Hewlett-Packard 1000 Series

MANAGEMENT SUMMARY

Hewlett-Packard has continued its practice of progressively enhancing the 1000 Series product line. The HP 1000 L-Series, the newest addition to the family of 16-bit processors, was introduced in March 1980. It uses silicon-on-sapphire (SOS) technology and distributed intelligence to achieve a significant reduction in system price. The HP 1000 family now includes 7 processors, 3 board computers, and 6 packaged systems built around the H 1000 L-Series, E-Series, and F-Series processors.

Hewlett-Packard has always been a leader in design implementation and in the integration of modern technological developments. The SOS technology is used in three different circuits in the L-Series (a single-chip CPU, a single-chip I/O processor, and an HP-IB interface). The benefits offered by SOS chips include high speed, low power consumption, greater circuit density, improved reliability, and design ease. The L-Series is a deviation in architecture and design from the M/E/F-Series processor yet maintains HP 1000 program compatibility.

The HP 1000 M-Series was announced in May 1974 as the 21MX Series, a lower-cost, enhanced version of the HP 2100A minicomputers. The term "companion" was used instead of "replacement" to emphasize several significant differences between the two products. The most noticeable difference concerned main memory: semiconductor (MOS) in the 21MX Series and core in the 2100A.

Another significant difference was in microprogrammability. The 2100A's basic instruction set was established in hardware and could not be user-altered. In contrast, the 21MX permitted users to define completely the instruction set as well as define special routines in writable control storage. This added flexibility allowed HP to penetrate the OEM market by making possible custom-tailored ➢

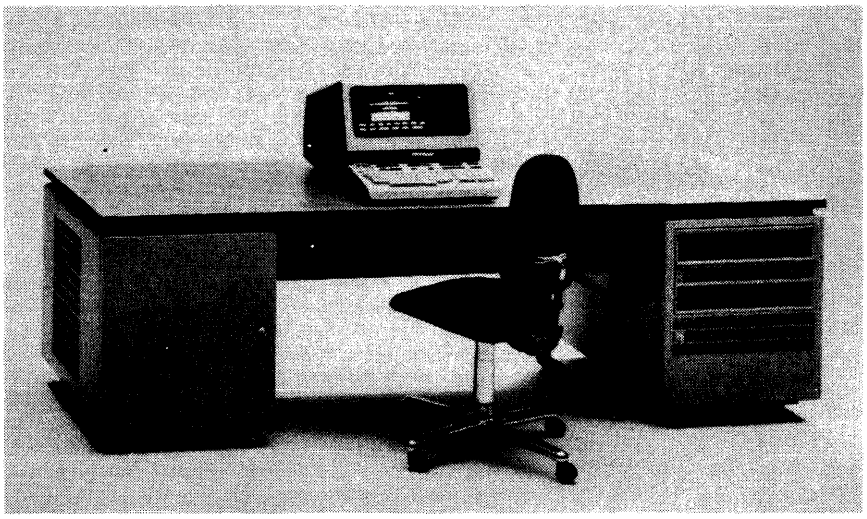
The Hewlett-Packard 1000 Series currently consists of four different processor families spanning a broad range of price and capability. The series of 16-bit processors is designed primarily for industrial automation applications (i.e., factory data collection, process control, numerical control of machines and robotics). These same capabilities also apply to applications in such fields as scientific and engineering computation; computer-aided design; simulation and modeling; graphics data acquisition, reduction, and analysis. Current sales efforts are aimed at both the OEM and end-user markets. Hewlett-Packard also offers a full range of peripherals and data collection devices to support the 1000 Series.

MAIN MEMORY: 64K to 2048K bytes
DISK CAPACITY: 12 to 960 megabytes
WORKSTATIONS: 1 to 64
PRINTERS: line and character, impact and thermal, to 1000 lpm
OTHER I/O: magnetic tape, plotters, punched card/tape, data collection devices, measurement/control cards

CHARACTERISTICS

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

Hewlett-Packard is one of the foremost manufacturers of sophisticated laboratory test equipment and specialized process control instrumentation. Other related products include both digital and analog graphic recorders, analytic instrumentation, and medical electronic instrumentation ➢



The top of the line among the HP 1000 packaged systems is the Model 45, which combines the new 2117F processor, high-performance RAM memory, the HP 2648A Graphics Terminal, the HP 7906 Disc Subsystem, and the RTE-IV Operating System. The system is expandable to 1280K bytes of memory and supports 10 I/O channels in this desk configuration.

Hewlett-Packard 1000 Series

The HP 1000 Series Product Family

	L-Series	M-Series	E-Series	F-Series
Processors	2103L	2108M 2112M	2109E 2113E	2111F 2117F
Board Computers	2103LK	2108MK	2109EK	None
System Packages	Model 9 Model 10	None	Model 20 Model 40	Model 25 Model 45

instruction sets for nearly any purpose. The 21MX Series was renamed and reconfigured to form the current HP 1000 M-Series in 1978.

An additional feature of the HP 1000 M-Series, memory mapping, allows users to access memory beyond 64K bytes. The M-Series processors are about 20 percent slower than their HP 2100A predecessors, but both HP and their users have overcome this; the users by implementing some of their software routines in firmware, and HP by announcing the faster HP 1000 E- and F-Series processors. Both solutions have enabled the HP 1000 Series to equal and surpass the 2100A's performance.

The HP 1000 E-Series is, of course, closely related to the earlier HP 21MX processors. It is completely compatible with the M-Series except that time-dependent routines or programs must be rewritten for the E-Series. This points up one of the major differences: speed of execution. HP states that a program written for the M-Series will run 60 to 100 percent faster for the 1000 E-Series. HP also states that instructions are executed 1.4 to 3 times faster on the 1000 E-Series. Floating-point instructions, on the average, are 2.5 times faster.

HP credits this improvement in execution speed to "variable micro-cycle timing." This technique allows the control processor to allocate 280 nanoseconds per micro-cycle to the slowest operations. It uses internal logic to assign 175 nanoseconds per micro-cycle to those operations that do not need the slower time. To complement this technique, HP offers two speeds of MOS memory: standard-performance memory with a 595 nanosecond cycle time and high-performance memory with a 350 nanosecond cycle speed. Be advised, however, that the dynamic mapping system adds 70 nanoseconds to the effective cycle time. Standard performance and high performance fault control memories are available to correct all single-bit errors and to detect all double-bit errors. Fault control adds another 70 nanoseconds to the cycle time.

The HP 1000 F-Series is the next logical step in the chain as it contains all of the E-Series features with several important enhancements. These include a hardware-implemented floating-point processor (FPP), a scientific instruction set (SIS), and a fast FORTRAN processor (FFP). The FPP reduces processing times for both single- and extended-arithmetic operations to provide speeds 2.5 to 6 times faster than on the 1000 E-Series. The FPP can be

systems. Other Hewlett-Packard Company divisions manufacture hand-held calculators and desk-top calculators. In fiscal year 1980, computers made up approximately 49 percent of Hewlett-Packard's total business. Approximately 40 percent of the business was attributed to the instrument group while medical, analytical and components groups contributed approximately 11 percent.

The Computer Groups organization includes the Computer Systems Division, which is responsible for the HP 3000; the General Systems Division, responsible for the HP 250 small business computer; the Boise Division, which is responsible for printers and tape drives; the Data Terminals Division, which is responsible for the display terminals, graphics terminals, remote consoles for the HP 250, and consoles for the 3000 Series 30; the Data Systems Division, responsible for the HP 1000 line; the Desktop Computer Division, which is responsible for the HP 9800 family; the Vancouver Division, responsible for dot-matrix printers and printing terminals; the Disk Memory Division, responsible for disk drives; the Greeley Division, which handles flexible disk units; the Information Systems Division, which handles CIS/3000, DSG/3000, IMAGE/QUERY/3000, and SIS/3000; the Business Computer Group; the Computer Support Division (SE and CE services); and the Genoble, France, Division (data collection devices).

Hewlett-Packard products are sold by 135 sales offices and serviced by 160 offices in 37 countries, and are manufactured in facilities in the U.S., United Kingdom, Germany, France, Japan, and Malayasia. The company employs about 60,000 persons worldwide, with about 25,000 involved in computational products.

MODELS: HP 1000 L-Series, HP 1000 M-Series, HP 1000 E-Series, and HP 1000 F-Series Processors; HP 1000 L-Series, HP 1000 M-Series, and HP 1000 E-Series Board Computers; and HP 1000 Model 9, 10, 20, 25, 40, and 45 Packaged Systems (based on the E-, F-, and L-Series Processors).

DATE ANNOUNCED: HP 1000 M-Series Models 2108M, May 1974; Model 2112M, May 1975; HP 1000 E-Series Models 2109E and 2113E, December 1975; HP 1000 F-Series Models 2111F and 2117F, May 1978; HP 1000 L-Series Model 2103L, March 1980; HP 1000 M-Series Model 2108MK Board Computer, August 1976; HP 1000 E-Series Model 2109EK Board Computer, May 1978; HP 1000 L-Series Model 2103LK Board Computer, March 1980; HP 1000 Model 20 Packaged System, March 1977; HP 1000 Model 25, 40, and 45 Packaged Systems, May 1978; HP 1000 Model 10 Packaged System, March 1980; HP 1000 Model 9 Packaged System, December 1980.

DATE OF FIRST DELIVERY: HP 1000 M-Series Models 2108M, August 1974; Model 2112M, late 1975; HP 1000 E-Series Models 2109E and 2113E, September 1976; HP 1000 F-Series Models 2111F and 2117F, August 1978; HP 1000 L-Series Model 2103L, March 1980; HP 1000 M-Series Model 2108MK Board Computer, June 1976; HP 1000 E-Series Model 2109EK Board Computer, September 1978; HP 1000 L-Series Model 2103LK Board Computer, March

Hewlett-Packard 1000 Series

PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION & SPEED	MANUFACTURER
MAGNETIC TAPE EQUIPMENT	All HP magnetic tape units accept 10½-inch reels, read and record on IBM/ANSI-compatible tape, contain read-after-write features, and can be configured with up to 4 drives	
7970B	9-track, 800 bpi, NRZI, 45 ips; 7970B-226 or -236 is the 1st drive, 7970B-220 or -230 the 2nd, 3rd or 4th drive; 36 KBS	Hewlett-Packard
7970E	9-track, 1600 bpi, PE, 45 ips; 7970E-226 or -236 is the 1st drive, 7970E-220 or -230 the 2nd to 4th master drive, 7970E-221 or -231 the 2nd to 4th slave drive; 72 KBS	Hewlett-Packard
PRINTERS		
2608A	Comb matrix, 5 x 7 dot matrix (5 x 9 for lower case in 128-char. set), 132 positions, 64/129-character sets, 10 characters per inch, 6 or 8 lines per inch, 4 to 14.9-inch paper, 8-channel VFU; 400/340 lpm	Hewlett-Packard
2631B	Dot matrix, 7 x 9, 136 positions, 128-character set, 10 characters per inch, 6 or 8 lines per inch, 1.2 to 15.75-inch paper, 8-channel VFU; 180 cps, used as remote spooled printer with RS-232-C interface	Hewlett-Packard
2613A/2613A-001	Drum, 136 positions, 64/96-character sets, 10 characters per inch, 6 or 8 lines per inch, 4 to 16.8-inch paper, 12-channel VFU, OCR-B character font available; 300/240 lpm	Dataproducts 2230
2617A/2617A-001	Drum, 132 positions, 64/96-character sets, 10 characters per inch, 6 or 8 lines per inch, 4 to 16.8-inch paper, 12-channel VFU, OCR-B character font available; 600/436 lpm	Dataproducts 2260
2619A/2619A-001	Drum, 132 positions, 64/96-character sets, 10 characters per inch, OCR-B character font available, 6 or 8 lines per inch, 4 to 19-inch paper, 12-channel VFU; 1000/750 lpm	Dataprinter
PUNCHED CARD EQUIPMENT		
12985A	Reader Subsystem; 2892A Reader and 12924A interface; 80-column, single hopper, stacker for 1000 cards, 600 cpm	Documation
PUNCHED TAPE EQUIPMENT		
12925A	Reader Subsystem; 2748B Reader, 12575C Tape Winder, and 12579A interface; 8-level code, rack mount; 500 cps	Hewlett-Packard
12926A	Punch Subsystem; 2895B Punch and 8-bit Duplex Register interface; 5- or 8-level code; paper, mylar, or plastic tape; 75 cps	Hewlett-Packard & Facit
PLOTTERS		
7245B	Printer/Plotter; 7.4-inch by 16.4-foot bidirectional paper drive for long-axis plotting; better than 0.06-inch resolution; up to 10.1 inches per second pen velocity; 7 x 9 dot-matrix characters at 38 cps; 14 x 9 dot-matrix characters at 19 cps	Hewlett-Packard
9872B/S	Graphics Plotter; 11- by 15.75-inch area, .001-inch resolution, 14 inches per second in each axis; 4 individually program-selectable pens for multicolor plotting; up to 36 programmable speeds from 0.4 to 14 inches per second in increments of 0.4 inches per second; character plotting at 3 characters per second for 0.01-inch characters; S indicates auto paper advance	Hewlett-Packard
7221B/S	Graphics Plotter, RS-232-C, 4 color, S indicates auto paper advance, 11.25 x 15.75 inches, .001 inch resolution, 14 inch/second velocity on each axis	Hewlett-Packard
7225A	Graphics Plotter, single pen, HP-IB interface, 8 x 11.2 inches, .001 inch resolution, 10 inch/second velocity on each axis	Hewlett-Packard

used as a control processor computing resource to increase microprogramming performance. The SIS, in conjunction with the FPP, achives execution speeds 6 to 24 times faster than equivalent software routines. The SIS includes mini instructions in the single-precision floating-point format. These are: sine, cosine, tangent, arc tangent, hyperbolic tangent, square root, exponent, natural logarithm, and base 10 logarithm. The fast FORTRAN processor provides firmware to replace nine frequently-used library subroutines.

At this point, the L-Series introduces SOS technology to the 1000 family. Introduced as the least costly of the HP 1000 computers, the L-Series brings distributed intelligence to the market to provide multiprogramming and a real-time executive for instrumentation and process-control applications. The L-Series supports program development in FORTRAN IV, BASIC, Pascal, and

1980; HP 1000 Model 20 Packaged System, May 1977; HP 1000 Model 25, 40, and 45 Packaged Systems, September 1978; HP 1000 Model 10 Packaged System, March 1980; HP 1000 Model 9 Packaged System, March 1980.

NUMBER INSTALLED TO DATE: Approximately 50,000 units worldwide, including boards, boxes, and systems.

DATA FORMATS

BASIC UNIT: 16-bit word plus one parity bit; 8-bit bytes and 32-bit double words can also be handled.

FIXED-POINT OPERANDS: 16-bit single-precision operand for all instructions except extended arithmetic (integer double-precision) and floating-point instructions, which are 32 bits long (double word). Single- and double-precision fixed-point operands are in two's complement integer notation.

Hewlett-Packard 1000 Series

PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION & SPEED	MANUFACTURER
TERMINALS		
	All Display/Graphics terminals listed below have a commonality of features (unless otherwise noted) including 1920-character display, 24 lines by 80 characters, 5 by 10 matrix generated in 9 by 15 cell, 64- or 128-Roman character sets, detachable ASCII keyboard with 10-key numeric pad, cursor tab, page control, inverse video, block or character mode operation and RS-232-C interface compatible with Bell 103A or 202 type modems; full or half duplex asynchronous transmission at 110 to 2400 bps.	
2621A/2621P	Interactive Display Terminal; 48-line memory, character mode, underline, 128-character set, 9600 bps; 2621P includes 120-cps thermal printer	Hewlett-Packard
2635B	Printing Terminal; 180 cps, automatic bidirectional printing, underline and display function modes, 16-channel computed VFU, EIA RS-232-C interface without modem control	Hewlett-Packard
2624A	Interactive Display Terminal, 7 x 11 dot matrix, 4 pages of display memory (optionally expandable to 9), 8 user-definable softkeys, optional line drawing and European character sets, external printer port, optional thermal printer	Hewlett-Packard
2626A	Interactive Display Terminal, 119 80 col. lines or 59 160 col. lines, 4 workspaces, 4 windows, dual comm ports, optional integral printer, extended character sets, user-definable softkeys	Hewlett-Packard
2675	Portable Printing Terminal, dual cartridge tape, thermal printing, 120 cps, 7 x 11 dot matrix, 132 col, expanded print, 40 characters per line, line drawing, 128 char ASCII, 10 alternate char. sets, RS-232-C, to 9600 baud, internal modem optional	Hewlett-Packard
2640B	Interactive Display Terminal (console); 1K-byte memory expandable to 8K bytes; 2 option slots, optional blinking, half-bright and underline display enhancements, and optional mathematical symbol, character line drawing, and large character sets.	Hewlett-Packard
2642A	Display Station, 88 line memory; 270K bytes of storage via flexible mini disk; optional second drive; text preparation commands; optional hard copy interface; RS-232-C, current loop, synch or asynch multipoint comm.	Hewlett-Packard
2645A	Interactive Display Terminal; 7 option slots, 4K-byte memory expandable to 12K bytes, 8 user-defined soft keys, optional display enhancements (see 2640B), off-line data preparation and editing, optional cartridge tape drives and optional special character sets (see 2640B)	Hewlett-Packard
2647A	Graphics Terminal; 9 user-defined soft keys, 6K-byte memory, 16K RAM's for 360 x 720-dot resolution graphic display and pan and zoom graphics, automatic plotting, graphics text composition	Hewlett-Packard
2648A	Graphics Terminal; 4 option slots and specifications of 2645A except 9 user-defined soft keys, 8K-byte memory expandable to 12K bytes; 16K RAM's for 360 X 720-dot resolution graphic display and pan and zoom graphics; separate or simultaneous alpha and graphic viewing, rubber band line, automatic plotting, graphics text composition	Hewlett-Packard
92900B	Data Capture Terminal Subsystem; 3070B Terminal and 40280A Interface; 12-key numeric pad, special keyboard and LED indicators for program interface, 15-digit numeric display; built-in multifunction reader for perforated non-embossed plastic badges, 80-column punched cards, or up to 80-column optical mark forms; up to one form or badge per minutes; built-in thermal printer with 5-by-7 dot matrix, 2.25-inch paper, 20 positions, and 64 ASCII character set; 3070A has std. HP-IB interface; 280 bytes per second (1 terminal) to 12 bytes per second (56 terminals)	Hewlett-Packard

assembler languages. This extends the L-Series attractiveness to the OEM market. The SOS technology generates this cost savings by providing a one-chip CPU and a processor chip on every I/O board.

