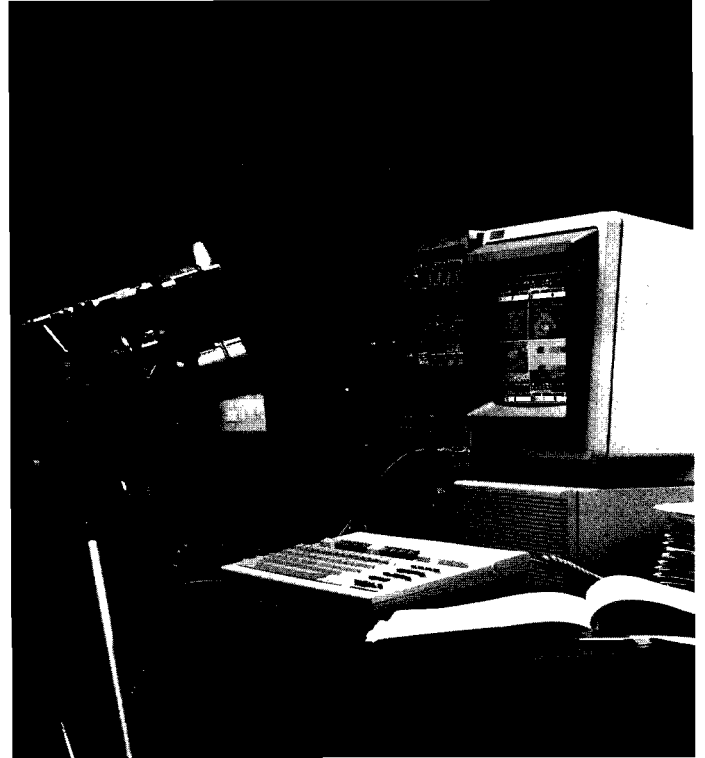
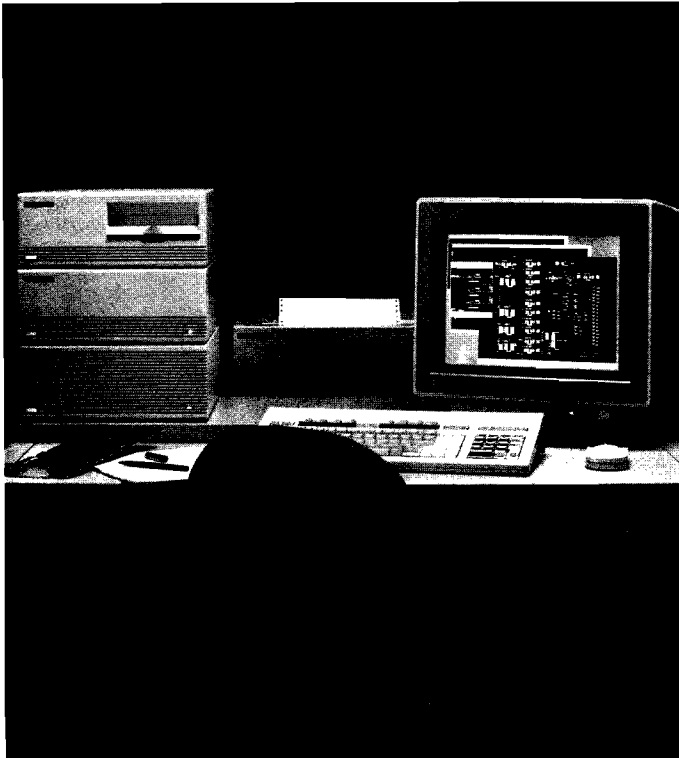


# HP 9000 Series 300 Hardware Technical Data



Effective: May 1, 1988\*



## Introduction

The HP 9000 Series 300 family of computing systems for technical applications consists of a variety of workstations as well as modular components. These components include a selection of processors with different performance levels, display systems, memory boards, interface cards, operating systems, and peripherals. The pre-configured workstations include the components most likely needed for typical applications. Compatibility throughout the Series 300 family is ensured via object-code compatibility. For complete information on system configurations and pricing, consult the HP 9000 Series 300 Pricing Information, Pub. No. 5951-6796D.

\* Data subject to change without notice.  
† All RAM is parity checking unless otherwise stated.

## Features Common to all Series 300 Systems

### System Processing Units

The basis for each Series 300 workstation is the system processing unit (SPU). The SPU contains the processor, RAM<sup>†</sup>, floating point co-processor (where applicable) and system interfaces. While the SPU configurations vary, as explained further in the SPU section, some features are common to all Series 300 system processing units.

Four Gbytes of virtual memory space (16 MBytes on the Model 310) is available for very large HP-UX programs and multiple processes, due to a memory management unit that translates virtual memory addresses into main memory physical locations. HP-UX allows up to 84 independent virtual processes to execute simultaneously, but this number can be modified according to the user's particular application requirements.

## Display Systems

The display systems available for the Series 300 are bit-mapped and capable of supporting the new generation of engineering applications. Series 300's full range of monitors includes a 12-inch monochrome monitor with integral tilt and swivel, a 12-inch color monitor with integral tilt and swivel, a choice of two 16-inch high-resolution color monitors, a 17-inch high-resolution monochrome monitor, a 19-inch high-resolution monochrome monitor, and a choice of two 19-inch high-resolution color monitors. All monitors operate at 60 Hz non-interlaced to eliminate flicker and so minimize operator fatigue.

## Input Devices

Complementing the ergonomic displays is the detached keyboard which connects to the computer by means of the HP-HIL (Hewlett-Packard- Human Interface Link) included with each Series 300 system. The HP-HIL is a serial interface capable of connecting up to seven devices, daisy-chain fashion, to a single interface port on the computer. Other HP-HIL input devices include a mouse, a 32-button box, rotary control knob, control dial box, an A- or B-size digitizer, a bar code reader, and the touchscreen bezel.

## Keyboards

The Series 300 employs two keyboards:

- HP 46021A
- HP 98203C

The **HP 46021A** has 107 keys, including eight special function keys. The keyboard features a numeric pad, auto-repeat, and sculptured keycaps with tactile feedback and N-key rollover.

46021A physical sizes are as follows:

Height . . . . . 40 mm (1.6 in.)  
Width . . . . . 452 mm (17.8 in.)  
Depth . . . . . 219 mm (8.7 in.)  
Net weight . . . . . 2.2 kg (4.75 lb.)  
Shipping weight . . . . . 2.6 kg (5.75 lb.)

The following languages are available: Belgian Dutch, Canadian French, Danish, Dutch, European Spanish, Finnish, French, German, Italian, ICON/European English, Katakana, Kanji, Latin Spanish, Norwegian, Swedish, Swiss French, Swiss German, U.K. English, and U.S. English.

The **HP 98203C** features a built-in rotary knob, allowing single-control cursor movement. The keyboard has 105 keys, including 10 special function keys. Additional features include numeric pad and ergonomic palm rest. The 98203C key layout is identical to that found on the Series 200 Models 226 and 236 keyboards. HP 98203C keyboard is supported only by Series 300 BASIC 4.03 and Pascal Language Systems 3.12 or later releases.

HP 98203C physical sizes are as follows:

Height . . . . . 62 mm (2.4 in.)  
Width . . . . . 440 mm (17.3 in.)  
Depth . . . . . 260 mm (10.2 in.)  
Net weight . . . . . 2.5 kg (5.5 lb.)  
Shipping weight . . . . . 2.7 kg (6 lb.)

The following languages are available: French, German, Katakana, Spanish, Swedish/Finnish and U.S. English.

## Operating Systems

Series 300 models fully support three primary operating systems: HP-UX\* (multi-tasking, multi-user), BASIC (single-user), and Pascal (single-user). BASIC and Pascal operating systems are capable of accessing up to 32 Mbytes of physical memory. The HP-UX operating system offers access of up to 32 Mbytes parity checking RAM or 48 Mbytes Error Checking and Correcting (ECC) RAM and also access to virtual memory capabilities.

The Model 318M supports only the HP-UX operating system. The Model 319C+ supports the HP-UX operating system and BASIC language system. The PC-305 and PC-308 support the BASIC operating system, as well as DOS. DOS also is supported on the Model 310, 320, 330, and 350 through the use of the HP Series 300 DOS Coprocessor.

\* HP's implementation of the AT&T UNIX® System V.2 Operating System in compliance with the System V Verification Suite II. UNIX is a trademark of AT&T in the U.S. and other countries.

# System Processing Units

## Hardware Comparison

	PC-305 (dual processors)		PC-308 (dual processors)		Model 310	Model 318M	Model 319C+	Model 320	Model 330	Model 350
<b>Central Processor</b>	MC68000	8086-compatible	MC68000	Intel 80286	MC68010	MC68020	MC68020	MC68020	MC68020	MC68020
Clock frequency	8 MHz	7.16 MHz	8 MHz	12 MHz	10 MHz	16.7 MHz	16.7 MHz	16.7 MHz	16.7 MHz	25 MHz
Wait states	0	0	0	1	0 (on-board RAM)	2	2	0 (cache)	2 (on-board RAM)	0 (cache)
<b>Floating Point</b>	N/A	Intel 8087	N/A	Intel 80287	Add-on 98635A	MC68881	MC68881	MC68881	MC68881	MC68881
Clock frequency (standard)	N/A	D1172A, 7.16 MHz	N/A	D1387A, 8 MHz	10 MHz	16.7 MHz	16.7 MHz	16.7 MHz	16.7 MHz	20 MHz
Accelerator	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Optional 98248A	Optional 98248A
<b>Memory Management Unit</b>										
Type	N/A	N/A	N/A	Intel 80286	HP Custom	MC68851	MC68851	HP Custom	MC68851	HP Custom
Virtual memory (HP-UX only)	N/A	N/A	N/A	N/A	16 Mbytes/process	4 Gbytes/process	4 Gbytes/process	4 Gbytes/process	4 Gbytes/process	4 Gbytes/process
Contexts	N/A	N/A	N/A	N/A	84 default, user-settable	84 default, user-settable	84 default, user-settable	84 default, user-settable	84 default, user-settable	84 default, user-settable
<b>Cache Memory</b>										
Type	N/A	N/A	N/A	N/A	N/A	Instruction cache	Instruction cache	Write through instruction and data (external to MC68020 instruction cache)	Instruction cache	Write through instruction and data (external to MC68020 instruction cache)
Size	N/A	N/A	N/A	N/A	N/A	256 bytes	256 bytes	16 Kbytes	256 bytes	32 Kbytes
Average cycle time	N/A	N/A	N/A	N/A	N/A	N/A	N/A	180 nsec	N/A	120 nsec
<b>Main Memory</b>										
Type	No parity	No parity	No parity	Byte parity error checking	Byte parity error checking	Byte parity error checking	Byte parity error checking	Byte parity error checking	Byte parity error checking	Byte parity error checking; optional ECC
RAM	512 Kbytes on-board	640 Kbytes on-board	512 Kbytes on-board	640 Kbytes on-board	1 Mbyte on-board	4 Mbytes on-board	4/8 Mbytes on-board	1/4 Mbytes (1/4 ea. 1M boards)	4 Mbytes on-board	8 Mbytes
Bus width	24b address, 16b data	20b address, 8b data	24b address, 16b data	24b address, 16b data	24b address, 16b data	32b address, 32b data	32b address, 32b data	24b address, 16b data	32b address, 32b data	32b address, 32b data
Average access time	500 nsec	560 nsec	500 nsec	375 nsec	540 nsec	240 nsec	240 nsec	390 nsec	240 nsec	180 nsec
<b>Additional Memory</b>	82303A, 82305A	D1174A Opt. 001/002	82303A, 82305A	45944A Opt. 001/002/003	98257A	N/A	98266A; 98266B	98257A	98258A	98258A/B/C; 98264A/B (ECC)
<b>Maximum Memory</b>	4 Mbytes	640 Kbytes Main; 8 Mbytes Expanded Memory Systems (EMS)	4 Mbytes	640 Kbytes Main; 8 Mbytes Expanded Memory Systems (EMS)	7.5 Mbytes	4 Mbytes	16 Mbytes	7.5 Mbytes	8 Mbytes	32 Mbytes; 48 Mbytes (ECC)

## Standard System Interfaces and Features

Interface	DIO Equivalent	PC-305	PC-308	Model 310	Model 318M	Model 319C+	Model 320	Model 330	Model 350
HP-IB	98624A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RS-232C	98644A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HP-HIL	—	Optional	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RS-422	98628A	Optional	Optional	Optional	No	No	Optional	Optional	Optional
LAN	98643A	Optional	Optional	Optional	Yes <sup>‡</sup>	Yes <sup>‡</sup>	320U	Yes <sup>‡</sup>	Yes <sup>‡</sup>
DMA	98620B	No	No	Optional	Yes	Yes	320U	Yes	Yes
High-speed HP-IB disc	98625B	No	No	Optional	No	Optional <sup>§</sup>	320U	Optional	Yes
System timer	—	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
User timer	—	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Battery-backed real-time clock	—	Yes	Yes	Yes	†	†	Yes	Yes	Yes
DOS software compatibility	98286A*	Yes	Yes	Optional	No	No	Optional	Optional	Optional

\* Also requires 98531A DOS Coprocessor software.

† The Models 318M and 319C+ include real-time clock with minimum expected run time of 12 hours, after power loss, without battery backup.

‡ The built-in LAN interface on Models 318M and 319C+ is a ThinLan with BNC "T" connector and ThinMau. The built-in LAN interface on Models 330 and 350 is either AUI (which can be used for ThickLAN, ThinLAN, or StarLAN 10) or ThinLAN BNC "T" connector and ThinMAU.

§ The optional high-speed HP-IB disc interface for the Model 319C+ is available only at initial order.

## Series 300 System Processing Units

### Models 318M, 319C+, 330, and 350 Overview

The Models 318M, 319C+, 330 and 350 feature the 32-bit MC68020 processor. In the Models 318M, 319C+ and 330, this processor operates at 16.7 MHz; in the Model 350 it operates at 25 MHz. These systems use a full 32-bit address and data path for both memory and I/O buses.

The Model 330/350 SPU is contained in a single, compact Design Plus box containing four system slots that are available to hold the system processor board, graphics board, system interface board, and RAM or accessory boards. All system boards plug into a 6Mbyte/sec asynchronous device I/O bus (DIO II) which features full 32 bits address and 32 bits data, non-multiplexed. The DIO II bus is fully compatible with a complete line of 16-bit DIO interfaces and accessories, and can easily be expanded via the 98570A direct-connect DIO II expander.

#### Model 318M

The SPU for the Model 318M is a 2-board system, utilizing the same CPU board as the Model 330. The system interface board is similar to that of the Models 330 and 350, with one exception. Instead of having provisions

to add a high-speed disc interface, it includes the video circuitry for the 1024 x 768 monochromatic display. (This circuitry is electrically identical to the 98544B high-resolution monochrome graphics board.) Standard ThinLAN, RS-232C<sup>#</sup> with DB25 connector, and HP-IB with DMA interfaces are included. The Model 318M contains no mechanical or electrical provisions for additional DIO II or DIO interface or accessory cards.

#### Model 319C+

Utilizing the same 16.67 MHz CPU as Model 318M and 330, the Model 319C+ is a two-board color workstation that offers cost-effective color solutions for many applications with limited expandability requirements.

The processor board of Model 319C+ contains the MC68020 CPU; MC68881 floating point coprocessor; standard ThinLAN; RS-232C<sup>#</sup> with DB25 connector, HP-IB with DMA, and HP-HIL interfaces; and either four or eight Mbytes RAM.

