x 40 bits 20 Standard No Standard Optional Standard	Software-assigned 128 64K bytes 3 PROM, 1-16K bytes 3.2 Optional Optional Standard Optional Optional	5 3 73,728 — ROM; 1K x 48 bits 16 Standard Standard Standard — Standard	5 3 98,304 — ROM; 1K x 48 bits 16 Standard Standard Standard — Standard	8 7 32K 6 ROM; 1.5K bytes 2.8, 4.4 Standard No Standard Optional Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 50K 1	Standard 960K 16	No 125K 8	No 125K 8	Standard 1M 4
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives Drum/fixed-head disk storage Magnetic tape cassettes/cartridges Magnetic tape, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	No Pack; 32-240M bytes No No No No 120 cps 100-1300 lpm Up to 15K bps 80 char. x 24 lines None	266K-5M bytes Cartridge; 10-400M bytes No Cassette; 1.2 KBS 72 KBS 300, 600 cpm 165 cps 300-1250 lpm Up to 9600 bps 80 char. x 24 lines Paper tape reader, paper tape punch	354K bytes Cartridge; 2.5-10M bytes No No 300, 600 cpm 30 cps 245-700 lpm Up to 9600 bps 80 char. x 24 lines None	354K bytes Pack & cartridge; 2.5-270M bytes No No 10, 60 KBS 300, 600 cpm 30 cps 245-700 lpm Up to 9600 bps 48 char. x 6 lines None	243-486K bytes Pack & cartridge; 2.49-10M bytes Fixed-head; 1M bytes Cassette; 1 KBS 9.6-120 KBS 100-600 cpm 30-165 cps 160-1100 lpm 50-48,000 bps See Comments Paper tape units, optical mark reader, plotter, etc.
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler None Time-sharing No No	Yes BASIC, CPL, PL/X Batch, real-time No Partially	Yes None Batch, interac- tive Partially —	Yes COBOL, RPG Batch, interac- tive Partially —	Assembler & macro assembler FORTRAN, BASIC, COBOL Batch, real-time No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment Date of first delivery Number installed to date	\$25,440 (32K bytes) \$7,000 (32K bytes) December 1975 4	\$9,500 (8K bytes) \$4,000 (8K bytes); \$6,000 (16K bytes) January 1975 250+	\$30,315 (24K bytes) — June 1973 2300+ (IV/40, 70)	\$68,055 (24K bytes) — February 1971 2300+ (IV/40, 70)	— — August 1975 Over 200
<b>COMMENTS</b>	Larger memory sizes include additional CPU's; Galaxy/5 is a rather large multiprocessing data base oriented com- puter utilizing many micropro- cessors to assist in the computer's overall function- ing	Also available as a turnkey system with ap- plications soft- ware for manu- facturers, whole- salers, account- ants, hospitals, construction, insurance agen- cies, and truck- ing firms	System price also includes 4 CRT's, 2.5- megabyte disk drive, and bi- synch. commu- nications con- troller	System price also includes 12 CRT's, 2.5- megabyte disk drive, and 9- track magnetic tape drive	CRT may be 40 char. x 16 lines or 80 char. x 24 lines

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MANUFACTURER & MODEL	Fujitsu Panafacom U-200	Fujitsu Panafacom U-300	Fujitsu Panafacom U-400	Fujitsu Facom R-E	General Automation SPC-16
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 2 8, 16, 32 16, 32, 48	16 + 2 8, 16, 32 16, 32, 48	16 + 2 8, 16, 32 16, 32, 48	16 16 16	16 16 16
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core, MOS 0.65, 0.75 0.28, 0.6 4K 32K Standard No Optional	Core, MOS 0.65, 0.75 0.28, 0.6 4K 32K Standard No Standard	Core, MOS 0.65, 0.75 0.28, 0.6 32K 128K Standard No Standard	Core 1.5 0.75 4K 32K Standard No No	Core 0.8, 0.96, 1.44 0.4, 0.48, 0.72 4K 128K No No No
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	8 7 32K 6 No  1.58, 3.15 Standard No Standard No Optional	8 7 32K 6 PROM; 2K bytes  0.8, 1.8 Standard Optional Standard No Standard	8 7 32K 6 PROM; 3K bytes  0.8, 1.8 Standard Optional Standard No Standard	1 4 512 5 No  6.0 No No No No Optional	16 6 32K 11 ROM; 4K words  0.8, 0.96, 1.44 Standard Optional Standard No Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1M 4	Standard 1M 9	Standard 1M 9	Standard 400K 1	Standard 1.04M 64-unlimited
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives  Drum/fixed-head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	243-486K bytes Pack & cartridge; 2.49-10M bytes Fixed-head; 1M bytes Cassette; 1 KBS  9.6-120 KBS 100-600 cpm 30-165 cps 160-1100 lpm 50-48,000 bps See Comments Paper tape units, optical mark reader, plotter, etc.	243-486K bytes Pack & cartridge; 2.49-10M bytes Fixed-head; 1M bytes Cassette; 1 KBS  9.6-120 KBS 100-600 cpm 30-165 cps 160-1100 cpm 50-48,000 bps See Comments Paper tape units, optical mark reader, plotter, etc.	243-486K bytes Pack & cartridge; 2.49-10M bytes Fixed-head; 1M bytes Cassette; 1 KBS  9.6-120 KBS 100-600 cpm 30-165 cps 160-1100 cpm 50-48,000 bps See Comments Paper tape units, optical mark reader, plotter etc.	No Cartridge; 131K bytes Drum; 65-262K bytes No  21.6 KBS 100-300 cpm No 120-440 lpm 40 char. x 16 lines Paper tape units, optical mark reader, plotter	294-884K bytes Pack & cartridge; 5-2400M bytes Fixed-head; 256K-2M bytes No  20-60 KBS 300-1000 cpm 10, 165 cps 200-600 lpm 75-9600 bps See Comments TTY, A/D units, paper tape units
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler FORTRAN, BASIC, COBOL  Batch, real-time  No No	Assembler & macro assembler FORTRAN, BASIC, COBOL  Batch, real-time  No No	Assembler & macro assembler FORTRAN, BASIC, COBOL  Batch, real-time  No No	Assembler  FORTRAN  No  No No	Assembler & macro assembler FORTRAN IV, BASIC, COBOL  Real-time, batch  No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	— —  October 1972 Over 1000	— —  June 1975 Over 100	— —  August 1975 Over 50	— —  March 1969 Over 1000	\$5,500 (4K words) \$2,600 (4K words)  May 1970 5000
<b>COMMENTS</b>	CRT may be 40 char. x 16 lines or 80 char. x 24 lines	CRT may be 40 char. x 16 lines or 80 char. x 24 lines	CRT may be 40 char. x 16 lines or 80 char. x 24 lines		The DM-100 Series is a line of packaged systems based on the SPC/16; CRT may be either 32 char. x 16 lines or 74 char. x 27 lines



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MANUFACTURER & MODEL	General Automation 18/30	General Automation 16/330	General Automation 16/440	GRI System 99/50	GTE IS/1000
<b>DATA FORMATS</b>					
Word length, bits	16 + 1	16 + 2	16 + 2	16	16 + 2
Fixed-point operand length, bits	16, 32	16	16	—	16
Instruction length, bits	16, 32	16, 32, 48	16, 32, 48	16-48	16, 32
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core; MOS
Cycle time, microseconds/word	1.2	0.72	0.72	1.76	0.75
Access time, microseconds/word	0.6	0.225	0.225	—	0.35; 0.30
Minimum capacity, words	4K	4K	16K	32K bytes	16K; 32K
Maximum capacity, words	64K	32K	1024K	64K bytes	1024K
Parity checking	Standard	Optional	Optional	No	Optional
Error correction	No	No	No	No	No
Storage protection	Standard	Optional	Optional	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	16	16	16	2, 8	16
No. of index registers	3	8	8	1	15
No. of directly addressable words	64K	64K	1M with MAP	32K	64K
No. of addressing modes	6	11	11	—	11
Control storage	—	ROM; 320 x 34 bits	PROM; 512 x 64 bits	—	No
Add time, microseconds	2.4	1.9	0.78	—	0.75
Hardware multiply/divide	Standard	Standard	Standard	Optional	Optional
Hardware floating point	No	Optional	Optional	No	No
Hardware byte manipulation	No	Standard	Standard	Optional	Standard
Battery backup	No	No	No	No	No
Real-time clock or timer	Standard	Standard	Standard	Optional	Standard
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	480K	1.25M	1M	568K	1M
No. of external interrupt levels	6-59	64-unlimited	64-unlimited	Unlimited	16
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	500K-2M bytes	500K-2M bytes	No	256K-2M bytes
Disk pack/cartridge drives	Pack & cartridge; 1.02-80M bytes	Pack & cartridge; 5-2400M bytes	Pack & cartridge; 5-2400M bytes	Cartridge; 10.6-42.4M bytes	Cartridge & pack; 2.5-2400M bytes
Drum-fixed-head disk storage	No	Fixed-head; 256K-2M bytes	Fixed-head; 256K-2M bytes	No	Fixed-head & drum; 512K-40M bytes
Magnetic tape cassettes/cartridges	No	No	No	Cassette	No
Magnetic tape, 1/2-inch	20-60 KBS	20-60 KBS	20-60 KBS	60 KBS	10-120 KBS
Punched card input	400, 1000 cpm	400, 1000 cpm	400, 1000 cpm	300 cpm	200-1000 cpm
Serial printer	No	10, 165 cps	10, 165 cps	88-330 cps	10-330 cps
Line printer	300, 600 lpm	200-600 lpm	200-600 lpm	200-600 lpm	200-600 lpm
Data communications interface	To 9600 bps	75-9600 bps	75-9600 bps	Up to 1200 bps	66-250K bps
CRT	See Comments	80 char. x 24 lines	80 char. x 24 lines	80 char. x 8 lines	80 char. x 24 lines
Other standard peripheral units	TTY, paper tape units, card punches, plotters	TTY, paper tape units, card punches, A/D converters, digital I/O, plotters	TTY, paper tape units, card punches, A/D converters, digital I/O, plotters	None	Comm. preprocessor, RS-232C and MIL 188C interfaces
<b>SOFTWARE</b>					
Assembler	Yes	Macro assembler	Macro assembler	Yes	Macro assembler
Compilers	APL, BASIC, COBOL, FORTRAN IV, RPG II	FORTTRAN IV, BASIC, COBOL	FORTTRAN IV, BASIC, COBOL	COBOL, RPG II	FORTTRAN, COBOL, PL/1
Operating system	Batch, real-time, time-sharing	Batch, real-time	Batch, real-time, time-sharing	Real-time, multi-user	Real-time, multi-programming
Language implemented in firmware	No	No	No	No	No
Operating system implemented in firmware	No	No	No	No	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$13,650 (8K words)	\$4,550 (4K words)	\$8,950 (16K words)	\$44,376 (32K bytes)	Under \$5,000 (16K)
Price of memory increment	\$4,000 (8K words)	\$3,000 (16K words)	\$3,000 (16K words)	—	NA
Date of first delivery	June 1969	January 1976	May 1975	NA	January 1972
Number installed to date	Over 1000	NA	400	NA	Over 2000
<b>COMMENTS</b>	The basis of DM-200 Series; CRT may be either 80 char. x 12 lines or 74 char. x 27 lines	Software and I/O compatible with SPC-16; packaged LSI single-board computer supporting core memory; intended for OEM dedicated applications	Software and I/O compatible with SPC-16; oriented toward multi-user environment	System price also includes cartridge disk, serial printer, and CRT	