The CPU chip includes the time-base generator and memory protect features which are separate boards on the other HP 1000 models. The processor board then includes the CPU and circuitry, two 2K- by 8-bit ROMs with standard boot loaders, a comprehensive self-test, and the virtual control panel firmware. The virtual control point firmware makes it possible for any ASCII terminal to act as the computer's control panel, with full access and to the machine's internal registers. This allows remote access and diagnosis of the L-Series computers via hard-wired or modem links.

A summary of the HP 1000 models follows.

The Model 2108M, announced in May 1974, is housed in an 8.75-inch chassis and permits five memory modules and

FLOATING-POINT OPERANDS: Six floating-point firmware instructions are provided for the HP 1000 systems. They are handled by hardware in the F-Series, firmware in the M- and E-Series, and software in the L-Series. Each 32-bit single-precision operand has a 7-bit exponent including sign and a 23-bit mantissa plus sign. The binary point is assumed to be between the mantissa sign and the mantissa.

The HP 1000 provides 32-bit single-precision, 48-bit extended-precision, and 64-bit double precision data formats. Both formats provide a 7-bit exponent including sign.

Both the floating-point firmware instruction set and the FPP provide an exponent range of 10 decimal raised to the +38th power. Likewise, both provide at least six significant decimal digits in the mantissa of the single-precision data format. The FPP also provides 11 significant decimal digits in the mantissa of the extended-precision data format.

INSTRUCTIONS: All M/E/F-Series instructions are one, two, three, or four words long. The L-Series uses single or double word instructions format.

INTERNAL CODE: ASCII for characters; binary for instructions, integers, and real numbers.

Hewlett-Packard 1000 Series

Characteristics of HP 1000 Series Systems

	L-Series	M-Series	E-Series	F-Series
Models	2103L	2108M/2112M	2109E/2113E	2111F/2117F
Memory Type	MOS	MOS	MOS	MOS
Standard memory (bytes)	64K/128K	64K/128K	64K/128K	128K
Total capacity (bytes) Standard memory Fault control memory	 64K/512K N/A	 1792K/2048K 1280K/1792K	 1792K/2048K 1280K/1792K	 1792K/2048K 1280K/1792K
Floating-point precision	48	48	48	64 bits
Firmware instructions	80	128	176	211
Total hardware registers	Hardwired	16	16	16
Program accessible registers	2	4	4	4
I/O channels (std)	8/14	9/14	9/14	9/14
I/O channels (opt)	None	32	32	32
Power-fail interrupt	Automatic	Automatic	Automatic	Automatic
Operating systems	RTE-L/XL	RTE/II/IVB/IVE	RTE/II/IVB/IVE	RTE/II/IVB/IVE
Languages	FORTRAN 4X, BASIC, Assembler, Pascal	FORTRAN IV, FORTRAN 4X, BASIC, C, Assembler, Pascal	FORTRAN IV, FORTRAN 4X, BASIC, C, Assembler, Pascal	FORTRAN IV, FORTRAN 4X, BASIC, C, Assembler, Pascal
Maximum # of physical devices	64	64	64	64
Optimum # of terminals	3-8	3-8	6-15	6-15
Comments:	Based on distributed intelligence architecture			Incorporates floating-point processor

up to nine I/O controller modules in the basic system. The 2108M can accommodate two I/O extender chassis for a maximum of 41 I/O channels. The 2108M can also accommodate a memory extender chassis, permitting memory expansion to 1792K bytes.

The 2112M was announced in May 1974 and features a 12¼-inch chassis that contains space for up to 10 memory modules (1280K bytes maximum). With the memory extender chassis, the memory capacity can go to 2048K bytes. The 2112M has slots for 14 I/O modules in the basic system and can accommodate a total of up to 46 I/O channels through two I/O extender chassis.

The 2109E, announced in December 1976, is the smallest member of the 1000 E-Series and employs the same housing and expansion capacities as the 2108M. The 2113E is the 1000 E-Series equivalent of the 2112M, with the same expansion possibilities; it was announced at the same time as the 2109E. The major difference in the memory expansion capabilities of the E Series over the M Series is the availability of both standard and high-performance MOS memory modules, currently available in 64K-byte and 128K-byte increments configured into large-memory packages.

The 2111F, announced along with the 2117F in May 1978, utilizes the same expansion capacities as the 2108M and

MAIN STORAGE

TYPE: Depending on model number, 16K or 64K dynamic N-channel MOS RAM chips for standard- or high-performance memories. Standard-performance memories are available for the 1000 L-, M-, and E-Series computers. High-performance memories are available for both the 1000 E- and 1000 F-Series computers. Each memory location is refreshed automatically every two milliseconds.

CYCLE TIME: In the following table, cycle times are given in nanoseconds. DMS indicates Dynamic Mapping Systems.

	1000 L Series	1000 M Series	1000 E Series*	1000 F Series*
Std. parity memory:				
Without DMS	**680**	**650**	**595**	**—**
With DMS	**680**	**650**	**665**	**—**
Std. fault control memory:				
Without DMS	**—**	**650**	**630**	**—**
With DMS	**—**	**650**	**700**	**—**
High-performance memory:				
Without DMS	**—**	**—**	**350**	**350**
With DMS	**—**	**—**	**420**	**420**
High-performance fault control memory:				
Without DMS	**—**	**—**	**420**	**420**
With DMS	**—**	**—**	**490**	**490**

***For the 1000 E and 1000 F Series, the given cycle time is within ±35 nanoseconds.**

Hewlett-Packard 1000 Series

HP 1000 PACKAGED SYSTEM COMPATIBILITY MATRIX SUMMARY

	MODEL 9		MODEL 10		MODEL 20		MODEL 25		MODEL 40		MODEL 45	
	2145A	2145B	2146A	2146B	2174A	2174B	2175A	2175B	2176C	2176D	2177C	2177D
Base System Price	$18,100	$17,500	$23,100	$22,500	$22,500	$22,500	$30,500	$30,500	$39,500	$39,500	$49,000	$49,000
Processor	1000 L		1000 L		1000 E		1000 F		1000 E		1000 F	
Operating System	RTE-L/XL		RTE-L/XL		RTE-M		RTE-M		RTE-IVB		RTE-IVB	
Console Terminal	2621		2621		2645		2645		2645		2648	
Min. Memory (bytes):												
Standard	64K		64K		64K		—		128K		—	
High-Performance	—		—		—		64K		—		128K	
System Disk	Dual Floppy		7910/Floppy		None		None		7906		7906	
Opt. System Disk	7906/10		7906/10		None		None		7906/20/25		7906/20/25	
Flexible Disk	Yes		Yes		Optional		Optional		Optional		Optional	
A/D Interface Subsystem	Optional		Optional		Optional		Optional		Optional		Optional	
Measurement and Control Processor	Optional		Optional		Optional		Optional		Optional		Optional	
Multipoint Terminal Interface Card	No		No		Optional		Optional		Optional		Optional	
RJE/1000	No		No		Optional		Optional		Optional		Optional	
DS/1000	Optional		Optional		Optional		Optional		Optional		Optional	
IMAGE/1000	Optional		Optional		Optional		Optional		Optional		Optional	
DATACAP/1000	No		No		Optional		Optional		Optional		Optional	
GRAPHICS/1000	No		No		Optional		Optional		Optional		Standard	

2109E and features a 12¼-inch chassis. The 2117F features two chassis that use 17½ inches of vertical space and is the 1000 F-Series equivalent of the 2112M and the 2113E with the same expansion capacities.

The 2108MK and the 2109EK are single-board versions of the 2108M and 2109E, respectively. When properly configured with chassis, etc., they may have the same memory and I/O expansion as the 2108M and 2109E. These HP1000 M- and E-Series processors are available with or without the HP 1000 instruction ROM, and can therefore be thought of as either high-performance control processors or HP 1000-compatible computers.

The 2103L, announced in March 1980, provides a CPU board and a 64K byte memory module in a 10-slot card cage including a power supply. The L-Series now supports 128K, 256K, 384K, and 512K byte memory configurations. The entire L-Series processor is on a single 6¾ inch x 11 inch circuit board. Eight slots are available for I/O interfaces, the 12013A Battery Backup Module, and/or the 12008A PROM Storage Module. At least one I/O interface and associated terminal or other peripheral is required for a usable system.

The 2103LK includes the L-Series CPU board and a 64K byte memory module. To offer maximum packaging flexibility for OEMs and end users, a 5- and 10-slot card cage are available as options. Also available are I/O interfaces, the 12013A Battery Backup Module, the 12008A PROM Module, and the 12035A Power Module.

The L-Series standard memory capacity was limited to 64K bytes of MOS memory. HP has extended this to 512K bytes of memory by their XL memory controllers which makes it possible to field upgrade L-Series processor to increase their memory. This can be accomplished in 128K byte increments or with one 512K bytes memory controller

CAPACITY: Standard and high-performance parity memories are available in two module sizes, 64K and 128K bytes. The L-Series also has a 512K byte module.

The standard minimum memory for packaged systems is as follows: Models 9 and 10, 64K bytes memory, Model 20, 64K bytes, standard-performance; Model 25, 64K bytes, high-performance; Model 40, 128K bytes, standard-performance; and Model 45, 128K bytes, high-performance. Maximum memory allowable in the packaged systems can be found in the following table under 2103L for Model 10; 2113E for Models 20 and 40; and under 2117F for Models 25 and 45.

The table also lists all other nonpackaged system configurations of memory available to the HP 1000 user.

Maximum Allowable Memory (bytes)

for HP 1000 Computer Systems

Checking Type:		Parity		Fault Control	
Performance Type:		Std.	High	Std.	High
2103L	Chassis	512K	—	—	—
2108M	Chassis	640K	—	512K	—
2108M	Chassis + extender	1792K	—	1280K	—
2109E	Chassis	640K	640K	512K	512K
2109E	Chassis + extender	1792K	1792K	1280K	1280K
2111F	Chassis	—	640K	—	512K
2111F	Chassis + extender	—	1792K	—	1280K
2112M	Chassis	1280K	—	1024K	—
2112M	Chassis + extender	2048K	—	1792K	—
2113E	Chassis	1280K	1280K	1024K	1024K
2113E	Chassis + extender	2048K	2048K	1792K	1792K
2117F	Chassis	—	1280K	—	1024K
2117F	Chassis + extender	—	2048K	—	1792K

All high-performance and standard-performance memory modules may be used with the fault control memory system, which consists of the controller and one or more 12779A/H or 12780A/H check bit array boards. Check bit array boards

Hewlett-Packard 1000 Series

card. The RTE-XL operating system is required to support this capability.

Hewlett-Packard currently offers six packages systems based on the HP 1000 processors. Models 20 and 40 are based on the 1000 E-Series Module 2113E processor; Models 25 and 45 on the 1000 F-Series Model 2117F processor; and Models 9 and 10 on the L-Series 2103L processor. The Models 9, 10, and 20 are packaged with 64K bytes of standard-performance memory; Model 25 with 64K bytes of high-performance memory; and Model 45 with 128K bytes of high-performance memory, Models 20 and 25 are memory-based systems, while Models 10, 40, and 45 are cartridge disk-based. Models 20 and 25 employ the RTE-M Operating System; Models 40 and 45, the RTE-IV Operating System; and Model 10, the RTE-L/XL operating system. Any peripheral device or memory module available to the HP 1000 processors can be employed with the packaged systems.

The Performance/45 is an HP 1000 System specially configured for computation and program development applications. The system is based on a Model 45 system with an F-Series processor and 512K bytes of fault control memory. The hardware is complemented by the FORTRAN 4X compiler and the Pascal compiler. The Performance/45 is not specifically covered in this report although all of its components are explained in detail.

To continue their strength in the market place, HP has packaged two of the HP 7925 Add-on Disk Drives into one 240 megabyte system to reduce the total price by 12 percent. The new 7925T provides disk storage in the form of two compact, removable disk packs, each including five data and two protective disks. The system has a 25 millisecond average random seek-time, and a 5 millisecond average track-to-track seek time. The HP 7925T is compatible with the HP 1000 M-, E-, and F-Series.

Several new printers and terminals have been recently introduced by HP. Some offer refinements and enhancements to the current printer and terminal selection while others open new areas of data collection through bar code and magnetic stripe readers and portable printing terminals.

The HP2613B Printer and HP 2635B Printing Terminal have enhanced paper- and forms-handling to page and text length via program control. Programmable horizontal and vertical tabs and margins, five new program-selectable print pitches, and an optional full 7 x 9 dot print matrix all increase the flexibility of this unit. The 7 x 9 dot matrix print head, however, reduces the print speed from 180 characters per second to 90 characters per second. A new interface supports full duplex transmission with Bell 103 or 212 type modems. Included also is a Printer Busy signal and switch selectable protocols: X-ON/X-OFF (RS-232-C) for non-HP systems or ENQ/ACK for HP systems. The HP 2635B Printing Terminal allows you to define forms and printing features through the keyboards 12 configuration keys.

mount in the memory section of the computer card cage and thus restrict total memory capacity. See the "Checking" topic below for more information on the fault control memory system.

CHECKING: Memory parity checking is standard with all models. Odd parity is employed, with one parity bit added to each word written into memory. A switch setting determines whether the processor will halt or ignore a parity error detected during a memory read; an indication is displayed on the front panel. If the processor is equipped with memory protection or the dynamic mapping system, parity errors cause an interrupt. The L-Series under RTE-4XL will down the bad partition rather than halt the entire machine.

The fault control memory system (FCMS) may be installed on all HP 1000 processors except the Model 2103L. The system is composed of the 2102C (standard-performance) or 2102H (high-performance) controller, one or more check bit array boards, and standard memory modules. FCMS is designed to automatically correct all single-bit errors and detect all double-bit errors and most multiple-bit (3 or more bits) errors. To detect and/or correct, FCMS appends to each memory module location (16 bits plus parity bit) a corresponding set of 5 check bits called a Hamming code, obtained from the check bit array board. The Hamming Code, together with an HP-developed algorithm, forms the mechanism for error detection and correction.

The 12779A (standard-performance) or 12779H (high-performance) Check Bit Array board can be configured to support any 64K, 128K, or 256K-byte block of memory in the lower half of any 512K-byte block of memory when the block boundary is a multiple of 64K bytes. The 12780A (Standard Performance) or 12780H (High Performance) Check Bit Array board can be configured to support any 64K, 128K, 256K, or 512K-byte block of memory when the block boundary is a multiple of 64K bytes. Both boards are composed of 16K dynamic N-channel MOS RAM chips.

STORAGE PROTECTION: Optional on all M, E, F-Series models and standard on the L-Series. The feature provides protection for storage addresses below the address set into a fence register under program control. An interrupt (second highest priority, shared with the parity error interrupt) is set whenever a user program attempts to alter a protected location, jump to a protected area, or execute an I/O instruction; the address of the offending instruction is placed in a violation register. Parity and memory protect features are separately enabled/disabled by standard I/O instructions. The lower boundary of protected memory is location 2. Any instruction except a jump may freely address memory locations 0 and 1 (the A and B registers). Also, an interrupt is generated if a user program attempts to execute a privileged instruction, and interrupts are enabled after three levels of indirect addressing are employed to prevent infinite indirect addressing runaways.

The dynamic mapping system (DMS) option is required for all M/E/F-Series processors with more than 64K bytes of memory. It has three different memory protection mechanisms: two fence registers, and both read and write protection for memory pages. The first fence register, called the Status Register, is contained in the memory expansion module (MEM) of the DMS option. The Status Register, along with other status information, defines the upper boundary of a protected area anywhere in memory, and indicates whether MEM was enabled or disabled at last interrupt time. The second fence register, the Base Page Fence Register, applies to page 0 only and allows this page to be subdivided into protected and non-protected areas that can be shared by several users.

RESERVED STORAGE: The first 64 main memory addresses are reserved for A and B register operation trap

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The HP 2675A is a portable printing terminal with built-in dual cartridge tape drives and an optional internal 300-baud modem. Auto answering allows the terminal to receive, print and/or store data from the host computer automatically transmit data to the computer without an operator to take advantage of off-peak rates. The 120 cps thermal printer produces a 7 x 11 dot matrix with 132 columns of data on an 842 inch wide paper. The alternate 40 columns per line is used for titles and labels. The standard line-drawing character set can print forms and highlight data. The dual cartridge tape drives allow you to access data by file name, absolute file number, or relative position. Eight user-definable softkeys allow the terminal to be tailored for your application. Local editing of up to 254 characters per line is accomplished via an input/output buffer and line transmission mode.

The Hewlett-Packard Data Capture Terminals, the HP 3075A desktop and HP 3076 wall mount also have new capabilities. These include a bar code reader, a magnetic stripe reader, an auxiliary IEEE-488 (HP-IB) interface and an auxiliary RS-232-C/CCITT V.24 port. The bar code reader can be set up via computer control to accept one of range of bar code selections including U.P.C., EAN, Code 39, and 2-out-of-5. The magnetic stripe reader accepts ANSI and ISO Badges with data recorded on Track 2, the American Banker's Association standard. The new IP Factory Datalink allows device connection to host computers over distances up to 4 kilometers (2.5 miles). The HP-IB interface permits as many as 14 devices to be connected as peripherals to a single Data Capture Terminal. The optional RS-232-C/CCITT V.24 interface operates at speeds from 110 to 9600 baud and can be programmed for many different communications requirements.

The Data Capture Terminals now handle punched or marked cards, and punched badges feedback to the user can be by prompting lights, a single line display, a 5-inch CRT or a strip printer. The magnetic strip reader can also be interfaced to the HP 3077A Time Reporting Terminal to improve security arrangements.

HP offers a number of operating systems for the 1000 Series. RTE-IVB/IVE/L/XL are classified as active software, each is described below.

The RTE-IVB is a disk-based RealTime Executive operating system with a session monitor to allocate resources and interface with on-line users. This provides a pseudo time-sharing capability to allow time-slicing to handle multiple users concurrently with protection. RTE-IVB supports a maximum user partition space of 54K bytes. This capacity is not diminished by the physical memory required by the operating system, I/O devices, or resident memory. RTE-IVB supports an Extended Memory Area (EMA) capability which provides a data area of nearly 2 megabytes.

RTE-IVB supports two modes of operation. Session activity involves program development, running

cells, interrupt handling, and dual-channel port controller channels 1 and 2. The uppermost 64 memory locations are reserved for the binary loader, which is loaded from a special ROM containing the permanent program. Transfer from ROM to main memory is controlled by the initial binary loader pushbutton switch on the front panel. These binary loader locations in main memory are not protected and can be used for program storage after loading.

