Model 319C+ Workstation's SPU Service Information Manual

HP 9000 Series 300 Computers
Model 319C+

HP Part Number 98564-90030

HEWLETT PACKARD

Printing History

New editions of this manual will incorporate all material updated since the previous edition. Update packages may be issued between editions and contain replacement and additional pages to be merged into the manual by the user. Each updated page will be indicated by a revision date at the bottom of the page. A vertical bar in the margin indicates the changes on each page. Note that pages which are rearranged due to changes on a previous page are not considered revised.

The manual printing date and part number indicate its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates which are incorporated at reprint do not cause the date to change.) The manual part number changes when extensive technical changes are incorporated.

November 1987...Edition 1

Notices

Radio Frequency Interference Statements

FCC Statement

Federal Communications Commission
Radio Frequency Interference Statement
(U.S.A. Only)

The Federal Communications Commission (in Subpart J of Part 15, Docket 20780) has specified that the following notice be brought to the attention of the users of this product.

Warning: This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

VCCI Statement (Japan Only)

この装置は，第一種情報装置（商工業地域において使用されるべき情報装置）

で商工業地域での電波障害防止を目的とした情報処理装置等電波障害自主規制

協議会（VCCI）基準に適合しております。

従って，住宅地域またはその隣接した地域で使用すると，ラジオ，テレビジ

ョン受信機等に受信障害を与えることがあります。

取扱説明書に従って正しい取り扱いをして下さい。

Manufacturer's Declaration (Germany Only)

Herstellerbescheinigung

Hiermit wird bescheinigt, daß dieses Gerät in Übereinstimmung mit den Bestimmungen der Postverfügung 1046/84 funkentstört ist. Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Safety Considerations

WARNINGs, CAUTIONs, and Notes

Warnings, cautions and notes are used throughout this document to alert the user to conditions of importance. They are used as follows:

- WARNINGS contain information which, if not observed, could result in injury to personnel or loss of life.

- CAUTIONS contain information which, if not observed, could result in damage to or destruction of equipment.

- Notes contain information that will assist you in accomplishing the job.

Examples:

WARNING

The power supply presents a hazard to personnel. Extreme care must be taken when connecting voltmeter probes to the test points. De-energize the product by turning it off and removing its power cord before connecting or removing test probes.

CAUTION

The printed circuit assemblies in this product are susceptible to damage by electro-static discharge. Extreme care must be taken when handling printed circuit assemblies. Use an Anti-static Workstation while handling printed circuit assemblies.

Note

Hewlett-Packard supports repair of this product only to the assembly level. The fault is diagnosed to the assembly that is causing the problem. That assembly is then replaced with a new or rebuilt one.

Information Locator

Finding Service Information

On the next page is a Service Information Locator. It shows where to find a variety of subjects dealing with servicing these products. To use this table, first find the type of information you need to reference in the left-hand column. Next, move to the right in that row to a referenced chapter number. Last, move up the column with the information's referenced chapter to the top. Across the top are manual titles and part numbers that have the information documented.

Chapter identifiers in the Locator use the following codes:

Chapter Number:	Numbers, such as 2. Inclusive chapters, such as 4-6.
Appendices:	Letters, such as A for Appendix A.
Entire Manual:	All
Varies:	* (Check Table of Contents or Index.)

In some cases, two or more references will be shown for a given information type. You should check all references to be sure you get the specific information you need.

For example, suppose you need to find out what the Repair Philosophy is for the Model 319C+ Workstation's SPU. Locating "Repair Philosophy" in the left-hand column, and moving to the right in that row, you'll notice that this information is in "Chapter 1" of a manual. At the top of this column is the manual's abbreviated title. Chapter 7 in this manual lists manual titles and part numbers for service information.

Service Information Locator

Manuals identified in this locator are abbreviated by their initials:

SIM	Service Information Manual		**IRM**	Installation Reference Manual
SHB	Service Handbook		**PIN**	Product Installation Note
CRM	Configuration Reference Manual		**TDS**	Technical Data Sheet/Price List
TTM	Series 300 Test Tools Manual			
SPM	Site Preparation Manual			

Service Information Locator

Service Information	SIM	SHB	CRM	TTM	SPM	IRM	PIN	TDS
Assembly replacement	2							
Block diagrams	1, 2	9						
Booting Operating Systems	4							
SPU tests	1, 5	2		1, 2, 3				
Configurations	1	3				All		All
CS/80 tests	1, 5	5		4				
Electrical requirements	1	1			3, A			*
Environmental requirements	1	2			4, A			*
Functional descriptions	3							
HP-HIL device tests				2, 3				
Installation	2	2	All		All	All	All	
I/O Bus architecture	1, 3							
Monitors	1	3	All		A	1		*
People who can help					1			
Options/Accessories	1, 3	3	All			All	All	*
Ordering spare parts	6	8						
Part numbers	6	8	All					
Peripherals	1	3	All					*
Preventive maintenance		2						
Product information	1	1	All		All	All	All	All
Product numbers	1	1, 3	All		A			All
Reference material	7	10	*			All		All
Self-tests	4, 5	5		1, 2				
Service notes	1	11						
Site preparation		2			All			
System Functional Tests	1, 5	5		1, 3				
Systems	1	3	All			All		*
Troubleshooting	5	4		All				
Turn-on	3, 4	4, 5				2		

Table of Contents

Chapter 2: Assembly Replacement

Chapter 3: Functional Description

Chapter 4: Boot ROM Functions

Chapter 5: Troubleshooting

Chapter 6: Parts Lists

Chapter 7: References

Product Information   **1**

Introduction

Workstations

Model 319C+ Color Workstations provide cost-effective performance for many applications with a true 32-bit CPU - the MC68020 operating at 16.67 MHz. An MC68881 floating-point co-processor augments system performance, supporting both single and double-precision floating-point arithmetic and transcendental math functions. Complementing this hardware is the Series 300 HP-UX operating system.

This workstation is well-suited for several design requirements of design engineers in electrical, mechanical, and software engineering. Many research applications previously requiring the power of a mainframe computer now can be executed locally on these powerful workstations.

The foundation of this workstation is the system processing unit (SPU). It uses a Design Plus case that holds the power supply, processor, memory and interfaces that support all the functions required for many system configurations.

Workstation Configurations

Several configurations are available. You should refer to the current *HP 9000 Series 300 Pricing Information and Technical Data Sheets* to find out exactly what is currently offered. Different amounts of memory and interface options are available for installation by qualified service personnel.

Features

Several useful features are available with the Model 319C+ Color Workstation. Table 1-1 lists these features.

Important Note

The Small Computer System Interface (SCSI) Option will not be available until a few months after the SPU's introduction. Contact your local HP Sales and Service Office for complete information.

Table 1-1. Model 319C+ Workstation Features

Product	Description
System Processing Unit	MC68020 CPU at 16.67 MHz MC68881 Floating Point Co-CPU, 16.67 MHz MC68851 Memory Management Unit, 16.67 MHz 4, 8, 12, or 16 Mbytes of RAM
SPU Interfaces	IEEE-488 HP-IB Interface RS-232C Serial Interface IEEE 802.3/Ethernet LAN Interface with ThinMAU Two channel DMA Controller RGB High-Res Color Video Output HP-HIL Optional Small Computer Systems Interface (SCSI) Optional High-Speed HP-IB
Monitor	HP 98785A High-Resolution Color, 1024 by 768 resolution.
Keyboard	HP 46021A (HP-HIL)
Operating Systems	HP-UX and NS/ARPA on 3.5-inch disc or 0.25-inch tape.
Options Available	
Opt. 010	Add High-Speed HP-IB Interface
Opt. 011	Add SCSI Interface (Available early 1988)
Opt. 022	HP-UX on 0.25-inch Tape
Opt. 045	HP-UX on 3.5-inch Disc
Opt. 060	Add HP 46060A Mouse
Opt. 084	Add HP 46084A ID Module
Opt. 108	8 Mbytes of RAM (Replace 4 Mbyte RAM with 8 Mbyte RAM)
Opt. 112	12 Mbytes of RAM (Replace 4 Mbyte RAM with 12 Mbyte RAM)
Opt. 116	16 Mbytes (Replace 4 Mbyte RAM with 16 Mbyte RAM)
Opt. 305	Add HP 50952B Opt. 022 NS-ARPA on 0.25-inch Tape
Opt. 306	Add HP 50952B Opt. 045 NS-ARPA on 3.25-inch Disc
Opt. 751	Replace HP 98785A 16-inch Monitor with HP 98751A 19-inch Monitor

SPU Physical Identification

Three different versions are available. Depending on the interface and add-on options, each version can be identified by the backpanel ports. Figure 1-1 shows each backpanel.
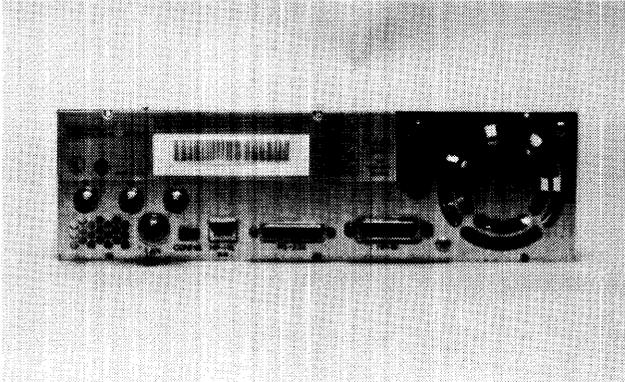
Figure 1-1a. Standard Model 319C+ Workstation SPU
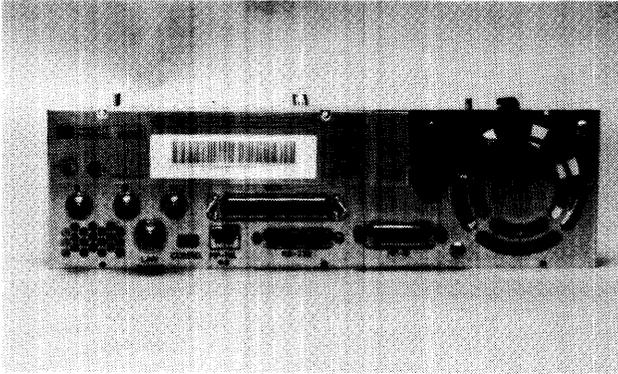
Figure 1-1b. Model 319C+ Workstation SPU with SCSI
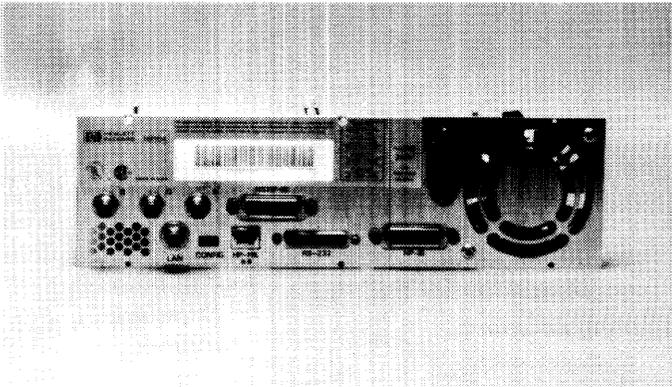
Figure 1-1c. Model 319C+ Workstation SPU with High-Speed HP-IB

Performance

The SPU provides 2 VAXIPS computational performance and offers high-performance graphics display capabilities to match the CPU. Model 319C+ SPU's are typically single-user workstations.

HP-UX-based applications for the following are typical:

- EE logical and physical design.
- 2D ME drafting.
- Low-end 2D mapping.
- Architecture, engineering and construction.
- HP-UX -based measurement automation.

SPU Hardware

Power Supply

A modular power supply is provided for the voltages required. No customer-accessible fuse is used. Instead the power supply has a fuse, that if blown, usually means the power supply should be replaced.

Processor Board

CPU Circuits
In addition to the MC68020 CPU, the processor board has a memory management unit (MMU) and two Boot ROMs. A floating-point co-processor, the MC68881, is also installed for increased system performance with many math routines. The processor board circuits are like the Model 330 computer's processor board. A speaker is also provided for an audio output.

Direct memory addressing is provided by a DMA chip integral with the processor board. A capacitor-backed real-time-clock provides time for about 12 hours should the SPU lose power.

Memory
Standard RAM consists of 4 or 8 Mbytes on the processor board. Additional RAM is available as an option to add 4 or 8 Mbytes for a total of up to 16 Mbytes of RAM.

In addition to either 4 or 8 Mbytes on the processor board, an add-on RAM board provides 4 or 8 Mbytes of RAM. Total system memory can be up to 16 Mbytes. RAM is auto-configuring which means there are no switches to set. As memory options are added, each 4 Mbyte block is configured below the existing memory.

Interfaces

Several interfaces on the processor board are used to couple the SPU to both user and system peripherals. These consist of:

- HP-HIL.
- HP-IB.
- RS-232.
- LAN.

A hole in the rear panel allows access to the LAN, HP-IB and RS-232 interface configuration switches on the processor board.

Bus Architecture

A 32-bit system bus connects to the video and I/O interface circuits. All memory operations are done on a separate memory bus.

Video Board

High-resolution color video is output to the workstation's monitor. Resolution is 1024 by 768 pixels. This board functions similar to the HP 98549A Low-Cost Graphics Interface used on other Series 300 computers.

One of two optional interfaces are available that are also located on this board:

- Small Computer Systems Interface (SCSI) (available early 1988).
- High-Speed HP-IB Interface

Only one of these interfaces is possible and which one is determined at point of sale.

Keyboard

Standard keyboard is the Integrated Terminal Format (ITF) HP 46021A Keyboard. It connects to the HP-HIL connector on the back panel.

The HP 98203C Keyboard is also supported but is not part of standard workstation bundled systems.

Operating Systems

HP-UX 6.0

The Model 319C+ Workstation's SPU can operate in a "compatibility mode" with the Model 330C and 350C computers when certain rules are followed.

For applications written in HP-UX, no operations may take place outside the confines of the Starbase Graphics Library. This means any operation which makes hardware-specific referenceds or which use *GESCAPES* under Starbase. Applications which have been linked to the 300H driver (for HP 98547A) in HP-UX versions 5.2 or 5.5 will operate on the Model 319C+'s SPU without changes. Applications which have been linked to the 300H driver in HP-UX versions 5.3 must re-link to the 300H driver under HP-UX version 6.0.

BASIC 5.1

Note

For use as a service tool only, BASIC 5.1 is supported on the Model 319C+ Workstation's SPU. BASIC 5.1 is not supported for user applications.

BASIC 5.1 (HP 98613C) is a revision of the Series 200/300 BASIC 4.0, Revision 4.03. BASIC 5.1 provides upward compatibility with BASIC 3.0 and 4.0. New for BASIC 5.1 is a Hierarchical File System (HFS) Binary. As a service tool, BASIC 5.1 permits fast booting of an operating system to check out the system. Simple, short programs may be used to verify the operation of peripherals or the SPU.

Product Identification

Several terms in this manual are used to describe and identify the various parts of the SPU. This section explains the terms used to improve your understanding of service information.

Identification Terms

Workstations Ordered by Customers.

A Model 319C+ Workstation is ordered by HP field offices for customers. This Model number refers to the products in the workstation, including the SPU. The proper term for the SPU is the Model 319C+ Workstation's SPU. It does not have a product or model number, nor should it be referred to as a computer.

Serial Numbers

The Model 319C+ Workstation's serial number is on the SPU's rear panel. Other equipment in the workstation will also have its own serial number. An example serial number is explained below:

Serial No. $\underbrace{XXXX}\ \underbrace{A0}\ \underbrace{1234}$ **Location:** On the rear panel.

Description:

— 5-digit unique workstation identifying number.

— Country of Origin Code.

— SPU Code, decoded as:
First 2 digits + 60 = Last 2 digits of year
SPU was introduced or significantly changed.
Last 2 digits = number of week in year SPU
was introduced or significantly changed.
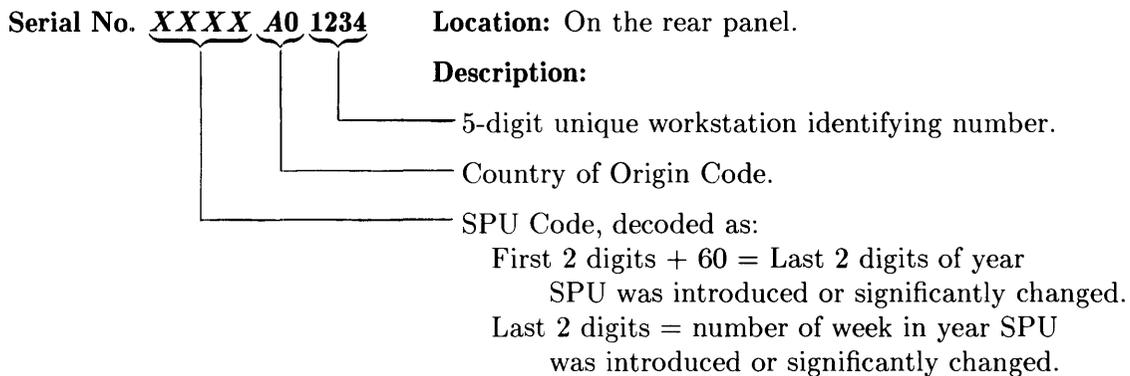
Hardware Terminology

Hardware means the physical elements of this workstation. Different parts and locations of hardware items are explained below.

Product Terms/Conventions

The following terms are used to describe products and their main parts and areas:

- **SPU** - System Processing Unit, a box containing the power supply, processor board and other assemblies such as RAM add-on or interface boards.

- **Internal (circuit)** - A circuit, such as an interface, that is part of the processor board. Internal does not mean "inside the SPU's case".

- **External (circuit)** - A circuit that is located on an assembly other than the processor board. External does not mean 'outside the SPU's case'.

- **Peripheral** - A device external to the SPU, such as a keyboard, monitor, disc drive, plotter, printer, etc.

- **System** - An SPU with one or more peripherals connected together to run an application for a desired end result.

Printed Circuit Boards

Printed Circuit (PC) boards in the SPU and are made of several component parts. In this manual, **boards** identify the printed circuit assemblies installed inside the SPU. Up to three are used in this SPU. Boards are not usually removed or installed by users.

Software Terminology

As used in this manual, software refers to information stored in, or on a device. Typically, this information can be changed and can be transferred to another location in the workstation. Types of software are:

- **Firmware** - The data or instructions in Read-Only-Memory (ROM) chips.

- **Operating Systems** - Computer languages, such as BASIC, Pascal, and HP-UX. They have various commands, statements, and keywords that when executed by the CPU in a particular sequence, cause SPU to manipulate data to some desired end result.

- **Application Program** - A series of operating system program lines in a specific sequence to cause specific actions, such as accounting, electro-mechanical design, data sampling and output, etc. This information is sometimes referred to as software as it is information that is stored in or on a medium and can be transferred.

Hardware Support Documentation

The purpose of this SPU's Hardware Documentation is to support the installation and maintenance of these products. Hardware Support Documentation consists of six manuals for the HP 9000 Series 300 Model 319C+ Workstation's SPU:

- Service Information Manual.
- Service Handbook.
- Service Notes.
- Test Tools Manual.
- Self-Paced Hardware Training Guide.
- HP 9000 Series 200/300/500 Site Preparation Manual.
- Series 300 Computer System Configuration Reference.

The following manuals also relate to hardware:

- Various Installation Notes.
- Series 300 Installation Reference.
- Series 200/300 Peripheral Installation Guide.

A complete listing of titles and part numbers is in Chapter 7 of this manual and the SPU's Service Handbook, Chapter 10.

Service Information Manual

This manual (the one you're reading now) contains tutorial information on the SPU's features, functional descriptions of each assembly, and how to replace these assemblies.

Its purpose is to serve as a learning tool in training environments wherein the service person learns how the SPU works and its parts are replaced. Most of the information in the Service Information Manual is not found in the Service Handbook.

Organization of the Service Information Manual is found in the Table of Contents.

Service Handbook

This manual is intended to be used on site during service situations. It contains information useful to configuring, troubleshooting, and replacing parts. It is organized as follows:

Chapter No. and Title	Contents
Chapter 1: Product Information	Has a brief description of the product, along with configuration and similar information. Product technical data is also listed.
Chapter 2: Environmental, Installation, and PM	Gives power requirements, and power cord data, and installation information. If preventive maintenance is required, it is shown in this chapter.
Chapter 3: Configuration	Lists product configurations and explains what each one is.
Chapter 4: Troubleshooting	Lists tools required, including Test Tools, and explains several troubleshooting procedures. Flow charts are frequently used.
Chapter 5: Tests	Lists tests to run to check out the SPU, some peripherals, and interfaces.
Chapter 6: Adjustments	There's no adjustments for the SPU.
Chapter 7: Systems	Refers to the Model 319C+ Workstation's Pricing Information and Technical Data sheet for bundled system configuration.
Chapter 8: Replacement Parts	Lists part numbers for all field-replaceable parts and explains how they may be obtained.
Chapter 9: Diagrams	Block diagrams of the products are shown here.
Chapter 10: Reference	Other documentation related to these products are listed here with their part numbers.
Chapter 11: Service Notes	When you receive Service Notes for this product, they should be inserted here.

Test Tools Manual

Series 200/300 Test Tools Manual supports a software package for verifying the integrity of Model 319C+ Workstation installations. The Test Tools manual and its associated discs or tape permit troubleshooting workstations in failure analysis. Part numbers for the complete Test Tools packages are:

- 09800-12300 for 3.5-inch disk drives.

- 09800-12700 for 5.25-inch disk drives.

Contents of the four parts of the Test Tools Manual are

Part No. and Title	Contents
Part I: Introduction and Built-In Tests	Introduces the Test Tools package and overviews the SPU self-tests and explains what the different tests do.
Part II: Computer Tests	Covers loading and running of Series 300 Computer Tests. Each test is explained as to what it does. Error messages are listed and explained.
Part III: System Functional Tests	Tells how various SPU-peripheral tests are loaded and run. Tests are explained, error messages shown and defined. Examples of some tests are given. Includes tests for HP-HIL devices.
Part IV: CS/80 Exercisers	Explains how tests for CS/80 disc drives are loaded, ran, and results are interpreted. Error messages are shown as well as several examples of running the tests.

