Service Information Manual

HP 9000 Series 300 Computers
Models 360/370

HP Part Number 98579-90030

Printing History

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

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

June 1988...Edition 1

Notices

Radio Frequency Interference Statements

FCC Statement

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

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

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

VCCI Statement (Japan Only)

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取扱説明書に従って正しい取り扱いをして下さい。

Manufacturer's Declaration (Germany Only)

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Safety Considerations

WARNINGs, CAUTIONs, and Notes

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

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

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

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

Examples:

WARNING

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

CAUTION

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

Note

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

Information Locator

Finding Service Information

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

Chapter identifiers in the Locator use the following codes:

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

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

For example, suppose you need to find out what the Repair Philosophy is for the HP 98570A 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's abbreviated title. Chapter 7 in this manual lists manual titles and part numbers for service information.

Service Information Locator

Manuals identified in this locator are abbreviated by their initials:

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

Service Information Locator

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

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Chapter 2: Assembly Replacement

Chapter 3: Functional Description

Chapter 4: Boot ROM Functions

Chapter 5: Troubleshooting

Chapter 6: Parts Lists

Chapter 7: References

Introduction

Purpose of this Training Guide

This manual is a Self-Paced Hardware Training Guide containing five lessons to help you learn how to maintain the Series 300 Models 360 and 370 computers.

Assembly level repair is the strategy covered in this course. Component level repair is not within the scope of this course, nor is it supported by Hewlett-Packard for this product. Both customers and Hewlett-Packard Customer Engineers are trained to the same level of repair. The same service tools are made available to both.

This Self-Paced course differs from most others for the Series 300 courses. The Models 360 and 370 do not greatly differ from the earlier Models 330 and 350, except in the CPU. In fact, they all share the same box and power supply, and use most of the same peripherals. This course concentrates on the differences between the 330/350 and the 360/370, and as a result, it is smaller in size, and is integrated with the Service Information Manual. The lessons follow the pattern of the Service Information Manual. The course is also structured so that when you finish it you may remove the pages relating to the course and you will have a complete Service Information Manual. The course page numbers are prefixed with "TG-".

Prerequisites

Computer Skills and Knowledge

You'll need certain experience levels to understand the material and perform the work in this course. To successfully complete this course, you should have:

- A good understanding of digital computer architecture, functions, and operation.
- Skills and knowledge in digital computer troubleshooting and maintenance.
- Successful completion of CE-95 Electrostatic Discharge Self-Paced Course.
- Successful completion of CE95-98562A HP 9000 Series 300 Models 330/350 Self-Paced Training Course.

Course Objectives

Upon completion of the Models 360/370 Self-Paced Hardware Training Course, you will have performed the following activities in a training environment:

- Demonstrate knowledge of the Model 360/370's features, operation, maintenance and support needs, particularly as they differ from those of the Models 330/350, by correctly answering at least 80% of the test items in each quiz and the Final Review relating to features, specifications, installation, configuration, fundamental operation, functional description, assembly, troubleshooting, and support.

- Configure and install the computer

- Assemble, disassemble, troubleshoot, and test the computer following procedures stated in the service documentation.

Time Required

As this is a Self-Paced course of instruction, you determine the rate of completion. Average time required to complete the course is shown below. Time required to gather the documents and hardware are not included in the actual time to complete each lesson.

Section/Lesson	Time Required
Lesson 1, Product Information and Assembly Replacement	½ hour
Lesson 2, Functional Description	½ hour
Lesson 3, Boot ROM Functions	½ hour
Lesson 4, Troubleshooting	½ hour
Lesson 5, Parts	½ hour
Total →	2½ hours

Necessary Tools

You will not need any tools in order to take this Study Guide. However, if you have access to a Model 360/370 and would like to practice disassembling it, you will need these tools:

- Static-Free Workstation (9300-0794)

- #1 Pozidriv Screwdriver

- #2 Pozidriv Screwdriver

- small flat-blade screwdriver

How To Use This Guide

This Study Guide has a quiz after each Chapter of the *Service Information Manual.* After you have read the Chapter, take the quiz. If you get any answers wrong, go back over the material to find out what you missed.

Hewlett-Packard would like you to fill out the **Training Evaluation Form** located in the Appendix. It's an opportunity for you to critique this self-paced course. We value your comments and they are used to improve the quality of our service training and documentation. Please complete this form and return it to:

> **Hewlett-Packard Company**
> **Technical Computer Group**
> **3404 East Harmony Road**
> **Fort Collins, Colorado 80525 USA**
>
> **Attention: TCG Product Support**

Safety Precautions

WARNING

Always turn the unit off and unplug the power cord before opening the unit, installing, or replacing any parts. If learning activities require power to be applied while the covers are removed, proceed only with extreme caution, using safe, live-unit maintenance procedures. Do not touch energized parts with your fingers. Heed and follow all "WARNING-HAZARDOUS VOLTAGE" labels. Failure to follow these precautions may result in serious injury.

Electro-Static Discharge Precautions

Computer integrated circuit components can be damaged by electrostatic 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 an average room.

The integrated circuits can be protected by setting up a static-free workstation and wearing static-free clothes before handling any of the printed circuit boards.

When you need to remove or install a PC board, remove power from the Expander first. With the static free workstation in place, touch the sheet metal chassis with your fingers before touching the PC board. If the board is not going to be re-installed, place it into an anti-static bag and set it aside.

Additional electro-static safety precautions are mentioned in this course as they are appropriate. Observing these precautions will extend the life of your Expander in addition to providing you with a trouble-free course of instruction.

If you have all of the required material for this course, you are ready to begin the training. Best wishes and enjoy the training.

Product Information
and Assembly Replacement

1

This lesson covers the subject of Models 360/370 product information and assembly replacement. When you have finished reading the two Chapters, take the test at the end.

Product Information

1

Introduction

Workstations

Model 360 and 370 workstations provide state-of-the-art performance for the most demanding applications with a true 32-bit processor— the MC68030 operating at a full 25 MHz (Model 360) or 33 MHz (Model 370). A companion MC68882 floating point co-processor augments system performance, supporting both single and double-precision floating-point arithmetic and transcendental math functions.

Both workstations are well-suited for the advanced design requirements of design engineers in electrical, mechanical, and software engineering, including such computation-intensive tasks as logic simulation and printed-circuit board routing. Many research applications previously requiring the power of a mainframe computer now can be executed locally on these powerful workstations. The Model 370 is very suitable for high-end test and measurement applications, and supports a variety of office automation software.

Foundations of these workstations are the computers, or system processing units (SPU). Each uses a single Design Plus box that holds the four system boards that support all the functions required for most system configurations.

System Configurations

Several workstation systems are available with monitors, software and a variety of peripherals. You should refer to the current *Model 360/370 Pricing Information and Technical Data Sheet* to find out exactly what is currently offered.

Supported configurations of hardware and software are identified in the *Series 300 Configuration Reference Manual*, part number 98561-90020.

Model 360 and 370 computer bundled systems include:

- Standard color and monochrome systems.

- Color systems with 2½D accelerator.

- Graphics systems for 3D images and solid shaded models.

- BASIC- and BASIC/UX-based measurement automation systems are available on the Model 360.

- Color and monochrome artificial intelligence development systems are available on the Model 370.

Typical system diagrams are shown in Figures 1-1 and 1-2.
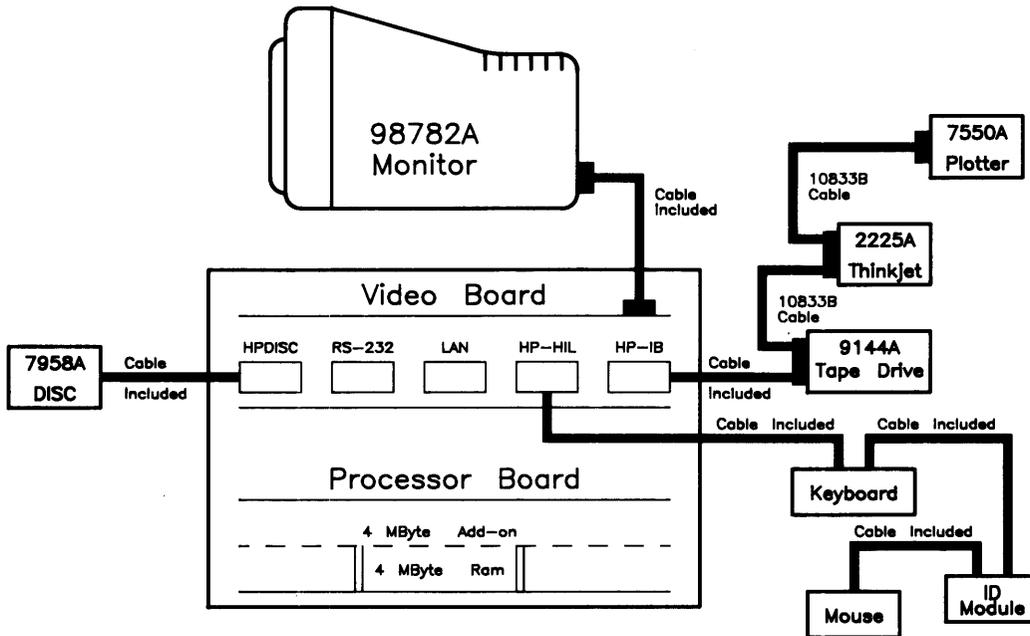
Figure 1-1. Model 360 Typical Workstation
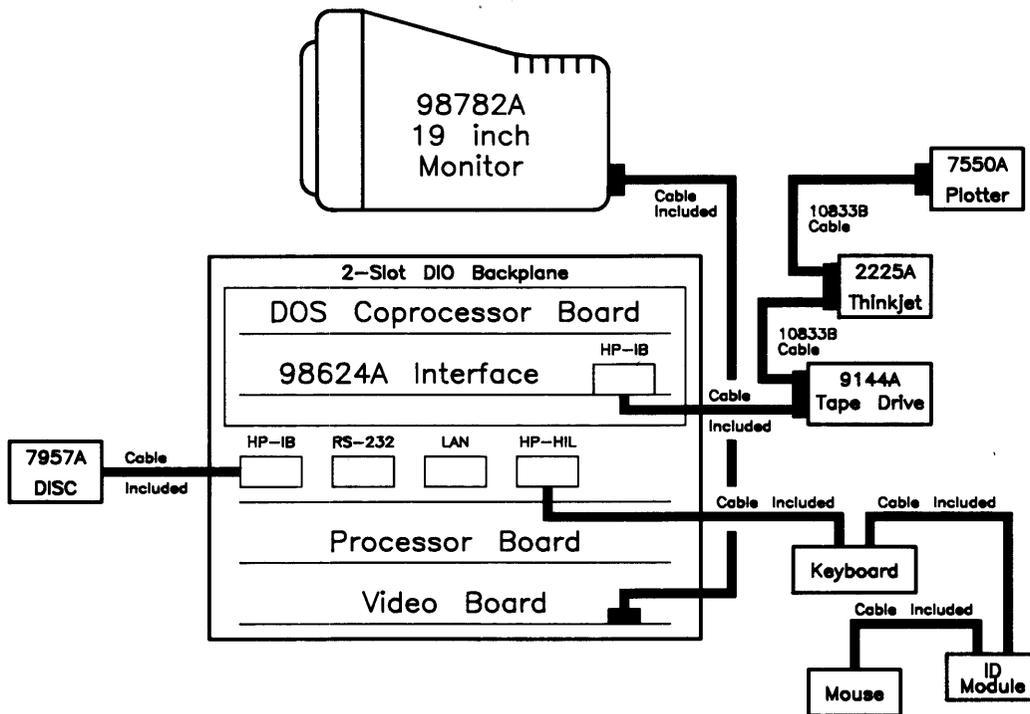
Figure 1-2. Model 370 Typical Workstation

Features

These computers have several useful features. Table 1-1 lists the main features.

Table 1-1. Model 360/370 Computer Features

Product/Option Number	Description

Model 360 (HP 98579A)	Model 360 system processing unit featuring:
	    MC68030 CPU, 25 MHz.
	    MC68882 Floating Point Co-CPU, 25 MHz.
	    4 Mbytes of Processor On-Board RAM.
	    4 Mbytes RAM Standard, Maximum 16 Mbytes.

Model 370 (HP 98579B)	Model 370 system processing unit featuring:
	    MC68030 CPU, 33 MHz.
	    MC68882 Floating Point Co-CPU, 33 MHz.
	    8 Mbytes RAM Standard, Maximum 48 Mbytes.
	    32-bit High-Speed System Bus.

Common Features	4 Gbytes Virtual Memory address space.
	32-bit DIO-II I/O Bus.
	IEEE-488 HP-IB Interface.
	RS-232C Serial Interface.
	IEEE 802.3/Ethernet LAN Interface, either BNC or
	  15-pin Connector.
	High-speed IEEE 488 Disc Interface.
	  (optional on Model 360).
	Optional ANSI X3.131-1986 Small Computer Systems Interface (SCSI)
	Two channel DMA Controller.
	HP-IB, HP-HIL, and RS-232 adapter cables.

Direct-Connect I/O Expanders	HP 98568A Opt. 132, 8 DIO Card Slots. HP 98570A 2 DIO-II System Board Slots and 4 DIO Card Slots.

Backplane Upgrades	HP 98242A 4-slot DIO backplane.
	  (Can be added to HP 98562B or to HP 98570A.)
	
	HP 98242B 2-slot DIO backplane.
	  (Can be added to HP 98562B or to HP 98570A.)
	
	HP 98570A Opt. 004 provides 2 DIO slots and 3 system slots.

Memory Boards	Optional Model 360 Memory:
	HP 98267A 4 Mbyte RAM Board
	HP 98267B 8 Mbyte RAM Board
	HP 98267C 12 Mbyte RAM Board
	Optional Model 370 Memory:
	    HP 98258A Add-on parity RAM control board and 4 Mbyte RAM Array.
	    HP 98258B 4 Mbyte parity RAM Add-on (requires 98258A).
	    HP 98258C 12 Mbyte parity RAM Add-on (requires 98258A).
	    HP 98264A Add-on ECC RAM control board and 8 Mbyte RAM Array.
	    HP 98264B Add-on ECC RAM control board and 16 Mbyte RAM Array.

MC68030 Processor

Both Models 360 and 370 feature a Motorola MC68030 CPU chip rather than the MC68020 found on Models 330 and 350. The 68030 is an extension of the 68020, and includes many additional features. Here is a summary of the new features:

The 68030 has an internal data cache in addition to the internal instruction cache. This means that data access during read cycles may be stored internally, where it is available for subsequent accesses. This reduces the number of external bus cycles when the data operand required by an instruction is already in the data cache.

The internal caches can be accessed in a single clock cycle. In addition, the bus controller provides a two-clock synchronous mode and burst mode accesses that can transfer data in as little as one clock per long word.

The 68030 contains an internal memory management unit that allows address translation to operate in parallel with the CPU core RAM, the internal caches and the bus controller.

Additional signals support emulation and system analysis. External debugging equipment can disable the MMU and internal caches in order to freeze the internal state of the 68030 during breakpoint processing. In addition, the 68030 indicates:

- the start of a refill of the instruction pipe

- instruction boundaries

- pending trace or interrupt processing

- exception processing

- halt conditions

This information allows external debugging equipment to trace 68030 internal activity and interact nonintrusively, thus reducing the debugging effort.

Performance

The Model 370 computer provides 7+ MIPS computational performance and offers high-performance graphics display to match the CPU. They are typically used as group resource workstations (shared by several designers) and as group computational and shared peripheral resources when networked to lower performance workstations belonging to individual engineers.

These workstations must be able to run UNIX-based applications for:

- Advanced design tasks (ME, EE, and others)
- Expert Systems Development
- PC Board Routing
- Circuit Simulation

High-end workstations must be networked via industry-standard LAN, preferably have AT&T System V UNIX[2] operating system compatibility, high-resolution monochrome or color displays, and very large RAM capacities.

Performance of Model 370 workstations is about **seven times that of a VAX 11/780*** minicomputer doing integer computation. Now, applications once limited to large mainframes can be executed locally. New applications of artificial intelligence, coupled with design software, can now be developed and significantly increase the productivity of the design professional.

Full potential of the MC68030 processor is realized by the use of a 64 Kbyte cache with 32-bit wide entries operating at a 60 nanosecond cycle time (zero processor wait states). This large, high-performance cache buffers the 33 MHz processor from the main memory operating at an average 180 nsec cycle time over a 32-bit wide system bus. The memory management unit internal to the MC68030 translates virtual memory addresses into physical memory addresses in parallel with cache-miss detection. This means that maximum system throughput is maintained for very large programs and multiple processes.

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* Workstation vendors use the VAX 11/780 performance as the yardstick for system CPU performance (MIPS). Using this yardstick makes the Model 370 a 7 MIPS system.
[2] UNIX is a trademark of AT & T

Hardware

CPU – MC68030

Both models are an extension of the Series 300 family. Through use of the MC68030 at 25 MHz (Model 360) and 33 MHz (Model 370), high-end performance of the Series 300 family is almost doubled and provides state-of-the-art technology.

Bus Architecture

A 16-bit I/O bus provides interfacing to most Series 200 and 300 accessory cards. This bus is called the DIO bus.

A 32-bit I/O bus called the DIO-II bus provides 6 Mbyte/sec transfer rates, handling even the highest-performance peripherals independently of processor access to main memory. It is compatible with the 16-bit DIO bus of the Series 200 and the Model 310 and 320 computers, allowing access to most accessory and interface cards available for those systems.

Model 370 memory boards are accessed by a third, very-high speed 32-bit system bus. Connecting between the processor board and RAM boards, it allows faster read and write cycles than the I/O busses would permit.

Figure 1-3 is a diagram of the I/O architecture for the Model 360 and 370 computers.
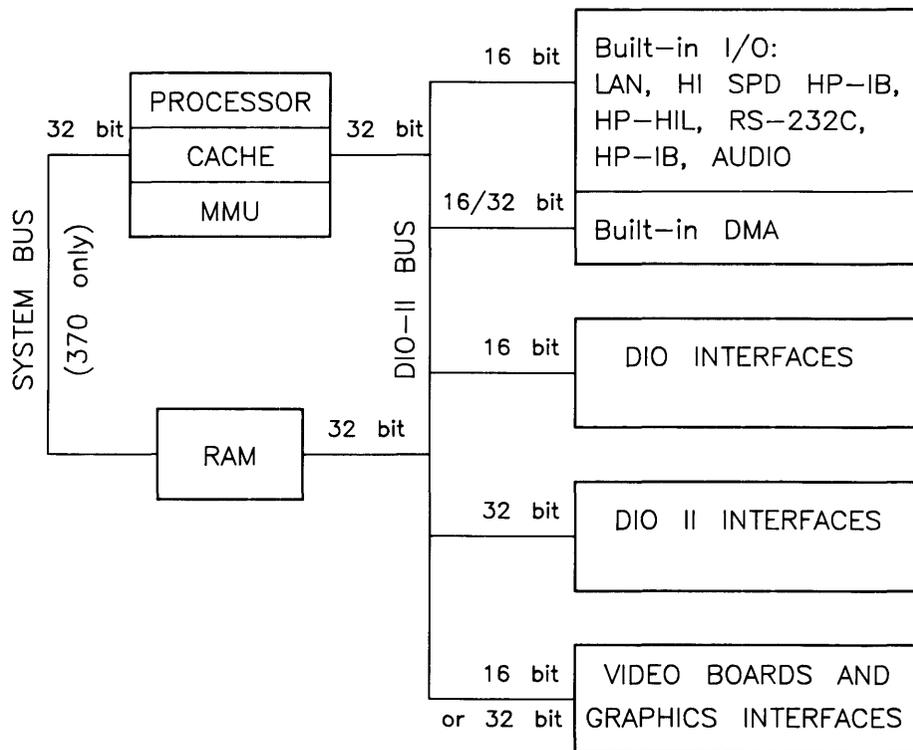
Figure 1-3. Model 360/370 Computer I/O Architecture

Motherboard/Backplane

As Figure 1-4 shows, three motherboard system-slot connectors are used by the system processor board, system interface board and RAM board. One system slot is available for the video board, display system interface board, floating-point accelerator or 2-slot DIO backplane.
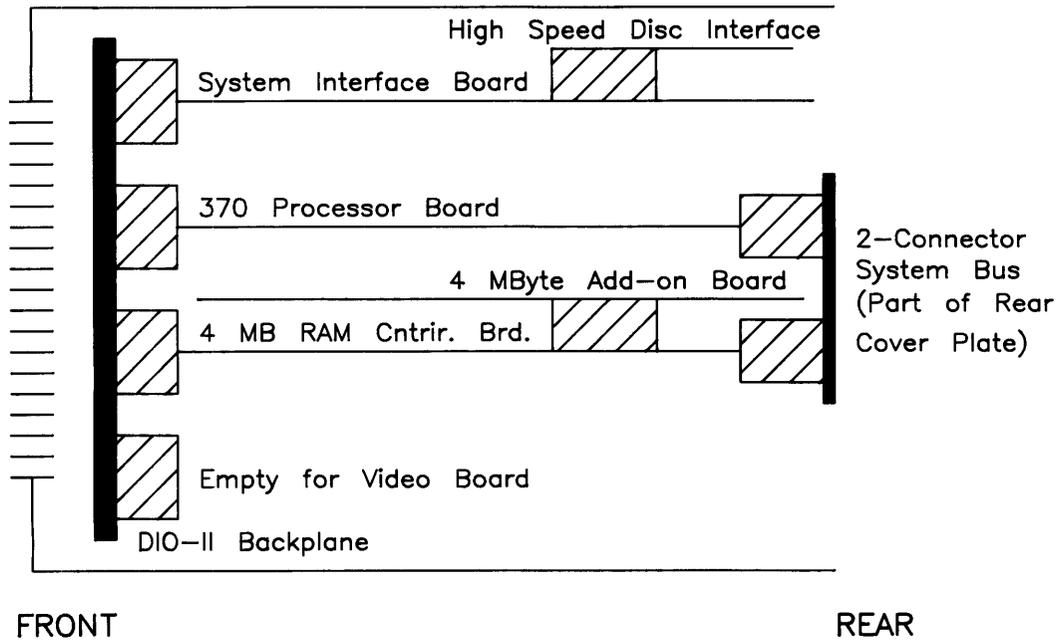
Figure 1-4. Model 370 System Slot Diagram

Keyboards

Two keyboards are compatible with the Model 360 and 370 HP-HIL interface:

HP 46021

Standard keyboard is the Integrated Terminal Format (ITF) Keyboard. It connects to the HP-HIL connector on the system interface board.

HP 98203C

An optional keyboard with the same keys and rotary control knob as used with several Series 200 and 300 computers. It is used on the HP-HIL interface.

HP 9000 Hardware Compatibility

Model 360 and 370 hardware compatibility ensures use and/or support of the same:

- Series 200/300 interface/accessory cards cards

- Series 300 graphics subsystems

- Peripherals supported on other Series 300 systems (except HP 98248A Floating-point Accelerator)

- The Model 360 supports all HP 98267 RAM boards. The Model 370 supports all HP 98258 and 98264 RAM boards.

These workstations are fully compatible with the wide range of disk and tape drives, printers and plotters, and HP-HIL devices.

Either of the two optional Direct-Connect I/O Expanders can be added to the Model 360 or 370, allowing system expansion as application needs increase.

In addition, a VMEbus Expander can be directly connected to the Model 360 or 370.

98570A
Direct Connect I/O Expander

4—Slot DIO Backplane
Option 004 deletes this
backplane leaving four
total system slots

Two System Slots

DIO—II Backplane

FRONT

Connector

REAR

370 SPU

Four System Slots

DIO—II Backplane
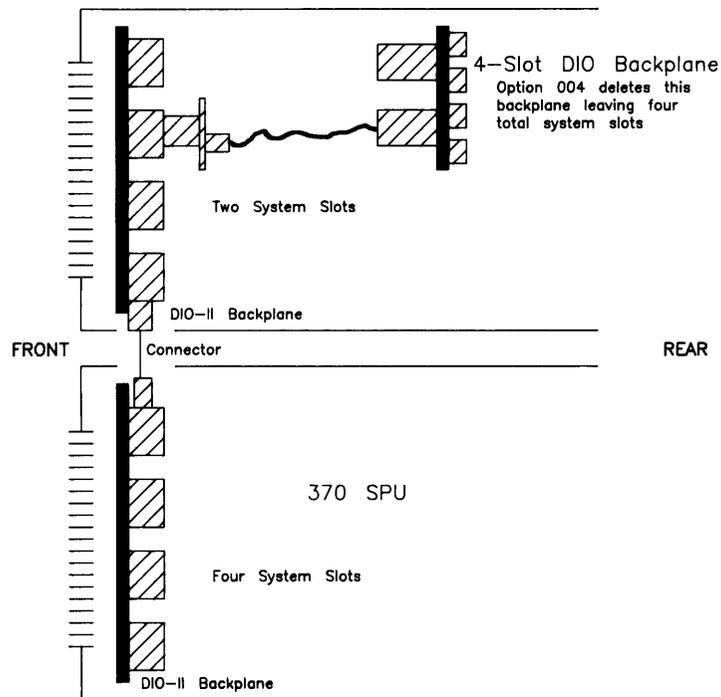
98568A with Option 132
Direct Connect I/O Expander

8—Slot DIO Backplane

FRONT

Connection

REAR

370 SPU

DIO—II Backplane
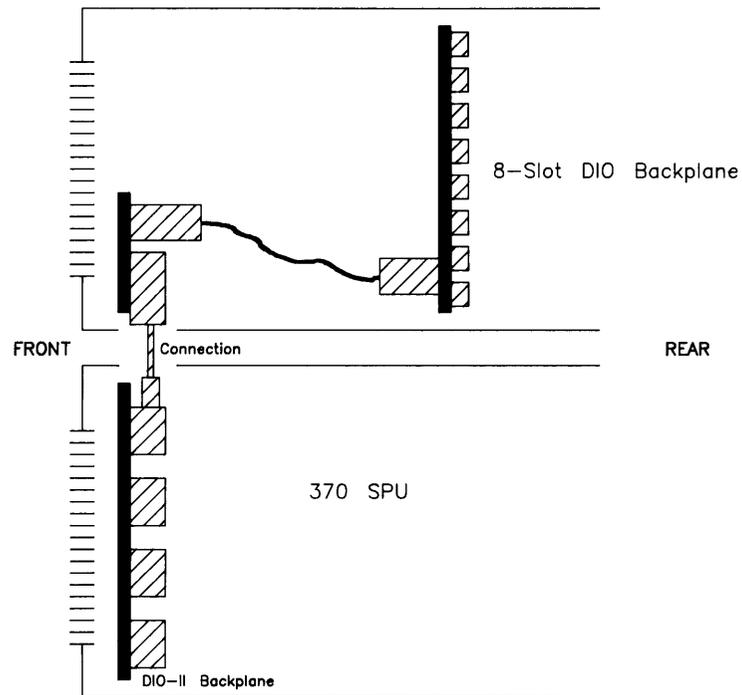
Figure 1-5. Direct Connect Expanders Diagram

Product Identification

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

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

- Systems Ordered by Customers
- Products Ordered by HP Field Offices
- Products Manufactured by Technical Computer Group at Fort Collins

Systems Ordered by Customers

When these computer systems are ordered by customers, a suffix is added to the Model number, such as Model 370AIM that identifies the computer system ordered by customers. Refer to the Model 370 Hardware Price List for a current listing of all bundled systems.

Products Ordered by HP Field Offices

A five-digit product number is used by HP field offices to order the computers. This number is strictly for ordering purposes and not for formal product identification. HP 9000 Series 300 Model 360 and 370 Computers are Product Number HP 98579A and HP 98579B, respectively. A complete explanation of these names and numbers is shown later in this chapter. Configuration and other product information is also covered.

Products Manufactured by HP Technical Workstations Operations

At the manufacturing division, the computer's are built and configured using the numbering conventions explained above. Note that these numbers relate only to the computer or bus expander and do not include peripherals, such as disk drives, some monitors and some accessories. Other HP divisions provide the rest of the products bundled with the computer system.

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.

2623 A 01234

Location: Behind the power supply access cover on the inside bottom of the chassis.

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.

Product Terms/Conventions

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, interface, and video boards, and other accessory cards. Sometimes the computer is referred to as the System Processing Unit (SPU).

- **DIO Slots** - The narrow slots for accessories in the back of the computer or expander. Two or four slots are available as options for the computer and expander. Distinction between these slots are:

    - The top slot is an **accessory card slot**.

    - The second slot down is an **I/O card slot**.

- **System Slots** - The wide slots in the computer or expander are for the processor, RAM, video, or system interface boards.

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

- **External (circuit)** - A circuit 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, disk drive, plotter, printer, bus expander, etc.

- **I/O Expander** - A device external to the computer that connects to the computer's DIO-II 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. For the Model 370 computer systems, the product name is Direct-Connect System Slot I/O Expander.

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

PC Boards

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

- **Cards** - Boards installed in the DIO card cage slots.

    - **I/O Card** - A card that outputs to and inputs from a peripheral device. They are installed in DIO slots. For example, an RS-232 I/O card.

    - **Accessory Card** - A card that only operates on the DIO 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 wide system slots or inside the product. Boards are not usually removed or installed by users.

  Two-board assemblies are those consisting of one board connecting to the motherboard and an "add-on" board attached to the bottom board. 8 and 16 Mbyte RAM two-board assemblies are examples.

- **Backplane** - The board in the card cage with connectors for DIO cards to plug into.

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 Support Documentation

The purpose of these computers and expanders Hardware Documentation is to support the installation and maintenance of these products. Hardware Support Documentation consists of six manuals for the HP 9000 Series 300 Models 360 and 370 Computers and HP 98568A Opt. 132 and HP 98570A Expanders:

- Service Information Manual

- Service Handbook

- Familiarization Guides

- Service Notes

- Test Tools Manual

- HP 9000 Series 200/300/500 Site Preparation Manual

- Series 300 Computer System Configuration Reference

The following manuals also relate to hardware:

- Various Installation Notes

- Series 300 Installation Reference

- Series 200/300 Peripheral Installation Guide

A complete listing of titles and part numbers is in Chapter 7 of this manual and the Model 360/370 Service Handbook, Chapter 10.

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 legal notices, safety situations explained, plus a Service Information Locator to help you find service information.
Chapter 1: Product Information	Introduces the computer/bus expander, covers features, technical information, options, accessories, operating systems, repair philosophy, and a general description of the Model 370 Computers and HP 98570 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 and Chapter 6 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. Turn-on displays are shown.
Chapter 5: Troubleshooting	This chapter contains tutorial information for troubleshooting the computer and bus expander. Self-test errors for the computer and expander are explained.
Chapter 6: Parts Lists	Has parts ordering information, as well as part numbers and descriptions of field replaceable parts.
Chapter 7: Reference	Contains hardware/software manual titles, and other helpful information.

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,	Has a brief description of the product, along with configuration and similar information. Product technical information is 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 Test Tools, and explains several troubleshooting procedures. Flow charts are frequently used.
Chapter 5, Tests	Lists tests to run to check out the computer, some peripherals, and some accessories and interfaces.
Chapter 6, Adjustments	There's no adjustments for the computer.
Chapter 7, Systems	Refers to the Model 360/370 Pricing Information and Technical Data sheet for current bundled system configurations.
Chapter 8, Replacement Parts	Lists part numbers for all field-replaceable parts and explains how they may be obtained.
Chapter 9, Diagrams	Block diagrams of the products are shown here.
Chapter 10, Reference	Other documentation related to these products are listed here with their part numbers.
Chapter 11, Service Notes	When you receive Service Notes for these products, they should be inserted here.

Familiarization Guide

Familiarization Guides are condensed service manuals for accessories and associated products used in the Model 360 and 370 computers. As new products are introduced, these Guides provide service information that can be inserted in this manual. This allows you to update the Model 360/370 Service Information Manual with the latest service material for accessories, such as interface cards, video boards, or expanders.

Organization of Familiarization Guides follows this general format:

Chapter No. and Title	Contents
Chapter 1, General Information	Includes a product description, technical information, preventive maintenance, warranty, and support services.
Chapter 2, Functional Description	Describes how the product works to the block diagram level and configurations.
Chapter 3, Troubleshooting	Covers troubleswhooting procedures and lists diagnostics that apply to the product.
Chapter 4, Adjustments	Adjustment procedures are explained.
Chapter 5, Parts	Explains how to replace assemblies, the repair philosophy, and has parts lists.

Service Notes

When a situation occurs that affects 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 Model 360/370 Service Handbook.

Installation Notes

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

Test Tools Manual

Series 200/300 Test Tools Manual supports a software package for verifying the integrity of Model 360/370 computer system installations. The Test Tools manual and its associated disks or tape permit troubleshooting computer systems in failure analysis. Part numbers for the complete Test Tools packages are:

- 09800-12300 for 3½-inch disk drives
- 09800-12500 for 5¼-inch disk drives
- 09800-12700 for ¼-inch tape 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 disk drives are loaded, ran, and results are interpreted. Error messages are shown as well as several examples of running the tests.

Series 300 Configuration Reference Manual

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

Section No. and Title	Contents
Section 1. Configuration Overview	Has configuration worksheets to assist in planning the application.
Section 2. Operating Systems and Application Software	Covers supported languages and media options.
Section 3. System Packaging	Lists the Model 370 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.

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 HP 9000 Computer System site. Includes a time frame for setting up the computer system, and identifies people who can provide assistance.
Chapter 3, Preparing the Electrical Environment	Includes power technical information, 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 technical information for electrical requirements, heat generation, temperature and humidity requirements, and shipping dimensions.
Appendix B	Contains forms to use for preparing the site, such as Pre-Installation Worksheet, Shipment Scheduling Form, and a Site Completion Checklist.

Installation Reference

The computer and 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, disk 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.