CENTRAL PROCESSORS

GENERAL: All HP 1000 M, E, F-Series processors include as standard a hard-wired control processor implemented in MSI and LSI TTL technology; a 24-bit control path; 16 standard registers, with 12 available to microprogrammers; an 8-bit iteration counter in the control processor; separate memory data, memory address, and I/O buses tied to the unified internal processor's S bus; a control processor unified single bus with program access to memory data, memory address, and I/O buses; 128 standard instructions including floating-point and extended arithmetic unit instructions (28 additional in the HP 1000 F-Series, including floating-point, scientific instruction processor, and fast FORTRAN processor); 211 user-accessible control processor instructions; and program compatibility with 2100 Series computer programs except those with timing loop dependence.

Also standard is memory parity checking; a multilevel vectored interrupt structure; up to four separate internal bootstrap loaders selectable from the front panel (paper tape is standard on the 1000 M, paper tape and disk on the 1000 E, and disc on the HP 1000 F-Series); loader protection through residence in special PROM's separate from the control ROM; AC standby mode and the ability to sustain power through temporary line loss (brownout); thermal sensing for automatic shutdown on excessive temperature; and separate I/O slots independent of memory size and processor options.

The L-Series is based on HP's proprietary Silicon-On-Sapphire (SOS) technology. A single chip CPU combined with a single chip I/O processor for every interface board provides distributed intelligence over a 16 bit data path. The CPU board includes 2 accumulators, 3 memory registers, and 2 supplementary registers. Power fail provisions, memory product logic, a time base generator interrupt, and an illegal instruction interrupt are also included on the central processor board. Eighty instructions, including integer arithmetic, memory and register references, and an I/O group provide instruction and program compatibility with the M/E/F-Series product lines. Other standard features include: a vectored priority interrupt system, a 2.8 megabyte per second bus speed, a self-test feature, bootstrap loaders, power fail/auto restart, and a virtual control panel. The bootstrap loaders can use either a disk memory via the HP-IB interface or a 12008A PROM Storage module as the loading device. The Virtual Control Panel (VCP) is ROM based and allows an operator to perform control panel functions via a locally or remotely connected terminal. Only one I/O card can have this capability in order to maintain system integrity. The VCP terminal can be used to examine and change contents of registers and memory locations, control program execution, and select and initiate a bootstrap load.

Exclusive to the HP 1000 E- and HP 1000 F-Series are these standard features: variable microcycle timing for the control processor; enhanced microprogrammability, including multiple subroutine levels, microprogrammable block I/O for intelligent microprogrammed I/O channels, and a microprogrammable processor port that allows external processors to be interfaced directly to the control processor; and remote program load (RPL) so the computer can be force-loaded from a remote site.

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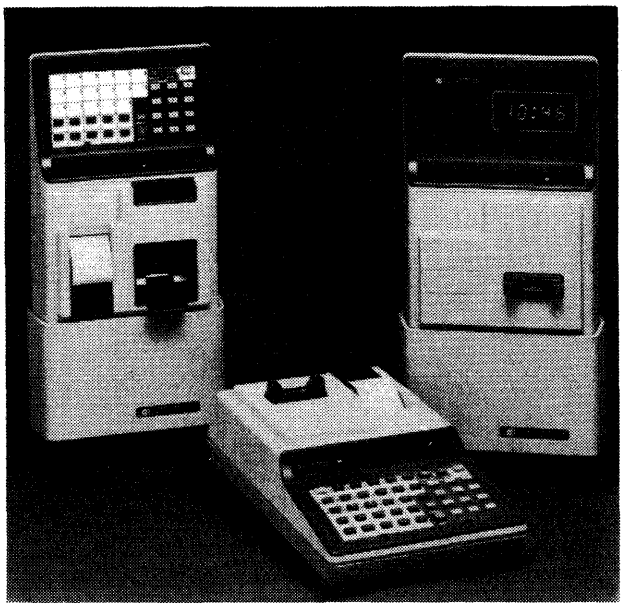

Three new Hewlett-Packard Data Capture Terminals gather essential industrial information where it originates, without need for computer-trained personnel. Operation of wall-mounted HP 3075A (left) is identical to desktop HP 3075A (center). HP 3077A Time Reporting Terminal (right) reads badges, records time.

background programs, data entry, automatic test control, and query access to a data base. Read-Time activity is concerned with response to external events, time-vertical controls, network data-processing, and on-line data capture. FORTRAN IV, Assembly language, and BASIC are supported by RTE-IVB. Optional micro-programming aids are available for on-line development and debugging of user-microprogrammed subroutines.

RTE-L and RTE-XL are the two HP operating systems designed for the L-Series processors. They differ in respect to memory capacity to conform with either L-Series configuration—the standard 64K byte memory or the 512K byte high density memory. RTE-L/XL utilizes a modular design to allow a range of configurations from small, operator-less, execute-only stations to full disk-based systems with program development capability. The I/O drives are designed to take advantage of the L-Series distributed architecture in order to maximize throughput.

The L-Series is tied to the M/E/F-Series in a number of ways. There is a high degree of program request and operator command compatibility with the HP 1000 RTE operating systems. User programs can be designed for transportability between the systems. Some of the program development tools found in RTE-L/XL can be executed on RTE-IVB systems. These include an interactive source editor (EDITR), a relocating loader (LOADR), and a system generator (RTLGN). The languages supported by RTE-L/XL include the HP Assembler, FORTRAN IV, PASCAL, and BASIC/1000L. These provide another level of system compatibility in the HP 1000 Series while allowing the user multi-lingual capabilities with a smaller system price tag.

Additional standard features on the HP 1000 F-Series include a hardware-implemented floating-point processor (FPP), a scientific instruction set (see instruction repertoire and below), and a fast FORTRAN processor (see optional features of the HP 1000 listed further below). The standard F-Series has been enhanced by the addition of double-word integer instructions that perform operations on 32-bit integers. The F-Series has also been enhanced by the introduction of an optional Vector Instruction Set (VIS) described later in this section.

The FPP reduces processing times for single-precision, double-precision, and extended-precision operations. Add/subtract takes a minimum of 4.9 microseconds, and multiply/divide 6.2 microseconds, thus helping to provide the level of floating-point computational performance required for many real-time applications.

Microprogrammers can use the FPP as a control processor computing resource to obtain performance increases over normal microprogramming. To the microprogrammer, the FPP provides a high-speed processor for floating-point and extended-precision integer operations. An example of the combination of FPP with direct microprogramming is given by execution of a Sine(X) library function. With FPP, the execution time is 127.5 microseconds, while with FPP and direct microprogramming, the execution time is 51.8 microseconds, more than 2.5 times faster.

The scientific instruction set works with the FPP to achieve execution speeds for trigonometric, logarithmic, and other transcendental functions 6 to 24 times faster than equivalent software routines. Execution time for square root averages 30.9 microseconds; sine and cosine times average less than 48 microseconds. In addition, by taking advantage of the extended-precision capabilities of the FPP, the scientific instruction set provides a single-precision result with accuracy superior to that obtained from software libraries. HP has expanded the capabilities of the scientific instruction set to include full double-precision accuracy with floating point operations increased in speed by 10 to 20 percent. Polynomial instructions are now included to process general-case polynomials 4 to 10 times faster than an equivalent software routine.

The HP Vector Instruction Set (VIS) is offered as optional equipment with new HP 1000 F-Series computers, or as a retrofit to earlier systems. The programmer now has 38 firmware vector instructions that work in conjunction with the Floating Point Processor to replace FORTRAN DO loops for interactive operations. The VIS includes instructions that perform vector-vector arithmetic and vector-scalar arithmetic, as well as products, pivot, swap, and maximum/minimum operations. The 4 to 10 times increase in speed of the VIS is due to a pipelining of data to the FPP and an elimination of loop overhead. HP states that a 100 by 100 matrix can be inverted in 12.25 seconds. The extended memory area of the RTE-IVB operating system allows data arrays of nearly two million bytes to be directly addressed from a user program. Applications for VIS include image processing, process optimization, 3-dimensional graphics, simulations of physical and chemical systems, linear programming, and signal and vibration analysis.

The 2108MK and 2109EK Board Computers can be viewed at two levels, as control processors and as full 1000 Series computers with the complete range of features and peripherals available (12723E instruction ROM installed in the 2108MK and 12728H instruction ROM installed in the 2109EK). In the 2109EK Board Computer, significant speed is achieved by fetching the next instruction from memory while the current one is being executed. This "pipelining" (or instruction prefetch) results in an effective doubling of

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To meet their user's data base management needs, HP offers a version of its famous IMAGE/QUERY package. IMAGE/1000 is a subset of HP's impressive IMAGE/3000 DBMS and is intended for disk-based systems with as little as 64K bytes of memory.

In keeping with the industry emphasis on distributed processing systems and networks, HP offers the DS/1000 (Distributed System/1000) networking software. DS/1000 provides an integrated set of high-level network facilities and procedures for resource sharing, distributed file management, program-to-program data exchange, and coordinated distribution of processor workloads to other HP 1000 and HP 3000 systems. DS/1000 provides a true nodal network architecture with store-and-forward communications supporting star, ring, and string configurations or combinations of these. For communications with an IBM 360/370 computer in a manner similar to that of the IBM 2780 batch terminal, HP offers RJE/1000. DS/1000 and RJE/1000 are combinations of hardware and software.

HP also offers the Multipoint Terminal subsystem, a microprocessor-based interface with supporting software that provides terminal communications between up to 32 HP 2645A and/or 2648A CRT terminals connected to an HP 1000 computer system.

Peripheral devices manufactured by Hewlett-Packard at this time are line printers (with rights to a Tally design), digital plotters, cartridge and disk pack drives, CRT terminals, magnetic tape subsystems, paper tape readers, and an optical mark card reader.

The HP 1000 family offers an extensive line of instrumentation and software for process control. Space limitations preclude a detailed description of these items in this report.

Services offered by HP with the 1000 systems include a library of contributed programs, 23 training courses, a documentation kit offered in advance of delivery, a software subscription service, a comprehensive software support service, diagnostic subscription service, in-house consultant service, maintenance service, and the HP *Communicator* magazine. Maintenance is offered through 188 offices worldwide.

USER REACTION

Seventeen users responded to the 1980 Datapro User Survey to report on twenty-four HP 1000 systems. All but two of the respondents purchased their systems outright while the two holdouts preferred to lease their HP 1000s. The principal applications listed were engineering/science with seven responses, manufacturing with six responses, distributed processing and transportation each with four responses, and service bureaus with three responses. Fourteen users noted in-house personnel to be their source of application programs. This is interesting when you consider that the next highest category, proprietary software

processor performance. Another feature of the Board Computers is the speed of the S-bus, with a transfer rate of 6 megabytes per second for the 2108MK and 11.4 megabytes per second for the 2109EK.

On the 2109EK Board Computer, automatic cold loading is a standard feature which offers a custom system initialization sequence. On power-up of a processor lacking the standard front panel assembly, control is passed to a user-written microprogram which can "cold load" main memory, perform an initialization sequence for a particular application, and monitor the system control panel.

The 2103LK Board Computer consists of a central processing board and 64K bytes of memory. It offers the maximum packaging flexibility to OEM's and end users designing their own systems. The Virtual Control Panel (VCD) allows remote system sites to be effectively managed or supported with a minimum cost.

The HP 1000 E- and F-Series control processor has a variable micro-instruction execution time of 175 or 280 nanoseconds. It employs a technique, known as dynamic micro-cycle timing, that assigns a 280-nanosecond micro-cycle to only those operations that need it. Otherwise, 175 nanoseconds are assigned to a micro-cycle. On the 1000 M-Series, the micro-cycle timing is fixed at 325 nanoseconds.

Microprograms on the HP 1000 M, E, F-Series processors consist of machine-level micro-instructions, each of which is a 24-bit word comprising 5 word fields, or micro-orders. Each micro-order, when decoded, activates one or more control lines to perform specific processor functions. Using the 211 micro-orders available, the microprogrammer has full access to all the HP 1000 M, E, F-Series features, including twelve 16-bit scratch-pad registers. Each 24-bit word (micro-instruction) comprises 5 fields. These fields are allotted to the following types of octally-coded micro-orders; a 4-bit operation field, a 5-bit special field, a 6-bit ALU and conditional field, a 5-bit store field, and a 5-bit S-bus field. Four micro-instruction word formats are used, which implement combinations of these five fields. Type 1 is for data transfer and modification; type 2, constant information; type 3, conditional branch; and type 4, unconditional branch. Micro-orders include 15 operations, 32 special, 32 ALU arithmetic, 32 conditional branch, 4 immediate modifier, 32 store-destination, 32 reverse jump sense, and 32 S bus source.

The M, E, F-Series control path is 24 bits wide, while the data path is 16 bits wide. The processor employs a single unified bus structure (S bus), with program access to memory, data memory address, and I/O buses. Burst transfers take place at the rate of 5.7 million words per second.

The L-Series incorporates a single backplane bus for memory, processor, and I/O with a data path width of 16 bits and a bus speed of up to 1.9 million words per second.

For the HP 1000 M-Series, optional firmware bootstrap loaders are available, each packaged on a 256-by-4-bit PROM. Currently available are the 12992B PROM for loading from a 7905/7906/7920/7925 Disk Drive, the 12992C PROM for loading from a 264X CRT Terminal cartridge tape drive, and 12992D PROM for loading from a magnetic tape drive. The 12992 C and D loaders are also optional on the HP 1000 E- and F-Series. The HP 1000 M/E/F-Series processors may have a maximum of four loaders selected from either standard or optional products. The L-Series offers three bootstrap loaders: 1) from disk memory via HP-IB interface; 2) from a 12008A PROM storage module; and 3) from HP mini cartridge tape unit. Loader 1 and 2 can be used for auto-boot at power-on. In addition, the L-Series can be boot loaded over DS 1000.

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packages, only received six responses. Five users listed contract programming as their application program source and three purchased "ready-made" programs from HP.

The HP 1000's covered spanned a wide range of system life. The average system has been in use for 30.5 months with the range of responses going from a new user with only 2 months experience to a veteran HPer with nearly 10 years on an HP 1000. The majority of the users reported on one system consisting of one CPU with from one to eighteen terminals. Four users had multi-CPU configurations with up to 50 terminals on-line. Fourteen respondents were FORTRAN users; three used BASIC; three, Assembly Language, and one, COBOL.

There were no problems reported to any significant degree. Three users reported their system proposed by the vendor was too small and had to be expanded. A different set of three users felt that their system costs exceeded their expectations. Three more respondents felt that it was hard to keep up with vendor enhancements and changes to the hardware and software.

The users were much more vocal in their praise of their HP 1000s. Seven users were happy with their response time; seven felt their systems were easy to reconfigure and expand; four thought that the data base language was efficient and effective; and three users noted that their delivery and/or installation of their equipment was ahead of schedule. A full rating of the users responses is detailed below.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	5	8	4	0	3.1
Reliability of mainframe	10	5	2	0	3.5
Reliability of peripherals	7	6	2	1	3.2
Maintenance service					
Responsiveness	4	8	3	1	2.9
Effectiveness	4	8	3	1	2.9
Technical support					
Trouble-shooting	3	3	8	1	2.5
Education	2	7	3	2	2.6
Documentation	2	6	5	2	2.5
Manufacturer's software					
Operating system	4	9	1	1	3.1
Compilers and assemblers	1	10	3	1	2.7
Applications programs	0	4	3	0	2.6
Ease of programming	1	13	1	1	2.9
Ease of conversion	1	5	3	1	2.6
Overall satisfaction	5	7	5	0	3.0

*Weighted average on a scale of 4.0 for Excellent.

Reviewing these ratings places the two highest scores at reliability of the mainframe and peripherals. This overall satisfaction is supported by the fact that seven users reported that they were planning to acquire additional software from HP. An additional five users are planning to expand their data communications facilities and three others are planning to go to other suppliers for proprietary software.

Hewlett-Packard seems to know how to keep their customer base happy. In response to the final question

Employing Remote Program Load (RPL), an HP 1000 E- or F-Series processor at a remote site may have an initial binary load performed automatically on power-up from a local peripheral or from a remote site. Under RPL operation, information normally keyed into the front panel is set in special switches on the CPU board, so that bootstrapping can take place. One of nine devices may be selected as a load unit on the 2109E or 2111F, while one of 14 devices is possible on the 2113E or 2117F. Loader selection is restricted to one of two supplied by the user. Remote forced loading is via a hard-wired 12966A or 12968A interface.

Options for the M/E/F-Series processors include memory protection, a dual-channel port controller, the dynamic mapping system, fast FORTRAN processor (standard on the HP 1000 F-Series), writable control store, user ROM control store, power failure recovery, and I/O and memory extenders.

The fast FORTRAN processor (FFP) provides firmware replacement of 18 frequently used library subroutines on the HP 1000 M-Series, 19 on the HP 1000 E-Series, and 9 on the HP 1000 F-Series. (Extended-precision floating-point routines are not needed since standard instructions exist for these functions, resulting in performance improvements of 2 to 20 times over the corresponding software subroutines.) The FFP is not offered with L-Series processors. Functions performed by the FFP, with their execution times in microseconds, include DBLE, which converts single to extended precision (13.02 microseconds for the 1000 F, 1000 E, or 1000 EK/15.28 microseconds for the 1000 M or 1000 MK); SNGL, the reverse of DBLE (18.2/20.15 to 65); XMPY for extended multiply (56.7 to 64.8/80.28 to 105.30); XDIV, for extended divide (80.7 to 93.1/107.90 to 163.15). XADD, for extended addition (38 to 50.7/40.25 to 130.90; XSUB, for extended subtraction (38 to 50.7/40.25 to 130.98; and GOTO, which transfers control to a location indicated by the FORTRAN-computed GOTO statement (10.6/13). Other routines include extended-precision move, normalization, and packing; setting a table of increasing value; two- and three-dimensional array mapping; and conditional control transfers. The FFP can be used with all FORTRAN language processors and is supported by BCS and all levels of RTE.

The 13306A FFP, designed for the HP 1000 E-Series, consists of 9 ROM IC's; 6 are 16-pin 1K-byte ROM's and 3 are 24-pin 4K ROM's; all mount on the firmware accessory board. The 12977B FFP, for use on the HP 1000 M-Series, consists of 1 user control store card to be mounted on the control store stand-offs of the CPU board.