Service Notes

When a situation occurs that effects servicing of the SPU that is not covered in existing documentation, a Service Note is written to explain it. Service Notes are distributed through a Subscription Service to HP Customer Engineers and to customers on the Cooperative Support Program for these products. Being half-page in size, they are intended to be placed in Chapter 11 of the Model 319C+ Workstation SPU's Service Handbook.

Installation Notes

Each separately available accessory or upgrade has an Installation Note packaged with it. These Notes have instructions for configuring and installing the hardware. In addition, an Installation Picture Guide is provided with each bundled system showing how to install and turn on the workstation.

Series 300 Configuration Reference Manual

All supported configurations of Series 300 Computer Systems are explained in this manual.

Section No. and Title	Contents
Section 1: Configuration Overview	Has configuration worksheets to assist in planning the application.
Section 2: Operating Systems and Application Software	Covers supported languages and media options.
Section 3: System Packaging	Lists the configurations, features and options available.
Section 4: Interface and Peripheral Selection	Explains Interfacing, networking, mass storage, monitors, printers, and other output peripherals.
Section 5: Support Services	Overviews Customer Training, installation and support services, and consulting.
Appendix A: Detailed Product Reference	Gives detail information about the SPU and peripherals.

Site Preparation Manual

Explains site preparation and how to prepare the site for hardware installation. Covers physical, environmental and electrical requirements. Its organization is shown below.

Chapter No. and Title	Contents
Chapter 1: Introduction	Explains the purpose and contents of the Site Preparation Manual.
Chapter 2: Responsibilities	Identifies customer and HP responsibilities for preparing the HP 9000 System site. Includes a time frame for setting up the workstation, and identifies people who can provide assistance.
Chapter 3: Preparing the Electrical Environment	Includes power technical data, dealing with electrical interference, connecting cables, and data communication configurations.
Chapter 4: Preparing the Physical Environment	Explains heat and humidity considerations, airborne contaminants, and shipping weights and dimensions for movement and storage.
Chapter 5: Providing Other Necessities	Covers media storage, equipment and record protection, supplies, and nearby telephones for assistance which are an integral part of preparing for and sustaining the operation of a workstation.
Chapter 6: Equipment Arrangement and Space Planning	Provides information and guidelines for planning the location of the workstation equipment at your site.
Chapter 7: When Your Computer Arrives	Discusses the final preparation for system arrival, coordinated deliveries, arrival dates, how to check for damage in shipment, unpacking the cartons, and scheduling the installation of HP 9000 Systems.
Appendix A	Lists product technical data for electrical requirements, heat generation, temperature and humidity requirements, and shipping dimensions.
Appendix B	Contains forms to use for preparing the site, such as Pre-Installation Worksheet, Shipment Scheduling Form, and a Site Completion Checklist.

Installation Reference

The workstation has step-by-step procedures for installing each part. An Installation Card is a pictorial set of instructions to show installers how to unpack, connect, and power up the SPU, disc drive, and monitor. More detailed information is contained in the Installation Reference. To install the operating system and/or application program, the documents supplied with these software products should be referred to.

Organization of the Installation Reference is:

Chapter No. and Title	Contents
Chapter 1: Introduction	Covers how the guide is organized and explains some SPU fundamentals.
Chapter 2: Installing Your Computer	Includes procedures on positioning the SPU, checking voltage settings, connecting power cords, and turning on the SPU.
Chapter 3: Installing Accessories	This chapter covers accessory configuration and installation.
Chapter 4: Installing Your Keyboard and Monitor	This chapter covers keyboard and monitor installation.
Chapter 5: Installing HP-IB Peripherals	Standard HP-IB peripheral configuration and connection procedures.
Chapter 6: Installing Non-HP-IB Peripherals	Peripheral configuration and connection procedures other than HP-IB.
Chapter 7: Reading the Self-Test	Covers procedures performed by self-test and how to interpret the results of the self-tests. Error messages are explained and help is provided should the user get into trouble at this point.
Reference	This chapter has information regarding internal configuration switches, running extended tests, Boot ROM error messages and tutorial information on data communications and interfacing.
Glossary	Provides explanations of computerese terms and phrases.

Technical Information

> **Note**
>
> Technical information listed below should not be interpreted as specifications. Official specifications are listed in the *HP 9000 Series 300 Hardware Technical Data and Pricing Sheet.*

Electrical

Line voltage/frequency	120 V ac @ 48-66 Hz
	240 V ac @ 48-66 Hz
Line transient spike immunity (1 nsec rise, 800 nsec duration)	1 KV dc
Power Consumption	110 Watts maximum
Current Requirements	1.9 A @ 120 V ac
	1.0 A @ 240 V ac
Maximum Heat Dissipation	380 BTU/hr
	112 Kcal/hr
Capacitor Back-up	Real-Time Clock on Processor Board

Environmental

Operating temperature	0 - 55° C (32 - 104° F)
Operating humidity	5 - 80% relative
Operating altitude	4 572 metres (15 000 feet)

Electromagnetic Interference

Standards met	FCC Class A
	VCCI Class 1
	VDE Class B, VDE 1046/84

Regulatory Requirements

Standards met	UL 478, 5th Edition
	CSA 220-M1986
	IEC 380, 2nd Edition; 435, 2nd Edition

Physical

Dimensions
    Height   104 mm (4.1 inches)
    Width   325 mm (12.8 inches)
    Length   444 mm (17.5 inches)
Weight   4.55 kg (10 pounds) maximum
Vibration Standard   Meets Class B requirements

Processor Board

CPU
    Type   Motorola MC68020
    Clock Frequency   16.67 Mhz
    Internal Architecture   32-bit data and address registers
    Address range   4 Gbytes virtual mapped to
                             4 Gbytes physical
    Data bus   32-bit synchronous to:
                             4 or 8 Mbytes On-board RAM and
                             4 or 8 Mbytes Add-On RAM

Floating point Coprocessor
    Type   Motorola MC68881
    Clock Frequency   16.67 Mhz
MMU
    Type   Motorola MC68851
    Clock Frequency   16.67 Mhz
LAN Interface
    Media   LAN coax cable (RG 58U)
    Protocols   IEEE 802.3, Ethernet
    Data Rate   10 Mbits /sec
Parallel Interface
    Type   HP-IB (IEEE 488)
    Data Rate   350 Kbyte/sec
    Number of connected devices   15 per interface devices supported
Serial Interface
    Type   RS-232C standard
Capacitor-backed Real-Time Clock
    Resolution   10 milliseconds
    Accuracy   ±5 seconds/day
    Clock life   24 hours

DMA

Input Clock	10 MHz
Channels	2
Channel Priority	Programmable, high or low, each channel
Channel Arbitration	Round-robin
Bus Arbitration	DIO daisy chain
Transfer Types	8-bit (byte) 16-bit (word) 32-bit (long word)
Max Transfers	4G transfers per arming
Bus Bandwidth Use Limits	Programmable: 100%, 50%, 25%, 12.5%
Min Cycle Time	300 ns
Max Theoretical Transfer Rate	13.3 Mbytes/sec
Typical Burst Transfer Rate	2.8 Mbytes/sec (word transfers to RAM controller boards
Interrupt levels	Programmable: 7, 6, 5, 4, 3
Address range	FFFFFFFF - 00000000

Memory

Size	4 Mbytes or 8 Mbytes
Type	Byte parity error-checking
Average cycle time	300 nsec

I/O Bus

Width	32 bits address; 16 bits data
Bus bandwidth	6 Mb/sec

Video-SCSI/HP-IB Board

Video Interface	High-Resolution Color

Shipping Information

The shipping container for each SPU includes the Localization Kit, which includes power cords, keyboard cable, HP-HIL cable, Safety and Regulatory Information, and Installation Picture Card.

Shipping Weight	9.1 kg (20 pounds)
Container Dimensions	Width - 533 mm (21 inches)
	Length - 584 mm (23 inches)
	Depth - 292 mm (11.5 inches
	Cube - 0.085 m^3 (3.21 feet^3)

HP-HIL and Video Accessories

Listed below are HP-HIL and video accessories compatible with the Model 319C+ Workstations. For a complete list, consult the *HP 9000 Series 300 Model 319C+ Workstation's Hardware Price List.*

Table 1-2. HP-HIL Devices

Product Number	Product Name/Description
46021A	ITF keyboard
46060A	2-button Mouse
46083A	HP-HIL Knob
46084A	ID Module
46085A	Control Dial Module
46086A	32-button Control Box
46087A	ANSI A/ISO A4-size digitizer
46088A	ANSI A/ISO A3-size digitizer
46089A	4-button cursor for 46087A and 46088A
46094A	Quadrature port
46095A	3-button mouse for 46094A

Hewlett-Packard Support

Support services and policies mentioned in this section are subject to change. Please consult your local Hewlett-Packard Sales and Service Office for the current support policies.

Repair Philosophy

Field Repair Philosophy for this SPU is assembly, or board level. This means that when a failure occurs, the problem is diagnosed to the assembly having the failed part. That assembly is then replaced. Replacement assemblies are available through local HP Sales and Service Offices.

Some assemblies may be exchanged for rebuilt ones. Other assemblies are only available as new ones. Refer to Chapter 6, or the Service Handbook, Chapter 8, for information on replacement parts.

Schematics

In support of the repair philosophy, this manual contains information to the assembly level. Schematics are not available for these products.

Supported Configurations

Only workstations with Hewlett-Packard approved parts, accessories, peripherals, operating systems and application programs are supported by Hewlett-Packard. Any workstation with other than HP approved hardware or software connected or installed must have the non-HP approved hardware and software removed by the customer before On-Site repair is accomplished.

HP Repair Services

There are many hardware support options available, from utilizing customer's maintenance groups to buying full support from the local HP Sales Office. Please contact your local Hewlett-Packard Sales and Service Office for complete information.

Hewlett-Packard provides repair services for Model 319C+ Workstation SPU's in four ways:

- Priority On-Site Service
- Next Day On-Site Service
- Standard System Maintenance Service
- Scheduled On-Site Service

More information is available in the *HP 9000 Series 300 Pricing Information Sheet* Contact your local HP Sales and Service for complete information on these services. Each is briefly described below.

Priority On-Site Service

If the workstation applications call for a high level of availability, Priority On-Site Service offers a four-hour coverage. This service is especially valuable if the customer does not stock spare equipment at his site.

Next Day On-Site Service
For Next Day On-Site Service, an HP Customer Engineer goes to the customers site on the next day (Monday through Friday, exluding HP Holidays) after the service call, troubleshoots, and repairs the hardware to the assembly level. The defective assembly is replaced with a new or rebuilt assembly. This service is available through a service contract or a time-and-materials basis.

Standard System Maintenance Service
HP will travel to a customer's site and provide all labor, parts, and materials deemed necessary to keep systems in good operating condition. Included are

- Corrective and Preventive Maintenance.

- Engineering improvements.

- Site environmental survey.

HP will utilize a customer-owned diagnostic modem used with the HP Support Link to test equipment covered the contract.

Scheduled On-Site Service
Provides the lowest on-site support costs for a minimum of twenty-five HP workstation products. HP will make weekly visits to a single central site which the customer specifies.

Repair by Customers

In addition, customers may obtain service training courses and spare parts to do their own repair. Contact your nearest HP Sales and Service Office for information concerning service training, special tools and test equipment, and spare parts.

Operating Systems Support

HP-UX Installation Services
A set of modular services that provide expert installation of hardware, operating system, and selected HP DesignCenter applications is available. They allow users to make productive use of their system in the shortest possible time. Services include:

- Interconnection of system hardware.

- Formatting discs.

- Loading and configuration of the HP-UX Operating System.

- Loading applications.

- Verification of system operation.

- Review of the system for its System Administrator.

Refer to the *HP 9000 Series 300 HP-UX Installation Services Technical Data (5954-9695)* for details and complete information.

Primary Support

There are numerous operating system support options:

- Account Management Support (AMS) provides a local SE, on-site assistance, one Response Center caller and one alternate for telephone assistance, and a Software Materials Subscription.

- Response Center Support (RCS) provides one Response Center caller and one alternate for telephone assistance, and Software Materials Subscription.

- Software Materials Subscription (SMS) provides software and manual updates, Software Status Bulletins, and HP communicator magazine. Updates to ROM-based systems are not provided.

Support For An Additional System

The following options support an additional system:

- Additional System Coverage extends AMS or RCS coverage on the operating system to one additional system under the same system manager. All support is delivered through the central system.

- Extended Materials Support extends SMS by providing the right to make one copy of all central system materials for use on one additional system.

- Additional Response Center Caller provides one additional caller and one alternate for access to the HP Response Center

- Manual Update Service (MUS) provides one copy of updates to software reference manuals.

- Software Notification Service (SNS) provides issues of the HP Communicator and Software Status Bulletin.

Assembly Replacement

<div style="text-align: right; font-size: 2em; font-weight: bold;">2</div>

Introduction

Tools Required

┌─────────────┐
│ **CAUTION** │
└─────────────┘

This SPU uses special screws requiring a Torx® T-10, Pozidriv #1, or #2 screwdrivers. Do not use other screwdrivers as they will damage the screw head recess.

All field replaceable parts can be accessed with these tools:

- T-10 Torx® screwdriver, 4-inch (100 mm) blade.
- Pozidriv® #1 screwdriver, 4-inch (100 mm) blade.
- Pozidriv® #2 screwdriver, 4-inch (100 mm) blade.
- One each of these nutdrivers.
  - 3/16-inch (8720-0001).
  - 5 mm (8720-1219).
  - 9/32-inch
  - 1/2-inch (8720-0007).
- 5/8-inch open-end wrench.

┌─────────────┐
│ **CAUTION** │
└─────────────┘

A static-free Workstation (9300-0794) should be used as a work surface. Anti-static bags should be used to store assemblies in.

Safety Precautions

Electrical

As with any electrical/electronic product, certain safety precautions must be practiced. These safety precautions, when followed protect both you and the equipment from injury and possible permanent damage.

WARNING

Always turn off the SPU and remove the power cord before removing the case to remove or replace an assembly. If maintenance requires power to be applied while the case is removed, proceed only with extreme caution using safe, live-unit maintenance procedures. Do not touch energized components or the L-shaped heat sink on the power supply.

Heed and follow all "WARNING-HAZARDOUS VOLTAGE" labels. Failure to follow these safety precautions may result in serious injury, or worse.

Electro-Static Discharge

Integrated circuit components in the SPU can be damaged by electro-static discharge. It doesn't make any difference whether the IC's are installed on a printed circuit board or laying on a table. Static charges can build up in people to a potential of several thousand volts by simply walking across a room.

These circuits in the SPU and peripherals can be protected by using a static free workstation and wearing clothes that do not hold static charges before handling any of the SPU's PC boards.

When you need to remove or install a part, turn off power to the SPU first. With the static free workstation in place, touch sheet metal with your fingers before touching the printed circuit assembly. If the assembly is not going to be re-installed, place the assembly in an anti-static bag.

Following these precautions will extend the life of the computer products you maintain.

Access Flow Chart

Figure 2-1 is an Assembly Access Flow Chart showing the sequence for removing parts. To use this chart, identify the part to be replaced at the bottom of the chart. Then start at the top of the chart and work through the steps toward the part to replace. Use this chart as a guide to install assemblies by starting at the bottom and working toward the top.

Referencing the SPU's Service Handbook, Chapter 8, Replaceable Parts, as you remove each assembly/part for the first time will help associate the part numbers with their respective assemblies.
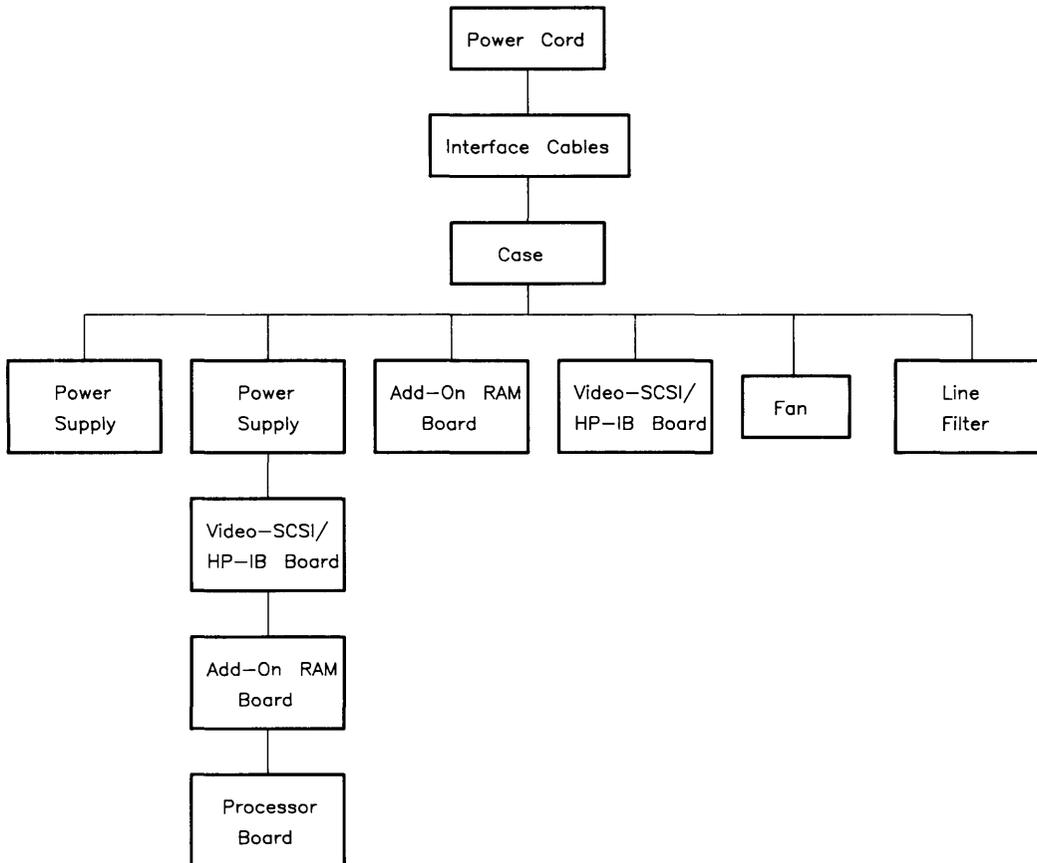
Figure 2-1. Assembly Access Flow Chart

Parts Diagrams

Table 2-1 lists the SPU parts with reference numbers associated with those in Figure 2-2. Figure 2-2 shows an exploded view of the SPU. It should help you determine parts orientation and identification for removal and installation.

Table 2-1. SPU Parts

Ref.	Description	Ref.	Description
1	Power Supply	16	Flat washer
2a	Processor board/ 4 Mb	17	Capacitor/washer
2b	Processor board/8 Mb	18	Shoulder washer
3a	4 Mb Add-On RAM board	19	Tongue bracket
3b	8 Mb Add-On RAM board	20	ON/OFF keycap
4a	Video board	21	Power supply plate
4b	Video-SCSI board	22	Power supply insulator
4c	Video-HS HP-IB board	23	Rail
5	Fan	24	Spacer, 33 mm
6	Line filter	25	Hex nut
7	Power distribution cable	26	HP-IB jack screw
8	ON/OFF cable	27	RS-232 jack screw
9a	Case	28	Lock washer, internal tooth
9b	Front Panel	29	Lock washer, internal tooth
10	Label, name	30	Lock washer, internal tooth
11	Molded foot	31	10-24 self-tapping screw
12	Bumper	32	Double hex nut
13a	Rear panel (standard)	33	Screw/washer assembly
13b	Rear panel for SCSI	34	Torx screw, 0.94-in. long
13c	Rear panel for HS HP-IB	35	Torx screw, 1.75-in. long
14	Label, 120/240 volt	36	Screw, M3 by 6 mm
15	Label, model/serial	37	Torx screw, M3
		38	Flat-head screw,
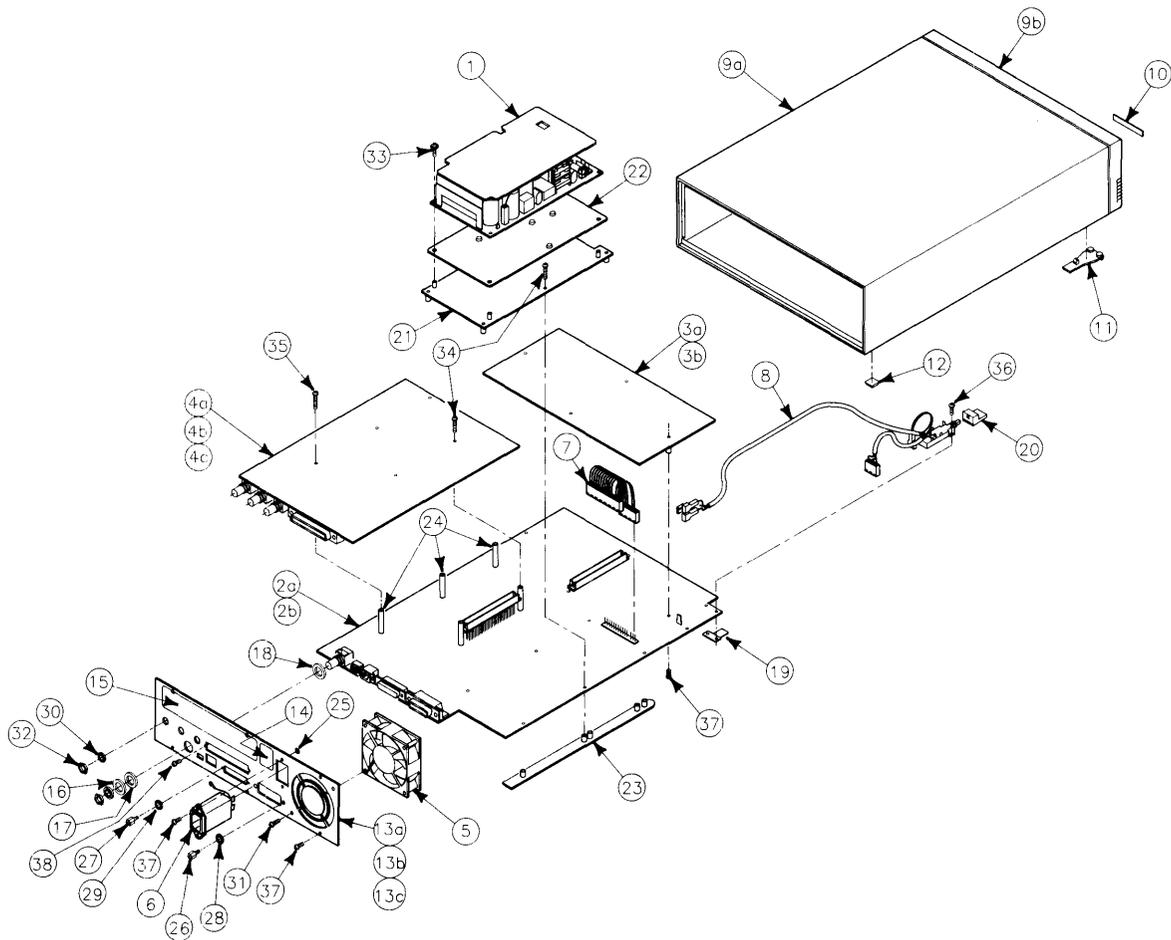
Figure 2-2. SPU Exploded Diagram

Procedures

Overview

In this section, procedures are listed for removing and installing each assembly. For each assembly, a list of Preliminary Requirements is listed. To perform these Preliminary Requirements, follow the steps shown in each Preliminary Item's replacement procedure.

