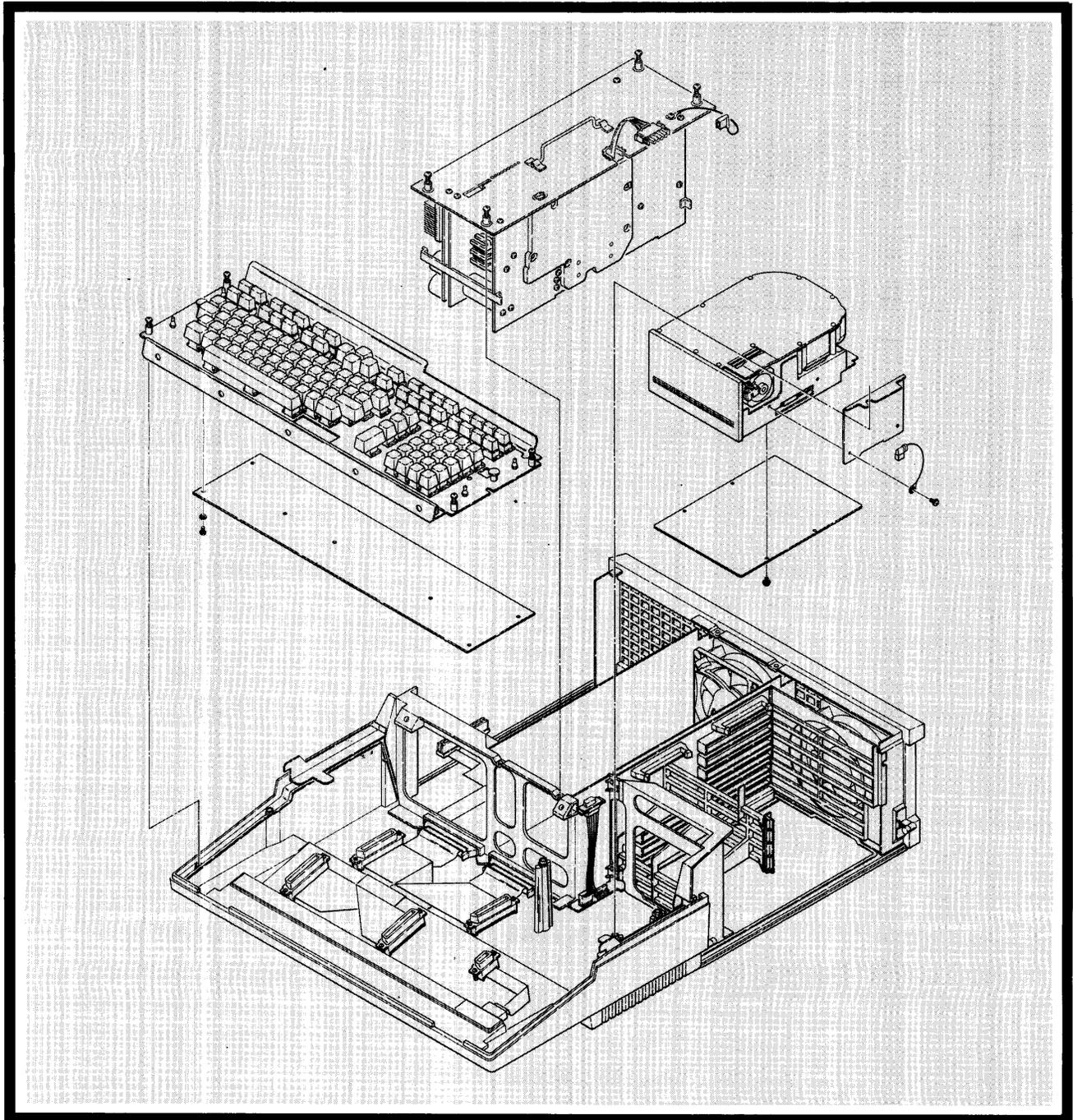


## HP 9020 Service Manual





# HP 9020 Service Manual

*for the HP 9000 Series 500  
Model 520 Computer*

Manual Part No. 09020-90037

This service manual is part of the HP 9000 Model 520 Service Documentation Package, part number 09020-80038.

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# 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.

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# General Information

**Chapter****1**

## Introduction

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**Note**

Hewlett-Packard assumes no responsibility for customer repairs or modifications.

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This manual contains servicing information for the Hewlett-Packard (HP) 9000 Model 520 Computer (hereinafter referred to as the computer). HP supports repairing the computer to the assembly level, that is, isolating the problem to the replaceable assembly. Then the defective assembly is exchanged for a new or rebuilt assembly.

This chapter contains general information about the computer and its servicing.

Additional information in this manual includes:

- Theory of Operation
- Troubleshooting Procedures
- Assembly Access Procedures
- Replaceable Parts
- Data Sheet (Specifications and Options)
- Installation and Test
- Error Messages
- Motherboard and I/O Backplane Pinout Data
- Option Installation Notes
- Sales and Support Offices

Note that the computer specifications and options are contained in Appendix A. Also, installation information is not contained in this chapter but is found in Appendix B.

Detailed servicing information is not provided for the following assemblies: 98770A Color Graphics Display, 98780A Monochromatic Display, and 9130K Flexible Disc Drive. To service one of these assemblies, refer to the appropriate manual listed in Table 1-1.

**Table 1-1. Computer Service Documentation**

Manual Title	Part Number
98770A Color Graphics Display Service Manual	98770-90031
98780A Monochromatic Display Service Manual	98780-90030
9130K Flexible Disc Drive Service Manual	09130-90030

---

**Note**

If you are unfamiliar with the computer, read the Installation and Test Manual contained in Appendix B of this manual.

---

## Description

The computer is a 32-bit system with integral processor stack, power supply, ac module, keyboard, display, printer, mass memory, and input/output (I/O) backplane. The printer and mass memory are optional assemblies.

The computer has one of two operating systems: BASIC or UNIX. Both systems are random-access memory (RAM) based and loaded from disc.

The computer processor consists of an NMOS-III based processor stack that, at a minimum, contains a central processor unit (CPU), an I/O processor (IOP), and memory assemblies. The CPU, IOP, and memory boards reside in the stack and communicate via the common memory processor bus (MPB).

The boards may be finstrates or polystrates. Finstrates are copper cored boards with the NMOS chips bonded to them. They provide the combined functions of cooling fins and ceramic substrates. Cooling air is drawn through the stack between the boards to dissipate heat from the chips. The boards are accessible from the left side of the computer.

Polystrates (from **polyimide** and **finstrate**) are polyimide boards without the copper core. However, copper heat sinks are mounted on the circuit side of the boards, to dissipate heat from the chips.

The CPU chip is a microprogrammed 32-bit processor. The IOP chip interfaces to the system I/O bus. Each IOP supports eight select codes. Up to three IOPs can be included in the computer. The RAM chips are addressed by a memory controller chip that corrects all single-bit errors. Memory can be made up of 256K, 512K, or 1 Megabyte RAM memory boards (1M byte RAM boards must be used in pairs).

