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## All About Minicomputers

For the past decade, minicomputers have been attracting more attention than any other 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.
- 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.

This report is designed to aid you in understanding what's available in the fast-moving minicomputer field and selecting the system that can best satisfy your requirements. You'll find detailed comparison charts covering the characteristics of 203 current minicomputers from 61 manufacturers.

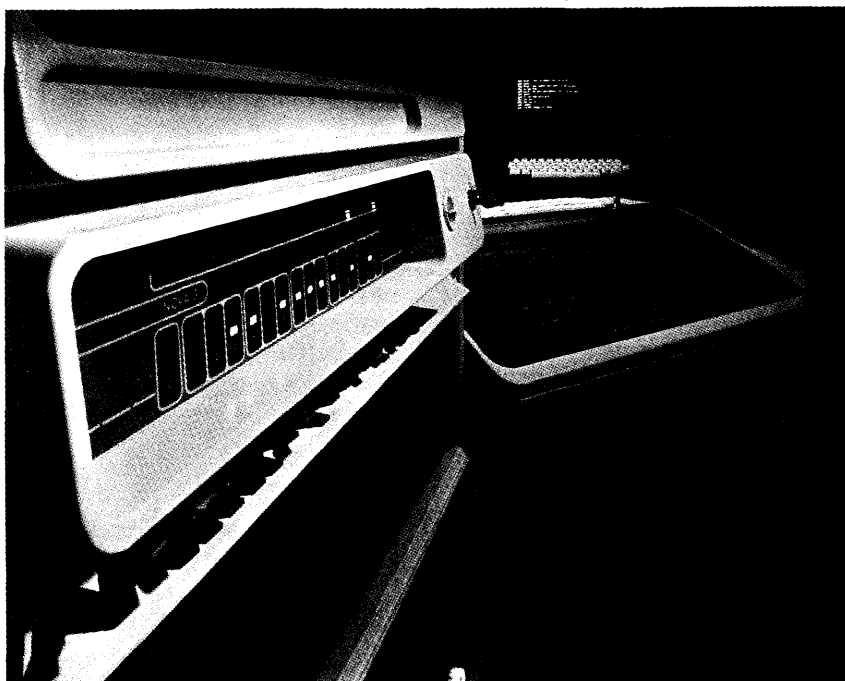
But what, exactly, is a minicomputer? Where are they being used? What are the significant features and drawbacks of these machines? How can you tell whether a minicomputer will fit into your own information processing plans? And, if so, which of the many available models represents the best overall choice 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 61 manufacturers are summarized in 41 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 “midicomputer” for the machines that range from \$20,000 on up to about \$100,000 in purchase price.

Throughout this report, we'll simplify the picture by using the single term “minicomputers” for the whole class of ➤



*The newest member of Data General's Nova 3 family is the Nova 3/D, which features memory mapping and protection for running unrelated programs simultaneously. The Nova 3/D supports up to 128K 16-bit words of MOS or core main memory. The high-density MOS memory is available with or without parity and comes in 32K, 16K, 8K, and 4K increments; the core memory comes in 16K and 8K increments.*

## All About Minicomputers

▷ stored-program digital computers which are suitable for general-purpose applications and are priced below \$100,000. 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).

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, CRT display terminal, 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 80,000 computers to date and currently commands roughly a 30 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, plays a much smaller role in the minicomputer market, although it is beginning to make up for lost time. The IBM Series/1, the company's first really competitive "pure" minicomputer, was introduced in November 1976 and is now competing aggressively with the products of DEC, Data General, Hewlett-Packard, and other minicomputer makers. (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 40,000 of them.

In the second echelon of minicomputer makers are aggressive, innovative young companies such as Computer Automation, 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, Sperry Rand, Texas Instruments, and Westinghouse. And then there are dozens of comparatively small, unproven companies whose survival will depend upon their ability to back up their imaginative hardware ideas with effective marketing, production, software, and customer support.

Two well-established minicomputer suppliers were acquired by larger computer companies during the past year. Varian Data Machines, the former minicomputer subsidiary of Varian Associates, was purchased by Sperry Rand Corporation and became a part of the Sperry Univac Division. Digital Computer Controls, whose claim to fame was a line of direct replacements for the Data General Nova minicomputers, became a wholly owned subsidiary of Data General itself.

In all, nearly 70 companies are now manufacturing minicomputers. The current offerings of 61 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: ▷

## All About Minicomputers

- ▷ ● Original equipment manufacturers, who incorporate the minicomputers into their own products or systems and are primarily interested in adequate performance at minimum cost.
- Knowledgeable end users, who demand the availability of peripheral equipment, software, and manufacturer support that will enable them to implement their own applications.
- Comparatively unsophisticated end users, who want complete systems programmed and installed on a "turnkey" basis.

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

### MINICOMPUTER TRENDS

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 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 Data General Eclipse S systems, Hewlett-Packard 21MX Series, Interdata 8/32C, and Microdata 3200.

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 Eclipse Series, and the Prime 500. Meanwhile, the increased computational power and flexibility made possible ▷

## All About Minicomputers

▷ by the use of a 32-bit word length are being stressed in such systems as the Interdata 8/32C Megamini, the SEL 32/55, and DEC's just-announced VAX-11/780.

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 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, hard-wired 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



## All About Minicomputers

- ▷ ● Time-sharing computational services
- Business data processing of all types.

### MINICOMPUTERS FOR BUSINESSMEN

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

Yet true minicomputers—as distinguished from the less powerful electronic accounting machines—were relatively slow 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 available, in the form of three significant trends.

First, numerous manufacturers have introduced minicomputer-based systems designed primarily for business data processing applications. Many of them are included in this report, and you can find the details on dozens of other business-oriented systems in a companion DATA-PRO 70 report called *All About Small Business Computers* (Report 70C-010-30).



*Microdata's new Express III is designed for systems houses, OEM's, and sophisticated end users requiring a computer system with multi-user, multiprogramming, and multi-language capabilities. Express III has a virtual memory operating system and supports COBOL, FORTRAN IV, and Microdata's Express Programming Language (EPL). The system can have up to 240K bytes of main memory, 40 million bytes of disk storage, and nine terminals.*

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, 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, too, are described in Report 70C-010-30, *All About Small Business Computers*. The systems houses are ▷

## All About Minicomputers

- ▷ 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 203 commercially available minicomputers from 61 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 1977; 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.

### Main Storage

The *storage type* generally falls into one of two basic categories, magnetic core or semiconductor memory. ▷

## All About Minicomputers

▷ 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. 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 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. This feature typically 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.

*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 single 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, increment- ▷

## All About Minicomputers

▷ ing, 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, 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. ▷



## All About Minicomputers

- ▷ 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.

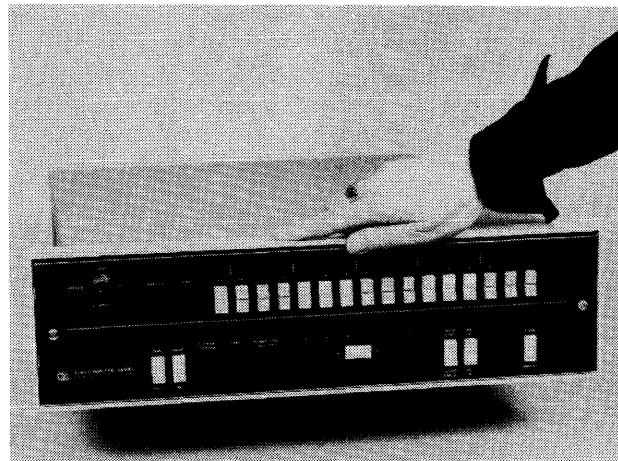
### Input/Output Control

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



*The smallest member of Hewlett-Packard's 21MX series of minicomputers, the Model M/10 can contain up to 32K words of MOS main memory. The six-model series also features memory mapping and control storage that can be either 325-nanosecond PROM fixed control storage or RAM writable control storage. Combinations of both types can be implemented up to a maximum of 4096 24-bit words.*

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 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?

## All About Minicomputers

➤ 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.

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 ➤

## All About Minicomputers

➤ 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 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," ➤

## All About Minicomputers

▷ “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, 1977. 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 61 suppliers whose products are listed in the comparison charts that follow.

*Anderson-Jacobson, Inc.*, 521 Charcot Avenue, San Jose, California 95131. Telephone (408) 263-8520.

*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.

*Beehive International*, 4901 Amelia Earhart Drive, Box 25668, Salt Lake City, Utah 84125. Telephone (801) 355-6000.

*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 Corp.*, 13500 Midway Road, Suite 208, Dallas, Texas 75240. Telephone (214) 233-3238.

*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.*, 411 North Freeway Blvd., P.O. Box 255000, Sacramento, California 95834. Telephone (916) 929-2020.

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

*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.

*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.

*Ehnek Incorporated*, Box 164, Manhattan, Kansas 66502. Telephone (913) 539-6104.

*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.

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

*General Robotics Corporation*, 57 North Main Street, Hartford, Wisconsin 53027. Telephone (414) 673-6800.

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

*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. ▷

## All About Minicomputers

- ▶ *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.
- 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) 575-8100.
- Lockheed Electronics Company, Data Products Division*, U.S. Highway 22, Plainfield, New Jersey 07060. Telephone (201) 757-1600.
- 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.
- 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.
- Rolm Corporation*, 18922 Forge Drive, Cupertino, California 95014. Telephone (408) 257-6440.
- Systems Engineering Laboratories, Inc.*, 6901 West Sunrise Boulevard, Fort Lauderdale, Florida 33313. Telephone (305) 587-2900.
- 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; now Sperry Univac Minicomputer Operations*, 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*, 2505 North Central Expressway, Dallas, Texas 75243. Telephone (214) 233-8400.
- Westinghouse Electric Corporation, Computer and Instrumentation Division, Computer Department*, 1200 West Colonial Drive, Orlando, Florida 32804. Telephone (305) 843-7030. □

### Minicomputer Specifications

MANUFACTURER & MODEL	Anderson Jacobsen 1500	Basic Four 350	Basic Four 400	Basic Four 600	Basic Four 700
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte 8, 16 8, 24	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	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, MOS 1.0; 0.8 0.8; 0.5 32K bytes 64K bytes No No No	MOS 0.60 0.40 24K bytes 64K bytes Standard No No	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
<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	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 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 1M 8	Standard 1M 8	Standard 1M 8	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, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	640K-2.56M bytes Cartridge; 10-40M bytes No No No 45, 120 cps 300 lpm 1200 bps; asynch. 80 char. x 24 lines —	No Cartridge; 5M bytes No No 10 KBS No 165 cps 300, 600 lpm 1200 bps 80 char. x 24 lines —	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 —
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler  BASIC ESP  Batch  Partially Partially	No  Business BASIC  Single-user inter- active No Partially	No  Business BASIC  Multi-user  No Partially	No  Business BASIC  Multi-user  No Partially	No  Business BASIC  Multi-user  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	\$19,990 (32K bytes) \$3,860 (32K bytes)  July 1977 25	\$34,400 (24K bytes) \$3,000 (8K bytes); \$3,500 (16K bytes) 1971 3000 (all models)	\$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)
<b>COMMENTS</b>	Multiprogramming operating system, up to eight partitions; client accounting software —Payroll, A/R, G/L, A/P, sales acctg., word proc.	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	Available as packaged systems only; system price also includes cartridge disk subsystem, serial or line printer, and CRT terminal

## Minicomputer Specifications

MANUFACTURER & MODEL	Basic Timesharing 4000 Series	Beehive International B 800	Bendix BDX9000	Burroughs L 9000 Series	Burroughs B 80
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 16, 32 16	16 16 16	16 16 16	64 — Variable	8-bit byte — Variable
<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 0.3 64K bytes 64K bytes Standard No Standard	MOS 0.750 0.350 4K 32K No No No	Core 1.0 0.5 4K 32K Optional No Optional	MOS 1.5 1.2 4K bytes 48K bytes Standard No Standard	MOS 1.0 0.5 32K bytes 128K bytes 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	2; not user-access. 2; not user-access. — — PROM, WCS; 98K bits 20 Standard Standard Standard Standard Standard	4 2 32K 3 PROM; 4K words 0.9 No No No Optional Standard	16 2 512 — No 2.0 Standard No No No Optional	None to user 4 — — RAM; 8K bytes — — Standard — —	None to user None to user — — ROM; 4K bytes — — Standard — —
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 616,666 60	Standard 350K 16	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 Pack & cartridge; 7.5-389M bytes No No To 72 KBS No No 300-900 lpm 2500 bps; asynch. No —	256K-1024K bytes 10M-40M bytes No No Yes 300 cps 165 cps 600 lpm 12.2K bps 80 char. x 25 lines A/D-D/A convert- ers, graphics, paper tape reader/punch	No Pack Fixed-head No Yes 200 cpm No 600 lpm No 80 char. x 24 lines A/D & D/A conver- ers, paper tape units	No No No Cassette; 1 KBS 10 KBS 480 cpm 60, 90, 120, 150 cps 90-250 lpm 9600 bps 32 char. x 8 lines Mag. ledger card reader	243K-6M bytes Cartridge; 4.6-27.6M bytes No Cassette; 1 KBS No No 60, 180 cps 160, 250 lpm 9600 bps 80 char. x 24 lines —
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	No BASIC X Time-sharing Partially Partially	Yes BASIC Time-sharing No No	Yes — No No No	Assembler COBOL — Fully —	No COBOL, RPG, NDL, MPL 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	\$35,950-\$56,300 — January 1976 NA	\$6,100 (4K bytes) incl. master CRT \$1,100 (4K bytes); \$1,340 (8K bytes) March 1976 Over 70	— — 1971 Over 25	\$16,490 (4K bytes) \$800 (2K bytes); \$1,400 (4K bytes) June 1975 Thousands	\$19,510 (32K bytes) \$900 (4K bytes) \$1,500 (16K bytes) April 1976 NA
<b>COMMENTS</b>	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	BOSS (Beehive Office Supervisory System) is based on the B 800 and is a modular, turnkey, packaged system for the first-time small business system user	Sold exclusively for ground support systems and not usually available commercially	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.

