IBM 5110 Computing System

MANAGEMENT SUMMARY

IBM introduced the 5110 Computing System in January 1978 as the "big brother" and eventual successor to the 5100 Portable Computer, IBM's first desk-top computer. The 5110 featured two to three times the internal computing power of the 5100, as well as diskette storage instead of or in addition to the 5100's cartridge tape.

The 5110, in turn, lost its place in the sun on February 5, 1980, when IBM unveiled the 5120 Computing System (Report M11-491-201). The 5120 is, in effect, a repackaged and lower-priced 5110 that features integrated dual diskette drives, a larger display screen, and a price tag approximately $3,000 lower than a similarly configured 5110 system.

In case anyone doubted that the 5120 would effectively supersede the 5110, IBM clarified the situation by simultaneously changing the 5110's production status from "new" to "limited new," which means that the company will no longer commit a new machine to a specific order. IBM also announced a 33 percent reduction in the price of incremental main memory for 5110 computers with more than the basic 16K bytes. As a result, the price of the costliest 5110 processor, the 64K Model C14, fell from $13,380 to $12,210.

The 5110, like the newer 5120, is suitable for a wide range of commercial and problem-solving applications in both small and large organizations. For small businesses, the system can be programmed in BASIC to handle the typical ▷

> IBM's desk-top computer can be programmed to handle a wide range of low-volume commercial and scientific applications. The 24 models of the 5110 are differentiated by their storage media (cartridge tape or diskette), main memory capacities (16K to 64K bytes), and programming languages (BASIC and/or APL). Purchase prices begin at $8,195.

CHARACTERISTICS

MANUFACTURER: IBM Corporation, General Systems Division, 4111 Northside Parkway N.W., P.O. Box 2150, Atlanta, Georgia 30342.

MODELS: 5110 Model 1 (tape/diskette) and Model 2 (diskette only).

DATE ANNOUNCED: January 1978.

DATE OF FIRST DELIVERY: February 1978.

DATA FORMATS

All access to the 5110 is through the BASIC or APL programming language, implemented in read-only memory. In general, these languages provide specific facilities for numeric integers, floating-point numeric values, numeric arrays, and alphanumeric strings. Internal data representation is binary floating-point. Instruction formats are, in effect, the BASIC or APL statements themselves. ▶
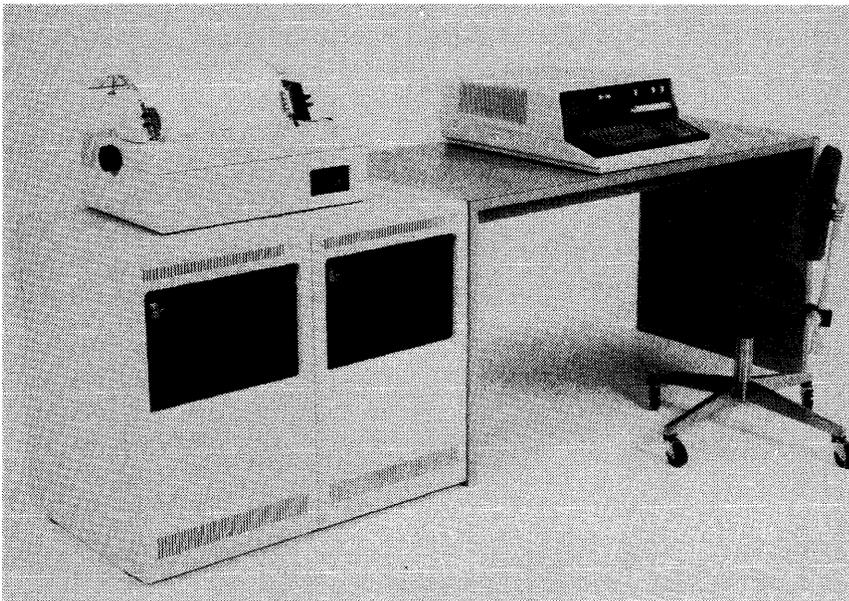
The 5110 Computing System shown includes the maximum complement of two 5114 Diskette Units, each housing two diskette drives. Each diskette can store up to 1.2 million characters of information, for a total on-line storage capacity of 4.8 million bytes. The keyboard/display houses the CPU with 16K, 32K, 48K, or 64K bytes of main memory and an optional magnetic tape cartridge unit. Two character printers are available with speeds of 80 and 120 cps, and both have upper and lower case capability.

REFERENCE EDITION: This is a mature product line and no significant further developments are anticipated. Because of its importance, coverage is being continued, but no future update is planned.

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▷commercial applications such as payroll, accounts receivable, and general ledger. In larger companies, the 5110 can serve both as a local data processing or problem-solving system and as a communications terminal linked to a larger host computer. In organizations of all sizes, the 5110's ease of use and interactive APL language implementation make it an effective "personal" computer for the problem-solving requirements of engineers, scientists, actuaries, financial analysts, and other professionals.

The basic 5110 Computing System consists of a desk-top unit that houses the central processing unit with 16K, 32K, 48K, or 64K bytes of main memory plus read-only storage for the language processor, a typewriter-like keyboard with a 10-key calculator pad, and a 1024-character display screen with full screen management and upper and lower case characters.

The 5110 is available in two basic models. Model 1 includes a magnetic tape cartridge drive and can also be equipped with diskette storage. It can store up to 204K bytes per tape cartridge or 1.2 million bytes on a single diskette. Model 2 allows diskette storage only. Up to two 5114 Diskette Units, each housing a maximum of two diskette drives, can be attached to either model of the 5110 for a maximum capacity of 4.8 million bytes of diskette storage. The diskette units can be used in a sequential or direct access mode. When data is written in the standard interchange mode, the diskettes also provide a means of exchanging data with other IBM systems, including the 3741, System/32, System/34, and Series/1. A diskette sort feature is available as an option.

Each of the two basic models of the 5110 is available in 12 submodels, offering the buyer a choice of 16K, 32K, 48K, or 64K bytes of main memory in conjunction with the BASIC Language Interpreter, the APL Language Interpreter, or both.