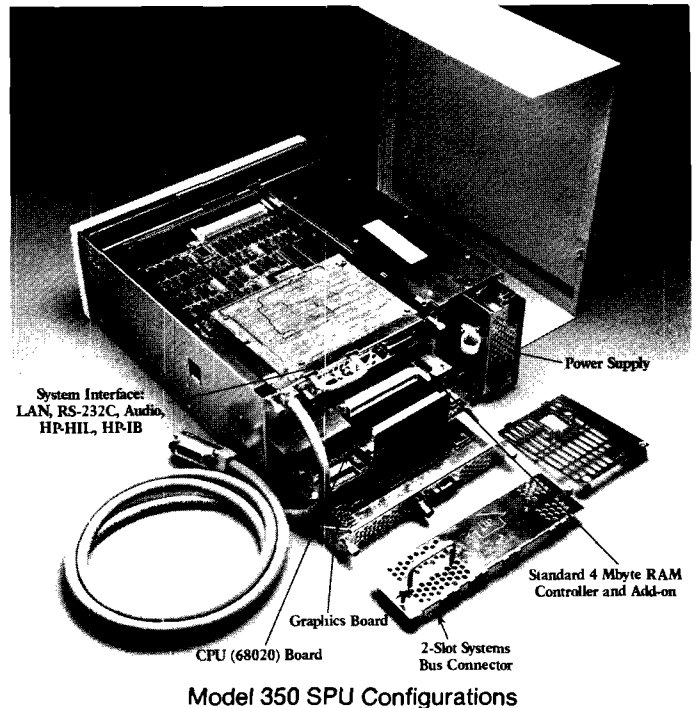
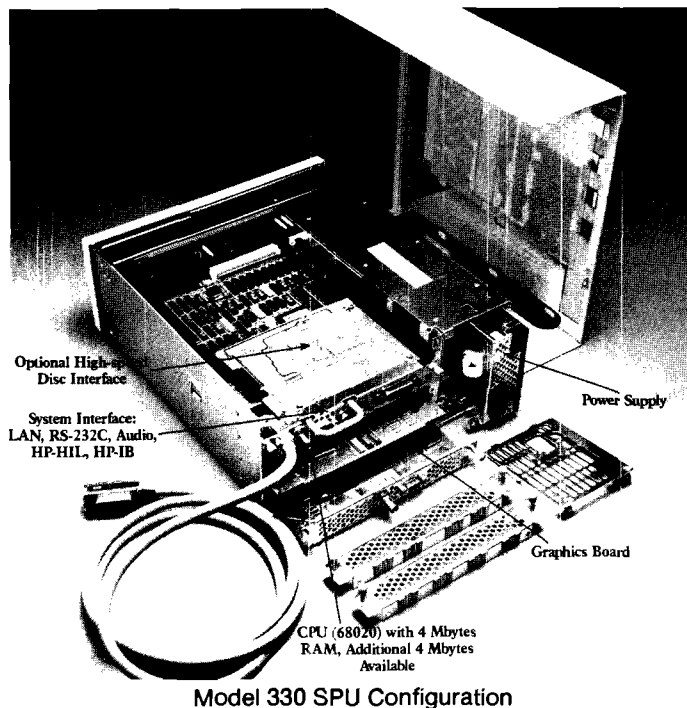
The graphics board contains the high-performance graphics display hardware in addition to an optional high-speed HP-IB disc interface. Included is the graphics circuitry for the 1024 x 768 color display.

An optional four or eight Mbytes of high-speed RAM is available to expand the system to 16 Mbytes. Like the Model 318M, the Model 319C+ has no provisions for additional DIO II or DIO interface or accessory cards.

# HP 98644A RS-232C equivalent.

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### Model 330

The architecture of the Model 330 is based on 16 MHz VLSI technology from Motorola: MC68020 processor, MC68881 floating point coprocessor, and Motorola 68851 paged memory management unit. Maximum system performance is ensured by operating the four Mbytes of on-board main memory synchronously with the 16.67 MHz MC68020 processor, providing 2 MIPS computational power. This 240 nanosecond (nsec) access time main memory is connected to the processor over a full 32-bit wide bus.

Hardware floating point is standard in the Model 330 to facilitate the floating point math operations frequently encountered in the technical computing environment. Both single- and double-precision floating point operations conform to the IEEE 754 standard for floating point formats.

The central processing unit (CPU), floating point hardware, memory manager, and memory electronics are contained on the processor board, while all necessary system I/O is located on the system interface board. Two DIO II slots are available for adding a graphics board and a 2-slot DIO backplane for Series 300 accessories such as HP's DOS Coprocessor, a four-port RS-232C multiplexer card, or any of a host of other interface cards. In a Model 330 without a graphics board, the 4-slot DIO backplane may be added to allow insertion of two additional Series 300 I/O cards.

The standard configuration for the Model 330 includes 4 Mbytes RAM. One 4 Mbyte parity checking RAM controller board may be added for a total of 8 Mbytes. HP-IB, RS-232C\* and LAN interfaces are also included.

### Model 350

The Model 350 SPU includes three standard boards:

- The CPU board with processor, memory management unit, floating point hardware and cache
- The system interface board with HP-IB IEEE 488 port, RS-232C\* port, HP-HIL, 2-channel DMA controller, LAN interface, system and user timers, and high-speed disc interface
- 8 Mbyte parity-checking RAM board standard, or optionally 16 Mbyte parity-checking RAM, 8 Mbytes Error-Checking and Correcting (ECC) RAM, or 16 Mbytes ECC RAM

The Model 350 SPU leaves one slot free for adding either a graphics board, 2-slot DIO adapter, or graphics system interface board. A 2-slot system bus connector couples the CPU board with the memory board installed in the Model 350. Up to two additional memory boards can be installed (for a maximum of three) on the system bus via 3-slot and 4-slot system bus connectors. The recommended maximum for parity-checking RAM is 32 Mbytes, while ECC maximum supported memory is 48 Mbytes.

Parity checking is performed on a byte-boundary basis - 4 bytes per 32-bit word. ECC RAM generates a checksum on a 32-bit word basis and provides single-bit error correction and double-bit error detection. Both parity and ECC RAM systems consist of a RAM array and a dual-port controller that multiplexes accesses from the CPU over the system bus and from bus masters on the DIO or DIO II bus.

\* HP 98644A RS-232C equivalent.

The full potential of the 25 MHz MC68020 processor is realized by the use of a 32 Kbyte cache with 32-bit wide entries operating at a 120 nsec cycle time (zero processor wait states). This large, high-performance cache buffers the 25 MHz processor from the main memory which operates at an average 180 nsec cycle time over a high-speed 32-bit wide system bus. The Model 350's custom memory management unit translates virtual memory addresses into physical memory addresses in parallel with cache-miss detection. This means that maximum throughput is maintained for very large HP-UX programs and multiple concurrent processes.

### RAM and RAM Add-on

The standard configuration for the Model 350 includes one 4 Mbyte RAM controller board, which occupies one system slot, and one 4 Mbyte RAM add-on board, for a total of 8 Mbytes. An optional 12 Mbyte RAM add-on board may be substituted for the 4 Mbyte RAM add-on board. With this arrangement, 4, 8, or 16 Mbytes per slot are provided. The maximum amount of parity-checking RAM on the system bus is currently restricted to 32 Mbytes (2 RAM board sets). In addition, Error Checking and

Correcting (ECC) RAM can be added via 8 or 16 Mbyte boards for a maximum of 48 Mbytes.

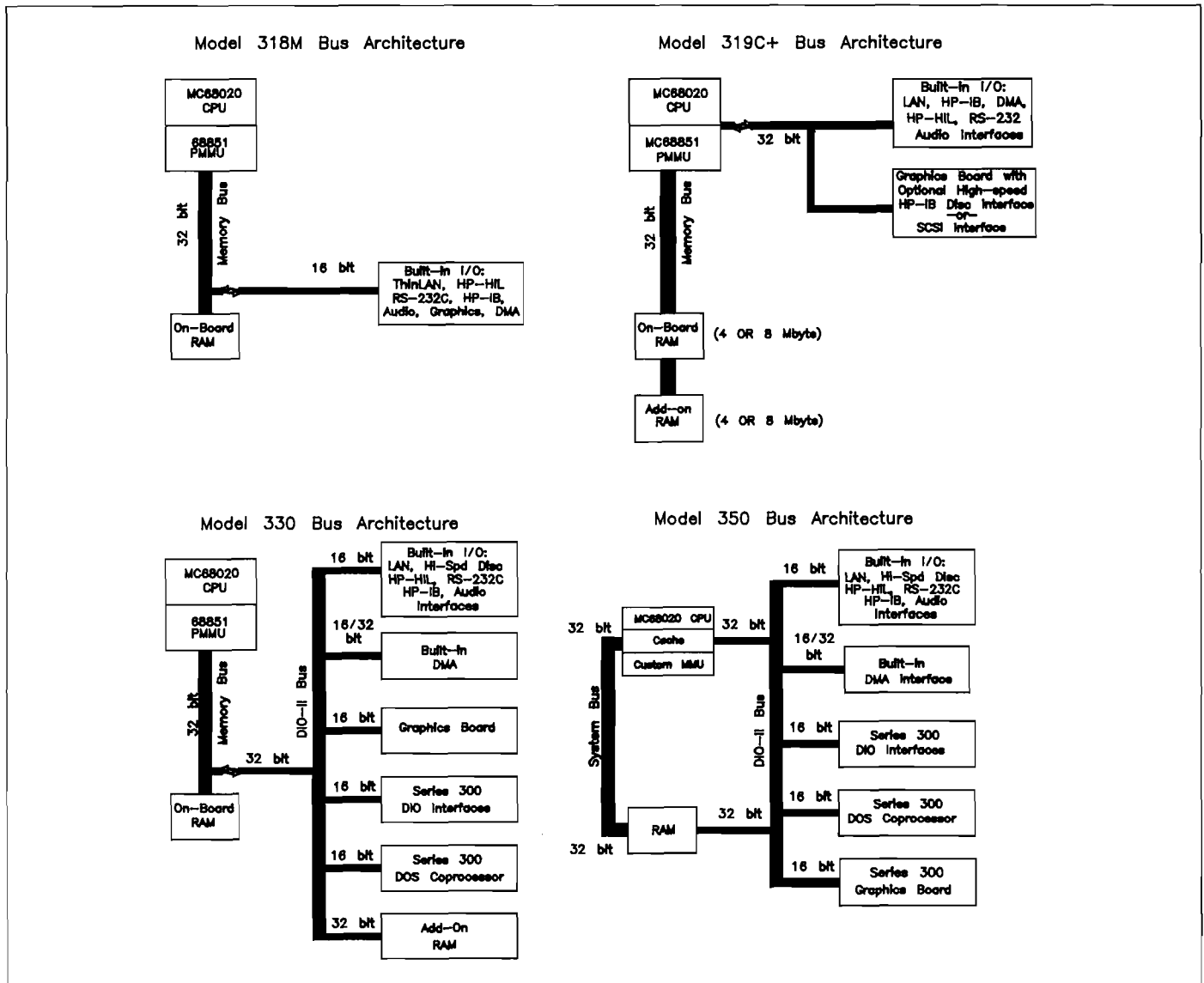
The standard configuration for the Model 330 includes 4 Mbytes RAM as discussed above. An additional 4 Mbyte RAM controller board may be added, for a total of 8 Mbytes.

The dual-ported RAM controller board supports a high-speed 32-bit synchronous system bus port and a 32-bit asynchronous DIO II port. The DIO II port also supports DIO bus masters allowing it to be used with boards such as the DOS Coprocessor.

The standard configuration for the Model 319C+ includes 4 Mbytes RAM on the processor board. 8 Mbytes on-board RAM is optionally available. An additional 4 or 8 Mbyte RAM add-on board, which is unique to the Model 319C+, can be added. The RAM add-on boards are available optionally at the time of SPU purchase or as HP 98266A (4 Mbyte) and HP 98266B (8 Mbyte).

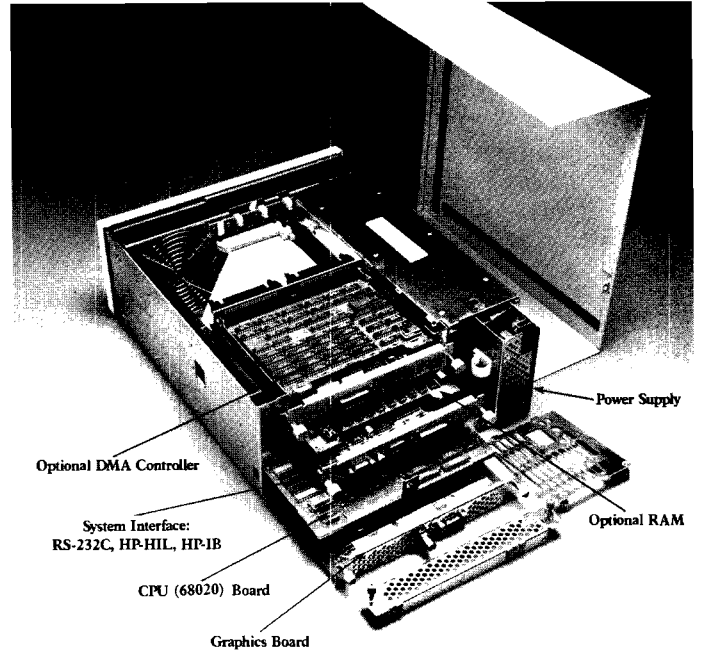
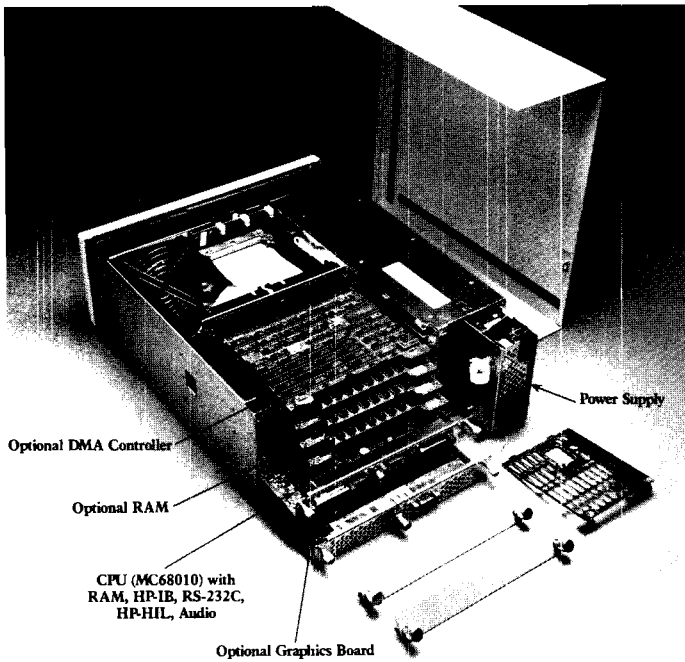
The standard configuration for the Model 318M includes 4 Mbytes RAM on the processor board. No additional RAM is available.

All add-on RAM should be installed by HP service personnel.



Model 318M, 319C+, 330 and 350 Bus Architecture

# Model 310 and Model 320



Model 310 and 320 SPU Configurations

Both the Model 310 and 320 feature a 32-bit internal architecture and 16-bit external data/24-bit address paths. The Model 320 operates at a higher clock rate.

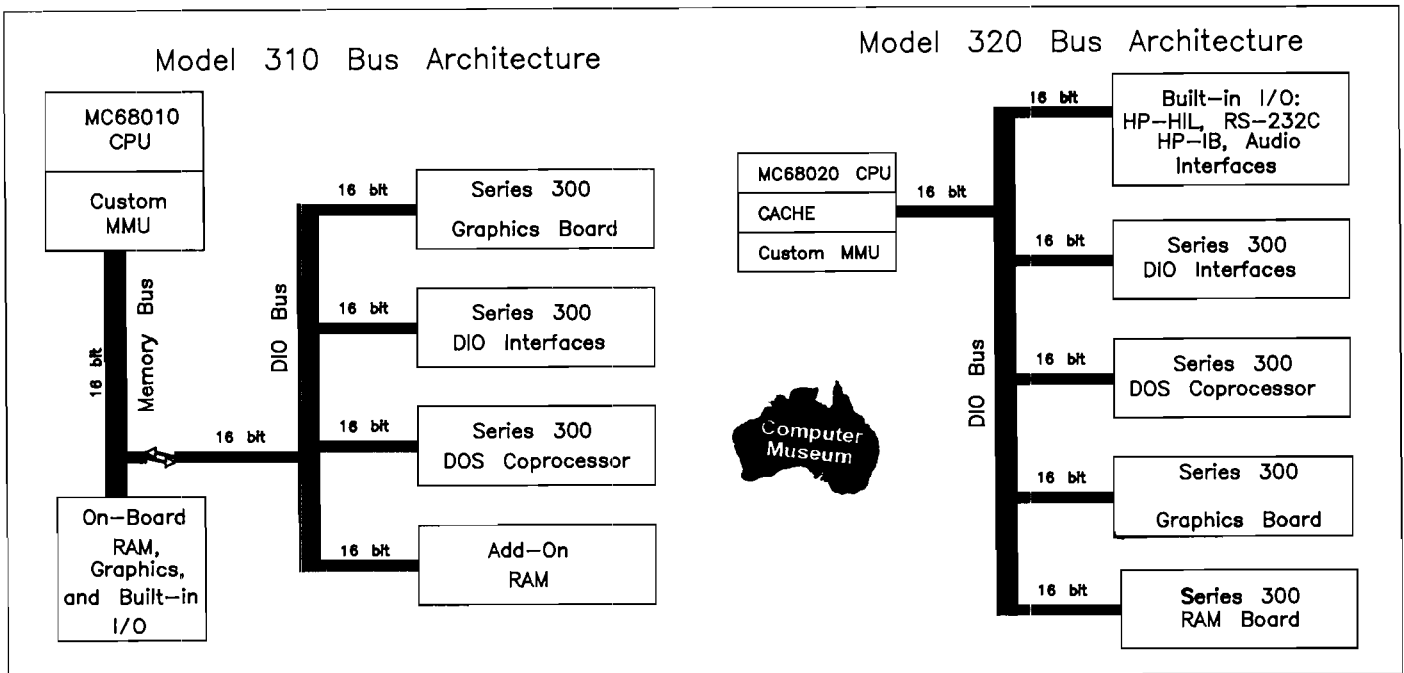
Architecture of the Model 310 and 320 memory, interface, and accessory cards features a 16-bit bi-directional data bus, 24-bit address bus and bus arbitration logic to allow multiple bus masters. The DIO memory and I/O bus is an asynchronous bus operating at 8 MHz, with an effective data throughput of 1.5 Mwords (3.0 Mbytes) per second transfer rate.