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MANUFACTURER & MODEL	Harris Slash 4	Harris Slash 6	Harris Slash 7	Hewlett-Packard Calculator Products Div. 9825	Hewlett-Packard Calculator Products Div. 9830
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	24 + 2 24, 48 24	24 + 5 24, 48 24	24 + 2 24, 48 24	8-bit byte — 16	8-bit byte — 16
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core; MOS 0.75; 0.2 0.3 8K 256K Standard No Optional	MOS 0.45 0.300 16K 256K No Standard Optional	Core; MOS 0.43; 0.2 0.3 32K 256K Standard No Optional	MOS — — 6844 bytes 31,420 bytes No No No	MOS 13 — 3520 bytes 30,144 bytes No No No
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	5 3 64K 4 No  0.75 Standard Optional Standard No Optional	5 3 64K 4 No  0.6 Standard Optional Standard Optional Optional	5 3 64K 4 No  0.43 Standard Optional Standard No Optional	Software-assigned Software-assigned — 8 See Comments  300 No No Standard No No	Software-assigned Software-assigned — 4 See Comments  1000 No No Standard No No
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Optional 1.3M 4-48	Optional 4.5M 24	Optional 1.9M 4-48	Standard 400K 2	No 1.2K 0
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives  Drum/fixed-head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, ½-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	310K-1.2M bytes Pack & cartridge; 2.7-160M bytes Fixed-head; 10.5M bytes Cassette; 30 cps  25-320 KBS 300-1000 cpm 30 cps 300-900 lpm 98K bps; synch. 80 char. x 24 lines Paper tape units, card reader/ punch	310K-3.7M bytes Pack & cartridge; 2.7-160M bytes Fixed-head; 10.5M bytes Cassette; 30 cps  25-320 KBS 300-1000 cpm 30 cps 300-900 lpm 98K bps; synch. 80 char. x 24 lines Paper tape units, card reader/ punch	310K-1.2M bytes Pack & cartridge; 2.7-160M bytes Fixed-head; 10.5M bytes Cassette; 30 cps  25-320 KBS 300-1000 cpm 30 cps 300-900 lpm 98K bps; synch. 80 char. x 24 lines Paper tape units, card reader/ punch	468K-15M bytes No  No  Cartridge; 2.75 KBS  No 300 cpm 30 cps 240 lpm No No Paper tape reader, paper tape punch, plotter	No Cartridge; 4.8-9.6M bytes No  Cassette; 375 bps  No 300 cpm 30 cps 165-300 lpm Up to 9600 bps 80 char. x 24 lines Paper tape reader, paper tape punch, plotter
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Macro assembler  FORTRAN IV, BAS., RPG II, SNOBOL Batch, real-time, time-sharing No No	Macro assembler  FORTRAN IV, BASIC, RPG II, SNOBOL Batch, real-time, time-sharing No No	Macro assembler  FORTRAN IV, BAS., RPG II, FORGO, COBOL Batch, real-time, time-sharing No No	No  HPL  Interactive  Fully Fully	No  BASIC  Interactive  Fully Fully
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$24,000 (8K words) \$7,000 (8K words)  September 1973 NA	\$14,500 (16K words) \$5,500 (16K words)  October 1976 NA	\$45,000 (32K words) \$25,000 (32K words)  November 1975 NA	\$5,900 (6844 bytes) \$1,600 (8K bytes) \$3,200 (16K bytes) January 1976 NA	\$4,900 (3520 bytes) \$1,000 (4K bytes) \$3,000 (12K bytes) November 1972 NA
<b>COMMENTS</b>	Basis for the S110 & S120 packaged sys- tems		Basis for the S210 & S220 packaged sys- tems	Approx. 31K bytes of ROM for oper. system and HPL language interp.; up to 16K bytes of addl. ROM can be added for language exten- sion & periph. control; system price also includes mag. tape car- tridge drive, 16-char. strip printer, and 32- char. display	Approx. 15K bytes of ROM for oper. sys. and BASIC language interp.; BASIC language extensions can be added in 2K-byte ROM modules to a maximum of 16K; sys. price also incl. mag. tape cassette drive & 32-char. display

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MANUFACTURER & MODEL	Hewlett-Packard Data Systems Div. 2100	Hewlett-Packard Data Systems Div. 21MX	Hewlett-Packard General Sys. Div. HP 3000 Series II	Honeywell System 700	Honeywell Level/6 Model 6/06
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 1 16, 32 16, 32	16 + 1 16, 32 16, 32	16 + 5 or + 1 — 8, 16	16 + 2 16 16	16 + 2 16 16
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core 0.98 0.49 8K 32K Standard No Standard	MOS 0.65 — 4K 256K Standard Optional Optional	MOS 0.7 0.35 64K 256K Standard Standard Standard	Core 0.800 0.400 8K 32K Optional No Optional	MOS 0.650 — 8K 64K Standard Optional Optional
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	2 0 2K 7 ROM/RAM; 1K	2 2 32K 7 ROM/RAM; 8.5K	20 1 None 6 ROM: 10K x 32 bits 0.55	2 2 512 14 No	2 2 512 14 —
Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	Standard Standard No No Standard	Standard Standard Standard No Optional	Standard Standard Standard Standard Standard	Standard No Standard No Standard	Standard No Standard No Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Optional 1M 60	Optional 616K 60	Standard 4.5M To 125	Standard 1M 54	Standard 500K 54
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drive Disk pack/cartridge drives  Drum/fixed-head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	No Cartridge & pack; 4.9-120M bytes No  No  20-72 KBS 200-600 cpm 10, 120 cps 240-1250 lpm 50K-2.5M bps 80 char. x 24 lines Plotters	No Cartridge & pack; 4.9-120M bytes No  No  20-36 KBS 200-600 cpm 10, 120 cps 240-1250 lpm 50K-2.5M bytes 80 char. x 24 lines Plotters	No Pack & cartridge; 15-376M bytes No  No  72 KBS 600 cpm 30, 120 cps 200-1250 lpm To 4800 bps; syn. 80 char. x 24 lines Paper tape units, punched card reader/punch	No Cartridge & pack; 1.25M-30M bytes Fixed-head; 64K-1M bytes Cassette; 700 cps  5.2-20.8 KBS 300-1050 cpm 10-165 cps 240-1100 lpm 45-10,800 bps 80 char. x 24 lines Paper tape units, process control interfaces	No Cartridge & pack; 1.25M-30M bytes Fixed-head; 64K-1M bytes Cassette; 700 cps  5.2-20.8 KBS 300-1050 cpm 10-165 cps 240-1100 lpm 45-10,800 bps 80 char. x 24 lines Paper tape units, process control interfaces
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler  FORTRAN, ALGOL  Real-time, time-sharing No No	Assembler & micro assembler FORTRAN, BASIC, ALGOL  Real-time, time- sharing, data base Partially No	Assembler & macro assembler COBOL, RPG II, FORTRAN IV, BASIC Batch, real-time, time-sharing Partially Partially	Macro assembler  BASIC, FORTRAN  Batch; real-time; multi-programming No No	Macro assembler  BASIC, FORTRAN  Batch; real-time; multi-programming No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$10,000 (4K words) \$2,500 (4K or 8K)  May 1973 Over 12,000	\$5,560 (4K MOS) \$1,500 (8K MOS)  May 1974 4000+	\$110,000 (64K words) —  June 1976 225 (3000 Series)	\$10,800 (8K words) \$3,200 (8K words)  NA 2000	\$7,900 (8K words) \$2,400 (8K words)  January 1976 NA
<b>COMMENTS</b>	Succeeded by 21MX series; now marketed primarily to existing accounts	21MX includes the 21MX-K microcomputer and the 21MX-E high-performance CPU; packaged systems include System 1000 computation system and 9600 & 9700 measurement and control systems	Asynchronous communications speeds to 2400 bps; 3000 Series II is an upgrade from previous 3000CX Series; sold only as a packaged system	Succeeded by Level 6, Model 6/06	Replacement for Model 700; microprogrammed emulator for Model 700 based on Level 6 CPU

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MANUFACTURER & MODEL	Honeywell Level 6 Model 6/34	Honeywell Level 6 Model 6/36	Honeywell Level 61 Model 61/58	Honeywell Level 61 Model 61/60	Honeywell Level 62 Model 62/40
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 2 16 16, 32, 48	16 + 2 16 16, 32, 48	8-bit byte 16 8-64	8-bit byte 16 8-64	8-bit byte + 1 16 16-64
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/words Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 0.650 — 8K 32K Standard No No	MOS 0.650 — 8K 64K Standard Optional No	Core 1.2 — 5K bytes 10K bytes Standard No No	MOS 1.2 — 10K bytes 10K bytes Standard No No	MOS 1 (2-byte fetch) — 64K bytes 128K bytes Standard Standard Standard
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	7 7 64K 14 — 1.9 Standard Standard Standard Optional Standard	7 7 64K 14 — 1.9 Standard Standard Standard Optional Standard	100 10 10K bytes 1 ROM; 7.68K bytes 115 No No Standard No No	100 10 10K bytes 1 ROM; 10K bytes 115 No No Standard No No	16 8 128K bytes 4 Bipolar; to 30K words — Standard Optional Standard No No
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1.5M 64	Standard 1.5M 64	Standard 312K —	Standard 312K —	Standard 1.587M —
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives Drum/fixed-head disk storage Magnetic tape cassettes/cartridges Magnetic tape, ½-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripherals	256K-1M bytes Cartridge; 2.5-40M bytes No No No 300, 500 cpm 10-165 cps 300-600 lpm 50-72,000 bps 80 char. x 12 lines —	256K-1M bytes Cartridge; 2.5-40M bytes No No No 300, 500 cpm 10-165 cps 300-600 lpm 50-72,000 bps 80 char. x 12 lines —	No Pack; 3.5-92M bytes No No No 100-300 cpm No 100-650 lpm Up to 9600 bps See Comments Card punch, extended mem- ory (16K-64K bytes; 312 KBS)	No Pack; 3.5-92M bytes No No No 100-300 cpm No 100-650 lpm Up to 4800 bps See Comments Card punch, extended mem- ory (16K-64K bytes; 312 KBS)	No Pack & cartridge; 11.6-160M bytes No Cassette; 700 bps 10.4-60 KBS 300-1050 cpm 30 cps 400-1600 lpm Up to 9600 bps See Comments Card punch
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	Assembler & macro-preprocessor FORTRAN Batch, multi-tasking No No	Assembler & macro-preprocessor FORTRAN Batch, multi-tasking No No	No COBOL Batch, time-sharing No No	No COBOL, BASIC Batch, time-sharing No No	No COBOL, RPG, FORTRAN Batch, real-time, time-sharing No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment Date of first delivery Number installed to date	\$3,990 (8K words) \$1,600 (8K words) January 1976 NA	\$5,600 (8K words) \$1,600 (8K words) January 1976 NA	\$20,060 (5K bytes) \$7,010 (5K bytes) November 1974 90 (Level 61)	\$25,380 (10K bytes) CPU cannot be expanded 2nd quarter 1975 90 (Level 61)	\$51,950 (64K bytes) \$1,960 (8K bytes) \$3,840 (16K bytes) June 1975 600+ (Level 62)
<b>COMMENTS</b>	Intended for OEM small system market	Enhanced version of Model 6/36 for larger OEM systems	GE, Hazeltine, and other terminals can be interfaced; see Report 70C-480-14 for more details	GE, Hazeltine, and other terminals can be interfaced; see Report 70C-480-14 for more details	GE, Hazeltine, and other terminals can be interfaced; system price also includes I/O peripheral controller, 6 I/O channels, 30-cps console printer, and 1 magnetic tape cassette drive; see Report 70C-480-13 for more details

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MANUFACTURER & MODEL	Honeywell Level 62 Model 62/60	IBM 5100	IBM System/32	IBM System/3	IBM 1130
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte + 1 16 16-64	8-bit byte — 16	8-bit byte 1-16 digits 24-48	8-bit byte 8-248 32, 40, 48	16 + 2 16, 32 16, 32
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/words Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 1 (2-byte fetch) — 64K bytes 256K bytes Standard Standard Standard	MOS 0.530 0.330 16K bytes 64K bytes Standard No No	MOS 0.6 0.250 16K bytes 32K bytes Standard No No	Core, MOS 1.52 — 8K bytes 256K bytes Standard Std. (Model 15) Std. (Model 15)	Core 2.2; 3.6 — 4K 32K Standard No No
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	16 8 256K bytes 4 Bipolar; to 30K words — Standard Optional Standard No No	64 0 64K bytes 2 ROM; 180K x 9 bits 1000 (approx.) Standard Standard Standard No No	— 2 32K bytes 2 ROM; 4K bytes 72 (5 bytes) No No Standard No No	1 2 64K bytes 1 No 24.4 No No Standard No Optional	2 3 32K 2 No 8; 4.9 Standard No No No No
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1.587M —	Standard 500K 3	Standard 889K 4	Standard 658K 5 (Models 8, 10, 12) 8 (Model 15)	Optional 278K; 455K 6
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives  Drum/fixed-head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	No Pack & cartridge; 11.6-480M bytes No  Cassette; 700 bps  10.4-60 KBS 300-1050 cpm 30 cps 400-1600 lpm Up to 9600 bps See Comments Card punch	No No No  Cartridge; 2.85 KBS  No No 80, 120 cps No Up to 300 bps 64 char. x 16 lines RS-232C interface available for non-IBM peripherals	243-303K bytes Nonrem. cartridge; 3.2-13.7M bytes No  No 12-50 cpm 40-80 cps 50-155 lpm Up to 7200 bps 40 char. x 6 lines Magnetic card reader	243K bytes Pack & cartridge; 2.5-506M bytes No  No 20-80 KBS 600, 1000 cpm 85, 115 cps 100-1100 lpm Up to 50K bps 40 char. x 12 lines MICR reader/sorter, optical mark reader	No Pack & cartridge; 512K-2.56M bytes No  No 15 KBS 100, 600 cpm 15 cps 100-1100 lpm Up to 4800 bps 74 char. x 52 lines Paper tape reader, paper tape punch, optical mark reader, plotter
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	No  COBOL, RPG, FORTRAN  Batch, real-time, time-sharing No No	No  BASIC, APL  Batch (one-program) Fully Fully	Macro assembler  RPG II  Batch (one-program) No Partially	No  BASIC, RPG II, COBOL, FORTRAN Batch, time-sharing No No	Assembler & macro assembler RPG II, FORTRAN  Batch  No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$75,410 (64K bytes) \$3,840 (16K bytes)  June 1974 600 + (Level 62)	\$8,975 (16K bytes) \$2,700 (16K bytes)  September 1975 NA	\$33,560 (16K bytes) \$1,350 (8K bytes)  March 1975 5500	\$12,560 (8K bytes) \$4,060 (4K bytes); \$4,550 (8K bytes) December 1970 30,000+	\$10,150 (4K words) \$5,160 (4K words)  November 1965 4000
<b>COMMENTS</b>	GE, Hazeltine, and other terminals can be interfaced; system price also includes I/O peripheral controller, 6 I/O channels, 30-cps console printer, and 1 magnetic tape cassette drive; see Report 70C-480-13 for more details	Portable computer weighing 50 pounds; sys-price also includes cartridge tape drive, CRT, and BASIC language interpreter	IBM's entry-level business computer; strong emphasis on packaged applications software; system price also includes 3.92M-bytes fixed disk drive, diskette drive, CRT, keyboard, and 40-cps unidirectional printer; see Report 70C-491-25 for details	Six different model lines currently available; see Report 70C-491-21 for more details	IBM 1800 is similar CPU with storage protection, real-time operating system, and extensive A/D and sensor units; see Report 70C-491-11 for more details