Optional input/output devices include the IBM 5106 Auxiliary Tape Unit, for 5110 Model 1 users desiring additional tape capacity, and two models of the IBM 5103 Printer. The 5103 Models 11 and 12 are bidirectional printers capable of printing 80 and 120 characters per second, respectively, in upper and lower case.

An optional Serial I/O feature permits connecting a wide range of peripheral devices available from sources other than IBM. The 5110 also offers an optional Parallel I/O adapter which provides the capability to attach up to 14 IEEE 488-1975 compatible devices such as laboratory instruments, plotters, and printers.

The 5110 offers a choice of asynchronous and/or bisynchronous communications adapters. The bisynchronous capability permits emulation of either an IBM 3741 or 2770 at speeds up to 4800 bps. In asynchronous mode, the 5110 emulates a 2741 terminal at either 134.5 or 300 bps. ▷

▶ MAIN STORAGE

TYPE: MOSFET (Metal-Oxide Semiconductor Field Effect Transistor).

CYCLE TIME: 530 nanoseconds per two-byte access.

CAPACITY: 16,384, 32,768, 49,152, or 65,536 bytes.

CHECKING: A parity bit is associated wiht each byte.

RESERVED STORAGE: A total of 4,624 bytes of main memory is reserved for the BASIC interpreter in addition to the read-only memory; for APL, a total of 6,915 bytes is reserved.

CENTRAL PROCESSOR

GENERAL: The two general models of the 5110 are distinguished by their storage media. Model 1 offers magnetic tape and optional diskette storage. Model 2 allows diskette storage only. Each model is available in 12 submodels offering a choice of the BASIC and/or APL languages and main memory sizes of 16K, 32K, 48K, or 64K bytes.

The internal structure of the 5110 has not been detailed publicly. It is based on a single-card microprocessor.

The instruction repertoire is effectively that of the BASIC and/or APL languages. These high-level languages permit symbolic addressing of data values, loop control, and program flow structuring, along with procedure-oriented facilities for numeric computations. Alphanumeric strings can be handled for display or printing of table heads, interactive prompting, error or condition displays, etc.

Each 5110 computer includes a 1024-character display and a keyboard. The keyboard keytops are engraved with symbols corresponding to the element of the language implemented in each model. For BASIC models, most of the language statement keywords can be entered with a single key depression in conjunction with the Command key. Also on BASIC models, the accompanying 10-key numeric keypad can be used as function keys, with the meanings defined by user programming. On both BASIC and APL models, the top row of keys carries alternate usage for various system and peripheral functions.

The BASIC and APL interpreters are implemented in read-only memory, or, as IBM refers to it, read-only storage (ROS). ROS is implemented in MOSFET technology for the 5110 with 72K- and 96K-bit chips. Also included in ROS are system control functions and I/O drivers.

The optional Diskette Sort Feature resides in read-only storage and provides for either full-record or record-address sorting of diskette data files. The sorts can be invoked from either BASIC or APL programs, and the sort keys can contain up to six control fields. Control statements can be either stored on diskette or entered from the keyboard in response to prompting messages.

The optional Audible Alarm can be programmed to signal error conditions or job completion.

PHYSICAL SPECIFICATIONS: The 5110 computer occupies a space 8 by 17.5 by 24 inches and weighs between 43 and 50 pounds. It operates on conventional 115-volt, 60-Hertz, 1-phase, grounded AC power.

The optional tape cartridge unit measures 7.25 by 10 by 12.25 inches and weighs 20 pounds. The optional printer weighs 55 pounds and measures 12.25 by 14 by 24 inches. The optional diskette unit measures 17.75 by 22.25 by 29 inches; the single- ▶

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PERIPHERALS

MODEL	DESCRIPTION & SPEED
INTEGRAL WITH 5110 PROCESSOR	
CRT/Keyboard	1024 characters; 16 lines of 64 characters; black on white or reverse, switch-selected; spread-out of left or right 32-char. line half, switch-selected; full screen edit capability; upper and lower case characters displayed
INTEGRAL WITH 5110 MODEL 1	
Magnetic Tape Cartridge Drive	Uses 3M-style tape cartridge containing 300 feet of 0.25-inch tape; data recorded in 512-char. physical blocks with logical records separated by record marks, program interpreted; 40 inches/sec.; 2850 char./sec. read, 950 char./sec. effective write, including write with backspace and read/check
MAGNETIC TAPE	
5106 Model 11	Auxiliary Tape Unit; same specifications as integral unit above; usable only with 5110 Model 1
DISKETTE DRIVES	See "Mass Storage" section of this report
PRINTERS	
5103 Model 11	80-cps Printer; prints serially in both left-to-right and right-to-left directions, using an impact matrix printing technique; prints upper and lower case characters, including all BASIC and APL special characters; 132 print positions; 10 characters/inch; 6 lines/inch; handles multi-part, fan-folded paper from 3½ to 15 inches in width and from 3 to 14 inches in fold-to-fold length; 80 characters/second
5103 Model 12	120-cps Printer; same as above, except speed is 120 characters/second
OTHER DEVICES	
5825	Parallel I/O Adapter; IEEE 488-1975 compatible
6103	Serial I/O Adapter; RS-232 compatible, 20 to 9600 bps
TV Monitor	Multiple CRT monitors can be connected serially; contact IBM for configurational possibilities and prices
Communications Adapters	See "Communications Control" section of this report

▷ Comparing the performance of the 5110 to that of the earlier IBM 5100, the most significant factor is the increased speed of the 5110's diskettes over the 5100's cartridge tape drive. In addition, the 5110 offers two to three times the internal computing power of the 5100, provides the capability to update diskette or tape data files in place, and can turn off its CRT display under program control. When the CRT is off, up to 18 percent of the total CPU processing time becomes available to the user rather than being used to refresh the CRT. Also, during certain jobs, printing on the 5110's IBM 5103 Printer can be performed while calculations are taking place.