### Minicomputer Specifications

MANUFACTURER & MODEL	Burroughs B 730/B 720	Burroughs B 770 Series	Burroughs B 800 Series	Burroughs B 1700 Series	Burroughs B 1720 Series
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	64 — Variable	16 — Variable	64, 16 — Variable	8-bit byte — Variable	64 — Variable
<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 0.5 32K bytes 80K bytes Standard No Standard	Core, MOS 1 0.4; 0.63 16K bytes 48K; 98K bytes Standard No Standard	MOS; bipolar 1 0.5 32K bytes 144K bytes Standard No Standard	MOS 1.5 1.0 24K bytes 128K bytes Standard No Standard	MOS 1.0 0.67 48K bytes 378K bytes 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; 3584 bytes  0.43 No No Standard — —	None to user None to user — — RAM; 32K bytes  — — No — — Standard	None to user None to user — — RAM; to 48K  — — No — — Standard	None to user None to user — — No  — No — — —	None to user None to user — — ROM; to 8K bytes  — — No — — —
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	— — —	Standard — —	Standard 2M bytes —	— — —	— — —
<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	243K-1.5 bytes Cartridge; 4.6-36.8M bytes No  Cassette; 1 KBS  10 KBS 600 cpm 60 cps 85-400 lpm 9600 bps 80 char. x 24 lines Card punch, card reader/punch	243K bytes Cartridge; 4.6-36.8M bytes No  Cassette; 1 KBS  10 KBS 300-800 cpm No 85-750 lpm 9600 bps No Up to 2 data com- munications pro- cessors; reader/ punch/data record.	2M bytes Pack/cartridge; 4.6-130.4M bytes Fixed-head; 9.4- 65.6M bytes Cassette; 3 KBS  10 KBS 300-600 cpm 120 cps 160-750 lpm 9600 bps 80 char. x 24 lines Card punch; card reader/punch; DDES	No Pack & cartridge; 2.3-697.6M bytes Fixed-head disk; 1.9M 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 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
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	No  COBOL, RPG, AEL  Real-time  Fully Fully	Assembler  COBOL, RPG, NDL, MPL  Batch, real-time  Fully Fully	No  COBOL, RPG, NDL, MPL  Batch, real-time  Fully Fully	No  COBOL, FORTRAN, RPG, BASIC, UPL, NDL Batch, real-time, time-sharing Fully Fully	No  COBOL, FORTRAN, RPG, BASIC, UPL, NDL Batch, real-time, time-sharing 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	\$20,900 (32K bytes) \$2,280 (8K bytes)  March 1973 NA	\$16,200 (32K bytes) \$990 (8K bytes)  1974 NA	\$32,400 (32K bytes) \$990 (8K MOS)  — NA	\$25,780 (24K bytes) \$2,500 (16K bytes)  3rd qtr. 1972 Over 1300 total	\$64,800 (48K bytes) \$2,500 (16K bytes)  2nd qtr. 1973 Over 1300 total
<b>COMMENTS</b>	System price in- cludes console printer; AEL and COBOL or RPG programs can run concurrently	Systems and com- munications pro- cessors; not all models allow all features present- ed		See Report 70C-112-04 for more details	See Report 70C-112-04 for more details



## Minicomputer Specifications

MANUFACTURER & MODEL	Burroughs B 1800 Series	Cascade Data Concept II	Cascade Data Concept III	Cascade Data Concept IV	Century Computer 200
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte — Variable	16 16-32 16-40	16 16-32 16-40	16 16-32 16-40	8-bit byte 8 8, 16, 24
<b>MAIN STORAGE</b> <b>Storage type</b> Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 1.7-2.0 — 48K bytes 512K bytes Standard No Standard	Core 1.2 0.35 16K 64K Standard No No	Core 1.0 0.35 16K 64K Standard No No	Core 1.0 0.2 16K 64K Standard No No	MOS 0.6 0.2 32K bytes 64K 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	None to user None to user — — ROM; 4K bytes  — — No — — Standard	16 3 32K 2 No  8.8 Standard No Standard No Optional	16 3 32K 2 No  7.5 (word) Standard No Standard No Optional	16 3 32K 2 No  2.0 (byte) Standard No Standard No Optional	16 16 64K bytes 17 PROM; to 2K bytes  2.6 Optional 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 413K 0	Standard 413K 0	Standard 413K 0	Optional 1M 15; 120
<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	486K bytes Pack & cartridge; 4.6-697M bytes No  Cassette; 1 KBS  10-120 KBS 300-1400 cps No 400-1500 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	1.2M bytes 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, card reader	2.4M bytes No  No  No  No 60 cps 200-400 lpm 9600 bps 80 char. x 16 lines Paper tape reader, paper tape punch, card reader	No Pack & cartridge; 10-1200M bytes No  Cassette; 300 cps  120 KBS 300, 600 lpm 165 cps 300, 600 lpm Up to 9600 bps 80 char. x 24 lines Paper tape reader
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	No  COBOL, RPG, MPL, NDL  Batch, real-time  Fully Fully	Macro assembler  RPG  Batch, real-time, time-sharing No No	Macro assembler  RPG  Batch, real-time, time-sharing No No	Macro assembler  No  Batch, real-time  Partially Partially	Yes  BASIC, CPL  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	\$76,000 (48K bytes) \$3,000 (16K bytes)  2nd qtr. 1977 NA	\$22,200 (16K bytes) \$1,200 (16K bytes) \$2,700 (32K bytes) January 1970 150	\$26,900 \$1,200 (16K bytes)  November 1977 —	\$14,000 \$1,200 (16K bytes)  April 1978 —	\$15,000 (32K bytes) \$3,200 (32K bytes)  February 1971 Over 600
<b>COMMENTS</b>	See Report 70C-112-05 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 system/ turnkey houses and dealers; volume discounts available

### Minicomputer Specifications

MANUFACTURER & MODEL	Century Computer 300	Century Computer 400	Century Computer 700	Century Computer 900	Century Computer 1000
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte 8 8, 16, 24	16 + 5 16 8, 16, 24	8 16 8, 16, 24, 32	8 16 8, 16, 24, 32	8, 16, 24 16 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	MOS 0.6 0.2 16K, 32K bytes 60K No No No	MOS 0.6 0.2 32K bytes 512K bytes Optional Optional Optional	MOS 0.6 0.2 32K bytes 256K bytes Optional Optional Optional	MOS 0.6 0.2 96K bytes 512K bytes Optional Optional Optional	MOS 1.2 0.5 128K bytes 512K bytes Optional 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	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	16 16 64K bytes 17 PROM; to 2K bytes  2.6 Optional Optional Standard Optional Optional	16 16 64K bytes 17 PROM; to 2K bytes  2.6 Optional Optional Standard Optional Optional	16 16 64K bytes 17 PROM; to 2K bytes  2.6 Optional Standard Standard Optional Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Optional 1M 15; 120	Standard 1M 120	Standard 1M 120	Standard 1M 120	Standard 1M 120
<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	376K bytes Pack & cartridge; 20-100M bytes No  Cassette; 300 cps  120 KBS 300, 600 lpm 165 cps 300, 600 lpm Up to 9600 bps 80 char. x 24 lines Paper tape reader	384K bytes 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; 10-120 bytes Fixed-head; 74- 296M bytes No  36 KBS 300 cpm 165 cps 600 lpm Up to 9600 bps 80 char. x 24 lines Paper tape reader	No Pack & cartridge; 10-120 bytes Fixed-head; 74- 296M bytes No  36 KBS 300 cpm 165 cps 600 lpm Up to 9600 bps 80 char. x 24 lines Paper tape reader	630K bytes Cartridge; 46.4M bytes No  No  120 KBS 300 cpm 300 cps 1200 lpm Up to 9600 bps 80 char. x 24 lines Paper tape reader
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Yes  BASIC, CPL  Batch, real-time  No No	Yes  BASIC, CPL  Batch, real-time;  No Partially	Yes  BASIC, CPL  Batch, real-time;  No Partially	Yes  BASIC, CPL  Batch, real-time;  No Partially	Yes  BASIC, CPL, ALGOL  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	\$17,000 (32K bytes) \$3,200 (32K bytes)  February 1971 Over 600	\$21,000 (32K bytes) \$3,200 (32K bytes)  March 1975 117	\$21,000 (32K bytes) \$3,200 (32K bytes)  April 1976 154	\$27,000 (32K bytes) \$3,200 (32K bytes)  June 1976 12	\$40,000 (32K bytes) \$3,200 (32K bytes)  June 1977 6
<b>COMMENTS</b>	System price also includes RS-232C interface; system is intended primarily for system/turnkey houses and dealers; volume discounts available	System price also includes RS-232C interface; system is intended primarily for system/turnkey houses and dealers; volume discounts available	System price also includes RS-232C interface; system is intended primarily for system/turnkey houses and dealers; volume discounts available		

## Minicomputer Specifications

MANUFACTURER & MODEL	Cincinnati Milacron CIP/2200B	Cincinnati Milacron CIP/4400	Computer Automation Naked Milli LSI-3/05	Computer Automation Naked Milli LSI-2 Series	Computer Automation Naked Milli LSI-4 Series
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 8-32 8-64	16 8-32 8-64	16 8, 16, 32 16, 32, 48	16 + 2 8, 16, 32 16, 32, 48	16 + 2 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 1.1 0.66 32K bytes 64K bytes Optional No No	MOS 0.9 0.6 64K bytes 256K bytes Standard No No	Core, MOS 0.98-1.6 0.5-0.8 512 8K No No No	Core, MOS 0.85-1.2 0.4-0.6 8K 512K Optional No No	Core or MOS 0.85-0.55 — 4K 256K Optional 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 32K 9 ROM; 16 x 2K bytes  10.3 Standard No Standard No Standard	3 1 32K 9 ROM 24 x 2K bits  2.1 Standard No Standard Optional Standard	2 1 128 8 ROM; 512 x 24 bits  6.25 (2 digits) No No Standard Optional Optional	2 1 32K 8 ROM; 512 x 56 bits  4.12, 2.06 Standard No Standard Optional Optional	2 8 64K 3 None  1.5-3.0 Optional Optional Standard Optional Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 909K 32-64	Standard 1.2M 32-64	Standard 250K 1	Standard 1M 3	Optional 115K —
<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	630K-2.52M bytes Cartridge; 5-4M bytes No  No  20 KBS 600 cpm 60 cps 60-600 lpm 9600 bps 80 char. x 12 lines Remote printer, keyboard printer, data entry station	630K-1.26M bytes Both; 10-320M bytes No  No  15 & 20KBS 600 cpm 60 cps 60-600 lpm 9600 bps 80 char. x 12 lines Remote printer, keyboard printer data entry station	243-972K bytes Cartridge; 4.92-19.68M bytes No  No  20 KBS 285 cpm 100, 165 cps No To 9600 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	972K bytes Cartridge & pack; 5-1200M bytes No  No  20 KBS 285 cps No 60-165 lpm 50K bpi 80 char. x 24 lines Paper tape units
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler RPG II   Batch, interactive  Fully No	Assembler & macro assembler RPG II   Multi-user inter- active, batch Fully No	Macro assembler  FORTRAN  Real-time  No No	Macro assembler  FORTRAN, BASIC  Batch, real-time, multi-tasking No No	Assembler, macro assembler BASIC, FORTRAN, PASCAL  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	\$16,100 (32K bytes) \$3,200 (32K bytes)  June 1973 590 (all models)	\$45,900 (64K bytes) \$3,200 (32K bytes)  July 1976 590 (all models)	\$725 (4K MOS)  \$550 (4K MOS)  January 1975 NA	\$1,750 (2/10)  \$985 (4K core)  July 1973 NA	\$995 (4K words)  \$995 (8K words)  — —
<b>COMMENTS</b>	Packaged system including CPU with 32K bytes, 960- character VDT, 60- cps printer dual floppy disk drives; accounting soft- ware available	Packaged system including CPU with 64K bytes printer, 60-lpm dual floppy disk drives, 960- character VDT; accounting soft- ware available	ROM/EPROM & RAM/ROM/PROM are available in combination; ROM, PROM, EROM available in max. capacities of 8K, 2K, & 4K words, respectively	ROM/EPROM & RAM/ROM/PROM are available in combination; ROM, PROM, EROM available in max. capacities of 8K, 2K, & 4K words respectively	

### Minicomputer Specifications

MANUFACTURER & MODEL	Computer Hardware Inc. 2130	Computer Hardware Inc. 3230	Computer Hardware Inc. 4210	Computer Hardware Inc. 4250	Computer Talk Model 400
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 16 16-64	16 16 16-64	16 — 16	16 — 16	16 8, 16, 32-128 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 0.8 0.25 8K 64K Standard No Optional	MOS 0.8 0.25 8K 256K Standard No Optional	MOS 0.47 0.3 4K 32K Standard No Optional	MOS 0.47 0.3 4K 1024K Standard Optional Optional	MOS 0.5; 0.3 0.3; 0.15 4K 512K Optional Optional See comments
<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 6 16K — —  1.6 Standard Optional No No Optional	8 6 16K — —  1.6 Standard Optional No No Optional	0 16 32K 8 No  4.662 Standard No Standard Optional Standard	0 16 32K 8 PROM; 256 x 45 bits 3.5 Standard No Standard Optional Standard	12 (4 more opt.) 2 32K; 512K 10 PROM; 768 words  1 Standard Standard Standard Standard Standard with date
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1.25M 8	Standard 1.25M 8	Standard — 8	Standard — 16	Standard 1M 1-256
<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; 320M 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	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	Yes No  No  No 30 cps 300 lpm 9600 bps 80 char. x 24 lines None	Yes Cartridge; 1.5M to 3M bytes No  Cassette; 1000 bps	110K-10M bytes Both; 1.2M-1 billion bytes Moving-head; 2.5M bytes 30-800 cps; 4 KBS  5-120 KBS 10-100 cpm 10-200 cps 220-600 lpm 50-9600; 56K 96 char. x 32 lines Digitizers, plotters, factory automation equipment
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler RPG, COBOL, FORTRAN  Batch, time-sharing  No No	Assembler & macro assembler RPG, COBOL, FORTRAN  Batch, time-sharing  No No	Assembler  FORTRAN  Real-time  No No	Macro assembler  FORTRAN, BASIC, COBOL  Real-time  No No	Assembler & macro assembler BASIC, FORTRAN, APL  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	\$60,000 — 1974 NA	\$77,000 — 1976 NA	NA NA NA NA	NA NA NA NA	\$24,950 (4K MOS) \$1,100 (4K) May 1975 NA
<b>COMMENTS</b>	Asynchronous communications to 9600 bps; system price also includes CRT and disk pack drive	Asynchronous communications to 9600 bps; system price also includes disk pack drive	Software and hardware supports CHI 4111 Time Clock—standard feature for T/A and Labor Distribution Control; pricing and availability not set to date	Software and hardware supports CHI 4111 Time Clock—standard feature for T/A and Labor Distribution Control; pricing and availability not set to date	Storage protection std. by memory partition and opt. by page; mapping to 512K opt.; 4K PROM opt.; on low power, memory is stored on disk; price includes CRT, light pen, modem, 1.2M-byte disk, arith. & I/O processors, & battery pack operation

## Minicomputer Specifications

MANUFACTURER & MODEL	Computer Talk Model 407	Computer Talk Model 408	Control Data Cyber 18-17	Control Data Cyber 18 Series	Data General Nova 3/4
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 8, 16, 32-128 16, 32, 48	16 8, 16, 32-128 16, 32, 48	16 + 1 16 16, 32	16 + 5 or + 1 16 16, 32	16 + 1 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 0.5; 0.3 0.3; 0.15 4K 512K Optional Optional See comments	MOS 0.5; 0.3 0.3; 0.15 4K 512K Optional Optional See comments	MOS 0.6, 0.9 — 4K 64K Standard No Standard	MOS 0.75 0.3 16K 128K Standard Optional Standard	Core, MOS 0.7 0.35 4K 32K Optional 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	12 (4 more opt.) 2 32K; 512K 10 PROM; 768 words  1 Standard Standard Standard Standard Standard with date	12 (4 more opt.) 2 32K; 512K 10 PROM; 768 words  1 Standard Standard Standard Standard Standard with date	2 2 (1 in memory) 256 7 No  1.8 Standard Optional Optional Optional Optional	6 6 64K 8 ROM/RAM; 8K instructions 1.76 Standard No Standard Optional Standard	4 2 256 6 No  0.7 Optional No No Optional Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1M 1-256	Standard 1M 1-256	Standard 1.6M 2-16	Standard 1.2M 2-16	Standard 1.10M 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	110K bytes Both; 1.2M-1 billion bytes Moving-head; 2.5M bytes 30-800 cps; 4 KBS  5-120 KBS 10-1000 cpm 10-200 cps 300 lpm 50-9600; 56K 96 char. x 32 lines Digitizers, plotters, factory automation equipment	110K-10M bytes Both; 1.2M-1 billion bytes Moving-head; 2.5M bytes 100 cps; 50 KBS  5-120 KBS 10-1000 cpm 10-200 cps 300 lpm 50-9600; 56K 96 char. x 32 lines Digitizers, plotters, factory automation equipment	None Cartridge; 4-36M bytes No  40 KBS 300 cpm No 300, 600 lpm Up to 9600 bps 80 char. x 24 lines A/D & D/A converters	560K bytes Pack/cartridge; 4-400M bytes No  80 KBS 300, 600 cpm 70 lpm 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
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler BASIC, FORTRAN, APL  Batch, real-time, time-sharing Partially Partially	Assembler & macro assembler BASIC, FORTRAN, APL  Batch, real-time, time-sharing Partially Partially	Assembler & macro assembler FORTRAN, BASIC, AUTRAN  Batch, real-time  No No	Macro assembler  FORTRAN, BASIC, RPG, COBOL  Batch, real-time, time-sharing No No	Assembler & macro assembler FORTRAN, BASIC, ALGOL  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	\$31,500 (4K MOS) \$1,100 (4K)  January 1978 NA	\$30,500 (4K MOS) \$1,100 (4K)  January 1978 NA	\$11,160 (8K bytes) \$2,360 (8K bytes)  July 1973 Over 500	\$16,700 (16K words) \$3,000 (16K words)  May 1976 NA	\$2,600 (4K MOS) —  April 1976 NA
<b>COMMENTS</b>	Expanded Model 400 with additional features: disk expanded to 2.5M bytes, 300-lpm x 132 printer and mini-floppy disk for I/O	Expanded Model 400 with additional features: disk expanded to 2.5M bytes, 300-lpm x 132 printer and mini-cassette for I/O			4-slot chassis; auto program load and power monitor/ auto restart opt.