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MANUFACTURER & MODEL	IBM System/360 Model 20	IBM System/7	ICL 2903	ICL 2904	Interdata 5/16
<b>DATA FORMATS</b>					
Word length, bits	8-bit byte	16 + 2	24 + 2	24 + 2	16
Fixed-point operand length, bits	8-128	16	12	12	8, 16, 32
Instruction length, bits	16, 32, 48	16, 32	24	24	16, 32
<b>MAIN STORAGE</b>					
Storage type	Core	Bipolar	MOS	MOS	MOS
Cycle time, microseconds/word	See Comments	0.4	1.14	1.14	0.6
Access time, microseconds/word	—	0.15	0.57	0.57	—
Minimum capacity, words	4K bytes	2K	16K	32K	4K
Maximum capacity, words	32K bytes	64K	48K	96K	32K
Parity checking	Standard	Standard	Standard	Standard	No
Error correction	No	—	No	No	No
Storage protection	No	No (Models A & B); Std. (Model E)	No	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	8 (see Comments)	4	8	8	16
No. of index registers	8 (see Comments)	28	4	4	15
No. of directly addressable words	—	64K	4K	4K	32K
No. of addressing modes	—	1	1	4	2
Control storage	ROM	No	8K, 12K	8K, 12K	Opt. ROM;
Add time, microseconds	58	0.8	17.7	11.8	to 48K bytes
Hardware multiply/divide	Standard	No	Standard	Standard	1.2
Hardware floating point	No	No	Optional	Optional	Standard
Hardware byte manipulation	Standard	No	No	No	Optional
Battery backup	No	No	No	No	Standard
Real-time clock or timer	Optional	Optional	Standard	Standard	No
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	156K	2M	500K	500K	450K
No. of external interrupt levels	1	64	None	None	1-255
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	Yes
Disk pack/cartridge drives	Pack; 2.7-21.6M bytes	Pack & cartridge; 4.9-69.8M bytes	Cartridge & pack; 9.8-270M (6-bit)	Cartridge & pack; 9.8-270M (6-bit)	No
Drum/fixed-head disk storage	No	Fixed-head; 502K bytes	No	No	No
Magnetic tape cassettes/cartridges	No	No	No	No	Cassette; 1 KBS
Magnetic tape, ½-inch	15-60 KBS	No	80 KCS	80 KCS	9-120 KBS
Punched card input	600, 1000 cpm	300 cpm	300 cpm	300 cpm	400, 1000 cpm
Serial printer	15.5 cps	No	No	No	10-30 cps
Line printer	260-1100 lpm	40-155 lpm	150-1500 lpm	150-1500 lpm	60-600 lpm
Data communications interface	Up to 50K bps	Up to 50K bps	To 9600 bps	To 9600 bps	To 9600 bps
CRT	No	No	80 chars. x 25 lines	80 chars. x 25 lines	80 char. x 24 lines
Other standard peripheral units	Card punch, MICR reader/ sorter	A/D converters, sensor units	DDE terminals, 256 chars.; hard-copy printer for CRT's	DDE terminals, 256 chars.	Paper tape units, A/D & D/A con- verters, graphic display
<b>SOFTWARE</b>					
Assembler	Assembler & macro assembler	Assembler & macro assembler	No	No	Assembler & macro assembler
Compilers	RPG II, PL/1	FORTRAN, APG/7	COBOL, FOR- TRAN, BASIC, RPG, ALGOL	COBOL, FORTRAN, RPG, ALGOL	FORTRAN, BASIC
Operating system	Batch	Batch, real-time	Batch; multitask., data base mgmt.	Batch; multitask., data base mgmt.	Batch, real-time
Language implemented in firmware	No	No	No	No	No
Operating system implemented in firmware	No	No	Partially	Partially	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$9,120 (4K bytes)	\$5,900 (2K words)	\$85,000	\$35,000	\$2,100 (4K words)
Price of memory increment	\$2,400 (4K bytes); \$6,380 (8K bytes)	\$2,535 (2K words); \$5,060 (4K words)	\$7,806-19,106 (4K)	\$12,116 (8K); \$18,174 (12K)	\$600 (4K words)
Date of first delivery	November 1964	1st quarter 1971	July 1974	NA	4th quarter 1976
Number installed to date	15,000	NA	20	5	NA
<b>COMMENTS</b>	Low end of IBM's 360 series; cycle times vary with processor models; 8 general-purpose registers are used for indexing, base addressing, and as accumulators; see Report 70C-491-02 for more details	System/7's form the base for many custom systems for voice response, Touch-Tone data entry, communications processing, etc.	Data characters are 6 bits; Cincom's TOTAL data base management system available	Data characters are 6 bits; Cullinane's IDMS and Cincom's TOTAL data base management systems available	Available as a board-based processor without chassis and peripherals

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MANUFACTURER & MODEL	Interdata 6/16	Interdata 8/16	Interdata 7/32	Interdata 8/32	Jacquard J-100
<b>DATA FORMATS</b>					
Word length, bits	16 + 1	16 + 1	32 + 2	32 + 2	16
Fixed-point operand length, bits	8, 16, 32	8, 16, 32	32	32	16, 32, 64
Instruction length, bits	16, 32	16, 32	16, 32, 48	16, 32, 48	16
<b>MAIN STORAGE</b>					
Storage type	MOS; core	Core	Core	Core	Core
Cycle time, microseconds/word	0.6; 1.0	0.75	0.75, 1.0	0.3	1.5
Access time, microseconds/word	—; 0.35	0.275	0.4, 0.5	0.4	—
Minimum capacity, words	4K	16K	16K	32K	16K
Maximum capacity, words	32K	32K	256K	256K	64K
Parity checking	Optional	Optional	Optional	Optional	No
Error correction	No	No	No	No	No
Storage protection	No	No	Optional	Standard	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	16	16	32	32-256	4
No. of index registers	15	15	30	30-240	2
No. of directly addressable words	32K	32K	256K	256K	256
No. of addressing modes	2	2	7	7	4
Control storage	ROM	ROM	ROM; 1792 x 24 bits	ROM; 1240 x 32 bits	No
Add time, microseconds	1.0	0.75	1.0	0.4	7
Hardware multiply/divide	Optional	Optional	Standard	Standard	No
Hardware floating point	No	Optional	Optional	Optional	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	No
Battery backup	Optional	No	No	No	No
Real-time clock or timer	Optional	Optional	Optional	Optional	Standard
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1M	1.33M	500K	1.25M	667K
No. of external interrupt levels	1-255	1-255	1-1024	4-1024	32
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	512K-1M bytes
Disk pack/cartridge drives	Pack & cartridge; 2.5-1024M bytes	Pack & cartridge; 2.5-1024M bytes	Pack & cartridge; 2.5-1024M bytes	Pack & cartridge; 2.5-1024M bytes	Pack & cartridge; 6-320M bytes
Drum/fixed-head disk storage	No	No	No	No	No
Magnetic tape cassettes/cartridges	Cassette; 1 KBS	Cassette; 1 KBS	Cassette; 1 KBS	Cassette; 1 KBS	No
Magnetic tape, 1/2-inch	9-120 KBS	9-120 KBS	9-120 KBS	9-120 KBS	10-40 KBS
Punched card input	400, 1000 cpm	400, 1000 cpm	400, 1000 cpm	400, 1000 cpm	No
Serial printer	10-30 cps	10-30 cps	10-30 cps	10-30 cps	30-166 cps
Line printer	60-600 lpm	60-600 lpm	60-600 lpm	60-600 lpm	300-900 lpm
Data communications interface	To 9600 bps	To 9600 bps	To 9600 bps	To 9600 bps	Up to 9600 bps
CRT	80 char. x 24 lines	80 char. x 24 lines	80 char. x 24 lines	80 char. x 24 lines	80 char. x 24 lines
Other standard peripheral units	Paper tape units, A/D & D/A converters, graphic display	Paper tape units, A/D & D/A converters, graphic display	Paper tape units, A/D & D/A converters, graphic display	Paper tape units, A/D & D/A converters, graphic display	RS-232C interface
<b>SOFTWARE</b>					
Assembler	Assembler & macro assembler	Assembler & macro assembler	Assembler & macro assembler	Assembler & macro assembler	Yes
Compilers	FORTRAN, BASIC	FORTRAN, BASIC	FORTRAN V, BASIC, COBOL	FORTRAN V, BASIC, COBOL	BASIC
Operating system	Batch, real-time	Batch, real-time	Batch, real-time	Batch, real-time	Time-sharing, multitasking
Language implemented in firmware	No	No	No	No	No
Operating system implemented in firmware	No	No	No	No	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$2,900 (4K words)	\$6,250 (16K words)	\$13,900 (16K words)	\$51,900 (32K words)	\$14,900 (16K words)
Price of memory increment	\$600 (4K words)	\$3,400 (16K words)	\$3,950 (16K words)	\$19,000 (64K words)	\$3,000 (16K words)
Date of first delivery	February 1975	4th quarter 1976	July 1974	June 1975	August 1975
Number installed to date	180	NA	400	100	Over 100
<b>COMMENTS</b>	Singleboard processor with single-board memory as large as 64K bytes; options include turnkey control panel, bootstrap loader, serial I/O port, chassis & power supply	Available options include hardware single & double precision floating-point units, fixed-point multiply/divide, list processing instructions, power fail/auto restart, turnkey console		512 words of writable control store optional; features instruction look-ahead; ITAM software provides remote batch terminal emulators	Sold only in packaged configuration consisting of a 16K-word CPU, dual floppy disk, CRT display/keyboard, real-time clock, and all software