The BASIC and APL languages have been significantly extended over their counterparts for the 5100. Here are some highlights of the increased flexibility and power of the 5110 BASIC language:

- The Dimension statement allows the user to enter an array of any size as long as it fits into memory. The user can also specify the number of characters, from 1 to 255, for a character variable.

- Error trapping by the user program can identify most errors, including end of file, I/O, and data conversion errors. ▷

▶ drive version weighs 120 pounds and the dual-drive version weighs 136 pounds.

CONFIGURATION RULES

The 5110 is a desk-top computer that contains a CRT display, keyboard, BASIC and/or APL language interpreter in read-only storage, and 16K, 32K, 48K, or 64K bytes of main memory.

Models A11 through C14 of the 5110 (i.e., the "Model 1's") include a built-in magnetic tape cartridge unit and can also be equipped with a 5106 Auxiliary Tape Cartridge Unit and/or a 5114 Diskette Unit. If the 5106 is not used, a second 5114 can be attached. Each 5114 can contain one or two diskette drives.

Models A21 through C24 of the 5110 (i.e., the "Model 2's") do not include the built-in tape cartridge unit and cannot accept the 5106 Auxiliary Tape Cartridge Unit. These models are designed to use diskette storage, and must be equipped with one or two 5114 Diskette Units, each containing one or two drives.

Any model of the 5110 can be equipped with one 5103 Printer, Model 11 (80 cps) or Model 12 (120 cps). The Channel Terminator feature is required if a 5103 Printer is *not* attached to a 5110 equipped with a 5106 Auxiliary Tape Cartridge Unit and/or a 5114 Diskette Unit.

Any model of the 5110 can also be equipped with a maximum of two of the following features: ▶

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⊳• A new FORM statement can be used in place of an IMAGE statement, adding among other uses the capability to automatically float a dollar sign, insert commas in numbers over 999.99, and convert a six-digit date to the more familiar month, day, year format.

• A new system function enables sorts to be performed in memory.

APL language enhancements for the 5110 include:

• Additional system commands for diskette I/O.

• Multiple-record reads and writes.

• Printer left margin control.

The new IBM 5120 Computing System is program-compatible with and equal in performance to a similarly configured 5110 system. The 5120's principal advantages are its larger display screen, its integrated dual diskette drives, its more compact packaging, and its substantially lower price. As an indication of IBM's future directions for its low-cost computing systems, it should be noted that no cartridge tape equipment is available for the 5120; the new system is offered only in diskette-oriented configurations.

The 5110 ranges in price from $8,195 for a minimum configuration to approximately $30,000 for a fully configured system, thereby extending into the low end of the System/34 price range. Deliveries began in February 1978. Field upgrades are available from the IBM 5100 to the 5110, but a 5110 cannot be field-upgraded to a 5120.

As it did with the 5100, IBM offers the 5110 as a purchase-only machine with an optional Purchase Pilot Test Plan. This plan enables a potential user to rent the system for three months, and the rental period can be extended for another three months.

USER REACTION

Early responses to Datapro's 1980 survey of computer users included questionnaires from four IBM 5110 users, as well as from four users of the older IBM 5100 and two early users of the recently announced IBM 5120.

Three of the 5110 users had been using their systems for periods ranging from 9 to 21 months. The fourth had installed a 5100 in 1975 and field-upgraded it to a 5110. All four were using their systems for business data processing. Specific applications included accounting, payroll/personnel, manufacturing, food service management, and education. All four users had written at least some of their applications programs in-house, while two were also using packaged programs from IBM and one had employed a contract programming firm.

Three of the four 5110 systems were 32K-byte configurations with dual diskette drives and a printer. The fourth was a 64K-byte system with a cartridge tape drive ⊳

➤• Asynchronous Communications Adapter

• Binary Synchronous Communications Adapter

• Serial I/O Adapter

• Parallel I/O Adapter

The optional Serial I/O Adapter provides an RS-232C interface on the 5110 that permits direct connection of any one of a variety of peripheral devices that satisfy the EIA Standard RS-232C specifications. Interaction with the attached device is through customer-supplied APL or BASIC programs, and data can be transferred in 5-, 6-, 7-, or 8-bit code at a speed of 20 to 9600 bits per second (2400 bps maximum for 5-bit code). No IBM software support for specific devices is currently offered. The Expansion Feature is a prerequisite for installation of the Serial I/O Adapter.

The Parallel I/O Adapter provides the capability to attach up to 14 IEEE 488-1975 compatible devices such as laboratory instruments, plotters, and printers to the IBM 5110, with the 5110 acting as the sole controller in the network. The feature is operated directly from the APL or BASIC languages with device-dependent message exchange in either 8-bit binary or 7-bit ASCII code.

The 5110 Computing System can be equipped to operate as a communications terminal by installing the Asynchronous Communications Adapter and/or the Binary Synchronous Communications Adapter, as described in the "Communications Control" section of this report.

MASS STORAGE

5114 DISKETTE UNIT: Contains one or two diskette drives for a maximum storage capacity of 2.4 million bytes. The unit provides a direct-access storage capability, supports multiple open files up to 10, and offers a media exchange capability with other diskette devices. Average access time is 243 milliseconds, including rotational delay but excluding head loading time. Rotational speed is 360 rpm. IBM diskette types 1, 2, and 2D can be initialized and used to READ/WRITE data and to LOAD/SAVE programs and data. Their specifications are as follows:

Diskette Type	Maximum Capacity, Bytes	Data Transfer Rate, Bytes/Second
1	306,000	31,300
2	606,000	31,300
2D	1,212,000	62,500

A maximum of two 5114 Diskette Units with four drives can be attached to any model of the IBM 5110, providing a total on-line storage capacity of up to 4.8 million bytes. Only one 5114, however, can be attached to a 5110 Model 1 if a 5106 Auxiliary Tape Cartridge Unit is also attached.