Technical Information

Note

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

Electrical

Line voltage/Frequency	120 V ac @ 48-66 Hz
	240 V ac @ 48-66 Hz
Fuse	8AF 250V
Backplane Power Available	

Model 360/370 Computer, HP 98568A Opt. 132 Expander, and HP 98570A Expander	Total Power Available from motherboard:
	  95 Watts @ +5 V dc
	  40 Watts @ +12 V dc
	  12 Watts @ −12 V dc

	Each system slot:
	  23 Watts @ +5 V dc
	  10 Watts @ +12 V dc
	  3 Watts @ −12 V dc

Line transient spike immunity (1 nsec rise, 800 nsec duration)	1 KV dc
Power Consumption	250 Watts maximum
Current Requirements	5.0 A @ 120 V ac 3.0 A @ 240 V ac
Maximum Heat Dissipation	853 BTU/hr 250 Kcal/hr
Battery Back-up	Real-Time Clock on System Interface Board

Environmental

Operating temperature	0 - 55° C
Operating humidity	5 - 95% relative
Operating altitude	4 572 metres (15 000 feet)

Electromagnetic Interference

Standards met

FCC Class A
VCCI Class 2
VDE Class B, VDE 1046/84

Regulatory Requirements

Standards met

UL 478, 5th Edition
CSA 154M-1983
IEC 380, 3rd Edition; 435, 2nd Edition

Physical

Dimensions
(Computer or Expander)
    Height

130 mm (5.12 inches)

    Width

325 mm (12.8 inches)

    Length

376 mm (14.8 inches)

Weight

11.8 kg (26 pounds) maximum

Vibration Standard

Meets Class B requirements

Model 360 Processor Board

CPU
    Type

Motorola MC68030

    Clock Frequency

25 Mhz

    Internal Architecture

32-bit data and address registers

    Address range

4 Gbytes virtual mapped to
4 Gbytes physical

    Data bus

32-bit synchronous to:
        4 Mbytes On-board RAM

Floating-point Co-processor

    Type

Motorola MC68882

    Clock Frequency

25 Mhz

On-Board memory
    Size

4 Mbytes

    Type

Byte parity error-checking

    Average cycle time

200 nsec

Model 370 Processor Board

CPU

Type	Motorola MC68030
Clock Frequency	33 MHz

Floating-point Co-processor

Type	Motorola MC68882
Clock Frequency	33 MHz

Cache Memory

Type	Write through, instruction, data (external to MC68030 caches)
RAM	64 Kbytes, 16K words of 32-bit entries
Cycle time	60 nsec
Partitioning	Four 32-bit words each; 4K partitions

Memory

Memory Boards

Type	Byte parity error-checking or error checking and correcting
System bus width	32 bits address; 32 bits data
Bandwidth	23 Mbyte/sec read; 14.8 Mbyte/sec write
Average cycle time	180 nsec

Memory Sizes

Model 360 Standard RAM	4 Mbytes on processor board
Model 360 Maximum RAM	16 Mbytes (4 Mbytes on processor plus one 4, 8 or 12 Mbyte RAM controller board)
Model 370 Standard RAM	8 Mbytes: 4 Mbyte controller board plus 4 Mbyte add-on board
Model 370 Maximum RAM	48 Mbytes (3 boards of 16 Mbytes each)

DIO-II I/O Bus

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

System Interface Board

LAN Interface
    Media   Coax cable (RG 58U)
    Protocols   IEEE 802.3, Ethernet
    Data Rate   10 Mbits /sec

Disc Interface
    Type   IEEE 488
    Data Rate   1 Mbyte/sec
    Number of connected drives   8 per interface supported
                                     (Additional disk interfaces are available as optional accessories)

Parallel Interface
    Type   IEEE 488
    Data Rate   370 Kbyte/sec
    Number of connected devices   15 per interface devices supported

Serial Interface
    Type   RS-232C standard
    Connector   DB9 with cable; adapter to DB25

Small Computer Systems Interface
    Type   ANSI X3.131-1986
    Data Rate   1.5 Mbytes/second (asynchronous)
    Number of connected devices   7 (not counting the SPU)

Battery-backed Real-Time Clock
    Resolution   10 milliseconds
    Accuracy $\pm$5 seconds/day
    Battery type   Lithium; 1 year expected life

Keyboard requirements   HP 46021A (ITF type) with HP-HIL interface, 107-key low profile with numeric keypad, 8 special-function keys

                                     HP 98203C with HP-HIL interface, 106-key with rotary control knob, including 10 special-function keys.

Shipping Information

The shipping container for each computer includes the Localization Kit, which includes power cords, fuse, keyboard cable, HP-HIL cable, Installation Reference, and Installation Picture Card.

Models 360 or 370 Computer

Shipping Weight   15.9 kg (35 pounds)
Container Dimensions   Width - 502 mm (19.75 inches)
                                Length - 559 mm (22.0 inches)
                                Depth - 267 mm (10.5 inches
                                Cube - 0.07 m^3 (2.65 feet^3)

HP 98568A Opt. 132 or 98570A Expander

Shipping Weight   12 kg (26.4 pounds)
Container Dimensions   Width - 502 mm (19.75 inches)
                                Length - 502 mm (19.75 inches)
                                Depth - 241 mm (9.5 inches)
                                Cube - 0.06 m^3 (2.03 feet^3)

HP-HIL and Video Accessories

Listed below are HP-HIL and video accessories compatible with the Model 370 workstations. For a complete list, consult the *HP 9000 Series 300 Model 370 Hardware Price List*, Part Number 5954-7061D.

Table 1-2. HP-HIL Devices

Product Number	Product Name/Description
46021A	ITF keyboard
46060A	2-button Mouse
46083A	HP-HIL Knob
46084A	ID Module
46085A	Control Dial Module
46086A	32-button Control Box
46087A	ANSI A/ISO A4-size digitizer
46088A	ANSI A/ISO A3-size digitizer
46089A	4-button cursor for 46087A and 46088A
46094A	Quadrature port
46095A	3-button mouse for 46094A
98203C	Large Keyboard with Knob

Table 1-3. Video Accessories

Bus and Type	Product Number	Product Name/Description
DIO Video Card	HP 98546A	Display Compatibility Interface
DIO-II System Boards	HP 98287A	HP 98700A Interface
	HP 98542A	Medium Resolution Monochrome Video Board
	HP 98543A	Medium Resolution Color Video Board
	HP 98544B	High Resolution Monochrome Video Board
	HP 98547A	6-plane High-performance Color Video Board
	HP 98548A	High Resolution Color Video Board
	HP 98549A	Low Cost Color Video Board
	HP 98550A	High Resolution Color Video Board

Hewlett-Packard Support

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

Repair Philosophy

Field Repair Philosophy for the Model 360/370 Computers and the HP 98568A Opt. 132 and 98570A Expander is assembly, or board level. This means that when a failure occurs, the problem is diagnosed to the assembly having the failed part. That assembly is then replaced. Replacement assemblies are available through local HP Sales and Service Offices.

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

Schematics

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

Supported Configurations

Only computer systems with Hewlett-Packard approved parts, accessories, peripherals, operating systems and application programs are supported by Hewlett-Packard. Any 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.

Repair Services

Hewlett-Packard provides repair services in three ways:

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

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.

Hardware Support Services

There are many hardware support options available, from utilizing on-site maintenance groups to buying full support from the local sales office. Please contact your local Hewlett-Packard Sales and Service Office for these services.

Operating Systems Support

Primary Support

There are numerous operating system support options:

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

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

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

Support For An Additional System

The following options support an additional system:

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

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

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

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

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

Assembly Replacement

2

Introduction

Replacing parts in either the computer and expander require almost identical procedures. With the exception of a few parts unique to each unit, the access and replacement procedures are the same.

When the process is the same for both the computer and expander, they are referred to as the "unit". If different procedures are used for the computer or expander, the name of the unit is used.

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. They will eventually damage the Pozidriv® screw head recess making screws hard to remove.

All field replaceable parts can be accessed with these tools:

- Static-free Workstation, HP Part Number 9300-0794
- #1 Pozidriv® screwdriver, 4-inch (100 mm) blade.

  Used for all screws except the power supply ground tab screw and expander to computer attaching screws.

- #2 Pozidriv® screwdriver, 4-inch (100 mm) blade.

  Used for the power supply ground tab screw and expander to computer attaching screws.

- Flat-tip screwdriver, 0.125-inch (3 mm) wide tip, 4-inch (100 mm) blade.
- Anti-Static Bags

Access Flow Chart

Figure 2-1 is an Assembly Access Flow Chart showing the access process to replace parts. To use this chart, identify the part to be replaced at the bottom of the chart. Then start at the top of the chart and work through the blocked steps toward the part to replace. This flow chart can also be used as a guide to install assemblies by starting at the bottom and working 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. Procedures in this chapter are also organized in the same manner.

Referencing the Model 360/370 Service Handbook, Chapter 8, Replaceable Parts, as you remove each assembly/part for the first time will help associate the part numbers with their respective assemblies.
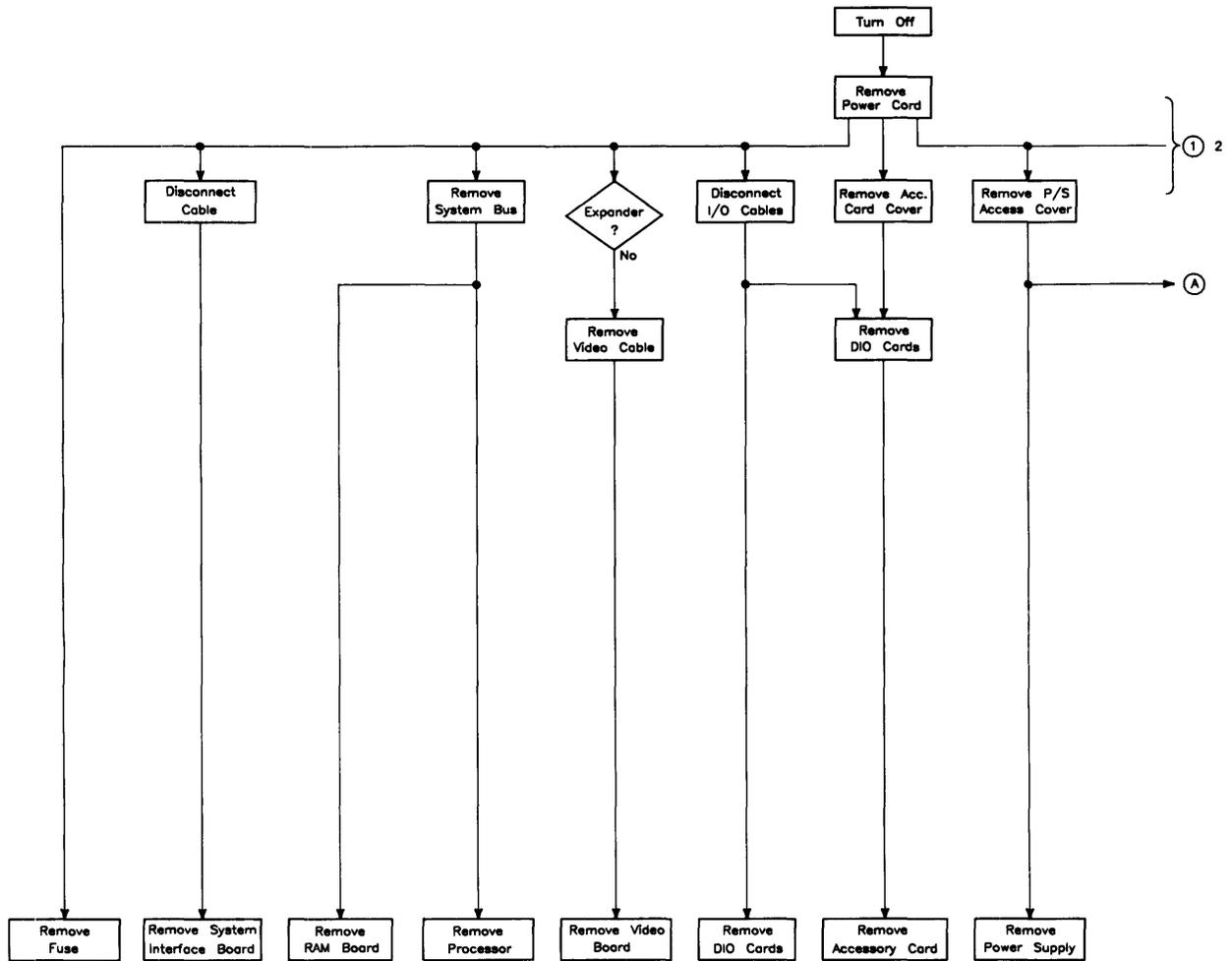
Figure 2-1a. Assembly Access Flow Chart
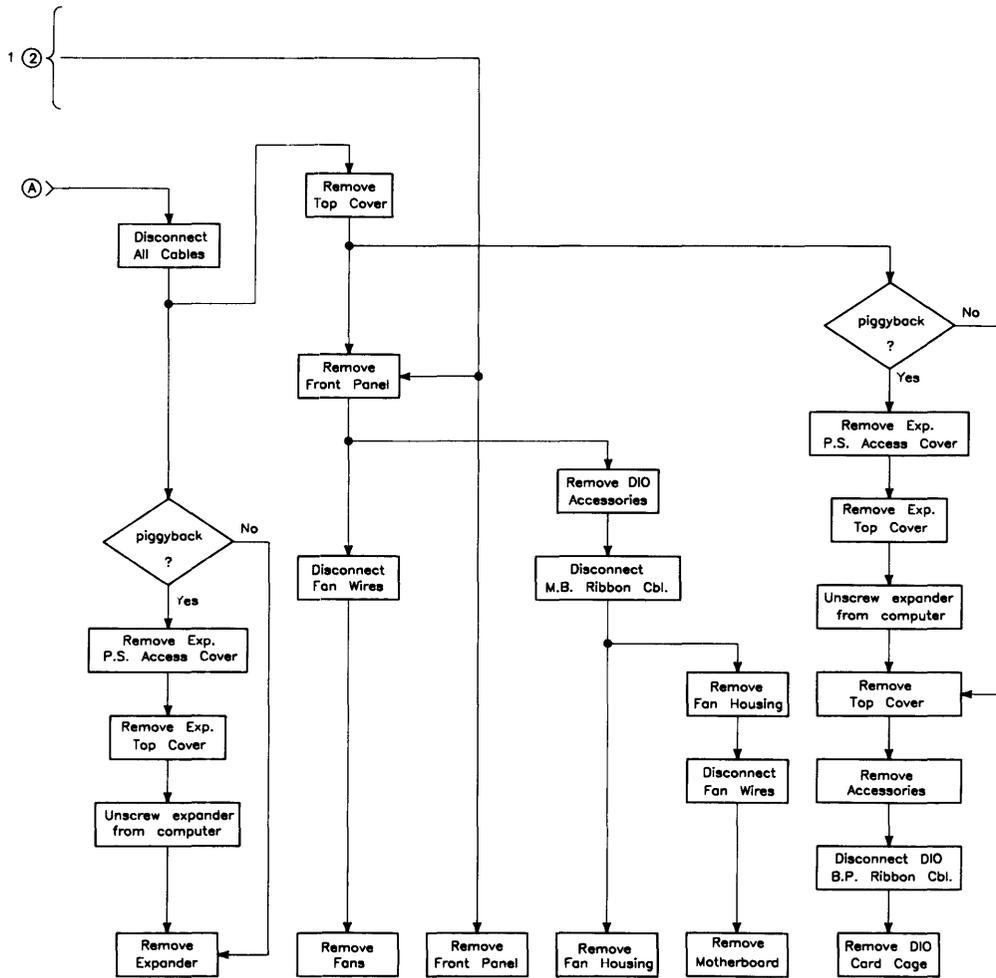
Figure 2-1b. Assembly Access Flow Chart

Parts Diagrams

Figure 2-2 and 2-3 show exploded views of the computer and expander. These diagrams should help you determine how the parts are installed or replaced.
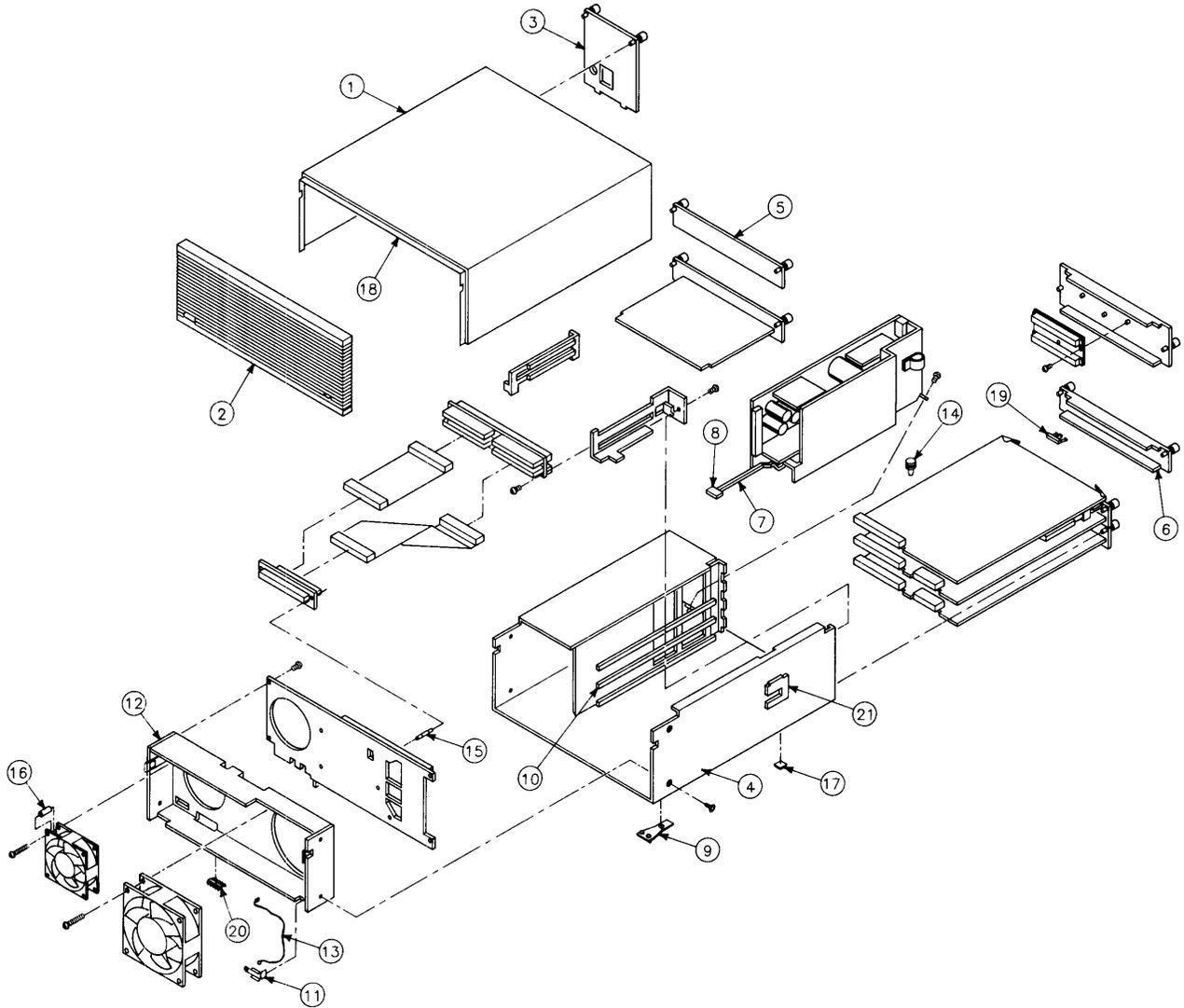
Figure 2-2. Computer Exploded Diagram
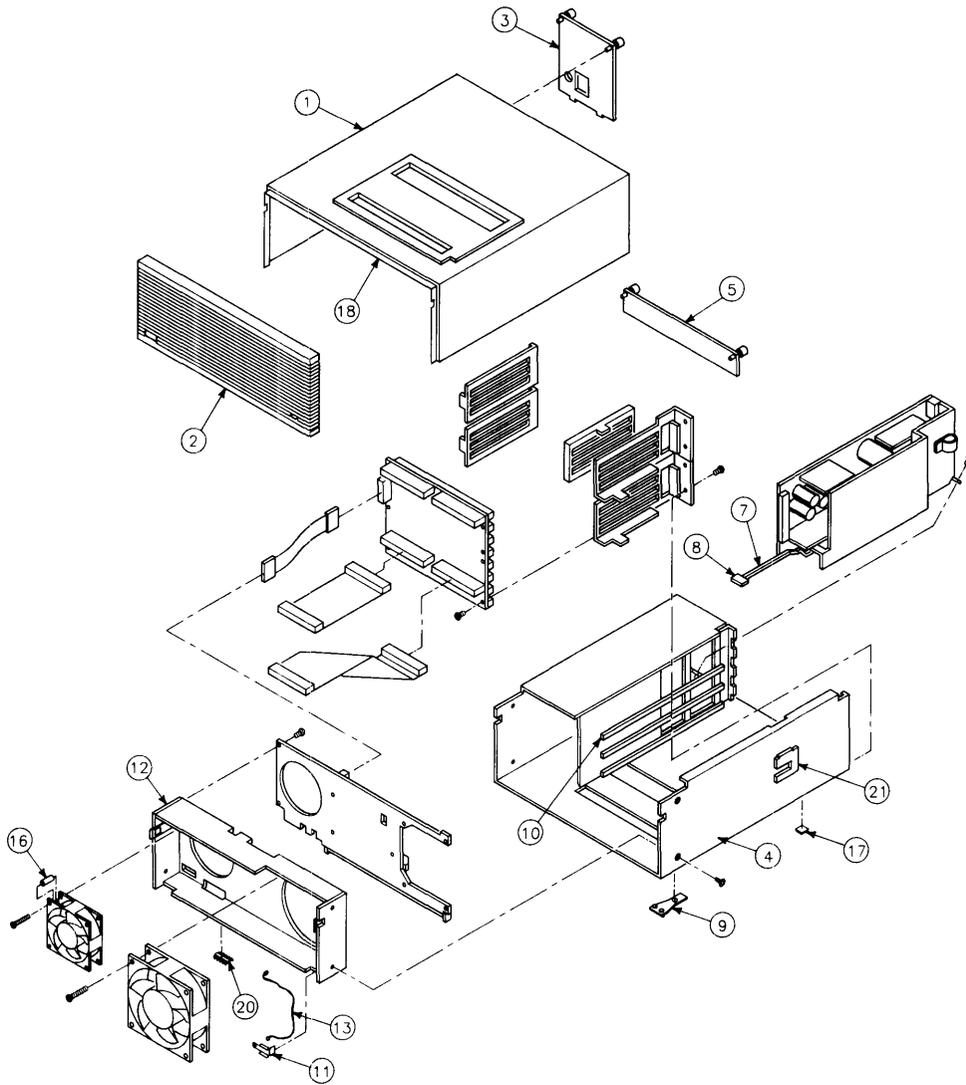
Figure 2-3. Expanders Exploded Diagram

Safety Precautions
Electrical 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 possible permanent damage.

WARNING

Always turn off the unit and remove the power cord before opening the unit 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.

System Board Installation

CAUTION

Do not use excessive force to seat system boards in the system slot connectors.

If excessive force seems to be needed to install a board, remove the board, and inspect the motherboard's connector for bent pins. Straighten any pins that appear to be bent.

Remove the top cover and all boards above the one that is difficult to seat.

Re-insert the board to the motherboard's connectors and adjust the position of the board's connector to mate correctly with the motherboard's connector. Carefully seat the board. Reinstall the other boards in the same manner, then replace the top cover.

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 ICs are installed on a printed circuit board or laying on a table. Static charges can build up in people to a potential of several thousand volts by simply walking across a room.

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

When you need to remove or install a part, remove power from the product first. With the static free workstation in place, touch sheet metal with your fingers before touching the printed circuit assembly. If the assembly is not going to be re-installed, place the assembly in an anti-static bag 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 2-4 shows the hardware orientation.
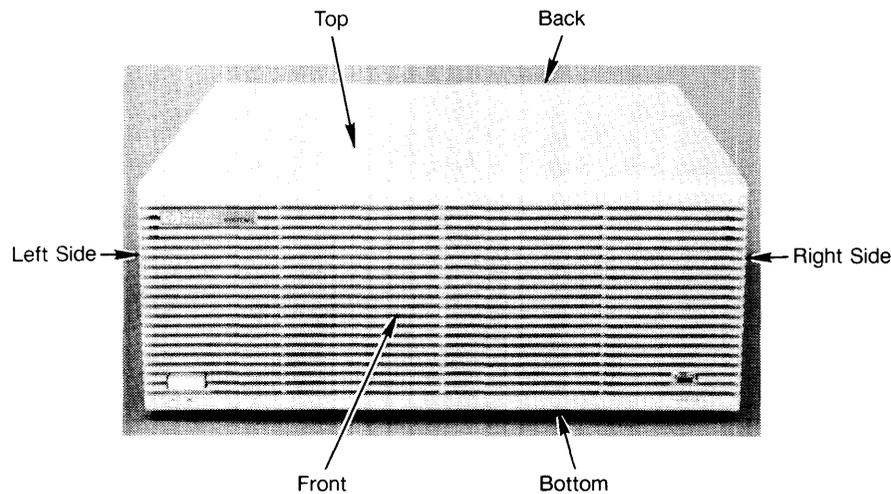
Figure 2-4. Hardware Orientation

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.

System Bus

Preliminary Requirements

1. Turn the computer off.

2. Remove the power cord.

Procedure

1. Loosen the two (or more) captive thumbscrews holding the system bus to the rear panel, until the thumbscrews pop up.

2. Pull the system bus straight out by its handle, removing the system bus from the processor and RAM boards.

3. To install the system bus, reverse Steps 1 and 2.

Processor Board

Preliminary Requirements

Turn the computer off and remove these assemblies:

1. Power cord.

2. System bus (if present).

Procedures

1. Check to see whether there is a cable installed between the HP 98248B Floating-point Accelerator and the processor board. Look for a flat, yellow cable covering the left two inches (50 mm) of one of the boards exposed by removing the system bus. If no yellow cable is present, skip to step 4.

2. If the yellow cable is present, pop the **bottom board** loose and slide it out far enough to completely expose the yellow cable.

3. Pull the cable free from the connector.

4. Leverage the processor board out with its board extractors.

5. Remove the processor board.

6. To install the processor board, reverse the above steps.

Floating-point Accelerator Board

Preliminary Requirements

Turn the computer off and remove these assemblies:

1. Power cord.

2. System bus (if present).

Procedures

1. Check to see whether there is a cable installed between the HP 98248B Floating-point Accelerator and the processor board. Look for a flat, yellow cable covering the left two inches (50 mm) of one of the boards exposed by removing the system bus. If no yellow cable is present, skip to step 4.

2. If the yellow cable is present, pop the **bottom board** loose and slide it out far enough to completely expose the yellow cable.

3. Pull the cable free from the connector.

4. Leverage the floating-point board out with its board extractors.

5. Remove the floating-point board.

6. To install the floating-point board, reverse the above steps.

Video Boards

Large video boards are usually in the top system slot. DIO video cards are in the DIO slots.

Preliminary Requirements

1. Turn the unit off.

2. Remove the power cord.

Procedures

1. Disconnect the video cables from the video board.

2. Using a #1 Pozidriv or your fingers, 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.

Interface Boards/Cards

These procedures apply to graphics display station or system interface boards in a system slot and I/O cards in a DIO slot.

Preliminary Requirements

1. Turn the unit off.

2. Remove the power cord.

Procedures

1. Disconnect the cables from the interface, except for the system interface board with high-speed disc add-on and HP-IB cable attached.

2. Unscrew the two captive thumbscrews holding the interface in the slot.

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 interface board/card from its slot.

Note

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

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4. To install the interface, reverse steps 1 through 3.

Battery Replacement

WARNING

Replace battery with Matsushita Electric 3V Lithium battery #BR 2325 (HP part number 1420-0314) ONLY! Use of another cell may present a risk of fire or explosion.

To replace the real-time clock's battery:

1. Remove the battery by holding the system interface board with the configuration switches up and raise the battery holder's positive (+) tab with your fingernail or a thin-blade screwdriver. Let the battery slide out of its holder.

2. Install a new battery by raising the positive (+) tab and inserting a new battery with its
   positive (+) side against the tab.

Add-On Interface Boards

This procedure tells how to remove these assemblies:

- 98265-66501 SCSI interface add-on
- 98562-66531 high-speed HP-IB interface add-on

Preliminary Requirements

Turn the computer off. Remove the power cord and the following assemblies:

- Remove the system interface board.

Procedures

1. Remove the screws holding the add-on board to the system interface board.

2. Each system interface board has different add-on interface cable attachments. Note the
   metal or plastic pin on the right-hand side of the system interface board that keeps the
   add-on interface cable connected to the add-on board. Use the applicable procedures
   below:

   a. On the 98562-66533 system interface board, rotate the add-on interface cable
      retaining plate counter-clockwise, then carefully remove the add-on interface cable
      from the add-on board. Then remove the add-on board.

   b. For the 98562-66534 system interface board, remove the add-on board with its cable
      attached. The cable should slide out of its retaining clip and can be removed from
      the add-on board.

3. Remove the cable from the add-on interface.

4. To install an add-on board, reverse steps 1, 2, and 3.

CAUTION

Use extreme caution when connecting the cable to the add-on board.
Improper connection will damage and bend pins on the add-on board
connector. Connect the pins first, then the cable.

Add-On RAM Boards (Model 360 Only)

This procedure tells how to remove these assemblies:

- 98267-66520 4 Mbyte RAM add-on
- 98267-66521 8 Mbyte RAM add-on
- 98267-66522 12 Mbyte RAM add-on

Preliminary Requirements

Turn the computer off. Remove the power cord and the following assemblies:

- Remove the Model 360 processor board.

Procedure

1. Remove the two or four screws holding the add-on board to the processor board.

2. Pull the add-on board straight up and away from the processor board.

DIO Accessory Cards

Preliminary Requirements

1. Turn the unit off.

2. Remove the power cord.

Procedures

1. If the card is behind a slot cover, remove the slot cover.

2. If the card is above and behind another card's rear panel, disconnect the cables from the card's panel, then remove the card.

3. Raise the card's extractor levers with your fingers and unseat the card from the unit's DIO backplane connector.

4. Remove the card.

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

Power Supply

Preliminary Requirements

1. Turn the unit off.

2. Remove the power cord.

Procedures

1. Unscrew the two captive thumbscrews holding the power supply access cover in place. Refer to Figure 2-5.

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.
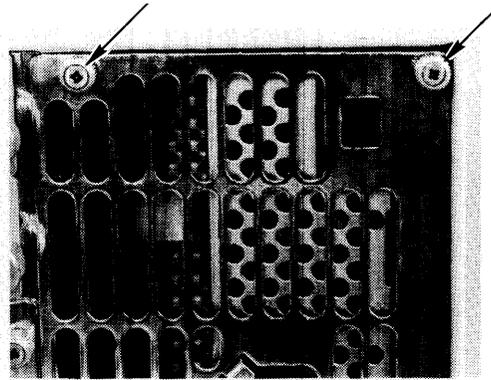
Figure 2-5. Power Supply Access Cover Screws

2. Remove the power supply access cover.

3. Remove the power supply grounding tab screw. Refer to Figure 2-6.
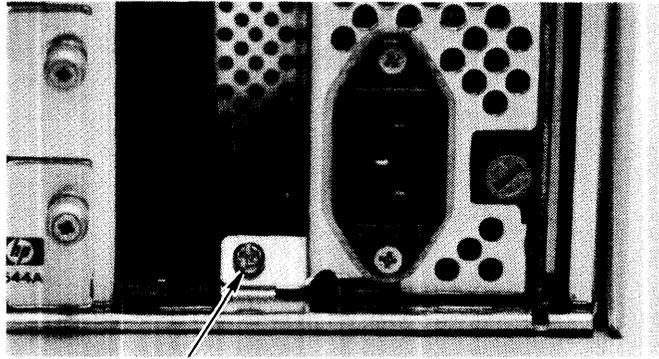
Figure 2-6. Power Supply Grounding Tab Screw

| CAUTION |

The ON-OFF button on the front of the computer is connected to the power supply by a long shaft. When removing the power supply, slide the power supply out carefully so you don't damage the ON-OFF switch shaft.

---

4. Remove the power supply.

Note

Replacement power supplies do not have the switch shaft connected. Install the switch shaft from the failed power supply on the replacement power supply.

---

5. Remove the switch shaft guide by pinching the tab shown in Figure 2-7 and removing the guide.
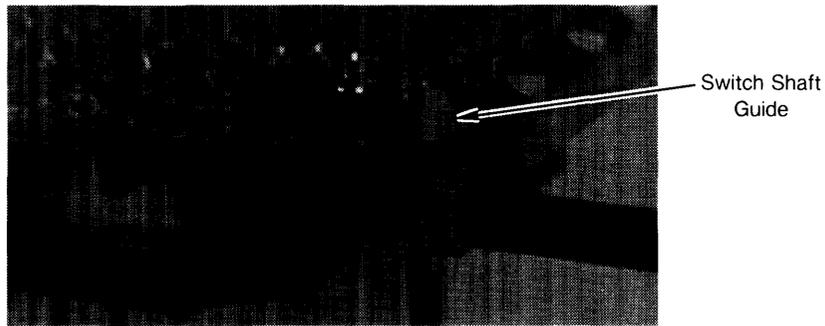
Switch Shaft
Guide

Figure 2-7. ON-OFF Switch Shaft Guide Removal

6. Remove the switch shaft from the ON-OFF switch by gently pulling the switch shaft off the switch. Refer to Figure 2-8.

Switch Shaft
Connection
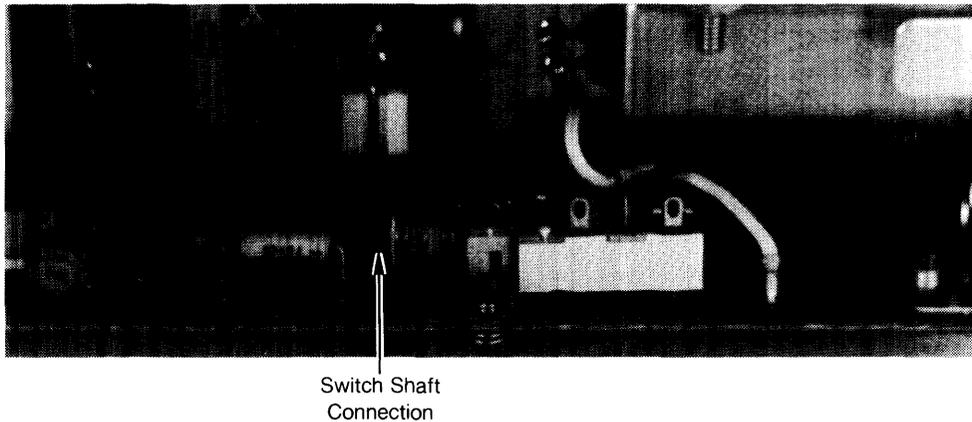
Figure 2-8. ON-OFF Switch Shaft Connection.

7. To install the power supply, reverse steps 1 through 6. Be sure to replace the power supply grounding screw.

Top Cover

Preliminary Requirements

Turn the unit(s) off. Remove the power cord(s) and these assemblies:

1. All cables from the installed accessory cards.

2. Power supply access cover.

3. Expander top cover, if the computer's top cover needs to be removed.

Expander Top Cover

When an 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 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.

1. Slide the expander's top cover to the rear and lift up on the back of the cover to remove it.

2. To install the top cover, place the top cover on the chassis, ensuring the RF shield plates are outside the sides of the chassis.

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.

---

3. Slide the top cover forward and fit the front of the top cover inside the front cover edges and engage the lip on both sides at the rear of the cover in the tabs on the chassis.