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MANUFACTURER & MODEL	Keronix IDS 16 Series	Litton 1300	Lockheed LEC 16	Lockheed SUE	Logical Machine Corp. ADAM
<b>DATA FORMATS</b>					
Word length, bits	16	16	16 + 1	16	16 + 1
Fixed-point operand length, bits	16	8, 16	8, 16	8, 16	14 digits
Instruction length, bits	16	8-56	16	16, 32	Variable
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	MOS
Cycle time, microseconds/word	1.2; 1.0; 0.80	1.2	1.0	0.8	0.55
Access time, microseconds/word	—	0.5	0.5	0.4	0.25
Minimum capacity, words	4K	8K bytes	8K	4K	32K bytes
Maximum capacity, words	1024K	40K bytes	64K	32K	64K bytes
Parity checking	No	Optional	Optional	No	Standard
Error correction	No	No	No	No	No
Storage protection	Optional	No	Optional	No	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	4	—	1	7	16
No. of index registers	2	16	1	7	16
No. of directly addressable words	64K	—	1K	256	—
No. of addressing modes	8	—	4	19	—
Control storage	—	ROM; 8-24K bytes	No	ROM; 512 x 36 bits	ROM; 512 x 32 bits
Add time, microseconds	1.2; 1.0; 0.80	225	2.0	2.79	1.0
Hardware multiply/divide	Optional	Standard	Optional	Standard	Standard
Hardware floating point	Optional	No	No	No	No
Hardware byte manipulation	Optional	Standard	Standard	Standard	Standard
Battery backup	No	No	No	No	No
Real-time clock or timer	Optional	No	Standard	Standard	No
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	Standard	Standard	Standard	No
Maximum I/O rate, words/sec	833K; 1M; 1.25M	833K	333K	590K	1.25M
No. of external interrupt levels	62	—	8-64	Variable	None
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	256-512K bytes	500K-3M bytes	No	No	No
Disk pack/cartridge drives	Cartridge & pack; 2.5-1200MB	No	No	Cartridge; 5-20M bytes	Cartridge; 10M bytes
Drum/fixed-head disk storage	No	No	No	No	No
Magnetic tape cassettes/cartridges	No	Cassette; 1.25 KBS	No	No	No
Magnetic tape, 1/2-inch	400 KBS	36 KBS	No	No	No
Punched card input	300-600 cpm	No	No	285 cpm	No
Serial printer	10-330 cps	140 cps	No	10, 100 cps	165, 330 cps
Line printer	To 1800 lpm	No	No	200-600 lpm	No
Data communications interface	To 9600 bps	No	110-9600 bps	75-9600 bps	No
CRT	80 char. x 25 lines	48 char. x 22 lines	No	No	80 char. x 24 lines
Other standard peripheral units	—	None	—	Paper tape units	None
<b>SOFTWARE</b>					
Assembler	Yes	Yes	Yes	Macro assembler	No
Compilers	BASIC, FORTRAN, COBOL	BASIC	FORTRAN	FORTRAN	ADAM
Operating system	Multi-user, multi-task	—	Real-time	Batch, multi- tasking	Real-time
Language implemented in firmware	No	Fully	No	No	Fully
Operating system implemented in firmware	No	Fully	No	No	Fully
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$2,900 (4K words)	\$15,465 (12K bytes)	\$7,615 (8K words)	\$4,350 (4K words)	\$39,995 (32K bytes)
Price of memory increment	\$1,500 (8K words)	—	\$2,475 (4K words)	\$2,000 (4K words); \$2,200 (8K words)	NA
Date of first delivery	April 1974	September 1974	February 1969	November 1972	April 1975
Number installed to date	Over 500	1050	Over 2000	Over 2000	About 100
<b>COMMENTS</b>					
	Keronix IDS 16 CPU's are software, memory, and I/O-compatible with Data General Nova Series CPU's	System price also includes a serial printer and magnetic tape cassette drive	Formerly known as MAC; sold for OEM usage only; peripherals supplied only on special request	Used as the basis for Lockheed System III business mini-computer system	CPU available only in ADAM small business system

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MANUFACTURER & MODEL	Melco U.S.A. Inc. Melcom 80 Series Model 31	Melco U.S.A. Inc. Melcom 80 Series Model 11	Melco U.S.A. Inc. Melcom 80 Series Model 11/M	Melco U.S.A. Inc. Melcom 80 Series Model 8	Micro Computer Machines MCM/700
<b>DATA FORMATS</b>					
Word length, bits	8	48 + 6	48 + 6	48	8 + 1
Fixed-point operand length, bits	8	8	8	8	8-64
Instruction length, bits	16, 32, 48	48	48	48	Variable
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	MOS	MOS	MOS
Cycle time, microseconds/word	0.8 (2 bytes)	0.8 (1 byte)	0.8 (1 byte)	0.8 (1 byte)	0.55
Access time, microseconds/word	—	—	—	—	—
Minimum capacity, words	16K	1K	1K	1K	2K bytes
Maximum capacity, words	64K	1K	4K	4K	8K bytes
Parity checking	Standard	Standard	Standard	Standard	Standard
Error correction	No	No	No	No	No
Storage protection	No	No	No	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	2	3	3	3	1
No. of index registers	2	0	0	0	0
No. of directly addressable words	64K bytes	1K bytes	1K bytes	1K bytes	16K
No. of addressing modes	2	1	1	1	—
Control storage	ROM; 6K x 8 bits	—	—	—	ROM; 32K bytes
Add time, microseconds	57.5	670	670	900	—
Hardware multiply/divide	No	No	No	No	Standard
Hardware floating point	No	No	No	No	Standard
Hardware byte manipulation	Standard	—	—	—	Standard
Battery backup	Yes	No	No	No	Standard
Real-time clock or timer	Optional	No	No	No	No
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	No	No	No	Standard
Maximum I/O rate, words/sec	1.2M	70KB	70KB	40KB	—
No. of external interrupt levels	7	1	1	1	No
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	250-500K bytes	250-500K bytes	250K-1M bytes	250K-1M bytes	250K-2M bytes
Disk pack/cartridge drives	Pack & cartridge; 10-160M bytes	Cartridge; 10-40M bytes	Cartridge; 10-40M bytes	No	No
Drum/fixed-head disk storage	Fixed-head; 380K bytes	Fixed-head; 60-420K bytes	Fixed-head; 60-420K bytes	No	No
Magnetic tape cassettes/cartridges	Cassette; 750 cps	Cassette; 750 cps	Cassette; 750 cps	Cassette; 750 cps	Cassette; 810 cps
Magnetic tape, ½-inch	20K, 40K bps	No	No	No	No
Punched card input	300, 600 cpm	300 cpm	300 cpm	No	400 cpm
Serial printer	165 cps	30, 120 cps	30, 120 cps	30, 120 cps	45 cps
Line printer	200, 400 lpm	60, 200 lpm	60, 200 lpm	No	No
Data communications interface	9600 bps	9600 bps; synch.	9600 bps; synch.	9600 bps; synch.	To 1200 bps
CRT	80 char. x 25 lines	32 char. x 16 lines	32 char. x 16 lines	32 char. x 16 lines	80 char. x 24 lines
Other standard peripheral units	Paper tape units	Paper tape units	Paper tape units	Paper tape units	GP interface; programmable RS-232C inter- face
<b>SOFTWARE</b>					
Assembler	Assembler	Assembler	Assembler	Assembler	No
Compilers	COBOL, PROGRESS	PROGRESS, COOL	PROGRESS, COOL	PROGRESS, COOL	APL
Operating system	Batch, real-time	Batch, real-time	—	—	Virtual memory, interactive
Language implemented in firmware	No	No	No	Fully	Fully
Operating system implemented in firmware	—	—	—	—	Fully
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	About \$40,000	About \$30,000	About \$30,000	About \$15,000	\$4,985 (2K bytes)
Price of memory increment	NA	NA	NA	NA	\$650 (2K bytes)
Date of first delivery	May 1975 (Japan)	April 1975 (Japan)	April 1975 (Japan)	July 1976 (Japan)	January 1975
Number installed to date	5000+ (all models)	5000+ (all models)	5000+ (all models)	5000+ (all models)	Over 200
<b>COMMENTS</b>					Features virtual storage capacity of up to 256K bytes using cassette tape or diskette; system price also includes an integral cassette drive, display, and keyboard

## All About Minicomputers

MANUFACTURER & MODEL	Micro Computer Machines MCM/800	Microdata Express I	Microdata Express II	Microdata Express X	Microdata Micro-One
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8 + 1 8-64 Variable	16 1, 2, 4, 8, 16, 32 8, 16, 32, 40	16 1, 2, 4, 8, 16, 32 8, 16, 32, 40	16 1, 2, 3, 8, 16, 32 8, 16, 32, 40	8-bit byte 8, 16, 24, 32 8, 16, 24, 32
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 1.2 — 4K bytes 16K bytes Standard No No	MOS 0.54 0.4 32K 64K Standard Optional Standard	MOS 0.54 0.4 32K 512K Standard Optional Standard	MOS 0.54 0.4 32K 512K Standard Optional Standard	Core, MOS 1.1 0.44 8K 32K No No No
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index No. of directly addressable words No. of addressing modes Control storage Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	1 0 16K — ROM; 32K bytes — Standard Standard Standard Standard No	5 (stack) 5 (stack) 64K 8 4K-byte ROM & PROM 0.405 Standard Optional Standard Optional Standard	5 (stack) 5 (stack) 512K 8 4K-byte ROM & PROM 0.405 Standard Optional Standard Optional Standard	5 (stack) 5 (stack) 512K 8 ROM & PROM; 4K bytes 0.405 Standard Optional Standard Optional Standard	15 Firmware-contrl'd. 32K Firmware-contrl'd. 4K-byte ROM & PROM 6.38 Standard No Standard No Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard — No	Standard 2M 1024 maximum	Standard 2M 1024 maximum	Standard 2M 1024 maximum	Optional 1M 2; 128
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives Drum/fixed-head disk storage Magnetic tape cassettes/cartridges Magnetic tape, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	250K-2M bytes No No Cassette; 810 cps No 400 cpm 45 cps No To 1200 bps 80 char. x 24 lines GP interface; programmable RS-232C interface	No Pack; 10M-50M bytes No Cartridge; 2.4 KBS No 200-1000 cpm 165 cps 300-600 lpm To 9600 bps 80 char. x 24 lines	No Pack & cartridge; 10-800M bytes Fixed head; 500K-8M bytes Cartridge; 2.4 KBS 40 KBS 200-1000 cpm 165 cps 300-600 lpm To 9600 bps 80 char. x 24 lines	No Cartridge; 10-160M bytes No No 40 KBS 200-1000 cpm 165 cps 125-600 lpm To 9600 bps 80 char. x 24 lines	No Cartridge; 10-40M bytes NO No 40 KBS 200-1000 cpm 165 cps 300-600 lpm To 9600 bps 80 char. x 24 lines Paper tape reader/punch
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	No APL Virtual memory, interactive Fully Fully	Yes FORTRAN, BASIC, EPL, COBOL Time-sharing No No	Yes FORTRAN, BASIC, EPL, COBOL Time-sharing No No	Yes FORTRAN, BASIC, EPL, COBOL Time-sharing No No	Yes BASIC No No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment Date of first delivery Number installed to date	\$8,400 (4K bytes) \$800 (4K bytes) July 1976 75	\$19,950 (32K words) \$4,500 (32K words) \$5,500 (w. ECC) 1st quarter 1977 NA	\$27,650 (32K words) \$4,500 (32K words); \$5,500 (w. ECC) 1st quarter 1977 NA	\$21,550 (32K words) — November 1976 NA	\$2,175 (8K words) \$75 (1K bytes) December 1974 150
<b>COMMENTS</b>	MSI implementa- tion of MCM/700 CPU; provides 8 to 10 times the performance levels of the MCM/700; features virtual storage capacity of up to 256K bytes using cas- sette tape or diskette; system price also in- cludes an integral cassette drive, display, keyboard, and RS-232 in- terface	System price also includes 10M-byte disk drive, mag- netic tape, mag- netic tape car- tridge drive, CRT, line printer, interface, desk cabinet, and all systems software	System price also includes 50M-byte disk drive, mag- netic tape car- tridge drive, CRT, line printer, interface, up- right cabinet, 4 RS-232C lines, and all systems software	System price also includes 10M-byte disk drive, reel- to-reel magnetic tape drive, CRT line printer in- terface, upright cabinet, 4 RS- 232C lines, and all systems soft- ware	Single-board processor; compati- ble with Micro- data 800 and 1600 computers