Instructions are based on the hardware orientation shown in Figure 2-3.
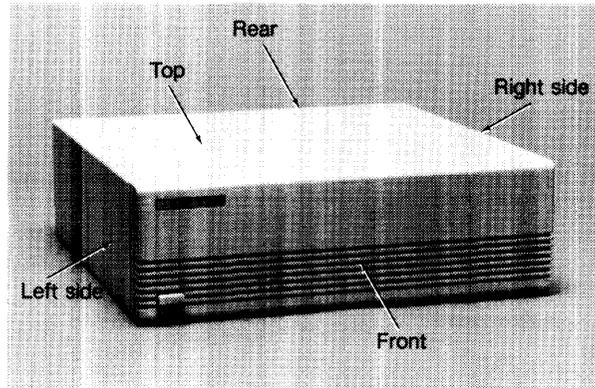
Figure 2-3. Hardware Orientation

Case

To replace any internal part, the case needs to be removed.

WARNING

A shock hazard exists on the power supply until about one minute after the SPU is turned off. Use caution in handling the internal assembly after the case is removed.

Preliminary Requirements

Turn the SPU off and remove these items:

1. Power cord.

2. Video and interface cables.

Removal

1. Remove the six screws (Figure 2-4) holding the rear panel to the case.
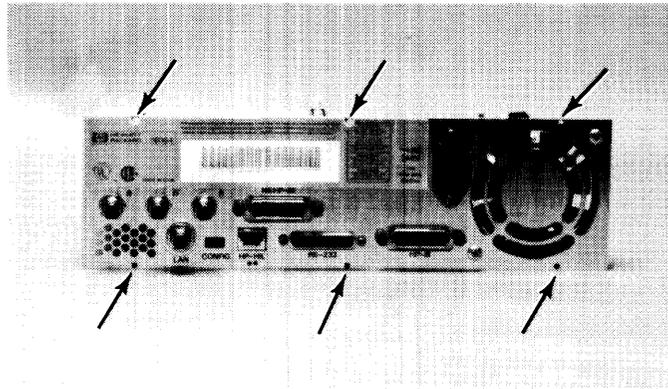
Figure 2-4. Rear Panel Screws

CAUTION

In the next step, the BNC connectors can be damaged if the SPU is not handled properly.

---

2. Stand the SPU on its left or right side.

| CAUTION |

When removing the case, ensure the IC pins on the bottom side of the processor board do not contact the bottom edge of the rear panel. Keep the bottom of the case clear of the pins, otherwise, damage to the pins or components may occur.

| CAUTION |

After the case is removed, the ON/OFF switch can be easily broken. Do not set the SPU down in a manner to put pressure on the switch.

3. Slide the SPU's internal assembly out of the case.

4. If the case needs to be replaced, remove the molded feet by unsnapping them from the bottom. They will be installed on the new case.

Installation

To install the case, stand the case on the front panel and:

1. Slide the internal assembly into the case.

2. Align the rails under the processor board with the rail guides in the bottom of the case.

3. Seat the internal assembly place and fasten the rear panel screws.

Case or Front Panel Replacement

If the case or front panel is damaged, both parts must be replaced. The front panel cannot be easily removed. To replace either the case or front panel, these new parts are needed:

- Case.

- Front panel.

- Name label.

- Bumper.

Preliminary Requirements

Turn the SPU off and remove these items:

1. Power cord.

2. Case.

3. Both molded feet.

Installing the Front Panel

1. Align the new front panel's attaching pins with their holes in the front of the case.

2. Press the front panel firmly and completely on to the case.

3. Remove the backing from two new bumpers and install them on the bottom of the case in the same position as the bumpers on the old case.

4. Remove the backing from the new name label and press it into place in the upper left-hand recess on the front panel.

5. Install the internal assembly in the case.

Power Supply

WARNING

A shock hazard exists on the power supply until about one minute after the SPU is turned off. Use caution in handling the power supply.

Preliminary Requirements

Turn the SPU off and remove these items:

1. Power cord.

2. Video and interface cables.

3. Case.

Removal

1. Remove the power connections as follows (Figure 2-5):

   a. Power distribution cable from the power supply.

   b. AC line cable from the power supply.
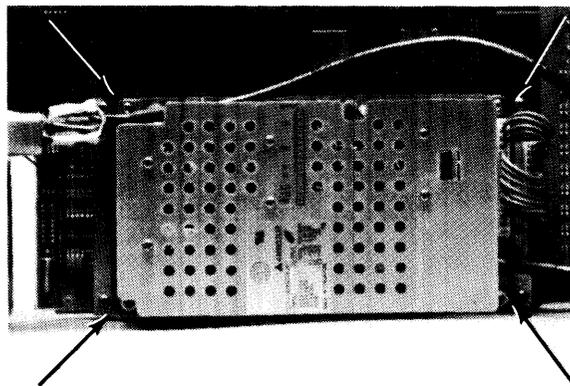
Figure 2-5. Power Supply Power Connectors and Screws

2. Remove the four power supply mounting screws (see Figure 2-5).

3. Remove the power supply.

$\boxed{\text{CAUTION}}$

Note the position of the voltage range jumper. It must be connected to
the 100-120 V ac position for low voltage range, or the 220-240 position
for high voltage range. Place the jumper in the correct position for the
local line voltage before installing a power supply.

---

4. If the processor board is to be removed, also remove the power supply insulator.

Installation
To install a power supply, reverse steps 1 through 5.

Video-SCSI/HP-IB Board
Preliminary Requirements
Turn the SPU off and remove these items:

1. Power cord.

2. Video and interface cables.

3. Case.

Removal

1. Remove the video-SCSI/HP-IB board's interface port screws in the back panel as follows:

   a. RGB video connector lock nuts, using the 5/8-inch open-end wrench.

   b. HP-IB, using the 9/32-inch nutdriver, or
      SCSI, using a #1 Pozidriv screwdriver.

2. Remove the three long screws holding the video-SCSI/HP-IB board to the processor
   board, their spacers and the right-hand rail below the processor board.

3. Remove the two short screws holding the video-SCSI/HP-IB board to the processor board
   and the middle rail below the processor board.

4. Separate the video-SCSI/HP-IB board from the processor board and pull it forward out
   of the back panel.

Installation
To install a video-SCSI/HP-IB board:

1. Place the video-SCSI/HP-IB board in the back panel and attach its connector to the
   connector on the processor board.

2. Fasten the video/interface ports to the back panels with the screws and locknuts.

3. Place the right-hand rail under the processor board, round end towards the front of the
   SPU and fasten the assembly together with a short self-tapping screw in the rear-most
   hole.

4. Install the other short self-tapping screw through the video-SCSI/HP-IB board and into the right-hand rail and tighten it in place.

5. Install three board spacers between the video-SCSI/HP-IB board and processor board and hold them in place with the three long self-tapping screws.

5. Place the middle rail under the processor board, round end towards the front of the SPU and fasten the assembly together with a long self-tapping screws.

Add-On RAM Boards

Preliminary Requirements

Turn the SPU off and remove these items:

1. Power cord.

2. Video and interface cables.

3. Case.

Removal

1. Remove these screws (Figure 2-6):

    a. Two machine screws holding the left and right sides of the add-on RAM board to the standoffs on the processor board.

    a. Two self-tapping screws next to the connector on the add-on RAM board.

Figure 2-6. Add-On RAM Board Screws

2. Remove the add-on board from the connector on the processor board.

Installation

To install an add-on RAM board, reverse steps 1 and 2.

$\boxed{\textbf{CAUTION}}$

The add-on RAM board's connector is keyed. An arrow and instructions "FRONT OF MACHINE" are printed on the front edge of the add-on RAM board. Install the board with the arrow pointing toward the edge of the processor board with the ON/OFF switch.

Processor Board

### Preliminary Requirements

Turn the SPU off and remove these items:

1. Power cord.

2. Video and interface cables.

3. Case.

4. Video-SCSI/HP-IB board.

5. Add-On RAM board.

6. Power Supply

7. Power Supply Insulator.

7. Power Supply Plate.

Removal

1. Disconnect these wires:

   a. Power distribution cable from the processor board.

   b. ON/OFF cable and switch from the processor board.

   c. Disconnect the fan wire connector from the processor board.

   d. Disconnect the power cable connectors from the line filter.

$\boxed{\textbf{CAUTION}}$

Note the colors of each wire to each spade lug on the line filter. These wires must be connected correctly when installing a processor board.

---

2. Remove the processor board's interface port screws in the back panel as follows:

   a. LAN, using the 5/8-inch open-end wrench.

   b. HP-IB, using the 9/32-inch nutdriver.

   c. RS-232, using the 3/16-inch nutdriver.

| CAUTION |

The capacitor-washer between the rear panel and the lockwasher on the LAN BNC (Bayonet Naval Connector) connector is extremely fragile and is easily broken. You may need to replace this capacitor washer when installing the processor board.

---

3. Remove the six screws holding the power supply plate to the processor board as follows:

   a. First remove the left-most screws and the left rail below the processor board.

   b. Last, remove the right-most screws and the middle rail below the processor board.

Note

The spacers between the video-SCSI/HP-IB board may fall out in the next step. Don't loose them.

---

4. Remove the three long screws holding the video-SCSI/HP-IB board to the processor board, their spacers and the right-hand rail below the processor board.

5. Remove the two short screws holding the video-SCSI/HP-IB board to the processor board.

6. Separate the processor board from the video-SCSI/HP-IB board and pull it forward out of the back panel.

Installation

| CAUTION |

When installing a processor board, ensure the brown and blue wires that connect to the line filter are properly connected; blue wire to the top spade lug and brown wire to the bottom spade lug.

---

1. Install the processor board in the back panel and connect it to the video-SCSI/HP-IB board.

2. Install the short self-tapping screw through the video-SCSI/HP-IB board and into the middle rail and tighten them in place.

3. Install a board spacer between the video-SCSI/HP-IB board between the rear-most holes.

4. Place the right-hand rail under the processor board, round end towards the front of the SPU and fasten the assembly together with a long self-tapping screw in the rear-most hole.

5. Install three spacers between the video-SCSI/HP-IB board and processor board and fasten the assembly together with the long self-tapping screws.

6. Place the nylon insulator on the LAN port, stepped edge towards back panel.

CAUTION

The capacitor-washer between the rear panel and the lockwasher on the LAN BNC connector is extremely fragile and is easily broken. DO NOT tighten the LAN port locknut too much.

---

7. Fasten the processor board's interface port screws in the back panel as follows:

   a. LAN, using the 5/8-inch open-end wrench.

   b. HP-IB, using the 9/32-inch nutdriver.

   c. RS-232, using the 3/16-inch nutdriver.

8. Place the power supply plate in place and position the left-hand rail in place below the processor board.

9. Place a short self-tapping screw in the left side, rear hole in the power supply plate to the rear hole in the left-hand rail and fasten it in place.

10. Place a short self-tapping screw in the left side, middle and front holes in the power supply plate to the right-hand and front holes in the left-hand rail and fasten them in place.

11. Place the power supply insulator in place.

12. Place the power supply in place.

13. Connect the following:

   a. Power cable to the line filter.

   b. Power Distribution cables between power supply and processor board.

   c. Fan wire connector to the processor board.

   d. Power cable to the edge of the power supply with a new tie-wrap.

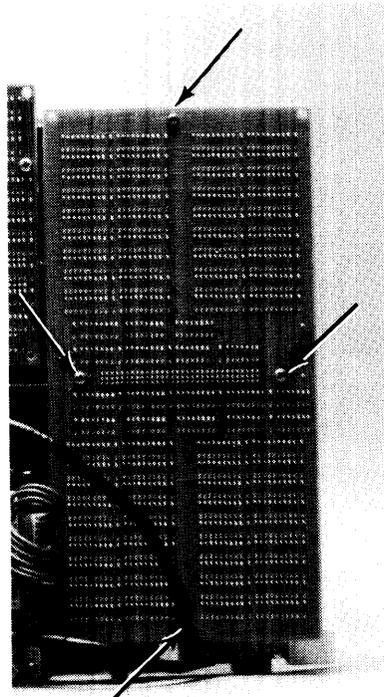   e. AC line cable from the power supply.

14. Replace the case.

Fan

Preliminary Requirements

Turn the SPU off and remove these items:

1. Power cord.

2. Video and interface cables.

3. Case.

Removal

1. Disconnect the fan wire connector from the processor board.

2. Remove the two screws holding the fan to the rear panel (Figure 2-7).

3. Remove the fan.
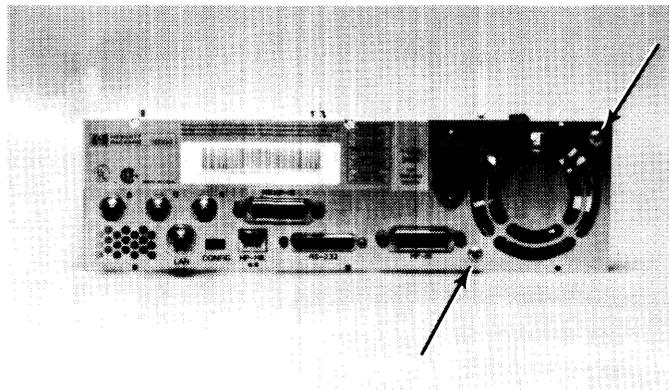
Figure 2-7. Rear Panel Screws

Installation

To install the fan, reverse steps 1 through 3.

Line Filter

Preliminary Requirements

Turn the SPU off and remove these items:

1. Power cord.

2. Video and interface cables.

3. Case.

Removal

1. Disconnect the line filter wires comming from the ON/OFF switch:

   a. Blue wire from the upper spade lug.

   b. Brown wire from the lower spade lug.

   c. Ground wire from the middle spade lug.

2. Unscrew the nut holding the green/yellow ground wire to the rear panel and remove the ground wire.

3. Remove the two screws holding the line filter to the rear panel (Figure 2-7).

3. Note the orientation of and remove the line filter.

Installation

$\boxed{\text{CAUTION}}$

When installing the line filter, ensure it is installed with the ground lug towards the right side of the SPU. Make sure the brown and blue wires from the ON/OFF switch are properly connected; blue wire to the top spade lug and brown wire to the bottom spade lug.

To install the line filter, reverse steps 1 through 3.

Functional Description

3

Introduction

Model 319C+ Color Workstation SPU's are a revised version of the Model 318M Monochrome Workstation's SPU. It provides good performance at low cost to meet the computer-intensive requirements for design automation as well as scientific analysis and general purpose computation. It's an enhanced version of the Model 318M with more memory, added interfaces, and more power. The correct name of this product is the System Processing Unit (SPU).

Most noticeable is the absence of accessory slots. The SPU is a restricted-configuration product and is upgradeable for memory and High-Speed HP-IB or SCSI interface options. User-installable accessories or expanders are not available for the Model 319C+ Workstation.

Packaging

These SPUs are complete within the case. All memory, interfacing, video and processing functions occur within the case. Three primary configurations are available and are distinguished by the layout of the back panel. Refer to Chapter 1 for the differences.

SPU Block Diagram

Figure 3-1 is a diagram of the SPU.
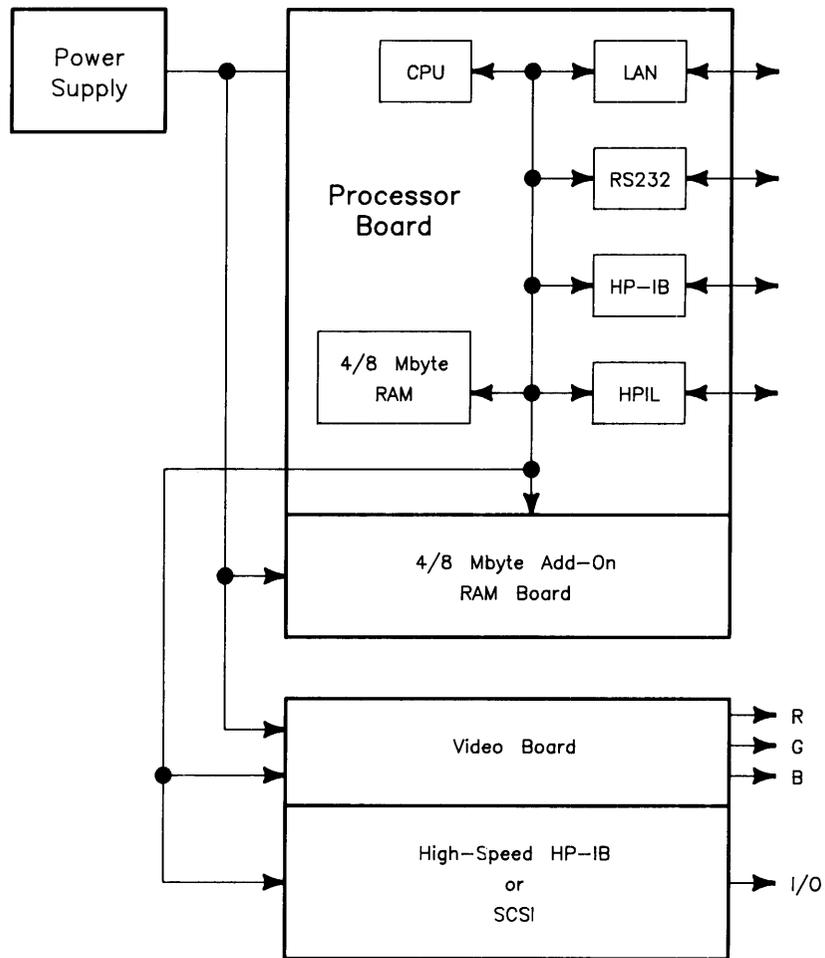
Figure 3-1. SPU Block Diagram

Hardware Overview

Processor Board

A Model 330 computer processor board is emulated in the Model 319C+'s SPU. It functions like the one used in the Model 330. It's major differences is having either 4 or 8 Mbytes of RAM and most interfacing circuits are on the processor board. The CPU is an MC68020 and the MC68881 Floating-Point Coprocessor are both clocked at 16.67 MHz.

Timer, Boot ROMs, and self-test LEDs comprise the fundamental hardware to self-test the SPU and boot the operating system. A 32-bit I/O bus interfaces this board with the add-on memory. Video, SCSI and high-speed HP-IB are interfaced with a 16-bit bus.

Note

Self-test LEDs are visible through the fan in the rear panel.

Video-HP-IB/SCSI Board

High-resolution color video is processed by the video circuits. Optional High-speed HP-IB or SCSI are also on the video board that attaches to the processor board. Color video circuits provide 1024 by 768 resolution for color monitors. The standard monitor for the SPU is the HP 98785A High-Resolution 16-inch Color Monitor.

System Interfaces

Interfaces, including HP-HIL, HP-IB, RS232, LAN, and DMA are on the processor board. Optional High-speed HP-IB or SCSI are on the video board that attaches to the processor board. This SPU supports the HP 98785A Color Monitor with the high-resolution color video electronics on the video board.

To maintain software compatibility, the designs of other interface cards are emulated. These cards are the HP 98625B, 98643, 98620B, and the original DIO size Series 300 human interface card. Each of these sections of the interfaces on the processor or add-on boards operates independently.

The LAN portion is software compatible with applications that used the current Series 200/300 DIO card (HP 98643A). Because of space constraints on the board, the LAN implementation of the LAN was chosen. The MAU is built into the card and, with the BNC "T" connector, connects directly to the coax.

DMA is implemented with a semi-custom CMOS standard cell. The chip features an HP proprietary 1.5 micron CMOS process and is a compatible superset of the HP 98620B DMA interface card.

Power Supply

All power to the boards is supplied by a non-adjustable switching power supply. Its characteristics are:

- Select either 120 V ac or 240 V ac line voltage by jumper.

- Internal fuse is part of the power supply and not replaceable.

- With the processor board installed, Dc outputs are:

    +5 V dc.
    +12 V dc.
    +12 V dc. Isolated
    −12 V dc.

- Maximum power consumed by SPU is 110 watts.

Refer to Figure 3-3 for the power supply functional description.

Input Section

Ac line voltage is supplied to the input section through the power cord. The ON/OFF pushbutton on the front panel is connected to a switch on the processor board. The ON/OFF switch is connected to the power supply by wires.

Line input potential through the power cord is applied to a high frequency line filter. This filter reduces the high frequency energy both entering and leaving the SPU. A filtered output is sent to the power switch. A non-replaceable in-line fuse is mounted on the power supply.

When the power switch is turned on, the line voltage is applied to the low-frequency filter circuit. This circuit reduces levels of low frequency RF energy both entering and leaving the power supply. After filtering, the line voltage is sent to the Bridge Rectifier Voltage Doubler. The input current is limited by a series resistor in the inrush limiter.

A line voltage jumper on the power supply controls the rectifier/ rectifier/doubler circuit. If the jumper is in the 120 V ac position, the voltage is both doubled and rectified. In the 240 V ac position, the voltage is only full-wave rectified. The output is sent to the storage capacitors.