The mainframe includes the motherboard, I/O backplane, interconnecting cables, power supply, and three cooling fans. The top covers, side covers, and keyboard bezel are also part of the basic computer.

The thermal printer is an optional module. Other hardware options include displays and mass storage devices. One of three displays can be selected, and flexible disc and fixed disc storage devices are available. Various combinations of CPU, IOP, and RAM memory boards can configure the processor stack. Also, several types of HP-IO cards are available for various interfacing requirements. Refer to Appendix A for additional information on options.

The HP-IO cards and mass storage controller cards are accessible from the right side of the computer, and the processor stack cards from the left side. The computer rests on three rubber feet at the front and two platen-like rollers at the rear. Thus, it can easily be moved for service accessibility by lifting slightly at the front and rolling forward or backward.

---

**CAUTION**

THE WINCHESTER FIXED DISC DRIVE CAN BE DAMAGED WHEN SUBJECTED TO A SHOCK OF 10G OPERATING OR 20G NON-OPERATING. TO PREVENT DAMAGE, LOWER COMPUTER GENTLY AFTER MOVING IT ON ITS ROLLERS.

---

Three dc box fans provide cooling for the computer. The fans draw the air through a grill under the keyboard and exhaust the air out the back of the computer. One fan is integral to the processor stack. The other fans are mounted to the chassis, one in the power supply area and one in the I/O card cage area. The I/O card cage fan operates at constant speed. The other two fans are variable, increasing in speed as the temperature increases. The computer shuts down if the temperature rises to 100°C in the stack or to 97°C in the power supply.

## Warnings, Cautions, and Notes

Warnings, cautions, and notes are used throughout this manual. Warnings call attention to potential hazards for personnel. Cautions call attention to potential hazards for equipment. Notes emphasize important information or instructions.

Although all warnings, cautions, and notes are important, one warning and one caution are included here to acquaint you with computer considerations.

---

**WARNING**

DISCHARGE POWER SUPPLY CAPACITORS USING POWER SUPPLY DISCHARGE TOOL, PART NUMBER 09855-67004, BEFORE REMOVING POWER SUPPLY FROM COMPUTER. FAILURE TO FOLLOW THIS PROCEDURE COULD RESULT IN EXPOSURE TO LETHAL SHOCK HAZARD.

---



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**CAUTION**

TO PREVENT DAMAGE DUE TO ELECTROSTATIC DISCHARGE (ESD), FOLLOW THE PROCEDURES PROVIDED IN CHAPTER 4.

---

## Repair Philosophy

The computer repair philosophy consists of early warning of probable failures, three overlapping levels of diagnostics, service utilities, and most assembly replacement within 15 minutes.

The computer is repaired at an assembly replacement level. Parts that are most commonly replaced are exchange parts and are on the Computer Support Division (CSD) exchange program. When an exchange part fails, it should be returned to CSD for repair, and a rebuilt part should be obtained. If a new part is purchased instead, it is unnecessary to return the failed part. Chapter 5 contains lists of all replaceable parts. Tables in Chapter 5 also list exchange parts with new and rebuilt part numbers.

In addition to the standard three levels of Field Service Inventory (FSI) sets, several other sets are available depending on the selected options. These are as follows:

- GP-IO I/O Card FSI
- HP-IB I/O Card FSI
- ASI I/O Card FSI
- PSI I/O Card FSI
- MUX I/O Card FSI
- LAN I/O Card FSI
- 98760A Standard Color Graphics Display FSI
- 98770A High Performance Color Graphics Display FSI
- 98780A Monochromatic Display FSI
- 9130K Flexible Disc Drive FSI

## Ac Components/Voltage Conversion

---

### WARNING

IF IT IS NECESSARY TO REPLACE THE POWER CORD, THE REPLACEMENT CORD MUST HAVE THE SAME POLARITY AS THE ORIGINAL CORD. OTHERWISE, A SHOCK HAZARD MIGHT EXIST WHICH COULD RESULT IN INJURY OR DEATH. ALSO, THE EQUIPMENT COULD BE SEVERELY DAMAGED IF EVEN A RELATIVELY MINOR INTERNAL FAILURE OCCURRED.

---

The ac module has an attached 6-foot power cord that plugs into an ac outlet to provide primary power to the computer. Besides the power cord, the ac module contains a line filter, ac module cable, and the on/off power switch/circuit breaker.

The computer is wired for either 110V or 220V and can be converted from one to the other in the field. Conversion requires changing the power cord, ac module cable, and power switch. Chapter 4 provides procedures for replacing all ac components.

## Safety

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### WARNING

LETHAL VOLTAGES ARE PRESENT INSIDE THE COMPUTER. OBSERVE ALL WARNINGS IN THIS MANUAL, AND OBSERVE THE FOLLOWING SAFETY PROCEDURES AND GUIDELINES.

---

### General Safety Procedure

- Do all possible operations with the computer unplugged from the power source.
- If installation, maintenance, or repair must be done with the computer energized, take the following precautions:
  - a. Never work alone in high-voltage areas. In case of accidental shock, a life may depend on rapid removal from the energized source and appropriate first-aid action.
  - b. Employees working in high-voltage areas should know where to obtain respiratory resuscitation and/or cardiopulmonary resuscitation (CPR), in case a fellow worker needs assistance.
  - c. In case of burns, treat only after the person is breathing and has a normal heartbeat.
- If primary wiring change is made, perform continuity test between power cord ground and metal chassis. Record results on Repair Order.

These simple precautions can save a life.

### Safety Guidelines for High-Voltage Testing

Here is a list of safety guidelines to be followed when working with voltages in excess of 50V dc or 50V ac root-mean-square (RMS).

1. Know each step of the test procedure. Check the test setup to be sure the instruments are connected properly and that all control settings are correct.
2. Never defeat interlocks.
3. Never have one hand on chassis or other ground while measuring high voltages with a probe held in the other hand. Use the one hand method, that is, probe in one hand, the other hand behind the back or in a pocket.
4. Make sure the probe being used has voltage insulation higher than the voltage being measured. Check wires and probes for cracked insulation and defects. If any defects are noted do not use until repairs are made.
5. Make certain that the instrument to be serviced is turned off and all capacitors, CRTs, and high-voltage circuits are discharged before any component or hardware is removed or touched. Remember that a circuit can be lethally charged if a component is open or missing, or if a wire is disconnected or open, even with the ac power switch off. Isolated heat sinks can also be statically charged.
6. Make certain that instruments used for testing are used within their rated specification. Never use instruments floated above their specified rating.
7. Never reach around energized high voltage circuits. Always turn equipment off and discharge the high voltage first.