Computer Top Cover

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

1. If an expander is installed:

   a. Remove the expander's attaching screws shown in Figure 2-9.
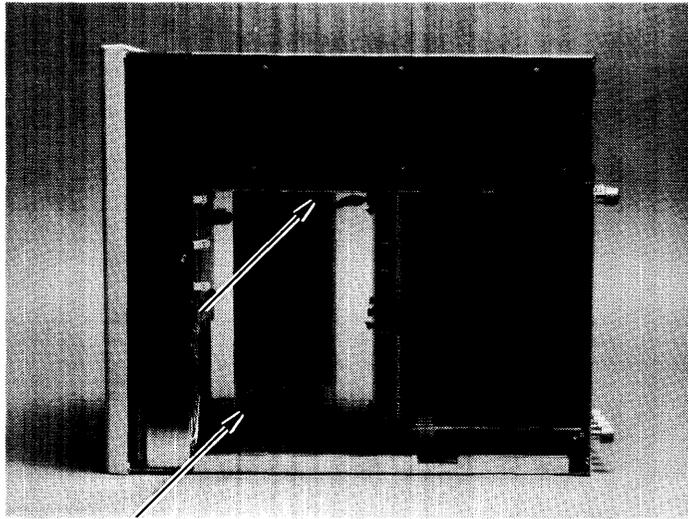
Figure 2-9. Expander to Computer Attaching Screws

   b. Remove the expander from the computer and install the connector's protective sleeve or set the expander on its side.

   c. Remove the flat-head screw that holds the computer's top cover to the motherboard connector.

2. Slide the computer's top cover to the rear and lift up on the back of the cover to remove it.

3. To install the top cover, place the top cover on the chassis, ensuring the RF shield plates are outside the sides of the chassis.

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.

---

4. Slide the top cover forward and fit the front of the top cover inside the front cover edges and engage the lip on both sides at the rear of the cover in the tabs on the chassis.

5. If an expander is to be installed:

   a. Replace the top cover screw.

   b. Install the expander.

   c. Replace the two expander attaching screws.

   d. Replace the expander top cover.

Front Panel

Preliminary Requirements

1. Turn the unit 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 2-10.
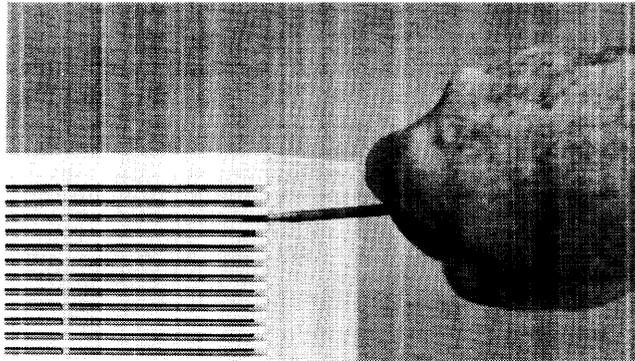
Figure 2-10. Releasing the Front Panel Catches

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 unit 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 mother-board. Refer to Figure 2-11.

Voltage Test   Fan Wire   LED Wire
Points   Connectors   Connector
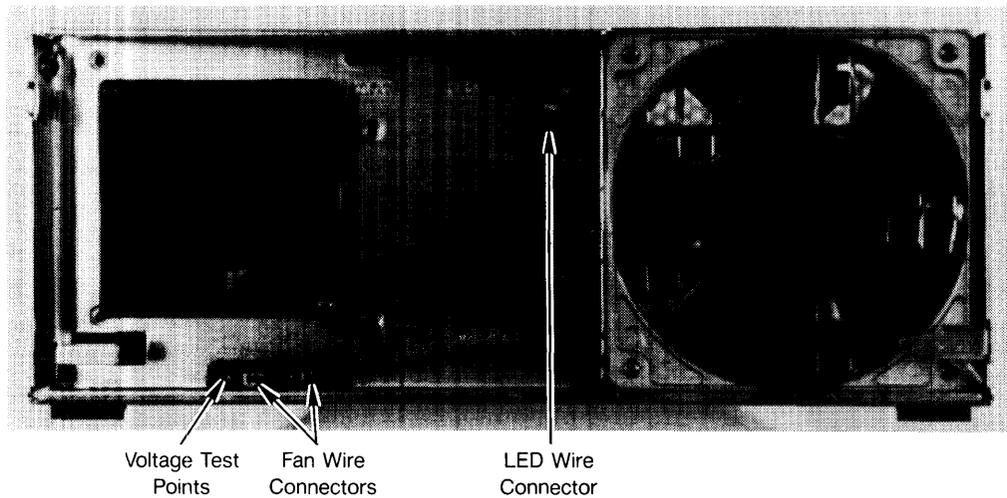
Figure 2-11. Fan Wire Connectors

2. For the large fan, slide the power-on LED/bracket toward the front and bend the wires aside.

3. Remove one of mounting screws from the fan to be replaced. Refer to Figure 2-12.
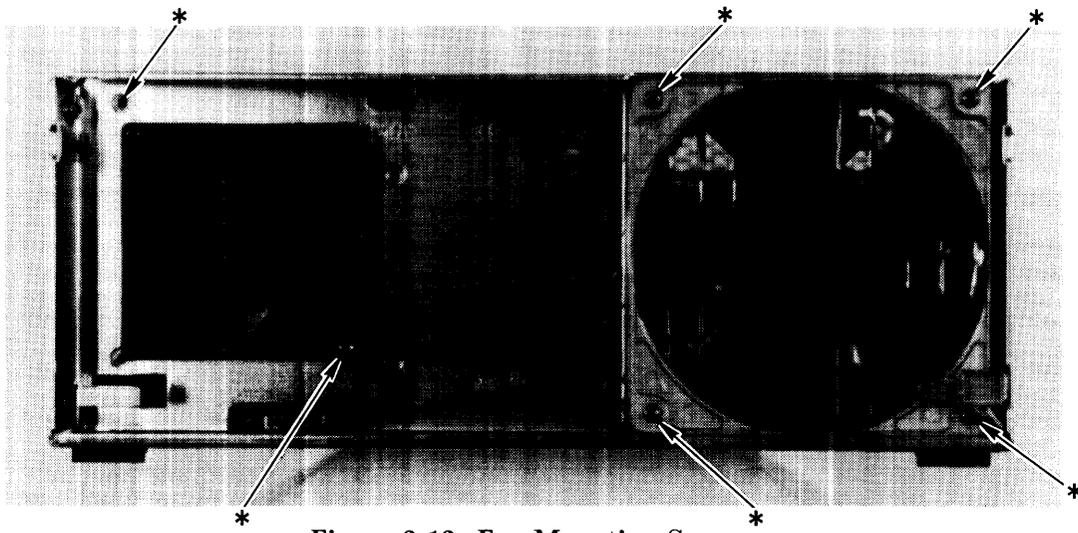
Figure 2-12. Fan Mounting Screws

4. While holding the fan in place with one hand, remove the other mounting screw from the fan.

4. Remove the fan.

5. To install the fan, reverse steps 1 through 3.

DIO Card Cages

DIO card cages come in 2- and 4- slot versions for the computer or HP 98570A expander. For the HP 98568A Opt. 132 expander, two 4-slot card cages are used. Replacement procedures are given for each type.

Preliminary Requirements

Turn the unit off. Remove the power cord and these items:

1. All cables from DIO cards in the slots.

2. DIO slot cover if installed.

3. Power supply access cover.

4. Remove the expander from the computer if the computer's 2- or 4-slot DIO card cage is to be removed.

5. Top cover.

Procedure

1. Disconnect the DIO ribbon cables from the motherboard.

2. Remove the screw holding the right side of the DIO card cage to the card cage bracket. Refer to Figure 2-13.

   a. If a 2-slot DIO expander is installed, the card cage bracket is a separate metal piece that slips into the slot on the right side of the computer.

   b. If a 4-slot DIO expander is installed, the card cage bracket is a tab that is part of the sheet-metal chassis on the right side of the computer.
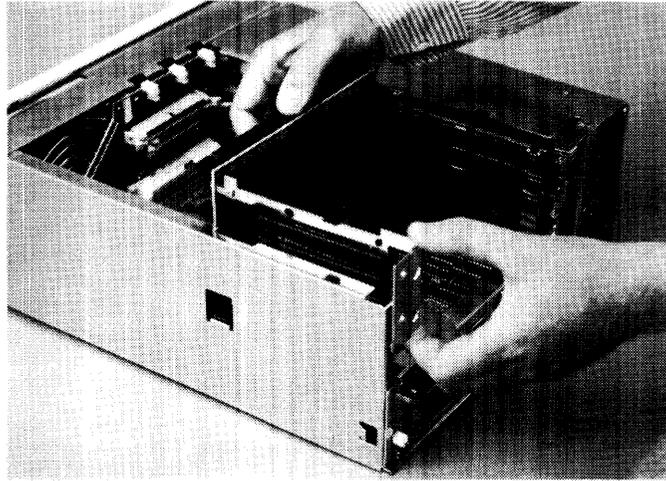
Figure 2-13. DIO Card Cage Bracket

3. Remove the screws holding the card cage to the chassis. Refer to Figure 2-14.
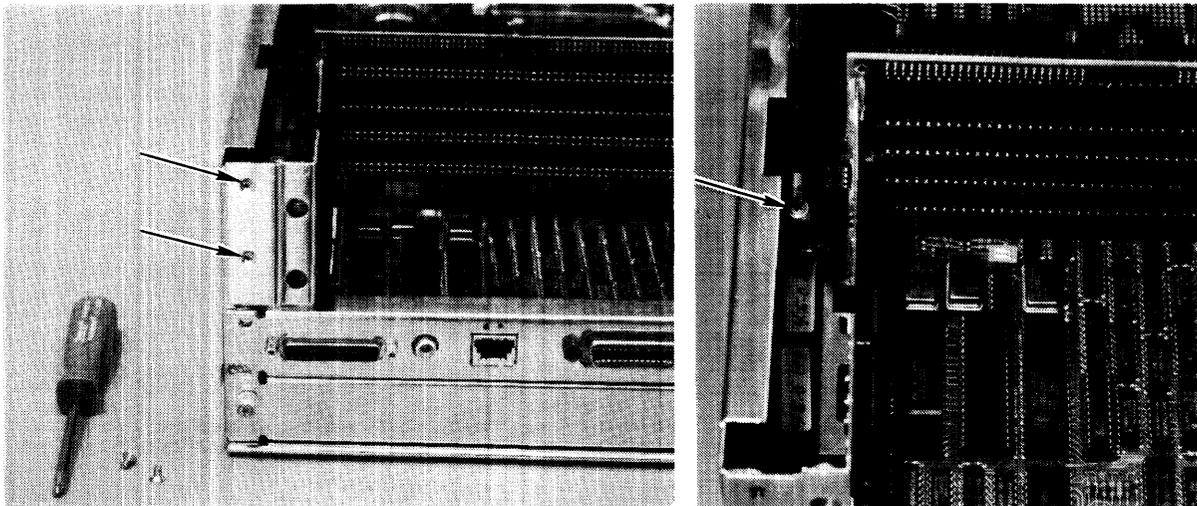
Figure 2-14. DIO Card Cage Screws

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

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

DIO Backplane

Each 2- and 4-slot DIO adaptor has a backplane for cards to connect to. When this backplane needs to be replaced, here's what you need to do.

Remove these parts first.

1. Power cord after turning the unit off.

2. Power supply access cover.

3. Top cover.

4. DIO adaptor.

Procedures

CAUTION

Note the motherboard DIO-II and backplane DIO connectors each ribbon cable is attached to. Mark the ribbon cables, if necessary to help you remember.

When replacing the backplane, these ribbon cables must be reconnected correctly. So, please watch out and put it back together right.

---

1. Note what ribbon cable is attached to the motherboard and backplane connectors, then remove the ribbon cables from the backplane.

2. Remove the screws holding the backplane PC board to the card guides. The number of screws will differ depending on the specific backplane.

Note

If the DIO backplane is installed with the ribbon cables hooked up to the backplane's top two connectors and a DIO card is installed, the card won't work. There are no power traces from the top backplane connectors to the DIO card slots. **Ribbon cables must connect only to the bottom backplane connectors.**

---

3. To install a backplane, reverse these steps.

Fan Housing

Preliminary Requirements

Turn the unit off. Remove the power cord plus these assemblies:

1. All assemblies from the DIO and/or system slots.

2. Front panel.

3. Power supply access cover.

4. Power supply.

5. Top cover.

Procedures

1. Disconnect any attached ribbon cables from the motherboard.

2. Disconnect both fan connectors from the motherboard.

3. Remove the four screws holding the fan housing in place. Refer to Figure 2-15.
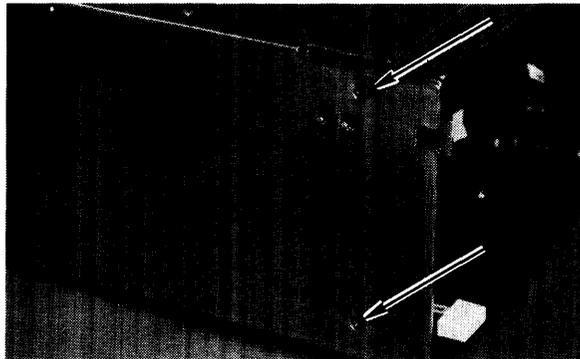
Figure 2-15. Fan Housing Screws

4. Pull the fan housing forward and remove it.

5. To install the fan housing, reverse steps 1 through 4.

Motherboard

Depending on the unit and its upgrades, different motherboards will be encountered. These procedures apply in all cases. Differences are shown relating to specific motherboards.

Preliminary Requirements

Turn the unit off and remove the power cord. Then remove these assemblies:

1. All boards from the system slots.

2. Power supply.

3. Top cover

4. Front panel.

5. Ribbon cables to motherboard.

6. Fan housing.

Procedure

1. Remove the LED and both fan wire connectors from the motherboard.

2. Remove the screws holding the motherboard to the fan housing, and remove it. Refer to Figure 2-16a, -16b, or -16c, depending on the unit.

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

Removal Screws *****
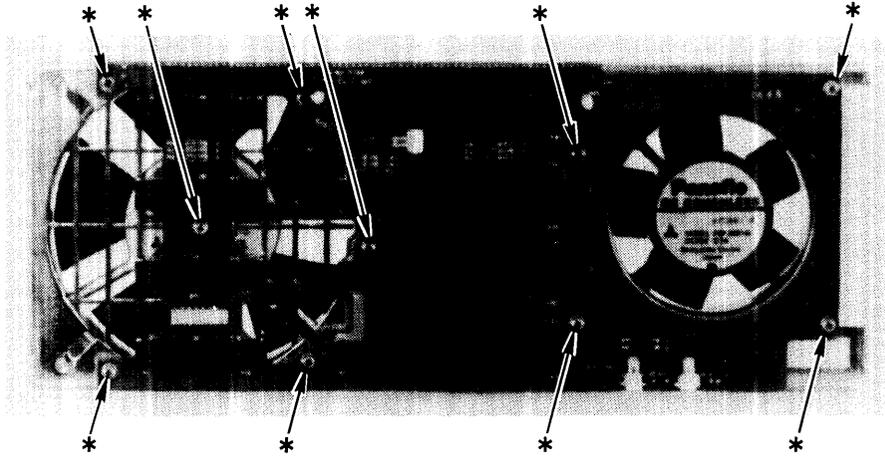
Figure 2-16a. Computer Motherboard Screws
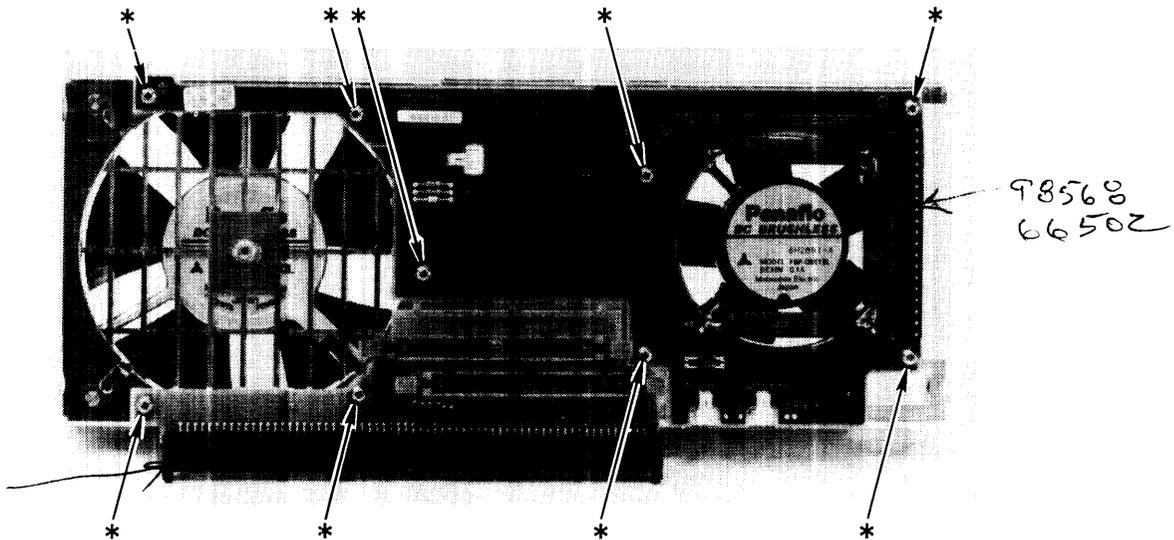
Figure 2-16b. HP 98568A Opt. 132 Expander Motherboard Screws
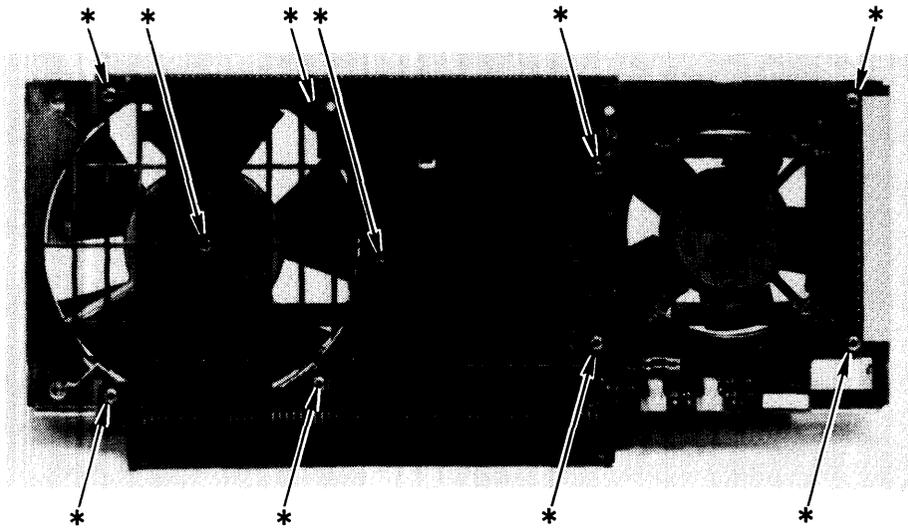
Figure 2-16c. HP 98570A Expander Motherboard Screws

Card Guides

Card guides on the left-hand side (power supply side) of the cage just snap into place. They may be removed by carefully unsnapping them.

Be sure they are replaced correctly, with the correct end toward the front and back of the unit.

Test Items

1. Models 360/370 support the same RAM as Models 330/350 except:

    a. The Model 360 does not support ECC RAM (HP 98264A/B).

    b. The Model 360 does not support the parity RAM (HP 98258A/B/C)

    c. The Model 360 has new RAM which is not supported by the Models 330/350.

    d. All of the above.

2. Which of these integrated circuit chips are found on the Model 330 processor board but not on the Model 360 processor board?

    a. MC68020

    b. MC68881

    c. MC68551

    d. All of the above.

3. Which of the boards or assemblies function with the Model 360/370 but not with the Model 330/350?

    a. The HP 98577A VMEbus Expander.

    b. The HP 98550A High-resolution Color Video Board.

    c. The HP 46084A ID Module.

    d. None of the above.

4. Which of these statements is correct?

    a. Model 360 disassembly/reassembly is identical to the Model 330.

    b. Model 360 disassembly/reassembly is identical to the Model 330 unless there is more than 4 Mbytes of RAM involoved.

    c. Model 370 disassembly/reassembly is somewhat similar to the Model 330.

    d. Model 370 disassembly/reassembly can not be compared to the Model 330.

5. Which of these statements is correct?

    a. Model 370 disassembly/reassembly is identical to the Model 350.

    b. Model 370 disassembly/reassembly is identical to the Model 350 unless there is an HP 98248B Floating-point Accelerator involved.

    c. Model 370 disassembly/reassembly is somewhat similar to the Model 350.

    d. Model 370 disassembly/reassembly can not be compared to the Model 350.

After you have answered all test items, turn to the back of this lesson and grade yourself from the Answers Sheet. If at least 80% of your answers are correct, you've successfully completed this quiz. If less than 80% of your answers are correct, you should review the areas of the lesson the missed test items cover.

Answers to Quiz 1

1 d

2 d

3 d (They all function with all Models 330/350/360/370)

4 b

5 b

Your Comments, Please.

Now's a good time to write down your comments regarding this lesson.
Refer to these comments when filling out the Course Evaluation.

Functional Description

2

Instructions

This lesson covers the subject of Models 360/370 Functional Description. When you have finished reading the Chapter, take the test at the end.

Functional Description   **3**

Introduction

Computer Overview

Models 360 and 370 are improved versions of the Model 330 and 350. They were redesigned for higher performance to meet the compute-intensive requirements for design automation, as well as scientific analysis, and general purpose computation. They are similar in construction and use the same power supply.

Expander Overview

Two direct-connect expanders permit additional accessory boards and cards to be used in the computer system. Each attaches directly to the computer through a solid connector between their motherboards.

In the expanders, the board and card slots are identified below. Depending on the version, there are:

- Two system and four standard DIO slots in a standard HP 98570A expander.

- Four system slots in an HP 98570A expander with a delete option for the four DIO slots.

- Eight DIO slots in an HP98568A Opt. 132 expander.

Computer Architecture

Here's an overview of the architecture used in the Model 360/370 computers. You'll note that these computers provide the peak performance potential of the Motorola architecture and maintain Series 300 compatibility.

Model 370 Cache-Based Design

The Model 370 employs a cache-based design. It has a large cache to accomodate the 33 MHz clock rate of the CPU and is 64 Kbytes in size. In addition, the Model 370 provides fast access times to high-speed RAM over a synchronous bus, the system bus. The system bus is connected between the processor board and RAM assemblies via a special system slot cover plate.

Figure 3-1 is a block diagram of the Model 360/370 architecture.
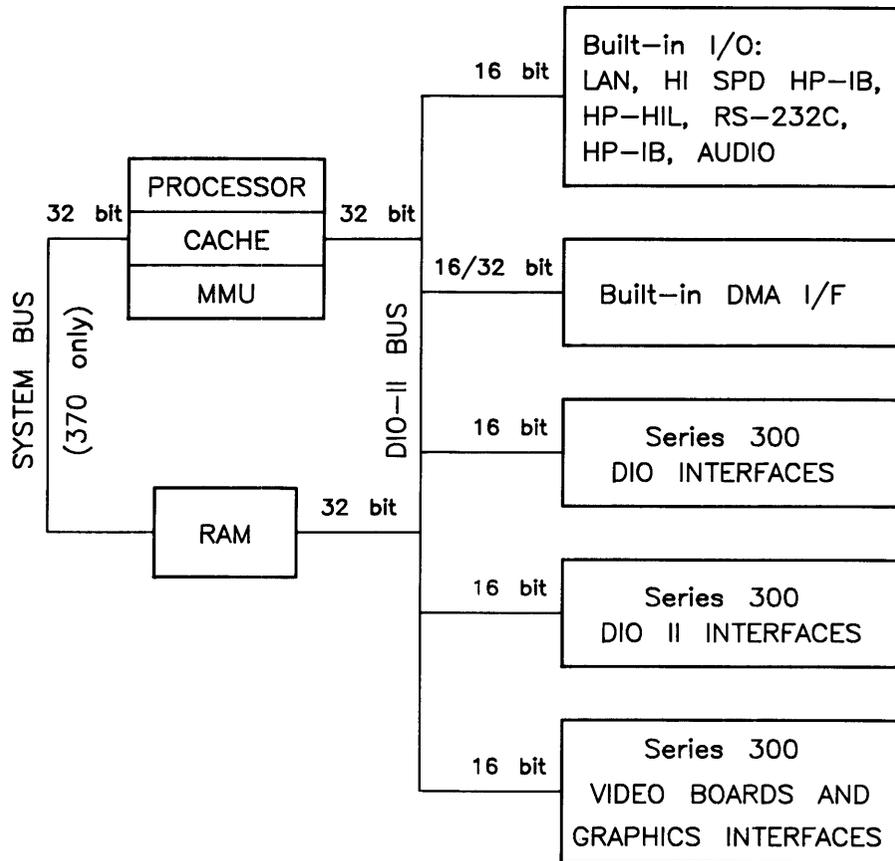
Figure 3-1. Model 360/370 Architecture Diagram
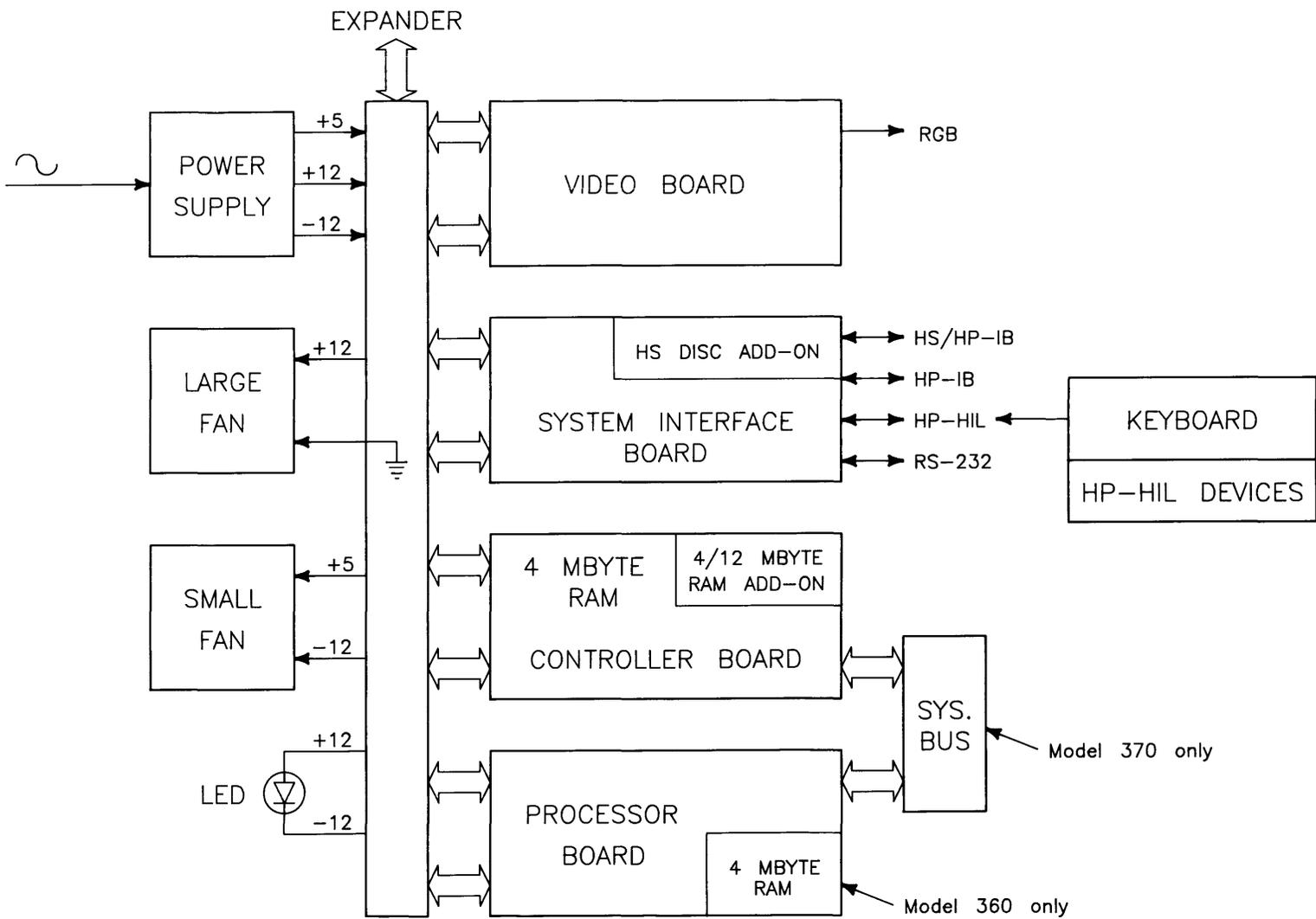
Figure 3-2. Model 360/370 Block Diagram

RAM is 32 bits wide. The cache fills at 23 Mbytes per second. The architecture comprises separate system bus (memory) and I/O busses. RAM is a dual-port design so the CPU and the I/O subsystem access RAM very nearly simultaneously, without contending for bus control. System performance is enhanced by the MC68030 executing program code with minimal conflict from I/O traffic to and from the disk drive.

Computer Packaging

Each is packaged in a Series 300 chassis like the Models 330 and 350. For most applications, an expander is not necessary.

The computer has four system slots for the processor, RAM board, system interface board, and video board. Each system slot is part of the new DIO-II 32-bit backplane. DIO-II is made up of a two-connector system. The first is identical to the Series 200/300 DIO connector. A second, or DIO-II connector adds eight address lines, sixteen data lines and more control lines. When used with the signals on the DIO connector, they allow 32-bit address and data transfers. DIO-II is designed to be compatible with DIO in two ways:

- DIO bus masters, like the DOS Co-processor, can talk to DIO-II boards.

- DIO-II bus masters like the processor and DMA on the system interface board, can talk to DIO accessory and video cards.

System Implementation

Figure 3-3 is a diagram of a typical configuration.

Processor Board

- **Model 360** -- 25 MHz MC68030, 25 MHz MC68882 coprocessor, 4 Mbytes RAM.

- **Model 370** -- 33 MHz MC68030, 33 MHz MC68882 coprocessor, 64 KByte cache.

RAM Boards

The following RAM boards are supported in the computer system:

- HP 98258A 4 Mbyte RAM Controller Board (Model 370 only).

- HP 98258B 4 Mbyte RAM Add-On Board (installed on the 4 Mbyte RAM controller board in a Model 370 only).

- HP 98258C 12 Mbyte RAM Add-On Board (installed on the 4 Mbyte RAM controller board in a Model 370 only).

- HP 98264A 8 Mbyte Error Checking and Correcting (ECC) RAM Board Assembly (installed in a Model 370 only).

- HP 98264B 16 Mbyte Error Checking and Correcting (ECC) RAM Board Assembly. (installed in a Model 370 only).

- HP 98267A 4 Mbyte add-on RAM Board (Model 360 only).

- HP 98267B 8 Mbyte add-on RAM Board (Model 360 only).

- HP 98267C 12 Mbyte add-on RAM Board (Model 360 only).

Standard RAM configurations are:

- **Model 360** -- Includes 4 MBytes on processor board.

  One 4, 8 or 12 Mbyte add-on RAM board may be added for a maximum of 16 Mbytes.

- **Model 370** -- Includes one 2-board 8 Mbyte assembly: one 4 Mbyte RAM Controller Board with a 4 Mbyte Add-On.

  Options convert the 8 MBytes to 16 MBytes by replacing the 4 Mbyte add-on with a 12 Mbyte add-on. Additional RAM is available to extend total RAM to 48 MBytes.

System Interface Board

A Single-board I/O system includes HP-HIL, HP-IB, RS232, LAN (either BNC or 15-pin connector), beeper, DMA, and may have the optional high-speed HP-IB disk interface or Small Computer Systems Interface (SCSI). It may be located in the HP 98570A expander.

Video Boards

These computers support the same monitors as Models 330 and 350. These bit-mapped Video boards include both medium and high resolution color and monochrome versions.

Model 360/370 computers support the following video boards:

- HP 98542A Medium-resolution Monochrome Video Board

- HP 98543A Medium-resolution Color Video Board

- HP 98544A High-resolution Monochrome Video Board

- HP 98545A High-resolution Color Video Board

- HP 98546A Display Compatibility Interface Card (requires DIO card cage)

- HP 98547A High-resolution Color Video Board

- HP 98548A High-resolution Monochrome Graphics Board

- HP 98550A High-resolution Color Graphics Board

- HP 98287A Interface to the HP 98700A Graphics Display Station (Requires DIO card cage)

Refer to the Series 300 Configuration Reference Manual for the current list of supported video boards.

Direct-Connect DIO or System Slot Expanders

An extension of the DIO and/or DIO-II interface bus using identical power supplies as the computer. Different slot sizes and quantities are available, depending on the expander and options.
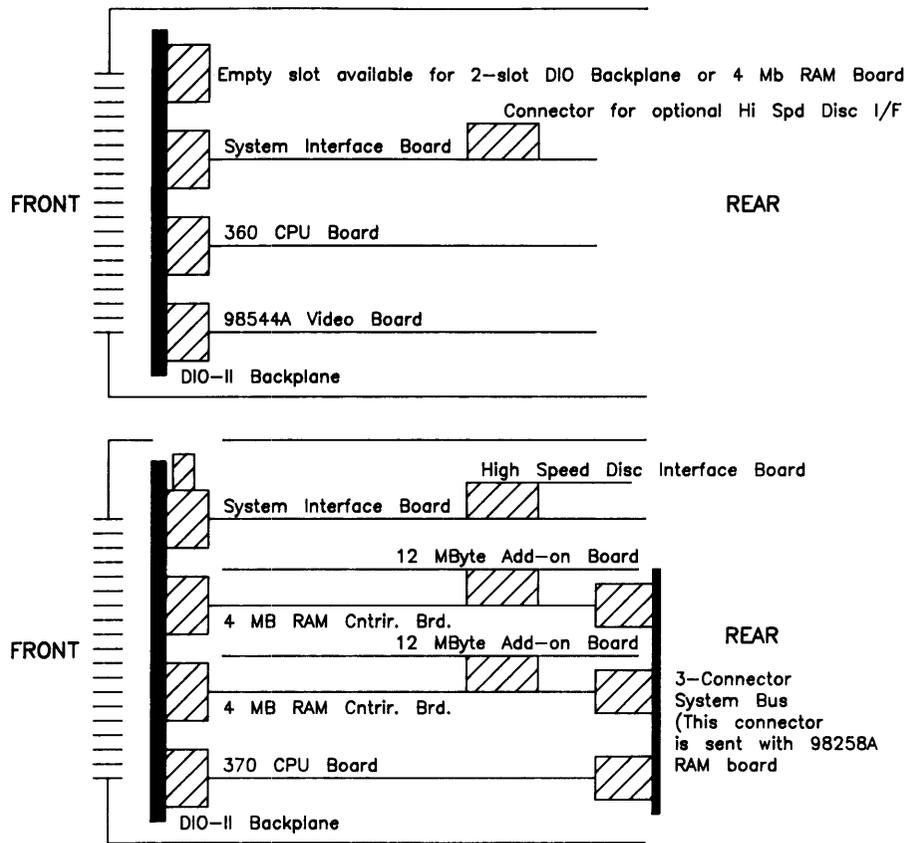
Figure 3-3. Model 360/370 Computer Configuration

System Interface Board

Human Interfaces

The system interface board is designed to meet most, if not all of the computer's human interface needs in a single system slot. It integrates RS-232, HP-IB, Audio, HP-HIL, Battery backed real time clock, LAN, DMA, and an optional high-speed disk HP-IB interface.

To maintain software compatibility, the designs of other interface cards are used. These cards are the HP 98625B, 98643, 98620B, and the original DIO size Series 300 human interface card. Each of these four sections of the board operates independently.