CONTROL STORAGE: On the 1000 E and 1000 F, control storage consists of 175- to 280-nanosecond full micro-instruction time PROM fixed control storage or RAM writable control storage (WCS), both LSI semiconductor. Combinations of both types can be implemented up to a maximum of 16,384 24-bit words. (Some of this area is reserved for planned HP enhancements.) Control storage is organized into 64 modules of 256 words each. The basic instruction set occupies 1024 words of PROM.

On the HP 1000 M-Series, control storage consists of 325-nanosecond cycle time PROM fixed control storage or RAM writable control storage (WCS). The PROM has an access time of 75 nanoseconds, and the WCS an access time of 110 nanoseconds. Combinations of both types can be implemented up to a maximum of 4096 24-bit words. Control storage is organized into 256-word modules or pages. The basic HP 1000 M-Series instruction set occupies 1024 words of PROM, or 4 modules, and is mounted on a single board under the CPU board. Two additional 512-word (two modules) boards can also be mounted under the CPU. One of these can be the DS/1000 firmware board; the other, the FFP/dynamic mapping instructions ROM board. If the user

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"Would you recommend this system to another user in your situation?", eleven users said yes while only two were negative. Of the two negative response, one recommended a HP 3000 as an alternate to his current system. This final overall recommendation combined with the reliability of the mainframe and the peripherals noted earlier describes a machine that people like, depend on, and use. What more can a computer user want?□

wishes to implement a totally custom instruction set, a third 512-word board can be substituted for the 1024-word basic instruction set. The remaining 2048 words of WCS, PROM, or ROM are contained on other boards which are mounted in the I/O card cage.

HP 1000 M-Series control storage module assignments include: modules 0, 14, and 15, base instruction set; module 1, front panel control; module 2, DMS instructions or user microprogramming; modules 3 to 5, FFP or user microprogramming; modules 6 to 11, planned HP enhancements or user microprogramming; and modules 12 and 13, user microprogramming.

The 12945A UCS is for use on the HP 1000 M-Series only. This board provides 2 modules of 256 24-bit words each. PROM's are allocated six per module. The 12945A has a cycle time of 325 nanoseconds. For the user electing to employ this board, 512 micro-instruction words are added to the standard micro-instruction set. The 12945A is mounted beneath the HP 1000 M-Series processor board and is attached to it by screws.

The 13197A WCS can be employed with any HP M/E/F-Series processor. Up to three of these 1024-word boards are allowable per processor. The 13197A is divided into 2 modules of 512 words each and has an access time of 132 nanoseconds maximum and a cycle time of 175 nanoseconds. Full microinstruction time depends on the processor: 325 nanoseconds for the HP 1000 M-Series and 175 to 280 nanoseconds for the HP 1000 E- or F-Series.

The 13197A WCS is a dual-port memory. One port connects to the control processor's memory space, and the other to the I/O backplane. Control processor subroutines are loaded into the 13197A using either programmed I/O or dual-channel port control (DCPC) transfers at full bandwidth via the I/O backplane memory port. Standard I/O instructions are then used to configure control store module addresses and enable the control processor memory port, thereby granting access to the loaded subroutines by the control processor.

REGISTERS: The standard programmable register complement includes two 16-bit accumulators (A and B), three memory control registers (the T- and P-registers are 16 bits each; the M-register is 15 bits long), and two 1-bit supplementary registers (overflow and extend flip-flops). The M/E/F Series also includes two 16-bit index registers (X and Y) and a 16-bit display register. The M-register holds the address of the memory location that the CPU is currently reading from or writing to. The T-register holds the contents of the location indicated by the M-register. The P-register holds the address of the next instruction to be fetched from memory.

In addition to the standard register set, the M/E/F Series also offers twelve 16-bit scratch registers accessible to the microprogrammer, a 16-bit latch register, an 8-bit iteration counter, and a status bit accessible to the micro-level programmer.

ADDRESSING: The HP 1000 M, 1000 E, 1000 F, 1000 MK (with 12728E instruction ROM), and 1000 EK (with 12728H instruction ROM) all have the following addressing modes: direct (2048 bytes of page 0 or the current page, or 64K bytes with the extended arithmetic memory reference instructions), page relative, indirect, page relative-indirect, indexed, and indirect-indexed (post-indexing). Indirect addressing is multiple-level.

The HP 1000 L-Series offers direct, multilevel-indirect, and register implicit addressing. Memory is logically comprised of 32 pages of 2048 bytes with direct access to current and base (page 0) pages and with indirect access to all pages. Physically memory can be expanded to 256 pages using RTE-XL with expanded memory management.

INSTRUCTION REPERTOIRE: The HP 1000 M-Series, 1000 MK (with 12728E instruction ROM), HP 1000 E-Series and 1000 EK (with 12728H instruction ROM) have 128 instructions as standard; the HP 1000 F-Series, 156 as standard; and the HP 1000 L-Series and 1000 LK, 80 as standard. Addition of the DMS option adds 38 memory expansion instructions to the M/E/F-Series. Up to 224 instruction codes are available. Many of these, however, have not yet been implemented.

There are 43 register reference instructions in the standard M/E/F-Series complement to perform functions upon the data in the A, B, and E registers only; the L Series has 39 instructions in this group divided into 20 Shift-Rotate and 19 Alter-Skip instructions.

The 14 standard memory reference instructions perform operations upon data in the single memory location addressed with data in an implied register, either A or B, or perform a jump. Registers A and B can, of course, be referenced as memory cells also.

There are 13 standard I/O instructions and 8 single-precision floating-point instructions for the M/E/F-Series. The HP 1000 F-Series adds floating-point/double integer conversion in both directions and eight extended-precision floating-point instructions.

The extended arithmetic instructions are divided into 4 (L-Series: 6) that do not reference a register directly and 6 which work only with data in the A and B registers without reference to memory. The L-Series also offers 4 Overflow bit manipulation instructions, a Halt code, and a dedicated I/O processor (discussed in detail in I/O control).

The FFP instructions are standard on the 1000 F and optional on the 1000 E- and 1000 M-Series. They are actually microcoded routines. For further details see the discussion under Central Processors.

The scientific instruction set is unique to the HP 1000 F-Series processor and consists of nine instructions: sine, cosine, tangent, arc tangent, hyperbolic tangent, square root, exponent, natural logarithm, and base 10 logarithm. This set employs the single-precision or double-precision floating-point format.

There are 38 instructions associated with the DMS feature. These work with the map, fence, A, and B registers—loading, storing, enabling, and disabling. Also, strings of words can be transferred to/from memory and map registers. Some jumps and jump to subroutines are also included, as are mapped memory to mapped memory word-string moves (using the A and B registers for source and destination addresses and the X registers for a count); reads of the MEM status register; cross compares and loads with the A and B registers and mapped memory; loads and stores of the entire map to/from memory based upon directions contained in A or B; and map-to-map transfers upon instructions contained in A or B.

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The HP 1000 M/E/F-Series instruction set is backward-compatible with all HP 2100 Series computers. All programs written for 2100 Series computers are compatible with the HP 1000 Series except those with timing loop dependence. The HP 1000 L-Series set is compatible with the other HP 1000 Series processors.

INSTRUCTION TIMINGS: All timings listed below are average timings in microseconds for 16-bit fixed-point and 32-bit floating-point operands:

HP 1000 L-Series or HP 1000 LK

	Fixed-Point	Floating-Point
Load/Store	4.1	N/A
Add/Subtract	4.5	435
Multiply	28.1	504
Divide	8.6-33.1	478
Compare & Skip	5.0	N/A

HP 1000 M-Series or HP 1000 MK*

	Fixed-Point	Floating-Point
Load/Store	1.9/2.9	NA
Add	1.9	23.7 to 67.6
Subtract	1.9	29.7 to 70.5
Multiply	12.3 to 13	47.8 to 56.1
Divide	15.9 to 18.2	61.4 to 77.7
Compare & Skip	2.6	NA

*With 12728E Instruction ROM.

HP 1000 E-Series or HP 1000 EK** with Standard-Performance Memory

	Fixed-Point	Floating-Point
Load/Store	1.19/1.85	NA
Add	1.19	13.13 to 27.65
Subtract	1.19	13.83 to 29.44
Multiply	5.7 to 6.7	25.48 to 35.11
Divide	8.1 to 9.6	34.02 to 47.32
Compare & Skip	1.23/1.72	NA

HP 1000 F-Series or HP 1000 E-Series or HP 1000 EK** with High-Performance Memory

	Fixed-Point	Floating-Point
Load/Store	0.91/1.26	NA
Add	0.91	12.91 to 27.44
Subtract	0.91	13.61 to 29.22
Multiply	5.3 to 6.0	25.27 to 34.90
Divide	7.7 to 9.1	33.18 to 47.11
Compare & Skip	1.09/1.43	NA

**With 12728H Instruction ROM.

HP 1000 F-Series with High-Performance Memory

	Single-Precision Floating-Point	Extended-Precision Floating-Point
Add/Subtract	4.8 to 7.7	10.3 to 13.8
Multiply	6.1 to 6.4	12.2 to 13.0
Divide	6.1 to 9.3	12.2 to 17.4

INTERRUPTS: The HP 1000 Series uses a vectored priority interrupt system which has up to 54 distinct interrupt levels (21 on L-Series). Of the 54 levels in the M/E/F-Series the first 4 are dedicated to power failure, parity checking, memory protection, and the dual-channel port controller interrupts; the remaining 50 interrupts are available for external devices on a priority basis. Current I/O slot limitations with two I/O extenders are as follows: 2108M, 2109E, and 2111F, 41; 2112M, 2113E, and 2117F, 46. Any interrupt except the two highest-priority ones, and thus any device, can be selectively enabled or disabled under program control. Interrupts that are received while the processor is in a halt mode are stored to be acted upon in order of priority when the run mode is restored.

The 21 interrupt priority levels in the L-Series are assigned in the following order: 1) memory parity; 2) illegal instructions; 3) memory protect; 4) power failure; 5) special interrupts; and 6) time base generator. The remaining 15 levels are available for I/O device interrupts.

PHYSICAL SPECIFICATIONS: All HP 1000 Series processors, the I/O extender, and memory chassis are mounted in standard racks. They have 19-inch-wide operator panels and a 16.75-inch-wide chassis behind the panel. All are 23 inches deep behind this panel, with a 23.5-inch overall depth for the processor and 24.5-inch overall depth for the memory and I/O extender chassis. The 2103LA is 5.25 inches high and weighs 31 pounds; the 2108M, 8.75 inches and 45 pounds; the 2112M, 12.25 inches and 65 pounds; the 2109E, 8.75 inches and 45 pounds; the 2113E, 12.25 inches and 65 pounds; the 2111F, 12.25 inches and 66 pounds; and the 2117F, 17.50 inches and 110 pounds.

All models use 110 or 220 VAC single-phase power with a 20 percent voltage tolerance and a frequency of from 47.5 to 66 Hertz. Power consumption for the 2103L, 2108M, and 2112M is a maximum of 500, 625, and 625 watts, respectively; the respective maximum heat dissipation is 1024, 2133, and 2133 BTU's per hour. On the HP 1000 E-Series, power consumption for the 2109E and 2113E is 625 watts maximum. The 2109E and 2113E each dissipate 2133 BTU's per hour. The 2111F consumes 625 watts and the 2117F an additional 200 watts. Heat dissipation on the 2111F is 2113 BTU's per hour; on the 2117F, 2815 BTU's per hour. A Memory Extender uses up to 300 watts, dissipating 1024 BTU's per hour. An I/O extender requires up to 770 watts maximum and dissipates 2138 BTU's per hour.

Operating temperatures for these computers and memory units range from 32 to 131 degrees F.; storage conditions can range from -40 to 167 degrees F. Relative humidity, at operating temperatures from 77 to 104 degrees F., can be 20 to 95 percent, noncondensing. The L-Series can tolerate a relative humidity from 5 to 95 percent at 104 degrees F, non condensing.

Packaged HP 1000 computer systems, based on the M-, E-, and F-Series, which are configured in cabinets are 64.25 inches high, 21 inches wide, and 39 inches deep. The table-mounted system console is 13.5 inches high, 17.5 inches wide, and 25.5 inches deep. The L-Series based packaged systems are 62.2 inches high, 29 inches wide, and 32 inches deep. The M-, E-, and F-Series based packaged HP 1000 computer systems which are in desk configurations are 28.25 inches high, 72 inches wide, and 31 inches deep. The L-Series based desk configurations are 36.5 inches high, 29 inches wide, and 32 inches deep. Recommended floor space requirements are from 9 by 9 feet to 15 by 9 feet depending on the model selected. System weight is from 312 to 690 pounds, also dependent on the model.

Operating temperatures range from 50 to 104 degrees F.; for the 2174A/B and 2175A/B, 32 to 104 degrees F. Storage conditions can range from -40 to 167 or 149 degrees F., depending on the model. Relative humidity for all models can be from 20 to 80 percent, noncondensing.

INPUT/OUTPUT CONTROL

I/O CHANNELS: There are two I/O mechanisms common to the M/E/F-Series processors: programmed I/O, through

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the A or B registers, or direct memory access, through the optional dual-channel port controller (DCPC). A third mechanism, exclusive to the 1000 E and 1000 F makes use of microprogram control. The L-Series uses an I/O Master Processor on each I/O interface card to support DMA capability.

The L-Series DMA structure requires only one interrupt per block transfer instead of one per data item. The L-Series has a maximum achievable DMA rate of 2.7 megabytes/second. The I/O Processor (IOP) also supports a self-configuring mode of operation. Instead of interrupting after a block transfer, the IOP fetches a new set of control words for the next transfer, reconfigures itself, and initiates another block transfer. This process continues as long as additional control word sets are available. This self-configured mode requires a maximum of 7 microseconds between successive transfer of a chained series. The IOP also automatically manages byte packing and unpacking when byte mode is specified.

The M/E/F-Series programmed I/O, which permits the user to manipulate data as it is transferred, is a three-step process: 1) device to I/O interface card in the I/O slot in the computer, 2) between the interface card and the A or B register via the I/O bus and the CPU, and 3) between the A or B register and memory via the S bus and the memory controller. This input sequence applies in reverse order for programmed I/O output. The maximum programmed I/O data transfer rate is 91,000 bytes per second on the 1000 M and 384K bytes per second on the 1000 E and F.

The M/E/F-Series DCPC contains all necessary logic to control DMA transfers for multiple devices. This arrangement avoids the need for redundant DMA control logic in each individual controller.

DMA data transfers with the optional dual-channel port controller, once the DCPC registers have been initialized by the program, proceed automatically. The process is in two steps: 1) between the device and its interface card; and 2) between the interface card and memory using the S bus, the I/O bus, and the memory controller. No programming is involved during the process. Two devices can use the DCPC at a time, with top priority being given to port 1.

The microprogrammable processor port (MPP) is implemented only on the HP 1000 E- and F-Series. In the 1000 F-Series, it is used for communication with the Floating Point Processor (FPP).

The MPP provides a direct interface to the CPU for user-designed hardware. The MPP provides address, data, and control capability, so external devices can be controlled and can transfer data at burst rates up to 11.4 megabytes per second for 32 bytes. The maximum continuous transfer rate for the MPP is 3.18 megabytes per second, a figure that is dependent on user microprogramming. The MPP has 16 I/O lines with 2 addressable devices at any one time.

The E- and F-Series also have a microprogrammable block I/O capability that allows transfer rates via the I/O backplane of up to 3.18 megabytes per second on input and 2.72 megabytes per second on output. These rates are dependent on user microprogramming. To implement microprogrammable block I/O, the user must design both I/O cards and block I/O control microprograms.

SIMULTANEOUS OPERATIONS: For the M/E/F-Series, DMA operations over the DCPC can be simultaneous with one another and with processor accesses to memory within the limit of the transfer rates and bandwidth, and in the priority order of DCPC channel 1, channel 2, and the processor. DCPC transfers occur on an I/O cycle-stealing basis, not subject to the I/O priority interrupt structure. Of course, CPU operations that do not require memory access can continue without interference during DMA data transfer.

The L-Series is entirely based on DMA operations. There is no DCPC but rather intelligent I/O boards which manage their own I/O. The I/O processor handles variable-length transfers by utilizing an end of transfer signal. Multiple DMA transfers can be accomplished without the interruption of the central processor.

CONFIGURATION RULES

Maximum Configuration parameters for a HP 1000 Series system are as follows:

- Up to 2.4 megabytes of main memory
- Up to 960 megabytes of on-line disk storage
- Up to 64 terminals
- Up to 4 magnetic tape drives

WORKSTATIONS: A total of 64 physical devices can be connected to the system. The number of terminals is limited by the amount of memory and the power of the processor. Too many "active" terminals will increase response time. Local and remote terminals are connected to the L-Series processor via the 12005A Asynchronous Serial Interface. The M/E/F-Series supports a variety of interfaces including: Point-to-Point, Multipoint, 8 and 16 channel multiplexers, current loop, and synchronous or asynchronous. The HP-IB interface is used on all of the HP 1000 Series processors. It is Hewlett-Packard's implementation of the IEEE Standard 488-1978.

DISK STORAGE: The L-Series supports two of the ICD (Integrated Controller Disk) disk drives with a maximum of two drives per interface. These units are available in 19.6 megabytes cartridge disk, and 12 megabytes fixed disk. The M/E/F-Series also supports these systems plus the 50 and 120 megabyte disk pack drives in addition to MAC (Multi-Access Controller) disk drives. The MAC drives support multiple processors and up to seven slave disk drives per master unit. The MAC drives are available in the 19.6 megabyte cartridge drive and the 50 and 120 megabyte sizes. Two flexible disk subsystems are also available for the M/E/F-Series. One offers 514K bytes of storage on one single-sided, double-density diskette. The system, 12732A, uses two I/O channels; one add-on drive is available for a total capacity of 1028K bytes. The 9895A subsystem provides 2.36 megabytes of storage on two double-sided, double-density diskettes. This unit is only supported by RTE-IVB.

MAGNETIC TAPE UNITS: Up to 4 magnetic tape drives are supported on the HP 1000 Series. HP offers both 800 bpi, NRZ1 and 1600 bpi, phase-encoded units. The only restriction is that you cannot mix different types of tape drives per controller.

PRINTERS: Line printers with rated speeds between 300 and 1000 lines per minute are supported by the M/E/F-Series.

MASS STORAGE

As a general preface, this key to HP disk model suffixes should prove helpful: H= ICD disk (HP-IB interface), M= MAC disk master, S= MAC disk slave, R= rack mount (7906 only), no "R"= floor standing unit.

