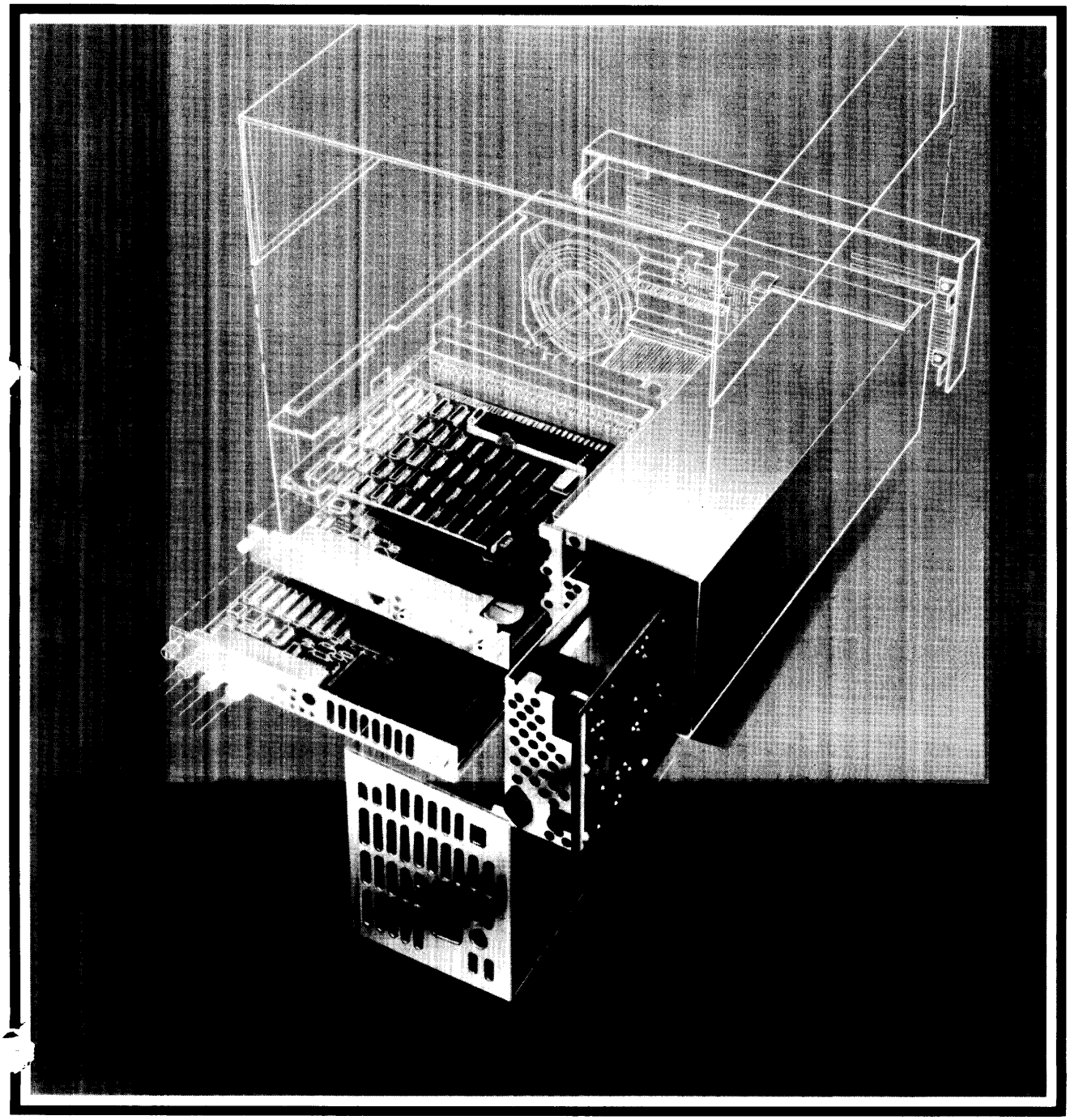
HP 9000 Series 300 Computers
Models 310/320 and
HP 98568A Bus Expander

HEWLETT PACKARD

Service Information Manual



Service Information Manual

for HP 9000 Series 300 Computers Model 310/320 and HP 98568A Bus Expander

Manual Reorder No. 98561-90030

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Printing History

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Safety Considerations

Your Attention, Please

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

- **WARNINGS** relate to activity which, if not properly performed, could result in injury to personnel or loss of life.
- **CAUTIONS** relate to activity, which if not properly performed, could result in damage to or destruction of equipment. In this case, injury to personnel is typically not a concern.
- **NOTES** provide information that will help understand situations and better prepare people in accomplishing the job.

Examples:

WARNING

The power supply presents a hazard to personnel when it is energized and exposed. Extreme care must be taken when connecting a voltmeter probes to the test points. Accidental bridging of the +5 volt supply to ground by rings or other jewelry can cause severe personal injury. De-energize the equipment by turning off the unit and removing the power cord before connecting or removing test probes.

CAUTION

The electronic assemblies in these products are susceptible to damage by electro-static discharge. Extreme care must be used when handling printed circuit assemblies. Handle printed circuit assemblies only when grounded to an anti-static workstation.

NOTE

Hewlett-Packard supports field repair 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.

Chapter 1
Product Information

Introduction

Series 300 Computers are modular computers. The HP 98568A Bus Expander permits an additional eight accessory slots to be used in the system. With a low entry cost and a wide range of accessories and interfaces, these computers provide technical-professional workstations that maximize productivity. Processing is accomplished by the MC68010 or MC68020 CPUs enabling high-speed data access and manipulation.

Available operating systems for these computers include BASIC, Pascal, and HP-UX. Several application programs are also available that run on any of these operating systems or on a subset of one of them.

Product Numbers and Terms

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

Product Identification Terms

Product Number

HP 9000 Series 300 Computer Systems are offered in two models. Model Numbers identifying these computer systems are:

- Model 310
- Model 320.

A complete explanation of these names and numbers is shown later in this chapter. Configuration and other product information is also covered.

Serial Numbers

Serial numbers are affixed to each computer and bus expander for identification purposes. A decal on each product has the serial number. An example serial number is explained below:

Serial No. 2322A01234

Location: Behind the power supply access cover on the bottom of the chassis for computer and bus expander.

Description:

5-digit unique identifying number.

Country of Origin Code.

Product Code, decoded as:
First 2 digits + 60 = Last 2 digits of year product was introduced or significantly changed.
Last 2 digits = number of week in year product was introduced or significantly changed.

Hardware Terminology

Hardware is used to define physical elements of these products. Different parts and locations of hardware items are explained below.

Products Types and Parts

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

- **Computer** - A product containing the central processing unit (CPU) and other assemblies such as RAM cards, interface cards, and other accessories. Sometimes the computer is referred to as the **mainframe**.
- **I/O Card cage** - The narrow slots for accessories in the back of the computer and bus expander. Four slots are available in the computer, in the bus expander there are eight of these slots. Distinction between these slots are:
  - Counting from the top, every odd slot is an **accessory card slot**.
  - Counting from the top, every even slot is an **I/O card slot**.
- **System Slots** - Two wider slots below the computer's accessory slots for the processor and HP 9854X Video Boards.
- **Internal (circuit)** - A circuit, such as an RS-232 interface, that is part of the processor board. Internal does not mean 'inside the computer's case parts'.
- **External (circuit)** - A circuit, such as an accessory RAM card, that is located on an assembly other than the processor board. External does not mean 'outside the computer's case parts'.
- **Peripheral** - A device external to the computer, such as a keyboard, monitor, disc drive, plotter, printer, bus expander, etc.
- **Bus Expander** - A device external to the computer that connects to the computer's I/O bus. This device provides power to its installed accessory cards and permits more of these cards to be used in the computer system. Sometimes they are called bus extenders.
- **System** - One or more computers with one or more peripherals connected together to run an application for a desired end result.

Assemblies

Assemblies in the computer and bus expander are made of several component parts. Identifying terms used in this manual are:

- **Cards** - Assemblies installed in the I/O card cage slots.
    - **I/O Card** - A card that outputs to and inputs from a peripheral device. They are installed in I/O slots. For example, an RS-232 I/O card.
    - **Accessory Card** - A card that only operates on the I/O bus and does not talk. to a peripheral device. They are installed in either I/O or accessory card slots.
- **Boards** - Assemblies installed in the two computer system slots, or inside the product. Boards are not usually removed or installed by users.
- **Backplane** - The board in the card cage with connectors for cards to plug into. In the computer, there's four connectors; in the bus expander, there are eight.

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 computer system. 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 computer 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 Documentation Organization

The purpose of the HP Series 300 Computer and HP 98568A Bus Expander Hardware Documentation is to support the installation and maintenance of these products. Hardware Documentation consists of six types of manuals:

- HP Series 200/300 Computer Test Tools Manual
- HP Series 300 Computer and HP 98568A Bus Expander Service Information Manual
- HP Series 300 Service Handbook
- HP Series 300 Service Notes
- HP 9000 Series 200/500 Site Preparation Manual
- Various Installation Notes
- HP Series 300 Installation Reference
- HP Series 300 Computer System Configuration Reference

A complete listing of titles and part numbers is in Chapter 6 of this manual and the HP Series 300 Service Handbook, Chapter 10.

HP Series 200/300 Computer Test Tools Manual

Series 200/300 Test Tools Manual supports a software package for verifying the integrity of Series 300 computer system installations. The Test Tools manual and its associated discs permit troubleshooting computer systems in failure analysis. Part numbers for the complete Test Tools packages are:

- 09800-12300 for 3.5-inch disk drives.
- 09800-12500 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 computer self-tests and explains what the different tests do.
Part II, Computer Tests	Covers loading and running of Series 200 and 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 computer-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.

HP Series 300 Computer and HP 98568A Bus Expander Service Information Manual

This manual (the one you're reading now) contains tutorial information on the computer's and bus expander's main 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 computer and bus expander 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 as follows:

Chapter No. and Title	Contents
Front Matter	Has warranty, printing history, Table of Contents, and Safety Situations explained.
Chapter 1: Product Information	Introduces the computer/bus expander, covers features, specifications, options, accessories, operating systems, repair philosophy, and a general description of the Series 300 Computers and HP 98568 Bus Expanders. Has an overview of how the Hardware Documentation is organized.
Chapter 2: Assembly Replacement	In this chapter, disassembly and reassembly of all field replaceable parts for the computer and bus expander are covered. Reference to the Service Handbook is made for part number information.
Chapter 3: Functional Description	Each assemblies functional description is covered to block diagram level.
Chapter 4: Boot ROM Functions	The sequence of events for power-up, self-tests, and booting an operating system are explained.
Chapter 5: Troubleshooting	This chapter contains tutorial information for troubleshooting the computer and bus expander. It has self-test errors as provided for the computer and bus expander explained.
Chapter 6: Reference	Has a Service Information Locator, documentation references, and other helpful information.

HP 9000 Series 300 Computers 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 Model 310 and 320 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 computers, accessories, and peripherals.

Series 300 Service Notes

When a situation occurs that effects servicing of the computer or bus expander 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 HP Series 300 Service Handbook.

Series 300 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 specifications are also listed.
Chapter 2, Environmental, Installation, and PM	Gives power requirements, fuse and power cord data, and installation information. If preventive maintenance is required, it is shown in this chapter.
Chapter 3, Configuration	Lists various product configurations and explains what each one is.
Chapter 4, Troubleshooting	Lists tools required, including System Tests, and explains several troubleshooting procedures. Flow charts are frequently used.
Chapter 6, Adjustments	If there are any field-level adjustments or alignments for the product, they are explained here.
Chapter 7, Systems	Shows supported system configurations. This chapter is the same as the Series 200 Configuration Guide
Chapter 8, Replacement Parts	Lists part numbers for all field-replaceable assemblies and explains how the parts 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	Service Notes for the products should be inserted here.

HP 9000 Series 200/300/500
Site Preparation Manual

Explains site preparation and how to prepare the computer 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 Series 9000 Computer System site. Includes a timeframe for setting up the computer system, and identifies people who can provide assistance.
Chapter 3, Preparing the Electrical Environment	Includes power specifications, 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, computer supplies, and nearby telephones for assistance which are an integral part of preparing for and sustaining the operation of a computer system.
Chapter 6, Equipment Arrangement and Space Planning	Provides information and guidelines for planning the location of the computer system 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 Computer Systems.
Appendix A	Lists product specifications 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 Notes

Each separately available accessory or upgrade has an Installation Note packaged with it. These Notes have instructions for configuring and installing the hardware.

Series 300 Installation Reference

The computer and bus expander each have step-by-step procedures for installing them. An Installation Card is a pictorial set of instructions to show the installer how to unpack, connect, and power up the computer, 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 computer fundamentals.
Chapter 2: Installing Your Computer	Includes procedures on positioning the computer, checking voltage settings, connecting power cords, and turning on the computer.
Chapter 3: Installing Accessories	This chapter covers accessory configuration and installation, such as memory or interface cards.
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.

Product Number Conventions

Each product number has its set of included hardware listed in Table 1-1. Product numbering conventions used with this computer are explained here to clarify the following information:

- Computer Systems Ordered by Customers.
- Computer Systems Ordered by HP Field Offices.
- Computer Products Manufactured by HP Ft. Collins Systems Division

Computer Systems Ordered by Customers.
When these computer systems are ordered by customers, a five-digit product number identifies the specific set of hardware comprising the computer system. This is the number customer's order when they want a system. Each model has two bundled systems as follows:

HP 9000 Series 300 Model 310

- **HP 98580A Measurement Automation System, consisting of:**
  - HP 98560A Computer
  - HP 35731A Monitor
  - HP 46020A Keyboard
  - Option 002, Delete 0.5M Byte RAM on processor board.
  - Option 008, Add HP 98546A Display Compatibility Interface.

- **HP 98581A Entry Design Automation System, consisting of:**
  - HP 98560B Computer
  - HP 46020A Keyboard
  - Option 008, Add HP 98546A Display Compatibility Interface.

HP 9000 Series 300 Model 320

- **HP 98582A High-Performance Software Engineering System, consisting of:**
  - HP 98560C Computer
  - HP 98782A Monitor

- **HP 98583A High-Performance Design Automation System, consisting of:**
  - HP 98560D Computer
  - HP 98568T Eight-Slot Bus Expander
  - HP 46081A HP-HIL Extension
  - HP 46020A Keyboard

Computer Systems Ordered by HP Field Offices.
Different five-digit product numbers are used by HP field offices to order Series 300 computer systems. These numbers are strictly for ordering purposes and not for product identification.

HP 9000 Series 300 Model 310

- HP 98560A Bundled Monochrome System
    - HP 98561A Computer
    - HP 98613B BASIC 4.0 Operating System
    - Option 002, Delete 0.5M Byte RAM on processor board.
    - Option 008, Add HP 98546A Display Compatibility Interface.

- HP 98560B Bundled Color System.
    - HP 98561A Option 003 Computer.
    - HP 98543A Color Video Board.
    - Option 008, Add HP 98546A Display Compatibility Interface.

HP 9000 Series 300 Model 320

- HP 98560C Bundled High-Resolution Monochrome System.
    - HP 98561B Computer.
    - HP 98544A Video Board.
    - HP 98257A 1M Byte Ram Card.
    - HP 98781A High-Resolution Monochrome Monitor.

- HP 98560D Bundled High-Resolution Color System.
    - HP 98561B Computer.
    - HP 98545A Video Board.
    - HP 98257A 1M Byte Ram Card.
    - HP 98782A High-Resolution Color Monitor.
    - HP 46081A HP-HIL Extension.

Chapter 5, References, lists localized systems that are configured for the language spoken in various countries.

Computer Products Manufactured by HP Ft. Collins Systems Division
At the manufacturing division, the computer's are built and configured using the numbering conventions explained below. Note that these numbers relate only to the computer or bs expander and do not include peripherals, such as disc drives, some monitors, and some accessories. Other HP divisions provide the rest of the products bundled with the computer system. Factory bundled systems are:

- **HP 98561A**
  - 98561-66512 Processor Board.
  - 98561-60001 4-slot Backplane.
  - Power supply, motherboard, and case parts.
  - Localized Power Cord.
  - Option 002, -66511 instead of -66512 processor board.
  - Option 003, -66513 instead of -66512 processor board.
  - Option 004, delete Backplane.
- **HP 98561B**
  - 98561-66519 Processor Board.
  - 98561-60001 4-slot Backplane.
  - Power Supply, Case parts, and motherboard.
  - Localized Power Cord.
  - 98561-66531 Human Interface Card.
  - 98257-66524 1M Byte RAM Card.

Series 300 Computer System Configurations

With a wide variety of configurations, the capability range of these computers is quite large. Table 1-1 shows what each of the four bundled configurations have for mainframes, accessories, peripherals, and operating systems. This information is also shown in the Service Handbook. A matrix to help identify Series 300 computers by assemblies installed and products bundled with the systems is shown in Table 1-2.

Complete product names and numbers for this computer are listed in the HP Series 300 Computer System Hardware Configuration Reference.

Table 1-1a. Series 300 Computer System Product Names and Numbers

Product Number	Description
Model 310	HP 98560A Computer, includes: MC68010 CPU processor board with - 512K bytes RAM HP-HIL, HP-IB, RS-232 and Audio Interfaces Medium-resolution monochrome video board 4-slot card cage for accessory and interface cards HP 46020A Keyboard HP 35731 Medium-resolution Monochrome Monitor HP 9153A 20M byte Winchester with 710K-byte Flexible Disc Drive Option 007 - Delete Disc Drive Option 008 - Add HP 98546A Display Compatibility Interface.
Model 310	HP 98560B Computer, includes: MC68010 CPU processor card with - 1M-byte of RAM HP-HIL, HP-IB, RS-232 and audio interfaces 4-slot card cage for accessory and interface cards HP 98543A Medium-resolution video board HP 46020A Keyboard HP 35741 Medium-resolution color Monitor HP 9133H 20M byte Winchester with 710K-byte Flexible Disc Drive Option 007 - Delete Disc Drive Option 008 - Add HP 98546A Display Compatibility Interface

Table 1-1b. Series 300 Computer System Product Names and Numbers (Continued)

Product Number	Description
Model 320	HP 98560C Computer, includes: MC68020 CPU processor card with 1M-byte of RAM HP-HIL, HP-IB, RS-232 and audio interfaces 4-slot card cage for interfaces and memory HP 98544A High-resolution monochrome video board HP 98257A 1M-byte) RAM card HP 46020A Keyboard HP 46081A Speaker Module HP 98781A High-Resolution Monochrome Monitor HP 7946A 55M byte Winchester Disc Drive with streaming backup Option 007 - Delete Disc Drive
Model 320	HP 98560D Computer, includes: MC68020 CPU processor card with 1M-byte of RAM 4-slot card cage for interfaces and memory HP 98545A High-resolution color video board HP 98530A Human Interface Card HP 98257A 1M-byte) RAM card HP 46020A Keyboard HP 46081A Speaker Module HP 7946A 55M byte Winchester Disc Drive with streaming backup Option 007 - Delete Disc Drive

Determining Computer System Numbers

Table 1-2 lists the assemblies installed by the factory in each of the four bundled Series 300 computer systems. To use Table 1-2, follow these steps:

1. Inventory the assemblies installed in the computer and locate them in the left-hand column.
2. In the matrix, find the column that has an "X" or Option Number (example: "003") for each assembly in the computer.
3. The column having each assembly identified corresponds to the ordered product shown across the top.

Table 1-2. Series 300 Computer Assembly Matrix

Factory Installed Assembly	Computer System Ordered			
	98560A	98560B	98560C	98560D
0950-1760 Power Supply	X	X	X	X
98204-66577 Disp. Comp. Intfc. Graphics Card	008			
98257-66524 1M Byte RAM Card			X	
98542-66570 Lo-Res Mono Video Board	008			
98543-66570 Lo-Res Color Video Board		X		
98544-66570 Hi-Res Mono Video Board			X	
98545-66570 Hi-Res Color Video Board				X
98546-66571 Lo-Res Disp. Comp. Intfc Video Card	008	008		
98561-60001 4-Slot Backplane	X[1]	X	X	X
98561-66501 Motherboard	X	X	X	X
98561-66511 Processor Board	002			
98561-66512 Processor Board	X			
98561-66513 Processor Board	003	X		
98561-66519 Processor Board			X	X
98561-66531 Human Interface Card			X	

[1] Option 004 deletes the 4-slot backplane.

Determining Bundled System Numbers

Table 1-3 lists the peripherals bundled for each of the four Series 300 computer systems. To use Table 1-3, follow these steps:

1. Inventory the peripherals shipped with the computer and locate them in the left-hand column.
2. In the matrix, find the column that has an "X" or Option Number (example: "003") for each peripheral in the system.
3. The column having each peripheral identified corresponds to the ordered product shown across the top.

Table 1-3. Series 300 Computer Bundled Product Matrix

	Computer System Ordered			
Bundled Product with System	**98560A**	**98560B**	**98560C**	**98560D**
HP 35731 Med-Res Monochrome Monitor	X			
HP 35741 Med-Res Color Monitor		X		
HP 46020A Keyboard	X	X	X	X
HP 46081A Speaker Module			X	X
HP 7946A 55M Byte Winchester Disc Drive			X[2]	X[2]
HP 9133H 20M Byte Winchester Disc Drive		X[2]		
HP 9153A 20M Byte Winchester Disc Drive	X[2]			
HP 98658A Bus Expander				
HP 98781A High-Res Monochrome Monitor			X	
HP 98782A High-Res Color Monitor				X
HP 98613B BASIC 4.0 Operating System	X			

[2] Option 007 deletes this Disc Drive.

Specifications

The following specifications apply to both the computer and bus expander.

Physical

Height:	130 mm (5.12 inches)
Width:	325 mm (12.80 inches)
Depth:	376 mm (14.80 inches)
Cube:	0.016 cubic metre (0.55 cubic feet)
Net weight (Max.):	Computer - 10.9 kg (24 pounds) Bus Expander - 10.4 kg (23 pounds)

Power Line Voltage and Frequency

Line Voltage:	100/120 V ac Certified 80 - 138 V ac. 220/240 V ac Certified 176 - 276 V ac. Switch-Selectable
Line Frequency:	48 to 66 Hz
Power Consumption:	250 W Maximum

Backplane Power Available

Note that these figures are *nominal*. Any assembly designed for installation in an accessory or computer slot must conform to HP 9000 Series 200/300 DIO Bus electrical and mechanical specifications listed in the Accessory Development Guide for HP 9000 Series 200/300 Computers (P/N 09800-90011).

Models 310 and 320 Computer	**HP 98568A Bus Expander**
31 W @ +5 V	62 W @ +5 V
19.2 W @ +12 V	38.4 W @ +12 V
6 W @ −12 V	12 W @ −12 V

Environmental

Operating Temperature:	0° to 55° C
Storage Temperature:	−40° to 75° C
Maximum Altitude:	4572 metres (15,000 feet)
Vibration:	30g Maximum Transport Shock 10.2 cm (4 inch) Free Fall Drop
Heat Dissipation:	853 BTU/hr (215 kCal) Maximum
Electro-Static Discharge Limit:	15 KV discharged through 300 pf and 500 ohms.
Line Transient Spike Immunity:	1 KV for 1 nsec rise time, 800 nsec duration.
Conducted EMI:	VDE 0871 - Level B FCC Parts 15, Subpart J - Level B
Radiated EMI:	VDE 0871 - Level B FCC Parts 15, Subpart J - Level B

System Clock

Resolution:	10 msec
Accuracy:	4.3 sec/day with electrical power. 4.5 sec/day with battery backup.

Shipping Information

Series 300 Computers

The shipping container for the Series 300 computers includes the Localization Kit, which includes two power cords, fuse, keyboard cable, HP-HIL cable, Installation Reference, and other miscellaneous documents.

Shipping Weight:	15.9 kg (35 pounds)
Container Dimensions	Width - 50.2 cm (19.75 inches) Length - 55.9 cm (22 inches) Depth - 26.7 cm (10.5 inches Cube - 0.07 cubic metres (2.65 cubic feet)

HP 98568A Bus Expander

Shipping Weight:	12 kg (26.4 pounds)
Container Dimensions	Width - 50.2 cm (19.75 inches) Length - 50.2 cm (19.75 inches)|L Depth - 24.1 cm (9.5 inches Cube - 0.06 cubic metres (2.03 cubic feet)

Service Support

Repair Philosophy

Field Repair Philosophy for the Series 300 Computers and the HP 98568 Bus Expander is assembly 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 replaced with rebuilt ones instead of new ones. Other assemblies are only available as new ones. Refer to the Series 300 Service Handbook, Chapter 8, Replaceable Parts, 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 Series 300 Computer Systems with Hewlett-Packard approved parts, accessories, peripherals, operating systems and application programs are supported by Hewlett-Packard. Any Series 300 Computer System 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 or Service Center repair is accomplished.

Hewlett Packard Support

Hewlett-Packard provides service support in three ways:

- On-Site Repair.
- Service Center Repair.
- Customer Repair.

Each of these are explained in the sections below.

On-Site Repair

For On-Site Repair, an HP Customer Engineer goes to the customers site, 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.

Hewlett-Packard Service Center Repair

The customer returns the defective product to the nearest HP Repair Center. An HP Customer Engineer repairs the product to the assembly level in the same manner as On-Site Repair. Upon being repaired, the product is returned to the customer. Contact your nearest HP Sales and Service Office for the location of the HP Repair Center, typical turn-around times, and shipping instructions.

Customer Repair
Customers have the option of repairing their own HP computer products. Contact your nearest HP Sales and Service Office for information concerning service training, special tools and test equipment, and spare parts.

Hewlett-Packard offers a Customer Cooperative Support Program to assist customers in maintaining their HP computer products. A variety of technical services and information are available. Your local HP Sales and Service can provide you with information about the Cooperative Support Program.