In the Model 310 and Model 320, DIO memory and interface cards plug into the backplane through a 100-pin edge connector. Each pair of DIO slots in the SPU or expander (see discussion under "System Accessories") can hold either two memory cards or one memory/accessory

card (with cover plate). A Model 310 SPU has four accessory slots and thus can hold either four memory cards; two interface cards and two memory cards; or one interface card and three memory cards. Model 320 has two available slots for add-on cards.

## Model 310

The Model 310 processor board includes an MC68010 processor, operating synchronously with on-board RAM, 512 or 1024 Kbytes RAM, paged memory management unit, medium-resolution bit-mapped video output, and standard interfaces. It has no floating point hardware built in; the HP 98635A floating point board provides hardware floating point performance.



Model 310 and 320 Bus Architectures



## Model 320

The Model 320 SPU consists of the processor board with MC68020 processor, cache, and MC68881 floating point coprocessor; human interface board with standard interfaces; and one 1 Mbyte RAM board.

The Model 320's processor board contains a 16 Kbyte instruction and data cache with 32-bit wide entries operating at 180 nsec cycle time (zero processor wait states). This high-speed cache buffers the 16.7 MHz processor from the main memory which operates at an average 540 nsec cycle time over a 16-bit wide system bus. Two main memory/read cycles are required to fill one 32-bit cache entry. The custom memory management unit translates virtual memory addresses into physical memory addresses in parallel with cache-miss detection. This means that excellent system throughput is maintained for very large HP-UX programs and multiple concurrent processes.

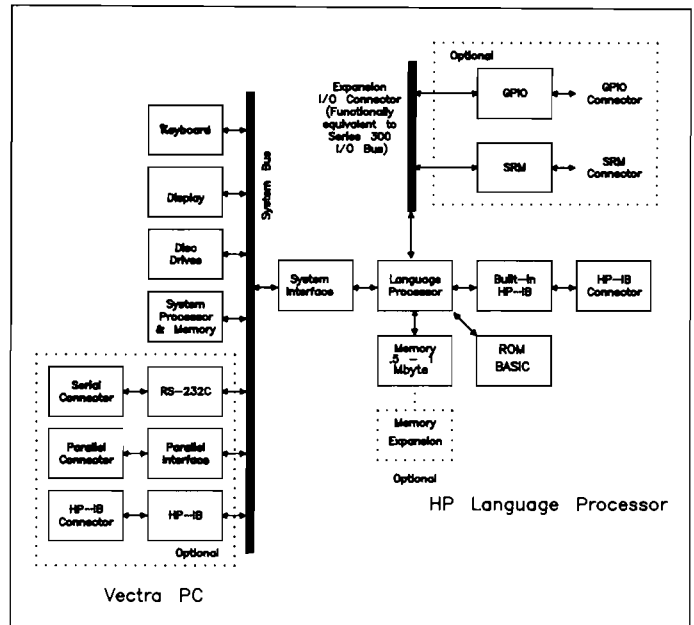
## PC-305 and PC-308

The PC-305 consists of an HP Vectra CS PC (8086-compatible) with the HP BASIC Language Processor, a plug-in accessory which provides the Vectra CS PC with the capabilities of a Series 300 BASIC/Pascal workstation. Consisting of a Vectra-size circuit board, the Language Processor contains a Motorola 68000 CPU, 512 Kbytes RAM (expandable to 4 Mbytes), HP-IB interface, DIO interface bus, BASIC 5.0 in ROM or optional Pascal 3.2 software on flexible discs. With the language processor, the Vectra CS PC allows programming and execution of BASIC/Pascal software. Software and data compatibility with PC-DOS files is provided.

Two DIO interfaces, GPIO and SRM, have been re-designed to meet the Vectra size and form specifications. They connect to the Language Processor through full DIO bus, thereby achieving maximum performance and compatibility. Vectra CS PC interfaces, such as serial (RS-232C) and parallel (Centronics), are also supported and emulate their Series 300 counterparts.

The language processor includes the ability to operate unattended in the background while the user runs a DOS application. While not true multi-tasking, this capability provides efficiency where the BASIC or Pascal program does not need the attention of the user or built-in Vectra CS PC resources.

The PC-308 consists of a Vectra ES/12 PC (Intel 80286 @ 12 MHz) with the same BASIC Language Processor found in the PC-305. The I/O transfer rates of the PC-305 and PC-308 are the same. However, because the PC-308 uses the Vectra ES/12 host system, the screen graphics performance is higher than that of the PC-305. Another PC-308 feature, the capability to accept IBM PC AT-style plug-in accessory cards, differs from the PC-305. The PC-305 accepts IBM PC XT-style cards.



Functional relationship of the HP BASIC Language Processor to the host Vectra PC.

## SPU Accessories

### I/O Expanders

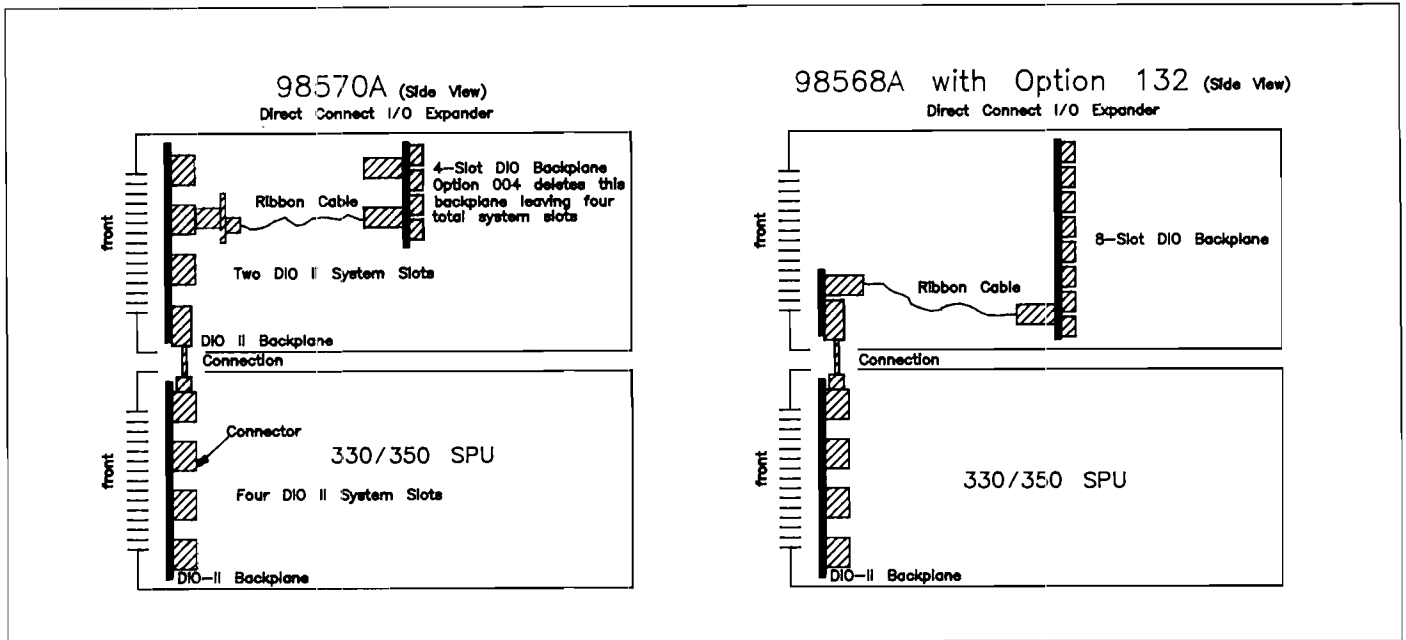
Several expanders are available to increase the I/O capabilities of the Series 300. A maximum of one direct-connect and two 9888A expanders is supported with Models 310 and 320. Models 330 and 350 support a maximum of two direct-connect expanders plus two 9888A expanders.

The 98568A direct-connect 8-slot DIO Expander features eight DIO slots to hold memory, interface, and accessory cards. Option 132 (not available as a stand-alone product) provides additional features which allow the 98568A to be connected to the DIO II backplane of the Models 330 and 350.

The 98570A direct-connect DIO II expander adds two DIO II slots and four DIO slots to a Model 330 or 350 SPU. Option 004 deletes the four DIO slots, making the 98570A a 4-slot DIO II expander.

The 98242B 2-slot DIO backplane can be added to a Model 330 or Model 350 SPU or to the 98570A Option 004 expander to provide two DIO slots and three DIO II slots. The 98242A 4-slot DIO backplane can be added to a 98570A Option 004 expander or to a Model 330 SPU to provide four DIO slots and two DIO II slots. The 9888A 16-slot DIO expander plugs into one DIO interface slot and can be used with any of the Series 300 SPUs.

Because the expanders (with the exception of the 9888A) are electrically passive, no additional wait states are induced when accessing memory or I/O cards installed in the expander. The 9888A is electrically buffered and induces one extra DIO clock cycle into 9888A accesses. The 9888A should only be used for adding DIO interface cards, where access time is not a critical factor.



Series 300 Expanders

## Upgrades

### Model 310 to Model 320 Field Upgrade

By using the field installable kit, HP 98243B, a standard Model 310 can be upgraded to a standard Model 320. The upgrade kit consists of:

- Model 320 processor board
- HP 98257A 1 Mbyte RAM Card
- HP-IB/HP-HIL/RS-232C battery-backed real-time clock interface card

An option to delete the 1 Mbyte RAM card is available. The Model 310 SPU Board must be returned to HP.

### Model 330 to Model 350 Field Upgrade

By using the field installable kit, HP 98244A, a standard Model 330 can be upgraded to a standard Model 350. This upgrade offers the improved power and performance of a 4 MIPS workstation and capability to expand to more than eight Mbytes RAM. The Model 350 offers a maximum of 48 Mbytes RAM, twice the CPU power of the Model 330 and object code compatibility with the Model 330. The Model 330 to Model 350 Upgrade kit consists of:

- Model 350 processor board
- System bus, 2-high connector (98562-66502)
- 98258A 4 Mbyte RAM Controller
- 98258B 4 Mbyte RAM Add-on
- 98262A High-speed HP-IB Disc Interface

An option is available which replaces the 2-high system bus with a 3-high system bus, allowing use of the floating point accelerator in the upgraded workstation. The Model 330 processor board must be returned to HP.

### Model 310 to Model 330 Upgrade

A Model 310 SPU can be upgraded to a Model 330 SPU, realizing three to five times higher performance.

### Model 320 to Model 350 Upgrade

A Model 320 SPU can be upgraded to a Model 350 SPU, doubling the expected performance of the workstation.

### Boot ROM Update to Rev. B (98563-67001)

Use of the discless node feature of HP-UX 6.0 or later revision requires Rev. B Boot ROM or later revision. The following models which were shipped prior to 1 January 1988 require the Boot ROM update in order to use the discless node feature.

- Model 310 with a serial number prefix prior to 2751Axxxxx, 2801Gxxxxx, or 2751Jxxxxx
- Model 320 with a serial number prefix prior to 2752Axxxxx, 2801Gxxxxx, or all xxxxJxxxxx
- Model 330 with a serial number prefix prior to 2740Axxxxx, 2752Gxxxxx, or 2740Jxxxxx
- Model 350 with a serial number prefix prior to 2747Axxxxx, 2801Gxxxxx, or 2747Jxxxxx
- 98243A/B Model 310 to Model 320 Field Upgrade, which includes a 98561-66516 processor board

Installation assistance can be purchased separately.

**Note:** Model 310 systems with a serial number less than 2522A02500 and Model 320 systems with a serial number less than 2543A02300 require an additional procedure to allow use of this update. Please contact your local HP service office for more information.

### Processor Board Update for Model 330 (98562-69013)

Use of the 98566A 2D Integer-based Graphics Accelerator or SCSI requires the latest revision of the Model 330 processor board. Model 330 systems with serial number prefixes prior to 2740Axxxxx, 2801Gxxxxx, or 2740Jxxxxx which were shipped prior to 1 January 1988 require this update. The update is a board exchange kit that includes a new system interface board and a new processor board with Rev. C Boot ROM revision. This update allows use of the discless node feature of HP-UX 6.0 or later revision and access to the 98566A graphic accelerator. The current CPU board and system interface board must be returned to HP.

**Processor Board Update for Model 350  
(98562-69517)**

Use of the 98556A 2D Integer-based Graphics Accelerator or SCSI requires the latest revision of the Model 350 processor board. Model 350 systems with a serial number prefix prior to 2747Axxxxx, 2801Gxxxxx, or 2747Jxxxxx which were shipped prior to 1 January 1988 require this update. The board exchange kit includes a new processor board with Rev. C Boot ROM, which allows use of the discless node feature of HP-UX 6.0 or later revision and access to the 98556A graphics accelerator. The current CPU board must be returned to HP.

**Standard I/O Specifications –  
Models 310, 318M, 319C+, 320,  
330 and 350**

DIO II Bus:  
Width ..... 32 bits address; 32 bits data  
Bus bandwidth ..... 6 Mb/second

DIO Bus:  
Width ..... 24 bits address; 16 bits data  
Bus bandwidth ..... 3 Mb/sec

LAN Interface (Models 318M, 319C+, 330 and 350):  
Connector ..... BNC "T" connector  
Required MAU ..... Built-in ThinMAU  
Media ..... ThinLAN coax cable (RG 58U)  
Protocol ..... IEEE 802.3/Ethernet  
Data rate ..... 10 Mbit/sec

Optional LAN Interface (Models 330 and 350):  
Connector ..... AUI (Attachment Unit Interface)  
Required MAU ..... Backbone MAU (HP 30241A) and AUI cable  
Media ..... ThickLAN coax cable  
Protocol ..... IEEE 802.3/Ethernet  
Data rate ..... 10 Mbit/sec

Parallel Interface:  
Type ..... IEEE 488  
Data rate ..... 350 Kbyte/sec  
Number of connected devices supported ..... 15 per interface

Serial Interface:  
Type ..... RS-232C standard (98644A equivalent)  
Connector ..... DB9 with cable adapter to DB25 (for 310, 318M and 319C+, DB25 connector)

Disc Interface (Models 319C+, 330 and 350):  
Type ..... IEEE 488  
Data rate ..... 1 Mbyte/sec  
Number of connected drives supported ..... 8 per interface (additional disc interfaces are available as optional accessories)

DMA Interface:  
Number of channels ..... 2

HP-HIL Interface:  
Number of devices supported ..... 7 total

**SPU Power Specifications**

	PC-305/PC-308	Model 318M	Model 319C+	Model 310, 320	Model 330, 350	98568A	98570A
<b>Source Consumption</b>	3.95A @ 115V 2.12A @ 230V	2.1A @ 115V 1.2A @ 230V	1.9A @ 120V 1.0A @ 240V	5.0A @ 90 – 132V, switch selectable 3.0A @ 180 – 250V, switch selectable			
<b>Line Frequency</b>	50-60 Hz	50-60 Hz	50-60 Hz	48 – 66 Hz			
<b>Power Consumption:</b> Watts maximum BTU/hour Kcal/hour	465W*	100 340 100	110 374 110	250 853 250			
<b>Power Availability:</b> Power supply maximum: At +5 volts At +12 volts At -12 volts	134W	N/A	N/A	150 Watts 20 Amps 3.6 Amps 1.1 Amps			
<b>DIO Backplane Power:</b> At +5 volts At +12 volts At -12 volts	N/A	N/A	N/A	31 Watts 19.2 Watts 6 Watts	N/A	62 Watts 38.4 Watts 12 Watts	N/A
<b>DIO II Backplane Power:</b> At +5 volts At +12 volts At -12 volts	N/A	N/A	N/A	N/A	85 Watts 40 Watts 12 Watts	N/A	62 Watts 38.4 Watts 12 Watts

\* Includes 150W convenience outlet.

## Physical Dimensions

### Models PC-305 and PC-308

	PC-305	PC-308
Height	160 mm (6.3 in.)	160 mm (6.3 in.)
Width	425 mm (16.7 in.)	425 mm (16.7 in.)
Depth	390 mm (15.4 in.)	390 mm (15.4 in.)
	Additional 4 inches in depth should be allowed for interface cables.	
Net weight	13.3 kg (29.4 lbs.)	13.9 kg (30.5 lbs.)

### Models 310, 320, 330, 350, 98568A/98570A

Height	130 mm (5.12 in.)
Width	325 mm (12.8 in.)
Depth	376 mm (14.8 in.)
	Additional 4 inches in depth should be allowed for interface cables.
Net weight	11.8 kg (26 lbs.) maximum
Shipping weight	13.8 kg (30.4 lbs.)