7906 H/HR/M/MR DISK CARTRIDGE DRIVE: The 7906 is a 19.6 megabyte drive with 9.8 megabytes of fixed disk and 9.8 megabytes of removable cartridge storage. It can be configured on the same controller as the 7910/20/25 drives.

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Data is recorded on 800 tracks per cartridge or disk using 48 256-byte sectors per track. Track-to-track, average, and across-all-tracks head positioning times are 5, 25, and 45 milliseconds, respectively. The rotational speed and delay and the data transfer rate are also the same as those for the 7920.

7910 HR DISK DRIVE: The 7910 HR is a 12 megabyte fixed disk drive. It uses an integral controller which is the same as in the 7906H/20H/25H drives.

7920 H/M DISK PACK DRIVE: The 7920 is a 50-megabyte drive employing a five-platter disk of the IBM 3330 type. Three of the five platters are actually used, with five surfaces for data and the sixth for servo use. The remaining two platters are for protection, with one located on the top of the pack and the other on the bottom. The add-on drive is 7920S, available singly or in packages.

Data is recorded at 4680 bpi on 815 tracks per surface, using 256-byte sectors and 48 sectors (12,288 bytes) per track. Track density is 384 tracks per inch. Space tracks are not included in the rated drive capacity of 50,073,600 bytes; 8 spare tracks per surface are provided. Track-to-track, average, and across-all-tracks head positioning times are 5, 25, and 45 milliseconds, respectively. The drive has a rotational speed of 3600 rpm with an average rotational delay of 8.3 milliseconds. The burst data transfer rate is 937,500 bytes per second. The 7920 drive is manufactured by Hewlett-Packard.

7925 H/M DISK PACK DRIVE: The 7925 has essentially the same design as the 7920 except that it is a 120-megabyte drive with 7 platters, 9 functional surfaces, 64 sectors per track, and 16,348 bytes per track. The rotational speed is 2700 rpm and the average rotational delay is 11.1 milliseconds.

7925T ADD-ON DISK STORAGE SYSTEM: HP has packaged two 7925S Disk Drives into one 240 megabyte system. This reduces the total price for the storage capacity. The 7925T provides two compact, removable disk packs (one for each drive). Each pack is made up of five data and two protective disks. The disk pack system provides a 25 millisec average random seek time and a 5 millisecond track-to-track time.

The MAC controller subsystems feature integral error detection, using a special seven-word error detection code appended to each sector. Under this scheme, one burst of erroneous data up to 32 bits long can be detected and corrected in each sector. Erroneous data blocks between 32 and 48 bits long can be detected but not corrected. Actual correction occurs in the controller buffer. Error detection logic in the disk controller computes a three-word mask that is Exclusive ORed with the incorrected data to form the correct version.

The 12009A interface provides the HP-IB channel required by the H/HR disk drives on the HP1000 L-Series. The 12821A is used for the H/HR disk drives on the M/E/F-Series. A maximum of two drives may be connected to each of these interfaces. The 13175B interface is used for the M/MR disk drives. These drives are only supported on the M/E/F Series processors. Each master disk in the M/MR group can support up to seven slave units. The slave units are available in the following sizes: 19.6 megabytes (7906S/SR), 50 megabytes (7920S), and 120 megabytes (7925S). The M/MR and the add-on S/SR units can be configured in a multi-CPU arrangement with up to seven additional processors sharing disk storage. Slave disks of differing capacities may be mixed on a single master.

12732A FLEXIBLE DISK SUBSYSTEMS: Includes one 514K-byte flexible disk drive and 12735A Interface Kit. The add-on drive is the 12733A. Up to three add-on drives can be supported by the subsystem, but configuration restrictions on the HP 1000 Series computer systems limit the number of add-on drives to one. This unit is not supported on L-Series systems.

Each single-sided flexible disk drive provides 514,560 bytes of storage. Recording is double-density, with 67 tracks per disk, 30 sectors per track, and 256 bytes per sector.

The drive revolves at 360 rpm, yielding an average rotational delay of 83.3 milliseconds. Typical head loading requires 50 milliseconds. Track-to-track head positioning requires 10 milliseconds plus 10 milliseconds for head settling. Average head positioning time is 267 milliseconds. The data transfer rate is 9,200 bytes per second using a standard disk format and 46,000 bytes per second using a special fast disk format in which the disk is formatted serially. This special format is most efficient for interaction with the RTE-M file manager.

9895A MASTER DUAL FLEXIBLE DISK DRIVE: Includes two double-sided, double-density diskettes. This unit provides 2.36 megabytes of storage and is available in a number of configurations including single drives and slave units. The 9895A drive may be used on the HP1000 M/E/F-Series processors running under the RTE-IVB operating system or HP1000 L-Series under the RTE-L/XL operating system.

INPUT/OUTPUT UNITS

Refer to the Peripherals/Terminals table.

HP is also an OEM peripherals supplier, and its OEM products are covered behind the Peripherals tab (section M13). HP can also provide a vast array of instrumentation, data acquisition, process control, numerical control, and analog/digital I/O equipment. Interfaces include the HP-IB, Hewlett-Packard's implementation of IEEE Standard 488-1978.

HP has introduced a series of plug-in measurement and control cards for use with the L-Series processors. These cards offer high-performance analog and digital I/O capability. They are programmable either through the operating system or directly via assembly language. The high-level analog input card has an eight-channel differential input. It is expandable to 40 channels and is capable of up to 55,000 readings per second with 12 bit resolution. Solid state differential multiplexers permit acquisition of data using four programmable full scale ranges from ± 1.28V to ± 10.24V. Digital I/O is available for use with more usual sensing and actuating devices. A digital input card provides 16 fully-isolated digital inputs with resistor-programmable threshold levels. The same card provides 16 relay outputs rated for 1A at 28 VDC or 0.5A at 120 VAC. Another digital card provides non-isolated 16-bit input and output for less noisy applications plus a separate 4-bit control and status register.

COMMUNICATIONS CONTROL

L-SERIES INTERFACES:

10285A LOGIC ANALYZER INTERFACE: provides for easy connection of the HP 1610A/B logic analyzer for both hardware and software development.

12005A ASYNCHRONOUS SERIAL INTERFACE: provides for connection of EIA RS-232-C, RS-422/423, or RS-449 compatible devices to the HP 1000 L-Series. This connection may be local via an optional cable, or remote, via a Bell 103 data set or equivalent modem. Optional cables are available for hardware connection to HP 2621A/P Interactive Terminals, HP 2635A Printing Terminals, or HP 2645A Display Stations.

12006A PARALLEL INTERFACE: a multi-purpose parallel interface for 8- or 16-bit bidirectional data transfer

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between external devices and the HP 1000 L-Series. The maximum data transfer rate is up to 2.1 million bytes/seconds via Direct Memory Access (DMA).

12007A DS/1000-IV HDLC MODEM INTERFACE: provides interface for modem communication between DS/1000-IV network nodes based on HP 1000 L-Series computers. The interface handles HDLC protocol generation and CRC-16 error checking.

12009A HP-IB INTERFACE: provides for connection of up to 14 Hewlett-Packard Interface Bus compatible devices to HP 1000 L-Series computers. HP-IB compatible devices include flexible and hard disks, printers, magnetic tape drives, plotters, graphics digitizers, and an intensive list of measurement instruments.

12010A BREADBOARD INTERFACE: provides standard L-Series I/O master circuit along with space for sixty 16-pin wire wrap sockets for user-designed custom interfaces. The printed circuit layout accommodates any mix of dual or single in-line integrated circuits.

12044A DS/1000-IV HDLC DIRECT CONNECT INTERFACE: provides interface for direct connect communication between DS/1000-IV network nodes based on HP 1000 L-Series computers. The interface handles HDLC protocol generation and CRC-16 error checking.

12063A ISOLATED 16-CHANNEL ISOLATED DIGITAL I/O: This interface card provides 16 opto-isolated inputs and 16 relay-isolated outputs.

M/E/F-SERIES INTERFACES:

59310B HP-IB INTERFACE: provides for connection of up to 14 HP-IB devices to the M/E/F-Series computers. This IEE-488-1978 implementation services all HP-IB devices except flexible and hard disk units.

12966A POINT-TO-POINT BUFFERED ASYNCHRONOUS BLOCK/CHARACTER MODE COMM INTERFACE: The 12966A is the most capable of HP's single-line asynchronous interfaces. It has a 128-character buffer and also a 256-character special character memory that can be used to set an interrupt flag whenever one of the 256 characters is received. The interface also has flags to indicate buffer status. The 12966A is programmed in HP's assembly language for one of 15 baud rates ranging from 50 to 9600 bits per second (these are also hardware-selectable), for a character size of 5, 6, 7, or 8 bits, for 1, 1½, or 2 stop bits, and for odd, even, or no parity. Modem control for any Bell type 103 or 202 modem (or equivalent) is implemented in software, with no modifications needed on the interface board. Attachment of local or remote terminals is via EIA or CCITT interfaces. The board can be used with hard-wired local terminals or with remotely connected terminals via modems. It has a secondary data channel capability (i.e., reverse channel, or the ability to receive, detect, and recognize control signals while transmitting).

12790A MULTIPOINT TERMINAL SUBSYSTEM INTERFACE: A microprocessor-based interface card that is microprogrammed to manage a hard-wired or modem-based RS-232-C interface, the binary synchronous 2645A multipoint line protocol, and an on-board data buffer. In conjunction with the 91730A Multipoint Terminal Subsystem Software Package, the 12790A supports HP 2645A or 2648A CRT terminals in block mode for program development or program execution. Program execution is under the control of one or more user application programs.

Employing this interface, up to 32 HP 2645A or 2648A terminals can be handled per multipoint line, subject to constraints of distance and operating system. The multipoint protocol implemented on the interface is 2645A multipoint protocol, which is similar to IBM bisynchronous protocol.

The microprocessor manages the routine communications processing, freeing the computer for other tasks. This processing includes control word decoding, data polling, error detection and up to 16 retransmissions, management of asynchronous or synchronous modem control signals, setting of modem control lines, management of the data buffer, and automatic text editing.

The 12790A incorporates a 1024-byte RAM as a data buffer, which allows up to 998-byte block data transfers to the computer and up to 1000-byte transfers from the computer. All transfers to and from the computer are via the DCPC.

The maximum line length between any two terminals is 2000 feet; total line length cannot exceed 16,000 feet. Synchronous speed may be up to 9600 bps regardless of the number of terminals or line length. Asynchronous speed is a function of line length and number of terminals per line, as indicated in the following table.

	Line speed		
Terminals per line	2400 bps	4800 bps	9600 bps
4	2000 ft.	2000 ft.	2000 ft.
8	2000 ft.	2000 ft.	1200 ft.
16	2000 ft.	1200 ft.	480 ft.
32	1200 ft.	480 ft.	120 ft.

Error detection is through the use of CRC (cyclic redundancy checking). Error correction is via program-specified retransmission (up to 16 times).

The 12790A can be used with any HP 1000 M/E/F-Series processor except the 2105A. The user may select from the following Bell-type data sets: 201A3, 201C, 202T, 208A, 208B, 209A or equivalent.

12792A 8-CHANNEL ASYNCHRONOUS MULTIPLEXER SUBSYSTEM: This newest addition to the HP M/E/F-Series interface product group offers high-performance microprocessor control for up to eight terminals or electrically compatible microprocessor devices. These devices and an optional multiplexer panel may be located up to 300 feet from the processor. Through the use of multiple interfaces, up to 62 devices can be supported. Each of the eight full-duplex channels is separately buffered and all communications from the interface memory to the processor backplane are via direct memory access (DMA) control.

Program development and execution are supported on the RTE-IVB operating system; application execution on the RTE-M (memory-based) operating system. Multiple multiplexer subsystems are supported by both of these operating systems.

12920B 16-CHANNEL ASYNCHRONOUS MULTIPLEXER: This unit provides EIA or CCITT interfacing for up to 16 communications devices at programmable data rates up to 2400 bits per second, in any mix of hard-wired terminals, 103-type data sets, or 202C-type data sets. For hard-wired devices, the multiplexer simulates a data set and can be hard-wired. For use with 202C-type data sets, an option (-001) is required, and this adds one card and requires a fourth slot.

Programmable are: 1) data rates from 57 to 2400 bits per second, 2) speed detection for six speeds plus the IBM 2741, 3) character lengths from 5 to 12 bits, 4) split speed operation, 5) parity generation and/or checking, and 6) full-duplex, half-duplex, or echoplex transmission mode. Hardware

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automatically detects breaks and assembles characters. The unit has a data-in and data-out line for each of the 16 channels, plus 5 receive-only diagnostic channels. Up to eight Bell 801-type automatic dialers can be attached.

Using the 12920B, a minor modification must be made when the operating system is BCS, since that operating system only configures the equipment table for up to eight devices on a controller.

The 12920B is hardware-compatible with 2108M, 2109E, 2112M, 2113E, 2111F, and 2117F processors.

12771A DS/1000 COMPUTER SERIAL INTERFACE: This is a two-card interface that forms a complete, hard-wired hardware communications link between two HP 1000 computer systems equipped with the 91740A/B DS/1000 Network Software-Firmware Package and managed by the RTE-M or RTE-IV operating system.

Errors detected in the hardware word parity check on the 12771A board and in the longitudinal or diagonal parity checks on the blocks received are corrected by retransmission. Transmission speeds are user-selected by jumper on each interface card to correspond with the cable length used, as tabulated below. Software overhead will slow down network throughput rates.

Cable Length, feet	Max. Transmission Speed, bytes per second
0-600	60,606
600-1200	38,460
1200-2000	22,222
2000-3000	12,048
3000-4000	22,222
4000-5400	12,048
5400-7300	6,288
7300-10000	3,214

The 12771A is compatible with all HP 1000 Series computers, and systems except the 2105 processor.

12773A DS/1000 COMPUTER MODEM INTERFACE: Provides for interconnection of HP 1000 Series computer systems in a DS/1000 network using full-duplex modems. The interface is supported by the 91740A/B Network Software-Firmware Package and is compatible with the EIA RS-232B and CCITT V.24 interfaces with full-duplex operation. The transmission link is full-duplex over switched (direct distance dial) or private (leased) common-carrier telephone lines. Modems may have automatic answering capability. Transmission is in bit-serial, synchronous, or asynchronous mode, depending on the modem used. Asynchronous data transfer rates of 75, 150, 300, 600, or 1200 bps are possible. Synchronous rates depend on the modem selected.

The user may select from several modems, including the Bell type 103A2, 103A3, 201A3, 201C, 202T, 208A, 209A data sets, or equivalent modem.

Errors detected in the hardware word parity check on the 12773A board and in the longitudinal or diagonal parity checks on the blocks received are corrected by retransmission.

12793A DS/1000-IV BISYNCH MODEM INTERFACE: a microprocessor-based interface for an RS-232-C or RS-449 modem-based communications link from an HP 1000 M/E/F-Series computer to a counterpart interface in an HP 3000 system with both systems operating in an HP-DSN environment.

12794A DS/1000-IV HDLC MODEM INTERFACE: provides modem communication between DS/1000-IV network nodes based on HP 1000 M/E/F-Series computers. The interface, in conjunction with 9750A DS/1000-IV software, supports high-level user access between HP 1000 computers.

12825A DS/1000-IV HDLC DIRECT CONNECT INTERFACE: This interface is the direct connect version of the 12794A Modem Interface. The interface supports hardwired links up to 1.36 miles.

12889A DS/1000-IV OR DS/1000 HARDWIRED SERIAL INTERFACE: This is a special-purpose high-speed serial asynchronous interface for direct (point-to-point) data communications between two HP 1000 M/E/F-Series computers or between an HP 1000 and HP 3000 computer. At a distance of 1,000 feet the maximum data rate can be 2.5 million *bits* per second; at 2,000 feet this data rate is halved. The feature is a single card, with data transmission taking place in one of four modes: program to program, program to DCPC, DCPC to program, or DCPC to DCPC. Included are automatic data acknowledgement (handshaking hardware), cyclic redundancy check (CRC) hardware for generation, transmission, and processing, and a 6-bit hardware address recognition circuit. The CRC uses a 15th degree polynomial. A pair of 75-ohm coaxial cables functions as a unidirectional pair of transmission lines for fast turnaround. The cable is optically isolated at the receiving end, enabling long-distance transmission with a low probability of errors due to common-mode noise or ground-level shifting.

The 12889A is hardware-compatible with all HP 1000 M/E/F-Series computers. Software support is provided by DS/1000 and DS/1000-IV.

TERMINAL INTERFACES: HP offers two low-to-medium-speed terminal interfaces for the M/E/F-Series: 1) the *12531C Teleprinter Interface* for use with EIA-compatible devices using Bell type 103 data sets or equivalent and 2) the *12531D Terminal Interface* for use with various terminal devices with optional local EIA and Bell 103 connections.

The 12531C normally uses locally connected teleprinters communicating via 20-milliampere current-loop signals. Data rates are jumper-selectable from among a choice of 110, 220, 440, 880, or 1760 bits per second, or at up to 2400 bits per second using an external clock. As with all of the HP terminal interfaces, the character size is fixed at eight bits, and the number of stop bits is a jumper-selectable one or two. Option --001 is used to locally connect EIA-compatible terminals. Also, as with the 12531D following, the optional type 103 data sets (option -002) can be used in the manual mode (hand-switched from send to receive) only.

The standard 12531D Terminal Interface differs from the standard 12531C Teleprinter Interface in only one major respect: the internal clock, and hence the five jumper-selectable bit rates, are different; in this case, the internally clocked rates are 150, 300, 600, 1200, or 2400 bits per second. An option (-001) is used to locally connect EIA-compatible terminals; another option (-002) is used to connecting 103-type data sets in the manual mode.

The 12880A Console Terminal Interface uses an external clock only, at a rate of up to 9600 bits per second. Its standard cable connects an EIA-type interface.

The 12531C, 12531D, and 12880A are hardware-compatible with all HP 1000 M/E/F-Series processors.

12618A SYNCHRONOUS COMMUNICATIONS INTERFACE: This is a full-duplex synchronous interface that operates with Bell 201, 203, or 208-type modems. The interface is programmable in HP assembly language and offers

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program-selectable character length (1 to 8 bits), choice of synchronization character, parity generation and checking (odd, even, or none), and special character recognition of any character provided by the program. The interface operates in either full- or half-duplex mode at a maximum data rate of 9600 bits per second. The 12618A has a 2-character buffer, and can attach modems via EIA or CCITT interfaces.