Chapter 2
Assembly Replacement

Introduction

Replacing parts and assemblies in the computer and bus expander require almost identical procedures for both products. With the exception of three assemblies, in the computer, the steps required to remove and install all assemblies are the same.

In each procedure where the process is the same for both the computer and bus expander, they are referred to as the "unit". When specific procedures are required for either the computer or bus expander, the name of the unit is used.

Assembly Access Flow Chart

Figure 2-1 is an Assembly Access Flow Chart showing the sequence of activities to replace the assemblies. To use this chart, identify the assembly to be replaced at the bottom of the chart. Then start at the top of the chart and work through the activity in each block, progressing toward the assembly you want to replace. This flow chart can also be used as a guide to install assemblies by starting at the bottom and working your way toward the top.

If you are learning how to replace parts in the computer and bus expander, you may want to start at the left side of the flow chart and remove each part in sequence. The procedures in this chapter are also organized in the same manner. Referencing the Series 300 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 items.

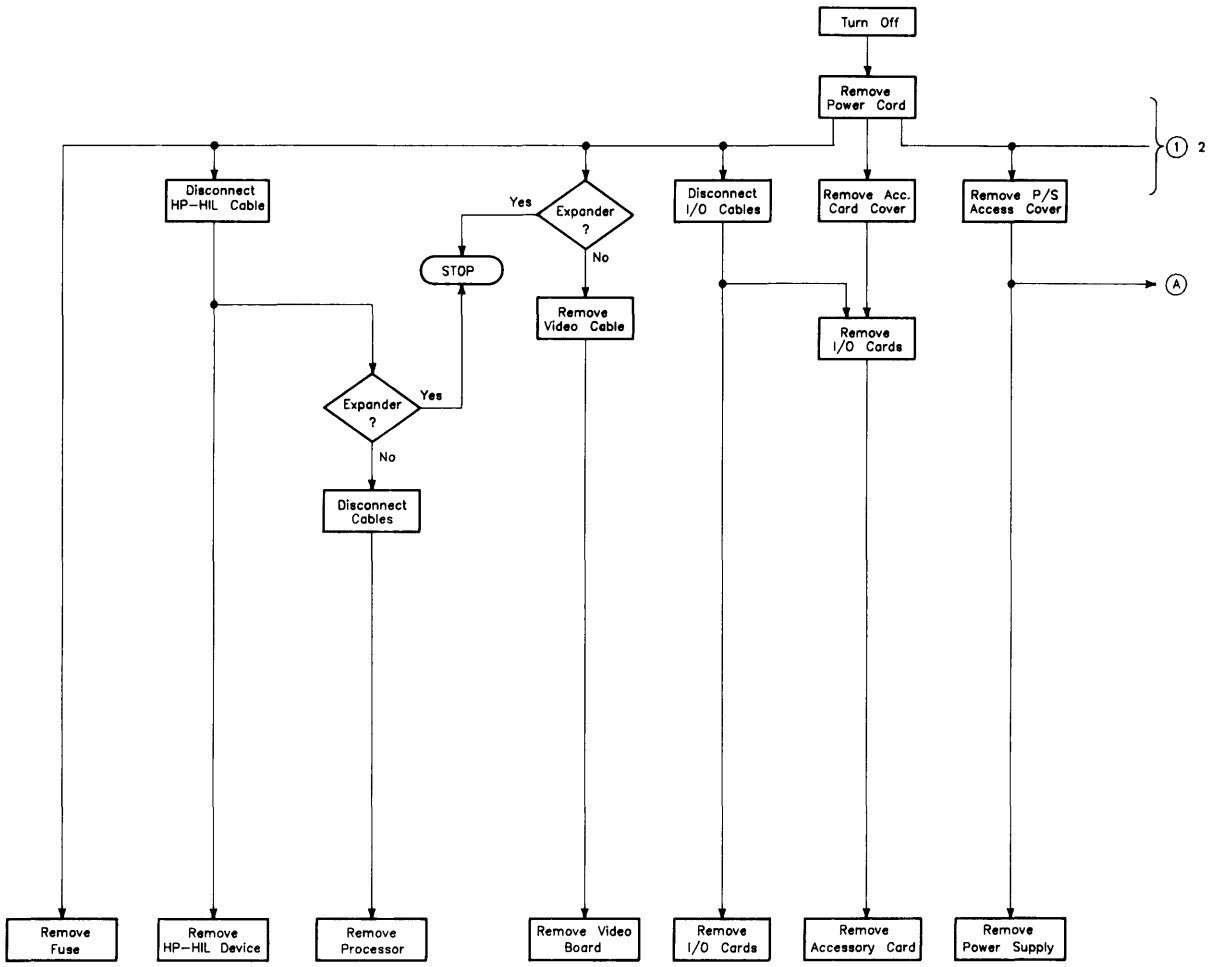


Fig. 2-1a. Assembly Access Flow Chart

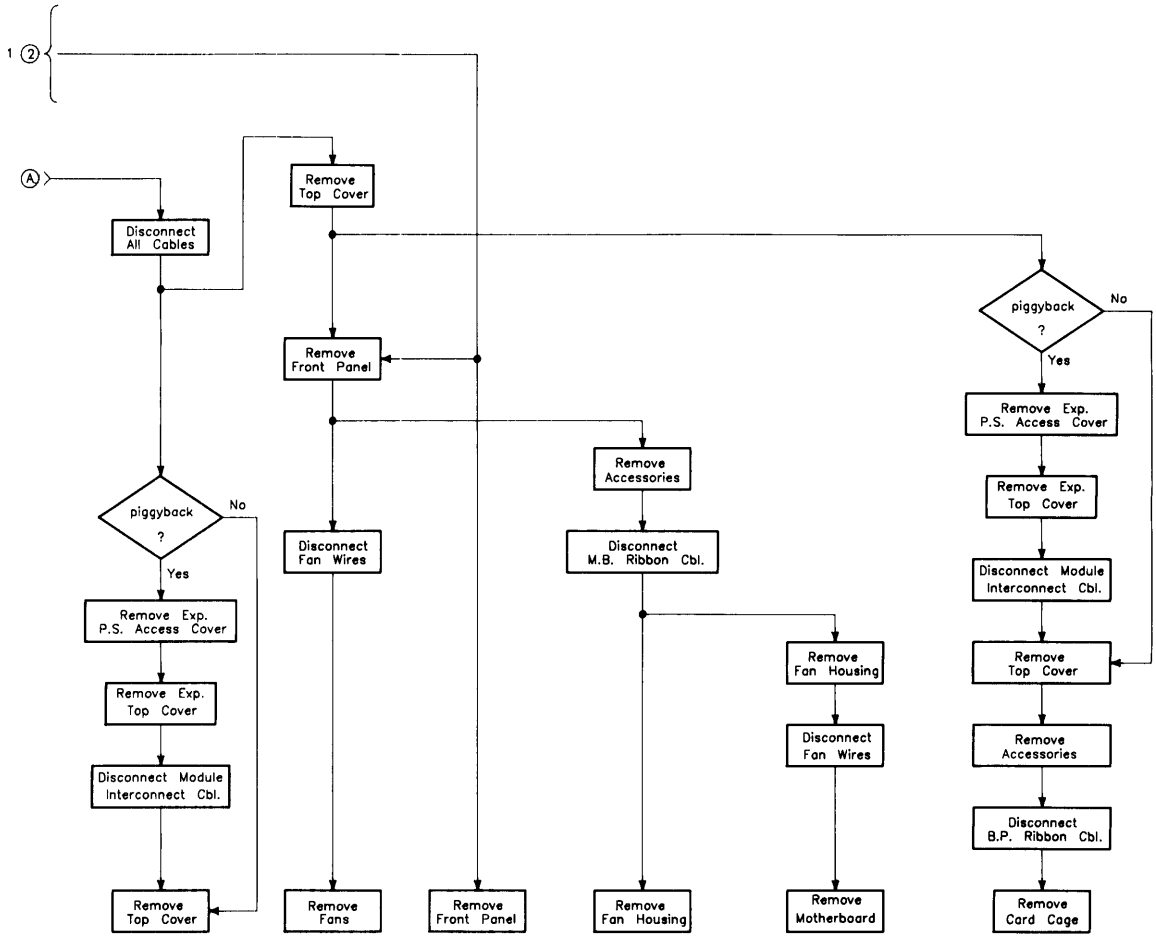


Fig. 2-1b. Assembly Access Flow Chart

Tools Required

CAUTION

The computer and bus expander use metric screws requiring the use of Pozidriv® screwdrivers. Do not use other cross-tip screwdrivers, such as Phillips or Reed-Prince, as they will eventually damage the Pozidriv® heads.

The following tools are required to access all field replaceable functional and mechanical assemblies:

- Static-free Workstation, HP Part Number 9300-0794
- #1 Pozidriv® screwdriver, 4-inch (100 mm) blade.
- #2 Pozidriv® screwdriver, 4-inch (100 mm) blade.
- Flat-tip screwdriver, 0.125-inch (3 mm) wide tip, 4-inch (100 mm) blade.
- Anti-Static Bags

Safety Precautions

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 damage.

WARNING

Always turn off the equipment and remove ac power cord before opening the computer/bus expander to remove or replace an assembly. If maintenance activity requires power to be applied while the protective covers are removed, proceed only with extreme caution using safe, live-unit maintenance procedures. Do not touch energized components or parts with your fingers. Heed and follow all "WARNING-HAZARDOUS VOLTAGE" labels. Failure to follow these safety precautions may result in serious injury, or worse.

Electro-Static Discharge Precautions

Integrated circuit components in these products 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.

Integrated circuits in the computer, bus expander, accessories and peripherals can be protected by setting up a static free workstation and wearing clothes that do not hold static charges before handling any of the computer's assemblies. This includes the internal assemblies as optional assemblies for the backplane.

When you need to remove or install an assembly or part, remove power from the product first. With the static free workstation in place, touch the backplane sheet metal with your fingers before touching the printed circuit assembly. If the assembly is not going to be re-installed, place the assembly into an anti-static bag and set it aside.

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

Assembly Replacement 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 following orientation of the hardware:

- The right side is the side on your right as you face the front of the unit. For example, the Power-On LED is on the unit's right side.
- The left side is the side on your left as you face the front of the unit. For example, the power supply is on the unit's left side.
- The front is the end toward you as you face the front panel. For example, the power switch is on the unit's front end.
- The back is the end away from you as you face the front panel. For example, the fuse is on the unit's back end.
- The top and bottom are relative to their normal positions.

These references are used in the procedures and should be followed regardless of how you are facing the unit. Figure 2-2 shows the hardware orientation.

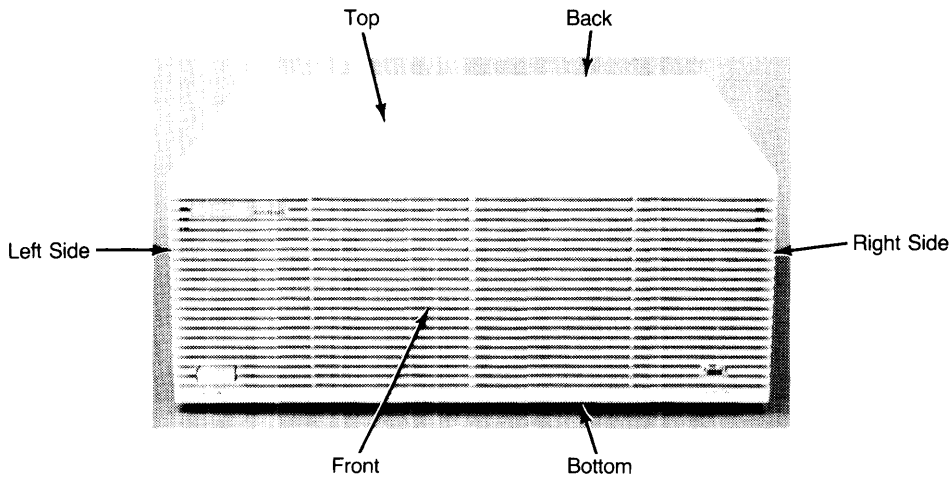


Figure 2-2. Hardware Orientation

Fuse

Preliminary Requirements

1. Turn the unit off.
2. Remove the power cord.

Procedures

1. Using a flat-tip screwdriver, press in on the fuse cap and rotate it counter-clockwise about ¼ turn. The fuse should pop out a little.
2. Pull out the fuse cap containing the fuse.
3. Remove the fuse from the fuse cap and replace it.
4. Reverse steps 1 through 3 to install the fuse.

HP-HIL Devices

Preliminary Requirements

1. Turn the unit off.
2. Remove the power cord.

Procedures

1. Disconnect the HP-HIL cable from the processor or accessory card panel.
2. Remove the HP-HIL device from the other end of the HP-HIL cable.
3. To install an HP-HIL device, reverse steps 1 and 2.

Processor Board

Preliminary Requirements

1. Turn the computer off.
2. Remove the power cord.

Procedures

1. Disconnect the HP-HIL, audio, and/or video cable from the processor board.
2. Using a flat tip screwdriver or your finger tips, unscrew the two captive screws holding the processor in the computer's system slot.
3. Remove the processor board.
4. To install the processor, reverse steps 1, 2 and 3.

Video Boards

Video boards are located in one of the system slots, usually the top one. Instructions listed below do not apply to the video cards installed in the accessory slots.

Preliminary Requirements

1. Turn the computer off.
2. Remove the power cord.

Procedures

1. Disconnect the video cables from the video board.
2. Using a flat tip screwdriver or your finger tips, unscrew the two captive screws holding the video board in its system slot.
3. Remove the video board.
4. To install the video board, reverse steps 1, 2, and 3.

I/O Cards

Preliminary Requirements

1. Turn the computer off.
2. Remove the power cord.

Procedures

1. Disconnect the I/O cables from the I/O card.
2. Using a flat tip screwdriver or your finger tips, unscrew the two captive screws holding the I/O card in the computer's backplane.

CAUTION

Some accessories consist of two assemblies connected together by ribbon cables. Do not completely remove these accessories with the panel on it until the cable has been disconnected. When reassembling these assemblies, sets, insert the top assembly first, then insert the lower one before connecting them together.

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3. Remove the I/O card from its I/O slot.

NOTE

Before installing I/O cards, ensure they are correctly configured for the application and/or peripherals.

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4. To install the I/O card, reverse steps 1, 2, and 3.

Accessory Cards

Preliminary Requirements

1. Turn the computer off.
2. Remove the power cord.

Procedures

1. If the accessory card is behind an accessory slot cover, remove the accessory slot cover.
2. If the accessory card is behind an I/O card rear panel, disconnect the I/O cables from the I/O card and remove the I/O card.
3. Raise the accessory card's ejector levers with your finger tips and unseat the accessory card from the unit's backplane connector.
4. Remove the accessory card.

NOTE

Before installing accessory cards, ensure they are correctly configured for the application and/or peripherals. Refer to the accessories Installation Note for the correct configuration.

---

5. To install the accessory card, reverse steps 1, 2, 3, and 4.

Power Supply

Preliminary Requirements

1. Turn the computer off.
2. Remove the power cord.

Procedures

1. Using a #1 Pozidriv® screwdriver, unscrew the two screws holding the power supply access cover in place. Refer to Figure 2-3.

WARNING

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

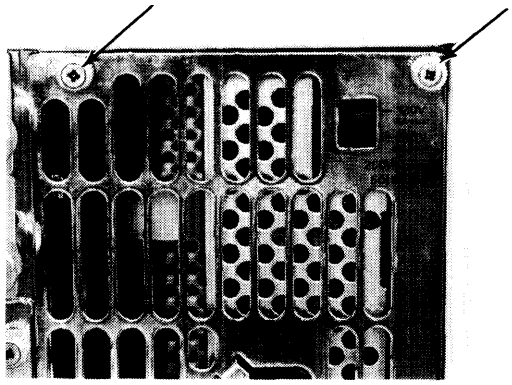


Figure 2-3. Power Supply Access Cover Screws

2. Remove the power supply access cover.
3. Using a #2 Pozidriv® screwdriver, unscrew the screw holding the power supply in place. Refer to Figure 2-3.
4. Remove the power supply.
5. To install the power supply, reverse steps 1 through 4. Be sure to replace the power supply grounding screw.

Top Cover

Preliminary Requirements

1. Turn the computer off.
2. Remove the power cord.
3. Disconnect all cables from the processor, video boards, and/or I/O cards.
4. Remove the power supply access cover.

Procedures

When the bus expander is mounted on top of the computer, its original top cover is placed on the computer and the computer's top cover is placed on the bus expander. Keep this in mind if top covers need replaced. Chapter 8 in the Service Handbook lists top cover part numbers with their original unit.

NOTE

If the bus expander is connected to and mounted on top of the computer, the top cover of the computer with the bus expander attached can be removed as a single assembly.

If the computer and bus expander are not mounted together, remove the unit's top cover by following these steps:

1. After the power supply access cover is removed, slide the top cover to the rear and lift up on the top cover to remove it.
2. To install the top cover, reverse step 1.

ASSEMBLY NOTE

When installing the top cover, ensure the lip on the back edge of the top cover catches the tab on the chassis when the top cover is fully seated in place.

If the bus expander is mounted on the computer, follow these steps to remove the computer's top cover with bus expander attached:

1. Remove the bus expander's power supply access cover.
2. Slide the bus expander's top cover to the rear and up and remove the bus expander's top cover.
3. Reach through the bus expander's bottom cable slot, and disconnect the module interconnect cables from the computer's backplane.
4. Slide the computer's top cover (with bus expander attached) to the rear and up and remove this assembly.
5. To install the computer's top cover (with bus expander attached), reverse steps 1 through 4.

Front Panel

Preliminary Requirements

1. Turn the computer off.
2. Remove the power cord.

Procedures

1. Using a thin blade flat-tip screwdriver, release the front panel catches on the right and left sides by pressing them inward as shown in Figure 2-4.

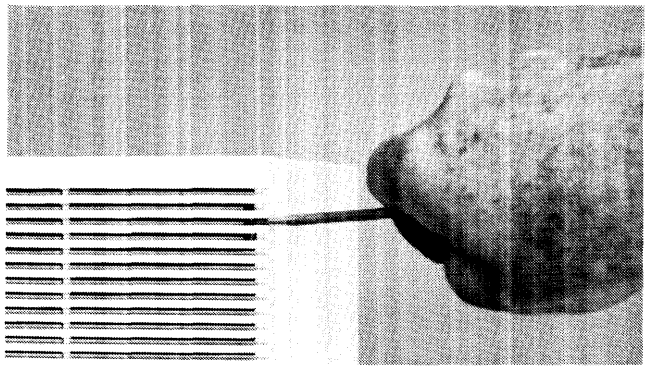


Figure 2-4. Releasing the Front Panel Catches

2. Carefully tilt the front panel forward to a 45° angle.
3. The front panel can be removed and set aside.

NOTE

When installing the front panel, ensure the lip at the bottom of the front panel fits over the sheet metal on the bottom of the fan housing.

---

4. To install the front panel, reverse steps 1 through 4.

Fans

Preliminary Requirements

1. Turn the computer off.
2. Remove the power cord.
3. Remove the front panel.

Procedures

1. Using needlenose pliers, disconnect the fan wire connector from its pins on the fan housing. Refer to Figure 2-5.

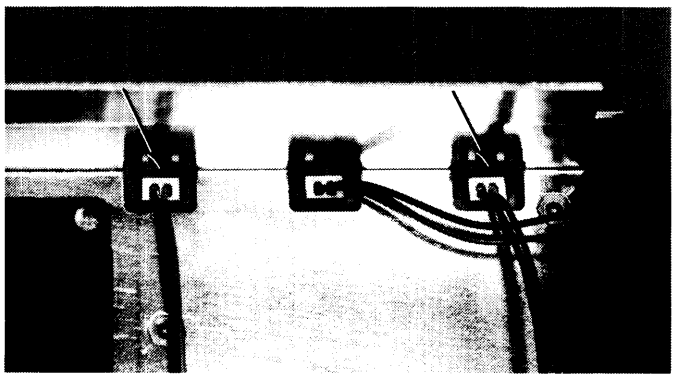


Figure 2-5. Fan Wire Connectors

2. Using a #1 Pozidriv® screwdriver, remove one of mounting screws from the fan to be replaced. Refer to Figure 2-6.

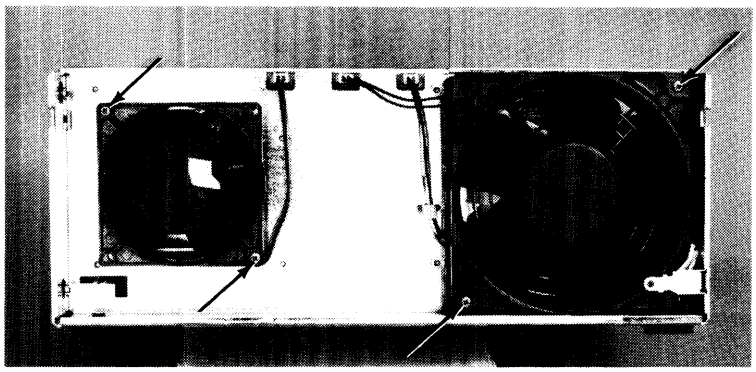


Figure 2-6. Fan Mounting Screws

3. While holding the fan in place with one hand, remove the other mounting screw from the fan.
4. To install the fan, reverse steps 1 through 3.

Fan Housing

Preliminary Requirements

1. Turn the unit off.
2. Remove the power cord.
3. Remove all assemblies from the accessory and/or system slots.
4. Remove the front panel.
5. Remove the power supply
6. Remove the top cover

Procedures

1. Disconnect the ribbon cables from the motherboard.
2. Using a #1 Pozidriv® screwdriver, remove the four screws holding the fan housing in place. Refer to Figure 2-7.

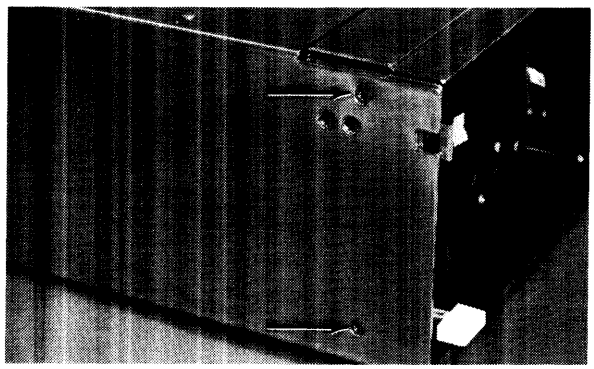


Figure 2-7. Fan Housing Fasteners

3. Pull the fan housing forward and remove it.
4. To install the fan housing, reverse steps 1 through 3.

Motherboard

Preliminary Requirements

1. Turn the unit off.
2. Remove the power cord.
3. Remove all assemblies from the accessory and/or system slots.
4. Remove the front panel.
5. Remove the top cover
4. Remove the power supply.
5. Remove the fan housing.

Procedure

1. Disconnect both fan wire connectors from the motherboard.
2. Using a #1 Pozidriv® screwdriver, remove the four screws holding the motherboard to the fan housing. Refer to Figure 2-8.

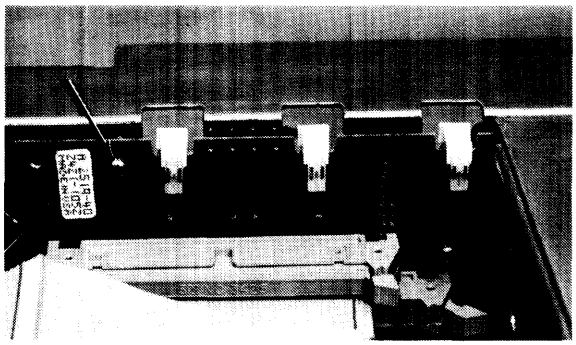


Figure 2-8. Motherboard Fasteners

3. To install the motherboard, reverse steps 1 and 2.

I/O Card Cage

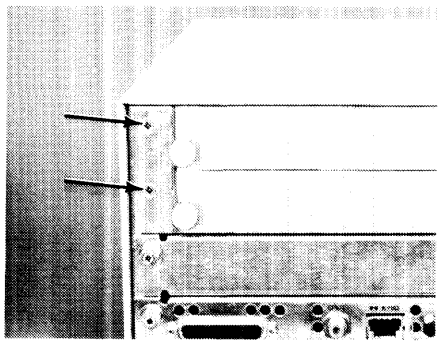
Preliminary Requirements

1. Turn the unit off.
2. Remove the power cord.
3. Disconnect all cables from I/O cards in the I/O slots.
4. Remove all cards from the accessory slots.
5. Remove the power supply access cover.
6. Remove the top cover.

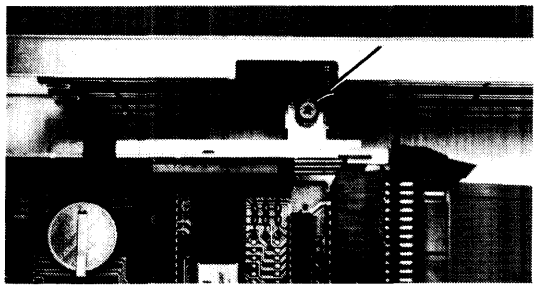
Note that if the bus expander is mounted on top of the computer and the computer's card cage needs to be replaced, the computer's top cover may be removed with the bus expander attached. Refer to the section on removing top covers.

Procedure

1. Disconnect the two ribbon cables from their connectors on the backplane.
2. Using a #1 Pozidriv® screwdriver, remove the screws holding the card cage to the chassis. Refer to Figure 2-9.