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MANUFACTURER & MODEL	Microdata 1600 Series	Microdata 32/S	Microdata 3200	Modular Computer Systems Modcomp II	Modular Computer Systems Modcomp IV
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 8, 16, 24, 32 8, 16, 24, 32	16 1, 2, 4, 8, 16, 32 8, 16, 24, 32, 40	16 8, 16 32 (micro)	16 + 1 16, 32 16, 32, 48	16 + 1 16, 32 16, 32, 48
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core 1.0 0.4 4K 32K No No No	MOS 0.35 0.3 4K 128K Standard No Standard	MOS 0.35 0.3 4K 128K Standard No No	Core; MOS 0.8; 0.6 0.4; — 8K 64K Standard No Optional	Core 0.5 0.4 16K 512K Standard No Standard
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	3 1 16K 8 4K-byte ROM & PROM 6.38 Standard No Standard No Standard	5 (stack) 5 (stack) 128K 8 4K-byte ROM & PROM 0.405 Standard Optional Standard Optional Standard	32 32 128K 8 4K-byte ROM & PROM 0.405 No No Standard No Standard	15 7 64K 7 No 0.8; 0.6 Standard Optional Standard No Optional	16 blocks of 15 16 blocks of 7 64K 7 No 0.56 Standard Optional Standard No Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Optional 1M 2; 128	Standard 2.5M 4; 1024	Standard 2.5M 4; 1024	Standard 1.93M Up to 128	Standard 4.8M Up to 128
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives  Drum/fixed-head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, 1/4-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	No Cartridge; 10-40M bytes No  No  40 KBS 200-1000 cpm 165 cps 300-600 lpm To 9600 bps 80 char. x 24 lines Paper tape reader/punch	No Cartridge; 10-40M bytes No  Cartridge; 2.4 KBS  40 KBS 200-1000 cpm 165 cps 300-600 lpm To 9600 bps 80 char. x 24 lines Paper tape reader/punch	No Cartridge; 10-40M bytes No  Cartridge; 2.4 KBS  40 KBS 200-1000 cpm 165 cps 300-600 lpm To 9600 bps 80 char. x 24 lines Paper tape reader/punch	315-630K bytes Pack & cartridge; 2.4-84M bytes Fixed-head; 262K-2M bytes No  120 KBS 300, 1000 cpm 30-132 cps 300-600 lpm 50-19.2K bps 80 char. x 24 lines Printer/plotter, A/D & D/A con- verters & dis- crete I/O	315-630K bytes Pack & cartridge; 2.4-84M bytes Fixed-head; 262K-2M bytes No  120 KBS 300, 1000 cpm 30-132 cps 300-600 lpm 50-19.2K bps 80 char. x 24 lines Printer/plotter, A/D & D/A con- verters & dis- crete I/O
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Yes  BASIC  No  No No	Yes  MPL  Batch  No No	Cross assembler  No  No  No No	Assembler & macro assembler FORTRAN IV, Extended BASIC  Batch, real-time  No No	Assembler & macro assembler FORTRAN IV, Extended BASIC  Batch, real-time  No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$5,850 (4K words) \$1,400 (4K words)  November 1971 6000	\$11,380 (4K words) \$2,930 (4K words)  March 1974 50	\$9,630 (4K words) \$2,930 (4K words)  October 1973 10	\$3,995 (8K words) \$1,100 (8K words)  March 1971 Over 1000	\$42,500 (64K words) \$14,500 (64K words)  June 1974 Over 500
<b>COMMENTS</b>	1600 Series fea- tures stack pro- cessing and char- acter string manipulation; also available in packaged version called REALITY	Software-level emulator that runs on 3200 for implementing MPL, a subset of PL/I	General-purpose system for emu- lation of spe- cialized archi- tecture such as the 32/S	4-port memory available for multiprocessor and I/O processor configurations; high-speed com- munications pro- cessor available	Features 32-bit parallel internal operation; 2048 relocating regis- ters and eight map files

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MANUFACTURER & MODEL	Mylee Digital Sciences 3G	Nanodata QM-1	NCR 299-100	NCR 299-200	NCR 499
<b>DATA FORMATS</b>					
Word length, bits	16	16 + 2	64	64	16 + 1
Fixed-point operand length, bits	8-128	Variable	16 digits	16 digits	12
Instruction length, bits	16-48	Variable	Variable	Variable	Variable
<b>MAIN STORAGE</b>					
Storage type	MOS	Core	Core	Core	Core
Cycle time, microseconds/word	0.8	0.75, 1.25	7 per bit	7 per bit	1.2
Access time, microseconds/word	—	0.38, 0.63	—	—	0.65
Minimum capacity, words	12K	16K	512 bytes	1K bytes	12K
Maximum capacity, words	72K	1024K	1K bytes	2K bytes	32K
Parity checking	No	Standard	Standard	Standard	Standard
Error correction	No	No	No	No	No
Storage protection	No	Standard	No	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	4	32	10-50 (in memory)	30-100 (in memory)	—
No. of index registers	4	12	—	—	—
No. of directly addressable words	28K	1024K	—	—	—
No. of addressing modes	—	—	—	—	—
Control storage	ROM	WCS; 32K x 36 bits	ROM; 12K words	ROM; 12K words	ROM 64K words
Add time, microseconds	20	0.75	220 milliseconds	220 milliseconds	1.7 milliseconds
Hardware multiply/divide	Standard	Standard	Standard	Standard	Standard
Hardware floating point	No	Standard	No	No	No
Hardware byte manipulation	Standard	Standard	No	No	No
Battery backup	No	Optional	No	No	No
Real-time clock or timer	No	Optional	No	No	No
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	Optional	No	No	Standard
Maximum I/O rate, words/sec	1M	1M	—	—	833K
No. of external interrupt levels	1-18	2,048	None	None	8
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	No
Disk pack/cartridge drives	Cartridge; 48-96M bytes	Pack & cartridge	No	No	Cartridge; 4.9-9.8M bytes
Drum/fixed-head disk storage	No	No	No	No	No
Magnetic tape cassettes/cartridges	No	Cartridge	No	Cassette; 750 cps	Cassette; 750 cps
Magnetic tape, ½-inch	No	Yes	No	No	No
Punched card input	300 cpm	1000 cpm	No	No	300 cpm
Serial printer	165 cps	No	15 cps	15 cps	75, 130 cps
Line printer	300 lpm	400-1000 lpm	No	No	55-300 lpm
Data communications interface	To 1200 bps	2M bps	No	1200 bps	300-9600 bps
CRT	32 char. x 11 lines	—	No	No	No
Other standard peripheral units	None	Paper tape units	Paper tape punch	Paper tape punch, mag. ledger card reader	Paper tape units, mag. ledger card reader
<b>SOFTWARE</b>					
Assembler	No	Assembler & macro assembler	Assembler	Assembler	NEAT/AM
Compilers	ACE	BASIC, ALGOL, COBOL, RPG, PL/1	No	No	No
Operating system	Real-time	Batch, real-time, time-sharing	No	No	No
Language implemented in firmware	Partially	—	Fully	Fully	No
Operating system implemented in firmware	Partially	—	Fully	Fully	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$37,500 (28K words)	\$125,000	\$7,250 (512 bytes)	\$9,300 (1K bytes)	\$17,900 (12K bytes)
Price of memory increment	—	—	\$325	\$325	\$1,100 (2K bytes)
Date of first delivery	May 1976	April 1974	November 1974	March 1975	February 1976
Number installed to date	18	10	3000 both types	3000 both types	400
<b>COMMENTS</b>	System price also includes 2 CRT's, 48M bytes of disk storage, a 165-cps printer, system software, and an inventory control applications package	Oriented toward emulation; emulators available for Data General Nova and others; up to 1K words of "nanostore" memory available	Replacement for electromechanical accounting machines	Replacement for electromechanical accounting machines	Replacement for NCR 399

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MANUFACTURER & MODEL	NCR 8200	NCR Century 75	NCR Century 50	NCR Century 100	NCR Century 101
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 2 16 16, 32, 48	8 + 1 8, 16 32-64	8 + 1 1-256 digits 32-64	8 + 1 1-256 digits 32-64	8 + 1 1-256 digits 32-64
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core 1.2 0.65 32K bytes 128K bytes Standard No No	Core 1.2 0.65 16K bytes 64K bytes Standard No No	Thin film 0.80 — 16K bytes 32K bytes Standard No No	Thin film 0.80 — 16K bytes 32K bytes Standard No No	Core 1.2 0.60 16K bytes 128K bytes Standard No Optional
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	— 27 (in memory) — — No  2.4 (8 digits) Standard No Standard No No	— 63 (in memory) — — No  25.2 (5 digits) Optional Standard Standard No Optional	— 63 (in memory) — — No  59 (5 digits) No Standard Standard No No	— 63 (in memory) — — No  59 (5 digits) No Standard Standard No No	— 63 (in memory) — — No  28.8 (5 digits) Optional Standard Standard No Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 833K 8	Standard 120K & 416K 8	Standard 40K & 108K 2	Standard 40K & 108K 2	Standard 120K & 416K 9
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives  Drum/fixed-head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, 1/4-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	No Cartridge; 4.9-39.2M bytes No  Cassette; 750 cps  No 300 cpm 173 cps 100-300 lpm 1200, 9600 bps 80 char. x 24 lines —	No Cartridge; 4.9-9.8M bytes No  No 10-320 KBS 300 cpm 6 cps 200-450 lpm 45-50,000 bps Interface only Paper tape units; MICR/OCR units	No Pack; 8.4-33.5M bytes No  Cassette; 750 cps  10-40 KBS 300-750 cpm 6 cps 125-900 lpm 45-50,000 bps 80 char. x 24 lines Paper tape units; MICR/OCR units	No Pack; 8.4-33.5M bytes No  Cassette; 750 cps  10-80 KBS 300-1200 cpm 6 cps 450-3000 lpm 45-50,000 bps 80 char. x 24 lines Paper tape units; MICR/OCR units	No Pack; 8.4-381.6M bytes No  Cassette; 750 cps  10-320 KBS 300-1200 cpm 6 cps 450-3500 lpm 45-50,000 bps 80 char. x 24 lines Paper tape units; MICR/OCR units
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	No  NEAT/3, COBOL  Batch, multiprogramming No No	No  COBOL, BASIC, FORTRAN, RPG, NEAT/3 Batch, multiprogramming No No	No  COBOL, BASIC, FORTRAN, NEAT/3 Batch, multiprogramming No No	No  COBOL, BASIC, FORTRAN, NEAT/3 Batch, multiprogramming No No	No  COBOL, BASIC, FORTRAN, NEAT/3 Batch, multiprogramming No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$17,425 (32K bytes) \$2,000 (8K bytes)  September 1974 300-400	\$56,850 (16K bytes) \$5,000 (8K bytes)  May 1976 50	\$47,000 (16K bytes) \$4,995 (16K bytes)  December 1970 1100 (50's & 100's)	\$71,500 (16K bytes) \$4,995 (16K bytes)  March 1963 1100 (50's & 100's)	\$69,520 (16K bytes) \$5,000 (8K bytes)  August 1972 1200
<b>COMMENTS</b>	8200 simulates a Century 101 computer and can execute all non-time-dependent software for the 101	System price also includes a card reader, line printer, disk drive, TTY, and cabinet; can be upgraded to Century 101; see Report 70C-656-01 for more details	System price also includes line printer, 8.4 MB disk drive, and card reader; no longer manufactured; available only in used or used-refurbished units; see Report 70C-656-01 for more details	System price also includes line printer, 8.4 MB disk drive, and card reader; no longer manufactured; available only in used or used-refurbished units; see Report 70C-656-01 for more details	System price also includes line printer, 8.4 MB disk drive, and card reader; see Report 70C-656-01 for more details

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MANUFACTURER & MODEL	NCR Century 151	Nixdorf 154	A/S Norsk Data Elektronikk Nord-10	A/S Norsk Data Elektronikk Nord-12	A/S Norsk Data Elektronikk Nord-50
<b>DATA FORMATS</b>					
Word length, bits	8 + 1	12	16 + 2	16 + 2	32
Fixed-point operand length, bits	1-256 digits	12	1, 8, 16, 32	1, 8, 16, 32	32
Instruction length, bits	32-64	12-48	16, 32, 48	16, 32, 48	32
<b>MAIN STORAGE</b>					
Storage type	MOS	Core	Core; MOS	MOS	MOS
Cycle time, microseconds/word	0.75 (1 or 2 bytes)	2	0.90; 0.50	0.90	0.5
Access time, microseconds/word	—	1	0.4; 0.40	0.40	0.4
Minimum capacity, words	64K bytes	6K	8K	4K	4K
Maximum capacity, words	128K bytes	24K	256K	64K	128K
Parity checking	Standard	Standard	Standard	Standard	Standard
Error correction	No	No	No	No	No
Storage protection	Optional	No	Optional	No	Standard
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	—	2	32	32	32
No. of index registers	63 (in memory)	3	32	32	16
No. of directly addressable words	—	—	256	256	4K
No. of addressing modes	—	—	8	8	—
Control storage	No	See comments	ROM	ROM	No
Add time, microseconds	18.0 (5 digits)	8	1.1	2.5	0.85
Hardware multiply/divide	Standard	Standard	Standard	Standard	Standard
Hardware floating point	No	No	Standard	Standard	Standard
Hardware byte manipulation	Standard	No	Standard	Standard	Standard
Battery backup	No	No	—	—	—
Real-time clock or timer	Optional	No	Standard	Standard	No
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access control	Standard	No	Standard	Standard	Standard
Maximum I/O rate, words/sec	120K & 545K	144K	830K	1.2M	—
No. of external interrupt levels	9	—	2048	2048	No
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drive	No	No	256K bytes	256K bytes	No
Disk pack/cartridge drives	Pack; 8.4-381.6M bytes	Pack	Pack & cartridge; 10-66M bytes	Pack & cartridge; 10-66M bytes	No
Drum/fixed-head disk storage	No	No	Fixed-head; 2M bytes	No	No
Magnetic tape cassettes/cartridges	Cassette; 750 cps	Cassette; 435 cps	Cassette; 800 cps	Cassette; 800 cps	No
Magnetic tape, 1/2-inch	10-320 KBS	10, 20 KBS	36-144 KBS	36-144 KBS	No
Punched card input	300-1200 cpm	60 cpm	285 cpm	28 5 cpm	No
Serial printer	6 cps	100, 165 cps	30, 180 cps	30, 180 cps	No
Line printer	450-3500 lpm	No	60-1500 lpm	60-1500 lpm	No
Data communications interface	45-50K bps	To 2400 bps	To 9600 bps	To 9600 bps	No
CRT	80 char. x 24 lines	No	80 char. x 24 lines	80 char. x 24 lines	No
Other standard peripherals units	Paper tape units, MICR/OCR units	Paper tape reader, paper tape punch, mag. ledger card reader	Paper tape units, card punch, plotters	Paper tape units, card punch, plotters	No
<b>SOFTWARE</b>					
Assembler	No	Yes	Assembler & macro assembler	Assembler & macro assembler	Assembler & macro assembler
Compilers	COBOL, BASIC, FORTRAN, NEAT/3	BOSS	RPG, FORTRAN, BASIC, N-PL, NODAL	RPG, FORTRAN, BASIC, N-PL, NODAL	FORTRAN
Operating system	Batch, multipro- gramming	—	Batch, real-time, time-sharing	Batch, real-time, time-sharing	None
Language implemented in firmware	No	Fully	No	No	No
Operating system implemented in firmware	No	Fully	No	No	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$119,925 (64K bytes)	\$22,490 (6K words)	\$115,000	\$34,000	—
Price of memory increment	\$20,000 (64K bytes)	—	—	—	—
Date of first delivery	February 1975	Nov. 1973 (840's)	June 1973	May 1975	NA
Number installed to date	50	3000 (840's)	NA	NA	NA
<b>COMMENTS</b>	See Report 70C-656-01 for more details	Control storage can be from 4K x 18 bits to 8K x 18 bits of ROM; system price is for the 840 sys- tem and includes a 100-cps print- er; Model 154 pro- cessor is used in 800 Series (840 is most recent member)	System price includes floppy disk, pack disk, serial printer, & reel-to-reel mag. tape; sold only in Europe	System price includes punched card reader, line printer & CRT; sold only in Europe	High-speed arithmetic pro- cessor for use with Nord-10 host CPU; this system shares all peripherals with the host system

