HP 1000 computers

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A modular family of computers for OEM and end user system applications

Hardware data

Introduction

Content and organization of this data book

This data book provides technical specifications on HP 1000 M-, E-, and F-Series Computers, and Memory systems, accessories, extenders, and general-purpose interfaces for those computers. For convenience, an overview is provided in section 1. Environmental specifications, product support information, and power specifications and accessories and interfaces applicability are given in information sheets in the rear of this data book.

For fast, easy location of a particular category of information in this data book, use the Quick reference index (facing). The more detailed Technical data index by model number in the left-hand column beside the Quick reference index is provided for reference to coverage of specific products.

Other related publications

The following additional publications provide supplementary technical data, pricing, and configuration information.

HP 1000 Computers and Systems Distributed Systems and Communications Data book. Provides data sheets on:

- DS/1000 software-firmware and interfaces
- RJE/1000 communications package
- CRT and printing terminals and related terminal per I/O channel software
- Multipoint software and interface
- Other data communications interfaces

HP 1000 Computers and Systems Peripherals Data book. Provides data sheets on:

- CRT, printing and data capture terminals
- Disc memories
- Magnetic tape units
- Line printers
- Card readers
- Punched tape I/O subsystems
- Graphics display and plotting devices and interfaces
- Instrumentation interfaces and subsystems
- Cabinets
- Environmental and physical characteristics and power requirements

HP 1000 Computers and Systems Active Software Data book. Provides data sheets on:

- Software support
- User training services for active software
- RTE-M and RTE-IV operating systems
- Program languages, including BASIC subsystems and the RTE Microprogramming package
- Libraries and support packages, including the Diagnostics library and the new GRAPHICS/1000 Graphics plotting software
- Data management software

HP 1000 Computers and Systems Mature Software Data book. Provides data sheets on:

- Software support
- User training services for mature software and subsystems supported by mature software operating systems
- RTE-II, BCS, RTE-B, and RTE-C operating systems
- Program languages
- Supporting libraries, including the 92066A RTE Measurement and Control Software package
- Distributed systems software supported by the mature software operating systems

HP 1000 Computers Selection and Configuration Guide. Provides selection, configuration, price, and prerequisite information for HP 1000 Computers, options, accessories, and compatible interfaces, peripherals, software, and support services.

HP 1000 Computer Systems Technical Data book. Provides data on:

- HP 1000 concept and HP 1000 Computer Systems
- HP 1000 Computers, memory systems, and accessories used in HP 1000 Computer Systems
- System consoles
- System disc memories
- Cabinets
- Product support
- Site planning information

HP Computer Systems Configuration and Site Preparation Guide. Provides configuration, price, prerequisite, and site preparation information for HP 1000 Computer Systems, options, accessories, and support services.

HP 1000 Computers
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HP 1000 Computers overview

The HP 1000 Computers comprise a powerful, modular family of general-purpose small computers that are especially well suited for real-time applications that demand high performance. All members of the HP 1000 family feature state-of-the-art, user microprogrammable central processing units, fast, reliable semiconductor memory systems, and operate under HP's broad range of Real-Time Executive (RTE) operating systems.

The three different series in the HP 1000 family, M-, E-, and F-Series, provide three classes of computing power within a tightly-knit, well-integrated family. The low-cost M-Series Computers provide HP 1000 power at an economical price for cost-critical applications. E-Series Computers provide roughly twice the computing power of M-Series models at a moderate price premium. The F-Series Computers combine the basic processing speed of the E-Series with dedicated hardware for executing floating point instructions, along with instruction set extensions for extremely fast execution of transcendental calculations and other commonly-used FORTRAN operations such as array address calculations. Because HP 1000 family members have upward-compatible instruction sets and use many of the same memory systems, I/O interfaces, and power systems, changing from one member to another can be done with minimal reinvestment in software, training, and spares provisioning.

HP 1000 Computers are available in a wide variety of packages to provide the most cost-effective solution for your computing need. The basic computers are available in a variety of desktop or rack mountable chassis sizes, complete with power system and many features, such as hardware multiply/divide, that are optional on other computers of the same class. M-Series and E-Series Computers are also available in board versions for high volume applications where it is useful to integrate the central processing unit into a product to achieve space and power economies.

HP 1000 E- and F-Series Computers also form the basis for complete HP 1000 Computer Systems, which combine computer, mass storage, CRT terminal, operating software and cabinetry into a full integrated, packaged system.

Individual HP 1000 Computers are described in more detail below.

The HP 1000 Computers

Three different series of HP 1000 Computers are offered, encompassing nine different models, as summarized in the following sections.

HP 1000 M-Series

The HP 1000 M-Series Computers offer proven performance in the most economical packages of the HP 1000 family. M-Series Computers come in a variety of packages, including the 2108MK BoardComputer, and three desk-top or rack-mountable units 2105A, 2108M, and 2112M), of which the 2108M and 2112M come equipped with the memory required to operate under HP's Real-Time Executive (RTE) operating system software.

HP 1000 M-Series Computers are thus an ideal choice for cost-critical applications that need the processing power and software support of the HP 1000 Computer family in an economical package. And, because M-Series Computers share features such as user microprogrammability, fast inexpensive memory systems, common I/O interfaces, and the powerful HP 1000 base instruction set, upgrading to a more powerful HP 1000 Computer can be done with minimal reinvestment in software, training, and spare parts provisioning.

The four different models of M-Series Computers are described below.

2105A is the lowest priced M-Series Computer. Requiring only 133 mm (5-1/4 in) of vertical rack space, it provides 4 mainframe I/O channels and space for up to 64k bytes of memory.

2108M is the medium-sized M-Series Computer. In 222 mm (8-3/4 in) of vertical rack space, it provides 9 mainframe I/O channels and space for 640k bytes of memory (512k bytes with fault control) and includes 64k bytes of standard performance memory.

2112M is the largest M-Series Computer. It provides 14 I/O channels and space for 1280k bytes of memory (1024k bytes with fault control) in 311 mm (12-1/4 in) of vertical rack space. It includes 128k bytes of standard performance memory.

2108MK is the M-Series processor board, which is offered in component form for high-volume applications that require the processing power of a minicomputer at lower unit costs. It includes 32k bytes of standard performance memory. Components available with the 2108MK include the HP 1000 instruction set, card cages with the capacity of the 2105A or 2108M Computer, and the M-Series operator's panel.

HP 1000 E-Series

HP 1000 E-Series Computers are intended for uses that require more processing power than the M-Series. The E-Series implementation of the HP 1000 architecture uses advanced technology along with a technique of dynamically varying the basic machine cycle (microcycle) to provide about twice the computing power of the M-Series. The E-Series central processing unit allocates its fastest data paths (175 nanoseconds) to the most commonly-used operations, and dynamically lengthens the cycle to 280 nanoseconds only when the less-frequently used operations occur. E-Series memory systems also contribute heavily to high performance, featuring memory cycle times as fast as 350 nanoseconds for all of main memory, thus obviating the need for costly, complicated cache memory systems.

HP 1000 E-Series Computers are available in BoardComputer, Computer, and System computer packages, as described below.

2109E provides 9 mainframe I/O channels and space for 640k bytes of memory (512k bytes with fault control), in 222 mm (8-3/4 in) of vertical panel space. It includes 64k bytes of standard performance memory.

2113E provides 14 mainframe I/O channels and space for 1280k bytes of memory 1024k bytes with fault control), in 311 mm (12-1/4 in) of vertical panel space. It includes 128k bytes of standard performance memory.

2109EK is the E-Series processor board, which is offered in component form for high-volume applications that require the exceptional processing power of the E-Series minicomputer at lower unit costs. It includes 32k bytes of standard performance memory. Components available with the 2109EK include the HP 1000 instruction set, a card cage with the capacity of the 2109E Computer, and the E-Series operator's panel.

HP 1000 F-Series

The HP 1000 F-Series Computers combine the basic processing speed of the E-Series central processing unit with a separate hardware floating point instruction processor, a Scientific Instruction Set that includes trigonometric, logarithmic, and other transcendental function instructions, and the FORTRAN accelerator routines of the Fast FORTRAN Processor. The F-Series thus offers the most computational power of the HP 1000 family. F-Series Computers have the same high performance I/O specifications as the E-Series and feature the same user microprogramming language and capabilities. The F-Series microprogrammer has an additional computing "resource" to call upon — the floating point processor itself.

2111F provides 9 mainframe I/O channels and space for 640k bytes of memory (512k bytes with fault control) in 311 mm (12-1/4 in) of vertical panel space. It includes 64k bytes of high performance memory.

2117F provides 14 mainframe I/O channels and space for 1280k bytes of memory (1024k bytes with fault control) in 445 mm (17-1/2 in) of vertical panel space. It includes 128k bytes of high performance memory.

HP 1000 Computers size and capacity comparison

	Computer Models				
	2105	2108 2109	2111	2112 2113	2117
PANEL HEIGHT					
Millimeters	133	222	311	311	445
Inches	5-1/4	8-3/4	12-1/4	12-1/4	17-1/2
MAINFRAME I/O CHANNELS	4	9	9	14	14
MAINFRAME MEMORY CAPACITY					
Memory module slots	2	5	5	10	10
Std/High perf. memory*	64kb	640kb	640kb	1280kb	1280kb
Fault control memory	n/a	512kb	512kb	1024kb	1024kb

**Memory capacities quoted are based on the use of 128k byte (12747) memory modules except for 13187B modules in 2105A, which cannot use the dynamic mapping system to address more than 64k bytes of memory. (High performance memory is usable only in 2109E, 2111F, 2113E, and 2117F computers).*

HP 1000 Computers performance comparison

SERIES	M-Series	E & F Series
CONTROL PROCESSOR		
Address space (instr. words)	4,096	16,384
Instruction execution time	325 ns	175/280 ns
MEMORY CYCLE TIME		
Standard performance memory	650 ns	595 ns*
High performance memory		350 ns*
DCPC (Direct Memory Access)		
INPUT RATES TO		
Standard performance memory	1.23Mb/s	1.95Mb/s
Fault control memory	1.23Mb/s	1.88Mb/s
High performance memory		2.28Mb/s
NON-DMS OUTPUT RATES FROM		
Standard performance memory	1.23Mb/s	1.77Mb/s
Fault control memory	1.23Mb/s	1.67Mb/s
High performance memory		2.28Mb/s
DMS OUTPUT RATES FROM		
Standard performance memory	1.23Mb/s	1.67Mb/s
Fault control memory	1.23Mb/s	1.62Mb/s
High performance memory		2.10Mb/s

**All memory cycle times quoted for the E and F Series Computers are subject to ±35 ns variation because memory accesses are asynchronous with respect to the cpu in those machines. Dynamic mapping system (DMS) for addressing greater than 64k bytes of memory adds 70 ns to these cycle times and fault control adds 35 ns.*

HP 1000 Extenders

I/O and memory capacities of HP 1000 computers can be increased through the use of the following I/O and memory extenders, each requiring only 222 mm (8-3/4 in) of vertical rack space.

12979B Dual-port I/O extender adds 16 I/O channels to the I/O capacity of any HP 1000 computer. Up to two of these extenders can be used to provide a total expansion of 32 I/O channels. A built-in programmable I/O bus switch provides the capability of switching the I/O extender I/O channels between two computers, which facilitates development of redundant computer systems and simplifies peripherals sharing between two computers.

12990B Memory extender adds 9 memory module slots to the capacity of 2108, 2109, 2111, 2112, 2113, or 2117 Computers, enough for 1152k bytes of additional memory, 768k bytes with fault control.

HP 1000 Computer memory systems

Standard memory systems

Except for the 2105A Computer, all HP 1000 Computers come equipped with standard memory, as follows:

2108MK and 2109EK BoardComputers include a 2102B Standard Performance Memory Controller and one 13187B 32k byte Standard Performance Memory Module.

2108M and 2109E Computers include a 2102B Standard Performance Memory Controller and two 13187B 32k byte Standard performance Memory Modules for a total of 64k bytes.

The 2111F Computer includes a 2102E High Performance Memory Controller and two 12741A 32k byte High Performance Memory Modules for a total of 64k bytes of high performance memory.

The 2112M Computer includes a 12784A 128k byte Standard Performance Memory Package, consisting of a 2102B Standard Performance Memory Controller, a 12747A 128k byte Standard Performance Memory Module, and the 12976B Dynamic Mapping System, which provides for addressing more than 64k bytes of memory.

The 2113E Computer includes a 12786A 128k byte Standard Performance Memory Package, consisting of a 2102B Standard Performance Memory Controller, a 12747A 128k byte Standard Performance Memory Module, and the 13305A Dynamic Mapping System, which provides for addressing more than 64k bytes of memory.

The 2117F Computer includes a 12788A 128k byte High Performance Memory Package, consisting of a 2102E High Performance Memory Controller, a 12747H 128k byte High Performance Memory Module, and the 13305A Dynamic Mapping System, which provides for addressing more than 64k bytes of memory.

Providing alternate memory systems

The standard memory in any of the HP 1000 Computers may be deleted by ordering the computer with option 014, if at least an equal amount (in k bytes) of alternate memory is specified on the same order under another product number(s). Alternate memory choices for HP 1000 Computers are as follows:

2108MK and 2108M Computers can be equipped with 12784A/B/C/D non-fault control memory packages or 12785A/B/C/D fault control memory packages, as summarized in the table, below, assuming that the 2108MK is used with the 18-slot 12728J Card Cage.

2109EK and 2109E Computers can be equipped with 2102E High Performance Memory Controller and 12741A High Performance Memory Modules or any of the HP 1000 E-Series compatible memory packages listed in the table below.

2111F, 2112M, 2113E, and 2117F Computers can be equipped with any of the compatible memory packages listed in the table below; computer series is identified by the suffix letter on the model number of each computer.

Packaged memory systems for HP 1000 Computers

	M-Series Standard Performance Memory Packages		E-Series Standard Performance Memory Packages		E and F-Series High Performance Memory Packages	
Memory Sizes	**No fault ctrl**	**W/fault ctrl**	**No fault ctrl**	**W/fault ctrl**	**No fault ctrl**	**W/fault ctrl**
128k bytes	12784A (A)	12785A	12786A (B)	12787A	12788A (C)	12789A
256k bytes	12784B	12785B	12786B	12787B	12788B	12789B
512k bytes	12784C	12785C	12786C	12787C	12788C	12789C
1024k bytes	12784D (D)	12785D (D)	**12786D (D)**	12787D (D)	12788D (D)	12789D (D)

(A) The 12784A Standard performance memory package is included in the 2112M Computer.

(B) The 12786A Standard performance memory package is included in the 2113E Computer.

(C) The 12788A High performance memory package is included in the 2117F Computer.

(D) These memory packages exceed the mainframe memory capacity of the 2108M, 2109E, and 2111F Computers; to accommodate this much memory, the 2112M, 2113E, or 2117F Computer should be ordered.

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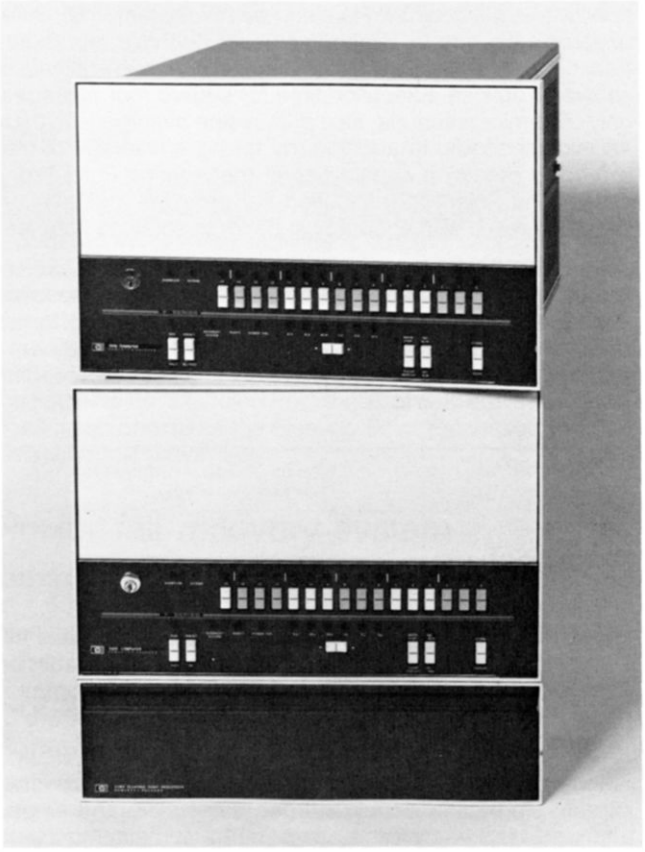
HP 1000
F-Series computers

models 2111F and 2117F

The F-Series are the most powerful HP 1000 Computers offered by Hewlett-Packard. These new machines combine the basic speed of the E-Series Computers with a new, high-performance Floating Point Processor, Scientific Instruction Set, and the FORTRAN accelerator routines of the Fast FORTRAN Processor to provide a high level of processing speed in a compact, economical package. The F-Series Computers are suitable for real-time applications that require exceptional processing speed and extended arithmetic precision.

A comprehensive range of software is available for both F-Series models, including program development support software and operating systems. Particularly noteworthy for computational applications involving large data arrays is HP's new disc-based RTE-IV operating system which can be used to equip the largest F-Series computer to process megabyte-sized data arrays. For additional information, see the HP 1000 Computers and Systems Active Software Data book, which is available from your Hewlett-Packard representative.

In addition, a full line of HP-manufactured peripherals and data communications interface kits is offered, enabling complete systems to be tailored around these new members of the HP 1000 family of computers.



Features

- High performance for computation intensive applications, provided by a unique combination of a high speed central processor, a high speed floating point processor, and a new set of instructions that further speed up processing in scientific and industrial computer applications
- High performance floating point processor dedicated to floating point operations. The processor works with both single-precision (32-bit) and extended precision (48-bit) numbers, and performs a single precision multiply in 6.2 microseconds.
- Scientific Instruction Set, a set of nine instructions for extremely fast computation of trigonometric and logarithmic functions. SIN(X), for example, requires less than 52 microseconds
- Fast FORTRAN Processor, a set of instructions that greatly accelerates FORTRAN operations by performing such jobs as array address calculations at hardware speed
- Powerful HP 1000 architecture and base instruction set, featuring variable microcycle timing for optimum price/performance
- High performance main memory, featuring a cycle time of 350 nanoseconds, is standard; 64k bytes in the 2111F, 128k bytes in 2117F. Fault control capability is optional
- Dynamic mapping system, optional in 2111F, standard in 2117F, provides for accessing up to 2 megabytes of memory (1.8 million bytes with fault control) in 2117F computer plus extender
- High speed direct memory access available via the Dual Channel Port Controller, with transfer rates up to 2.3 million bytes per second
- Fully user microprogrammable
  - — Complete microprogramming support software available
  - — Floating point processor is available as a computing resource to the microprogrammer
- Two models to choose from:
  - — 2111F, with space for up to 640k bytes of memory and nine I/O channels in 12-1/4 inch mainframe
  - — 2117F, with space for up to 1280k bytes of memory and fourteen I/O channels, in 17-1/2 inches of panel space
- Auto bootup and remote program load capability
- Self test for CPU and memory
- Disc loader program, contained in non-volatile Read-Only Memory is standard

The new HP 1000 F-Series — more processing speed and precision for your computational applications

A new hardware-implemented Floating Point Processor, included with the F-Series, slashes processing times for single-precision and extended precision operations. Add/subtract takes as little as 4.9 microseconds; multiply/divide in as little as 6.2 microseconds, thus providing the high level of floating point computational performance required for many real-time applications.

A new Scientific Instruction Set consisting of nine instructions works with the new Floating Point Processor 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 only 30.9 microseconds; sine and cosine average less than 48 microseconds. In addition, by taking advantage of the extended precision capabilities of the Floating Point Processor, the Scientific Instruction Set provides a single-precision result with accuracy superior to software libraries.

A Fast-FORTRAN Processor, a set of routines that accelerate the performance of FORTRAN programs, is also standard in the F-Series computers. Parameter passing, array address calculation floating point conversion operations, and other commonly-used FORTRAN routines are speeded up by a factor of 2 to 20.

Architecture

The HP 1000 F-Series architecture features a fully-microprogrammable control processor, which includes all arithmetic functions in addition to the calculation capabilities described above, I/O, self test, and full operator control panel. Four general-purpose registers are available, two of which may be used as index registers.

Standard F-Series instructions include indexed instructions; integer, single and double integer conversion, and single and extended-precision floating point arithmetic; trigonometric and logarithmic functions; data communications; I/O; and a full complement of instructions for logical operations and bit/byte manipulation.

The F-Series offers extensive software program and I/O compatibility with HP 1000 M- and E-Series Computers. F-Series processors have been optimized for performance with a microprogrammed control processor that directs operations of the other functional units. The control processor speed has been increased for certain operations by a sophisticated technique that varies microinstruction cycle time, depending on the complexity of the operation.

Efficiency of the microprogrammed routines that determine the machine language operation has also been increased through the mechanism of instruction and operand prefetch. The result is a high performance computer that retains both instruction set compatibility with earlier HP computers, and flexibility of user-microprogramming. The CPU-memory interface is totally asynchronous in the F-Series, adding flexibility to the powerful memory structure.

All I/O channels are fully-powered, buffered, and bi-directional. Because of modular design, mainframe memory capacity is completely independent of I/O capacity, so that either memory or I/O modules may be added without taking valuable mainframe space from the other. Mainframe memory capacity is 640k bytes in the 2111F and 1280k bytes in the 2117F (512 and 1024k bytes, respectively, with fault control). Up to nine additional modules may be added in the HP 12990B Memory Extender for a total capacity of 1792k bytes (1280k bytes with fault control) in a 2111F and 2048k bytes (1792k bytes with fault control) in a 2117F.

A full line of interface controllers is available to interface HP-manufactured peripherals, instrumentation, communications devices, or specialized devices.

For applications which demand even higher performance, F-Series users can expand their instruction repertoire with HP-supplied microprogrammed subroutines. Optional enhancements include the dynamic mapping system (standard in the 2117F) for expanded memory management, DS/1000 firmware for DS/1000 network communications, and RTE-IV Extended Memory Area (EMA) firmware.

User microprogramming

The advantage of microprogramming. The power and flexibility of control processor microprogramming is readily available to F-Series users. Control processor access provides users with the ability to perform commonly-used software routines 2 to 20 times faster in microcode. Control processor routines are written in an assembly-like language, stored in control processor memory, and called directly from Assembly, FORTRAN, or BASIC programs.

The control processor and control store capacity. Control processor programmers have access to a powerful processor within F-Series computers that executes instructions in 175-to-280 nanoseconds, and provides multi-level nested subroutines, 211 instructions, 12 high-speed scratchpad registers, and a 5k word address space available to the user. Up to 3k words of user microprograms may be implemented in Writable Control Store for microprogram development and dynamic loading of microprograms. Fully-developed microprograms may be stored in Programmable Read-Only Memory (PROM), a more permanent and secure storage medium for microprograms.

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

Software support for microprogram development. Control processor program development is aided by HP's complete software development tools, which include a micro-assembler, microdebug editor, program overlay load utility, and PROM tape generator, as well as a complete documentation package.

Memory system

Much of the speed of the F-Series Computer is due to the high speed of its primary memory systems. The F-Series Computer includes a memory system that cycles in 350 nanoseconds and with a capacity up to 2 million bytes. Parity checking is standard in all HP 1000 memory systems. Fault control memory systems, which are capable of detecting and correcting all single-bit memory errors, and detecting all double bit errors, are optionally available (fault control reduces maximum memory capacity to about 1.8 million bytes).

For efficient handling of large memory systems, the Dynamic Mapping System (DMS) is available in the 2111F, standard in the 2117F. A combination of hardware and control processor programs, DMS is a powerful memory manager that allows F-Series users to address up to 2.048M (2048k) bytes of memory and provides read and/or write protection of each individual 2048-byte page. Four independent memory maps are provided — one for the operating system, one for the user, and two port controller maps for direct memory access operations. DMS adds 38 powerful memory management instructions to the standard F-Series instruction set. This capability is fully supported by HP's RTE-M and RTE-IV real-time executive operating systems which offer multi-user access to as many as 64 multi-user program partitions. In RTE-IV, support of large-memory systems also gives the user access to data arrays up to megabyte size in one or more Extended Memory Areas (EMAs).

Input/output

The F-Series I/O system features a multi-level, vectored priority interrupt structure. There are 50 distinct interrupt levels, each with a unique priority assignment.Any I/O device can be selectively enabled or disabled, or the entire interrupt system (except power fail and parity error interrupts) can be enabled or disabled under program control.

Data transfer between the computer and I/O devices may take place under program control, dual channel port controller (DCPC) control, or microprogram control. The DCPC provides two direct links between memory and I/O devices, and is program assignable to any two devices. DCPC transfers occur on an I/O cycle-stealing basis, not subject to the I/O priority interrupt structure.

For applications where higher transfer rates are desirable, The F-Series has a special Microprogrammable Block I/O capability that allows transfer rates up to 3.1 million bytes/second. This capability can be implemented through user-designed I/O cards and block I/O control microprograms.

Remote and local program load

The initial binary loading (IBL) function is easily performed on F-Series Computers. For local bootstrap loading, a 64-word ROM-resident IBL program is called by a push-button switch on the front panel. Paper tape and disc loader ROMs are standard. Up to two additional HP or user-supplied loader ROMs may be added to any F-Series Computer. The user can plug in up to four different loader ROMs if the standard loader ROMs are removed.

Computers at remote sites can be force-loaded from a central location through the use of a remote program load (RPL) capability. Information normally keyed into the front panel is set in switches on the CPU board, so the bootstrapping sequence may be initiated from a remote site, or automatically initiated on power-up from a local peripheral.

Self test

A comprehensive set of diagnostic routines permanently stored in read-only memory (ROM) is standard in the F-Series. Two of these routines, executed each time the IBL/TEST function is executed, provide quick tests of the processor and first 64k bytes of physical memory for verification of operating condition. A third test, executed whenever the machine is powered up, thoroughly tests the processor and all installed memory. This test may also be run manually. Two other tests, executed from the front panel, provide quick verification checks of the Floating Point Processor and the Scientific Instruction Set.

Power fail recovery system

The optional power fail recovery system provides a minimum of 1.6 hours of memory sustaining power for the largest memory configuration in the event of complete power failure.

Software

The HP 1000 F-Series maintains extensive program compatibility with earlier members of the HP 1000 family, so users can take advantage of many man-years of software development. This includes compatibility of the Floating Point Processor with the standard firmware floating point instructions of previous machines.

A wide range of operating system software is available. Real-time executive (RTE) systems, available in disc and main memory-resident versions, are multiprogramming systems that permit priority scheduling of several real-time programs while concurrent background processing also takes place.

The memory-based RTE-M and disc-based RTE-IV operating systems can support up to 2.048 megabytes of memory, managed by DMS. Comprehensive software systems are also available for computer networking.

Languages supported by HP operating systems include FORTRAN IV, HP real-time BASIC, Assembly language, and micro-assembly language. Utility software includes a debugging routine, interactive editors, and an extensive library of commonly-used computational routines.

F-Series users may also take advantage of a wide variety of thoroughly-tested and documented programs that have been contributed to the HP Library of Contributed User Software (LOCUS).

Functional specifications

Processor architecture

Implementation: Diagonally microprogrammed in MSI and SSI hardware, supplemented by the Floating Point Processor

Data path width: 16 bits

Standard registers:
Accumulators: 2 (A and B), 16 bits each, addressable as registers or memory locations
Index: 2 (X and Y), 16 bits each
Memory control: 3 (T,P) 16 bits each; (M), 15 bits
Supplementary: 2 (overflow and extend), 1 bit each
Manual data: 1 16-bit (display)

Instruction types:

Memory-to-accumulator	Accumulator-to-I/O
Memory-to-memory	Device control
Direct register modification	

Instruction formats:

Combined single word	Single-precision floating point
Single word	Extended-precision floating point

Instruction expansion: 176 instruction codes are available to the microprogrammer for instruction set additions.

Addressing modes:

Direct	Triple word
Multi-level indirect	Double word
Indexed	Single word
Indirect indexed	Byte
Register implicit	Bit

Bus structure: Separate memory data, memory address, and I/O buses tied to the unified internal processor's S Bus

Memory structure: 32 pages of 2048 bytes, with direct access to current or base page (page 0) pages; indirect or indexed access to all pages

Memory expansion: Paged memory address space expandable to 1024 pages of 2048 bytes using the 13305A Dynamic Mapping System

Input/Output: Vectored priority interrupt structure for up to 50 I/O and system devices, such as DCPC, power fail, parity, and memory protect.

Control processor

Implementation: Hardwired MSI and SSI TTL

Instruction execution time: Variable, 175 or 280 nsec

Control path: 24 bits

Data path: 16 bits

Registers:
Standard registers: 4 (A,B,X,Y)
Scratch registers: 12 16-bit registers accessible to the microprogrammer
Iteration counter: 8 bits
Instruction register: 16 bits
Latch register: 16 bits
Status flag: 1 bit
Subroutine levels stack: 3 — 14 bits each

Bus structure: Unified single bus with program access to memory data, memory address, and I/O buses

Bus speed: 11.4M bytes/sec

Instruction formats:
TYPE 1 Data transfer and modification
TYPE 2 Constant formation
TYPE 3 Conditional branch
TYPE 4 Unconditional branch

Control memory structure:
Type: Bipolar LSI semiconductor R/W or ROM
Address space: 16,384 words; 64 modules of 256-words each
Word size: 24 bits
Cycle time: Variable, 175 or 280 nsec

Module assignments
(1 module = 256 words of control memory):
0 to 3 assigned to F-Series base instruction set, including the new Floating Point Processor instructions
4 through 27 reserved for HP enhancements
28-31 available for user microroutines
32 reserved for Dynamic Mapping instruction set Instructions
33 through 35 reserved for Fast FORTRAN Processor
36 and 37 reserved for RTE-IV Extended Memory Area mapping instructions
38 and 39 reserved for DS/1000 firmware
40 through 43 reserved for Scientific Instruction Set
44 and 45 reserved for HP instruction set enhancements
46 through 63 reserved for user microroutines

Control processor instructions: 211 total; up to 5 may be combined in 1 instruction
Operations: 15 total
Special: 32 total
ALU and conditional: 68 total

Store (destination): 32 total
S-bus (source): 32 total
Reverse Sense: 32 total

Memory parity check

Operation: Monitors all words read from memory. Utilizes 17th bit in memory. Switch programmable to halt or ignore parity error when detected. Interrupt on error requires memory protect option. Parity error indication is displayed on the front panel.

Power fail interrupt

Priority: Highest priority interrupt

Power failure: Detects power failure and generates an interrupt to memory location 4 for vector to user-written power failure routine. A minimum of 500 microseconds is provided for execution of the user-written system state save routine.

Microprogrammable block I/O

I/O control lines: 3 special lines on I/O backplane

NOTE: Requires user designed I/O cards

Maximum synchronous transfer rate: 2.28M bytes/sec (input); 3.17M bytes/sec (output).

Remote program load

Load device selection: 1 of 9 devices in a 2111F; 1 of 14 devices in a 2117F

Loader selection: One of 2 optional loader ROMs

Operating modes: A) Automatically on power-up; B) Remote forced load with 12966A or 12968A interface (Hardwired); C) Load after certain halts under program control.

Compatibility

Instruction set: The HP 1000 F-Series instruction set is backwards compatible with all previous HP 1000 and 2100 Series computers

Program: Most programs written for HP 1000 and 2100 Series computers are compatible with the F-Series, except those with timing loop dependence.

Approximate instruction execution times

Instruction	Execution Time (μsec) with High Performance Memory Min.	Typ.	Max.	MNI*
Single-precision Floating Point Instructions (8 total)				
Add/Subtract	4.9	4.9	6.5	
Multiply	6.2	6.3	6.5	
Divide	6.2	7.5	9.0	
Conversion to single integer	3.7	4.0	4.8	
Conversion to double integer	3.5	3.8	5.9	
Conversion from single integer	3.4	3.7	4.5	
Conversion from double integer	3.3	3.7	5.2	
Extended-precision Floating Point Instructions (8 total)				
Add/Subtract	10.7	10.7	13.3	
Multiply	12.6	12.9	13.3	
Divide	12.6	14.8	17.1	
Conversion to single integer	5.8	6.1	6.9	
Conversion to double integer	6.4	6.4	8.4	
Conversion from single integer	5.9	6.0	6.6	
Conversion from double integer	6.6	6.6	7.3	
Scientific Instruction Set Instructions (9 total)				
SIN (Sine) function		47.6	51.8	8.0
COS (Cosine) function		47.9	52.0	9.0
TAN (Tangent) function		48.4	53.7	8.0
ATAN (Arc Tangent) function		42.4	52.6	12.0
TANH (Hyperbolic Tangent) function		57.2	66.5	9.0
SQRT (Square Root) function		30.9	37.8	11.0
EXP (e^x) function		44.7	51.9	8.0
ALOG (Natural Logarithm) function		43.3	46.3	8.0
ALOGT (Base 10 Logarithm) function		49.4	52.6	8.0
Fast FORTRAN Processor Instructions (9 total)				
Moves to new locations:				
— Extended precision variable	8.96		12.81	
— Address of parameters from calling sequence into subroutine list	13.9 +3.7*NP		13.9 +3.7*NP	
Calculation of X*2N for real X and integer N	8.4		8.4	
Unpacking of real variable	3.1		3.1	
Normalization, rounding, and packing of mantissa of extended precision variable	18.9		29.5	11.6
Complementing of extended precision variable	11.7		12.1	
Complementing and normalization of extended precision variable	22.1		33.4	12.2
Transfer of control to destination of FORTRAN computed GOTO statement	10.6		10.6	
Computes address of specified element of 2 or 3-dimensional array	17.7		27.2	
Memory reference group (14 total)				
Add/load/AND/IOR/XOR			0.91	
Store			1.26	
Jump			0.74	
Jump to subroutine			1.61	
Compare (normal/skip)			1.09/1.43	
Increment, skip if zero			1.54/1.61	
Indirect address, per level			0.46	
Register reference group (43 total)				
Normal/skip			0.91/1.26	
I/O group (13 total)				
SFS/SFC/SOS/SOC (normal/skip)	1.58/1.96		2.28/2.66	
All others	1.58		2.28	

Approximate instruction execution times, continued

Instruction	Execution Time (μsec) with High Performance Memory Min.	Typ.	Max.	MNI*
Extended instruction group (10 total)				
Integer multiply	5.3		6.0	
Integer divide	7.7		9.1	
Double load			2.07	
Double store			2.7	
Shift/rotate (basic)			1.47	
Additional per shift			0.175	
Indirect addressing/level			0.81	
Index instructions (32 total)				
Copy			1.29	
Exchange			1.92	
Decrement/increment (normal/skip)			1.75/2.0	
Load or add index			2.66	
Store index			2.94	
Load indexed			3.19	
Store indexed			3.46	
Jump and load Y			2.67	
Jump and index X			2.28	
Data communications (10 total)				
Load byte			3.36	
Store byte			3.89	
Move bytes (basic)			3.75	
Additional per byte			4.05	
Move words (basic)			3.75	
Additional per word			1.68	
Compare bytes (basic)			3.75	
Additional per byte	3.5		3.78	
Compare words (basic)			3.75	
Additional per word			2.38	
Scan for byte (basic)			1.92	
Additional per byte			2.735	
Set or clear bits			4.48	
Test bits (normal/skip)			4.73/4.94	

NOTES:

**MNI = Maximum Non-Interruptible time.*

Fault control memory and dynamic mapping system may each add 0 to 0.2 microseconds to these instruction execution times.

Asynchronous memory may cause variations of ±0.035 microseconds per memory reference.

More detailed instruction times are supplied in the HP 1000 F-Series reference manual (02111-90001)

Scientific instruction set

Data format: Single-precision

Execution times and function definitions: See Approximate instruction execution times table

Accuracy: RMS relative error for the various Scientific Instruction Set functions is as follows:

Function	RMS Rel. Error	Function	RMS Rel. Error
SIN	8.80E-8	SQRT	6.74E-8
COS	8.82E-8	EXP	1.38E-7
TAN	1.99E-7	ALOG	1.28E-7
ATAN	1.34E-7	ALOGT	1.39E-7
TANH	1.33E-7		

Floating Point Processor (FPP)

Floating point data formats:
Single-precision: 32 bits (4 bytes), providing at least 6 significant decimal digits in mantissa
Extended-precision: 48 bits (6 bytes), providing at least 11 significant decimal digits in mantissa

Exponent range: Exponent range: 2^{-128} to 2^{+127} in all floating point data formats; decimal equivalent is $10^{\mp 38}$.

Fixed point data formats:
Single-precision: 16 bits (2 bytes), twos complement integer
Double-precision: 32 bits (4 bytes), twos complement integer

Execution times: See Approximate instruction execution times table

Computation times applicable to direct, chained microprogramming use of the Floating Point Processor: The following computation times apply to directly microprogrammed use of the Floating Point Processor for chained floating point calculations in which intermediate results are not transferred to and from the F-Series Computer memory.