8. NEVER WORK ALONE. Be familiar with location of power switches in your area and what they control. Turn off power to free a fellow worker from high voltage without energizing yourself.
9. Keep work area neat, free of any interfacing conductive material, and free of any sharp objects. Remember, a reaction to a shock can cause one to strike nearby objects which can result in a serious injury.
10. Always leave safety shields in place unless work must be done on circuits behind the shields.
11. Never leave work area with high-voltage equipment energized and high-voltage circuits exposed.
12. Have available and use approved warning signs and tags where high-voltage testing is in process.
13. Do not make measurements in a circuit where a corona is present. Corona can be identified by a pale-blue color, from a buzzing sound emanating from sharp metal points in the circuit, or from the odor of ozone.
14. Hands, shoes, floor, and workbench must be dry. Avoid making measurements under humid, damp, or other environmental conditions that could affect the dielectric withstanding voltage of the test leads or instruments.
15. All test procedures and safety procedures should be strictly followed at all times.

## Grounding Requirements

To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the computer chassis be grounded. The computer is equipped with a three-conductor power cable which, when connected to an appropriate power receptacle, grounds the computer chassis.

## Printer Paper Loading

---

### CAUTION

HP-SUPPLIED THERMAL PAPER IS FORMULATED SPECIFICALLY TO WORK WITH THE BUILT-IN PRINTER. THERMAL PAPER FROM OTHER SOURCES MAY OR MAY NOT WORK WITH YOUR INTERNAL PRINTER. THEREFORE HP IS NOT RESPONSIBLE FOR DAMAGES CAUSED BY USING NON-HP-APPROVED PAPER.

---

When the printer detects an out-of-paper condition, it stops printing. If it runs out of paper while printing, it finishes the current page and ejects it before stopping.

HP replacement paper is available in either metric or English sizes, and in either blue or black print. Chapter 5 lists the part numbers and descriptions of HP replacement paper. One box of paper contains four packs of 330 pages each for a total of 1320 sheets per box. Call HP's toll-free order number, 800-538-8787, to order replacement paper.

Procedures for installing paper in the printer are contained in Appendix B.

## Flexible Disc Media

---

### CAUTION

HP-SUPPLIED FLEXIBLE DISCS ARE MANUFACTURED SPECIFICALLY TO WORK WITH HP DISC DRIVES AS USED IN THE COMPUTER. FLEXIBLE DISCS FROM OTHER SOURCES MAY OR MAY NOT WORK WITH YOUR INTERNAL DISC DRIVES. THEREFORE HP IS NOT RESPONSIBLE FOR DAMAGES CAUSED BY USING NON-HP-APPROVED FLEXIBLE DISCS.

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The storage medium used in the 9130K disc drive is a flexible disc commonly called a mini-floppy. The flexible disc measures 133.4 mm (5.25 inches) in diameter and has a 27.5 mm (1.125 inch) hole for alignment on the disc drive spindle. The disc is enclosed in a protective plastic jacket with a slot for head access to the recording surface. Both sides of the flexible disc are used for data storage.

By using flexible discs identified as “double-sided”, up to 264K bytes of data can be stored on each disc. Refer to the appropriate programming or reference manual for details about the exact amount of available user storage. Double-sided flexible discs (HP part number 92190A, package of ten) are available from HP's Computer Supplies Operation, by calling the toll-free order number 800-538-8787.

Each flexible disc must be initialized before it can be used for data storage. The initialization procedure marks each disc track, checks for defective tracks, and may establish file directories. Refer to the programming or reference manual for correct procedures.

Care must be taken when handling and storing flexible discs to maintain disc integrity. Refer to Appendix B for additional information on flexible discs.

## Computer Cleaning

The computer case and the air intake grill should be cleaned as required according to the following instructions.

### Case

The computer has been painted with a durable, long lasting, water-based paint which is non-toxic and environmentally safe. It will preserve the appearance of the computer for many years. Clean the computer according to the following instructions to sustain the quality finish indefinitely. Should the finish be damaged, consult your local HP Sales and Support Office (Appendix G) for available touch-up paints.

---

#### CAUTION

CHEMICAL SPRAY-ON CLEANERS USED FOR APPLIANCES AND OTHER HOUSEHOLD APPLICATIONS MAY DAMAGE THE FINISH. THESE OR OTHER CHEMICAL CLEANERS SHOULD NOT BE USED. DO NOT USE DETERGENTS THAT CONTAIN AMMONIA, BENZENES, CHLORIDES, OR ABRASIVES. DISPLAY GLASS SHOULD NOT BE CLEANED WITH ANY CLEANER. ONLY CLEAN WATER SHOULD BE USED FOR CLEANING DISPLAY GLASS.

---

Before cleaning the computer, turn off the power switch, unplug the power cord, and remove any interconnecting cables. Dampen a clean, soft, lint-free cloth with a solution of clean water and mild soap. Wipe the soiled areas of the computer, ensuring that no cleaning solution gets inside the computer. For cleaning more heavily soiled areas, a solution of 80% clean water and 20% isopropyl alcohol may be used. Using a clean, soft, lint-free cloth dampened with clean water, wipe over all areas that were cleaned with cleaning solution. Then dry the computer with a clean, soft, dry cloth. A non-abrasive eraser may be used to remove pen and pencil marks.

### Air Intake Grill

Cooling air is drawn through the air intake grill at the bottom front of the computer and is exhausted at the rear. Ensure that the grill is free of obstructions at all times. Vacuum or brush grill as necessary.

## 9130K Flexible Disc Drive Cleaning

To clean the read/write heads on the 9130K Flexible Disc Drive, use the software supplied in the System Integrity Tests and the hardware contained in the 92193A Disc Drive Cleaning Kit available from HP Computer Supplies Operation.

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# Theory of Operation

**Chapter****2**

## Introduction

This chapter describes the theory of operation of the computer. Included are functional descriptions of each section of the computer with more detailed description where appropriate. Figure 2-1 is a functional block diagram of the computer, showing all the functional modules described in this chapter. Figure 2-2 shows how the computer modules are interconnected. It provides cabling information, connector designations, and number of pins per connector.

Some of the functional units described in this chapter are standard in the computer, and others are optional. Familiarize yourself with the particular computer being serviced to know which sections of this chapter are applicable and which are not.