### Minicomputer Specifications

MANUFACTURER & MODEL	Data General Nova 3/12, 3-D	Data General Eclipse S/130	Data General Eclipse S/200	Data General Eclipse S/230	Data General Eclipse C/300
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 1 16 16	16 + 5 16 16, 32	16 + 5 16 16, 32	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	Core, MOS 0.7 0.35 4K 32K Optional No No; see comments	Core, MOS 0.8, 0.5-0.7 0.4 16K 128K No Standard 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	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	4 2 256 6 No  0.7 Optional Optional No Optional Optional	4 + 4 2 + 16 64K 7 PROM/RAM; 4 x 56 bits 0.6 Standard No Optional Optional Standard	4 2 32K 7 ROM; 256 x 56 bits 0.6 Standard Optional Standard No Optional	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
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1.10M 16	Standard 1.25M 16	Standard 1.25M 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	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; 10-1520M bytes Fixed-head; 1-16M bytes Cassette; 1.6 KBS  10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm 56,000 bps 80 char. x 24 lines Modular digital & analog data control & acquisition sub- system optional	315K-2.5M bytes Pack & cartridge; 10-1520M bytes Fixed-head; 1-16M bytes Cassette; 1.6 KBS  10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm 56,000 bps 80 char. x 24 lines Modular digital & analog data control & acquisition sub- system optional	315K-2.5M bytes Pack & cartridge; 10-1520M bytes Fixed-head; 1-16M bytes Cassette; 1.6 KBS  10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm 56,000 bps 80 char. x 24 lines Modular digital & analog data control & acquisition sub- system optional	315K-2.5M bytes Pack & cartridge; 10-1520M bytes Fixed-head; 1-16M bytes Cassette; 1.6 KBS  10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm 56,000 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	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	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	\$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)	\$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)
<b>COMMENTS</b>	12-slot chassis; memory manage- ment unit stand- ard; memory allo- cation and protec- tion unit standard on 3-D	256 56-bit words of writable control store optionally available	256 56-bit words of writable control store, memory allo- cation and protec- tion unit optionally available	256 56-bit words of writable control store, extended memory allocation and protection unit optionally avail- able; error correc- tion std. on MOS, opt. on core	Extended arithme- tic processor stand- ard; memory allo- cation and protec- tion unit optional; error correction std. on MOS, opt. on core

## Minicomputer Specifications

MANUFACTURER & MODEL	Data General Eclipse C/330	Datapoint 1100	Datapoint 1150	Datapoint 1170	Datapoint 1500
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 5 16 16, 32	8-bit byte 8 8-24	8-bit byte 8 8-24	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	MOS 1.6 0.6 4K bytes 16K bytes No No No	MOS 0.8 0.3 24K bytes 24K bytes Standard Standard Standard	MOS 0.8 0.3 48K bytes 48K bytes Standard Standard Standard	MOS 0.65 0.3 32K bytes 32K bytes Standard Standard 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; 2K x 56 bits 0.6 Standard Standard Standard No Optional	2 12 16K bytes 2 No 4.8 No No Standard No Optional	2 16 24K bytes 2 ROM; 4K bytes 1.4 No No No No No	2 16 48K bytes 2 ROM; 4K bytes 1.4 No Standard No No	2 16 32K bytes 2 ROM; 4K bytes 1.8 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 1.25M 16	No 195K —	No 114K —	No 114K —	No 250K —
<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; 10-1520M bytes Fixed-head; 1-16M bytes Cassette; 1.6 KBS 10-72 KBS 150-1000 cpm 10-165 cps 240-600 lpm 56,000 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	512K-1M bytes No No No 9.6-20 KBS 300 cpm 80-160 cps 300, 600 lpm Up to 9600 bps 80 char. x 12 lines	512K-1M bytes No No No 9.6-20 KBS 300 cpm 80-160 cps 300, 600 lpm Up to 9600 bps 80 char. x 12 lines	512K No No No No No 80-160 cps No Up to 4800 bps 80 char. x 24 lines
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler FORTRAN, BASIC, BASIC, ALGOL Batch, real-time time-sharing No No	Yes BASIC, RPG II, SCRIBE, DATA- BUS, DATAFORM BATCH No No	Yes DATABUS, MULTI- FORM, BASIC, RPG II BATCH No No	Yes BASIC, DATA- SHARE, DATABUS, MULTIFORM, RPG II Batch, time-sharing No No	No DATABUS, DATAFORM Batch, stand-alone 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	\$30,000 (32K core) \$4,500 (16K core); \$8,500 (32K MOS) October 1976 1000+ (all models)	\$6,400 (4K bytes) \$434 (4K bytes) January 1974 6000	\$14,480 (24K bytes) — August 1976 NA	\$15,980 (48K bytes) — July 1977 NA	\$5,950 (32K bytes) — October 1977 NA
<b>COMMENTS</b>	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	1152 system with 24K memory and two diskette drives	1172 system with 48K memory and two diskette drives	All user instructions are in high-level language

Minicomputer Specifications

MANUFACTURER & MODEL	Datapoint 2200	Datapoint 5500	Datapoint 6600	Datsaaba Systems 5051 & 5052	Datsaaba Systems 5020
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte 8 8-24	8-bit byte 8 8-24	8-bit byte 8 8-24	16 1-255 digits 16-128	16 + 2 8, 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 1.6 0.6 4K bytes 16K bytes No No No	MOS 0.8 0.3 48K bytes 48K bytes Standard No Standard	MOS 0.6 0.2 120K bytes 120K bytes Standard Standard Standard	Core 0.98; 1.2 — 4K; 8K 32K No No Standard	Core 1.2 — 4K 32K 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	2 12 16K bytes 2 No  4.8 No No Standard No Optional	2 16 48K bytes 2 ROM; 4K bytes  1.4 No No Standard No Optional	2 16 120K bytes 2 ROM; 4K bytes  1.15 Standard No Standard No No	7 7 32K 8 —  3.2 Standard No Standard No Optional	8 3 256 3 —  7.2 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	No 195K —	No 114K —	No 125K —	Standard 1M 5	Optional — —
<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	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 —	256K-1M bytes Pack & cartridge; 2.4-200M 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 —	No Pack & cartridge; 2.5-200M bytes No  Cassette; 352 cps  9.6-20KBS 300 cpm 80-160 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
<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	Yes  BASIC, RPG II, SCRIBE, DATA- BUS, DATAFORM Batch, time-sharing  No No	Yes  BASIC, RPG II, COB., DATASH., DATABUS, DATAFORM, SCRIBE Batch, time-sharing  No No	No  Logic-3/MALL  Time-sharing  No No	Yes  DIL-5  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	\$8,571 (4K bytes) \$1,432 (4K bytes); \$1,647 (8K bytes) April 1972 9000	\$26,271 (48K bytes) CPU cannot be expanded December 1974 500	\$34,000 (120K bytes) — July 1977 NA	\$45,000 (8K words) \$2,000 (8K words) NA NA	— — 1971 4000
<b>COMMENTS</b>	System price also includes integral CRT/keyboard and dual cassette tape drives	System price also includes integral CRT/keyboard and dual cassette tape drives	System price also includes integral CRT/keyboard, dual cassette tape drives, multipoint communications adapter, and software. A batch processing system with no comm. adapter costs \$32,500	Basis for Datsaaba D15 business minicomputer system; interpreter-based system for up to 16 simultaneous users; system price also includes 10-megabyte disk drive, CRT workstation and serial printer	Basis for Datsaaba D5/20 business minicomputer system; terminal oriented system for data collection and on-line data entry; intelligent terminals can process data locally



## Minicomputer Specifications

MANUFACTURER & MODEL	Decision Data System/4	Digital Computer Controls D-116	Digital Equipment PDP-8/A	Digital Equipment PDP-11/03	Digital Equipment PDP-11/04
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte 8 16-32	16 8 8	12 12 12	16 16 16, 32, 48	16 + 2 16 16, 32, 48
<b>MAIN STORAGE</b> <b>Storage type</b> Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	MOS 1 0.5 32K bytes 64K bytes Standard No No	MOS, Core 1.6 0.6 32K 128K Optional Optional Standard	Core; MOS 1.2; 1.5; 2.4 0.6; 0.75; 2.4 1K 128K 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
<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 3 ROM; 2K  — Standard No Standard No Standard	8 4 32 6 —  1.57 Standard No Standard Optional Optional	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 Optional Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 400K 8	Standard 625K 16	Standard 526-667K 1-64	Standard 833K 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, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	1-3M bytes Cartridge; 5.40M bytes No  No  No 300-1200 cpm 120 cps 600 lpm Up to 9600 bps 80 char. x 24 lines None	256K-2.08M bytes Pack & cartridge; 2.4-640M bytes No  Cassette; 1.5 KBS  2.5-120 KBS 150-600 cpm 30 cps 60-600 lpm 250K bps; synch. 80 char. x 24 lines Paper tape units, A/D & D/A con- verters, card punch, plot., TTY	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 180 cps No 50-56,000 bps 80 char. x 24 lines Serial line and parallel line con- trollers	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	No  RPG, Phrase  Batch, interactive  No Partially	Macro assembler  FORTRAN & BASIC  Batch, real-time, time-sharing No No	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
<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	\$19,305 (32K bytes) \$1,450 (16K bytes)  July 1975 15	\$9,400 (4K bytes) \$7,000 (8K bytes)  NA NA	\$1,835-\$8,295  \$2,850 (8K core); \$1,230 (4K MOS) December 1974 Over 30,000	\$1,995  \$990 (8K core); \$625 (8K MOS) NA NA	\$3,995 (16K MOS);  \$4,695 (16K core); \$2,280 (16K core) NA NA
<b>COMMENTS</b>		Digital Computer Controls is now a subsidiary of Data General Corp.	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

Minicomputer Specifications

MANUFACTURER & MODEL	Digital Equipment PDP-11/34	Digital Equipment PDP-11/35 & 11/40	Digital Equipment PDP-11/45	Digital Equipment PDP-11/55	Digital Equipment PDP-11/70
<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	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 0.98; 0.725 0.51; 0.635 16K 124K Standard No Standard	Core 0.98 0.36 8K 124K Optional No Optional	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
<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 32K 8 —  2.03 Optional Optional Standard Optional Standard	6 6 32K 8 No  1.07 Optional Optional Standard No Optional	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
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard — Variable	Standard 2M Variable	Standard 2M (core); 4M (bi.) Variable	Standard 2M (core); 4M (bi.) Variable	Standard 2.9M Variable
<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 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 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
<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  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
<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	\$9,050 (32K MOS); \$10,030 (32K core) \$1,700 (16K MOS); \$2,280 (16K core) NA NA	\$19,600  \$5,390 (32K core) NA NA	\$41,800 (64K core)  \$5,390 (32K core); \$4,620 (8K bipol.) NA NA	\$41,800 (64K core)  \$5,390 (32K core); \$4,620 (8K bipol.) NA NA	\$63,000 (128K core) \$18,590 (128K core) NA NA
<b>COMMENTS</b>	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	PDP-11/45 features two internal Unibuses, one normal-speed and one high-speed	PDP-11/55 is based on a PDP-11/45 with core and bipolar memory; designed for applications requiring high-speed calculations	Uses same technology as PDP-11/45 and includes 2048 bytes of cache memory for increased performance; disk storage & mag tape periph. avail. in packaged system called Datasystem 570

## Minicomputer Specifications

MANUFACTURER & MODEL	Digital Equipment PDP-11/60	Digital Equipment XVM	Digital Scientific 5010	Digital Scientific 5020	Digital Scientific 5030
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 2 16 16, 32, 48	18 18, 36 18	16 + 2 16-32 16-32	16 + 2 16-32 16-32	16 + 2 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 0.98 — 32K 256K Standard Standard (MOS) Standard	Core 0.98 — 32K 128K No No Standard	Core, MOS 0.9, 0.5 0.5, 0.3 4K 16K Standard No Standard	Core, MOS 0.9, 0.5 0.5, 0.3 8K 32K Standard No Standard	Core, MOS 0.9, 0.5 0.5, 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	8 8 32K 8 RAM; 1K words  2.2 Standard Standard Standard No Standard	1 1 8K 4 No  1.78 Standard Optional No No Standard	1 + 1 3 16K 4 PROM  1.37 Standard No No No No	1 + 1 3 32K 4 PROM  1.37 Standard No No No Optional	1 + 1 3 64K 4 PROM  1.37 Standard Optional No Optional Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard — Variable	Standard 1M Variable	Standard 1M-2M 6	Standard 1M-2M 6	Standard 1M-2M 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	256-512K bytes Cartridge & pack; 2.5-1408M bytes Fixed-head; 512K-8M bytes Cassette; 562 cps  10-72 KBS 285-1200 cps 30-180 cps 230-1200 lpm 50-56,000 bps 80 char. x 24 lines DEC tape, 8325 words/sec.; paper tape reader, paper tape punch	No Cartridge & pack; 2.5-320M bytes No No  9-36KBS 300, 1000 cpm 30-180 cps 300, 1200 lpm To 9600 bps 80 char. x 24 lines Graphics units, laboratory inter- faces	No Cartridge; 1-5M bytes No No  Optional 600, 1000 cpm 180 cps 300, 600 lpm Up to 19,200 bps 80 char. x 24 lines —	No Pack, cartridge; 1-40M bytes Optional No  Optional 600, 1000 cpm 180 cps 300, 600 lpm Up to 19,200 bps 80 char. x 24 lines Paper tape reader/ punch; XY plotter	No Pack, cartridge; 1-40M bytes Fixed-head; 1-2M bytes No  30, 60 KBS 600, 1000 cpm 180 cps 300, 600 lpm Up to 19,200 bps 80 char. x 24 lines Paper tape reader/ punch; XY plotter
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler BASIC, FORTRAN, COBOL  Real-time, interac- tive, time-sharing No No	Macro assembler  FORTRAN, ALGOL, FOCAL  Batch, real-time, multi-user No No	Assembler & macro assembler RPG II, FOTRAN, BASIC  Batch  No No	Assembler & macro assembler COBOL, RPG II, FORTRAN, BASIC  Batch, time-sharing  No No	Assembler & macro assembler COBOL, RPG II, FORTRAN, BASIC, APL Batch, 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	\$35,700 (32K core)  \$6,600 (32K core) \$5,000 (32K MOS) June 1977 —	\$37,500 (32K)  \$9,000 (32K) — 1200	\$18,000  \$1,000 (4K by.) MOS \$2,100 (8K by.) core NA NA	\$21,300  \$1,800 (8K by.) MOS \$2,100 (8K by.) core NA NA	\$25,350  \$1,800 (8K by.) MOS \$2,100 (8K by.) core NA NA
<b>COMMENTS</b>	Includes user- accessible micropro- gramming; error- correcting memory	XVM systems are enhanced PDP-15 systems featuring a memory proces- sor that performs instruction "look- ahead" using a 4- word instruction stack and a PDP- 11/05 CPU as a front-end I/O pro- cessor	Intelligent RJE or local batch for appli- cations requiring high-speed calcula- tions; expandable to Model 5020	Up to 5 concurrent users in a mixed conversational and batch mode; IBM 1130-compatible plus the ability to per- form multiprogram- ming in a time-shar- ing environment. Expandable to Model 5030	Up to 32 concurrent users in a mixed conversational and batch mode; IBM 1130-compatible plus the ability to per- form multiprogram- ming in a time-shar- ing environment