The LAN portion of the system interface board is software compatible with the current Series 200/300 DIO card (HP 98643A). Two versions of the LAN interface are available:

- On the 98562-66533 system interface board, the MAU (medium attachment unit) circuits are built into the board and, with a BNC "T" connector, connects directly to the LAN coaxial cable.

- On the 98562-66534 system interface board, no MAU circuits are on the board and a 15-pin connector is used for the LAN cable. An external MAU is required.

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

Add-on Interface
The System Interface Board contains a mechanical and electrical connection for adding an optional interface. At this time, there are two choices for the optional interface:

- a high-speed HP-IB interface optimized for disk storage

- a Small Computer System Interface (SCSI)

Monitor Compatibility
Both models support the current Series 300 video boards and display systems.

- 512 by 400 monochrome and 4 plane color.

- 1024 by 768 monochrome and 6 plane color.

- HP 98720 1280 by 1024 Solid Rendering Display System.

- HP 98720H 1024 by 768 Graphics Display Station.

- HP 98730 1280 by 1024 Solid Rendering Display System.

- HP 98730H 1024 by 768 Graphics Display Station.

Direct-Connect Expanders
Two expanders are available for these computers. Each connects to the computer through a rigid connection to the motherboard. Only one can be used at a time.

HP 98568A Expander, Opt.132
Option #132 modifies the existing HP 98568A to support the 32-bit DIO-II backplane. It adds eight DIO slots to the system in the same way that the HP 98568A without the option adds DIO slots for the Models 330/350, but with a different physical connection.

Support for DIO cards follows the same rules as for Models 330/350: interface cards may only be located in every other slot. Accessory cards may be installed in any slot. And since the smaller DIO-RAM (256K and 1 Mbyte) boards and DMA accessories don't work, for all practical purposes this 8-slot expander is really a 4-slot DIO interface expander.

HP 98570A Expander
This expander adds two DIO-II system slots and four DIO slots. An available option deletes the 4-slot DIO backplane and converts the 98570A to 4 system slots.

HP 9888A Expander
For 16 slots, the HP 9888A is plugged into any available DIO slot in the computer. Up to two HP 9888A expanders are supported and provide 16 functional DIO slots (a total of 32 DIO slots) for interface cards.

Accessory cards which act as busmasters are not supported in the HP 9888A Expander.
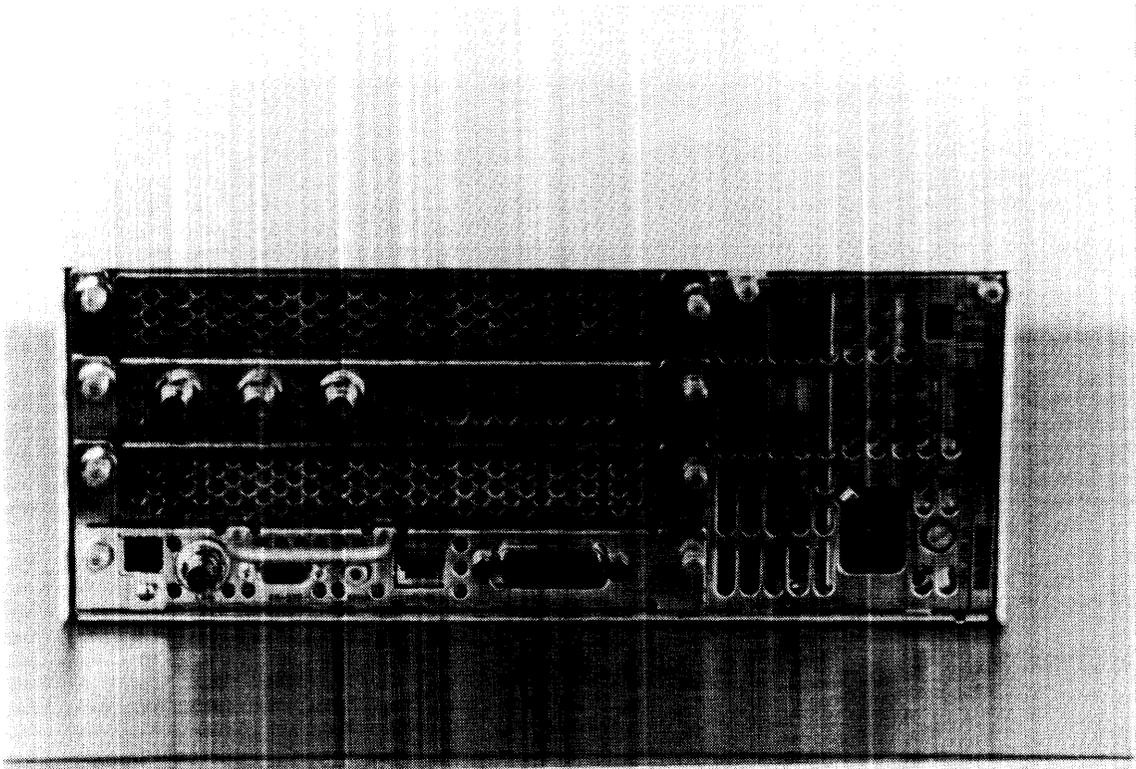
Figure 3-4. Computer and Expander Back Panels

DIO Adapters

Upgrades are available to convert the larger system board slots to smaller DIO card slots in the computer or the HP 98570A expander. Only one upgrade may be located in the computer.

HP 98242A 4-Slot DIO Adapter

This adapter converts two system slots to four DIO slots. The HP 98242A is standard in the HP 98570A Expander, but may be deleted using Option 004. For customers who delete it when they purchase the expander, but later wish to add it, the adapter is also available separately.
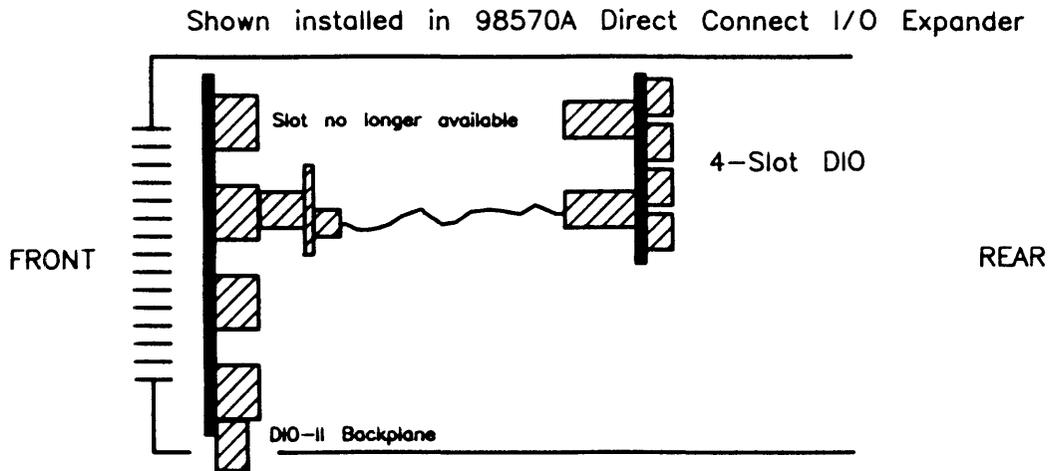
Figure 3-5. HP 98242A 4-Slot Adaptor Diagram

HP 98242B 2-Slot DIO Adaptor

The second adapter converts one system slot to two DIO slots. Use it with Model 370 when no bit-mapped video board is used, such as terminal-based multi-user systems . Some bundled systems will have it installed to accommodate the HP 98700A's DIO interface card.

DIO interface cards may only be located in every other slot. HP 98256/7 RAM cards are not supported. Thus, the 4-slot DIO upgrade is essentially a 2-slot upgrade, and the 2-slot upgrade is essentially a single slot upgrade.
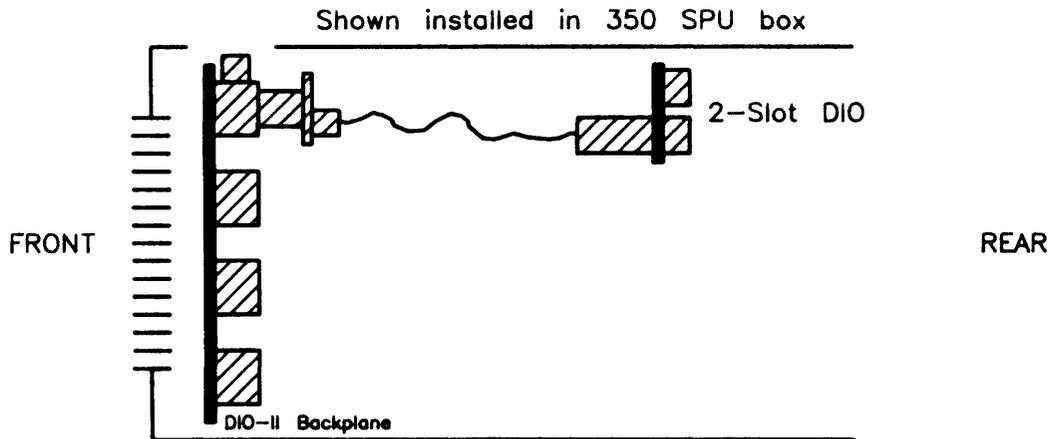
Figure 3-6. HP 98242B 2-Slot Adaptor Diagram

Power Supply

Introduction

Both computers and expanders use this power supply. The power supply provides all power to the assemblies installed in the unit. It is a non-adjustable switching supply that is an exchange assembly.

Power Supply Characteristics

Power supply characteristics are

- Operates on 120 or 240 V ac, 50-60 Hz.

- Outputs these voltages:

    - +5 V dc

    - +12 V dc

    - −12 V dc

- Power-Up RESET signal sent to processor board to initialize CPU.

Maximum power consumed by the computer or expander is 250 watts. For the computer, power consumption by the power supply and assemblies in the system slots is included in the 250 watts. The remaining 147 watts is available for assemblies in the units system or DIO slots. In the expander, most of the power is available for system boards or DIO cards.

The following table shows the power available to all combined motherboard, DIO, and system slots for Model 360/370 computers and HP 98568A Opt. 132 and HP 98570A expanders.

Voltage	Power Available	Current Available
+5 V dc	95 Watts	19 Amps
+12 V dc	40 Watts	3.3 Amps
−12 V dc	12 Watts	1 Amp

CAUTION

When boards are installed in the unit, they use power and the amount left over is less than shown in the table above.

Before installing boards or cards in the unit, ensure the total maximum power consumed by all cards and boards for each voltage in the unit does not exceed the power available at that voltage. If the board or card to be installed require more power than is available, damage to the accessory or computer/expander may result. Refer to the Service Handbook, Chapter 3.

Figure 3-8 is a block diagram of the power supply used in the computer and expander.
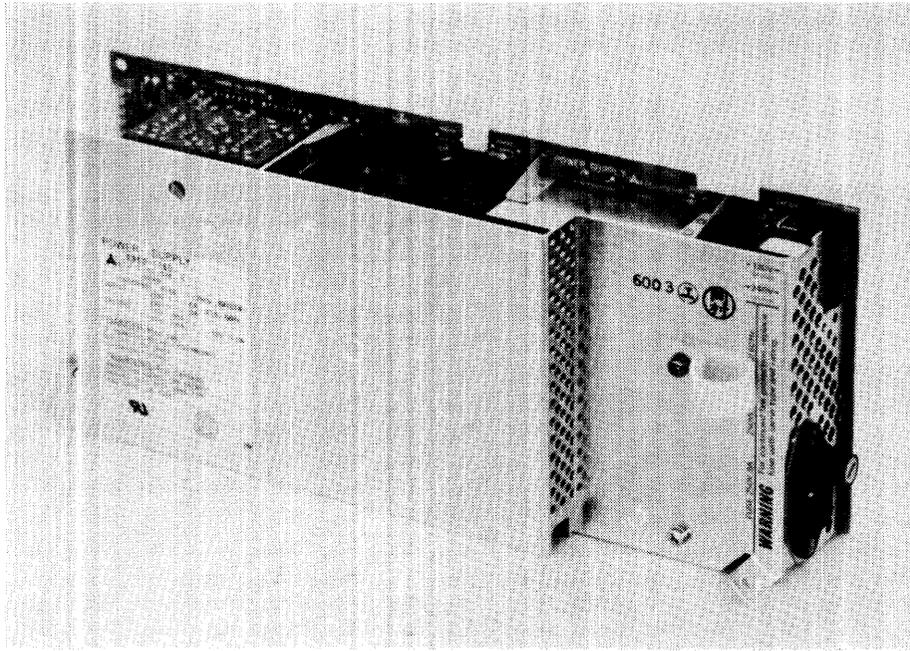
Figure 3-7. Computer/Expander Power Supply

Figure 3-8. Power Supply Block Diagram
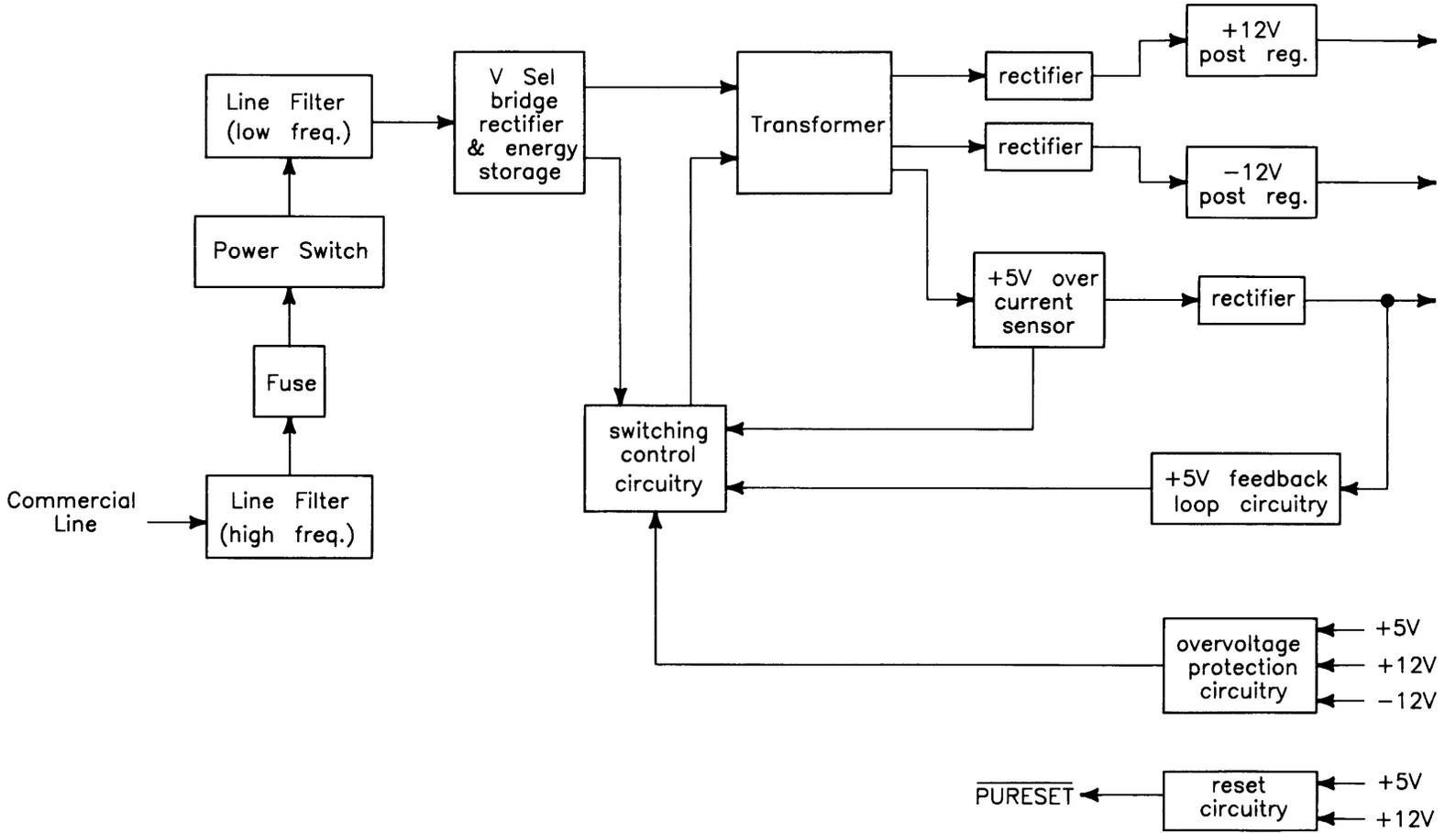
Input Section

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

- High Frequency Filtering.
- Fusing.
- 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 in Table 3-1.

Table 3-1. Voltage Ranges and Fusing

Voltage Setting	Tolerance	Fuse Rating
120 V ac	+10%, −25%	8AF 250 Volt
240 V ac	+4%, −19%	8AF 250 Volt

The fuse rating 8AF means an 8 ampere fuse with a type F delay before opening. 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 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 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 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 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 assemblies installed in the unit. Figures 3-9 and 3-10 shows how power is distributed in the computer and expander.
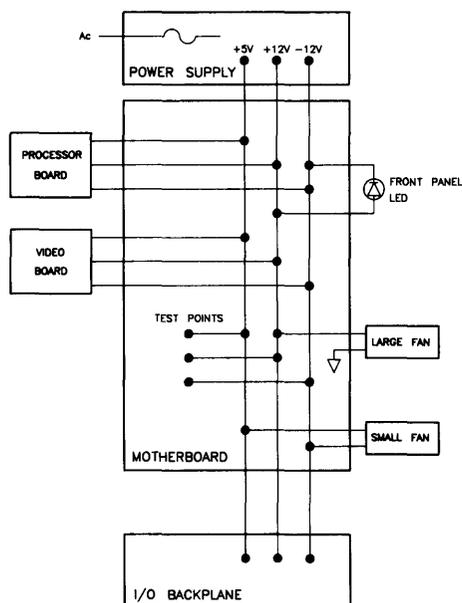
Figure 3-9. Computer Power Distribution
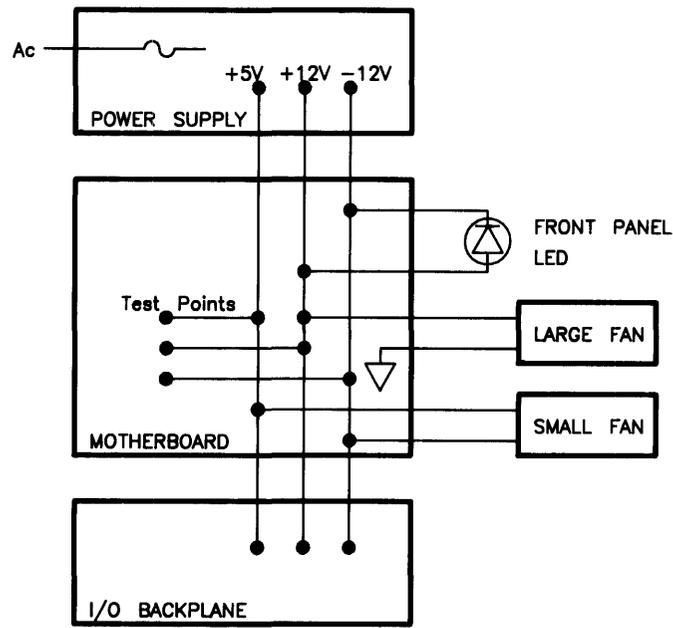
Figure 3-10. Expander Power Distribution

Power supply outputs are distributed through the motherboard. Test points are located on the motherboard and are accessible behind the front panel.

CAUTION

When custom designed accessory cards are being used in the DIO or DIO-II slots, their power consumption must be added to all cards and boards used in the unit. Information regarding the design of custom accessory cards is contained in the HP 9000 Series 300 Model 360/370 Accessory Development Guide, part number 98562-90010.

When the DIO adapters are installed, power is distributed through the ribbon cables from the motherboard to these DIO backplanes connectors:

- Bottom connector on 2-slot DIO adapters.

- Bottom and next to top connector on 4-slot DIO adapters.

None of the other ribbon cable connectors have traces connecting power from the ribbon cable to the DIO slots. DIO interface accessories will get power only when connected in the bottom of each pair of DIO slots. Only data and control traces connect the top of each pair of DIO slots to the bottom one.

Motherboard

Introduction

Each unit has a different motherboard. This is necessary for the different connectors and shapes used for the computer and the two expanders. Refer to Figure 3-11 for the differences.

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 board.

Functions

Power is connected from the motherboard to the optional DIO backplane via a ribbon cable. In the computer, boards in the system slots are powered directly from the motherboard through two system slot connectors. Voltage test points are on the back of the motherboard and are accessible from behind the front panel.

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.

The top of the motherboard is a large connector to interface with expanders. Data, control, and status signals are ported through this connector. There are no active components on the motherboard. Both the computer's and expander's motherboard have the same part number.
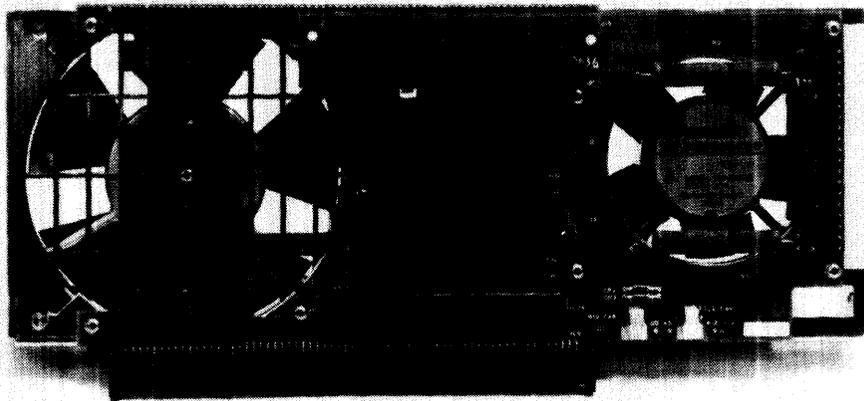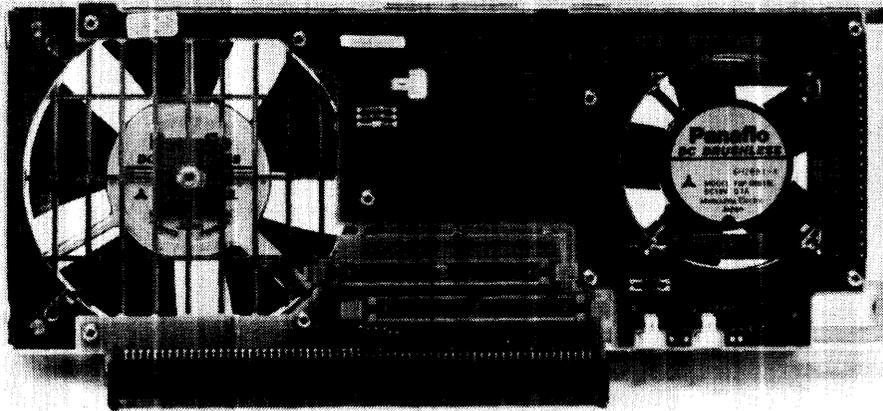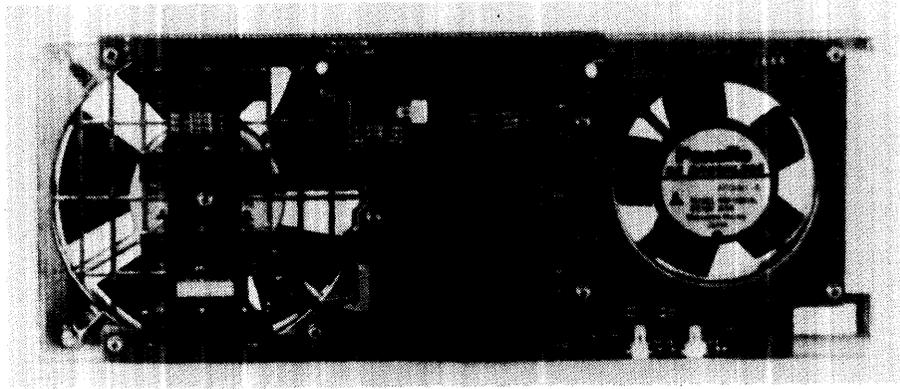
Figure 3-11. Computer and Expanders Motherboards

HP 98242 DIO Backplane Board

Introduction

DIO backplanes are used as an option for the computer and standard in expanders.

Two versions are used:

- 2-Slot, used as an option to the computer and HP 98570A expander.

- 4-Slot, used as an option to the computer and HP 98570A expander. Two of these are used in the HP 98568A Opt. 132 expander for eight DIO slots.

Functions

Each expands a single motherboard DIO bus connector to either two or four slots for use with Series 200 or 300 accessory or interface cards. Function wise, they're no more than an extension of the DIO connector on the motherboard.

There are no active components on the DIO backplane boards or their associated ribbon cables.

Model 360 Processor Board

Introduction

The Model 360 processor board has the following major parts:

- 25 MHz MC68030 CPU.
- 25 MHZ MC68882 Floating-Point Coprocessor.
- MC6840 Timer.
- Boot ROMs.
- Self-Test LEDs.
- 4 Mbytes of RAM.

The Model 360 processor can be viewed as a Model 350 processor board combined with an HP 98258A RAM board (controller and 4 Mbyte RAM array). The RAM controller occupies the space created when the memory management circuitry was moved into the 68030 processor chip.

Refer to Figure 3-12 for the following descriptions.

Central Processing Unit

An MC68030 CPU is used on the Model 360 processor board. It is clocked at 25 MHz.

On-Board RAM

Memory on the Model 360 processor board is similar to the 4 Mbyte RAM controller board. It's like the RAM controller board, but simpler in operation. It is completely auto-configuring, rather than being switch-addressed. A comparison between the RAM section of Figure 3-12 and the RAM controller diagram in Figure 3-15 shows the difference.

RAM Configuration
All Model 360 RAM is auto-configuring.
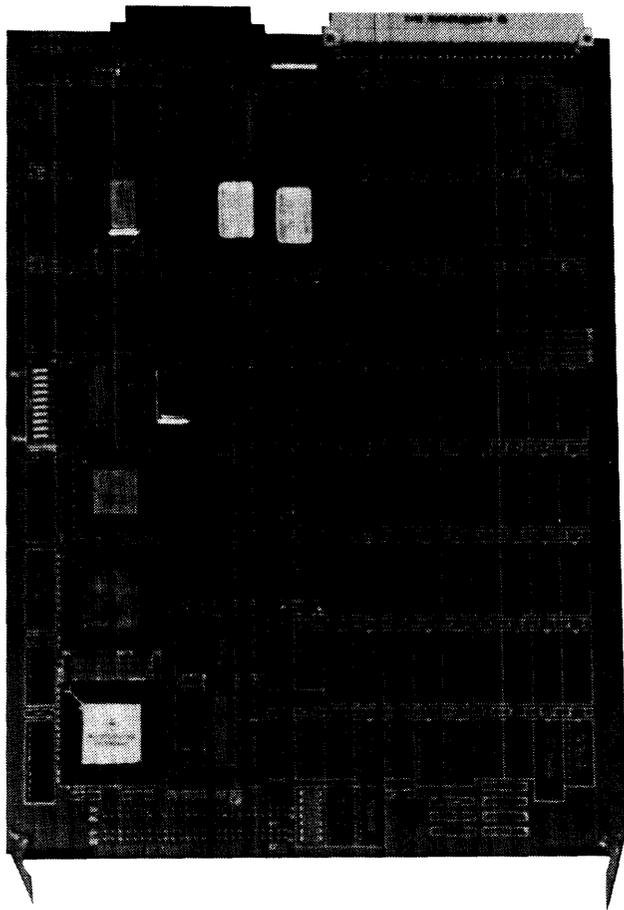
Figure 3-13. Model 360 Processor Board
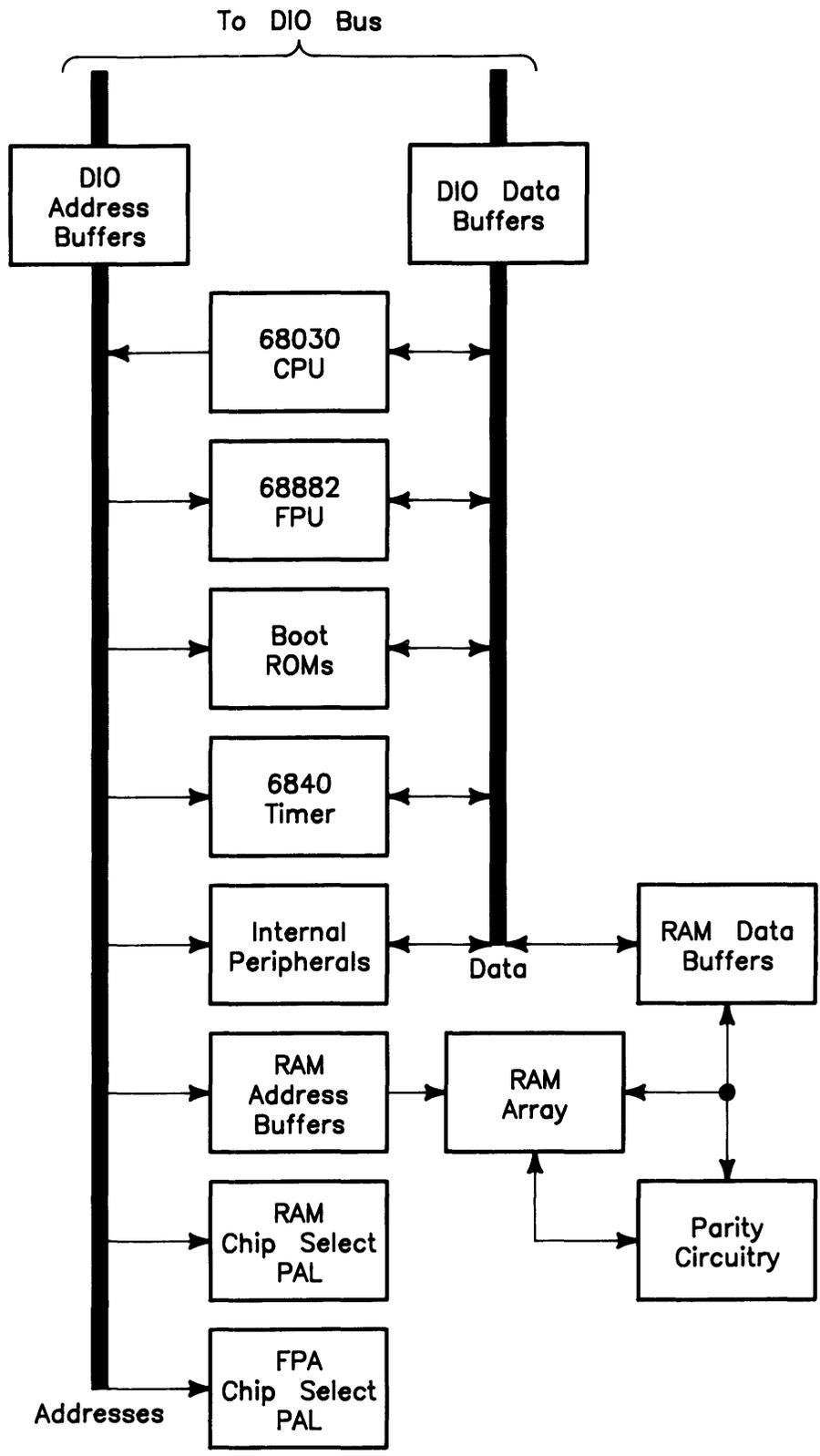
Figure 3-14. Model 360 Processor Board Block Diagram

Model 370 Processor Board

Introduction

This high-performance processor board for the Model 370 computer has:

- 33 MHz MC68030 CPU.
- 33 MHz MC68882 Floating Point Co-processor.
- 64 Kbyte direct mapped instruction/data cache.
- MC6840 Timer.
- Boot ROM.
- Self-Test LEDs.

Figure 3-16 is a block diagram of the Model 370 processor board. Refer to this diagram for functional descriptions.

Central Processing Unit

A Motorola MC68030 CPU functions as the CPU on this board. Its asynchronous data bus is 32-bits wide for both addresses and data. The Model 370 supports 48 Mbytes of RAM , although the MC68030 chip can actually address a larger amount. Operating at 33 MHz, it is significantly faster than other workstation CPUs.

The CPU has 57 instruction types and handles 7 major data types. It also has 18 addressing modes, 6 maskable and 1 non-maskable interrupt levels. Six stack frames exist in the MC68030.

Coprocessor

A floating-point coprocessor is used to increase system performance when certain floating-point math routines are part of the application. An MC68882 chip performs these functions. It implements the required IEEE standard capabilities.