	Computation Time (μsec)		
Instruction	**Min.**	**Typ.**	**Max.**
Single-precision Floating Point Operations (8 total)			
Add/Subtract	0.55	0.63	3.15
Multiply	1.55	1.78	2.5
Divide	1.65	3.03	4.9
Conversion to single integer	0.33	0.88	1.45
Conversion to double integer	0.33	1.48	2.65
Conversion from single integer	0.28	0.6	1.45
Conversion from double integer	0.28	0.6	1.45
Extended-precision Floating Point Operations (8 total)			
Add/Subtract	0.55	0.68	4.8
Multiply	2.4	2.75	3.3
Divide	2.5	4.88	7.7
Conversion to single integer	0.33	0.88	1.45
Conversion to double integer	0.33	1.48	2.65
Conversion from single integer	0.28	0.6	1.45
Conversion from double integer	0.28	0.6	1.45

Fast FORTRAN processor (FFP)

Data formats and exponent range: Same as Hardware Floating Point Processor.

Execution times: See Approximate instruction execution times table

Configuration information:

Input/output capacity:	2111F	2117F
I/O channels in mainframe	9	14
With first I/O extender	25	30
With two I/O extenders	41	46
Standard memory:	64kb	128kb
Memory module spaces		
In computer only	5	10
In computer & extender	14	19
Max. non-fault control memory*		
In computer only	0.640Mb	1.280Mb
In computer & extender	1.792Mb	2.048Mb
Max. fault control memory*		
In computer only	0.512Mb	1.024Mb
In computer & extender	1.280Mb	1.792Mb

Based on use of 128k byte memory modules.

Control processor address space:
Total address space: 16k 24-bit words
PROM address space available on FAB board: 1k, exclusive of space dedicated to Dynamic Mapping Instructions*†
WCS overlay address space using 1k WCS boards: 3k**
User PROMs address space using 2k UCS board: 2k**

** Subtract 0.5k each for Extended Memory Area mapping instructions (with 92067A RTE-IV) and DS/1000 firmware (with 91740B DS/1000 Network software-formware).*

† Mounted on 3.5k firmware accessory board under CPU board.

*** Mounted on board(s) in CPU I/O backplane, using I/O slots*

Electrical specifications

AC power required

2111F Line voltage: 88-132V (110V ± 20%); 176-264V 220V ± 20%) with option 015. Input line voltage range is easily changed in the field by moving jumper connections.

2117F Line voltage: Computer mainframe is same as 2111F; Floating Point Processor voltage selector offers choice of 90-110V (100V ± 10%), 108-132V (120V ± 10%), 198-242V (220V ± 10%), and 216-264V (240V ± 10%) input line voltage ranges.

Line frequency: 47.5-66 Hz.

Maximum power required:
2111F: 625W
2117F: 825W

Current available (+) required (−) for memory, I/O interfaces and accessories

See power specifications and applicability summary tables pages 10-0 and 10-1.

Power supply

Storage after line failure: Sustains computer through a line loss of 8 milliseconds when operating at the nominal ac line voltage

Input line overvoltage protection: Circuit breaker protects against surge caused by connecting computer to twice nominal line voltage

Input line transients: Withstands power line transients up to ±500V for 50μsec wide pulse, up to ±1000V for 100 nsec wide pulse, without damage

Output voltage regulation: ±5%, except −2V is ±10%

Output protection: All voltages are protected for over-voltage and over-current

Thermal sensing: Monitors internal temperature and automatically shuts down computer if temperature exceeds specified level.

Safety

Models 2111F and 2117F are recognized by Underwriters Laboratories, Inc., and certified by the Canadian Standards Association (with the exception of option 015).

Physical characteristics

Dimensions, cm & (in)	**2111F**	**2117F**
Panel width:	48.3 (19)	48.3 (19)
Behind-panel width:	42.6 (16-3/4)	42.6 (16-3/4)
Overall depth:	62.2 (24-1/2)	62.2 (24-1/2)
Depth behind panel:	58.4 (23)	58.4 (23)
Height	31.1 (12-1/4)	44.5 (17-1/2)

Weight, kg & (lb)

2111F: 30 (66)
2117F: 50 (110)

Ventilation

Air intake is on the left side, exhaust is on the right hand side.

Heat dissipation

2111F: 580 kilogram-calories/hour (2303 BTU/hour)

2117F: 752 kilogram-calories/hour (2986 BTU/hour)

Air flow	2111F	2117F*
Cubic meters/minute:	7.9	11
Cubic feet/minute:	280	390

** 2117F air flow includes flow through the computer mainframe and through the floating point processor, which is a separate package of the 2117F.*

Ordering information

2111F Computer

The 2111F Computer consists of:

1. 2111B Computer with paper tape and disc loader ROMs.
2. 2102E High performance memory controller and two 12741A 32k byte High performance memory modules.
3. 12943-16001 and 16002; 24396-12001, 12002, and 12003; 12740-16001; 12977-16004 and 16005; and 24296-60001 Diagnostics and configurator on paper tape.
4. 02111-90001 HP 1000 F-Series computers operating and reference manual.
5. 02109-90014 Microprogramming manual.
6. 2111-90002 HP 1000 F-Series installation and service manual.
7. 12943-90004, 24396-140001, 12740-90001, and 12977-90002 diagnostic manuals.

2117F Computer

The 2117F Computer consists of:

1. 2117B Computer with separate mainframe, including paper tape and disc loader ROMs, and 02117-60001 Floating Point Processor.
2. 12788A 128k byte High performance memory package, including 2102E Memory controller, 12747H 128k byte High performance memory module, and 13305A Dynamic mapping system.

3-7. Same as items 3 through 7 of 2111F Computer, listed above.

8. 12740-90007 Floating Point Processor installation and service manual.

2111F and 2117F Option

014: Deletes standard memory, item 2, above, from 2111F or 2117F, to permit its replacement, with another HP high performance memory system, with or without fault control, which must be ordered separately.

015: 220V operation (applies only to 2111F and computer mainframe of 2117F; Floating Point Processor input voltages are switch selectable).

2111F and 2117F accessories

For list of accessories that are compatible with the 2111F and 2117F computers, see the power specifications and applicability summary on pages 10-0 and 10-1, referring to the Series F applicability column.

HEWLETT hp PACKARD

HP 1000 E-series computers

models 2109E and 2113E

The HP 1000 E-Series computers are intermediate-performance members of the HP 1000 Computer Family. Combining successful HP 1000 architecture with a unique design philosophy, the E-Series has the power to meet tough computing demands.

A comprehensive range of software is available for both models, including compilers, and operating systems. In addition, a full line of HP-manufactured peripherals and data communications interface kits is offered, enabling complete systems to be tailored around these members of the HP 1000 Family.

Features

- Proven HP 1000 architecture, providing extensive compatibility with HP 1000 Series processor options, peripherals, operating systems, and software
- Variable microcycle timing (VMT) for maximum processor speed
- Powerful instruction set with 128 instructions
- 2.28 million byte/second direct memory access transfer rate available with Dual Channel Port Controller (DCPC)
- User microprogrammable, with complete user-microcode support
- Two models to choose from:
  — 2109E, with space for up to 640k bytes of memory and nine I/O channels in 8-3/4 inch mainframe
  — 2113E, with space for up to 1280k bytes of memory and fourteen I/O channels in 12-1/4 inch mainframe
- Standard performance main memory is standard: 64k bytes in 2109E, 128k bytes in 2113E. 350 nanosecond High performance memory and/or fault control capability is optional
- Dynamic mapping system, optional in 2109E, standard in 2113E, provides for accessing up to two megabytes of memory (1.8 million bytes with fault control) in 2113E computer plus memory extender
- Remote program load capability
- Self test for CPU and memory
- Microprogrammable processor port, permitting external processors to be interfaced directly to the E-Series control processor
- Microprogrammable block I/O for intelligent microprogrammed I/O channels
- Paper tape and disc loader ROM's are standard

Description

Architecture

HP 1000 E-Series architecture features a fully-microprogrammed processor, which includes all arithmetic functions, I/O, and full operator control panel. Four general-purpose registers are available, two of which may be used as index registers.

Standard E-Series instructions include indexed instructions, integer and floating point arithmetic, data communications, I/O, and a full complement of instructions for logical operations and bit/byte manipulation.

The E-Series offers extensive software program and I/O compatibility with other HP 1000 computers. E-Series processors have been optimized for performance with a microprogrammed control processor that directs operations of the other functional units. The control processor speed has been increased for certain operations by a sophisticated technique that varies microinstruction cycle time, depending on the complexity of the operation.

Efficiency of the microprogrammed routines that determine the machine language operation has also been increased through the mechanisms of instruction and operand prefetch. The result is a high-performance computer that retains both instruction set compatibility with earlier HP computers, and flexibility of user-microprogramming. The CPU-memory interface is totally asynchronous in the E-Series, adding flexibility to the powerful memory structure.

All I/O channels are fully-powered, buffered, and bidirectional. Because of modular design, mainframe memory capacity is completely independent of I/O capacity, so that either memory or I/O modules may be added without taking valuable mainframe space from the other. Mainframe memory capacity is 640k bytes in the 2109E and 1280k bytes in the 2113E (512 and 1024k bytes, respectively, with fault

control). Up to nine additional modules may be added in the HP 12990B Memory Extender for a total capacity of 1792k bytes (1280k bytes with fault control) in a 2109E and 2048k bytes (1792k bytes with fault control) in a 2113E.

A full line of I/O interface controllers is available to interface HP-manufactured peripherals, instrumentation, communications devices, or specialized devices.

For applications which demand even higher performance, E-Series users can expand their instruction repetoire with HP-supplied microprogrammed subroutines. Enhancements include the dynamic mapping system, available in 2109E, standard in 2113E, for expanded memory management, and Fast FORTRAN processor for fast handling of scientific routines.

User-microprogramming

The power and flexibility of control processor microprogramming is readily available to E-Series users. Control processor access provides users with the ability to perform commonly-used subroutines 2-to-20 times faster than with conventional computing techniques. Control processor subroutines are written in a simple assembly language, stored in control processor memory, and called directly from Assembly, BASIC, or FORTRAN programs.

Control processor programmers have access to a powerful processor within E-Series computers that executes instructions in 175-to-280 nanoseconds, and provides multilevel nested subroutines, 211 instructions, 12 high-speed scratchpad registers, and an 8.5k word user address space. Up to 5.5k words of commonly-used control processor programs may be stored in programmable read-only memory (PROM). The additional 3k word address space provides a control processor program overlay area implemented with writable control store. Program overlays provide a flexible system able to react to dynamic changes in speed requirements dictated by user program mix.

Control processor program development is aided by HP's complete software development tools, which include an assembler, debug editor, program overlay utility, and PROM tape generator, as well as a complete documentation package.

Memory system

The E-Series includes a standard performance memory system that utilizes the same field-proven semiconductor memory modules as the HP 1000 M-Series. Based on 4k or 16k bit MOS/RAM semiconductor chips, this system combines speed, reliability, and economy. High-speed, 350 ns cycle time memory is available to increase performance by up to 30%. For data integrity, memory parity check is standard and fault control capability may be added to improve the MTBF of memory systems. Memory is easily expandable by plug-in 32k and 128k byte modules.

For efficient handling of large memory systems, the dynamic mapping system (DMS) is available in the 2109E, standard in the 2113E. A combination of hardware and control processor programs, DMS is a powerful memory manager that allows E-Series users to address up to 2048k bytes of memory, and provides read and/or write protection of each individual 2,048 byte page. Four independent memory maps are provided — one for the system, one for the user, and two port controller maps for direct memory access operations. DMS adds 38 powerful memory management instructions to the standard E-Series instruction set. This capability is fully supported by HP's RTE-M and RTE-IV real-time executive operating systems which offer multi-user access to as many as 64 multi-user program partitions. In RTE-IV, support of large-memory systems also gives the user access to megabyte-sized data arrays in one or more Extended Memory Areas (EMAs).

Input/output

The E-Series I/O system features a multilevel vectored priority interrupt structure. There are 50 distinct interrupt levels, each with a unique priority assignment. Any I/O device can be selectively enabled or disabled or, the entire interrupt system (except power fail and parity error interrupts) can be enabled or disabled under program control.

Data transfer between the computer and I/O devices may take place under program control, dual channel port controller (DCPC) control, or microprogram control. The DCPC provides two direct links between memory and I/O devices, and is program-assignable to any two devices. DCPC transfers occur on an I/O cycle-stealing basis, not subject to the I/O priority interrupt structure.

For applications where higher transfer rates are desirable, the E-Series has a special Microprogrammable Block I/O capability that allows transfer rates up to 3.1 million bytes/second. This capability can be implemented through user-designed I/O cards and block I/O control microprograms.

Remote and local program load

The initial binary-loading (IBL) function is easily performed on E-Series computers. For local bootstrap loading, a 64-word ROM-resident IBL program is called by a push-button switch on the front panel. Paper tape and disc loader ROM's are standard. Up to two additional HP or user-supplied loader ROMs may be added to any E-Series computer. The user can plug in up to four different loader ROMs if the standard loader ROMs are removed.

Computers at remote sites can be force-loaded from a central location through the use of a remote program load (RPL) capability. Information normally keyed into the front panel is set in switches on the CPU board, so the bootstrapping sequence may be initiated from a remote site, or automatically initiated on power-up from a local peripheral.

Self test

A comprehensive set of diagnostic routines permanently stored in read-only memory (ROM) is standard in the E-Series. Two of these routines, executed each time the IBL/TEST function is executed, provide quick tests of the processor and first 64k bytes of physical memory for verification of operating condition. A third test, executed whenever the machine is powered up, thoroughly tests the processor and all installed memory. This test may also be run manually.

Microprogrammable processor port (MPP)

The microprogrammable processor port provides a direct interface to the CPU for user-designed hardware processors. The MPP provides address, data, and control capability, so external processors can be controlled and can transfer data at burst rates up to 11.4M bytes/second.

Power system

HP 1000 E-Series power systems will operate normally in environments where power fluctuates widely. Input line voltages and frequencies may vary considerably without affecting computer operations. The optional power fail recovery system provides a minimum of 1.6 hours of memory sustaining power for the largest memory configuration, in the event of complete power failure.

Software

The HP 1000 E-Series maintains extensive program compatibility with earlier members of the HP 1000 Family, so users can take advantage of many man-years of software development.

A wide range of operating system software is available. Real-time executive (RTE) systems, available in disc and main memory-resident versions, are multi-programming systems that permit priority scheduling of several real-time programs while concurrent background processing takes place.

The memory-based RTE-M and disc-based RTE-IV operating systems can support up to 2.048M bytes of memory, managed by DMS. Comprehensive software systems are also available for computer networking.

Languages supported by HP operating systems include FORTRAN IV, HP BASIC, Assembler, and user microprogramming. Utility software includes a debugging routine, a symbolic editor, and an extensive library of commonly-used computational routines.

E-Series users may also take advantage of a wide variety of thoroughly-tested and documented programs that have been contributed to the HP User Library.

Functional specifications

Processor architecture

Implementation: Diagonally microprogrammed in MSI and SSI hardware

Data path width: 16 bits

Standard Registers:
Accumulators: 2 (A and B), 16 bits each, addressable as registers or memory locations
Index: 2 (X and Y), 16 bits each
Memory control: 3 (T,P), 16 bits each; (M), 15 bits
Supplementary: 2 (overflow and extend), 1 bit each
Manual data: 1 16-bit (display)

Instruction types:

Memory-to-accumulator	Accumulator-to-I/O
Memory-to-memory	Device control
Direct register modification	

Instruction formats:

Combined single-word	Single-precision floating point
Single-word	Extended precision floating point

Instruction expansion: 176 instruction codes are available to the microprogrammer for instruction set additions.

Addressing modes:

Direct	Double word
Multilevel-indirect	Single word
Indexed	Byte
Indirect indexed	Bit
Register implicit	

Bus structure: Separate memory data, memory address, and I/O buses tied to the unified internal processor's S Bus

Memory structure: 32 pages of 2048 bytes, with direct access to current or base (page 0) pages; indirect or indexed access to all pages

Memory expansion: Paged memory address space expandable to 1024 pages of 2048 bytes using the 13305A Dynamic Mapping System

Input/output: Vectored priority interrupt structure for up to 50 I/O and system devices, such as DMS, power fail, parity, and memory protect.

Control processor

Implementation: Hardwired MSI and SSI TTL

Instruction execution time: Variable, 175 or 280 nsec

Control path: 24 bits

Data path: 16 bits

Registers:
Standard registers: 4 (A,B,X,Y)
Scratch registers: 12 16-bit registers accessible to the microprogrammer
Iteration counter: 8 bits
Instruction register: 16 bits
Latch register: 16 bits
Status flag: 1 bit
Subroutine levels stack: 3-14 bits each

Instruction formats:
TYPE 1 Data transfer and modification
TYPE 2 Constant formation
TYPE 3 Conditional branch
TYPE 4 Unconditional branch

Bus structure: Unified single bus with program access to memory data, memory address, and I/O buses

Bus speed: 11.4M bytes/sec

Control memory structure:
Type: Bipolar LSI semiconductor R/W or ROM
Address space: 16,384 words; 64 modules of 256-words each
Word size: 24 bits
Cycle time: Variable: 175 or 280 nsec

Module assignments (1 module = 256 words of control memory):
0 to 3 assigned to E-Series base instruction set
Modules 4 through 31 available for user microroutines
Module 32 reserved for DMS instructions
Modules 33 through 35 reserved for Fast FORTRAN Processor
Modules 36 and 37 reserved for RTE-IV Extended Memory Area mapping instructions
Modules 38 and 39 reserved for DS/1000 firmware
Modules 40 through 45 reserved for future HP instruction set enhancements
Modules 46 to 63 reserved for user microroutines
Modules 44 and 45 reserved for future HP instruction set enhancements
Modules 46 to 63 reserved for user microroutines

Control processor instructions: 211 total; up to 5 may be combined in 1 instruction
Operations: 15 total
Special: 32 total
ALU and conditional: 68 total
Store (destination): 32 total
S bus (source): 32 total
Reverse Sense: 32 total

Memory parity check

Operation: Monitors all words read from memory. Utilizes 17th bit in memory. Switch programmable to halt or ignore parity error when detected. Interrupt on error requires memory protect option. Parity error indication is displayed on the front panel.

Approximate instruction execution times

Instruction	Execution Time (μsec) With Std Performance Memory	With High Performance Memory
Memory reference group (14 total)		
Add/load/AND/IOR/XOR	1.19	0.91
Store	1.85	1.26
Jump	0.74	0.74
Jump to subroutine	1.85	1.61
Compare (normal/skip)	1.23/1.72	1.09/1.43
Increment, skip if zero	2.03	1.54/1.61
Indirect addr/level	0.575	0.46
Register reference group (43 total)		
Normal/skip	1.19/1.29	0.91/1.26
Input/Output group (13 total)		
SFS/SFC/SOS/SOC (normal)	1.58-2.28	1.58-2.28
SFS/SFC/SOS/SOC (skip)	2.03-2.73	1.96-2.66
All others	1.58-2.28	1.58-2.28
Extended instruction group (10 total)		
Multiply	5.74-6.72	5.3-6.0
Divide	8.09-9.63	7.7-9.1
Double load	3.185	2.07
Double store	3.71	2.7
Shift/rotate (basic)	2.065	1.47
Additional per shift	0.175	0.175
Indirect addressing	1.19	0.81
Index instructions (32 total)		
Copy	1.435	1.29
Exchange	2.065	1.92
Decr./increment (normal)	2.03	1.75
Decr./increment (skip)	2.52	2.00
Load/add index	3.05	2.66
Store index	3.43	2.94
Load indexed	3.745	3.19
Store indexed	3.815	3.46
Jump and load Y	2.8	2.67
Jump and index X	2.625	2.28
Data communications (10 total)		
Load byte	3.5/3.78	3.36
Store byte	4.45/4.83	3.89
Move bytes (basic)	4.27	3.75
Additional per byte	4.235	4.05
Move words (basic)	4.27	3.75
Additional per word	1.75	1.68
Compare bytes (basic)	4.27	3.75
Additional per byte	3.5/3.78	3.5/3.78
Compare words (basic)	4.27	3.75
Additional per word	2.87	2.38
Scan for byte (basic)	2.17	1.92
Additional per byte	2.735	2.735
Set or clear bits	5.215	4.48
Test bits (normal/skip)	5.36/5.67	4.73/4.94
Floating point instructions (6 total)		
Add	13.13-27.65	12.91-27.44
Subtract	13.83-29.44	13.61-29.22
Multiply	25.48-35.11	25.27-34.90
Divide	34.02-47.32	33.18-47.11
Fix	4.31-7.6	4.06-7.35
Float	6.97-10.82	6.97-10.82

NOTES:

Fault control memory and dynamic mapping system may each add 0 to 0.14 microseconds to these instruction execution times.

Asynchronous memory may cause variations of ±0.035 μsec per memory reference.

More detailed instruction execution times are supplied in the E-Series reference manual (02109-90014).

Power fail interrupt

Priority: Highest priority interrupt

Power failure: Detects power failure and generates an interrupt to memory location 4 for vector to user-written power failure routine. A minimum of 500 microseconds is provided for execution of the user-written system state save routine.

Microprogrammable processor port

Addressable devices: 2

I/O Lines: 16

Control lines: 9

Maximum burst transfer rate: 11.4 M bytes/sec for 32 bytes.

Maximum continuous transfer rate: 3.18M bytes/sec*

Maximum cable length: 1.2m (4 ft), properly terminated.

**User-microprogram dependent.*

Microprogrammable block I/O

I/O control lines: 3 special lines on I/O backplane

NOTE: Requires user-designed I/O cards

Maximum synchronous transfer rate: 2.28M bytes/sec (input); 3.17M bytes/sec (output).

**User-microprogram dependent.*

Remote program load

Load device selection: 1 of 9 devices in a 2109B; 1 of 14 devices in a 2113B

Loader selection: One of 2 optional loader ROMS.

Operating modes: A) Automatically on power-up; B) Remote forced load with 12966A or 12968A interface (Hardwired); C) Load after certain halts under program control.

Compatibility

Instruction set: The HP 1000 E-Series instruction set is backwards compatible with other HP 1000 and 2100 Series computers.

Program: Most programs written for other HP 1000 and 2100 Series computers are compatible with the HP 1000 E-Series except those with timing loop dependence.

Configuration information

Input/output capacity:	**2109E**	**2113E**
I/O channels in mainframe	9	14
With first extender	25	30
With two extenders	41	46
Standard memory:	**64kb**	**128kb**
Memory capacity		
Memory module spaces		
In Computer only	5	10
In Computer & extender	14	19
Max. non-fault control memory*		
In Computer only	0.640Mb	1.280Mb
In Computer & extender	1.792Mb	2.048Mb
Max. fault control memory*		
In Computer only	0.512Mb	1.024Mb
In Computer & extender	1.280Mb	1.792Mb

**Based on use of 128k byte memory modules.*

Control processor address space

Total address space: 16k 24-bit words

User PROM address space on FAB board: 3.5k*†

WCS overlay address space using 1k WCS boards: 3k**

User PROMs address space using 2k UCS board: 2k**

**Subtract 0.5k each for RTE-IV Extended Memory Area Mapping instructions and DS/1000 firmware, 1k for Scientific Instruction Set, and 1.5k for Dynamic Mapping Instructions and/or Fast FORTRAN Processor.*

†*Mounted on 3.5k firmware accessory board under cpu board.*

***Mounted on board(s) in cpu I/O backplane, using I/O slots.*

Electrical specifications

AC power required

Line voltage: 88-132V (110V ± 20%); 176-264V (220V ± 20%), with option 015. Input line voltage range is easily changed in the field by moving jumper connections.

Line frequency: 47.5 - 66Hz.

Maximum power required: 625W

Current available (+) required (−) for memory, I/O interfaces and accessories

See power specifications and applicability summary tables, pages 10-0 and 10-1.

Power supply

Storage after line failure: Sustains computer through a line loss of 8 msec when operating at the nominal ac line voltage.

Input line overvoltage protection: Circuit breaker protects against surge caused by connecting computer to twice nominal line voltage.

Input line transients: Withstands power line transients up to ±500V for 50 μsec wide pulse, up to ±1000V for 100 nsec wide pulse, without damage.

Output voltage regulation: ±5%, except −2V is ±10%.

Output protection: All voltages are protected for over-voltage and over current.

Thermal sensing: Monitors internal temperature and automatically shuts down the computer if temperature exceeds specified level.

Safety

Models 2109E and 2113E are recognized by Underwriters Laboratories, Inc. and certified by the Canadian Standards Association (with the exception of Option 015).

Physical characteristics

Dimensions

Width: 48.3 cm (19 in) panel; 42.6 cm (16-3/4 in) behind panel casting.
Depth: 62.2 cm (24-1/2 in) overall; 58.4 cm (23 in) behind panel casting.
2109E Height: 22.2 cm (8-3/4 in).
2113E Height: 31.1 cm (12-1/4 in).

Weight

2109E: 20.4 kg (45 lb).
2113E: 29.5 kg (65 lb).

Ventilation

Air intake is on the left side, exhaust is on the right hand side.

Heat dissipation

580 kilogram-calories/hour (2303 BTU/hour).

Air flow	2109E	2113E
Cubic metres/minute	5.7	7.9
Cubic feet/minute	200	280

Ordering information

2109E Computer

The 2109E includes:

1. 2109B computer.
2. 2102B standard performance memory controller and two 13187B 32k byte standard performance memory modules.
3. 13304A Firmware accessory board.
4. 12943-16001 and 16002, 24396-12001 through 12003 and 24296-60001 diagnostics and configurator, and 12943-90004, 24396-14001 and 02100-90157 diagnostic and diagnostic configurator manuals.
5. 02109-90001 HP 1000 E-Series reference manual.
6. 02109-90014 HP 1000 E-Series microprogramming manual.
7. 02109-90002 HP 1000 E-Series installation and service manual.

2113E Computer

The 2113E Computer includes:

1. 2113B computer.
2. 12786A 128k byte Standard performance memory package, including 2102B Memory controller, 12747A 128k byte memory module, and 13305A Dynamic mapping system.

3-7. Same as items 3 through 7 of 2109E Computer, above.

2109E and 2113E option

014: Deletes standard memory, item 2, above, from 2109E or 2113E, to permit its replacement with another HP 1000 E-Series compatible standard performance or high performance memory system, with or without fault control, which must be ordered separately.

015 220V (176-264V) operation

2109E and 2113E accessories

See power specifications and applicability summary, pages 10-0 and 10-1, referring to the E-Series applicability column.

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HP 1000 M-series computers

models 2105A, 2108M, 2112M

The HP 1000 M-Series computers are a flexible and economical implementation of Hewlett-Packard's HP 1000 architecture. Standard features include a powerful instruction set with floating point and data communications instructions, integer arithmetic, automatic parity generation and checking, and fully-independent memory and I/O sections in the computer mainframe. Plug-in instructions are available to increase M-Series performance.

Utilizing the latest 4k and 16k RAM semiconductor memory, memory modules offer a choice of 32 and 128k byte capacities. Fault control (error detection and correction) is available for important reliability improvements in large-memory systems or systems that require fault secure operation.

Microprogramming power and speed is readily available in the form of writable control store modules; it may also be permanently fused into programmable read-only memory (PROM) and plugged into processor control store.

Comprehensive HP 1000 software includes assemblers, compilers, and operating systems. A full line of HP-manufactured peripherals and data communications interface kits is available for tailoring complete systems around HP 1000 computers.

Features

- 128 powerful standard instructions including:
  - — Floating point
  - — Integer arithmetic
  - — Data communications
  - — Index instructions
  - — Memory and register reference
  - — I/O group
- Fully user-microprogrammable with complete software support
- 650 nanosecond main memory is standard in largest M-Series computers: 64k bytes in 2108M, 128k bytes in 2112M. Fault control capability is optional
- Dynamic mapping system, optional in 2108M, standard in 2112M, provides for accessing up to two megabytes of memory (1.8 million bytes with fault control) in 2112M computer plus memory extender
- Optional power fail recovery system for automatic restart capability and for providing a minimum of 1.6 hours of memory sustaining power in the event of complete power failure
- Paper tape loader program, contained in non-volatile Read-Only Memory, is standard
- Modular design and packaging for easy expandability and maintenance
- Brownout proof power supply for high tolerance to power line variations and power interruptions
- Large memory capacity in compact mainframe providing:
  - — 64k bytes in the 5-1/4-inch 2105A
  - — 640k bytes in the 8-3/4-inch 2108M
  - — 1280k bytes in the 12-1/4-inch 2112M
- Standard memory parity generation and checking that protects programs against bit loss, resulting in reduced software development and maintenance costs

Functional specifications

Processor architecture

Implementation: Diagonally microprogrammed with LSI and MSI hardware.

Data path width: 16 bits

Standard registers:
Accumulators: 2 (A and B), 16 bits each. Implicitly addressable, also explicitly addressable as memory locations
Index: 2 (X and Y), 16 bits each
Memory control: 3 (T,P), 16 bits each; (M), 15 bits
Supplementary: 2 (overflow and extend), one bit each
Manual data: 1 16-bit (display)

Instruction types:

Memory-to-accumulator	Accumulator-to-I/O
Memory-to-memory	Device control
Direct register modification	

Instruction formats:

Combined single-word	Double-word
Single-word	Triple-word

Instruction expansion: 256 instruction codes are available for instruction additions.

Addressing modes:

Direct	Double-word
Multilevel-indirect	Single-word
Indexed	Byte
Indirect indexed	Bit
Register implicit	

Bus structure: Separate memory data, memory address, and I/O buses tied to the unified internal processor's S-bus.

Memory structure: 32 pages of 2048 bytes, with direct access to current or base (page 0) pages; indirect or indexed access to all pages

Memory expansion: Paged memory address space expandable to 1024 pages of 2048 bytes each, using the 12976B Dynamic Mapping System

Input/output: Vectored priority interrupt structure for up to four system devices and 46 I/O devices

Input/output structure:

Memory and I/O addresses	Interrupt vector function	Control/access function
0	—	Interrupt system
1	—	Program panel
2	—	DCPC channel 1
3	—	DCPC channel 2
4	Power failure	Central interrupt register
5	Memory protect, parity, DMS	Memory protect, DMS
6	DCPC channel 1 Completion	DCPC channel 1
7	DCPC channel 2 Completion	DCPC channel 2
10	I/O devices	I/O devices
:	:	:
77	.	.

Control processor

Architecture: Hardwired

Implementation: MSI TTL

Control path: 24 bits

Data path: 16 bits

Registers:
Standard registers: 4 (A,B,X,Y)
Scratch registers: 12 16 bit registers accessible to the microprogrammer
Iteration counter: 8 bits
Latch register: 16 bits
Status flag: 1 bit

Instruction formats:
TYPE 1 Data transfer and modification
TYPE 2 Constant formation
TYPE 3 Conditional branch
TYPE 4 Unconditional branch

Bus structure: Unified single bus with program access to memory data, memory address, and I/O buses

Control Memory structure:
Type: Bipolar LSI semiconductor R/W or ROM
Address space: 4096 words; 16 modules of 256 words each
Word width: 24 bits
Cycle time: 325 nsec

Module assignments:
0, 14, and 15 assigned to base instruction set
Module 1 used for front panel control
Module 2 used for DMS instructions
Modules 3-5 used for fast FORTRAN processor
Modules 6-9 for user microroutines
Modules 10 and 11 used for DS/1000 firmware
Modules 12 and 13 reserved for user microroutines

Microinstructions: 211 total; up to 5 may be combined in 1 instruction cycle

Operations: 15	Immediate modifier: 4
Special: 32	Store-destination: 32
ALU arithmetic: 32	Reverse jump sense: 32
Conditional branch: 32	S bus-source: 32

Execution time: 325 nsec

Memory parity check

Monitors all words read from memory. Utilizes 17th bit in memory. Switch-programmable to halt or ignore parity error when detected. Interrupt on error requires memory protect option. Parity error indication is displayed on the front panel.

Power fail interrupt

Priority: Highest priority interrupt

Power failure: Detects power failure and generates an interrupt to memory location 4 for user-written power failure routine. A minimum of 500 microseconds is provided for execution of the user-written system state save routine.

Loader protection

All loaders reside in special ROM's separate from the control ROM, and are loaded into the last 64 words of main memory by activating front panel switches. A paper tape loader is standard and disc, terminal, or mag tape loader ROM's are optional. Four switch-selectable loader spaces are provided to accommodate other modes of operation as a user option. User-generated loaders may be written in assembly language, written into PROMS, and mounted in sockets on the CPU board.

Volatility protection

AC standby mode and sustaining power for line loss of 8 milliseconds before entering power fail routine. Power fail recovery system provides a minimum of 1.6 hours of battery-supplied memory standby power.

Instruction execution times (microseconds)

Reference and I/O instructions (70 total)	Min.	Max.
Memory reference group (14 total)	1.9	2.9
Register reference group (43 total)	2.6	2.9
I/O group (13 total)	2.6	3.9

Extended arithmetic instructions (10 total)	Min.	Max.
Multiply	12.3	13.0
Divide	13.6	17.5
Double load		4.9
Double store		4.9
Shift/rotate	3.6	8.4
Indirect-addressing		1.3

Index instructions (32 total)	Max.
Copy A/B to X/Y	2.3
Copy X/Y to A/B	2.3
Exchange registers A/B-X/Y	3.3
Increment/decrement Index registers	3.3
Load index	*4.9
Store index	*5.2
Load A/B registers, indexed	*4.9
Store A/B registers, indexed	*5.2
Add memory-to-index registers	*4.9
Jump and load Y	*5.5
Jump and index Y	4.6

**Plus 1.3 μsec/level of indirect addressing*

Data communications instructions (10 total)	Setup	Execute
Load byte	4.6	5.2
Store byte	5.8	6.2
Move bytes	8.8	7.3
Move words	7.8	3.3
Compare bytes	8.8	8.1
Compare words	6.8	4.2
Scan for byte	2.3	4.9
Set bits	7.8	
Clear bits	7.8	
Test bits	7.1	

NOTE: Multiple execute steps may take place for each instruction set-up.

Floating point instructions (6 total)	Min.	Max.
Add	23.7	67.6
Subtract	29.7	70.5
Multiply	47.8	56.1
Divide	61.4	77.7
Fix	6.5	12.7

Configuration information	2105A	2108M	2113M
Input/output capacity:			
I/O channels in mainframe	4	9	14
With first I/O extender	20	25	30
With two I/O extenders	36	41	46
Standard memory:	none	64kb	128kb
Memory capacity:			
Memory module spaces			
In computer only	2	5	10
In computer & extender	n/a	14	19
Max. non-fault control memory*			
In computer only	64kb	0.640Mb	1.280Mb
In computer & extender	n/a	1.792M	2.048Mb
Max. fault control memory*			
In computer only		0.512Mb	1.024Mb
In computer & extender		1.280Mb	1.792Mb

**Based on use of 128k byte memory modules.*

Compatibility

Instruction set: The HP 1000 M-Series is backward compatible with all previous 2100 Series computers.

Program: Most programs written for 2100 Series computers are compatible with the HP 1000 M-Series except those with timing loop dependence.

Electrical specifications

AC power required

Line voltage: 88-132V (110V ±20%); 176-264V (220V ±20%) with option 015. Input line voltage is easily changed in the field by moving jumper connections.

Line frequency: 47.5 to 66 Hz

Maximum power required:

2105A	2108M	2112M
400W	625W	625W

Current available (+) required (−) for memory, I/O interfaces and accessories

See power specifications and applicability summary tables, pages 10-0 and 10-1.

Power supply

Storage after line failure: Sustains processor through a line loss of 8 msec when operating at the normal 110/220 VAC.

Input line overvoltage protection: Input protection circuit in series with line fuse causes supply to crowbar for line voltages >40% above normal.

Input line transients: Withstands power line transients up to ±500V for 50 μsec wide pulse, up to ±1000V for 100 nsec wide pulse, without damage.

Output voltage regulation: ±5%, except −2V is ±10%.

Output protection: All voltages are protected for over-voltage and overcurrent.

Thermal sensing: Monitors internal temperature and automatically shuts down the computer if temperature exceeds specified level.

Safety

Models 2105A, 2108M, and 2112M are recognized by Underwriters Laboratories, Inc., and certified by the Canadian Standards Association (with the exception of Option 015).

Physical characteristics

Dimensions

Width: 48.3 cm (19 in) panel; 42.6 cm (16-3/4 in) behind panel casting.

Depth: 62.2 cm (24-1/2 in) overall; 58.4 cm (23 in) behind panel casting.

2105A Height: 13.3 cm (5-1/4 in).

2108M Height: 22.2 cm (8-3/4 in).

2112M Height: 31.1 cm (12-1/4 in).

Weight

2105A: 17.7 kg (39 lb).

2108M: 20.4 kg (45 lb).

2112M: 29.5 kg (65 lb).

Ventilation

Air intake is on the left side, exhaust is on the right side.