### Minicomputer Specifications

MANUFACTURER & MODEL	Digital Scientific 4030/40	Digital Systems Galaxy 15 Model 130	Digital Systems Galaxy 15 Model 140	Digital Systems Galaxy 15 Model 150	Digital Systems Galaxy 15 Model 170
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 2 16-32 16-32	8 8 to 2048 16, 32, 48	8 8 to 2048 16, 32, 48	8 8 to 2048 16, 32, 48	8 8 to 2048 16, 32, 48
<b>MAIN STORAGE</b> <b>Storage type</b> Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	Core 4 .5 8K 128K Standard No Standard	MOS 0.50 0.50 64K bytes 128K bytes Standard Standard No	MOS 0.50 0.50 128K bytes 256K bytes Standard Standard No	MOS 0.50 0.50 256K bytes 512K bytes Standard Standard No	MOS 0.50 0.50 1M bytes 1M bytes Standard Standard 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	Up to 28 3 64K 4 ROM; 4K words  2.9 Standard Standard No No Standard	7 7 64K 1 PROM; 512 x 40 bits 0.30 Standard No Standard Optional Standard	14 14 128K 1 PROM; 1024 x 40 bits 0.30 Standard No Standard Optional Standard	21 21 256K 1 PROM; 1536 x 40 bits 0.30 Standard No Standard Optional Standard	28 28 1M 1 PROM; 2048 x 40 bits 0.30 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 1M 16	Standard 30K 15	Standard 60K 30	Standard 90K 45	Standard 120K 60
<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; 1-160M bytes Fixed-head; 1-2M bytes No  30, 60 KBS 60, 1000 cpm 180 cps 300 to 1000 lpm Up to 19,200 bps 80 char. x 24 lines Paper tape reader/ punch, XY plotter, digital/analog I/O	No Pack; 80-240M bytes No  1600 bpi No 120 cps 200 to 900 lpm 110-9600 bps 80 char. x 24 lines 15-port asynchron- ous multiplexer	No Pack; 160-400M bytes No  1600 bpi No 120 cps 200-900 lpm 110-9600 bps 80 char. x 24 lines 15-port asynchron- ous multiplexer	No Pack; 240-560M bytes No  1600 bpi No 120 cps 200-900 lpm 110-9600 bps 80 char. x 24 lines 15-port asynchron- ous multiplexer	No Pack; 240-800M bytes No  1600 bpi No 120 cps 200-900 lpm 110-9600 bps 80 char. x 24 lines 15-part asynchron- ous multiplexer
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler COBOL, RPG II, FORTRAN, BASIC, APL Real-time, time- sharing Partially No	Yes  RPG II, BASIC/5, PL/G  Time-sharing  No No	Yes  RPG II, BASIC/5, PL/G  Time-sharing  No No	Yes  RPG II, BASIC/5, PL/G  Time-sharing  No No	Yes  RPG II, BASIC/5, PL/G  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	\$33,850 (4030); \$42,285 (4040) \$4,000 (8K bytes) core 1970 240+ (both models)	\$32,700  \$11,900 (64K bytes) August 1976 6	\$59,400  \$11,900 (64K bytes) January 1977 3	\$99,200  \$11,900 (64K bytes) NA NA	\$234,300  NA NA NA
<b>COMMENTS</b>	Real-time, process- control monitoring and time-sharing/ multi-programming operating systems; IBM 1130 and 1800 compatible; user microprogram- mable	In-cabinet, on-site upgrades available on all configura- tions; Galaxy/5 is a multiple micropro- cessor system; DMA channel and communications interface are both microprocessor- based	Has two CPU's and two DMA channels; each DMA supports 15 high-speed devices	Has three CPU's and three DMA channels; all CPU's execute independ- ent instruction streams	Has four CPU's and four DMA channels

## Minicomputer Specifications

MANUFACTURER & MODEL	Ebnak 77	Ebnak Mini-77	Financial Computer System III/10	Financial Computer System III/6	Four Phase IV/40
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 16-32 16, 32, 48	16 16-32 16, 32, 48	8-bit byte 8 8	8-bit byte 8 8	24 15 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	Static MOS 0.35 0.35 8K 96K Optional No Standard	Static MOS 0.35 0.35 8K 32K Optional No Standard	MOS 0.6 0.2 4K bytes 256K bytes Optional Optional Optional	MOS 0.6 0.2 4K bytes 256K bytes Optional Optional Optional	MOS 2 — 24K bytes 96K 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	16 16 32K 5 None  4.7 Standard Standard Standard Optional Standard	16 16 32K 5 None  4.7 Standard Standard Standard Optional Standard	Software-assigned 128 64K bytes 3 PROM, 1-16K bytes 3.2 Optional Optional Standard Optional Optional	Software-assigned 128 64K bytes 3 PROM, 1-16K bytes 3.2 Optional Optional Standard Optional Optional	2 3 98,304 3 ROM; 1K x 48 bits  16 Standard Standard Standard — Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Optional 500K 17	Optional 500K 17	Standard 960K 16	Standard 960K 16	No 125K 8
<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	0.5-1.0M bytes No  No  Cassette; 1 KBS  No No 120-275 cpm 300 lpm 76.8K bps 64 char. x 16 lines 64-bit parallel I/O, A/D & D/A con- verters	0.1-1.0M bytes No  No  Cassette; 1 KBS  No No 120-275 cpm 300 lpm 76.8K bps 64 char. x 16 lines 64-bit parallel I/O, A/D & D/A con- verters	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	266K-2M bytes Cartridge; 10-400M bytes No  Cassette; 1.2 KBS  72 KBS 300, 600 lpm 30 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 20 cps 245-1800 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  EASE, PASCAL, BASIC  Real-time, time- sharing Optional Partially	Yes  EASE, PASCAL, BASIC  Real-time  Optional Partially	Yes  BASIC, CPL, PL/X  Batch, real-time  No Partially	Yes  BASIC, CPL, PL/X  Batch, real-time  No Partially	Yes  None  Batch, interactive  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	\$2,700 (16K bytes) \$900 (8K words)  3rd qtr. 1977 4	\$1,700 (16K bytes) \$900 (8K words)  4th qtr. 1977 2	\$29,950 (32K bytes)  \$1,600 (16K bytes); \$3,000 (32K bytes) January 1975 250+	\$17,950 (32K bytes)  \$1,600 (16K bytes); \$3,000 (32K bytes) January 1975 250+	\$37,440 (24K bytes)  —  June 1973 6000 (all models)
<b>COMMENTS</b>	Both system prices include 16-bit parallel I/O, 2 serial I/O ports, an operating system residing in 4K EPROM on a 16K-capacity board with a PROM programmer, and complete hardware manuals. Software supplied with the system includes an assembler, editor, utilities library, and EASE compiler		Also available as a turnkey system with applications software for manufacturers, wholesalers, accountants, hospitals, construction, insurance agencies, and trucking firms	Also available as a turnkey system with applications software for manufacturers, wholesalers, accountants, hospitals, construction, insurance agencies, and trucking firms	System price also includes 4 CRT's, 2.5-megabyte disk drive, and bisynch. communications controller

### Minicomputer Specifications

MANUFACTURER & MODEL	Four Phase IV/70	General Automation 18/30	General Automation 16/330	General Automation 16/440	General Automation SPC-16
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	24 15 24	16 + 1 16, 32 16, 32	16 + 2 16 16, 32, 48	16 + 2 16 16, 32, 48	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 2 — 24K bytes 96K bytes Standard No No	Core 1.2 0.6 4K 64K Standard No Standard	Core 0.72 0.225 4K 32K Optional No Optional	Core 0.72 0.225 16K 1024K Optional No Optional	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	5 3 98,304 — ROM; 1K x 48 bits 16 Standard Standard Standard — Standard	16 3 64K 6 — 2.4 Standard No No No Standard	16 8 64K 11 ROM; 320 x 34 bits 1.9 Standard Optional Standard No Standard	16 8 1M with MAP 11 PROM; 512 x 64 bits 0.78 Standard Optional Standard No Standard	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	No 125K 8	Standard 480K 6-59	Standard 1.25M 64-unlimited	Standard 1M 64-unlimited	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	354K bytes Pack & cartridge; 2.5-270M bytes No  No  10, 60 KBS 300, 600 cpm 30 cps 245-1800 lpm Up to 9600 bps 80 char. x 24 lines None	No Pack & cartridge; 1.02-80M bytes No  No  20-60 KBS 400, 1000 cpm No 300, 600 lpm To 9600 bps See Comments TTY, paper tape units, card punches, plotters	500K-2M bytes Pack & cartridge; 5-2400M bytes Fixed-head; 256K-2M bytes No  20-60 KBS 400, 1000 cpm 10, 165 cps 200-600 lpm 75-9600 bps 80 char. x 24 lines TTY, paper tape units, card punches, A/D converters, digital I/O plotters Macro assembler	500K-2M bytes Pack & cartridge; 5-2400M bytes Fixed-head; 256K-2M bytes No  20-60 KBS 400, 1000 cpm 10, 165 cps 200-600 lpm 75-9600 bps 80 char. x 24 lines TTY, paper tape units, card punches, A/D converters, digital I/O plotters Macro assembler	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	Yes  COBOL, RPG  Batch, interactive  Partially —	Yes  APL, BASIC, COBOL, FORTRAN IV, RPG II  Batch, real-time, time-sharing No No	Macro assembler  FORTRAN IV, BASIC, COBOL  Batch, real-time  No No	Macro assembler  FORTRAN IV, BASIC, COBOL  Batch, real-time, time-sharing  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	\$72,315 (48K bytes) —  February 1971 6000 (all models)	\$13,650 (8K words)  \$4,000 (8K words)  June 1969 Over 1000	\$4,550 (4K words)  \$3,000 (16K words)  January 1976 NA	\$8,950 (16K words)  \$3,000 (16K words)  May 1975 400+	\$5,500 (4K words)  \$2,600 (4K words)  May 1970 5000+
<b>COMMENTS</b>	System price also includes 12 CRT's, 2.5-megabyte disk drive, and 9-track magnetic tape drive	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	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

### Minicomputer Specifications

MANUFACTURER & MODEL	General Robotics 11/X3	GRI System 99/50	Harris Slash 4	Harris Slash 6	Harris Slash 7
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 16 16, 32, 48	16 — 16-48	24 + 2 24, 48 24	24 + 5 24, 48 24	24 + 2 24, 48 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	MOS 0.60 0.45 4K 32K No No No	Core; MOS 1.76 0.3 32K bytes 64K bytes Optional No No	Core; MOS 0.75; 0.2 0.3 8K 256K Standard No Optional	MOS 0.45 0.3 16K 256K No Standard Optional	Core; MOS 0.43; 0.2 0.3 32K 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	6 6 32K 8 No  3.50 Optional Optional Standard Optional Standard	8 1 32K 5 —  1.76 Optional No Standard Optional Optional	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  0.58 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 500K 1	Standard 568K Unlimited	Optional 1.3M 4-48	Optional 2.3M 8-24	Optional 1.9M 4-48
<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	600K-2400K Pack & cartridge; 2.5M-80M No  No  20-72 KBS No 30-100 cps 13-600 lpm 75-9600 bps 80 char. x 24 lines A/D and D/A converters, graphics, programmable clock	No Cartridge; 10.6-42.4M bytes No  Cassette  60 KBS 300 cpm 88-330 cps 200-600 lpm Up to 9600 bps 80 char. x 24 lines Paper tape equip., A/D and D/A converters, industrial devices	310K-1.2M bytes Pack & cartridge; 2.7-300M bytes Fixed-head; 10.8M bytes  —  25-320 KBS 300-1000 cpm 30 cps 300-900 lpm 96K bps; synch. 80 char. x 24 lines Paper tape units, plotter/printer	310K-3.7M bytes Pack & cartridge; 2.7-300M bytes Fixed-head; 10.8M bytes  —  25-320 KBS 300-1000 cpm 30 cps 300-900 lpm 98K bps; synch. 80 char. x 24 lines Paper tape units, plotter/printer	310K-1.2M bytes Pack & cartridge; 2.7-300M bytes Fixed-head; 10.8M bytes  —  25-320 KBS 300-1000 cpm 30 cps 300-900 lpm 98K bps; synch. 80 char. x 24 lines Paper tape units, plotter/printer
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler and macro assembler FORTRAN, BASIC, APL, SSP  Batch, real-time  Debug No	Yes  BASIC, RPG II  Real-time, multi-user No No	Macro assembler  FORTRAN IV, BASIC, RPG II, SNOBOL, FORGO Batch, real-time, time-sharing No No	Macro assembler  FORTRAN IV, BASIC, RPG II, SNOBOL, FORGO Batch, real-time, time-sharing No No	Macro assembler  FORTRAN IV, BASIC, RPG II, FORGO, SNOBOL Batch, real-time, time-sharing 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	\$4,750 (20K bytes)  \$950 (8K MOS)  June 1976 Over 100	\$6,410 (8K words)  \$3,890 (16K words) NA NA	\$24,000 (8K words) \$7,000 (8K words)  September 1973 NA	\$17,900 (16K words) \$5,500 (16K words)  December 1976 NA	\$55,000 (32K words) \$30,000 (32K words)  November 1975 NA
<b>COMMENTS</b>	Hardware and software compatible with DEC LSI-11; 16 LSI slot backplane, UNIBUS port option	Basis for the GRI System 99 small business computer			

### Minicomputer Specifications

MANUFACTURER & MODEL	Harris S115	Harris S125	Harris S135	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 + 5 24, 48 24, 48	24 + 5 24, 48 24, 48	24 + 5 24, 48 24, 48	16 64 bits 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	MOS 0.45 0.30 48K 256K No Standard Standard	MOS 0.45 0.30 48K 208K No Standard Standard	MOS 0.45 0.30 48K 208K No Standard Standard	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 NA  0.6 Standard No Standard Optional Standard	5 3 64K 4 NA  0.6 Standard Optional Standard Optional Standard	5 3 64K 4 NA  0.6 Standard Optional Standard Optional Standard	2 — 2K 8 See Comments  1.6 No No Standard No Optional	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	Standard 2.3M 16, 24	Standard 2.3M 16, 24	Standard 2.3M 16, 24	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, 1/2-inch Punched card input Serial printer Line printer Data communications interface CRT Other standard peripheral units	310K-3.7M bytes Pack & cartridge; 10.8M-1200M bytes Fixed-head; 1-2.5M bytes —  25-320 KBS 300-1000 cps 30 cps 300-900 lpm  80 char. x 24 lines Paper tape units, plotter/printer, A/D equip., graphics, and communication	310K-3.7M bytes Pack & cartridge; 10.8M-1200M bytes Fixed-head; 1-2.5M bytes —  25-320 KBS 300-1000 cps 30 cps 300-900 lpm  80 char. x 24 lines Paper tape units, plotter/printer, A/D equip., graphics, and communication	310K-3.7M bytes Pack & cartridge; 10.8M-1200M bytes Fixed-head; 1-2.5M bytes —  25-320 KBS 300-1000 cps 30 cps 300-900 lpm  80 char. x 24 lines Paper tape units, plotter/printer, A/D equip., graphics, and communication	468K-15M bytes No No Cartridge; 2.75 KBS  No 300 cpm 30-180 cps 240 lpm Up to 9600 bps See comments Paper tape reader, paper tape punch, plotter, digitizer,	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, BASIC, RPG II, SNOBOL, FORGO, COBOL Batch, real-time, time-sharing No No	Macro assembler  FORTRAN, BASIC, RPG II, SNOBOL, FORGO, COBOL Batch, real-time, time-sharing No No	Macro assembler  FORTRAN, BASIC, RPG, SNOBOL, FORGO, COBOL Batch, real-time, time-sharing No No	No HPL  Interactive/inter- pretive 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	\$85,000 \$5,500 (16K words)  NA	\$100,000 \$5,500 (16K words)  NA	\$150,000 \$5,500 (16K words)  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>	DBMS available at extra cost; price includes CPU with 144K bytes memory; 768K bytes virtual memory; system console CRT; 10.8M-byte disk; 800-bpi, 45-ips mag. tape unit; DMA with 4 ports	DBMS available at extra cost; price includes CPU with 144K bytes memory; 3072K bytes virtual memory; system console CRT; 10.8M-byte disk; 800-bpi, 45-ips mag. tape unit; DMA with 4 ports	DBMS available at extra cost; price includes CPU with 384K bytes memory; 12,288K bytes virtual memory; system console CRT; 40M byte disk; 800-bpi, 45-ips mag. tape unit; DMA with 4 ports	Approx. 31K bytes of ROM for oper. system and HPL language interp.; up to 16K bytes of addl. ROM can be added for language extension & periph. control; system price also includes mag. tape cartridge drive, 16-char. strip printer, and 32-char. display; CRT can be added as a peripheral	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