### Model 318M

Height	104 mm (4.10 in.)
Width	325 mm (12.8 in.)
Depth	325 mm (12.8 in.)
	Additional 4 inches in depth should be allowed for interface cables.
Net weight	4.5 kg (10 lbs.) maximum
Shipping weight	6.5 kg (14.4 lbs.)

### Model 319C+

Height	104 mm (4.10 in.)
Width	325 mm (12.8 in.)
Depth	444 mm (17.5 in.)
	Additional 4 inches in depth should be allowed for interface cables.
Net weight	6.8 kg (15 lbs.) maximum
Shipping weight	10.0 kg (22 lbs.)

## SPU Environmental Range

### Models PC-305 and PC-308

Operating temperature	-5° to 40°C
Storage temperature	-40° to 70°C
Humidity	5% to 80% R.H. (non-condensing)
Maximum altitude	4,570m (15,000 ft.)
EMI	Conducted and radiated interference meets FTZ Level A; FCC Class B

### Models 310, 318, 319, 320, 330 and 350

Operating temperature	0° to +55°C
Storage temperature	-40°C to +71°C
Maximum wet-bulb temperature	40°C

Humidity	5 to 95% R.H. non-condensing
Maximum altitude	4,570m (15,000 ft.)
EMI, Models 310 and 320	Conducted and radiated interference meets FTZ Level A; FCC Class A
EMI, Models 318M, 319, 330 and 350	Conducted and radiated interference meets FCC Class A; VDE 1046/84 Level B; VCCI Class 1

### Additional Regulatory

Compliance	UL 478, 5th edition; CSA 22.2 No. 154, M-1983; IEC 380, 2nd edition; IEC 435, 2nd edition; (Model 319C+ only, CSA 22.2 No. 220-M1986)
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## Clock and Timers

### Real-time Clock

Resolution	10 milliseconds
Accuracy	+5 seconds/day
Battery backup (except Models 318M and 319C+)	Lithium, expected life = 1 year
Expected run time after power loss (Models 318M and 319C+)	12 hours

### Timers

Match interrupt	Match on time of day 0.00 to 84600.00 sec.
Delay interrupt	10 msec. to 1.94 days
Cyclical interrupt	10 msec. to 1.94 days
System timer	4 μsec. resolution accurate to 25 ppm

### Audio

Three independent tone generators	controllable over 30 db.
Frequency range	81.46 Hz to 83.3 KHz
Resolution	Capable of approximate chromatic scale over five octaves
Duration	0.01 sec. to 2.55 second/tone

## Display Systems

The Series 300 features twelve display systems: eleven are bit-mapped display systems which allow user selection of different text styles and sizes to be intermixed with graphics information on the same screen. Of these eleven, eight fit in a DIO II slot, the ninth is the 98700A Graphic Display Station, and the tenth is the 98720A Solid Rendering Display Controller. The eleventh is the 98730A Solid Rendering Display Controller. The twelfth display system separates alpha and graphics information for full compatibility with Series 200 programs written to take advantage of independent control of alpha and graphics.

## Series 300 Graphics Boards

Series 300 graphics boards provide a choice of either monochrome or color and medium- or high-resolution formats. The display architecture is organized on a byte-per-pixel basis. Each frame buffer plane in a color system can be manipulated independently of the others, providing flexibility to the system programmer in implementing graphics applications on the Series 300 computer systems.

To achieve maximum functional density at lowest cost, each board employs VLSI technology. The graphics board's VLSI chips operate independently from the main CPU, freeing up the processor to perform other functions while the display system is performing screen blanking, scrolling or window moves, thereby maximizing system throughput.

The technical specifications of Series 300 graphics boards (98542A/43A/44B/47A) are listed in the following table.

Description	Resolution	
	Medium	High
VLSI clock rate	9 MHz	16 MHz
Frame buffer size (pixels/plane)	1024 x 512	1024 x 1024
Displayed buffer size (pixels/plane)	512 x 400*	1024 x 768
Window move speed (pixels/second)	11.2M	20M
Scrolling speed (pixels/second)	16.9M	30M
Pixel write speed, maximum:		
• Horizontal (pixels/second)	1M	1.9M
• Vertical (pixels/second)	.28M	.5M
Pixel write speed by CPU:		
• Model 310 (pixels/second)	60,000	60,000
• Model 320 (pixels/second)	120,000	120,000
Screen erase time (msec)	36	40

\* These are half-width, rectangular pixels to improve alpha resolution.

### 98542A – Medium-resolution (512 x 400) Monochrome Graphics Board

This board provides a high-quality display suitable for desktop or lab bench use. It features both alpha text and graphics capabilities and is supplied with a 2.4 meter cable for use with the HP 35731A 12-inch monochrome monitor with built-in speaker and integrated tilt and swivel. The HP 35731A/B monitor also supports an optional HP-HIL touchscreen bezel and can be rack mounted (Rack Mounting Kit HP 98567A) for computer-aided test applications.

### 98543A – Medium-resolution (512 x 400) Color Graphics Board

This board features high-quality color text and graphics capability suitable for desktop or lab bench use. Four planes provide 16 simultaneous colors selectable from a color palette of over 16 million hues. The board comes supplied with 2.4 meter RGB cables for use with the HP 35741A 12-inch color monitor with built-in speaker and integrated tilt and swivel. The 35741A/B monitor also supports an optional HP-HIL touchscreen bezel and can be rack mounted.

### 98544B – High-resolution (1024 x 768) Monochrome Graphics Board

This board provides a high-resolution display suitable for desktop or CAD system use. It drives the 98786A 17-inch high-resolution monochrome monitor with built-in tilt and swivel. The 98544B graphics board is supplied with a 1.7 meter coax video cable and a 2.5 meter coax audio cable.

### 98547A – High-resolution (1024 x 768) Color Graphics Board

This board provides a high-resolution display suitable for CAD system use. It comes with a 3 meter RGB cable for use with the 98751A 19-inch or 98785A 16-inch high-resolution color monitors. The board features six planes of frame buffer to provide 64 simultaneous colors from a color palette of over 16 million hues.

## Series 300 High-performance Graphics Boards

The Series 300 high-performance graphics boards are a family of graphics subsystems providing a range of resolutions and graphics planes. High performance has been designed into the boards through custom-designed HP VLSI components. The boards feature bit-per-pixel addressing, overlay planes, hardware support of vectors, general polygons and filled geometries for enhanced system interactivity.

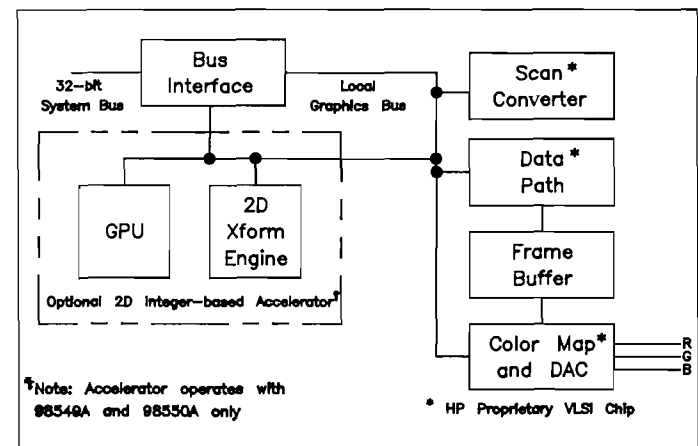
### VLSI Implementation

The custom VLSI in the Series 300 high-performance graphics boards gives higher reliability and performance at lower cost.

The scan converter chip takes the end-points of lines or polygons and calculates the position of all pixels within the line or polygon. Since this calculation is done in VLSI rather than software, the performance is dramatically improved.

The data path chip gives the board the ability to update the frame buffer at a rate of 74 million pixels per second.

The color map Digital to Analog Converter (DAC) provides the 108 MHz video rate needed for a 1280 x 1024 resolution, 60 Hz display. It allows 256 colors to be simultaneously displayed from a palette of over 16 million in the image planes. This chip also provides the special color map hardware for mixing overlay information with image information.



Series 300 High-performance Graphics Board Diagram

### 98548A – High-resolution (1280 x 1024) Monochrome Graphics Board

The 98548A monochrome board features the 1280 x 1024 resolution most needed for computer-aided publishing and software engineering. In addition to the improved resolution, the 98548A provides bit-per-pixel addressing for fast movement of screen images such as menus and windows. The 98548A also provides hardware scan converter circuits for high-speed vector, polygon and area-fill performance. The 98548A requires the 98788A 19-inch monochrome monitor.

### 98549A – High-resolution (1024 x 768) Color Graphics Board

The 98549A color graphics board provides 1024 x 768 resolution and is offered as an upgrade option. The 98549A features the same scan converter and data path chips as the 98550A for high-performance graphics.

The six planes may be software configured as six color planes, which allow for 64 colors, or as four color planes, which allow 16 colors and two overlay planes.

The 98549A also accommodates the 98556A 2D Integer-based Graphics Accelerator. The 98549A may use the 98751A 19-inch color monitor or the 98785A 16-inch color monitor.

### 98550A – High-resolution (1280 x 1024) Color Graphics Board

This graphics board provides the 1280 x 1024 resolution needed for demanding 2D graphics applications. A hardware scan converter provides high-speed vector, polygon and circle generation. High-speed block transfer circuits provide fast BITBLT performance. The 98550A provides eight color planes which allow 256 colors from a palette of over 16 million. These color planes can also be used as four planes double-buffered for interactive pan-zoom of 16-color images.

Two additional overlay planes can be used for cursors, menus, text or temporary storage. The use of these overlay planes can make application writing a much easier task. The 98550A also accommodates the 98556A Integer-based Graphics Accelerator. The 98550A may use the 98752A 19-inch color monitor or the 98788A 16-inch color monitor.

### Model 319C+ High-resolution (1024 x 768) Color Graphics Board

The graphics subsystem in the Model 319C+ provides six color planes which allow 64 colors from a palette of over 16 million. These planes can be configured as four color planes and two overlay planes.

## Technical Specifications of Series 300 Graphics Boards (98548A/49A/50A and Model 319C+)

### System Graphics Performance<sup>†</sup>

#### Polyline Drawing Speed:

Device coordinates\*

(50-vector polylines, 20 pixels per vector, 45 degree angle) . . . . . 76,000 vectors per second

#### World coordinates<sup>†</sup>

(50-vector polylines, 20 pixels per vector, 45 degree angle) . . . . . 13,500 vectors per second

#### Filled Polygon Drawing

##### Speed:

#### Device coordinates

(4-sided oblique polygons, 30 pixels per side) . . . . . 1,700 polygons per second

#### World coordinates

(4-sided oblique polygons, 30 pixels per side) . . . . . 800 polygons per second

#### Block Transfer:

##### Main memory to frame buffer:

Bit/pixel – Starbase speed . . . . . 4 megapixels per second

Byte/pixel – Starbase speed . . . . . 1.7 megapixels per second

##### Frame buffer to frame

##### buffer – peak

##### hardware speed:

Screen clear . . . . . 74 pixels per second

SOURCE rule . . . . . 39 pixels per second

XOR rule . . . . . 28 pixels per second

## HP 98556A 2D Integer-Based Graphics Accelerator

The HP 98556A 2D Integer-Based Graphics Accelerator further extends the graphics performance of the Model 330 and 350 color graphic workstations which include the HP 98550A or 98549A graphics boards.

Through the use of a dedicated graphics processing unit and 2D integer-based transform engine, the HP 98556A Graphics Accelerator provides the capability to realize “real-time”, interactive pan and zoom functions for graphics-intensive 2D integer-based applications.

The 2D Graphics Accelerator provides a 32-bit world coordinate interface directly to the graphics pipeline. This speeds the display process by moving the software intensive operations of transform calculations and device coordinate scaling directly to the graphics hardware that has been optimized to perform those tasks.

The 2D Graphics Accelerator is supported by the Starbase Graphics Library with optimized integer interface commands for the full performance of the accelerator. The 2D Graphics Accelerator will operate in multiple, moveable and obscurable windows and provide window performance improvements through the use of clip list management and context switch support.

Performance of the 2D Graphics Accelerator may be obtained with a simple field add-on board that takes advantage of the existing 98550A or 98549A graphics subsystem.<sup>§</sup> It connects to the existing graphics board through an interface connector and exists in a “sandwich” configuration.

\* Information is sent to the graphics board in device coordinates.

† Starbase transforms world coordinates to device coordinates and sends device coordinates to the graphics board.

‡ Performance measured with Model 350 SPU.

§ The HP 98556A is supported on Models 330 and 350 workstations with C+, CH, or CHX graphics including the HP 98550A or 98549A graphics boards.

#### Additional 2D Graphics Accelerator functions:

- Transformation and clipping of lines, polylines and circles
- Programmable radix point for controlling precision and dynamic range of viewing operations
- Peak performance > 300,000 vectors/second
- Attribute management (colors, full style, ...)
- Primitives including lines, polygons and circles
- Matrix operations
- Fast-stroked text
- Cursors including stroked and raster cursors and picking
- Window acceleration

Accelerator vector speed*	300,000 vectors per second
Vector performance through Starbase Graphics Library	225,000 vectors per second
Stroked text	6,000 characters per second
Graphics Processing Unit	MC68020
Integer Math Unit	Weitek 8137
Interface	32-bit integer

#### Power Requirements

Source consumption	3.4A @ 5 Vdc <sup>†</sup>
Power consumption:	
Watts (maximum)	33
BTU/hr	112.7
Kcal/hr	28.4

#### Environmental Range

Operating temperature	0°C to 55°C
Humidity	5% to 95% relative, non-condensing
Maximum wet-bulb temperature	40°C
Storage environment	-40° to +71°C
Maximum operating altitude	4,570m (15,000 ft)
Maximum survival altitude	15,240m (50,000 ft)
EMI	PCB; maintains host system compliance
Additional regulatory compliance	PCB; maintains host system compliance

### 98700A - 3D Display Controller

The HP 98700A is designed to meet your 2D and 3D wireframe needs. When combined with the 98710A Graphics Accelerator, this system provides performance an order of magnitude greater than the HP 98547A High-Resolution Color Video Board, and supports the same monitors.

The subsystem's interface plugs into an I/O slot in the Series 300 and accepts data from the SPU at a rate of over 1.5 Mbytes/second. Four planes of frame buffer are standard, with an additional four planes available for a total of 256 simultaneous colors displayable from a palette of over 16 million hues.

\* 10 pixel vectors, clipped, transformed and drawn.

† The source consumption for the HP 98556A combined with the graphics board is 6.6A @ 5 Vdc.

### 98710A - Graphics Accelerator

The HP 98710A Graphics Accelerator for the 98700A Display Station contains a bit-slice processor with writable control store, floating point add, multiply and divide chips, as well as a vector generator chip with associated fast area fill hardware.

A hardware scan converter and transform engine perform 2D and 3D transformations, polygon clipping and filling, and perspective division - improving performance by more than an order of magnitude over handling these functions in software.

The following table provides a brief summary of the graphics performance of the 98700A Graphics Display Controller with the HP 98710A Graphics Accelerator installed:

### Technical Specifications - 98700A with 98710A

#### Accelerator Specifications

Hardware vector generation	Up to 2.5 megapixels per second
Line types	Eight
Hardware area fill	Up to 12 megapixels per second with 2x2 and 4x4 support

#### Performance Specifications

Frame buffer size (pixels per plane)	1024 x 1024
Displayed buffer size (pixels per plane)	1024 x 768
Window move speed (pixels per second)	16M
Scrolling speed (pixels per second)	24M
Pixel write speed during hardware vector generation (pixels per second)	2.5M
Vector generation speed (25 pixel vectors per second)	62K
Area fill speed (pixels per second)	12M

#### Power Requirements

Line voltage	90 - 125 Vac, 198 - 250 Vac
Line frequency	48 - 66 Hz
Current requirements	2.3A (each) @ 90 - 125 Vac maximum 1.2A (each) @ 198 - 250 Vac maximum
Power consumption (maximum)	130 watts, 450 BTU/hour (each)

## Operating Environmental Range

### Temperature:

Operating . . . . . 0°C to 55°C  
Non-operating . . . . . -40°C to 75°C

### Humidity:

Operating 40°C . . . . . 15% to 95%  
Non-operating 65°C . . . . . @ 90%

### Altitude:

Operating . . . . . 4,570m (15,000 ft.)  
Non-operating . . . . . 15,240m (50,000 ft.)

### Electromagnetic

Interference (EMI): . . . . . Conducted and radiated  
interference meets FCC  
Class A; FTZ Level A

Regulatory compliance . . . . . UL 478, 5th Edition; CSA  
22.2 No. 154M-1983; IEC  
380, 3rd Edition; IEC 435,  
2nd Edition

## Physical Specifications

Height . . . . . 132 mm (5.2 in.) (each)  
Width . . . . . 325 mm (12.8 in.) (each)  
Depth . . . . . 292 mm (11.5 in.) (each)  
Net weight . . . . . 6.8 kg (15 lb.) (each)  
Shipping weight . . . . . 8.1 kg (18 lbs.) (each)

## 98720A - Solid Rendering Display Controller

The 98720A Display Controller provides the resolution and number of displayable colors necessary for 3D solid graphics applications. The 98720A display system can grow from a 16-color low-cost system to a high-performance system with 16.7 million colors by simply adding frame buffer memory and a graphics accelerator.