Heat dissipation	2105A	2108M	2112M
K-Cal/hr, max.	344	580	580
BTU/hr, max.	1365	2303	2303

Air flow	2105A	2108M	2112M
Cubic meters/min	5.7	5.7	7.9
Cubic ft/min	200	200	280

Ordering information

2105A Computer

The 2105A Computer includes:
1. 2105A Computer.
2. 02108-60038 computer diagnostic software and manuals kit (software on paper tape).
3. 02108-90002 Reference manual.
4. 02108-90004 Operator's manual.
5. 02108-90006 Operation and service manual.
6. 02108-90008 Microprogramming manual.
7. 02108-90014 Microprogramming pocket guide.
8. 05951-9162 Microcoding form.

2108M Computer

The 2108M Computer includes:
1. 2108B Computer.
2. 2102B Standard performance memory controller and two 13187B 32k byte Standard performance memory modules.
3. 02108-60038 computer diagnostic software and manuals kit (software on paper tape).
4. 02108-90037 Operation & reference manual.
5. 02108-90035 Installation & service manual.
6. 02108-90008 Microprogramming manual.
7. 02108-90014 Microprogramming pocket guide.
8. 05951-9162 Microcoding form.

2112M Computer

The 2112M Computer includes:
1. 2112B Computer.
2. 12784A 128k byte Standard perfor nance memory package, including 2102B Memory controller, 12747A 128k byte Memory module, and 12976B Dynamic mapping system.

3-8. Same as items 3-8 of 2108M, above.

2105A, 2108M, and 2112M option

014: Deletes standard memory, item 2, above, from 2108M or 2113M, to permit its replacement with another HP 1000 M-Series compatible standard performance memory system, with or without fault control, which must be ordered separately.

015: 220V (176-264V) operation.

Accessories and field upgrades

For list of accessories that are compatible with the 2105A, 2108M, and 2112M Computers, see the power specifications and applicability summary on pages 10-0 and 10-1, referring to the series M applicability column.

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HP 1000 M-Series and E-Series Board Computers and Accessories

models 2108MK, 2109EK, 12728A-J

HP HP 1000 M-Series and E-Series Board Computers offer the power, speed, and flexibility of M-series and E-series Computers in a convenient package for system integration. In addition to a choice of M-series and E-series CPU boards, accessories are available, such as front panel control assemblies and a choice of card cages and backplanes.

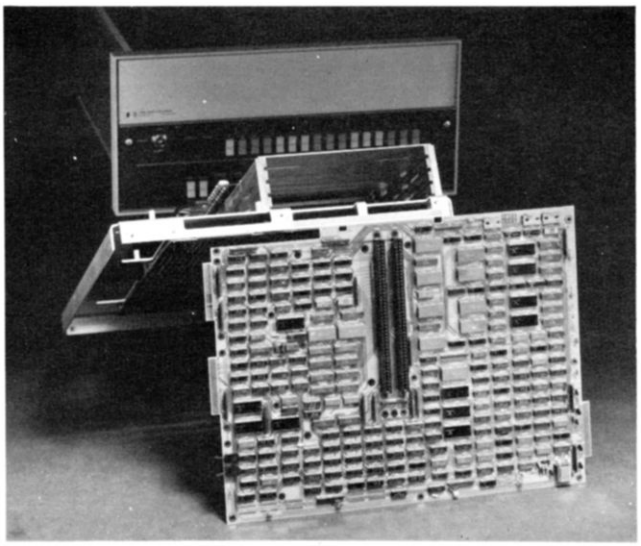
Features

- HP 1000 Computer compatibility for:
  - — Immediate usability of the full range of HP 1000 Computer options, peripherals, operating systems, and software
  - — Powerful HP 1000 instruction set
  - — User-microprogrammability for easy access to high performance control processor
  - — Versatile, vectored I/O interrupt structure
  - — Forced load capability
- High performance microprogrammable control with:
  - — High-level 24-bit control processor with pipelined instruction execution
  - — 211 instructions
  - — 16 general-purpose registers
  - — 6M byte/sec data bus (2108MK)/11.4M byte/sec data bus (2109EK)
  - — 64-device multi-level vectored priority interrupt I/O
  - — Up to 64k byte read/write storage
- Includes 32k bytes of semiconductor memory; up to 2.048 million bytes can be accessed using optional dynamic mapping system
- Reductions in system cost through elimination of redundant power supplies, control panels, etc
- Optional operator's panel means computer power can be built into systems without end-user awareness of special training
- Compatible HP 1000 system support will mean shorter software development times and reduced engineering costs

Functional description

The 2108MK and 2109EK make available the processing power of M-series and E-series Computers at the board level so the user need not purchase system hardware which may be redundant in his application, such as the power supply, control panel, card cage, and cover of packaged computers. At the same time the user can purchase control panels, a choice of card cages, and the HP 1000 instruction set, as required for his application.

The ability to interact directly with the processor allows designers to create custom control panels or custom control arrangements for specific applications. Use of M-Series and E-Series Board Computers hidden in customized products permits simplification of user procedures for start-up and program loading.



The compatibility of the HP 1000 Board Computers with the HP 1000 Computer line enables users to develop, test, and demonstrate applications on a packaged HP 1000 computer before completing system integration. Such system pretesting increases development efficiency and cost effectiveness.

The HP 1000 Board Computer as an HP 1000-compatible computer

The 2108MK and 2109EK processor boards with the HP 1000 instruction set provide HP 1000-compatible computer capabilities. These include access to HP 1000 memory systems, I/O interface cards, peripherals, microprogramming tools, and instruction set. 128 base set instructions are available, including floating point; integer arithmetic; data communications; index instructions; and I/O, memory, and register reference instructions.

Software compatibility. This level of processor is also compatible with HP 1000 software, including high-level, assembly, and microprogramming languages, real-time executive systems available in memory-based and disc-based configurations, systems utilities, and library routines that speed and simplify the development of application software.

Versatile I/O structure. The HP 1000-compatible I/O structure features multi-level vectored priority interrupts. The available card cages can hold either four or nine I/O cards, with a broad range of peripherals and instrumentation interfaces available.

Forced load provides a customizable system initialization sequence. When the computer is powered up and the standard front panel assembly is not connected, control will be passed to a user-written ROM program. The ROM program can "cold-load" main memory, perform an initialization sequence for a particular application, and monitor the system control panel.

The HP 1000 Board Computer as a high-performance control processor

The 2108MK and 2109EK may also be viewed as high-powered, microprogrammable control processors. The 2108MK can perform a register-to-register add in one 325-nanosecond cycle; the 2109EK performs the same add in only 175 nanoseconds. Further speed is achieved by fetching the next instruction from control memory while the current one is being executed. Pipelining (or instruction prefetch) results in an effective doubling of processor performance. Up to five of the 211 instructions can be combined and executed in a single processor cycle.

Another important control processor feature on both Board Computers is the central bus — the S-bus. It fans out to subsidiary I/O data, I/O address, and memory address buses. The S-bus runs at 6M bytes per second in the 2108MK, 11.4M bytes per second in the 2109EK. Bus transfers are controlled directly by the programmer for maximum flexibility. The powerful I/O bus is a 16-bit (two byte) parallel structure with separate controls, vectored priority interrupt with programmable main memory vectors, and programmable interrupt rate testing on two levels for up to 64 devices.

The 2108MK and 2109EK have both read/write and read-only memory capabilities. The main read/write memory can be modified under program control, and access for up to 64k bytes is standard.

Functional specifications

As a computer (2108MK requires 12728E instruction set; 2109EK requires 12728H instruction set)

Processor: 16-bit, HP 1000-compatible instruction set.

Registers:

Accumulators:	2 (A&B), 16 bits
Index:	2 (X&Y), 16 bits
Flags:	2 (overflow & extend)
Manual data entry:	1 (display), 16 bits

2108MK control memory: 4,096 24-bit words; sixteen 256-word modules, allocated as follows:

Modules 0, 1, 14, and 15: HP 1000 emulation
Module 2: Dynamic mapping system (DMS)
Modules 3, 4, and 5: Fast Fortran processor (FFP)
Modules 12 and 13: reserved for user microcode (if DMS and FFP are not used, modules 2 through 13 can be available for user microcode)

2109EK control memory: 16,384 24-bit words; sixty-four (64) 256-word modules, allocated as follows:

Modules 0 through 3: HP 1000 emulation
Modules 4 through 19: reserved for HP instruction set enhancements
Modules 20 through 31: reserved for user's microcode or HP instruction set enhancements
Module 32: Dynamic mapping system (DMS)
Modules 33, 34, and 35: Fast Fortran processor (FFP)
Modules 36 through 45: reserved for HP enhancements
Modules 46 through 63: reserved for user microcode

Automatic cold load: Provides branch to module 11 of control module on computer power-up when standard operator's control panel is not installed.

Computer compatibility: The 2108MK shares the same wide selection of parts and accessories as the HP 1000 M-series computers. The 2109EK is likewise compatible with the accessories for the higher-performance HP 1000 E-series computers.

Instructions and execution times:

Instructions	Execution Times (μsec) 2108MK with std perf. memory	2109EK with std perf. memory	2109EK with high perf. memory
Memory reference group (14 total)			
Add/load/AND/IOR/XOR	1.94	1.19	0.91
Store	2.27	1.85	1.26
Jump	1.94	0.74	0.74
Jump to subroutine	2.27	1.85	1.61
Compare (normal/skip)	2.27/2.59	1.23/1.72	1.09/1.43
Increment, skip if zero	2.59/2.92	2.03	1.54/1.61
Indirect address, per level	1.3	0.575	0.46
Register reference group (43 total)			
Normal/skip	2.59/2.92	1.19/1.29	0.91/1.26
Input/output group (13 total)			
SFS/SFC/SOS/SOC (normal)	2.59-3.89	1.58-2.28	1.58-2.28
SFS/SFC/SOS/SOC (skip)	2.59-3.89	2.03-2.73	1.96-2.66
All others	2.59-3.89	1.58-2.28	1.58-2.28
Extended instruction group (10 total)			
Multiply	12.32-13.30	5.74-6.72	5.3 -6.0
Divide	15.92-18.20	8.09-9.63	7.7 -9.1
Double load	4.54	3.185	2.07
Double store	4.86	3.71	2.7
Shift/rotate (basic)	3.57-8.43	2.065	1.47
Additional per shift	n/a	0.175	0.175
Indirect addressing	1.3	1.19	0.81
Index instructions (32 total)			
Copy	2.3	1.435	1.29
Exchange	3.3	2.065	1.92
Decrement/increment (normal)	4.9*	2.03	1.75
Decrement/increment (skip)		2.52	2.00
Load/add index	4.9*	3.05	2.66
Store index	5.2*	3.43	2.94
Load indexed	4.9*	3.745	3.19
Store indexed	5.2*	3.815	3.46
Jump and load Y	5.5*	2.8	2.67
Jump and index X	4.6*	2.625	2.28
Data communications (10 total)			
Load byte (basic/execute per byte)	4.6/5.2	3.50/3.78	3.36
Store byte (basic/execute per byte)	5.8/6.2	4.45/4.83	3.89
Move bytes (basic/execute per byte)	8.8/7.3	4.27/4.235	3.75/4.05
Move words (basic/execute per word)	7.8/3.3	4.27/1.75	3.75/1.68
Compare bytes (basic/ex. per byte)	8.8/8.1	4.27/3.78	3.75/3.78
Compare words (basic/ex. per word)	6.8/4.2	4.27/2.87	3.75/2.38
Scan for byte (basic/ex. per byte)	2.3/4.9	2.17/2.735	1.92/2.735
Set or clear bits	7.8	5.215	4.48
Test bits (normal/skip)	7.1	5.36/5.67	4.73/4.94
Floating point instructions (6 total)			
Add	23.7 -67.6	13.13-27.65	12.91-27.44
Subtract	29.7 -70.5	13.83-29.44	13.61-29.22
Multiply	47.8 -56.1	25.48-35.11	25.27-34.90
Divide	61.4 -77.7	34.02-47.32	33.18-47.11
Fix	6.5 -12.7	4.31- 7.6	4.06- 7.35
Float	12.7 -38.6	6.97-10.82	6.97-10.82

**+1.3 μsec for each level of indirect addressing*

As a control processor

Processor: 24-bit control path; 16-bit data path.

Registers:

General-purpose:	16, 16 bits
Latch:	1, 16 bits
Loop control counter:	1, 8 bits
Flags:	3, 1 bit

Instructions:

Operations:	15
ALU and conditional:	68
Special:	32
Store (destination):	32
Reverse jump sense:	32
S bus source:	32

2108MK instruction execution time: 325 nsec.

2109EK instruction execution time: variable, 175 or 280 nsec.

2108MK off-board control store memory:

Address space:	4,096 24-bit words.
Technology:	Bipolar LSI.
Types:	User control store ROM and/or Writable control store (WCS)
Access times:	ROM = 75 nsec; WCS = 110 nsec.

2109EK off-board control store memory:

Address space:	16,384 24-bit words.
Technology:	Bipolar LSI.
Types:	User control store ROM and/or Writable control store (WCS)
Access times	ROM = 75 nsec; WCS = 110 nsec.

Buses:

S-bus: 16 bits, 6M byte/sec data rate in 2108MK, 11.4M byte/sec data rate in 2109EK.
I/O data bus: 16 bits, 1.234M byte/sec data rate in 2108K, 1.95M byte/sec data rate in 2109EK.
Memory address bus: 15 bits.

Electrical specifications

Logic levels (all TTL)

Input: 0.8V maximum, logical low: 2.0V minimum, logical high.

Output: 0.8V maximum, logical low; 2.4V minimum, logical high.

I/O bus drivers and receivers

Same logic levels as output; in addition, each external TTL load must have a 1.5Ω pull-down resistor to −2V.

DC requirements for HP 1000 Board Computers, directly-related accessories, memory products, and memory related accessories:

Product Number and Name	2108MK	2109EK	DC Power requirements +5V‡	+12V‡	−12V‡	−2V‡
Computers						
2108MK Board Computer	X		12.275A	—	—	0.2A
12728C Control Panel Assembly	X		1.7A	—	—	—
12728E Instruction ROM Board	X		1.2A	—	—	—
2109EK Board Computer		X	12.275A	—	—	0.2A
12728G Control Panel Assembly		X	1.5A	—	—	—
12728H Instruction ROMs		X	(A)	—	—	—

‡ *Includes both CPU and dedicated memory power supply requirements (memory power supply requirements are not included in specifications for fully assembled HP 1000 Computers because they could not exceed the current capacity allocated to them in those machines).*

Product Number and Name	2108MK	2109EK	DC Power requirements +5V‡	+12V‡	−12V‡	−2V‡
Standard Perf. Mem. Products						
2102B Mem. Controller	X	X	1.7A	—	0.01A	0.01A
12998A 16kb Mem. Module	X	X	0.89A	0.61A	0.08A	—
13187B first 32kb Mem. Module	X	X	1.075A	0.56A	0.02A	—
13187B add'l 32kb Mem. Module	X	X	1.075A	0.14A	0.02A	—
12747A first 128kb Mem. Module	B	X	1.075A	0.56A	0.02A	—
12747A add'l 128kb Mem. Mod.	B	X	1.075A	0.14A	0.02A	—
12784A 128kb Mem. Pack. (C)	B		9.125A	0.56A	0.03A	0.06A
12784B 256kb Mem. Pack. (C)	B		10.2A	0.7A	0.05A	0.06A
12784C 512kb Mem. Pack. (C)	B		12.35A	0.98A	0.09A	0.06A
12784D 1024kb Mem Pack (C)	B		13.425A	0.92A	0.11A	0.06A
12786A 128kb Mem. Pack. (C)		X	7.925A	0.56A	0.03A	0.06A
12786B 256kb Mem. Pack. (C)		X	9.0A	0.7A	0.05A	0.06A
12786C 512kb Mem. Pack. (C)		X	11.15A	0.78A	0.09A	0.06A
12786D 1024kb Mem Pack (C)		X	12.225A	0.92A	0.11	0.06A
Standard Performance Fault Control Memory Products						
2102C Memory Controller	B	X	4.1A	—	0.01A	—
12779A first 256kb Ck Bit Bd	B	X	0.9A	0.2A	0.02A	—
12779A add'l 256kb Ck Bit Bd	B	X	0.9A	0.08A	0.02A	—
12780A first 512kb Ck Bit Bd	B	X	1.1A	0.3A	0.02A	—
12780A add'l 512kb Ck Bit Bd	B	X	1.1A	0.16A	0.02A	—
12785A 128kb Mem. Pack. (C)	B		12.425A	0.76A	0.05A	0.05A
12785B 256kb Mem. Pack. (C)	B		13.5A	0.9A	0.07A	0.05A
12785C 512kb Mem. Pack. (C)	B		15.85A	1.28A	0.11A	0.05A
12785D 1024kb Mem. Pack. (C)	B		21.25A	1.856A	0.21A	0.05A
12787A 128kb Mem. Pack. (C)		X	11.225A	0.76A	0.05A	0.05A
12787B 256kb Mem. Pack. (C)		X	12.3A	0.9A	0.07A	0.05A
12787C 512kb Mem. Pack. (C)		X	14.65A	1.28A	0.11A	0.05A
12787D 1024kb Mem. Pack. (C)		X	20.05A	1.856A	0.21A	0.05A
High Performance Memory Products						
2102E Memory Controller		X	3.2A	—	—	—
12741A first 32kb Mem. Mod.		X	1.075A	0.56A	0.02A	—
12741A add'l 32kb Mem. Mod.		X	1.075A	0.14A	0.02A	—
12747H first 128kb Mem Mod.		X	1.075A	0.56A	0.02A	—
12747H add'l 128kb Mem. Mod.		X	1.075A	0.14A	0.02A	—
12788A 128kb Mem. Pack. (C)		X	9.425A	0.56A	0.02A	0.05A
12788B 256kb Mem. Pack. (C)		X	10.5A	0.7A	0.04A	0.05A
12788C 512kb Mem. Pack. (C)		X	12.65A	0.98A	0.08A	0.05A
12788D 1024kb Mem Pack (C)		X	13.725A	1.12A	0.1A	0.05A
High performance Fault Control Memory Products						
2102H Memory Controller		X	4.1A	—	0.01A	—
12779H first 256kb Ck Bit Bd		X	0.9A	0.2A	0.02A	—
12779H add'l 256kb Ck Bit Bd		X	0.9A	0.08A	0.02A	—
12780H first 512kb Ck Bit Bd		X	1.1A	0.3A	0.02A	—
12780H add'l 512kb Ck Bit Bd		X	1.1A	0.16A	0.02A	—
12789A 128kb Mem. Pack (C)		X	11.225A	0.76A	0.05A	0.05A
12789B 256kb Mem. Pack. (C)		X	12.3A	0.9A	0.07A	0.05A
12789C 512kb Mem. Pack. (C)		X	14.65A	1.28A	0.11A	0.05A
12789D 1024kb Mem. Pack (C)		X	20.05A	1.856A	0.21A	0.05A
Memory-Related Accessories						
12892B Mem. Protect (D)	B	X	1.25A	—	—	0.05A
12731A Mem. Exp. Mod. (D)	B	X	3.9A	—	—	—
12976B Dyn. Mapping System	B		6.35A	—	—	0.05A
13305A Dyn. Mapping System		X	5.15A	—	—	0.05A
12897B Dual Chan. Port Ctrlr.	X	X	2.4A	—	—	0.05A

‡*Includes both CPU and dedicated memory power supply requirements (memory power supply requirements are not included in specifications for fully assembled HP 1000 Computers because they could not exceed the current capacity allocated to them in those machines).*

(A) 12728H current requirements are included in requirements for 2109EK.

(B) Applicable only to 2108MK Computers with 12728J card cage; the 12728A card cage does not dedicated card spaces required for the B-identified products.

(C) All memory packages include the appropriate memory controller, one or more 128k byte memory modules, and the 12976B or 13305A Dynamic Mapping System, and fault control check bit array boards in fault control memory packages.

(D) 12892B Memory Protect and 12731A Memory Expansion Module are both included in 12976B and 13305A Dynamic Mapping Systems.

Dc requirements for HP 1000 Computer extenders, non-memory accessories, and I/O interfaces.

See table on page 10-1.

Power supply regulation requirement

Required regulation at the power distribution connector, including line, load, ripple, and noise is ±5%.

Power supply control signals

Proper operation of the 2108MK or 2109EK processor board, including power fail/auto restart capability, requires signals indicating:

1. AC line voltage within limits.
2. All DC voltages within limits.
3. Presence or absence of fully-charged battery back-up for memory.

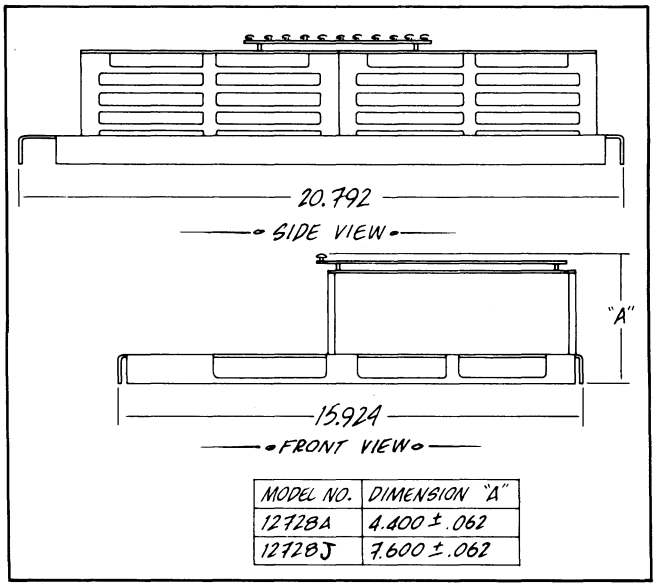
Physical characteristics

Processor board dimensions

Centimeters: 46 × 33 × 1.9
Inches: 18-1/8 × 13 × 3/4

Dimensions of card cages (in inches)

See illustration, below.



MODEL NO.	DIMENSION "A"
12728A	4.400 ± .062
12728J	7.600 ± .062

Weight

Model		
2108MK:	6.8 kg	(15 lb)
2109EK:	6.8 kg	(15 lb)
12728A:	2.9 kg	(6.3 lb)
12728C/G:	371 g	(13 oz)
12728D/F:	1.8 kg	(4.0 lb)
12728E:	86 g	(3 oz)
12728H:	86g	(3 oz)
12728J:	3.6kg	(7.81 lb)

Heat dissipation	kg-cal/hr	BTU/hr
2108MK/2109EK Board Computer:	41.2	163.5
12728C/G Front Panel Assy:	7.3	29
12728E Base instr. board:	5.2	20.5
12945A User ctrl store bd:	9.5	37.5
12728H Instruction ROMs:	Incl. in 2109EK	
13304A Firmware Access. bd:	7.7	30.7
2102B Memory controller:	7.3	29
2102C Memory controller:	17.0	67.7
2102E Memory controller:	13.8	54.8
Per memory module:	6.7	26.8
Per check bit board:	7.7	30.7

Air flow requirements*	cu meters/ min	cu ft/min
2108MK/2109EK Board Computer:	0.566	20
12728C/G Front Panel Assy:	0.0849	3
12728E Base instr. board:	0.0566	2
12945A User ctrl store bd:	0.0849	3
12728H Instruction ROMs:	Incl. in 2109EK	
13304A Firmware access. bd:	0.0849	3
2102B Memory controller:	0.0849	3
2102C Memory controller:	0.2264	8
2102E Memory controller:	0.1698	6
Per memory module:	0.0849	3
Per check bit board:	0.0849	3

** Air flow must parallel the surface of the processor board and other boards used with the processor.*

Ordering information

Compatibility

2108MK	2109EK	HP 1000 Board Computer Components
X		**2108MK Processor,** including: 1. 5060-8352 processor board. 2. 02108-60039 power wiring assembly. 3. 2102B Standard performance memory controller. 4. 13187B 32k byte Standard performance memory module.
X		**12728C Front control panel assembly** When used with the 12728E base set instructions, the 12728C provides a full programmer's console for the 2108MK.
X		**12728D Documentation package** This package completely documents the 2108MK for design, service, and support activities. It includes the 02108-90027 engineering and reference manual.
X		**12728E Base set instructions** These are microcode routines in read-only memory for emulation by the 2108MK processor of all the standard and extended instructions of HP 1000 computers, plus automatic cold load capability. It includes: 1. 5061-1367 ROM board assembly. 2. 5061-1336 Cable assembly. 3. Attaching hardware. 4. 02108-90029 Information sheet.

Compatibility

2108MK	2109EK	HP 1000 BoardComputer Components, Continued
	X	**2109EK Processor,** including: 1. 05061-1400 processor board. 2. 02108-60039 power wiring assembly. 3. 2102B Standard performance memory controller. 4. 13187B 32k byte Standard performance memory module.
	X	**12728F Documentation package** This package completely documents the 2109EK for design, service, and support activities. It includes the 12728-90001 engineering and reference document.
	X	**12728G Front control panel assembly** When used with the 12728H Instruction ROMs, the 12728G provides a full programmer's console for the 2109EK.
	X	**12728H Instruction ROMs** These are microcode routines in six read-only memory chips for emulation by the 2109EK processor of all the standard and extended instructions of HP 1000 computers, plus automatic cold load capability. It includes: 1. 5090-0563 through 0568 ROM chips. 2. 02109-90029 Information sheet.
X		**12728A Card Cage kit** The 12728A card cage kit provides capacity equivalent to the 2105A Computer; 4 I/O slots, 1 dual-channel port controller slot, 1 memory controller slot, and 2 memory module slots. It includes: 1. 02108-00035 Deck, 2. Four 02105-40001 Printed circuit module guides. 3. 02105-60002 I/O backplane. 4. 02105-60005 Memory backplane. 5. Two 02108-00012 Card cage covers. 6. 5060-8345 Cross-over assembly. 7. 02108-60034 Power supply cable assembly. 8. Assembly hardware. 9. 02108-90029 Information sheet.
X	X	**12728J Card Cage kit** The 12728J card cage kit provides capacity equivalent to the 2108M or 2109E Computer: 9 I/O slots, 1 dual-channel port controller slot, 1 memory controller slot, 1 memory protect slot, 1 memory expansion module slot, and 5 memory module slots. It includes: 1. 5000-8087 Universal deck. 2. Four 02108-40001 Printed circuit module guides. 3. 02108-60007 I/O backplane. 4. 5061-1382 Memory backplane. 5. Two 02108-00012 Card cage covers. 6. 5061-1388 Cross-over assembly. 7. 5061-1364 Power supply cable assembly. 8. Assembly hardware. 9. 02108-90029 Information sheet.

2108MK and 2109EK option

014: Deletes standard memory, 2108MK and 2109EK items 3 and 4, above, to permit replacement with another compatible HP 1000 M-Series or E-Series memory system, with or without fault control, which must be ordered separately.

2108MK and 2109EK accessories

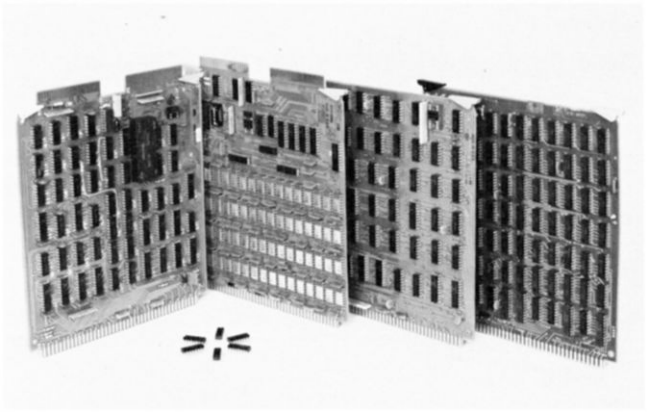
For list of alternate memory products, memory-related accessories, extenders, and other accessories and I/O interfaces that are compatible with the 2108MK and 2109EK Board Computers, see the DC requirements table in this data sheet and the power specifications and applicability table on page 10-1, referring to Series M applicability for 2108MK and Series E applicability for 2109EK.

HEWLETT hp PACKARD

Standard performance memory system for HP 1000 M-Series and E-Series Computers

models 2102B, 13187B, 12747A, 12784A-D, and 12786A-D

The standard performance memory system for HP 1000 E-, and M-Series computers consists of a 2102B memory controller and one or more memory modules, ranging in capacity from 32k to 128k bytes. With 128k byte memory modules, dynamic mapping in the computer, and a 12990B memory extender, main memory can be expanded to 2.048M bytes. The latest 4k and 16k MOS/RAM technology combined with extensive testing by Hewlett-Packard assures maximum reliability. Standard performance memory modules may also be used with the standard performance fault control memory controller and check bit array boards (models 2102C, 12779A, and 12780A), recommended for large-memory systems, to provide significant MTBF improvement (maximum memory with fault control is 1.792M bytes). Complete memory systems, including the controller, Dynamic Mapping System, and the appropriate number of memory modules and fault control check bit boards are available as preconfigured packages for ordering convenience.



12786A 128k byte Standard performance memory package, including, left to right: 2102B Memory controller, 12747A 128k byte Memory module, 12892B Memory rotect module, and 12731A Memory expansion module; 13307A Dynamic mapping instruction ROMs in the foreground

Features

- **High reliability 4k and 16k N-channel MOS/RAM memory chips**
- **595 ns system cycle time (E-Series), 650 ns (M-Series)**
- **16-bit data word (2 bytes) with 17th parity bit standard**
- **High density – 32k, or 128k bytes on a single memory module**
- **Convenient, economical large-memory packages**

Functional specifications

Memory organization

Type: 4k (13187B) or 16k (12747A) N-channel MOS/RAM chips.

Word size: 17 bits (2 bytes plus parity bit).

Configuration: 2102B controller supports multiple plug-in memory modules.

System cycle time: 650 ns for M-Series Computer; 595 ns ±35 ns for E-Series Computer. Dynamic mapping system adds 70 ns to memory cycle time for E-Series Computers only.

Volatility protection: HP 1000 computers provide memory sustaining power for a line loss of 8 milliseconds; the optional power fail recovery system provides memory power in case of total line failure.

Refresh: Each memory location is refreshed automatically every 2 milliseconds.

Capacity (bytes)

M Series Computers E-Series Computers	2105A	2108 2109	2112 2113
Max. mainframe memory	64k*	640k	1280k
12990B Extender memory	n/a	1152k	1152k
Total (computer + extender)	64k*	1792k	2048k**

**Based on use of 13187B 32k byte Memory modules*

***The maximum memory addressable by the Dynamic Mapping System is 2048k (2.048M) bytes*

Memory (bytes) provided by memory packages

M-Series packages:	12784A	12784B	12784C	12784D
E-Series packages:	12786A	12786B	12786C	12786D
Bytes of Memory:	128k	256k	512k	1024k

NOTE: k bytes consists of 1024 bytes of memory.

Standard performance memory system configuration information

Memory slots required: One for the 2102B memory controller plus one for each memory module.

Computer accessories required: Parity error address detection requires the memory protect module; expansion beyond 64k bytes requires the dynamic mapping system.

Computer accessories recommended: 12944A/B or 12991B power fail recovery system.

Installation: To install, configure memory modules to desired memory module addresses, plug controller and modules into designated slots in the memory backplane of the computer, and connect the cable from the controller to all of the memory modules.

12784A-D configuration information

Compatibility: The 12784A, B, C, and D Standard performance memory expansion packages are compatible with 2108 and 2112 computers, but not with 2105 computer.

Memory module slots required:

Product number	12784A	12784B	12784C	12784D
Slots required	1	2	4	8

Control store locations required: One for DMI instructions board included with 12784A, B, C, or D.

Other locations used: Dedicated slots for the 2102B Memory Controller and the 12892B Memory Protect and 12731A Memory expansion modules included with 12784A, B, C, or D.

Software recommended: RTE-M or RTE-IV Real-time executive operating system (92064A or 92067A).

Installation: Connect the DMI/FFP instructions board to the processor board and plug in the 12731A and 12892B modules. Install the memory controller and modules as specified above.

12786A-D configuration information

Compatibility: The 12786A, B, C, and D Standard performance memory expansion packages are compatible with 2109 and 2113 computers.

Memory module slots required:

Product number	12786A	12786B	12786C	12786D
Slots required	1	2	4	8

Prerequisite: 13304A Firmware accessory board.

Control store locations required: One 256 word module in the 1k section of the Firmware accessory board.

Other locations used: Dedicated slots for the 2102B Memory controller and the 12892B Memory Protect and 12731A Memory expansion modules included with 12786A, B, C, or D.

Software recommended: RTE-M or RTE-IV Real-time executive operating system (92064A or 92067A).

Installation: Plug the DMI ROMs into their sockets on the 13304A firmware accessory board and connect the firmware accessory board to the processor board. Plug in the 12731A and 12892B modules. Install the memory controller and modules as specified above.

Electrical specifications

DC required in HP 1000 Computers

See power specifications and applicability table on page 10-0.

DC required with HP 1000 Board Computers

See DC requirements table on page 1-21.

Ordering information

2102B Standard performance memory controller

The 2102B Standard performance memory controller includes:

1. 02102-60001 memory controller board.
2. 02112-60016 cable with eleven connectors.
3. 24395-16001 memory diagnostic on punched tape.
4. 24395-90001 manual of diagnostics.
5. 02102-90001 installation manual.

13187B 32k byte memory module

The 13187B memory module includes:

1. 13187-60001 32k byte memory module.
2. 13187-90004 installation manual.

12747A 128k byte memory module

The 12747A memory module includes:

1. 12747-60001 128k byte memory module.
2. 13187-90004 installation manual.

12784A 128k byte Standard performance memory package for M-Series

The 12784A memory package includes:

1. 2102B Memory controller
2. 12929-16001 DMS diagnostic on paper tape.
3. 12929-90003 MEM diagnostic manual.
4. 12747A 128k byte memory module.
5. 12892B Memory protect module.
6. 12731A Memory expansion module.
7. 12778B Dynamic mapping instruction group.

12784B 256k byte Standard performance memory package for M-Series

The 12784B memory package is the same as the 12784A package, but with two 12747A 128k byte memory modules.

12784C 512k byte Standard performance memory package for M-Series

The 12784C memory package is the same as the 12784A package, but with four 12747A 128k byte memory modules.

12784D 1024k byte Standard performance memory package for M-Series

The 12784D memory package is the same as the 12784A memory package, but with eight 12747A 128k byte memory modules.

12786A 128k byte Standard performance memory package for E-Series

The 12786A memory package includes:

1-6. Same as items 1-6 of the 12784A package, above.

7. 13307A Dynamic mapping instruction ROMs.

12786B 256k byte Standard performance memory package for E-Series

The 12786B memory package is the same as the 12786A package, but with two 12747A 128k byte memory modules.

12786C 512k byte Standard performance memory package for E-Series

The 12786C memory package is the same as the 12786A package, but with four 12747A60001 128k byte memory modules.

12786D 1024k byte Standard performance memory package for E-Series

The 12786D memory package is the same as the 12786A package but with eight 12747A 128k byte memory modules.

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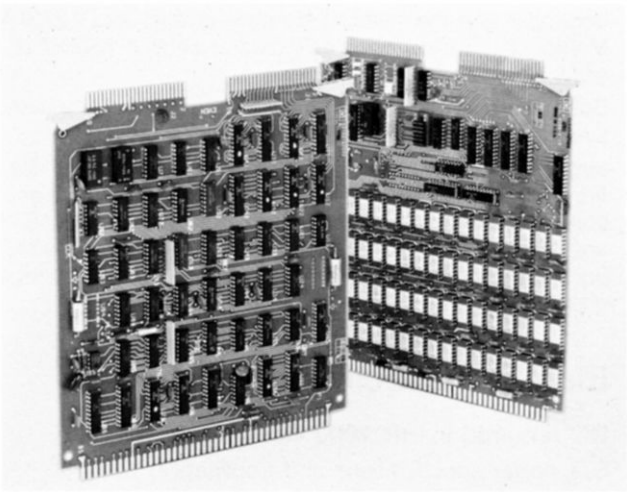
High-performance memory system for HP 1000 E-Series and F-Series Computers

models 2102E, 12741A, 12747H, and 12788A-D

The high performance memory system for HP 1000 F- or E-Series computers consists of a 2102E memory controller and one or more 12741A 32k byte or 12747A 128k byte memory modules. With 128k byte memory modules, dynamic mapping in the computer, and a 12990B memory extender, main memory can be expanded to 2.048M bytes. The latest 4k and 16k MOS/RAM technology combined with extensive testing by Hewlett-Packard assures maximum reliability.

The 12788A-D Memory packages provide a convenient, economical means of obtaining the 2102E Memory controller and 128k, 256k, 512k, and 1024k byte blocks of high performance memory, along with the dynamic mapping system that is required to address more than 64k bytes of memory. High performance memory modules may also be used with a new high performance fault control memory controller and check bit array boards (models 2102H, 12779H, and 12780H), recommended for large-memory systems, to provide significant MTBF improvement (maximum memory with fault control is 1.792M bytes).



High performance memory system controller (left) and 12747H 128k byte high performance memory module.