## Minicomputer Specifications

MANUFACTURER & MODEL	Hewlett-Packard Calculator Products Div. System 45	Hewlett-Packard Data Systems Div. 2100	Hewlett-Packard Data Systems Div. 21MX M-Series	Hewlett-Packard Data Systems Div. 21MX K-Series	Hewlett-Packard Data Systems Div. 21MX E-Series
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 64 16	16 + 1 16, 32 16, 32	16 + 1 16, 32 16, 32	16 + 1 16, 32 16, 32	16 + 1 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 — 13,498 bytes 62,650 bytes No No No	Core 0.98 0.49 8K 32K Standard No Standard	MOS 0.65 — 8K 1,024,000 Standard Optional Optional	MOS 0.65 — 8K 1,024,000 Standard Optional Optional	MOS 0.595, 0.35 — 8K 1,024,000 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	4 — 2K 8 —  1.6 No No Standard No Optional	2 0 2K 7 ROM/RAM: 1K  1.96 Standard Standard No No Standard	2 2 2K 7 ROM/RAM: 4K  1.9 Standard Standard Standard Optional Optional	2 2 2K 7 ROM/RAM: 4K  1.9 Optional Optional Optional Optional Optional	2 2 2K 7 ROM/RAM: 1-6K  1.19 Standard Standard Standard Optional Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 400K 2	Optional 1M 60	Optional 616K 50	Optional 616K 50	Optional 1050K 50
<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	500K-24M bytes Pack & cartridge; 15M-6400M bytes No  Cartridge; 1.48 KBS  No 300 cpm 30-100 cps 240-480 lpm Up to 9600 bps 80 char. x 24 lines Paper tape reader, paper tape punch, plotter	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	0.5-2M bytes Cartridge & pack; 4.9-400M bytes No  Yes 20-72 KBS 300, 600 cpm 180 cps 1250 lpm 50K-2.5M bytes Plotters, meas. & control processor, plug-in ADC, IEEE Std. 488-1975 intfce., TV intfce. Assembler & micro assembler FORTRAN, BASIC	0.5-2M bytes Cartridge & pack; 4.9-400M bytes No  Yes 20-72 KBS 300, 600 lpm 180 cps 1250 lpm 50K-2.5M bytes Plotters, meas. & control processor, plug-in ADC, IEEE Std. 488-1975 intfce., TV intfce. Assembler & micro assembler FORTRAN, BASIC	0.5-2M bytes Cartridge & pack; 4.9-400M bytes No  Yes 20-72 KBS 300, 600 cpm 180 cps 1250 lpm 50K-2.5M bytes Plotters, meas. or control processor, plug-in ADC, IEEE std. 488-1975 intfce., TV intfce. Assembler & micro assembler FORTRAN, BASIC
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	No  BASIC  Interactive/ interpretive Fully Fully	Assembler  FORTRAN, ALGOL  Real-time, time-sharing No No	Real-time, time-sharing, DBMS Partially No	Real-time, time-sharing, DBMS Partially No	Real-time, time-sharing, DBMS 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	\$11,500 (13,498 bytes) \$2,400 (16,384 bytes) November 1977 NA	\$10,000 (4K words) \$2,500 (4K or 8K) May 1973 Over 12,000	\$5,500 (8K MOS) \$750 (8K words) May 1974	\$1,475 (cpu only) \$750 (8K words) June 1976	\$7,200 (8K MOS) \$750 (8K words) November 1976
<b>COMMENTS</b>	98K bytes of ROM for operating sys- tem and enhanced BASIC interpreter; up to 80K bytes of additional ROM can be added for lan- guage extensions and peripheral con- trol; internal op- tions can include graphics capability, 2nd tape drive, and 80-char. thermal printer	Succeeded by 21MX series; now marketed primarily to existing ac- counts		21MX M-Series processor board available with choice of two card cages, front panel, and/or standard 21MX instruction set in component form for OEM's	Packaged systems include HP 1000, HP 2000 ACCESS, and HP 2026

### Minicomputer Specifications

MANUFACTURER & MODEL	Hewlett-Packard General Sys. Div. HP 3000 Series II	Hewlett-Packard General Sys. Div. HP 3000 Series I	Honeywell Level 6 Model 6/06	Honeywell Level 6 Model 6/34	Honeywell Level 6 Model 6/36
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 5 or + 1 — 8, 16	16 + 1 — 8, 16	16 + 2 16 16	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	MOS 0.7 0.35 128K bytes 512K bytes Standard Standard Standard	Core 1.05 0.525 128K bytes 128K bytes Standard No Standard	MOS 0.650 — 8K 64K Standard Optional Optional	MOS, Core 0.650 — 8K 32K Standard No No	MOS, Core 0.650 — 8K 64K Standard Optional 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	20 1 64K bytes 6 ROM: 10K x 32 bits 1.05 Standard Standard Standard Standard Standard	16 1 64K bytes 6 ROM: 4 x 36 1.23 Standard Standard Standard No Standard	2 2 512 14 — 2.0 Standard No Standard No Standard	7 3 64K 14 — 1.9 Standard No Standard Optional Standard	7 3 64K 14 — 1.9 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 2.86M To 125	Standard 1.92M To 125	Standard 500K 54	Standard 1.5M 64	Standard 1.5M 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 Pack & cartridge; 15-400M bytes No 110K bytes 72 KBS 600 cpm 30, 180 cps 200-1250 lpm To 9600 bps 80 char. x 24 lines Paper tape units, punched card reader/punch, graphics terminal	No Pack & cartridge; 15-400M bytes No 72 KBS 600 cpm 30, 180 cps 200-1250 lpm 1200 bps 80 char. x 24 lines Paper tape, punched card reader/punch, graphics terminal	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	256K-1M bytes Cartridge 2.5-40M bytes No No 25-60 KBS 300, 500 cpm 10-165 cps 300-600 lpm 50-72,000 bps 80 char. x 12 lines —	256K-1M bytes 2.5-40M bytes No No 25-60 KBS 300, 500 cpm 10-165 cps 300-600 lpm 50-72,000 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 COBOL, RPG II, FORTRAN IV, BASIC, SPL Batch, real-time, time-sharing Partially Partially	Assembler & macro assembler SPL, COBOL, RPG II, FORTRAN IV, BASIC Batch, real-time, time-sharing Partially Partially	Macro assembler BASIC, FORTRAN Batch; real-time; multi-programming No No	Assembler & macro- preprocessor FORTRAN Batch, multi- tasking No No	Assembler & macro- preprocessor FORTRAN Batch, multi- tasking 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	\$110,000 (128K bytes) \$3,700 (64K bytes) June 1976 1000	\$75,000 (128K bytes) — April 1977 25	\$7,900 (8K words) \$2,400 (8K words) January 1976 NA	\$5,200 (8K words) \$1,250 (8K words) January 1976 Over 1000	\$6,550 (8K words) \$1,250 (8K words) January 1976 NA
<b>COMMENTS</b>	The Series II ranges in price from \$110,000 to \$300,000 and offers a wide variety of communications options, data base management, and peripherals	The Series I is the entry-level product in HP's 3000 line; it is fully upgradable to a Series II	Replacement for Model 700; micro- programmed emulator for Model 700 based on Level 6 CPU	Intended for OEM small system market	Enhanced version of Model 6/34 for larger OEM systems

## Minicomputer Specifications

MANUFACTURER & MODEL	Honeywell Level 6 Model 6/43	Honeywell Level 61 Model 61/58	Honeywell Level 61 Model 61/60	Honeywell Level 62
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 16, 32 16, 32, 48	8-bit byte 16 8-64	8-bit byte 16 8-64	8 + 1 16, 32 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	MOS 0.650, 0.550 — 16K 1024K Standard Optional Optional	Core 1.2 — 5K bytes 10K bytes Standard No No	MOS 1.2 — 10K bytes 10K bytes Standard No No	MOS 1.0 (2 byte fetch) 0.5 (2 byte fetch) 48K 224K 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	7 3 1024K 14 — 1.0 Standard Optional 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 224K bytes 4 ROM, to 30K bytes  See comments 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 1.5M 64	Standard 312K —	Standard 312K —	Standard 1.587M 1-14
<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	256K-1M bytes Cartridge; 2.5-40M bytes No  No  25-60 KBS 300, 500 cpm 10-165 cps 300-600 lpm 50-7200 bps 80 char. x 24 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 memory (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 memory (16K-64K bytes; 312 KBS)	256-512K bytes Pack; 40-480M bytes No  700 bps  10-60 KBS 300-1050 cpm 30/120 cps 100-1600 lpm To 9600 bps 80 char. by 12 lines Card punch
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler & macro- preprocessor FORTRAN  No  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 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	\$12,300 (16K words)  \$1,250  February 1977 No	\$20,060 (5K bytes)  \$7,010 (5K bytes)  November 1974 150 (Level 61)	\$25,380 (10K bytes)  CPU cannot be expanded  2nd quarter 1975 150 (Level 61)	\$36,900 (48K bytes)  \$4,677 (16K bytes)  June 1975 Over 1800
<b>COMMENTS</b>	Designed for the larger minicomputer applica- tions	Small business computer system built in France; no longer actively marketed; GE, Hazeltine, and other terminals can be interfaced	Small business computer system built in France; no longer actively marketed; GE, Hazeltine, and other terminals can be interfaced	Business data processing system built in Italy; CPU is available with 4 different performance levels; see Report 70C-480-12 for more details

Minicomputer Specifications

MANUFACTURER & MODEL	IBM Series/1	IBM System/3	IBM System/7	IBM System/32	IBM System/34
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 32 32, 64	8-bit byte 8-248 32, 40, 48	16 + 2 16 16,32	8-bit byte 1-16 digits 24-48	8-bit byte 1-16 digits 32, 40, 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 0.6, 0.8 — 16K bytes 128K bytes Standard No Standard	Core, MOS 1.52 — 8K bytes 256K bytes Standard Std. (Model 15) Std. (Model 15)	Bipolar 0.4 0.15 2K 64K Standard — No (Models A & B); Std. (Model E)	MOS 0.6 0.250 16K bytes 32K bytes Standard No No	MOS 0.6 — 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	— 34 64K bytes 4 No  2.6, 8.4 (2 bytes) No Optional Standard Optional Optional	1 2 64K bytes 1 No  24.4 No No Standard No Optional	4 28 64K 1 No  0.8 No No No No Optional	— 2 32K bytes 2 ROM; 4K bytes  150.8 (5 digits) No No Standard No No	— 2 32K bytes 2 —  68.5 (5 digits) No No Standard — —
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard — 256	Standard 658K 5 (Models 8, 10, 12) 8 (Model 15)	Standard 2M 64	Standard 889K 4	Standard — —
<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	492-606K bytes Pack; 9M-9.4M bytes No  No  No No 120 cps 155-414 lpm 2400-9600 bps 80 char. x 24 lines Sensor I/O	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 80 char. x 12 lines MICR reader/sorter, optical mark reader	No Pack & cartridge; 4.9-69.8M bytes Fixed-head; 502K bytes No  No 300 cpm No 40-155 lpm Up to 50K bps No A/D converters, sensor units	243-303K bytes Nonrem. cartridge; 3.2-13.7M bytes No  No 12-50 cpm 40-80 cps 40-1100lpm Up to 7200 bps 40 char. x 6 lines Magnetic card reader	303K bytes Nonrem. cartridge; 8.6-27.1M bytes No  No 100, 600 cpm 15 cps 40-1100lpm 4800 bps 74 char. x 52 lines No
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Macro assembler  FORTRAN, PL/1  Real-time, multi- tasking Partially Partially	No  BASIC, RPG II, COBOL, FORTRAN  Batch, time-sharing  No No	Assembler & macro assembler FORTRAN, APG/7  Batch, real-time  No No	Macro assembler  RPG II  Batch (one-program)  No Partially	Yes  RPG II  Interactive  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	\$4,540  \$1,800 (16K bytes)  — —	\$12,560 (8K bytes)  \$2,950 (4K bytes)  December 1970 30,000+	\$5,310 (2K words)  \$2,285 (2K words)  1st quarter 1971 NA	\$33,560 (16K bytes)  \$878 (8K bytes)  March 1975 5500+	\$34,700  \$1,600  — —
<b>COMMENTS</b>	Introduced in November 1976 as IBM's first "pure" minicomputer; offered on a purchase- only basis to OEM's as well as end users	Six different model lines currently avail- able; see Report 70C-491-21 for more details	System/7's form the base for many custom systems for voice response, Touch-Tone data entry communica- tions processing, etc.	IBM's entry-level business computer; strong emphasis on packaged applica- tions software; system price also includes 3.92M- byte fixed disk drive, diskette drive, CRT, keyboard, and 40-cps unidirectional printer; see Report 70C-491-25 for details	Similar to System/ 34, but features more processing power, larger memory, larger disk capacity, and multiple independent workstations; see Report 70C-491-27 for details

## Minicomputer Specifications

MANUFACTURER & MODEL	IBM System/360 Model 20	IBM 1130	IBM 5100	ICL 2903	ICL 2904
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8-bit byte 8-128 16, 32, 48	16 + 2 16, 32 16, 32	8-bit byte — 16	24 + 2 12 24	24 + 2 12 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 See Comments — 4K bytes 32K bytes Standard No No No	Core 2.2; 3.6 — 4K 32K Standard No No	MOS 0.530 0.330 16K bytes 64K bytes Standard No No	MOS 1.14 0.57 16K 48K Standard No No	MOS 1.14 0.57 32K 96K 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	8 (see Comments) 8 (see Comments) — — ROM  58 Standard No Standard No Optional	2 3 32K 2 No  8; 4.9 Standard No No No	64 0 64K bytes 2 ROM; 180K x 9 bits 1000 (approx.) Standard Standard Standard No No	8 4 4K 4 8K, 12K  17.7 Standard Optional No No Standard	8 4 4K 4 8K, 12K  11.8 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 156K 1	Optional 278K; 455K 6	Standard 500K 3	Standard 500K None	Standard 500K 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 Pack; 2.7-21.6M bytes No  No  15-60 KBS 600, 1000 cpm 15.5 cps 260-1100 lpm Up to 50K bps No Card punch, MICR reader/sorter	No Pack & cartridge; 512K-2.56M bytes No  No  15 KBS 100, 600 cpm 15 cps 40-1100 lpm Up to 4800 bps 74 char. x 52 lines Paper tape reader, paper tape punch, optical mark reader, plotter	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	No Cartridge & pack; 9.8-270M (6-bit) No  No  80 KCS 300 cpm No 150-1500 lpm To 9600 bps 80 chars. x 25 lines DDE terminals, 256 chars.; hard-copy printer for CRT's	No Cartridge & pack; 9.8-270M (6-bit) No  No  80 KCS 300 cpm No 150-1500 lpm To 9600 bps 80 chars. x 25 lines DDE terminals, 256 chars.
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler RPG II, PL/1   Batch  No No	Assembler & macro assembler RPG II, FORTRAN   Batch  No No	No  BASIC, APL  Batch (one-program)  Fully Fully	No  COBOL, FORTRAN, BASIC, RPG, ALGOL Batch; multitask., data base mgmt. No Partially	No  COBOL, FORTRAN, RPG, ALGOL Batch; multitask., data base mgmt. 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	\$8,210 (4K bytes) \$2,160 (4K bytes)  November 1964 15,000+	\$8,630 (4K words) \$4,390 (4K words)  November 1965 4000+	\$9,975 (16K bytes) \$1,750 (16K bytes)  September 1975 NA	\$85,000 \$7,806-19,106 (4K)  July 1974 20	\$35,000 \$12,116 (8K); \$18,174 (12K) NA 5
<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	IBM 1800 is similar CPU with storage protection, real-time operating system, and extensive A/D and sensor units	Portable computer weighing 50 pounds; system price also includes cartridge tape drive, CRT, and BASIC language interpreter	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

### Minicomputer Specifications

MANUFACTURER & MODEL	ICL System Ten/220	Interdata 6/16	Interdata 8/16	Interdata 7/32C	Interdata 8/32C
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	6 6 6	16 + 1 8, 16, 32 16, 32	16 + 1 8, 16, 32 16, 32	32 + 2 32 16, 32, 48	32 + 2 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 2.2 1.1 20K 160K No No Standard	MOS; core 0.6; 1.0 —; 0.35 4K 32K Optional No No	Core 0.75 0.275 16K 32K Optional No No	Core 0.75, 1.0 0.4, 0.5 16K 256K Optional No Optional	Core 0.3 0.4 32K 256K Optional 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	1 3 9990 2 —  80.3 Standard No No No Optional	16 15 32K 4K ROM  1.0 Optional No Standard Optional Optional	16 15 32K 4K ROM  0.75 Optional Optional Standard No Optional	32 30 256K 7 ROM; 1792 x 24 bits 1.0 Standard Optional Standard No Optional	32-256 30-240 256K 7 ROM; 1240 x 32 bits 0.4 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 229,166 No	Standard 1M 1-255	Standard 1.33M 1-255	Standard 500K 1-1024	Standard 1.25M 4-1024
<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; 8-160M bytes  No  No  50 MCS No — 125-400 lpm 2400 bps 80 char. x 24 lines —	No Pack & cartridge; 2.5-1024M bytes No  Cassette; 1 KBS  9-120 KBS 400, 1000 cpm 10-30 cps 60-600 lpm To 9600 bps 80 char. x 24 lines Paper tape units, A/D & D/A con- verters, graphic display	No Pack & cartridge; 2.5-1024M bytes No  Cassette; 1 KBS  9-120 KBS 400, 1000 cpm 10-30 cps 60-600 lpm To 9600 bps 80 char. x 24 lines Paper tape units, A/D & D/A con- verters, graphic display	No Pack & cartridge; 2.5-1024M bytes No  Cassette; 1 KBS  9-120 KBS 400, 1000 cpm 10-30 cps 60-600 lpm To 9600 bps 80 char. x 24 lines Paper tape units, A/D & D/A con- verters, graphic display	No Pack & cartridge; 2.5-1024M bytes No  Cassette; 1 KBS  9-120 KBS 400, 1000 cpm 10-30 cps 60-600 lpm To 9600 bps 80 char. x 24 lines Paper tape units, A/D & D/A con- verters, graphic display
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler and macro assembler RPG II   Batch, real-time  No Partially	Assembler & macro assembler FORTRAN, BASIC   Batch, real-time  No No	Assembler & macro assembler FORTRAN, BASIC   Batch, real-time  No No	Assembler & macro assembler FORTRAN V, BASIC, COBOL   Batch, real-time  No No	Assembler & macro assembler FORTRAN V, 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	\$16,800 \$4,000 (20K words)  June 1970 4000	\$2,900 (4K words) \$500 (4K words)  February 1975 180+	\$6,250 (16K words) \$4,500 (16K words)  4th quarter 1976 NA	\$11,695 (16K words) \$3,950 (16K words)  July 1974 400+	\$51,900 (32K words) \$19,000 (64K words) June 1975 100+
<b>COMMENTS</b>	Improved version of the former Singer System Ten; CPU power fail/auto restart included	Singleboard pro- cessor 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 in- structions, power fail/auto restart, turnkey console		512 words of writable control store optional; features instruction look-ahead; ITAM software provides remote batch ter- minal emulators