The display system is particularly optimized for fast rendering of fully-shaded objects with hidden surfaces removed. This combination of speed and feature set provides an excellent graphics platform for solid modelling applications. The key features which provide this performance are:

- 3D polygons with shading, hidden-surface removal, and light source generation in hardware and microcode.
- B-spline capability, implemented in microcode, allowing generation of curved lines, meshes, and surfaces.
- Overlay planes for windowing, alpha, cursors, and menus.

To obtain interactive graphics performance, the traditional four-stage graphics pipeline has been modified:

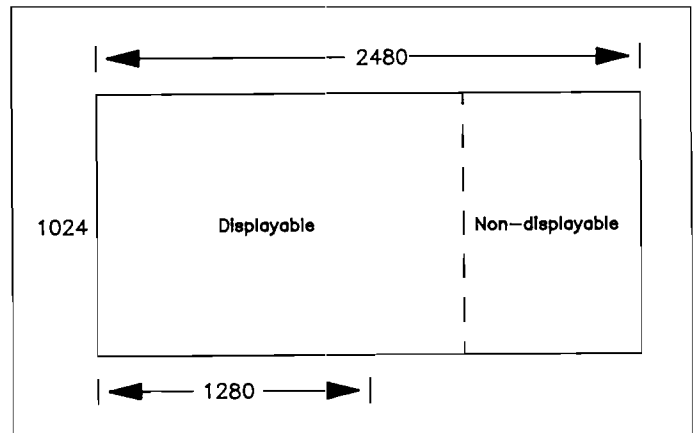
- Dual-ported memory has been added between each stage of the graphics pipeline, allowing each stage to operate independently, increasing the throughput of the pipeline.
- VLSI was used to eliminate pipeline bottlenecks.

The displayable resolution supported by the Display Controller is 1280 x 1024. The choice of monitor is 16-inch (98789A) or 19-inch (98752A). In its minimum

configuration, four planes of graphics memory is available. Frame buffer memory can be added in increments of 8 planes to a maximum of 32 planes plus 4 overlay planes.

Overlay planes provide the capability to do windowing, cursors, menus and alpha independently of the graphics images, and with 8 simultaneous colors.

Each frame buffer board supplies 2048 x 1024 bytes of graphics memory; the non-display portion is used for hidden surface removal (HSR). With a maximum 32-plane system, 24 planes (and 16.7 million simultaneous colors) are available for the graphics image; 8 planes plus "off screen" graphics memory provides a full-screen 16-bit Z-buffer for HSR. With less than 32 planes, Z-buffering is also available. For example, in a 24-plane system, it is possible to allocate 16 planes of the frame buffer for image (256 colors double-buffered) and 8 planes for HSR. Alternately, all 24 planes may be used for image with non-displayable memory used for strip-mode HSR.



98720A Frame Buffer Memory

## 98721A - Solid Rendering Graphics Accelerator

The 98721A 3D Solid Rendering Graphics Accelerator contains a bit-slice processor with writable control store, floating point integrated circuits for add, multiply and divide functions, and high-speed 6-axis scan converter. This provides the hardware and microcode implementation of the routines required by 3D applications, such as:

- Lights (up to 8 sources, color and intensity adjustable) - directional, ambient, positional, spotlight, colored
- Dithering
- Shading
- Hidden-surface removal
- Fourth-order non-uniform rational B-splines with trimming curves
- Specular highlighting

Hidden-surface removal requires frame buffer memory (HP 98720A Option 722 or HP 98722A Upgrade). The non-displayable portion of the frame buffer can be used if a low-cost, strip-Z-buffer system is needed. However, adding an extra frame buffer board to the system allows hidden-surface removal performance to increase by three times using full 16-bit Z-buffer.



# Technical Specifications – 98720A with 98721A\*

## Graphics Data

Frame buffer size	2048 x 1024
Frame buffer planes	4, 8, 16, 24, or 32 (maximum 1280 x 1024 displayable, 24-bit image planes, additional 8 planes and non-displayable portions of video RAM provide full 16-bit Z-buffering)
Overlay planes	0 (4-plane system) 4 (8, 16, 24, or 32-plane system)
Video signals	RS-343
Color palette	16.7 million
Mathematical representation	32-bit floating point
Z-buffer	Hardware, 16-bit full or strip
Control memory	Writable control store
Double buffering	4, 8, or 12 planes

## System Capabilities

### Primitives:

- Vectors
- Polylines
- Circles
- Arcs
- Polygons
  - n-sided, concave, convex, crossing, doughnut, wireframe
- B-spline (fourth-order non-uniform rational, with trimming)
  - curved lines, meshes, surfaces

### Image Rendering:

- Depth cueing
- Hidden-surface removal
- Flat shading
- Gouraud shading
- Phong lighting model
  - specular and diffuse reflections
- Lights (up to 8 sources, color and intensity adjustable)
  - directional, ambient, positional, spotlight, colored
- Transparency
- Perspective projection

### Software:

- CGI-based
- 3D hierarchical PHIGS-based display list
  - system memory or virtual memory, giving nearly unlimited size
- Hierarchical segments
  - segment contents editable
  - picking supported

### Dimensional Capabilities:

- Geometric transformations
  - scale, rotate, translate, perspective
  - concatenation of transformations
  - light source and perspective
- 32-bit IEEE floating point
- 2D and 3D coordinates
- 6-plane clipping

## Peak Performance

Display list traversal	190,000 vectors per second
Graphics accelerator	180,000 coordinates per second
Scan conversion	16 million pixels per second
Raster operations	125 million pixels per second using rectangular area fill
Window move speed	17 million pixels per second
Area fill speed	124 million pixels per second

## Power Requirements

Line voltage	90 – 125 Vac, 198 – 250 Vac
Line frequency	48 – 66 Hz
Current requirements:	
Main supply	6.2A (each) @ 90–125 Vac maximum; 4.4A @ 198–250 Vac maximum
Auxiliary supply	3.8A (each) @ 90–125 Vac maximum 2.7A (each) @ 198–250 Vac maximum

## Power consumption

(maximum)	130 Watts, 450 BTU per hour (each)
Main supply	380 Watts, 1262 BTU per hour
Auxiliary supply	250 Watts, 818 BTU per hour

## Operating Environmental Range

### Temperature:

Operating	0°C to 55°C
Non-operating	-40°C to 71°C

### Humidity:

Operating 40°C	15% to 95%
Non-operating 65°C	@ 90%

### Altitude:

Operating	4,570m (15,000 ft.)
Non-operating	15,240m (50,000 ft.)

EMI	Conducted and radiated interference meets FCC Class A; VCCI Class 1; VDE 1046/84 Level B
Regulatory compliance	UL 478, 5th Edition; CSA 22.2 No. 154M-1983; IEC 380, 3rd Edition; IEC 435, 2nd Edition

## Physical Specifications

Height	235 mm (9.3 in.)
Width	325 mm (12.8 in.)
Depth	550 mm (21.7 in.)
Net weight	23.2 kg (51 lb.)

\* Specifications listed are for a full system including a Graphics Accelerator, 32-plane frame buffer memory and four overlay planes.

## 98730A - Solid Rendering Display Controller

The 98730A Display Controller is a high-performance solid-rendering subsystem that extends the performance of the 98720A. The 98730A provides the most advanced and extensive 3D solid rendering feature set available in the industry. These features dramatically increase the user's competitiveness by maximizing graphics interactivity and displaying photorealistic images.

For customers with imaging applications, the system can be configured without the graphics accelerator and Z-buffer. This system provides the user with frame buffer memory, overlay planes, pixel pan and zoom and blending capabilities.

The 98720A remains an excellent platform for solid modeling at a significantly lower price than the 98730A.

## 98732A - Solid Rendering Graphics Accelerator & Full 16-Bit Z-buffer

The design of the 98732A graphics accelerator is based upon the industry-leading 98721A accelerator. The 98721A graphics accelerator was integrated into a custom VLSI microprogrammable CPU using HP's 1-micron NMOS-III technology, which allows the graphics system to be configured with up to three transform engines running in parallel. This integration provides three to ten times the performance of the 98721A.

Additional enhancements include a more extensive feature set, new geometric primitives, full speed Z-buffer and improved communication links between all the subsystems. The result is a system offering a consistently higher level of performance than ever before attainable for markets that require interactivity and photorealistic images.

## Technical Specifications - 98730A with 98732A\*

### Graphics Data

Frame buffer size . . . . . 2048 x 1024  
 Frame buffer planes . . . . . 8, 16 or 24 (maximum 1280 x 1024 displayable; nondisplayable portions are used for fonts, etc.)

Overlay planes . . . . . 4  
 Video signals . . . . . RS-343  
 Color palette . . . . . 16.7M  
 Mathematical

representation . . . . . 32-bit floating point  
 Z-buffer . . . . . Hardware, 16-bit full  
 Control memory . . . . . Writable control store  
 Double buffering . . . . . 4, 8, or 12 planes

### System Capabilities

The 98730A/32A supports the complete 98720A/21A feature set and is fully object code and source code compatible. The 98730A subsystem has the following additional capabilities:

### Primitives:

- Triangle strips
- Quadrilateral mesh
- Polymarkers
- Text
- Annotation matrix
- Culling
- Hardware cursor tracking
- Pixel pan and zoom
- Image blending
- Gamma correction
- Sixth order non-uniform rational B-splines with trimming

### Image Rendering:

- Enhanced depth cueing model
- Phigs+ backface model
- Phigs+ lighting model
- Full performance when using:
  - Dithering
  - Transparency
  - Z-buffering
- 16 light sources

### Software:

- Optional ray tracing<sup>†</sup>
- Optional radiosity<sup>†</sup>
- CGM
- X Window System™
- Local 3D MOMA windows (Multiple Obscurable Movable Accelerated windows)



### System Performance\*

Polylines . . . . .	240K (3D) vectors per second
	270K (2D) vectors per second
Triangle strip <sup>‡</sup> . . . . .	38K (3D) triangles per second
	50K (2D) triangles per second
Quadrilateral mesh <sup>‡</sup> . . . . .	35K (3D) quads per second
	45K (2D) quads per second

### Peak Performance\*

Display list traversal . . . . .	250K (3D) vectors per second
	333K (2D) vectors per second
Graphics accelerator (using the 3 parallel accelerators) . . . . .	900K (3D) coordinates per second
	2.2M (2D) coordinates per second
Scan conversion . . . . .	16M pixels per second
Raster operations . . . . .	15M pixels per second
Window move speed . . . . .	19M pixels per second
Area fill speed . . . . .	125M pixels per second

\* Specifications listed are for a full system including the Graphics Accelerator, full 16-bit Z-buffer, and 24 planes of frame buffer memory.  
<sup>†</sup> HP anticipates shipping this product at the end of 1988 but reserves the right to make changes to the product and introduction date.  
<sup>‡</sup> with light sources and shading  
 X Window System is a trademark of Massachusetts Institute of Technology.

## Power Requirements

Line voltage	90–125 Vac 198–250 Vac
Line frequency	48–66 Hz
Current requirements:	
Main supply	5.1A @ 90–125 Vac 3.1A @ 198–250 Vac
Auxiliary supply	5.1A @ 90–125 Vac 3.1A @ 198–250 Vac
Power consumption (max.)	660 Watts
Main supply	330 Watts
Auxiliary supply	330 Watts

## Operating Environmental Range

### Temperature:

Operating	0°C to 55°C
Non-operating	-40°C to 71°C

### Humidity:

Operating 40°C	15% to 95%
Non-operating 65°C	@ 90%

### Altitude:

Operating	4,570m (15,000 ft.)
Non-operating	15,240m (50,000 ft.)

EMI ..... Conducted and radiated interference meets FCC Class A; VCCI Class 1; VDE 1046/84 Level B

Regulatory compliance ..... UL 478, 5th Edition; CSA 22.2 No. 154M-1983; IEC 380, 3rd Edition; IEC 435 2nd Edition

## Physical Specifications

Height	312 mm (12.3 in.)
Width	325 mm (12.8 in.)
Depth	570 mm (22.4 in.)
Net weight	27 kg (59 lb.) maximum configuration 20 kg (43 lb.) minimum configuration

## Hard Copy Output for 98720A/30A

Versatec Hardcopy Support (HP 98053A) allows users to make color graphics dumps of the 98720A or 98730A displays on paper or transparencies. The Versatec-support product consists of software, interface cable, and documentation. The GPIO Interface (HP 98622A) must be purchased separately. Supported plotters are available from Versatec.

## Series 200 Display Compatibility Interface

The 98546A Display Compatibility Interface provides separate alpha and graphics planes and is completely compatible with Series 200 Models 236 and 217 displays in both functionality and resolution. The graphics aspect ratio of 1.33:1 is compatible with all Series 200 graphics displays as well. Graphics resolution is 512 x 390; alpha format is 25 lines of 80 characters per line.

The 98546A is a pair of I/O cards that is intended for use in conjunction with a medium-resolution bit-mapped display. It is capable of driving either the HP 35731A 12-inch monochrome monitor or the HP 35741A 12-inch color monitor (connected to the "green" monitor input). A relay on the 98546A allows you to switch between the 98546A alpha/graphics display or a 98542A monochrome bit-mapped display by means of simple keyboard and program commands. (When connected to a 98543A color bit-mapped video board, the 98546A interface will display only green text and graphics in the compatibility mode. User software selects between bit-mapped color display or green alpha/graphics display.)

The 98546A would normally be connected to the HP 35731A 12-inch monochrome monitor. Either of the Series 300 high-resolution video boards can be used in the same system as the 98546A, but the resulting system will be a two-monitor system – one a high-resolution bit-mapped display, the other a monochrome alpha/graphics display. The two display systems are independent of one another.

# Monitor Specifications

	35731A/B Monochrome	35741A/B Color	98785A Color	98751A Color	98789A Color	98752A Color	98786A Monochrome	98788A Monochrome
Size (measured diagonally)	310 mm (12 in.)	310 mm (12 in.)	406 mm (16 in.)	480 mm (19 in.)	406 mm (16 in.)	480 mm (19 in.)	432 mm (17 in.)	480 mm (19 in.)
Alphanumeric capacity (default font)	80 characters, 26 lines	80 characters, 26 lines	128 characters, 48 lines	128 characters, 48 lines	128 characters, 48 lines	128 characters, 48 lines	128 characters, 48 lines	128 characters, 48 lines
Character height and width	3.7 mm wide, 4.9 mm tall	3.7 mm wide, 4.9 mm tall	2 mm wide, 2.9 mm tall	2.5 mm wide, 3.2 mm tall	2.3 mm wide, 3.2 mm tall	2.7 mm wide, 3.8 mm tall	1.8 mm wide, 3.0 mm tall	2.7 mm wide, 3.8 mm tall
Graphics capability: Resolution	512 dots horizontal, 400 dots vertical	512 dots horizontal, 400 dots vertical	1024 dots horizontal, 768 dots vertical	1024 dots horizontal, 768 dots vertical	1280 dots horizontal, 1024 dots vertical	1280 dots horizontal, 1024 dots vertical	1024 dots horizontal, 768 dots vertical	1280 dots horizontal, 1024 dots vertical
Raster size	210 mm x 164 mm	210 mm x 164 mm	297 mm x 238 mm	360 mm x 270 mm	295 mm x 236 mm	343 mm x 274 mm	304 mm x 234 mm	343 mm x 274 mm
ROM character set	256 characters	256 characters	276 characters	276 characters	276 characters	276 characters	276 characters	276 characters
Character font	9 x 12 character in a 12 x 15 cell*	9 x 12 character in a 12 x 15 cell*	7 x 10 character in an 8 x 16 cell†	7 x 10 character in an 8 x 16 cell	10 x 15 character in a 10 x 21 cell	10 x 15 character in a 10 x 21 cell	7 x 10 character in an 8 x 16 cell†	10 x 15 character in a 10 x 21 cell
Intensity adjustable up to	50 FL	36 FL	35 FL	30 FL	35 FL	27 FL	35 FL	27 FL
Refresh rate	60 Hz	60 Hz	60 Hz	60 Hz	60 Hz	60 Hz	60 Hz	60 Hz
Scan rate	24.9 - 25.5 KHz	24.9 - 25.5 KHz	47.7 KHz	47.7 KHz	63.3 KHz	63.3 KHz	47.7 KHz	63.3 KHz
Implosion protection	Tension band	Tension band	Safety glass with anti-glare coating	Safety glass, bonded panel with thin-film, anti-glare coating	Safety glass, bonded panel with silica, anti-glare coating	Safety glass, bonded panel with thin-film, anti-glare coating	Safety glass, bonded panel with thin-film, anti-glare coating	Safety glass, bonded panel with thin-film, anti-glare coating
Tube phosphor	p 31	p 22	p 22	p 22	p 22	p 22	p 40	p 40
Chromaticity coordinates	N/A	X Y Red 0.63 0.35 Green 0.30 0.60 Blue 0.15 0.06	X Y Red 0.62 0.34 Green 0.28 0.60 Blue 0.16 0.07	X Y Red 0.63 0.34 Green 0.28 0.60 Blue 0.16 0.07	X Y Red 0.62 0.34 Green 0.28 0.60 Blue 0.16 0.07	X Y Red 0.63 0.34 Green 0.28 0.60 Blue 0.16 0.07	X Y 0.26 0.32	X Y 0.26 0.32
Physical dimensions:								
Height	332 mm (13.7 in.)	345 mm (13.6 in.)	380 mm (15 in.)	436 mm (17.1 in.)	380 mm (15 in.)	436 mm (17.1 in.)	422 mm (16.6 in.)	420 mm (16.5 in.)
Width	340 mm (13.4 in.)	328 mm (12.9 in.)	406 mm (16 in.)	408 mm (16.1 in.)	406 mm (16 in.)	408 mm (16.1 in.)	435 mm (17.1 in.)	480 mm (18.9 in.)
Depth†	240 mm (9.5 in.)	390 mm (15.4 in.)	450 mm (17.7 in.)	535 mm (21.0 in.)	450 mm (17.7 in.)	535 mm (21.0 in.)	370 mm (14.6 in.)	407 mm (16 in.)
Net weight	10 kg (22 lbs.)	13.9 kg (30.6 lbs.)	26 kg (57 lbs.)	35 kg (77 lbs.)	26.5 kg (58.3 lbs.)	35 kg (77 lbs.)	20.0 kg (44 lbs.)	21.8 kg (48 lbs.)
Shipping weight	12 kg (26.4 lbs.)	15.9 kg (35 lbs.)	28 kg (62 lbs.)	40 kg (88 lbs.)	28 kg (62 lbs.)	40 kg (88 lbs.)	27.0 kg (59 lbs.)	27 kg (59.4 lbs.)
Compatible interfaces	98542A, 98546A	98543A, 98546A	98547A, 98549A, 98700A	98547A, 98549A, 98700A	98550A, 98720A, 98730A	98550A, 98720A, 98730A	98544B	98548A

\* Character width is measured in half-pixels on medium-resolution, bit-mapped display systems.