The functional units described in this chapter are as follows:

- Power supply assembly
- Processor stack
- Keyboard
- Display
- Thermal printer
- Mass storage (flexible and fixed disc drives)
- Motherboard
- I/O backplane

2-2 Theory of Operation

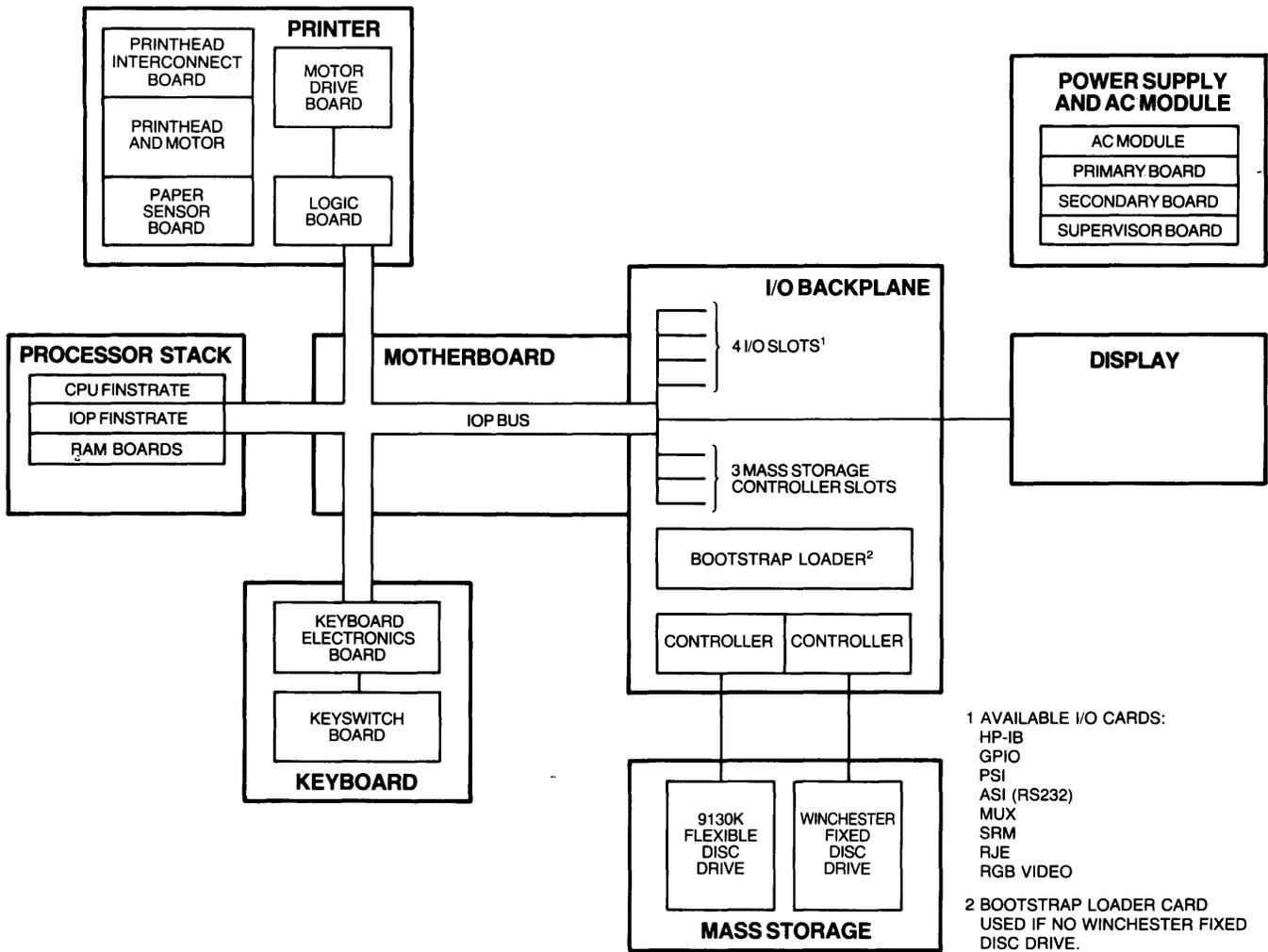


Figure 2-1. Computer Block Diagram

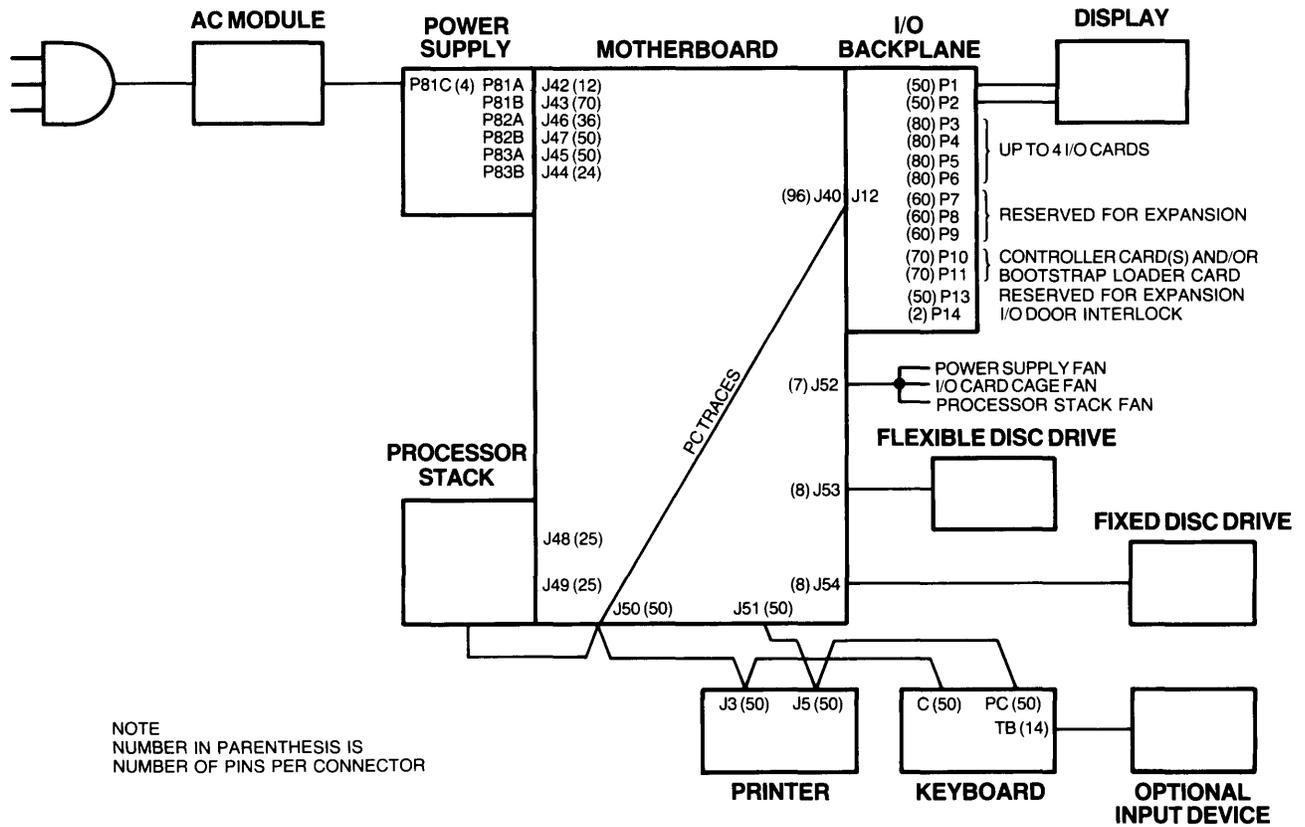


Figure 2-2. Computer Interconnection Diagram

## Power Supply Assembly

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### WARNING

DO NOT SERVICE THE POWER SUPPLY ASSEMBLY UNTIL THE COMPUTER POWER CORD HAS BEEN UNPLUGGED FROM THE AC OUTLET AND THE POWER SUPPLY CAPACITORS HAVE BEEN COMPLETELY DISCHARGED. SEE CHAPTER 4 FOR ADDITIONAL INFORMATION.