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

Memory Management

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

Both the logical and physical address spaces are divided up into 4 Kbyte pages. The MMU provides the capability to map any logical page into any physical page. Write protection is provided by the MMU at the page and segment level. The table structure is the same as the Model 350 computer's MMU; this similarity allows software compatibility.
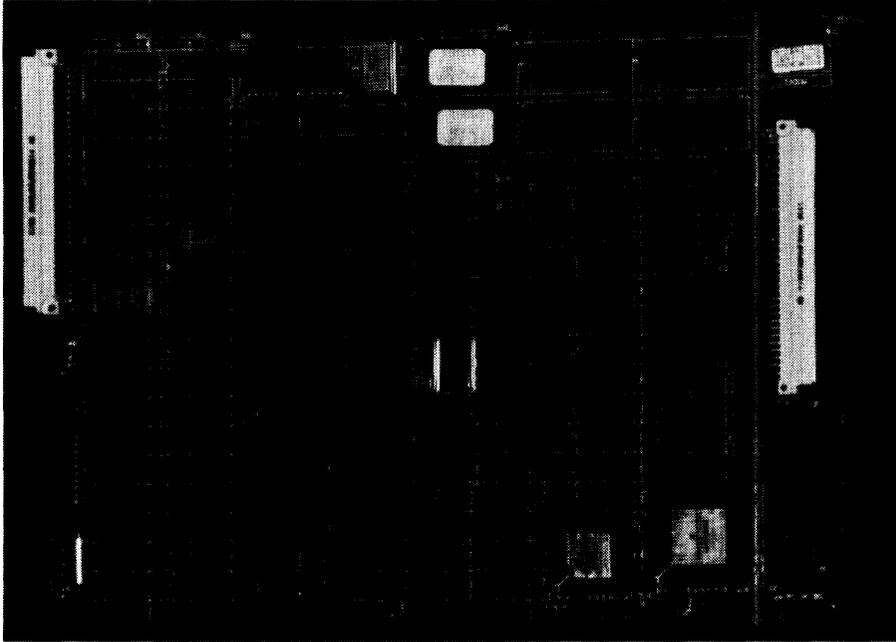
Figure 3-15. Model 370 Processor Board
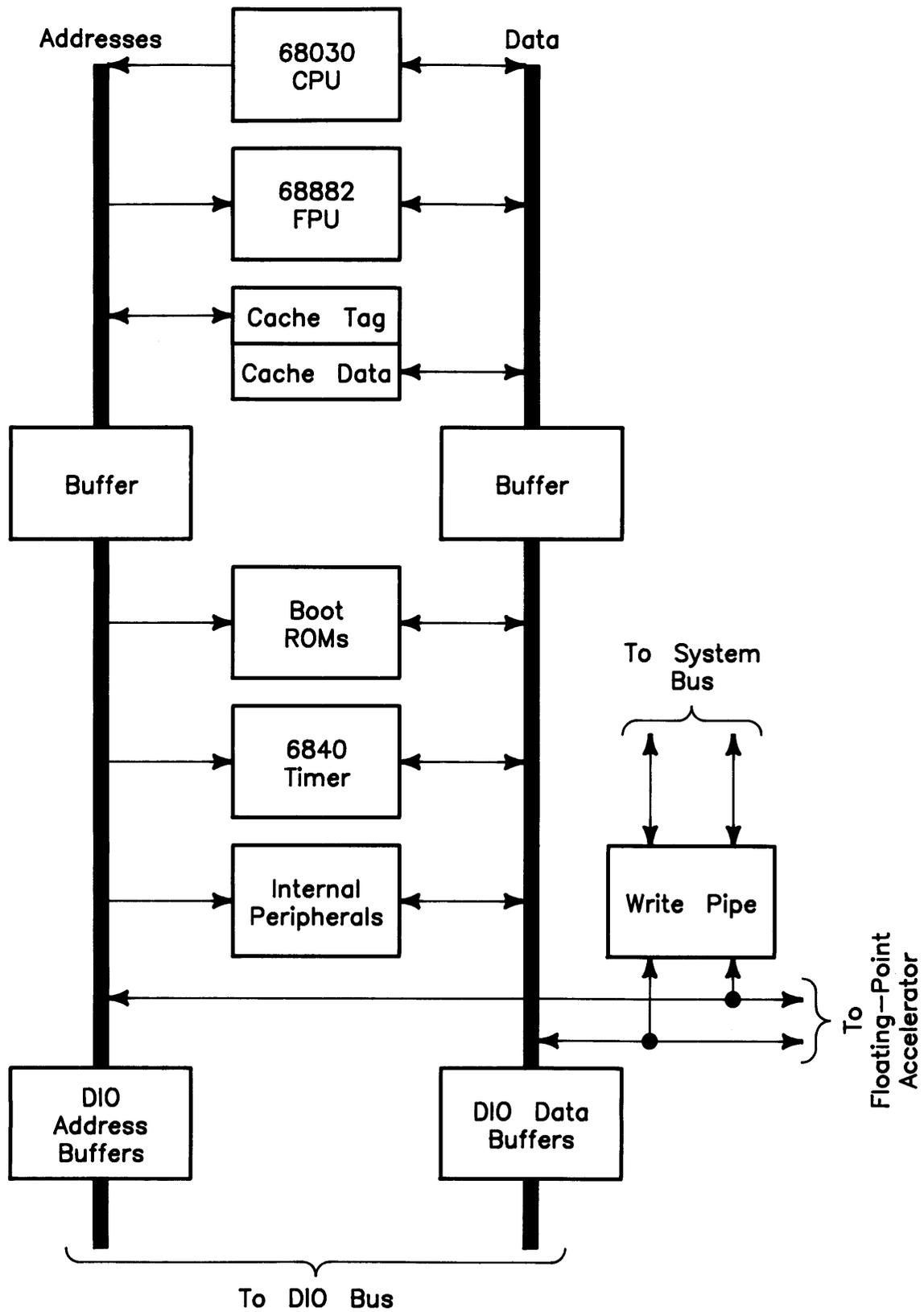
Figure 3-16. Model 370 Processor Board Block Diagram

Translation Tables

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

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

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

Translation Lookaside Buffer

The TLB is a cache for address translations. When a translation has been completed, it is stored in the TLB so that a complete translation doesn't always need to be done when that logical address is accessed again. The organization of the TLB is a fully-associative cache. The depth of the TLB is 22 entries.

Because the TLB stores data from main memory, any changes in the translation tables must be followed with either a complete or selective purge of the TLB. The TLB must also be purged whenever the root pointers are changed. The 68030 processor automatically purges the entire TLB whenever either of the root pointers are written.

Cache

On the processor, a 64 Kbyte physical cache is used for data and instructions. It is a static memory array that is fast enough to allow the CPU to read data in two clock states, or 60 ns. This cache is set-associative with a set size of one. When data is coming into the cache, there is exactly one place where it can be stored. Cache is organized as 4096 lines of 16 bytes each. Hit rate of this cache is about 79% because of this larger line size.

Two banks of RAMs are used. The larger group is the cache data RAMs, where the actual data is stored. A smaller group is the cache key, where the upper bits of the address are saved. A cache entry consists of 16 bytes of data, along with 17 bits of key data.

During a CPU read cycle, the address is compared to the address in the key in the one location where that data could be stored. If the address matches, the cache data memories drive the data directly to the CPU. If the cache misses, the associated hardware will start a bus cycle to read four long words, and fill one line of the cache.

The bottom 512 Mbytes of address space cannot be cached because it is I/O space. The remaining 3584 Mbytes can be cached if desired. It is controlled by the Cache Inhibit bit in the page table entry.

More information can be referenced in these manuals:

- MC68030 Users Manual

- MC68882 Users Manual

- HP 9000 DIO-II Accessory Development Guide (98562-90010).

Boot ROM and Self-Test LEDs

A Boot ROM (actually two chips) whose instructions are executed by the CPU shortly after power up is used on this processor board.

Test LEDs are visible through the front cover slots. Different patterns of onn and off (1s and 0s) correspond to binary or hexadecimal error codes. These codes help you find out what's working and what is not.

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

Bus Architecture

Introduction

Two or three bus systems are used between the processor boards and memory or accessories and interfaces:

- System Bus -- for fast RAM read/write cycles, Model 370 only.

- DIO Bus -- for I/O operations with earlier Series 200/300 accessory cards.

- DIO-II Bus -- for better I/O operations with the newer Model 360/370 interface and video boards.

Model 370 System Bus

Memory boards are tightly coupled to the Model 370 processor through a high-speed system bus. This allows much faster memory cycles and more RAM on memory boards. The system bus supports 32-bit addresses and data increasing maximum possible memory address space to 4 Gbytes. Synchronous to the processor clock, it supports a write cycle, a read cycle, and a quad-read cycle.

A 2-slot system bus connects the Model 370 processor to one RAM controller board and support up to 16 Mbytes of RAM. When the second RAM controller board is added for more than 16 Mbytes of RAM, the 3-slot system bus connects the processor board to both 4 Mbyte RAM controller boards.

DIO and DIO-II Bus

The standard 16-bit DIO (also used in previous Series 300 computers) is used: all existing Series 300 I/O cards will function normally. DIO-II extends additional signal lines to some system slots, which allow 32-bit address and data transfer.

DIO-II supports standard Series 300 system size boards, as well as the newer 32-bit system boards. In the system slots, a second connector has been added that carries eight additional address lines, 16 additional data lines, and several new control signals. The processor drives the lower 23 address bits on DIO address lines, and drives the upper eight bits on the new address lines. The most significant sixteen bits of data are transferred on DIO lines, and the least significant 16 bits are transferred on DIO-II lines.

When the Model 370 processor is not performing I/O cycles, it does not need the DIO/DIO-II bus at all. Another bus master could obtain control of the bus while the processor continues running, using the system bus. This parallelism allows very high throughput with DMA.

DIO and DIO II are both asynchronous busses, with DIO II being a superset of DIO. The timing of DIO II has been changed from that of DIO. The master initiates a bus cycle by asserting the address and the appropriate address strobe(s) and data strobe(s). The slave then responds by taking the data off the bus during a WRITE cycle or by putting data on the bus during a READ cycle. The slave then completes the cycle by asserting one of the DTACK* (Data Transfer ACKnowledge) signals.

In DIO-II there are four distinct types of bus cycles:

- Address only.
- Single data transfer.
- Block data transfer.
- Read modify write (RMW).

DIO adaptors are available for the computer and expander to convert DIO-II system slots to 2- or 4-slots for use with standard DIO accessory cards. The earlier HP 98256A 256 Kbyte and HP 98257 1 Mbyte RAM cards are not supported in this configuration, due to bus timing and addressing differences.

RAM Boards

Introduction

This section covers the various RAM configurations found in Models 360 and 370.

Model 360 RAM

Two types of RAM boards are used in the Model 360:

- Parity-checking RAM, HP 98267A/B/C.

- Parity-checking RAM, located on the processor board.

Each of the RAM configurations is listed in Table 3-2.

Table 3-2. Model 360 RAM Boards

Product No.	Product Name
HP 98267A	4 Mbyte add-on RAM Board
HP 98267B	8 Mbyte Add-On RAM Board
HP 98267C	12 Mbyte Add-On RAM Board
none	4 Mbyte RAM array on processor board

There is a great deal of similarity between these RAM boards and the HP 98258 parity RAM boards supported by the Models 330/350.

The 4 Mbytes on the processor board are similar to the HP 98258A 4 Mbyte RAM controller board.

The HP 98267A 4 Mbyte add-on board is similar to the HP 98258B 4 Mbyte add-on board.

The HP 98267B 8 Mbyte add-on board is similar to the HP 98258B, except that it contains an 8 Mbyte array instead of a 4 Mbyte array.

The HP 98267C 12 Mbyte add-on board is similar to the HP 98258C 12 Mbyte add-on board.

However, please note that the HP 98258 RAM boards are not supported in the Model 360. If they are inadvertantly placed in a Model 360, the resulting operation will be unsatisfactory. Refer to the RAM section of the Troubleshooting chapter for a summary of symptoms.

For Model 360 computers, 16 Mbytes of RAM is supported; 4 Mbytes on the processor board and one 4, 8 or 12 Mbyte RAM controller board.

Model 370 RAM

Two types of RAM boards are used in the Model 370:

- Parity-checking RAM, HP 98258A/B/C.

- Error Checking and Correcting (ECC) RAM, HP 98264A/B.

Each of the RAM boards is listed in Table 3-3.

Table 3-3. Model 370 RAM Boards

Product No.	Product Name
HP 98258A	4 Mbyte RAM Controller Board
HP 98258B	4 Mbyte RAM Add-On Board
HP 98258C	12 Mbyte RAM Add-On Board
HP 98264A	8 Mbyte ECC RAM Board
HP 98264B	16 Mbyte ECC RAM Board

Either a 4 or 12 Mbyte Add-On board can be added to the 4 Mbyte RAM Board. With this arrangement, 4, 8 or 16 Mbytes of RAM in each system slot is possible. Maximum RAM in the system (inside the computer) is 32 Mbytes (two 16 Mbyte 2-board assemblies) for a Model 370.

HP 98264A/B ECC RAM boards may be used in the Model 370. They may be installed in addition to the HP 98258 RAM boards.

HP 98256A 256 Kbyte and HP 98257A 1 Mbyte RAM Cards are not supported on these computers; they won't function correctly.

RAM Architecture

Although the Parity and ECC boards perform their functions in different ways, the functions which they perform are quite similar. Since troubleshooting requires an understanding of the various functions rather than individual circuits, this Functional Description covers both types of boards. Thus, the following discussion covers both except in areas where it specifically states that it relates to only one.

The RAM products consist of two logical units—one which stores the data in a RAM array and one which controls accesses to the RAM array and interfaces it to the SPU. Physically, the RAM array circuitry is located on one printed circuit board, called the RAM Array board, and the control and interface circuitry is located on another board, called the Control board, although the Parity Control board contains one 4 Mbyte RAM array. The accompanying Block Diagram illustrates the functions of these units.

The feature of the Parity and ECC RAM Boards which distinguishes them from ordinary RAM boards is the ability to detect and correct or report errors. This function is accomplished by the Check Bit Generator/Checker, which functions as follows:

The RAM boards store data as a 32-bit word. HP 98258 boards use an additional four bits to store parity information. Each byte has its own parity bit.

HP 98264 boards use seven additional bits to store ECC bits. ECC bits carry error detection information in this manner: 2^{32} combinations of data bits are coded as 2^{32} legal combinations of 2^{39} bits. By carefully selecting the legal codes, no two codes differ in less than four bit locations. The codeword is recognized as illegal if a bit is in error. Further, if only one bit is in error, there is only one codeword different by just one bit. Thus, it is easy to determine which bit is incorrect. Since each bit may have only two states, the incorrect bit can be corrected by simply inverting it. This process is similar to using a vocabulary of words which are sufficiently different from each other that if you type any single letter incorrectly, there is only one possible choice for the correct word.

The Generator section of the Check Bit Generator/Checker produces the appropriate four or seven bits for each 32-bit data word. These bits are stored in the RAM array with the data word. When the data word is read, the Generator/Checker reproduces the check bits and compares them to the check bits read from the storage location. If they differ, the Generator/Checker proceeds in this manner:

- It asserts interrupt level 7 if any HP 98258 error error occurs.

- It asserts interrupt level 7 if a double-bit HP 98264 error occurs.

- If a single-bit error occurs on an HP 98264 board and the board **is not** enabled to interrupt on single-bit errors, the Generator/Checker corrects the error in the data word sent on to the SPU (it does **not** correct it in the RAM array) and finishes the requested bus cycle.

- If a single-bit error occurs on an HP 98264 board and the board **is** enabled to interrupt on single-bit errors, the Generator/Checker asserts interrupt level 2 on the DIO-II bus in addition to correcting the error as above in the data word sent on to the SPU.

The Control Board communicates with the SPU via two buses—the DIO-II Bus and the faster system bus. It contains an interface for each bus, one is called the System Bus Interface and the other is the DIO-II Interface. They have the same function—to interface to their specific bus.

During a write-to-memory operation, the SPU sends a data word to the RAM board along with the address of a storage location for the data word. During a read-from-memory operation, the SPU sends the storage location address only, and receives back the data word stored at that location.

The data word sent to the RAM board is temporarily stored in the Data_In Latch. The data is also sent to the Check Bit Generator/Checker, which generates the appropriate check bits and stores them temporarily in the Check_Bit_In Latch.

The RAM boards use dynamic RAM ICs which must be refreshed. This function is accomplished by the Refresh Controller, which generates refresh requests to the RAM Cycle Controller at the current refresh request rate.

The RAM Cycle Controller, in combination with the Refresh Controller, is the source of RAM Row Address Strobe (RAS), Column Address Strobe (CAS) and Write Enable (WE) signals. These signals are sent on to the Row and Column Multiplexor.

The address sent to the RAM board is sent to the Arbitration Controller. Since the RAM board may receive conflicting or overlapping requests via either or both of two busses (DIO-II or system), the Arbitration Controller is needed to determine which request the RAM array will service. The address is then sent on to the Row and Column Multiplexor.

The Row and Column Multiplexor logically ands the address from the Arbitration Controller with RAS and CAS. When the correct storage location is selected, the WE strobe pulse causes the data word and check bits to be transferred from the In Latches to permanent storage in the RAM Array.

The RAM Array is composed of blocks 4 Mbytes in size. The HP 98258 Parity RAM boards contain one block on the Control Board, and zero, one or three blocks on the Array Board, for a total of 4, 8 or 16 Mbytes. The HP 98264 ECC RAM boards have two or four blocks on the Array Board, for a total of 8 or 16 Mbytes. Each block has its own Row and Column Multiplexor.

Each block is composed of 1 Mbit by 1 bit dynamic RAMs. There are 36 DRAMs in the case of the Parity boards and 39 in the case of the ECC boards. The excess above 32 DRAMs is required in order to accommodate the data integrity scheme (the Check Bit Generator/Checker is described above).

When the SPU desires information to be read from the RAM Array, it sends the address of the appropriate storage location to the RAM board. This address follows the same path as for writes. When the correct storage location has been selected by the Row and Column Multiplexor, a strobe pulse causes the contents to be transferred to the Data_Out Register and the Check_Bits_Out Register. The Check Bits are sent to the Check Bit Generator/Checker and processed as described above. The data word is sent back to the SPU along the same path as for incoming data, except that in the HP 98264 only, it passes through the Check Bit Generator/Checker for correction.
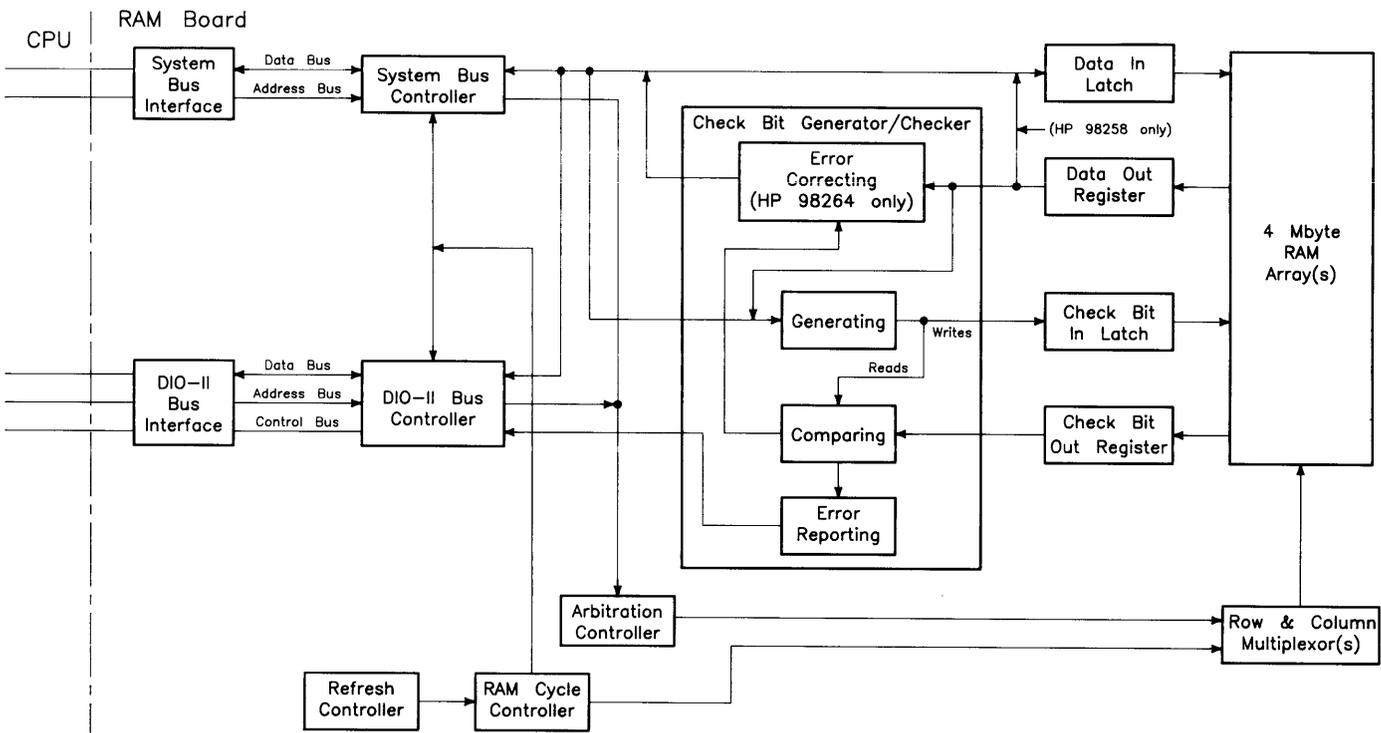
Figure 3-17. RAM Product Block Diagram

RAM Configuration

All Model 360 RAM is completely auto-configuring.

Memory configuration and addressing for the HP 98258 and HP 98264 boards are set by ten address switches. These switches determine the top address of a 4, 8 or 16 Mbyte block of RAM.

Setting Address Switches

RAM assemblies (any of the three combinations of HP 98258A/B/C or HP 98258A/B RAM boards must be configured on address boundaries equal to the RAM on the assemblies. In other words, 4 Mbyte assemblies can only be addressed to every 4M addresses starting from the top of RAM; 8 Mbyte 2-board assemblies at every 8M address; 16 Mbyte 2-board assemblies at every 16M address.

Ten RAM configuration switches (S31 (MSB) through S22 (LSB)) are used to set the address. They determine the addresses used on the assembly and are set to the top address in the block of RAM the assembly will respond to.

Switches are set to one of the 4 Mbyte RAM blocks starting at the top of RAM, address FFFFFFFF. Only the three most significant digits (MSD) of hexadecimal addresses are affected. As the first eight switches (S31 through S24) represent the two MSDs, the last two switches (S23, S22) can only change the third hexadecimal MSD by 4M addresses; the lower two binary positions of the third hexadecimal digit are implied as 1. Therefore, RAM is addressed in 4 Mbyte blocks.

Table 3-4 lists all possible configuration switch settings for a Model 370 computer.

Table 3-4. HP 98258A/B/C and HP 98264A/B RAM Configuration

Decimal Address	3 Hex MSDs	Switch Settings
4 294 967 295	FFF	1111 1111 11
4 290 772 991	FFB	1111 1111 10
4 286 578 687	FF7	1111 1111 01
4 282 384 383	FF3	1111 1111 00
4 278 190 079	FEF	1111 1110 11
4 273 995 775	FEB	1111 1110 10
4 269 801 471	FE7	1111 1110 01
4 265 607 167	FE3	1111 1110 00

Several Model 370 configurations exist, depending on what RAM assemblies are used. Table 3-5 shows three examples. RAM assemblies in examples include those with the 4 or 12 Mbyte add-on boards for the 8 and 16 Mbyte sizes. Arrows in the table indicate the 4 Mbyte address block(s) used by the Add-On RAM Boards.

Table 3-5. Example Model 370 RAM Configurations
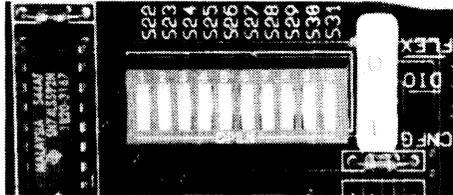
Block Top Address	Example 1, 32 Mbyte Total RAM Assy./Config. Sw.	Example 2, 16 Mbyte Total RAM Assy./Config. Sw.	Example 3, 20 Mbyte Total RAM Assy./Config. Sw.
FFF	16 Mbyte 1111 1111 11	8 Mbyte 1111 1111 11	4 Mbyte 1111 1111 11
FFB	↓	↓	16 Mbyte 1111 1111 10
FF7	↓	8 Mbyte 1111 1111 01	↓
FF3	↓	↓	↓
FEF	16 Mbyte 1111 1110 11		↓
FEB	↓		
FE7	↓		
FE3	↓		

Video Boards

Introduction

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.

A variety of monochromatic and color video boards are available for 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 by 400 pixels and drives the low resolution monochromatic monitors.

- HP 98543A Medium-Resolution Color Video Board. This version displays 512 by 400 pixel pairs and drives the low-resolution color monitors.

- HP 98544B High-Resolution Monochromatic Video Board. This version displays 1024 by 768 individual pixels and drives the high-resolution color monitors.

- HP 98547A High-Resolution Color Video Output Board. This version displays 1024 by 768 individual pixels and drives the high-resolution color monitors.

- HP 98548B High-Resolution Monochromatic Video Board. This version displays 1024 by 768 individual pixels and drives the high-resolution color monitors.

- HP 98549A Low-Cost Color Video Output Board. This version displays 1024 by 768 individual pixels and drives the high-resolution color monitors.

- HP 98550A High-Resolution Color Video Output Board. This version displays 1280 by 1024 individual pixels and drives the high-resolution color monitors.

These boards make extensive use of large scale integrated (LSI) circuits. Up to six (depending on the board) 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 similar functions, which are:

- Establish display clock frequency in the computer system.
- Initialize according to the specific monitor used.
- Identifies itself and set character shape by ID/FONT ROM.
- Respond to interrupts on DIO/DIO-II 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. Refer to Figure 3-18.
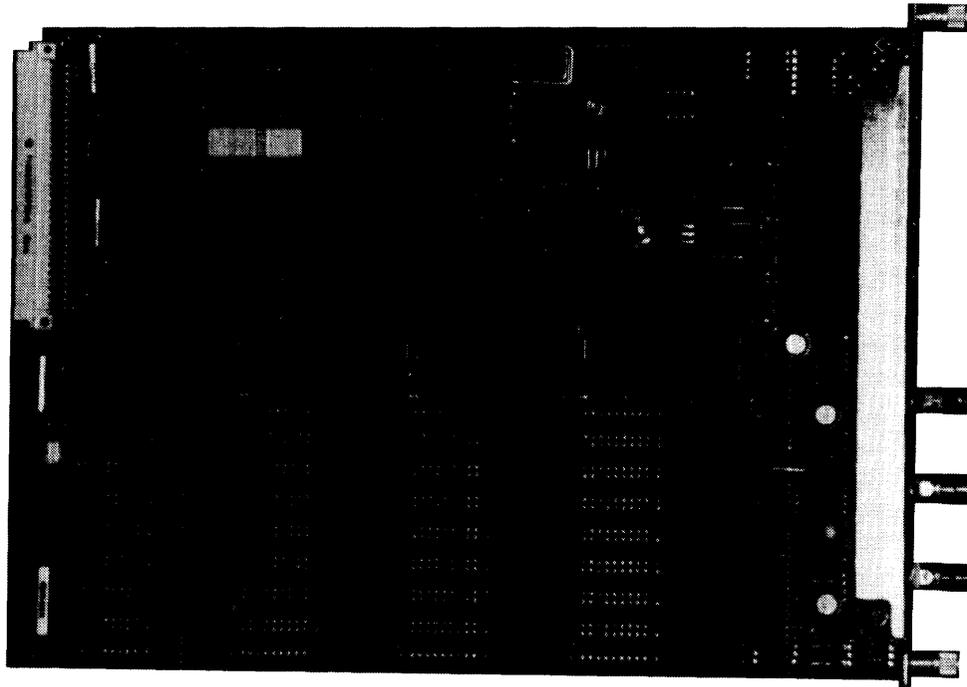
Figure 3-18. Typical Video Board

Figure 3-19. Typical Video Board Block Diagram
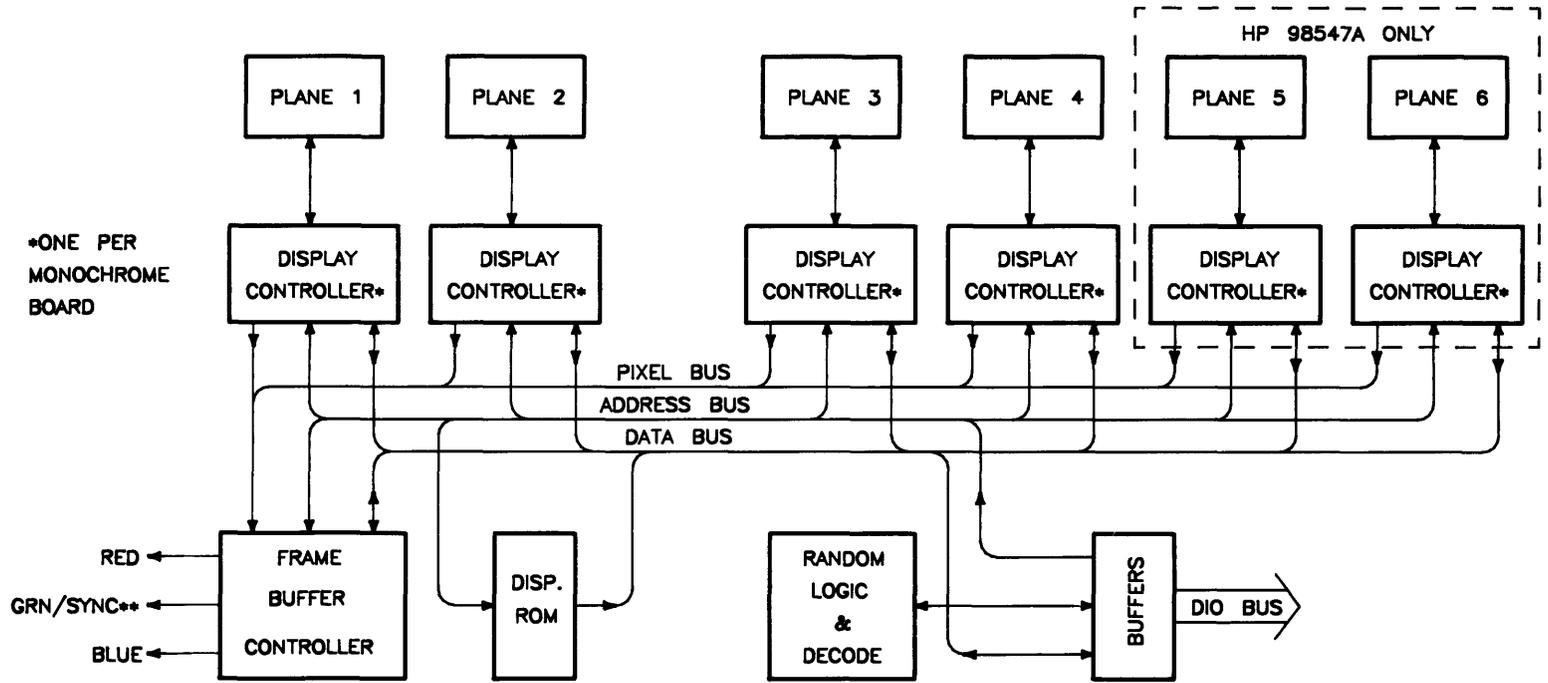
*ONE PER
MONOCHROME
BOARD

**COMPOSITE VIDEO
ON MONOCHROME BOARDS.
RED/BLUE/GREEN ONLY ON
COLOR BOARDS.

HP 98547A ONLY

PLANE 1 PLANE 2 PLANE 3 PLANE 4 PLANE 5 PLANE 6

DISPLAY CONTROLLER* DISPLAY CONTROLLER* DISPLAY CONTROLLER* DISPLAY CONTROLLER* DISPLAY CONTROLLER* DISPLAY CONTROLLER*

PIXEL BUS
ADDRESS BUS
DATA BUS

RED
GRN/SYNC**
BLUE

FRAME BUFFER CONTROLLER

DISP. ROM

RANDOM LOGIC & DECODE

BUFFERS

DIO BUS

Video RAM

Both high- and medium-resolution color video boards have four or six 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 boards requires more memory chips per plane. Resolution is 1024 by 768 single pixels.

Color Mapping

Color boards have four or six 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 Controllers 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 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 possibilities.
- 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 monochromatic boards, composite video with sync is output through a single BNC connector. In

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 stream. 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.

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.

Identification and Font ROM

Each video board has an ID/FONT ROM. This is a 16 Kbyte 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:

Table 3-6. Pixel Display Matrix

Video Board	Character Matrix	Character Cell
Medium-Resolution	9 by 12	10 by 15
High-Resolution	6 by 10	8 by 16

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.

System Interface Board

Introduction

The System Interface Board meets most, if not all, I/O needs of the Design Automation marketplace. Functions provided by this board include:

- RS-232.
- HP-IB.
- Audio Jack.
- HP-HIL.
- LAN.
- DMA.
- Optional High-Speed Disk HP-IB Interface Add-On.
- Optional Small Computer System Interface Add-On.

The system interface board allows this wide range of interfaces at the minimum cost. The LAN and optional high-speed disk interface add-on allows users to choose the interfaces that are necessary for their application.
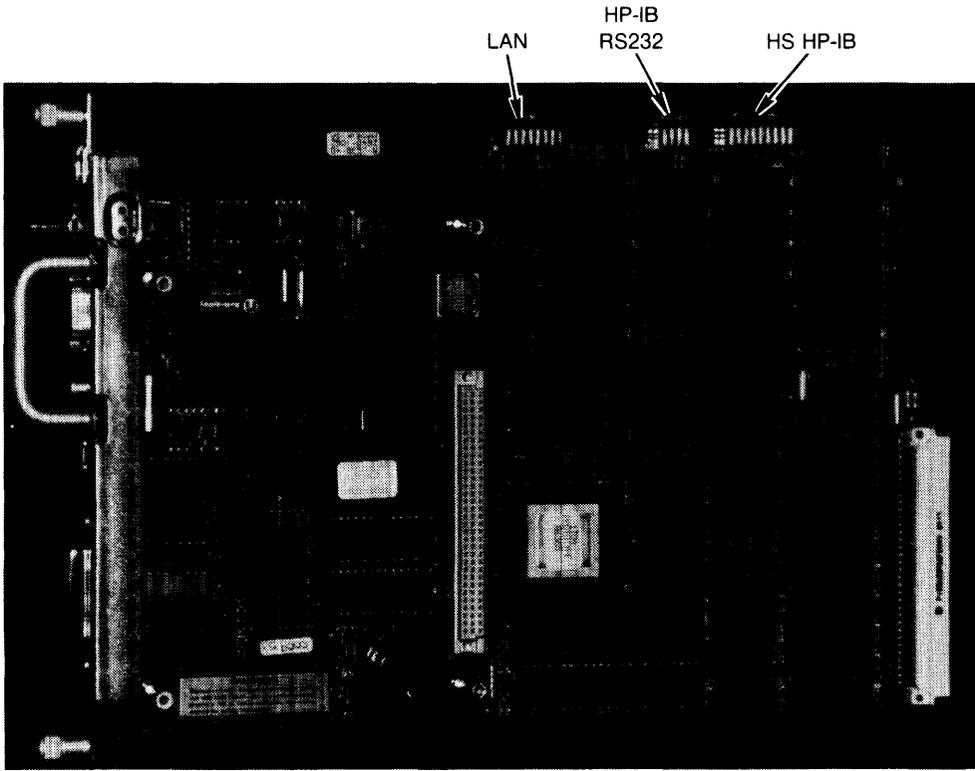
Figure 3-20. System Interface Board

Figure 3-21. System Interface Board Block Diagram

Direct Memory Addressing

DMA chip architecture is a compatible superset of the HP 98620B DMA Controller which is used with HP 9000 series 200 and 300 computers. The chip is a Standard-Cell design implemented in a CMOS process. Refer to Table 3-7 for DMA specifications.

Table 3-7. DMA Specifications

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

LAN Interface

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

- Backplane interface to the DIO-II bus.

- Shared memory area.

- Frontplane interface to the network.

Interface with the DIO-II bus includes select code decoding, interrupt control, data bus buffers and latches, and address multiplexers. A 16-bit wide data bus is used.

Eight DIP switches on the system interface board control the following LAN functions:

- Select Code, 0 through 31.

- Interrupt Level, 3 through 6.

- Local/Remote.

Switches for LAN interface configuration are explained Table 3-8. Refer to the picture of the system interface board, Figure 3-19a for its location.

LAN on 98562-66533

A LAN interface with a built-in MAU is part of the 98562-66533 system interface boards.

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

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

The LAN portion of the board is software compatible with the HP 98643 LAN/300 Link Card.

LAN on 98562-66534

When Option 015 is ordered with the bundled system a system interface board with an AUI (attachment unit interface) connector is installed at the factory. This system interface board is not available as a separate product or an upgrade. Part number of this board is 98562-66534.

System interface board LAN connectors for the AUI enables connections to an external MAU. The MAU circuits are not on the 98562-66534 board.

A replaceable fuse, located behind the AUI connector, protects the LAN circuits from MAU faults.

RS-232 Interface

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

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

- Permanently sets the select code to 9. 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.

Three switches on the system interface board are associated with RS-232. Located on the HPIB/RS232 configuration switch, they perform the following functions:

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

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

- **DIS** -- Disables the RS-232 at select code 9 so it won't be found.