† User settable in HP-UX.

‡ Additional 4 inches in depth should be allowed for interface cables, and 2.5 inches on the left side for ventilation.

# Monitor Environmental Range and Regulatory Compliance

	35731A/B	35741A/B	98785A, 98789A, 98751A, 98752A	98786A, 98788A
<b>Temperature:</b> Operating Non-operating	0° to 55°C -40° to 75°C	0° to 55°C -40° to 65°C	10° to 40°C -40° to 65°C	0° to 55°C -40° to 71°C
<b>Humidity:</b> Operating 40°C	5% to 95%C	5% to 95%C	10% to 80%C	15% to 95%C
<b>Altitude (meters):</b> Operating Non-operating	0 to 4,570 0 to 15,240	0 to 4,570 0 to 15,240	0 to 3,352 0 to 15,240	0 to 4,570 0 to 15,240
<b>Regulatory Compliance</b> for EMI	VDE "B", FCC "B" in typical system	VDE "B", FCC "B" in typical system	VDE "B", FCC "A" in typical system	VDE "B", FCC "A" in typical system
<b>Regulatory compliance</b> for product safety	UL, CSA, IEC, NEMKO*, SEV*, FEI*	UL, CSA, IEC, NEMKO*, SEV*, FEI*	UL, CSA, IEC, SEV, FEI	UL, CSA, IEC, SEV, FEI

\* 'A' version does not have these.

## Graphics Upgrades

Graphics boards, graphics accelerators, display controllers, and monitors can be returned for credit toward similar components with higher performance, higher resolution, color, or 3D.

Return credit for a graphics accelerator is allowed only when an accelerator is ordered. There is generally a limit of one return credit for one destination product ordered. Ask your HP sales representative for specific details on the upgrade program.

## Series 300 Human Interface Access

The following table summarizes the HP-HIL devices available for Series 300 computers. HP-HIL (Hewlett-Packard – Human Interface Link) devices provide low-cost input to Series 300 computer systems. They are connected in a "daisy-chain" fashion with up to seven devices supported on a single HP-HIL (or HIL for short) interface.

HP-IB or RS-232C input devices are also available, as shown in the following table.

Product No.	Description	Interface Required	Cable Included
<b>Graphics Input/Picking Devices</b>			
35723A	HP-Touchscreen bezel for 35731/41 Monitors	HP-HIL	—
46021A	Keyboard	HP-HIL	—
46060A	HP Mouse (2-button)	HP-HIL	1.4m
46060B	HP Mouse (3-button)	HP-HIL	—
46083A	Knob	HP-HIL	0.5m
46084A	ID Module	HP-HIL	0.5m
46085A	Control Dial Box	HP-HIL	0.8 ... 3m
46086A	32-button Box	HP-HIL	0.8 ... 3m
46087A	ANSI A/ISO A4-size Digitizer	HP-HIL	0.8 ... 3m
46088A	ANSI B/ISO A3-size Digitizer	HP-HIL	0.8 ... 3m
46089A	4-button Cursor for 46087/88A (orderable as Opt. 001 on either digitizer)	46087/88A	Included
46094A	Quadrature Port	HP-HIL	0.5m
46095A	3-button Mouse	HP-HIL 46094	1.2m
<b>Bar Code Readers</b>			
39800/01A	Bar Code Reader	RS-232C	None
92916A	Bar Code Reader	HP-HIL	.7 ... 1.83m
<b>HP-HIL Extensions</b>			
46080A	2.4m Extension (no audio)	HP-HIL	2.4m
46081A	2.4m Extension (with audio)	HP-HIL	2.4m
46082A	15m HP-HIL Remote Extension (with audio and RGB video)	HP-HIL	15m, 0.5m
46082B	30m HP-HIL Remote Extension (with audio and RGB video)	HP-HIL	30m, 0.5m

## Series 300 Local Area Networking

### NS-ARPA Services/300 Local Area Networking (LAN)

NS-ARPA Services/300 supports the File Transfer Protocol (FTP), Telnet, and Simple Mail Transfer Protocol (SMTP), ARPA services, and the rcp, rlogin, and remsh Berkeley Systems Distribution (BSD) 4.2 networking services. In addition, the BSD 4.2 socket interface is supported. These services use the Department of Defense Advanced Research Projects Agency (ARPA) standard Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) transports.

Network Services-ARPA Services/300 provides transparent Remote File Access (RFA) between HP-UX systems. It provides file transfer (NFT) between Series 300, Series 800, HP 3000, HP 1000 A-Series and DEC VAX/VMS computers.

Link-level access capability is provided for customers who have the expertise to write higher performance networked applications.

NS-ARPA Services/300 and the 98643A LAN/300 Link combine to provide high-speed local area network communication supporting either IEEE-802.3 or Ethernet LAN standards.

### Network File System (NFS) Services/300

NFS permits computers to share file systems over a local area network. Computers running NFS may access remote databases containing drawings, schematics, netlists, graphics or source code. Most user level commands (e.g., list, remove, copy, ...) operating locally, will work on a remote file, in most cases, without any noticeable change in response time.

NFS distinguishes itself from competing products by operating on computers and operating systems from different manufacturers. Thus, NFS provides multi-vendor file sharing and has become the de facto industry standard for file sharing. HP's version of NFS contains the major components of NFS Revision 3.0:

- Capabilities to mount remote file systems and transparently access files on remote machines
- External Data Representation (XDR) specifies alignment and size of data types in a machine-independent manner
- Remote Procedure Call (RPC) allows programmers to execute routines on remote machines and upon completion receive the results. RPC allows network programmers to write customized networking applications
- Yellow Pages (YP) gives the user centrally administered data look up service, includes utilities for global system administration and the associated user level commands

To run NFS, the NS-ARPA Services/300 product must be installed.

## HP-UX Asynchronous Data Communications

HP-UX and most UNIX operating system and UNIX-like systems can communicate using uucp protocol over hardwired, leased, dial-up and X.25 lines. File transfer, remote command execution (uux) and virtual terminal (cu) capabilities are provided. HP-UX electronic mail uses the uucp facility.

Uucp connections (except hardwired) are generally not dedicated. Systems communicate on demand. Your system can simultaneously communicate with as many systems as you have available ports (subject to single- and multi-user license limits). There is no limit to the number of systems with which you can potentially communicate in turn.

Any RS-232C interface is sufficient for hardwired operation, although the direct-connect ports of the 98642A Multiplexer are not recommended. All other connections require a modem-compatible interface and cable. An X.25 connection requires a modem port of an HP 2334A Option 123 Multi-MUX X.25 cluster controller.

The virtual terminal capability of cu makes your terminal (through your system) appear to be a terminal connected to a remote system. Cu can communicate with most systems that are compatible with 7- or 8-bit asynchronous ASCII terminals. In general, cu works with any system with which HP terminals work, except for block-mode applications.

### HP 2392A and VT100 Terminal Emulation

The 98791B Terminal Emulation package is a stand-alone Pascal 3.1 (execute-only based) application that makes your Series 300 computer emulate an HP 2392A terminal (including block mode), or DEC's VT100 Terminal Emulator (requires 46084A ID Module).

### Shared Resource Management (SRM)

An SRM network consists of one or more SRM servers and up to 63 workstations. The server provides a shared hierarchical file system and spooled printer and plotter support. Workstations communicate only with servers. Workstation-to-workstation and server-to-server communication is not supported.

BASIC and Pascal workstations can be discless using the server's file system as their sole file system (including system boot). HP-UX workstations may be included in the SRM network. HP-UX workstations transfer files to and from the SRM Server and submit data for spooling to a printer and plotter by merely writing to a file in one of the server's spool directories.

## Series 300 Networking

Feature	Local Area Network (LAN)	uucp, uux, cu	2392A/VT100 Emulator	Shared Resource Management (SRM)
Operating system required	HP-UX	HP-UX	Stand-alone or Pascal	BASIC, HP-UX or Pascal
Network services provided	NFS, RFA, NFT, LLA, FTP, Telnet, SMTP, rcp, rlogin, remsh, BSD sockets	NFT, RCX, VT	VT, NFT	NFT (HP-UX), RFA (BASIC and Pascal)
Other systems on network	Series 200, 500, 800, HP 1000 'A' Series, HP 3000, VAX/VMS, ARPA/BSD 4.2 Systems <sup>†</sup> , HP Vectra	Any HP-UX, most async hosts	Any HP, DEC, most async hosts	Series 200, 500, PC-308
Bit rate	10 Mbps	9.6 Kbps	9.6 Kbps	750 Kbps
Maximum distance	1500m	Unlimited	Unlimited	1000m
Maximum nodes	1024	Unlimited	Unlimited	63
Connect method	Ethernet/802.3, Coax	RS-232C, X.25	RS-232C	Coax

**Key:** NFT - Net File Transfer RFA - Remote File and Directory Access VT - Terminal Access RCX - Remote Command Execution LLA - Line Level Access

<sup>†</sup> Check with your local HP sales office for systems which HP supports.

## Series 300 Data Storage

Hewlett-Packard offers a wide range of discs from low-cost floppy discs to high-performance hard discs. The following table summarizes the discs available for the Series 300 computer systems and the relative performance levels of each. (Performance levels are presented here as "I/Os/sec", or input-outputs per second.)

High-speed discs have an instantaneous transfer rate in excess of 300 Kbytes/sec and deliver their listed performance only when connected to a high-speed disc

interface (HP 98625B or Model 330/350 built-in) in a system which has a DMA controller. The built-in HP-IB and 98624A interfaces support only standard speed mode.

*Note: The built-in HP-IB of the Models 310, 330 and 350 computers has less overhead than the 98624A. If you do not plan to purchase a high-speed disc interface, plan to use the built-in HP-IB for your system disc and add a 98624A HP-IB for peripherals.*

### Series 300 Data Storage (in order of increasing capacity)

Product No.	Capacity (bytes)	Performance I/O/sec	Transfer Rate	Media Type
9122C	2M (1.42 formatted)	-	Standard	3½-inch microfloppy disc
9127A	270K, 360K, 380K	-	Standard	5¼-inch floppy disc
9122S	631K, 710K, 788K	-	Standard	3½-inch microfloppy disc
9122D	631K, 710K, 788K	-	Standard	3½-inch microfloppy disc
9154A	10.0M	10	Standard	Fixed
9153A	10.0M, 631-788K	10	Standard	Fixed, 3½-inch microfloppy disc
9153B	20M	11	Standard	Fixed, 3½-inch microfloppy disc
9154B	20M	11	Standard	Fixed
7907A	20.5M + 20.5M	20	High	Fixed, removable
7957A/58A	81/130M	24.1	High	Fixed
7933H	404M	23	High	Fixed
7935H	404M	23	High	Removable
7935HR	404M	23	High	Removable (remarketed from FRD)
7936H/37H	307/571M	32.5	High	Fixed
7959B/63B	304M	35.3	High	Fixed
7957S/58S/59S	107/161/323M	35.3	High	Fixed

## Series 300 Magnetic Tape Drives

Product No./Description	Density (cpi)	Tape Capacity in Mbytes	Read After Write	Performance in Mb/min.	Separate Controller Option
<b>1/4-inch Cartridge Tape Drives</b> 9144A, stand-alone drive	10,000	67	Standard	2	Standard
35401A, stand-alone	10,000	8 x 67	Standard	2	Standard
<b>1/2-inch 9-track Tape Drives</b> 7974A, stand-alone drive	1,600	45	Standard	8	Standard
Opt. 800, adds	800	22	Standard	4	Standard

### Discussion of Terms

- **Density** – the number of characters per inch (cpi) that can be stored on the tape. The 1/4-inch figure is based on the 600-ft. tape (88140LC). The 1/2-inch figure is based on a 2400-ft. tape with a 16384 byte record size.
- **Capacity** – The maximum number of bytes that can be stored on one tape. The assumptions are the same as for density.
- **Read-after-write** – when writing to the tape, the drive itself is verifying the data (reading the written data and comparing it).
- **Performance** – The figures account for just the magnetic tape I/O. Normal backup operations are slower due to the time required to locate and read the files being saved.
- **Separate Controller** – The tape drive has its own controller electronics, HP-IB connector and HP-IB address. Disc operations are unaffected if the tape is on a separate HP-IB interface. This is the recommended configuration if you have a separate HP-IB interface for the tape drive (usually the same bus used for other non-disc devices).

## Series 300 Terminals

Product	Alpha Thruput	Phosphors Available	Graphics Size	Diagonal Size	Alpha Resolution	Features
HP 700/92	38,400	P31, P188, P194	N/A	14-inch	27 x 80/132	PP, SS
HP 700/22	38,400	P31, P188, P194	N/A	14-inch	27 x 132	PP, SS
HP 700/41	38,400	P31, P194	N/A	14-inch	27 x 80	PP, SS
HP 700/43	38,400	P31, P188, P194	N/A	14-inch	27 x 80/132	PP, SS
2393A	19,200	P31	512 x 390	12-inch	27 x 80	HP-HIL, PP, SS
2397A	19,200	P22	512 x 390	12-inch	27 x 80	HP-HIL, PP, SS
<i>Portable Plus</i> (45711)	4,800	LCD	480 x 128	9-inch	16 x 80	DP, IM, PC, PP
HP 150-II (45850)	19,200	P31	512 x 390	12-inch	26 x 80	HP-HIL, DP, IM, PC, PP, SS
9807A <i>Integral</i>	1,800	EL	512 x 255*	9-inch	24 x 80	HP-HIL, IM, IP, PC
<i>Vectra</i>	9,600	P22, P31	512 x 390*	12-inch	25 x 80	HP-HIL, IM, PC, PP, SS

\* These terminals are not supported as graphics devices by HP-UX.

### Discussion of Terms

- **Features** – a quick summary of the major distinguishing features of the terminals. If the feature is uppercase, it is standard; lowercase, it is optional.
  - DP – Dual Port – can connect to two hosts
  - HP-HIL – HP-HIL input devices are supported
  - IM – An Internal Model is available
  - IP – An Internal Printer is available
  - PC – Terminal is also a Personal Computer
  - PP – Printer Port is available
  - SS – Has Smooth Scrolling capability

The phosphors are:

- EL – Electroluminescent (black or amber)
- LCD – Liquid Crystal (black on white)
- P22 – Full Color
- P31 – Green
- P188 – White
- P194 – Amber

- **Alpha Resolution** – listed in lines x columns. Terminals with more than 24 lines use the additional lines for softkey labels and/or terminal status messages. All terminals (except the Portable and Integral) display characters at an effective resolution of 9 x 14 or better (7 x 11 with half-dot shifting).



## Series 300 Printers

A wide range of printers is available for Series 300 computer systems, varying in price, performance, and print

technology used. The following table summarizes these supported printers.