The 12618A is hardware-compatible with all HP 1000 computer systems. Software support is provided by the RJE/1000 software.

SOFTWARE

OPERATING SYSTEMS: The HP 1000 Series computers offer a number of operating systems based on the Real-Time Executive (RTE) system. RTE-II is a disk-based, real-time, multi-user operating system intended for memory configurations of 64K bytes or less. RTE-IVB supports memory configurations of up to two megabytes and provides more powerful multiprogramming capabilities and greater multi-user throughput than RTE-II. RTE-IVB also adds a Session Monitor to systematically allocate resources and an Extended Memory Area (EMA) to maximize program memory. RTE-IVE is a memory-based, execute-only subset of RTE-IVB. It is primarily intended for dedicated applications in a network environment. The HP 1000 L-Series requires RTE-L which is functionally compatible to RTE-IVB in respect to program requests and operator commands. RTE-XL increases the memory management capabilities of RTE-L to support the L-Series high density memory configurations. Please note that the RTE operating systems are compatible with all of the M/E/F-Series processors with the exception of RTE-L and -XL which are specific to the L-Series products.

Real-Time Executive II (RTE-II) is a disk-based operating system that provides real-time and background disk swapping partitions and operates in a maximum of 64K bytes of main memory. Program swapping to and from disk memory extends its multi-user capability. Typically, over 37,000 bytes of memory are available for users' programs under RTE-II in a 64K-byte system.

RTE-II offers a batch spool monitor, file management, on-line system generator, and drivers for all standard peripherals. It can be configured to support HP's IMAGE data base management system, automatic test or measurement using multiple instrument clusters connected via the HP-1B interface bus, and on-line development by the user of new microcoded instructions for the system through the use of the RTE Microprogramming Package.

Furthermore, RTE-II supports concurrent processing and program development in FORTRAN IV, Conversational Multi-User Real-Time BASIC, FORTRAN 4X (extended ANSII 1966 compiler) and HP Assembly language. An interactive text editor is supplied for program development. Time, event, and program-to-program scheduling is available for real-time measurement, control and/or automatic test applications. Priority scheduling of programs allows for priority levels from 1 through 32,767. A relocatable library is supported.

An I/O scheduling and control monitor provides I/O operation concurrently with program execution in RTE-II. The Network Central Communications Package (NCCP) is available under RTE-II. Finally a multi-terminal monitor enables multiple users to edit or run programs from several terminals simultaneously, concurrently with other real-time operations.

RTE-II requires a minimum of a processor with direct memory access or dual-channel port controller, firmware accessory board, memory protect, power fail recovery, memory protect, and time base generator; a cartridge or disk pack drive; and a system console, which may be a teleprinter, keyboard printer, or keyboard CRT terminal with any supported standard input device (punched tape or mini-cartridge).

RTE-II is sold and supported by Hewlett-Packard as a mature software product.

Real-Time Executive IVB is a disk-based real-time operating system used for management of the operations and resources of the HP 1000 Model 40 and 45 systems and the M/E/F-Series processors. The system can handle event-driven, time slice, and batch programs while providing a human-engineered session interface for multiple users. The session monitor is an interface for on-line multi-terminal users to control and coordinate access to system resources.

RTE-IVB supports an Extended Memory Area (EMA) capability which allows users a data area in memory equal to total physical memory less that needed for the system, I/O drives, resident programs, common areas, and the user's disk resident program. This equates to nearly 2 megabytes in a 2.048 megabyte system. Extended memory areas are used for large amounts of data storage, acquisition, and processing. Because EMA data accessing does not involve any disk access, it is useful for data acquisition at real-time rates. Scientific applications using large matrices, including matrix inversions, can be easily handled.

RTE-IVB can manage up to 64 disk-resident multi-user program partitions in up to 2.048 megabytes of memory. The user can have up to 54K bytes per partition for program code, independent of physical memory used by the system and drives. Concurrent execution and development of FORTRAN IV, FORTRAN 4X, Assembly language, and BASIC (optional) programs is also featured. An optional RTE microprogramming package is available for on-line developments and debugging of user-microprogrammed subroutines. An optional RTE Profile Monitor package pinpoints activity in user programs. This directs the user to areas which could be optimized for performance improvement.

RTE-IVB includes a decimal arithmetic library containing routines for addition, subtraction, multiplication, and division of decimal character string numbers that exceed the integer, floating point and extended precision capabilities of the standard libraries.

RTE-IVB also provides the user with the option to enter a reconfiguration dialog at every boot-up. This dialog can provide for changes of I/O select code assignments and identification of pages of memory that contain parity errors, plus the ability to change the total number of memory pages, change the size of system available memory, change the number and size of disk-resident partitions, change program assignments to specific partitions, and change the size requirements of individual programs. The changes in I/O and memory configuration can be made temporarily, for only the current boot-up, or can be permanently incorporated into the system during the reconfiguration dialog.

Under RTE-IVB, an improved multi-terminal monitor (MTM) coordinates multi-user access to all system facilities from up to 16 different terminals. The MTM gives each terminal user access to a previously created copy of the file manager and an individually identified copy of the program to be run under request by the user. Specific break and abort commands for program termination are available.

The RTE-IVB operating system provides support for the following HP systems and software: IMAGE/1000 Data Base Management Systems, DATACAP/1000 data capture software, F-Series Vector Instruction Set, GRAPHICS/

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1000 graphics plotting software, and DS/1000 software-firmware. Also included are protected file domains; an interactive help facility; a batch-spool monitor for single-stream, multi-job batch processing; and input/output spooling for slow peripherals.

Real-Time Executive-IVE is an execute-only, memory based subset of the disk-based RTE-IVB system. Supporting a 2 megabyte memory capacity, RTE-IVE is intended for user-assembled systems with up to 64 multi-user program partitions. RTE-IVE can function as either a DS/1000-IV network node or as a stand alone program executing system. At boot-up, the user has the ability to reconfigure memory partitions and I/O. Spooling and program swapping are not supported in RTE-IVE.

Real-Time Executives L and XL are real-time operating systems for management of the operations and resources of the HP 1000 Model 9 or 10 and systems based on the L-Series processors. These systems provide multiprogramming capability with concurrent program execution and may be configured as memory-based or disk-based systems. RTE-L and -XL differ with respect to memory capacity with RTE-L managing 64K bytes of main memory and RTE-XL handling up to 512K bytes of HP's high density memory.

Program execution may be scheduled by time, event, program-to-program, or operator intervention. HP 1000 Assembler, Pascal/1000, FORTRAN 4X, and BASIC/1000L are supported in the RTE-L and -XL environments. Pascal/1000 programs may be executed but not compiled under RTE-L. Both compilation and execution of Pascal/1000 are supported in RTE-XL. Program development tools such as an interactive source editor (EDITR), program debugger (DBUGR), relocating loader (LOADR), and system generator (RTLGN) are included in RTE-4XL. EDITR, LOADR, AND RTLGN can also be executed on RTE-IVB systems. This compatibility is indicative of the program request and operator command similarities shared by the HP 1000 RTE operating systems. RTE-L/XL also supports the IMAGE/1000 Data Base Management System and the DS/1000-IV Network Communications software.

RTE-L/XL has been optimized to take advantage of the L-Series multiprocessor I/O architecture. Modular device and interface drivers provide efficient I/O without a large memory overhead. RTE-XL has additional capabilities to take advantage of the L-Series 512K bytes of high density memory. The L-Series supports 32,767 levels of priority; RTE-XL allows time slicing within each priority level.

RTE-XL extends the L-Series DMA capabilities to the 512K bytes of memory with support of up to 255 user partitions and up to 64K bytes per user partition space.

RTE-L/XL also includes a set of utility programs for the following purposes:

- Disk backup from one flexible disk to another or from one hard disk to another.
- Installing the boot-up file, BOOTEX, onto the beginning of a disk.
- Converting an absolute binary program file into a memory image file.
- Converting a memory image file into an absolute binary file.
- Concatenating relocatable subroutines into one relocatable file for use as a library file during system generation or on-line program relocation.
- Formatting, initialization, and sparing of disk packs.
- Concatenating memory image program files with the system image to produce a memory-based operating system.

Configuration requirements for RTE-L are as follows: any 2103L/LK computer or HP 1000 Model 9 or 10 System with a boot-up source (PROM module, disk, terminal with mini cartridge, DS/1000-IV network links), an 12005A asynchronous terminal interface, and a minimum of 64K bytes of main memory. The RTE-XL requires a minimum of 128K bytes of extended memory.

PROGRAMMING LANGUAGES: The languages available for the HP 1000 Series computers and systems include BASIC, FORTRAN, PASCAL, HP Assembler, RTE Assembler, and C.

BASIC/1000D provides on-line program development in disk-based RTE-II/III/IV/IVB systems and multi-user operation for up to four users through the use of multiple copies of BASIC. This version of BASIC has disk file access program statements addressed to the batch spool monitor in RTE-II and RTE-IV, automatic chaining and linking of program segments so they can run as one program, character string arithmic, logical, and trigonometric functions, as well as the statements addressed to IMAGE/1000 in RTE-II/IV/IVB systems, and character string definition and manipulation. BASIC/1000D supports HP-IB programming, but does not support distributed systems.

BASIC/1000L is a single-user subsystem for conversational development, testing, and execution of Real-Time BASIC programs in HP 1000 systems running under a disk-based configuration of RTE-L or XL operating system. This version of BASIC provides time and event scheduled operation of up to 16 tasks. BASIC/1000L features include: character string manipulation with string variables; support of bit manipulation, access to subroutines or functions within a FORTRAN or Assembly language, and print with format control. High-Level subroutine calls for instrumentation are supported, including multi-instrument clusters that are bus-connected via the HP-IB. The memory required for BASIC/1000L consists of a 32K byte background area, of which 12K bytes are available for the user's real-time BASIC program.

BASIC/1000M provides on-line conversational program development in memory-based RTE-M systems. This version of BASIC differs in that it has the capabilities of character string definition and manipulation (up to 255 characters), and supports HP-IB programming, but does not support distributed systems.

This version of BASIC is considered to be a mature software product.

HP FORTRAN IV is a two-pass compiler based on the ANSI Standard X3.9-1966. HP-supported extensions include the following: 1) a subscript expression may be any expression allowed in HP FORTRAN IV; 2) initial, terminal, and step-size parameters of a DO statement can be any arithmetic expression; 3) the step-size parameter of a DO statement can be either positive or negative, which provides for incrementing or decrementing to the terminal value; 4) the integer variable reference in a computed GO TO can be replaced by any arithmetic expression; 5) any two arithmetic types can be mixed in any relational or arithmetic operation except exponentiation; 6) an unsubscripted array name is an admissible list element in a DATA statement; and 7) automatic EMA map request generation for FORTRAN IV programs to be used with the RTE-IV operating system.

Supported system capabilities include: 1) real-time operations by providing for the passing of program priority, type, and time-scheduling information from the source language program I.D. statement to the relocatable object program,

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and providing for EXEC calls to link users' programs to desired actions by the Real-Time Executive; 2) disk file access via the Batch-Spool Monitor of RTE-II or RTE-IV; 3) system-to-system communication program statements addressed to the 91700A Network Central Communications Package (RTE-II only); 4 system-to-system program statements addressed to the DS/1000 Network Software/Firmware for communication with other HP 1000 and/or HP 3000 computer systems (not under RTE-II); 5 high-level calls to instrumentation and control and peripheral subsystems; 6) data base access and manipulation program statements addressed to IMAGE/1000 in RTE-II or RTE-IV systems; 7) decimal string arithmetic calls for string lengths exceeding standard program libraries; and 8) EMA mapping in RTE-IV systems.

FORTRAN 4X is a superset for ANSI FORTRAN X3.9—1966 and includes many extensions compatible with other minicomputer's FORTRAN 66 compilers. FORTRAN/4X performs local optimization of the object code to improve operating efficiency and resource economy. The computer performs constant expression folding, several types of subscript optimizations, branch structure optimization and improved register allocation. The main features of HP's FORTRAN 4X are: double-word integer and double-precision real data types; IF-THEN-ELSE construction; arrays of seven dimensions, embedded comments; and bit shift intrinsic functions. The I/O enhancements include: direct access I/O, list directed I/O, internal files ENCODE and DECODE; END= and ERR=I/O specific's; and OPEN, CLOSE, and INQUIRE statements.

FORTRAN 4X is upwards compatible with HP's FORTRAN IV and can compile programs using as small a partition as 26K bytes. With a 56K byte partition, it can compile programs containing up to 5000 lines of code.

Pascal/1000 is a superset of industry-standard PASCAL. The Pascal/1000 compiler translates Pascal source code to RTE Assembly language source code which is then automatically assembled to produce object code. Pascal/1000 includes several extensions to take advantage of the capabilities of the HP 1000. These extensions include: 32-bit integer and double-precision floating point data types, predefined procedures for directed access I/O, and separate compilation with load-time module linking. Pascal/1000 is compatible with other software systems, such as IMAGE/1000, GRAPHICS/1000, and DS/1000.

The *RTE Assembler* makes use of the basic HP 1000 Series instructions, mnemonic operation codes, and symbolic addressing. Output can be either absolute or relocatable object code. Assembly language features include page-free programming, fixed- and floating-point pseudo-operations, and the ability to reserve storage with a COMMON statement. When a program written in RTE Assembly Language is run under RTE-L or XL, certain instructions, such as byte and bit manipulation and index register usage, will execute in software rather than firmware.

Supported system capabilities include: 1) system-to-system communication program statements addressed to the 91700A Network Central Communications Package; 2) real-time operation by providing for the passing of program priority, type, and time-scheduling information from the source language program I.D. statement to the relocatable object program, and providing for EXEC calls to link users' programs to desired actions by the Real-Time Executive; 3) disk file access via the Batch-Spool Monitor of RTE-II or RTE-IV; 4) support of the word, byte, and bit processing and index register instructions of the 1000 E and 1000 F computers; 5) system-to-system program statements addressed to the DS/1000 Network Software/Firmware for communication with other HP 1000 and/or HP 3000 computer systems (not under RTE-II); 6) data base access and manipulation program statements addressed to IMAGE/1000 in RTE-II or RTE-IV systems; 7) decimal string arithmetic calls for string lengths exceeding standard program libraries; and 8) EMA mapping in RTE-IV systems.

HP 1000 "C" Compiler is an implementation of the C programming language on HP 1000 computers for use by programmers with previous experience with both RTE and C. C is both a low-level and a high-level language. It gives the programmer control that is typically found only in Assembly language while offering productivity advantages of a system such as Pascal.

The HP/C compiler is compatible with HP RTE/IVB and produces code that will execute on the HP 1000 M/E/F-Series computers. HP/C is a full implementation of the C programming language including an input/output library compatible to UNIX. The HP/C compiler was developed for HP by Corporate Computer Systems, Inc. and is designated as third party software. HP offers HP/C software to the Bell system and U.S. Government customers on an "as is" basis. No guarantee is made for compatibility with future software.

HP IMAGE/1000: This database which is similar to HP's IMAGE/3000 data base management system is usable on HP 1000 Series processors with memory capacities as small as 64K bytes. IMAGE/1000 provides small-system users with a multi-terminal, multi-program, data base management system with most of the features of the large IMAGE/3000 system.

A side-by-side comparison of IMAGE/1000 size limitations with those of IMAGE/3000 is given in the following table.

	IMAGE/ 3000	IMAGE/ 1000
Data item names per data base	255	255
Data items per data entry	127	127
Data sets per data base	99	50
Detail data sets per master data set	16	16
Master data sets per detail data set	16	16
Search items (keys) per detail data set	16	16
Maximum entry size, bytes	4,094	4,096
Entries per chain	65,535	disk vol. size*
Characters per data base name	6	6
Characters per password	8	6
Characters per data set name	16	6
Characters per data item name	16	6
Data set size, megabytes	47	disk vol. size*
Data base size, megabytes	200	960 (200 under RTE-L)

*32,767 bytes under RTE-L.

IMAGE/1000 is a powerful data base management system designed to provide engineers and scientists with a lab or manufacturing data base which is flexible and easy to use as a means of storing and retrieving large amounts of data. It allows multiple users and programs to perform data collection, summarization, analysis, and reporting. QUERY/1000 is an English-like inquiry language for on-line inquiry and report generation.

An IMAGE/1000 data base on one system can be accessed by another HP 1000 in a DS/1000 network. The data base in any networked RTE-IVB HP 1000 can be accessed directly through any number of intervening network nodes either programmatically or through QUERY/1000, IMAGE's English-like inquiry language. IMAGE/1000 with QUERY

requires an HP 1000 processor operating under RTE-IVB or RTE-XL; IMAGE/1000 without QUERY can operate on a L/M/E/F-Series processor running under RTE-L with 64K bytes of memory or RTE-IVB with 128K bytes of memory.

DATACAP/1000-II: This real-time data capture system is intended for manufacturing and distribution firms in support of HP's Data Capture Terminals, the HP 3075A, 3076A, and 3077A. The menu-driven format reduces the time and cost to design, install, and maintain a real-time data capture system. Up to 56 HP data capture terminals with various configurations can be linked to an HP 1000 M/E/F-Series computer with the RTE-IVB operating system and 384K bytes of memory.

A user can now easily and interactively create data entry transactions via a CRT terminal to define data entry sequence, input method, validation, and storage. DATACAP/1000-II also provides documentation for each transaction specification to aid in support and maintenance follow up. The ability to retrieve, update, and validate data without special programming is available through IMAGE/1000.

Data can be entered via the numeric or optional alphanumeric keypad, optional type V badge reader or optional multi-function reader which can be configured to read mark-since cards, punched cards, or Type III badges. The terminals can also support magnetic stripe and bar code wand readers. Each HP 1000 system with DATACAP/1000 can manage up to 56 of these terminals via one or more communications links. Each link can be up to five miles long, using a single cable. Telephone connections are used for more remote terminal locations.

COMMUNICATIONS SOFTWARE

91750 DISTRIBUTED SYSTEM/1000-IV (DS/1000-IV): This product provides an integrated set of high-level network facilities and procedures. These include network resource-sharing, distributed file management, communication between application programs (program-to-program data exchange), and coordinated distribution of processor workloads to other HP 1000 computers or systems and/or HP 3000 Series II and Series III systems.

DS/1000-IV features network-wide nodal addressing with store-and-forward communications for maximum configuration flexibility, remote system generation and remote program development and testing between HP 1000 systems, remote command processing between any two HP 1000 network nodes (even nodes that are not directly connected except through an intervening HP 1000 node), and HP 1000 virtual terminal capability with respect to HP 3000 Series II and Series III systems.