Features

- **350 nanosecond system cycle time**
- **Highly reliable, 4k N-channel MOS/RAM memory chips**
- **16-bit data word (2 bytes) with 17th bit for parity**
- **32k or 128k bytes on a single memory module**
- **Convenient, economical large-memory packages**

Functional specifications

Capacity (bytes)

E-Series Computers	**2109**	**2113**
F-Series Computers	**2111**	**2117**
Max. mainframe memory	640k	1280k
12990B Extender memory	1152k	1152k
Total (computer + extender	1792k	2048k*

**The maximum memory addressable by the Dynamic Mapping System is 2048k (2.048M) bytes*

Memory (bytes) provided by memory packages

Packages:	12788A	12788B	12788C	12788D
Bytes of Memory:	128k	256k	512k	1024k

NOTE: k bytes consists of 1024 bytes of memory

Memory organization

Type: 4k or 16k N-channel MOS/RAM memory chips

Word size: 17 bits (2 bytes plus parity)

Configuration: 2102E controller supports multiple plug-in memory modules

System cycle time: 350 nsec ±35 nsec. DMS adds 70 nsec.

Volatility protection: HP 1000 computers provide memory sustaining power for a line loss of up to 8 msec. The optional Power Fail Recovery System provides memory power in case of total line failure.

Refresh: Each memory location is refreshed automatically every 2 msec.

High performance memory system configuration information

Compatibility: The 2102E memory controller and 12741A and 12747H memory modules are compatible with 2109, 2111, 2113, and 2117 computers

High performance memory system controller (left) and 12747H 128k byte high performance memory module.

Memory slots required: One for the 2102E memory controller plus one for each memory module.

Computer accessories required: Parity error address detection requires the memory protect module; expansion beyond 64k bytes requires the dynamic mapping system.

Computer accessories recommended: 12944B or 12991B power fail recovery system.

Installation: To install, configure memory modules to desired memory module addresses, plug controller and modules into designated slots in the memory backplane of the computer, and connect the cable from the controller to all of the memory modules.

12788A-D configuration information

Compatibility: The 12788A, B, C, and D High performance memory expansion packages are compatible with 2109, 2111, 2113, and 2117 computers.

Prerequisites: 13304A Firmware accessory board (included in 2111 and 2117).

Memory module slots required:

Product number	12788A	12788B	12788C	12788D
Slots required	1	2	4	8

Control store locations required: One 256 word module in the 1k section of the Firmware accessory board.

Other locations used: Dedicated slots for the 2102E Memory controller and the 12892B Memory protect and 12731A Memory expansion modules included with the 12788A, B, C, or D.

Software recommended: RTE-M or RTE-IV Real-time executive operating system (92064A or 92067A).

Installation: Plug the DMI ROMs into sockets on the 13304A firmware accessory board and connect the firmware accessory board to the processor board and plug in the 12731A and 12892B modules into their dedicated slots in the memory section of the computer. Install the memory controller and memory modules as specified above.

Electrical specifications

DC required in HP 1000 Computers

See power specifications and applicability table on page 10-0.

DC required with HP 1000 Board Computers

See DC requirements table on page 1-21.

Ordering information

2102E High performance memory controller

The 2102E High performance memory controller includes:
1. 02102-60002 memory controller board.
2. 02112-60016 cable with eleven connectors.
3. 24395-16001 memory diagnostic on punched tape.
4. 24395-90001 manual of diagnostics.
5. 02102-90005 installation manual.

12741A memory module

12741A memory module includes:
1. 12741-60001 memory module.
2. 13187-90004 installation manual.

12747H memory module

The 12747H memory module includes:
1. 12747-60002 memory module.
2. 13187-90004 installation manual.

12788A 128k byte High performance memory package

The 12788A memory package includes:
1. 2102E High performance memory controller.
2. 12892B Memory protect module.
3. 12731A Memory expansion module.
4. 13307A Dynamic mapping instructions.
5. 12929-16001 DMS diagnostic on paper tape.
6. 12929-90003 Memory expansion module diagnostic manual.
7. 12747H 128k byte memory module.

12788B 256k byte High performance memory package

The 12788B memory package is the same as the 12788A package, but with two 12747H 128k byte memory modules.

12788C 512k byte High performance memory package

The 12788C memory expansion package is the same as the 12788A package, but with four 12747H 128k byte memory modules.

12788D 1024k byte High performance memory package

The 12788D memory package is the same as the 12788A package, but with eight 12747H 128k byte memory modules.

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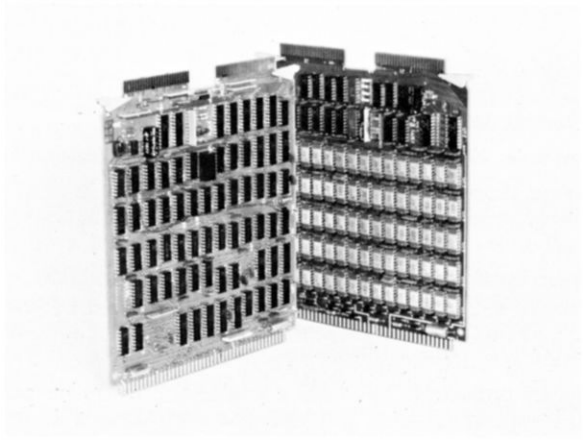
Standard performance fault control memory system for HP 1000 M-Series and E-Series Computers

models 2102C, 12779A, 12780A, 12785A-D, and 12787A-D

The standard performance fault control memory system brings fault-secure memory operation to HP 1000 family computers. The system consisting of a controller and one or more check bit array boards, along with the appropriate number of standard performance memory modules, is capable of correcting all single-bit memory errors, and of detecting all double-bit and most multiple bit errors. The fault control system is particularly valuable in computer systems with large amounts of memory, or where fault-secure operation is essential. Because of the modular structure of the fault control memory system, any HP 1000 M-,or E-Series computer with standard performance memory can be upgraded to fault control capability simply by substituting the fault control memory controller and adding appropriate check bit array boards.

The 12785A-D and 12787A-D Memory packages, for the HP 1000 M-Series and E-Series computers respectively, provide a convenient means of obtaining the 2102C Memory controller and fault control memory, including both memory modules and check bit boards, along with the dynamic mapping components that are required to address more than 64k bytes of memory.



Standard performance fault control memory system controller (left) and 12780A 512k byte Check bit array board (right). 12779A 256k byte Check bit array board (not shown) is a half-loaded version of the 12780A board.

Features

- **Automatic correction of all single-bit errors.**
- **Detection of all double-bit errors and most multiple (3 or more) bit errors.**
- **Sophisticated 22-bit Hamming error correction code optimized for speed of correction.**
- **Significant Mean Time Between Failures (MTFB) improvement**
- **Modular system structure allows expansion within fault control system at any time without changes to existing hardware or software.**
- **Compatibility with all HP 1000 family computers and HP 12998A, 13187A/B, and 12747A memory modules.**
- **State-of-the-art 16k MOS/RAM chips for high packaging density.**
- **Fault-indicating LEDs for ease of maintenance.**
- **Convenient, economical large-memory packages.**

Functional specifications

Configuration

Standard performance fault control memory systems are configured with one 2102C controller, one or more 12779A/12780A check bit array boards, and one or more 13187B, or 12747A memory modules. Check bit boards and memory modules mount in the memory section of the computer card cage. For example, the 2113 Computer with ten memory slots can accommodate up to one million bytes of fault control memory, since it provides space for eight 12747A 128k byte memory modules plus two 12780A check bit array boards.

The check bit array boards provide the additional bits required to execute the Hamming error correction code. The check bits are appended to the 17 bits on the memory module itself to form a 22-bit word. For this reason, the amount of memory in the system must **exactly** equal the amount supported by the check bit array boards. Two different check bit array boards are available, each of which can be configured to support the block sizes listed below.

12779A check bit board: can be configured to support any 64k, 128k, or 256k byte block of memory when the block boundary is a multiple of 64k bytes and the block is located within one of the following address ranges: 0-256kb, 512kb-768kb, 1024kb-1280kb, 1536kb-1792kb.

12780A check bit board: can be configured to support any 64k, 128k, 256k, or 512k byte block of memory when the boundary of the supported block is a multiple of 64k bytes.

Configuration choices

Memory size (bytes)	Check bit boards req'd 12779A	12780A	Memory size (bytes)	Check bit boards req'd 12779A	12780A
64k	1	0	640/768k	1	1
128k	1	0	896k	1	2
192k	2	0	1024k	0	2
256k	1	0	1280k	1	2
320k/384k	1	1	1536k	0	3
448k	2	1	1664k	1	3
512k	0	1	1792k	1	3

Capacity (bytes)

M-Series Computers	**2108**	**2112**
E-Series Computers	**2109**	**2113**
Max. mainframe memory	512k	1024k
12990B Extender memory	768k	768k
total (computer + extender)	1280k	1792k

Memory (bytes) provided by memory packages

M-Series packages:	12785A	12785B	12785C	12785D
E-Series packages:	12787A	12787B	12787C	12787D
Bytes of Memory:	128k	256k	512k	1024k

NOTE: k bytes consists of 1024 bytes of memory.

Memory organization

Type: 4k (13187B) or 16k (12747A, 12779A, and 12780A) N-channel MOS/RAM chips.

Word size: 22 bits (2 bytes plus 5 check bits and parity bit).

Configuration: 2102C controller supports multiple plug-in memory modules and check bit boards, which can be intermixed on the same controller.

System cycle time: 650 ns for M-Series computer; 630 ns ± 35 ns for E-Series computer. Dynamic mapping system, adds 70 ns to memory cycle time for E-Series Computers only.

Volatility protection: HP 1000 computers provide memory sustaining power for a line loss of 8 milliseconds; the optional power fail recovery system provides memory power in case of total line failure.

Refresh: Each memory location is refreshed automatically every 2 milliseconds.

Standard performance fault control memory system configuration information

Memory slots required: One for the 2102C memory controller plus one for each memory module and each check bit board.

Computer accessories required: Memory expansion beyond 64k bytes requires the dynamic mapping system.

Computer accessories recommended: 12944B or 12991B power fail recovery system.

Installation: To install, configure memory modules to desired module addresses; configure check bit boards to correct memory block size and to module addresses, and set mode jumper to correction mode; plug controller, memory modules, and check bit boards into user-assigned slots in the memory backplane, and connect the memory cable from the controller to all of the check bit and memory boards and the fault control cable from the controller to the check bit boards, all of which must be adjacent to the memory controller.

12785A-D configuration information

Compatibility: The 12785A, B, C, and D standard performance fault control memory packages are compatible with 2108 and 2112 computers, but not with 2105 computer.

Memory module slots required:

Product number	12785A	12785B	12785C	12785D
Slots required	2	3	5	10

Control store locations required: One for DMI instructions board included with 12785A, B, C, or D.

Other locations used: Dedicated slots for the 2102C Memory controller and for the 12892B Memory protect and 12731A Memory expansion modules included with 12785A, B, C, or D.

Software recommended: RTE-M or RTE-IV Real-time executive operating system (92064A or 92067A).

Installation: Connect the DMI/FFP instructions board to the processor board and plug in the 12731A and 12892B modules into their dedicated slots in the memory section of the computer. Install the check bit boards and memory modules and memory controller as specified above.

12787A-D configuration information

Compatibility: The 12787A, B, C, and D Fault control memory packages are compatible with 2109, and 2113 computers.

Prerequisites: 13304A Firmware accessory board.

Memory module slots required:

Product number	12787A	12787B	12787C	12787D
Slots required	2	3	5	10

Control store locations required: One 256 word module in the 1k section of the Firmware accessory board.

Other locations used: Dedicated slots for the 2102C Memory controller and for the 12892B Memory protect and 12731A Memory expansion modules included with 12787A, B, C, or D.

Software recommended: RTE-M or RTE-IV Real-time executive operating system (92064A or 92067A).

Installation: Plug the DMI ROMs into sockets on the 13304A Firmware accessory board and connect the firmware accessory board to the processor board and plug in the 12731A and 12892B modules into their dedicated slots in the memory section of the computer. Install the check bit boards, memory modules, and memory controller as specified above.

Electrical specifications

DC required in HP 1000 Computers

See power specifications and applicability table on page 10-0.

DC required with HP 1000 Board Computers

See DC requirements table on page 1-21.

Ordering information

2102C Standard performance fault control memory controller

The 2102C memory controller includes:
1. 02102-60003 Fault control memory controller.
2. 02112-60016 cable with eleven connectors.
3. 02108-60041 fault control cable with six connectors.
4. 24395-16001 memory diagnostic on punched tape.
5. 24395-90001 manual of diagnostics.
6. 02102-90011 installation manual.

12779A Standard performance check bit array board

The 12779A check bit array board includes:
1. 12779-60001 check bit array board.
2. 12779-90001 installation manual.

12780A Standard performance check bit array board

The 12780A check bit array board includes:
1. 12780-60001 check bit array board.
2. 12779-90001 installation manual.

12785A 128k byte Standard performance fault control memory package for HP 1000 M-Series

The 12785A memory package includes:
1. 2102C Memory controller.
2. 12892B Memory protect module.
3. 12731A Memory expansion module.
4. 12778B Dynamic mapping instruction board.
5. 12929-16001 DMS diagnostic on paper tape.
6. 12929-90003 Memory expansion module diagnostic manual.
7. 12747A 128k byte memory module.
8. 12779A 256k byte check bit array board.

12785B 256k byte Standard performance fault control memory package for HP 1000 M-Series

The 12785B memory package is the same as the 12785A package, but with two 12747A 128k byte memory modules.

12785C 512k byte Standard performance fault control memory package for HP 1000 M-Series

The 12785C memory package is the same as the 12785A package, but with four 12747A 128k byte memory modules and a 12780A 512k byte check bit array board instead of the 12779A check bit board.

12785D 1024k byte Standard performance fault control memory package for HP 1000 M-Series

The 12785D memory package is the same as the 12785A package, but with eight 12747A 128k byte memory modules and two 12780A 512 byte check bit array boards instead of the 12779A check bit board.

12787A 128k byte Standard performance fault control memory package for HP 1000 E-Series

The 12787A memory package includes:
1. 2102C Memory controller.
2. 12892B Memory protect module.
3. 12731A Memory expansion module.
4. 13307A Dynamic mapping instructions.
5. 12929-16001 DMS diagnostic on paper tape.
6. 12929-90003 Memory expansion module diagnostic manual.
7. 12747A 128k byte memory module.
8. 12779A 256k byte check bit array board.

12787B 256k byte Standard performance fault control memory package for HP 1000 E-Series

The 12787B memory package is the same as the 12787A package, but with two 12747A 128k byte memory modules.

12787C 512k byte Standard performance fault control memory package for HP 1000 E-Series

The 12787C memory package is the same as the 12787A package, but with four 12747A 128k byte memory modules and a 12780A 512k byte check bit array board instead of the 12779A check bit board.

12787D 1024k byte Standard performance fault control memory package for HP 1000 E-Series

The 12787D memory package is the same as the 12787A package, but with eight 12747A 128k byte memory modules and two 12780A 512k byte check bit array boards instead of the 12779A check bit board.

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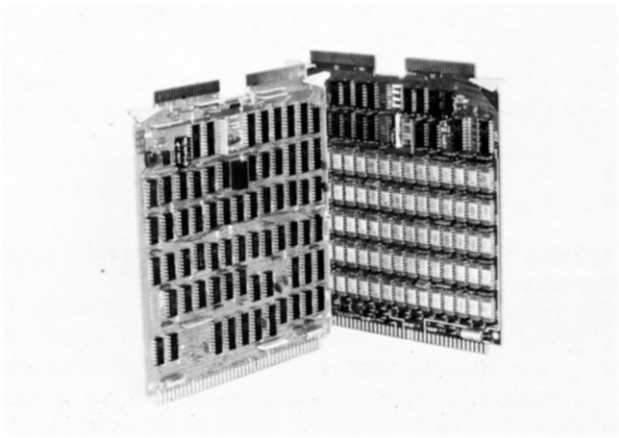
High performance fault control memory system for HP 1000 E-Series and F-Series Computers

models 2102H, 12779H, 12780H, and 12789A-D

The high performance fault control memory system brings fault-secure memory operation to HP 1000 E-Series or F-Series computers. The system consisting of a controller and one or more check bit array boards, along with the appropriate number of high performance memory modules, is capable of correcting all single-bit memory errors, and of detecting all double-bit and most multiple bit errors. The fault control system is particularly valuable in computer systems with large amounts of memory, or where fault-secure operation is essential. Because of the modular structure of the fault control memory system, any HP 1000 F- or E-Series computer with high performance memory can be upgraded to fault control capability simply by substituting the fault control memory controller and adding appropriate number of check bit array boards.

The 12789A-D Memory packages provide a convenient means of obtaining the 2102H Memory controller and 128k, 256k, 512k, and 1024k byte blocks of fault control memory, including both memory modules and check bit boards, along with the dynamic mapping components that are required to address more than 64k bytes of memory.



Fault control memory system memory controller (left) and 12780H 512k byte Check bit array board (right). 12779H 256k byte Check bit array board (not shown) is a half-loaded version of the 12780H board.

Features

- **Automatic correction of all single-bit errors.**
- **Detection of all double-bit errors and most multiple (3 or more) bit errors.**
- **Sophisticated 22-bit Hamming error correction code optimized for speed or correction.**
- **Significant Mean Time Between Failures (MTBF) improvement**
- **Modular system structure allows expansion within fault control system at any time without changes to existing hardware or software.**
- **State-of-the-art 16k MOS/RAM chips for high packaging density.**
- **Fault-indicating LEDs for ease of maintenance.**
- **Convenient, economical large-memory packages.**

Functional specifications

Configuration

High performance fault control memory systems are configured with one 2102H controller, one or more 12779H/12780H check bit array boards, and one or more 12741A or 12747H memory modules. Check bit boards and memory modules mount in the memory section of the computer card cage. For example, the 2113 Computer with ten memory slots can accommodate up to one million bytes of fault control memory, since it provides space for eight 12747H 128k byte memory modules plus two 12780H check bit array boards.

The check bit array boards provide the additional bits required to execute the Hamming error correction code. The check bits are appended to the 17 bits on the memory module itself to form a 22-bit word. For this reason, the amount of memory in the system must **exactly** equal the amount supported by the check bit array boards. Two different check bit array boards are available, each of which can be configured to support the block sizes listed below.

12779H check bit board: can be configured to support any 64k, 128k, or 256k byte block of memory when the block boundary is a multiple of 64k bytes and the block is located within one of the following address ranges: 0-256kb, 512kb-768kb, 1024kb-1280kb, 1536kb-1792kb.

12780H check bit board: can be configured to support any 64k, 128k, 256k, or 512k byte block of memory when the boundary of the supported block is a multiple of 64k bytes.

Configuration choices

Memory size (bytes)	Check bit boards req'd 12779H	12780H	Memory size (bytes)	Check bit boards req'd 12779H	12780H
64k	1	0	640/768k	1	1
128k	1	0	896k	1	2
192k	2	0	1024k	0	2
256k	1	0	1280k	1	2
320k/384k	1	1	1536k	0	3
448k	2	1	1664k	1	3
512k	0	1	1792k	1	3

Memory organization

Type: 4k (12741A) or 16k (12747H, 12779H, and 12780H) N-channel MOS/RAM chips.

Word size: 22 bits (2 bytes plus 5 check bits and parity bit).

Configuration: 2102H controller supports multiple plug-in memory modules and check bit boards, which can be intermixed on the same controller.

System cycle time: 420 ns ± 35 ns for HP 1000 E/F-Series computer without dynamic mapping system, 490 ns ± 35 ns in HP 1000 E/F-Series computer with dynamic mapping system.

Volatility protection: HP 1000 computers provide memory sustaining power for a line loss of 8 milliseconds; the optional power fail recovery system provides memory power in case of total line failure.

Refresh: Each memory location is refreshed automatically every 2 milliseconds.

Capacity (bytes)

E-Series Computers	2109	2113
F-Series Computers	2111	2117
Max. mainframe memory	512k	1024k
12990B Extender memory	768k	768k
Total (computer + extender)	1280k	1792k

Memory (bytes) provided by memory packages

Packages:	12789A	12789B	12789C	12789D
Bytes of Memory:	128k	256k	512k	1024k

NOTE: k bytes consists of 1024 bytes of memory.

High performance fault control memory system configuration information

Memory slots required: One for the 2102H memory controller plus one for each memory module and each check bit board.

Computer accessories required: Memory expansion beyond 64k bytes requires the dynamic mapping system.

Computer accessories recommended: 12944B or 12991B power fail recovery system.

Installation: To install, configure memory modules to desired module addresses; configure check bit boards to correct memory block size and to module addresses, and set mode jumper to correction mode; plug controller, memory modules, and check bit boards into user-assigned slots in the memory backplane, and connect the memory cable from the controller to all of the check bit and memory boards and the fault control cable from the controller to the check bit boards, all of which must be adjacent to the memory controller.

12789A-D configuration information

Compatibility: The 12789A, B, C, and D Fault control memory packages are compatible with 2109, 2111, 2113, and 2117 computers.

Prerequisites: 13304A Firmware accessory board (included in 2111 and 2117).

Memory module slots required:

Product number	12789A	12789B	12789C	12789D
Slots required	2	3	5	10

Control store locations required: One 256 word module in the 1k section of the Firmware accessory board.

Other locations used: Dedicated slots for the 2102H Memory controller and for the 12892B Memory protect and 12731A Memory expansion modules included with 12789A, B, C, or D.

Software recommended: RTE-M or RTE-IV Real-time executive operating system (92064A or 92067A).

Installation: Plug the DMI ROMs into sockets on the 13304A Firmware accessory board and connect the firmware accessory board to the processor board and plug in the 12731A and 12892B modules into their dedicated slots in the memory section of the computer. Install the check bit boards, memory modules, and memory controller as specified above.

Electrical specifications

DC required in HP 1000 Computers

See power specifications and applicability table on page 10-0.

DC required with HP 1000 Board Computers

See DC requirements table on page 1-21.

Ordering information

2102H High performance fault control memory controller

The 2102H memory controller includes:
1. 02102-60004 Fault control memory controller.
2. 02112-60016 cable with eleven connectors.
3. 02108-60041 fault control cable with six connectors.
4. 24395-16001 memory diagnostic on punched tape.
5. 24395-90001 manual of diagnostics.
6. 02102-90013 installation manual.

12779H High performance check bit array board

The 12779H check bit array board includes:
1. 12779-60002 check bit array board.
2. 12779-90001 installation manual.

12780H High performance check bit array board

The 12780H check bit array board includes:
1. 12780-60002 check bit array board.
2. 12779-90001 installation manual.

12789A 128k byte High performance fault control memory package

The 12789A memory package includes:
1. 2102H Memory controller.
2. 12892B Memory protect module.
3. 12731A Memory expansion module.
4. 13307A Dynamic mapping instructions.
5. 12929-16001 DMS diagnostic on paper tape.
6. 12929-90003 Memory expansion module diagnostic manual.
7. 12747H 128k byte memory module.
8. 12779H 256k byte check bit array board.

12789B 256k byte High performance fault control memory package

The 12789B memory package is the same as the 12789A package, but with two 12747H 128k byte memory modules.

12789C 512k byte High performance fault control memory package

The 12789C memory package is the same as the 12789A package, but with four 12747H 128k byte memory modules and a 12780H 512k byte check bit array board instead of the 12747H check bit board.

12789D 1024k byte High performance fault control memory package

The 12789D memory package is the same as the 12789A package, but with eight 12747H 128k byte memory modules and two 12780H 512k byte check bit array boards instead of the 12779H check bit board.

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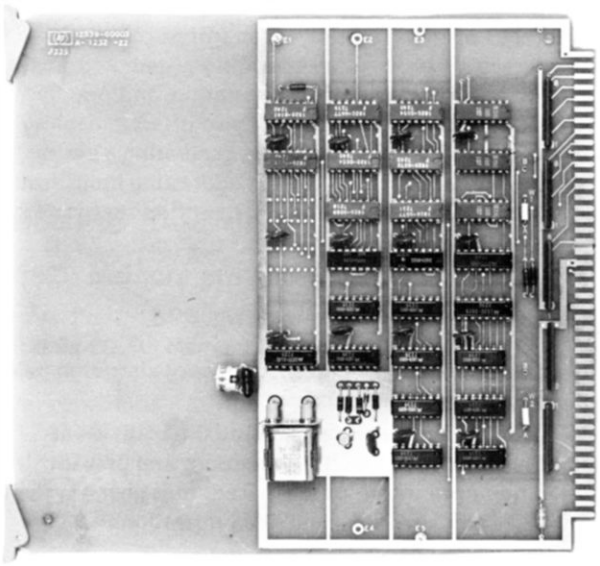
Time base generator

model 12539C

The 12539C Time Base Generator provides a system software clock for interfacing time-dependent equipment. All time base generator functions are contained on a single, plug-in card that has its own select code. The card provides command and interrupt logic, a 100kHz oscillator, eight decade frequency dividers, and output selection logic.

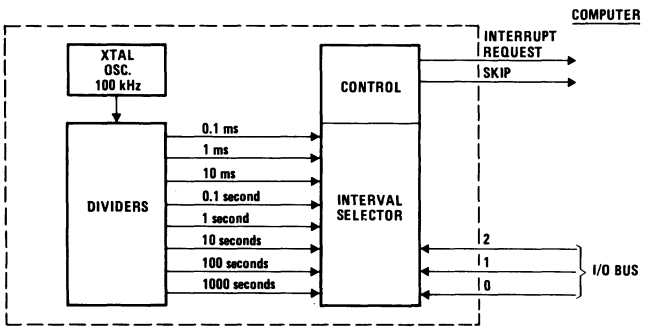


Features

- **Multiple time bases**
- **Built-in error detection**
- **Easy assembly-language programming**
- **Operates with interrupt or skip routines**
- **Accurate to 1/2 second/day**
- **Plugs into I/O slot of any HP 1000 computer**

Description

The time intervals are generated in decade steps from 100 microseconds to 1000 seconds (16.67 minutes) and are derived from the crystal oscillator. Any interval (in 100-microsecond increments) may be selected by use of a simple, assembly-language program loop. Built-in error detection provides an error status bit to the computer when a time interval is not acknowledged.



A signal from the computer enables the generator. The 100kHz oscillator signal is formed into eight time base intervals by the divider circuit. The appropriate time base is selected by using one of the following interval codes:

Binary code	000	001	010	011
Interval (millisec)	0.1	1.0	10	100
Binary code	100	101	110	111
Interval (seconds)	1.0	10	100	1000

When the selected interval is elapsed, the control logic requests an interrupt or enables a skip signal to the counter.

Functional specifications

Base intervals

0.1, 1, 10, and 100 milliseconds and 1, 10, 100, and 1000 seconds.

Accuracy

Stability: 2 parts in 10^6/week.

Temperature effects: 20 parts in 10^6 over temperature range of 15° to 35°C (59° to 95°F).

Total stability: 1/2 second/24-hour day

Electrical specifications

Current required from computer power supply

0.76A (+5V), 0.016A (-2V)

Ordering information

12539C Time base generator

The 12539C Time base generator includes:

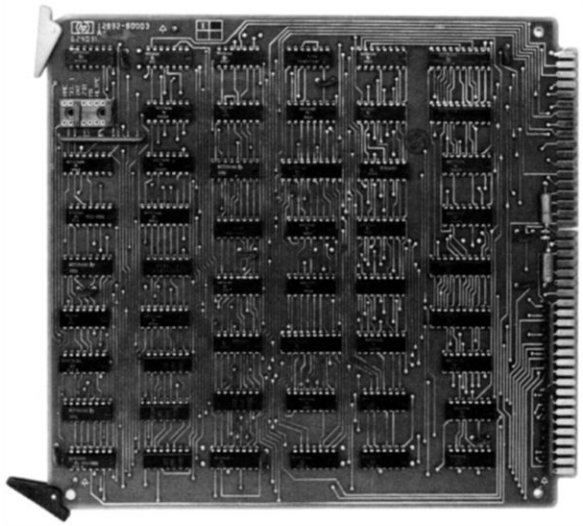
1. 12539-60003 Time base generator.
2. 12539-16001 Diagnostic on paper tape.
3. 12539-90011 and 02100-90157 Diagnostic manuals.
4. 12539-90008 Operating and service manual.

HEWLETT PACKARD

Memory protect

model 12892B

The 12892B Memory Protect, when installed in the memory section, provides an operating system with the capability to protect itself from alteration, and preserve system control of I/O functions. It also offers capability to detect parity error operations by generating a parity interrupt, prevents infinite indirect addressing loops from holding off interrupt servicing, and identifies user violations when operating with DMS.



Features

- **Memory protect logic prevents memory alteration below a programmable fence address**
- **I/O protect logic provides vectored interrupt on attempted execution of I/O instructions and prevents I/O operation until interrupt is serviced, thus giving system exclusive control of I/O and DMS operations**
- **Parity error interrupt logic provides an interrupt on occurrence of a parity error in memory and saves the parity error address**
- **Parity and memory protect features separately enabled/disabled by standard I/O instructions**
- **Computer may be switch-selected to interrupt or halt on parity error**
- **Operates in conjuction with dynamic mapping to provide interrupts for paged memory violations, privileged instruction violations, or parity errors**
- **Indirect level counter enables interruption of long indirect address loops**

Functional description

Memory protect fence

Memory protect provides capability to protect a selected block of memory from a programmable fence downward, against alteration by programmed instructions (EXCEPT those directly involving the A and B registers.) Any programmed instruction except JMP may freely address the A and B registers as locations 00000 and 00001, respectively. By removing the appropriate jumper, it is possible to prevent a JSB to A or B.

I/O control

With an STC 05 instruction, memory protect logic prohibits the execution of all I/O instructions except those involving the operator panel SCϕ1. This feature limits I/O operations to interrupt on DCPC only. Programming the system to direct all I/O interrupts to an executive program provides exclusive control of the I/O system. Memory protect logic is disabled automatically by any interrupt and must be reenabled by an STC 05 instruction at the end of each interrupt subroutine.

Programming

The following programming rules pertain to the use of memory protect, assuming an STC 05 instruction has been given:

A. Location 00002 is the lower boundary of protected memory. Locations 00000 and 00001 are the A and B register addresses.

B. JMP instructions may not reference the A or B register; however, a JSB instruction may do so. By removing the appropriate jumper, it is possible to prevent a JSB to A or B.

C. The upper boundary, memory address, is loaded into the fence register from A or B register by an OTA 05 or OTB 05 instruction, respectively. Memory locations below but not including this address are protected.

D. Execution will be inhibited and an interrupt to location 00005 will occur if a JMP, JSB, ISZ, STA, STB or DST instruction (also CBT, JLY, JPY, MVB, MVW, SAX, SAY, SBX, SBY, STX, and STY of the extended instruction group) directly addresses a location in protected memory. Execution will also be inhibited if any instruction is attempted, including HLT but excluding those addressing select code 01, the S register, and the overflow register.

After three successive levels of indirect addressing, the memory protect logic will allow a pending I/O interrupt. The 12892B can be jumper-configured to permit I/O instructions to any select code. HLT is still inhibited and all other protection features remain unchanged.

E. Any instruction not mentioned in step D is legal, even if the instruction directly references a protected memory address. Indirect addressing through protected memory by those instructions listed in step D is also legal provided that the ultimate effective address is outside the protected memory area.

For more detailed information, refer to the HP 1000 Computer Series Reference Manual.

Functional specifications

Compatibility

The 12892B is compatible with 2108, 2109, 2111, 2112, 2113, and 2117 Computers, but not with the 2105A Computer because no dedicated slot is provided for memory protect in that smaller machine.

Configuration information

Slots required: 1 dedicated slot in computer mainframe.

Software recommended: 24396F diagnostic package on mini-cartridge.

Installation: To install, insert the 12892B board directly into dedicated slot in memory backplane. No cables required.

Electrical specifications

Current required from computer power supply

Model	+5V	-2V	+12V	-12V
12892B	1.25A	.05A	—	—

Ordering information

12892B Memory protect

12892B Memory protect includes:

1. 12892-60003 Memory protect card.
2. 12892-16001 Memory protect parity error diagnostic on paper tape.
3. 12892-90005 Parity error diagnostic manual.
4. 12892-90007 Installation manual.

HEWLETT PACKARD

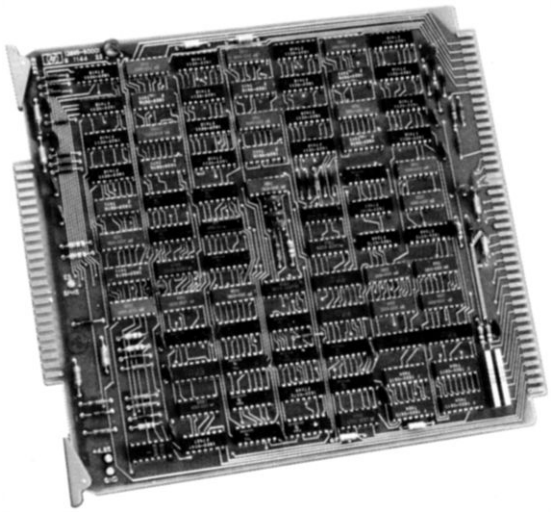
Dual channel port controllers

models 12897B, 12898A

The 12897B Dual Channel Port Controller (DCPC) provides a direct port between computer interfaces and memory. Two programmable channels can connect any I/O device to memory; these channels are program-assignable and reassignable, operating on a cycle-stealing basis with the processor.

When operating with the 13305A or 12976B Dynamic Mapping System (DMS), each channel is allocated a separate, automatically-enabled memory map to provide logical-to-physical memory translation.

DCPC operation in the 12979B Dual-port I/O extender requires the 12898A extender DCPC. Operation and software are identical for devices in either the extender or the computer.



Features

- **Program-assignable to any I/O channel**
- **Independent word count and address register for each channel**
- **Completely compatible with the 13305A or 12976B Dynamic Mapping System**
- **Common DMA controller for lower interfacing costs**
- **Direct data transfers to and from memory**
- **Operating system can interrogate word count registers to monitor transfer progress**

Functional specifications

DCPC transfer rates (megabytes/second)

Transfer operations and memory controller models	Computer Models 2105 2108 2112	2109 2111 2113 2117
Input		
2102B (Std performance memory)	1.23	1.95
2102C (Std perf fault ctrl memory)	1.23	1.88
2102E (High performance memory)		2.28
Output, non-Dynamic mapping		
2102B (Std performance memory)	1.23	1.77
2102C (Std perf fault ctrl memory)	1.23	1.67
2102E (High performance memory)		2.28
Output with Dynamic mapping		
2102B (Std performance memory)	1.23	1.67
2102C (Std perf fault ctrl memory)	1.23	1.62
2102E (High performance memory)		2.1

Capacity

Number of channels: 2

Number of memory ports: 1

Registers: 2 word count registers; 2 address registers; 2 select code registers

Word size: 16 bits (2 bytes)

Maximum block size: 65,536 bytes

Program-assignable: To any I/O channel

Configuration information

Slots required: 1, dedicated

Software recommended: Diagnostic package on paper tape (24396A), or minicartridges (24396F).

Installation: To install the 12897B, insert it directly into slot 110 of the HP 1000 memory backplane. For the 12898A, insert it directly into a dedicated slot in the 12979B I/O extender.

Electrical specifications

Current required from computer/extender power supply

Model	+5V	-2V
12897B	2.4A	.08A
12898A	.5A	.04A

Ordering information

12897B Dual channel port controller

The 12897B Dual channel port controller for HP 1000 Computers includes:

1. 12897-60004 Dual channel port controller assembly.
2. 12897-60002 Cable
3. 24322-16002 Diagnostic on paper tape
4. 24322-90002 Diagnostic manual
5. 12897-90005 Installation manual

12898A Dual channel port controller for 12979B Dual-port I/O extender

The 12898A Dual channel port controller includes:

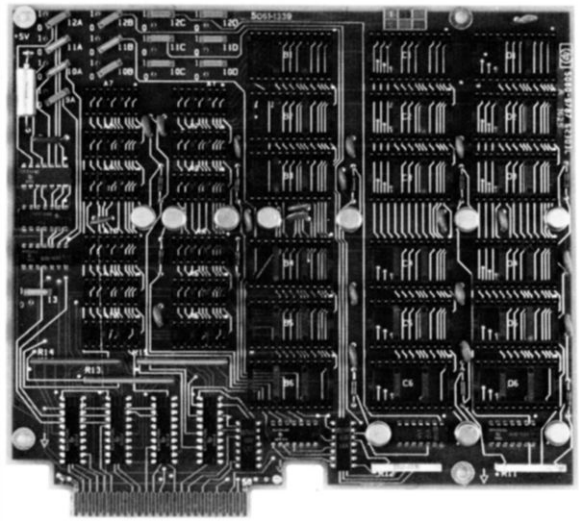
1. 12898-60001 dual channel port controller assembly.
2. 12898-90001 installation manual.