---

The power supply assembly is a switching regulator assembly that provides power to the entire computer. Figure 2-3 is a functional block diagram of the assembly. The power supply assembly converts ac line voltage to the following dc voltages. The actual voltages are listed first; the voltages in parentheses are the truncated designations used throughout the manual.

- + 17.5 to + 23 (+ 19 unregulated)
- 17.5 to - 23 (- 19 unregulated)
- + 16 (+ 16 bias supply voltage)
- + 12.1 (+ 12)
- + 12.1 (+ 12MM, Mass Memory)
- 12.1 (- 12)
- + 6.7 (+ 6)
- + 5.1 (+ 5)
- + 3.85 (+ 3)
- 2 (- 2)

LEDs on the assembly indicate overvoltage or undervoltage conditions for dc supplies, as well as overtemperature, peak power exceeded, and I/O door or processor stack door open.

An ac module which mounts above the I/O card cage is connected to the assembly by a cable harness. The ac module consists of an on/off power switch/circuit breaker, line filter, and wiring harness. An attached male line cord plugs into the ac power source.

The power supply assembly is cooled by a dc box fan mounted on the rear of the mainframe. The fan is not an integral part of the assembly.

The power supply assembly has three printed circuit boards: the primary board, the secondary board, and the supervisor board. The following description is organized according to the functions performed by the ac module and these three boards.

The power supply assembly plugs into the motherboard in the computer base via six connectors, two per board. These connectors, and their associated motherboard traces, interconnect the power supply assembly boards, and carry voltage and signal lines between the power supply assembly and other computer modules.

Fifteen status-indicating, light-emitting diodes (LEDs) are contained on the supervisor board. They are described in a following subsection in this chapter.

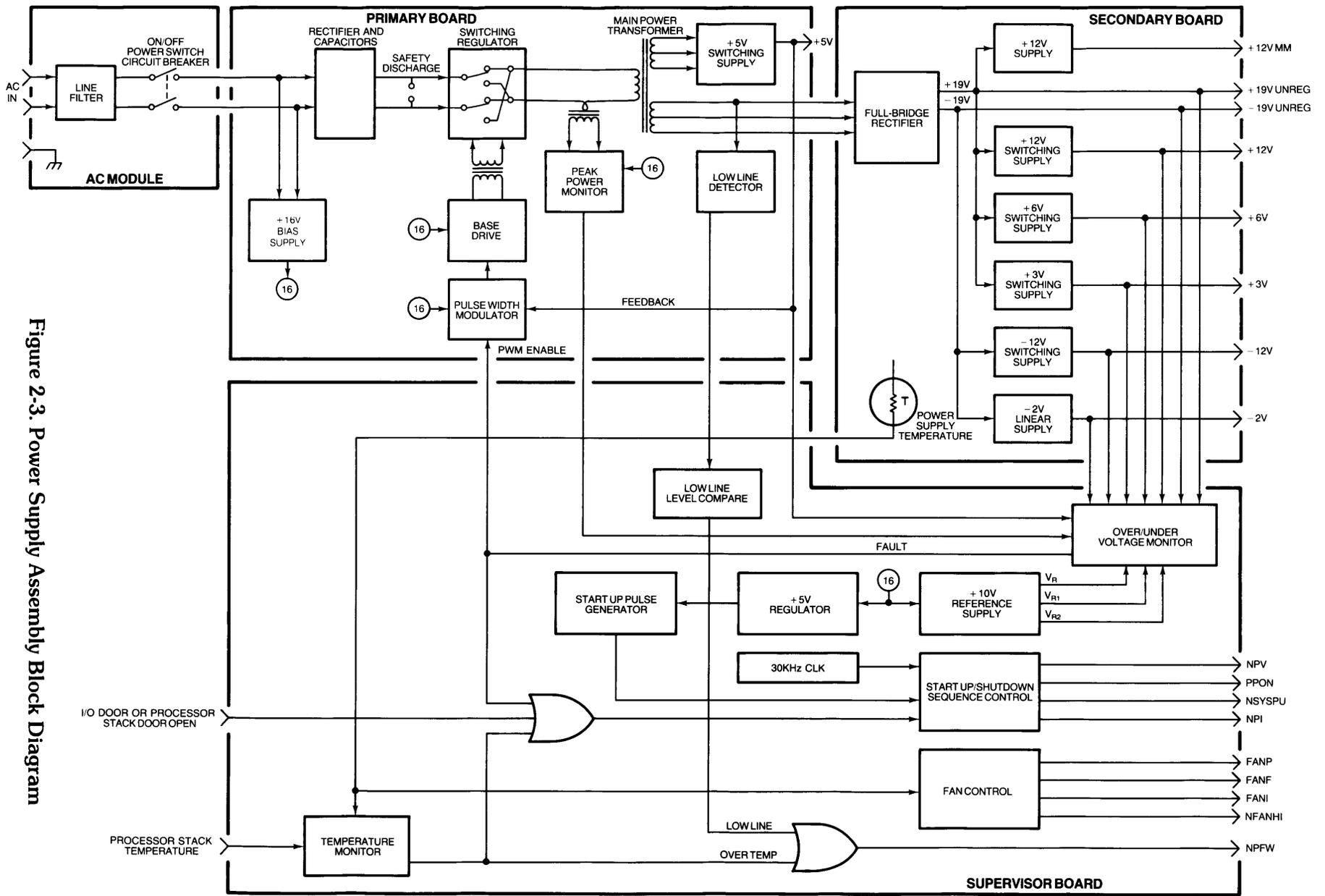


Figure 2-3. Power Supply Assembly Block Diagram

## Ac Module

The ac module has an attached 6-foot line cord that plugs into an ac outlet. The line filter reduces conducted emissions from the power supply assembly. It also presents the ac voltage to the on/off power switch/circuit breaker which enables/disables ac power to the computer.

The trip point of the circuit breaker depends on which power configuration is being used. The 110V breaker trips at 15 amps line or line overvoltage. The 220V breaker trips at 10 amps. Reset the circuit breaker by turning the switch off and then turning it back on.

## Primary Board

After being rectified, the ac to the primary board charges two 2800 $\mu$ fd capacitors. Each capacitor is charged to 150-200V, depending on the line voltage and load.

The rectified dc voltage from the capacitors feeds a switching regulator. The regulator drives current through the main power transformer.

Rectifiers at the output of the main power transformer develop the +5V switching supply. This supply provides +5V for use throughout the computer. The +5V output is monitored by the supervisor board for overvoltage and undervoltage. Also, the +5V output feeds the pulse width modulator. The modulator output controls the base drive which in turn controls the switching transistors. The pulse-width-modulator-enable signal (PWM ENABLE) from the supervisor board enables the modulator as long as no fault signal is present. A fault signal disables the modulator, shutting down the power supply assembly.