Computer



Bus Expander

Figure 2-9. Card Cage Fasteners

3. Slide the card cage out of position by sliding it slightly to the right until the tabs on its left side clear their mounting slots and remove the card cage.

ASSEMBLY NOTE

Note that the left side of the card cage fits outside the chassis and the right side fits inside the chassis.

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4. To install the card cage, reverse steps 1, 2, and 3.

Chapter 3
Functional Description

Power Supply

General Description

Both Series 300 Computers and HP 98568 Bus Expander use this power supply. The 0950-1760 power supply provides all power to the assemblies installed in the computer or bus expander. It is a non-adjustable switching supply that is an exchange assembly.

Power Supply Characteristics

Power supply outputs are:

- +5 V dc
- +12 V dc
- −12 V dc
- Power-Up RESET

Maximum power consumed by the computer or bus expander is 250 watts. For the computer, power consumption by the power supply and assemblies in the system slots is included in this figure. The remaining power is available for assemblies in the computer's accessory card slots. In the bus expander, most of the power is available for its accessory card slots.

Table 3-1 shows the power available for each voltage in the accessory card slots for both the Series 300 Computers and the HP 98568A Bus Expander.

Table 3-1. Backplane Power Limits

Series 300 Computer	HP 98568 Bus Expander
+5 V dc, 31 Watts	+5 V dc, 62 Watts
+12 V dc, 19.2 Watts	+12 V dc, 38.4 Watts
−12 V dc, 6 Watts	−12 V dc, 12 Watts

CAUTION

Before installing assemblies in the the computer or bus expander accessory card slots, ensure the total maximum power consumed by each accessory and I/O card for each voltage does not exceed the power available at each voltage for the backplane. If the accessory and I/O cards installed require more power than is available, damage to the accessory/I/O card or computer/bus expander may result.

Figure 3-1 is a block diagram of the 0950-1760 power supply.

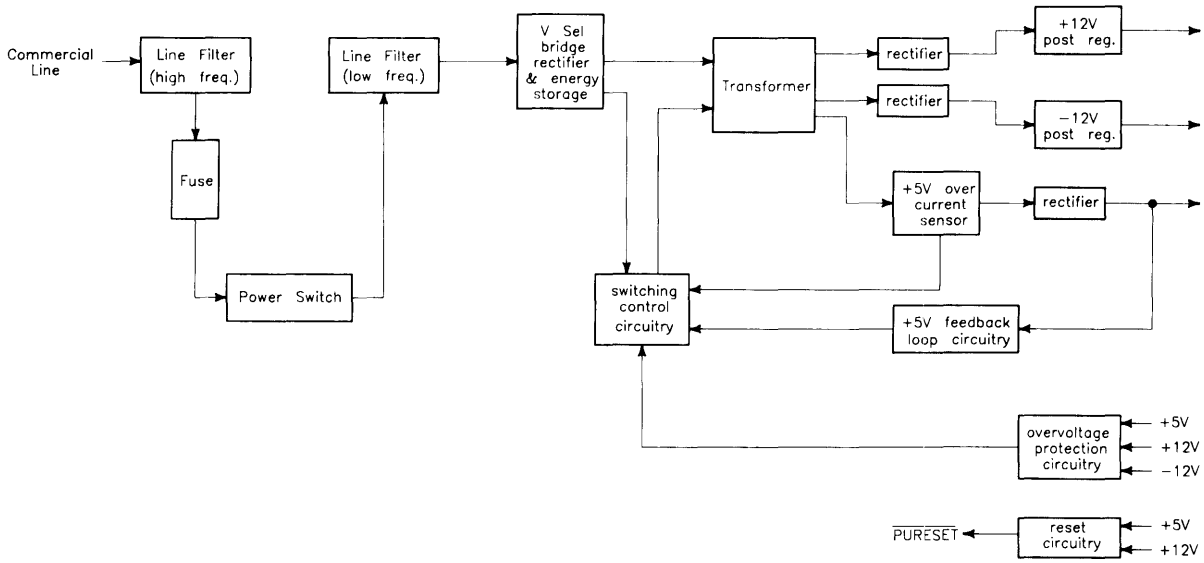


Figure 3-1. Power Supply Block Diagram

Input Section

Ac line voltage is supplied to the input section through the power cord. Functions of the input section are:

- High Frequency Filtering
- Fuse
- On-Off Switching
- Input Voltage Selection
- Low Frequency Filtering

High Frequency Filtering

Line input voltage through the power cord is applied to a high-frequency line filter. This filter traps high frequency noise from both entering or leaving the power supply. It enables the output voltages to be virtually free from voltage spikes that may appear at the input. The filtered output is sent to the fuse and power switch.

Fuse

For both line voltage ranges, the same size fuse protects the power supply. Voltage selection and fuse size are shown below:

Voltage Setting	Line Voltage	Fuse Rating
120 V ac	85 to 129 V ac	8A Normal Blow
240 V ac	187 to 255 V ac	8A Normal Blow

In both cases, the line frequency is 48-66 Hz.

Low Frequency Filtering

When the power switch is turned on, voltage is applied to the Low Frequency Filtering circuits. These circuits trap low frequencies entering or leaving the power supply. They also reduce ripple in the output voltages. After filtering, the line voltage is sent to the Bridge Rectifier Section.

On-Off Switching

This operator-controlled switch connects power to the Low Frequency Line Filter. Located on the computer (or bus expander) front panel, it is mechanically connected to the power supply by a switch extension. When turned to the ON position, a green LED on the front panel is lit. The LED is connected to the voltage outputs and indicates that all power supplies are operating.

Input Voltage Selection

A voltage select switch is set to either the 120 V ac or 240 V ac position, depending on the line voltage. Voltage selection changes the input voltage to the bridge rectifier to make the bridge output the same for either line voltage.

Rectification and Switching Control Circuits

Functions of the Rectification and Switching Control circuits are:

- Full-Wave Bridge Rectifier
- Switching Control Circuit
- Power Transformer

Full-Wave Bridge Rectifier

Part of the input ac voltage is applied across a full-wave bridge network that outputs a DC voltage. Large storage capacitors charge up to this voltage and provide a constant energy supply to the individual power supply circuits.

Switching Control Circuit

Voltage from the rectifier feeds a Switching Control Circuit that controls the amount of power going to each of the output voltage regulators. +5 V dc feedback is applied to the Switching Control Circuit to regulate the +5 V dc output. Overvoltage protection signals also input the Switching Control Circuit that will cause the power supply to shut down if voltage in the output supplies goes too high. A +5 V dc over-current sensor input is another input to the Switching Control Circuit.

Power Transformer

Input ac voltage is also applied to the primary windings of a power transformer. Three sets of secondary windings each feed a voltage regulator for the output voltages. A voltage select switch is set to the line voltage range and causes the power transformer to have the same voltage output for both line voltage ranges.

Power Supply Regulators

Functions of the Power Supply Regulators are:

- +5 V dc Power Supply
- +12 V dc Power Supply
- −12 V dc Power Supply

+5 V dc

Voltage from the power transformer feeds through a +5 V dc current sensor than goes to the +5 V dc rectifier. Output from the +5 V dc rectifier is nominally 5.07 V dc ±0.18 V dc. The +5 V dc output is also fed to the +5 V dc Feedback Loop Circuit for regulation. It also is fed to the Overvoltage Protection Circuit and Reset Circuit. If the +5 V dc fails, the Power-On LED on the front panel will go out as the +5 V dc is part of the controlling voltage for the Switching Control Circuit.

+12 V dc

Voltage from the power transformer feeds through a rectifier then to a +12 V dc Post Regulator. The output from the Post Regulator is nominally +12.29 V dc ±0.43 V dc. In addition to being distributed in the computer (or bus expander), the +12 V dc output is also fed to the Overvoltage Protection Circuit and Reset Circuit. External to the power supply, the +12 V dc is connected to one side of the Power-On LED on the front panel.

−12 V dc

Voltage from the power transformer feeds directly to a −12 V dc Post Regulator. The output from the Post Regulator is nominally −12.29 V dc ±0.43 V dc. In addition to being distributed in the computer (or bus expander), the +12 V dc output is also fed to the Overvoltage Protection Circuit and Reset Circuit. External to the power supply, the −12 V dc is connected to the other side of the Power-On LED on the front panel.

Protection and Reset Circuits

Functions of the Protection and Reset Circuits are:

- Overvoltage Protection
- Reset Signal Generation

Overvoltage Protection Circuit

All output voltages are inputs to the Overvoltage Protection Circuit. If the voltage goes high, the circuit will shut down the power supply, protecting its components as well as components in other areas of the computer (or bus expander). The output of the Overvoltage Protection Circuit feeds the Switching Control Circuit.

Reset Circuit

When ac line voltage is applied, the power supplies start building up their output voltages. The +5 and +12 V dc supplies input the Reset Circuit. As these inputs reach their operating voltages, the processor board circuits are also being powered up. When normal operating levels are reached, a Power-Up RESET (PURESET) signal is sent to the CPU to initialize it and start the Boot ROM sequence.

Power Distribution

Power Distribution routes power to the functional assemblies installed

- Overvoltage Protection
- Reset Signal Generation

Figure 3-2 shows how power is distributed in the computer. Figure 3-3 shows how power is distributed in the bus expander.

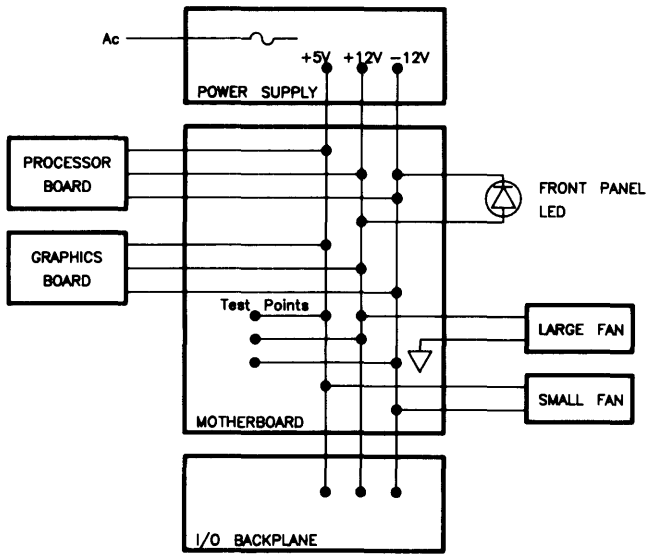


Figure 3-2. Computer Power Distribution

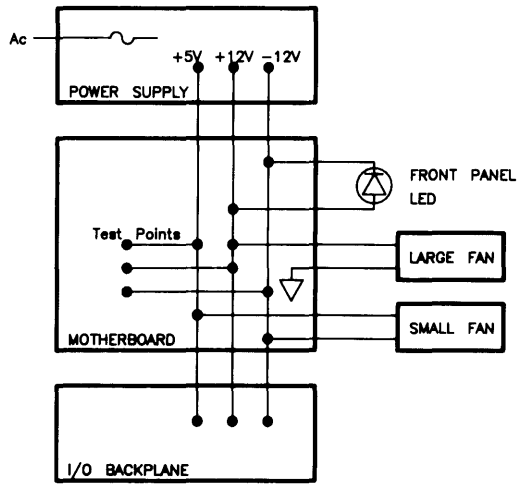


Figure 3-3. Bus Expander Power Distribution

Power supply outputs are distributed through the motherboard. Test points for power measurement are located on the motherboard.

Power is connected from the motherboard to the I/O backplane via a ribbon cable. In the computer, boards in the system slots are powered directly from the motherboard.

Two fans are connected to motherboard power connections. The large fan is tied to the +12 and ground. The small fan is tied between +5 and −12 V dc.

Wires from the front-panel LED are connected to the +12 and −12 V dc voltages on the motherboard.

CAUTION

When custom designed accessory cards are being developed for the I/O card cage, their power consumption must not exceed the power available at the backplane. Information regarding the design of custom accessory cards is contained in the HP 9000 Series 200/300 Accessory Development Guide, HP Part Number 09800-90011.

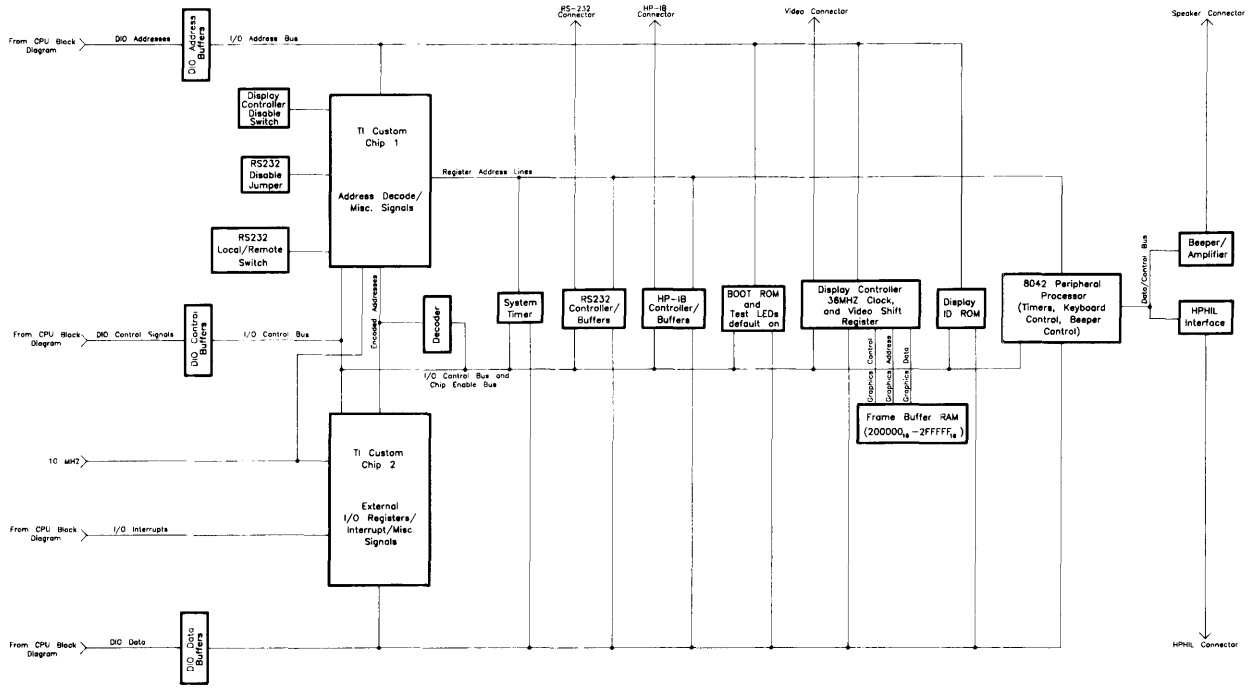
98561-66511 Processor Board

General Description

The 98561-66511 processor board has the following features:

- MC6840 System Timer.
- 10 MHz MC68010 microprocessor.
- Boot ROM.
- Eight Self-Test LEDs
- 0.5 M-byte of RAM.
- MCA2800ALS RAM Controller.
- Memory Management Unit.
- HP-IB Interface.
- RS-232 Interface.
- Bit-Mapped Monochromatic Video Output.
- HP-HIL Keyboard Electronics with battery Real Time Clock.
- Miscellaneous other components needed by HP Operating Systems (HP-UX, Pascal, BASIC).

Figure 3-4 is a block diagram of the 98561-66511 processor board. Refer to this diagram for functional descriptions.



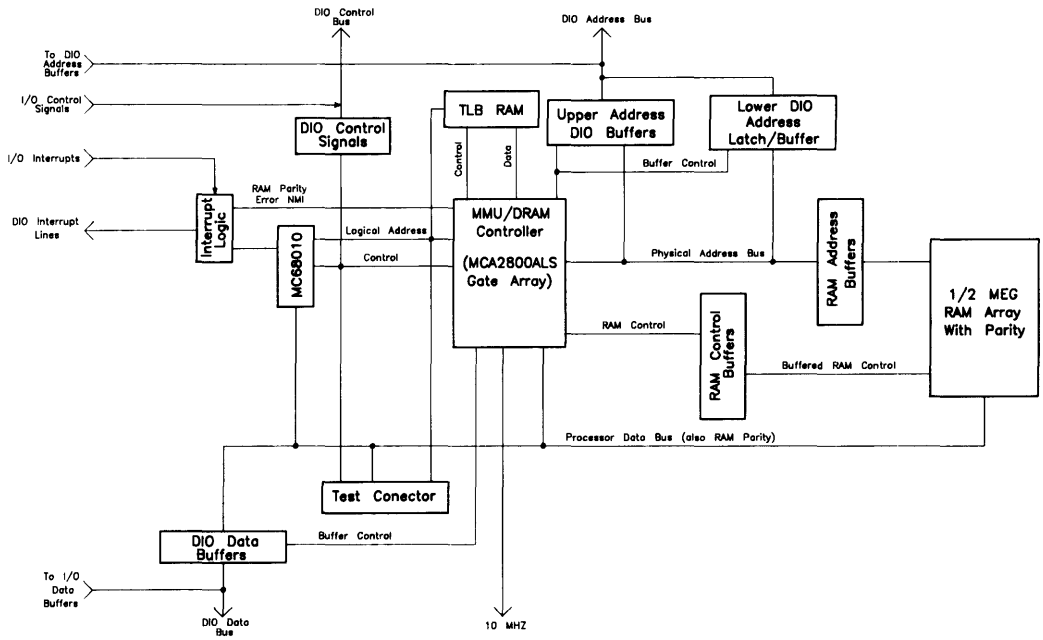


Figure 3-4. 98561-66511 Processor Board Block Diagram

System Timer

With the variety of processor boards and the difference in instruction execution speeds between many of these boards, Series 200 software required hardware support for its time dependent operations. The MC6840 timer is the device this processor board uses.

There are no external registers implemented to supplement the registers which already exist within the MC6840. Registers within the MC6840 are multiple-mapped within a 16 K-byte memory region.

For information as to the functioning of the registers within the MC6840, refer to the MC6840 Programmable Timer Module (PTM) data sheet which can be found in the Motorola Microprocessors Data Manual.

Central Processing Unit

A Motorola MC68010 CPU functions as the main processor chip on this assembly. Operating at 10 MHz, it provides fast instruction time.

Its asynchronous data bus is 16-bits wide for both addresses and internal registers. The MC68020 CPU can address 16 M-bytes of RAM and can directly address 7.5 M-byte of RAM. Operating at 10 MHz, it is somewhat slower than the MC68020 CPU.

The CPU has 57 instruction types and handles 5 major data types. It also has 14 addressing modes, 6 maskable and 1 non-maskable interrupt levels.

RAM

One-half M-byte of RAM is installed on the 98561-66511 board. This RAM has optional parity and is auto-locating to 0.5 M-byte boundaries in the computer's memory map. Auto-locating means the processor's RAM will respond to 0.5 M addresses that exists immediately below blocks of addresses the accessory RAM cards are configured for. This block of addresses may also be between the address accessory RAM cards are configured for providing exactly 0.5 M addresses exist. If accessory RAM cards are configured such to have an empty section of RAM of less than or greater than 0.5 M addresses, an error will occur during the turn-on memory test. RAM control is performed by an MCA2800ALS gate array which also serves as the MMU.

Optional RAM cards installed in accessory slots have access times somewhat slower than RAM on the processor board. RAM cards in the I/O card cage has a minimum access time of approximately 620 nano-seconds compared to the 400 nano-second access time for processor on-board RAM.

RS-232

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. The processor board's RS-232 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. The HP 98644 card has switches which allow this address to be changed.
- Does not allow reconfiguration to change the RS-232's ID to that of the HP 98626 card.

Two switches on the 98561-66511 board are associated with RS-232. They perform the following functions:

- Controls the local/remote bit in the ID register.
- 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 K-byte 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. HP-IB on this processor board is much like HP-IB implementations on other HP 9000 Series 200 computers. It uses a TMS9914 HP-IB controller which allows data transfer rates up to 450 K-bytes/second. The TMS9914 is a memory-mapped I/O device which is multiple-mapped within a 64 K-byte internal I/O device.

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 K-byte block of memory in the internal I/O address range.

Information on the TMA9914A and its registers can be found in the 'TMS9914A General Purpose Interface Bus (GPIB) Controller' Data Manual.

Video Circuits

All the electronics for sending video to a monochromatic bit-mapped display are also part of the 98561-66511 board. The video circuits have the following functions:

- Frame Buffer, consisting of eight 16K by 4 RAM chips for 400 lines of 1024 pixels in each line.
- Frame Buffer Controller, the same as on the Video Output Boards.
- Display ID ROM, in an 8 K-byte ROM
- A video shift-register.
- A pixel clock.

When the computer application uses a separate video board, a switch on the processor board must be set to the 1 position to disable the logic for the processor's on-board video circuits.

The frame buffer for these video circuits is memory mapped to addresses in the display frame buffer block of RAM. A single bit-mapped plane organized as one byte per pixel is used. Due to the resolution of 1024 horizontal by 400 vertical dots, the pixels are not square. When the frame buffer is read, invalid data is returned for the unused planes.

Keyboard Electronics

Features on this processor board is in the keyboard interface electronics, and a battery backed-up real-time clock. Software gains access to this real-time clock through the 8042 keyboard controller.

Boot ROMs and Self-Test LEDs

98561-66511 has a Boot ROM whose instructions are executed by the CPU shortly after power up.

Test LEDs are on the processor board to help service personnel in trouble shooting. The Boot ROM functions are explained in Chapter 4.

Other Circuits

An Intel 8042 Universal Peripheral Interface 8-Bit Microcomputer performs several functions on the processor board:

- Interfaced to a SN76494 digital complex sound generator IC.
- Provides several 10 millisecond resolution timers.
- Performs key-code conversions for the keyboard.
- Manages the HP-HIL Interface.
- Has a battery backed-up Real Time Clock tied to its peripheral data path.

HP-HIL

General Description

Hewlett-Packard Human Interface Link (HP-HIL) is an HP standard for interfacing Series 300 computers and other workstations to human input devices. A list of all devices is shown in Table 3-2.

Asynchronous serial communications protocol enables you to select a set of input devices, connect them to your computer, and work with any application program.

HP-HIL circuits exist on the following assemblies used in Series 300 computers:

- 98561-66511 Processor Board.
- 98561-66512 Processor Board.
- 98561-66513 Processor Board.
- 98561-66531 Human Interface Card

A link controller exists on these assemblies to control 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 3-5.

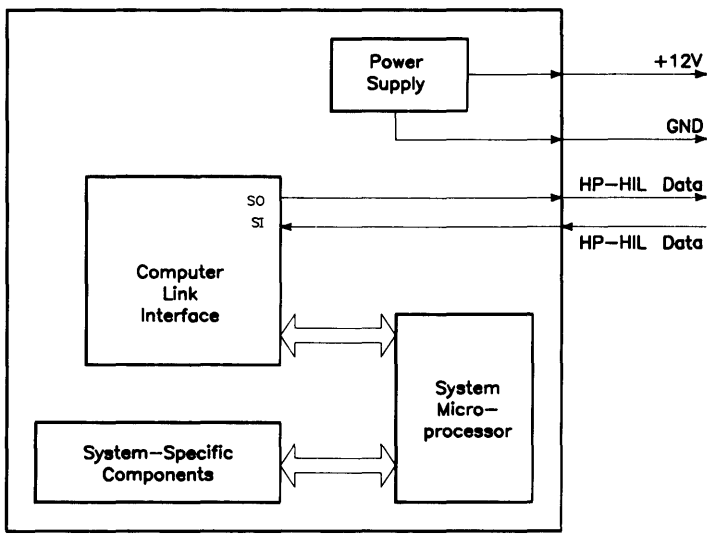


Figure 3-5. HP-HIL Link Controller

Power Supply

One voltage, +12 Vdc is taken from the host computer 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 No.	Device Name	Milliamps	Watts
HP 35723A	Touchscreen Bezel	250	3.0
HP 46020A	ITF Keyboard	100	1.2
HP 46021A	ITF Keyboard	145	1.74
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] Extension cables have two boxes, each draws 25 mA.
[2] Includes HP 46089A 4-Button Cursor.
[3] Port Device requires 80 mA and the device attached to it cannot exceed 120 mA.

Computer-Link Interface

Series 300 computer DIO bus architecture is interfaced to the HP-HIL microprocessor in these circuits. They allow device input data to be used by the host computer.

Microprocessor

The HP-HIL microprocessor on the computer's assembly 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 host computer 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 3-6.

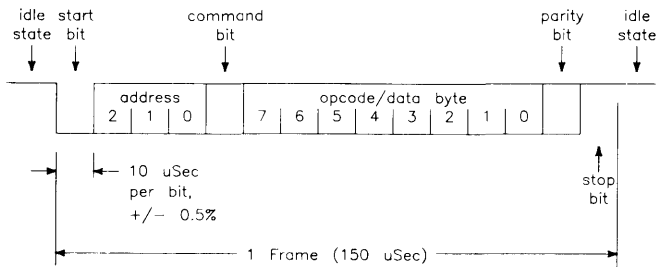


Figure 3-6. HP-HIL Frame Structure

Frames may be sent up to once each 154 sec 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 computer is turned on, the link is polled for devices. Each device on the link has its own ID which is sent to the computer and stored in memory. The link is polled 60 times per second. Should a device have data to input to the computer, it sends its data frame to the computer 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.

Interface Cables

A four-wire cable connects HP-HIL devices to each other and to the computer. AMP Shielded Data Link (SDL) connectors are used and are easily installed and removed from the computer or device. Keyboard cable connectors are keyed and are marked with dots to indicate where they are connected. Figure 3-7 shows the connector pinouts.