HEWLETT PACKARD

HP 1000 E-Series Firmware accessory board (FAB)

model 13304A

The 13304A Firmware Accessory Board provides an HP 1000 E-Series computer with space for 3.5k words of non-volatile control store. This space is used for HP-supplied enhancements, such as the 13307A Dynamic mapping instruction ROMs, the 12823A Scientific Instruction Set, DS/1000 firmware, RTE-IV EMA firmware, and the 13306A Fast Fortran processor ROMs, and/or user-written microprograms. It accommodates both 4k (512 X 8) and 1k (256 X 4) bipolar ROM's or PROM's and is configured into four different address spaces. The 13304A Firmware Accessory Board is included in HP 1000 F-Series computers.

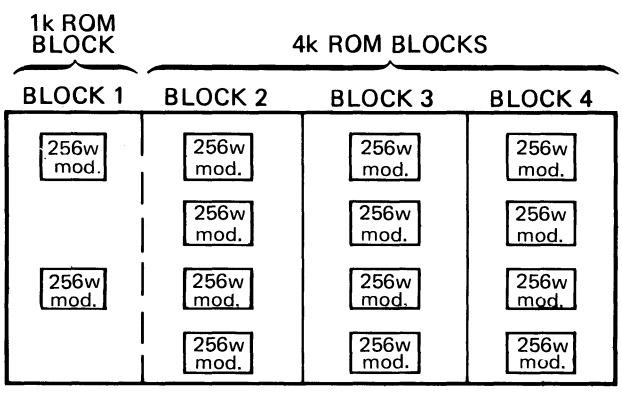


Features

- **Four individually-configurable blocks (3.5k words) of non-volatile address space provided for HP 1000 E-Series computers**
- **Utilizes 4k and 1k ROM's or PROM's**
- **Routines execute with no performance degradation from standard processor cycle times**
- **Compatible with HP microprogramming support software**
- **Easy configuration with plug-in jumpers**
- **ROM's current switched for low standby power**

Functional description

The 13304A Firmware Accessory Board is arranged in four configurable address spaces (blocks) as shown in the diagram. Three of these blocks are 1k words (four each of 256 word modules) and use six 4k ROM's/block. These blocks can also be loaded with three 4k ROM's if only two modules are needed. The remaining block contains up to 512 words (two each of 256 word modules) and uses 12 1k ROM's. This block can also be loaded with six 1k ROM's if only one module is needed.



One jumper determines whether the FAB will be used in the upper or lower 8k of the E-Series 16k control store address space (Modules 0-31 vs. 32-63).

Once the upper or lower 8k address space is selected, each block can be jumpered to independently configure it to any address space within that 8k.

Functional specifications

Organization

Word size: 24 bits

Module size: 256 words

Board capacity: 3 1k word blocks of 4 modules each (4k ROM's), 1 512 word block of 2 modules (1k ROM's), each block individually configurable

Processor capacity: 1 13304A Board

Cycle time: 175 nsec

ROM's or PROM's/module: 12 for 1k ROM block, 6 for each 4k ROM block

Reserved modules: HP 13306A, fast FORTRAN processor uses 1 module of 1k ROM's and 2 modules of 4k ROM's; HP 13305A/13307A dynamic mapping system/instructions uses 1 module of 1k ROM's; HP 12823A Scientific Instruction Set uses four modules of 4k ROMs; DS/1000 and RTE-IV EMA instructions each use 2 modules of 4k ROMs.

Recommended PROM's

4k: Signetics 82S141, Intel 3624, or Harris 4M7641

1k: HP 1816-0782, or Harris 7611-5

Configuration information

The 13304A Firmware Accessory Board is configured as described in installation and service manual. Check CPU +5V power supply current capacity prior to installation.

Installation: After the ROM's or PROM's are correctly installed and configured on the FAB board, it is secured beneath the E-Series CPU by four screws. Electrical connection is made by attaching the flat cable from the FAB connector to connector J2 on the CPU (and UCS or WCS if installed).

Software recommended:

92061A	RTE microprogramming software package on paper tape
- 020	Above on minicartridge for 2644A/45A/48A

Electrical specifications

Current required from +5V computer power supply

Power saver circuit limits current to 1.8A, maximum, regardless of the number of ROMs installed.

Ordering information

13304A Firmware accessory board

The 13304A Firmware accessory board includes:

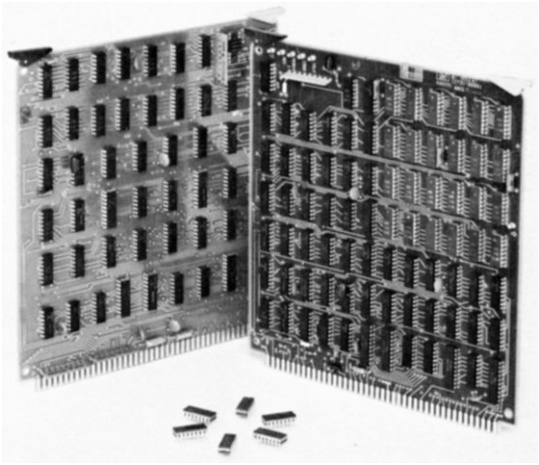
1. 5061-1339 Firmware accessory board.
2. 1258-0124 Jumper plugs.
3. 5060-8344 Connector assembly.
4. 2360-0115 Mounting hardware.
5. 13304-90001 Installation and service manual.

HEWLETT hp PACKARD

Dynamic mapping system for HP 1000 E-Series and F-Series Computers

models 13305A, 12731A, 12892B, and 13307A

The 13305A dynamic mapping system (DMS) for HP 1000 E/F-Series computers provides for expansion of memory beyond the 64k bytes that is normally the maximum addressable by 16-bit computers.



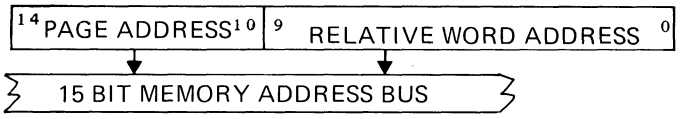
Features

- **Two million byte address space**
- **Read and/or write protection for each page**
- **Four dynamically alterable memory maps; two for program execution and two for the dual channel port controller**
- **Program execution from non-contiguous page locations**
- **DCPC communication with a memory area separate from program space concurrently with program execution**
- **DCPC transfers to/from non-contiguous segments of memory**
- **Compatibility with previous software for HP 1000 family computers**
- **38 instructions for memory management**
- **Provision of independent and shared base page segments using programmable fence**
- **Parity error interrupt logic that permits removal of erring memory pages from active use under program control**
- **Provision for sharing of programs and data between concurrent users**
- **Installation in dedicated slots in computer mainframe, so additional rack space is not needed**
- **Field or factory installability**

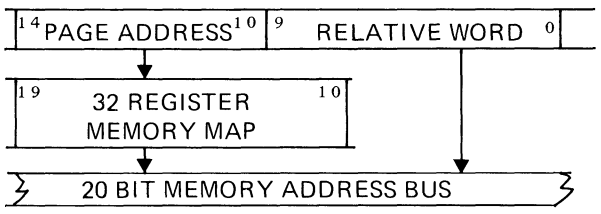
Dynamic mapping description

The basic addressing space of the HP 1000 E/F-Series is 65,536 bytes, called the "logical" memory. The amount of semiconductor memory actually installed in the computer is called the "physical" memory. An HP 1000 E/F-Series computer with Dynamic Mapping System (DMS) has an address space of two million bytes for physical memory. Dynamic mapping allows physical memory to be mapped into logical memory via four dynamically alterable memory maps, a capability that is fully software supported by HP's RTE-M and RTE-IV operating systems.

The basic memory addressing scheme of the HP 1000 provides for addressing of 32 pages of memory, each page being 2048 bytes. This memory is addressed through a 15 bit memory address bus. The upper five bits of this bus provide the page address, and lower ten bits provide the relative word address within the page.



The Memory expansion module of the dynamic mapping system converts the 5-bit page address into a 10-bit page address and thereby allows 2^{10} or 1024 pages to be addressed. The conversion is accomplished by allowing the original 5-bit page address to identify one of 32 registers within a "memory map". Each of these memory map registers contains the new, user specified 10-bit page address. This new page address is then joined with the original 10-bit relative word address to form a 20-bit memory address.



All registers within the memory map are dynamically alterable. To maximize system performance capability, there are four separate memory maps in the memory expansion module, selectable under program control: user map, system map, and two dual channel port controller (DCPC) maps.

Functional specifications

Memory address space provided

2048k bytes (2,097,152 bytes)

Dynamic mapping instructions

All 38 DMS instructions are microprogrammed and assigned to control store module 32.

MNEM	Description	Typical Execute Times (μsec)▲	OP CODES
MBI	Move Bytes Into	4.94+1.82/wd	105702
MBF	Move Bytes From	+2.66 for	105703
MBW	Move Bytes Within	odd byte	105704
MWI	Move Words Into	2.59 +	105705
MWF	Move Words From	1.82/word	105706
MWW	Move Words Within		105707
SYA/B	Load/Store System	46-50.5-	101710/105710
USA/B	Load/Store User	46-50.5	101711/105711
PAA/B	Load/Store Port A	46-50.5	101712/105712
PBA/B	Load/Store Port B	46-50.5	101713/105713
SSM	Store Status in Memory	3.71*	105714
JRS	Jump and Restore Status	5.32-6.06*	105715
XMM	Transfer Map or Memory	4.27†	105720
XMS	Transfer Map Sequentially	4.10†	105721
XMA/B	Transfer Maps Internally	29.35	101722/105722
XLA/B	Cross Load	3.57*	101724/105724
XSA/B	Cross Store	4.17*	101725/105725
XCA/B	Cross Compare	3.57-4.24	101726/105726
LFA/B	Load Fence	2.17	101727/105727
RSA/B	Read Status	2.17	101730/105730
RVA/B	Read Violation	2.17	101731/105731
DJP	Disable and JMP	3.75*	105732
DJS	Disable and JSB	4.41*	105733
SJP	Enable System and JMP	3.75*	105734
SJS	Enable System and JSB	4.41*	105735
UJP	Enable User and JMP	4.17*	105736
UJS	Enable User and JSB	4.17*	105737

**Add 1.26 μsec for each level of indirect addressing.*

†Add 1.62 μsec for each map loaded.

▲Using std performance memory, without fault control.

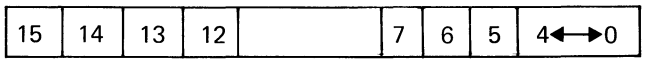
Dynamic mapping power fail characteristics

Power failure automatically enables the system map, and a minimum execution time of 500 μs is assured the programmer. A power fail routine should include routines to save as many maps as desired.

Upon restoration of power, all maps are disabled and none are considered valid. It is the responsibility of the power fail recovery software to restore the maps as desired.

Violation register

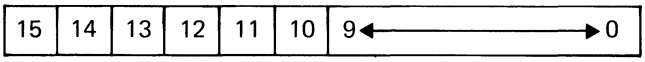
The memory expansion module violation register contains information so the programmer can detect where a fault occurred in hardware or software and what steps must be taken to correct it:



15	Read violation
14	Write violation
13	Base page violation
12	DMS privileged instruction
7	ME-bus enabled at violation
6	Maps enabled at violation
5	System user enabled at violation
0 - 4	Map register

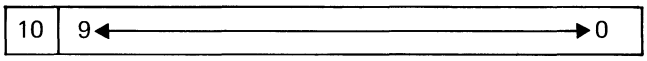
Status register

The memory expansion module status register allows the programmer to determine whether the MEM is on or off currently, and at time of the last interrupt, as well as indicates the address for the base page fence.



15	MEM enabled at last interrupt
14	System/user map selected at last interrupt
13	MEM currently enabled
12	System/user map currently selected
11	DMS protected mode
10	Portion mapped
0 - 9	Base page fence

Base page fence register



0-9	Fence address
10	Portion of base page mapped

Bit 10 = 0: Fence $\leqslant M < 2000_8$ is mapped

Bit 10 = 1: $1 < M <$ Fence is mapped

Memory protect

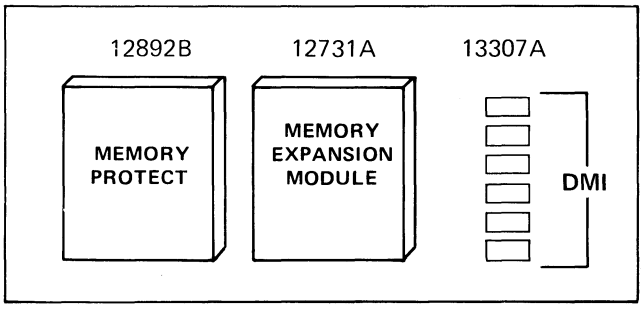
The memory protect feature of DMS provides all the capability of HP's 12892B memory protect plus the capability to read and/or write protect each individual page of physical memory.

Memory protect allows a block of logical memory of any size, from a selectable fence downward, to be protected against alteration by programmed instructions except those directly involving the A and B registers. This is in addition to the page-by-page protection provided within DMS.

Memory protect logic, when enabled, prohibits the execution of all I/O instructions except those referencing the switch register and the overflow register. This feature allows I/O to be controlled by interrupt only.

Although the memory expansion module performs its mapping function without the memory protect board installed, memory protect is required if the protection features are to be used.

Configuration information



Compatibility: 13305A is compatible with 2109, 2111, 2113, and 2117 Computers.

Prerequisite: 13304A Firmware accessory board for mounting dynamic mapping instruction ROMs.

Control store locations required: One 256 word module on the Firmware accessory board.

Other locations used: One dedicated slot each for the 12892B memory protect module and the 12731A memory expansion module in 2109, 2111, 2113, or 2117 Computer.

Software recommended: RTE-M or RTE-IV Real-time executive operating system (92064A or 92067A).

Installation: Plug the 13307A DMI ROMs into sockets on the firmware accessory board and connect the firmware accessory board to the processor board. Then plug the 12892B and 12731A modules into the memory section of the computer to complete installation.

Electrical specifications

Current required from +5V computer power supply

Model	13305A	12731A	12892B	13307A
+5V current	5.15A	3.9A	1.25A	(A)

(A) 0.78A used by 13307A is included in current used by 13304A Firmware accessory board and is not included in the current requirement for the 13305A Dynamic Mapping System.

Ordering information

NOTE: The 13305A Dynamic mapping system is furnished with the 12786A-D, 12787A-D, 12788A-D, and 12789A-D Memory packages, which thus afford an economical, alternative means of obtaining the dynamic mapping system.

13305A Dynamic mapping system

The 13305A Dynamic mapping system includes:

1. 12731A Memory expansion module.
2. 12892B Memory protect.
3. 13307A Dynamic mapping instructions.
4. 12929-16001 DMS diagnostic on paper tape.
5. 12929-90003 Memory expansion module diagnostic manual.

12731A Memory expansion module

The 12731A Memory expansion module includes:

1. 12731-60001 Memory expansion module.
2. 13305-60001 Dynamic mapping system installation manual.

13307A Dynamic mapping instructions

The 13307A Dynamic mapping instructions include:

1. 13307-80011 through 80016 (six) instruction ROMs.
2. 13305-90001 Installation manual.

12892B Memory protect

The 12892B Memory protect, also available separately (see separate data sheet), includes:

1. 12892-60003 Memory protect module.
2. 12892-16001 Memory protect parity error diagnostic on paper tape.
3. 12892-90005 Parity error diagnostic manual.
4. 12892-90007 Installation manual.

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HP 1000 M-Series dynamic mapping system

models 12976B, 12731A, and 12892B

The 12976B Dynamic mapping system (DMS) for HP 1000 M-Series computers provides for expansion of memory beyond the 64k bytes that is normally the maximum addressable by 16-bit computers.

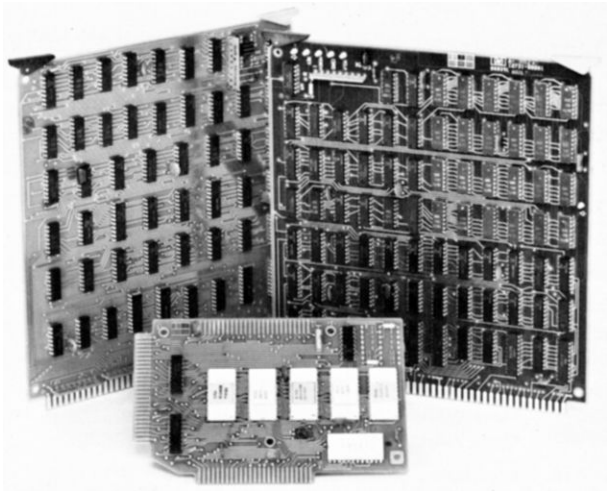
The Hewlett-Packard Fast Fortran processor (FFP) instructions may be added to the 12976B Dynamic Mapping System as an option (12976B-003).

Features

- **Two million byte address space**
- **Read and/or write protection for each page**
- **Four dynamically alterable memory maps; two for program execution and two for the dual channel port controller**
- **Program execution from non-contiguous page locations**
- **DCPC communication with a memory area separate from program space concurrently with program execution**
- **DCPC transfers to/from non-contiguous segments of memory**
- **Compatibility with previous software for HP 1000 family computers**
- **38 instructions for memory management**
- **Provision of independent and shared base page segments using programmable fence**
- **Parity error interrupt logic that permits removal of erring memory pages from active use under program control**
- **Provision for sharing of programs and data between concurrent users**
- **Installation in dedicated slots in computer mainframe, so additional rack space is not needed**
- **Choice of convenient, economical packages for expansion of standard performance or fault control memory**
- **Field or factory installability**

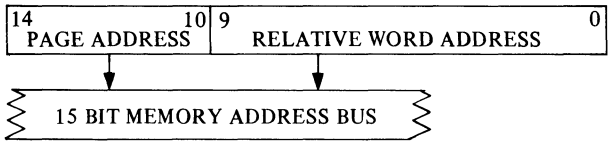
Dynamic mapping description

The basic addressing space of the HP 1000 M-Series is 65,536 bytes, called the "logical" memory. The amount of semiconductor memory actually installed in the computer is called the "physical" memory. An HP 1000 M-Series computer with Dynamic Mapping System (DMS) has an address space of two million bytes for physical memory. Dynamic mapping allows physical memory to be mapped into logical memory via four dynamically alterable memory maps, a capability that is fully software supported by HP's RTE-M and RTE-IV operating systems.

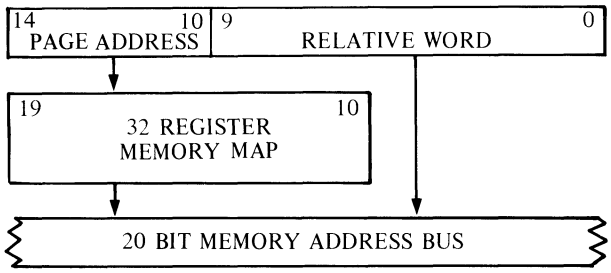


12976B and 003 Dynamic mapping system; firmware board (foreground) includes Fast Fortran processor instructions as well as dynamic mapping instructions

The basic memory addressing scheme of the HP 1000 provides for addressing of 32 pages of memory, each page being 2048 bytes. This memory is addressed through a 15-bit memory address bus. The upper five bits of this bus provide the page address, and the lower ten bits provide the relative word address within the page.



The memory expansion module of the dynamic mapping system converts the 5-bit page address into a 10-bit page address and thereby allows 2^{10} or 1024 pages to be addressed. The conversion is accomplished by allowing the original 5-bit page address to identify one of 32 registers within a "memory map". Each of these memory map registers contains the new user specified 10-bit page address. This new page address is then joined with the original 10-bit relative word address to form a 20-bit memory address.



All registers within the memory map are dynamically alterable. To maximize system performance capability, there are four separate memory maps in the memory expansion module, selectable under program control: user map, system map, and two dual channel port controller (DCPC) maps.

Functional specifications

Memory address space provided

2048k bytes (2,097,152 bytes)

Dynamic mapping instructions

All 38 DMS instructions are microprogrammed and assigned to control store module 32.

MNEM	Description	Typical Execute Times (μsec)	OP CODES
MBI	Move Bytes Into	6.49+2.92/wd	105702
MBF	Move Bytes From	+3.89 for	105703
MBW	Move Bytes Within	odd byte	105704
MWI	Move Words Into	3.24+	105705
MWF	Move Words From	2.92/word	105706
MWW	Move Words Within		105707
SYA/B	Load/Store System	47.125-47.8	101710/105710
USA/B	Load/Store User	47.125-47.8	101711/105711
PAA/B	Load/Store Port A	47.125-47.8	101712/105712
PBA/B	Load/Store Port B	47.125-47.8	101713/105713
SSM	Store Status in Memory	5.84	105714
JRS	Jump and Restore Status	9.1-10.4*	105715
XMM	Transfer Map or Memory	9.75†	105720
XMS	Transfer Map Sequentially	8.45†	105721
XMA/B	Tranfer Maps Internally	15.26-16.56	101722/105722
XLA/B	Cross Load	5.53*	101724/105724
XSA/B	Cross Store	5.53*	101725/105725
XCA/B	Cross Compare	6.18*	101726/105726
LFA/B	Load Fence	3.57	101727/105727
RSA/B	Read Status	2.59	101730/105730
RVA/B	Read Violtation	2.27	101731/105731
DJP	Disable and JMP	5.85*	105732
DJS	Disable and JSB	6.5*	105733
SJP	Enable System and JMP	5.85*	105734
SJS	Enable System and JSB	6.5*	105735
UJP	Enable User and JMP	5.85*	105736
UJS	Enable User and JSB	6.5*	105737

**Add 1.3 μsec for each level of indirect addressing.*

†Add 1.3 μsec for each map loaded.

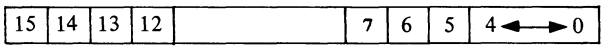
Dynamic mapping power fail characteristics

Power failure automatically enables the system map, and a minimum execution time of 500 microseconds is assured the programmer. A power fail routine should include routines to save as manymaps as desired.

Upon restoration of power, all maps are disabled and none are considered valid. It is the responsibility of the power fail recovery software to restore the maps as desired.

Violation register

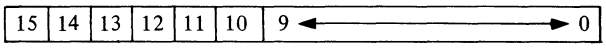
The memory expansion module violation register contains information so the programmer can detect where a fault occurred in hardware or software and what steps must be taken to correct it:



15	Read violation
14	Write violation
13	Base page violation
12	DMS privileged instruction
7	ME-bus enabled
6	Maps enabled
5	System/user map selected
0-9	Map register

Status register

The memory expansion module status register allows the programmer to determine whether the MEM is on or off currently, and at time of the last interrupt, as well as indicates the address for the base page fence.



15	MEM enabled at last interrupt
14	System/user map selected at last interrupt
13	MEM currently enabled
12	System/user map currently selected
11	DMS protected mode
10	Portion mapped
0-9	Base page fence

Memory protect

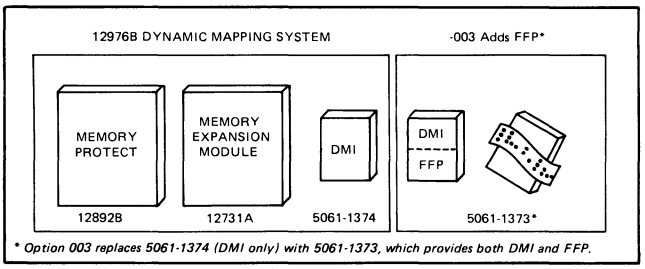
The memory protect feature of DMS provides all the capability of HP's 12892B memory protect plus the capability to read and/or write protect each individual page of physical memory.

Memory protect allows a block of logical memory of any size, from a selectable fence downward, to be protected against alteration by programmed instructions except those directly involving the A and B registers. This is in addition to the page-by-page protection provided within the DMS.

Memory protect logic, when enabled, prohibits the execution of all I/O instructions except those referencing the switch register and the overflow register. This feature allows I/O to be controlled by interrupt only.

Although the memory expansion module may perform its mapping function without the memory protect board being installed, memory protect is required before the protect features may be used.

Configuration information



** Option 003 replaces 5061-1374 (DMI only) with 5061-1373, which provides both DMI and FFP.*

Compatibility: 12976B is compatible with 2108 and 2112 Computers, not with 2105A Computer.

Control store location required: One for DMI instruction board supplied with standard 12976B; Fast Fortran processor and DMI instructions (12976B-003) also fit on this board.

Other locations used: One dedicated slot each for the 12892B memory protect module and the 12731A memory expansion module in 2108 or 2112 Computer.

Software recommended: RTE-M or RTE-IV Real-time executive operating system (92064 or 92067A).

Installation: Connect the DMI board to the processor board. Then plug the 12892B and 12731A modules into their dedicated slots in the memory section of the computer to complete installation.

Electrical specifications

Model	12976B	12976B+003	12731A	12892B
+5V current	6.35A	6.35A	3.9A	1.25A

Ordering information

NOTE: The 12976B Dynamic mapping system is furnished with the 12784A-D and 12785A-D Memory packages, which thus afford an economical alternative means of obtaining the dynamic mapping system.

12976B Dynamic mapping system

The 12976B Dynamic mapping system includes:

1. 12731A Memory expansion module.
2. 12892B Memory protect.
3. 5061-1374 Dynamic mapping instruction board.
4. 12929-16001 DMS diagnostic on paper tape.
5. 12976-90005 DMS installation manual.
6. 12929-90003 Memory expansion diagnostic manual.
7. 02108-90002 M-Series reference manual.

12976B option 003

12976B option 003 replaces the 5061-1374 Dynamic mapping instructions board with the 12977B Fast Fortran processor board, which includes both Dynamic mapping and Fast Fortran instructions (see 12977B data sheet for items included).

12731A Memory expansion module

The 12731A Memory expansion module includes:

1. 12731-60001 Memory expansion module.
2. 13305-60001 Dynamic mapping system installation manual.

12892B Memory protect

The 12982B Memory protect, also available separately (see separate data sheet), includes:

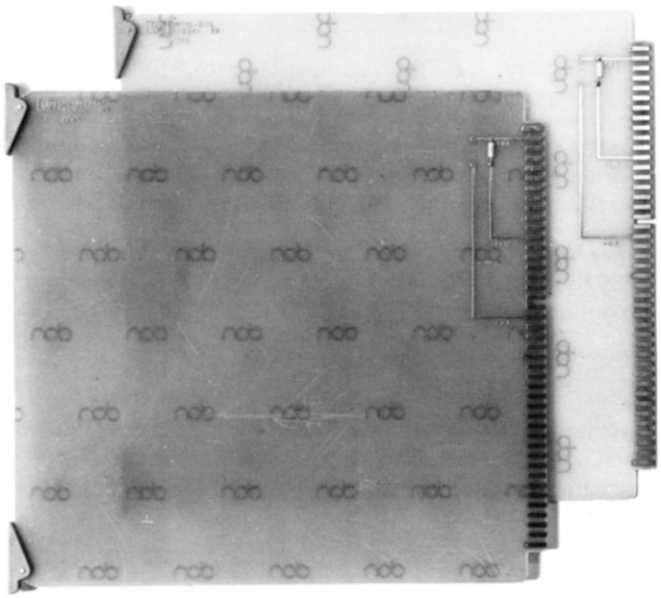
1. 12892-60003 Memory protect module.
2. 12892-16001 Memory protect parity error diagnostic on paper tape.
3. 12892-90005 Parity error diagnostic manual.
4. 12892-90007 Installation manual.

HEWLETT hp PACKARD

Priority jumper card

model 12777A

The HP 12777A provides a means of completing the I/O priority chain when blank I/O slots are configured into a system. This card passes the interrupt priority chain through to I/O cards which follow the blank space, thus making it possible for them to cause an interrupt.



Two 12777A priority jumper cards

Features

- **Completes HP 1000 computer I/O priority chain**
- **Allows blanks to be configured into I/O backplane**
- **Saves moving I/O cards and reconfiguration to complete interrupt priority chain**

Functional specifications

Application

This card provides a direct short between PRL (Pin 3) and PRH (Pin 23). It may also be used to tie +5V to PRL (Pin 3).

Installation

To install, plug into HP 1000 computer I/O slot which it is desirable to leave blank while passing I/O priority chain.

Ordering information

12777A Priority Jumper Card

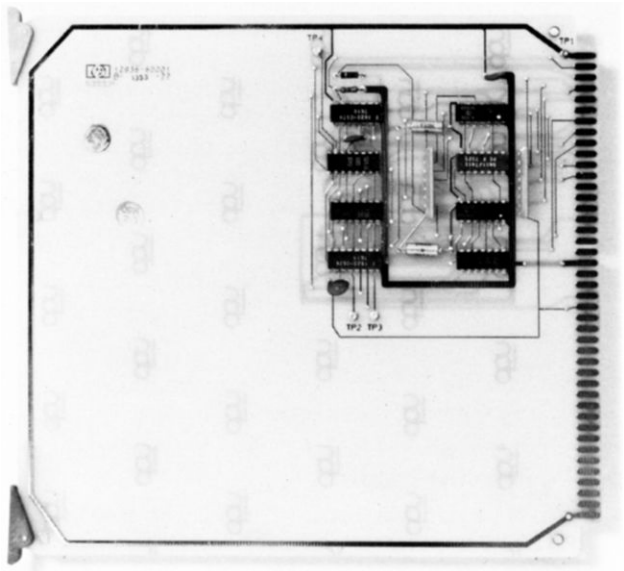
The 12777A priority jumper card provides the 02116-6110 priority jumper card.

HEWLETT hp PACKARD

Privileged interrupt fence for DOS systems

model 12936A

The 12936A Privileged interrupt fence provides a means to distinguish between privileged (high priority/low select code) and non-privileged (low priority/high select code) I/O devices in DOS systems. It is physically installed in the computer I/O backplane between the I/O channel(s) serving a privileged device(s) and I/O channels serving other devices.



Features

- **Hardware support for privileged interrupt operation in DOS systems.**
- **Interrupt control circuitry.**
- **Programmable inhibition of priority line to lower priority devices.**

Functional specifications

Configuration information

Computer compatibility: The 12936A Privileged interrupt fence is compatible with 2105, 2108, 2109, 2112, and 2113 computers; however, its use with the 2105, which has only 4 I/O channels, is highly improbable.

Computer I/O channels required: One.

Software support: Software support for the 12936A Privileged interrupt fence is limited to the diagnostic furnished with it, which is also available in the 24396A-F diagnostic library.

Installation: Plug the 12936A into the computer I/O backplane in the I/O slot immediately below the I/O interfaces serving privileged devices and integrate the 12936A into the computer's real-time operating system.

Electrical specifications

Current required from computer power supply
0.3A (+5V), 0.03A (-2V).

Ordering information

12936A Privileged interrupt fence

The 12936A Privileged interrupt fence includes:

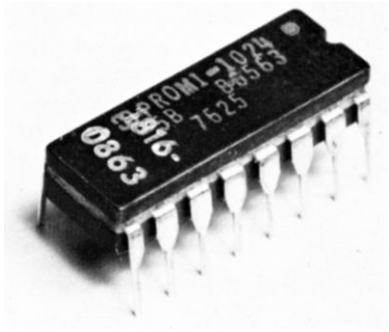
1. 12936-60001 Privileged interrupt fence card.
2. 12936-16001 Diagnostic on paper tape.
3. 12936-90001 Installation and service manual.

HEWLETT hp PACKARD

Loader ROM s

models 12992A, 12992B, 12992C, 12992D

The HP 1000 optional loader ROMs consist of four independent products, each consisting of one 256 x 4 bit PROM. Two of the four ROMs allow absolute binary programs to be loaded into HP 1000 memory from a 2645A or 2648A cartridge tape or a 7970 9-track magnetic tape unit. The remaining two ROMs are used to load programs in disc boot format from 7900/7901/2883 discs or from a 7905/7906/7920 cartridge/top-loading disc.



Typical loader ROM

Features

- **Provides a choice of program loading from disc, magnetic tape, or tape cassette**
- **Each of the installed loader ROMs can be selected using the switch register**
- **Up to three optional loader ROMs may be used in an HP 1000 Computer**

Functional specifications

Application

12992A: Bootstrap loader for 7900/7901/2883 disc.

12992B: Bootstrap loader for 7905/7906/7920 disc.

12992C: Minicartridge loader for 2645A/48A/44A CRT Terminals.

12992D: Loader for 9-track 7970B/E Magnetic Tape Unit (must be unit 0).*

**7970E tape speed with HP 1000 M-Series must be 37.5 ips or less when used with 12992D loader ROM.*

NOTE: 12992 loader ROM's ordered with an HP 1000 computer are installed at the factory.

Configuration information

Optional loader CPU sockets required: 1 per loader

Prerequisites: HP 1000 with 16k bytes or more memory

HP 1000 M-Series installation: To install, remove CPU board from mainframe, insert 12992 loader ROM in one of three optional loader ROM sockets, (see diagram at right), and reinstall CPU board.

HP 1000 E/F-Series installation: To install loader ROMs in the two unoccupied sockets, unplug modules from the lower half of the memory card cage, plug in the ROMs, and reinstall the removed modules in the memory card cage. Access to replace the standard punched tape and disc bootstrap loader ROMs with other ROMs requires removal and reinstallation of the cpu board.

Electrical specifications

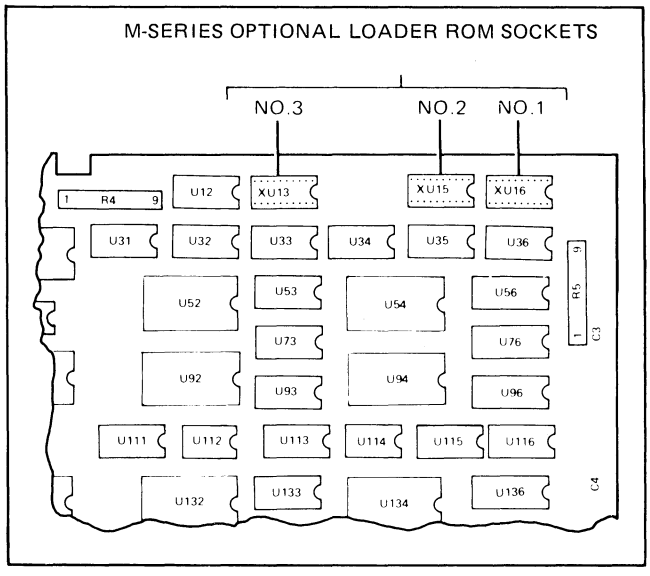
Current required from +5V computer power supply

130 mA per loader ROM

Ordering information

12992A 7900A disc loader ROM
12992B 7905A/7906/7920M disc loader ROM
12992C 2645A/48A/44A cartridge loader ROM
12992D 7970B/E 9 track magnetic tape loader ROM

Each loader ROM includes an installation manual (12992-90007).

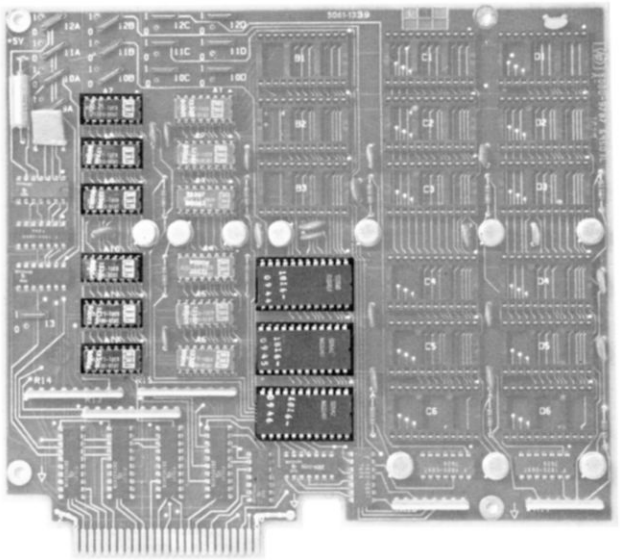


HEWLETT hp PACKARD

HP 1000 E-series fast FORTRAN processor (FFP)

model 13306A

The HP 13306A Fast FORTRAN Processor consists of 20 microcoded subroutines which enhance performance of FORTRAN programs, assembly language programs, and scientific application programs. These routines are stored in bipolar ROMs mounted on the 13304A Firmware Accessory Board and executed by the HP 1000 E-Series control processor. The Fast FORTRAN Processor is standard in HP 1000 F-Series computers.



13306A Fast FORTRAN Processor mounted on 13304A Firmware accessory board

Features

- **Firmware microcode for 20 instructions and subroutines:**
  - **Extended precision floating point addition, subtraction, multiplication, and division**
  - **Single precision to extended floating point conversion**
  - **Extended precision to single precision conversion**
  - **Extended precision move**
  - **Extended precision normalization and pack**
  - **Two and three dimensional array mapping**
  - **Subroutine parameter transfer**
  - **Conditional control transfer**
- **Can be used with FORTRAN IV, and assembly language**
- **Provides 2 to 20-fold increase in program execution**

Functional description

Each fast FORTRAN subroutine has a unique instruction code associated with it. When a high-level language program is compiled, a subroutine call to the program library is generated by the compiler. The loader then replaces the subroutine call with the appropriate fast FORTRAN machine code. Execution of the fast FORTRAN code calls a firmware routine, allowing the control processor to execute the instruction.