The main power transformer has another secondary winding that provides raw power to the secondary board. This power is used to generate the unregulated +19V and -19V which in turn generate all the other secondary supplies.

The low line detector circuitry monitors the voltage on the secondary winding of the main power transformer. That voltage is transferred to the supervisor board where it is compared to a reference voltage. If the voltage on the secondary winding drops too low, a power-fail-warning (NPFW) is sent to the processor. This provides a 4 to 8 ms warning before the power is actually shut down by the fault circuitry.

The peak power monitor is a current sense transformer in series with the main power transformer primary winding. Its purpose is to protect the switching transistors from damage due to an excessive power condition. When the current exceeds 9A, the monitor generates a fault signal to shut down the power supply assembly.

A +16V bias supply provides power to various monitor and control circuits throughout the power supply assembly. This supply stays active when the power supply is shut down due to a fault condition. It controls the power supply LEDs and governs power supply start-up.

## Secondary Board

Power from the main power transformer on the primary board is transferred via bus bars to the secondary board. There, a tapped rectifier converts the raw ac power into unregulated +19V and -19V dc. These voltages in turn operate several switching regulators and one linear regulator. The voltages produced, which are used throughout the computer, are +12V, -12V, +6V, +3V, and

–2V. The +6V, +3V, and –2V outputs are used exclusively by the processor stack. Also, a separate +12V output is produced to drive mass storage devices.

A temperature-sensing thermistor is mounted on the secondary board heat sink. This thermistor is monitored by the supervisor board and controls the power supply fan and the processor stack fan. These two dc box fans operate at three speeds: low, medium, and high.

When the power supply assembly thermistor detects that the temperature of the secondary board heat sink has risen above 39°C, the circuitry steps the fans to medium speed. A further rise of temperature above 51°C causes stepping of the fans to high speed, and the user is notified that the fans have reached their maximum speed. At 97°C, a power fail warning (NPFW) is transmitted, and 4 to 8 ms later the power supply is shut down. The power supply assembly is also shut down if a temperature sensor on the CPU finstrate in the processor stack detects a temperature over 100°C.

When cooling off, the fans step from high to medium speed when the temperature drops below 46°C, and from medium to low speed when the temperature drops below 34°C.

## Supervisor Board

The supervisor board contains most of the monitoring, control, and fault-indicating circuitry for the power supply assembly.

The overvoltage and undervoltage monitor checks the voltage outputs of all secondary board power supplies except the +12MMV supply for mass storage devices. The monitor also checks the +5V output and the peak power monitor from the primary board. If a fault is detected, the pulse width modulator is disabled, the shutdown sequence is enabled, and the appropriate LEDs are lit.

Temperature monitors check the power supply assembly thermistor, described in preceding paragraphs, and the processor stack thermistor. When the processor stack temperature exceeds 100°C or the power supply temperature exceeds 97°C, this board generates the power fail warning (NPFW) signal and initiates the shutdown sequence.

A +10V reference supply provides the voltage condition references for over and under voltage monitoring and temperature sensing. This supply is enabled by the +16V bias supply from the primary board.

The fan control circuitry provides a constant –10V to the I/O card cage fan (FANI on Figure 2-3) whenever power is on. This fan never changes speed. The fan control circuitry also provides –10V to the power supply assembly fan (FANP) and processor stack fan (FANF) as long as the power supply assembly temperature does not exceed 39°C. When the power supply assembly thermistor detects between 39°C and 51°C, the fan control circuitry provides –12V to the two fans, stepping them to medium speed. Between 51°C and 97°C, the fans are stepped to high speed at –14V. The fan high signal (NFANHI) is also sent to the processor which sends a message to the user, indicating that the computer is performing maximum cooling and that a further temperature increase could result in shutdown.

If either the I/O door or processor stack door is opened while the power supply assembly is operating, the shutdown sequence is initiated.

The start-up/shutdown sequence control circuitry is controlled by a 30-kHz clock. The signals generated by this circuitry are defined as follows:

PPON – Primary Power On; all outputs in specification.

NPV – Not Power Valid; this signal is the inverse of PPON, and therefore signifies “not all outputs in specification”.

NPI – Not Pop In; used to reset the processor stack.

NSYSPU – Not System Pop Unsynchronized; used with NPI to cause the processor stack to perform a self-test.

### Status LEDs

Fifteen LEDs are contained in the power supply assembly to provide fault status indications. All LEDs are contained on the supervisor board. Specific reasons for power supply assembly failures are indicated by the LEDs.

Two LEDs are visible from the rear of the computer through the power supply assembly fan. The green LED is tied to the +16V bias supply. When lit, the green LED indicates that power is applied to the assembly and bias voltage is available from the primary board. The yellow LED indicates that no failures have been detected. It also indicates that the supervisor board is enabled and capable of detecting faults and shutting down the power supply assembly if a failure is detected.

The other LEDs are visible at the top of the power supply assembly with the front cover removed. They are labeled on the assembly and defined as follows:

**DOORS OPEN** – indicates that I/O card cage door or processor stack door is open. **OV** also lights.

**STACK TEMP** – indicates that processor stack temperature has exceeded 100°C.

**SEC BOARD** – indicates that +12MM mass storage power supply has failed or that temperature in power supply assembly has exceeded 97°C.

**PWR** – indicates that peak primary current exceeded 9A.

**OV** – used in conjunction with voltage LEDs described below; “on” indicates an overvoltage condition on one or more of the supplies or door open, “off” indicates an undervoltage condition.

– **19** – indicates a fault condition on the applicable supply. If the **OV** LED is also lit, an overvoltage condition is indicated. If the **OV** LED is not lit, an undervoltage condition is indicated.

**3**

**5**

**6**

**12**

**19**

### Power Diagrams

Figures 2-4, 2-5, and 2-6 illustrate power distribution, voltage sensing, and safety grounding, respectively.