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

HP-IB Interface

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

One configuration switch for HP-IB system controller is on the system interface board. Located on the HPIB/RS-232 configuration switch block, the SC switch is set to 1 if the computer is the system controller or 0 if not.

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

Configuration Switches

Three DIP switch blocks on the system interface board configure interfaces for:

- Local Area Network (Table 3-8).

- HP-IB and RS-232 (Table 3-9).

- High-Speed HP-IB Add-On (Table 3-10).

Refer to the picture of the system interface board, Figure 3-19a for its location.

Table 3-8. Eight LAN Configuration Switches
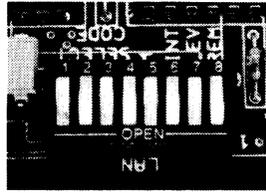
Switch Label	Function/How It's Used
SELECT (1 - 5)	Select Code: 1 (L) is LSB, 5 (M) is MSB. (Shipped with 10101, SC-21)
INT (6) LEV (7)	Interrupt Level: LEV (7) is MSB 7 6 - - 0 0 = Level 3 0 1 = Level 4 1 0 = Level 5 (Shipped setting) 1 1 = Level 6
REM (8)	Local/Remote 0 = Local (Shipped setting) 1 = Remote

Table 3-9. HP-IB and RS-232 Configuration Switches
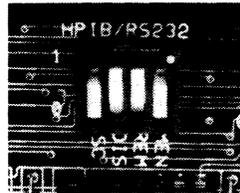
Switch Label	Function/How It's Used
MEN	Modem Enable 1 = Modem lines enabled (Shipped setting) 0 = Modem lines disabled
REM	Remote Terminal Enable 1 = Remote Mode 0 = Local Mode (Shipped setting)
DIS	RS-232 Disable 0 = Enabled(Shipped setting) 1 = Disabled
SC	Internal HP-IB System Controller 1 = System Controller (Shipped setting) 0 = Not System Controller

High-Speed HP-IB Add-On

The high-speed disk interface add-on (product number HP 98262) is identical to the HP 98625B card. It allows word wide transfers during DMA cycles and is fully supported by software. Because of limited space, the High Speed Disk card is implemented on a separate board. This board configuration has the benefit of allowing users to order the HP 98262A High-Speed Disk Add-On to upgrade their system interface board.
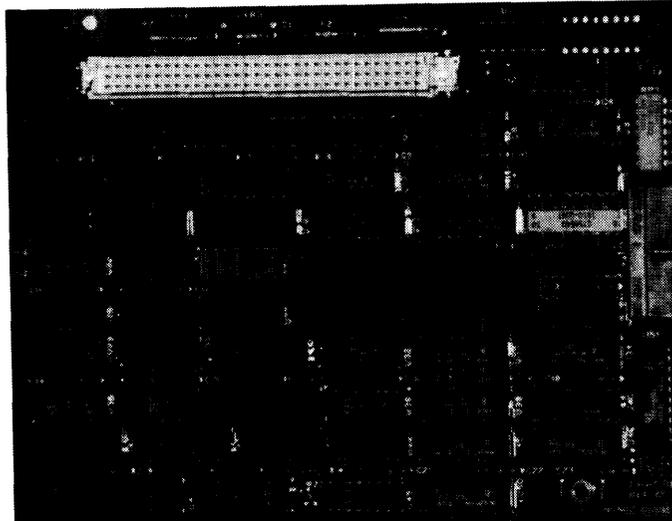
Figure 3-22. High-Speed HP-IB Add-On Board
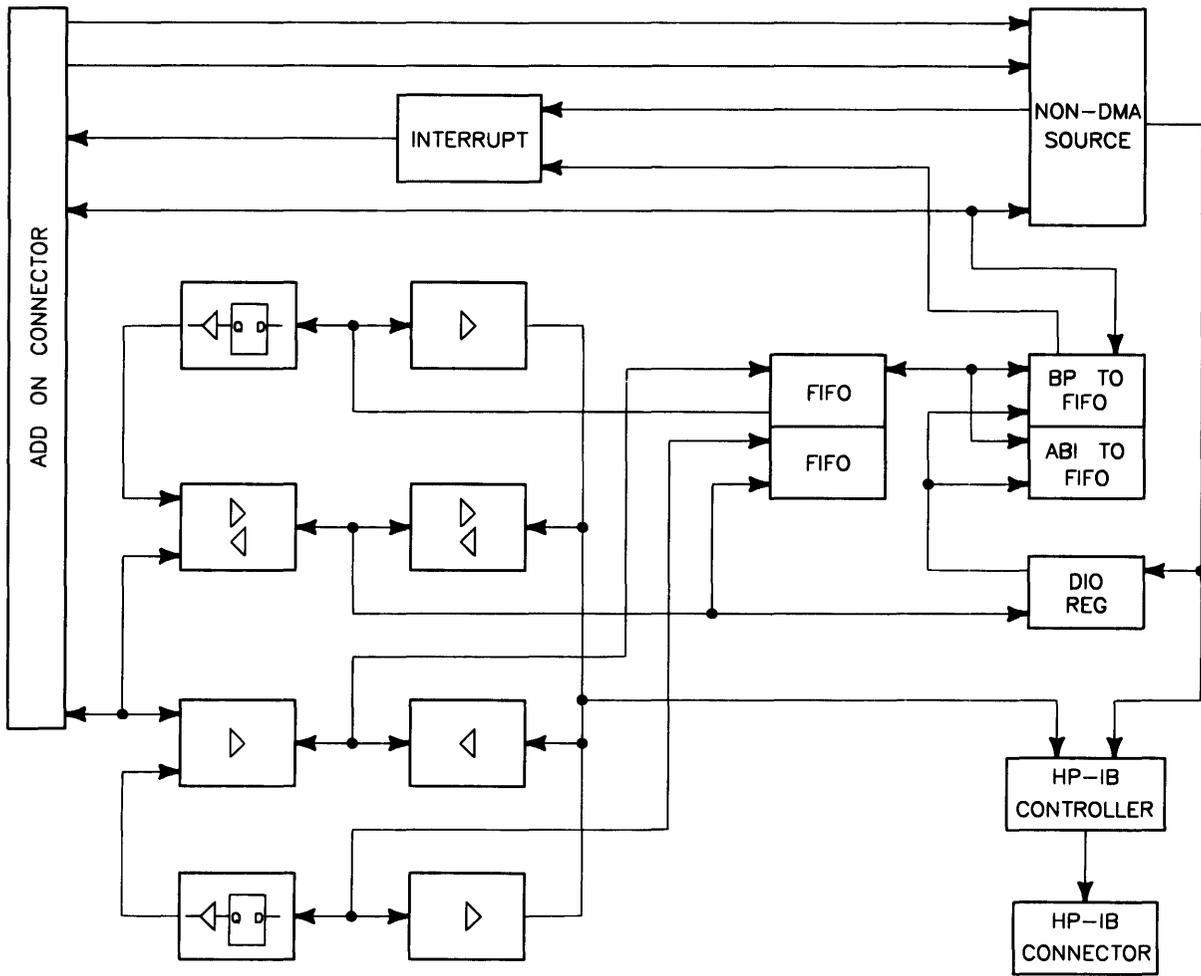
Figure 3-23. High-Speed HP-IB Add-On Board Diagram

The optional high-speed HP-IB interface configuration switches control:

- Select Code, 0 through 31.
- Interrupt Level, 3 through 6.
- System Controller.
- Low/High Speed.

Switches on the system interface board for high-speed disk interface configuration are shown in Table 3-10. Refer to Figure 3-19a to locate these switches.

Table 3-10. High-Speed HP-IB Add-On Configuration Switches
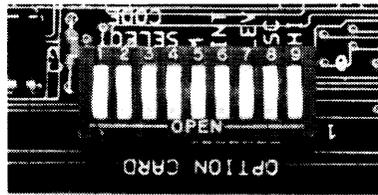
Switch Label	Function/How It's Used
SELECT (1 - 5)	Select Code: 1 (L) is LSB, 5 (M) is MSB Shipped with SC-14
INT (6) LEV (7)	Interrupt Level: LEV (7) is MSB 7 6 - - 0 0 = Level 3 0 1 = Level 4 (Shipped setting) 1 0 = Level 5 1 1 = Level 6
SC (8)	System Controller 1 = System Controller (Shipped setting) 0 = Not System Controller
LOW (9)	Low/High Speed 0 = Low Speed 1 = High Speed (Shipped setting)

Small Computer System Interface Add-On

The small computer system interface (SCSI) add-on (product number HP 98265A) is a new design which emulates the Industry Standard with the same name. Because of limited space, the SCSI card is implemented on a separate board. This board configuration has the benefit of allowing users to order the HP 98265A High-Speed Disk Add-On to upgrade their system interface board or order it already installed in their CPU.

SCSI Node Address

Each device on a SCSI bus must have a unique address from zero to seven, called the node address. The SCSI card contains three jumpers which set its address at seven.

Although there is no need foreseen to do so, the node address of the SCSI card can be changed by cutting one or more of the jumpers. Use this diagram to locate the correct jumpers:
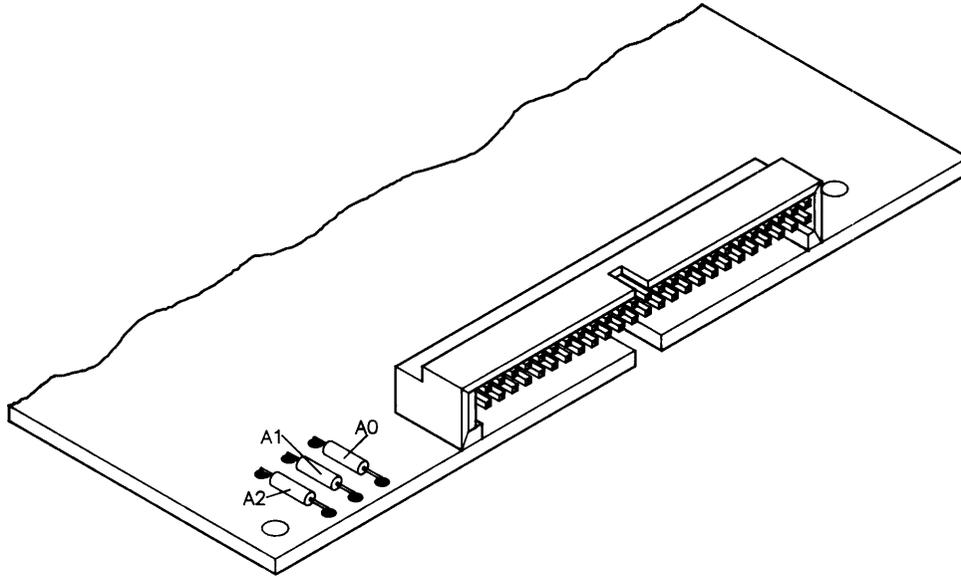
Figure 3-24. Node Address Jumpers

A jumper installed is a logical "1". Jumper A2 represents the most-significant bit. As an example, the address can be changed to six by cutting jumper A0.

System Interface Board Switches

The system interface board (that's the large board the SCSI card is mounted on) contains a switch block for configuring some SCSI card functions. The switch block is labelled "OPTION CARD", and can be located with this Figure:
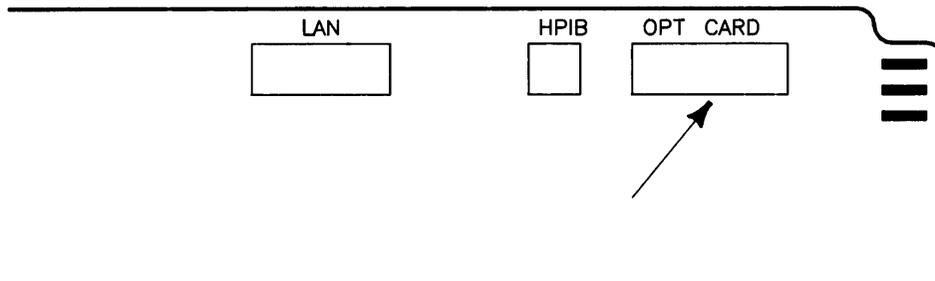
Figure 3-25. Locating the Option Card Switch Block

Here are the functions and how to set the switches:

Select Code
The SCSI card must be set at a unique address from eight to 31 on the internal SPU bus. Five switches determine the select code of the SCSI card. The factory setting is 14.

Interrupt Level
The SCSI card must be set to an interrupt level of four. Two switches determine the interrupt level of the card. The factory setting is four.

Parity
The user can choose to have data checked for parity. One switch configures the system to use parity checking. The factory setting is enabled. Parity checking is highly recommended[1]. All devices on the bus must support parity if it is used.

---

[1] If your system contains a Revision C boot ROM, you must enable parity.
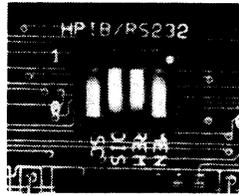
Table 3-11. System Interface Board Configuration Switches

Switch Label	Function/How It's Used
LOW (9)	Parity Checking 1 = Parity Checking Enabled 0 = Parity Checking Not Enabled
SC (8)	Not used
LEV (7) INT (6)	Interrupt Level: LEV (7) is MSB 7 6 - - 0 1 = Level 4
M (5) SELECT (1 - 4)	Select Code: M (5) is MSB. 5 4 3 2 1 5 4 3 2 1 - - - - - - - - - - 0 1 0 0 0 = Select Code 8 1 0 1 0 0 = Select Code 20 0 1 0 0 1 = Select Code 9 1 0 1 0 1 = Select Code 21 0 1 0 1 0 = Select Code 10 1 0 1 1 0 = Select Code 22 0 1 0 1 1 = Select Code 11 1 0 1 1 1 = Select Code 23 0 1 1 0 0 = Select Code 12 1 1 0 0 0 = Select Code 24 0 1 1 0 1 = Select Code 13 1 1 0 0 1 = Select Code 25 0 1 1 1 0 = Select Code 14 1 1 0 1 0 = Select Code 26 0 1 1 1 1 = Select Code 15 1 1 0 1 1 = Select Code 27 1 0 0 0 0 = Select Code 16 1 1 1 0 0 = Select Code 28 1 0 0 0 1 = Select Code 17 1 1 1 0 1 = Select Code 29 1 0 0 1 0 = Select Code 18 1 1 1 1 0 = Select Code 30 1 0 0 1 1 = Select Code 19 1 1 1 1 1 = Select Code 31

Device Address

Each device must have a unique device address from 0 to 6. Some devices set their device address with external switches; others are factory-set internally. This information can be determined from the product documentation.

Termination

The SCSI system must be terminated with a single-ended terminator. One is included with the interface. It must be attached to the **end** device, unless the end device contains internal termination in which case the terminator is unneeded. No intermediate device can be terminated. If another device is internally terminated, it must be put at the end of the string, or the internal termination physically removed.

If you do not know whether a particular device is terminated internally, refer to the documentation accompanying the device.

The SCSI bus must be terminated at both ends. The SCSI card furnishes termination for one end of the bus. Peripheral devices must have either no termination or optional termination, except that one peripheral device may be permanently terminated, provided that it goes on the end of the bus.

The terminator for the SCSI card end of the bus is permanently installed. Do not remove it, since operation without it grossly violates the 0.1 Metre stub length restriction of the SCSI bus.

Termination for devices with no termination is provided by the terminator included in the product. It is installed in the empty cable connector on the end device.
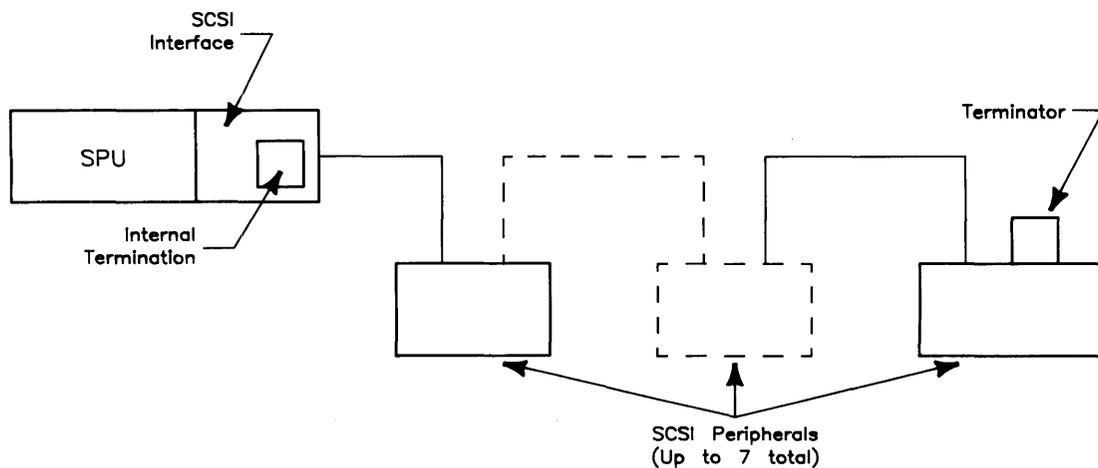
Figure 3-26. Termination

System Integrity

All peripheral devices must be connected and turned on before turning the computer on. Also, do not turn peripherals off, disconnect them from the system or add additional peripherals after the computer has been turned on.

SCSI Function

The primary function of the SCSI interface is to take data written in DIO-II format from the DIO-II bus, translate it to SCSI format, and transmit it down the SCSI bus to a target device, and vice versa. A secondary function is to keep track of the status of the SCSI bus and inform the SPU of the status.

Although the process of transferring data back and forth between the DIO-II bus and the SCSI bus is quite complex, it can be summarized very simply. Here is a block diagram of the data transfer process:
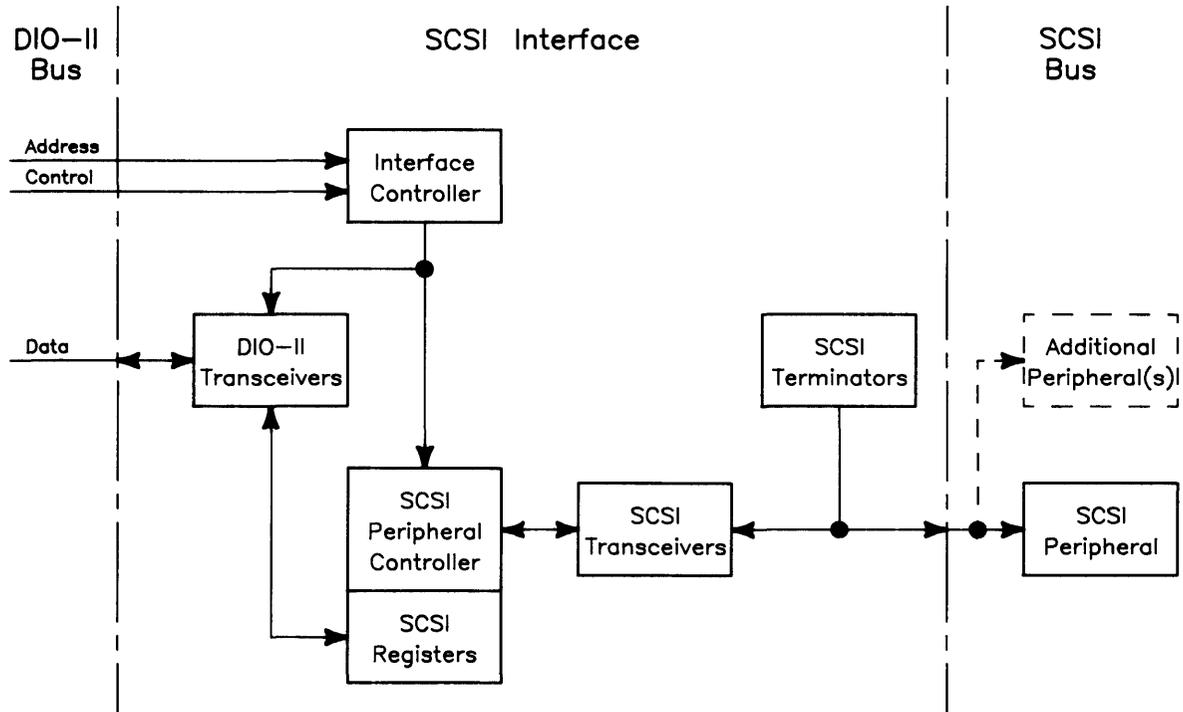
Figure 3-27. Data Transfer Block Diagram

Here is an outline of the data transfer process:

1. The interface controller arbitrates for control of the SCSI bus.

2. The interface controller selects the target device to transfer data to.

3. The interface controller sends a SCSI command to the target device.

4. The target device puts the SCSI bus into Data Out phase.

5. The mainframe uses DMA to transfer data from system RAM to the interface controller.

6. The interface controller handshakes the data out onto the SCSI bus.

7. The target device handshakes the data in from the SCSI bus.

8. The target device puts the SCSI bus into Status phase, and status information is sent from the target.

9. The target device puts the SCSI bus into Message In phase, and a command complete message is sent from the target.

Transferring data from a SCSI device to the SPU is the reverse of this procedure:

1. The interface controller arbitrates for control of the SCSI bus.

2. The interface controller selects the target device to transfer data from.

3. The interface controller sends a SCSI command to the target device.

4. The target device puts the SCSI bus into Data In phase.

5. The target device handshakes the data out onto the SCSI bus.

6. The interface controller handshakes the data in from the SCSI bus.

7. The mainframe uses DMA to transfer data from the interface controller to system RAM.

8. The target device puts the SCSI bus into Status phase, and status information is sent from the target.

9. The target device puts the SCSI bus into Message In phase, and a command complete message is sent from the target.

Control and status information is collected by the interface controller and stored in the DIO-II registers. The interface controller transfers this information into the DIO-II transceivers at the direction of the SPU. The SPU then reads the data from the transceivers. Here is a block diagram of this process:
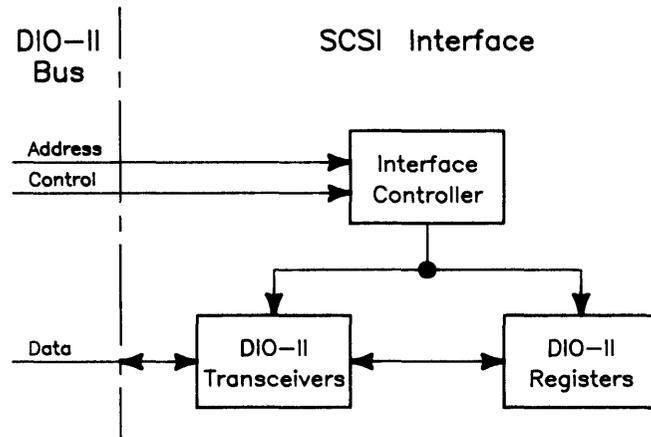
Figure 3-28. Control and Status Information Transfer Block Diagram

The DIO-II registers consist of four read/write registers accessible by the SPU. Here is a description of the registers:

Register Name	Read Function	Write Function
ID/Reset	SCSI Identification	Reset
DMA/Interrupt	Status	Control
Wraparound	Data	Control
Configuration	Status	Data Latch Reset

ID/Reset Register When read by the SPU, this register provides the SCSI ID, which is 39 (27 hex). A write of any value to this register generates a hardware reset. This resets the interface controller, the SCSI peripheral controller and the DMA/Interrupt and Wraparound Control registers.

DMA/Interrupt Register This register contains SPU-supplied instructions concerning interrupt enable, DMA direction and DMA enable. When read, it provides the current entries for this data as well as the interrupt level and whether the card is currently generating an interrupt.

Wraparound Register This register is used for diagnosing problems with the interface rather than normal operation. When written to, it drives certain control signals on the SCSI bus, thereby allowing the SPU to emulate a target SCSI device for the SCSI peripheral controller to communicate with. When read, it returns the data that is currently active on the SCSI data bus.

Configuration Register When written to, the DMA data path is cleared. When read, this register returns the SCSI address occupied by the interface, whether parity checking is enabled and whether the SCSI terminators are powered. the system controller and a desired peripheral. The SCSI interface can function as a target device (for high-speed computer-to-computer communications, for example), but it usually functions as an initiator.

The architecture of the card is straightforward. The SCSI Protocol Controller (or SPC) is connected to the SCSI cable through single-ended line drivers. The other side of the SPC is connected through an enhanced implementation of DIO to the host mainframe (DIO with 32-bit DMA).

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

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

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

HP-HIL Devices

Introduction

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 HP-HIL devices is shown in Table 3-12.

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

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

- Up to seven devices can be on the link.

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

- Series 300 Maximum link current is 1 A.

Link Controller

A block diagram of a typical link controller is shown in Figure 3-29.
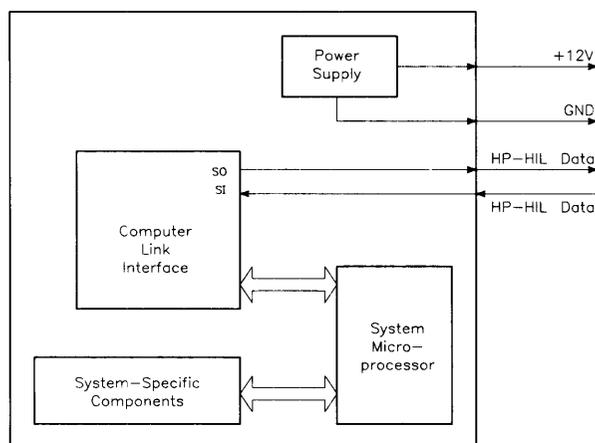
Figure 3-29. HP-HIL Link Controller Block Diagram

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 3-12, devices are listed with their power requirements.

Table 3-12. HP-HIL Devices and Power Requirements

Product Number	Device Name	Milliamps	Watts
HP 35723A	Touchscreen Bezel	250	3.0
HP 46021A	ITF Keyboard	100	1.2
HP 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	370	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 devices require 80 mA; devices attached cannot exceed 120 mA.

Computer-Link Interface

Model 370 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 3-30.
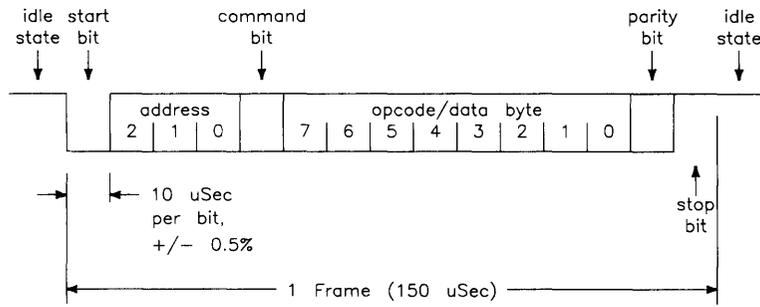
Figure 3-30. HP-HIL Frame Structure

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.

HP-HIL 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 3-31 shows the connector pinouts.
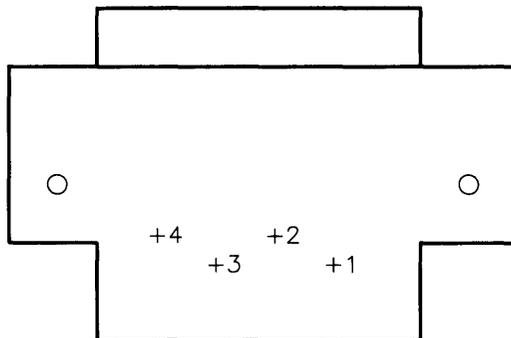
Figure 3-31. HP-HIL Cable Connector

Device Controller

A block diagram of a typical device controller is shown in Figure 3-32.
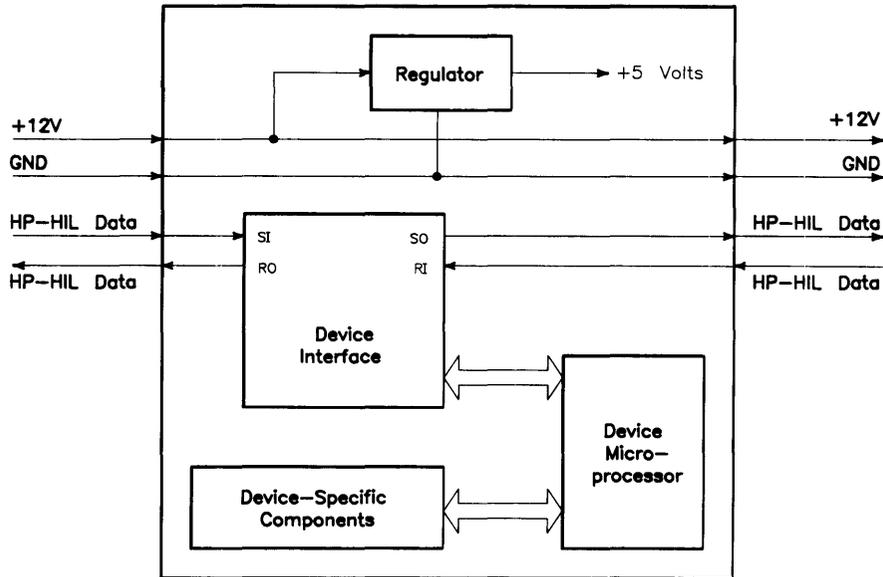
Figure 3-32. HP-HIL Device Controller Block Diagram

Regulator

From the HP-HIL cable, +12 V dc is regulated down to +5Vdc for use by device components. The +12 V dc 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.

Test Items

1. The Model 360 processor board can be viewed as a:

    a. Model 330 processor board with a new SPU chip.

    b. Model 350 processor board with a new SPU chip.

    c. Model 350 processor board combined with an HP 98258A RAM board.

    d. Choices b and c taken together.

2. Model 360 RAM:

    a. is addressed just like Model 330 RAM.

    b. is similar to the HP 98258A/B/C parity RAM boards.

    c. can be used in a Model 330.

    d. None of the above.

3. Which of these statements are true?

    a. The SCSI interface is basically a cheap HP-IB interface.

    b. An important difference between HP-IB and SCSI is that the SCSI must be terminated and the HP-IB does not.

    c. The SCSI card Node Address is not changeable.

    d. HP-IB and SCSI use the same set of Interrupt Levels.

4. System Interface Board option card switches are the same for HP-IB and SCSI except for:

    a. Switch 9 selects SCSI Parity Checking and HP-IB Low/High Speed.

    b. Switch 8 selects HP-IB System Controller, but is unused in a SCSI system.

    c. A and B are both true.

    d. Select Code switches 1 thru 5.

5. Which of these statements are true?

    a. The new SCSI add-on board will not function in Models 330/350.

    b. The new 98562-66534 AUI System Interface board will not function in Models 330/350.

    c. The HP 98267A/B/C cards will not function in Models 330/350.

    d. The HP 98258A/B/C RAM boards will only function in Models 330/350.

After you have answered all test items, turn to the back of this lesson and grade yourself from the Answers Sheet. If at least 80% of your answers are correct, you've successfully completed this quiz. If less than 80% of your answers are correct, you should review the areas of the lesson the missed test items cover.

Answers to Quiz 2

1 b

2 d

3 b

4 c

5 c

Your Comments, Please.

Now's a good time to write down your comments regarding this lesson. Refer to these comments when filling out the Course Evaluation.

Boot ROM Functions

3

Instructions

This lesson covers the subject of Models 360/370 boot ROM functions. When you have read the Chapter, take the test at the end.

Boot ROM Functions

4

Introduction

A Series 300 Boot ROM, Revision C1, is used in the Model 370. All Model 360 computers except for a few early units also contain the Revision C1 boot ROM. The few early units contain a Revision C boot ROM. The Revision C is nearly identical to the Revision C1, the major difference being that the Revision C boot ROM is unable to tell whether parity has been disabled when using the SCSI add-on card. A work-around is to simply enable parity at all times.

When the computer is turned on, three Boot ROM instruction sets are executed by the CPU:

- Power-Up Sequence.
- Self-Tests.
- Booting Operating Systems.

Power-Up Sequence

When the computer is turned on the CPU executes a power-up sequence of events (the complete algorithm is described later in this chapter) before an operating system is booted. This is required to initialize and test hardware to make sure the computer is ready to boot an operating system. Power-up sequence is shown below.

1. Test CPU.
2. Determine 24- or 32-bit address range.
3. Turn on self-test LEDs.
4. Turn on the compatibility display interface.
5. Test the top 16 Kbytes of RAM.
6. Set up data structures.
7. Search for any boot extension ROMs and call any valid ones.
8. Determine processor type (i.e., MC68030).
9. Initialize and test processor board timer.
10. Look for a RAM monitor/debugger.
11. Reset all I/O.
12. Initialize the video circuits.
13. Checksum the Boot ROM.

14. Display CPU type.

15. Look for floating point co-processor.

16. Look for MS-DOS co-processor.

17. Initialize keyboard electronics.

18. Drop interrupt level.

19. Preload for main RAM test.

20. Initialize and clear compatibility display graphics.

21. Test internal HP-IB.

22. Test DMA.

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

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

25. Initialize the bottom of memory.

26. Find external I/O cards. Report all found. Test the following at select codes 0 through 31 and 132 through 255.

    a. HP 98629 SRM controller.

    b. HP 98527 RGB color video output card.

    c. HP 98624 TI9914 low-speed HP-IB.

    d. HP 98626 RS-232.

    e. HP 98644 RS-232.

    f. HP 98628 RS-232.

    g. HP 98642 4-port multiplexed RS-232.

    h. HP 98643 LAN.

    i. HP 98265 SCSI.

    j. HP 98625 High-Speed HP-IB.

27. All bit-mapped video circuits are initialized and cleared.

28. All interfaces with I/O Dependent Code test capability are tested.

29. Checksum any ROMs in ROM space and report any problems.

30. 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 operating system will eventually be booted. To enter configure mode press [CTRL]-[C] before a system is booted but after the keyboard is initialized (e.g. after the keyboard message is displayed).