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MANUFACTURER & MODEL	Olivetti A5	Olivetti A6	Olivetti A7	Philips P300	Philips P350
<b>DATA FORMATS</b>					
Word length, bits	64	64	8 + 1	8	64
Fixed-point operand length, bits	64	64	6	Variable	64
Instruction length, bits	16	16	16, 32	8, 56	64
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	MOS	Core	Core
Cycle time, microseconds/word	1.5	1.5	0.9	1.5	1.5
Access time, microseconds/word	—	—	0.8	0.6	0.6
Minimum capacity, words	512	2K	16K	8K bytes	600
Maximum capacity, words	4K	4K	48K	16K bytes	1200
Parity checking	No	No	Standard	No	No
Error correction	No	No	No	No	No
Storage protection	No	No	No	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	47	111-485	—	8	Software-assigned
No. of index registers	0	0	0	8	0
No. of directly addressable words	4K	4K	48K	—	1200
No. of addressing modes	—	—	—	—	—
Control storage	ROM; 8-16K x 16 bits	ROM	ROM; 8K x 16 bits	ROM; 64K x 8 bits	No
Add time, microseconds	10	10	6.1	—	1.5
Hardware multiply/divide	No	No	No	No	Standard
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	—	—	Standard	Standard	—
Battery backup	No	No	No	No	No
Real-time clock or timer	No	No	No	No	No
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	—	—	—	Standard	Standard
Maximum I/O rate, words/sec	1M	1M	650K	—	—
No. of external interrupt levels	None	None	None	None	None
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	1.2M	512K	No	No
Disk pack/cartridge drives	No	No	Cartridge; 10-40M bytes	No	Cartridge; 256K-9.2M bytes
Drum/fixed-head disk storage	No	No	Fixed-head; 160K bytes	No	No
Magnetic tape cassettes/cartridges	Cassette; 1 KBS	Cassette; 1 KBS	Cassette; 1 KBS	Cassette; 1 KBS	Cassette; 1 KBS
Magnetic tape, ½-inch	No	No	No	No	No
Punched card input	No	No	400 cpm	No	280 cpm
Serial printer	16 cps	16 cps	40-175 cps	50 cps	40 cps
Line printer	60 lpm	60, 300 lpm	300, 600 lpm	No	120-600 lpm
Data communications interface	4800 bps; synch.	4800 bps; synch.	9600 bps; synch.	To 9600 bps; synch.	To 9600 bps; synch.
CRT	No	No	No; see Comments	No	No
Other standard peripheral units	Paper tape units, mag. ledger card reader	Paper tape units, mag. ledger card reader	Paper tape units, card punch, mag. ledger card reader	Paper tape punch, card punch, mag. ledger card reader	Paper tape units, card punch, mag. ledger card reader
<b>SOFTWARE</b>					
Assembler	Yes	Yes	Assembler & macro assembler	Yes	Yes
Compilers	APCO	APCO	RPG, PL/1	—	—
Operating system	Batch (one program)	Batch (one program)	Batch (two programs)	Batch (one program)	Batch (one program)
Language implemented in firmware	Fully	Fully	Fully	Partially	No
Operating system implemented in firmware	Fully	Partially	Partially	Partially	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$4,900 (512 bytes)	\$8,820 (2K bytes)	\$15,500 (16K bytes)	\$7,000 (8K bytes)	\$15,500 (600 words)
Price of memory increment	\$600 (1K bytes)	—	\$1,000 (4K bytes)	\$1,200 (8K bytes)	\$8,500 (400 words)
Date of first delivery	February 1975	January 1976	March 1975	June 1975	June 1970
Number installed to date	NA	NA	NA	300	2000
<b>COMMENTS</b>	Asynch. communications speed is 1200 bps; integral but optional mag. ledger units allows mag. cards to be used for program storage	Asynch. communications speed is 1200 bps; integral but optional mag. ledger unit allows mag. cards to be used for program storage	Asynch. communications speed is 1200 bps; A7 includes integral 16-character numeric display	Asynch. communications speed to 2400 bps	Asynch. communications speed to 2400 bps



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MANUFACTURER & MODEL	Prime 100	Prime 200	Prime 300	Prime 400	Qantel Q7
<b>DATA FORMATS</b>					
Word length, bits	16	16 + 2	16 + 2	16 + 2 or + 5	8-bit byte
Fixed-point operand length, bits	16, 32	16, 32	16, 32	16, 32	—
Instruction length, bits	16, 32	16, 32	16, 32	16, 32, 48	24-48
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	MOS	MOS; bipolar cache	MOS
Cycle time, microseconds/word	1.0	0.750	0.750	0.760	1.5
Access time, microseconds/word	0.680	0.600	0.600	0.600	—
Minimum capacity, words	4K	4K	8K	64K	32K
Maximum capacity, words	64K	64K	256K	4096K	64K
Parity checking	No	Standard	Standard	Standard	No
Error correction	No	No	No	Optional	No
Storage protection	No	No	Std.; 3 levels	Std.; 3 levels	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	1	1	1 (32-bit)	17 (in memory)
No. of index registers	1	1	1	2 (32-bit)	0
No. of directly addressable words	64K	64K	64K	64K	32K
No. of addressing modes	4	4	4	4	—
Control storage	No	No	PROM; 512 x 64 bits	PROM; 2K x 64 bits	ROM; 1.5K bytes
Add time, microseconds	2.44	1.96	1.56	0.56	127.5 (5 digits)
Hardware multiply/divide	Optional	Optional	Standard	Standard	No
Hardware floating point	No	Optional	Optional	Standard	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Battery backup	Optional	Optional	Optional	No	No
Real-time clock or timer	Optional	Optional	Optional	Standard	Optional
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	694K	1.0M	1.137M	1.25M	667K
No. of external interrupt levels	64	64	64	64	1
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	512K-2.0M bytes	512K-2.0M bytes	512K-2.0M bytes	512K-2.0M bytes	No
Disk pack/cartridge drives	Pack & cartridge;	Pack & cartridge;	Pack & cartridge;	Pack & cartridge;	Pack & cartridge;
Drum/fixed-head disk storage	2.9-1200M bytes	2.9-1200M bytes	2.9-1200M bytes	2.9-1200M bytes	6-122.8M bytes
Magnetic tape cassettes/cartridges	Fixed-head;	Fixed-head;	Fixed-head;	Fixed-head;	No
	512K-1M bytes	512K-1M bytes	512K-1M bytes	512K-1M bytes	No
Magnetic tape, ½-inch	No	No	No	No	No
Punched card input	To 72 KBS	To 72 KBS	To 72 KBS	To 72 KBS	20, 36 KBS
Serial printer	300 cpm	300 cpm	300 cpm	300 cpm	500 cpm
Line printer	165 cps	165 cps	165 cps	165 cps	165 cps
Data communications interface	To 600 lpm	To 600 lpm	To 600 lpm	To 600 lpm	300-1200 lpm
CRT	To 56K bps	To 56K bps	To 56K bps	To 56K bps	50K bps; synch.
Other standard peripheral units	80 char. x 24 lines	80 char. x 24 lines	80 char. x 24 lines	80 char. x 24 lines	72 char. x 24 lines
	Paper tape, A/D and D/A conv., card reader/punch	Paper tape, A/D and D/A conv., card reader/punch	Paper tape, A/D and D/A conv., card reader/punch	Paper tape, A/D and D/A conv., card reader/punch	Paper tape reader
<b>SOFTWARE</b>					
Assembler	Macro assembler	Macro assembler	Macro and micro assemblers	Macro and micro assemblers	Yes
Compilers	BASIC, FORTRAN	BASIC, FORTRAN	BASIC, FORTRAN, COBOL, RPG II	BASIC, FORTRAN, COBOL, ALGOL	QIC (BASIC)
Operating system	Batch, real-time, multi-user	Batch, real-time, multi-user	Real-time, multi-user, virtual mem.	Real-time, multi-user, virtual mem.	Time-sharing
Language implemented in firmware	Partially	Partially	Partially	Partially	Partially
Operating system implemented in firmware	Partially	Partially	Partially	Partially	Partially
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$4,600 (4K words)	\$5,600 (4K words)	\$12,500 (8K words)	\$48,700 (64K words)	\$32,000 (32K words)
Price of memory increment	\$1,900 (4K words); \$3,400 (8K words)	\$1,200 (4K words); \$3,900 (8K words)	\$3,000 (8K words); \$4,000 (16K wds.)	\$12,000 (32K wds.); \$22,500 (64K wds.)	\$2,225 (8K bytes)
Date of first delivery	June 1973	November 1972	September 1973	March 1976	1st quarter 1974
Number installed to date	1300 (all models)	1300 (all models)	1300 (all models)	1300 (all models)	450
<b>COMMENTS</b>		Basis for Create/1.2 packaged business system	Basis for Create/2.2, Create/2.4, Create/3.4, and Create/4.2 packaged business systems; virtual memory management system permits addressing up to 128K bytes per user	Basis for Create/4.2 packaged business system; virtual memory management system permits addressing up to 512M bytes per user; 2K-byte cache memory std.; 2 to 1 memory interleaving std.	Processor used in Models 800, 900, 950, 1200; system price includes serial printer & cartridge disk