## Minicomputer Specifications

MANUFACTURER & MODEL	Interdata 5/16	Jacquard J-100	Keronix IDS 16 Series	Litton/Sweda International Litton 1600 Series	Lockheed LEC 16
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 8, 16, 32 16, 32	16 16, 32, 64 16	16 16 16	16 16 16	16 + 1 8, 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 0.6 — 4K 32K No No No	Core 1.5 — 16K 64K No No No	Core 1.2; 1.0; 0.80 — 4K 1024K No No Optional	Core 1.2 0.5 32K 32K No No No	Core 1.0 0.5 8K 64K 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	16 15 32K 2 Opt. ROM; to 48K bytes 1.2 Standard Optional Standard No Standard	4 2 256 4 No 7 No No No No Standard	4 2 64K 8 — 1.2; 1.0; 0.8 Optional Optional Optional No Optional	— 16 — — No 0.95 Standard No Standard No No	1 1 1K 4 No 2.0 Optional 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 450K 1-255	Standard 667K 32	Standard 833K; 1M; 1.25M 62	Standard — —	Standard 333K 8-64
<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	Yes No  No  Cassette; 1 KBS  9-120 KBS 400, 1000 cpm 10-30 cps 60-600 lpm To 9600 bps 80 char. x 24 lines Paper tape units, A/D & D/A con- verters, graphic display	512K-1M bytes Pack & cartridge; 6-320M bytes No No 10-72 KBS No 30-166 cps 300-900 lpm Up to 9600 bps 80 char. x 24 lines RS-232C interface	256-512K bytes Cartridge & pack; 2.5-1200MB No No 400 KBS 300-600 cpm 10-330 cps To 1800 lpm To 9600 bps 80 char. x 25 lines —	No Cartridge; 10M bytes No No No No 165 cps No No 80 char. x 24 lines None	No No  No  No No No No 110-9600 bps No —
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler FORTRAN, BASIC  Batch, real-time No No	Yes BASIC  Time-sharing, multitasking No No	Yes BASIC, FORTRAN, COBOL  Multi-user, multi-task No No	No BASIC  Batch, time-sharing Fully Fully	Yes FORTRAN  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	\$2,000 (4K words) \$600 (4K words)  4th quarter 1976 NA	\$21,060 (16K words) \$3,000 (16K words)  August 1975 500	\$2,900 (4K words) \$1,500 (8K words)  April 1974 Over 500	\$22,000 —  NA NA	\$7,615 (8K words) \$2,475 (4K words)  February 1969 Over 2000
<b>COMMENTS</b>	Available as a board-based pro- cessor without chassis and periph- erals	Sold only in pack- aged configuration consisting of a 16K- word CPU, dual floppy disk, CRT display/keyboard, real-time clock, and all software	Keronix IDS 16 CPU's are software, memory, and I/O- compatible with Data General Nova Series CPU's	Small business com- puter system based on Data General Nova 1220 pro- cessor	Formerly known as MAC; sold for OEM usage only; periph- erals supplied only on special request

### Minicomputer Specifications

MANUFACTURER & MODEL	Lockheed SUE/System III	Micro Computer Machines MCM/700	Micro Computer Machines MCM/800	Microdata Micro-One	Microdata Express III
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 8, 16 16, 32	8 + 1 8-64 Variable	8 + 1 8-64 Variable	8-bit byte 8, 16, 24, 32 8, 16, 24, 32	16 1, 2, 4, 8, 16, 32 8, 16, 32, 40
<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 0.5, 0.85 0.5, 0.425 16K MOS, 8K core 128K Optional No No	MOS 0.55 — 2K bytes 8K bytes Standard No No	MOS 1.2 — 4K bytes 16K bytes Standard No No	Core, MOS 1.1 0.44 8K 32K No No No	MOS 1.1 0.54 0.6 32K 240K — 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 32K 19 ROM: 52 x 36 bits 4.5 Optional No Standard No Standard	1 0 16K — ROM: 32K bytes — Standard Standard Standard Standard No	1 0 16K — ROM: 32K bytes — Standard Standard Standard Standard No	15 Firmware-contrld. 32K Firmware-contrld. 4K-byte ROM & PROM 6.38 Standard No Standard No Standard	5 (stack) 5 (stack) 256K 8 4K-byte ROM & PROM 0.405 Standard Optional Standard Optional Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 1M Variable	Standard — No	Standard — No	Optional 1M 2; 128	Standard 1M 1024 maximum
<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	256K-512K bytes Pack & cartridge; 5.0-(4) 150M bytes No No 80/1600 bpi 285 cps 88, 165 cpm 300, 600 lpm 110-9600 bps 80 char. x 24 lines —	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	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 Cassette; 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 Pack & cartridge; 10-200M bytes No No 40 KBS 200-1000 cpm 120, 165 cps 300, 600 lpm To 9600 bps 80 char. x 24 lines —
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	Macro assembler FORTRAN, RPG II Multi-tasking No No	No APL Virtual memory, interactive Fully Fully	No APL Virtual memory, interactive Fully Fully	Yes BASIC No No No	— FORTRAN, BASIC, EPL, COBOL Virtual memory, 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	\$10,780 (16K MOS) \$3,350 (16K MOS); \$1,950 (8K core) November 1972 Over 2000	\$4,985 (2K bytes) \$650 (2K bytes) January 1975 180	\$9,200 (8K bytes) \$1,600 (8K bytes) July 1976 150	\$2,175 (8K words) \$75 (1K bytes) December 1974 150+	\$38,850 (64K bytes) \$6,350 (64K bytes w. ECC) 3rd quarter 1977 NA
<b>COMMENTS</b>	Used as the basis for Lockheed System III business minicomputer system	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	MSI implementation 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 cassette tape or diskette; system price also includes an integral cassette drive, display, keyboard, and RS-232 interface	Single-board processor; compatible with Microdata 800 and 1600 computers	Multi-user (up to 9), multi-language, and multiprogramming capability; system price also includes 10M-byte disk drive, reel-to-reel magnetic tape, CRT, line printer interface, 4 RS-232C lines, upright cabinet, and all systems software



## Minicomputer Specifications

MANUFACTURER & MODEL	Microdata 1600 Series	Microdata 3200	Modular Computer Systems Modcomp II	Modular Computer Systems Modcomp IV	Mylee Digital Sciences 3000
<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 8, 16 32 (micro)	16 + 1 16, 32 16, 32, 48	16 + 1 16, 32 16, 32, 48	16 8-128 16-48
<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 No	Core; MOS 0.8; 0.6 0.4; — 8K 64K Standard No Optional	Core 0.5 0.4 16K 512K Standard No Standard	MOS 0.8 — 12K 72K 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 16K 8 4K-byte ROM & PROM 6.38 Standard No Standard No Standard	32 32 128K 8 4K-byte ROM & PROM 0.405 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	4 4 28K — ROM  20 Standard 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 1M 2; 128	Standard 2.5M 4; 1024	Standard 1.93M Up to 128	Standard 3.5M Up to 128	Standard 1M 1-18
<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; 10-40M bytes No  No  40 KBS 200-1000 cpm 165 cps 300-600 lpm To 9600 bps 80 char. x 24 lines Paper tape reader/ 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/ reader/punch	315-630K bytes Pack & cartridge; 2.4-168M bytes Fixed-head; 262K-2M bytes No  120 KBS 300, 1000 cpm 30-132 cps 300-600 lpm 50-56K bps 80 char. x 24 lines Printer/plotter, A/D & D/A con- verters & discrete I/O	315-630K bytes Pack & cartridge; 2.4-168M bytes Fixed-head; 262K-2M bytes No  120 KBS 300, 1000 cpm 30-132 cps 300-600 lpm 50-56K bps 80 char. x 24 lines Printer/plotter, A/D & D/A con- verters & discrete I/O and memory	No Cartridge; 48-96M bytes No  No  No 300 cpm 165 cps 300 lpm To 1200 bps 32 char. x 11 lines None
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Yes  BASIC  No  No No	Cross assembler  No  No  No No	Assembler & macro assembler FORTRAN, BASIC, RPG II, COBOL, CORAL Batch, real-time, comm. exec.  No No	Assembler & macro assembler FORTRAN, BASIC, RPG II, COBOL, CORAL Batch, real-time  No No	No  ACE  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	\$5,850 (4K words) \$1,400 (4K words)  November 1971 6000+	\$9,630 (4K words) \$2,930 (4K words)  October 1973 NA	\$3,995 (8K words) \$1,100 (8K words)  March 1971 Over 2000	\$42,500 (64K words) \$14,500 (64K words)  June 1974 Over 300	\$37,500 (28K) —  May 1976 16
<b>COMMENTS</b>	1600 Series fea- tures stack process- ing and character string manipula- tion; also available in packaged version called REALITY	General-purpose system for emula- tion of specialized architecture such as the 32/S	4-port memory available for multi- processor and I/O processor configu- rations; high- speed communica- tions processor available	Features 32-bit parallel internal op- eration; 2048 re- locating registers and eight map files	System price also includes 2 CRT's, 48M bytes of disk storage, a 165-cps printer, system software, and an inventory control applications pack- age

### Minicomputer Specifications

MANUFACTURER & MODEL	Nanodata QM/1	NCR 299-100	NCR 299-200	NCR 499	NCR Century 75
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	18 + 2 Variable Variable	64 16 digits Variable	64 16 digits Variable	16 + 1 12 Variable	8 + 1 8, 16 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 0.75, 1.25 0.35 16K 1,024K Standard Optional Optional	Core 7 per bit — 512 bytes 1K bytes Standard No No	Core 7 per bit — 1K bytes 2K bytes Standard No No	Core 1.2 0.65 12K 32K Standard No No	Core 1.2 0.65 16K 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	32 32 256K Variable RAM; 40 x 16  0.75 Standard Standard Standard Optional Optional	10-50 (in memory) — — — ROM; 12K words  220 milliseconds Standard No No Optional No	30-100 (in memory) — — — ROM; 12K words  220 milliseconds Standard No No Optional No	— — — — ROM; 64K words  1.7 milliseconds Standard No No No No	— 63 (in memory) — — No  25.2 (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	Optional 1M 2,048	No — None	No — None	Standard 833K 8	Standard 120K & 416K 8
<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; 12-60M No  Cartridge; 2.5M bytes  200 KBS 200-1000 cps 120 cps 600-1250 lpm Up to 50K bps Yes IBM 360 and Univac 1100 com- patible channel	No No No No No No No Paper tape punch	No No No No No 1200 bps Paper tape punch, mag. ledger card reader	No Cartridge; 4.9-9.8M bytes No  Cassette; 750 cps  No 300 cpm 75, 130 cps 55-300 lpm 300-9600 bps No Paper tape units, mag. ledger card reader	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
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler and macro assembler PASCAL, APL/SV, see Comments  See Comments  Yes No	Assembler  No  No  Fully Fully	Assembler  No  No  Fully Fully	NEAT/AM  No  No  No No	No  COBOL, BASIC, FORTRAN, RPG, NEAT/3 Batch, multipro- gramming 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	\$176,000  \$4,960 (16K words)  1975 14	\$7,250 (512 bytes)  \$325  November 1974 3000 both types	\$9,300 (1K bytes)  \$325  March 1975 3000 both types	\$17,900 (12K bytes) \$1,100 (2K bytes)  February 1976 400	\$56,850 (16K bytes) \$5,000 (8K bytes)  May 1976 50
<b>COMMENTS</b>	Emulations offered include IBM 360, 370, 7094; Univac 1106; DEC 11/05- 11/40; DG Nova; CDC 160A; Delco 352; RCA 234SCP; UYK-7, -20; and microprocessors; emulation lab soft- ware provided	Replacement for electromechanical accounting ma- chines	Replacement for electromechanical accounting ma- chines	Replacement for NCR 399	System price also includes a card reader, line printer, disk drive, TTY, and cabinet; can be upgraded to Century 101

## Minicomputer Specifications

MANUFACTURER & MODEL	NCR Century 50	NCR Century 100	NCR Century 101	NCR Century 151	NCR 8200
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8 + 1 1-256 digits 32-64	8 + 1 1-256 digits 32-64	8 + 1 1-256 digits 32-64	8 + 1 1-256 digits 32-64	16 + 2 16 16, 32, 48
<b>MAIN STORAGE</b> <b>Storage type</b> Cycle time, microseconds/word Access time, microseconds/word Minimum capacity, words Maximum capacity, words Parity checking Error correction Storage protection	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	MOS 0.75 (1 or 2 bytes) — 64K bytes 128K bytes Standard No Optional	Core 1.2 0.65 32K bytes 128K 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	— 63 (in memory) — — No	— 63 (in memory) — — No	— 63 (in memory) — — No	— 63 (in memory) — — No	— 27 (in memory) — — No
Add time, microseconds Hardware multiply/divide Hardware floating point Hardware byte manipulation Battery backup Real-time clock or timer	59 (5 digits) No Standard Standard No No	59 (5 digits) No Standard Standard No No	28.8 (5 digits) Optional Standard Standard No Optional	18.0 (5 digits) Standard No Standard No Optional	2.4 (8 digits) Standard No Standard No No
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 40K & 108K 2	Standard 40K & 108K 2	Standard 120K & 416K 9	Standard 120K & 545K 9	Standard 833K 8
<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; 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	No Pack; 8.4-381.6M bytes No Cassette; 750 cps 10-320 KBS 300-1200 cpm 6 cps 450-3500 lpm 45-50K bps 80 char. x 24 lines Paper tape units; MICR/OCR 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 —
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	No COBOL, BASIC, FORTRAN, NEAT/3 Batch, multipro- gramming No No	No COBOL, BASIC, FORTRAN, NEAT/3 Batch, multipro- gramming No No	No COBOL, BASIC, FORTRAN, NEAT/3 Batch, multipro- gramming No No	No COBOL, BASIC, FORTRAN, NEAT/3 Batch, multipro- gramming No No	No NEAT/3, COBOL  Batch, multipro- gramming 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	\$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	\$119,925 (64K bytes) \$20,000 (64K bytes) February 1975 50	\$17,425 (32K bytes) \$2,000 (8K bytes) September 1974 300-400
<b>COMMENTS</b>	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		8200 simulates a Century 101 computer and can execute all non-time-dependent software for the 101