240V
Position   Voltage Select   120V
                             Position
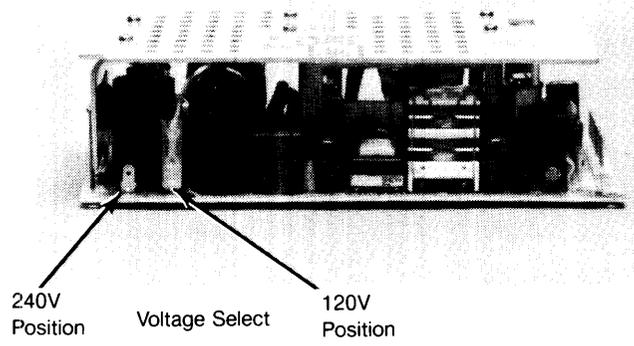
Figure 3-2. Power Supply
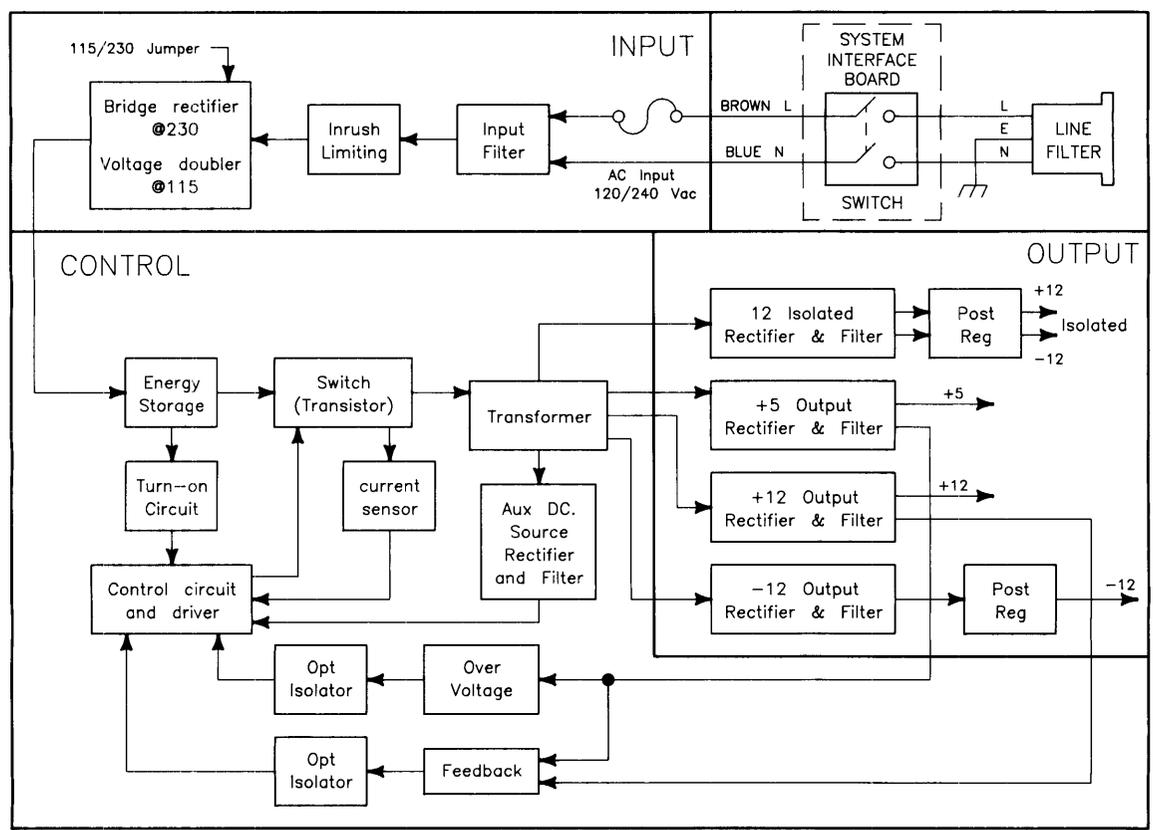
Figure 3-3. Power Supply Block Diagram

Functional Description **41**

Control Section

Energy is stored in two large capacitors used by the transistor switch which transfers energy from the capacitors to the transformer.

Operating in the forward converter mode, the transformer transfers energy during the on cycle to the outputs. Energy is transferred to the output capacitor (filter) through the rectifier and output inductor.

An opto isolator feeds the error signal to the control circuit which adjusts the duty cycle (pulse width modulation). A primary current sensor and the over voltage opto isolator also feeds the control circuits.

Output Section

Each voltage output rectifier and filter circuit is fed by the transformer. Both the +5 and +12 V dc outputs are wired directly to the power connector.

The −12 V dc output is post regulated with a three-terminal regulator. The +5 V dc output is regulated to be within TTL limits of ±0.25 V dc. A 12 V dc isolated output is regulated to 9 V dc for the LAN circuits on the processor board.

Feedback is provided by comparing a scaled version of the +5 and +12 outputs to a reference and driving an opto isolator.

Voltage Tests

When making voltage tests, the power supply must have sufficient load to regulate properly. The following assemblies must be installed before making voltage tests:

- Power distribution cable.

- Processor board.

If the power supply is unloaded, the voltage outputs will not be correct.

Processor Board

Overview

This high-performance processor board for the SPU has:

- 16.67 MHz MC68020 CPU.
- 16.67 MHz MC68881 Floating Point Co-processor.
- MC68851 Memory Management Unit.
- MC6840 Timer.
- Two Boot ROMs.
- Self-Test LEDs.
- 4 or 8 Mbytes of RAM.
- HP-IB Interface,
- RS-232 Interface.
- HP-HIL Interface.
- Thin LAN.
- DMA.
- Audio output (speaker).

Figure 3-5 is a block diagram of the processor board. Refer to this diagram for functional descriptions.
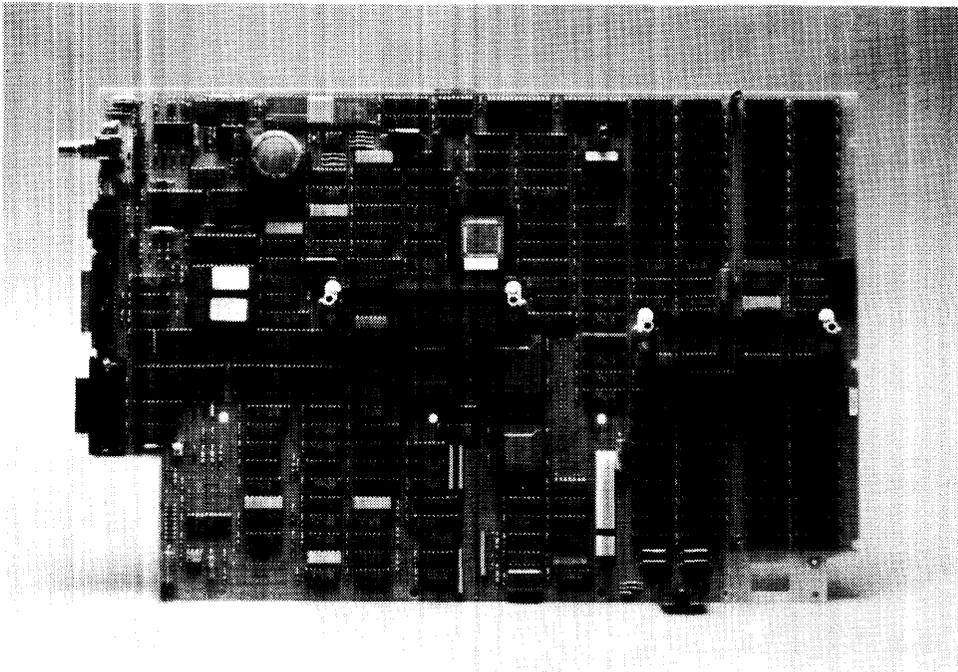
Figure 3-4. Processor Board
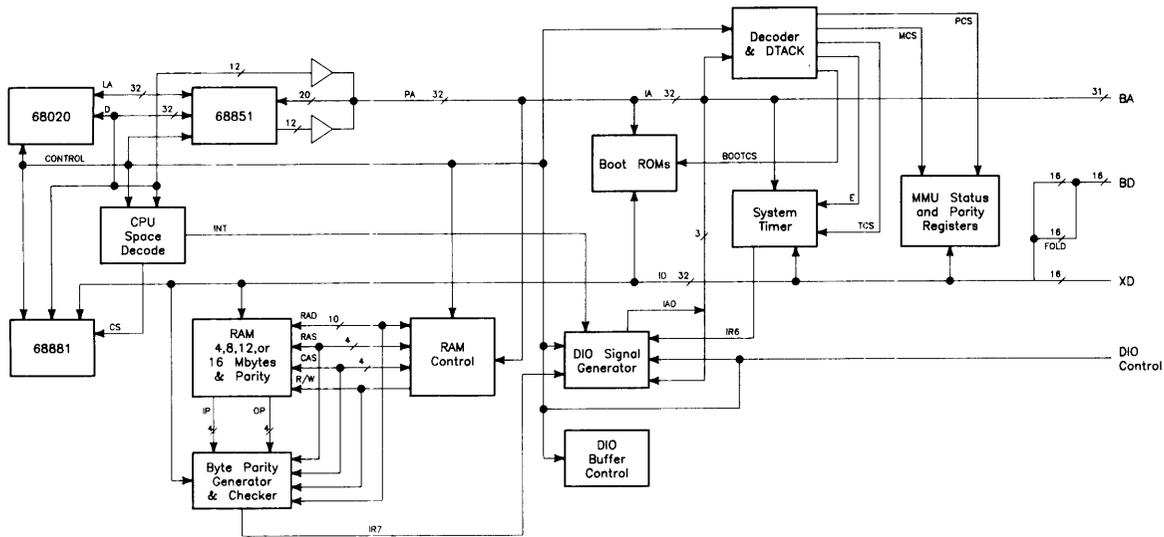
Figure 3-5. Processor Board and RAM Block Diagram

Central Processing Unit

A Motorola MC68020 CPU is used. Its synchronous data bus is 32-bits wide for both addresses and data registers. The MC68020 CPU can address 4 Gbytes of RAM. Operating at 16.67 MHz, it is significantly faster than many workstation CPUs.

The CPU has 57 instruction types and handles 7 major data types. It also has 18 addressing modes, 6 maskable and 1 non-maskable interrupt levels. Six stack frames exist in the MC68020.

At power-up, the CPU executes instructions from the Boot ROM to determine the presence of video circuits. Data in the video board's ID/FONT ROM is placed in a display controller register to set the display clock frequency.

Interrupt structure is similar to DIO interrupts. On receiving an interrupt and verifying the interrupt is coming from the video circuit, the CPU must then poll the video circuit to determine if it is the interrupting device.

Co-Processor

A floating-point co-processor is used to increase system performance when certain floating-point math routines are part of the application. An MC68881 chip performs these functions. It implements the required IEEE standard capabilities.

Floating-point instructions become part of the language of the CPU in its operation.

Boot ROM and Self-Test LEDs

Two Boot ROM chips whose instructions are executed by the CPU shortly after power up is used on this processor board.

Eight Self-Test LEDs are visible through the fan in the rear panel. Different patterns of on and off (1s and 0s) correspond to binary or hexadecimal error codes. These codes help you find out what's working and what is not.

Chapter 4 provides an in-depth explanation of the Boot ROM functions. Chapter 5 explains the error codes and other troubleshooting processes.

Memory Management Unit

The processor board uses the MC68851 MMU for its memory management. No cache is used on this processor board.

MMU connections to the CPU are through the coprocessor interface. All accesses to registers within the PMMU are done by use of coprocessor instructions rather than memory mapped registers. Page size is 4 Kbytes. The Translation Lookaside Buffer (TLB) is a 64-entry Content Addressable Memory (CAM) containing the most recently used translations. When a miss in the TLB occurs the MMU requests the bus from the MC68020 and conducts its own table walks. When the translation is retrieved the bus is returned to the MC68020 which re-runs the cycle with the correct translation contained within the MMU. The MMU can address the 4 Mbytes of physical address space used in this SPU.

The MMU translates CPU logical addresses into physical addresses and handles access rights. Translation information is contained in tables resident in main memory. MMU halts the processor and performs bus cycles to access these tables. Translations are stored in a Translation Lookaside Buffer (TLB) so the tables do not need to be accessed for every CPU cycle. The CPU can run at the same speed with the MMU on or off.

Both the logical and physical address spaces are divided up into 4 Kbyte pages. The MMU provides the capability to map any logical page into any physical page. Write protection is provided by the MMU at the page and segment level. The table structure is the same as the Model 320, 330 and 350 computer's MMU; this similarity allows software compatibility.

Translation Tables

When the CPU attempts an access to a logical address whose translation is not resident in the TLB, an address translation cycle must be executed. This is called a table walk. The table algorithms used for address translation use segment and page tables, and user/supervisor root pointers.

Two levels of tables exist. The second layer is the Page table, which contains the physical addresses, called translations. The first layer is the segment table, which mainly contains addresses of page tables. 32-bit logical address are divided into three offsets. Separate tables can exist for user and supervisor accesses.

Root pointers are hardware registers that contain the upper 20 bits of the starting address of the segment table. One pointer is used for supervisor mode, and one for user. The segment table offset is concatenated with selected root pointer, creating the address of the segment table entry. The MMU performs a memory cycle and reads from that address. Page table offset is concatenated to the bottom of the data from the segment table, which create the address of the page table entry. The MMU reads this address from memory. Information returned is the address of the physical page. This is the translation, and it is stored in the TLB for future reference.

Translation Lookaside Buffer

The TLB is a cache for address translations. When a translation has been completed, it is stored in the TLB so that a complete translation doesn't always need to be done when that logical address is accessed again. Organization of the TLB is a 64 entry content addressable memory (CAM).

Because the TLB stores data from main memory, any changes in the translation tables must be followed with either a complete or selective purge of the TLB. The TLB must also be purged whenever the root pointers are changed. The processor board automatically purges the entire TLB whenever either of the root pointers are written.

For more information on tables within the PMMU consult the MC68851 Users Guide.

I/O Bus

A 32-bit asynchronous DIO bus (also used in the other Series 300 computers) is used. When the processor is not performing I/O cycles, it does not need the DIO bus at all.

Several different subsystems reside on the bus and interact with each other by using various bus signal lines. Interface select codes, addresses, and data are transmitted via this bus. Memory read/write cycles between the CPU and memory occur on the memory bus.

There is no provision to expand this bus outside the SPU using bus expanders.

Direct Memory Addressing

DMA chip architecture is a compatible superset of the HP 98620B DMA Controller which is used with other Series 300 computers. The chip is a Standard-Cell design implemented in a CMOS process.

Processor Board Interfaces

Overview

The processor board's interfaces meets most, if not all, I/O needs of the Design Automation marketplace. These interfaces include:

- RS-232.
- HP-IB.
- HP-HIL.
- LAN.
- DMA.

To maintain software compatibility, the designs of several existing interface accessories used in other Series 300 computers were integrated together. Interface products emulated on the processor board are:

- HP 98643 Local Area Network (LAN)/300 Link.
- HP 98620B DMA Controller.
- 98561-66532 Human Interface Card.

Each of these sections of the processor board operates independently from one another. Software compatibility is assured.

LAN Interface

Local Area Network (LAN) functions are divided into three areas:

- Interface to the DIO bus.
- Shared memory area.
- Frontplane interface to the network.

Interface with the DIO bus includes select code decoding, interrupt control, data bus buffers and latches, and address multiplexers. A 32-bit wide data bus is used.

The shared memory area has the memory controller circuits, 16 Kbytes of RAM, 64 nybbles of nonvolatile storage of the node address, and standard DIO control, status, and ID registers. Multiplexing of DIO information and the LAN chip set is also part of the controller circuit.

Frontplane circuits include the LAN chip set, timer, and the transceiver chip. The LAN chip set serves the dual function of a DMA controller and an Ethernet/EEEE 802.3 controller. Encoded data from the SIA is transmitted by the transceiver chip. Data from the network is sent by the transceiver chip to the SIA.

Configuration for LAN select code and interrupt levels are fixed by hardware as follows:

- Select Code at 21.
- Interrupt level at 5.

Local/Remote control is one of the configuration switches accessible through the configuration port on the back panel. This switch should be set to 0 as the remote function is not currently used.

RS-232 Interface

An RS-232 Interface section is part of the processor board's electronics. Using an INS8250 UART, it's almost identical to the HP 98644A RS-232 Serial Interface Card. It differs from the HP 98644A Interface Card in that it:

- Allows interrupts at level 5 only. There are no switches to change the interrupt level is the same as the HP 98644 Card.

- Permanently sets the select code to 9.

- Does not allow reconfiguration to change the RS-232's ID to that of the HP 98626 card.

Two switches on the processor board are associated with RS-232. Accessible through the configuration switch port in the rear panel, they perform the following functions:

- **REM** – Controls the local/remote bit in the ID register.

- **MEN** – Sets the handshake input lines to their default condition, all ones.

In addition to the registers built into the INS8250 UART, two external register have also been implemented. Both sets of registers are multi-mapped within a 64 Kbyte region of memory associated with I/O select code 9.

HP-IB Interface

Hewlett-Packard Interface Bus (HP-IB) is HP's version of the IEEE 488 interface standard and is much like HP-IB implementations on other HP 9000 Series 200/300 computers. It uses a TMS9914 HP-IB controller which allows data transfer rates up to 450 Kbytes/second. The TMS9914 is a memory-mapped I/O device which is multiple-mapped within a 64 Kbyte block of memory.

Two registers control hardware which can generate an interrupt as a result of a HP-IB device responding to a parallel poll. It has the ability to generate an interrupt from a parallel poll response. For this feature, two registers external to the TMS9914 are used. These registers are in addition to the two external registers that exist for internal HP-IB interfaces in other Series 200 computers.

All registers associated with the HP-IB are multiple mapped within a 64 Kbyte block of memory in the internal I/O address range.

One configuration switch for HP-IB system controller is on the processor board. Accessible through the back panel, the SC switch is set to 1 if the SPU is the system controller or 0 if not.

Configuration Switches
On the back panel, a port through which a screwdriver or other pointed object may be used to set the configuration switches.

<div style="text-align:center">**WARNING**</div>

Turn the SPU OFF before setting a configuration switch. Hazardous voltages exist inside the SPU. A shock hazard exists unless the SPU is turned OFF.

Three DIP switches configure the HP-IB and RS-232 interfaces for:

- RS-232 Modem ENable.

- RS-232 REMemote enable.

- HP-IB system controller.

The fourth switch is used for LAN. Table 3-1 explains the use of these switches.

<div style="text-align:center">**Table 3-1. HP-IB and RS-232 Configuration Switches**</div>
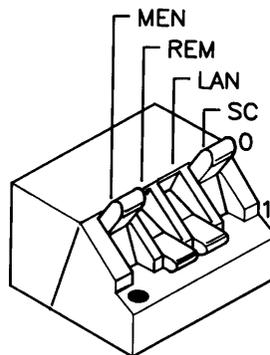
Switch Label	Function/How It's Used
MEN	RS-232 Modem Enable 1 = Modem lines enabled (Shipped setting) 0 = Modem lines disabled
REM	RS-232 Remote Terminal Enable 1 = Remote Mode 0 = Local Mode (Shipped setting)
LAN	LAN Local/Remote 1 = Remote Mode (not currently used) 0 = Local Mode (Shipped setting)
SC	Internal HP-IB System Controller 1 = System Controller (Shipped setting) 0 = Not System Controller

HP-HIL Interface/Devices

Overview

Hewlett-Packard Human Interface Link (HP-HIL) is an HP standard for interfacing certain HP computers and SPUs to human input devices. Asynchronous serial communications protocol enables you to select a set of input devices, connect them to your SPU, and work with any application program.

A link controller on the processor board controls the HP-HIL. Each HP-HIL device has an circuit to interface information to and from the device. Limitations for the HP-HIL are:

- Up to seven devices can be on the link.

- Maximum distance between devices is 2.4 metres, total link maximum length is 16.8 metres. This does not include the 15 or 30 metre extensions.

- Series 300 Maximum link current is 1 A.

Link Controller

A block diagram of a typical link controller is shown in Figure 3-6.
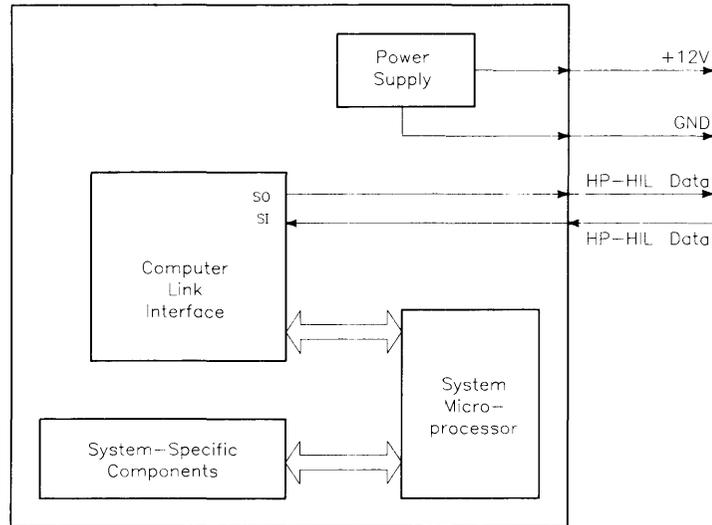
Figure 3-6. HP-HIL Link Controller Block Diagram

Power Supply. One voltage, +12 Vdc is taken from the SPU and output as a regulated power supply to external devices on the link. Up to 1 A can be supplied to devices. When configuring HP-HIL devices with Series 300 computers, care must be used to ensure the total power drawn by all devices does not exceed 1 A. In Table 3-2, devices are listed with their power requirements.