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

```
Copyright 1988,          KEY  ACTION
Hewlett-Packard Company.   T  Extended Self-Test
All Rights Reserved.       L  Continuous Self-Test Loop

BOOTROM Rev. C1
Bit Mapped Display
MC68030 Processor
MC68882 Coprocessor
Keyboard
HP-IB
DMA-CO
RAM 524128 Bytes
HP98644 at 9
HP98625 (HPIB) at 14
HP98643 at 21 01019FFA0001




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

Figure 4-1. Example Configure Mode Display

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

Extended Testing

If [T] is pressed, the self-test will be started over and the long memory test will be executed (a marching/walking ones and zeros test, taking approximately 4 seconds per megabyte depending on clock speed) rather than the default, short memory test (an address/address compliment test, taking approximately 1 second per megabyte depending on clock speed). This mode will also invoke extended testing on LAN and SCSI interfaces (does external loopback and cable testing). The latter testing will request the user to power off any SCSI peripherals and attach the appropriate end of the SCSI test connector. Interfaces having IODC download test code will also perform extended testing.

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

Continuous Self-Test

Pressing ⌑L⌑ causes the Boot ROM to continuously repeat the self-test portion of its code. This is a toggle switch, so entering configure mode by typing ⌑CTRL⌑-⌑C⌑ while already in continuous self-test mode, and typing ⌑L⌑ again, will stop the continuous self-test and will cause the Boot ROM to continue normal operation.

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

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

  In this case the Boot ROM stops with the display blanked and oooooo●● on the LEDs. If a compatibility (old style alpha/graphics) display controller is present, then the message `RAM FAILED ABOVE FFFFC000` will be displayed.

- **Boot ROM checksum failure**

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

50/60 Hz CRT

The 50/60 Hz CRT options are only available when a compatibility (old style alpha/graphics) display controller is present. Then, if ⌑5⌑ or ⌑6⌑ is pressed, a soft override of the power-up CRT frequency occurs. The power-up CRT frequency of the compatibility display controller is determined by a switch on the controller 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 display controller and a bit mapped display controller present, then the key pressed will effect the alpha CRT (even though the '5' and '6' are not displayed). If no alpha/graphics display controller is present and ⌑5⌑ or ⌑6⌑ is pressed, the Boot ROM will re-enter self test, but the CRT will not be effected.

The Human Interface

Several devices can act as the "console", or primary human interface, for the Boot ROM. The list of possible console devices as of revision C1 is explained in the next section.

Output Devices

- 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 Series 300. See the section of this chapter describing Remote Human Interface for Boot ROM requirements.

- HP 98626 RS-232 card with the remote bit set (with a supported HP terminal).

- HP 98644 RS-232 card with the remote bit set (with a supported HP terminal).

- Internal RS-232 controller (same as 98644 card, but built into CPU board or Human Interface accessory board) with the remote bit set (with a supported HP terminal).*

- A bit-mapped video circuit at internal address 560000_{16}. This includes:

  - HP 98548A

  - HP 98549A

  - HP 98550A

  - HP 98556A

  - HP 98720A

  - HP 98730A

  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/INITIALIZATION ROMs containing ID information.

- A bit-mapped video circuit at any DIO II address 01000000 up to $01C00000_{16}$. These correspond to select codes 132 to 255. These include:

  - HP 98548A.

  - HP 98549A.

- A "compatibility" display controller. This alpha/graphics display controller is a modification of the HP 98204B card. It must have the same CRT ID register as the HP 98204B. Note that the Boot ROM will turn off video to this display controller just before booting a system. It is up to the operating system to restore video if this display is to be used.

- HP 98627 RGB color display controller.

The Boot ROM chooses the output devices in the following manner:

- If there is a remote card, choose the one with the lowest select code.

- If there is an internal bit mapped display controller, choose it as console.

- If there is a bit mapped display controller in DIO 2 space, choose the one with the lowest select code. If not go the next step.

- If there is a compatibility display controller, choose it as console. If not go to the next step.

- If there is an HP 98627 RGB display controller then choose it as console. If not go on to the next step.

- Use dummy display drivers.

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 display controller and any compatibility display controller that it finds, even if that controller is not chosen as the console device. Note that if a device fails self-test then for the above algorithm, the device is considered "not present". The Boot ROM always tests a device before choosing it as the console output device.

Input Devices

- Remote HP 98642 card with supported HP terminal.

- Remote HP 98626 card with supported HP terminal.

- Remote HP 98644 card with supported HP terminal.

- Remote internal RS-232 controller (same as 98644 card, but built into CPU board or Human Interface accessory board) with supported HP terminal.

- Internal HP-HIL keyboard/HP-IB card (or built-in hardware).

- External HP-HIL keyboard. The only version of this hardware currently in existence is the keyboard built-in the HP 98720 display controller.

The Boot ROM chooses input devices in the following manner:

Note that if an internal HP-HIL interface and a remote terminal are both present in a system, they will both be enabled. Similarly, if an external HP-HIL interface and a remote console are both present in a system, they will both be enabled, provided no internal keyboard is present.

An external interface will never be enabled when an internal interface is present.

When more than one external keyboard is present, then only one with the lowest select code is enabled. If several HP 98720s exist on a system, then it is the user's responsibility to ensure that the external keyboard associated with the HP 98720 display controller at the address 560000 has the lowest select code of all the external keyboards in the system. This must be done to ensure that the keyboard associated with HP 98720 "A" is not input console while the display of HP 98720 "B" is output console. The Boot ROM does not attempt to verify the display/keyboard relationship.

Note that if a keyboard controller or a remote RS-232 card fails, then it is considered by the above algorithm to be "not present". For example, if an internal keyboard fails self-test, a "Keyboard Failed" message will be displayed, however, the input device search algorithm will go ahead and look for an external keyboard. The Boot ROM always tests a device before choosing it as the console input device.

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

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

Remote Human Interface

Very early in the power-up sequence, a search is made for an:

- HP 98642 4 port, multiplexed RS-232,
- HP 98626 RS-232 interface or
- HP 98644 RS-232 interface.

with its "remote" bit set. The search starts at select code 0 and ends at select code 31 or when a remote 98642, 98626 or 98644 card is found that passes self-test. If one is found, it becomes the remote human interface. If the remote human interface is a 98642 card, the terminal on port 1 will be used as the console. All other ports are ignored by the Boot ROM.

Note that the internal RS-232 (on CPU board or on Human Interface accessory board) is really a 98644 card and will be treated as such by the Boot ROM.

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

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

With the 98626 card, the Boot ROM will use the baud rate, pacing, and line characteristics specified by the 98626 card's 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 Rev C1 Boot ROM is:

Bit 6	Bit 7	Handshake Type
0	0	ENQ/ACK
0	1	No handshake
1	1	No handshake

Note

HP 98626 cards are currently 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 hangs, waiting forever for and ACK in response to it's ENQ.

Since the HP 98644 and HP 98642 cards have no 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

- XON/XOFF handshaking.

The display on the terminal will be the same as the display on a display controller. The keyboard functionality will also be the same, except that the Break key on the terminal is mapped to the RESET key on the local keyboard.

During the self-test of I/O cards, the card driving the remote interface will not be disturbed. It was tested earlier and passed. (Otherwise, the interface could be confused or disabled from the test.)

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

Booting Operating Systems

Boot System Selection

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

Unattended Operation

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

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

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

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

On an SRM with multiple systems, make the first system to be found a system that looks at the host's SRM node address and uses the node address to decide what secondary system to boot. (The Boot ROM can then be called to boot a particular system.)

Attended Operation

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

        Keyboard

        Console Keyboard at XX (where XX is the select code of an external
                            keyboard)

The boot selection menu displays all accessible systems as the Boot ROM locates them. A system 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 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 displayed below:

```
Copyright 1988,
Hewlett-Packard Company.          :REMOTE, 21, 0, 8
All Rights Reserved.              1B SYSTEM_BASIC
                                  :ROM
BOOTROM Rev. C1                   B
Bit Mapped Display
MC68030 Processor
MC68882 Coprocessor
Keyboard
HP-IB
DMA-CO                            :HP8290X, 706, 0
RAM 1572704 Bytes
HP98642 at 8                      :HP7908, 803, 0
HP98626 at 9                      1H SYSTEM_HP-UX
HP98625 (HPIB) at 14              :REMOTE, 20, 0, 8
HP98629 at 20                     1F SYSTEM_FORTRAN
HP98643 (LAN) at 21 08000900ABCD  2F SYSTEM_FORTH
                                  1Z SYSTEM_4TH
                                  1P SYSTEM_PASCAL
                                  1b SYSburp



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

Figure 4-2. Example Menu Screen

A ROM system is selected by a single letter. If the user knows that a particular choice is desired (such as "2F" or "31B"), then the user can type that response as the machine powers up to make a selection. This simple human interface makes it possible to make a selection without even having or seeing a CRT.

The state machine is executed in the interrupt service routine for the human interface input device.

Note that only keys A-Z, a-z, and 0-9 are allowed to select a system. Other keys are simply ignored. This makes the handling of all localized keyboards much simpler.

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

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

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

Boot System Priority Control

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

1. External discs at select codes 0-31 on bus address 0, unit 0, volume 0 (HP-IB and SCSI)

2. An SRM at node 0 at select code 21 on volume 8

3. A LAN interface at select code 21

4. HP 98259 Bubble RAM on select code 30

5. HP 98255 EPROM card "disc", unit 0

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 LANs at select code 0-31

9. Remaining HP 98259 Bubble RAM card on select codes 0 through 29 and 31

10. Remaining HP 98255 "disc" (EPROM) units

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

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

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

- High priority addresses before low priority addresses.
- Soft systems before hard systems.
- Local systems before remote systems (Local refers to dedicated devices and remote refers to shared devices, i.e. an SRM).
- Removable media before non-removable media.
- Internal systems before external systems (Internal refers to operating systems on integrated devices).
- Small capacity devices before large capacity devices.

Default Mass Storage Is

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

- Default MSUS for operating systems,

- Device from which to load an autostart program, and

- Device from which to do a secondary load.

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

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

- The first device found with L.I.F., S.D.F., or UNIX formatted media present if ROM is specified in DEFAULT_MSUS, or

- 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

- A L.I.F. media in a 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 Rev C Boot ROM can boot a system (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 9914 HP-IB card

- HP 98629 SRM card

- HP 98643 LAN card

- HP 98265 SCSI card

- HP 98625A/B HP-IB cards (Except never with 8290X due to hardware timing problems)

- HP 98620 DMA card

- HP 98255 EPROM card

- HP 98259 Bubble RAM card

The following interface protocols can be used to boot a system with the Rev C Boot ROM:

- CS/80

- SS/80

- Amigo

- LAN RMP boot protocol

- SCSI direct access device

- SRM

- EPROM

- BUBBLES

The following is a list of all media formats from which a system may be booted using the Revision C1 Boot ROM:

- L.I.F. 8000_{16}.

- SRM

- UNIX (3000) (Boot Area) (Note that this is different from HP-UX)

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

- ROM systems

- SRM via HP 98629 card, /SYSTEMS directory only

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

- SCSI and LAN boot servers

- "Disc" format EPROMs (HP 98255)

- HP 98259 Bubble RAM card

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

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

- CS/80 Tape

Note

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

For all devices there are seven generic error messages:

- `No Device` -- The device disappeared.

- `No Medium` -- There was no media (e.g. flexible disk) present or no server for LAN.

- `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 a system 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 systems, it will not terminate the scan. In this case the error(s) will be listed on the left hand side of the screen. Below is an example display with several errors.

```
Copyright 1988,
Hewlett-Packard Company.          :REMOTE, 21, 0, 8
All Rights Reserved.              2B SYSTEM_BASIC
                                  :ROM
BOOTROM Rev. C1                   B
Bit Mapped Display
MC68030 Processor
Console Keyboard at 14
HP-IB                             :HP9895, 801, 2
DMA-CO                            3B SYSTEM_BAS
RAM 1572704 Bytes                 1Z SYSTEM_4TH
HP98626 at 2                      :HP7908, 803, 0
HP98625 at 8                      1b SYSburp
HP98642 at 9                      :REMOTE, 20, 0, 8
HP98629 at 20                     1F SYSTEM_FORTRAN
HP98629 at 21                     2F SYSTEM_FORTH
:HP8290X, 804, 0                  1P SYSTEM_PASCAL
Bad Hardware
:REMOTE, 20, 1, 8
No Device


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

Figure 4-3. Example Display with Errors

Booting From The SRM

Placing bootable systems on sector oriented devices is fairly straight forward. On LIF devices a system file must be created, and on SDF and HP-UX devices a boot area must be created. For the SRM, systems 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, system files can be deleted, or added. This means that the Boot ROM may show a system that does not exist anymore, may not show a system that does exist, or may never show a system that has always been there.

If a system 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.

RESET will re-start Boot ROM execution. RESETs are locked-out or deferred during all mass storage operations to prevent leaving devices stranded in strange states.

Self-Tests

When the computer first powers up, the CPU starts executing Boot ROM code. Before code is executed to boot an operating system, several things need to be set up and tested. The Boot ROM has several code segments to manage these responsibilities:

- **Hardware Initialization Support.**

  Some hardware must be initialized at power-up as soon as possible to prevent improper operation. This initialization is cheaper in the Boot ROM than in the hardware. (Examples are display initialization and floating RAM positioning -- neither of which can wait for a system to be loaded.)

- Field Replaceable Unit Go/No-Go Self-Test Support.

  The primary objective is to tell user that the computer is okay. This consists of indicating all such devices present and reporting all detectable failures.

  Boot ROM self-tests are by no means guaranteed to handle all hardware failures correctly. Several things contribute to this. They include current hardware design, limited code space, limited development time, and the fact that testing for unknown or unexperienced failures is virtually impossible.

  Several "UNEXPECTED" failure messages may be displayed at any time. When the CPU executes an instruction set, certain events are expected to occur. Should an interrupt (either internally from the CPU or externally from some other device) occur and cause a RAM or CPU address to be used out of sequence, an "UNEXPECTED USE OF (address) error message is displayed. Table 4-1 lists these messages. The addresses 5 most significant digits are FFFFF so only the 3 least significant digits (LSD) are used in the table. When a range of addresses is shown, each address is the range is 6 addresses apart.

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

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

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

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

Table 4-1. "UNEXPECTED USE OF (address)" Failure Messages

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

Failure Indications

As the self-test progresses, the LEDs 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.

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

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

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

```
CONTINUE AT OWN RISK (Press RETURN To Continue)
```

Once this message has been printed, 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 CRT to warm up and for the user to read the error messages. These failures are usually non-fatal so, in an unattended mode, the Boot ROM will still boot the first system it finds. Pushing the RETURN key will terminate the beeping error code and abort the one minute wait. Pushing the RETURN key will also make the machine attended.

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

General Description of Failure Codes

Table 4-2 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 designator's indicate the LED in that position is on or off, depending on the binary code used to represent the device or failure type.

Table 4-2. General Failure LED Indications

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

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

State and Failure Codes

Table 4-3 lists the LED failure codes used in the computer's Boot ROMs. Codes are listed here in numerical order for easy reference, and then again in order of occurrence and priority.

Table 4-3a. Self-Test LED Special State and Failure Codes

(In numerical order):

LEDs	Explanation
oooo oooo	No failure
oooo ooo●	Failed CPU register test.
oooo oo●o	Testing top 16 Kbytes of RAM.
oooo oo●●	Failure in top 16 Kbytes of RAM.
oooo o●oo	Top 16 Kbytes of RAM missing or not found by CPU.
oooo o●o●	Searching for user-supplied Extension ROM.
oooo o●●o	Start executing Extension ROM instructions.
oooo o●●●	Starting Test Vector list.
oooo ●ooo	Resetting all interfaces.
oooo ●oo●	Searching for alpha video circuits.
oooo ●o●o	Testing RAM for I/O on-board test code.
oooo ●o●●	I/O on-board test code running.
oooo ●●oo	Internal BMD checksum.
oooo ●●o●	DIO-II console testing.
oooo ●●●o	Failed Boot ROM checksum.
oooo ●●●●	Pre-loading RAM for main test.
ooo● oooo	RAM Testing
ooo● ooo●	Failure: Not enough RAM.
ooo● oo●o	Failure: ROM system.
ooo● oo●●	Failure: Boot error.
ooo● o●oo	Failure: OS tried to start loading at too high of an address.
ooo● o●o●	Failure: Not enough RAM to load OS.

Table 4-3b. Self-Test LED State and Failure Codes for Interfaces

(In numerical order)

LEDs	Explanation
oo●o oooo	Failure: 4 ms timer.
oo●o oo●o	Failure: Processor board keyboard circuit.
oo●o oo●●	Failure: External keyboard circuit.
oo●o o●oo	Failure: Internal HP-IB circuit
oo●o ●ooo	Failure: DMA circuit.
oo●o ●●oo	Failure - one of these high-res video circuits: Font ROM is bad. Font ROM is not usable. Could not find US ASCII character set.
oo●o ●●o●	Failure: Video board bit map circuit.
o●oo oooo	Failure: I/O circuit at select code 0. Each successive LED pattern represents an I/O failure at select codes 2 through 30.
o●o● ●●●●	Failure: I/O circuit at select code 31.

Table 4-4a. Turn-On, Self-Test, and Boot Displayed Messages

Displayed Message	Explanation and Procedure
RAM FAILED ABOVE FFFFC000	Failure in top 16 Kbytes of RAM. Replace processor board.
RAM GONE ABOVE FFFFC000	CPU could not find top 16 Kbytes of RAM. Replace processor board.
TESTING MEMORY	User RAM is being tested.
LOADING MEMORY	RAM is loading with Boot ROM code.
BOOTING A SYSTEM	An OS is being loaded into RAM.
SEARCHING FOR A SYSTEM (ENTER To Pause)	Looking for an OS on mass storage devices. Press [Enter] to stop the search.
SEARCHING FOR A SYSTEM (RETURN To Pause)	Looking for an OS on mass storage devices. Press [Return] to stop the search.
PAUSED (ENTER To Continue)	Computer has paused. Press [Enter] To Continue.
PAUSED (RETURN To Continue)	Computer has paused. Press [Return] To Continue.
CONFIGURE MODE	Self-test is in configure mode. Press [T] for extended self-test. Press [L] for continuous self-test.
SELF-TEST MODE	Computer is in self-test mode.
RESET To Power-Up	Press [Reset] to re-start power up sequence.
RESET TO RE-Try	Press [Reset] to re-try what failed before.
CONTINUE AT OWN RISK (ENTER To Continue)	A self-test was not completed. You may continue but errors may occur. Press [Enter] to re-start power up sequence.
CONTINUE AT OWN RISK (RETURN To Continue)	A self-test was not completed. You may continue but errors may occur. Press [Return] to re-start power up sequence.
WAITING 1 MINUTE (ENTER To Abort Wait)	Computer has paused while you decide what to do next. Press [Enter] to abort wait and continue.
WAITING 1 MINUTE (RETURN To Abort Wait)	Computer has paused while you decide what to do next. Press [Return] to abort wait and continue.
UNEXPECTED USE OF HHHHHHHH	Refer to Table 4-3.
NOT ENOUGH MEMORY	Not enough RAM to load OS.

Table 4-4b. Turn-On, Self-Test, and Boot Displayed Messages (cont.)

Displayed Message	Explanation and Procedure

SYSTEM WOULD LOAD TOO HIGH	An addressing error would make the OS start loading at too high of a RAM address.
	One of these situations probably occurred:
	    1. Bad OS media.
	    2. Error in information transfer.
	    3. Error in CPU, I/O or mass storage hardware.
	Try again. If error message repeats, troubleshoot or replace the above items.

SYSTEM NOT FOUND	Selected OS was not found on available mass storage devices. Verify desired OS is on a mass storage device and retry.
Bit Mapped Display	Bit-mapped video circuits on video board identified.
Keyboard	Processor board's keyboard circuits identified.
Console Keyboard at SC	Remote keyboard circuits identified at select code SC.
HP-IB	Processor board's HP-IB circuits identified.
HP98260	Interface (HP 98260 or equivalent) identified.
DMA	Processor board's DMA circuits identified.
MC68030 Processor	MC68030 CPU identified.
MC68882 CoProcessor	MC68882 Floating-Point Co-processor identified.
BBBBBBB Bytes	BBBBBBB is the amount of RAM in bytes the self-test found in the computer.

MEMORY FAILED AT HHHHHHHH	Memory failed at hex address HHHHHHHH.
	Replace one of these assemblies, depending on which one has the failed memory address:
	    Processor board.
	    Add-On RAM board.

DATA PARITY ERROR AT HHHHHHHH	A parity error occurred with hex address HHHHHHHH.
	Replace one of these assemblies, depending on which one has the failed memory address:
	    Processor board.
	    Add-On RAM board.

PARITY BIT ERROR AT HHHHHHHH	A parity bit error occurred with hex address HHHHHHHH.
	Replace one of these assemblies, depending on which one has the failed memory address:
	    Processor board.
	    Add-On RAM board.

Table 4-4c. Turn-On, Self-Test, and Boot Displayed Messages (cont.)

Displayed Message	Explanation and Procedure
MEMORY GONE AT HHHHHHHH	A read or write cycle was attempted at address HH-HHHHHH but no memory found at that address. Replace one of these assemblies, depending on which one has the failed memory address: 　　Processor board. 　　Add-On RAM board.
F Disc Error	An error occurred in disc drive information. Troubleshoot disc drive/media and replace one of these assemblies: 　　Media. 　　Disc drive board.
XXXXXXXX at SC	An accessory card or the equivalent circuit was found at select code SC and is identified by its HP product number and type.
Remote Interface at SC	A remote interface was identified at select code SC.
HP98265 (SCSI S 16)	SCSI identified as S (single-ended) at select code 16.
HP98265 (SCSI D 32)	SCSI identified as D (differential) at select code 32.
HP98265 (SCSI D 16)	SCSI identified as D (differential) at select code 16.

Tests Performed By the Revision C1 BootROM
Unextendable Code Segment

The first section of code in the Boot ROM consists of a series of tests and initialization routines which set up the computer so the rest of the Boot ROM code can function safely. 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):

- Bus Error Handler.

  The BUS ERROR vector is set up to point a routine which, based on the value of the stack pointer, decides if we have a stack.

- 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.

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

  The stack pointer is set and a register is set to point to the address of the next routine. The Boot ROM steps through the first 16 Kbytes of memory, pre-loading it and to initialize for the top memory test. If a bus error does not occur, the Boot ROM reads every 64 Kbyte boundary until a bus error occurs or until just before location $FFFF800000_{16}$ is reached.

- Cycle LEDs.

  A register 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 delay between memory pre-load and the test to check for refresh failures. If the LED ripple is successful, then this is noted in a data register.

- Check for Test ROM.

  If the Boot ROM is not at power-up, then this step is skipped. A register is set to the next step.

- Check for Video Circuits.

  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 compatibility (alpha/graphics) video circuit. Then the Boot ROM looks for a bit-mapped video board 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 flag is set to indicate the presence of a bit mapped display.

- 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.

- Determine Which, if Any, Alpha Video Circuit is Present.

  Register A6 is set to the location of the top RAM test routine. An algorithm is used to determine which video board, if any, is present.

- Initialize and Blank Alpha Video Circuit, if Present.

  If a compatibility (alpha) display controller is present, then it will be initialized and blanked.

- 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, ●ooo o●oo will be displayed on LEDs. If memory is missing, o●oo o●oo will be displayed on LEDs. If an alpha display controller is present, the Boot ROM will also write the messages "RAM FAILED ABOVE FFC000" and "RAM GONE ABOVE FFC000" for memory failure and memory missing, respectively. These messages will not be printed on a bit mapped display controller as it is too difficult to write to a bit mapped controller without any stack space or RAM.

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

The second part of this code section depends upon a working RAM stack, and includes the following (as in the previous section, the LEDs are set to a new value before each step):

- Set Up Data Structures.

- The test list is set up in temporary RAM.

- The boot list and device driver list are set up.

Extendable Code Segment

This section of code allows one to add, replace or delete parts of the power-up sequence without requiring that the Boot ROM be replaced. These upgrades can be done via a boot extension ROM. In this section the Boot ROM calls any boot extensions, executes the test list vectors, and loops through self-test if continuous self-test is enabled.

The following is a step by step list of what happens in the extendable code segment. As before, each step is preceded by an indication of that step on the LEDs.

1. **Call All Boot Extensions:**

   Any boot extensions are called to allow changes to the test list and the boot list. If the boot extension header indicates that the extension code can be checksummed, then the checksum will be executed before any part of that extension is executed.

2. The Test List:

   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:

   a. Indicate on LEDs the device being tested.

   b. If the device is present, then

      If the test or initialization fails, then indicate the failure.

   c. Otherwise indicate the presence of the device.

The test list for the Series 300 Rev. C1 Boot ROM is as follows:

1. **Which CPU:**

   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 chip is an MC68000. If the processor was not an MC68000, then a divide by zero is executed and the stack is checked to distinguish between an MC68010, an MC68020 and an MC68030.

2. **Initialize Timer:**

   The Boot ROM determines if there is a timer on the CPU board. If there is one, then it is tested and initialized. If one is not present, or if a failure occurred, then the Boot ROM halts with oooo o●o● on the LEDs.

3. **Initialize Monitor:**

   The Boot ROM determines if a RAM video circuit is present at 00880000_{16}. If there is one, then its presence is indicated.

4. **Reset I/O:**

   A RESET instruction is executed to clear all I/O. The Boot ROM checks the internal keyboard controller, if present, to ensure that its timer does not lose time.

5. **Initialize and Test Display:**

   The output human interface soft vectors are set up to handle whichever video circuits are installed or dummy video drivers are set up if no controller is present.

   If an alpha video circuit is present, then a memory test of the alpha, and highlight memories is executed.

   If a bit map video circuit is present, then its ID/INIT ROM is checksummed and the circuit is 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 displayed on the bottom line of the display. See the section in this chapter on Human Interface for the console selection algorithms.

6. **Display Copyright Notice:**

   The Boot ROM displays a 1988 copyright message.

7. **Boot ROM Checksum:**

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

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

8. **Display CPU Type:**

   The Boot ROM displays the type of CPU.

9. Identify Floating Point Hardware:

   The Boot ROM looks for and identifies, if present, the HP 98248A/B floating point accelerator board or the MC68882 floating point coprocessor chip.

10. Initialize, and Test Keyboard Electronics:

The keyboard human interface vectors are set up for the internal keyboard , if one is present, and the keyboard self-test value is checked. If the keyboard failed self-test, then the message `Keyboard Failed` is displayed and the appropriate error code is set to the LEDs and the beeper. If the internal keyboard interface is present and passed self-test, then the message `Keyboard` is displayed. If no internal keyboard is present, then the external I/O space is searched for an external keyboard. If an external keyboard is found, it is treated just like an internal keyboard except that the message `Console Keyboard at XX` (where XX is the select code of the external keyboard) is displayed if the keyboard passes self-test, and the message `Console Keyboard at XX Failed` is displayed if the keyboard fails self-test.

Note that only the external keyboard chosen as Console Keyboard will be tested. Other external keyboards will be identified, but not tested.

The message `RESET to Power-Up` is shown on the bottom line of the display.

11. **Drop Interrupt Level:**

The interrupt level is dropped to zero.

12. **Pre-load Memory:**

The message `LOADING MEMORY` is shown on the bottom 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 shown on the last line of the display. Then a 300 ms delay is executed to catch refresh failures.

13. Test and Initialize Old Style Graphics:

If a compatibility monitor with graphics memory 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 indicated 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 internal HP-IB hardware is present and if 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 a DMA circuit is present then the message `HP98620A` or `HP98620B` is displayed.

16. **I/O Card Tests:**

   The Boot ROM scans select codes 0 through 31. 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,

      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 display controller card,

      HP 98624 HP-IB card,

      HP 98626 RS-232 card,

      HP 98643 LAN card,

      HP 98625 SCSI card,

      HP 98644 RS-232 card,

      HP 98628 RS-232 card, or

      HP 98642 4-port multiplexed RS-232 card.

   b. 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 card is indicated by the message:

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

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

      HP 98625B HP-IB

      HP 98622 GPIO

      HP 98623 BCD

      HP 98640 ACD

      HP 98695 3270 Emulator

      External bit-mapped video circuits with a primary ID of 25 and and secondary ID of 0 or 1

      External keyboard (i.e., keyboard in the external I/O space) with ID 9 (will be identified as Keyboard at XX where XX is its select code)

      HP 98653 EPROM Programmer

      HP 98633 Multiprogrammer Interface

HP 98659 Bubble RAM

HP 98641

HP 98691

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

d. 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.

17. **Test ROM Systems:**

The Boot ROM searches the ROM space from 64 Kbytes 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 display controllers will be ignored, and the message `ROM X at <address> Ignored` will be displayed, and the appropriate value will be sent to the LEDs.

18. **Test RAM:**

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

19. **Set Up Memory:**

The message `SELF-TEST MODE` appears on the bottom 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 64 Kbyte boundary. If the failure was is in the top 64K, the Boot ROM drops back to the next 2K boundary.

The available RAM is displayed as `<Base-Ten-Number> Bytes`. It should equal 174 bytes less than the amount of RAM installed.

20. **Allocate Memory:**

Temporary memory is set up for the boot scanner and booter routines.

21. **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 [Return] 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 CRT to warm up before continuing, and will display the message WAITING 1 MINUTE (RETURN To Abort Wait). Pressing [Return] will cause the Boot ROM to abort the one minute wait and continue.

```
Copyright 1988,
Hewlett-Packard Company.
All Rights Reserved.

BOOTROM Rev. C1
MC68030
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 4-4. 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 16 Kbytes 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 always 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)
```

Where:

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

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

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

Where:

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

I/O Dependent Code Test

A major new test capability has been added to Rev C and later bootROMs. The concept is taken from the HPPA and is known as I/O Dependent Code (IODC) entry point test. The basic concept is that an interface will carry its own test code in on-board ROM. This code is moved to system main RAM and executed by the host CPU. From a user's perspective, there are effects on how failures are reported.

The simplest change is that instead of a Failed message at the end of an interface identification, there will be one or more lines of indented text saying which part of the interface failed.

The most complex change is that under extended test mode, the user may be asked to perform certain actions and will be given more information about what happened during one or more steps in the test.

During extended test mode the display is organized into several sections.

```
 --------------------------------------------------------------------
|      device identification     |result : test section description  |
|      status messages           |                                   |
|                                |                                   |
|                                |                                   |
|                                |                                   |
|                                |                                   |
|                                |-----------------------------------|
|                                |         general messages          |
|                                |                                   |
|                                |                                   |
|                                |                                   |
|                                |                                   |
|                                |                                   |
|                                |                                   |
|                                |                                   |
|                                |                                   |
+--------------------------------+-----------------------------------+
| prompt line                                                        |
+--------------------------------------------------------------------+
| reset action line                          system selection field  |
+--------------------------------------------------------------------+
```

Figure 4-5. Extended Test Mode Display Organization

The left section contains the name and status of interfaces and system components identified and or tested so far. The lowest one on the display is the interface currently being tested.

The prompt line normally shows the SELF-TEST MODE message but when the user is asked for input, this line will describe which keys may be pressed and what they will do.

The only keys recognized at this point are:

- [Reset] which will abort the whole test operation and go to the RESET state It is described earlier in this chapter.

- **SPACE**

- [Return]

- [A] through [Z]

- [a] through [z]

- [0] through [9]

- All other keys are ignored.

The reset line shows that the RESET function is active and the selection field shows the current system selector. Information on this line has been fully described earlier in this chapter.

The upper right hand area contains one line identification/descriptions of each section of the test, possibly one for each FRU in the interface. The left end of each line will contain a result. The result will be "passed" or "failed" indicating that the test has been run and the result of the test. If this field is blank it indicates that either the section has been skipped or not run. Test sections are performed in the order shown on the display.

The area, below the section descriptions is used to display general information about a test section, direct user actions and display failure messages. Failure messages will also appear in the left half of the display. This general information area is cleared after each section has been done.

The size of the two right hand areas is determined by the number of test sections.

Small Computer Systems Interface

The SCSI is identified by one of these messages:

        PPPPPPP (SCSI s n) at SC

where: PPPPPPP is the HP product or equivalent thereof.
s is an S for single-ended line drivers.
s is a D for differential line drivers.
n is 16 for a 16-bit wide DMA path.
n is 32 for a 32-bit wide DMA path.

Currently only the 32 and 16 bit single-ended varieties exist:

        HP98265 (SCSI S 32) at 14
        HP98265 (SCSI S 16) at 14

SCSI Testing

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

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

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

        register test failed
        fuse burned out

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

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

Extended testing is done in a non-looping extended test mode. This mode uses the IODC interface as described above. There are 3 sections to this test.

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- Register test (as done in normal testing).

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

- Loopback test.

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

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

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

  `X cancels, RETURN continues testing`, wherein pressing ⌈X⌋ cancels the test or ⌈Return⌋ continues the SCSI test.

  This test checks transmit and receive functionality both with and without DMA interaction. If there is only one device attached to the interface, the test can be performed with the device turned off and the cable still attached. If there is more than one device then the cable must be detached from the device before running this test. If this test fails, cable test can still be executed. If the user cancels testing at this point by typing X in response to the prompt, this section and the following sections are skipped. It will take a second or so with bit-mapped video circuits to clear the display and shut down the IODC interface.

- Cable test.

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

  `Attach SINGLE-ENDED test connector`, meaning connect the single-ended part of the SCSI test connector to the SCSI port on the back panel of the computer.

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

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

- Reconfiguring the System.

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

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

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

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

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

SCSI Interface ID Situations

During the search for a system phase of the boot process, the Rev. C Boot ROM looks for an SCSI interface by checking only the least significant 3 bits of each interface ID. This means any interface whose ID code has the least significant 3 bits set to 1 will be accessed as if they were an SCSI interface. Interfaces and their ID involved are:

- HP 98265A SCSI Interface Card; ID 7 (00111).

- HP 98630A Breadboard Card; ID 15 (01111).

- Datacomm devices; ID 23 (10111).

- HP internal devices; ID 31 (11111).

Of these interfaces, the HP 98630A Breadboard Card may cause the most concern. The Breadboard Card may need to have a higher select code than the HP-IB or SCSI interface to prevent this problem. Otherwise, the Breadboard Card should have an ID of 16 (1000).

User Interface Specifications For LAN Boot Operations

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

        HP98643 (LAN) at 21, 080009000001

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

        HP98643 (LAN) at 21

then

        HP98643 (LAN) at 21, 080009000001

If a failure is detected in the power-up test, the following failure message will be displayed:

        HP98643 (LAN) at 21, 080009000001 Failed

This shows that one of the internal tests on the card failed. The tests include register operations, shared ram, non-volatile ram checksum and several different internal loopback tests.

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

- CABLE Failed

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

- MAU Failed

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

- NO HEARTBEAT

    This message is only a warning. This shows that the interfaces self-test (done after every transmission) is failing. In can also appear on Ether Net type MAUs because this self check feature is not implemented. This message is new for REV C. The same condition occurring with REV B will be detected by the normal test passing and the extended test showing only a Failed message.

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

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