### Minicomputer Specifications

MANUFACTURER & MODEL	NCR 8230	NCR 8250	Olivetti A5	Olivetti A6	Olivetti A7
<b>DATA FORMATS</b>					
Word length, bits	16 + 2	16 + 2	64	64	8 + 1
Fixed-point operand length, bits	16	16	64	64	6
Instruction length, bits	16, 32, 48	16, 32, 48	16	16	16, 32
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	MOS	MOS	MOS
Cycle time, microseconds/word	0.8	0.8	1.5	1.5	0.9
Access time, microseconds/word	—	—	—	—	0.8
Minimum capacity, words	48K bytes	48K bytes	512	2K	16K
Maximum capacity, words	64K bytes	64K bytes	4K	4K	48K
Parity checking	Standard	Standard	No	No	Standard
Error correction	No	No	No	No	No
Storage protection	No	No	No	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	—	—	47	111-485	—
No. of index registers	27 (in memory)	27 (in memory)	0	0	0
No. of directly addressable words	—	—	4K	4K	48K
No. of addressing modes	—	—	—	—	—
Control storage	No	No	ROM; 8-16K x 16 bits	ROM	ROM; 8K x 16 bits
Add time, microseconds	—	—	10	10	6.1
Hardware multiply/divide	Standard	Standard	No	No	No
Hardware floating point	No	No	No	No	No
Hardware byte manipulation	Standard	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	833K	833K	1M	1M	650K
No. of external interrupt levels	8	8	None	None	None
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	1.8M bytes	5M bytes	No	1.2M	512K
Disk pack/cartridge drives	—	Cartridge; 9.8-2.5M bytes	No	No	Cartridge; 10-40M bytes
Drum/fixed-head disk storage	No	No	No	No	Fixed-head; 160K bytes
Magnetic tape cassettes/cartridges	Cassette; 450K bytes	Cassette; 450K bytes	Cassette; 1 KBS	Cassette; 1 KBS	Cassette; 1 KBS
Magnetic tape, 1/2-inch	10-20 KBS	10-20 KBS	No	No	No
Punched card input	300 cpm	300 cpm	No	No	400 cpm
Serial printer	173 cps	173 cps	16 cps	16 cps	40-175 cps
Line printer	100-300 lpm	100-300 lpm	60 lpm	60, 300 lpm	300, 600 lpm
Data communications interface	1200, 9600 bps	1200, 9600 bps	4800 bps; synch.	4800 bps; synch.	9600 bps; synch.
CRT	80 char. x 24 lines	80 char. x 24 lines	No	No	No; see Comments
Other standard peripheral units	—	—	Paper tape units, mag. ledger card reader	Paper tape units, mag. ledger card reader	Paper tape units, mag. punch, mag. ledger card reader
<b>SOFTWARE</b>					
Assembler	No	No	Yes	Yes	Assembler & macro assembler
Compilers	NEAT/3, COBOL	NEAT/3, COBOL	APCO	APCO	RPG, PL/1
Operating system	Batch, multipro- gramming	Batch, multipro- gramming	Batch (one pro- gram)	Batch (one pro- gram)	Batch (two pro- grams)
Language implemented in firmware	No	No	Fully	Fully	Fully
Operating system implemented in firmware	No	No	Fully	Partially	Partially
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel and min. mem. in chassis	\$28,600	\$42,250	\$4,900 (512 bytes)	\$8,820 (4K bytes)	\$12,935 (16K bytes)
Price of memory increment	—	—	\$600 (1K bytes)	—	\$1,200 (8K bytes)
Date of first delivery	June 1977	March 1977	February 1975	January 1976	March 1975
Number installed to date	NA	NA	NA	NA	NA
<b>COMMENTS</b>			Asynch. communi- cations speed is 1200 bps; integral but optional mag. ledger unit allows mag. cards to be used for program storage	Asynch. communi- cations speed is 1200 bps; integral but optional mag. ledger unit allows mag. cards to be used for program storage	Asynch. communi- cations speed is 1200 bps; A7 includes integral 16-character numeric display

## Minicomputer Specifications

MANUFACTURER & MODEL	Olivetti P 6060	Philips P300	Phillips P330	Philips P350	Prime 100
<b>DATA FORMATS</b>					
Word length, bits	32	8	8	64	16
Fixed-point operand length, bits	—	Variable	Variable	64	16, 32
Instruction length, bits	—	8, 56	1-8	64	16, 32
<b>MAIN STORAGE</b>					
Storage type	MOS	Core	Core	Core	MOS
Cycle time, microseconds/word	0.562	1.5	1.5	1.5	1.0
Access time, microseconds/word	0.700	0.6	0.6	0.6	0.680
Minimum capacity, words	16K bytes	8K bytes	24K bytes	600	16K bytes
Maximum capacity, words	48K bytes	16K bytes	32K bytes	1200	128K bytes
Parity checking	—	No	No	No	No
Error correction	—	No	No	No	No
Storage protection	—	No	Standard	No	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	—	8	16	Software-assigned	1
No. of index registers	—	8	8	0	1
No. of directly addressable words	—	—	16	1200	64K
No. of addressing modes	—	—	3	—	4
Control storage	—	ROM; 64K x 8 bits	ROM; 64K bits	No	No
Add time, microseconds	—	—	1.2	1.5	2.44
Hardware multiply/divide	—	No	No	Standard	Optional
Hardware floating point	—	No	No	No	No
Hardware byte manipulation	—	Standard	Standard	—	Standard
Battery backup	No	No	No	No	Optional
Real-time clock or timer	No	No	No	No	Optional
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Optional	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	300K	—	—	—	694K
No. of external interrupt levels	—	None	None	None	64
<b>PERIPHERAL EQUIPMENT</b>					
Floppy disk (diskette) drives	256K	0.5M bytes	2M bytes	No	512K-2.0M bytes
Disk pack/cartridge drives	Pending	No	No	Cartridge; 256K-9.2M bytes	Pack & cartridge; 12-2400M bytes
Drum/fixed-head disk storage	Pending	No	No	No	Fixed-head; 512K-1M bytes
Magnetic tape cassettes/cartridges	Cassette; 1 KBS	Cassette; 1 KBS	Cassette; 1 KBS	Cassette; 1 KBS	No
Magnetic tape, 1/2-inch	1600 bpi	No	No	No	To 120 KBS
Punched card input	300 cpm	No	No	280 cpm	285 cpm
Serial printer	120, 175, 300 cps	50 cps	80 cps	40 cps	165 cps
Line printer	No	70 lpm	70 lpm	120-600 lpm	To 1220 lpm
Data communications interface	To 19.2K bps	To 9600 bps; synch.	To 9600 bps; synch.	To 9600 bps; synch.	To 56K bps
CRT	No	No	80 char. x 24 lines	No	80 char. x 24 lines
Other standard peripheral units	Paper tape reader, paper tape punch, I/O typewriter	Paper tape punch, card punch, mag. ledger card reader		Paper tape units, card punch, mag. ledger card reader	Paper tape, A/D and D/A conv., card reader/punch
<b>SOFTWARE</b>					
Assembler	No	Yes	Yes	Yes	Macro assembler
Compilers	BASIC	—	PHOCAL	—	BASIC, FORTRAN
Operating system	Real-time	Transaction	Transaction	Batch (one program)	Batch, real-time, multi-user
Language implemented in firmware	Partially	Partially	Partially	No	Partially
Operating system implemented in firmware	Partially	Partially	Partially	No	Partially
<b>PRICING &amp; AVAILABILITY</b>					
Price of CPU, power supply, front panel and min. mem. in chassis	\$8,950	\$7,500 (8K bytes)	\$23,990 (24K bytes)	\$15,500 (600 words)	\$5,500 (16K bytes)
Price of memory increment	\$850 (8K bytes)	\$1,200 (8K bytes)	\$1,500 (8K bytes)	\$8,500 (400 words)	\$3,400 (16K bytes)
Date of first delivery	January 1977	June 1975	July 1977	June 1970	June 1973
Number installed to date	NA	1150	150	2000	650
<b>COMMENTS</b>	Desktop computer features integrated 80-cps/80-col. thermal printer, dual floppy disk drives, display, 16K user memory, and full typewriter keyboard with BASIC keywords and operating system commands	Asynch. communications speed to 2400 bps	Transaction-oriented business computer with strong emphasis on packaged application software	Asynch. communications speed to 2400 bps	

### Minicomputer Specifications

MANUFACTURER & MODEL	Prime 200	Prime 300	Prime 400	Prime 500	Qantel 900, 950
<b>DATA FORMATS</b>					
Word length, bits	16 + 2	16 + 2	16 + 2 or + 6	16 + 2 or + 6	8
Fixed-point operand length, bits	16, 32	16, 32	16, 32	16, 32	—
Instruction length, bits	16, 32	16, 32	16, 32, 48	16, 32, 48	24-48
<b>MAIN STORAGE</b>					
Storage type	MOS	MOS	MOS; bipolar cache	MOS; bipolar cache	MOS
Cycle time, microseconds/word	0.750	0.750	0.760	0.760	1.5
Access time, microseconds/word	0.600	0.600	0.600	0.600	—
Minimum capacity, words	16K bytes	16K bytes	128K bytes	256K bytes	32K
Maximum capacity, words	128K bytes	128K bytes	8M bytes	8M bytes	64K
Parity checking	Standard	Standard	Standard	Standard	No
Error correction	No	No	Optional	Standard	No
Storage protection	No	Std., 3 levels	Std.; 3 levels	Std.; 3 levels	No
<b>CENTRAL PROCESSOR</b>					
No. of accumulators	1	1	1 (32-bit)	1 (32-bit)	17 in memory
No. of index registers	1	1	2 (32-bit)	2 (32-bit)	—
No. of directly addressable words	64K	64K	64K	64K	32K
No. of addressing modes	4	4	4	4	—
Control storage	No	PROM; 512 x 64 bits	PROM; 2K x 64 bits	PROM; 2K x 64 bits	ROM
Add time, microseconds	1.96	1.56	0.56	0.56	—
Hardware multiply/divide	Optional	Standard	Standard	Standard	No
Hardware floating point	Optional	Standard	Standard	Standard	No
Hardware byte manipulation	Standard	Standard	Standard	Standard	Standard
Battery backup	Optional	Optional	No	No	No
Real-time clock or timer	Optional	Optional	Standard	Standard	Optional
<b>INPUT/OUTPUT CONTROL</b>					
Direct memory access channel	Standard	Standard	Standard	Standard	Standard
Maximum I/O rate, words/sec	1.0M	1.137M	1.25M	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	512-2.0M bytes	No
Disk pack/cartridge drives	Pack & cartridge; 12-2400M bytes	Pack & cartridge; 12-2400M bytes	Pack & cartridge; 2.9-1200M bytes	Pack & cartridge; 12-2400M bytes	Cartridge; 6-36M bytes
Drum/fixed-head disk storage	Fixed-head; 512K-1M bytes	Fixed-head; 512K-1M bytes	Fixed-head; 512K-1M bytes	Fixed-head; 512K-1M bytes	No
Magnetic tape cassettes/cartridges	No	No	No	No	No
Magnetic tape, 1/2-inch	To 120 KBS	To 120 KBS	To 120 KBS	To 120 KBS	36-72 KBS
Punched card input	285 cpm	285 cpm	285 cpm	285 cpm	500 cpm
Serial printer	165 cps	165 cps	165 cps	165 cps	165 cps
Line printer	To 1220 lpm	To 1220 lpm	To 1220 lpm	To 1220 lpm	300-600 lpm
Data communications interface	To 56K bps	To 56K bps	To 56K bps	To 56K bps	38-50K bps
CRT	80 char. x 24 lines	80 char. x 24 lines	80 char. x 24 lines	80 char. x 24 lines	64 char. x 27 lines
Other standard peripheral units	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 and micro assemblers	Macro and micro assemblers	Macro and micro assemblers	Yes
Compilers	BASIC, FORTRAN	BASIC, FORTRAN, COBOL, RPG II	BASIC, FORTRAN, RPG II, COBOL, FORMS	BASIC, FORTRAN, RPG, COBOL, FORMS	QIC (BASIC)
Operating system	Batch, real-time, multi-user	Real-time, multi-user, virtual mem.	Real-time, multi-user, virtual mem.	Real-time, multi-user, virtual memory	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	\$6,800 (16K bytes)	\$17,600 (16K bytes)	\$65,100 (128K bytes)	\$125,500 (256K bytes)	\$27,900 (system price)
Price of memory increment	\$3,900 (16K bytes)	\$8,500 (64K bytes)	\$8,500 (64K bytes)	\$30,000 (256K bytes)	\$1,950 (8K bytes)
Date of first delivery	November 1972	September 1973	March 1976	March 1976	1st qtr. 1977
Number installed to date	300	450	250	10	NA
<b>COMMENTS</b>		Virtual memory management system permits addressing up to 128K bytes per user	Virtual memory management system permits addressing up to 512M bytes per user; 2K-byte cache memory std.; 2 to 1 memory interleaving std.	Virtual memory management system permits addressing up to 512M bytes per user; 2K-byte cache memory std.; 2 to 1 memory interleaving std.	Basic system price includes CRT, 6MB disk, serial printer, 32K memory

## Minicomputer Specifications

MANUFACTURER & MODEL	Qantel 1400	Qantel 1400-2	Randal Link 100	Randal Link 200	Randal Link 500
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8 — 24-48	8 — 24-48	16 Variable 16, 32, 48	16 Variable 16, 32, 48	16 Variable 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 1.1 — 40K 128K No No No	MOS 1.1 — 48K 128K No No No	MOS 0.3 0.3 16K 32K No No	MOS 0.3 0.3 16K bytes 32K bytes No No	MOS 0.3 0.3 16K 64K 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	6 + 17 in memory — 64K — ROM — No No Standard No Optional	6 + 17 in memory — 64K — ROM — No No Standard No Optional	4 2 512 4 ROM; 256 x 64 bits 1.2 No No No No Standard	4 2 512 4 ROM; 256 x 64 bits 1.2 No No No No Standard	4 2 512 4 ROM; 256 x 64 bits 1.2 No No No No Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 909K 2	Standard 909K 2	Standard 800K 1	Standard 800K 1	Standard 800K 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	No Cartridge; 12-600M bytes No No 36-72 KBS 500 cpm 165 cps 300-600 lpm 38-50K bps 64 char. x 27 lines Paper tape reader	No Cartridge; 12-600M bytes No No 36-72 KBS 500 cpm 165 cps 300-600 lpm 38-50K bps 64 char. x 27 lines Paper tape reader	4K-2.4M bytes Cartridge; 4M-40M bytes No No 10-72 KBS 450 cpm 30-180 cps 300 lpm 9600 bps 84 char. x 24 lines —	400K-6M bytes Cartridge; 10-40M bytes No No 10-72 KBS 450 cpm 30-180 cps 300 lpm Up to 9600 bps 80 char. x 12 lines —	4K-2.4M bytes Cartridge; 4M-40M bytes No No 10-72 KBS 450 cpm 30-180 cps 300 lpm 9600 bps 84 char. x 24 lines —
<b>SOFTWARE</b> Assembler Compilers Operating system Language implemented in firmware Operating system implemented in firmware	Yes QIC (BASIC) Time-sharing Partially Partially	Yes QIC (BASIC) Time-sharing Partially Partially	No No Time-sharing No No	No No Time-sharing No No	No No 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	\$43,900 (system price) \$1,950 (8K bytes) 2nd qtr. 1977 NA	\$64,900 (system price) \$1,950 (8K bytes) 2nd qtr. 1977 NA	\$12,750 \$1,900 (16K bytes) October 1975 225	\$12,750 (16K bytes) \$1,900 (16K bytes) August 1976 225	\$45,900 \$2,950 (32K bytes) October 1977 3
<b>COMMENTS</b>	Basic system price includes 40K memory, 12MB disk, CRT, 300-lpm printer	Basic system price includes 48K memory, 25MB disk, 2 CRT's, 300-lpm printer, 1600-bpi mag. tape drive	Sold as packaged business system only; includes hard- copy terminal and 630K-byte diskette drive	Available only in packaged business system; price also includes CRT and 10-megabyte disk drive	Sold as packaged business system only; includes 180- cps printer, CRT, 50M-byte disk drive, and 1.2M-byte floppy drive