In assembly language, the machine opcodes of the fast FORTRAN processor and the appropriate parameter lists are used instead of the overlay library, to execute fast FORTRAN instructions (refer to the manual "Relocatable Subroutine," HP part number 24998-90001). For example, when the extended precision divide routine, XDIV, is to be executed in FFP microcode, a programmer simply replaces the assembly language statement JSB XDIV by the corresponding opcode 105204 as follows:

Assembly language	Assembly language
JSB .XDIV (Call subroutine)	OCT 105204 (Call FFP microcode subroutine)
DEF X (Result)	DEF X (Result)
DEF Y (1st operand)	DEF Y (1st operand)
DEF Z (2nd operand)	DEF Z (2nd operand)

Functional specifications

Microcoded routines

See next page

Configuration information

Control store locations required: One 256 word module in 1k section and 512 words in the 4k section of the Firmware accessory board.

Accessories required: 13304A firmware accessory board

Software recommended:

24396F Diagnostic package on minicartridge
24396A Diagnostic package on paper tape

Installation: The 13306A ROM IC's are inserted into sockets on the 13304A FAB (firmware accessory board – see diagram); then, the FAB is mounted in the E-Series CPU.

Microcoded routines

Microcoded routines	Description	Execution time in usec† Min	Max	Max. Non-interruptable	Opcode
DBLE	Converts single to extended precision	13.02	13.02		105201
SNGL	Converts extended to single precision	18.2	18.2		105202
[1].XMPY and XMPY	Extended multiply	56.0 56.7	64.8 65.5	36.4μs max	105203 and 105211
[1].XDIV and XDIV	Extended divide	80.0 80.7	92.4 93.1	37.8μs max	105204 and 105212
[1].XADD and XADD	Extended add	37.5 38.0	50.2 50.7	25.7μs max	105213 and 105207
[1].XSUB and XSUB	Extended subtract	37.5	50.2	25.7μs max	105214 and 105210
[2].DFER and .XFER	Transfers an extended precision variable to another location	12.810 8.96	12.8 12.7		105205 and 105220
.CFER	4WD move	14.9	14.9		
.PWR2	Calculates X*2N for real X and integer N	8.4	8.4		105225
.FLUN	Unpacks a real variable	3.1	3.1		105226
.XPAK	Normalizes, rounds and packs mantissa of an extended precision number	18.9	29.5	11.6μs max	105206
.PACK	Normalizes a real variable	19.2	27.2		105230
.XCOM	Compliments an extended precision number	11.7	12.1		105215
..DCM	Compliments and normalizes an extended precision number	22.1	33.4	12.2μs max	105216
DDINT	Converts extended precision real to extended integer	23.9	58.6	30.6μs max	105217
.GOTO	Transfers control to location indicated by FORTRAN computed GOTO statement	10.6	10.6		105221
..MAP	Computes the address of a specified element of 2 or 3 dimensional array	17.7	27.2		105222
[3].ENTR	Transfers address of parameters from a calling sequence into a subroutine list	13.9 + 3.7 * NP'			105223
.ENTP		13.6 + 3.7 * NP'			105224
.SETP	Sets a table of increasing values for DOS III	6.4 + 1.2 * count Interruptible for count> 30			105227

†Using standard performance memory

[1] The difference between .AA and AA is a return address as follows:

```
JSB.AA      JSB AA
DEF X       DEF * + N  (return address)
DEF Y       DEF X
Etc.        DEF Y
 .           .
             .
             .
             Etc. (Nth arguments)
```

[2] The difference between .DFER and .XFER is as follows:

```
LDA (address of N)    JSB.DFER
LDB (address of Y)    DEF Y
JSB.XFER              DEF X
```

[3] The difference between .ENTR and .ENTP is:

.ENTR	.ENTP
For all BCS subroutines, all DOS/RTE utility routines	.For all privileged routines and re-entrant routines

Electrical specifications

Current required from +5V computer power supply

Included in electrical specifications of 13304A Firmware Accessory Board.

Ordering information

13306A Fast Fortran processor

The 13306A Fast Fortran processor includes:

1. 1816-0944 through 0946, three 4k ROM instruction ICs.
2. 13306-80001 through 80006, six 1k ROM instruction ICs.
3. 12977-16004 and 16005 FFP diagnostics on paper tape.
4. 13306-90001 Installation manual.
5. 12977-90002 Diagnostic manual.

Additional equipment required for installation

13304A Firmware Accessory Board

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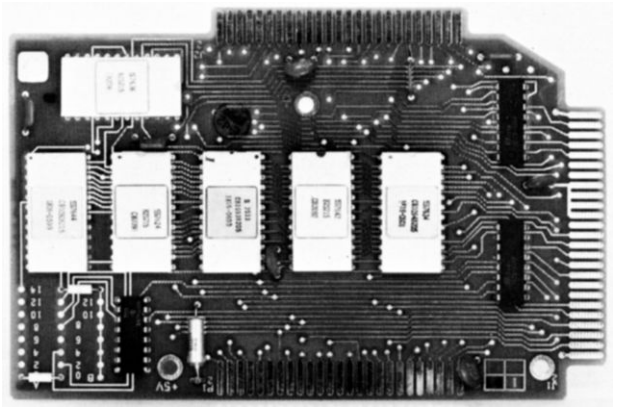
HP 1000 M-Series
Fast FORTRAN processor

model 12977B

The 12977B Fast FORTRAN Processor consists of 20 microcoded subroutines which enhance performance of Fortran programs, assembly language programs, and scientific application programs. These routines are stored in bipolar read-only memory and executed by HP 1000 M-Series processors. The 12977B also includes dynamic mapping instructions on the same board. The 12977B is a prerequisite to upgrading HP 1000 M-Series computers with FFP and DMI on two boards to be compatible with DS/1000 firmware supplied with the 91740A DS/1000 software-firmware.



Features

- **Firmware microcode for 20 new instructions and subroutines:**
  - **Extended precision floating point addition, subtraction, multiplication, division**
  - **Single precision to extended floating point conversion**
  - **Extended precision to single precision conversion**
  - **Extended precision move**
  - **Extended precision normalization and pack**
  - **Two and three dimensional array mapping**
  - **Subroutine parameter transfer**
  - **Conditional control transfer**
- **Includes library for use with FORTRAN IV, and assembly language**
- **Provides 2 to 20-fold increase in program execution**
- **Includes dynamic mapping instructions**

Functional description

Each fast FORTRAN subroutine has a unique instruction code associated with it. When a high level language program is compiled, a subroutine call to the program library is generated by the compiler. The library then replaces the subroutine call with the appropriate fast FORTRAN machine code. Execution of the fast FORTRAN code calls a firmware routine allowing the microprocessor to execute the instruction.

In assembly language, the machine opcodes of the fast FORTRAN processor and the appropriate parameter lists are used instead of the overlay library, to execute fast FORTRAN instructions (refer to the manual "Relocatable Subroutines", HP part number 24998-90001). For example, when the extended precision divide routine, .XDIV, is to be executed in FFP microcode, a programmer simply replaces the assembly language statement JSB .XDIV by the corresponding opcode 105204 as follows:

Assembly language	Assembly language
JSB .XDIV (Call subroutine)	OCT 105204 (Call FFP microcode)
DEF X (Result)	DEF X (Result)
DEF Y (1st operand)	DEF Y (1st operand)
DEF Z (2nd operand)	DEF Z (2nd operand)

Functional specifications

Microcoded routines

See next page

Configuration information

CPU control store module locations required: 2

Software recommended:
24396F Diagnostic package on minicartridge
24396A Diagnostic package on paper tape

Installation: To install, remove 21MX CPU bottom cover; using screws, install the FFP module on control store standoffs on the CPU board. Replace the cover.

Electrical specifications

Current required from +5V computer power supply

1.2A, total for both Fast FORTRAN and Dynamic mapping instructions, both of which are included on this board.

Microcoded routines

Microcoded routines	Description	Execution time in μsec Min	Max	Max Non-interruptible	Opcode
DBLE	Converts single to extended precision	15.28	15.28		105201
SNGL	Converts extended to single precision	20.15	65.00		105202
[1].XMPY and XMPY	Extended multiply	80.28 80.28	105.3	75.08μs	105203 and 105211
[1].XDIV and XDIV	Extended divide	107.9 107.9	163.15 163.15	75.08μs	105204 and 105212
[1].XADD and XADD	Extended add	42.25 42.25	130.98 130.98	75.08μs	105213 and 105207
[1].XSUB and XSUB	Extended subtract	42.25 42.25	130.98 130.98	75.08μs	105214 and 105210
[2].DFER and .XFER	Transfers an extended precision variable to another location	9.75 9.75	13.33 13.33		105205 and 105220
.PWR2	Calculates X*2N for real X and integer N	12.35	12.35		105225
.FLUN	Unpacks a real variable	4.23	4.23		105226
.XPAK	Normalizes, rounds and packs mantissa of an extended precision number	19.5	99.13	75.08μs	105206
.PACK	Normalizes a real variable	13.33	52.33		105230
.XCOM	Compliments an extended precision number	12.68	15.28		105215
..DCM	Compliments and normalizes an extended precision number	25.35	104.33	75.08μs	105216
DDINT	Converts extended precision real to extended integer	31.53	183.3	75.08μs	105217
.GOTO	Transfers control to location indicated by FORTRAN computed GOTO statement	13.0	13.0		105221
..MAP	Computes the address of a specified element of 2 or 3 dimensional array	26.98	43.88		105222
[3].ENTR	Transfers address of parameters from a	16.25 + 3.9 *NP'			105223
.ENTP	calling sequence into a subroutine list	15.93 + 3.9 *NP'			105224
.SETP	Sets a table of increasing values for DOS III	7.8 + 1.95 *count Interruptible count > 30			105227

[1] The difference between .AA and AA is a return address as follows:

JSB.AA	JSB AA
DEF X	DEF * + N (return address)
DEF Y	DEF X
Etc.	DEF Y
.	.
	.
	.
	Etc. (Nth arguments)

[2] The difference between .DFER and .XFER is as follows:

LDA (address of N)	JSB.DFER
LDB (address of Y)	DEF Y
JSB.XFER	DEF X

[3] The difference between .ENTR and .ENTP is:

.ENTR	.ENTP
For all BCS subroutines, all DOS/RTE utility routines	.For all privileged routines and re-entrant routines

Ordering information

12977B Fast FORTRAN processor

The 12977B Fast FORTRAN processor includes:

1. 5061-1373 Fast FORTRAN processor board (includes Dynamic mapping instructions).
2. 12977-16004 and 16005 Diagnostics on paper tape.
3. 12977-90008 Installation manual.
4. 12977-90002 Diagnostic manual.

Ordered as part of 12976B Dynamic Mapping System

The HP 1000 M-Series Fast FORTRAN processor can also be ordered with the 12976B Dynamic Mapping System, as 12976B option 003.

HEWLETT PACKARD

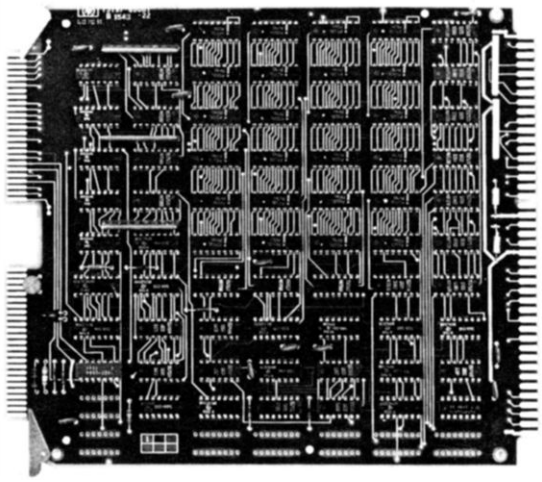
HP 1000 computers
1k writable control store

model 13197A

The 13197A Writable Control Store (WCS) provides 1024 words of control processor overlay memory. WCS allows the user to develop, debug, and test control processor programs using the HP 92061A RTE Microprogramming Package.

Written in a simple assembly language, control processor programs can increase subroutine performance by a factor of 2 to 20 times over conventional programming techniques.

Once developed, control processor programs may be implemented in two forms. First, they can be disc or main memory-resident and dynamically overlayed on 13197A writable control store memory space. These programs are loaded using RTE operating system-compatible software that treats the control processor as an allocatable resource. Alternatively, commonly-used control processor programs can be written into PROM memory and stored in non-volatile control processor memory space on user control store cards.



Features

- **Provides 1K words of control processor overlay memory divided into 2 blocks of 512 words each**
- **Programmable module address space assignments for each module**
- **Compatible with all HP 1000 computers**
- **Low power consumption**
- **Fast 175 nanosecond cycle time**
- **Can be loaded using DCPC transfers at full DCPC transfer rate**
- **Up to three 13197A's may be used with HP 1000 computers**
- **Can override installed PROM-based subroutines**
- **Control processor programs can be shared between multiple users**

Functional description

The 13197A WCS is a dual port memory. One port connects to the control processor's memory space, and the other to the HP 1000 Computer I/O backplane. Control processor subroutines are loaded into the 13197A using either programmed I/O or 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.

If the WCS is configured with the same module address as installed user PROM modules, those routines loaded into WCS are executed, taking priority over installed PROM subroutines. In this manner, the effective number of available control processor subroutine entry points is significantly increased.

Functional specifications

Organization

Words available: 1024 words, 2 modules of 512 words each
Word size: 24 bits
Access time: 132 nsec/maximum
Full microinstruction time: 325 nsec, (2105/2108/2112), 175-280 nsec, (2109/2111/2113/2117).
M-Series priority:
1) 1k WCS/2k UCS 2) Base set and 512-word UCS

E/F-Series priority:

1) 1k WCS	3) E-/F-Series base set
2) 2k UCS	4) FAB

Configuration information

I/O slots required: 1 (must be SC 10, 11, or 12)
Software required:

92061A	RTE microprogramming software package on paper tape
-020	Above on minicartridge for 2644A/45A

Software recommended: 24396F diagnostic on minicartridges
Installation: To install, insert WCS in I/O slot 10, 11, or 12 and connect the cable assembly.

Electrical specifications

Current required from computer power supply

2.2A(+5V), 0.007A(-2V).

Ordering information

13197A 1k Writable control store

The 13197A 1k Writable control store includes:

1. 13197-60001 Writable control store board.
2. 5060-8393 Flat cable assembly.
3. 13197-16002 Diagnostic on paper tape.
4. 13197-90001 WCS driver manual.
5. 13197-90002 Diagnostic manual.
6. 13197-90003 Reference manual (covers installation and service).

HEWLETT hp PACKARD

HP 1000 computers user control store

model 13047A

The 13047A 2K User Control Store Board provides HP 1000 Computer microprogrammers with eight 256-word modules of non-volatile memory address space. Module addresses are switch-selectable with a given module configurable to any address within control store address space. Using an HP 12909B PROM writer in HP 1000 M-Series computers and its supporting software, programmers can write their programs into programmable read only memory chips (PROM's) and verify that their contents match the expected data pattern. They can also supply recommended vendors with necessary information for generating masked or programmed read only memory chips compatible with the 13047A. In either case, microprograms stored in read only memory chips are mounted on the UCS board which, in turn, is conveniently installed in the I/O card cage of HP 1000 computers.

An optional set of diagnostic PROM's is available for the 13047A which gives the user or HP customer engineer ability to thoroughly test 13047A operation in HP 1000 M-Series computers. When recommended PROM's are used, the 13047A is fully-compatible with all HP 1000 computers with no reduction in control processor cycle time.

Features

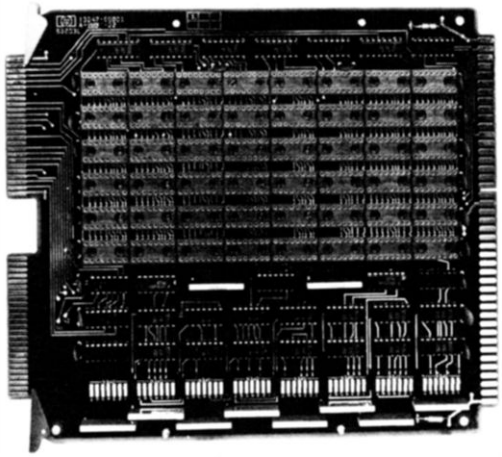
- **Eight individually-configurable modules (2048 words) of non-volatile address space provided for HP 1000 computers**
- **Routines execute with no performance degradation from standard processor cycle times**
- **Compatible with HP microprogramming support software**
- **Saves main memory address space**
- **Provides a measure of proprietary software security**
- **Microprograms undisturbed by CPU programs or power failures**
- **Compatible with all HP 1000 computers**

Functional specifications

Organization

Word size: 24 bits
Module size: 256 words
Module capacity: 8 modules (individually configurable)
Processor capacity*: 1 board
Cycle time: 325 nsec
PROMs/module: 6
Recommended PROMs: HP 1816-0782, Harris 7611-5.

** Depends on available power.*



Configuration information

I/O slots required: 1 (must be select code 10, 11, or 12)

NOTE 1: Use appropriate HP 1000 Computer Series documentation when selecting control store module addresses for the 13047A to avoid conflict with HP microcode products.

NOTE 2: +5V power supply current available in the particular system configuration should be checked to assure sufficient +5V current capacity is available for the 13047A.

Installation: To install, insert in I/O slot 10, 11, or 12 and connect jumper cable assembly to processor board.

Software recommended:

92061A	RTE microprogramming software package on paper tape.
-020	Above on minicartridge for 2644A/45A/48A

Electrical specifications

Current required from +5V computer power supply

Basic logic on board: 1.15A
Each 256 word module: 0.78A
Maximum for fully loaded board: 7.39A

Ordering information

13047A User control store board

The 13047A User control store board includes:

1. 13047-60001 User control store board.
2. 5060-8363 Flat cable assembly.
3. 13047-90001 Installation manual.

13047A option 001

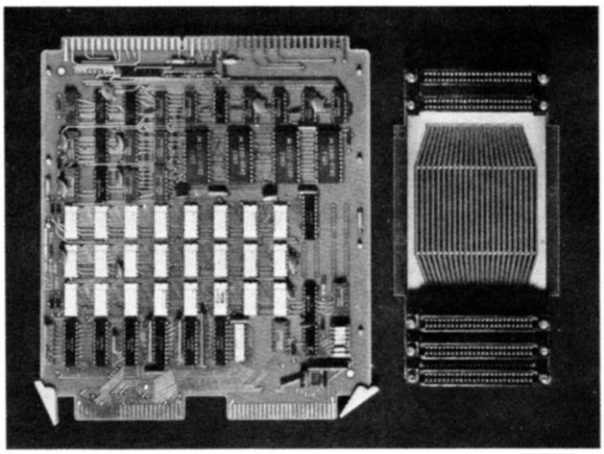
The 13047A option 001 provides a set of diagnostic PROMs.

HEWLETT hp PACKARD

HP 1000 M-series writable control store

model 12978A

The 12978A Writable Control Store (WCS) Card contains semiconductor random-access memory for R/W storage of microprograms. It can be used with HP 1000 M-Series computers.



Features

- **Makes computer control section programmable**
- **256 words of 24 bits/word for microprogram storage**
- **Enables full use of machine architecture, including 12 additional high-speed scratch registers**
- **325-nanosecond cycle time**
- **Dynamically alterable under program control**
- **Complete software support package available**
- **Compatible with 92061A RTE microprogramming package**

Functional specifications

Organization

Words available: 256.

Word size: 24 bits.

Microinstruction time: 325 nsec.

Configuration information

I/O slots required: 1 (must be SC10, 11, or 12)

Software required: 92061A RTE microprogramming package, 12978A-001 DOS-III software, or 12978A-002 BCS software

Control store module configuration: The 12978A is configured to one of the 16 available control store memory addresses. As such, users should refer to HP 1000 computer processor documentation before selecting module address to avoid conflict with existing or planned HP microcode products.

Installation: To install, configure WCS control store module address, insert WCS in an I/O slot, and connect the jumper cable assembly.

Electrical specifications

Current required from computer power supply

4.6A (+5V), 0.15A (-2V)

Ordering information

12978A Writable control store

The 12978A Writable control store includes:

1. 12908-60006 Writable control store board.
2. 5060-8393 Jumper cable assembly.
3. 12908-16001 Diagnostic.
4. 12908-90013 Diagnostic manual.

12978A options

001: DOS software, including 12978-90004 driver, 12978-16001 microassembler, 12978-16002 microdebug editor, 24278-60001 DVR33, and 24333-60001 WCS utility.

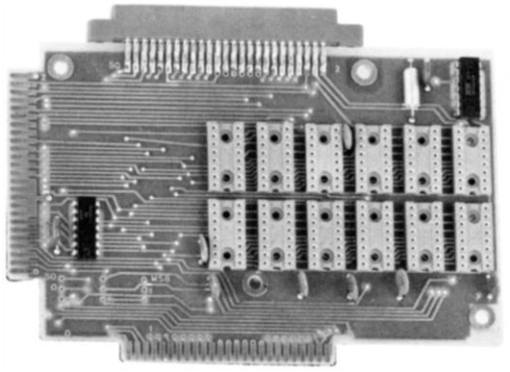
002: BCS software, including 12908-90003 driver, 12978-16003 microassembler, 12978-16004 debug editor, 24277-60001 BCS driver, and 24283-60001 I/O utility.

HEWLETT PACKARD

HP 1000 M-series user control store

model 12945A

The 12945A User Control Store Board provides HP 1000 M-Series microprogrammers with two consecutive 256-word modules of non-volatile memory address space. Using an HP 12909B PROM writer and its supporting software, programmers can write their programs into programmable read-only memory chips (PROM's) and verify that their contents match the expected data pattern. They can also supply recommended vendors with necessary information for generating masked or programmed read-only memory chips compatible with the 12945A. In either case, microprograms stored in read-only memory chips are mounted on the UCS board which, in turn, is conveniently mounted beneath the HP 1000 M-Series cpu board.



Features

- **512 words of non-volatile memory space provided for HP 1000 M-Series computers**
- **Very cost-effective means of adding microprograms**
- **Compatibility with HP microprogramming support software**

Functional specifications

Organization

Word size: 24 bits
Module size: 256 words
Module capacity: 2 modules (must be consecutive)
Cycle time: 325 nsec
PROMS/module: 6
Recommended PROMS: HP 1816-0872, Harris 7611-5.

Configuration information

Each 12945A board uses one of the available processor control store board positions.

Control store board availability	In 2105/08/12	In 2108K
Base capacity:	2 boards	3 boards
Used for 12728E:		-1 board
Used for 12976B DMS:	-1 board	-1 board
Used for 12977B FFP, with DMS.	-1 board	-1 board

NOTE: Use appropriate HP 1000 computer series manuals when selecting control store module addresses for the 12945A to avoid conflict with HP microcode products.

Software recommended

92061A RTE microprogramming software package on paper tape.
-020 Above on minicartridge for 2644A/45A/48A.

Installation: To install loaded 12945A board, attach it to the control processor board with either a side jumper connector to an adjacent UCS board or a jumper connector directly to the processor board.

Electrical specifications

Current required from +5V computer power supply

Configuration	+5V
Logic only	.1A maximum
1 module loaded	.88A maximum
2 modules fully loaded	1.76A maximum

Ordering information

12945A User control store

The 12945A User control store includes:

1. 5060-8391 User control store board.
2. Three 8159-0005 Jumper wires.
3. Mounting hardware.
4. 12945-90001 Installation manual.

5060-1336 Jumper cable assembly

This cable is needed only for 2108K control processor configuration.

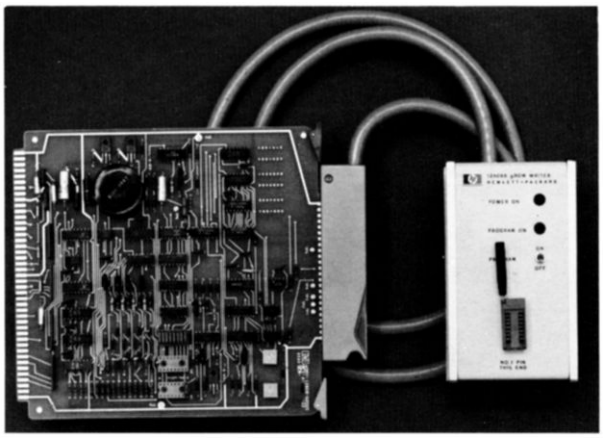
1816-0872 PROMs

HEWLETT hp PACKARD

HP 1000 M-series programmable Read-only memory (PROM) writer

model 12909B

The 12909B Programmable Read-Only Memory (PROM) Writer allows users to permanently transfer microprograms from memory to PROM chips after debugging. The PROM writer consists of a card that inserts into an I/O slot and a small box used to fuse the PROM chips. It can be used with HP 1000 M-Series computers.



Features

- **256 X 4 PROM fused without expensive special tooling**
- **User control of fuse parameters provided through the system console**
- **Any single memory location or complete array can be written into PROM's**
- **Patterns from compatible ROM's copied into PROM's in a two-stage operation**
- **Complete fusing in ten seconds**
- **ROM contents printed on system console**
- **Runs under BCS or DOS operating system**
- **PROM contents verified with desired pattern stored in memory**

Functional specifications

Configuration information

I/O slots required: 1; must be the last card in the priority chain.
Software required: 24287-60001, rev. B PROM writer control program

NOTE: A flat surface should be available within 1.2 meters (4 feet) of the back of the system cabinet on which to set the PROM writer mounting fixture.

Electrical specifications

Burn pulse

Rise time: Slew rate limited 20 - 40 μsec
Pedestal voltage: Value programmed by jumpers to manufacturers specifications, tolerance ±2.5%
Current limit: Value programmed by jumpers to manufacturers specifications, tolerance ±10%

Reference voltage: 5.00V ± .01V adjustable
±2% T.C. + aging
PROM Vcc: Value programmed by jumpers to manufacturer specifications, tolerance ±2.5%

Current required from computer power supply

1.2A(+5V), 0.04A(-2V), 0.3A (-12V, 0.5A(+12V).

Ordering information

12909B PROM writer

The 12909B PROM writer includes:

1. 12909-60005 PROM writer board.
2. 12909-60002 PROM writer mounting fixture.
3. 1816-0250 Test ROM.
4. 24287-60001 PROM writer control program on paper tape.
5. 24287-60002 DOS adapter to PROM writer control program on paper tape.
6. 24360-16001 Diagnostic on paper tape.
7. 12909-90005 Installation and service manual.
8. 12909-90009 Operating and reference manual.
9. 24360-90001 Diagnostic manual.

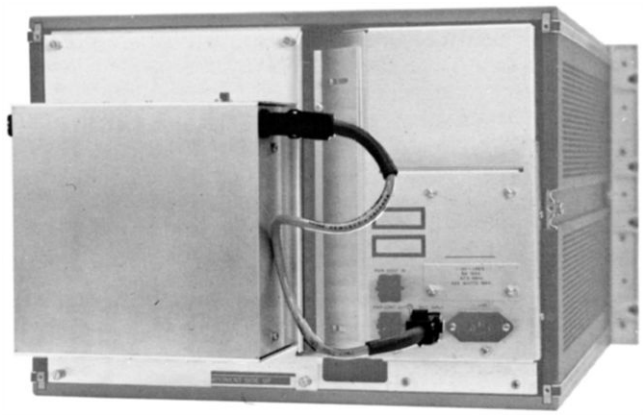
1816-0015 PROMs

HEWLETT hp PACKARD

Power fail recovery systems for HP 1000 computers and memory extender

models 12944B and 12991B

The 12944B and 12991B power fail recovery systems provide battery sustaining power for memory during line power outages, as well as battery charging circuitry, and battery charge state testing. If a line power outage does not last long enough to deplete available battery charge, the power fail/auto restart feature of HP 1000 computers may be used to resume processing. If, on the other hand, a line power outage lasts long enough to deplete available battery charge, the power fail recovery system prevents automatic power up and signals the operator that this condition exists.



12991B power pack mounted on rear of 2113 Computer

Features

- Sustains memory through power failures
- Tests battery charge state and provides a low battery warning indicator
- Provides automatic memory clear on power failures lasting longer than available battery charge
- Operates throughout the entire range of HP 1000 environmental specifications

Functional specifications

Application

12944B is used for battery backup of 2108B and 2109B Computers. It contains one 14-volt sealed lead-acid battery with a rating of 5 ampere-hours.

12991B is used for battery backup of 2111B, 2112B, 2113B, and 2117B Computers and 12990B Memory extenders. It contains one 14-volt sealed lead-acid battery with a rating of 10 ampere-hours.

Memory sustaining time

No. of mem. modules:	1	2	3	4	5	6	7	8	9	10
Hours with 12944B:	4.1	3.3	2.5	1.9	1.6					
Hours with 12991B:	4.4	3.8	3.4	3.0	2.6	2.3	2.2	2.1	2.0	1.8

Power restart

Detects resumption of power and generates an interrupt to trap cell for user-written restart program which has been protected in memory by the sustaining battery.

Power control and charge unit

Monitors battery charge status and provides slow charge

Sustaining battery

Type: 14 volt, 5 amp-hr (12944B) or 10 amp-hr (12991B) sealed lead acid

Charging rate: 2A, maximum

Battery charge time

Approximately 16 hours to fully-charge

Installation

To install, secure the battery pack to the back of the computer or memory extender, plug the printed circuit cards into the power supply, and connect the battery cable to the extender's input battery connector.

Physical characteristics

12944B: Adds 11.1 cm (4-3/8 in) to overall depth, 4.3 kg (9.5 lb) to weight of the 2109B Computer on which it is used.

12991B: Adds 11.1 cm (4-3/8 in) to overall depth, 7.3 kg (16 lb) to weight of the 2111B, 2113B, or 2117B Computer or the 12990B Memory extender.

Ordering information

12944B power fail recovery system

The 12944B power fail recovery system includes:

1. 12944-60001 battery pack.
2. 5061-1348 battery charging assembly.
3. 5061-1349 battery backup assembly.
4. 12944-60002 cable.
5. 12944-90005 installation manual.

12991B power fail recovery system

The 12991B power fail recovery system includes:

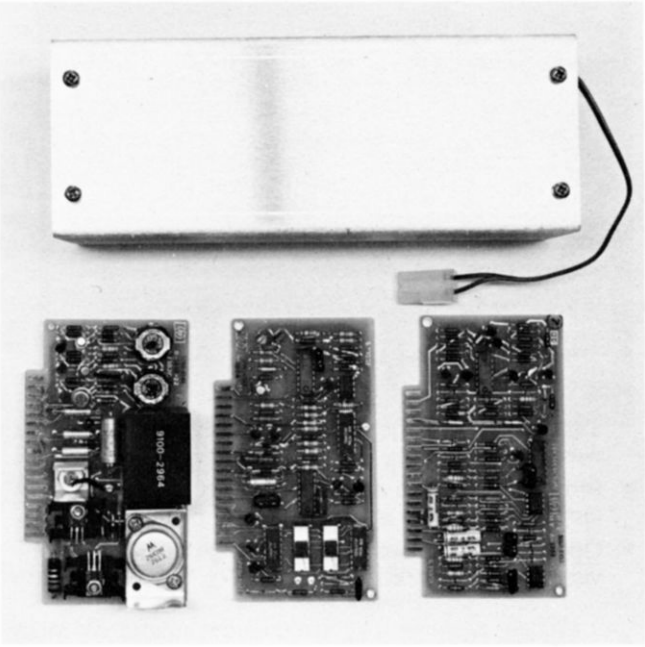
1. 12991-60001 battery pack and mounting hardware.
2. 5061-1348 battery charging assembly.
3. 5061-1349 battery backup assembly.
4. 12944-60002 cable.
5. 12991-90004 installation manual.

HEWLETT hp PACKARD

Power fail recovery system for 2105A computer

model 12944A

The 12944A power fail recovery system provides battery sustaining power for memory during line power outages, battery charging circuitry, and battery charge state testing. If a line power outage does not last long enough to deplete available battery charge, the power fail/auto restart feature of HP 1000 computers may be used to resume processing. If, on the other hand, a line power outage lasts long enough to deplete available battery charge, the power fail recovery systems prevent automatic power up, and signal the operator that this condition exists.



Features

- Sustains memory through power failures
- Tests battery charge state and provides a low battery warning indicator
- Provides automatic memory clear on power failures lasting longer than available battery charge
- Operates through the entire range of HP 1000 environmental specifications

Functional specifications

Application

12944A is used for battery backup of the 2105A Computer. It contains one 12-volt package of nickel cadmium batteries with a rating of 3.5 ampere-hours.

Power restart

Detects resumption of power and generates an interrupt to trap cell for user-written restart program which has been protected in memory by the sustaining battery.

Power control and charge unit

Monitors battery charge status and provides slow charge.

Sustaining battery

Type: 12 Volt nickel-cadmium
Charging rate: 350 mA constant current

Memory sustaining time

Three hours.

Battery charge time

Approximately 16 hours to full charge

Battery cycle servicing

Once every three to six months the battery should be completely discharged by turning computer line power off for over five hours.

Installation

To install, secure the battery pack to the back of the I/O card cage cover. Install the printed circuit cards in the power supply. Then, connect the battery cable to the processor's battery input connector.

Physical characteristics

12944A adds 7.3 cm (2-7/8 in) to overall depth, 2.5 kg (5.5 lb) to weight of 2105A Computer on which it is used.

Ordering information

12944A Power fail recovery system

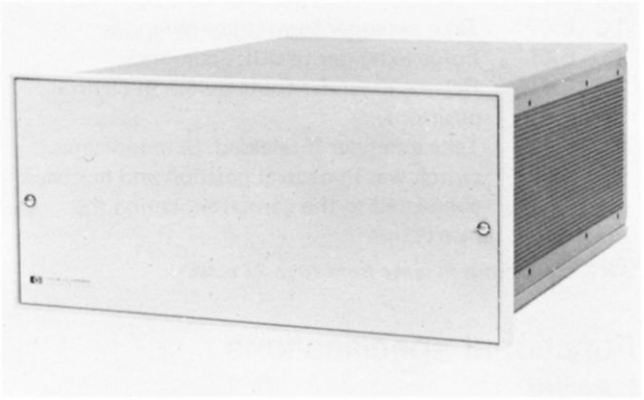
The 12944A power fail recovery system includes:
1. 1420-0206 battery pack.
2. 5060-8346 battery output assembly.
3. 5060-8347 battery control assembly 1.
4. 5060-8353 battery control assembly 2.
5. 02108-00006 and 00007 battery box cover and box.
6. 12944-90001 installation manual.
7. Attaching hardware.

HEWLETT PACKARD

Dual-port I/O extender and dual CPU kit

models 12979B and 12781A

The 12979B Dual-Port I/O Extender expands the I/O capacity of HP 1000 computers by offering additional channels to house standard interface cards. Integral to the 12979B is a programmable I/O bus switch that provides the capability to develop redundant computer systems, and for peripheral sharing between two computers.



Features

- **Provides 16 additional I/O slots per extender, with up to two extenders per computer**
- **Integral I/O bus switch provides capability for redundant systems and peripheral sharing**
- **Solid state switching logic for speed and high reliability**
- **Power supply designed for high reliability and serviceability, with the same wide input line voltage tolerance as HP 1000 computers**
- **Optional direct memory access with dual-channel port controller accessory.**
- **Full continuity of interrupt locations**

Functional description

I/O expansion

The 12979B extender provides 17 I/O slots for standard interface cards. Adding the 12979B to any HP 1000 computer provides a net addition of 16 slots, since one mainframe slot is required for the extender buffer card. Space is also provided in the extender for mounting the 12898A Dual-Channel Port Controller accessory, which provides direct memory access capability for any perpheral connected via the I/O extender.

The I/O extender, when used in the single port mode, is transparent to the programmer. Any select code (I/O device address) may be programmed into it, and I/O cards will operate with the same speed and flexibility as those in the computer mainframe.

The first I/O slot in the extender can be programmed to any select code, so devices can be moved from the computer to the extender to balance power consumption or to share with another cpu without losing select codes.

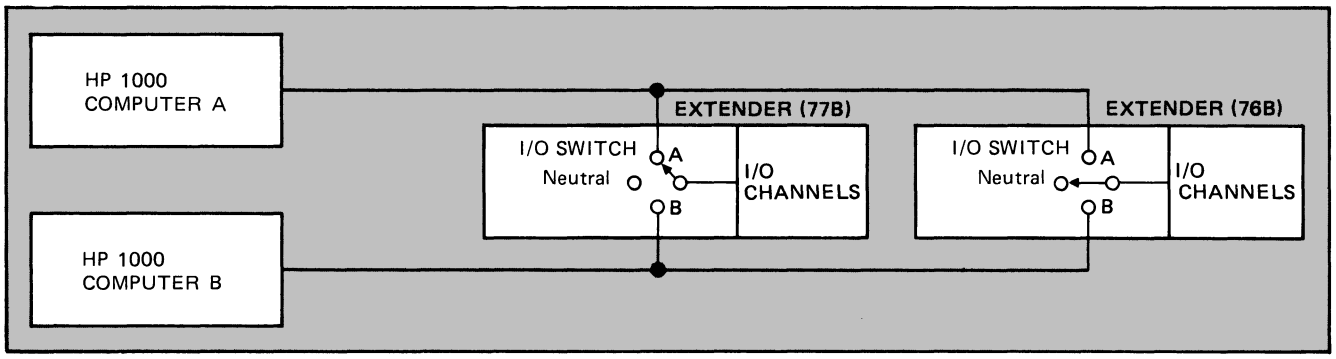
I/O bus switch

Integral to the extender is a programmable I/O bus switch that can transfer control of I/O devices connected to the extender between two HP 1000 computers (M-Series, E-Series, or F-Series). This capability makes it easy to set up a variety of configurations for redundancy and peripheral sharing.