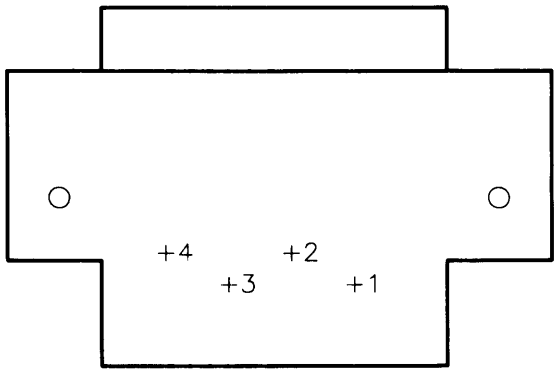


Figure 3-7. HP-HIL Cable Connector

Device Controller

A block diagram of a typical device controller is shown in Figure 3-8.

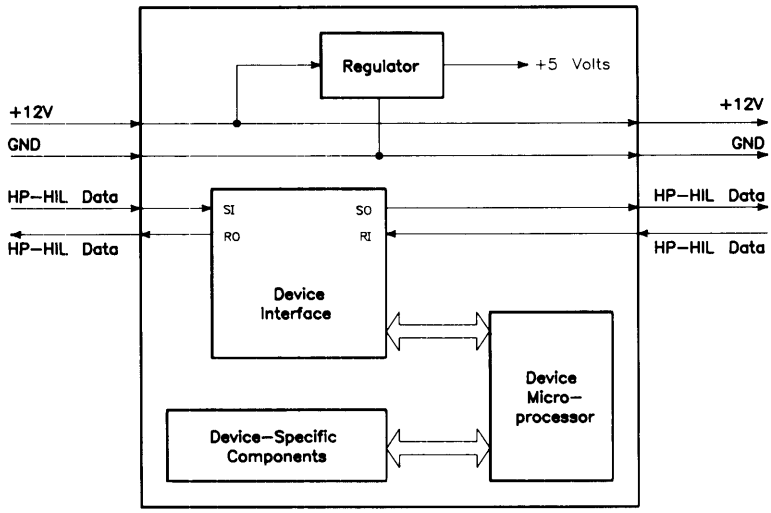


Figure 3-8. HP-HIL Device Controller

Regulator

From the HP-HIL cable, +12 Vdc is regulated down to +5Vdc for use by device components. The +12 Vdc input is also sent to components needing that supply.

Device Interface

The device interface serves as the communication link between the device and system HP-HIL microprocessor. In addition to transmitting and receiving data, it also interrupts the device microprocessor when a correctly addressed data frame or improper format is received. It also provides device hardware reset, lowers the NMI line at power-up and at device hard reset command.

Device Microprocessor

Tasks performed by the device microprocessor include maintaining the interface, data sending and receiving tasks. It also converts device information to data for the device microprocessor to send to the computer as human input information.

Device-Specific Components

Various components are used depending on the device. Digitizers, keyboards, knobs, and a host of other human input functions are converted to data for the device microprocessor. Each device will have its own specific components, depending on the input task details.

98561-66512 Processor Board

General Description

The 98561-66512 processor board has the following features:

- MC6840 System Timer.
- 10 MHz MC68010 microprocessor.
- Boot ROM.
- Eight Self-Test LEDs
- 1 M-byte of RAM.
- MCA2800ALS RAM Controller.
- Memory Management Unit.
- HP-IB Interface.
- RS-232 Interface.
- Bit-Mapped Monochromatic Video Output.
- HP-HIL Keyboard Electronics with battery backed-up Real Time Clock.
- Miscellaneous other components needed by HP Operating Systems (HP-UX, Pascal, BASIC).

Figure 3-9 is a block diagram of the 98561-66512 processor board. Refer to this diagram for functional descriptions.

This processor is the same as the 98561-66511 except for the amount of RAM.

RAM

One M-byte of RAM is contained on the 98561-66512 board. This RAM has optional parity and is auto-locating to 1 M-byte boundaries in the computer's memory map. Auto-locating means the processor's RAM will respond to 1 M addresses that exists immediately below blocks of addresses the accessory RAM cards are configured for. This block of addresses may also be between the addresses accessory RAM cards are configured for providing exactly 1 M addresses exist. If accessory RAM cards are configured such to have an empty section of RAM of less than 1 M addresses, an error will occur during the turn-on memory test.

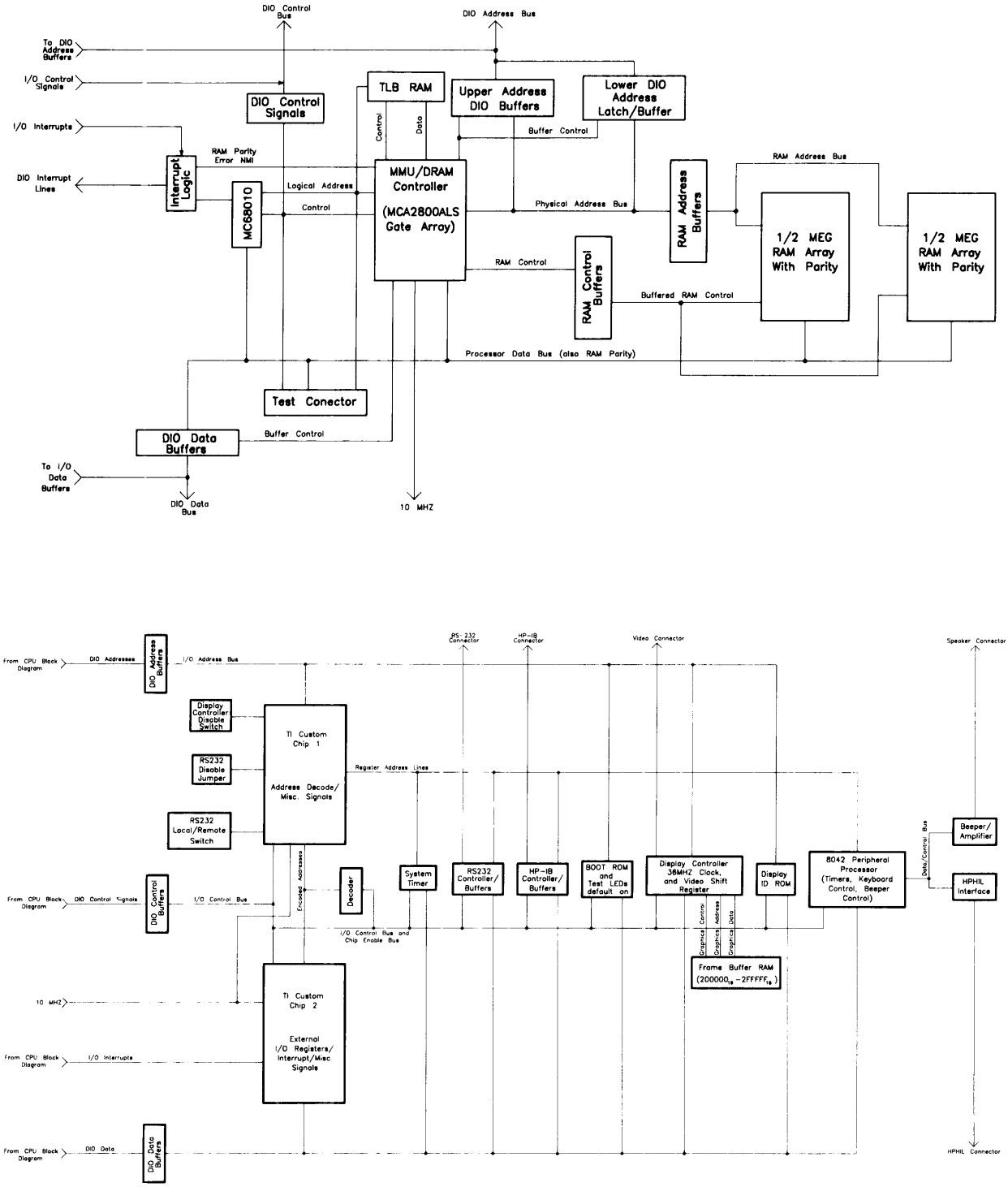


Figure 3-9. 98561-66512 Processor Board Block Diagram

98561-66513 Processor Board

General Description

The 98561-66513 processor board has the following features:

- MC6840 System Timer.
- 10 MHz MC68010 microprocessor.
- Boot ROM.
- Eight Self-Test LEDs
- 1 M-byte of RAM.
- MCA2800ALS RAM Controller.
- Memory Management Unit.
- HP-IB Interface.
- RS-232 Interface.
- HP-HIL Keyboard Electronics with battery backed-up Real Time Clock.
- Miscellaneous other components needed by HP Operating Systems (HP-UX, Pascal, BASIC).

Figure 3-10 is a block diagram of the 98561-66513 processor board. Refer to this diagram for functional descriptions.

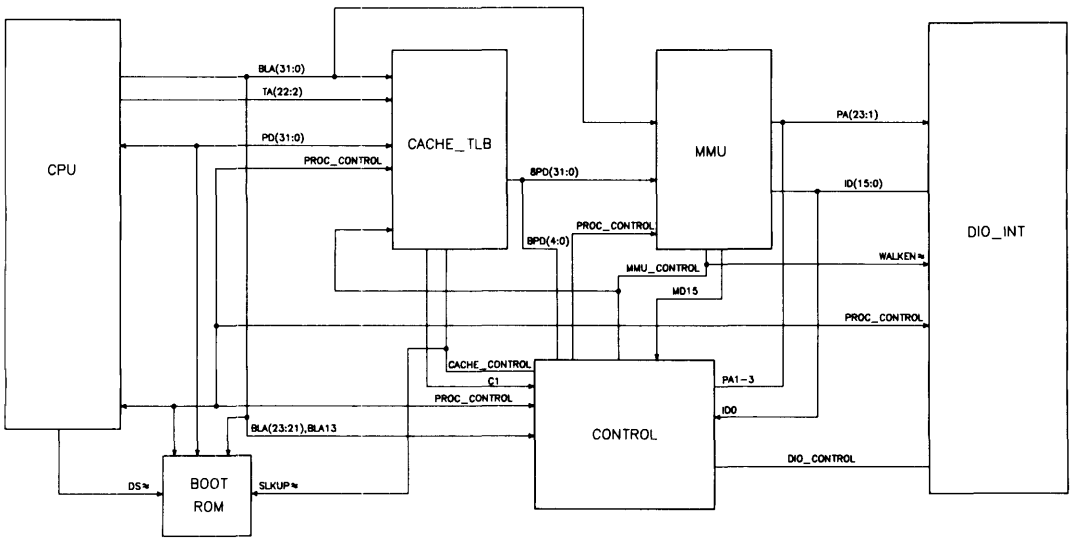


Figure 3-10. 98561-66513 Processor Board Block Diagram

This processor is the same as the 98561-66511 except for RAM and video circuits. 1 M-byte of RAM is on-board but no video circuits are available. A video board or card must be installed in a system or accessory card slot for use with a monitor.

RAM

One M-byte of RAM is contained on the 98561-66513 board. This RAM functions the same as the 98561-66512 board.

98561-66519 Processor Board

General Description

The 98561-66519 processor board has the following features:

- MC6840 System Timer.
- 16.6 MHz MC68020 microprocessor.
- Optional MC68881 Floating-Point Coprocessor
- Boot ROM.
- Eight Self-Test LEDs
- 32-bit wide Virtual Cache Memory
- 32-bit wide Memory Management Unit
- Miscellaneous other components needed by HP Operating Systems (HP-UX, Pascal, BASIC).

Figure 3-11 is a block diagram of the 98561-66519 processor. Refer to this diagram for functional descriptions.

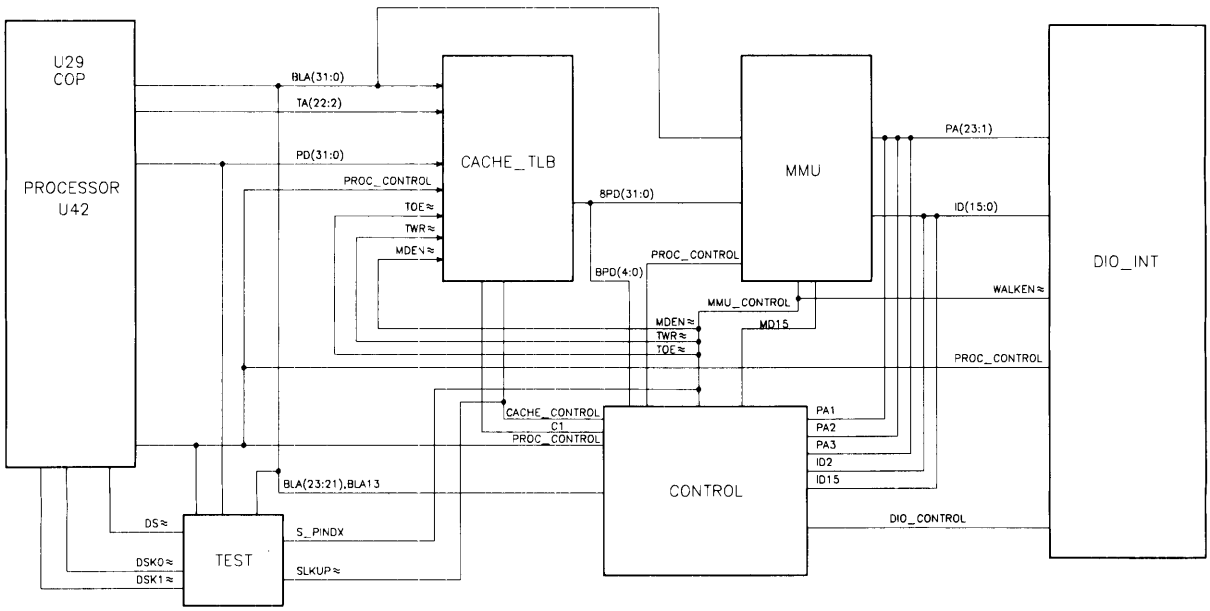


Figure 3-11. 98561-66519 Processor Board Block Diagram

Note that the 98561-66519 processor does not have RAM, I/O, video circuits, or a keyboard interface. When this processor is used in the computer, the 98651-66530 Human Interface Card must be used to provide interfaces to monitors, keyboards, and other peripherals.

An upgrade processor kit, HP 98243A, is available for customers to upgrade their computer system from one with a MC68010 CPU to one with the MC 68020 CPU. This upgrade is to be installed by qualified service personnel.

Central Processing Unit

A Motorola MC68020 CPU functions as the main processor chip on this assembly. It functions similar to the MC68010 CPU, but has several improvements.

Its asynchronous data bus is 32-bits wide for both addresses and internal registers. The MC68020 CPU can address 4 G-bytes of RAM and can directly address 7.5 M-byte of RAM. Operating at 16.6 MHz, it is significantly faster than the MC68010 CPU.

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.

Coprocessor

A floating-point coprocessor is used to increase system performance when certain math routines are part of the application. An MC68881 chip performs these functions. It implements the required IEEE standard capabilities. Performance is significantly greater than the HP 98635A Floating-Point Card.

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

Memory Management Unit

The MMU provides the capability to map any logical page of memory into any physical page. Both logical and physical pages are divided into 4 K-byte pages. A Translation Lookaside Buffer (TLB) is used to store MMU translations. The TLB operates like a cache and is 2K entries deep split into two 1K portions with one for the user and one for the supervisor.

Cache Memory Sub-System

A high-speed direct mapped 16 K-byte cache memory is external to the CPU It stores both instructions and data accesses. It is set associative with a set size of one and a line size of two 32-bit words. Operating as a virtual cache instead of a physical cache, it has greater performance than earlier HP Series 200 computer cache memory sub-systems.

Boot ROMs and Self-Test LEDs

The 98561-66519 processor has a Boot ROM whose operation is like the 98561-66511 processor. LEDs are used for self-tests and their operation and functions are the same.

Motherboard

General Description

Virtually all assemblies connect directly or indirectly to the motherboard. It has connectors for other assemblies to interface with each other. Test points for power supply voltages are marked on the top edge.

There are no active components on the motherboard. Both the computer's and bus expander's motherboard have the same part number.

Backplane Board

General Description

One backplane board is used in the computer. Two are used in the bus expander. Each connects to the motherboard by ribbon cables. They provide connection to the DIO bus for accessory cards such as interface or RAM.

There are no active components on the backplane board. Both the computer's and bus expander's backplane boards have the same part number.

Video Boards

General Description

Video boards allow the computer to send bit-mapped display information to medium or high resolution monitors. The user may upgrade his computer system from medium to high resolution by installing a different board. Upgrading is accomplished through an exchange program. It may be performed by the user with common tools without CE support.

One monochromatic and two color video boards are available for the HP Series 300 computer systems. The color boards provide four-plane color display capability allowing the user to display 16 colors from a palette of over 16 million colors. A description of these boards follows:

- HP 98542A Medium-Resolution Monochromatic Video Board. This version displays 512 X 400 pixels and drives the low resolution monochromatic monitors.
- HP 98543A Medium-Resolution Color Video Board. This version displays 512 X 400 pixel pairs and drives the low-resolution color monitors.
- HP 98544A High-Resolution Monochromatic Video Board. This version displays 1024 X 768 individual pixels and drives the high-resolution color monitors.
- HP 98545A High-Resolution Color Video Output Board. This version displays 1024 X 768 individual pixels and drives the high-resolution color monitors.

These boards make extensive use of large scale integrated (LSI) circuits. Up to four NMOS III Display Controller chips provide an integrated bit mapped display with window-move hardware and frame buffer support. Color mapping is entirely handled by another NMOS III chip called the Frame Buffer Controller. This chip performs color mapping and D to A conversion. Video memory consists of uses nibble-wide (4-bit) Display RAM (DRAM). The major difference between these assemblies is the amount of DRAM each has.

Video boards perform the similiar functions, which are:

- Establish display clock frequency in the computer system.
- Initialize according to the specific monitor used.
- Respond to interrupts on DIO bus to change color map data.
- Control the display RAM maps.
- Color boards output Red-Green/Sync-Blue Video to the color monitor.
- Monochromatic boards output Video/Sync to the monochromatic monitor.

Each of these is explained in the following functional description. Reference to Fig. 3-12 is suggested.

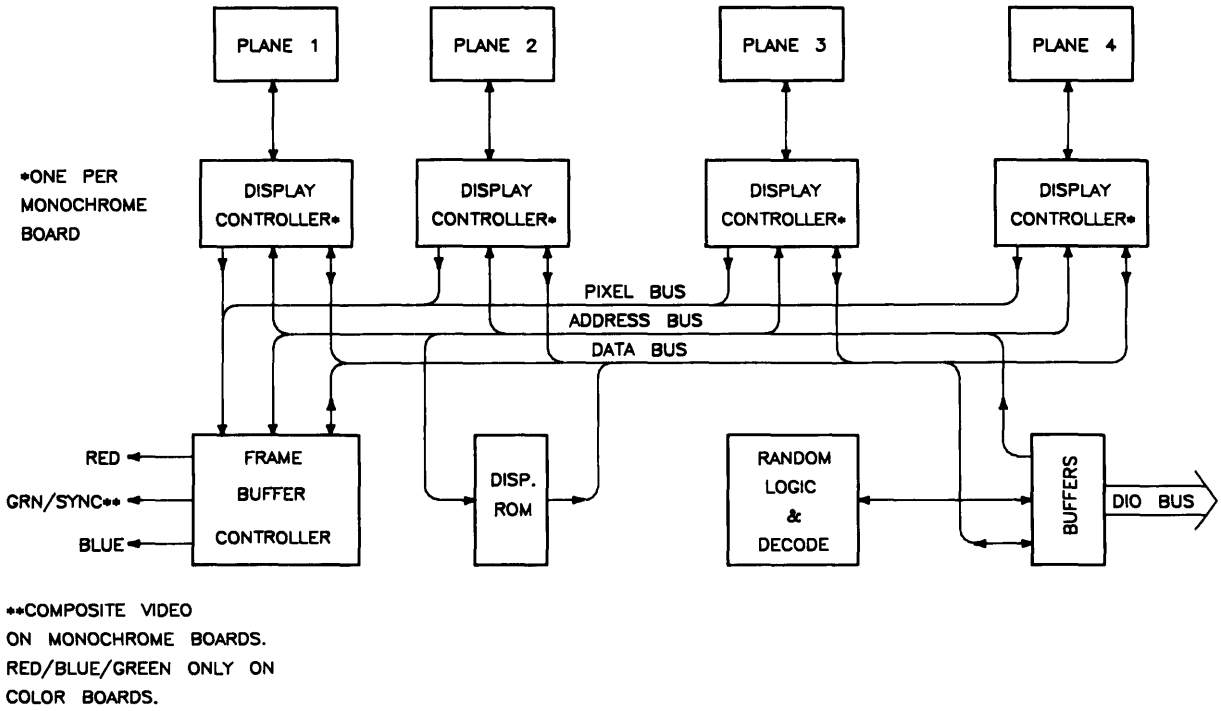


Figure 3-12. Video Board Block Diagram

Video RAM

Both high- and medium-resolution color video boards have four planes of memory. The medium-resolution board uses eight memory chips per plane. This is enough to display 512 doubled pixels by 400 scan lines. High-resolution also uses four planes but requires 16 memory chips per plane. Resolution is 1024 X 768 single pixels. Video memory uses nybble (4-bit) wide Display RAM (DRAM).

Table 3-3 shows how the display RAM is organized for the desired resolution for each board.

Table 3-3. Video Board RAM and Resolution

Video Board	Number of 16K X 4 RAM Chips	Total RAM per Board	Resolution on Monitor
HP 98542 Med-Res Monochrome	8	64K bytes	512 by 400
HP 98543 Med-Res Color	32	256K bytes	512 by 400
HP 98544 High-Res Monochrome	16	128K bytes	1024 by 768
HP 98545 High-Res Color	64	512K bytes	1024 by 768

Color Mapping

Each color board has four plane color mapping. Mapping is entirely under control of the Frame Buffer Controller. The high-resolution board has more RAM than the medium-resolution board.

Display Controller

The Display Contollers are the heart of these video boards. They provide complete video control and bit-mapped alpha support for one graphics plane. Interfacing directly with the computer CPU, it integrates and manages most display functions. The functions of the Display Controllers are:

- Provide horizontal and vertical timing signals to the sweep section of the video board.
- Provide refresh data to the frame buffer.
- Generate the blinking underline cursor.
- Enable window move operations.
- Output video and sync signals to the frame buffers.

Architecture provides for either color or grey-scale monochromatic display use. The display is organized with one memory byte for each display pixel. This corresponds to a maximum capability of eight planes with one byte per pixel per plane. Each bit in the byte goes to a separate frame buffer memory plane. Pixel data is transferred 32 bits (or pixels) at a time by read and write operations with display RAM by the video board. Logic internal to this chip enables software to perform byte-per-pixel access.

Frame Buffer Controller

The Frame Buffer Controller resides on two busses; the computer's CPU DIO bus, and the frame buffer data bus. It performs the following functions:

- Receives frame buffer data for DRAM refresh.
- Maps 4 bits per pixel into 256 colors out of more than 16 million colors.
- Generates graphics video outputs.
- Allows the CPU to read and write the color map.

Communication on the CPU bus consists of register reads and writes in byte format under control of the CPU. On the memory bus, communication consists of frame buffer word loads under control of the Color Display Controller.

Video Output

Video output is compatible with several HP monitors. Standard Red, Green (with sync), and Blue outputs are available through BNC connectors on the color boards. For the monochromatic boards, composite video with sync is output through a single BNC connector.

For color boards, a data merging circuit in the Frame Buffer Controller combines color and blanking data from the display memory into a 24-bit data stram. Three digital to analog converters change this data stream into a current source for each of the three color outputs. These outputs connect through cables to the video amplifiers in the color monitor.

Display RAM Control

Frame buffer and the Frame Buffer Controller register set are fixed in internal address space. Frame Buffer Controller registers and the processor board's Frame Buffer Controller both use the same addresses.

When the processor board used in the computer has video circuits on-board, and the application requires a video board to be installed in a system slot for use with the monitor, the Frame Buffer Controller chip in the processor's video circuits is disabled by a switch located on the processor. This switch must be set before the video board is installed in a system slot.

Interrupt Structure

The interrupt structure is similar to DIO interrupts. On receiving an interrupt and verifying the interrupt is coming from the video board, the CPU must then poll the video boards to determine the interrupting device.

ID/FONT ROM

Each video board has an ID/FONT ROM. This is a 16K-byte wide ROM that supplies the CPU with information about the video board type. Initialization and dot clock frequency information is also provided.

Alpha character font is the size and shape of the dot matrix used to create letters, numbers, and other keyboard symbols. The system monitor will display the font defined in the ID/FONT ROM during computer power-up and self test. If another font is required for the application, the operating system or application software can specify another available font to be used. Standard FONT, or pixel display matrix for the video boards is shown below:

Medium-Resolution Display:	9 X 12 Character, 10 X 15 Cell
High-Resolution Display:	6 X 10 Character, 8 X 16 Cell

Clocks and Timing

The display clock frequency is different for each video board. At power-up, the CPU executes instructions from the Boot ROM to determine the presence of and type of the video board. Data in the ID/FONT ROM is placed in a Display Controller register to set the display clock frequency.

Human Interface Card

General Description

A 98651-66530 Human Interface Card is an accessory used in computers having the 98561-66519 processor. As the -66519 processor does not have any interfaces, this card provides the following features:

- HP-HIL Interface
- HP-IB Interface
- RS-232 Interface
- Speaker Output

Figure 3-13 is a block diagram of the human interface card. Refer to this diagram for functional descriptions.