In addition, the integral and/or auxiliary cartridge tape units can be used to store data and programs in a 5110 Model 12 system (see Peripherals table). The maximum capacity of a tape cartridge is 204K bytes. Data and programs can be indexed for direct retrieval, but the method of access is necessarily sequential rather than random.

INPUT/OUTPUT UNITS

See Peripherals table.

COMMUNICATIONS CONTROL

ASYNCHRONOUS COMMUNICATIONS ADAPTER: Permits the 5110 to communicate with a remote IBM or other ➤

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▷ and printer. All four systems had been purchased from IBM.

The following table shows how the four IBM 5110 users rated their systems and the associated IBM service, support, and software. Also shown are the weighted average ratings assigned by all 10 of the responding IBM 5100 Series users (i.e., four 5100 users and two 5120 users in addition to the four 5110 users).

	Excellent	Good	Fair	Poor	WA* (Four 5110 Users)	WA* (Ten 5100 Series Users)
Ease of operation	3	0	1	0	3.5	3.5
Reliability of mainframe	3	0	1	0	3.5	3.6
Reliability of peripherals	3	1	0	0	3.8	3.8
Maintenance service:						
Responsiveness	2	2	0	0	3.5	3.6
Effectiveness	3	1	0	0	3.8	3.6
Technical support:						
Trouble-shooting	2	0	2	0	3.0	3.0
Education	1	2	0	1	2.8	2.8
Documentation	2	0	0	2	2.5	2.9
Manufacturer's software:						
Operating system	1	1	1	0	3.0	3.2
Compilers & assemblers	2	0	2	0	3.0	3.1
Applications programs	1	1	0	1	2.7	2.8
Ease of programming	3	0	1	0	3.5	3.6
Ease of conversion	2	0	0	0	4.0	3.7
Overall satisfaction	2	1	0	1	3.0	3.3

*Weighted Average user rating on a scale of 4.0 for Excellent.

Although the 5110 earned weighted average user ratings in the good-to-excellent range in most categories, two of the responding users were well pleased with virtually every aspect of the system while the other two were sharply critical. All of the "fair" and "poor" ratings in the table came from these two disenchanted users. The ratings supplied by the IBM 5100 and 5120 users showed considerably less divergence than those of the 5110 users, yet the weighted averge ratings from all 10 of the 5100 Series users fell within 0.1 point of those from the four 5110 users in 9 of the 14 rating categories.

The two dissatisfied 5110 users were particularly displeased with the software and the associated technical support. One criticized the system for "bad price/performance" and lack of expandability, while the other commented that the 5110's "cost is too high compared to others of the same or greater capacity." Predictably, neither of these users would recommend the system to others in their situations, and one plans to replace the 5110 during 1980.

The other two 5110 users were thoroughly pleased with their systems. One rated the 5110 "excellent" in all 14 categories and had only one specific comment: "No complaint—perfectly satisfied." The other rated the system "good" in three categories (maintenance responsiveness, education, and applications programs) ▷

▶ computer; the 5110 appears as an IBM 2741 typewriter terminal (using EBCDIC or Correspondence Code) to the remote system. Data is transmitted in half-duplex, asynchronous, start/stop mode at a speed of 134.5 or 300 bits per second over appropriate B1, B2, C1, C2, or D1 facilities. Line connection is via a customer-supplied modem. The Expansion Feature is a prerequisite.

The 5110 in asynchronous mode can be connected to an IBM System/370, 303X, or 4300 Series computer via an Integrated Communications Adapter or a 3704 or 3705 Communications Controller with the Emulation Program (EP/VS) or the Network Control Program (NCP/VS). Host-system software support for the 5110 operating as a 2741 is provided by OS/VS1 or OS/VS2 with BTAM, TCAM, or VTAM; by DOS/VS with VTAM; and by VM/370.

While operating in the asynchronous communications mode, the 5110 is a dedicated terminal device; user programs cannot be entered or executed. The 5110's keyboard is used in the same way as a 2741 keyboard. Output is displayed on the CRT and can also be printed on the optional 5103 Printer. Data can also be transmitted from and received on diskettes.

BINARY SYNCHRONOUS COMMUNICATIONS ADAPTER (BSCA): Equips the 5110, through either BASIC or APL program control, to function on a switched or non-switched (leased or private) communications line as a processor terminal emulating either the IBM 2770 or 3741 line protocol at a transmission speed of 600 to 4800 bits per second. A 5110 emulating the 2770 line protocol can communicate with an IBM System/370, 303X, or 4300 Series computer supported by OS/VS1 or OS/VS2 BTAM or TCAM, DOS/VS BTAM via an Integrated Communications Adapter, or a 3704 or 3705 Communications Controller with NCP or EP. A 5110 emulating the 3741 line protocol can communicate with any of the following:

- A 5110 or 5120 equipped with the BSCA.

- A 3741 Model 2 or 4.

- A System/3, System/32, or System/34 equipped with the appropriate communications adapter.

The BSCA wil operate with any of the above systems capable of communicating over a point-to-point (non-switched) data link at 1200/600, 2000, 2400, or 4800 bps. The 5120 can also operate as a BSC tributary station on a multipoint (leased or private) line in conjunction with a System/370, 303X, or 4300 control station at 1200 to 4800 bps.

The BSCA operates in half-duplex mode, and its operation is overlapped with that of the 5103 Printer. The adapter supports transmission and reception of blocked records. Switched-network versions also support manual dialing and manual or Auto-Answer (where the attached modem supports the latter capability). The BSCA can be configured to use the EBCDIC or EBCDIC Transparency code. An Internal Clock generates synchronizing and timing signals when these are not provided by the attached modem.

When the BSCA is installed, one of the following features must be added to provide the appropriate line interface: an Integrated Modem, an EIA/CCITT interface, or a Dataphone Digital Service Adapter. These features are described below.