The switch is operable under either manual or program control, and has three positions, defined as follows:

Connected to cpu port A: In this position, the I/O extender is connected to the computer associated with port A, and all devices interfaced via the extender are available to that computer. When connected, operations are totally transparent to the computer program.

Connected to cpu port B: Operation is the same as described for port A, above, except that the computer connected to port B has exclusive access to the extender and the devices connected to it.



Two-computer connection to two dual-port I/O extenders

Neutral: Neither computer is connected. The extender or devices connected to it can be serviced while in this position without discontinuing operations in either computer.

I/O bus switch programming

Switch programming is addressed to a select code (I/O device address), which can be any number from 70 to 77 octal, that is set by selector switches beneath the deck of the extender. The switch is controlled by the four input/output instructions defined below, which have a unique meaning when addressed to the I/O extender select code (in range from 70 to 77 octal).

Instruction	Purpose
STC EXT*	Take extender from other computer
CLC EXT*	Force extender to other computer
CLF EXT*	Release extender (puts switch in Neutral position)
SFC EXT*	Take extender if released. Skip indicates switch was in neutral position and has been connected to the computer issuing the instruction

**EXT = select code in range from 70 to 77 octal.*

Functional specifications

Capacity

Extender: 17 I/O channels (16 additional).

Extenders per computer: Two, maximum.

Computer I/O channels used: One per extender.

I/O switch characteristics

Number of computer ports: Two.

Switching time: One I/O instruction.

Configuration information

Maximum separation between computer and extender: 1.8m (6 ft), cable length limited.

Minimum clearances: 7.6cm (3 in) for rear cable; 5.7cm (2-1/4 in) air intake inside clearance.

Power fail communication: Status of the power supplies in HP 1000 computers and I/O extenders is communicated via power control cables. A power failure or power shutdown in a computer or extender causes a power down signal to be transmitted over the power control cable(s) to any other computer or extender that is connected. When a computer receives the signal, a power fail interrupt is generated in that computer. Connection of the power control cables is required for orderly shutdown because a power failure or power down in an extender will cause unpredictable control and data signals that **may** cause loss of control over the computer's operation. Therefore, although use of the power control cables limits full redundant operation, their installation is required, as shown in the 12979B installation manual.

Installation: To install, mount the 12979B in a rack less than 1.8m (6 ft) from the HP 1000 computer(s). Connect the power control cable between the extender and computer. Install an I/O buffer card in the first unused I/O slot in the computer(s). Configure the I/O extender control card to the first select code desired in the extender, the desired select code for the I/O switch, and the source of the priority chain for both computer ports (if both are used). Connect the I/O control signal flat cable(s) between the extender and the cpu board(s) in the computer(s) and connect the I/O data cable(s) between the I/O buffer card(s) in the computer(s) and the I/O extender control card. If only one computer is connected to the extender, the extender configuration switches can be set to lock the switch to that machine, avoiding the necessity of issuing STC EXT each time the system is powered up.

Electrical specifications

AC power required

88-132V, 47.5-66 Hz, 625W, maximum; 176-264V, 47.5-66 Hz with option 015. Input line voltage range is easily changed in the field by moving jumper connections.

Current required from computer

2A(+5V) and 1.35A(-2V) for I/O buffer card.

Current available to I/O slots

4.5A(+12V),47A(+5V),5A(-2V),2.5A(-12V),0.25A(+28V)

Power supply

Storage after line failure: I/O extender continues normal operation through temporary power interruptions of up to 8 milliseconds when operating at the minimum ac line voltage.

Output protection: All voltages are protected for over voltage and over current.

Thermal sensing: Monitors internal temperature and automatically shuts down I/O extender if temperature exceeds specified level.

Safety

The 12979B is recognized by Underwriters Laboratories, Inc., and certified by the Canadian Standard Association (with the exception of option 015).

Physical characteristics

Dimensions

Width: 48.3cm (19 in) panel; 42.6cm (16-3/4 in) behind panel casting.

Depth: 62.2cm (24-1/2 in) overall; 58.4cm (23 in) behind panel casting.

Height: 22.2cm (8-3/4 in).

Weight

16 kg (35 lb)

Heat dissipation

538 kilogram-calories/hr (2138 BTU/hr).

Ventilation

Air flow is 5.7 cubic meters/min (200 cubic feet/min), intake on left side, exhaust on right side.

Ordering information

12979B Dual port I/O extender

The 12979B includes:

1. 12979B Dual port I/O Extender.
2. 12979-60022 I/O buffer card.
3. 12979-60024 I/O data cable, 2.1m (7 ft) long.
4. 12979-60008 I/O control cable.
5. 12979-60025 power control cable.
6. 12979-16001 diagnostic on paper tape.
7. 12979-90016 installation and service manual.
8. 12979-90014 operating and reference manual.
9. 12979-90010 diagnostic manual.
10. 12979-60026 power control cable adaptor.

12781A dual cpu kit

The 12781A dual cpu kit includes:

1. 12979-60022 I/O buffer card.
2. 12979-60024 I/O data cable 2.1m (7 ft) long.
3. 12979-60008 I/O control cable.
4. 12979-60025 power control cable.
5. 12979-60026 power control cable adapter.

12898A dual channel port controller for 12979B

The 12898A dual channel port controller for the 12979B includes:

1. 12898-60001 dual channel port controller assembly.
2. 12898-90001 installation manual.

I/O extender option

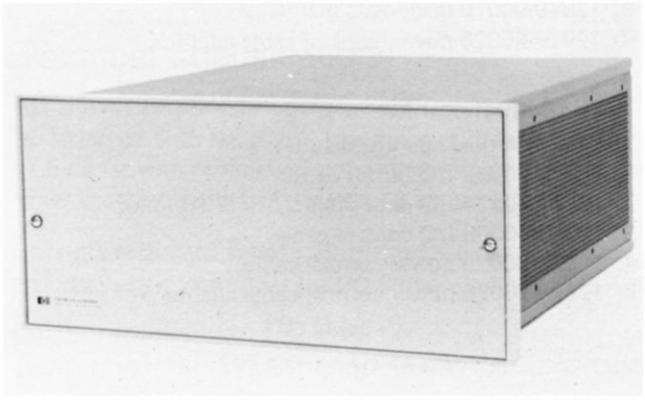
015: 220V (176-264V) operation.

HEWLETT hp PACKARD

Memory extender

model 12990B

The 12990B Memory Extender provides for expansion of HP 1000 computer memory capacity. The extender has space for nine additional semiconductor memory modules in a compact 22.2cm (8-3/4 in) frame.



Features

- **Memory access and cycle time not affected with the addition of a 12990B.**
- **Space for nine additional semiconductor memory modules**
- **Low physical profile—22.2cm (8-3/4 in) high**
- **Ease of installation—only three cables are required, and memory modules plug-in**
- **Brownout-proof power supply included**
- **Uses no computer mainframe power**
- **Optional power fail recovery system installs inside the extender frame**
- **Power failure interrupt to the computer for system integrity**
- **Compatibility with all HP 1000 M, E- or F- Series computers, except the 2105A**

Functional specifications

Capacity

No. of memory modules: nine.

Byte of memory: 144k with 16k byte (12998A) modules; 288k with 32k byte (13187B or 12741A) modules; 1152k with 12747A/H modules.

Configuration information

Computer compatibility and prerequisite: The 12990B memory extender is compatible with 2108, 2109, 2111, 2112, 2113, and 2117 computers with dynamic mapping system (12976B in 2108 or 2112, 13305A in 2109, 2111, 2113, or 2117). The 12990B is not compatible with the 2105A.

Mounting: The 12990B must be mounted in the rack directly below the HP 1000 computer.

Installation: To install, remove the HP 1000 computer from the rack and remove, exchange, and re-install the bottom covers of the computer and extender. Install the computer and extender in the rack, with the extender directly below the computer. Connect the power control cable between the computer and extender, configure and install the additional memory modules in the extender, and connect the flat cable between the memory controller and all of the memory modules.

Electrical specifications

AC power required

88-132V, 47.5-66 Hz, 300W, maximum; 176-264V, 47.5-66 Hz with option 015. Input line voltage range is easily changed in the field by moving jumper connections.

Power supply

Storage after line failure: Memory extender continues normal operation through temporary power interruptions of up to 8 milliseconds when operating at the minimum ac line voltage.

Output protection: All voltages are protected for over voltage and over current.

Thermal sensing: Monitors internal temperature and automatically shuts down memory extender if temperature exceeds specified level.

Safety

The 12990B is recognized by Underwriter's Laboratories, Inc., and certified by the Canadian Standards Association (with the exception of option 015).

Physical characteristics

Dimensions

Width: 48.3 cm (19 in) panel; 42.6 cm (16-3/4 in) behind panel casting.

Depth: 62.2 cm (24-1/2 in) overall; 58.4 cm (23 in) behind panel casting.

Height: 22.2 cm (8-3/4 in).

Weight

18.3 kg (40 lb).

Heat dissipation

258 kilogram-calories/hr (1024 BTU/hr).

Ventilation

Air flow is 5.7 cubic meters/min (200 cubic feet/min), intake on left side, exhaust on right side.

Ordering information

12990B memory extender

The 12990B memory extender includes:

1. 12990B memory extender.
2. 12990-60014 computer-extender power control cable.
3. 12990-60015 extended memory cable (20 connectors).
4. 12990-90007 installation manual.

Option

015: 220V (176-264V) operation.

Required accessory

12976B Dynamic mapping system or 12784A/B/C/D or 12785A/B/C/D Memory package in 2108 or 2112 Computer or 13305A Dynamic mapping system or 12786A/B/C/D, 12787A/B/C/D, 12788A/B/C/D, or 12789A/B/C/D Memory package in 2109, 2111, 2113, or 2117 Computer.

Recommended accessory

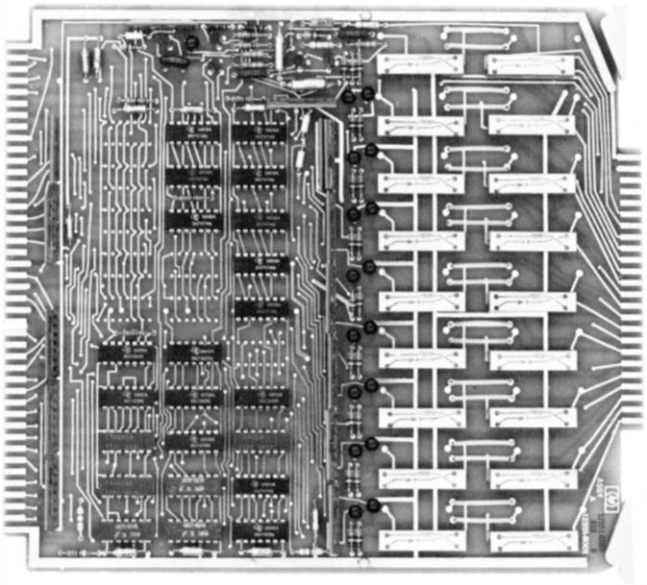
12991B power fail recovery system.

HEWLETT hp PACKARD

16-Bit relay output register

model 12551B

The 12551B 16-Bit Relay Output Register provides 16 floating contact closures which can be used for controlling one device, or be subdivided in any combination to control several devices. The voltages switched through the relay contacts can differ from each other and from computer ground by as much as 100V peak. Contacts can be connected in series, parallel, or in series-parallel—with or without diode isolation.



Features

- **16 isolated contact closures**
- **16-bit data storage register**
- **Automatic initialization at computer turn-on**
- **Command-interrupt capability**

Description

Each bit of the 16-bit relay output register directly drives an individual form A contact. Each contact is isolated from all other lines and also from computer power and ground. An OUTPUT program instruction (OTA/B) transfers 16 data bits from the computer's A- or B-register to the relay output register flip-flops which, in turn, energize the corresponding relays through transistor driver circuits.

The relays retain their states unless changed by the next OTA/B instruction. Relay contacts open or close within one millisecond following transfer of new bit states to the storage register on the card.

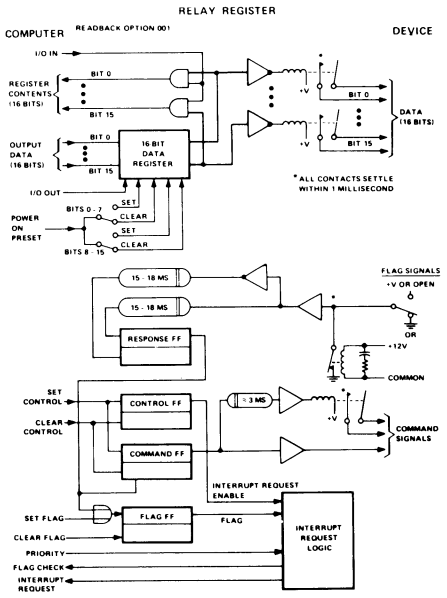
In addition to the 16-bit relay output, the relay register is equipped with command and interrupt logic that makes possible a two-way exchange of control and status request information between the computer and controlled equipment. Typically, the computer will use the command logic to "tell" a controlled device that new data has been entered into the Relay Register. The controlled device will normally use the interrupt logic to "ask" the computer for the next data word to be transferred via the Relay Register.

There is a choice of two command outputs, which can be used individually or simultaneously. One of the outputs comes from a ground-referenced driver transistor and the other is an isolated contact closure that can be used as flexibly as any of the 16 sets of relay contacts that make up the output data.

On an input command, an interrupt request is generated in response to a flag signal from the controlled device via an isolated flag input to a relay coil as well as a ground-referenced input to a driver transistor.

Turn-on of computer power automatically presets register flip-flops that store the output bit states for the various relays. Hardwired jumper connections to each group of eight flip-flops determine whether all flip-flops in a group will be set, closing the respective relay contacts, or cleared, allowing the contacts to open. Initialization assures that the states of all relays are known immediately after power turn-on—a particularly valuable feature when power supplies are being programmed.

A simplified block diagram of the relay output register appears below.



Functional specifications

Relay contacts

States: All contacts are normally open when power is off. Contacts close individually in response to "1" bit states from computer.

Maximum power: 10W peak or continuous/contact.

Maximum voltage: 100V peak or continuous across open contacts, between output connector pins, and with respect to computer ground on the register card.

Maximum current: 500mA/contact, peak or continuous.

Life: 10-million operations under rated load.

Resistance: 0.1Ω at 100mA (higher at lower current).

Protection: Mounting positions are provided for connecting contact protection resistors in series with contacts of each relay.

Settling time: 1 millisecond, max., for pull-in or drop-out.

Data output

"1" level: Contact closed

"0" level: Contact open

Power-on preset: Register is normally wired to preset all data relays open. Upon request at time of ordering, register will be wired to preset bits 15 through 8 or bits 7 through 0 open, or all bits closed when power is turned on.

Command output

Ground-referenced:
"1" level: 0V, 12mA current sink
"0" level: +12V through 10kΩ

Isolated (floating relay contact with ratings as specified above):
"1" level: Contact closed
"0" level: Contact open

Response (flag) input:

Ground-referenced:
Normal: 0V, 12mA current sink from NPN transistor
Set-flag: Open circuit
Response delay: 15 milliseconds, nominal

Isolated:
Normal: 12V, 15mA to relay coil
Set-flag: No input to relay coil
Response delay: 15 milliseconds, nominal

Configuration information

Computer compatibility: The 12551B Relay register interface is compatible with all HP 1000 computers.

I/O channels required: One per interface.

Software support: Software support for the 12551B Relay register is limited to the diagnostic furnished with it, which is also available in the 24396A-F diagnostic library. A user-written driver, programmed in Assembly language, will be required to run this interface in an operating system.

Installation: To install, plug the interface into the computer I/O backplane, connect the interface to external equipment with a user-fabricated cable, and integrate the interface and user-written driver into the computer's operating system.

Electrical specifications

Current required from computer power supply

	+5V	-2V	+12V
12551B	0.6A	0.39A	0.24A
12551B & 001	1.1A	0.59A	0.24A

Ordering information

12551B Relay output register

The 12551B Relay output register includes:

1. 12551-6001 16 bit relay register.
2. 5060-8339 48-pin connector kit.
3. 24391-16001 Diagnostic on paper tape.
4. 12551-90002 Operation and installation manual.
5. 24391-90001 Diagnostic manual.

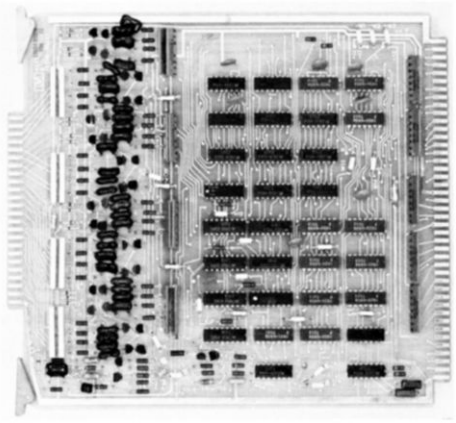
12551B option 001

Option 001 adds bit state read-back to the 12551B Relay register.

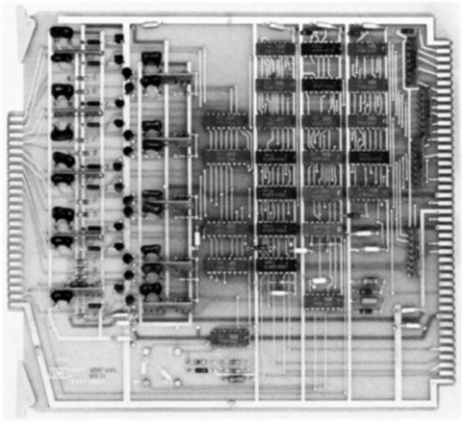
HEWLETT hp PACKARD

Duplex register cards

models 12554A, 12597A



12554A 16-Bit duplex register I/O card



12597A 8-Bit duplex register I/O card

The 12554A and 12597A Duplex Register Cards provide an easy way to interface HP 1000 computers with a wide range of external devices used for online production test, lab design, or measurement applications. Model 12554 offers 16-bit input and output storage registers plus control and interrupt logic. Model 12597A offers 8-bit registers plus control and interrupt logic.

Both models are general-purpose interfaces designed to provide wide flexibility when used with conventional-output digital devices.

Features

- **Dual 8- or 16-bit data registers**
- **Choice of positive or negative transistor interface**
- **Includes control and interrupt logic**

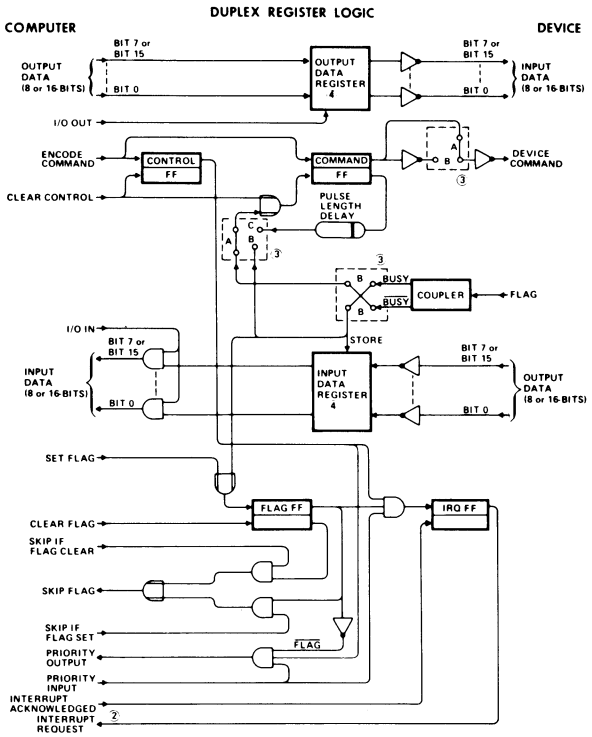
Output operations

An output instruction and an accompanying I/O OUT signal from the computer transfers eight or 16 bits from the computer's A- or B-register to the output data register on the card. These bits are then applied to the external device without further intervention by the computer. Next, the computer issues a device command which "tells" the device that the data is ready to be acted upon.

When the external device is ready for the next data word, it returns a flag signal to the duplex register card.

Input operations

When the external device is ready to supply data to the computer, it must issue a flag signal to the duplex register card. This signal enters data into the card's input register and sets up a request for service to the computer. The computer responds with an input instruction which enters data into its A- or B-register.



Functional specifications

Capacity

12554A: 16 bit input and 16 bit output

12597A: 8 bit input and 8 bit output.

Data input/output (standard 12554A/12597A)

Logic sense: Positive in/positive out.

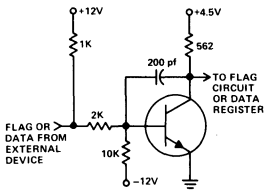
Input "1": 0 to +0.5V, 12 mA max. sink.

Input "0": +8V through 700Ω.

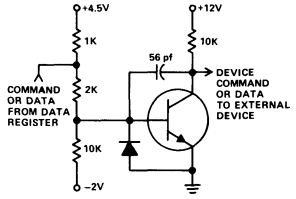
Output "1": 0 to +0.5V, 12 mA max. sink.

Output "0": +12V, 10kΩ source.

Positive in/positive out circuits



DEVICE FLAG & DATA INPUT



DEVICE COMMAND & DATA OUTPUT

Data input/output 12554A/12597A option 001

Logic sense: Negative in/negative out.

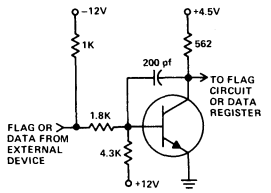
Input "1": -8V through 700Ω.

Input "0": 0 to -0.5V, 12 mA max. sink.

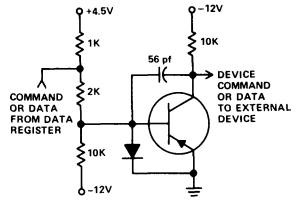
Output "1": -12V, 10kΩ source.

Output "0": 0 to -0.5V, 12 mA max. sink.

Negative in/negative out circuits



DEVICE FLAG & DATA INPUT



DEVICE COMMAND & DATA OUTPUT

Device command output

Command signal to external device indicates data is ready in output register and is terminated by a device flag signal input.

Device flag input

External device command to interface card strobes data to input storage register and sets interface card flag flip-flop.

Configuration information

Computer compatibility: The 12554A and 12597A Duplex register interfaces are compatible with all HP 1000 computers.

I/O channels required: One per interface.

Software support: Except for punched tape subsystems using the 12597A interface, software support for the 12554A and 12597A interfaces is limited to the diagnostic furnished with them, which is also available in the 24396A-F diagnostic library. A user-written driver programmed in Assembly language will be required for general-purpose use of these interfaces in a computer operating system.

Installation: To install, plug the interface into the computer I/O backplane, connect the optional (or a user-fabricated) cable to external equipment, and integrate the interface and driver into the computer's operating system.

Electrical specifications

Current required from computer power supply

	+5V	-2V	-12V	+12V
12554A	1.11A	.06A	.03A	.023A
12554A & 001	1.11A	.06A	.25A	.025A
12597A	.75A	.05A	.02A	.05A
12597A & 001	.75A	.05A	.05A	.02A

Ordering information

12554A 16 bit duplex register

The 12554A 16-bit duplex register includes:

1. 12554-60023 positive in/positive out 16-bit duplex register interface card.
2. 02116-6178 48-pin connector kit.
3. 24391-16001 Diagnostic on paper tape.
4. 12554-90021 Interface manual.
5. 24391-90001 Diagnostic manual.

12554A option 001

Option 001 replaces the 12554-60023 positive in/positive out interface card with the 12554-60024 negative in/negative out interface card and the 12554-90021 interface manual with the 12554-90022 interface manual.

12597A 8 bit duplex register

The 12597A 8-bit duplex register includes:

1. 12597-6001 positive in/positive out 8-bit duplex register interface card.
2. 02116-6178 48-pin connector kit.
3. 1251-0332 Test connector.
4. 24391-16001 Diagnostic on paper tape.
5. 12597-9002 Interface manual.
6. 24391-90001 Diagnostic manual.

12597A options

001: Replaces the 12597-6001 positive in/positive out interface card with the 12597-6002 negative in/negative out interface card and the 12597-9002 interface manual with the 12554-90021 interface manual.

002: Adds 12597-6004 2748B interface cable, 12597-16001 paper tape reader/punch diagnostic (on paper tape), 12597-90022 paper tape reader interface manual, and 12597-90031 diagnostic manual to standard 12597A.

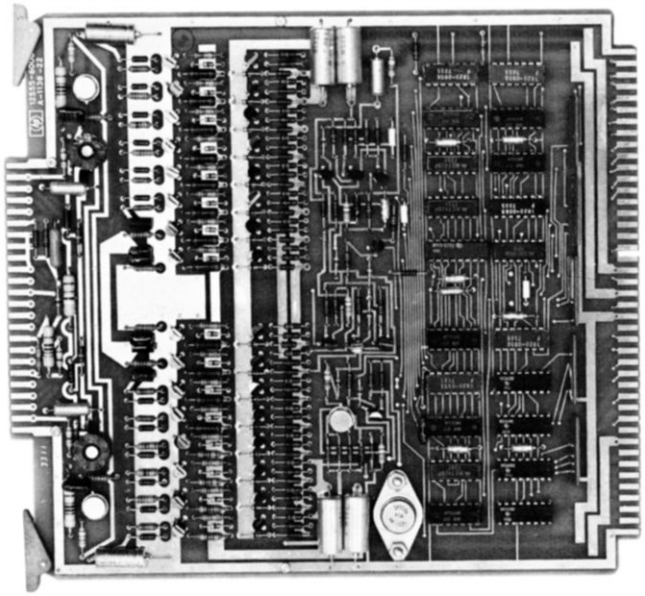
005: Adds 12597-60061 2895B interface cable, 12597-16001 paper tape reader/punch diagnostic (on paper tape), 12597-90025 tape punch interface manual, and 12597-90031 diagnostic manual to standard 12597A.

HEWLETT hp PACKARD

Digital-to-analog converter

model 12555B

The D-A converter provides two analog outputs ranging between 0 and +10 volts. Resolution of each channel is 8 bits. Blanking and "erase" signals are also provided by the D-A converter for use with oscilloscopes and X-Y plotters. D-A converter operation may be under program control with dual channel port controller (DCPC) control.



Features

- **Continuous, rapid graphical display of data using conventional oscilloscopes**
- **Rapid graphical display of semi-static data using storage-type oscilloscopes**
- **Plotting of graphical data using an analog X-Y plotter to obtain low-to-medium resolution point plots**
- **Providing programmed voltage references for use in programming power supplies**

Functional specifications

Analog output

Voltage range: 0 to +10V nominal

Accuracy: ±100 mV full scale

Zero offset: ±40mV (one count)

Linearity: To ±40mV within one machine cycle from the end of the OUTPUT (OTA/B) program instruction

Blanking pulses and erase signal

High: +10V to -10V (nominal)

Low: +1 to -1V (nominal)

Pulse length: 2 instr. times

Erase signal: Transistor closure to ground

Configuration information

Computer compatibility: The 12555B Dual DAC interface is compatible with the 2105, 2108, and 2112 computers and may also be compatible with the 2109, 2111, 2113, and 2117 computers, but has not been tested for such compatibility by HP.

Software required: A user-written driver, programmed in Assembly language, will be required to run the 12555B interface in a computer operating system.

Installation: To install, plug the interface into the computer I/O backplane, connect the interface to external equipment with user-fabricated cable, and integrate the interface and user-written driver into the computer's operating system.

Electrical specifications

Current required from computer power supply

2.4A (+5V), 1.08A (-2V), 0.5A (+12V), 0.36A (-12V)

Ordering information

12555B Dual D-to-A converter

The 12555B Dual D-to-A converter includes:

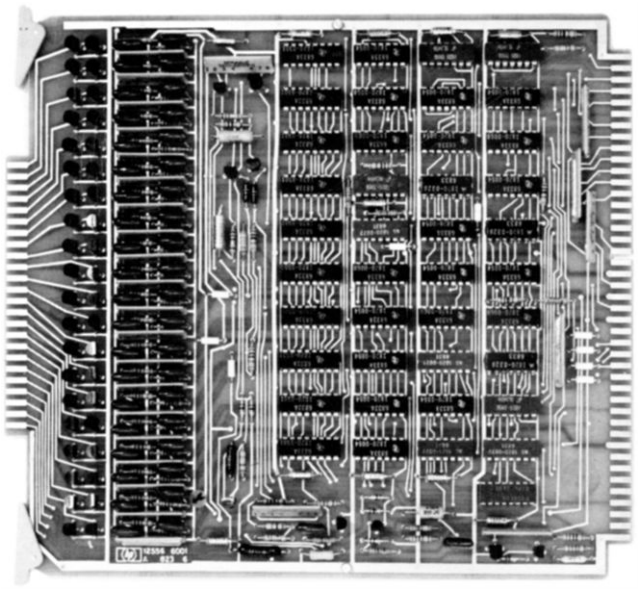
1. 12555-60001 Dual 8-bit D-to-A card.
2. 5060-8340 24-pin connector kit.
3. 12555-90063 Interface manual.

HEWLETT hp PACKARD

40-Bit register

model 12556B

The HP 12556B is an output interface with 40-bit capacity. Its applications include driving HP model 5055A and 5050B digital recorders, program input lines of stimulus or measuring instruments, or control panel indicators or control lines.



Features

- **40 bit (10 BCD digit) capacity**
- **Choice of ASCII or binary assembly modes**
- **Includes recorder command-holdoff interface**

Output modes

The 40-bit register offers a choice of two output modes, ASCII and binary. In ASCII mode, the register assembles the BCD portion of ASCII characters from six words in memory, as shown in figure 1, to form a 41-bit output (10 BCD digits plus control bit). In binary mode, the register output is assembled from three words of memory, as shown in figure 2.

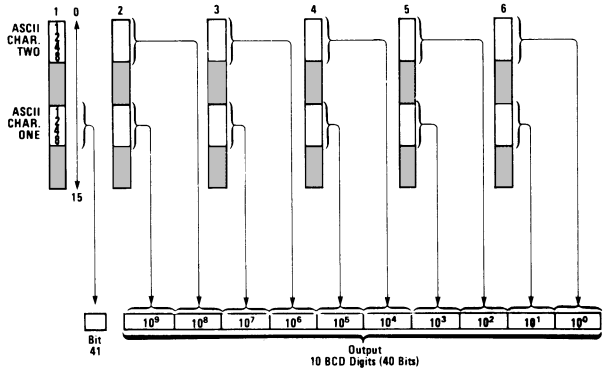


Figure 1. Output assembly in ASCII mode

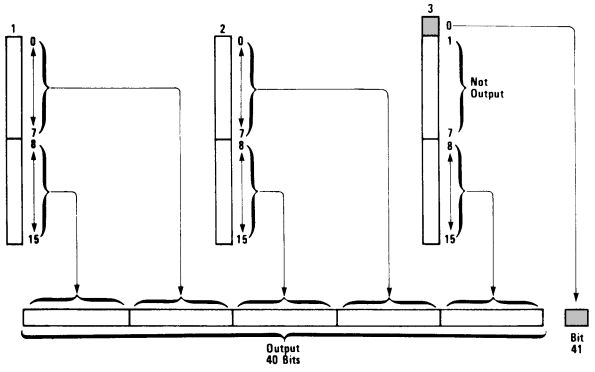
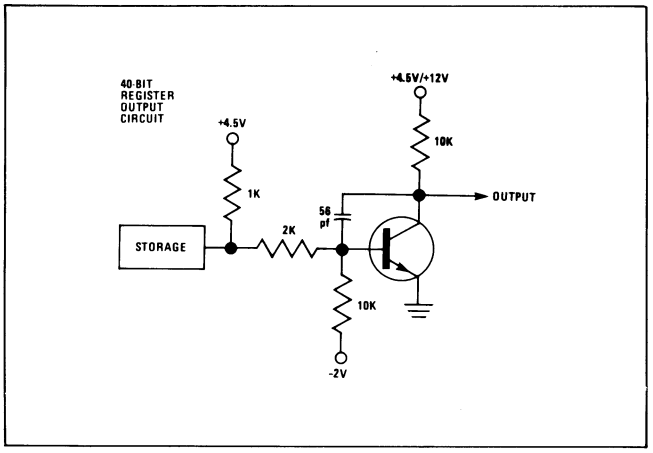


Figure 2. Output assembly in binary mode



Functional specifications

Data output

No. of bits: 40 data, 1 control

"1" level: +12V/+4.5V, jumper selectable through 10kΩ

"0" level: 0V, 10mA max. current sink

Reference voltages

Positive: +9V/+3.33V, jumper sel, 100 sel, 100Ω impedence

Negative: +1V/+0.37V, jumper sel, 44Ω impedance

Command output

Standard: 50μs pulse from < + 1V to +7.8V

Option 002 negative command: 50μs pulse from > +5V/+7.8V, jumper selectable to < +1V (may be changed to positive command by changing jumper)

Flag input from external device

Standard: +7V to +15V, 2.2mA min, from -0.7V or open circuit state (return to ground or open circuit sets flag).

Option 002: +4.5V to +15V, 2.2mA min, from -0.7V or open circuit state (return to ground or open circuit sets flag)

Status input from external device

-3V to -30V, 0.61mA min, from +5V open circuit state

Output presetting

Power on: Turn-on of computer presets all output bits to "0" state

Programmed: All output bits can be program-preset to either "1" or "0" states

Override timer

Timing: Sets flag after 300 milliseconds if external device has not returned flag

Status: Bit 3 to input bus is set if override timer has set flag

Output assembly modes

ASCII: Bits 11-8 and 3-0 from 16-bit word are assembled to form output

Binary: All bits of 16-bit word form output, most significant bit first

(Modes can be selected by jumpers or programming)

Configuration information

Computer compatibility: The 12556B is compatible with all HP 1000 computers

I/O channels required: One per 12556B interface card

Memory required for RTE driver: 500 bytes; 640 bytes with BASIC/1000M/D interface

Software recommended: RTE driver DVR54, which is included in 92066A RTE Measurement and Control Drivers Package.

Electrical specifications

Current required from computer power supply

0.9A (+5V), 0.08A (-2V), 0.15A (+12V), 0.01A (-12V)

Ordering information

12556B 40-bit register

The 12556B 40-bit register includes:

1. 12556-6002 positive-true 40-bit register card.
2. 5060-8339 48-pin connector kit.
3. 20348-60001 Diagnostic on paper tape.
4. 12556-9002 Interface manual.

12556B Options

001: Replaces 5060-8339 connector kit with 02547-6040 2.4m (8 ft) cable for connection to 505A/B, 5055A, or 562AR Digital Recorder.

002: Replaces items 1, 3, and 4 of standard 12556B with:

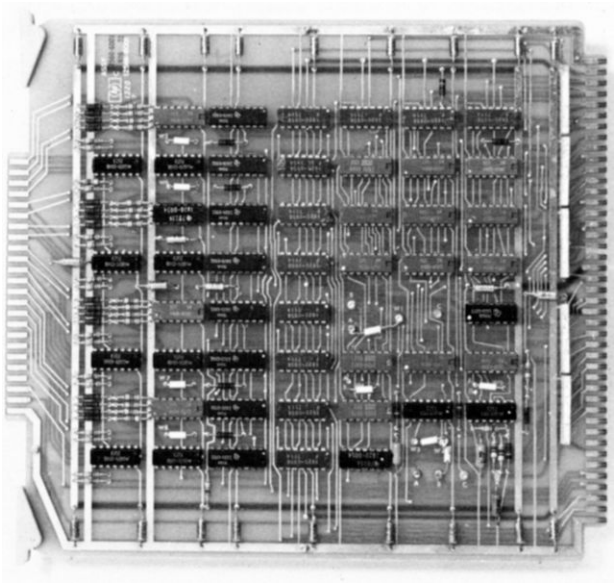
1. 12556-60022 ground-true 40-bit register card.
2. 12556-60023 Test connector.
3. 12556-60024 Test cable.
4. 29026-60001 Diagnostic on paper tape.
5. 12556-90028 Interface manual.

HEWLETT hp PACKARD

Microcircuit interface

model 12566B

The microcircuit interface card permits interfacing to an external device with the popular DTL/TTL family of integrated circuits, at data speeds much greater than can be achieved with discrete-components. Typical devices are those used for on-line production testing, lab design work, and those applications involving measuring instrumentation. The interface card permits input and output information flow between the computer and an external device. It features separate 16-bit input and output storage registers, plus control and interrupt logic. These features offer a wide latitude in configuring your instrument measurements for computer analysis.