Product No.	Speed*	Technology	Character Resolution	Paper Size	Graphics Resolution
2225A/D <i>ThinkJet</i> printer	150 cps	Inkjet	11 x 12	8.5	96 x 96
2227A <i>QuietJet Plus</i> printer (RS-232C)	160/40 cps	Inkjet	19 x 32 Near Letter Quality	8.5/15	96 x 96, 192 x 192
2227B <i>QuietJet Plus</i> printer (HP-IB)	160/40 cps	Inkjet	19 x 32 Near Letter Quality	8.5/15	96 x 96, 192 x 192
2228A <i>QuietJet</i> printer	160/40 cps	Inkjet	19 x 32 Near Letter Quality	8.5/11	96 x 96, 192 x 192
2235B <i>RuggedWriter 480</i> printer	240/480 cps	DMI	36 x 24 Letter Quality	8.5/15	90 x 90, 180 x 180
2276A <i>DeskJet</i> printer	120/240 cps	Inkjet	300 dpi	8.5/11 8.5/14, A4	75 - 300 dpi
2563B	300 lpm	LIDM	5 of 13 x 7	16.7	70 x 72, 140 x 144
2564B	600 lpm	LIDM	5 of 13 x 7	16.7	70 x 72, 140 x 144
2566B	900 lpm	LIDM	5 of 13 x 7	18.0	70 x 72, 140 x 144
2603A	45 cps	FCI	Full	16.7	N/A
2684A/D/P <i>LaserJet 2000</i> printer	20 ppm	Laser	300 dpi	8.5/11	75 - 300 dpi
33440A <i>LaserJet Series II</i> printer	8 ppm	Laser	300 dpi	8.5	75 - 300 dpi
2932A	200 cps	DMI	9 x 12	15	90 x 90
2934A	200 cps	DMI	9 x 12, 36 x 24	15	90 x 90
3630A <i>PaintJet</i> color graphics printer	167 cps	Inkjet	30 x 15	8.5	180 x 180

\*Speed Key    cps - characters per second    dpi - dots per inch    LIDM - Line Impact Dot Matrix    lpm - lines per minute    ppm - pages per minute

The Series 300 operating systems do not require a printer. The selection of a printer depends entirely on your intended use. There are several criteria you may wish to use.

- Speed - expressed in characters per second (cps), lines per minute (lpm) or pages per minute (ppm) depending on the print technology employed. For program development, where the typical program listing is 60 lines per page with an average of 60 characters per line, cps approximately equals lpm, and you can convert ppm to lpm by multiplying ppm by 60. For 132 column reports, convert cps to lpm by multiplying cps by 0.45 (the lpm/ppm relationship is unchanged).
- Technology - The choice of impact vs non-impact printing technology affects other criteria, primarily multiple part printing (possible only with impact) and noise (non-impact is quieter). Thermal printers also require special paper which is typically more expensive than impact paper. The abbreviations used are:
  - DMI - Dot Matrix Impact
  - FCI - Full Character Impact (e.g., Daisywheel)
  - Inkjet - Thinkjet non-impact dot-matrix
  - Laser - Laser Page Printing, non-impact
  - Thermal - Thermal non-impact dot-matrix
- Character Resolution - This is the number of horizontal X vertical dots used in the character cell. The 2560 series printers use half-dot shifting and can place the horizontal dots at about twice as many locations for higher apparent resolution. Those printers which list two resolutions have a "high density" mode (at lower speed).
- Paper Size - HP printers handle 8½-inch wide or 14-inch wide paper. Most can handle paper narrower than their maximum size. Refer to separate printer data sheets for more information.

- Graphics - Most HP printers can print monochromatic single-level grey scale graphics images. The *HP PaintJet* color graphics printer is capable of producing thousands of colors through software controls. Where the printer has graphics, the resolution in dots per inch (dpi) is given. A range of resolutions is given for printers which can scale their graphics.
- Fonts - All HP printers have at least one built-in printing font. Most offer additional fonts in one of the following forms:
  - Disc - Interchangeable printwheel
  - Cartridge - Plug-in ROM cartridge
  - ROM - Fixed selection of ROM fonts
  - Soft - Downloadable software

## Series 300 Graphics Plotters

The Series 300 computer systems support several graphics plotters as well as the ability to direct a screen image to a dot-matrix printer for hardcopy.

Many printers can generate a hardcopy of a displayed CRT image. This method is faster than plotting, but is limited to a single color.

Plotters provide high-resolution multiple-color hardcopy of graphics. This requires re-executing the program which generated the CRT image and directing its output to the plotter.

- Media Size - shown per ANSI nomenclature. ANSI/ISO sizes are A/A4, B/A3, C/A2, D/A1 and E/A0.
- Mechanical Resolution - shown in mm. The addressable resolution typically is different.
- Pen Speed - shown in cm/sec.

Product No.	Media Sizes	Mechanical Resolution	Pen Speed	Pen Acceleration	Number of Pens	Media Feed	Pen Types*
7440A	A	0.025	40	1.2g	8	Manual	P, T
7475A	A, B	0.025	38	2g	6	Manual	P, T
7550A	A, B	0.00625	80	6g	8	Sheet	D, P, R, T
7570A	C/D	0.013	40	2.8g	8	Manual	D, P
7595A	A - E	0.00625	60	5.7g	8	Manual	D, P, R, T
7596A	A - E	0.00625	60	5.7g	8	Roll	D, P, R, T
*Pen Types Key: D - Drafting P - fiber-tip Paper R - Roller ball T - fiber-tip Transparency							

## Series 300 Cabinets and Racks

There are several cabinets, workstation tables, and EIA racks available. The Computer User's Catalog (Part Number 5953-2450) lists accessories for your computer system. The HP Catalog (Part Number 5954-0168) lists EIA rack mount accessories available, and the following table lists Series 300 adaptors available for mounting into a 19-inch EIA rack.

19-inch EIA rack-mount adapters have the following vertical height specifications:

### Product No.

### Height

98569A:	
SPU only	178 mm (7 inches)
SPU and expander	312 mm (12.25 inches)
98567A/B	400 mm (15.75 inches)
19500B	132.6 mm (5.25 inches)
19512A	269.24 mm (10.6 inches)
35490A	279.4 mm (11 inches)

## 19-inch EIA Rack-mount Adaptors

Product No.	Description
98569A	For 5-unit high 325 mm-wide, 376 mm-deep devices (full support for Series 300 SPU and Expander)
19500B	For one or two 78 mm, 104 mm, or 130 mm-high, 325 mm-wide, 285 mm-deep devices (no support for Series 300 SPU or Expander)
19512A	For 7936/37 (307/571 Mbyte) disc drives
35490A	For 3540 1/4-inch tape autocharger
98567A	For 35731A/B monitors
98567B	For 35741A/B monitors

## Series 300 Cabinets (interior dimensions)

Cabinet Model	Description	Depth (mm)	Height (mm)	Height in Design Plus Units (1 unit = 26 mm)	Rails or Shelf
92211M	Roll-around rack	375	341	13	Included
92211L	Roll-around rack	474	523	20	Included
92211R	Roll-around rack	705	575	22	92211S
98787B	Tilt and swivel unit for the 98751A, 98752A, 98785A or 98789A monitors	330	76	3	N/A
92213B	CAD mini-workstation table with pull-out work surface, keyboard drawer and monitor platform	711-914	Table: 720 Monitor Platform: 749	N/A	N/A
92213D	"C"-size drawing holder with extension arm. Attaches to 92213B table.	N/A	N/A	N/A	N/A
19511A	Roll-around rack for 7936/37 disc drives	705	575	22	Included

The 92211L/M/R Design Plus cabinets accept 325 mm-wide HP computers and peripherals. Wider computers and peripherals (such as the 9888A Bus Expander) may be placed on top of the 92211L/M cabinets or in the bays of the 97064A table or 9221OR storage module.

All cabinets are open front. A 92211T filler panel kit is available for the 92211R cabinet. None of the cabinets include a power tap.

The height of Design Plus devices may be expressed in Design Plus units. Each unit is 26 mm. The 92211 cabinet rails may be installed at vertical intervals of one unit. All devices in the cabinet may stack on a single rail set. The 9706A table has one moveable shelf in each of its two equipment bays.

## Series 300 Interfacing Capabilities and Enhancements

In addition to built-in HP-IB, HP-HIL and RS-232C interfaces, Series 300 offers a choice of plug-in interface enhancements\*:

- Series 300 DOS Coprocessor System (98286S)
- LAN/300 Link (98643A)
- Shared Resource Management Interface (50962A)
- Datacomm Interface (98628A)
- Programmable Datacomm Interface (98690A, 98691A)
- 4-channel RS-232C Multiplexer (98642A)
- Serial Interface (98626A, 98644A)
- Floating Point Accelerator (98248A)
- Floating Point Math Card (98635A)
- 2-channel DMA Controller (98620B)
- High-speed HP-IB Disc Interface (98625B)
- SCSI Single-ended Board (98265A)
- 128 Kbyte Bubble Memory Card (98259A)
- 256 Kbyte EPROM Card (98255A)
- Breadboard Card (98630A)
- GPIO Interface (98622A)
- HP-IB Interface (98624A)
- PC Instruments Interface (98647A)
- 6944A Multiprogrammer Interface (98633A)
- VMEbus Expander (98577A)
- VMEbus Interface (98646A, 98385A/R)
- BCD Interface (98623A)
- 7-channel Analog-to-Digital Interface (98640A)
- EPROM Programmer System (98253A)
- 256 Kbyte RAM Card with Parity (98256A)
- 1 Mbyte RAM Card with Parity (98257A)
- Color Video Interface (98627A)

For more information on the interfaces or language support, refer to the applicable section(s) below and on the following pages, or consult the *Series 300 Configuration Reference Manual*, Part Number 98561-90020.

## Series 300 DOS Coprocessor

The 98286S DOS Coprocessor System provides IBM PC AT software compatibility for the Series 300. The addition of the DOS Coprocessor provides access to thousands of compatible MS®-DOS based programs for use on the Series 300, including such popular applications as

Lotus 1-2-3®, Wordperfect®, and R:BASE® System V. Due to innovative design and unique operating characteristics, this second generation system typically provides superior interactive DOS/UNIX performance uncharacteristic of systems of this type.

The System is comprised of an 80286-based Coprocessor DIO I card (with socket for an optional 80287 Numeric Coprocessor, product number D1387A) and associated emulation software. The system requires the latest revision of HP-UX, minimum Application Execution Environment (AXE), and works with either the Models 310, 320, 330<sup>‡</sup> or 350<sup>‡</sup> SPUs using a variety of supported display systems. In order to provide compatibility with "off-the-shelf" PC AT software, the 9127A 5¼-inch 360K flexible disc drive is available. To provide international support, emulation is provided for 17 different localized keyboards (across North America and Europe).

A high level of DOS and UNIX integration is provided, allowing DOS to run as an HP-UX task within or separate from the HP Windows/9000 system. Capabilities are provided that allow the DOS user to transparently access and share the HP-UX file system through a standard logical DOS drive letter identifier (D:). In addition, filters are provided that allow easy translation of ASCII files between DOS and HP-UX format. Users of HP 110s, HP 150s, or 720K 3½-inch disc PC-compatible machines can also transfer DOS files between the systems using special HP-UX file interchange capabilities via 3½-inch media and associated drives.

The system emulates many popular IBM PC accessory cards using specialized software and existing Series 300 hardware resources. While it depends upon the actual Series 300 configuration, this results in the emulation of a powerful PC AT system including expanded memory (over 4 Mbytes can be supported), printers, plotters, and even the system mouse (allowing the HP-HIL mouse to emulate the MS mouse). A variety of PC I/O emulation/redirection is provided to allow standard HP connected devices (i.e., RS-232C or HP-IB) to be used transparently as DOS devices via emulation of standard PC interfaces (RS-232C and Centronics).

While a minimum of the AXE portion of the HP-UX operating system is required, the system can easily be used in a typical BASIC/Pascal environment. The system can be configured in the "auto-boot" mode that allows a DOS session to be started and ended with no HP-UX interaction. In fact, when used in this configuration, very little HP-UX knowledge is required. A user-friendly installation procedure allows the user, even if he or she has virtually no HP-UX or DOS knowledge, to completely install a DOS Coprocessor system in under 15 minutes. Please refer to the *DOS Coprocessor Technical Supplement* (Pub. No. 5954-9390) for more detailed technical information.

\* Not all interfaces work with all operating systems. Please check the appropriate operating system technical data for support information.

‡ Models 330 and 350 require an available DIO slot. Lotus 1-2-3 is a registered trademark of Lotus Development Corporation. Wordperfect is a registered trademark of Wordperfect Corporation. R:BASE System V is a registered trademark of Microrim. MS is a registered trademark of MicroSoft Corporation.

## LAN/300 Link

The LAN/300 Link interface card provides both protocol management (Ethernet or IEEE 802.3) and electrical levels of communications on the 10 megabit/second local area network. The LAN/300 Link is used by both Series 200 and Series 300 systems, utilizing the NS/200 and NS-ARPA Services/300 software. The LAN/300 Link Interface can be attached to either a thin cabled LAN (RG58) or thicker cabled LAN.

## Shared Resource Management Coax Interface

The 50962A SRM interface is part of the connection between the computer and an SRM Server. The SRM system (HP 50960A) is a dedicated file and printer/plotter server for HP 9000 workstations. It provides the capability to share resources such as discs, printers and plotters among a local cluster of workstations including the Series 200, 300, 500, and Vectra with the BASIC or Pascal Language Processor installed.

The hardware link between the workstation and the server is provided by a coax network. The coax network features a thin coaxial cable connected in daisy-chain fashion from node to node. Up to 25 nodes can be connected for up to a total length of 1000 meters on a single network. Multiple coax networks may be connected to a single server or workstation as long as sufficient interface slots are available. The 92227X Coax Cables are available in a variety of lengths.

## RS-423/RS-232C Data Communications Interface

The 98628A Data Communications Interface provides buffered data transfer, protocol management and appropriate electrical levels for asynchronous serial communications. This card also supports the Distributed System Network/Data Link (DSN/DL) protocol for communications to an HP 1000 minicomputer. A terminal emulation program, which takes advantage of this card for communication to other computers, is available. Programs written in BASIC or Pascal can communicate through this interface. HP-UX offers drivers compatible with this card as well.

### Electrical Interface Capabilities

- RS-232C, V.24/V.28
- RS-449
- RS-423, V.10

### Data Rates and Formats

All signals present at the 98628A interface card's connector conform electrically to EIA RS-232C and CCITT V.28/V.24 specifications. Data formats include 5, 6, 7 or 8 bits/character and 1, 1.5 or 2 stop bits. Odd, even or no parity is selectable and fixing the parity bit to 0 or 1 is also selectable.

Standard data rates available with internal clocking: 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 3600, 4800, 7200, 9600, 19,200.

## Interrupt Capability

The 98628A Serial Interface Card is capable of generating interrupts to the computer. The interface can be programmed to interrupt on the following conditions:

### ASYNCR

- Data or control block available
- Prompt received
- Framing and/or parity error
- Modem line change (DSR, DCD, CTS, RI)
- No activity timeout
- Lost carrier or connection timeout
- End-of-line received
- Break received

## Programmable Datacomm Interface

The Programmable Datacomm Interface product provides a spectrum of capabilities that can be tailored to meet special datacomm and/or serial interfacing needs. The product consists of two pieces – the Development Package (98690A) and the interface card (98691A). The 98690A Development Package contains the essential information and tools required by a sophisticated user to do firmware programming of the 98691A Programmable Datacomm Interface. The 98691A is a microprogrammable interface which is intended to be a foundation for designing application-oriented communications products. It is based on the Z-80 CPU, Counter Timer Chip and Serial I/O chip.

### Data Rates and Formats

The Z-80A Counter Timer Chip provides one system timer, and a programmable baud rate for the SIO channel. Available speeds follow:

- Synchronous: maximum 460 Kbaud; minimum 50 baud.
- Asynchronous: maximum 57 Kbaud; minimum 50 baud.
- The maximum speed with an external clock is 736 Kbaud for synchronous communications.

Data formats provided by the Z-80 SIO chip are 5, 6, 7 or 8 bits/character and 1, 1.5 or 2 stop bits, odd, even or no parity for asynchronous communications. The SIO chip supports CRC-16 or CCITT block frame check for Synchronous operations.

### Electrical Interface Compatibility:

- RS-232C, V.24/V.28
- RS-449
- RS-423, V.10
- RS-422, V.11 (with user-built cable)

## 4-Channel Asynchronous Multiplexer

The HP 98642A Multiplexer provides four asynchronous RS-232C-compatible ports on a single interface. Three ports are intended for local or direct connection. The fourth port can be used either locally or to interface to RS-232C-compatible modems. A wide range of selectable transmission modes and formats permits three hardwired and one remote connection of various terminals, printers, plotters and other asynchronous devices.