INTEGRATED MODEMS: IBM offers three types of integrated modems for use with a 5110 equipped with the BSCA. Models 5500 and 5501 provide for BSC data transmission at 1200 bps over non-switched and switched facilities, respectively. Model 5508 handles BSC transmission over non-switched facilities at 1200 bps, with provision for backup attachment to the switched network with Auto Answer. ▶

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▷and "excellent" in all the rest. Both these users plan to use their systems throughout 1980 and would recommend the 5110 to others in their situations.

Despite the dichotomy of user opinion we encountered in this small survey sample, it's clear that the 5110 is a reliable, easy-to-use system that's well suited for a variety of low-volume computing needs. It's equally clear that other current microcomputer-based systems offer substantially more performance per dollar. IBM has obviously recognized this price/performance gap and significantly narrowed it with the new 5120 Computing System (Report M11-491-201), which features improved packaging at a considerably lower price.□

➤ **EIA/CCITT INTERFACE:** Provides a cable and interface to permit the attachment of an external IBM or NON-IBM modem that meets the RS-232C specifications.

DATAPHONE DIGITAL SERVICE (DDS) ADAPTER: Enables a BSCA-equipped 5110 to transmit and receive data at 2400 or 4800 bps over AT&T's non-switched DDS network.

SOFTWARE

OPERATING SYSTEM: The 5110 does not have an operating system in the usual sense of the word. Its system control functions are integrated into the read-only storage (ROS) module, with some main memroy space required for symbol tables, etc. System control functions are primarily concerned with coordinating the interface between the user programs and the language interpreters and peripheral devices.

In effect, there are three modes of usage: program development, interactive program writing with execution, and interactive execution of a previously written and stored program. Depending on the computer model, the programming language may be BASIC, APL, or both. In the combination BASIC/APL models, a switch allows user selection of the language to be used.

PROGRAMMING LANGUAGES: *BASIC* for the 5110 supports stream data files and matrix (two-dimensional array) operations. Independent output to the printer of data displayed on the built-in CRT is supported. BASIC includes capabilities for manipulating alphanumeric strings. Other features of the 5110 BASIC language include an Indexed File Access Method and an update in place capability for diskette data files, dynamic print formatting, and an ascending/descending index sort capability. The statements use English-like forms, so BASIC is the logical choice for first-time computer users and is recommended by IBM for commercial applications on the 5110. In addition to ROS, the BASIC interpreter uses 4,624 bytes of main memory, which is not available to the user.

APL for the 5110 is an implementation of the APL/SV language (Release 3.0) that supports arrays of up to 63 dimensions, as well as comprehensive mathematical, logical, and relational operators and functions. Independent output to the printer of data displayed on the built-in CRT is also supported. APL language extensions for the 5110 include additional system commands for diskette input/output, multiple-record reading and writing, and printer left margin control. APL is the logical choice if complex mathematical or logical operations are required. In addition to ROS, the APL interpreter uses 6,915 bytes of main memory, which is not available to the user.

UTILITY PROGRAMS: Four "Problem Solver Libraries" are currently supported by IBM for both the 5110 and 5120 Computing Systems. Each library consists of a series of programs designed to facilitate the system's use in a specific class of applications. The Print Plot Library is available for both BASIC and APL-oriented systems, while the other three libraries are offered only in BASIC versions.

The *Business Analysis/BASIC Problem Solver Library* includes 30 BASIC routines specifically oriented to problems in spread sheet, investment, depreciation, break-even, and time series analysis. The spread sheet analysis is a general report preparation tool that permits tabular presentation of data with line arithmetic (e.g., multiply line 2 by line 3) and cumulative column presentations. Data values can be entered from the keyboard or from a previously recorded magnetic tape cartridge file. Some routines allow the user to insert his own algorithm if the standard facilities provided do not include the operation he needs. The investment analysis series of programs permits computation of return on investment, discount cash flow analysis, multiple and single loan analysis, lease versus purchase analysis, and make versus buy analysis. Included in the depreciation analysis series of programs are straight line, sum-of-years digits, declining balance, and equipment units methods. The break-even or cost/volume profit analysis series permits computation with definite probablistic assumptions. The time series analysis group of programs provides a wide range of computational capabilities for time-oriented data for compound growth rate projection, moving average, and seasonal or cyclical analysis, as well as for simple statistical problems such as auto or cross covariance and correlation, exponential smoothing, and simple regression.

Generalized routines also provided in this library permit a user to construct and display histograms, create and update user files, resequence or rearrange records in files, and print data files. A 32K BASIC system is required. The optional printer is recommended for the spread sheet analysis program group.

The *Math/BASIC Problem Solver Library* includes a comprehensive set of numerical analysis routines. The facilities provided can be broadly grouped into calculus, including integration, differentiation, and solution of ordinary differential equations; linear equations and matrix analysis, including eigenproblems, least squares solutions, linear programming, and solution of linear equations; approximations to functions and zeroes of functions, including several interpolation and approximation methods, function smoothing, minimums and maximums of tabulated functions, etc.; and evaluations of advanced mathematical functions such as the Gamma function, Bessel and modified Bessel functions, elliptic integrals and functions, orthogonal polynomials, etc.

Thirty of the 42 Math/BASIC routines will operate on a minimum 16K BASIC system. The other 12 routines require a 32K machine.

The *STAT/BASIC Problem Solver Library* includes 41 routines for the analysis of numerical data through commonly used statistical techniques. The routines can be broadly grouped into elementary statistics, including histogram, cross-tabulation, moment, tally, and Chi-square and T test; regression and correlation analysis, including simple, stepwise, multiple, and polynomial regression; multivariate analysis, including discriminant analysis, canonical correlation, and factor analysis; analysis of variance; time series analysis, including moving average, seasonal and cyclical analysis, auto and cross covariance and correlation, and triple exponential smoothing; nonparametric statistics; and biostatistics, including survival rate and profit analysis. Four routines in the library provide capabilities to enter and display/print, correct, modify, generate, or smooth data. ➤

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► The STAT/BASIC routines can be used on a minimum 16K BASIC system. The routines adjust automatically to utilize various storage capacities and I/O options.