Features

- **DTL/TTL compatible**
- **Dual 16 bit storage registers**
- **Input and output operation**
- **Interrupt logic for ease of use with instrumentation**

Description

The 12566B Microcircuit Interface card enables HP computers to exchange input and output information with most digital measurement devices with DTL/TTL output voltage levels. Although the 12566B is designed as a general-purpose microcircuit interface, it has many features found in specific peripheral device interfaces. Included are 16-bit input and output storage registers which provide temporary storage during data transfer, plus control and interrupt logic.

Also provided is a device command (action) line to the external device and a flag (action completed) response line from external device. You can choose from a combination of device command and flag signal logic levels to fit your particular needs: jumpers permit plus-true, plus-false, or plus-false pulse-mode encode signal levels; jumpers permit a plus-going or minus-going signal as the flag signal to initiate an interrupt and/or to turn off the device command signal. Also, it is possible to remove a jumper and obtain ungated inputs to the input register of the card; data can be input without receipt of a flag signal from the device. Input, output, and combined input/output operations are possible between the computer and external device when interfaced through the microcircuit interface card.

Combined input/output operations

The microcircuit interface card includes two independent registers which allow a two-way flow of information between the computer and an external device. A typical combined input/output operation would be output of control information to a measuring device that measures data from several input channels. The output register would provide control information to the external device and the input register would accept the results of the measurements. If the external device is a printer, for example, data is transferred through the output register and status information may be read back into the input register.

Direct memory access operations

This interface card is also fully compatible with direct memory access and dual channel port controller in HP 1000 computers. It is easily programmed to accept or send high speed 16-bit data transfers to instrumentation or other computers.

Pulse mode operation

The pulse mode of operation permits use of the microcircuit interface card for those applications where data lines are shared and data can appear at the output of the interface card for a certain period of time only. By changing jumpers on the card, both the encode signal and the output data can be 'pulsed' out simultaneously.

Interconnecting cable

Due to the fast rise times and low voltage level outputs from this interface card, it is recommended that twisted-pair cable be used to connect the computer interface card to the external device.

Functional specifications

Capacity

16 bit input and 16 bit output

Data and flag inputs (standard)

Logic sense: Ground-true, positive false.

"1" State: 0 to +0.5V, 15 mA required.

"0" State: +2.4V to +5V.

Bias and impedance: +3V, 300Ω to +5V.

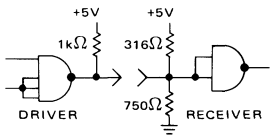
Data and encode outputs (standard)

Logic sense: Ground-true, positive false.

"1" State: 0 to +0.5V, 31 mA current sink.

"0" State: +2.4V to +5V, 1kΩ impedance.

Ground-true logic circuits (can be OR-tied)



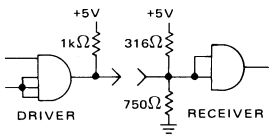
GROUND-TRUE LOGIC
(Can be 'OR-tied')

Data and flag inputs and data and encode outputs (option 002)

Logic sense: Positive-true, ground false.

"1" and "0" States and input bias and impedance: Same as standard interface, but "1" and "0" states are inverted.

Positive-true logic circuits (option 002 – cannot be OR-tied)



POSITIVE-TRUE LOGIC
(Cannot be 'OR-tied')

Configuration information

Computer compatibility: The 12566B Microcircuit interface is compatible with all HP 1000 computers. computers.

I/O channels required: One per interface.

Software support: Software support for the 12566B Microcircuit interface is limited to the diagnostic furnished with it, which is also available in the 24396A-F diagnostic library. A user-written driver, programmed in Assembly language, will be required to run this interface in a computer operating system.

Installation: To install, plug the interface into the computer I/O backplane, connect the interface to external equipment with user-fabricated, twisted pair cable, and integrate the interface and user-written driver into the computer's operating system.

Electrical specifications

Current required from computer power supply

1.1A (+5V), 0.05A (-2V)

Ordering information

12566A Microcircuit interface

The 12566B Microcircuit interface includes:

1. 12566-60024 ground-true, positive false microcircuit interface card.
2. 5060-8339 48-pin connector kit.
3. 8120-1846 4.6m (15 ft) cable with 36 twisted pair lead wires.
4. 1251-0332 24-pin test connector.
5. 24391-16001 Diagnostic on paper tape.
6. 12566-90015 Interface manual.
7. 24391-90001 Diagnostic manual.

12566A options

001: Replaces 5060-8339 48-pin connector kit with 5060-8340 24-pin connector kit for connection to a single bi-directional data bus and sets microcircuit card to operate in pulse mode.

002: Replaces 12566-60024 ground-true, positive false microcircuit interface card with 12566-60025 positive-true, ground false microcircuit interface card.

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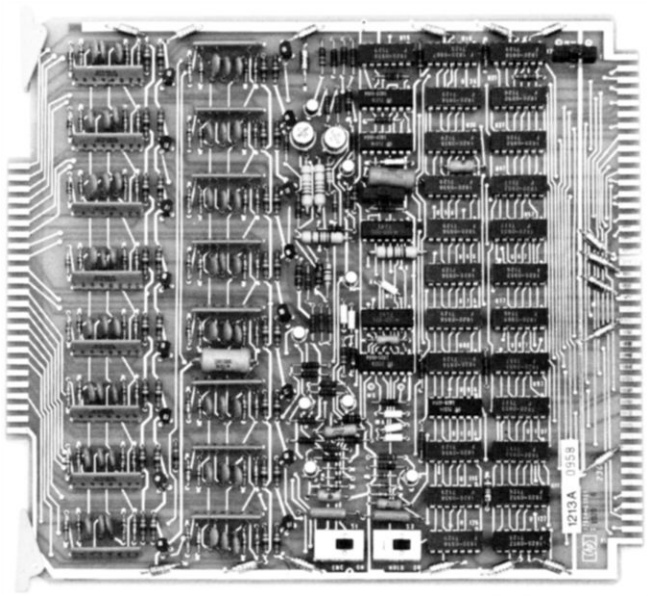
Data source interface card

model 12604B

The 12604B is a measuring instrument data source interface card with 32-bit capacity. As such, it can transfer up to 8 BCD digits from counters, DVM's, etc., to HP 1000 computers. Referenced capacitive coupling (see circuit diagram) accommodates logic levels between -100V and +100V, making the DSI a universal interface for digital instruments.



Features

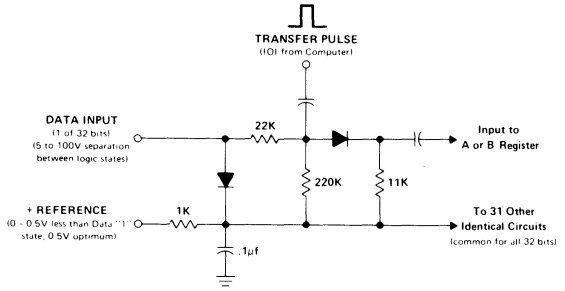
- **32-bit (8 BCD digit) capacity**
- **Accommodates wide range of referenced logic levels**
- **Provides measurement triggering signal to external data source**

Functional specifications

Data input

Range of levels: between -100V and +100V

Threshold: "1" state more positive than "0" state by 5V (min) to 100V (max)



Data input circuit diagram

Control

Positive encode: Shift from -12V (through 10kΩ) to gnd.

Negative encode: Shift from +13.5V (through 9kΩ) to gnd.

Pulsed encode: 60 or 80 μsec duration, jumper selectable

Positive hold: +17V through 1kΩ (10 mA max)

Negative hold: -11V through 2.2kΩ (10mA max)

Record command: +4.5V to +24V (or -4.5V to -24V), 20 μsec minimum-duration pulse, ac-coupled.

External low set: +4.5V logic pulse to set for first 16 bits input (not required for normal operation)

Configuration information

I/O channels required: One per 12604B interface card.

Memory required for RTE driver: 200 bytes; 440 bytes with BASIC/1000M/D device interface routine.

Software recommended: RTE driver DVR40, which is included in the 92066A RTE Measurement and Control Drivers Package.

Electrical specifications

Current required from computer power supply

1.1A (+5V), 0.35A (-2V), 0.024A (-12V), 0.01A (+12V), 0.037A (+30V)

Ordering information

12604B Data source interface

The 12604B Data source interface includes:

1. 12604-60001 Data source interface card.
2. 5060-8339 48-pin connector kit.
3. 20337-60001 Diagnostic on paper tape.
4. 12604-90002 Interface manual.

12604B Options

001: Replaces 5060-8339 connector kit with 12604-60002 3.6m (12 ft) cable to HP 2402A/2401C DVM.

002: Replaces 5060-8339 connector kit with 02116-6153 3.6m (12 ft) cable to older HP counters.

003: Replaces 5060-8339 connector kit with 12604-60008 3.6m (12 ft) cable to newer integrated circuit HP counters with printed circuit edge connector for BCD output.

005: Replaces 5060-8339 connector kit with 12604-60004 3.6m (12 ft) cable to HP 3450 DVM.

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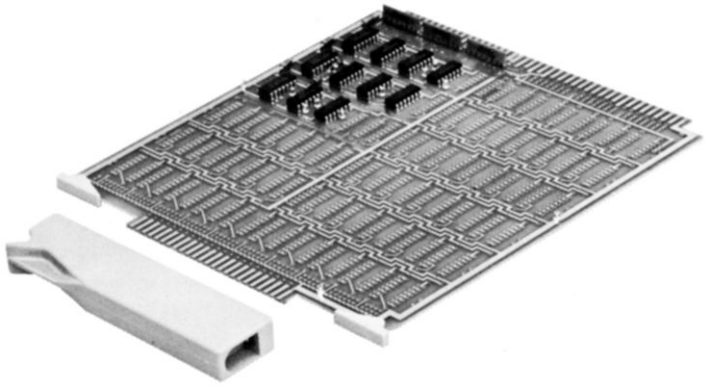
Interface breadboard/RTE privileged interrupt fence

model 12620A

The 12620A Interface Breadboard is a standard interface card for HP 1000 computers with the standard flag and interrupt logic pretested on the board. This logic occupies 11 of the 60 microcircuit positions, leaving 49 available receptacles. In addition to its use as a breadboard, it can also serve as a privileged interrupt fence card in RTE systems.

A printed circuit pad adjacent to each microcircuit pin provides easy solder connections on either side of the card. The pin structure will also accommodate commercially-available sockets or wire wrap pin sockets. +5V power and ground sources run along the board with convenient jumper points to pins on TTL packages.



Features

- **Works with any HP 1000 computer**
- **Standard flag, interrupt logic pretested on the board**
- **Easy scope probe connection**

Functional specifications

Scope tie points on the breadboard interface

TIE POINT	FUNCTION
TP1	(Flag.) Input signal is ground-true. A ground sets the Flag Buffer flip-flop. Must remain true for at least 200 nanoseconds.
TP2	(ENF Signal.) Signal is + during T2 of computer timing. ENF gates Flag Buffer into Flag flip-flop.
TP3	(SIR Signal.) Signal is + during T5. SIR enables inputs into Interrupt flip-flop.
TP4	(STC Command.) Goes to ground (true) during a Set Control (STC) instruction at this address.
TP5	(CLC Command.) Goes to ground (true) during a Clear Control (CLC) instruction at this address.
TP6	(CRS Signal.) Ground-true signal, occurs at power turn-on, when PRESET button is pressed, or a CLC 00 instruction is executed.
TP7	(Flag FF output, set side.) + True.
TP8	(Flag FF output, clear side.) + True.
TP9	(Decoded address.) Contains most significant and least significant address digits, and IOG (I/O Group) instruction. + True. Goes + when I/O instruction selects this card.
TP10,11,12	(Ground.) For scope probe ground.

Electrical specifications

Current required from computer power supply

0.32A (+5V) for flag and interrupt circuits on card. Total current will depend upon additional requirements of circuits added by the user.

Ordering information

12620A Interface breadboard

The 12620A interface breadboard includes:

1. 5060-6282 TTL breadboard.
2. 5060-8339 48-pin connector kit.
3. 5951-4498 Pocket guide to interfacing.
4. 12620-90001 Interface manual.

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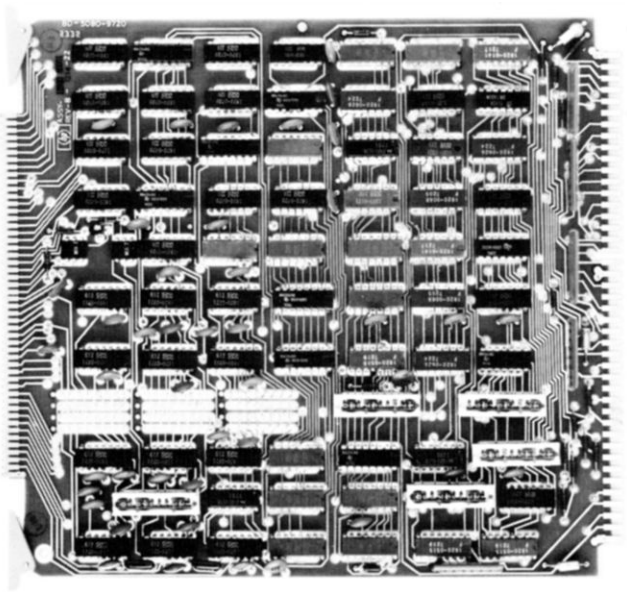
Dual-channel universal interface card

model 12930A

The 12930A Dual-Channel Universal Interface Card is designed to interface HP 1000 computers with a wide variety of external input/output devices. The card's versatility is achieved by employing a set of programmable switches which may be positioned to accommodate most external device interface requirements. The card's dual-channel design provides for rapid transfer of large data blocks (up to 616,000 16-bit words/second) over relatively long distances (up to 152m or 500 ft) as well as the exchange of control and status information. The universal interface card offers a choice of differential or TTL logic (ground true/positive true). Operationally, in HP 1000 M-Series Computers only, it provides for successive cycle stealing under DCPC control, separately addressable and independently programmed data and control/status channels, and a power status monitor.



Features

- **Differential line drivers and receivers**
- **Separate data and control channels**
- **Dual 16-bit data registers**
- **6-bit command and status registers**

Description

The universal interface card provides two interface channels. The higher priority (lower select code) duplex data channel transfers 16-bit data words between the computer and the input/output device. This channel includes data transfer control circuits and two storage registers which allow the interface card to accept and send data when convenient for the I/O device. The lower priority (higher select code) control/status channel transfers up to six bits of command and status information. This channel is equipped with 6-bit control and command registers. Status information is strobed directly between the computer and external device without intermediate storage so that device/computer status is continuously available.

Each interface channel has a set of independently programmable switches which accommodate diverse interface requirements. A set of general-purpose switches is also provided.

The universal interface card may be programmed for input-only, output-only or combined input-output operation using data-channel, control-status, or dual-channel modes. Three logic types are available: differential driver (standard), ground-true TTL (options 001 and 003), and positive-true TTL (option 002).

Functional specifications

Capacity

Duplex data input/output channel: 16 bit input and 16 bit output.

Command-status channel: 6 bit command output and 6 bit status input.

Types of logic

Standard: Differential.

Options 001 and 003: Ground-true, positive false TTL.

Option 002: Positive-true, ground false TTL.

Output levels, differential or TTL

Positive state: +2.4V, 0.8 mA (source).

Ground state: +0.4V, 32 mA (sink).

Differential input levels (see circuit next page)

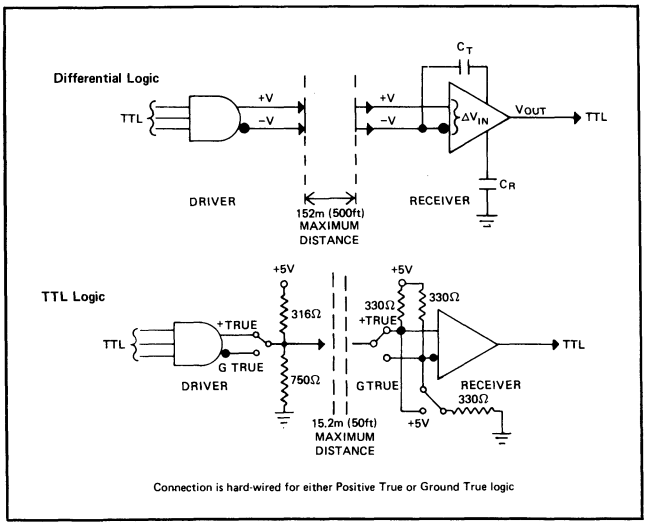
"1" State: Voltage differential greater than or equal to +1V, 2.5kΩ input impedance.

"0" State: Voltage differential less than or equal to -1V, 2.5kΩ input impedance.

TTL input levels (see circuit next page)

Positive state: +2.4V to 5.0V, 330Ω to +5V.

Ground state: 0 to 0.5V, 15 mA.



Maximum DCPC transfer rates

In HP 1000 M-Series Computer: 616,000 words/second.

In HP 1000 E-/F-Series Computer: 552,000 words/second.

Maximum interface cable length

Standard: 152m (500 feet).

Options 001 and 002: 7.6m (25 feet).

Option 003: 15.2m (50 feet).

Configuration information

Computer compatibility: The 12930A Universal interface is compatible with all HP 1000 computers.
ters.

I/O channels required: One if only the duplex data channel on the interface is used; two, with the second physically filled by the priority jumper card included with the 12930A, when both the duplex data channel and the control-status channel are used.

Software support: Software support for the 12930A interface is limited to the diagnostic furnished with it. A user-written driver, programmed in Assembly language, will be required to run this interface in a computer operating system.

Installation: To install, set the select code switches on the card for the select codes to be used by the duplex data channel (and the command-status channel if used). Then plug the interface into the computer I/O backplane, plug the priority jumper card into the adjacent channel whose code is being used by the second channel on the 12930A interface. Connect the interface to external equipment with user-fabricated (or option 003 preassembled) cable and integrate the interface and user-written driver into the computer's operating system.

Electrical specifications

Current required from computer power supply

	+5V	-2V
12930A	1.8A	.1A
12930A & 001 or 002	2.2A	.1A

Ordering information

12930A Dual channel universal interface

The 12930A interface includes:

1. 12930-60001 Dual channel universal interface card with differential logic.
2. 12930-60007 7.6m (25 ft) cable kit with connector kit and interface cabling for assembly by the user.
3. 12930-60006 Test connector.
4. 02116-6110 Priority jumper card.
5. 24289-60001 Diagnostic on paper tape.
6. 12930-90001 Interface manual.
7. 12930-90004 Test manual.

12930A options

001: Replaces 12930-60001 differential logic interface with 12930-60004 TTL ground-true logic interface and the 12930-60006 test connector with the 12930-60014 test connector.

002: Replaces 12930-60001 differential logic interface with 12930-60005 TTL positive-true logic interface and the 12930-60006 test connector with 12930-60015 test connector.

003: Replaces 12930-60001 differential logic interface with 12930-60004 TTL ground-true logic interface, the 12930-60007 connector kit with 12930-60012 15.2m (50 ft) interface cable assembly for connection to the 2894A Card reader/punch, and the 12930-60006 test connector with the 12930-60014 test connector.

HEWLETT PACKARD

Environmental specifications and product support information

Environmental specifications

Except where otherwise specified in the individual data sheets, all products in this data book meet the Hewlett-Packard Class B Environmental Specification, as follows:

Temperature

Operating: 0° to 55°C (32° to 131°F)

Storage: −40° to 75°C (−40° to 167°F)

Relative humidity

20% to 95% at 40°C (104°F), non-condensing

Altitude

Operating: to 4500 metres (15,000 ft)
Non-operating: to 15300 metres (50,000 ft)

Vibration and shock

Type tested to qualify for normal shipping and handling shock and vibration (contact factory for review of any application that requires operation under continuous vibration).

Vibration: 0.30 mm (0.012 in) p-p, 10-55 Hz, 3 axis.
Shock: 30g, 11 Ms, 1/2 sine, 3 axis.

Product support

Support offered for HP 1000 Computers and accessories includes:

1. User training services.
2. Site prep consultation.
3. Installation assistance.
4. Warranty.
5. Diagnostics subscription service.
6. Hardware service agreements.
7. Software notification service.
8. Software subscription service.
9. Comprehensive software support.
10. Software consulting service.

User training services

Regularly-scheduled training is available on HP 1000 software and on hardware maintenance. The courses offered are listed in the HP Computer Systems Group Course Schedule, along with registration information and course locations. The course schedule is available from your Hewlett-Packard Sales Representative.

Site prep consultation

Consultation on site preparation for HP 1000 Computers and accessories is available as service product 92850A. This service includes a visit to your facility to an HP Customer Engineer, who will assist your people in determining what electrical and environmental preparation should be accomplished at the operating site for your equipment prior to its installation.

Installation assistance

All items in this data book are customer-installed products when ordered as components (not in an HP 1000 Computer System). Installation assistance is available on request at prevailing service rates.

Warranty

All Hewlett-Packard software products, computers, components, and systems are covered by warranty for a minimum of 30 days or a maximum of 90 days, depending on the type of product and the conditions of purchase. For specific information, contact your Hewlett-Packard Sales Representative.

Diagnostics Subscription Service

The 24396S Diagnostics Subscription Service provides quarterly distribution of update information and revised diagnostic routines necessary to keep the 24396A/D/E/F Diagnostics Library up to date with respect to diagnostic improvements by the factory. Updated diagnostic routines are available on paper tape, Mini cartridges, or 800 bpi or 1600 bpi magnetic tape. Documentation is updated by providing revised diagnostic manuals or updating supplements to affected manuals. The 24396S service is ordered in monthly units for a minimum of six months, billable quarterly, or it can be prepaid for an entire year.

Hardware service agreements

Service agreements are available for coverage of HP 1000 Computers and accessories. The Basic Monthly Maintenance Charge (BMMC) covering all necessary parts, labor, and travel within the normal service zone for preventive maintenance, remedial maintenance, and engineering updates will be quoted on request by your Hewlett-Packard Sales Representative. The basic charge provides coverage from 8 A.M. to 5 P.M., five days per week, excluding Hewlett-Packard holidays. Extended coverage is available at additional cost.

Software support services

HP 1000 Software, described in the HP 1000 Computers and Systems Active Software and Mature Software data books, is supported by the following services:

Software Notification Service. Gives periodic information on software changes.

Software Subscription Service. Provides software updates on user-specified media as well as update to documentation. Includes Software Notification Service when ordered for a software operating system.

Comprehensive Software Support. Combines Software Subscription Service with a Phone-In Consulting Service that provides for answering customer's questions on HP 1000 software covered by this service.

Software Consulting service. Provides the on-site services of a trained HP System Engineer in daily units for helping customers better understand how to apply their software.

For more information, ask your Hewlett-Packard Sales Representative for the HP 1000 Computers and Systems Active Software Data book or Mature Software Data book.

Ordering information

Product numbers, descriptions, and prices for all HP 1000 Computers and software support services are given in the HP 1000 Computers Selection and Configuration Guide, which is available from your Hewlett-Packard Sales Representative.

Power specifications and applicability summary for HP 1000 Computers, Memory Products, and Memory-Related Accessories

Product Number and Name	Applies To Series M	E	F	Max. AC Power Req'd*	Computer power supply current available (+)/required (−) for memory, accessories, and I/O interfaces +5V(A)	+5V(B)	+12V	−12V	−2V
Computers and Floating Point Processor									
2105A Computer	X			400W	+12.8A	+12.8A	+1.0A	+1.0A	+5.0A
2108M Computer	X			625W	+36.6A	+34.9A	+2.5A	+2.0A	+6.0A
2112M Computer	X			625W	+30.7A	+29.6A	+2.5A	+2.0A	+6.0A
2109E Computer		X		625W	+34.8A	+33.1A	+2.5A	+2.0A	+6.0A
2113E Computer		X		625W	+30.1A	+29A	+2.5A	+2.0A	+6.0A
2111F Computer			X	625W	+21.9A	+20.1A	+2.5A	+2.0A	+6.0A
2117F Computer			X	825W	+28.8A	+27.5A	+2.5A	+2.0A	+6.0A
Standard Performance Memory Products									
2102B Memory Controller	X	X		n/a	−1.2A	−1.7A	—	—	−0.01A
12998A 16k byte Memory Module	X	X		n/a	−0.51A	−0.89A	—	—	—
13187B 32k byte Memory Module	X	X		n/a	−0.475A	−1.075A	—	—	—
12747A 128k byte Memory Module	C	X		n/a	−0.475A	−1.075A	—	—	—
12784A 128k byte Memory Package (D)	C			n/a	−8.025A	−9.125A	—	—	−0.06A
12784B 256k byte Memory Package (D)	C			n/a	−8.5A	−10.2A	—	—	−0.06A
12784C 512k byte Memory Package (D)	C			n/a	−9.45A	−12.35A	—	—	−0.06A
12784D 1024k byte Memory Package (D)	C			n/a	−11.35A	−13.725A	—	—	−0.06A
12786A 128k byte Memory Package (D)		X		n/a	−6.825A	−7.925A	—	—	−0.06A
12786B 256k byte Memory Package (D)		X		n/a	−7.3A	−9.0A	—	—	−0.06A
12786C 512k byte Memory Package (D)		X		n/a	−8.25A	−11.15A	—	—	−0.06A
12786D 1024k byte Memory Package (D)		X		n/a	−8.725A	−12.225A	—	—	−0.06A
Standard Performance Fault Control Memory Products									
2102C Memory Controller	C	X		n/a	−3.3A	−4.1A	—	—	—
12779A 256k byte Check Bit Array Board	C	X		n/a	−0.25A	−0.9A	—	—	—
12780A 512k byte Check Bit Array Board	C	X		n/a	−0.3A	−1.1A	—	—	—
12785A 128k byte Memory Package (D)	C			n/a	−10.375A	−12.425A	—	—	−0.05A
12785B 256k byte Memory Package (D)	C			n/a	−10.85A	−13.5A	—	—	−0.05A
12785C 512k byte Memory Package (D)	C			n/a	−11.85A	−15.85A	—	—	−0.05A
12785D 1024k byte Memory Package (D)	C			n/a	−14.05A	−21.25A	—	—	−0.05A
12787A 128k byte Memory Package (D)		X		n/a	−9.175A	−11.225A	—	—	−0.05A
12787B 256k byte Memory Package (D)		X		n/a	−9.65A	−12.3A	—	—	−0.05A
12787C 512k byte Memory Package (D)		X		n/a	−10.65A	−14.65A	—	—	−0.05A
12787D 1024k byte Memory Package (D)		X		n/a	−12.85A	−20.05A	—	—	−0.05A
High Performance Memory Products									
2102E Memory Controller		X	X	n/a	−2.56A	−3.2A	—	—	—
12741A 32k byte Memory Module		X	X	n/a	−0.475A	−1.075A	—	—	—
12747H 128k byte Memory Module		X	X	n/a	−0.475A	−1.075A	—	—	—
12788A 128k byte Memory Package (D)		X	X	n/a	−8.185A	−9.425A	—	—	−0.05A
12788B 256k byte Memory Package (D)		X	X	n/a	−8.66A	−10.5A	—	—	−0.05A
12788C 512k byte Memory Package (D)		X	X	n/a	−9.61A	−12.65A	—	—	−0.05A
12788D 1024k byte Memory Package (D)		X	X	n/a	−11.51A	−13.725A	—	—	−0.05A
High Performance Fault Control Memory Products									
2102H Memory Controller		X	X	n/a	−3.3A	−4.1A	—	—	—
12779H 256k byte Check Bit Array Board		X	X	n/a	−0.25A	−0.9A	—	—	—
12780H 512k byte Check Bit Array Board		X	X	n/a	−0.3A	−1.1A	—	—	—
12789A 128k byte Memory Package (D)		X	X	n/a	−9.175A	−11.225A	—	—	−0.05A
12789B 256k byte Memory Package (D)		X	X	n/a	−9.65A	−12.3A	—	—	−0.05A
12789C 512k byte Memory Package (D)		X	X	n/a	−10.65A	−14.65A	—	—	−0.05A
12789D 1024k byte Memory Package (D)		X	X	n/a	−12.85A	−20.05A	—	—	−0.05A
Memory-Related Accessories									
12892B Memory Protect (E)	C	X	X	n/a	−1.25A	−1.25A	—	—	−0.05A
12731A Memory Expansion Module (E)	C	X	X	n/a	−3.9A	−3.9A	—	—	—
12976B Dynamic Mapping System	C			n/a	−6.35A	−6.35A	—	—	−0.05A
13305A Dynamic Mapping System		X	X	n/a	−5.15A	−5.15A	—	—	−0.05A
12897B Dual Channel Port Controller	X	X	X	n/a	−2.4A	−2.4A	—	—	−0.05A

**Line voltages are 88-132V (110V ±20%–standard) or 176-264V (220V ±20%–Option 015) for all HP 1000 Computers and Extenders, except for the Floating Point Processor included with the 2117 Computer, which offers switch-selectable 90-110V (100V ±10%), 108-132V (120V ±10%), 198-242V (220V ±10%), and 216-264V (240V ±10%) line voltage ranges.*

(A) +5V current requirements for HP 1000 Computer with 12944B or 12991B Power Fail Recovery System (strongly recommended).

(B) +5V current requirements for HP 1000 Computer without 12944B or 12991B Power Fail Recovery System (+5V current requirements are higher for memory controllers, memory modules, and fault control check bit array boards).

(C) Applicable only to 2108 and 2112 M-Series Computers; the 2105A Computer does not provide dedicated card spaces required for the C-identified products.

(D) All memory packages include the appropriate memory controller, one or more 128k byte memory modules, and the 12976B or 13305A Dynamic Mapping System, and fault control check bit array boards in fault control memory packages.

(E) 12892B Memory Protect and 12731A Memory Expansion Module are both included in 12976B and 13305A Dynamic Mapping Systems.

(I) This product capability is included in the 2111 and 2117 F-Series Computers.

Power specifications and applicability summary for HP 1000 Computer Extenders, non-memory Accessories, and I/O Interfaces

Product Number and name	Applies To Series M	E	F	Max. AC Power Req'd*	Computer power supply current available (+)/required (−) for memory, accessories, and I/O interfaces +5V(A)	+5V(B)	+12V	−12V	−2V
Extenders									
12979B Dual-Port I/O Extender	X	X	X	625W	−2.0A	−2.0A	—	—	−1.35A
12781A Dual CPU Kit	X	X	X	n/a	−2.0A	−2.0A	—	—	−1.35A
12990B Memory Extender	C	X	X	300W	n/a	n/a	n/a	n/a	n/a
Firmware Products									
12977B Fast FORTRAN Processor	X			n/a	−1.2A**	−1.2A**	—	—	—
13306A Fast FORTRAN Processor		X	I	n/a	(F)	(F)	—	—	—
12823A Scientific Instruction Set		X	I	n/a	(F)	(F)	—	—	—
91740P DS/1000 Firmware	X			n/a	−1.2A	−1.2A	—	—	—
91740R DS/1000 Firmware		X	X	n/a	(F)	(F)	—	—	—
92067R RTE-IV EMA Firmware		X	X	n/a	(F)	(F)	—	—	—
13307A Dynamic Mapping Instructions (G)		X	X	n/a	(F)	(F)	—	—	—
User Microprogramming Products									
13304A Firmware Accessory Board (3.5k)		X	I	n/a	−1.8A	−1.8A	—	—	—
12945A User Control Store Board (0.25k)	X			n/a	−2.2A	−2.2A	—	—	—
12978A Writable Control Store (0.25k)	X			n/a	−4.6A	−4.6A	—	—	—
13047A User Control Store Board (2k)	X	X	X	n/a	(H)	(H)	—	—	—
13197A Writable Control Store (1k)	X	X	X	n/a	−2.2A	−2.2A	—	—	—
Other Mainframe Accessories									
12992 Loader ROMs (each)	X	X	X	n/a	−0.13A	−0.13A	—	—	—
12539C Time Base Generator	X	X	X	n/a	−0.76A	−0.76A	—	—	−0.016A
12620A Breadboard Interface for priv. int. control	X	X	X	n/a	−0.32A	−0.32A	—	—	—
Data Communications Interfaces									
12531C Teleprinter Interface	X	X	X	n/a	−0.76A	−0.76A	−0.05A	−0.1A	−0.05A
12531D Terminal Interface	X	X	X	n/a	−0.76A	−0.76A	−0.24A	−0.01A	−0.05A
12587B Asynchronous Comm. Interface	X			n/a	−1.6A	−1.6A	−0.08A	−0.05A	−0.07A
12589A Auto Calling Unit Interface	X			n/a	−0.65A	−0.65A	−0.05A	−0.055A	−0.05A
12618A Sync Comm. Interface (2 cards)	X	X	X	n/a	−2.18A	−2.18A	−0.1A	−0.07A	−0.23A
12771A Computer Serial Interface	X	X	X	n/a	−1.6A	−1.6A	−0.09A	−0.095A	−0.07A
12773A Computer Modem Interface	X	X	X	n/a	−1.6A	−1.6A	−0.04A	−0.04A	−0.07A
12790A Multipoint Terminal Interface	X	X	X	n/a	−3.0A	−3.0A	−0.018A	−0.1A	−0.059A
12880A Terminal Interface	X	X	X	n/a	−0.86A	−0.86A	−0.24A	−0.01A	−0.05A
12889A Hardwired Serial Interface	X	X	X	n/a	−2.25A	−2.25A	−0.125A	−0.05A	−0.01A
12920B Async Comm. Multiplexer (3 cards)	X	X	X	n/a	−5.53A	−5.53A	−0.241A	−0.477A	−0.258A
12920B Opt. 001 (Adds 1 card)	X	X	X	n/a	−1.44A	−1.44A	−0.156A	−0.236A	−0.102A
12966A Buffered Async Comm. Interface	X	X	X	n/a	−1.95A	−1.95A	−0.02A	−0.06A	−0.07A
12967A Synchronous Comm. Interface	X	X	X	n/a	−1.75A	−1.75A	−0.01A	−0.02A	−0.06A
12968A Asynchronous Comm. Interface	X	X	X	n/a	−1.3A	−1.3A	−0.01A	−0.04A	−0.05A
General-Purpose Interfaces									
12551B 16-Bit Relay Output Register	X	X	X	n/a	−0.6A	−0.6A	−0.24A	—	−0.39A
12551B+001 Relay Register	X	X	X	n/a	−1.1A	−1.1A	−0.24A	—	−0.59A
12554A 16-Bit Duplex Register	X	X	X	n/a	−1.11A	−1.11A	−0.25A	−0.25A	−0.06A
12566B Microcircuit interface	X	X	X	n/a	−1.1A	−1.1A	—	—	−0.05A
12597A 8-Bit Duplex Register	X	X	X	n/a	−0.75A	−0.75A	−0.05A	−0.05A	−0.05A
12930A Universal Interface	X	X	X	n/a	−1.8A	−1.8A	—	—	−0.1A
12930A+001 or 002 Universal Interface	X	X	X	n/a	−2.2A	−2.2A	—	—	−0.1A
Measurement and Control Interfaces									
12555A Digital-to-Analog Converter	X			n/a	−2.4A	−2.4A	−0.5A	−0.36A	−1.08A
12556B 40-Bit Register	X	X		n/a	−0.9A	−0.9A	−0.15A	−0.01A	−0.08A
12604B Data Source Interface Card (J)	X	X		n/a	−1.1A	−1.1A	−0.01A	−0.024A	−0.35A
59310B HP-IB Interface Kit	X	X	X	n/a	−3.0A	−3.0A	—	—	−0.1A
91000A Plug-In 20kHz A-to-D Interface	X	X	X	n/a	−2.4A	−2.4A	—	—	−0.065A
Graphics Interfaces									
12560A Digital Plotter Interface	X	X	X	n/a	−0.9A	−0.9A	—	−0.06A	−0.48A
91200B TV Interface (3 cards required for color)	X	X	X	n/a	−1.2A	−1.2A	−0.32A	−0.05A	−0.05A

(A) +5V current requirements for HP 1000 Computer with 12944B or 12991B Power Fail Recovery System (strongly recommended).

(B) +5V current requirements for HP 1000 Computer without 12944B or 12991B Power Fail Recovery System (+5V current requirements are higher for memory controllers, memory modules, and fault control check bit array boards).

(F) This current requirement is included in the requirement of the 13304A Firmware Accessory Board.

(G) The 13307A Dynamic Mapping Instructions are included in the 13305A Dynamic Mapping System and in all of E/F-Series compatible memory packages.

(H) 13047A uses 1.15A plus 0.78A for each 256 instruction words; −7.39A when fully loaded.

(I) This product capability is included in the 2111B and 2117B F-Series Computers.

(J) 12604B also uses 0.037A from +30V computer power supply.

** Line voltages are 88-132V (110V ±20% – standard) or 176-264V (220V ±20% – option 015) for Extenders on this page.*

*** The 12977B Fast FORTRAN Processor −1.2V current requirement is included in the requirements listed for the 12976B Dynamic Mapping System and the 12784A-C and 12785A-D Memory Packages, and should not be added to current requirements of a computer containing any of those products.*

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