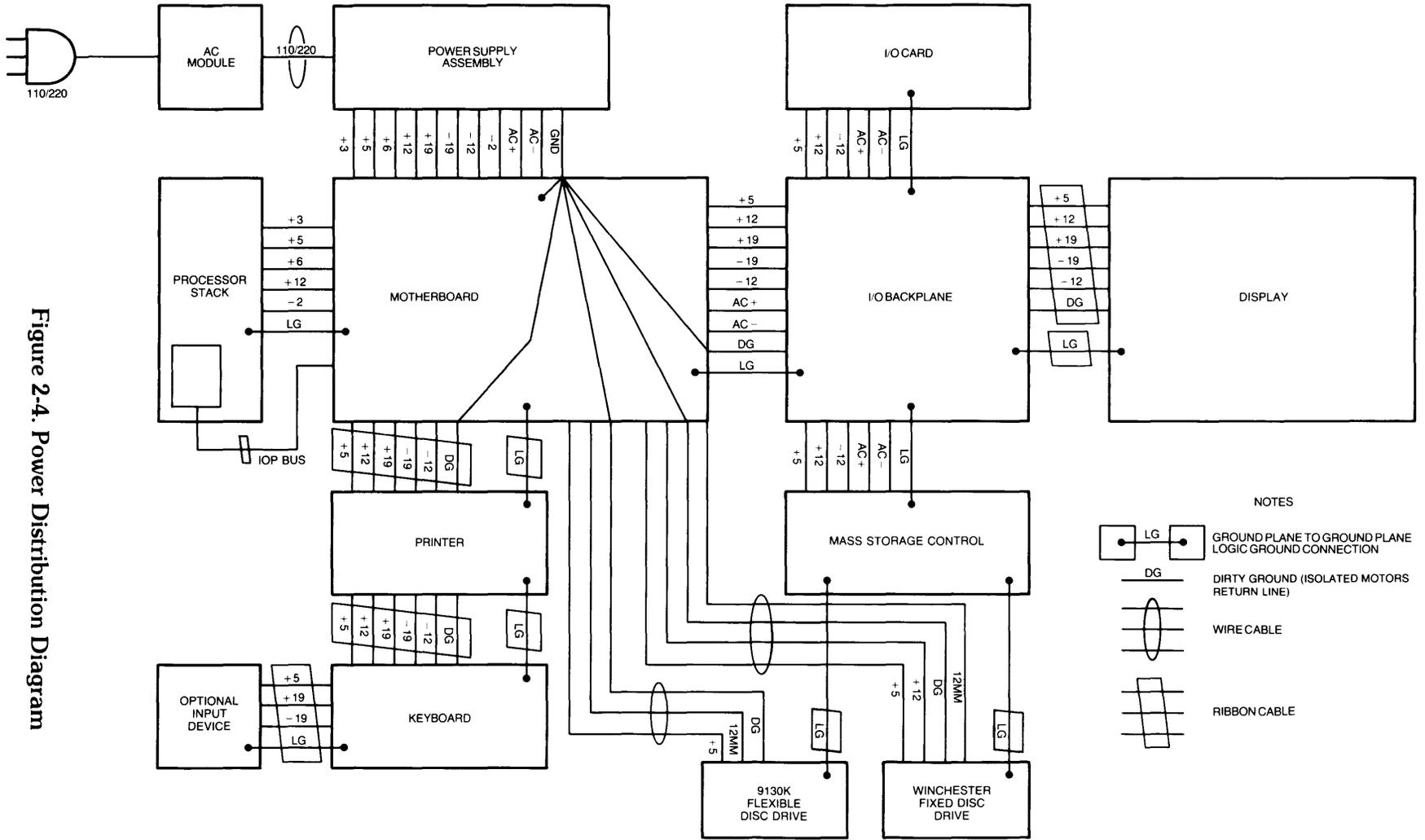


Figure 2-4. Power Distribution Diagram

2-10 Theory of Operation

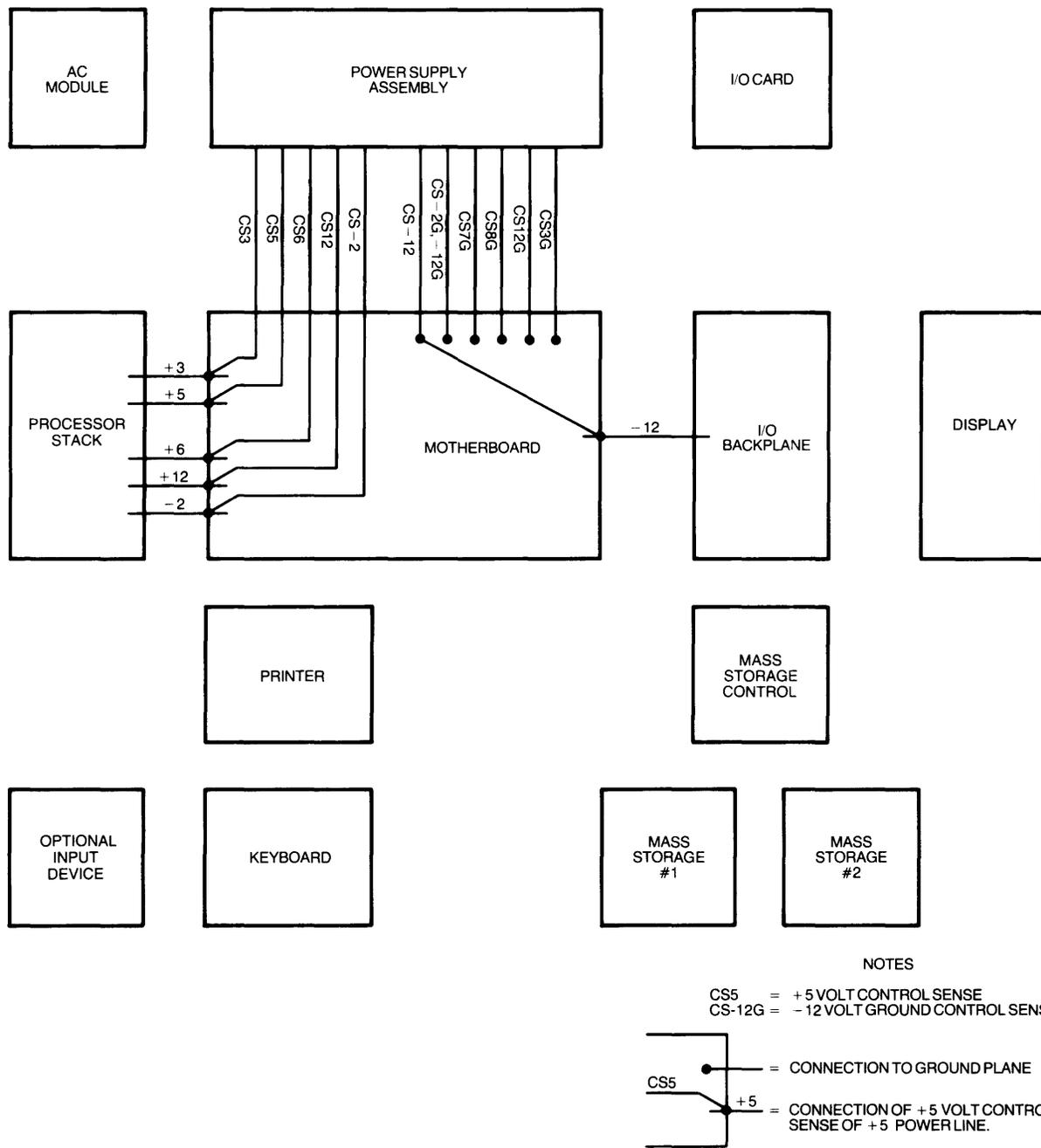


Figure 2-5. Voltage Sensing Diagram

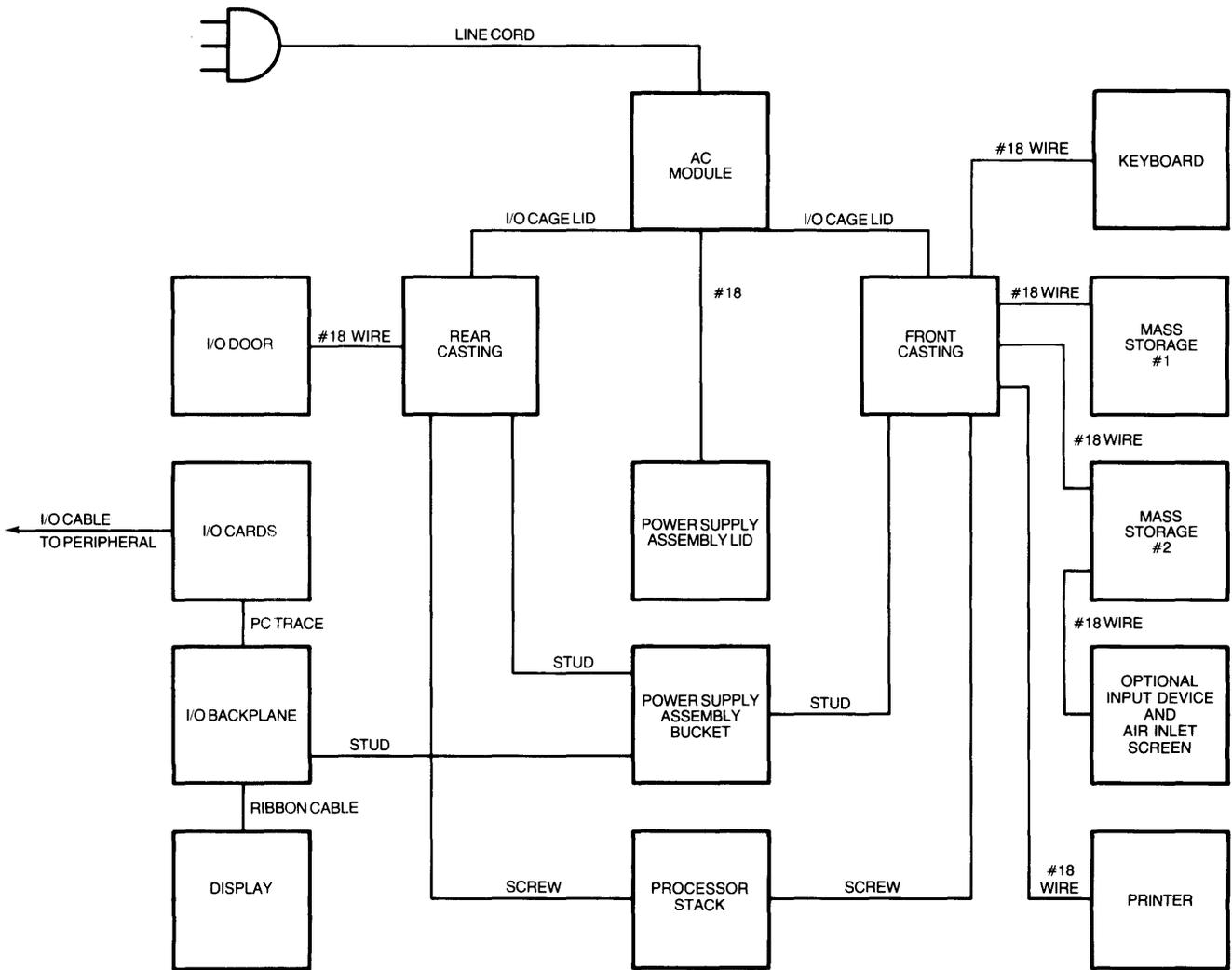


Figure 2-6. Safety Grounding Diagram

## Processor Stack

The processor stack is a 32-bit computer system that controls all computer operations. The stack consists of an enclosing and supporting case, up to 12 boards, stack motherboard, and clock board. The boards may be finstrates or polystrates.

Finstrates are copper-cored cards with NMOS-III chips bonded to them. Finstrates provide the combined functions of cooling fins and ceramic substrates.

Polystrates (from **polyimide** and **finstrate**) are polyimide boards without the copper core. However, copper heat sinks are mounted on the circuit side of the board, to dissipate heat from the chips.

All boards plug into the common Memory Processor Bus (MPB), provided on the mother board (Figure 2-7).

The case has a door that can be opened to provide access to the upper 9 slots or removed to provide access to all 12 slots. A dc box fan attached to one end of the stack provides cooling air to the boards.

The stack interconnects with the computer motherboard via two 25-pin connectors and a 50-conductor input/output processor (IOP) cable. The 25-pin connectors on the bottom of the stack interconnect with connectors on the computer motherboard when the stack is positioned in the computer. These connectors provide power and control signals. The internal IOP ribbon cable connects to the IOP finstrate in slot #2.

### Stack Configurations

The stack has 12 slots numbered from 1 to 12, with slot #1 the bottom slot and slot #12 the top. All slots are interconnected by the memory processor bus via the stack motherboard. The Memory Processor Bus (MPB), which has 32 data/address lines and 12 control lines, interconnects all boards to the IOP finstrate(s). The IOP finstrate in slot #2 is connected to the internal IOP cable which is routed to the motherboard.