The *Print Plot/Problem Solver Library* includes a series of modules that provide a wide range of plotting capabilities and utilize data received from a BASIC program, from an APL program, or directly from a keyboard. With the addition of a Serial I/O Adatper, the 5110 can utilize an absolute vector plotter or a storage display terminal. The program provides the capability for generating line graphs, bar charts, histograms, point plotting, and others. The user specifies metric or inch plotting, the size and location of the graph within the plot limits, the location of the origin within the graph, the X and Y values at the origin, horizontal and vertical scaling factors (either linear or logarithmic), and automatic axes, automatic grids, horizontal and vertical dot density, special symbols, and any data files that are used in conjunction with program-generated and keyboard data. The platen of the 5103 Printer is reversible so that the paper can be moved backward as well as forward.

Print Plot/BASIC requires a 32K BASIC system, while Print Plot/APL requires a 32K APL system.

BRADS II (Business Report Application Development System II) is a field-developed data management system that enables non-programmers to define and create files, maintain the files, build file inquiries, and generate reports from the file data. Thus, BRADS II enables users with no knowledge of BASIC programming to develop simple applications such as asset inventories, company telephone directories, price lists, mailing lists, and bills of materials. User with BASIC programming experience can use BRADS II to facilitate the development of more complex applications.

The *BRADS II/Spread Sheet Generator (SPREAD)* extends BRADS II's applicability to a wide range of financial and business planning and management reporting operations. SPREAD adds "row and column" data generation and manipulation facilities to BRADS II's data base and report generation facilities to ease the preparation of "spread sheet" reports and various derivatives of these reports. Its use is recommended for applications such as balance sheets, budget planning and forecasting, cash requirements and forecasting, commercial loan evaluation, comparative analysis, investment analysis, material and labor requirements, and product planning.

The minimum equipment requirement for both BRADS II and SPREAD is a 5110 Model B22 Comupter (32K BASIC), the Diskette Sort feature, a 5103 Model 11 Printer, and a 5114 Diskette Unit.

APPLICATION PROGRAMS: IBM currently offers six cross-industry accounting application packages for the 5110 and 5120, as described below. In addition, a number of Field-Developed Programs (FDP's) and Installed User Programs (IUP's) have been developed for the 5110; these are listed under "Software Prices" at the end of this report.

The six accounting application packages—Billing, Payroll, Accounts Payable, Accounts Receivable, Inventory Reporting, and General Ledger—were announced along with the 5120 and represent enhanced versions of earlier field-developed accounting programs for the 5110. The six packages have a number of common features:

● The applications are interrelated through generation of transaction data files on diskettes for direct input to other applications where appropriate.

● Ease of use is enhanced by means of menu-driven selection of procedures and/or screen prompting.

● Installation-time tailoring allows the user to select key options and specific control and report data.

● Auditability and control are provided through techniques such as zero balancing and control totals.

● BRADS II file definitions are provided, facilitating the use of the BRADS II data management program to create and maintain files, handle file inquiries, and generate reports from the file data.

● The program documentation is oriented toward customer self-sufficiency during installation and operation.

● IBM's Atlanta-based Installation Support Center provides a customer "hot line" to answer questions about the installation and operation of these programs.

● The minimum equipment requirement is a 5110 Model B22 Computer (32K BASIC), the Diskette Sort feature (not required for the Payroll package), a 5103 Model 11 Printer, and a 5114 Diskette Unit with two drives (or a similarly configured IBM 5120 system).

IBM 5120 Billing is a cross-industry post-billing application that creates invoices for customer orders which have already been picked and shipped. If the IBM 5120 Accounts Receivable (A/R) and Inventory Reporting programs are also installed, the customer name and address, item descriptions, and prices are automatically obtained from diskette customer and item files. If not, the data can be keyed in for each invoice. Transaction records are created for direct input to the A/R and Inventory Reporting programs. Features of the Billing application include: interactive entry and editing of customer orders; ability to override fixed data during data entry; invoicing by single order, specified orders, or batch orders; automatic price extensions; optional application of discounts based on invoice totals; broken-case pricing; up to two sales taxes plus federal excise tax; up to three classes of special charges (packing, freight, etc.); and creation of credit memos for returns and adjustments.

IBM 5120 Payroll performs basic payroll computations and produces payroll checks with earnings statements, a deduction report, a distribution journal, W-2 forms with subtotals, and 941A forms. Features of the system include: both hourly and salaried payrolls; weekly, biweekly, semimonthly, or monthly pay periods; processing of vacation, holiday, and sick time; provision for piecework wages, two overtime rates, a shift differential premium, pay rates based on "skill" codes, commissions, awards, bonuses, etc.; provision for user-specified tax tables for federal and state/local tax computation; provision for various non-statutory deductions; interactive data entry for file creation, maintenance, and transactions; inquiry to any employee record; generation of summary job/department cost distribution data for input to the General Ledger program; and security provisions based on user-selected passwords.

IBM 5120 Accounts Payable is designed to aid the user in controlling cash outflow while maintaining detailed records of vendor invoices and credits. Features of this application include: multi-company support; interactive data entry and correction capability; payment by "due date," "on demand," or "within date"; allowance for expedited payments when necessary; provision of information to help management take advantage of vendor discounts; ability to handle partially prepared invoices, adjustments, transfers, reversals, and debit and credit memos on an accrual basis; credit memo tracking through key reports; cash disbursements from up to nine specified bank acounts; accounting for and deduction of cash discounts; provision for inquiries to the vendor master file; use of specified general ledger accounts; and optional provision of journal entry data on diskette for input to the General Ledger program. ►

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▶ *IBM 5120 Accounts Receivable* is designed to provide timely information to help improve cash flow and reduce bad debt losses through control of the user's receivables. The accounts receivable transactions are summarized into debts and credits to the general ledger accounts. The system produces a summarized journal report and an optional diskette general ledger transaction file, summarized by account, for input to the General Ledger program. Features of the Accounts Receivable system include: interactive entry and correction of invoice, debit memo, credit memo, payment, adjustment, and late charge data; choice of open item or balance forward accounting; accounts receivable aging, including three aged, one current, and one future period, with aged trail balance on demand; automatic creation of late charge transactions; deferred statement printing; ability to suppress statements and/or late charges on an individual customer basis; credit limit and past due reporting; and interfaces to the Billing and General Ledger programs.