Table 3-2. HP-HIL Devices and Power Requirements

Product Number	Device Name	Milliamps	Watts
HP 35723A	Touchscreen Bezel	250	3.0
HP 46021A	ITF Keyboard	100	1.2
HP 46060A	HP Mouse	200	2.4
HP 46080A	Extension Module	25	0.3
HP 46081A	3 Metre Ext.	25	0.3
HP 46082A/B	15/30 Metre Extension[1]	50	0.6
HP 46083A	Rotary Control Knob	110	1.32
HP 46084A	ID Module	60	0.72
HP 46085A	Control Dials	350	4.2
HP 46086A	Button Box	80	0.96
HP 46087A[2]	"A"-Size Digitizer[2]	200	2.4
HP 46088A[2]	"B"-Size Digitizer[2]	200	2.4
HP 46094A	Quadrature Port Device[3]	80	1.2
HP 46095A	Three-Button Mouse	80	0.96
HP 92916A	Barcode Reader	100	1.2

Notes: [1] Extensions have two boxes, each draws 25 mA.
         [2] Includes HP 46089A 4-Button Cursor.
         [3] Port devices require 80 mA; devices attached cannot exceed 120 mA.

Computer-Link Interface. DIO bus architecture is interfaced to the HP-HIL microprocessor in these circuits. They allow device input data to be used by the SPU.

Microprocessor. The HP-HIL microprocessor on the processor board provides support for link protocol and is responsible for:

- Configuring the link.
- Processing input device data.
- Error recovery.
- Initiating commands onto the link through the Link Interface.

Link Interface. Data is exchanged between the device and the SPU through the link interface. It accepts commands from the microprocessor for transmitting and receiving messages in an HP-HIL frame format.

Each frame is a 150 μsec long, 15-bit fixed format. A frame is shown in Figure 3-7.
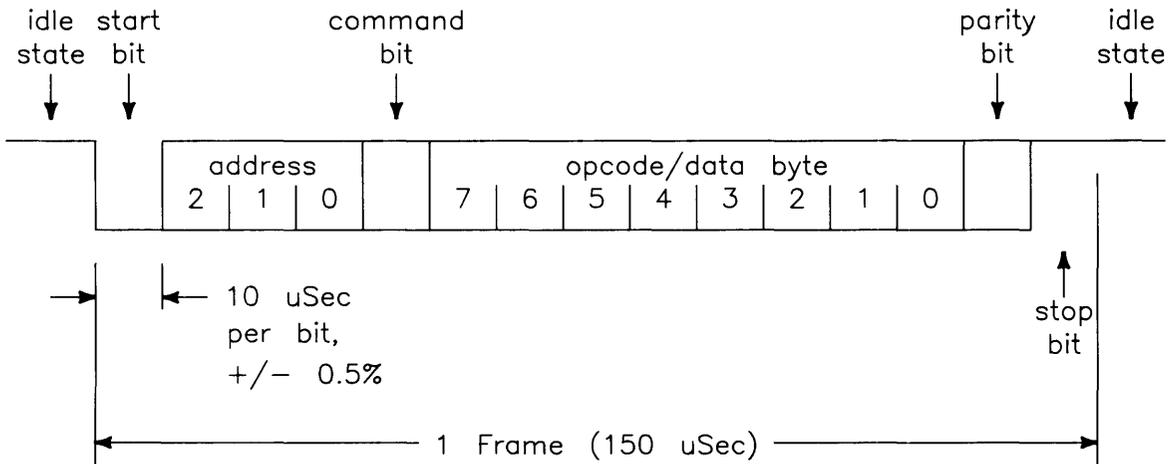
Figure 3-7. HP-HIL Frame Structure

Frames may be sent up to once each 154 μsec allowing data transfer rates of up to 6500 bytes/second. HP-HIL protocol performs automatic configuration, identification, and polling of up to seven devices. Error recovery, device and system reset, and simple output commands provide a simple device integration.

When the SPU is turned on, the link is polled for devices. Each device on the link has its own ID which is sent to the SPU and stored in memory. The link is polled 60 times per second. Should a device have data to input to the SPU, it sends its data frame to the SPU for processing. As each device's frames has its own address in a 3-bit word, no more than 7 devices can be used on the link at one time.

HP-HIL Cables
A four-wire cable connects HP-HIL devices to each other and to the SPU.

Memory

Configurations

Model 319C+ Color Workstations have several memory options. These options are explained in Table 3-3.

Table 3-3. Model 319C+ Color Workstation Memory Configurations

Option	Memory Size/Location
Standard	4 Mbyte on Processor Board
Option 108	8 Mbyte on Processor Board.
Option 112	12 Mbyte, 8 Mbyte on Processor Board plus 4 Mbyte Add-on Board.
	This configuration also works: 12 Mbyte, 4 Mbyte on Processor Board plus 8 Mbyte Add-on Board.
Option 116	16 Mbyte, 8 Mbyte on Processor Board plus 8 Mbyte Add-on Board.

Memory on the processor board is either 4 or 8 Mbytes, depending on the option ordered. Either a 4 or 8 Mbyte Add-On board can be added to the processor board. With this arrangement, 4, 8, 12 or 16 Mbytes of RAM can be used with the workstation. Maximum RAM in the system is 16 Mbytes.

All RAM in Model 319C+ Workstation SPUs is autoconfiguring. When add-on RAM boards are added to the processor board RAM, the added RAM is configured below the 4 or 8 Mbyte address space used by processor board RAM.

Refer to Figure 3-5 for the RAM block diagrams.
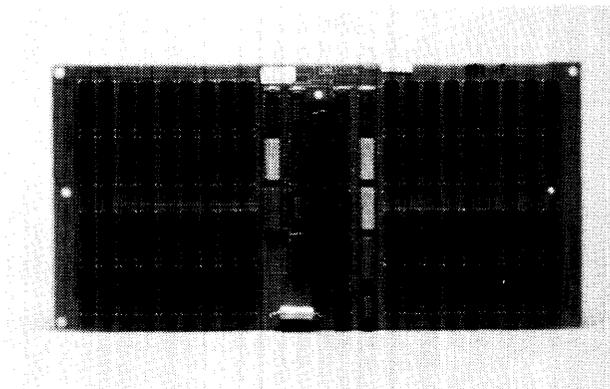
Figure 3-8. 4 or 8 Mbyte RAM Add-On Board

Architecture

A RAM controller is located on the processor board. It manages all the RAM in the SPU. Add-on RAM is also controlled by the processor board's RAM controller. The RAM controller circuits has control and interface circuits used for read and write functions. A memory bus handles all memory data and address transfers.

Address and Size

The address select and autosize block automatically configures all RAM. Processor board RAM is set to the top of RAM (address FFFFFFFF). If add-on RAM is added, that RAM is configured 4 or 8 Mbytes below the processor board RAM. Add-on RAM boards add either 4 or 8 Mbytes, depending on their size.

Maximum RAM in the workstation is 16 Mbytes. As RAM is installed or removed the auto-configuring circuits adjust for the amount in the SPU.

RAM Clock

The RAM controller is clocked by 16.67 MHz generated from a 33.33 MHz crystal on the processor board.

Board Select

A board select circuit will determine when the board is being accessed and will issue a bus select. The RAM block select circuit will determine which 4 Mbyte block is being accessed. Two 4 Mbyte blocks may exist on the processor board and two 4 Mbyte blocks may exist on the add-on board. When the self-tests check memory and an error is displayed, the failing board can be identified by the failing address. Table 3-4 lists each board and the memory addresses assigned to it.

Table 3-4. Memory Addresses and Locations

Total RAM, Configuration	Board Address Range (Top to Bottom in Block)
4 Mbytes Total 4 Mbytes on Processor Board	FFFFFFFF to FFC00000
8 Mbyte Total 8 Mbytes on Processor Board	FFFFFFFF to FF800000
12 Mbyte Total 4 Mbytes on Processor Board 8 Mbytes on Add-On RAM Board	FFFFFFFF to FFC00000 FFBFFFFF to FF400000
16 Mbyte Total 8 Mbytes on Processor Board 8 Mbytes on Add-On RAM Board	FFFFFFFF to FF800000 FF7FFFFF to FF000000

Write Cycle

For a write cycle, after select is issued, both the data and the parity will be written to the appropriate RAM chips.

Read Cycles

After select is issued, the lower address lines will be latched. Then the appropriate RAM chips will be read and parity will be checked providing parity is enabled. If there is a parity error, it is indicated to the CPU. If there is no parity error, the data will be read.

Fold Buffer

A fold buffer is used to 'fold' data from the upper 16 data bits to the lower 16 data bits, or the other way around. This is used when a 16 bit device, such as the high-speed HP-IB interface, accesses data that is stored in 32-bit format.

Control Register

The control register is used to turn on and off parity and to determine if interrupt was caused by a parity error.

Video-SCSI/HP-IB Board

Important Note

The SCSI option will not be available at SPU introduction but will be delayed for several months. Contact your local HP Sales and Service Office for more information.

Depending on the option ordered, this board will have the following functions as listed below and pictured in Figure 3-9.

- Only video circuits, 98564-66570.

- Video and SCSI circuits, 98564-66571.

- Video and high-speed HP-IB, 98564-66572.
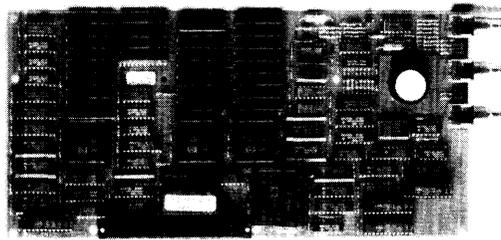
Figure 3-9a. Video Board with Video Circuits
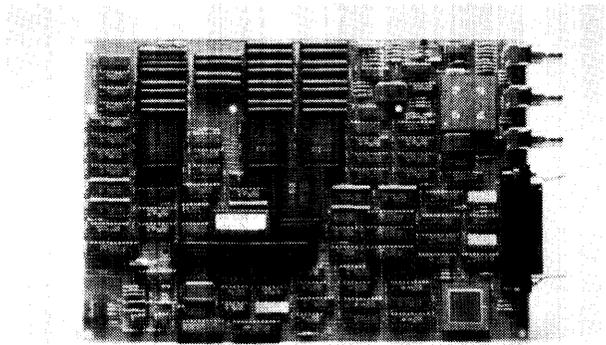
Figure 3-9b. Video Board with Video and SCSI Circuits
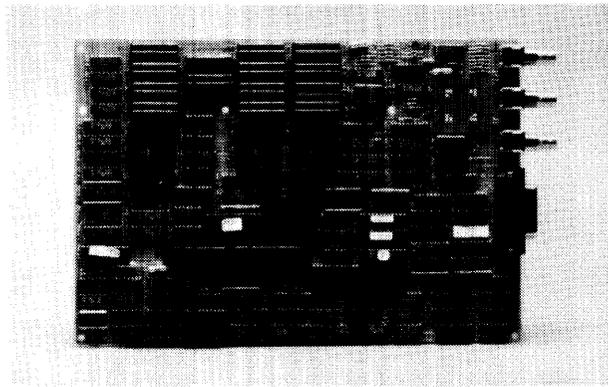
Figure 3-9c. Video Board with Video and High-Speed HP-IB Circuits

Video Circuit

Overview

Video circuits provide high-resolution color video for color monitors. Resolution is 1024 by 768 pixels from a 6-plane frame buffer.

Software compatible with previous 4 and 6 plane video boards with HP-UX operating system can also be used with the Model 319C+ Workstation.

A hardware cursor isn't used, therefore the flashing underscore cursor is not available on the video. It is implemented by software.

The Bit-Blt (bit-boundary block transfer) functions of the video are greatly improved over previous video boards in that bit per pixel operations are supported as well as previous byte per pixel.
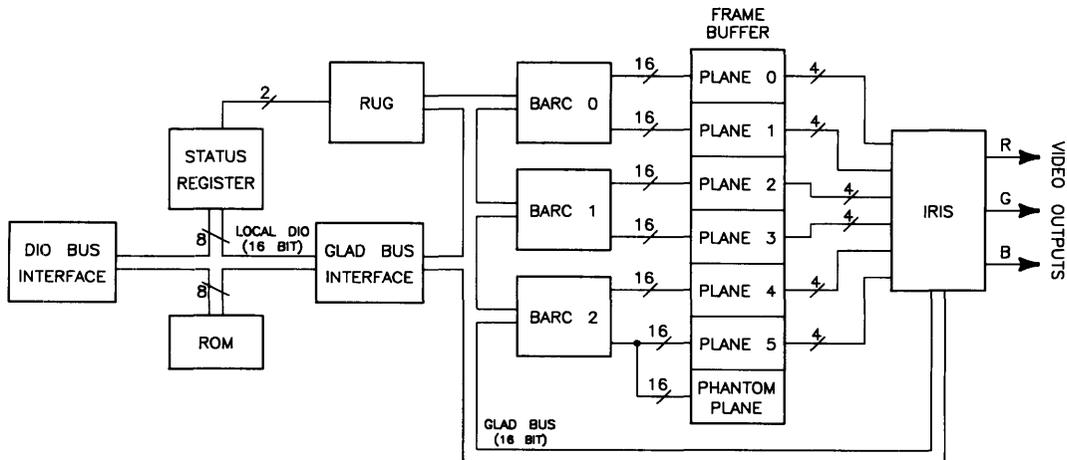
Figure 3-10. Video Circuit Block Diagram

Functional Description

GLAD Bus Controller. The GLAD (Graphics Logical Address and Data) bus control signals are generated by several on-board PALs. The controller arbitrates between cycle requests for:

- VRAM shift register data transfer and refresh.
- Scan Converter vector/Bit-Blt read/write operations.
- SPU frame buffer/register read/write operations.
- All VRAM refresh.
- Read/write cycles to and from VRAM.
- Read/write cycles to and from registers in the Scan Converter, BARC (Bi-planer Access RAM Controller), and IRIS (color map and video controller chip).

GLAD Bus. The GLAD bus is a 16-bit multiplexed address and data bus designed for tightly coupled communication between Scan Converter, BARC, IRIS, and the frame buffer (throught BARC).

Scan Conversion. The Scan Converter chip generates and clips pixels. Given vector end points, it performs the Bresenham algorithms to produce the individual pixel addresses which it then writes to the frame buffer through the BARC data path chips (one BARC for every two planes of frame buffer).

It also has circuits to make circles and area filling. For circles, the center point and radius are written to the Scan Converter which generates and clips the pixels. The area fill is accomplished by a triangle fill algorithm where the CPU provides pre-sorted polygon vertices. These triangles are filled into a phantom plane.

Both 2 and 3 operand Bit-Blt functions are supported. The 2 operand Bit-Blt is controlled by the window replacement rule. The 3 operand Bit-Blt is controlled by the three operand replacement rule. The BARC chips control the type of Bit-Blt being performed.

Color Mapping and Display Control. The IRIS chip controls the serial ports of the VRAM and converts all the data stream from the VRAMs to the appropriate color as defined by the color lookup table in IRIS. IRIS has 8 bit DACs driving the output. With 6 planes, 64 colors are displayable at any one time. All of the video control signal generation is provided by IRIS. These signals are combined with the data stream inside IRIS so the RGB video outputs are taken directly from the IRIS output pins.

ID/Font ROM. The ID/Font ROM provides the CPU information about the video circuits. Pixel matrix, initialization, and dot clock frequency data is provided. The ROM is a 256K ROM that has the first 8 Kwords, accessible 1 byte at a time on odd byte boundaries, and the last 16 Kwords used for display ID ROM functions.

Alpha character font is the size and shape of the dot matrix for creating alpha characters. The system monitor displays the font required for the application, and opreating system. Sometimes the software will specify another available font to be used if required. Standard pixel display matrix is a 6 by 10 character matrix in an 8 by 16 character cell.

Small Computer Systems Interface

SCSI Overview

A Small Computer Systems Interface (SCSI) option provides a protocol that is a standard for a bus which enjoys a growing acceptance with all types of workstations. Its main advantages lie in its accaptance as a standard, speed and low hardware cost. It is defined by ANSI standard X3T9.2. Only HP 9000 Series 300 HP-UX Rev. 6.0 and later may be used with SCSI.

Available as an option for the Model 319C+ Color Workstation's SPU, SCSI circuits are mounted on the video board. It occupies the same physical space as the high-speed HP-IB circuits and as a result, users must choose between SCSI and high-speed HP-IB if both options are considered for the application.

SCSI is connected to an SCSI disc drive with a 0.5 metre, shielded cable. Other devices are connected in daisy-chain fashion via shielded SCSI cables which are available from HP in various lengths. An SCSI terminator is required on the SCSI peripheral to allow proper operation. Figure 3-10 shows a typical system using the SCSI bus.
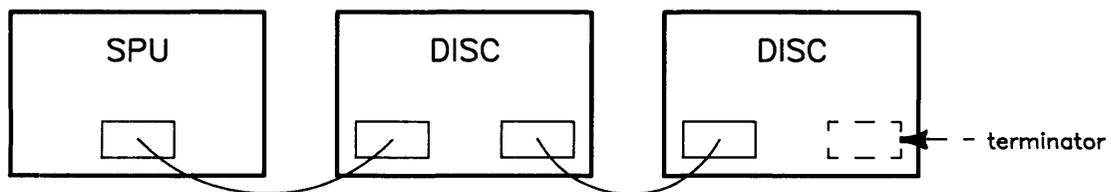
Figure 3-11. A Typical SCSI System

SCSI communicates with peripheral devices across the bus by means of a set of protocols called HP Common, which is Hewlett-Packard's version of the Common Command Set. These protocols are implemented in HP-UX revision 6.0 and all later revisions.

The use of disconnect/reselect by the peripherals is strongly encouraged for conventional hard disks It is required in the case of lower performance peripherals, for reasons of efficient bus utilization.

Feature Set

Major features of the SCSI option are:

- Data transfer rates of up to 1.5 times that of high-speed HP-IB.

- Industry standard hardware and software.

- Access to broad range of peripheral features not offered by HP.

- Many compatible product offerings planned by HP.

Unsupported SCSI Attributes

Differential Drive. Both single-ended and differential drive are part of the SCSI standard. However, the Model 319C+ SPU's SCSI option supports single-ended drive only.

Slow Devices. There is no intention of providing multiple SCSI busses in order to accomodate peripherals that utilize the bus inefficiently. The word "inefficient" can be quantified by defining these three classes of peripherals:

Class	Description
2	Bursts data in asynchronous or synchronous modes at a minimum of 1.5 megabytes per second.
	Disconnects from bus if needed such that no dead time in excess of 5 milliseconds is created on the bus.
	Maintains an average data rate in excess of 1 Mbyte per second after data transfer starts.
	Does not hold the bus longer than 100 milliseconds in normal operation.
1	Bursts data in asynchronous mode at a minimum rate of 1 Mbyte per second.
	Disconnects from bus if needed such that no dead time in excess of 40 milliseconds is created on the bus.
	Maintains an average data rate in excess of 400 Kbytes per second after data transfer starts.
	Does not hold the bus longer than 200 milliseconds during normal operation.
0	Any peripheral not meeting Class 1 specifications.

'Normal operation' is defined as a 16 Kbyte read or write for a random-access mass storage peripheral. For a physically streaming device, it is operation in streaming mode. For devices such a printers and optical scanners, it is continuous operation at full mechanical speed for the device.

Class 2 peripherals are preferred. Class 1 are acceptable, if a significant price advantage exists for a particular device. Class 0 devices are not supported by the SCSI card.

SCSI versus HP-IB

SCSI hardware in combination with HP Common is analogous to HP-IB hardware and CS80. The SCSI standard provides data transfer rates of up to four times that of HP-IB. Here are some other differences:

Interfacing to Peripherals. SCSI is limited to eight devices. With the SCSI card implementation, that means one mainframe and up to seven peripherals. By comparison, HP-IB is limited to 31 devices.

Termination. The SCSI bus must be terminated at both ends. HP-IB does not require termination.

Chaining. SCSI devices must be connected in daisy-chain fashion. HP-IB devices may be connected in any configuration, that is, chaining, starring or any combination.

Specific Connectors. Connection to the SCSI bus is by a 50 pin micro-ribbon cable with shielded connector. The HP-IB connector is a 24-pin D-style connector configured in two rows of 12 pins.

Configuration

SCSI Node Address. Each device on a SCSI bus must have a unique address from zero to seven, called the node address. The SCSI circuit is fixed at Node Address 0.

SCSI Bus Termination. The SCSI bus must be terminated at both ends. The SCSI circuit furnishes termination for the SPU end of the bus. Peripheral devices must have either no termination or optional termination, except that one peripheral device may be permanently terminated, provided that it goes on the end of the bus. Termination for devices with no termination is provided by the terminator included in the product. It is installed in the empty cable connector on the end device.

Parity. The SCSI circuit is fixed generating odd parity on the SCSI bus. Data received with incorrect parity is logged as an error.

Adding or Removing a Device. You may want to remove a device or substitute one for another as part of the troubleshooting process (such as to confirm that a particular device is defective), but don't want to shut the HP-UX system down to do it. Here is how to add or remove a device without shutting down and turning off the system each time:

To remove a device:

1. Use the `unmount` command to unmount the device from the HP-UX operating system.

2. Turn off power to the device.

3. disconnect the device from the SCSI bus.

If you are not going to add a device in the place of the one which you just removed, be sure to reconnect the bus. If the removed device was on the end, make sure that you move the termination to the previous device on the bus.

To add a device:

1. Connect the device to the SCSI bus.

2. Turn on power to the device.

3. Use the `mount` command to mount the device.

Cabling

Cable Options. There are three cable options in the SCSI protocol. The standard is an unshielded ribbon cable with 50 conductors.

- Alternative 1 is similar to the standard cable except that it is shielded.

- Alternative 2 is a shielded round cable with 25 pairs of twisted wire. Pin 1 is twisted with pin 26, and so forth.

Note that the ribbon cables are intended to connect devices which are mounted in the same enclosure. The Alternative I cable was chosen for the SCSI card because there is little chance that it will connect to a device in the same enclosure as the SPU. The shielded ribbon cable is entirely suitable for connecting devices which are located in one enclosure.

Connecting Cables. The SCSI option comes equipped with a 0.5-metre, Alternative II shielded (round) cable, for connecting the SPU to one peripheral device. Cables for connecting additional devices are available in various lengths from Direct Marketing Division (DMK).

Some cables manufactured under the name "Apple®" fit the mechanical specifications, but will not function properly with the SCSI card.

The alternative 2 cables for use with the SCSI card are identical to those used on differential SCSI busses.