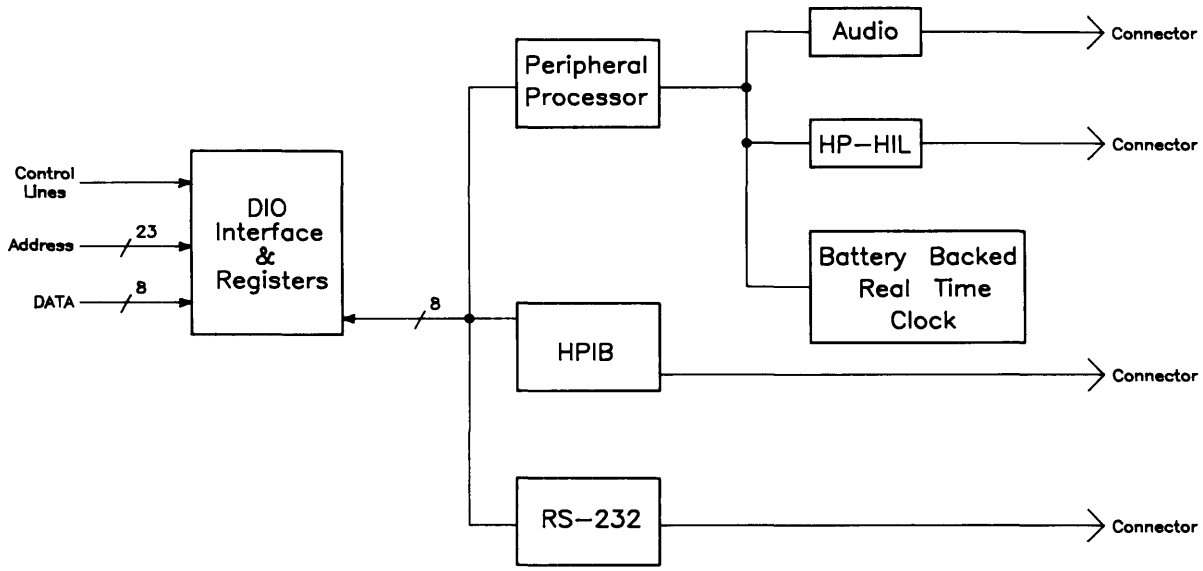


Figure 3-13. Human Interface Card Block Diagram

Functional Description

Each of the above functions use virtually the same electronics as the interface circuits on processors for the same functions. The major difference is the RS-232 connector which is 9-pin instead of 25-pin.

HP 98546 Display Compatibility Interface

General Description

An HP 98546A Display Compatibility Interface enables bit-mapped video from the computer to be compatible with the HP 35721, HP 35731, and HP 35741 monitors when one of the following operating systems is used:

- HP Series 200 BASIC 2.0, 2.1, and 3.0.
- HP Series 200 Pascal 2.0, 2.1 and 3.0.

The two video cards included are exchange assemblies and may be individually replaced. Parts of this interface are:

- Video Card, 98546-66570
- Graphics Card, 98204-66577
- Various Video Cables

Both cards are installed in adjacent slots. The video card must be in an I/O slot with the graphics card in the accessory slot directly above the video card.

This two-card set has the following functions:

- Bit-Mapped Video Input
- Katakana or Roman 8 Character font.
- 50 or 60 Hz Refresh Rate Selection
- Alpha and/or Graphics Video Output

Figure 3-14 and 3-15 are block diagrams of the cards. Refer to these diagrams for functional descriptions.

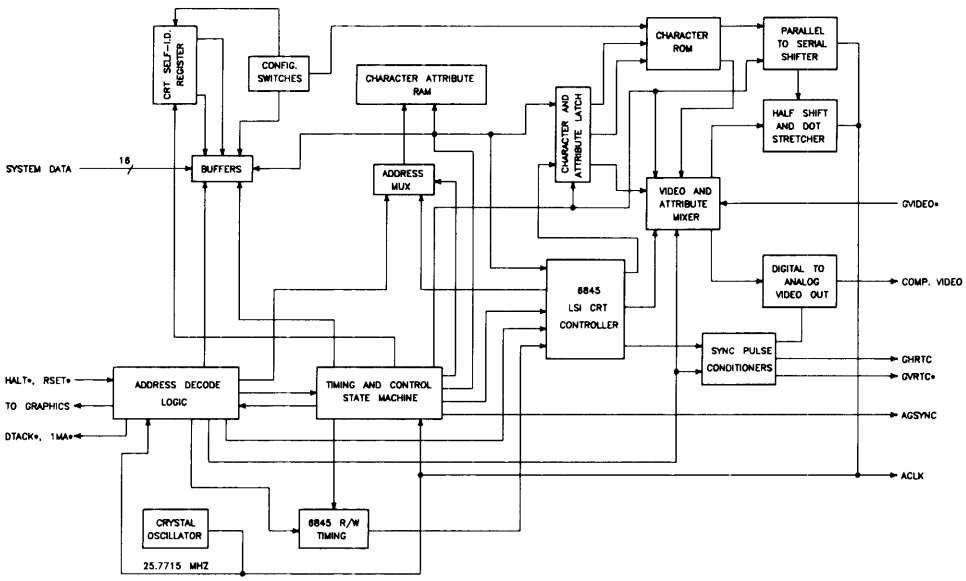


Figure 3-14. HP 98546A Display Compatibility Interface (Graphics) Block Diagram

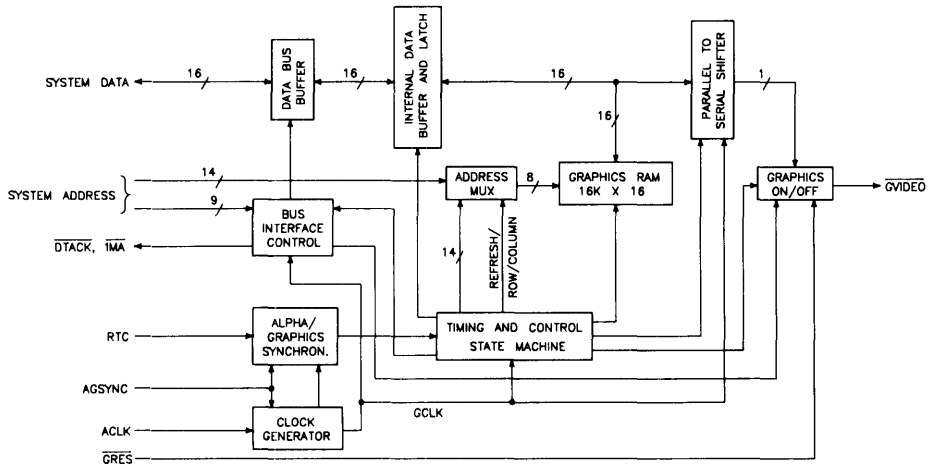


Figure 3-15. HP 98546A Display Compatibility Interface (Video) Block Diagram

Video Card

Input Video

Bit-Mapped video from video circuits is input to the video card through the BNC connector labeled **Video In**. Depending on the mode of the computer this will be either alpha or graphics video. In graphics mode, video is sent to the graphics card through a ribbon cable connecting the two cards. In alpha mode, video and sync pulses are fed to the alpha video circuits.

Timing and Drivers

Timing clock signals and video driver circuits required to interface the graphics card are on the video card. Vertical sync circuits are controlled by the position of the 50/60 Hz monitor refresh rate switch. Both vertical and horizontal sync pulses are output to the video circuits to be part of the composite video output.

Alpha Video

Alpha video is stored in on-board RAM and provides 25 lines of text with 80 characters per line. Provisions for inverse video and half-bright user-definable key labels in the bottom two display lines are enabled through software programming. Text is 8-bit ASCII modified for the monitors supported. A switch determines whether Katakana or Roman 8 character font will be used.

Configuration Switches

Two switches determine display refresh rate and alpha character font. Refresh rate is determined by the switch farthest from the edge connectors and should be set to the line voltage frequency. Otherwise, the monitor's display may flicker. A 50 Hz and 60 Hz position is available and the printed circuit board is labeled accordingly next to this switch.

The switch nearest the edge connectors determines the character font. When the computer system is used in Japan, or when BASIC or Pascal operating systems with revisions lower than 3.0 is used, this switch should be placed in the 0 position to enable the Katakana characters to be displayed. For all other countries, the switch should be placed in the 1 position to enable the Roman 8 style of characters. Labeling on the printed circuit board next to the switch with a 0 and 1 identifies the respective switch positions.

Video Output

Alpha and/or graphics Video is combined with sync pulses from the timing circuits as a composite video signal. Video is output from the **Monitor** BNC connector on the video card's rear panel.

When graphics mode is selected by software, graphics video from the graphics card is input to the video card and output from the BNC connector labeled **Monitor**. When alpha video is selected, alpha video is output from the same connector. This type of video is called separate alpha/graphics video.

For systems using a color monitor with this card set, the green video with sync is input from the color video circuits in the computer and is processed the same as composite monochrome video. The **Monitor** output, which in this case is green video with sync, is connected to the green input connector on the color monitor. Red and Blue outputs from the video board in the system slot are fed directly to the Red and Blue input connectors on the color monitor.

Graphics Card

Circuits required to control the graphics video are on the graphics card. This card is the same one used with the HP 98204 Composite Video Cards for Series 200 computers.

Graphics Video

Inputs from the video card through the ribbon cable are converted to a 390 by 512 graphics display and stored in on-board RAM. Graphics memory is organized such that the first 8 pixels displayed in the upper left-hand corner of the display correspond to the first byte of memory in graphics RAM. Each succeding byte corresponds to the next 8 pixels to the right in the graphics display.

Graphics Video Output

Graphics video is sent back to the video card through the ribbon connector.

Chapter 4
Boot ROM Functions

Introduction

This chapter describes the functions of the Boot ROM in the Series 300 computers. After the power to the computer is turned on, two Boot ROM instruction sets are executed by the CPU. Each instruction set is the same for all Series 300 computers.

- Power-Up Sequence
- Boot System Selection

Power-Up Sequence

Power-up Algorithm

Power-up Philosophy used in these computers is based on the following algorithms:

- Keep it as small as possible (Let systems loaded later take as much of the burden as is feasible).
- Keep it as short as possible.
- Test and initialize devices necessary for operation of Boot ROM code (CPU, Boot ROM, RAM) first.
- Test and initialize devices used for interaction with user during power-up (display, keyboard, and some I/O) second.
- Test and initialize devices used for booting (HP-IB, and SRM interface card) last.
- Items not required to power-up should not prevent power-up.
- Exhaustive testing & diagnostics and the testing of devices not used by the boot ROM should be done by Series 300 Test Tools and/or by some other means. *The Boot ROM instructions and tests are not a component level diagnostic tool.*

Table 4-1 shows the flow of events for the Power-Up Sequence. It shows everything that happens between power-up and the start of the boot scanner. This includes self-test and initialization. During the Power-Up Sequence, the LEDs and the monitor's display are used to tell what is happening. The section that follows discusses how the LEDs are used.

Pressing [Reset] will re-start the Power-Up Sequence. RESETs are locked-out or deferred during all mass storage operations to prevent leaving devices stranded in unknown states.

On power-up, the CPU is initialized and executes the Power-Up Sequence instructions in the Boot ROM. The Power-Up Sequence is shown in Table 4-2.

Table 4-1. Power-Up Flow Chart

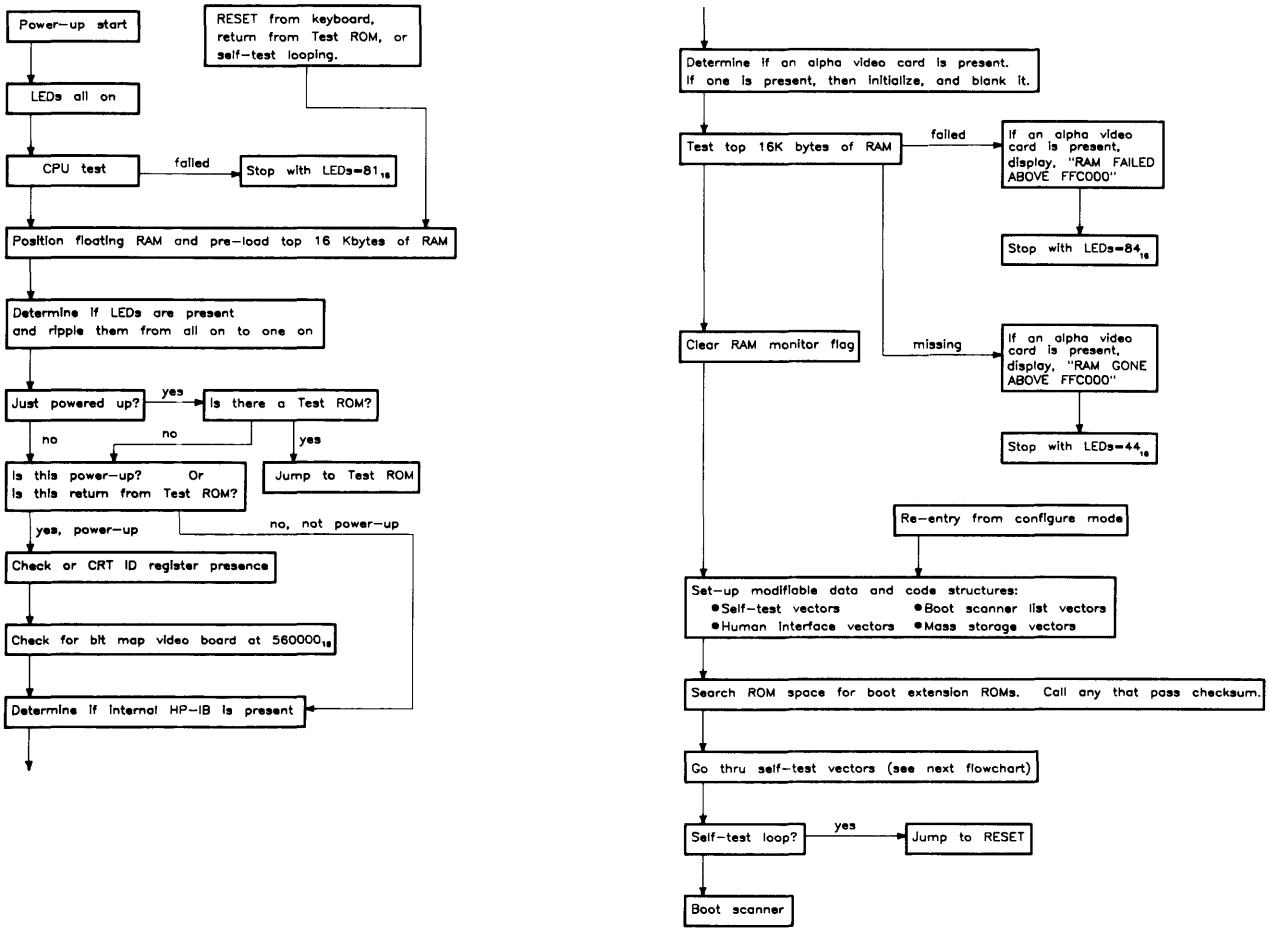


Table 4-1. Power-Up Flow Chart (Continued)

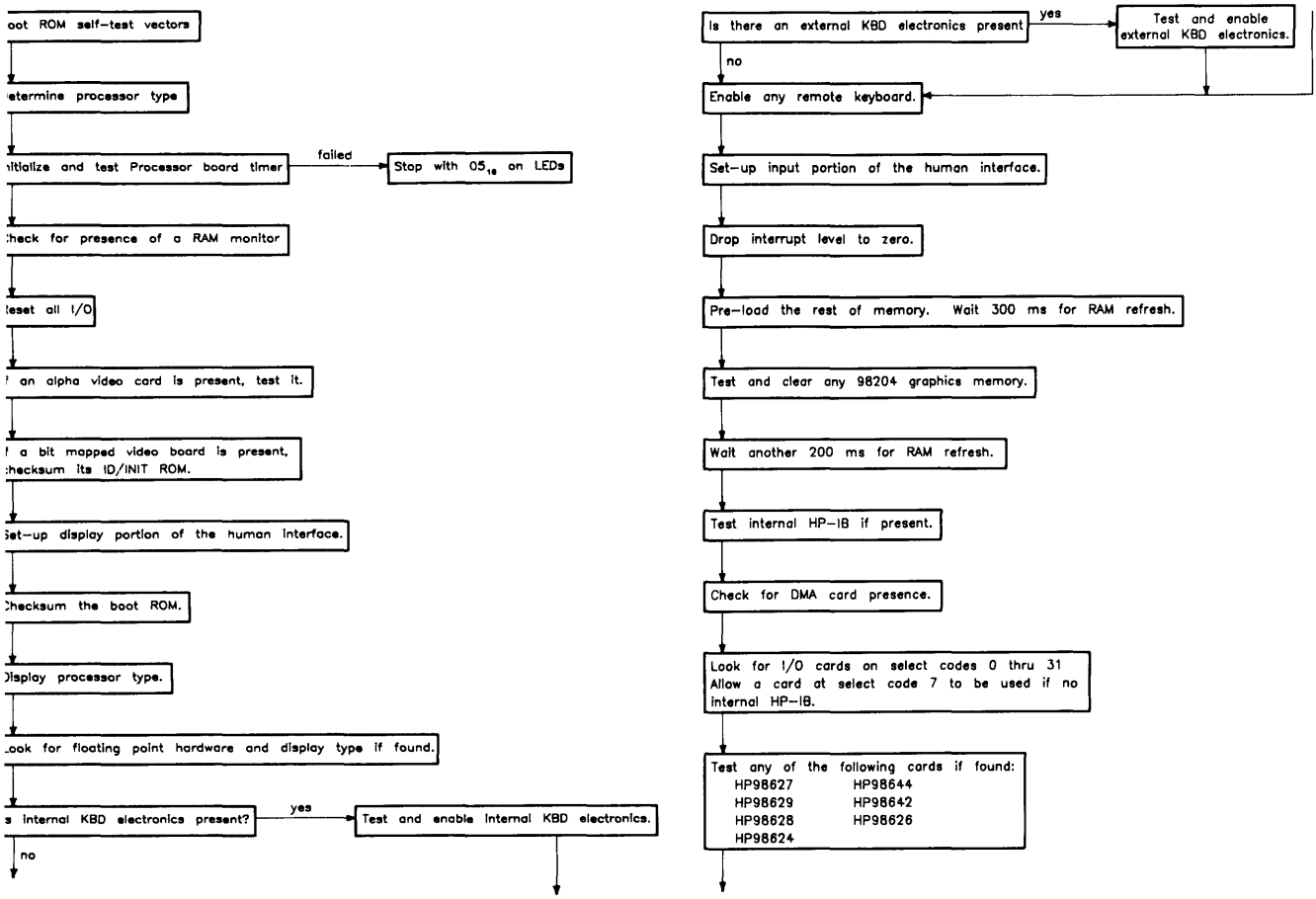
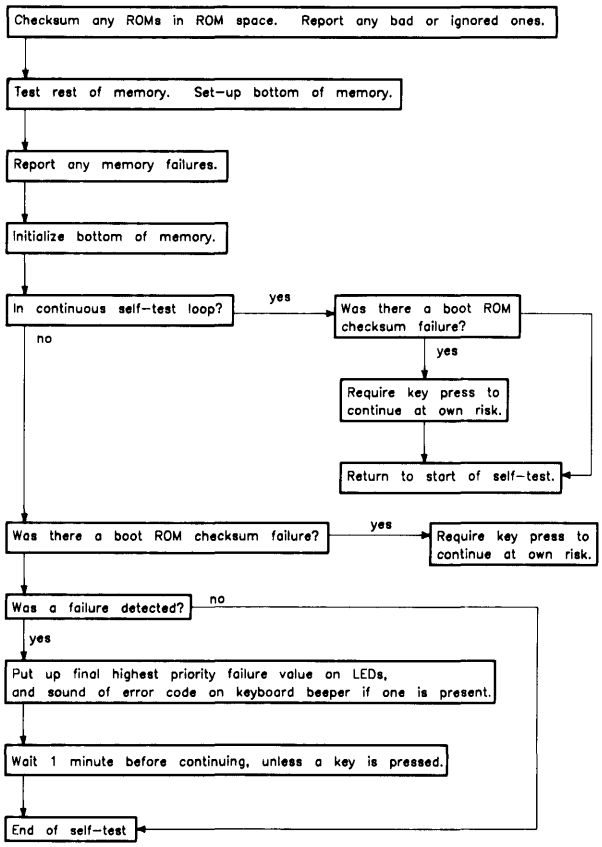


Table 4-2. Power-Up Sequence.



Power-Up Sequence Explained

1. Turn on test LEDs.
2. Test CPU.
3. Set up data structures.
4. Search for any Boot Extension ROMs and call any valid ones.
5. Determine CPU type (MC68010 or MC68020).
6. Initialize and test processor board timer.
7. Look for a RAM monitor.
8. Reset all I/O.
9. Initialize the video circuits.
10. Checksum the Boot ROM.
11. Display CPU chip type.
12. Initialize keyboard electronics.
13. Drop interrupt level.
14. If HP 98546A Compatibility Display Interface is found, initialize and clear graphics.
15. Test HP-IB on processor board.
16. Find any Direct Memory Access (DMA).
17. Find accessory I/O cards. Report all found. Test the following:
    a. HP 98629 SRM Controller.
    b. HP 98527 Color Output Card.
    c. HP 98624 (TI9914 HP-IB).
    d. HP 98626 RS-232 Interface Card.
    e. HP 98644 RS-232 Interface Card.
    f. HP 98628 RS-232 Interface Card.
    g. HP 98642 4-port Multiplexed RS-232 Card.
18. Checksum any ROMs in ROM address range and report any problems.
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. 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 OS will eventually be booted. To enter Configure Mode, wait until one of the following keyboard messages is displayed:

Message	Location of Keyboard Electronics
`Keyboard`	On processor board.
`Console Keyboard at XX`	On card other than HP 98644A in I/O slot.
`98644 at XX`	On HP 98644A Card in I/O slot.

Where `XX` is the select code of the interface card.

Then, before an operating system is booted, hold CTRL down and press C.

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 an abnormal state (e.g. disc spinning).