The DS/1000-IV software in each system, or network node, consists of several layers. The Network Service Intrinsics (NSI/1000) are called by the user's application programs or operator commands to generate the transaction format for master requests to remote nodes, with data as required.

The Network Interface Monitors (NIM/1000) process incoming master requests received from the Communications Management software (CM/1000) and link them as required to the user's slave programs, file management routines, or the RTE exec. The CM/1000 layer routes network transactions, queues them, and manages the local system resources necessary for network communications. CM/1000 also manages the store-and-forward operations.

The CM/1000 layer communicates with the interface hardware, which may be several hard-wired and/or modem interface cards, via the Communications Access Method/1000 (CAM/1000) software and firmware. CAM/1000 provides a line protocol for the control of communications input and output, including error detection and correction by retransmission. The lower layers are managed by software, firmware, and hardware so as to be completely transparent to the user. Changes to these layers of the network can be made with little or no effect on the user's application programs.

For HP 1000 to HP 3000 communications, the CM/1000 layer includes translators for conversion of HP 1000 requests and replies to/from DS/3000 format. The CM/1000 software is designed to work with only one remote HP 3000 system and does not provide for nodal addressing or store-and-forward operation to/from the HP 3000. CAM/1000 for HP 1000 to HP 3000 communication is a software-only synchronous line controller.

Dynamic message rerouting is available for networks with alternate communication paths. When a node or link failure is detected, the software attempts to locate and set up an alternate path. If more than one such path exists, the best route will be selected from a relative "cost" table prepared by the network manager. This feature is only available on DS/1000-IV to DS/1000-IV communications links.

Message accounting provides an end-to-end protocol that prevents duplication of messages and re-transmits messages lost due to line failure. Also, the message accounting function provides channel status information to the user. This feature is optional and can be used selectively for those channels requiring high reliability in order to save memory and CPU overhead. This feature is also only available on DS/1000-IV to DS-1000-IV networks.

Transaction logging and reporting allows the user to analyze and optimize network traffic. It also provides a method to isolate all communications link faults. All message request and reply buffers are logged onto a disk or magnetic tape for later analysis.

DS/1000-IV also includes two programs that use the 12007A or 12044A L-Series HDLC interface in a L-Series network node to allow remote access to the Virtual Control Panel (VCP) in that node. These programs provide control access to the VCP program and also monitor and display messages from the VCP program. The remote operator can examine and change the contents of registers and memory locations, control the execution of diagnostics and other programs, and select a bootstrap loader and initiate the boot procedure. The remote VCP access cannot take advantage of the store-and-forward capability of the DS/1000-IV network and can only be accomplished from a neighboring node.

The accuracy of both hard-wired and modem communications between HP 1000 systems is supported by LRC/VRC/DRC (longitudinal, vertical, and diagonal) redundancy checking. HP 1000 to HP 3000 communications are error-checked by the CRC-16 error detection method, which is implemented in hardware on the 12889A and 12793A interface cards. Detection of an error results in a request for retransmission.

The 91750A DS/1000-IV software products are compatible with the 32190A DS/3000 software in HP 3000 Series II/III/30/33 systems and the 91780A RJE/1000 IBM 360/370 remote job entry package. The DS/1000-IV software is backward compatible with the 91740A Network Software.

DS/1000 operates under RTE-IVB, RTE-L, or RTE-M on all HP 1000 Series processors.

91780 RJE/1000: This software/hardware package enables an HP 1000 Series computer system to communicate with IBM 360/370 batch-oriented computers in a manner similar to an IBM 2780 Data Transmission Terminal. However, RJE/1000 does not support these IBM 2780 features:

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terminal identification, multipoint operation, and bell operation. RJE/1000 is implemented under RTE-II/III/IV/IVB operating systems. The package can be employed in a multiprogramming environment that allows concurrent program development, computation, and data acquisition while communicating with an IBM 360/370 batch system.

Data is transmitted in either half- or full-duplex mode over dial-up or leased lines using Bisync protocol. Magnetic tape drives, disk drives, card readers, or CRT terminals can be used as remote job entry devices via modems at the speeds indicated in the table below. Line printers can serve as output devices.

Connection and Modem Type	Max. Synchronous Data Rate, half or full duplex
Switched telephone network and:	
Bell 201A modem	2000 bps
Bell 201C modem	2400 bps
Bell 208B modem	4800 bps*
Non-Bell modem	4800-9600 bps
Private lines and:	
Bell 201B modem	2400 bps
Bell 201C modem	2400 bps
Bell 208A modem	4800 bps
Bell 209A modem	9600 bps
Non-Bell modem	4800-9600 bps

*Half duplex only.

Features include EBCDIC transparency, auto turnaround, auto answer, multirecord transmission, end of media, and EBCDIC and ASCII code sets. RJE/1000 operates directly with HASP in IBM operating systems using the BTAM, TCAM, or RTAM access methods. RJE/1000 also operates with the HASP, RES, and JES/2 scheduler software. Also included is Trace, an off-line data link diagnostic analysis facility. Trace provides for logging communications on an RJE/1000 link. Logging is on magnetic tape or disk for subsequent printout and analysis.

The RJE/1000 hardware consists of two boards. The software is supplied on paper tapes and operates on all processors in the M/E/F-Series and on all packaged systems except the Model 20 and Model 25.

91730 MULTIPOINT TERMINAL SUBSYSTEM SOFTWARE: This package provides multipoint terminal communications between HP 2645A, 2648A, 2649B, and/or 2649C CRT Terminals and an HP 1000 Series computer system. Features of the package include support of single I/O channel communications with multiple CRT terminals on a single communications line, program development and/or application program execution at multipoint terminals on RTE-IV-based systems, application program execution on RTE-M-based systems, computer interface block transfers up to 1000 characters long, support for up to eight 12790A Multipoint Terminal Interfaces, a multipoint master application program capability, a multipoint network status display program, command identification of multipoint terminals, auto-acknowledgement of data entry, group and line message broadcast capabilities, an intelligent polling algorithm, a system-level exerciser program, and a power fail restart subroutine. 91730 requires a M/E/F Series computer with 128K bytes of memory operating under RTE-M/IV/IVB. For further information, see the section on the 12790A Multipoint Terminal Subsystem Interface.

91731 ASYNCHRONOUS MULTIPLEXER SUBSYSTEM SOFTWARE: This package provides software support for multiplexed terminal communication between an HP 1000 M/E/F-Series computer and HP CRT display and printing terminals using the 12920B 16-channel interface. This package provides block mode data transfer capability and hardwired or full-duplex communication support. Channel control lets the user programmatically specify baud and time-out rates for each channel. Split speed operation is also supported with 264XA/B terminals. The 91731 can handle two 12920B interfaces to support a total of 32 terminals, operating at speeds up to 2400 bps.

UTILITIES:

EDIT/1000, an interactive screen editor, allows the user to work in either line mode or screen mode. In line mode, it provides for basic text maintenance, character string search and replace capabilities, and interactive instructions. In screen mode, the user is able to take advantage of the local editing capabilities of smart HP terminals. EDIT/1000 runs on M/E/F-Series computers operating under RTE-IV/IVB.

RTE Profile Monitor (RPM) is a package that profiles program activity, showing the user precisely where execution bottlenecks exist. RPM runs on M/E/F-Series computers operating under RTE-IV/IVB. RPM can be used on any program executing under RTE-IVB or RTE-IV. RPM functions in two phases. The first is a sample phase in which the program to be profiled is executed while being monitored by a program called CTRAC. A second program, CPLOT, traces the program's activity profile on a line printer.

The RTE Microprogramming Package (RTEMP), designed to run under RTE-II/IV/IVB, allows the user to develop microprogrammed routines for use on the HP 1000 Series computers (M/E/F-Series). Such routines can increase program executive speeds by from 2 to 20 times. These micro-coded instructions can be called directly from FORTRAN, BASIC, or HP Assembly language programs.

RTEMP features: 1) a microassembler; 2) a cross-reference generator for simplified program development; 3) a micro-debug editor for interactive program editing and checkout; 4) operator-entered microprogram breakpoints; 5) full Writeable Control Store (WCS) support, including driver, load utilities, and load verification routines; 6) dynamic WCS overlay utilities; 7) up to 3072 instructions in WCS; and 8) a PROM tape generator for outputting production microcode on (punched) PROM "burn" tapes in user-specified format.

WCS cards can be fully used in the multiprogrammed environment of the RTE-II/IV/IVB operating systems. The following modes of operation are possible: 1) several programs executing in memory can use different micro-programmed functions in WCS; 2) several executing programs can share the same WCS microprograms; or 3) several executing programs can share the same WCS control store space and the required microprograms can be overlaid into that space as needed by each program.

The WCS driver requires 2160 bytes of resident memory. Other programs in the RTE Microprogramming Package require a 16K-byte background partition in RTE-II or an 18K-byte partition in RTE-IV/IVB including the 2K bytes required for the base page in each RTE-IV/IVB disc-resident partition.

DIAGNOSTICS:

The HP 24397 L-Series Diagnostics Package provides standalone testing of the L-Series CPU, memory, and its set of interface cards. Diagnostic software may be loaded into memory from a 2645A terminal with a cartridge tape unit or from a 12023A/12024A flexible disk subsystem. Remote diagnostic capability is available via phone lines using a Bell 103 modem or equivalent and the virtual control panel (VCP).

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The HP 24396 diagnostic library products enable HP 1000 M/E/F-Series computer users to load diagnostic or control programs into memory from any one of six different input devices. These include paper tape, two disk cartridge units, two mag tape units, and the HP mini cartridge.

APPLICATIONS: HP offers more than 500 scientific applications programs and subroutines for use on the HP 1000 Series.

The 92840A GRAPHICS/1000 Plotting Software offers a set of 55 modularly usable plotting support routines for FORTRAN, BASIC, or Assembly language programmers. GRAPHICS/1000 supports the HP 2648 Graphics Terminal, the 9872 Graphics Plotter, and the 7245 Plotter/Printer. GRAPHICS/1000 operates under RTE-M/IV/IVB.

PRICING

POLICY: The HP 1000 Series systems are available on either a purchase or third-party lease basis.

Lease rates can be calculated as percentages of the list (purchase) price payable per month for terms from three to five years in accordance with the following table:

Term, months	Percent of List Price per Month
36	3.192
42	2.796
48	2.500
60	2.088

The leases are noncancellable, but a special provision is available that permits cancellation on nine months' notice for an additional premium of 1.25 percent of the list price per month.

A purchase option provision is available throughout the duration of a lease; a substantial portion of the lease payments can be applied to the purchase price. In all cases, maintenance is separately charged at varying rates depending upon the contract type. OEM discounts of up to 30 percent are available to systems houses. A list of available software, with associated purchase prices, appears in the accompanying price list.

Assistance for software products is provided at prevailing service rates or through phone-in consulting of comprehensive software support. Assistance is provided for RTE-M, RTE-II, RTE-IV/IVB, RTE-L/XL, programming languages, RJE/1000, DS/1000 Network Software, and all software products.

SUPPORT: Maintenance contracts are available for purchased systems, and the monthly maintenance charges are included on the equipment price list. The contracts are mandatory for all leased systems.

Maintenance is offered through 67 U.S. offices, 9 Canadian offices, and 121 international offices. The standard Basic Monthly Maintenance Charge (BMMC) contract includes six preventive maintenance calls a year. The basic monthly contract calls for next day response within a 100-mile radius of a major metropolitan area. Coverage is provided Monday through Friday, 8 a.m. to 5 p.m. Extended coverage is available in most locations (see below). The contract also covers automatic software and reference manual updates and service on non-reproducible system failures.

In the table below, the rates for extended maintenance coverage can be obtained by multiplying the figure shown by the Basic Monthly Maintenance Charge shown on the price list.

Hours of Coverage	Five-Day Service	Six-Day Service	Seven-Day Service
8 to 5 (8 hrs)*	BMCC	1.1	1.2
8 to 9 (12 hrs.)	1.1	1.15	1.25
8 to 12 (16 hrs.)	1.2	1.25	1.3
8 to 8 (24 hrs.)	1.3	1.35	1.4

*Occasional extra service is billable at a $200 surcharge.

Regularly scheduled courses are given at HP's Training Centers. These courses may also be given on-site provided it is suitably equipped and can support a class of ten. Contact HP directly for details of such an arrangement. Standard courses and their prices are available from your Hewlett-Packard representative.

HP offers a documentation kit with each system. In advance, the package can be obtained for a fee of $28. The HP Software Notification Service provides a year's subscription to the *HP Communicator* and other publications that contain information on software updates, useful software tips, training course schedules, and other pertinent information.

The present software support policy for the HP 1000, which became effective in August 1979, contains the following qualifications:

- An HP-trained System Manager responsible for maintaining the integrity of the system's hardware and software or a trained designated alternate must be identified as a contact for HP.
- The same level of service must be purchased for all of the HP software products which make up one computer system. Due to the interaction among software elements, service cannot be given to specific software products while omitting others.
- Additional phone-in service at the central site can be purchased as many times as desired. The name of a single authorized caller must be provided for each additional caller service purchased. Additional phone-in service cannot be purchased unless Customer Support Service (CSS) has been purchased.
- Central system CSS support of additional systems can be purchased only by customers with multiple installations. It cannot be purchased unless one of the installations has purchased Customer Support Service.
- A minimum of three months of support must be purchased.
- If twelve months of software support is ordered concurrently with the HP 1000 software, HP will provide an additional 90-day period of the services ordered at no charge.

All HP 1000 software products are discountable under Hewlett-Packard Computer Products Purchase Agreements. Software support services are not discountable.

Services that accompany software purchased under the support policy include phone-in consulting with an HP systems engineer (with an advertised four-hour response time) within a 100-mile radius of the HP sales office, software updates, reference manual updates, software status bulletins every two weeks. The phone-in consulting service may also be used for interpretation of HP documentation. Software bulletins and updates also offer an avenue for interpretation of HP documentation.

Hewlett-Packard indicates that if a software product is discontinued from sale, support will continue for an

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additional five-year period. Thereafter, support will be provided on an as-available and time-and-material basis.

On-site consulting services by HP systems engineers are available to resolve software and documentation problems which cannot be solved using the phone-in service. If the problem reported is not associated with an HP software design error or system malfunction, the on-site services are considered outside the scope of HP's software and support agreement and subject to a time and materials charge. HP is not obligated to provide any on-site services for HP software products which the customer has modified. When on-site, the SE will help the customer to identify, verify, isolate, and work around problems caused by HP software. Assistance is available weekdays, excluding HP holidays, during HP working hours, at distances not more than 100 miles from the nearest HP office designated to provide on-site SE services. Support for facilities farther away can be provided at additional cost.

EQUIPMENT: Numerous packaged systems are offered in the HP 1000 product line. Information on the configuration and pricing of these systems can be found in the equipment price list. ■

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.
PROCESSORS			
2103L	L-Series Computer with 64K bytes of memory and eight available I/O channels	$4,450	$25
-011	Substitute 128K bytes XL memory for standard memory (not compatible with 012)	1,500	8
-012	Substitute 512K bytes XL memory for standard memory (not compatible with 011)	11,000	55
2108M	M-Series Computer with 64K bytes of memory; expandable to 640K bytes of memory and nine I/O channels	7,700	71
-014	Deletes memory controller and modules (must order other HP memory)	-2,400	-14
-300	Computer in low profile cabinet	1,200	1
2112M	M-Series Computer with 128K bytes of memory; expandable to 1280K bytes of memory and 14 I/O channels	10,600	107
-013	With 64K bytes of memory instead of 128K bytes	-1,450	-36
-014	Deletes memory controller and modules (must order other HP memory)	-3,900	-50
-300	Computer in low profile cabinet	-1,200	1
2109E	E-Series Computer with 64K bytes of memory; expandable to 640K bytes and 9 I/O channels	9,100	74
-012	Replaces standard memory with high performance modules	600	0
-014	Deletes memory controller and modules (must order other HP memory)	-2,450	-14
-300	Computer in low profile cabinet	1,200	1
2113E	E-Series Computer with 128K bytes of memory; expandable to 1280K bytes and 14 I/O channels	11,000	108
E-012	With 64K bytes of high performance memory instead of 128K bytes of standard memory	-850	-34
-013	With 64K bytes of memory instead of 128K bytes	-1,450	-34
-014	Deletes memory controller and modules (must order other HP memory)	-3,900	-48
-300	Computer in low profile cabinet	1,200	1
2111F	F-Series Computer with 64K bytes of memory; expandable to 640K bytes and nine I/O channels	14,000	109
-014	Deletes memory controller and modules (must order other HP memory)	-3,050	-14
-300	Computer in low profile cabinet	1,200	1
2117F	F-Series Computer with 128K bytes of memory, expandable to 1280K bytes and 14 I/O channels	17,600	123
-013	With 64K bytes of memory instead of 128K bytes	-1,450	-34
-014	Deletes memory controller and modules (must order other HP memory)	-4,500	-48
-301	Computer in low profile cabinet with 115V power module	1,600	3
-302	Computer in low profile cabinet with 230V power module	1,600	3
BOARD COMPUTERS			
2103LK	L-Series with 64K bytes memory	2,250	NA
-011	Substitutes 128K bytes XL memory for standard memory (not compatible with 012)	1,500	NA
-012	Substitutes 512K bytes XL memory for standard memory (not compatible with 011)	11,000	NA
2108MK	M-Series with 64K bytes of memory	3,500	NA
-014	Deletes memory controller and modules (must order other HP memory)	-2,450	NA
2109EK	E-Series with 64K bytes of memory	3,900	NA
-014	Deletes memory controller and modules (must order other HP memory)	-1,349	NA
PACKAGED SYSTEMS			
2145A	HP 1000 Model 9 System with L-Series processor, 64K bytes of memory, dual flexible disks, and 11 I/O channels in 56-inch cabinet (requires system console), inc. RTE-L operating system	16,600	100
2145B	2145A in 29.75-inch cabinet	16,000	100
2146A	HP 1000 Model 10 System with L-Series processor, 64K bytes of memory, single flexible disk, and 11 I/O channels in 56-inch cabinet (requires system console and disk) inc. RTE-L operating system	13,600	77
2146B	2146A in 36 inch cabinet	13,000	77
-011	Substitutes 128K bytes XL memory for standard 64K bytes of memory and RTE-XL for RTE-L operating system (not compatible with opt 012)	1,700	8
-012	Substitutes 512K bytes XL memory for standard 64K bytes of memory and RTE-XL for RTE-L operating system (not compatible with opt 011)	11,000	55
2174A	HP 1000 Model 20 System with E-Series processor and 64K bytes of memory; expandable to 2048K bytes of memory (with 12990B Extender) and 12 I/O channels in 56-inch cabinet	22,500	140
-014	Deletes memory controller and modules (must order other HP memory)	-2,450	-30
-018	Deletes 2645A system console and interface (must order other system console and appropriate interface)	-5,940	-24