Third-Party Issues

The SCSI option has a potential problem unlike most products, in that it is expected to be used in conjunction with non-HP equipment. Here are some of the possible pitfalls to be aware of:

- **Drivers:** Any peripheral device must have a driver in HP-UX. The one furnished in the software is intended for use with HP devices, and probably will not work with non-HP devices. Users of non-HP devices are expected to furnish their own driver. Normally, this will be written by the OEM or other volume supplier. However, there may be cases in which the user is not furnished with a suitable driver. Writing of this driver is still the user's responsibility, and not HP's.

- **Service:** Occasionally, a combination HP and third-party systems will fail to operate properly. HP's responsibility extends only to the end of the cable. Once the Customer Engineer has ascertained that the HP hardware and software is functioning correctly, it is up to the system owner to pursue a solution.

Several potential problems may occur with connecting non-HP peripherals. Users who connect non-HP peripherals will have to ensure that they have a suitable driver. Further, there is enough flexibility in the SCSI standard that a particular combination is not guaranteed to work. Also, if commands other than those in HP Common are utilized, the HP-UX drivers must be modified.

Functional Description

Architecture. The architecture of the card is straightforward. The SCSI Protocol Controller (or SPC) is connected to the SCSI cable through single-ended line drivers. The other side of the SPC is connected through a DIO-like interface to the host mainframe.

Internal registers of the SPC are memory-mapped into the address space of the card, and appear as 8-bit registers. These registers are readable at odd byte addresses. During writes, the proper parity bit is always generated and supplied to the SPC. Any data written by the CPU in the upper byte of a word transfer is ignored. A byte write to an even address will cause a bus error.

Parity generation is implemented for both the registers in the SPC and the DMA data path. Parity checking is done by the SPC for the DMA path, and the result is available in the SERR register. Due to the lack of parity on DIO, the actual parity bit cannot be transferred to or from system RAM. Parity is always odd.

Data words (16-bit) can be transferred under DMA control between the interface and main system memory.

An interrupt circuit is available, and will normally be used to inform the host CPU of state changes on the bus. The host initiates a transaction with the mass storage device, and then responds to interrupts as it proceeds. The interrupt signal is generated by the SPC, and logically ANDed with the IE bit from DIO register 3. Therefore, even the 'unmaskable' interrupt described in the SPC manual can be inhibited.

An electronic fuse in the SCSI interface's +5 V dc power input will blow when excessive current is drawn. When trying to boot an OS through the SCSI interface and the SCSI electronic fuse blows, the fuse may be reset by re-starting the self-tests and boot sequence. Note that if the condition that caused the fuse to blow has not been corrected, the fuse will blow again as soon as the SPU is turned on.

If this fuse blows while HP-UX is executing, constant interrupts will occur. The SCSI driver to turn off the SCSI interface. If the SCSI disc drive is a root disc in the HP-UX system, that root disc drive will need to have its power cycled. However, if the root disc drive is used with HP-IB, the HP-UX system will continue running but no SCSI discs will function until the HP-UX system is taken down and power is cycled.
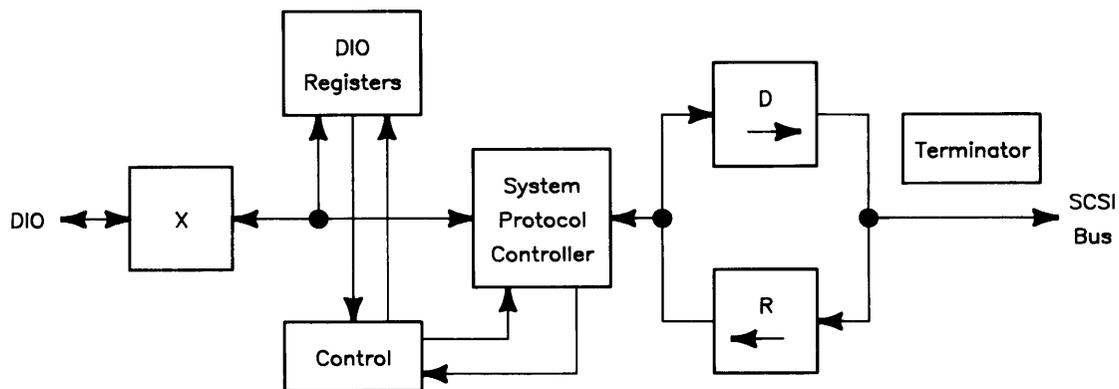
Figure 3-12. SCSI Block Diagram

Self-tests for SCSI are explained in Chapter 4 and 5.

High-Speed HP-IB

Overview

The high-speed HP-IB interface option is functionally identical to the HP 98625B card. It allows word wide transfers during DMA cycles and is fully supported by software. Because of limited space, the circuits are implemented on the video board instead of the SCSI circuits when the high-speed HP-IB option is ordered.

A picture of the video/high-speed HP-IB board is shown in Figure 3-9. A block diagram is shown in Figure 3-12.

The optional high-speed HP-IB interface configuration is fixed as follows:

- Select Code 14.
- Interrupt Level 4.
- System Controller.
- High-Speed.
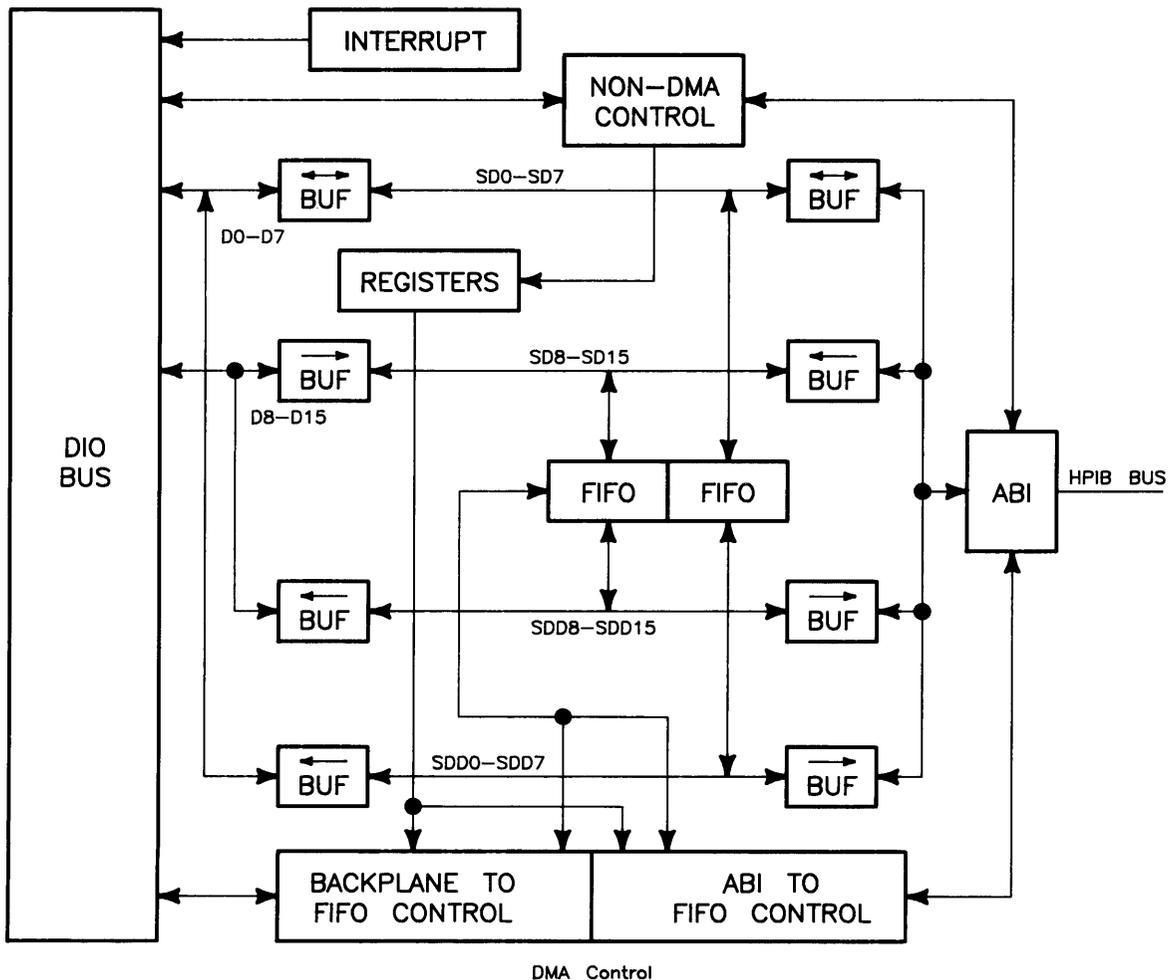
Figure 3-13. High-Speed HP-IB Block Diagram

Boot ROM Functions

<div style="text-align: right; font-size: 2em;">**4**</div>

Introduction

A Series 300 Boot ROM, Revision C, is used in the Model 319C+ Workstation's SPU. Other Series 300 computers use similar Boot ROMs. When the SPU is turned, two Boot ROM instruction sets are executed by the CPU:

- Power-Up/Self-Test Sequence.

- Booting Operating Systems.

Power-Up/Self-Test Sequence

When the SPU is turned on the CPU executes the power-up/self-test sequence before an operating system is booted. This is required to initialize and test hardware to make sure the SPU is ready to boot an operating system. The Model 319C+ SPU's power-up sequence is shown below.

1. Test CPU.

2. Determine 24 or 32 bit address range.

3. Turn on self-test LEDs.

4. Test the top 16 Kbytes of RAM.

5. Set up data structures.

6. Search for any boot extension ROMs and call any valid ones.

7. Determine processor type (MC68020).

8. Initialize and test processor board timer.

9. Reset all I/O.

10. Initialize the video circuits.

11. Checksum the Boot ROM.

12. Display CPU type.

13. Look for floating point co-processor.

14. Initialize keyboard electronics.

15. Drop interrupt level.

16. Preload for main RAM test.

17. Test internal HP-IB.

18. Test DMA.

19. Test remaining RAM and set up bottom of memory.

20. Report any memory failures and the amount of memory found.

21. Initialize the bottom of memory.

22. Find, report, and test the following interfaces:

    a. Processor board HP-IB.

    b. Processor board RS-232.

    c. Processor board LAN.

    d. SCSI, if installed.

    e. High-speed HP-IB, if installed.

23. Video circuits are initialized and cleared.

24. Output final LED value.

Configure Mode Software Override

Configure mode is a Boot ROM feature that allows the modification of some power-up defaults independent of which language will eventually be booted. To enter configure mode press [CTRL]-[C] before a system is booted but after the keyboard is initialized (e.g. after the keyboard message is displayed).

All mass storage operations lock-out and defer the response to the [CTRL]-[C] (just as they defer RESETs). This is to prevent leaving a mass storage device stranded in a strange state (e.g. disc spinning).

```
Copyright 1987,                    KEY    ACTION
Hewlett-Packard Company.            T     Extended Self-Test
All Rights Reserved.                L     Continuous Self-Test Loop

BOOTROM Rev. C
Bit Mapped Display
MC68020 Processor
MC68881 Coprocessor
Keyboard
HP-IB
DMA-CO
RAM 524128 Bytes
HP98644 at 9
HP98625 (HPIB) at 14
HP98643 at 21 01019FFA0001




CONFIGURE MODE
RESET To Power-Up                                              1H
```

Figure 4-1. Example Power-Up Display in Configure Mode

Once in Configure Mode, two options are displayed. If no key is typed within approximately 5 minutes, the Boot ROM will time-out and start power-up over again. Regardless of the option chosen, most of the self-test will be repeated. If the memory test has already been completed and the extended self-test option is chosen, then the main memory test portion of the self-test will be repeated, otherwise it will not.

Extended Testing

If ⌈T⌉ is pressed, the self-test will be started over and the long memory test will be executed, taking approximately 4 seconds per megabyte rather than the default, short memory test taking approximately 1 second per megabyte. This mode will also invoke extended testing on LAN and SCSI interfaces (does external loopback and cable testing). The latter testing will request the user to power off any SCSI peripherals and attach the appropriate end of the SCSI test connector.

Extended Test Mode can be invoked while running in looping mode. The result is continuous extended testing. SCSI extended testing will not be done in this combination.

Continuous Self-Test

Pressing ⌈L⌉ causes the Boot ROM to continuously repeat the self-test portion of its code. Entering configure mode while already in continuous self-test mode and choosing the "L" option, will stop the continuous self-test and will cause the Boot ROM to continue normal operation.

While in continuous self-test mode, the Boot ROM will not wait, beep or stop for most failures, but will just continue looping through self-test. The following failures will stop self-test looping:

- **A memory failure in the top 16K bytes.**

  In this case the Boot ROM stops with the display blanked and oooooo●● on the LEDs.

- **Boot ROM checksum failure**

  In this case the Boot ROM stops with the message CONTINUE AT OWN RISK (RETURN To Continue) is displayed, the value oooo●●●o on the LEDs, and then beeps appropriate low and high tones. Pressing ⌈Return⌉ will cause the Boot ROM to continue self-test looping.

The Human Interface

Some devices may act as the "console", or primary human interface, for the Boot ROM. As of this revision, the list of possible console devices is explained in the next section.

Output Devices

- Supported HP terminals are defined as those terminals supported by HP on HP-UX for Series 300. See the section of this chapter describing Remote Human Interface for Boot ROM requirements.

- Internal RS-232 controller with the remote bit set (with a supported HP terminal).

- The bit-mapped video circuit.

Only one output device at a time will be used as the console output device, however, the Boot ROM will initialize and clear the bit-mapped video circuit even if that circuit is not chosen as the console device. Note that if a device fails self-test then for the above algorithm, the device is considered "not present". The Boot ROM always tests a device before choosing it as the the console output device.

Input Devices

Two types of input devices are used:

- RS-232 controller on processor board with supported HP terminal.

- HP-HIL keyboard circuits on processor board.

Note that if a remote terminal is present in a system, both the HP-IL and RS-232 controllers will both be enabled.

Note that if a keyboard controller fails, then it is considered to be "not present" and no keyboard failed message will be displayed. In this case, the RS-232 interface would be the only other input device providing the remote bit is set and a terminal is used. The Boot ROM always tests a device before choosing it as the console input device.

If no output device is present, but a keyboard is present, then that keyboard will still act as the console input device. Similarly, if no input device is present, but video circuits are present, then the video circuit will still act as the console output device. If neither an input device nor an output device is present, the Boot ROM will go ahead and automatically boot the default operating systems as long as no errors are discovered during self test (see the section on Self-Test for more details).

Remote terminals as consoles are discussed in more detail in the next section.

Remote Human Interface

Very early in the power-up sequence, a search is made for a RS-232 interface with its "remote" bit set. If one is found, it becomes the remote human interface. Note that the RS-232 appears as an HP 98644 card and will be treated as such by the Boot ROM.

To indicate that a remote human interface has been found (at, for example, select code 9), the first line of the display will show:

        Remote Interface at 9

After this point the display will not change until a system is booted. The keyboard electronics will work just as they would if there were no remote console (see previous section for details).

Using a Remote Interface

To use the remote interface, an 80 wide terminal with at least 24 lines that accepts the following HP standard terminal escape sequences is required:

Key Sequence	Function
Escape H Escape J	To Clear Screen and reset cursor
Escape &aDDY	To Move Cursor to Row DD
Escape &aDDC	To Move Cursor to Column DD

The Boot ROM will use the baud rate, pacing, and line characteristics of the RS-232 interface.

Since the RS-232 circuit has no switches for the following functions, they will always be assigned the following characteristics when used as remote console by the Boot ROM:

- 8 bits/char,
- no parity,
- a single stop bit,
- 9600 baud, and
- XON/XOFF handshaking.

The display on the terminal will be the same as the display on a monitor. Keyboard functionality will also be the same, except that the [Break] key on the terminal is mapped to the [Reset] key on the local keyboard.

During the self-test of I/O cards, the circuit driving the remote interface will not be disturbed. It was tested earlier and passed.

Note that use of the [Enter] and [Tab] keys during Boot ROM execution can cause the terminal's display to become scrambled.

```
Copyright 1987,
Hewlett-Packard Company.
All Rights Reserved.

BOOTROM Rev. A
MC68010
Bit Mapped Display
Keyboard Failed
HP-IB
HP98642 at 9 Failed
HP98629 at 20
Memory Failed at FFFC5932
  (W:BBBB4444, R:BBBB4464)
196448 Bytes




WAITING 1 MINUTE (RETURN To Abort Wait)
RESET To Power-Up
```

Figure 4-2. Example Screen Display With Multiple Power-up Self-Test Errors

Memory Tests

Memory tests are performed on main memory. The same messages are used for reporting all memory failures, but they are interpreted slightly differently for word and byte memory tests.

For word wide memory test errors, the following message is displayed:

```
Memory Failed at AAAAAAAA
 (W:BBCCDDEE, R:FFGGHHII)
```

Where:

- W: BBCCDDEE is the write pattern,
- R: FFGGHHII is the read pattern,
- BB and FF are at address AAAAAAAA,
- CC and GG are at address AAAAAAAA+1,
- DD and EE are at address AAAAAAAA+2, and
- EE and II are at address AAAAAAAA+3.

For byte-wide display and interface circuit memory test errors, the following message is displayed:

```
Memory Failed at AAAAAAAA
 (W:BBCCDDEE, R:FFGGHHII)
```

Where:

- W: BBCCDDEE is the write pattern,
- R: FFGGHHII is the read pattern,
- BB and FF are at address AAAAAAAA,
- CC and GG are at address AAAAAAAA+2,
- DD and EE are at address AAAAAAAA+4, and
- EE and II are at address AAAAAAAA+6.

Parity checking is enabled during the memory test phase. Error messages are of two types:

```
parity bit error at FFFF1234
```

Means a failure was detected in the parity checking RAM for the address shown.

```
data parity error at FFFF4321
 (W:BBCCDDEE, R:FFGGHHII)
```

A RAM failure was detected at the address shown. The address in parity error messages is the lowest of four consecutive addresses. Errors could have occurred in any or all of these four addresses. Parity errors will be displayed during the TESTING MEMORY phase of the self-test and testing will continue.

Small Computer Systems Interface

SCSI Identification

The SCSI is identified by this message:

```
HP98265 (SCSI S 16) at 14
```

If two SCSI devices are listed at the same bus address, the SPU will stop. To correct this, make sure each SCSI device has its own unique address.

If all SCSI addresses are listed for the same device, change the address on the device to an other address other than 7. Address 7 is the SCSI interface and must not be used as a SCSI peripheral address.

SCSI Testing

There are two levels of SCSI testing: normal and extended.

Normal testing is done at powerup or if the Boot ROM is in LOOPING test mode. This test only checks the general functionality of various registers on the interface. It will only detect gross failures.

The identification line may be followed by one of these error messages:

```
register test failed
fuse burned out
```

If any of these messages appear, no attempt will be made to use the interface as a boot source.

The "fuse" is an electronic fuse which can be reset by either pressing [Reset] to cause the boot rom to restart or by cycling power to the SPU.

Extended testing includes three parts:

- Register test (as done in normal testing).

  This test is always run and if it fails, the remaining sections will be skipped.

- Loopback test.

  This test displays these messages in the order listed and the indicated actions are required:

  Turn OFF ALL SCSI devices, which means to turn off power to ALL SCSI peripherals. If a particular sequence is required for proper system shut-down, that sequence must be followed.

  Disconnect cable at nearest device, meaning remove the SCSI cable at the first SCSI peripheral down the SCSI interface from the SPU.

  X cancels, RETURN continues testing, wherein pressing [X] cancels the test or [Return] continues the SCSI test.

  This test checks transmit and receive functionality both with and without DMA interaction. If this test fails, cable test can still be executed. If the user cancels testing at this point by typing [X] in response to the prompt, this section and the following sections are skipped. It will take a second or so with bit-mapped video circuits to clear the display.

- Cable test.

  This test displays these messages in the order listed and the indicated actions are required:

  `Attach SINGLE-ENDED test connector`, meaning connect the single-ended part of the SCSI test connector (5061-6565) to the cable disconnected from the peripheral.

  `X cancels, RETURN continues testing`, the same as before.

  This test requires the use of a special test connector and should be skipped if one is not available. The purpose of this test is to check the cable for shorted or broken wires. If the loopback test failed, this test may also fail due to failed circuitry on the interface board rather than due to a bad cable. At the end of this test, it is very important that the test connector be removed. Failure to do so will cause the Boot ROM to hang while trying to use the interface connected to this cable.

- Reconfiguring the System.

  These messages are displayed after the SCSI tests are completed and the indicated actions are required:

  `Remove test connector`, here's when you remove the SCSI test connector from the cable. This message is only given if the cable test has been run.

  Note: The test connector must be removed before continuing. If the test connector is left on and operations are continued, the SPU will stop.

  `Connect cable to device`, meaning connect the SCSI interface cable to the SCSI peripheral it was earlier removed from.

  `Restore power to devices`, this is when you turn on all SCSI peripherals.

  `RETURN continues operations`, and pressing [Return] continues with the next part of the self-test and booting operations.

Booting Operating Systems

Boot System Selection

The Boot ROM provides two modes of operation, attended and unattended. These two modes allow a user to either select from multiple operating systems on multiple boot devices or to automatically boot a system with no human intervention.

Unattended Operation

In an unattended situation, the first system found will be loaded and given control. To find a system the Boot ROM will search a boot list of prioritized devices. The first system found on one of these devices will be booted. If no system is found, the boot list will be searched again until a system is found. This allows discs not present at power-up be found after their initialization is complete.

Once a device has been successfully accessed, it will never be accessed again until re-power-up or a reset. This minimizes wear on mass storage devices and limits the confusion of systems disappearing and re-appearing on shared resources such as the LAN server.

To force the boot of a particular system when the machine is unattended, the user has the following options:

- Make sure that the system to be booted is the first to be found according to the boot list search. (This is quite easy to do simply by changing device addresses, select codes, or system names, or by moving systems. The prioritized boot list is discussed in detail latter in this chapter.)

- On a LAN server with multiple systems, the system administrator can determine what operating system is booted by each workstation.