An example Configure Mode display is shown in Figure 4-1.

```
                                    KEY   ACTION
Copyright 1985,
Hewlett-Packard Company.             T    Extended Self-Test
All Rights Reserved.                 L    Continuous Self-Test Loop

BOOTROM Rev. A
Bit Mapped Display
Keyboard
HP-IB
HP 98620B
HP 98642 at 12
HP 98625 at 8
HP 98629 at 20
524128 Bytes




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

Figure 4-1. Example Configure Mode Display

Once in Configure Mode, several options are displayed. One of the option keys must be pressed within approximately 5 minutes of entering Configure Mode. Otherwise, the Boot ROM will time-out and start power-up over again. Available options are:

- Force Long Memory Test
- Continuous Self-Test
- 50 Hz CRT
- 60 Hz CRT

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.

Force Long Memory Test

If the [T] key is pressed, the self-test will be started over and the long memory test will be executed. Long memory test is a marching/walking ones and zeros test taking about 1 second per 64K of RAM.

Otherwise, the default short memory test will be executed. The short memory test is an address/address complement test taking about 1 second per 256K of RAM.

Continuous Self-Test

Pressing [L] causes the Boot ROM to continuously repeat the self-test portion of its code. This is a toggle switch, so entering Configure Mode while already in Continuous Self-Test Mode, and choosing the "L" option, will stop the continuous self-test and 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. However, the following failures **will** stop self-test looping:

- **A CPU register failure:**

  In this case the Boot ROM stops with the display blanked and the value 81_{16} on the LEDs.

- **Memory failure in the top 16K bytes:**

  In this case the Boot ROM stops with the display blanked and the value 84_{16} on the LEDs. If a non-bit-mapped video board and monitor is connected, the message `NEED GOOD RAM ABOVE FFC000` will be displayed on that monitor.

- **Boot ROM checksum failure:**

  In this case the Boot ROM stops with the message `CONTINUE AT OWN RISK (Press RETURN To Continue)` on the display, the value 83_{16} and then beeps four low tones and two high tones. Pressing [Return] will cause the Boot ROM to continue self-test looping.

50 or 60 Hz CRT

Ac line voltage is either 50 Hz or 60 Hz. A monitor's vertical sweep frequency may cause display flicker if an incompatibility exists between the ac line frequency and the vertical sweep frequency. These options permits the user to set the video board for the local line voltage frequency.

The 50/60 Hertz CRT options are only available with non-bit-mapped video cards. With one of these cards installed, if [5] or [6] is pressed, a soft override of the power-up CRT frequency occurs. The power-up CRT frequency of the HP 98546 Display Compatibility Interface is determined by a switch on its video card. When this switch is set to 0, the power-up default is 60 Hz, when this switch is set to 1, the power-up default is 50 Hz. If [5] or [6] is pressed during configure mode when there is both an alpha/graphics video card set and a bit mapped video board present, then the key pressed will effect the alpha display (even though the '5' and '6' are not displayed). If no alpha/graphics video card set is present and [5] or [6] is pressed, the Boot ROM will re-enter self test, but the display will not be effected.

An example Configure Mode display with 50/60 Hz information is shown in Figure 4-2.

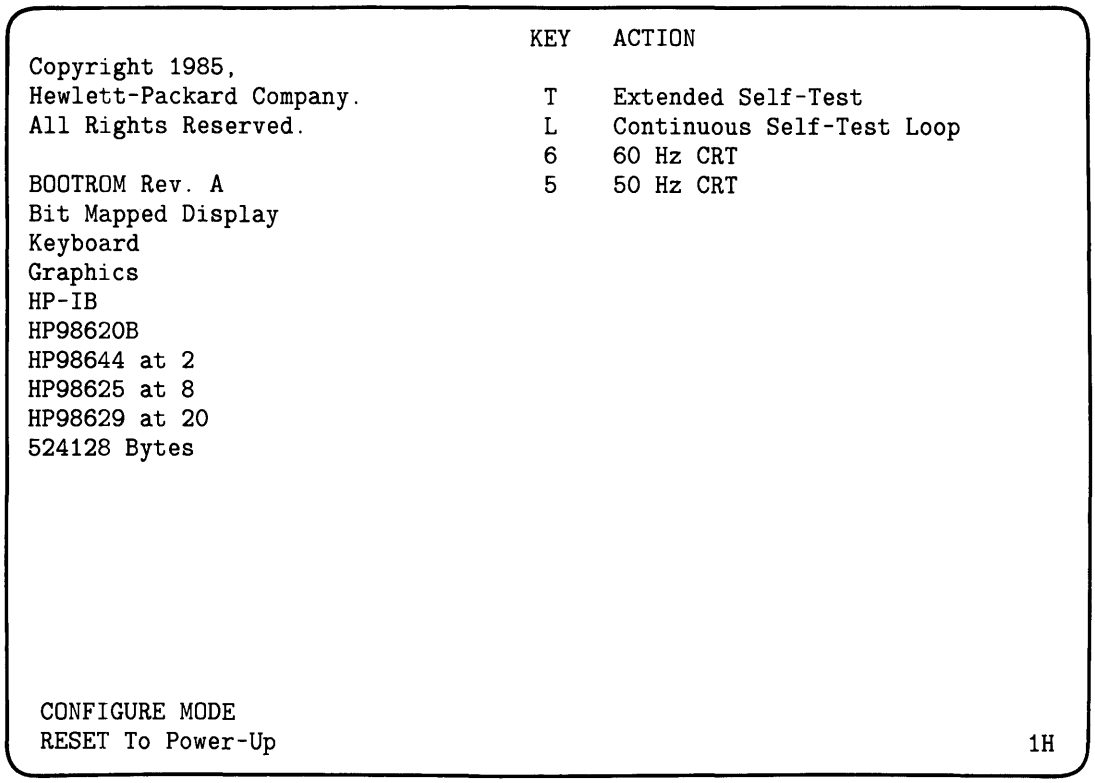


Figure 4-2. Configure Mode Screen Display with 50/60 Hz Information

The Human Interface

Several devices may act as the "console", or primary human interface for the Boot ROM. These devices permit input and output functions between the person and the computer system. Possible console devices are:

Output Devices

Functional output devices are listed below.

- HP 98642 (4-port, multiplexed RS-232) card with the remote bit set (with a supported HP terminal).

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

- HP 98626 card with the remote bit set (with a supported HP terminal).
- HP 98644 card with the remote bit set (with a supported HP terminal).
- Human Interface Card (98561-66530) or Processor board RS-232 controller (same as 98644 card) with the remote bit set (with a supported HP terminal).[1]
- A bit mapped video board at internal address 560000_{16}. This includes the HP 98700 and all of the processor boards with video circuits.

  The Boot ROM tries to talk to devices with a primary DIO ID of 25 and a secondary DIO ID of 1, and it expects these devices to have ID/FONT ROM information.

- An HP 98546 Compatibility Display Interface. This alpha/graphics video card set is similar to the HP 98204B card. Note that the Boot ROM will turn off video to this card set just before booting an OS. It is up to the operating system to restore video if this card set is to be used.
- HP 98627 Color Card

Input Devices

Functional input devices are listed below.

- Remote HP 98642 card with supported HP terminal.
- Remote HP 98626 card with supported HP terminal.
- Remote HP 98644 card with supported HP terminal.
- Human Interface Card (98561-66530) or processor board RS-232 controller (same as 98644 card) with the remote bit set (with a supported HP terminal).[1]
- Processor board HP-HIL, keyboard, and HP-IB electronics.
- I/O slot HP-HIL or keyboard electronics. The only version of this hardware is the keyboard electronics in the HP 98700 Display Controller.

[1] Only one output device at a time will be used as the console output device, however, the Boot ROM will initialize and clear any bit-mapped video circuits on the processor board and on video cards in the accessory slots that it finds, even if that video circuit is not chosen as the output to the console device.

The Boot ROM chooses the output devices in the manner shown in Figure 4-3.

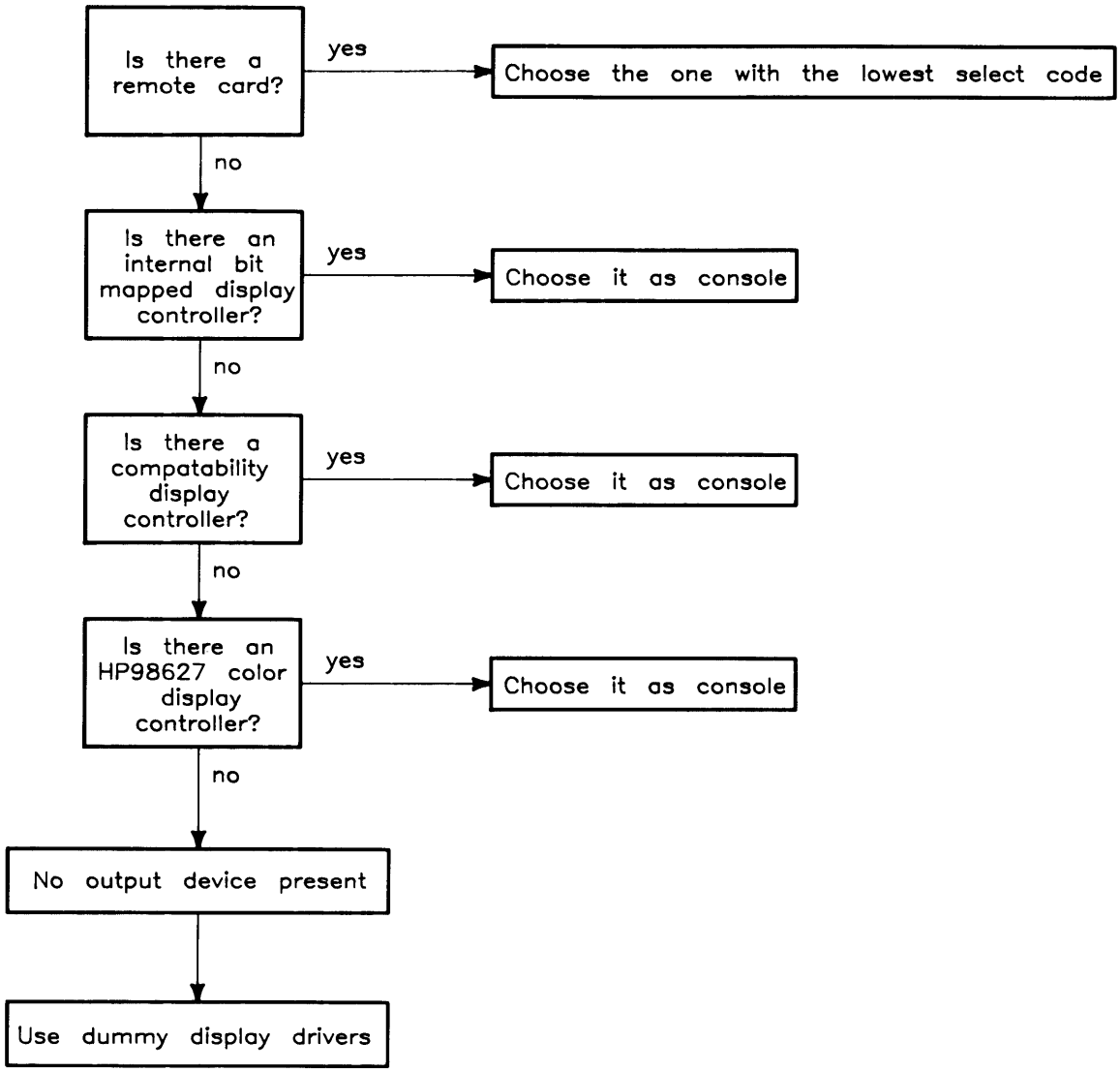


Figure 4-3 Boot ROM Output Device Selection Flow Chart

The Boot ROM chooses the input devices in the manner shown in Figure 4-4.

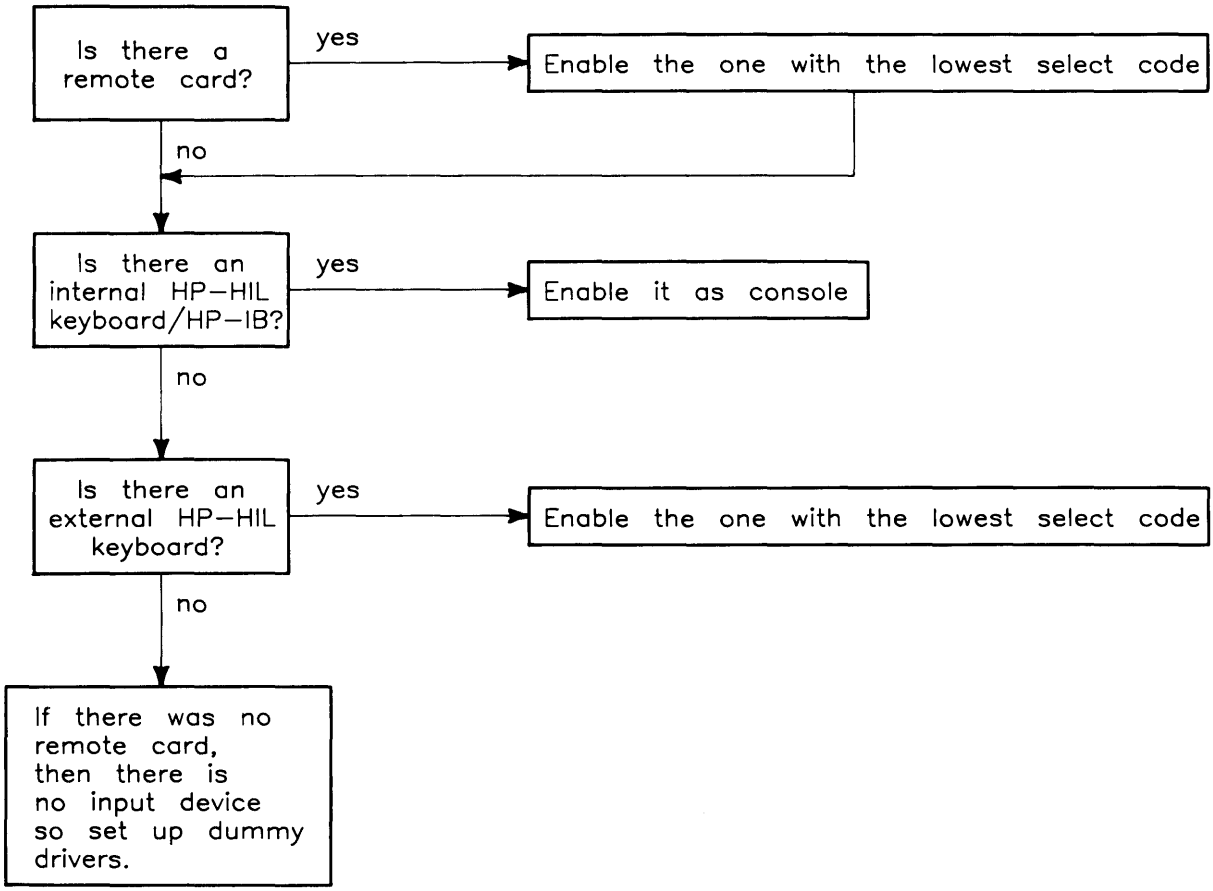


Figure 4-4. Boot ROM Input Device Selection Flow Chart

Note that if processor board keyboard electronics and a remote terminal are both present in a system, they will both be enabled. Similarly, if accessory card keyboard electronics and a remote console are both present in a system, they will both be enabled, provided no processor board keyboard electronics are present. Keyboard electronics on an accessory card will never be enabled when the processor board has keyboard electronics.

When more than one set of accessory card keyboard electronics is present, then only one with the lowest select code is enabled. If several HP 98700s exist on a system, then it is the user's responsibility to ensure that the accessory card keyboard electronics associated with the HP 98700 display controller at the address 560000_{16} has the lowest select code of all accessory card keyboard electronics in the system. This must be done to ensure that the keyboard associated with HP 98700 "A" is not input console while the display of HP 98700 "B" is output console. The Boot ROM does not attempt to verify the display/keyboard relationship.

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 a video output is present, then that video output 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. Refer to 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 one of the following interfaces with its "remote" switch set:

- HP 98642 (4 port, multiplexed RS-232),
- HP 98626 RS-232 Interface Card
- HP 98644 RS-232 Interface Card

The search starts at select code 0 and ends at select code 31 or when one of these remote cards is found that passes self-test. If one is found, it becomes the Remote Human Interface. If the Remote Human Interface is an HP 98642 card, the the terminal on port 1 will be used as the console. All other ports are ignored by the Boot ROM.

NOTE

Note that the 98561-66511 processor board or 98561-66530 Human Interface Card with on-board RS-232 interface is treated as an HP 98644 RS-232 interface card 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 internal display, if present, will display:

```
Remote Interface at 9
```

After this point the internal display will not change until a system is booted. Any internal or external keyboard, if present, will work just as it would if there were no remote console (see previous section for details).

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:

Terminal Escape Sequence	Display Activity
Escape H Escape J	Clear Screen and reset cursor
Escape &aDDY	Move Cursor to Row DD
Escape &aDDC	Move Cursor to Column DD

With the HP 98626 card, the Boot ROM will use the baud rate, pacing, and line characteristics specified by the card's configuration switches. The "handshake type" bits in the Line Control Switch Register are shown as "reserved for future use" in the Installation Manual. The definition given these bits by other OS's, and the one adhered to by the Boot ROM is:

Bit 6	Bit 7	Handshake type
0	0	ENQ/CK
1	0	XON/XOFF
0	1	no handshake
1	1	no handshake

NOTE

HP 98626 cards are shipped with these switches at zero. When booted with ENQ/ACK enabled on the HP 98626 card and XON/XOFF enabled on the terminal, the Boot ROM sequence stops, waiting forever for a response.

Since the HP 98644 and HP 98642 cards do not have line characteristic switches, 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 terminal's display will be the same as a monitor driven by video electronics on a 98561-66511 processor board. Keyboard functions 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 card driving the remote interface will not be disturbed. It was tested earlier and passed. Otherwise, the interface could be disabled.

Self-Test

When the machine first powers up, the boot ROM gets control. Before transferring control to a system by booting it, the boot ROM has several responsibilities.

Hardware Initialization Support.

Some hardware must be initialized as soon as possible after power-up to prevent improper operation. Examples are display initialization and floating RAM positioning, neither of which can wait for an OS to be loaded.

Assembly Self-Test Support.

Self-Tests have about 95% confidence that a tested logic assembly is functioning properly. The reason for these tests is to tell the user that the computer is okay. This consists of indicating all installed accessories in the computer (and bus expander, if connected) and reporting all detected failures.

Boot ROM self-test routines may not identify and indicate all hardware failures correctly. Several things contribute to this. They include hardware design and the fact that testing for 100% of all failure types is virtually impossible.

Several `UNEXPECTED` failures that can be displayed on the monitor are explained in Chapter 4. These messages have the following format:

Tests Performed by the Boot ROM

Set-Up Code Segment

A series of tests and initialization routines which set up the computer so the rest of the Boot ROM code can function safely are the first section of Boot ROM code. For example, the first part of this code section cannot depend on a working stack. The first priority of this code section is to set up the computer so a stack can be used.

The first part of the unextendable code segment, the part that must work without a stack, includes the following routines (note that, before each step, the LEDs are set to a new value which reflects that step):

1. Bus Error Handler:

   The BUS ERROR vector is set up to point to a routine which, based on the value of the stack pointer, decides if we have a stack. If there is no real stack, then the value of the stack pointer will be less than 100_{16}. In this case, the stack pointer will be reset to 100_{16} and the Boot ROM will jump to the address contained in register A6.

2. CPU Test:

   Three different values are passed, one at a time, through each of the CPU Registers. If the value that comes out of the last register is different from the value that went into the first register, for any of the three values, then the Boot ROM halts with a "CPU Failed" code on the LEDs.

3. Position Floating RAM and Pre-load the Top of Memory:

   The stack pointer is set to 100_{16}, and register A6 is set to point to the address of the next routine. The Boot ROM steps through the first 16K bytes of memory, pre-loading it until a bus error occurs to position floating RAM (on the MC 68010 only) and to initialize for the top memory test. If a bus error does not occur, the Boot ROM starts at -1 and reads every 64K byte boundary until a bus error occurs or until just before the bottom RAM address is reached.

4. Cycle LEDs:

   Register A6 is set to the address of the next routine in case a bus error occurs. The LEDs are rippled from all on to all off except one. There is a small delay for each ripple state which is used to cause a 500ms delay between memory pre-load and the test to check for refresh failures.

5. Check for Test ROM:

   If the Boot ROM is not at power-up, then this step is skipped. Register A6 is set to the next step. The instruction "jump to next step" is moved into the location 810000_{16} If the location 810000_{16}. does not have a 60_{16} in it, then the Boot ROM skips to the next step, otherwise it executes a jump to 810000_{16}. The Test ROM should return through location $19c_{16}$.

6. Check for video electronics:

   If the Boot ROM is not at power-up and is not returning from the Test ROM, then this step is skipped. A check is done for the CRT ID register of a HP 98546A card set. A bit is set to indicate its presence. Then the Boot ROM looks for a bit mapped video boards by checking location 560000_{16} for a primary DIO ID of 25 and a secondary ID of 1. If the proper ID is found, then a bit is set to to indicate the presence of a bit-mapped video board.

7. Determine if Internal HP-IB is Present:

   Register A6 is set to the address of the next step. Channel zero of the DMA card is disarmed if the DMA card is present. An internal HP-IB card is present if register three is set up such that bit 7 = 1, bit 6 = 0 and bit 0 = 0, and if bits 7 and 6 are unaffected by writing, and if bits 7, 6, and 0 are unaffected by bus precharging.

8. Determine Which, if any, Alpha video card is Present:

   Register A6 is set to the location of the top RAM test routine. Note that only video assemblies with a CRT ID registers are supported.

9. Initialize and Blank Alpha Display Controller, if Present:

   If an HP 98546A card set is present, then it will be initialized and blanked.

10. Top RAM Test:

    Register A6 is set to the location of the fatal error handler routine. A memory test is executed on just enough RAM to allow the rest of the Boot ROM code to operate. (A "fatal error" will occur when there is not enough RAM.) If there is a memory failure, 84_{16} will be displayed on LEDs. If memory is missing, 44_{16} will be displayed on LEDs. If an alpha display controller is present, the Boot ROM will also write one of these messages:

    ```
    RAM  FAILED ABOVE FFC000

    RAM GONE ABOVE FFC000
    ```

    for memory failure and memory missing, respectively. These messages will not be displayed on a monitor through a bit-mapped video board.

NOTE

If high RAM fails or is missing, then the LEDs and beeper will give the only notification on a system with a bit-mapped video board or remote console.

---

11. Set Up Data Structures:
    a. The two global variables SYSFLAG and SYSFLAG2 are set up.
    b. ATTENDED is set to false. ATTENDED is a Boot supervisor flag which indicates whether or not the keyboard has been accessed.
    c. The test list is set up in temporary RAM.
    d. The Boot list and device driver list are set up.

NOTE

The remaining steps depend upon a working RAM stack. As in the previous steps, the LEDs are set to a new value before each step.

Test and Boot Code Segment

This section explains the sequence the CPU executes Boot ROM test list vectors and loops through self-test if continuous self-test is enabled.

The Test List (like the Boot List) is a temporary structure used by the Boot ROM to allow upgrades and extensions. The Test List is a linked list whose elements are vectors which point to test code for various devices. The test and/or initialization code for a given devices is generally of the format:

> Indicate on LEDs the device being tested.
>
> If the device is present THEN
>
> F the test initialization fails THEN indicate the failure
>
> ELSE indicate the presence of thedevice.

A step-by-step list of what happens in this Boot ROM code segment is explained. As before, each step is preceded by an indication of that step on the LEDs. The test list for the Boot ROM is as follows:

1. Which Processor:

   An exception format word is pushed onto the stack, and an RTE is executed. The state of the stack indicates whether or not the processor is an MC68000[1]. If the CPU was not an MC68000, then a divide by zero is executed and the stack is checked to distinguish between an MC68010 and an MC68020 CPU. The Boot ROM does not distinguish between an MC68010 and an MC68012 CPU. Sysflag2 is set up accordingly.

2. Initialize Timer:

   The Boot ROM determines if there is a timer on the processor. If there is one, then it is tested and initialized, and a bit is set in sysflag2 to indicate its presence. If one is not present, or if a failure occurred, then the Boot ROM halts with 05_{16} on the LEDs.

3. Initialize Monitor:

   The Boot ROM determines if a RAM Monitor is present at 880000_{16}. If there is one, then its presence is indicated in F_AREA.

4. Reset I/O:

   A RESET instruction is executed to clear all I/O. The Boot ROM sets up the processor's keyboard electronics, if present, to ensure that its timer does not lose time. Keyboard electronics on an accessory card are not set up.

5. Initialize and Test Display:

[1] Much of this Boot ROM code is used in other HP 9000 Series 200 computers using the MC68000 CPU. In this case, a MC68000CPU will not be found and the CPU will look for a MC68010 or MC68020 CPU on the processor board.

The output human interface soft vectors are set up to to handle the video output circuits or dummy display drivers are set up if no video circuits are present. If alpha video output circuits are present, then a memory test of the alpha, and highlight memories is executed. If bit-map video output circuits are present, then its ID/FONT ROM is checksummed and the circuits are initialized and cleared. If a failure is discovered it is indicated on the LEDs and the problem is remembered in F_AREA. The message `SELF-TEST MODE` is shown on the bottom line of the display. See the section on Human Interface for the console selection algorithms.

6. Display Copyright Notice:

   The Boot ROM displays a 1985 copyright message.

7. Boot ROM Checksum:

   If the Boot ROM checksums successfully, then the Boot ROM version (`BOOTROM Rev. A`) is displayed, otherwise the message `BOOTROM Rev. A Failed` will be displayed. If there was a video circuit memory failure discovered in the alpha display initialization and test routine, then it will be shown on the display as:

   ```
   Memory Failed at <Hex-Address>
   (W:<Hex-Write-Pattern>, R:<Hex-Read-Pattern>)
   ```

   The addresses and data indicate "movep.l" values.

8. Identify Floating Point Hardware.

   A search is made for the MC98881 Coprocessor and the HP 98635A Floating Point Card. If either is present, it is identified but not tested.

9. Initialize, and Test Keyboard Electronics:

   The keyboard human interface vectors are set up for the processor's keyboard electronics, if present, and their self-test value is checked. If the keyboard electronics failed self-test, then `Keyboard Failed` is displayed and the appropriate error code is sent to the LEDs and the beeper. If the processor's keyboard interface is present and passed self-test, then the message `Keyboard` is displayed.

   If no processor keyboard electronics are present, then the external I/O space is searched for accessory card keyboard electronics (for the HP 98700A). If found, it is treated the same as the processor keyboard electronics except that the message `Keyboard at 8` (where X is the select code of the accessory card keyboard electronics) is displayed if the keyboard passes self-test, and the message `Console Keyboard at XX Failed` is displayed if it fails self-test.

NOTE

Note that only the I/O card keyboard electronics chosen as console keyboard will be tested. Several seconds are required to identify the console keyboard. Other keyboard electronics in I/O slots will be identified, but not tested.

---

10. The message `RESET to Power-Up` appears on the last line of the display.
11. Drop Interrupt Level:

    The interrupt level is dropped to zero.
12. Pre-load Memory:

    The message `LOADING MEMORY` appears on the last line of the display while the end of memory is found by pre-loading the RAM not currently in use by the Boot ROM code. If a long test is to be done, the RAM is loaded with $EEEE1111_{16}$. If the fast test is to be done, each RAM location is loaded with its own address. When pre-loading is finished, the message `SELF-TEST MODE` is displayed on the last line of the display. Then, a 300 ms delay is executed to catch refresh failures.
13. Test and Initialize Graphics on Alpha/Graphics Card.

    If an HP 98546A is present, then it is tested with a byte-wide RAM test. If the graphics test is passed, then the message `Graphics` is displayed. If the graphics test is failed, then the message `Graphics Failed` is displayed and the appropriate value is sent to the LEDs. If there is a graphics memory failure, it is shown on the display as following two lines:

    ```
    Memory Failed at <Hex-Address>
    (W:<Hex-Write-Pattern>, R:<Hex-Read-Pattern>)
    ```

    Finally, graphics memory is cleared.
14. Test HP-IB:

    If the processor has HP-IB and it is the system controller then the Boot ROM will test it. If the HP-IB hardware fails the test, then the message `HP-IB Failed` is displayed and the appropriate value is sent to the LEDs. If the HP-IB hardware is present and had no failures, then `HP-IB` is displayed.
15. Check For DMA Presence:

    If the DMA card is present then the message `HP98620A` or `HP98620B` is displayed. No testing of the DMA card is done.
16. I/O Card Tests:

    Select codes 0 through 31 are scanned by the Boot ROM. For each select code the following steps are taken:

    a. The appropriate value is sent to the LEDs indicating which select code is being examined.

    b. If one of the following cards is found at the current select code, it will be tested by the Boot ROM:

    - HP 98629 SRM Controller card
    - HP 98627 Color Card
    - HP 98624 (TI9914 HP-IB) Card
    - HP 98626 RS-232 Interface Card
    - HP 98644 RS-232 Interface Card

- HP 98628 RS-232 Interface Card, or
- HP 98642 4-port Multiplexed RS-232 Interface Card

If the card at the current select code has no failures, then the message `HP98XXX` is displayed for that card. If the card fails, then the message `HP98XXX Failed` is displayed for that card and the appropriate value is displayed on the LEDs. A memory failure on the HP 98627 Color Output Card is indicated by the message:

```
Memory Failure at <Hex-Address>
(W:<Hex-Write-Pattern>, R:<Hex-Read-Pattern>)
```

where address and data indicate the "movep.l" values.

The following I/O cards are identified by the Boot ROM, but are not tested:

- HP 98622 (GPIO)
- HP 98622 GPIO
- HP 98623 (BCD)
- HP 98625A HP-IB card
- HP 98625B HP-IB card
- Accessory slot bit-mapped video cards with primary ID 25 and secondary ID 0 or 1
- HP 98633 Multiprogrammer Interface
- HP 98640 (ACD)
- HP 98641 LAN Card
- HP 98643 LAN Card
- HP 98653 EPROM Programmer
- HP 98659 Bubble RAM Card
- HP 98691 LAN Card
- HP 98695 (3270 Emulator)

Note that the HP 98620 DMA card is identified earlier in the self-test sequence.

17. If the Boot ROM finds an external I/O card that it does not recognize, it will display the message

    ```
    IDXX at YY
    ```

    where XX is the combined value of the card's primary and secondary IDs, and YY is the card's select code.

18. Test ROM Operating Systems:

The Boot ROM searches the ROM space from 64K bytes to 4 Mbytes. For each ROM header found, that ROM is checksummed unless the checksum disable bit is set. ROMs which fail checksum are indicated on the LEDs and the message `ROM X at <address> Failed` is displayed. Any ROM which supports only 50 character wide alpha video will be ignored, and the message `ROM X at <address> Ignored` will be displayed, and the appropriate value will be sent to the LEDs.

19. Test RAM:

    The message `TESTING MEMORY` is displayed on the last line of the display, and the rest of memory is tested.

20. Set Up Memory:

    The message `SELF-TEST MODE` is printed on the last line of the display. If a memory failure occurred, then the appropriate value is sent to the LEDs and following message is displayed:

    ```
    Memory Failed at <Hex-Address>
    (W:<Hex-Write-Pattern>, R:<Hex-Read-Pattern>)
    ```

    After a failure the Boot ROM drops back to the next 64K byte boundary, unless the failure was is in the top 64K, in which case the Boot ROM drops back to the next 2K boundary. The global Boot ROM variables are set up. Available RAM is displayed as a base ten number in bytes. The amount of RAM available should equal the amount of RAM installed minus 164 bytes.

    For example if one HP 98257 RAM card was installed in a computer's accessory slot and a 98561-66511 processor is in a system slot, the amount of RAM displayed would be `1572906 Bytes.`

21. Allocate Memory:

    Temporary memory is set up for the Boot scanner and Booter routines.

22. Display Final LED value:

    If an error occurred during self-test, then the appropriate value will be sent to the LEDs and sounded off on the beeper. The lower seven bits of LED value are sounded off (MSB first) with ones represented by high frequency long notes and zeros represented by low frequency short notes. If a Boot ROM checksum error has occurred, then the Boot ROM will stop execution with the message `CONTINUE AT OWN RISK (RETURN To Continue)` on the bottom line of the display. The Boot ROM will continue if the Return key is pressed. If an error has occurred and continuous self-test looping is not enabled, and the error was not a Boot ROM checksum error, then the Boot ROM will wait one minute for the monitor to warm up before continuing, and will display the message `WAITING 1 MINUTE (RETURN To Abort Wait)`. Pressing the Return key will cause the Boot ROM to abort the one minute wait and continue.