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EQUIPMENT PRICES

PACKAGED SYSTEMS (Continued)

		Purchase Price	Monthly Maint.
-032	Adds flexible disk subsystem, FORTRAN, and Assembly language programming support	4,800	42
2174B	In desk configuration instead of cabinet	22,500	139
2175A	HP 1000 Model 25 System with F-Series processor, 64K bytes of high performance memory, expandable to 2048K bytes (with 12990B Extender & special racking), and 12 I/O channels in 56-inch cabinet)	30,500	178
-014	Deletes memory controller and modules (must order other HP high performance memory)	-3,050	-36
-018	Deletes 2645A system console and interface (must order other system console and appropriate interface)	-5,940	-24
-032	Adds flexible disk subsystem, FORTRAN, and Assembly language programming support	4,800	42
2175B	In desk configuration instead of cabinet	30,500	177
2176C	HP 1000 Model 40 System with E Series processor, 128K bytes of memory, expandable to 2048K bytes of memory, (with 12990B Extender) and 11 I/O channels in 56-inch cabinet (must order option 019)	39,500	258
-002	Additional cabinet bay with space for magnetic tape and second disk drive (one only)	2,300	4
-014	Deletes memory controller and modules (must order at least 128K bytes of other HP memory)	-3,900	-48
-019	Deletes 2645A system console, 19.6 megabyte disk drive, and interface; (must order system console, disk, and interfaces separately)	-21,040	-121
2176D	HP 1000 Model 40 System with E-Series processor, 128K bytes of memory, expandable to 1280K bytes of memory and 11 I/O channels in desk cabinet (must order option 019)	39,500	260
-002	Standalone cabinet with space for magnetic tape and disk drive (one only)	3,200	1
-014	Deletes memory controller and modules (must order at least 128K bytes of other HP memory)	-3,900	-48
-019	Deletes 2645A system console, 19.6 megabyte disk drive, and interfaces; (must order system console, disk and interfaces separately)	-22,040	-124
2177C	HP 1000 Model 45 System with F-Series processor, 128K bytes of memory, expandable to 2048K bytes (with 12990B extender and special racking) and 10 I/O channels in 56-inch cabinet (must order option 019)	49,000	284
-002	Additional cabinet bay with space for magnetic tape and second disk drive (one only)	2,300	4
-014	Deletes memory controller and modules (must order at least 128K bytes of other high performance HP memory)	-4,500	-48
-019	Deletes 2645A system console, 19.6 megabyte disk, and interfaces (must order system console, disk, and interfaces separately)	-23,490	-125
2177D	HP 1000 Model 45 System with F-Series processor, 128K bytes of memory, expandable to 1280K bytes of memory and 10 I/O channels in desk cabinet (must order option 019)	49,000	286
-002	Standalone cabinet with space for magnetic tape and disk drive (one only)	3,200	1
-014	Deletes memory controller and modules (must order at least 128K bytes of other high performance HP memory)	-4,500	-48
-019	Deletes 2645A system console, 19.6 megabyte disk, and interfaces (must order system console, disk, and interfaces separately)	-24,490	-128

PROCESSOR OPTIONS

L-Series

12008A	PROM Storage Module	550	3
12011A	Extender Card	250	0
12012A	Priority Jumper Card	65	0
12013A	Battery Backup Card	425	5

M/E/F-Series

12539C	Time Base Generator	350	3
12777A	Priority Jumper Card	60	0
12791A	Firmware Expansion Module	575	3
12897B	Dual Channel Port Controller	750	8
12944B	Power Fail Recovery System for 2108M/2109E	850	11
12945A	M-Series User Control Store	300	9
12977B	M-Series Fast FORTRAN Processor (incl. DMI)	950	10
12991B	Power Fail Recovery System for 2111F/12M/13E/17F and 12990B	960	11
12992B	7905A/06M/20M/25M Disk Loader ROM for E/F-Series RPL compatibility	100	0
12992C	264X Terminal Loader ROM	100	0
12992D	Magnetic Tape Loader ROM	100	0
12992E	12732A Flexible Disk Loader ROM	100	0
12992F	7900 Disk Loader ROM for E/F-Series RPL compatibility	100	0
13197A	1K Writable Control Store	2,000	11
13306A	E-Series Fast FORTRAN Processor (FFP)	650	2
12979B	Dual-Port I/O Extender (16 additional channels)	6,000	11
12781A	Dual CPU kit for 12979B	1,050	0
12898A	Dual Channel Port Controller for 12979B	350	11
12990B	Memory Extender (up to 1024K bytes additional capacity)	4,500	6

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EQUIPMENT PRICES

MEMORY

Memory packages consist of a memory controller, 128K byte memory module(s), memory protect module, memory expansion module, dynamic mapping system, and dynamic mapping system diagnostics on paper tape (also check bit array boards in fault control packages)

		Purchase Price	Monthly Maint.
12002A	L-Series 128K bytes XL memory controller	2,800	16
12002B	L-Series 512K bytes high density XL controller	12,000	63
/B-001	Upgrade option with replacement firmware for CPU	200	-8
12003A	L-Series 128K bytes of XL memory array card, max. of 3 cards per system, used to expand memory beyond 128K bytes with 12002A controller	2,500	12
12784A	128K byte memory package for M-Series	3,900	50
12784B	256K byte memory package	5,700	74
12784C	512K byte memory package	9,300	122
12784D	1024K byte memory package	16,500	218
12785A	128K byte fault control memory package	5,300	65
12785B	256K byte fault control memory package	7,100	89
12785C	512K byte fault control memory package	11,500	148
12785D	1024K byte fault control memory package	20,600	270
12786A	128K byte memory package for E-Series	3,900	48
12786B	256K byte memory package	5,700	72
12786C	512K byte memory package	9,300	120
12786D	1024K byte memory package	16,500	216
12787A	128K byte fault control memory package	5,300	63
12787B	256K byte fault control memory package	7,100	87
12787C	512K byte fault control memory package	11,500	146
12787D	1024K byte fault control memory package	20,600	268
12788A	128K byte high-performance memory package for E/F-Series	4,500	48
12788B	256K byte high-performance memory package	6,700	72
12788C	512K byte high-performance memory package	11,100	120
12788D	1024K byte high-performance memory package	19,900	216
12789A	128K byte fault control memory package	5,850	63
12789B	256K byte fault control memory package	8,050	87
12789C	512K byte fault control memory package	13,400	146
12789D	1024K byte fault control memory package	24,400	268
2102B	Standard performance memory controller for M/E-Series	700	7
2102C	Standard performance fault control memory controller for M/E-Series	1,000	7
2102E	High performance memory controller for M/E-Series	850	7
2102H	High performance memory controller for E/F-Series	1,000	7
12746A	64K byte standard performance module for M/E-Series	1,750	7
12746H	64K byte high performance module for E/F-Series	2,200	7
12747A	128K byte standard performance module for M/E-Series	2,300	24
12747H	128K byte high performance module for E/F-Series	2,800	24
12779A	M/E-Series 256K byte standard performance check bit board	1,400	15
12779H	E/F-Series 256K byte high performance check bit board	1,600	15
12780A	M/E-Series 512K byte standard performance check bit board	2,400	26
12780H	E/F-Series 512K byte high performance check bit board	2,800	26
12976B	M-Series dynamic mapping system	1,950	19
-003	Adds Fast FORTRAN processor	750	6
13305A	E/F-Series Dynamic Mapping System	1,650	17
12731A	Memory Expansion Module	1,000	6
12778B	M-Series Dynamic Mapping Instructions	500	4
12892B	Memory Protect Module	500	9
13307A	E/F-Series Dynamic Mapping Instructions	500	2

MASS STORAGE

7906H	19.6-megabyte cartridge ICD drive in low profile cabinet	14,000	79
79064HR	7960H, rack mounted	13,000	76
7910HR	12-megabyte fixed disk, rack mounted	7,950	22
7920H	50-megabyte ICD drive in low profile cabinet	17,000	73
7925H	120-megabyte ICD drive in low profile cabinet	19,000	65
12009A	HP-IB interface to L-Series	850	5
12821A	ICD interface to M/E/F-Series	800	4
7906M	19.6-megabyte MAC Master Cartridge disk drive in low profile cabinet	16,000	89
7906MR	7906M, rack mounted	15,000	86
7906S	19.6-megabyte MAC Slave Cartridge disk in low profile cabinet	11,000	78
7906SR	7906S, rack mounted	10,000	74
7920M	50-megabyte MAC Master Cartridge disk drive in low profile cabinet	19,000	87
7920S	50-megabyte MAC Slave Disk drive in low profile cabinet	14,000	75
7925M	120-megabyte MAC Master Cartridge disk drive in low profile cabinet	21,000	79
7925S	120-megabyte MAC Slave disk drive in low profile cabinet	17,000	65
7925T	Two 7925S MAC Slave disk drives	29,950	130
13175B	MAC (79xxM) disk interface	700	6
13178C	Multi-unit CPU interface to 79xxM MAC disks	1,200	6

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint.
MASS STORAGE (Continued)			
12940A	Formatted disk cartridge for 7906/7905 disk drive	180	—
13356A	Formatted disk pack for 7925 disk drive	850	—
13394A	Formatted disk pack for 7920 disk drive	525	—
13357A	Alignment pack for 7925 disk	1,750	0
13359C	Servo reformatter for 7906 disk	2,700	NA
13398A	Alignment pack for 7920 disk	1,400	NA
19903A	7906M/S Space Parts not including disk controller spares	4,300	NA
19904A	7906M/S Tool Kit	5,300	NA
19905A	7920/25M/S Spare Parts	8,700	NA
19906A	7920/25M/S Tool Kit	5,200	NA
19007A	13307C Spare Parts	3,100	NA
12732A	Flexible disk subsystem for M/E/F-Series, 514K-bytes on one single-sided, double density disk (uses 2 I/O channels)	4,200	34
12733A	Additional flexible disk drive	2,800	18
9895A	Master dual flexible disk drive, 2.36-megabytes on two double-sided, double-density disks, requires RTE-1VB	6,500	55
-002	Rack mounting hardware	0	0
-010	Master single flexible disk drive (deletes one dual drive)	-1,750	-21
-011	Slave single flexible disk drive (deletes controller and one drive)	-2,750	-31
-012	Slave dual flexible disk drive (deletes controller)	-1,000	-10
MAGNETIC TAPE EQUIPMENT			
7970B	Magnetic tape unit, 800 bpi, 9-track, 45 ips, NRZI	7,870	59
-220	For 2nd-4th add-on drive in low profile cabinet	1,830	2
-226	For subsystem in low profile cabinet, includes 2-card interface	3,880	12
-230	For rack mounting 2nd-4th add-on drive	580	0
-236	For rack mounting subsystem, includes 2-card interface	2,630	11
7970E	Magnetic Tape Unit, 1600 bpi, 9-track, 45 ips, Phase Encoded	9,500	67
-220	For 2nd-4th add-on drive in low profile cabinet	1,740	2
-226	For subsystem in low profile cabinet, includes 2 card interface	3,265	21
-230	For rack mounting 2nd-4th add-on drive	490	0
-236	For rack mounting subsystem, includes 2 card interface	2,015	19
PRINTERS			
2601A	Daisywheel printer, 40 cps, 10/12/15 cpi	4,500	39
2608A	Line printer, 320-400 lpm, 132 col, 128-character set	9,900	70*
-001	With Arabic, Cyrillic, Katakana, and drawing character sets (no option 002)	150	0
-002	With APL, French, German, Swedish/Finnish, Norwegian/Danish, Spanish, British, Japanese ASCII, and Roman Extender character sets (no option 001)	150	0
-090	12-inch VFC instead of -11 inch VFC	0	0
-110	Adds sound cover/static eliminator	200	0
-210	Interface to M/E/F-Series Computer (includes installation)	1,000	3
2631B	Printer, 180 cps, 136 col, 128-character set, optional character sets available at nominal charge	3,900	24
-001 thru 010	Optional character sets	150	0
-210	Line printer interface to M/E/F-Series (customer installed)	650	3
-214	Package for connection 12009A L-Series HP-IB interface, includes cable	350	NA
2631G	Graphics printer; supported as raster dump device	4,900	27
7310A	Graphics printer, 200-500 lpm, 80 col, requires 59310B interface to M/E/F-Series, optional character sets available	5,900	38
-240	Package for connection as 264x auxiliary printer	155	NA
9876A	Thermal graphics printer, 90-400 lpm, 80 col	4,500	25
-240	Package for connection as 264x auxiliary printer	325	1
2613A	Line printer, 300 lpm, 136 col, 64-character set	12,750	160*
-001	96 character set, 240 lpm	1,850	0
-002	64 character OCR-B font	0	0
-003	96 character OCR-B font, 240 lpm	1,850	0
-100	Interface to M/E/F-Series (includes installation)	1,000	3
2617A	Line printer, 600 lpm, 136 col, 64-character set (same options as 2613A)	17,250	175*
-100	Interface to M/E/F-Series (includes installation)	1,000	3
2619A	Line printer, 1000 lpm, 132 col, 64 character set	24,500	264*
-001	96 character set, 750 lpm	1,350	0
-002	64 character OCR-B font	650	0
-003	96 character OCR-B font	2,000	0
-100	Interface to M/E/F-Series (includes installation)	1,000	3
12009A	Printer interface, 2631A + 046/2631B + 214 to L-Series, customer installed	850	5
12845B	Printer interface, 2613A, 2617A, 2619A, 2613A, or 2631B + 050 to M/E/F-Series	1,000	3
26099A	Printer interface, 2608A to M/E/F-Series, customer installed	650	3

*Maintenance price varies with use

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EQUIPMENT PRICES

HARDWARE/INTERFACES

		Purchase Price	Monthly Maint.
L-Series			
10285A	Logic analyzer interface	350	—
12010A	Breadboard interface	500	—
12063A	Isolated 16-channel isolated digital I/O card with 16 opto-isolated inputs and 16 relay-isolated outputs	1,500	5
M/E/F-Series			
12551B	16-bit relay output register interface	515	2
12554A	16-bit duplex register interface	350	3
12555B	Dual D-to-A converter (M-Series)	600	3
12556B	40-bit output registers	650	4
12566B	Microcircuit interface	400	3
12597A	8-bit duplex register	350	2
12620A	Breadboard interface	200	3
12930A	Dual-channel universal interface	1,000	3
2240A	Measurement & Control Processor with four function card slots	3,000	13
2241A	Measurement & Control Processor Extender, adds four function card slots	1,650	1
91000A	Plug-in A-to-D interface subsystem	1,600	13

SOFTWARE

ACTIVE SOFTWARE

		Price	Customer Support	Software Subscription
92068	RTE-IVB operating system software-firmware for M/E/F-Series computer with 128K or more memory	$5,000	$300	$100
92068E	License to generate and operate one RTE-IVE system	1,500	NA	NA
92070	RTE-L operating system for L-Series computer	2,500	240	95
92071	RTE-XL operating system for L-Series computer; requires 12002A/B L-Series Extended Memory Controller	3,000	240	95
92101	BASIC/1000D subsystem for M/E/F-Series computer operating under RTE-II/III/IV/IVB, software on paper tapes	1,000	40	20
92076	BASIC/1000L subsystem for L-Series computer operating under RTE/L/XL	500	40	20
92832	Pascal/1000 for M/E/F-Series computer with 384K bytes of memory operating under RTE-IVB	4,000	40	20
92854	Pascal/1000 for L-Series computer operating under RTE-XL	4,000	50	20
92834	FORTRAN 4X for L/M/E/F-Series computer operating RTE-L or RTE-IVB	1,000	25	10
92074	EDIT/1000 Interactive screen editor for M/E/F-Series computer operating under RTE-IVB	100	*	*
92083	RTE Profile Monitor for M/E/F-Series computer operating under RTE-IV/IVB	2,000	35	15
91750	DS/1000-IV Software for L/M/E/F-Series computer operating under RTE-L/M/IVB with 64K bytes of memory (L-Series), at least 128K bytes of memory (M/E/F-Series)	4,000	65	30
91780	RJE/1000, includes two-card sync modem interface, for M/E/F-Series computer operating under RTE/II/IV/IVB, software on paper tape	5,000	65	20
91730	Multipoint terminal interface subsystem software package, for M/E/F-Series computer with 128K bytes of memory operating under RTE-M/IV/IVB	250	45	15
91731	Asynchronous multiplexer subsystem software for M/E/F-Series computer with 128K bytes of memory operating under RTE-M/IV/IVB	250	40	15
92069	IMAGE/1000 Data Base Management System with Query for M/E/F-Series computer operating under RTE-IVB	3,500	55	30
92073	IMAGE/1000 Data Base Management System without Query for L/M/E/F-Series computer operating under RTE-L/RTE-IVB with 64K bytes of memory (L-Series), 128K bytes of memory (M/E/F-Series)	2,500	30	15
92080	DATACAP/1000-II Data Capture Software for M/E/F-Series computer, with at least 384K bytes of memory operating under RTE-IVB	5,000	55	20
92841	Graphics/1000-11 Device-Independent Graphics Library for L/M/E/F-Series computer operating under RTE-L/XL/IVB/IVE	2,000	40	20

*Support included with 92068 software support for RTE-IVB

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SOFTWARE

		Price	Customer Support	Software Subscription
ACTIVE SOFTWARE (Continued)				
92842	Graphics/1000-11 Advanced Graphics Package 3D, requires 92841A software and RTE-XL/IVB/IVE operating system	4,000	60	20
92835	Signal/1000 Digital signal processing package for M/E/F-Series computer operating under RTE-IVB	4,000	NA	20
12824	Vector Instruction Set, including software equivalents, for M/E/F-Series computer operating under RTE-IVB	1,500	20	15
92400	Sensor-based DAS Utility Library, software on paper tapes	250	20	10
92066	RTE-Measure and Control Software for M/E/F-Series computer operating under RTE-11/IV/IVB, software on paper tapes	250	35	15
91711	On-Line Diagnostic and Verification Package for M/E/F-Series computer operating under RTE-IVB or RTE-M	500	NA	20
24397	L-Series Diagnostics Package	200	NA	10
24600	L-Series Data Communications Diagnostic Package	200	NA	10