## Features

- Four full duplex asynchronous serial I/O ports
- One port with 10-wire full duplex modem control capability
- EIA RS-232C, CCITT V.28 compatibility
- Programmable data rates for each port up to 19.2 Kbaud
- Programmable character size: 5, 6, 7 or 8 bits/character
- Programmable parity: odd, even, none
- Programmable number of stop bits: 1 or 2
- Parity, overrun, framing error check detects transmission faults
- Firmware-based self-help text helps assure interface integrity
- On-board buffering: eight circular FIFO data buffers; four (128 character) receive buffers and four (16 character) transmit buffers (one for each port).
- Programmable interrupt interval
- Special character recognition
- System console support

## RS-232C Serial Interfaces

The 98626A and 98644A Serial Interfaces provide bit-serial communication between the computer and asynchronous EIA RS-232C (CCITT V.28/V.24) devices. Data rates range from 50 to 19,200 baud (bits/second). A variety of cabling options allow for terminal and peripheral connections. Terminal emulation software, BASIC and Pascal programs, and the HP-UX operating system can communicate with other RS-232C devices using this interface.

## Interrupt Capability

The 98626A/98644A Serial Interfaces are capable of generating interrupts under the following conditions:

- Receive buffer full
- Transmitter buffer empty
- Receive buffer overrun error
- Received character parity error
- Received character framing error
- Received break indication
- Carrier detect line change
- Clear-to-send line change
- Data-set-ready line change
- Ring indicator change from on to off

This interrupt capability allows the interface to operate in a full duplex fashion when information is input under interrupt control while information is output by standard write commands.

## Floating Point Accelerator for Models 330 and 350

The 98248A Floating Point Accelerator increases the performance of the Model 330 or 350 by up to three times, as measured by popular floating point benchmarks.

The 98248A is configured as a two-board assembly which occupies one DIO II slot of the Model 330 or 350 SPU. The assembly contains specialized floating point math chips and control circuitry which perform the operations of addition, subtraction, multiplication and division. In addition to the connection to the DIO II bus, the FPA connects to the Model 350 "system bus." This

high-speed communication link between the CPU, RAM and FPA allows maximum performance of the FPA when used with the Model 350.

## Floating Point Math Card

The 98635A Floating Point Math Board enhances the performance of the Model 310 systems and supports the proposed IEEE standard for binary floating point numbers. With this board, the computational performance can be increased up to three times. Performance, however, is highly dependent on the application, language and operating system.

## DMA Controller Card

The 98620B DMA Controller Card enhances the Series 300's interfacing capability by providing two DMA channels for I/O data transfer. This high-speed I/O capability works with the 98622A GPIO, 98624A HP-IB and internal HP-IB interfaces and the 98625B disc interface. Although the 98620B can accommodate DMA transfer rates up to the memory cycle rate (approx. 1.2M transfers/sec), lower DMA rates can be expected because actual rates are dependent on a number of factors. The typical maximum transfer rate for the 98622A GPIO Interface is approximately 750K transfers per second; for the 98624A and internal HP-IB interfaces approximately 330K transfers per second; and for the 98625B Disc Interface approximately 750 Kbytes per second.

## Disc Interface

The 98625B (for Models 310 and 320) and 98626A (for Models 330 and 350) High-speed HP-IB Disc Interfaces provide an interface to the Command Set 80 discs (79XX) that offer the maximum transfer rate available. The interfaces, when used with the 98620B DMA card in Models 310 and 320 (built-in DMA in Models 330 and 350), allow buffered DMA data transfers between the Series 300 system and the Command Set 80 disc. The interfaces allow up to eight discs to be connected to one interface card. It is recommended that a 98620B DMA card be included in any Model 310 or 320 using a 98625B, as little performance improvement is seen over a 98624A unless a DMA card is installed.

## DMA Capability

- Burst Mode DMA transfer (Word Mode)

## SCSI Interface

Two single card implementations of the SCSI protocol are available. One card is designed for the Models 330 and 350 and is available both as an SPU option (Opt. 011) and as a customer-installable product (98265A). The other card is for the Model 319 and is only available as an SPU option (Opt. 011). Both interface cards conform to the industry standard defined by the document ANSI x3.131-1986.

These cards are installed in the SPU without consuming any I/O slots. A 98265B external HP-IB disc interface may be used concurrently with SCSI. For more information on the SCSI I/F cards, please see the *HP 9000 Series 300 SCSI Cards Hardware Data sheet*, Pub. No. 5951-6800.

## 128 Kbyte Bubble Memory Card

The 98259A Magnetic Bubble Memory Card features 128 Kbytes of non-volatile data storage. The 98259A provides increased reliability and durability over flexible disc storage in adverse environmental conditions.

### Access Times and Data Transfer Rates

Access time:

Average . . . . . 42 milliseconds

Worst case . . . . . 90 milliseconds

Average transfer rate:

Input . . . . . 8 Kbytes/second

Output . . . . . 8 Kbytes/second

## EPROM Card

The 98255A EPROM Card contains 16 sockets for EPROMs to allow up to 256 Kbytes of storage using Intel 27128 EPROMs or equivalent. 128 Kbytes of storage are available using Intel 2764 EPROMs or equivalent. EPROM integrated circuits must exhibit access times of 250 nanoseconds or less. EPROM integrated circuits must be used as pairs (2, 4, ... 16). The EPROM cards acts as a mass storage device.

## Breadboard Card

The 98630A Breadboard Interface allows experienced hardware designers to design their own custom interface to the computer when none of the interface cards provided by HP will fit a particular requirement. The interface consists of a printed circuit board with the necessary buffering to properly interface to the Series 200 or 300 backplane. Most of the space on the board contains tinned holes on standard centers to allow a prototyping area for custom interface design.

Board space for prototyping: 96 square cm (15 square inches). Hole patterns are on 100 mil centers.

## GPIO Interface

The 98622A GPIO Interface provides 16 bits of latched input or 16 bits of latched output data with handshake control lines for bi-directional transfer of information. Extended control and status lines are available for applications that require more than one signal from the computer. Several handshake modes are user-selectable to permit interfacing to a variety of equipment.

### Data Input/Output and Handshake Control Signals

There are 16 input data lines and 16 output data lines. The input data lines are terminated by a resistive divider of 3K Ohms to +5V and 6.2K Ohms to ground accepting standard TTL signals. The Output lines provide high current/voltage drivers, using open-collector buffers.

### Interrupt Capability

The 98622A is capable of generating interrupts to the computer under the following conditions:

- Handshake complete
- Device ready
- Transfer complete

### DMA Capability

The 98622A is capable of carrying out DMA transfers. The following DMA capabilities are supported by the 98622A:

- Word or Byte Mode DMA
- Regular or Burst DMA transfer

## HP-IB Interface

In addition to the standard built-in HP-IB interface, there is an optional external 98624A HP-IB Interface Card. Both interfaces implement the IEEE 488-1978 Standard Digital Interface for Programmable Instrumentation. Both interfaces can communicate with as many as 14 HP-IB compatible instruments, connected with a maximum of 20 meters (65.6 ft.) of cable.

### Interrupt Capability

The internal and 98624A HP-IB interfaces are capable of generating interrupts under the following conditions:

- Controller addressed
- Talker addressed
- Listener addressed
- Service Request (SRQ) detected
- Parallel Poll configuration change
- EOI received
- Serial Poll active
- Remote/Local configuration change
- MY address mode change
- Group Execute Trigger received
- Source handshake error
- Unrecognized universal command
- Unrecognized address command
- Secondary command received
- Device Clear received
- Interface Clear detected

### DMA Capability

The internal and 98624A HP-IB interfaces are capable of carrying out DMA transfers via the optional two-channel 98620B DMA Controller Card. The following DMA capabilities are supported:

- Byte Mode DMA
- Regular DMA transfer (no burst DMA)

## PC Instruments Bus Interface

The 98647A PC Instruments Interface connects the computer to a family of low cost instrument modules. Modules available include a 50MHz Oscilloscope, a 4½ Digit DMM, a 100 MHz Counter, a 5 MHz Function Generator, an 8-Channel Relay MUX, an 8-Channel Relay Actuator, a 12-Bit Dual Voltage D/A, a 16-bit Digital I/O, a 50 Volt Power Supply, 20 Volt Power Supply, a 300 MHz Dual VHF Multiplexer, and a Breadboard Module. A unified command set, included with the interface, simplifies the generation of BASIC control programs by allowing many of the parameters to be entered directly through a mouse or Touchscreen.

## HP 6944A Multiprogrammer Interface

The HP 98633A Interface connects the computer to the 6944A Multiprogrammer, a 16-slot, instrument cardcage, which can be customized to a wide variety of applications. A family of over 25 plug-in cards provide simultaneous buffered A/D measurements to 500 kHz, D/A, counter, digital I/O, relay, and power supply control capabilities. Continuous data transfer to disc at speeds of up to 200 KHz are also available.

## VMEbus Expander

The HP 98577A VMEbus Expander connects directly to the HP Model 330 and 350 workstations to provide highly transparent access to the industry-standard VMEbus revision C.1. The expander provides four available slots for installation of revision C.1-compatible VMEbus cards. A fifth slot is occupied by the interface and system controller card. The HP 98577A VMEbus Expander housing is the same size as Models 330, 350 and the HP 98570A DIO II Expander.

Supported configurations include:

- Model 330\* or 350 with one HP 98577A VMEbus Expander and HP-UX 6.0 or later revision
- Model 330\* or 350, one HP 98570A DIO II expander, and one HP 98577A VMEbus Expander and HP-UX 6.0 or later revision

Porting Existing "kernel-level" drivers or writing new drivers for third-party VMEbus cards is made easier by the Series 300 HP-UX Driver Development Guide supplied with each VMEbus Expander. Use this documentation to customize existing C language drivers or to write entirely new drivers. Drivers written expressly for the HP 98646A VMEbus Adapter must be re-written to take advantage of the kernel-level access.

### VMEbus Expander Features

- Supports both DIO II and VMEbus masters
- Supports all VMEbus arbitration levels
- Supports VMEbus hardware vectored interrupts
- Peak hardware data transfer rate of 5 Mbytes per second
- Total solutions – VMEbus card cage, power supply, system controller, bus converter and documentation

### VME Technical Specifications

#### Design Specifications

Design reference . . . . . VME Specification Revision C.1, HP DIO II bus specification

#### VME Slot 1 functions:

Bus arbiter . . . . . Priority, round-robin (software selectable)  
 Interrupts . . . . . IACK daisy-chain driver  
 System clock . . . . . 16 MHz  
 VMS bus . . . . . Not supported  
 VMS clock . . . . . Not supported  
 Bi-directional DMA . . . . . Supported in A32 mode only

Maximum hardware transfer rate . . . . . 5 Mbytes per second

#### Address translation width:

DIO II to VME . . . . . 16-bit, 24-bit, 32-bit addresses  
 VME to DIO II . . . . . 24-bit, 32-bit addresses

#### Data translation width:

DIO II to VME . . . . . 8-bit (even,odd), 16-bit, 32-bit  
 VME to DIO II . . . . . 8-bit (even,odd), 16-bit, 32-bit

#### Address translation range . . . . 4 Mbyte to 4 Gbyte

#### VME address modifiers (in hex):

Generates . . . . . 29,39,09 (short, standard and extended non-privileged data access)  
 Receives . . . . . 39, 3a, 3d, 3e (std, non-block tfr) 09, 0a, 0d, 0e (ext, non-block tfr)  
 Bus daisy chains . . . . . IACK, BG3, BG2, BG1, BG0  
 DIO bus arbitration positions . . . . . xbg1, bg, bg1, bg2 (switch selectable)  
 Bus grant/Acknowledge . . . . . RWD (Release When Done), ROR (Release On Request)

#### Incremental cycle translation time

Best case . . . . . 125 nsec  
 Worst case . . . . . 400 nsec  
 Typical . . . . . 250 nsec

#### Protocols:

Block transfer . . . . . Not supported  
 Read-modify-write . . . . . Supported  
 Unaligned transfers . . . . . Supported on Model 350 only  
 Address pipelining . . . . . supported on VME master to DIO slave transactions

#### Watchdog timers:

Bus error . . . . . 6  $\mu$ sec via DIO processor board  
 Interrupt acknowledge . . . . . 6 $\mu$ sec via DIO processor board  
 Bus arbitration . . . . . None

#### Interrupt levels:

DIO to VME . . . . . None  
 VME to DIO . . . . . Levels 7 through 1, maskable<sup>†</sup>

#### Signals:

STSRESET . . . . . Supported  
 Booting from VMEbus interfaces . . . . . Not supported

#### Optional signals:

ACFAIL, SYSFAIL, +5STANDBY and SERDAT . . . . . Not supported

\* Model 330 systems sold prior to January 1988 may require replacement of the processor board. Contact your local HP service office for Service Note 98562A-1.

† Both single-handler systems and distributed systems are supported and interrupts are automatically handled by the workstation processor.

## Power Specifications

Input voltages	90–132 Vac or 180–264 Vac (switch selectable)
Line frequency	50–60 Hz
Power consumption:	
Watts (maximum)	175
BTU/hr	595
Total power available from VMEbus slots:	
Power at +5V	36.4 Watts
Power at +12V	24.0 Watts
Power at –12V	24.0 Watts

## Physical Dimensions

Height	130 mm (5.12 in.)
Width	325 mm (12.8 in.)
Depth	376 mm (14.8 in.) Allow an additional four inches for interface cables.
Net weight	10 kg (22 lbs.)

## Environmental Range

Operating temperature	0° to +55°C
Humidity	5% to 95% relative, non-condensing

Maximum wet-bulb temperature	40°C
Storage environment	–40° to +71°C
Maximum operating altitude	4,572m (15,00 ft)
Maximum survival altitude	15,240m (50,000 ft)
EMI	Conducted and radiated interference meets FCC Class A; VDE 1046/84 Level B; VCCI Class 1
Additional regulatory compliance	UI 478, 5th Edition; CSA 22.2 No. 154 and 220; IEC 380, 2nd Edition; IEC 435, 2nd Edition

## VMEbus Interface

The VMEbus Interface provides bi-directional data transfer capabilities between the Series 300 and the VMEbus (IEE P1014), permitting configurations of both HP-IB and VME systems. The package consists of the HP 98646A VMEbus Interface hardware and HP 98385A/R VMEbus Driver Software. The hardware consists of two cards connected by two shielded flat cables. The DIO card fits into the backplane of the Series 300. Select code and DIO interrupt level are configurable on the card. The VME master module fits into any standard double height VMEbus Rack. The VME arbitration channel is configurable on the card, allowing communications between VME Arbiter and Masters. The 98385A/R drivers are supplied for all three operating systems: BASIC, Pascal, and HP-UX.

## Data Rates and Formats

The 98646A provides 24-bit addressing and either 8- or 16-bit data transfers. Data transfer rates are shown below:

16.6 MHz 68020	Output	Input
BASIC/Pascal	1.3 Mbytes/sec	1.3 Mbytes/sec
HP-UX	950 Kbytes/sec	959 Kbytes/sec

## Interrupt Capability

The 98646A and 98385A/R support all seven VMEbus interrupt levels. The interrupt priority of the DIO to the Series 300 computer and the Bus Request (BR) and Bus Grant (BGIN/BGOUT) channels of the VMEbus are switch-selectable. The arbitration function is not built into the 98646A, but the set of lines used for arbitration are switch-selectable on the VMEbus card.

## DMA Capability

- DMA capability is not currently supported.

## BCD Interface

The 98623A BCD Interface connects the computer with bit-parallel, digit-parallel, binary-coded decimal devices for data input. Up to eight significant BCD digits, two sign bits (mantissa and exponent), exponent digit, function code digit, and an overload bit can be read. Input format is selectable, allowing two independent instruments to be read from one 98623A Interface Card. Data can also be accepted as five input bytes of pure binary information. Eight data output lines are also provided for use as general purpose control and/or data output lines.

## Interrupt Capability

The 98623A BCD Interface is capable of generating interrupts to the computer under a peripheral ready condition.

## Analog Input Interface

The 98640A Analog Input Interface is an analog to digital converter for Series 300 systems. It provides a low cost, easy-to-use data acquisition solution for low point count applications. Communication to the interface involves reading or writing to appropriate locations on the card or calling subroutines in the 98645A Measurement Library from BASIC or Pascal environments. The 98640A provides the following features:

- Seven differential input channels plus one channel for referencing
- 55,000 samples per second to system memory
- 13-bit resolution (includes sign bit)
- Four programmable input ranges
- Input overvoltage protection
- 90 dB common mode rejection at 60 Hz
- Internal and external pacing/triggering
- Successive approximation analog to digital converter
- On-board crystal-controlled clock



Aperture time of sample  
and hold .....25 nanoseconds  
Temperature coefficient for  
voltage offset .....10 microvolts per degree C  
Time from first read to hold  
at 55 KHz.....7 microseconds  
Linearity ..... .02% of full scale  
Input resistance (on each  
channel).....100 megohms

## Warranties

The warranty covering a specific system is determined by the HP WARRANTY AND INSTALLATION TERMS in effect at the time of purchase. These terms are specified in HP Pub. No. 5954-1617(D) for the United States and in similar documents for other countries.