IBM 5120 Inventory Reporting aids the user in making purchasing decisions by producing management reports that reflect stock movement, on-hand and on-order quantities, as well as sales and cost data. Features of the system include: perpetual inventory maintenance; on-demand stock status reporting, with flagging of exception items (out of stock, below reorder level, etc.); provision for inquiries to the inventory master file; comprehensive inventory analysis reports; maintenance of month-to-date and year-to-date sales and cost data for all items; item costing by both average cost and last cost; physical inventory list, in sequence by warehouse and location; maintenance of separate quantity on-hand and warehouse location data for up to three warehouses; and ability to handle broken-case quantities.

IBM 5120 General Ledger handles the basic bookkeeping functions of posting journal entries to the general ledger and producing financial statements. Features of the system include: use of standard double-entry bookkeeping principles; production of a general ledger, general ledger trial balance, chart of accounts, and transaction listings; production of a balance sheet and income statement in concise 8½-by-11-inch format; use of a master menu screen, with optional return after each procedure; ability to accommodate up to 11 major division of accounts; user tailoring of the account structure within each division; and ability to accept diskette transaction files generated by the IBM 5120 Payroll, Accounts Payable, and Accounts Receivable programs.

PRICING

POLICY: The 5110 Computing System is available for purchase or through a Purchase Pilot Test Plan. A separate maintenance contract is available. No on-site installation assistance is provided with this product; the customer sets up the system from step-by-step instructions packaged with the unit. The warranty period is 3 months and 10 days from the date of shipment from the IBM plant. All units are shipped FOB Plant of Manufacture, which means that the customer pays the transportation charges. The 5110 is currently in "limited new production" status; IBM will not commit a new machine to a specific order.

The Purchase Pilot Test Plan enables prospective purchasers to try out the 5110 without committing the full purchase price. The plan provides for a contract period that allows three months' use of the system at a price ranging from approximately 18 to 22 percent of the purchase price, depending upon the model, options, and peripherals selected. This price includes maintenance and is payable in three equal monthly installments. One additional test period of three

months can be contracted for. After that, customers who had a 5110 installed under the Test Plan as of February 5, 1980, may extend the test period for up to six additional extensions of one month each; the charge for each month is one-third of the then-current unit charge. Conversion to purchase can be made at any time, with credit toward the purchase price of up to 70 percent of the Test Plan payments.

IBM's standard 10 percent educational discount applies to the 5110 Computing System.

The 5110 is in IBM maintenance group D. Prime-shift maintenance is provided for any consecutive nine-hour period between 7 a.m. and 6 p.m., Monday through Friday. The premium for extended maintenance coverage is expressed in the table below as a percentage of the prime-shift maintenance charges, which are shown in the accompanying price list.

	Consecutive Hours				
	9*	12	16	20	24
Monday-Friday (until 8 a.m. Saturday)	10%	12%	14%	16%	18%
Saturday (until 8 a.m. Sunday)	4%	5%	7%	8%	9%
Sunday (until 8 a.m. Monday)	5%	7%	9%	11%	12%

*For periods outside the basic 7 a.m. to 6 p.m. prime shift.

For users without a maintenance contract, the 5110 is maintained under per-call class 2. The per-call charge for service during regular hours is $77 per hour, and during off hours the charge is $89 per hour.

The hourly rate for IBM systems engineering services is $57. SE services are offered on an "as available" basis.

IBM software for the 5110 is separately licensed and available for the monthly license fees or one-time charges listed in the "Software Prices" section that follows.

EQUIPMENT: The prices shown for the following representative systems include all of the indicated hardware but do not include software license charges.

MINIMUM BASIC SYSTEM: Consists of BASIC 5110 Model B11, which includes integral CRT display, magnetic tape cartridge drive, and 16,384 bytes of main storage. About 11,800 bytes of main storage are available to the user. The BASIC interpreter is included. The purchase price of this system is $8,195, and the monthly maintenance cost is $60.

TYPICAL BUSINESS-ORIENTED SYSTEM: Consists of BASIC 5110 Model B22, which includes integral CRT display and 32,768 bytes of main memory, plus the Diskette Sort feature, the 5114 diskette unit with dual drives (2.4 megabytes), and the 120-cps 5103-12 printer. About 28,100 bytes of main memory are available to the user. The BASIC interpreter is included. The purchase price is $16,405, and the monthly maintenance cost is $131.

LARGE SCIENTIFIC SYSTEM: Consists of APL 5110 Model A14, which includes integral CRT display, magnetic tape cartridge drive, and 65,536 bytes of main memory, plus the 5114 diskette unit with dual drives (2.4 megabytes) and the 80-cps 5103-11 printer. About 58,600 bytes of main memory are available to the user. The APL Interpreter is included. The purchase price is $19,190, and the monthly maintenance cost is $147.■