```
Copyright 1985,
Hewlett-Packard Company.
All Rights Reserved.

BOOTROM Rev. A
MC68020 Processor
MC68881 Coprocessor
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 4-5. Example Screen Display With Multiple Power-up Self-Test Errors:

Memory Tests

Word (16 bit) wide tests are executed on main memory. There are two types of word wide tests used. Tests on the upper 16K bytes and all peripherals always use the slower, walking ones and zeros, test. The rest of main memory may use either the slow test, or a faster "address in memory" test.

Byte (8 bit) wide tests use the walking ones/zeros test. This test is used on any peripheral that has less than full word wide memory (e.g. alpha display controller memory, and some graphics 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)
```

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 memory test errors, the following message is displayed:

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

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.

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 an operating system with no user intervention.

Unattended Operation

In an Unattended situation, the first operating system found will be loaded and given control. To find an OS, the Boot ROM will search a boot list of prioritized devices. The first OS system found on one of these devices will be booted. If none is found, the boot list will be searched again until a one is found. This allows discs not present at power-up to 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 operating systems disappearing and re-appearing on shared resource management systems.

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

- Make sure that the OS 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 OS names, or by moving OSs. The prioritized boot list is discussed in detail latter in this section.
- On an SRM with multiple OSs, make the first OS to be found one that looks at the host's SRM node address and uses the node address to decide what secondary OS to boot. (The Boot ROM can then be called to boot a particular OS.)

Attended Operation

To force the boot of an OS not chosen by the boot list, the user must enter Attended Operation Mode. This mode is entered by pressing the 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 OS is booted. A good way to do this is to hold down the space bar until the OS 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
```

`Console Keyboard at XX`	where XX is the lowest select code of keyboard electronics in an I/O slot.
`HP 986XX at X`	where the Xs are the type and select code of the remote human interface.

The boot selection menu displays all accessible OSs as the Boot ROM locates them. An OS is selected by typing the one to three character string (a single letter or a 1 to 2-digit number followed by a single letter) listed in the menu. Note that the character used to enter Attended Operation Mode is considered part of this string.

As the keys are accepted they appear in the lower right hand corner of the display. An example menu screen is shown in Figure 4-6.

```
Copyright 1985,
Hewlett-Packard Company.
All Rights Reserved.

BOOTROM Rev. A
MC68020 Processor
Bit Mapped Display
Keyboard
HP-IB
HP98620B
HP98644 at 2
HP98642 at 8
HP98626 at 9
HP98625 at 14
HP98629 at 20
HP98629 at 21
1572906 Bytes

                                  :REMOTE, 21, 0, 8
                                     2B  SYSTEM_BASIC
                                  :ROM
                                     B  B
                                       A  A
                                       H  H
                                     F  F
                                     Z  +
                                  :HP8290X, 706, 0
                                     3B  SYSTEM_BAS
                                  :HP7908, 803, 0
                                     1H  SYSTEM_HP-UX
                                  :REMOTE, 20, 0, 8
                                     1F  SYSTEM_FORTRAN
                                     2F  SYSTEM_FORTH
                                     1Z  SYSTEM_4TH
                                     1P  SYSTEM_PASCAL
                                     1b  SYSburp



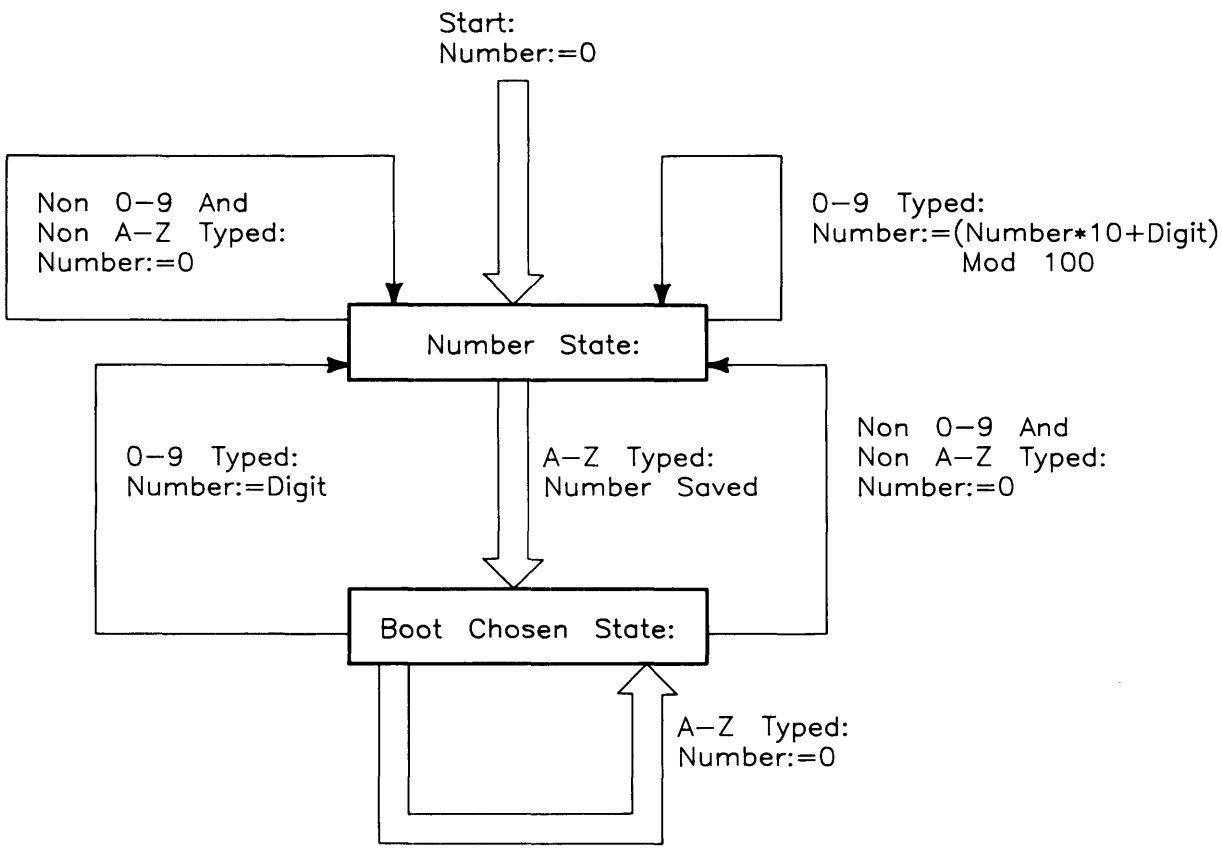

 SEARCHING FOR A SYSTEM (Press RETURN To Pause)
 RESET To Power-Up                                                  1H
```

Figure 4-6. Attended Operation Mode Display Example.

A ROM OS is selected by a number-letter entry. If the user knows that a particular choice is desired, such as "2F" or "31B", then the user can type that response as the computer powers up to make a selection. This simple human interface makes it possible to make a selection without waiting for the display to show what OSs are available.

A state diagram of how the Boot ROM interprets the key sequence for selecting an OS is shown in Table 4-4.

Table 4-4. Boot ROM Key Sequence Interpretation State Diagram



The state diagram shown in Table 4-4 is executed in the interrupt service routine for the human interface input device.

Note that only keys [A] through [Z], [a] through [z], and [0] through [9] are allowed to select an OS. Other keys are simply ignored. This makes the handling of all nationalized keyboards much simpler.

Because it is possible to find more OSs 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 (Press RETURN To Pause)
```

or

```
PAUSED (Press 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 OSs. This priority order is determined by the boot list. The boot list for the Boot ROM is:

1. External discs at select codes 0-31 on bus address 0, unit 0, volume 0
2. An SRM at node 0 at select code 21 on volume 8
3. HP 98259 Bubble Memory Card on select code 30
4. HP 98255 EPROM Card "disc", unit 0
5. ROM operating systems
6. Remaining external discs at select codes 0-31, bus addresses 0-7, units 0-16, volumes 0-7
7. Remaining SRMs at select codes 0-31
8. Remaining HP 98259 Bubble Memory Cards on select codes 0 through 29 and 31
9. Remaining HP 98255 EPROM Card "disc" units

Each device is allowed to have multiple OSs. Again, if the machine is unattended, it will boot the first OS found. If the machine is attended (i.e. a key was struck after the input human interface was initialized), it will display all OSs found until one is selected and that one 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 that a ROM OS at 80000_{16}, will be found before another ROM OS at 100000_{16}, and 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 permits change and control of which OS will be booted in the Unattended Mode. Priorities used to establish the boot list are:

- High priority addresses before low priority addresses
- Soft OSs before hard OSs
- Local OSs before remote OSs (Local refers to dedicated devices and remote refers to shared devices, i.e. an SRM)
- Flexible media before Hard media
- Internal OSs before external OSs (Internal refers to operating systems on processor boards in the computer.)
- Small capacity devices before large capacity devices

Default Mass Storage Variable

The boot ROM is responsible for setting up the default mass storage variable, DEFAULT_MSUS. It is used by OSs 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 according to the following algorithm:

1. Same as the MSUS of the booted OS for all but ROM OS, or
    a. A non-ROM value passed in DEFAULT_MSUS to the booter routine (this is done only by OSs calling the booter, not by the Boot ROM itself), or
    b. The first device found with LIF, SDF, or UNIX formatted media present if ROM is specified in DEFAULT_MSUS, or
    c. The 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
    d. A LIF media in an HP 8290XM drive at HP-IB 700 drive 0, if ROM is specified in DEFAULT_MSUS and no devices are present.

Supported Boot Configurations

Listed below are all hardware interfaces over which the Boot ROM can boot an OS on all 32 I/O Select Codes where applicable.

- Internal HP-IB (If not present, external select code 7 is available for any of the other interfaces.)
- HP 98624 HP-IB Interface Card
- HP 98629 SRM Card
- HP 98625A/B HP-IB Interface Card (Except not with HP 8290X.)
- HP 98620A/B DMA Card
- HP 98255 EPROM Card
- HP 98259 Bubble Memory Card

Interface protocols that can be used to boot an OS with the Boot ROM are:

- CS/80
- SS/80
- Amigo
- SRM
- EPROM
- BUBBLES

Media formats from which an OS may be booted using the Boot ROM are:

- LIF (8000_{16})
- SRM
- SDF HP 9000 Model 520; 0700_{16} (Mid-Range Format) (Boot Area)
- UNIX (3000_{16}) (Boot Area) (Note that this is different from HP-UX.)

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

- SRM via HP 98629 card, `/SYSTEMS` directory only
- AMIGO protocol HP-IB Discs (e.g. 8290XM, 9895, L-Codes and 7906/20/25)
- HP 98255 EPROM Card in "Disc" format.
- HP 98259 Bubble Memory Card
- CS/80 protocol HP-IB discs (e.g. HP 7908)
- SS/80 protocol HP-IB discs (e.g. HP 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.

For all devices there are seven generic error messages that can be displayed:

Message	Meaning
`No Device`	Communication was lost with the device.
`No Medium`	There was no media (e.g. floppy disc) present.
`Not Ready`	The device was not ready.
`Read Error`	An error occurred while reading from the device.
`Bad Hardware`	A hardware fault occurred.
`Bad State`	The device is in an unknown or unexpected error state.
`Bus Error`	A bus error occurred during a memory transfer

If the error terminates the actual load of an OS, it will appear in the next to the bottom line of the display followed by the device mass storage specifier (e.g. `:HP7908, 803, 0`). If the error occurs during scanning for OSs, it will not terminate the scan. In this case the error(s) will be listed on the left hand side of the display. Figure 4-7 is an example display with several errors:

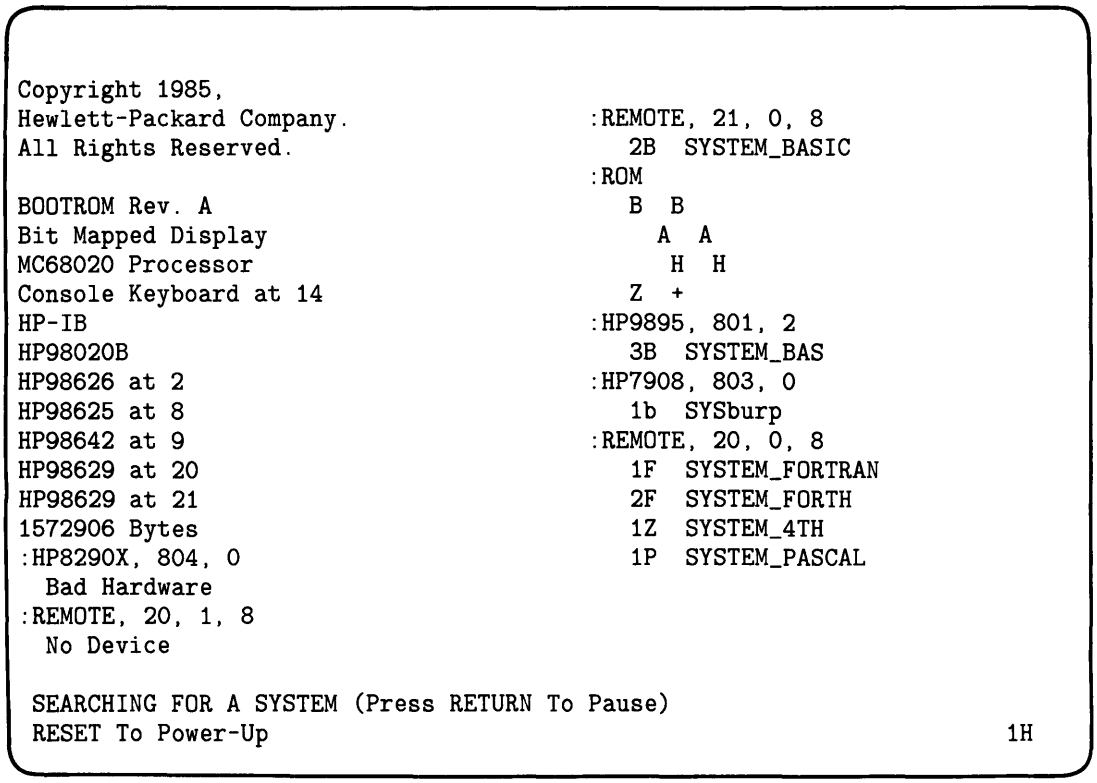


Figure 4-7. Boot Display with Errors

Chapter 5 explains troubleshooting the computer and bus expander using self-test errors displayed on the monitor or LEDs.

Booting From The SRM

Placing bootable OSs on sector oriented devices is fairly straight forward. On LIF devices an OS file must be created, and on SDF and HP-UX devices a boot area must be created. For the SRM, OSs to be booted must be placed in system files in the directory `/SYSTEMS`.

Because the SRM is a shared resource there are some unavoidable and peculiar behaviors that can be exhibited if the `/SYSTEMS` directory changes while the Boot ROM is scanning it. During the scanning or booting process, the order of the directory can be re-arranged, OS files can be deleted, or added. This means that the Boot ROM may show an OS that does not exist anymore, may not show an OS that does exist, or may never show an OS that has always been there.

If an OS that does not exist is chosen to be booted, the Boot ROM will stop with the error `NOT FOUND`. A reset is required to try again.

As long as the `/SYSTEMS` directory is stable, which is usually the case, everything will work as expected.

Chapter 5
Troubleshooting

Introduction

The Troubleshooting Process

Troubleshooting computer systems can be defined as a process of answering 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?
- After the immediate problem is solved, what caused it to happen?

Getting the answers to these questions usually makes the troubleshooting process much more effective and less costly. When a failure in one of these computer system occurs, remember these questions and get the answers to each of them. After you have all answers possible, determine what could be the most probable cause of the problem. Sometimes you will 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 explains why the answers to these questions are what they are.

Materials Required

Several items are required to troubleshoot the HP Series 300 Computer and HP 98568A Bus Expander to the failed assembly:

- Series 300 Computer and HP 98568A Bus Expander Service Handbook
- Series 200/300 Test Tools Manual and Test Discs.
- Digital Voltmeter.
- Anti-Static Workstation.

Test LED Displays

Eight test LEDs are located behind the front panel and are visible from the front of the computer. In this manual, the LED's are shown in the following context:

LED On	●
LED Off	○

Troubleshooting Procedures

System Level

System level troubleshooting consists of finding out what part of a computer system is not working correctly. A system consists of the computer and its installed accessories, the interfaces, the peripherals, and the power source the hardware is connected to. Each of these system elements is subject to the environment which includes, physical, electrical, and human factors.

When part or all of the computer system fails, the initial activity should be directed towards finding what part of the system 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 and the system was doing when the system, 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.

Running tests on the system 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 date is an example. Mass storage, graphics, or other functions can be checked in the same way. These type of tests are called Quick Checks.

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 computer or bus expander has the problem. The rest of this chapter covers troubleshooting these products.

Computer/Bus Expander Troubleshooting

Both units may be troubleshot the same, except for the boards in the computer's system slots . Each has the same power supply, motherboard, fans, and backplane system.

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

Table 5-1. Computer/Bus Expander Troubleshooting Procedures

Procedure	What MUST Function
Inoperative Unit	Nothing
Live Unit	Power Supply Motherboard
Functional Unit	Computer: Power Supply Part of processor Part of motherboard Top 16K of RAM DIO Bus Some inputs from keyboard Output to operate monitor Bus Expander: Power Supply Part of motherboard One accessory/I/O card

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

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 basic problems:

- Defective power supply.
- Voltage select switch in wrong position
- Improper line voltage 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 unit when it is plugged in. Turn the unit off and unplug the unit before placing test leads, checking fuses, or removing/installing assemblies.

---

1. Check that the voltage select switch is set correctly. Refer to Chapter 2 in the Service Handbook for the correct procedures.
2. Check that the fuse is good and of the correct size. If the fuse is defective, replace it. If the fuse is good, skip to Step 4.
3. Turn the unit on, then turn it off and recheck the fuse. If the fuse is defective skip to Step 5, otherwise go on to Step 4.
4. If one or both fans are not rotating, check the voltage across the inoperative fan's voltage terminals. If the voltage is correct, the fan is defective. If not, continue with the voltage check procedure. Fan voltage should be as shown below.
    a. Large fan voltage: +12 Vdc.
    a. Small fan voltage: +18 Vdc.
5. If the fuse is open, one of the installed assemblies is defective.
6. Remove all assemblies from the backplane (and system slots if the computer is being worked on).
7. Replace the fuse. Install the power cord and turn the unit on, then turn it off and recheck the fuse. If the fuse is good, one of the removed assemblies is defective. If the fuse is open, the power supply, motherboard, or backplane is defective; go to Step 8.
8. Remove the card cage. After installing a new fuse turn the unit on, then off, and check the fuse. If the fuse is good, the backplane is defective, If the fuse is defective, the power supply or motherboard is defective.
9. Repeat Step 8 but instead remove the motherboard. If the fuse is good, the motherboard is defective. Otherwise, the power supply is defective. After replacing the defective unit, you should now be able to perform Live Unit Troubleshooting Procedures.

Live Unit Procedure

A live unit is one which has a motherboard and properly functioning power supply but the unit 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 a bus in the computer or bus expander can shut the system down and prevent the execution of any instructions, even those from the self-test.

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.

Live Unit Procedure is explained by first assuming either the computer or bus expander is defective but which one cannot be determined at this time. Depending on the application, several accessory cards may be installed in both units. Once the problem in the computer system has been isolated to the computer/bus expander units, it's sometimes best to start with a minimum configuration.

Minimum Configuration

A minimum configuration consists of just enough assemblies to function at a minimum level, but not necessarily correct. For this computer, a minimum functional level is that required to light the Self-Test LEDs. Minimum hardware to do this is:

- Power Supply.
- Motherboard.
- Processor Board.
- At least 16K-bytes of RAM configured at the top of memory.

For the bus expander, the minimum functional configuration is:

- Power Supply.
- Motherboard.
- One functional accessory card.

Computer Minimum Configuration

To get a minimum configuration in the computer, follow these steps after verifying the power supply functions correctly.

CAUTION

Remember to turn the unit off and unplug it before removing any assembly.

1. Turn the unit off.
2. Separate the bus expander from the computer.
3. Remove all accessory cards. Leave enough RAM installed that's configured at the top of memory.
4. Leave the processor board in.
5. Remove the top cover and disconnect the ribbon cable from the backplane.
6. Plug the unit in and turn it on. The Self-Test LED's should ripple and change state several times.
7. If the LED's do not light or ripple, turn the computer off, unplug it, and relocate the processor to the other system slot.
8. Plug the computer in, turn it on, and watch the LEDs. If the LED's don't light or ripple, either the motherboard or processor is bad. Replace one or the other and retest until the LED's light and/or ripple.

Before you can proceed further, the minimum configuration must work. If this configuration works, then you can proceed to the next level, Functional Unit Troubleshooting.

Bus Expander Minimum Configuration

To get a minimum configuration in the bus expander, follow these steps after verifying the power supply functions correctly.

CAUTION

Remember to turn the unit off and unplug it before removing any assembly.

1. Turn the unit off.
2. Remove all accessory cards except one that can be recognized by the self-test.
3. Plug the bus expander in and turn it on.
4. Turn the computer on.
5. Verify the self-test identifies and/or correctly tests the accessory card in the bus expander.

   If the accessory card does not pass self-test, turn both units off, and relocate the accessory card to another slot.

6. Repeat steps 4 and 5 until the bus expander's accessory card passes self-test. If the accessory card does not pass self-test, either the accessory card or the bus expander is defective. In this case, repeat steps 6 and 7 using another accessory card.

Before you can proceed further, the minimum configuration must work. If this configuration works, then you can proceed to the next level, Functional Unit Troubleshooting.

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 LEDs for the computer. For the bus expander, one accessory card must at least pass self-test.

For the computer to pass the minimum computer configuration functions correctly, the LED's should end up as:



Once the computer minimum configuration self-test passes, you're ready to start testing with an Intermediate Configuration.

Intermediate Configuration

There are several ways to configure the computer for intermediate level troubleshooting in Functional Unit procedures. A good place to start is by having memory configured to address at the top of RAM. This will verify that more of the processor board is working. The procedures are:

1. Turn off the computer, unplug it, and reconnect the ribbon cables to the backplane.
2. If required, install a memory card configured for the top of RAM.
3. Plug the computer in, turn it on and watch the LED's go through self-test.
4. If the LED pattern is correct, skip to Step 6.