Attended Operation

To force the boot of a system not chosen by the boot list, the user must enter "attended mode." This mode is entered by typing ☐ (space bar), ⌈Return⌋, or any letter or number during power-up after the input portion of the human interface (i.e., the keyboard or terminal) has been initialized but before a default system is booted. A good way to do this is to hold down the space bar until the system selection menu is seen. This will cause a boot selection menu to be displayed. A user can be sure that the input human interface has been initialized when one of the following (depending on the human interface provided) is displayed in the self-test list:

    Keyboard

The boot selection menu displays all accessible systems as the Boot ROM locates them. A system is selected by typing the two to three character string (a 1 to 2 digit number followed by a single letter) listed in the menu. Note that the character used to enter attended mode is considered part of this string.

As the keys are pressed, they are identified the lower right hand corner of the display.

An example display is shown in Figure 4-3.

```
Copyright 1987,
Hewlett-Packard Company.          :HP7908, 803, 0
All Rights Reserved.                 1H  SYSTEM_HP-UX
                                  :REMOTE, 21, 0, 8
BOOTROM Rev. C                       2H  SYSTEM_HP-UX
Bit Mapped Display
MC68020 Processor
MC68881 Coprocessor
Keyboard
HP-IB
RAM 1572704 Bytes
HP98625 (HPIB) at 14
HP98643 (LAN) at 21 08000900ABCD




SEARCHING FOR A SYSTEM (RETURN To Pause)
RESET To Power-Up                                          1H
```

Figure 4-3. Example Display Listing Operating Systems

If you know that a particular choice is desired (such as "1H"), then you can type that response as the SPU powers up to make a selection. This simple human interface makes it possible to make a selection without even having or seeing a monitor. Note that only keys A-Z, a-z, and 0-9 are allowed to select a system. Other keys are simply ignored.

Because it is possible to find more systems than there are lines on the display, the search scan can be paused and continued by toggling the RETURN key. The line next to the bottom of the screen indicates the current state with one of two messages:

SEARCHING FOR A SYSTEM (RETURN To Pause), or
PAUSED (RETURN To Continue)

The menu will wrap around to the top of the screen and overwrite itself whenever all available lines are used. When the Boot ROM is paused, all activity stops. Because the keyboard is polled, there may be a delay before a key press takes effect.

Boot System Priority Control

Devices are searched in priority order for systems. This priority order is determined by the boot list shown below:

1. Disc drives at select codes 0-31 on bus address 0, unit 0, volume 0

2. Remaining disc drives at select codes 0-31, bus addresses 0-7, units 0-16, volumes 0-7

Each device is allowed to have multiple systems. Again, if the SPU is unattended, it will boot the first system found. If the SPU is attended (i.e. a key was struck after the input human interface was initialized), it will display all systems found until a system is selected and that system is found.

For each category in the boot list, there is also an order of search based on address location. In all cases, lower addresses are found first. This means a device at select code 0 will be found before a device at select code 7. If a device has multiple addresses to locate it, then searching is done at a local level first. For example, after looking at select code 7, bus address 1, unit 1, the Boot ROM will look at select code 7, bus address 1, unit 2 before going to select code 8.

The boot list was designed to make it easy to change and control which system will be booted in the unattended mode. The guidelines used to establish the boot list are as follows:

- High priority addresses before low priority addresses.

- Local systems before remote systems (Local refers to dedicated devices and remote refers to shared devices.).

- Removable media before non-removable media.

- Small capacity devices before large capacity devices.

Default Mass Storage Is

The Boot ROM is responsible for setting up the default mass storage variable, DEFAULT_MSUS. It is used by systems for three purposes as the:

- Default MSUS for operating systems.

- Device from which to load an autostart program, and

- Device from which to do a secondary load.

The DEFAULT_MSUS is set to the following algorithm which is the:

- Same as the MSUS of the booted system, OR a A non-ROM value passed in DE-FAULT_MSUS to the booter routine (this is done only by systems calling the booter, not by the Boot ROM itself), or

- First device found present in the boot list if ROM is specified in DEFAULT_MSUS and no media can be found (i.e., an on-line disc drive with no media present), or

Supported Boot Configurations

The Model 319C+ SPU can boot operating systems via HP-IB. Media formats from which a system may be booted are:

- L.I.F.

- UNIX (Boot Area) (Note that this is different from HP-UX. See Chapter 5, the HP-UX Programmer's Guide, for details.)

The Boot ROM can boot systems from the following boot devices:

- AMIGO protocol HPIB Discs (e.g. 8290XM, 9895, L-Codes and 7906/20/25)

- CS/80 protocol HP-IB discs (e.g. 7908)

- SS/80 protocol HP-IB discs (e.g. 9122)

- CS/80 Tape.

Note

Some of these devices, namely the HP 7906/20/25, may not meet EMI requirements when used with Series 300 computers, but their support in the drivers comes inexpensively with other discs that are supported.

LAN Boot Operations

User Interface Specifications

LAN interfaces are identified by its product number or circuit equivalent, then (LAN) then the select code, and link address of the interface as:

```
HP98643 (LAN) at 21, 080009000001
```

Any time the interface is identified certain tests are also run Before the test the display will show

```
HP98643 (LAN) at 21
```

then

```
HP98643 (LAN) at 21, 080009000001
```

If a failure is detected in the powerup test, the following failure message will be displayed:

```
HP98643 (LAN) at 21, 080009000001 Failed
```

This shows that one of the internal tests on the card failed.

If extended testing is selected by pressing $\boxed{\text{CTRL}}\text{-}\boxed{\text{C}}$ then $\boxed{\text{T}}$, the LAN card is subject to the normal testing plus external loopback tests. The following error messages may be displayed below the LAN identification message:

- **CABLE Failed**

  This shows that the cable is not connected or improperly terminated.

- **MAU Failed**

  This shows that the MAU circuitry failed. This is not likely on SPUs where the interface is built-in. On non built-in LAN cards this could mean that the MAU was not plugged into the card.

- **NO HEARTBEAT**

  This message is only a warning. This shows that the interfaces self-test (done after every transmission) is failing.

If no servers respond to the Boot ROM's attempts to initiate a boot session then the user will see no other indication of LAN activity.

For each server that responds, display will show :**LAN**, followed by the select code, followed by either the servers name or its Link Address. Under this will appear the list of systems provided by that server:

    :**LAN, 21, 080009000008**, or
    :**LAN, 21, (local server name)**

If a system calls the Boot ROM to boot/reboot a system and a file name is specified and the msus is for LAN, the Boot ROM will retry indefinitly to contact the server at the given link address. All other devices have a fixed number of retries/timeout and will report No Medium or SYSTEM NOT FOUND.

The system call for a boot/reboot on LAN is the only time an indefinite retry/timeout is used.

Troubleshooting

5

Introduction

Analytic Troubleshooting

Troubleshooting SPUs is the process of getting answers to these five questions:

- What exactly is wrong, or what are the bad symptoms?
- Where are the bad symptoms appearing?
- When do the bad symptoms occur?
- How bad is the problem or to what extent does it occur?
- What actually caused the problem in the first place?

Getting the answers to these questions usually makes the troubleshooting process much more effective and less costly. When a failure in a workstation occurs, remember these questions and get the answers to each of them.

After you have all answers possible, decide what's the most probable cause of the problem. Sometimes you'll arrive at several choices for a cause. For each choice, qualify it against the answers to the questions above. The most probable cause is the one that logically justifies the correct answers to these questions.

Materials Required

Several items may be required to troubleshoot the SPU to the failed assembly:

- Model 319C+ Workstation SPU's Service Handbook
- Series 200/300 Test Tools Package.
- SCSI Test Connector (1252-2297).
- Digital Voltmeter.
- Anti-Static Workstation.

Test LED Displays

Eight test LEDs are located behind the fan and are visible from the rear of the SPU by looking through the fan. In this manual, the LED's are shown in the following context:

LED On   ●

LED Off   ○

Troubleshooting Procedures

Workstation Level

Workstation troubleshooting consists of finding out what part of it is not working correctly. A Model 319C+ Workstation consists of the SPU and its installed peripherals, power source, *and the users*. Each of these elements is subject to the environment which includes, physical, electrical, and human factors.

When part or all of the workstation fails, your initial activity should be finding the part that has the problem. One of the best things to do first is to talk to the users and ask them to give specific information on what they were doing when the workstation, or part of it, failed. You may have to duplicate their activities in order to make the failure occur. If the failure is intermittent, this process may take some time.

An important part of troubleshooting is to get the workstation in a minimum working configuration that shows the failure symptoms.

Running tests on the workstation can also be helpful. A test is nothing more than a specific action with the system that should result in a specific response. Simple tests are nothing more than typing in simple instructions on the keyboard and executing them. A command to print or plot specific data is an example. Mass storage, graphics, or other functions can be checked in the same way. These type of tests are called Quick Checks.

For quick checks, the HP 98613D Series 300 BASIC 5.2 operating system may be used. It allows short booting time, easy programming, and can serve as a test tool to check the workstation.

After determining what part, or product, of the system is failing, the next step is to find out what part of the product is causing the problem. In this case, it is assumed that the SPU has the problem. The rest of this chapter covers troubleshooting the SPU.

SPU Troubleshooting

Three levels of troubleshooting the SPU is explained. For each level different portions of the SPU must be operational. A summary of these levels and what must be operational is shown in Table 5-1.

In order to choose the best approach to start with, obtain as much information as possible from the user. If the unit is not working at all, the Inoperative Unit Procedure is a good place to start. If the user indicates that most of the unit is operating properly, the Functional Unit Procedure may be a good place to start. If the users information is not conclusive, use the following procedure to determine the problem area:

1. Turn the unit on and check for fan and Self-Test LED operation.

2. If the fan or LED's aren't working, go to the Inoperative Unit Procedure. If they do work, go to the Functional Unit Procedure.

Table 5-1. SPU Troubleshooting Procedures

Procedure	What MUST Function
Inoperative Unit	Nothing
Live Unit	Power Supply
Functional Unit	Power Supply Part of CPU circuits Part of interfaces Top 16K of RAM Some inputs from keyboard Video to operate monitor

Inoperative Unit Procedure

An Inoperative Unit is one which does not appear to function at all. No power-on or self-test LEDs, fan rotation, or response to keyboard inputs are typical symptoms. Nearly all inoperative units have one of these problems:

- Defective power supply.

- Voltage select connector in wrong position.

- Improper line voltage/frequency or defective power cord.

Follow this procedure to isolate the problem. If an assembly is defective, this procedure indicates which assembly should be replaced to eliminate the problem.

WARNING

Hazardous voltages are present in the SPU when it is plugged in. Turn the unit off and unplug the SPU before placing test leads, checking fuses, or removing/installing assemblies.

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1. Check that the voltage select connector is installed correctly. Refer to Chapter 3 in this manual or Chapter 2 in the Service Handbook for the correct procedures.

2. Ensure the processor board is properly installed and see if the power supply output voltages are correct. If they aren't, replace the power supply.

3. If the fan is not rotating, check the voltages at the test points on the power distribution cable. Remember at least the processor board must be installed or the voltages will be about 1 volt in error. The fan voltage may also be checked at the fan wire connector on the processor board. Fan voltage should be +12 V dc.

Live Unit Procedure

A live unit is one which has a properly functioning power supply but the SPU will not function. One of the assemblies installed (other than the power supply) is usually defective. Live units often are very difficult to troubleshoot, since a problem anywhere on the I/O bus in the SPU can shut the workstation down and prevent the execution of any instructions, even those from the Boot ROM.

The Live Unit Procedure is a method for finding the defective assembly which is preventing the processor from executing instructions. It assumes that the power supply is operating properly, and the self-test tried to run, but didn't.

If the power supply is not operating properly, refer to the Dead Unit Procedure. If the turn-on self-test runs enough to either display a failure, stalls in a meaningless state, or passes, refer to the Functional Unit Procedure.

Once the problem in the workstation has been isolated to the SPU, it's sometimes best to start with a minimum configuration.

Minimum Configuration

A minimum SPU configuration is one with just enough hardware installed to have self-test function. The self-tests don't have to pass, just work. Here's the hardware required for a minimum configuration.

- Power Supply.

- Processor Board.

You may have to remove the add-on RAM board and video-SCSI/HP-IB board to get the SPU to function if a problem is on one of these boards.

Testing the minimum configuration is relatively simple. Just remove the internal assembly, then follow these steps:

1. Plug the SPU in and turn it on. The Self-Test LED's should ripple and change state several times.

2. If the LED's do not light or ripple, turn the SPU off, unplug it, and replace the processor board, then retest.

3. Turn it on, and watch the LEDs. If the LED's don't light or ripple, check continuity of all the wires in the power distribution cable and replace it if necessary.

Functional Unit Troubleshooting

A functional unit is one that passes the minimum configuration test. It doesn't have to function properly, but at least start the self-test and light the test LEDs.

SCSI Test Connector

Note

To allow complete self-tests of the SPU when the SCSI option is installed, an SCSI test connector must be connected to the SCSI interface port or cable.

An SCSI test connector (1252-2297) provides loop-back test information to the SPU's SCSI interface. The connector can be used in either single-ended or differential configurations. It connects to the SCSI port like the cable.

Two loop-back configurations are present on the SCSI test connector:

- Single-Ended.

- Differential.

Each is explained in Table 5-2.

Table 5-2. SCSI Test Connector Configurations

SCSI Type	
Single-Ended	Connects to SCSI interface port on rear of SPU, or
	Connects to peripheral end of SCSI interface cable, or
	Replaces SCSI Terminator on SCSI peripheral.
Differential	Not implemented for Model 319C+ Workstation

Minimum Configuration

For the SPU to pass the minimum configuration functions correctly, the LED's should end up as oooo oooo.

Once the minimum configuration self-test passes, you're ready to start testing a functional unit with the self-tests.

1. Plug the SPU in, turn it on and watch the LED's go through self-test.

2. If a failure is indicated, refer to the LED, refer to the tables at the end of this chapter to determine the failed assembly.

Table 5-3. Minimum Functional System

Assembly	Minimum Functions Performed
Power Supply	All voltages normal and within specifications.
Processor Board	CPU executes self-test, cycles memory, most instructions executed OK.
	Memory addresses, read/writes, and refreshes.
	Inputs/Outputs data between CPU and peripherals via HP-IB, HP-HIL, RS-232 or SCSI interfaces. **Note: If an SCSI interface option is installed, the SCSI terminator must be installed to allow complete SCSI self-tests.**
	Processes and outputs video.
Keyboard	Inputs information.
Disc Drive	Stores, reads, writes data.
Monitor	Displays information.

Once these functions work, a similar process can be used to install and check other system functions. This also may be a good point to load and run one of the tests in the Series 200/300 Test Tools Package. Refer to the Test Tools Manual for tests information such as:

- Minimum Hardware Configuration Required.
- Test Loading and Running.
- Interpreting Test Results.

Series 300 Test Tools are explained later in this chapter.

Self-Test

Use the self-test to troubleshoot a unit which can execute some instructions, but cannot accept, store or output data correctly. This means that the basic elements of the SPU are functioning. The basic elements include the power supply, processor board, and at least the first 16 Kbytes of RAM. If any of these are not known to be functional, refer to the Initial Troubleshooting Procedure section.

The self-test checks most assemblies in the SPU. Both pass and error displays in binary are shown by the LED display. LED's are located behind the rear panel and are visible through the lower portion of the fan.

For a functional description of the self-tests, refer to Chapter 4.

Failure Indications

As the self-test progresses, the LED's display the current state. At the end of the test, a power-up with no errors is indicated by all LEDs turned off and by immediate entry into the boot scanner.

Should a failure occur during the self-tests, it will be indicated on the LEDs at the end of the tests. If there was more than one failure, the highest priority failure will be indicated on the LEDs. All the LED values are shown in Table 5-4.

The highest priority failure is also output to the beeper, if present. The lower seven bits of the LED value are beeped in seven tones as follows:,

- Most significant bit first.

- One second beep per bit.

- A zero (LED off) is represented by a low tone.

- A one (LED on) is represented by a high tone.

If no failure occurs, the beeper will not sound off. If the failure was a Boot ROM checksum error, the following message will be displayed:

        CONTINUE AT OWN RISK (Press RETURN To Continue)

Once this message has been printed, the [Return] key must be pressed to continue to the boot scanner. The probability is fairly low that the error will adversely affect the user, but if it does, it could be catastrophic.

For all other failures, the message:

        WAITING 1 MINUTE (Press RETURN To Abort Wait)

will be displayed.

The Boot ROM will time out after approximately one minute and will then continue into the boot scanner. This allows time for the display to warm up and for the user to read the error messages. These failures are usually non-fatal so, in an Unattended Mode, the Boot ROM will still boot the first OS it finds. Pressing [Return] will terminate the beeping error code and abort the one minute wait. Pressing [Return] will also make the SPU revert to the Attended Mode. This means that the Boot ROM will display all OSes found and will not boot one until one in chosen and entered by the user.

SCSI Interface Fusing

An electronic fuse in the SCSI interface's +5 V dc power input will blow when excessive current is drawn. When trying to boot an OS through the SCSI interface and the SCSI electronic fuse blows, the fuse may be reset by re-starting the self-tests and boot sequence. Note that if the condition that caused the fuse to blow has not been corrected, the fuse will blow again as soon as the SPU is turned on.

If this fuse blows while HP-UX is executing, constant RST (definition?) interrupts will occur. The SCSI driver to turn off the SCSI interface. If the SCSI disc drive is a root disc in the HP-UX system, that root disc drive will need to have its power cycled. However, if the root disc drive is used with HP-IB, the HP-UX system will continue running but no SCSI discs will function until the HP-UX system is taken down and power is cycled.

General Description of LED Failure Codes

Failure Indications

If a failure occurred during the self-tests, then that failure will be indicated on the LEDs at the end of the tests. If there was more than one failure, the highest priority failure will be indicated on the LEDs. All the LED values are listed below.

The highest priority failure is also sounded off on the beeper, if present. The lower 7 bits of the LED value are sounded off, most significant bit first, one second per bit, with a zero represented by a low tone and a one represented by a high tone. If no failure occurs, the beeper will not sound off.

If the failure was a Boot ROM checksum error, the following message will be displayed:

        CONTINUE AT OWN RISK (Press RETURN To Continue)

Once this message has been printed, [Return] must be pressed to continue to the boot scanner. The probability is fairly low that the error will adversely affect the user, but if it does, it could be catastrophic.

For all other failures, the message:

        WAITING 1 MINUTE (Press RETURN To Abort Wait)

will be displayed. The Boot ROM will time out after approximately one minute and will then continue into the boot scanner. This allows time for the CRT to warm up and for the user to read the error messages. These failures are usually non-fatal so, in an unattended mode, the Boot ROM will still boot the first system it finds. Pushing the RETURN key will terminate the beeping error code and abort the one minute wait. Pushing the RETURN key will also make the machine attended.

This means that the Boot ROM will display all systems found and will not boot a system until one in chosen and entered by the user.

Table 5-5 shows the general meaning of error codes. These codes are explained further in other tables. LED patterns are represented by a black dot for on and a white dot for off. Letter designators indicate the LED in that position is on or off, depending on the binary code used to represent the device or failure type.

<p align="center">Table 5-5. General Failure LED Indications</p>

Upper 2 Bits Fail Indicator	LED Code and Failure Description
State Indication Only:	ooSS SSSS Where SS SSSS Indicates State of Power-up
Required Device Missing or DTACK Failure:	o●DD DDDD Where DD DDDD Indicates Device
Failing Device:	●oDD DDDD Where DD DDDD Indicates Device
Special Codes (Special Case Highest Priority Codes):	●●●● ●●●● LEDs Never Accessed (or Unused Code) o●●● ●●●● LEDs Failed to DTACK oooo ooo● Timer on processor board has failed or is missing.

Lower 2 Bits State or Device Codes	LED Code and Failure Description
Miscellaneous (Highest Priority):	XXoo FFFF Where FFFF indicates Failure (Xs are don't-care bits)
Internal Peripheral Failure (Medium Priority):	XXo● PPPP Where PPPP is Peripheral Number
I/O Card Failure (Lowest Priority):	XX●S SSSS Where S SSSS is Select Code

LED State and Failure Codes

Table 5-6 lists the LED failure codes used in the SPU's Boot ROMs. Codes are listed here in numerical order for easy reference, and then again in order of occurrence and priority.

Table 5-6a. Self-Test LED Special State and Failure Codes
(In numerical order):

LEDs	Explanation	Problem Solution
oooo oooo	No failure	
oooo ooo●	Failed CPU register test.	Replace processor board
oooo oo●o	Testing top 16 Kbytes of RAM.	
oooo oo●●	Failure in top 16 Kbytes of RAM.	Replace processor board
oooo o●oo	Top 16 Kbytes of RAM missing or not found by CPU.	Replace processor board
oooo o●●●	Starting test vector list.	
oooo ●ooo	Resetting all interfaces.	
oooo ●oo●	Searching for console display.	
oooo ●●oo	Internal bit-mapped display checksum.	
oooo ●●●o	Failed Boot ROM checksum.	Replace processor board.
oooo ●●●●	Pre-loading RAM for main test.	
ooo● oooo	RAM Testing	
ooo● ooo●	Failure: Not enough RAM.	Replace processor board.
ooo● oo●●	Failure: Boot error.	Replace processor board. Replace OS media. Replace user-supplied accessory board.
ooo● o●oo	Failure: OS tried to start loading at too high of an address.	Replace OS media. Replace processor board.
ooo● o●o●	Failure: Not enough RAM to load OS.	Upgrade to more RAM. Use smaller OS.

Table 5-6b. Self-Test LED State and Failure Codes for Interfaces
(In numerical order)

LEDs	Explanation	Problem Solution
oo●o oooo	Failure: 4 ms timer.	Replace processor board.
oo●o oo●o	Failure: Processor board keyboard circuit.	Replace processor board.
oo●o o●oo	Failure: Processor board HP-IB circuit	Replace processor board.
oo●o ●ooo	Failure: Processor board DMA circuit.	Replace processor board.

oo●o ●●oo	Failure - one of these:
	    Font ROM is bad.
	    Font ROM is not useable.
	    Could not find US ASCII character set.
		Replace video board.

oo●o ●●o●	Failure: Video board bit map circuit.	Replace video board.
o●oo ●●●o	Failure: High-speed HP-IB or SCSI circuit.	Replace video-I/O board.
o●oo ●oo●	Failure: RS-232 circuit.	Replace processor board.
o●oo o●oo	Failure: SCSI circuit.	Replace video/SCSI board.