IBM 5110 Computing System

EQUIPMENT PRICES

	Purchase	Monthly Maint.	3-Month Contract Period Charge
PROCESSORS AND MAIN MEMORY			
5110 Model 1 Portable Computer; includes 1024-character display, magnetic tape cartridge drive, ROS for language processor, and main memory as detailed below:			
APL Language Interpreter—			
A11 With 16,384 bytes of main memory	9,025	60.00	1,635
A12 With 32,768 bytes of main memory	9,810	65.00	1,905
A13 With 49,152 bytes of main memory	10,595	70.00	2,175
A14 With 65,536 bytes of main memory	11,380	75.00	2,445
BASIC Language Interpreter—			
B11 With 16,384 bytes of main memory	8,195	60.00	1,485
B12 With 32,768 bytes of main memory	8,980	65.00	1,755
B13 With 49,152 bytes of main memory	9,765	70.00	2,025
B14 With 65,536 bytes of main memory	10,550	75.00	2,295
APL and BASIC Language Interpreters—			
C11 With 16,384 bytes of main memory	9,855	65.00	1,785
C12 With 32,768 bytes of main memory	10,640	70.00	2,055
C13 With 49,152 bytes of main memory	11,425	75.00	2,325
C14 With 65,536 bytes of main memory	12,210	80.00	2,595
5110 Model 2 Portable Computer; includes 1024-character display, ROS for language processor, and main memory as detailed below:			
APL Language Interpreter—			
A21 With 16,384 bytes of main memory	7,865	45.00	1,425
A22 With 32,768 bytes of main memory	8,650	50.00	1,695
A23 With 49,152 bytes of main memory	9,435	55.00	1,965
A24 With 65,536 bytes of main memory	10,220	60.00	2,235
BASIC Language Interpreter—			
B21 With 16,384 bytes of main memory	7,035	45.00	1,275
B22 With 32,768 bytes of main memory	7,820	50.00	1,545
B23 With 49,152 bytes of main memory	8,605	55.00	1,815
B24 With 65,536 bytes of main memory	9,390	60.00	2,085
APL and BASIC Language Interpreters—			
C21 With 16,384 bytes of main memory	8,695	50.00	1,575
C22 With 32,768 bytes of main memory	9,480	55.00	1,845
C23 With 49,152 bytes of main memory	10,265	60.00	2,115
C24 With 65,536 bytes of main memory	11,050	65.00	2,385

PROCESSOR UPGRADE OPTIONS

	Purchase	Monthly Maint.	3-Month Contract Period Charge
— Models A21 through C24 can be field-upgraded to Model 1's to provide for the inboard tape cartridge unit and the attachment of the 5106 Auxiliary Tape Cartridge unit. Other models can be upgraded for additional memory and to combine BASIC and APL. Prices for field upgrades range from $785 to $5,175.	—	—	—

OPTIONS

		Purchase	Monthly Maint.	3-Month Contract Period Charge
1250	Audible Alarm	50	NC	9
1524	Expansion Feature; required for Asynchronous Communications Adapter or Serial I/O Adapter	270	7.00	45
1525	Asynchronous Communications Adapter	540	11.50	90
1600	Channel Terminator	180	1.00	30
2074	Binary Synchronous Communications Adapter	1,800	11.50	300
3200	Diskette Sort Feature	360	2.00	60
3701	EIA/CCITT Interface	430	4.50	66
5500	1200-BPS Integrated Modem, non-switched	660	5.00	99
5501	1200-BPS Integrated Modem, switched	880	7.00	132
5508	1200-BPS Integrated Modem, switched back-up	1,015	10.00	153
5650	DDS Adapter, point-to-point	840	5.00	126
5651	DDS Adapter, multipoint tributary	840	5.00	126
5825	Parallel I/O Adapter	630	17.50	105
6301	Serial I/O Adapter	630	17.50	105
1501	Carrying Case, soft	113	NC	—

IBM 5110 Computing System

EQUIPMENT PRICES

		Purchase	Monthly Maint.	3-Month Contract Period Charge
MASS STORAGE				
5114	Diskette Unit with one 1.2-megabyte drive	3,445	25.00	630
3240	Second 1.2-megabyte diskette drive	1,710	15.00	285
MAGNETIC TAPE DRIVES				
5106	Auxiliary Tape Unit	1,535	11.50	279
	Tape Cartridges, per package of five	100	—	—
PRINTERS				
5103-11	Printer, 80 cps	2,655	32	480
5103-12	Printer, 120 cps	3,070	39	555
—	Upgrade option, from 80 to 120 cps	500	—	—

SOFTWARE PRICES

		Monthly Charge	One-Time Charge
UTILITY PROGRAMS			
5721-DC3	Print Plot/BASIC Problem Solver Library	—	$500
5721-DC4	Print Plot/APL Problem Solver Library	—	500
5721-DC5	Business Analysis/BASIC Problem Solver Library	—	525
5721-DC6	MATH/BASIC Problem Solver Library	—	525
5721-DC7	STAT/BASIC Problem Solver Library	—	525
5798-NPL	Business Report Application Development System (FDP)	$ 50*	—
5798-NPT	Basic Text Editor (FDP)	50*	
5798-NRC	Optical Mark Readers (FDP)	—	500
5798-NRH	Screen Design Aid (FDP)	—	225
APPLICATION PROGRAMS			
5721-XB1	IBM 5120 Billing	60**	—
5721-XB2	IBM 5120 Payroll	60**	—
5721-XB3	IBM 5120 Accounts Payable	60**	—
5721-XB4	IBM 5120 Accounts Receivable	60**	—
5721-XB5	IBM 5120 Inventory Reporting	60**	—
5721-XB6	IBM 5120 General Ledger	60**	—
5796-NQA	Payroll/Labor Costing (IUP)	135*	—
5796-NQB	Comprehensive Construction Payroll/Job Costing (IUP)	160*	—
5796-NTX	Doctors Office Management System (IUP)	250*	—
5798-NKK	Project Control System (FDP)	300*	—
5798-NLN	Bowling League Scoring System (FDP)	110*	—
5798-NLP	International Air Freight Optimization System (FDP)	100*	—
5798-NPG	Business Planning (FDP)	200*	—
5798-NPH	General Ledger (FDP)	75*	—
5798-NPJ	Payroll (FDP)	80*	—
5798-NPK	Accounts Payable (FDP)	75*	—
5798-NPN	Accounts Receivable (FDP)	75*	—
5798-NQQ	Meat Blending (FDP)	150*	—
5798-NRE	Computing for an Accounting Practice (FDP)	145*	—
5798-NTW	Insurance Agents and Brokers (FDP)	165*	—
5798-NWA	Fixed Asset Accounting and Control System (FDP)	140*	—

*Paid up in 12 months.
**Paid up in 24 months.