### Minicomputer Specifications

MANUFACTURER & MODEL	Raytheon PTS-1200	Raytheon RDS-500	RoIm 1602A (AN/UJK-19)	RoIm 1603A (AN/UJK-12)	RoIm 1664 (AN/UJK-28)
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 8, 16, 24 16, 32	16 + 2 16 16, 32	16 16, 32 16, 32	16 16 16, 32	16 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 1.28 0.80 24K 64K No No No	Core or MOS 0.70; 0.90 0.450 16K 64K Standard Standard Optional	Core 1.0 0.5 16K 64K No No No	Core 1.2 0.6 16K 32K No No No	Core 1.0 0.5 16K 64K No 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 2 32K 10 No  2.8 No No Standard No Standard	1 1 64K 2 No  1.4 Standard Optional Standard No Optional	4 2 64K 5 ROM; 1K x 56 bits 1.0 Standard Optional Standard No Optional	4 2 32K 4 —  5.9 Optional No Standard No Optional	12 2 64K 6 ROM; 4K x 32 bits 1.0 Standard 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 125 KBS 16	Standard 2.86M 16	Standard 666K 16	Standard 768K 16	Standard 1M 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	No Pack & cartridge; 2.5-320M bytes No  Cassette; 600 cps  Yes 300 cpm 30-165 cps 300-600 lpm To 9600 bps 80 char. x 24 lines —	No Cartridge & pack; 2.5-920M bytes Fixed-head; 770K-25.2M bytes Cassette  30-120 KBS 300, 1000 cpm 10-165 cps 300-1250 lpm To 19.2K bps 80 char. x 24 lines Apollo Array Processor, plot- ters, A/D and D/A converters	Yes 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 con- verters	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 con- verters	Yes 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 con- verters
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Yes  MACROL  Multiprogram- ming, batch, R.T. No Partially	Macro assembler  FORTRAN, COBOL  Batch, real-time, multiprogramming No No	Assembler & macro assembler ALGOL, BASIC, FORTRAN  Batch, real-time  No No	Assembler & macro assembler ALGOL, BASIC, FORTRAN  Batch, real-time  No No	Assembler & macro assembler ALGOL, BASIC, FORTRAN  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	\$30,580 (48K bytes) \$750-\$3,000  November 1974 300	\$15,800 (32K bytes) \$3,750 (16K bytes)  February 1973 Over 400	\$25,250 (16K words) \$7,000 (16K words)  1977 NA	\$13,400 (16K words) \$6,000 (16K words)  1976 60	\$39,450 (16K words) \$1,000 (16K words)  1976 85
<b>COMMENTS</b>	Display-oriented system for up to 12 Raytheon PTS-100 programmable terminals; 3270/2780/3780/HASP support	Apollo Array Processor can perform 22 specialized array operations	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; com-compatible with DG Nova	Designed to meet Mil-E-5400 & Mil-E-16400 specif. ATR chassis; tri-processor militarized computer, upward-compatible with other RoIm computers



## Minicomputer Specifications

MANUFACTURER & MODEL	RoIm 1650 (AN/UJK-19)	Systems Engineering Laboratories 32/35	Systems Engineering Laboratories 32/55	Systems Engineering Laboratories 32/75	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 16, 32 16, 32	32 + 4 16, 32 16, 32	32 + 4 16, 32 16, 32	16 + 1 8, 16, 32, 64 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 256K Standard No Standard	Core 0.6/0.9 0.3/0.45 32K 4M 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 4 PROM; 2K x 48 bits  1.8 Standard Standard Standard No Standard	8 3 128K 4 PROM; 4K x 48 bits  1.2 Standard Standard Standard No Standard	8 3 128K 4 ROM  1.2/1.8 Standard Standard Standard No Standard	8 3 1K — —  0.50 Standard 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 666K 16	Standard 6.67M 6-112	Standard 6.67M 6-112	Standard 6.7M 6-112	Standard 1.25M —
<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; 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; 5-1200M bytes Fixed-head; 1-8M bytes No  72-120 KBS 300-1000 cpm No 125-600 lpm 50K bps; synch. 80 char. x 24 lines Card punch, TTY, A/D, D/A equip.	No Pack & cartridge; 5-1200M bytes Fixed-head; 1-8M bytes No  72-120 KBS 300-1000 cpm No 125-600 lpm 50K bps; synch. 80 char. x 24 lines Card punch, TTY, A/D, D/A equip.	No Pack & cartridge; 5-1200M bytes Fixed-head; 1-8M bytes No  72-120 KBS 400-1000 cpm No 125-600 lpm 50K bps; synch. 80 char. x 24 lines Paper tape equip.	No Cartridge & pack; 10-160M bytes No No  36-72 KBS 600 cpm No 300-1500 lpm 50-56K bps 80 char. x 24 lines —
<b>SOFTWARE</b> Assembler Compilers  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 FORTRAN IV, BASIC, COBOL  Real-time  No No	Assembler & macro assembler FORTRAN IV, BASIC, COBOL  Real-time  No No	Assembler & macro assembler BASIC, FORTRAN, COBOL  Real-time  No No	Assembler & macro assembler COBOL, TAL, FORTRAN  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	\$23,000 (16K words) \$7,000 (16K words) August 1976 10	\$27,300 (8K words) \$6,300 (8K words) October 1975 250	\$68,000 (32K words) \$7,000 (16K words) January 1978 —	\$20,400 (32K words) \$8,000 (32K words) May 1976 NA
<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	600 and 800-nanosecond memory; minimum configuration is CPU with 32K words of memory, real-time clock, control panel, power supplies, cabinet, chassis, tie controller	Multiprocessor systems containing from 2 to 16 CPU's for failure resistance; all system components are dual-ported, and CPU's have dual buses

### Minicomputer Specifications

MANUFACTURER & MODEL	Tandem T16/1403	Tektronix 4051	Texas Instruments 960B	Texas Instruments 980B	Texas Instruments 990/4
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	16 + 6 8, 16, 32, 64 16	8-bit byte 8 8, 16, 24	16 + 6 8, 16 32	16 + 6 8, 16 16, 32, 48	16 + 1 8, 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	MOS 0.50 0.50 32K 256K No Standard Standard	MOS 1.2 0.45 8K bytes 32K bytes No No No	MOS 0.75 — 8K 64K No Standard Standard	MOS 0.75 — 8K 64K No Standard Standard	MOS 0.65 — 1K 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	8 3 1K — —  0.50 Standard No Standard Standard Standard	2 1 32K 7 ROM; 36K-156K bytes 2.0 No No Standard Optional Optional	16 16 64K 15 ROM; 256 x 16 bits  3.6 Optional No No Optional Optional	2 1 64K 15 ROM; 256 x 16 bits  1.75 Standard No Standard Optional Optional	Unlimited (memory) Unlimited (memory) 64K 8 ROM  4.7 Standard No Standard — Standard
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 2M —	Optional 3.5K No	Standard 1.3M 3-2048	Standard 1M 4-32	No 1.5M 8-2048
<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; 10-160M bytes  No  No  36-72 KBS 600 cpm No 300-1500 lpm 50-56K bps 80 char. x 24 lines —	No No  No  Cartridge  No No 180 cps No 110-2400 bps asyn. 72 char. x 35 lines Plotter, CRT hard- copy device	No Cartridge & pack; 2.28-392M bytes No  Cassette; 120 cps  30 KBS 300 cpm 30-330 cps No 110-9600 bps 80 char. x 24 lines Process control inter- faces, A/D & D/A converters	No Cartridge & pack; 2.28-392M bytes No  Cassette; 120 cps  30 KBS 300 cpm 30-330 cps No 110-9600 bps 80 char. x 24 lines Paper tape units	242-968K bytes No  No  Cassette; 120 cps  No 400 cpm 30-150 cps 300-600 lpm 75-9600 bps 80 char. x 24 lines PROM programmer
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler COBOL, TAL, FORTRAN  Virtual mem., multi- prog., multiprog. Partially Partially	No  BASIC  Batch  Fully Fully	Assembler & macro preprocessor FORTRAN  Single-user, real-time, multiprogramming No No	Assembler & macro preprocessor FORTRAN, BASIC  Singer-user, multi- programming No No	Yes  FORTRAN  Real-time, multi-task  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	\$22,000 (32K words) \$7,500 (32K words)  May 1976 NA	\$6,995 (8K bytes) \$2,390 (8K bytes)  December 1975 NA	\$4,500 (8K words) \$1,400 (8K words)  May 1974 NA	\$5,150 (8K words) \$1,400 (8K words)  May 1974 NA	\$1,525 (256 words) \$625 (4K words)  March 1976 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; specifica- tions are transparent to user since all programming is in BASIC	Heavily supported for process control appli- cations		Based on TI's TMS9900 16-bit microprocessor

## Minicomputer Specifications

MANUFACTURER & MODEL	Texas Instruments 990/10	Univac 9200 & 9300	Univac 90/25	Univac 90/30	Univac BC/7
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	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	8-bit byte 1-32 16, 32, 48	8 8 8, 16, 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	MOS 0.65 — 8K 1024K Optional Optional Optional	Plated wire 1.2; 0.6 — 8K bytes 32K bytes Standard No No	MOS 0.65 — 64K bytes 128K bytes Standard No Optional	MOS 0.6 (2-byte fetch) — 32K bytes 524K bytes Standard No Optional	MOS 1.0 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	Unlimited (memory) Unlimited (memory) 64K 8 No  3.6 Standard No Standard — Standard	8 8 — — No  40.8; 20.4 (16 bits) See Comments No Standard No No	16 16 — — ROM; 1K x 32 bits  7.8 (32 bits) Standard Optional Standard No Standard	16 16 — — ROM; 1K x 82 bits  5.4 (32 bits) Standard Optional Standard No Standard	1 6 64K bytes 3 —  106 (5 digits) — — Standard No No
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 4M 16-2048	Optional 312K —	Standard 760K bytes 6	Standard 1.8M 6	Standard 600K bytes —
<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	242-968K bytes Cartridge; 3-200M bytes No  Cassette; 120 cps  30-60 KBS 400 cpm 30-150 cps 300-600 lpm 75-9600 bps 80 char. x 24 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	972K Pack, cartridge; 33-66M bytes No No  40 KBS 300 cpm 30 cps 300-500 lpm 50K bps 64 char. x 16 lines Paper tape, card punch	972K bytes Pack; 33M-1600M bytes No No  20-320 KBS 300, 600, 1000 cpm 30 cps 300-2000 lpm To 50K bps 64 char. x 16 lines Paper tape reader/ punch, card punch, optical scanner	2M bytes Cartridge; 40M bytes No No  20, 40 KBS No 200 cps 125-250 lpm 9600 bps 80 char. x 24 lines Punched card reader
<b>SOFTWARE</b> Assembler  Compilers  Operating system  Language implemented in firmware Operating system implemented in firmware	Assembler & macro assembler FORTRAN, BASIC, COBOL  Real-time, multi-task No No	Yes COBOL, FORTRAN, RPG  Batch, real-time, timesharing No No	Assembler & macro assembler COBOL, FORTRAN, RPG II, BASIC  Batch, real-time No Partially	Yes COBOL, FORTRAN, RPG II, BASIC  Batch, real-time, time-sharing No Partially	No RPG II  Interactive 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	\$2,595 (8K words) \$1,000 (8K words); \$1,950 (8K ERCC) March 1976 NA	\$34,176 (8K-9200) \$57,120 (8K-9300) \$13,008 (4K-9200) \$15,120 (4K-9300) 3rd quarter 1966 NA	\$66,096 \$14,256 (32K bytes) July 1977 —	\$70,632 (32K bytes) \$6,048 (16K bytes) 1st quarter 1975 NA	\$17,283 \$1,100 (16K bytes) April 1977 —
<b>COMMENTS</b>	MSI implementation of 990/4 CPU with enhancements; can have up to 16 disk controllers per CPU	Multiply & divide are optional on 9200 & 9300 card system, and standard on all others; no longer being manufactured	Smallest member of Univac Series 90 family	System price also includes integrated peripheral channel, interval timers, CRT/keyboard, and Univac 9200/9300 & IBM 360/20 compatibility; see Report 70C-877-04 for more details	System price includes CRT workstation, dual diskette drives, and I/O controllers

### Minicomputer Specifications

MANUFACTURER & MODEL	Varian V73	Varian V75	Varian V76	Varian V77	Wang PCS-II
<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	16 16 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 0.66 0.56 8K 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	1 8 2048 8 WCS; 256 x 16 bits  0.74-2.31 Standard Optional Standard Optional Standard	NA NA — ROM; 425K bytes  800 Standard Standard Standard Optional Optional
<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	Standard 1.51M 8	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	1080K words 515.6M words  Fixed-head; 246K words No  20, 30 KBS 300 cpm 165 cps 300-600 lpm 9600 bps 80 char. x 24 lines Paper tape units, plotters	89-178K bytes No  No Cassette; 326 bps  No 300 cpm 200 cps 600 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	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	\$4,000 \$1,350 December 1976 NA	\$6,200 (8K bytes) \$1,700 (8K bytes); March 1977 NA
<b>COMMENTS</b>	Dual-ported memories; odd/even interleaving for core memories standard; TOTAL data base management system available; Varian Data Systems is now part of Sperry Univac	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	Varian Data Systems is now part of Sperry Univac	Portable computer weighing 62 lbs.

## Minicomputer Specifications

MANUFACTURER & MODEL	Wang 2200 VP	Wang 2200T	Warrex Centurion I-A	Warrex Centurion II	Warrex Centurion IIA
<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 + 2 8, 16 4, 8, 12	8 + 1 8, 16 8, 16, 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	MOS 0.6 — 16K bytes 64K bytes No No No	MOS 1.6 — 4K bytes 32K bytes No No No	MOS 0.8 — 32K 60K Optional No No	MOS 0.8 — 16K 16K Optional No No	MOS 0.8 — 32K 60K Optional 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	— — — — ROM; 48K words .13 Standard Standard Standard No Optional	32; not user-access. 32; not user-access. — — ROM; 42.5K words 800 Standard Standard Standard No No	128 16 256 7 No 3.6 (16 bits) No No Standard No Standard	128 8 256 7 No — No No Standard No Standard	128 16 256 7 No 3.6 (16 bits) No 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 100K None	No 10K None	Standard 600K 16	Standard 600K 16	Standard 600K 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	262-786K bytes Cartridge; 1.5-20M bytes No Cassette; 326 bps 10 KBS 300 cpm 200 cps 600 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	Standard No No No No No 175 cps 125-600 lpm Optional 80 char. x 24 lines None	No Cartridge; 41.6M bytes No Cassette; 200 cps No 300 cpm 175 cps 125-600 lpm Optional 80 char. x 24 lines Paper tape reader	Standard Pack; 10.4-41.6M bytes No No No 175 cps 125-600 lpm Optional 80 char. x 24 lines None
<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 None Multi-tasking No No	Yes BASIC, FORTRAN Multi-tasking No No	Yes None Multi-tasking 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	\$9,000 (16K bytes) \$3,000 (16K bytes) November 1977 NA	\$4,000 (4K bytes) \$2,000 (8K bytes) February 1975 NA	\$20,000 \$1,250 NA NA	\$26,950 \$1,250 1975 NA	\$30,000 \$1,250 NA NA
<b>COMMENTS</b>		Also available in packaged systems WCS-20 & WCS-30			

### Minicomputer Specifications

MANUFACTURER & MODEL	Warrex Centurion III	Warrex Centurion IV	Warrex Centurion VI	Westinghouse 2500
<b>DATA FORMATS</b> Word length, bits Fixed-point operand length, bits Instruction length, bits	8 + 1 8, 16 8, 16, 24	8 + 1 8, 16 8, 16, 24	8 + 1 4, 8 4, 8, 16	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 0.8 — 32K 60K Optional No No	MOS 0.800 — 20K 256K Optional No No	MOS 0.6 — 32K 252K Optional Standard 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	128 16 256 7 No  3.6 (16 bits) No No Standard No Standard	128 96 256 7 No  — No No Standard No Standard	128 16 256 7 No  2.2 No No Standard No Standard	1 2 256 14 PROM; 1K words  1.7 Standard Standard No No Optional
<b>INPUT/OUTPUT CONTROL</b> Direct memory access channel Maximum I/O rate, words/sec No. of external interrupt levels	Standard 600K 16	Standard 600K 16	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	Optional Cartridge; 10.4-41.6M bytes No  No No 300 cpm 175 cps 125-600 lpm Optional 80 char. x 24 lines None	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	Optional Cartridge; 10.4-77.6M bytes No  No No 300 cpm Optional 125-600 lpm Optional 80 char. x 24 lines None	250-1000K bytes Pack & cartridge; 2.4-67M bytes Fixed-head; 128K-2M bytes  No 20-40 KBS 300, 600 cpm 10, 30 cps 300, 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	Yes  None  Multi-tasking  No No	Yes  FORTRAN, BASIC, CPL1, CPL2  Multi-tasking  No No	Yes  No  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	\$40,000 \$1,250 NA NA	\$26,950 (20K bytes) \$1,250 (4K bytes) 1970 150 (all models)	— — 1st qtr. 1978 NA	\$14,700 (32K words) \$3,500 (8K words); \$8,000 (32K words) June 1971 625
<b>COMMENTS</b>		Available only in pack- aged 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 com- munications speeds to 1800 bps