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MANUFACTURER & MODEL	Qantel Q7.5	Randal 200	Raytheon PTS-1200	Raytheon RDS-500	A/S Regnecentralen RC 6000
<b>DATA FORMATS</b>					
Word length, bits	8-bit byte	16	16	16 + 2	24
Fixed-point operand length, bits	—	Variable	8, 16, 24	16	24, 48
Instruction length, bits	24-48	16, 32, 48	16, 32	8, 16, 32	12
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	MOS	Core	Core
Cycle time, microseconds/word	1.1	0.3	1.28	0.70; 0.80; 0.90	20
Access time, microseconds/word	—	0.3	0.80	—	10
Minimum capacity, words	40K	32K bytes	24K	8K	16K
Maximum capacity, words	128K	64K bytes	64K	64K	16K
Parity checking	No	No	No	Optional	No
Error correction	No	No	No	No	No
Storage protection	No	Standard	No	Optional	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	6 (+17 in mem.)	4	1	8	4
No. of index registers	—	2	2	1	3
No. of directly addressable words	64K	512	32K	64K	4K
No. of addressing modes	—	4	10	6	—
Control storage	ROM	ROM; 256 x 64 bits	No	No	—
Add time, microseconds	—	1.2	2.8	1.4; 1.6; 1.8	50
Hardware multiply/divide	No	Optional	No	Standard	No
Hardware floating point	No	No	No	Optional	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	No
Battery backup	No	Optional	No	No	No
Real-time clock or timer	Optional	Standard	Standard	Optional	Standard
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	909K	800K	125 KBS	1.0	500K
No. of external interrupt levels	2	—	16	16	1-14
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	No	No	No	No	Yes
Disk pack/cartridge drives	Pack & cartridge; 6-122.8M bytes	Cartridge; 10-40M bytes	Cartridge; 2.6-20.8M bytes	Cartridge & pack; 2.5-207.8M bytes	Cartridge
Drum/fixed-head disk storage	No	No	No	Fixed-head; 770K-25.2M bytes	Fixed-head
Magnetic tape cassettes/cartridges	No	No	Cassette; 600 cps	No	Cassette & cartridge
Magnetic tape, 1/2-inch	20, 36 KBS	10-72 KBS	No	20.8-200 KBS	Yes
Punched card input	500 cpm	450 cpm	300 cpm	300, 1000 cpm	600 cpm
Serial printer	165 cps	30, 180 cps	10-165 cps	10 cps	—
Line printer	300-1200 lpm	300, 600 lpm	300 lpm	300, 1250 lpm	To 600 lpm
Data communications interface	50K bps; synch.	Up to 9600 bps	To 9600 bps	110-9600 bps	Yes
CRT	72 char. x 24 lines	80 char. x 12 lines	40 char. x 12 lines	72 char. x 35 lines	No
Other standard peripheral units	Paper tape reader	Paper tape reader, paper tape punch	—	Appollo Array Processor, plot- ters, A/D and D/A converters	Card punch
<b>SOFTWARE</b>					
Assembler	Yes	No	No	Macro assembler	Yes
Compilers	QIC (BASIC)	BASIC	MACROL, AUTOQUERY	FORTRAN	FORTRAN, ALGOL
Operating system	Time-sharing	Time-sharing	Multiprogram- ming	Batch, real-time, multiprogramming	Batch, real-time, time-sharing
Language implemented in firmware	Partially	No	No	No	No
Operating system implemented in firmware	Partially	No	No	No	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$42,500 (40K bytes)	\$20,000 (16K bytes)	\$30,580 (24K words)	\$7,300 (8K words)	\$18,000 (16K words)
Price of memory increment	—	\$1,500 (16K bytes)	\$750-\$3,000	\$2,300 (8K words)	—
Date of first delivery	January 1976	August 1976	November 1974	February 1973	May 1975
Number installed to date	20	NA	150-200	Over 200	NA
<b>COMMENTS</b>	Processor used in Model 1300; system price includes serial printer & cartridge disk	Available only in packaged business system; price also includes CRT and 10-megabyte disk drive	Display-oriented system for up to 12 Raytheon PTS-100 programmable terminals	Appollo Array Processor can perform 22 specialized array operations; widely used in seismic data processing	Based on RC 3600; emulates RC 8000

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MANUFACTURER & MODEL	A/S Regnecentralen RC 8000	A/S Regnecentralen RC 3600	Roim 1602 (AN/UYK-19)	Roim 1603 (AN/UYK-27)	Roim 1664 (AN/UYK-28)
<b>DATA FORMATS</b>					
Word length, bits	24	24	16	16	16
Fixed-point operand length, bits	24, 48	24, 48	16, 32	16	16, 32
Instruction length, bits	12	12	16, 32	16, 32	16, 32, 48
<b>MAIN STORAGE</b>					
Storage type	Core	Core	Core	Core	Core
Cycle time, microseconds/word	0.8	1.0	1.0	1.2	1.0
Access time, microseconds/word	0.4	0.5	0.5	0.6	0.5
Minimum capacity, words	4K	8K	8K	8K	8K
Maximum capacity, words	4096K	32K	256K	32K	256K
Parity checking	Standard	No	No	No	No
Error correction	No	No	No	No	No
Storage protection	Standard	No	Optional	Optional	Optional
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	4	4	4	4	12
No. of index registers	3	2	2	2	2
No. of directly addressable words	4K	256	64K	32K	64K
No. of addressing modes	—	—	5	4	6
Control storage	—	—	ROM; 2K x 32 bits	—	ROM; 4K x 32 bits
Add time, microseconds	1.8	1.4	1.0	5.9	1.0
Hardware multiply/divide	Standard	No	Standard	Optional	Standard
Hardware floating point	Standard	No	Optional	No	Standard
Hardware byte manipulation	Standard	No	Standard	Standard	Standard
Battery backup	No	No	No	No	No
Real-time clock or timer	Standard	Standard	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1M	500K	1M	768K	1M
No. of external interrupt levels	1-256	1-14	16	16	16
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	Yes	Yes	No	No	No
Disk pack/cartridge drives	Pack & cartridge	Cartridge	Cartridge; 5-10M bytes	Cartridge; 5-10M bytes	Cartridge; 5-10M bytes
Drum/fixed-head disk storage	Fixed-head	Fixed-head	Fixed-head; 2M bytes	Fixed-head; 2M bytes	Fixed-head; 2M bytes
Magnetic tape cassettes/cartridges	Cassette & cartridge	Cassette & cartridge	No	No	No
Magnetic tape, 1/2-inch	Yes	Yes	60 KBS	60 KBS	60 KBS
Punched card input	600 cpm	600 cpm	300 cpm	300 cpm	300 cpm
Serial printer	—	—	15 cps	15 cps	15 cps
Line printer	To 1800 lpm	To 1800 lpm	1100 lpm	1100 lpm	1100 lpm
Data communications interface	Yes	Yes	20K bps	20K bps	20K bps
CRT	No	No	80 char. x 24 lines	80 char. x 24 lines	80 char. x 24 lines
Other standard peripheral units	Card punch	Card punch	Paper tape units, D/A & A/D converters	Paper tape units, D/A & A/D converters	Paper tape units, D/A & A/D converters
<b>SOFTWARE</b>					
Assembler	Yes	Yes	Assembler & macro assembler	Assembler & macro assembler	Assembler & macro assembler
Compilers	FORTRAN, ALGOL	MUSIL	ALGOL, BASIC, FORTRAN	ALGOL, BASIC, FORTRAN	ALGOL, BASIC, FORTRAN
Operating system	Batch, real-time, time-sharing	Batch, real-time, time-sharing	Batch, real-time	Batch, real-time	Batch, real-time
Language implemented in firmware	No	No	No	No	No
Operating system implemented in firmware	No	No	No	No	No
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel, and min. mem. in chassis	\$68,500 (4K words)	\$35,000 (8K words)	\$22,250 (8K words)	\$9,245 (8K words)	\$36,850 (8K words)
Price of memory increment	—	—	\$6,000 (8K words)	\$5,000 (8K words)	\$6,250 (8K words)
Date of first delivery	April 1976	June 1971	1972	1974	1976
Number installed to date	NA	Over 150	300	45	15
<b>COMMENTS</b>	Designed for multiprocessor operation; minimum configuration includes RC 3600 front end	Principally a satellite system for RJE, front end, data entry, data collection, and media conversion	Qualified to Mil-E-5400 & Mil-E-16400 specif.; ATR chassis; micro-programmed militarized CPU, upward-compatible with DG Nova	Qualified to Mil-E-5400 & Mil-E-16400 specif.; ATR chassis; low-priced, faster version of previously offered Model 1601; compatible with DG Nova	Designed to meet Mil-E-5400 & Mil-E-16400 specif. ATR chassis; tri-processor militarized super-computer, upward-compatible with other Roim computers

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MANUFACTURER & MODEL	Roim 1650 (AN/UYK-34)	Systems Engineering Laboratories 32/35	Systems Engineering Laboratories 32/50	Systems Engineering Laboratories 32/55	Tandem T16/1102
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 16, 32 16, 32	32 + 4 8, 16, 32, 64 16, 32	32 + 4 8, 16, 32, 64 16, 32	32 + 4 8, 16, 32, 64 16, 32	16 + 1 8, 16, 32 16
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core 1.0 0.5 16K 32K No No Optional	Core 0.9 0.45 16K 128K Standard No Standard	Core 0.6 0.3 8K 16K Standard No Standard	Core 0.6 0.3 8K 256K Standard No Standard	Core 0.80 0.50 32K 256K Standard No Standard
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	4 2 32K 5 PROM; 1K x 52 bits 1.05 Standard Optional Standard No Optional	8 3 128K 6 PROM; 2K x 48 bits 0.90 Standard Standard Standard No Standard	8 3 128K 6 PROM; 4K x 48 bits 1.2 Standard Standard Standard No Standard	8 3 128K 6 PROM; 4K x 48 bits 1.2 Standard Standard Standard No Standard	8 3 1K — — 0.50 Standard No Standard No Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 666K 16	Standard 6.67M 16-112	Standard 6.67M 16-128	Standard 6.67M 16-128	Standard 1.25M —
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drive Disk pack/cartridge drives Drum/fixed-head disk storage Magnetic tape cassettes/cartridges Magnetic tape, 1/4-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral	No Cartridge; 5-10M bytes Fixed-head; 2M bytes No 60 KBS 300 cpm 15 cps 1100 lpm 20K bps 80 char. x 24 lines Paper tape units, D/A & A/D units	No Pack & cartridge; 5-320M bytes Fixed-head; 1-4M bytes No 25-120 KBS 300-1000 cpm No 125-600 lpm 50K bps; synch. 80 char. x 24 lines Paper tape units, card punch, TTY units	No Pack & cartridge; 5-320M bytes Fixed-head; 1-4M bytes No 25-120 KBS 300-1000 cpm No 125-600 lpm 50K bps; synch. 80 char. x 24 lines Paper tape units, card punch, TTY units	No Pack & cartridge; 5-320M bytes Fixed-head; 1-4M bytes No 25-120 KBS 300-1000 cpm No 125-600 lpm 50K bps; synch. 80 char. x 24 lines Paper tape units, card punch, TTY units	No Cartridge & pack; 10-200M bytes No No 36 KBS 600 cpm No 125-1500 lpm 50-56K bps 80 char. x 24 lines —
<b>SOFTWARE</b> Assembler Compiler Operating system Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler ALGOL, BASIC, FORTRAN Batch, real-time No No	Assembler & macro assembler RPG, FORTRAN IV, BASIC Batch, real-time, time-sharing No No	Assembler & macro assembler RPG, FORTRAN IV, BASIC Batch, real-time, time-sharing No No	Assembler & macro assembler RPG, FORTRAN IV, BASIC Batch, real-time, time-sharing No No	No COBOL, TAL Virtual mem., multiproc., multiprog. Partially Partially
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment Date of first delivery Number installed to date	\$26,250 (16K words) \$7,000 (16K words) NA NA	\$25,000 (16K words) — August 1976 NA	\$18,000 (8K words) \$6,300 (8K words) October 1975 NA	\$25,000 (8K words) \$6,300 (8K words) October 1975 NA	\$18,500 (32K words) \$8,000 (32K words) May 1976 10 (both models)
<b>COMMENTS</b>	Designed to meet Mil-E-5400 & Mil-E-16400 specif.; half ATR version of Roim 1602	Asynch. communications to 9600 bps; instruction look-ahead utilized	Asynch. communications to 9600 bps	Asynch. communications to 9600 bps	Multiprocessor systems containing from 2 to 16 CPU's for failure resistance; all system components are dual-ported, and CPU's have dual buses