   If the pattern is incorrect, either the backplane or the processor is bad. Power down and relocate the memory card in another accessory slot, then retest. If necessary, run the test with the memory card in each accessory slot.
5. If the LED pattern is correct, skip to Step 6. If the pattern is incorrect, either the backplane or processor is bad. Replace each one and retest until the correct LED pattern is achieved.
6. Power down and unplug the computer. Install a video board and connect it to a monitor. Turn on the monitor.
7. Turn on the computer. Watch the self-test display on the monitor.

8. The display should be correct and reflect the total memory in the computer,

   If the self-test display is correct, skip to Step 9.

   If the self-test display is incorrect, the monitor, processor or video board may be defective. Replace these and test as required to get the correct display.

9. Turn the computer off and install the HP-HIL interface and cable, then install the keyboard.

10. Turn the computer on and observe the self-test display. Check the keyboard to see if the self-test sequence responds to the keyboard. If the response is correct, you now have a Minimum Functional System. If the response is incorrect, go on to Step 11.

11. If the response to the keyboard inputs in incorrect, the keyboard, its electronics, or cable could be defective. Replace each until keyboard response is correct.

To have a Minimum Functional System, the following hardware must perform the indicated functions as shown in Table 5-2.

Table 5-2. Minimum Functional System

Assembly	Functions Performed
Power Supply	All voltages normal and within specifications.
Processor Board	CPU chip executes self-test, cycles memory, most instructions executed OK.
One Memory Card	Addresses, read/writes, and refreshes.
Video Board	Processes and outputs video.
Keyboard and its Interface	Inputs data that is processed.
Monitor	Displays Self-Test information.

Once this level of operation is achieved, a similar process can be used to install and check other accessories, interfaces, and peripherals in the complete system. This also may be a good point to load and run one of the computer tests. Refer to the Test Tools manual for tests information such as:

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

Series 300 Test Tools are explained in the next section.

Test Tools

Overview

Series 200/300 Test Tools is a software package for verifying the integrity of Series 200 and 300 computer 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 Series 200 and 300 computer 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 internal or external flexible disc drive for loading and running the test software.

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

Computer Tests

Series 300 Computer Tests are supplied on one of two discs, the other is for for Series 200 computers. They test the processor board, RAM, internal display and interface electronics, and other internal functions.

System Functional Tests

Five discs contain these tests. The first disc contains the Pascal-based operating system environment and the main menu; the other discs contains the test programs. These tests are used to verify communication between the computer 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 computer, and that the computer 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 Test Tools software package is provided on both 3.5 inch and 5.25 inch discs and manual as follows:

Description	Part Number
Series 200/300 Test Tools, 3.5-inch disc	09800-12300
Series 200/300 Test Tools, 5.25-inch disc	09800-12500

Contents of each package is listed below.

Contents	Part Number
Series 200/300 Test Tools Manual	09800-90001
Series 200 Computer Tests Disc Rev. 1.1	09800-10X36 (X = 3 for 3.5-inch discs.) (X = 5 for 5.25-inch discs.)
Series 300 Computer Tests Disc Rev. 01.00	98561-11X34
Series 200/300 System Functional Tests Discs:	
SFT0 Disc Rev. 1.2	09800-11X34
SFT1 Disc Rev. 1.2	09800-11X35
SFT2 Disc Rev. 1.2	09800-11X36
SFT3 Disc Rev. 1.2	09800-11X37
SFT4 Disc Rev. 1.2	09800-11X38
CS/80 Exerciser Disc Rev. 3.1	09800-11X04

Turn-on Self Test

Use the Turn-on 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 computer are functioning. The basic elements include the power supply, processor, CPU bus, boot ROMs, and at least the first 16k bytes 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 computer. Both pass and error displays in binary are shown by the LED display. LED's are located behind the front panel and are visible through the holes in the front panel.

For a functional description of the Turn-On Self-Test, refer to Chapter 3.

Self-Test Error Displays

On the following pages are several tables showing self-test error displays. When the self-test fails, refer to these tables to identify the hardware that most likely is causing the problem.

Table 5-3a, Boot ROM Unexpected Failure Messages.

Message: `UNEXPECTED USE OF FFFFFFhh`

hh =	What Unexpected Event Occurred
FA	Bus Error
F4	Address Error
EE	Illegal Instruction
E8	Zero by zero trap
E2	Check trap
DC	TrapV trap
D6	Privilege violation
D0	Trace trap
CA	1010 Opcode
C4	1111 Opcode
BE	Interrupt level 1
B8	2
B2	3
AC	4
A6	5
A0	6
9A	7
94	Trap 0
8E	1
88	2
82	3
7C	4
76	5
70	6
6A	7
64	8

Table 5-3b, Boot ROM Unexpected Failure Messages

Message: `UNEXPECTED USE OF FFFFFFhh`

Message	What Unexpected Event Occurred
5E	Trap 9
58	A
52	B
4C	C
46	D
40	E
3A	F
34	Pseudo vector 1 `RESET` from keyboard
2E	Pseudo vector 2 Keyboard timeout (fast handshake)
28	Pseudo vector 3 Battery backup interrupt
22	Pseudo vector 4 Non-Maskable Interrupt from backplane
1C	Spurious interrupt
16	Vectored interrupt 0
10	1
0A	2
04	3
FE	4
F8	5
F2	6
EC	7
E6	Format Error, coprocessor violation, or unknown
E0	MC68881 Coprocessor exception vectors

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 5-5.

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 computer revert to the Attended Mode. This means that the Boot ROM will display all OSs found and will not boot one until one in chosen and entered by the user.

General Description of Failure Codes

Table 5-4 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.

Table 5-4. General LED Code Failure Indications

	LED Pattern
Failure Indications, via Upper Two Bits	**General Description of Failure**
State Indication Only:	○○ SS SSSS Where SS SSSS Indicates State of Power-up
Required Device Missing or DTACK Failure:	○● DD DDDD Where DD DDDD Indicates Device
Failing Device:	●○ DD DDDD Where DD DDDD Indicates Device
Special Codes (Special Case Highest Priority Codes):	● ● ● ● ● ● ● ● LEDs Never Accessed (or Unused Code)
	○ ● ● ● ● ● ● ● LEDs Failed to DTACK
	○ ○ ○ ○ ○ ● ○ ● Timer on processor board has failed or is missing.
State or Device Codes, Via Lower 6 Bits	
Miscellaneous (Highest Priority):	XX ○○ FFFF Where FFFF indicates Failure (Xs are don't-care bits)
Internal Peripheral Failure (Medium Priority):	XX ○● PPPP Where PPPP is Peripheral Number
I/O Card Failure (Lowest Priority):	XX ● S SSSS Where S SSSS is Select Code

State and Failure Codes

Table 5-5a is a list of all LED failure codes used in the HP 98561 Boot ROM. Codes are listed here in numerical order for easy reference, and then again in order of occurrence and priority.

Table 5-5a, HP 98561 Boot ROM LED State and Failure Codes

(In numerical order):

Explanation	LED Code
No failure	○ ○ ○ ○ ○ ○ ○ ○
LED ripple (all on, then off in sequence from MSB)	○ ○ ○ ○ ○ ○ ○ ●
Resetting I/O	○ ○ ○ ○ ○ ○ ● ○
Checksumming Boot ROM (or LED ripple)	○ ○ ○ ○ ○ ○ ● ●
Testing top RAM (or maybe the Boot ROM checksum failed)	○ ○ ○ ○ ○ ● ○ ○
Processor board timer failed or is missing	○ ○ ○ ○ ○ ● ○ ●
Searching for boot extension ROMs	○ ○ ○ ○ ○ ● ● ○
starting test vector list (or LED ripple)	○ ○ ○ ○ ○ ● ● ●
Preloading RAM	○ ○ ○ ○ ● ○ ○ ○
Testing RAM	○ ○ ○ ○ ● ○ ○ ●
Checksumming ROM systems	○ ○ ○ ○ ● ● ○ ●
LED ripple	○ ○ ○ ○ ● ● ● ●
Testing internal keyboard (or an interrupt line is stuck)	○ ○ ○ ● ○ ○ ● ○
Testing external keyboard	○ ○ ○ ● ○ ● ○ ○
Testing internal HP-IB	○ ○ ○ ● ○ ● ● ○
Testing internal mass storage	○ ○ ○ ● ○ ● ● ○
Testing DMA card	○ ○ ○ ● ● ○ ○ ○
Checksumming ID/INIT ROM on bit-mapped video board	○ ○ ○ ● ● ● ○ ●
Testing alpha video board	○ ○ ○ ● ● ● ● ○
Testing graphics on alpha/graphics (or LED ripple)	○ ○ ○ ● ● ● ● ●
Testing I/O card on select code 0	○ ○ ● ○ ○ ○ ○ ○
Testing I/O card on select code 1	○ ○ ● ○ ○ ○ ○ ●
through	through
Testing I/O card on select code 9	○ ○ ● ○ ● ○ ○ ●
through	through
Testing I/O card on select code 31 (and LED ripple)	○ ○ ● ● ● ● ● ●

Table 5-5b, HP 98561 Boot ROM LED State and Failure Codes

(Continued from Table 5-5a)

Explanation	LED Code
RAM gone above FFC000	○ ● ○ ○ ○ ● ○ ○
LEDs Failed to DTCK or LED ripple	○ ● ● ● ● ● ● ●
CPU register test failure	● ○ ○ ○ ○ ○ ○ ●
Boot ROM checksum failure	● ○ ○ ○ ○ ○ ● ●
RAM failure above FFC000	● ○ ○ ○ ○ ● ○ ○
RAM failure	● ○ ○ ○ ● ○ ○ ●
Insufficient RAM	● ○ ○ ○ ● ○ ● ○
ROM system failure	● ○ ○ ○ ● ● ○ ●
Processor Board Keyboard Electronics Failure	● ○ ○ ● ○ ○ ● ○
External Keyboard Failure	● ○ ○ ● ○ ○ ● ●
Internal HP-IB failure	● ○ ○ ● ○ ● ○ ○
DMA card failure	● ○ ○ ● ● ○ ○ ○
Font for video board missing or bad	● ○ ○ ● ● ● ○ ○
Video board failed	● ○ ○ ● ● ● ○ ●
Alpha video card failure	● ○ ○ ● ● ● ● ○
Graphics failure on alpha/graphics board	● ○ ○ ● ● ● ● ●
I/O card on select code 0 failure	● ○ ● ○ ○ ○ ○ ○
I/O card on select code 1 failure	● ○ ● ○ ○ ○ ○ ●
through	through
I/O card on select code 9 failure	● ○ ● ○ ● ○ ○ ●
through	through
I/O card on select code 31 failure	● ○ ● ● ● ● ● ●
LEDs never accessed (or LED ripple)	● ● ● ● ● ● ● ●

Table 5-6. Boot ROM LED State Codes (in order of occurrence)

Explanation	LED Code
LED ripple (all on, then off in sequence from MSB)	○ ○ ○ ○ ○ ○ ○ ●
Testing top RAM	○ ○ ○ ○ ○ ● ○ ○
Searching for boot extension ROMs	○ ○ ○ ○ ○ ● ● ○
Starting test vector list	○ ○ ○ ○ ○ ● ● ●
Testing Processor Board Timer	○ ○ ○ ○ ○ ● ○ ●
Resetting I/O	○ ○ ○ ○ ○ ○ ● ○
Testing Alpha Card	○ ○ ○ ● ● ● ● ○
Testing processor board video circuits	○ ○ ○ ● ● ● ○ ●
Testing processor board keyboard electronics	○ ○ ○ ● ○ ○ ● ○
Testing accessory card keyboard electronics	○ ○ ○ ● ○ ○ ● ●
Checksumming Boot ROM	○ ○ ○ ○ ○ ○ ● ●
Preloading RAM	○ ○ ○ ○ ● ○ ○ ○
Testing graphics on alpha/raphics cad	○ ○ ○ ● ● ● ● ●
Testing processor board HP-IB	○ ○ ○ ● ○ ● ○ ○
Testing DMA Card	○ ○ ○ ● ● ○ ○ ○
Testing I/O card on Select Code 0	○ ○ ● ○ ○ ○ ○ ○
Testing I/O card on Select Code 1	○ ○ ● ○ ○ ○ ○ ●
through	through
Te ing I/O Card on Select Code 9	○ ○ ● ○ ● ○ ○ ●
through	through
Testing I/O card on Select Code 31	○ ○ ● ● ● ● ● ●
Checksumming ROM systems	○ ○ ○ ○ ● ● ○ ●
Testing RAM	○ ○ ○ ○ ● ○ ○ ●

Table 5-6. Boot ROM LED Failure Codes

(in order of priority)

Explanation	LED Code
LE Ds never accessed	● ● ● ● ● ● ● ●
LEDs failed to DTACK	○ ● ● ● ● ● ● ●
CPU failure	● ○ ○ ○ ○ ○ ○ ●
Processor board timer failed	○ ○ ○ ○ ○ ● ○ ●
Boot ROM checksum failure	● ○ ○ ○ ○ ○ ● ●
Top RAM test failure	● ○ ○ ○ ○ ● ○ ○
RAM failure	● ○ ○ ○ ● ○ ○ ●
Insufficient RAM	● ○ ○ ○ ● ○ ● ○
ROM system failure	● ○ ○ ○ ● ● ○ ●
Processor keyboard electronics failure	● ○ ○ ● ○ ○ ● ○
Accessory card keyboard electronics failure	● ○ ○ ● ○ ○ ● ●
Internal HP-IB failure	● ○ ○ ● ○ ● ○ ○
D MA card failure	● ○ ○ ● ● ○ ○ ○
I/O card on select code 0 failure	● ○ ○ ● ○ ○ ○ ○
O card on select code 1 failure	● ○ ○ ● ○ ○ ○ ●
through	through
I/O card on select code 9 failure	● ○ ○ ● ● ○ ○ ●
through	through
O card on select code 31 failure	● ○ ● ● ● ● ● ●
Alpha video card failure	● ○ ○ ● ● ● ● ○
Processor board video electronics failure	● ○ ○ ● ● ● ○ ●
Font failure in processor board video circuit	● ○ ○ ● ● ● ○ ○
Graphics failure on alpha/graphics card.	● ○ ○ ● ● ● ● ●
No Failure	○ ○ ○ ○ ○ ○ ○ ○

Chapter 6
References

How to Use This Chapter

Information in this chapter should help you in various situations. The references include part numbers of hardware and software documents used with the Series 300 computer systems. Locating various service oriented subjects is made easier by use of a service information locator.

Service Information Locator

Table 6-1 shows where to find a variety of subjects dealing with servicing the computer and bus expander. 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 Table 6-1 use the following codes:

Chapter Number:	Numbers, such as 2. Inclusive chapters, such as 4-6.
Appendices:	Letters, such as A.
Entire Manual:	# symbol.

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 HP 98568A Bus Expander. 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 Title, "HP Series 300 Computer and HP 98568A Bus Expander Service Information Manual", and the manual's part number "98561-90030". In this case, that happens to be this manual.

Table 6-1. Service Information Locator

Service Information	Series 300 Computers/Bus Expander Service Information Manual 98561-90030	Series 300 Service Handbook 98561-90039	HP 9000 Series 200/300/500 Site Preparation Manual 09000-90041	HP 9000 Series 300 Accessory/Option Installation Notes (Various)	Series 300 Computers Installation Reference 98561-90000	HP 9000 Series 300 Configuration Reference Manual 98561-90020	HP 9000 Series 200/300 Test Tools Manual 09800-90001	Series 200/300 Computers Accessory Development Guide 09800-90011
Adjustments/Alignments		6						
Assembly Part Numbers		8						
Assembly Replacement	2							
Block Diagrams	2	9						
Booting Operating Systems	4							
Computer Tests	1,5						2	
CS/80 Exercisers	1,5						4	
DIO Bus Architecture/Theory								#
Electrical Requirements	1	1	3					
Environmental Requirements	1	2	4					
Functional Description	3,4							
HP-HIL Device Tests	1,5						3	
HP People Who Can Help			2					
Options/Accessories	1	3		#	2,3	3,4		
Ordering Spare Parts		9						
Preventive Maintenance		2						
Product Configuration	1	3		#	5,6	#		
Product Information	1	1		#	1	#		
Product Specifications	1	1,2				A		
Reference Material	6	10			#			
Repair Philosophy	1							
Self-Tests	4,5	5			7		1	
Service Notes	1	11						
Site Preparation	1	11	#					
Supported Peripherals	1	2,3	A	#	4-6	4		
System Configuration	1	3		#	2	#		
System Functional Tests	1	5					3	
Troubleshooting	4	4		#				
Turn-On	4			#	1,7			

Localized System Identification

HP 9000 Series 300 computer systems have keyboards and display characters localized for the language spoken and written in several countries. When an HP field office orders a Series 300 computer system, 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 6-2 identifies the letter suffixes to product numbers for these systems.

Table 6-2. Localized System Numbers

Local Language	Localized System Suffix
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

For example, a 98580B system ordered from an HP field office in Toronto, Canada, to be used by English speaking Canadians, the field would order 98580BL.

Related Documentation

BASIC Operating System

HP 98613A – HP 9000 Series 200 and 300
BASIC 3.0 and 4.0 Operating System

Table 6-3. BASIC 3.0 Operating System Manuals

HP Part Number	Manual Title
98613-87901	BASIC 3.0 Manual Kit (one each of the following)
98613-90011	BASIC Programming Techniques
98613-90021	BASIC Interfacing Techniques
98613-90031	BASIC Graphics Techniques
98613-90041	BASIC User's Guide
98613-90051	BASIC Language Reference
98613-90061	BASIC Condensed Reference
98613-90071	BASIC Documentation Guide and Master Index
98613-90082	BASIC 4.0 Software Manual Catalog
98613-90091	Utilities Library Manual
98613-90092	Loader Utility Manual
98613-10010	3.0 CSUB Preparation Manual

Table 6-4. BASIC 4.0 Operating System Manuals

HP Part Number	Manual Title
98613-87904	BASIC 4.0 Manual Kit (one each of the following)
5957-7953	HP 9000 Series 300 Memory Configuration Wheel
5957-7954	HP 9000 Series 200 Memory Configuration Wheel
97005-90000	Peripheral Installation Guide
98613-90011	BASIC Programming Techniques
98613-90021	BASIC Interfacing Techniques
98613-90031	BASIC Graphics Techniques
98613-90041	BASIC User's Guide
98613-90051	BASIC Language Reference
98613-90061	BASIC Condensed Reference
98613-90071	BASIC Documentation Guide and Master Index
98613-90082	BASIC 4.0 Software Manual Catalog
98613-90091	Utilities Library Manual
98613-90092	Loader Utility Manual

Pascal Operating Systems

HP 98615A – HP 9000 Series 200
Pascal 3.0 and 3.1 Operating System

Table 6-5. Pascal 3.0 Operating System Manuals

HP Part Number	Manual Title
98615-87902	Pascal 3.0 Manual Kit (one each of the following)
09826-90073	MC68000 Users Guide (Motorola)
98615-90016	Pascal Documentation Guide and Index
98615-90022	Pascal Workstation System
98615-90031	Pascal Procedure Library
98615-90036	Pascal Graphics Techniques
98615-90041	Pascal User's Guide
98615-90051	Pascal Language Reference for Series 200 Computers

Table 6-6. Pascal 3.1 Operating System Manuals

HP Part Number	Manual Title
98615-87903	Pascal 3.1 Manual Kit (one each of the following)
5957-7953	HP 9000 Series 300 Memory Configuration Wheel
5957-7954	HP 9000 Series 200 Memory Configuration Wheel
98615-90606	MC68020 Users Guide (Motorola)
98615-90607	MC68881 Users Guide (Motorola)
97005-90000	Peripheral Installation Guide
98561-90020	Series 300 Configuration Reference Guide
98615-90016	Pascal Documentation Guide and Index
98615-90022	Pascal Workstation System
98615-90031	Pascal Procedure Library
98615-90036	Pascal Graphics Techniques
98615-90041	Pascal User's Guide
98615-90051	Pascal Language Reference for Series 200 Computers

HP-UX

HP 98515A – HP 9000 Series 300
HP-UX Application Execution Environment

Table 6-7. HP-UX Application Execution Environment Documentation

HP Part Number	Manual Title
5957-7953	HP 9000 Series 300 Memory Configuration Wheel
97005-90000	Peripheral Installation Guide
97005-90010	HP-UX Software Status Bulletin
97033-90608	Documentation Map
98515-90000	Applications Execution Environment User's Guide
98515-90604	5.0 to 5.1 Update Instructions

HP 98597A or HP 98517A – HP 9000 Series 300
HP-UX Programming Environment

Table 6-8. HP-UX Programming Environment Documentation

HP Part Number	Manual Title
5957-7953	HP 9000 Series 300 Memory Configuration Wheel
09000-90008	HP-UX Reference
09826-90073	M68000 16/32-Bit Microprocessor Programmer's Reference Manual
92865-90002	Term0 Reference Manual
97005-90000	Peripherial Installation Guide
97005-90010	HP 9000 Series 200/300 HP-UX Software Status Bulletin
97033-90046	HP-UX Portability Guide
97033-90049	HP-UX System Administrator's Manual
97033-90608	Documentation Map
97069-90000	HP Windows/9000 User's Manual
97069-90010	HP Windows/9000 Programmer's Manual
97069-90020	HP Windows/9000 Reference
97069-90700	Term0 Reference Manual Spine Insert
97089-90000	The C Programming Language

Table 6-8 (cont.). HP-UX Programming Environment Documentation

HP Part Number	Manual Title
97089-90021	Concepts & Tutorials Vol. 1 Text Editors and Processors
97089-90031	Concepts & Tutorials Vol. 2 Text Formatters
97089-90041	Concepts & Tutorials Vol. 3 Programming Environment
97089-90051	Concepts & Tutorials Vol. 4 Device I/O and User Interfacing
97089-90061	Concepts & Tutorials Vol. 5 Shells and Miscellaneous Tools
97089-90070	Concepts & Tutorials Vol. 6 Graphics
97089-90081	Concepts & Tutorials Vol. 7 Facilities for Series 200, 300 and 500
98515-90000	Applications Execution Environment User's Guide
98597-90604	HP-UX 5.0 to 5.1 Update
98561-90020	Configuration Reference Guide
98592-90010	Starbase Device Drivers Library
98592-90030	Starbase C Pocket Reference
98592-90060	Starbase Reference
98680-90601	A User Guide to the UNIX[1] Sys.

[1] UNIX is a trademark of AT&T Bell Laboratories

HP 98518A or HP 98598A – HP 9000 Series 300 FORTRAN77 Compiler Software

Table 6-9. FORTRAN77 Compiler Software Documentation

HP Part Number	Manual Title
92836-90005	FORTRAN77 Programming with HP Computers
97081-90040	FORTRAN/9000 Reference
98592-90040	Starbase FORTRAN Pocket Reference

HP 98519A or HP 98599A – HP 9000 Series 300 Pascal Compiler Software

Table 6-10. Pascal Compiler Software Documentation

HP Part Number	Manual Title
09826-90072	Programming and Problem Solving with Pascal
98592-90050	Starbase Pascal Pocket Reference
98615-90051	HP Pascal Language Reference

HP 98520A or HP 98600A AGP/DGL Graphics Library Software

Table 6-11. AGP/DGL Graphics Library Software Documentation

HP Part Number	Manual Title
97084-90000	Device-independent Graphics Library Programmer Reference Manual
97084-90003	Device-independent Graphics Library Supplement for HP-UX Systems
97084-90027	DGL Device Handlers Manual
97085-90003	AGP Supplement for HP-UX Systems
97085-90005	AGP Language Reference
97085-90010	AGP User's Guide

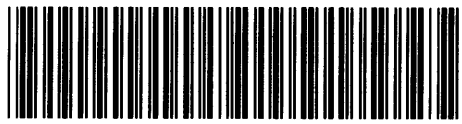
Installation Manuals/Notes

Table 6-13. Product Installation Manuals/Notes

HP Part Number	Manual Title
5957-7953	Series 300 Memory Configuration Wheel
5958-4342	HP 98542/3/4/5A Video Board Installation Note
5958-4343	HP 98569A Rack-Mount Kit Installation Note
5958-4344	HP 98567A Rack-Mount Kit Installation Note
5958-4351	HP 98567B Rack-Mount Kit Installation Note
98242-90600	HP 98243A Upgrade Processor Installation Note
98243-90600	HP 98242A Four-Slot Backplane Installation Note
98257-90000	HP 98256A/HP 98257A RAM Card Installation Note
98546-90600	HP 98546A Display Compatibility Interface Installation Note
98568-90600	HP 98568A Eight-Slot Bus Expander Installation Note
98620-90001	HP 98620B DMA Card Installation Note
98560-90001	HP 98580A Installation Card (for HP 98560A computer)
98560-90002	HP 98581A Installation Card (for HP 98560B computer)
98560-90003	HP 98582A Installation Card (for HP 98560C computer)
98560-90004	HP 98583A Installation Card (for HP 98560D computer)
98622-90000	HP 98622A GPIO Installation Manual
98623-90000	HP 98623A BCD Installation Note
98624-90000	HP 98624A HP-IB Installation Note
98625-90000	HP 98625A/B Disc Interface Installation Manual
98626-90000	HP 98626A RS-232 Installation Manual
98627-90000	HP 98627A Color Video Interface Installation Manual
98628-90001	HP 98628/98691 Datacomm Installation Manual
98630-90000	HP 98630A Breadboard Installation Manual
98635-90000	HP 98635A Floating-Point Math Card Installation Note



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