```
:LAN, 21, 080009000008
1H SYSTEM_HPUX
2B SYSTEM_BKUP
```

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

Error Message	Meaning
SYSTEM NOT FOUND	The server could not open the selected file, or the file was of the wrong type.
No Server	The server did not respond to a boot request
Not Ready	LAN hardware powerup or reset failed.
Read Error	Open worked but server has since failed to respond or has sent an eof message.
Bad Hardware	LAN hardware failed to respond to some operation or it reported some catastrophic failure.
Bad State	Bootrom code damaged.

Read Interface Technical Information
The LAN drivers will support the read interface as used by secondary loaders.

The LAN MSUS is

- fmt = 7

- dev = 2

- sc = card select code

In hex this is E2xxSCxx. The x fields are don't cares, the SC field is the select code. Other fields in the msus may be non zero but are not significant for read interface purposes.

The LIF volume images allowed for LAN booting deviate from the LIF standard in that:

- The directory must begin on either sector 1 or sector 2.

- The files in the directory MUST all have the same start, length and type values.

- Empty entries are skipped.

- Both the logical and physical end of directory conditions are recognized.

The LAN boot protocol is intended only to transport files NOT directories. The LIF volume image is used as a mechanism to provide the information normally supplied by the directory on a LIF volume. Neither the volume name or file names are ever examined. It is assumed that the correct name was used given to the server.

The multiple files with identical type, start and length values is used by the HP-UX secondary loader. All HP-UX type system files boot the same physical file, which is the secondary loader. This loader then examines the name under which it was booted then loads the corresponding a.out file.

The M_READ MEDIA parameter is used as follows:

- If the file is a LIF volume image then

  - If MEDIA is true then offsets are volume image relative.

  - If MEDIA is false then offsets are from the start address given in a directory entry.

- If the file is not a LIF volume image then then offsets are always from the beginning of the file.

Errors are signaled by the standard read interface escape codes. Table 4-5 lists the Lan boot errors.

Table 4-5. LAN Boot Errors

Error Message	Meaning
No Server	(M_FOPEN only) The server did not respond to a boot request.
Not Ready	(M_FOPEN or M_READ) LAN hardware powerup or reset failed, or M_FOPEN was called without calling M_INIT, or M_READ was called without calling M_FOPEN.
Read Error	For M_FOPEN, the open operation worked but the server has since then failed to respond to a read request or the server sent eof. For M_READ, the server failed to respond to a read request or the server sent eof.
Bad Hardware	(M_FOPEN or M_READ) the LAN hardware failed to respond to some operation or reported a catastrophic error.
Bad State	(M_FOPEN or M_READ) damaged bootrom code.

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

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

Test Items

1. Which of these statements are true?

   a. All Models 360/370 contain a Revision C boot ROM.

   b. All Models 360/370 contain a Revision C1 boot ROM.

   c. All Model 370s and most Model 360s contain a Revision C1 boot ROM. A few early Model 360s contain the Revision C boot ROM.

   d. The Revision C1 boot ROM is quite diferent from the Revision C.

2. Which of these statements are true?

   a. An external interface may be enabled if an internal interface is present.

   b. A remote terminal may be enabled if an internal interface is present.

   c. If more than one keyboards are present, the one with the highest select code will be enabled.

   d. If an external HP-HIL interface and a remote console are both present in a system, they will **always** be enabled.

3. When booting an unattended system,

   a. The first system found will be loaded and given control.

   b. If no system is found, the boot ROM will display a No System Found message on the CRT, then quit.

   c. A device successfully accessed during a boot list search will be accessed in each subsequent search until a system is found.

   d. None of the above.

4. In order to force attended operation, the operator must:

   a. Turn the system on with the power switch.

   b. Press the space bar immediately after turning the computer on.

   c. Press the return key immediately after turning the computer on.

   d. answer b or c, as well as any letter or number key.

5. When searching the boot list:

   a. Lower addresses are found first.

   b. Local systems are found before remote systems.

   c. Small capacity devices are found before large capacity devices.

   d. All the above.

After you have answered all test items, turn to the back of this lesson and grade yourself from the Answers Sheet. If at least 80% of your answers are correct, you've successfully completed this quiz. If less than 80% of your answers are correct, you should review the areas of the lesson the missed test items cover.

Answers to Quiz 3

1 a

2 b

3 a

4 d

5 d

Your Comments, Please.

Now's a good time to write down your comments regarding this lesson. Refer to these comments when filling out the Course Evaluation.

Troubleshooting

4

Instructions

This lesson covers the subject of troubleshooting the Models 360/370. When you have read the Chapter, take the test at the end.

Troubleshooting

5

Introduction

Analytic Troubleshooting

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

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

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

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

Materials Required

Several items are required to troubleshoot the computer or expander to the failed assembly:

- Model 360/370 Computer and HP 98568 Opt. 132/98570A Expander Service Handbook
- Series 200/300 Test Tools Package.
- Digital Voltmeter.
- Anti-Static Workstation.

Test LED Displays

Note

LED displays in this chapter are for Revision C and C1 bootROMs. Although these boot ROMs are slightly different, their test and diagnostic functions are identical. They are both referred to in this manual as Revision C boot ROMs.

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
- o = 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, interfaces, peripherals, power source **and the users**. 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, your initial activity should be finding the 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 were 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 expander has the problem. The rest of this chapter covers troubleshooting the computer and expander.

Computer/Expander Troubleshooting

Both units may be analyzed alike, except for the processor in a computer's system slot. 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.

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.

Table 5-1. Computer/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-II Bus
	    Some inputs from keyboard
	    Output to operate monitor
	
	Bus Expander:
	    Power Supply
	    Part of motherboard
	    One accessory card

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/frequency or defective power cord.

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

WARNING

Hazardous voltages are present in the 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 V dc.

    b. Small fan voltage: +17 V dc (+5 and −12 V dc).

5. If the fuse is open, one of the installed assemblies is defective.

6. Remove all assemblies from the slots.

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. Disconnect the card cage ribbon cables. 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 blown, 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 4 Mbytes of RAM configured at the top of memory.

For the bus expander, the minimum functional configuration is:

- Power Supply.

- Motherboard.

- One functional board or card.

Computer Minimum Configuration

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

1. Turn the unit off.

2. Separate the bus expander from the computer.

3. Remove all accessories. Leave enough RAM installed that's configured at the top of memory.

4. Leave the processor board in.

5. Remove the top cover and diskonnect 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.

1. Turn the unit off.

2. Remove all boards/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 board/card in the bus expander.

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

6. Repeat steps 4 and 5 until the board or card passes self-test. If the assembly does not pass self-test, either it or the bus expander is defective. In this case, repeat steps 6 and 7 using another board or 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 oooo oooo. Once the computer minimum configuration self-test passes, you're ready to start testing with an Intermediate Configuration.

Intermediate Configuration

You may configure the computer several ways 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. Install a memory board (without system bus on a Model 370) 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 board in another system slot, then retest. If necessary, run the test with the memory board in each system slot.

5. If the LED pattern is correct, skip to Step 6. If the pattern is incorrect, either motherboard or processor is bad. Replace each one and retest until the correct LED pattern is achieved.

6. If you're testing a Model 360 computer, skip to Step 12. For a Model 370, power down and unplug the computer. Install the system bus between the processor board and a memory board.

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 12.

9. Power down and unplug the computer. Install a video board and connect it to a monitor. Turn on the monitor.

10. Turn on the computer. Watch the self-test display on the monitor.

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

   If the self-test display is correct, skip to Step 12.

   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.

12. Turn the computer off and install the system interface board, then install the keyboard.

13. 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.

14. 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	Minimum Functions Performed
Power Supply	All voltages normal and within specifications.
Processor Board	CPU chip executes self-test, cycles memory, most instructions executed OK, self-test LED light.
4 Mbytes of RAM	Addresses, read/writes, and refreshes.
Video Board	Processes and outputs video.
System interface board.	Inputs/Outputs data between processor and peripherals.
Monitor	Displays 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 tests in the Series 200/300 Test Tools Package. Refer to the Test Tools Manual for tests information such as:

- Minimum Hardware Configuration Required.

- Test Loading and Running.

- Interpreting Test Results.

Series 300 Model 360/370 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 Model 360 and 370 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 these computer's 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 disk drive for loading and running the test software.

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

Computer Tests

Series 300 Computer Tests for the Model 360 and 370 computers are supplied on one of two disks, the other is for Series 200 computers. They test the processor board, RAM, video and interface electronics, and other functions.

System Functional Tests

Five disks contain these tests. The first disk contains the Pascal-based operating system environment and the main menu; the other disks 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 disk and is used to verify that CS/80 disk drives are correctly connected to the computer, and that the computer can successfully write and retrieve data to and from the disk or tape. The Pascal-based program also provides access to CS/80 disk and tape error logs for analyzing drive and media performance. This information is useful for troubleshooting, and for planning preventive maintenance programs.

Package Contents

The combined Series 200/300 Test Tools software package is provided on a variety of media as shown below:

Media	Part Number
one 1/4-inch tape	09800-12700
eight 3 1/2-inch disks	09800-12300
eight 5 1/4-inch disks	09800-12500

The tape version consists of one tape and the manual.

The disk versions consist of the manual and these disks:

> Series 200 Computer Tests Disk Rev. 1.1
> Series 300 Computer Tests Disk Rev. 2.0
> Series 200/300 System Functional Tests Disks:
> > SFT0 Disk Rev. 1.2
> > SFT1 Disk Rev. 1.2
> > SFT2 Disk Rev. 1.2
> > SFT3 Disk Rev. 1.2
> > SFT4 Disk Rev. 1.2
> CS/80 Exerciser Disk Rev. 3.1

Self-Test

Use the self-test to troubleshoot a unit which can execute some instructions, but cannot accept, store or output data correctly. This means that the basic elements of the computer are functioning. The basic elements include the power supply, processor board, 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 and displays error displays in binary on 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 self-tests, refer to Chapter 4.

Failure Indications

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

Should a failure occur during the self-tests, it will be indicated on the LEDs at the end of the tests. If there was more than one failure, the highest priority failure will be indicated on the LEDs. All the LED values are shown in Table 5-3.

The highest priority failure is also output to the beeper, if present. The LED value is 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 5-3 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 5-3. General Failure LED Indications

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

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

State and Failure Codes

Table 5-4 lists the LED failure codes used in the computer's Boot ROMs. Codes are listed here in numerical order for easy reference, and then again in order of occurrence and priority.

Table 5-4a. Self-Test LED Special State and Failure Codes
(In numerical order):

LEDs	Explanation
oooo oooo	No failure
oooo ooo●	Failed CPU register test.
oooo oo●o	Testing top 16 Kbytes of RAM.
oooo oo●●	Failure in top 16 Kbytes of RAM.
oooo o●oo	Top 16 Kbytes of RAM missing or not found by CPU.
oooo o●o●	Searching for user-supplied Extension ROM.
oooo o●●o	Start executing Extension ROM instructions.
oooo o●●●	Starting Test Vector list.
oooo ●ooo	Resetting all interfaces.
oooo ●oo●	Searching for alpha video circuits.
oooo ●o●o	Testing RAM for I/O on-board test code.
oooo ●o●●	I/O on-board test code running.
oooo ●●oo	Internal BMD checksum.
oooo ●●o●	DIO-II console testing.
oooo ●●●o	Failed Boot ROM checksum.
oooo ●●●●	Pre-loading RAM for main test.
ooo● oooo	RAM Testing
ooo● ooo●	Failure: Not enough RAM.
ooo● oo●o	Failure: ROM system.
ooo● oo●●	Failure: Boot error.
ooo● o●oo	Failure: OS tried to start loading at too high of an address.
ooo● o●o●	Failure: Not enough RAM to load OS.

Table 5-4b. Self-Test LED State and Failure Codes for Interfaces
(In numerical order)

LEDs	Explanation
oo●o oooo	Failure: 4 ms timer.
oo●o oo●o	Failure: Processor board keyboard circuit.
oo●o oo●●	Failure: External keyboard circuit.
oo●o o●oo	Failure: Internal HP-IB circuit
oo●o ●ooo	Failure: DMA circuit.

oo●o ●●oo	Failure - one of these high-res video circuits:
	    Font ROM is bad.
	    Font ROM is not usable.
	    Could not find US ASCII character set.

oo●o ●●o●	Failure: Video board bit map circuit.
o●oo oooo	Failure: I/O circuit at select code 0. Each successive LED pattern represents an I/O failure at select codes 2 through 30.
o●o● ●●●●	Failure: I/O circuit at select code 31.

Model 360 RAM

Although the HP 98258 and HP 98264 RAM boards are not supported in the Model 360, they are physically compatible and may find their way into a Model 360. For instance, a person upgrading a Model 330 or 350 to a 360 may inadvertantly leave the RAM boards in the backplane. Here is a summary of the problems which can arise in this circumstance:

Any of three situations can arise:

1. The unsupported RAM can be addressed such that it overlaps the Model 360 RAM.

2. The unsupported RAM can be addressed such that it is not contiguous with the Model 360 RAM.

3. The unsupported RAM can be addressed such that it is directly below the Model 360 RAM.

In Situation 1, both RAM boards will be occupying the same address space. Bus errors will occur, and operation will cease.

In Situation 2, the bootROM will never see the non-contiguous RAM. It will not be listed in the power-up display and operation will be normal. This situation is undesireable because the unsupported board is taking up a slot and consuming power.

In Situation 3, the RAM will be listed in the power-up display. Operation will be normal except that it will be slow. This is undesireable because the customer will not obtain the expected performance.

Test Items

1. When turning the unit on, the self-test LEDs do not light up. What could be wrong?

    a. The power supply is defective.

    b. The voltage select switch is in the wrong position.

    c. The unit is connected to an improper voltage or frequency.

    d. Any of the above.

2. The System Functional Tests:

    a. are written in HP-UX

    b. add significantly to the confidence levels achieved by the boot ROM self-test program.

    c. are primarily used to verify communication between the computer and supported peripherals.

    d. exercise peripherals and provide worst-case tests at maximum speed and similar margin-of-safety tests.

3. When upgrading an existing Model 330 computer to a Model 360, a customer inadvertently left the HP 98258A RAM board in the computer. The symptom will be:

    a. Numerous bus errors will occur while the boot ROM checks the RAM.

    b. Operation will be slow, but normal otherwise.

    c. The boot ROM will simply ignore the HP 98248A RAM board, and proceed normally.

    d. Any of the above, depending on the address setting of the HP 98258A board.

4. The self-test LEDs light at power-up, and soon turn off. What do you know about the computer?

    a. The boot ROM self-test has not found any errors.

    b. The +5 volt power supply line is normal.

    c. The processor board and at least some RAM are connected to the power supply.

    d. All of the above.

5. Which of these statements are true?

    a. If the boot ROM slef-test encounters a non-fatal error, operation will halt.

    b. The failure with the highest priority will always be annunciated on the beeper.

    c. The self-test LEDs will only indicate the highest priority failure.

    d. All of the above.

After you have answered all test items, turn to the back of this lesson and grade yourself from the Answers Sheet. If at least 80% of your answers are correct, you've successfully completed this quiz. If less than 80% of your answers are correct, you should review the areas of the lesson the missed test items cover.

Answers to Quiz 4

1 d

2 c

3 d

4 d

5 c

Your Comments, Please.

Now's a good time to write down your comments regarding this lesson. Refer to these comments when filling out the Course Evaluation.

Parts

<div style="text-align: right">**5**</div>

Quiz 5

Instructions

This lesson covers the subject of Model 360/370 parts. When you have read the Chapter, take the test at the end.

Parts Lists

6

Replacement Parts Information

Introduction

Field replaceable parts are listed in this chapter for the computers and expanders. Components, such as ICs, are not available for field repair.

Parts are available direct from:

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

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

Name: _____

Address: _____

City, State ZIP: _____

Telephone: _____

Cooperative Support Program

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

Exchange Parts

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

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

Part Number Lists

The parts listed in this section apply to both Models 360/370 computers and the HP 98568A Opt. 32 and HP 98570A expander, unless noted otherwise. Various interfaces, accessories and HP-HIL devices are also listed.

Labels

Part Number	Description	Comments
98562-84002	Identification Label	
5958-4325	UL Info Label	
7120-3428	CSA Label	
7121-4858	Service Warning Label	
7121-4733	Serial Label	
7124-2083	Voltage warning label	
98570-84002	FCC Label, Expander	
7121-4859	Fuse Rating Label	
98562-84005	Battery Warning Label	
5955-8036	Computer compliance label	
5955-8037	Peripheral compliance label	
9320-5673	Blank ID# label	

Computer Electrical Parts
Miscellaneous Electrical Parts

Part Number	Description	Comments
1250-0781	BNC coax adaptor	
5180-0410	Large fan	
5180-1303	Small fan	
5180-0407	LED cable assembly	
98561-61601	DIO Bus cable (short)	
98561-61602	DIO Bus cable (long)	
98561-61604	RS-232 cable	
98562-61600	High-Speed HP-IB cable	
2110-0342	Main fuse, 8AF, 250 Volt	
2110-0520	LAN fuse	For 98562-66534 board
1420-0314	Battery	See warning below.

Printed Circuit Boards

Exchange Part Number	New Part Number	Description	Comments
	0950-1760	Power supply (without switch shaft)	
	98561-66500	DIO-II backplane	
98579-69510	98579-66510	Model 360 Processor board	
98579-69515	98579-66515	Model 370 Processor board	
98267-69520	98267-66520	4 Mbyte add-on RAM board (360 only)	
98267-69521	98267-66521	8 Mbyte add-on RAM board (360 only)	
98267-69522	98267-66522	12 Mbyte add-on RAM board (360 only)	
98265-69501	98265-66501	Small Computer System Interface board	
98562-69531	98562-66531	High-speed HP-IB add-on card	
98562-69533	98562-66533	System interface board	With BNC LAN connector (thin-LAN)
98562-69534	98562-66534	System interface board	With 15-pin LAN connector (thick-LAN)
	98562-66501	Motherboard	
	98562-66502	2-connector system bus	
	98562-66503	3-connector system bus	
	98562-66506	2-slot DIO backplane	
98542-69570	98542-66570	Med-res monochrome video board	
98543-69570	98543-66570	Med-res color video board	
98544-69570	98544-66570	Hi-res monochrome video board	
98545-69570	98545-66570	Hi-res color video board	
98546-69571	98546-66571	Display compatibility video card	
98547-69570	98547-66570	Hi-res color video board	
98204-69577	98204-66577	Display compatibility graphics card	
98548-69570	98548-66570	Hi-res monochrome video board	
98550-69572	98550-66572	Hi-res color video board	

Static-Free Bags

Part Number	Description	Comments
9222-0978	9-inch by 10-inch cushioned pouch, for DIO cards	
9222-0980	9-inch by 15-inch cushioned pouch, for system boards	

Computer Case Parts
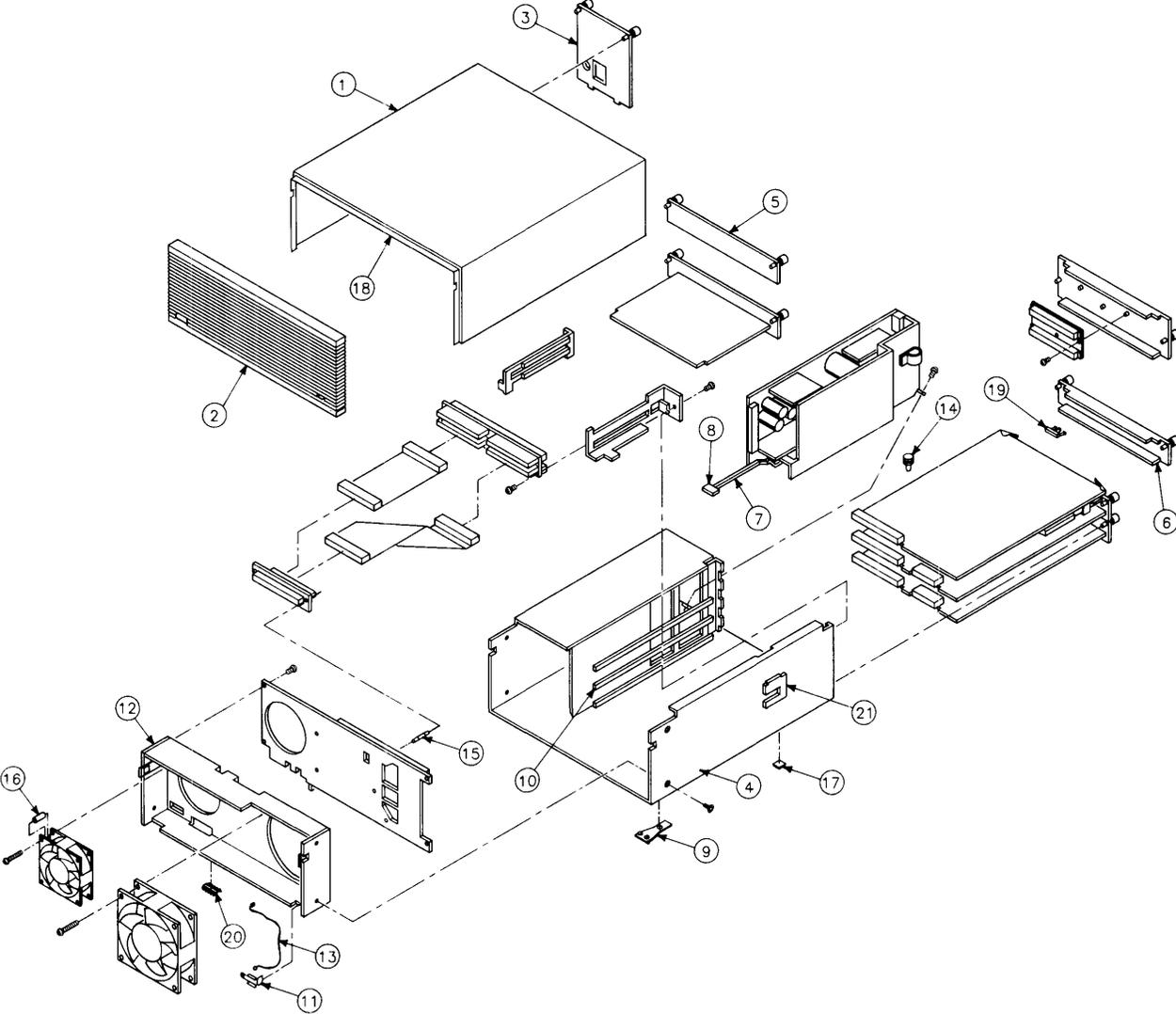
Figure 6-1. Model 360/370 Computer Case Parts.

Computer Case Parts List

Ref.	Part Number	Description	Comments
1	5001-9009	Top cover	
2	5041-2413	Front panel	
3	5001-3700	Power supply cover	
4	5001-3696	Chassis	
5	98561-04102	2-slot cover plate	
6	98561-04107	Cover plate	
7	5041-2412	Power switch shaft	
8	5041-1203	ON-OFF pushbutton	
9	09121-48303	Molded foot	
10	0403-0379	PC board guide	
11	5001-9001	LED bracket	
12	5001-9011	Fan plate	
13	09817-47700	Light pipe	
14	0380-1655	Snap-in spacer	
15	0380-1901	Support post	
16	0380-0012	Round spacer, 0.875-in. long	
17	0403-0427	Mounting foot bumper	
18	5041-2420	Top cover insulator	
19	5180-0409	Spring clip	
20	8160-0389	Double RFI finger	
21	5001-3694	Card guide bracket	
	0515-0219	Screw M3 × 6, flat head	
	0515-0389	Screw M3.3 × 8, pan head, ext. lock washer	
	0515-0536	Screw M3 × 0.5, machine	
	0515-0990	Screw M3 × 3.5, pan head, ext. lock washer	
	0515-1146	Screw M3 × 6, pan head patch	

Expander Case Parts Diagram
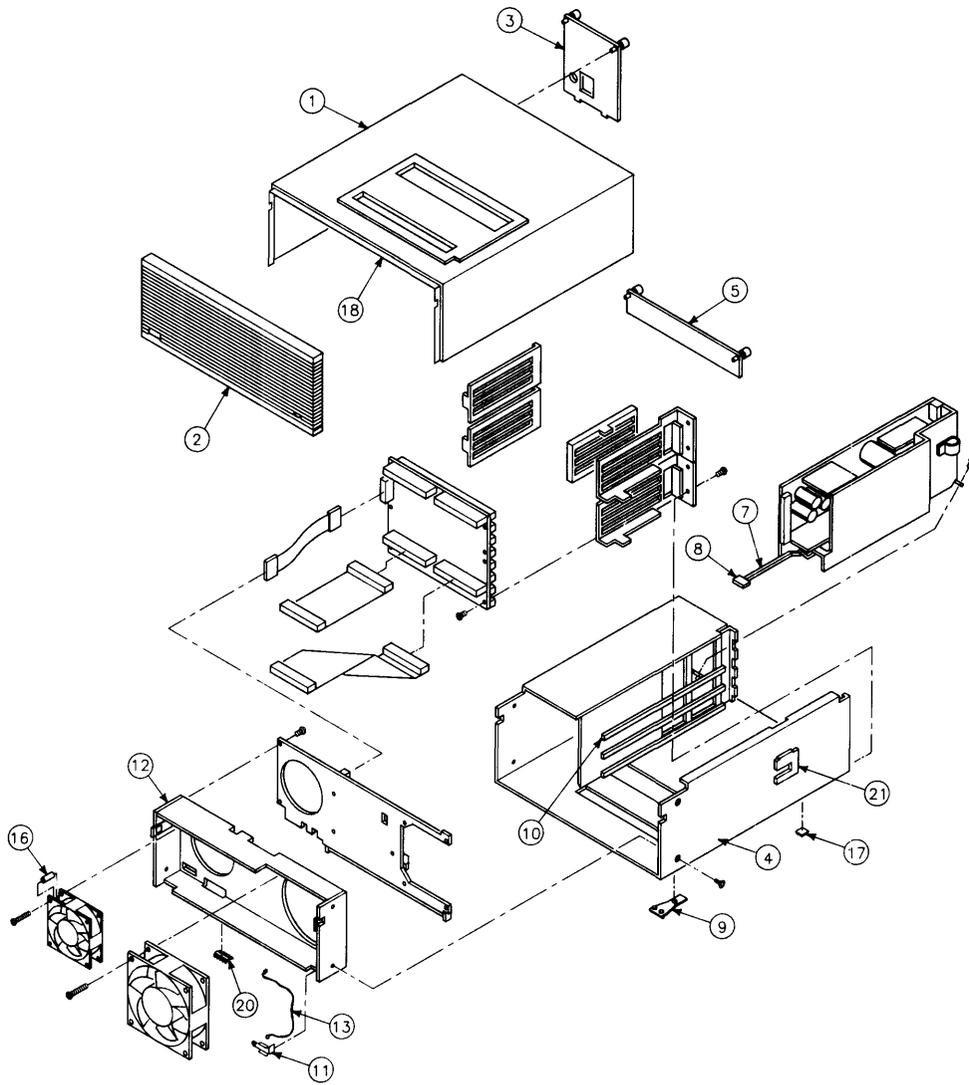
Figure 6-2. Expander Case Parts Diagram

HP 98570A and 98568A Opt. 132 Expander

Expander Case Parts List

Ref.	Part Number	Description	Comments
1	5001-9015	Top cover (with cable slots)	
2	5041-2413	Front panel	
3	5001-3700	Power supply cover	
4	5001-9014	Chassis	
5	98561-04102	2-slot cover plate	
6	5001-9016	System slot cover plate	
7	5041-2410	Power switch shaft	
8	5041-1203	ON-OFF pushbutton	
9	09121-48303	Molded foot	
10	0403-0397	PC board guide	
11	5001-9001	LED bracket	
12	5001-9011	Fan plate	
13	09817-47700	Light pipe	
14	0380-1655	Snap-in spacer	
15	0380-1901	Support post	
16	0380-0012	Round spacer, 0.875-in. long	
17	0403-0427	Mounting foot bumper	
18	5041-2420	Top cover insulator	
19	5180-0409	Spring clip	
20	8160-0389	Double RFI finger	
21	5001-3694	Card guide bracket	
	5041-2414	Ganged card guide	
	5041-2418	Pin cover	
	5041-2419	Channel-lock	
18	5041-2420	Top cover insulator	
	98561-04107	Cover plate	
	0515-0219	Screw M3 × 6, flat head	
	0515-1146	Screw M3.5 × 8, pan head, ext. lock washer	
	0515-0898	Screw M4 × 7, 6mm long	
	0515-0913	Screw M4 × 7, 10mm long	
	0515-0990	Screw M3 × 3.5, pan head, ext. lock washer	

Printed Circuit Boards

Part Number	Description	Comments
0950-1760	Power supply (without switch shaft)	
98570-66501	HP 98570 Standard motherboard	
98562-66508	Adaptor Board/Cable	
98561-66501	4-slot DIO Backplane	
98568-66500	HP 98668 Opt. 132 8-slot backplane	

Miscellaneous Electrical Parts

Part Number	Description	Comments
5180-0410	Large fan	
5180-1303	Small fan	
5180-0407	LED cable assembly	
98561-61601	DIO Bus cable (short)	
98561-61602	DIO Bus cable (long)	

External Cables

Part Number	Description	Comments
8120-3616	Color Cable	
	Audio Cable, RCA-RCA	
09920-61602	Interface Cable	
8120-4483	Video Cable	
	Adaptor, RCA-BNC	
	Color Cable, High-resolution	
	Cable, 4963-E-24	
5061-6533	Video Cable, RCA-RCA	
	Audio Cable, RCA-earphone	
98562-61600	Add-on HP-IB card cable	
98265-61601	Add-on SCSI card cable	
1252-2297	SCSI terminator	
5061-6565	SCSI test connector	
8120-4998	1-metre SCSI peripheral interface cable (both ends standard)	
8120-5158	0.5-metre SCSI peripheral interface cable (both ends standard)	
8120-5159	2-metre SCSI peripheral interface cable (both ends standard)	
8120-5160	1-metre SCSI extender cable (one end male, one end female)	

HP-HIL Devices

Exchange Part Number	New Part Number	Description	Comments
35723-69003	35723-66003	Touchscreen PC board	
	46021-60201	ASCII Keyboard	
	46020-60001	Keyboard Cable	
	HP 46060A	HP Mouse	
	46080-61601	Video Cable, 3-conductor	
	46081-61601	2.4-metre extension cable	
	46082-61601	Short audio cable	
	46082-61602	30-metre audio extension cable	
	46082-61603	30-metre video cable	
	46082-61604	15-metre remote cable	
	46082-61605	15-metre video cable	
	46083-61601	Short audio cable	
	46083-67901	Switch cap assembly	
	HP 46085A	Control dials	
	46085-85000	Overlay	
	0403-0430	Molded foot	
	QEDS-7099	RPG Pot assembly	
	5041-2416	RPG knob	
	HP 46084A	ID module	
	HP 46086A	Button box	
	HP 46087A	"A" size digitizer	
	HP 46088A	"B" size digitizer	
	HP 46094A	Quadrature port device	
	HP 46095A	3-button mouse	
	HP 92916A	Bar code reader	

Test Items

1. Which of these assemblies are exchange assemblies?

    a. Power Supply

    b. SCSI add-on board

    c. Fast HP-IB add-on board

    d. All the above, except the power supply.

2. The HP 98568A and HP 98570A Expanders share which of these parts with the Models 360/370?

    a. Front panel

    b. Top cover

    c. Chassis

    d. All the above.

3. Models 360/370 share the same boards except:

    a. The video board

    b. The System Interface board

    c. The Add-on interface board

    d. None of the above.

4. What parts are not obtainable through from HP?

    a. Common hardware parts such as nuts and bolts.

    b. Integrated circuits such as the MC68030.

    c. Common cables such as video cables.

    d. Plastic case parts.

5. In order to receive credit for an exchange part, the user must:

    a. Return the replaced part to the Corporate Parts Center.

    b. Return the replaced part within 15 days.

    c. Contact their Sales Rep in order to initiate the crediting process.

    d. Call the Corporate Parts Center for return authorization.

After you have answered all test items, turn to the back of this lesson and grade yourself from the Answers Sheet. If at least 80% of your answers are correct, you've successfully completed this quiz. If less than 80% of your answers are correct, you should review the areas of the lesson the missed test items cover.

Answers to Quiz 5

1 d

2 a

3 d

4 b

5 b

Appendix

Models 360/370 Computers
Self-Paced Hardware Training Guide
Course Completion Summary

Lesson	Date Completed	Time Completed	Supervisor's Initials
1. Product Information	_____	_____	_____
2. Functional Description	_____	_____	_____
3. Boot ROM Functions	_____	_____	_____
4. Troubleshooting	_____	_____	_____
5. Parts	_____	_____	_____

Program Completion Date _____

Student's Signature _____

Company Name _____

Company Address _____

Date _____

References

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Introduction

Information in this chapter should help you in various situations. The references include part numbers of many hardware documents used with Model 360/370 computer systems.

Service and installation information is listed in this chapter as follows:

- *Familiarization Guides* provide service information, including functional descriptions, configurations, testing and part numbers.

- *Installation Manuals/Notes* show how the products are installed in Model 360 and 370 computer systems.

- *Accessory Development Guides* and *References* have technical information about the product to assist in hardware development or service.

Service Information Locator

A Service Information Locator is located in the front of this manual and in the front of the Model 360/370 Service Handbook. It lists subjects and shows chapter numbers in other Hardware Support Document that has the information.

Localized System Identification

Model 360/370 computer systems have keyboards and display characters localized for the language spoken and written in several countries. When an HP field office orders a 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 7-1 identifies the letter suffixes to product numbers for these systems.

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

Table 7-1. Localized System Suffixes

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

Related Hardware Documentation

Hardware Support Documentation

Table 7-2. Hardware Support Documentation

Printed Pages Part Number	Manual Title
09000-90041	HP 9000 Series 200/300/500 Site Preparation Manual
09800-90001	HP 9000 Series 200/300 Test Tools Manual
98248-90001	HP 98248B Floating-Point Accelerator Familiarization Guide
98248-90020	HP 98248 Floating-Point Accelerator Reference
98264-90000	HP 98258A/B/C and HP 98264A/B RAM Board Familiarization Guide
98265-90000	HP 98265A SCSI Interface Card Familiarization Guide
98265-90010	SCSI Technical Reference
98547-90600	HP 98547A Video Board Hardware Notice
98548-90000	HP 98548A Color Video Board Familiarization Guide
98549-90000	HP 98549A Graphics Interface Familiarization Guide
98549-90800	HP 98549A Graphics Interface Familiarization Guide Update
98550-90000	HP 98550A Graphics Interface Familiarization Guide
98550-90800	HP 98550A Graphics Interface Familiarization Guide Update
98556-90000	HP 98556A 2D Integer Based Graphics Accelerator Familiarization Guide
98556-90039	HP 98556A 2D Integer Based Graphics Accelerator CE Handbook
98577-90000	HP 98577A VMEbus Expander Familiarization Guide
98577-90005	HP 98577A VMEbus Expander Accessory Development Guide
98561-90020	Series 300 Configuration Reference Manual
98562-90011	DIO-II Accessory Development Guide
98579-90030	HP 9000 Series 300 Model 360/370 Service Information Manual
98579-90039	HP 9000 Series 300 Model 360/370 Service Handbook
98603-90000	HP 98603B BASIC 5.1 ROM Board Familiarization Guide

Installation Manuals/Notes

Table 7-3. Installation Manuals/Notes

Printed Pages Part Number	Manual Title
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
98242-90601	HP 98242A/B 2-Slot DIO Backplane Installation Note
98247-90600	HP 98247A Model 330-to-360 Upgrade Installation Note
98247-90601	HP 98247B Model 330/350/360-to-370 Upgrade Installation Note
98247-90602	HP 98247A System Interface Board Installation Note
98248-90603	HP 98248B Floating Point Accelerator Installation Note
98262-90601	HP 98262A High-Speed Disc Add-On Board Installation Note
98267-90600	HP 98267A/B/C RAM Board Installation Note
98265-90601	HP 98265A SCSI Interface Card Installation Note
98546-90600	HP 98546A Display Compatibility Interface Installation Note
98548-90601	HP 98548A Color Interface Installation Note
98549-90602	HP 98549A Color Video Board Installation Note
98550-90603	HP 98550A Color Video Board Installation Note
98556-90601	HP 98556A Integer Based Graphics Accelerator Installation Note
98560-90623	HP 98562B/98587B/98586B Installation Note
98568-90600	HP 98568A Eight-Slot Bus Expander Installation Note
98603-90603	HP 98603B BASIC 5.1 ROM Board Installation Note
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

Table 7-4. Document Binders

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

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