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MANUFACTURER & MODEL	Tandem T16/1402	Tektronix 4051	Texas Instruments 960B	Texas Instruments 980B
<b>DATA FORMATS</b>				
Word length, bits	16 + 6	8-bit byte	16 + 6	16 + 6
Fixed-point operand length, bits	8, 16, 32	8	8, 16	8, 16
Instruction length, bits	16	8, 16, 24	32	16, 32, 48
<b>MAIN STORAGE</b>				
Storage type	MOS	MOS	MOS	MOS
Cycle time, microseconds/word	0.50	1.2	0.75	0.75
Access time, microseconds/word	0.50	0.45	—	—
Minimum capacity, words	32K	8K bytes	8K	8K
Maximum capacity, words	256K	32K bytes	64K	64K
Parity checking	No	No	No	No
Error correction	Standard	No	Standard	Standard
Storage protection	Standard	No	Standard	Standard
<b>CENTRAL PROCESSOR</b>				
No. of accumulators	8	2	16	2
No. of index registers	3	1	16	1
No. of directly addressable words	1K	32K	64K	64K
No. of addressing modes	—	7	15	15
Control storage	—	ROM; 36K-156K bytes	ROM; 256 x 16 bits	ROM; 256 x 16 bits
Add time, microseconds	0.50	2.0	3.6	1.75
Hardware multiply/divide	Standard	No	Optional	Standard
Hardware floating point	No	No	No	No
Hardware byte manipulation	Standard	Standard	No	Standard
Battery backup	No	Optional	Optional	Optional
Real-time clock or timer	Standard	Optional	Optional	Optional
<b>INPUT/OUTPUT CONTROL</b>				
Direct memory access channel	Standard	Optional	Standard	Standard
Maximum I/O rate, words/sec	2M	3.5K	1.3M	1M
No. of external interrupt levels	—	No	3-2048	4-32
<b>PERIPHERAL EQUIPMENT</b>				
Floppy disk (diskette) drives	No	No	No	No
Disk pack/cartridge drives	Cartridge & pack; 10-200M bytes	No	Cartridge & pack; 2.28-392M bytes	Cartridge & pack; 2.28-392M bytes
Drum/fixed-head disk storage	No	No	Fixed-head; 458-916K bytes	Fixed-head; 458-916K bytes
Magnetic tape cassettes/cartridges	No	Cartridge	Cassette; 800 cps	Cassette; 800 cps
Magnetic tape, ½-inch	36 KBS	No	30 KBS	30 KBS
Punched card input	600 cpm	No	300 cpm	300 cpm
Serial printer	No	180 cps	30-330 cps	30-330 cps
Line printer	120-1500 lpm	No	365 lpm	365 lpm
Data communications interface	50-56K bps	110-2400 bps asynch.	110-9600 bps	110-9600 bps
CRT	80 char. x 24 lines	72 char. x 35 lines	80 char. x 24 lines	80 char. x 24 lines
Other standard peripheral units	—	Plotter, CRT hard-copy device	Process control interfaces, A/D & D/A converters	Paper tape units
<b>SOFTWARE</b>				
Assembler	No	No	Assembler & macro preprocessor	Assembler & macro preprocessor
Compilers	COBOL, TAL	BASIC	FORTTRAN	FORTTRAN, BASIC
Operating system	Virtual mem., multiprog., multiprog.	Batch	Single-user, real-time, multiprogramming	Single-user, multiprogramming
Language implemented in firmware	Partially	Fully	No	No
Operating system implemented in firmware	Partially	Fully	No	No
<b>PRICING &amp; AVAILABILITY</b>				
Price of CPU, power supply, front panel, and min. mem. in chassis	\$19,500 (32K words)	\$6,995 (8K bytes)	\$4,350 (8K words)	\$4,975 (8K words)
Price of memory increment	\$6,500 (32K words)	\$2,390 (8K bytes)	\$1,400 (8K words)	\$1,400 (8K words)
Date of first delivery	May 1976	December 1975	May 1974	May 1974
Number installed to date	10 (both models)	NA	NA	NA
<b>COMMENTS</b>	Multiprocessor systems containing from 2 to 16 CPU's for failure resistance; all system components are dual-ported, and CPU's have dual buses	Based on Motorola/AMI 6800; specifications are transparent to user since all programming is in BASIC	Heavily supported for process control applications	

## All About Minicomputers

MANUFACTURER & MODEL	Texas Instruments 990/4	Texas Instruments 990/10	Univac 9200 & 9300	Univac 90/30
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 1 8, 16 16, 32, 48	16 + 1 or + 6 8, 16 16, 32, 48	8-bit byte 1-32 16, 32, 48	8-bit byte 1-32 16, 32, 48
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 0.65 — 1K 32K Optional No Optional	MOS 0.65 — 8K 1024K Optional Optional Optional	Plated wire 1.2; 0.6 — 8K bytes 32K bytes Standard No No	MOS 0.6 (2-byte fetch) — 32K bytes 524K bytes Standard No Optional
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage	Unlimited (memory) Unlimited (memory) 64K 8 ROM	Unlimited (memory) Unlimited (memory) 64K 8 No	8 8 — — No	16 16 — — ROM; 1K x 82 bits
Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	4.7 Standard No Standard — Standard	3.6 Standard No Standard — Standard	40.8; 20.4 (16 bits) See comments No Standard No No	5.4 (32 bits) Standard Optional Standard No Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	No 1.5M 8-2048	Standard 4M 16-2048	Optional 312K —	Standard 1.8M —
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives Drum/fixed-head disk storage Magnetic tape cassettes/cartridges Magnetic tape, ½-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	242-968K bytes Cartridges; 3-12M bytes No Cassette; 800 cps No 400 cpm 30-120 cps No 75-9600 bps 80 char. x 12 lines PROM programmer	242-968K bytes Cartridge; 3-12M bytes No Cassette; 800 cps No 400 cpm 30-120 cps No 75-9600 bps 80 char. x 12 lines PROM programmer	No Pack & cartridge; 3.2-1860M bytes No No 34, 68 KBS 400-1000 cpm 30 cps 250-2000 lpm To 250K bps — Paper tape reader/ punch, card punch, optional scanner	No Pack; 29M-1600M bytes No No 8.5-320 KBS 600, 1000 cpm 30 cps 500-2000 lpm To 50K bps — Paper tape reader/ punch, card punch, optical scanner
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	No No Real-time, multi-task No No	Assembler & macro assembler FORTRAN, BASIC, COBOL Real-time, multi-task No No	Yes COBOL, FORTRAN, RPG Batch, real-time, timesharing No No	Yes COBOL, FORTRAN, RPG II Batch, real-time, time-sharing Partially Partially
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment Date of first delivery Number installed to date	\$575 (256 words) \$625 (4K words) March 1976 1000+ (990 Series)	\$1,975 (8K words) \$1,000 (8K words); \$1,950 (8K ERCC) March 1976 1000+ (990 Series)	\$34,176 (8K-9200) \$57,120 (8K-9300) \$13,008 (4K-9200) \$15,120 (4K-9300) 3rd quarter 1966 NA	\$78,480 (32K bytes) \$6,720 (16K bytes) \$13,440 (32K bytes) 1st quarter 1975 NA
<b>COMMENTS</b>	Based on TI's TMS9900 16-bit microprocessor	MSI implementation of 990/4 CPU with enhancements	Multiply & divide are optional on 9200 & 9300 card system, and standard on all others; no longer being manufactured; see Report 70C-877-01 for more details	Smallest member of Univac Series 90; system price also includes integrated peripheral channel, 2 interval timers, CRT/keyboard, and Univac 9200/9300 & IBM 360/20 compatibility; see Report 70C-877-04 for more details

## All About Minicomputers

MANUFACTURER & MODEL	Varian V73	Varian V75	Varian V76	Wang PCS
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 2 16 (8, 32 opt.) 16, 32	16 + 2 8, 16, 32 16, 32	16 + 2 8, 16, 32 16, 32	8-bit byte 8 8
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core; MOS 0.66; 0.33 — 8K 256K Optional No Standard	Core; MOS 0.99, 0.66; 0.33 — 64K 256K Optional No Standard	MOS 0.66 — 16K 1024K Optional No Standard	MOS 1.6 — 8K bytes 32K bytes No No No
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	3 1 2K 8 WCS; 4K x 64 bits  1.32; 0.66 Standard Optional Optional Optional Standard	8 7 2K 8 WCS; 4K x 64 bits  1.98; 1.32; 0.66 Standard Optional Standard Optional Standard	8 7 2K 8 WCS; 4K x 64 bits  1.32 Standard Optional Standard Optional Optional	32; not user-access. 32; not user-access. — — ROM; 24K words  800 Standard Standard Standard No No
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1M 8-64	Standard 1M 8-64	Standard 1M 8-64	No 10K None
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives  Drum/fixed-head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	No Cartridge & pack; 2.34-373.6M bytes Fixed-head; 123-492K bytes No  20, 30 KBS 300 cpm 10, 165 cps 300-2000 lpm To 50K bps 80 char. x 24 lines Status line of printer/ plotters; A/D & D/A converters	No Cartridge & pack; 2.34-373.6M bytes Fixed-head; 123-492K bytes No  20, 30 KBS 300 cpm 10, 165 cps 300-2000 lpm To 50K bps 80 char. x 24 lines Status line of printer/ plotters; A/D & D/A converters	No Cartridge & pack; 2.34-373.6M bytes Fixed-head; 123-492K bytes No  20, 30 KBS 300 cpm 10, 165 cps 300-2000 lpm To 50K bps 80 char. x 24 lines Status line of printer/ plotters; A/D & D/A converters	No No No No Cassette; 326 bps  No No 120 cps 250 lpm To 9600 bps 64 char. x 16 lines Plotter
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Macro assembler & micro assembler FORTRAN, BASIC, COBOL, RPG  Batch, real-time, multi-task No No	Macro assembler & micro assembler FORTRAN, BASIC, COBOL, RPG  Batch, real-time, multi-task No No	Macro assembler & micro assembler FORTRAN, BASIC, COBOL, RPG  Batch, real-time, multi-task No No	No  BASIC  Interactive  Fully Partially
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$15,530 (8K words)  \$5,000 (8K MOS); \$3,500 (8K core) November 1972 NA	\$39,000 (64K words)  \$16,000 (64K core); \$5,000 (8K MOS) August 1975 NA	\$8,400 (16K words)  \$2,900 (16K words) January 1976 NA	\$5,400 (8K bytes)  \$1,600 (8K bytes); \$3,000 (16K bytes) May 1976 NA
<b>COMMENTS</b>	Dual-ported memories; odd/even interleaving for core memories standard; TOTAL data base management system available	Single- and dual-ported memories; odd/even interleaving for core memories standard; TOTAL data base management system available	Dual-ported memories; optional 1K-word cache memory; TOTAL data base management system available	Portable computer weighing 57 lbs.

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MANUFACTURER & MODEL	Wang 2200S	Wang 2200T	Warrex Centurion IV	Westinghouse 2500
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte 8 8	8-bit byte 8 8	8 + 1 8, 16 8, 16, 24	16 16, 32 16, 32
<b>MAIN STORAGE</b> Storage type Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 1.6 — 4K bytes 32K bytes No No No	MOS 1.6 — 4K bytes 32K bytes No No No	MOS 0.800 — 20K 256K Optional No No	Core 0.75; 0.95 0.33; 0.35 8K 1M Standard No Optional
<b>CENTRAL PROCESSOR</b> No. of accumulators No. of index registers No. of directly addressable words No. of addressing modes Control storage  Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	32; not user-access. 32; not user-access. — — ROM; 24K words  800 Standard Standard Standard No No	32; not user-access. 32; not user-access. — — ROM; 42.5K words  800 Standard Standard Standard No No	128 96 256 7 No  — No No Standard No Standard	1 2 256 14 No  1.7 Standard Optional No No Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	No 10K None	No 10K None	Standard 600K 16	Standard 1M 4-128
<b>PERIPHERAL EQUIPMENT</b> Floppy disk (diskette) drives Disk pack/cartridge drives  Drum/fixed-head disk storage  Magnetic tape cassettes/cartridges  Magnetic tape, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	262-786K bytes Cartridge; 1.2-20M bytes No  Cassette; 326 bps  10 KBS 300 cpm 200 cps 250 lpm To 9600 bps 64 char. x 16 lines Paper tape reader, paper tape punch, card punch, plotter	262-786K bytes Cartridge; 1.2-20M bytes No  Cassette; 326 bps  10 KBS 300 cpm 200 cps 250 lpm To 9600 bps 64 char. x 16 lines Paper tape reader, paper tape punch, card punch plotter	1.2M bytes Cartridge; 10.5-42.5M bytes No  Cassette; 200 cps  24 KBS 300 cpm 175 cps 125-600 lpm 75-9600 bps 80 char. x 24 lines Paper tape reader	No Pack & cartridge; 2.4-67M bytes Fixed-head; 128K-2M bytes No  20-40 KBS 300, 600 cpm 10, 30 cps 200, 700 lpm 9600 bps; synch. 80 char. x 24 lines Paper tape units, plotter, D/A & A/D converters, process I/O
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	No  BASIC  Interactive  Fully Partially	No  BASIC  Interactive  Fully Partially	Yes  FORTRAN, BASIC, CPL1, CPL2  Multi-tasking  No No	Assembler & macro assembler FORTRAN, BASIC, RPG  Batch, real-time  No No
<b>PRICING &amp; AVAILABILITY</b> Price of CPU, power supply, front panel, and min. mem. in chassis Price of memory increment  Date of first delivery Number installed to date	\$2,400 (4K bytes)  \$1,200 (4K bytes); \$2,000 (8K bytes) February 1975 NA	\$4,000 (4K bytes)  \$2,000 (8K bytes) February 1975 NA	\$26,950 (20K bytes)  \$1,250 (4K bytes) 1970 150 (all models)	\$15,000 (32K words)  \$3,500 (8K words); \$8,000 (32K words) June 1971 300
<b>COMMENTS</b>	Requires options for high-speed I/O and disk capabilities; can be upgraded to 2200T status; also available in packaged system WCS-10	Also available in pack- aged systems WCS-20 & WCS-30	Microcomputer-based system to be intro- duced in 1st quarter 1977 as enhanced version of Centurion IV; available only in packaged systems; system price also includes 10.4MB cartridge disk drive, one CRT display/ keyboard, and one 175-cps printer	Virtual addressing used with 1M-word memory; multiple CPU's with shared memory up to 4M words; asynchronous communications speeds to 1800 bps