Table 5-7. Turn-On, Self-Test, and Boot Displayed Messages

Displayed Message	Explanation and Procedure
RAM FAILED ABOVE FFFFC000	Failure in top 16 Kbytes of RAM. Replace processor board.
RAM GONE ABOVE FFFFC000	CPU could not find top 16 Kbytes of RAM. Replace processor board.
TESTING MEMORY	User RAM is being tested.
LOADING MEMORY	RAM is loading with Boot ROM code.
BOOTING A SYSTEM	An OS is being loaded into RAM.
SEARCHING FOR A SYSTEM (RETURN To Pause)	Looking for an OS on mass storage devices. Press Return to stop the search.
PAUSED (RETURN To Continue)	SPU has paused. Press Return To Continue.
CONFIGURE MODE	Self-test is in configure mode. Press T for extended self-test. Press L for continuous self-test.
SELF-TEST MODE	SPU is in self-test mode.
RESET To Power-Up	Press Reset to re-start power up sequence.
RESET TO RE-Try	Press Reset to re-try what failed before.
CONTINUE AT OWN RISK (RETURN To Continue)	A self-test was not completed. You may continue but errors may occur. Press Return to re-start power up sequence.
WAITING 1 MINUTE (RETURN To Abort Wait)	SPU has paused while you decide what to do next. Press Return to abort wait and continue.
UNEXPECTED USE OF HHHHHHHH	Refer to Table 5-8.
NOT ENOUGH MEMORY	Not enough RAM to load OS.
SYSTEM WOULD LOAD TOO HIGH	An addressing error would make the OS start loading at too high of a RAM address. One of these situations probably occurred: 1. Bad OS media. 2. Error in information transfer. 3. Error in CPU, I/O or mass storage hardware. Try again. If error message repeats, troubleshoot or replace the above items.
SYSTEM NOT FOUND	Selected OS was not found on available mass storage devices. Verify desired OS is on a mass storage device and retry.
(Bit Mapped Display	Bit-mapped video circuits on video board identified.
Keyboard	Processor board's keyboard circuits identified.
HP-IB	Processor board's HP-IB circuits identified.

Table 5-7. Turn-On, Self-Test, and Boot Displayed Messages (cont.)

Displayed Message	Explanation and Procedure
HP98260	Interface (HP 98260 or equivalent) identified.
DMA-CO	Processor board's DMA circuits identified.
MC68020 Processor	MC68020 CPU identified.
MC68881 CoProcessor	MC68881 Floating-Point Co-processor identified.
RAM BBBBBBB Bytes	BBBBBBB is the amount of RAM in bytes the self-test found in the SPU.
MEMORY FAILED AT HHHHHHHH	Memory failed at hex address HHHHHHHH. Replace one of these assemblies, depending on which one has the failed memory address: Processor board. Add-On RAM board.
DATA PARITY ERROR AT HHHHHHHH	A parity error occurred with hex address HHHHHHHH. Replace one of these assemblies, depending on which one has the failed memory address: Processor board. Add-On RAM board.
PARITY BIT ERROR AT HHHHHHHH	A parity bit error occurred with hex address HHHHHHHH. Replace one of these assemblies, depending on which one has the failed memory address: Processor board. Add-On RAM board.
MEMORY GONE AT HHHHHHHH	A read or write cycle was attempted at address HHHHHHHH but no memory found at that address. Replace one of these assemblies, depending on which one has the failed memory address: Processor board. Add-On RAM board.
XXXXX at SC	A circuit equivalent to an HP product (XXXXX) and type was found at select code SC
Remote Interface at SC	A remote interface was identified at select code SC.
HP98265 (SCSI S 16)at SC	SCSI identified as S (single-ended) and 16-bit DMA capable at select code SC.

Other Failure Indications

'UNEXPECTED' Error Messages

Several "UNEXPECTED" failure messages may be displayed at any time. Table 5-8 lists these messages. The addresses 5 most significant digits are FFFFF so only the 3 least significant digits (LSD) are used in the table. When a range of addresses is shown, each address is the range is 6 addresses apart.

When an "UNEXPECTED" failure message equates to an interrupt level, vectored interrupt, or trap, the following situations normally exist:

- **Interrupt level 1 through 7:** Can happen at any time and are usually caused by an interface set to the indicated interrupt level. If the error repeats, the interface should be replaced.

- **CPU traps:** Usually occurs when the operating system is being used. A CPU trap indicates something in the CPU didn't go right. If the error repeats, the processor board should be replaced or use a fresh copy of the operating system.

- **Other errors:** Several things can cause these errors, either on the processor board on in an interface circuit. If the error repeats, the processor board or interface should be replaced.

  If messages are meaningless or garbled, something went wrong and can compound the situation. Restart or cycle power to the SPU. If messages are still incoherent, the processor board or another interface circuit may need to be replaced.

Table 5-8. "UNEXPECTED USE OF (address)" Failure Messages

3 Hex LSDs	What Unexpected Event Occurred
FFA	Bus error
FF4	Address error
FFE	Illegal instruction
FE8	Zero by zero trap
FE2	Check trap
FDC	TRAPV TRAP
FD6	Privilege violation
FD0	Trace trap
FCA	1010 Opcode
FC4	1111 Opcode
FBE	Interrupt level 1 (keyboard)
FB8	Interrupt level 2 (not used)
FB2	Interrupt level 3
FAC	Interrupt level 4
FA6	Interrupt level 5
FA0	Interrupt level 6
F9A	Interrupt level 7 (RESET from keyboard)
F3A to F94	CPU Traps
F34	Reset from keyboard
F2E	Keyboard timeout (fast handshake)
F28	Battery backup interrupt
F22	NMI from the backplane
F1C	Spurious interrupt
EEC to F16	Vectored interrupts
EE6	Format error, co-processor violation or unknown.
EE0	MC 8881 Co-processor exception vectors.

LAN Boot Failures

If a failure is detected in the powerup test, the following failure message will be displayed:

    HP98643 (LAN) at 21, 080009000001 Failed

This shows that one of the internal tests on the processor board's LAN circuit failed.

If extended testing is selected by pressing `CTRL`-`C` then `T`, the LAN card is subject to the noraml testing plus external loopback tests. The following error messages may be displayed below the LAN identification message:

- **CABLE Failed**

  This shows that the cable is not connected or improperly terminated.

- **MAU Failed**

  This shows that the media access unit (MAU) circuitry failed. This is not likely on SPUs where the interface is built-in.

- **NO HEARTBEAT**

  This message is only a warning. This shows that the interfaces self-test (done after every transmission) is failing.

If no servers respond to the Boot ROM's attempts to initiate a boot session then the user will see no other indication of LAN activity.

LAN Boot Error Messages

LAN error messages will show at the lower left of the display and consist of an error name followed by the same identification string shown above the list of system names.

Table 5-9. LAN Boot Error Messages

Error Message	Meaning
SYSTEM NOT FOUND	The server could not open the selected file, or the file was of the wrong type.
No Server	The server did not respond to a boot request.
Not Ready	LAN hardware powerup or reset failed.
Read Error	The open operation worked but the server has since then failed to respond to a read request or the server sent end of file.
	The server failed to respond to a read request or the server sent eof.
Bad Hardware	The LAN hardware failed to respond to some operation or reported a catastrophic error.
Bad State	Damaged Boot ROM code

Test Tools

Overview

Series 200/300 Test Tools is a software package for verifying the integrity of Series 200 and 300 system installations. While the tests do not provide totally comprehensive system diagnostics, they are a valuable tool for trained service personnel when installing, servicing, and troubleshooting these workstations. The tests can also be used by less-experienced users and operators for determining whether or not professional assistance is needed to identify and fix a system malfunction.

The tests described in this manual are for testing and troubleshooting Series 300 systems that do not require formal verification of operation before use. Series 300 HP-UX systems have a more critical need for system verification tests, so these tests may be used as part of the standard HP-UX operating system (HP-UX System Functional Tests and CS/80 Exerciser programs are very similar to the equivalent tests described in this manual). The Series 300 Computer Tests described in Part II of this manual can be used for troubleshooting beyond the testing level provided by HP-UX test programs, provided the system being tested has an external flexible disc drive for loading and running the test software.

Series 200/300 Test Tools provide the following test capabilities when combined with the SPU's Boot ROM self-test.

Computer Tests

Series 300 Computer Tests for the Model 319C+ Workstaion's SPU are supplied on one of two discs, the other is for for Series 200 computers. They test the boards in the SPU (except the power supply).

System Functional Tests

Five discs contain these tests. The first disc contains the test operating system environment and the main menu; the other discs contains the test programs. These tests are used to verify communication between the SPU and supported peripherals. They do not add significantly to the confidence levels achieved by the Boot ROM self-test program, though they expand confidence in overall system integrity by providing visible proof that communication with selected peripherals is correct and that interfacing is connected and set up correctly. The tests do not provide any worst-case tests at maximum speed or similar margin-of-safety tests.

CS/80 Exercisers

CS/80 Exerciser Programs are supplied on a single disc and is used to verify that CS/80 disc drives are correctly connected to the SPU, and that the SPU can successfully write and retrieve data to and from the disc or tape. The Pascal-based program also provides access to CS/80 disc and tape error logs for analyzing drive and media performance. This information is useful for troubleshooting, and for planning preventive maintenance programs.

Package Contents

The combined Series 200/300 Test Tools software package is provided on both 3.5-inch discs and 0.25-inch tape as shown below:

Description	Part Number
Series 200/300 Test Tools, one 0.25-inch tape	09800-12700
Series 200/300 Test Tools, eight 3.5-inch discs	09800-12300

Discs in the 3.5-inch disc package are listed below.

Contents	Part Number
Series 200/300 Test Tools Manual	09800-90001
Series 200 Computer Tests Disc Rev. 1.1	09800-10336
Series 300 Computer Tests Disc Rev. 3.0	98561-10334
Series 200/300 System Functional Tests Discs:	
SFT0 Disc Rev. 1.2	09800-11334
SFT1 Disc Rev. 1.2	09800-11335
SFT2 Disc Rev. 1.2	09800-11336
SFT3 Disc Rev. 1.2	09800-11337
SFT4 Disc Rev. 1.2	09800-11338
CS/80 Exerciser Disc Rev. 3.1	09800-11304

One tape and the manual are packaged with the tape version.

Parts Lists

<div style="text-align: right; font-size: 2em;">**6**</div>

Parts Information

Introduction

Field replaceable parts are listed in this chapter for the Model 319C+ Workstation's SPU. Components, such as ICs, are not available for field repair.

Parts are available direct from:

> Corporate Parts Center
> 333 Logue Avenue
> Mountain View, California 94042 USA
>
> Telephone: (415) 968-9200

Parts may be ordered through your local HP Sales and Service Office. To help get parts as soon as possible, please write the address and telephone number of your local HP Office in the spaces below.

Name: _____

Address: _____

City, State ZIP: _____

Telephone: _____

Cooperative Support Program

HP's Cooperative Support Program is available for customers that can provide technical assistance, manual updates, and other helpful information for hardware support. Your local HP Sales and Service Office can provide the information for this support service.

Exchange Parts

Exchange parts are available for some items at a reduced cost. When an exchange part is ordered, your account will be charged for a new part. Customers have 15 days to return the failed part to receive credit for the difference between a new and exchange part.

Please return failed exchange parts to your local HP Sales and Service Office as soon as possible. Place them in anti-static bags (see Parts List for part numbers) and package them securely in a sturdy container. It's a good idea to save the containers and static-free bags you receive parts in and use them to ship parts in.

Part Number Lists

Parts listed in this section apply to only the Model 318M Workstation's SPU.

Static-Free Bags

Part Number	Description	Comments
9222-0980	9-inch by 15-inch cushioned pouch, for system boards	

SPU Electrical Parts
Miscellaneous Electrical Parts

Part Number	Description	Comments
98564-61602	Power distribution cable	
98564-62701	Line filter	
09125-68500	Fan	

Printed Circuit Boards

Exchange Part Number	New Part Number	Description	Comments
	98564-67002	Power supply	
98564-69508	98564-66508	Processor board w/4 Mbyte	
98564-69509	98564-66509	Processor board w/8 Mbyte	
98564-69520	98564-66520	Add-on RAM board, 4 Mbyte	
98564-69521	98564-66521	Add-on RAM board, 8 Mbyte	
98564-69570	98564-66570	Video board	
98564-69571	98564-66571	Video board w/SCSI	
98564-69572	98564-66572	Video board w/HS HP-IB	

External Cables

Part Number	Description	Comments
	RGB video cable	
T-68722-C	SCSI cable, 0.5 metre	
1252-2297	SCSI Single-ended terminator	
5061-6565	SCSI Test connector	

HP-HIL Devices

Exchange Part Number	New Part Number	Description	Comments
	46021-60201	ASCII Keyboard	
	46020-60001	Keyboard Cable	
	HP 46060A	HP Mouse	
	46081-61601	2.4-metre extension cable	
	46082-61601	Short audio cable	
	46082-61602	30-metre audio extension cable	
	46082-61604	15-metre remote cable	
	46082-61605	15-metre video cable	
	46083-61601	Short audio cable	
	46083-67901	Switch cap assembly	
	HP 46085A	Control dials	
	46085-85000	Overlay	
	0403-0430	Molded foot	
	QEDS-7099	RPG assembly	
	5041-2416	RPG knob	
	HP 46084A	ID module	
	HP 46086A	Button box	
	HP 46087A	"A" size digitizer	
	HP 46088A	"B" size digitizer	
	HP 46094A	Quadrature port device	
	HP 46095A	3-button mouse	
	HP 92916A	Bar code reader	

SPU Case Parts
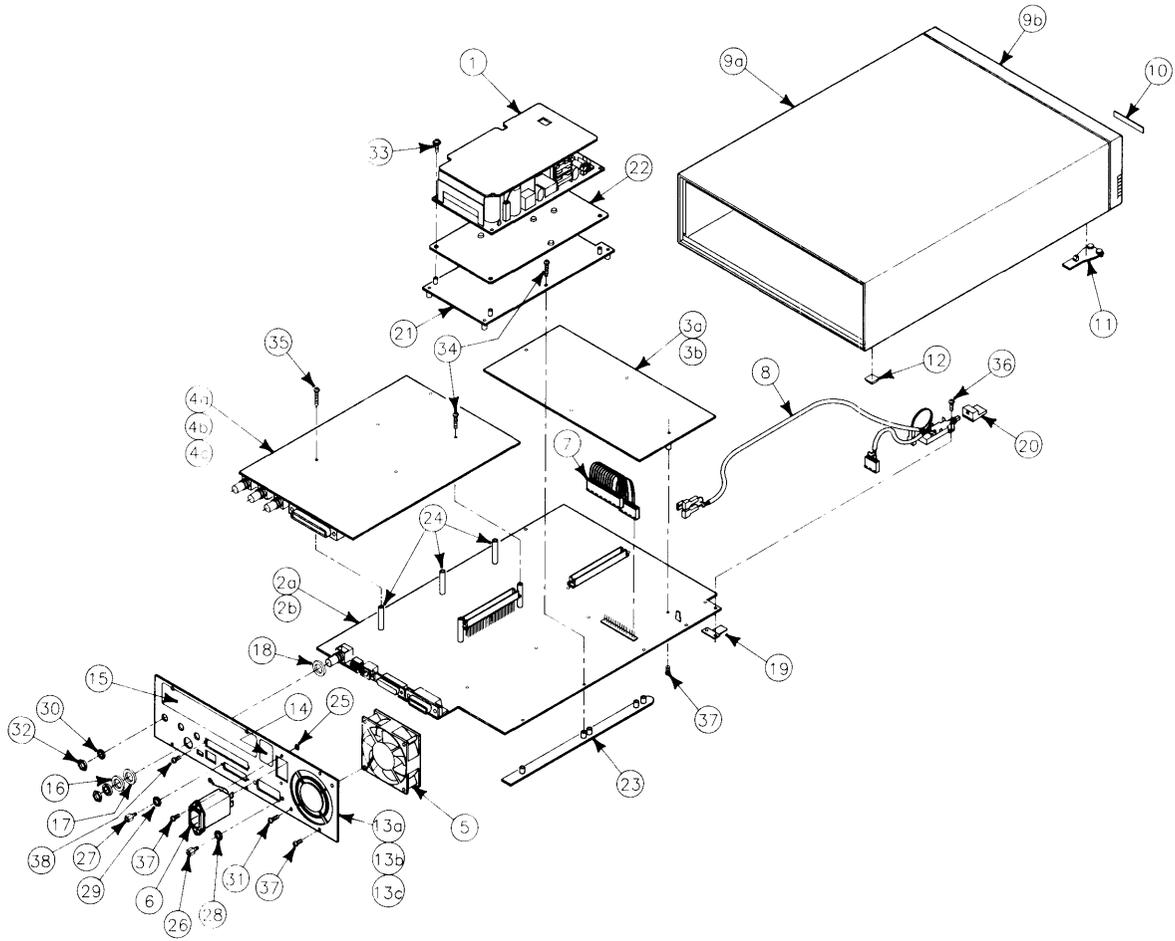
Figure 6-1. SPU Exploded View

SPU Case Parts List

Ref.	Part Number	Description	Ref.	Part Number	Description
1	98564-67002	Power Supply	16	3050-0604	Flat washer
2a	98564-66510	Processor board/ 4 Mb	17	0160-6777	Capacitor/washer
2b	98564-66511	Processor board/8 Mb	18	3050-1291	Shoulder washer
3a	98564-66520	4 Mb Add-On RAM board	19	5001-9030	Tongue bracket
3b	98564-66521	8 Mb Add-On RAM board	20	5041-2424	ON/OFF keycap
4a	98564-66570	Video board	21	5001-9028	Power supply plate
4b	98564-66571	Video-SCSI board	22	5041-2426	Power supply insulator
4c	98564-66572	Video-HS HP-IB board	23	5041-2423	Rail
5	5180-1336	Fan	24	0380-1947	Spacer, 33 mm
6	98564-62701	Line filter	25	0505-0082	Hex nut
7	98564-61602	Power distribution cable	26	0380-0643	HP-IB jack screw
8	98564-61602	ON/OFF cable	27	1251-7812	RS-232 jack screw
9a	5001-9025	Case	28	2190-0407	Lock washer, internal tooth
9b	35751-40001	Front panel	29	2190-0054	Lock washer, internal tooth
10	98561-84002	Label, name	30	2190-0409	Lock washer, internal tooth
11	09121-48303	Molded foot	31	0624-0525	10-24 self-tapping screw
12	0403-0427	Bumper	32	2940-0256	Double hex nut
13a	5001-9027	Rear panel (standard)	33	0515-1919	Screw/washer assembly
13b	5001-9026	Rear panel for SCSI	34	0624-0706	Torx screw, 0.94-in. long
13c	5001-9029	Rear panel for HS HP-IB	35	0624-0707	Torx screw, 1.75-in. long
14	98564-84002	Label, 120/240 volt	36	0515-1851	Screw, M3 by 6 mm
15	98564-84001	Label, model/serial	37	0515-0372	Torx screw, M3
			38	2200-0104	Flat-head screw,

References

7

Introduction

Information in this chapter should help you in various situations. The references include part numbers of many hardware documents used with Model 319C+ Workstations.

Service Information Locator

In the front of this manual, and in the front of the Model 319C+ Workstation Service Handbook, is a Service Information Locator. It lists subjects and shows chapter numbers in other Hardware Support Documents that has the information.

Localized System Identification

Model 319C+ Workstations have keyboards and display characters localized for the language spoken and written in several countries. When an HP field office orders a workstation, a letter suffix is added to the field office ordering number to ensure the correct keyboard and character font is bundled with the hardware. Table 7-1 identifies the letter suffixes to product numbers for these systems.

For example, a system ordered from an HP field office in Toronto, Canada, to be used by English speaking Canadians, the field would order 98562BL.

Table 7-1. Localized System Suffixes

Local Language	Localized System Suffix
U.S.A English	A
French Canadian	C
German	D
European Spanish	E
French	F
Dutch Canadian	H
Katakana (Japanese)	J
Intercontinental English	K
Canadian English	L
Latin Spanish	M
Norwegian	N
Swiss German	P
Swiss French	Q
Swedish	S
UK English	U
Belgium Dutch	W
Finnish	X
Danish	Y
Italian	Z

Related Hardware Documentation

Hardware Support Documentation

Table 7-2. Hardware Support Documentation

Printed Pages Part Number	Manual Title
09000-90041	HP 9000 Series 200/300/500 Site Preparation Manual
98561-90020	Series 300 Configuration Reference Manual
09800-90001	HP 9000 Series 200/300 Test Tools Manual
98563-90030	HP 9000 Series 300 Model 319C+ Workstation's SPU Service Information Manual
98563-90039	HP 9000 Series 300 Model 319C+ Workstation's SPU Service Handbook
98563-90099	HP 9000 Series 300 Model 319C+ Workstation's SPU Self-Paced Hardware Training Guide

Table 7-3. Document Binders

Binder Part Number	Description
9282-1077	1-inch, 3-ring, 8.5 by 11-inch page size, 300 pages
9282-1078	1.5-inch, 3-ring, 8.5 by 11-inch page size, 350 pages
9282-1079	2-inch, 3-ring, 8.5 by 11-inch page size, 600 pages
9282-1080	2.5-inch, 3-ring, 8.5 by 11-inch page size, 750 pages
9282-1081	1-inch, 3-ring, 7 by 8.5-inch page size, 300 pages
9282-1082	1.25-inch, 3-ring, 7 by 8.5-inch page size, 450 pages
9282-1080	1.5-inch, 3-ring, 7 by 8.5-inch page size, 600 pages

Installation Manuals/Notes

Table 7-4. Installation Manuals/Guides

Printed Pages Part Number	Manual Title
98564-90614	Model 319C+ Workstation Installation Card
98561-90000	HP 9000 Series 300 Installation Reference
98561-90027	HP 9000 Series 300 Peripheral Installation Guide

HEWLETT PACKARD

98564-90630

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