Four types of boards can be used in the stack: central processor unit (CPU), input/output processor (IOP), and random access memory (RAM). A load board may also be required, depending on stack configuration. All are described in the following paragraphs.

The stack can be configured with various combinations of boards. One or two CPU finstrates can be added. One or two IOP finstrates can be added. Any number of RAM boards are allowed. However, if 1 Megabyte RAM boards are used, they must be used in pairs.

The following rules must be observed for all configurations:

- Slot #1 must always contain a CPU finstrate.
- Slot #2 must always contain an IOP finstrate.
- If there is one additional IOP finstrate, it must be contained in slot #3. If there are two additional IOP finstrates, they must be contained in slots #3 and #4.
- No empty slot is permitted between two finstrates.
- 1 Megabyte RAM boards must be used in pairs (2, 4, 6, 8, or 10).



Minimum and maximum configurations are as follows:

Finstrate	Minimum	Maximum*
CPU	1	3
IOP	1	3
RAM	1	10

\* Maximum of 12 finstrates per stack.

## Stack Boards

Board types and functions are described in the following paragraphs. Each board has a self-test that runs on powerup or system reset. Self-tests are described in Chapter 3.

### CPU Board

Two types of CPU board perform all the central processing for the computer. The first type of CPU contains a clock buffer and a CPU chip. All CPU microcode, and the hardware to decode and execute instructions, are included in the CPU chip.

The second type of CPU board contains an additional three math chips (add/subtract, multiply, and divide) to provide floating point, 32 bit or 64 bit, double precision math solutions. The CPU sends control information and data to the math chip registers. The answer is returned to the CPU a few computer states later. These math chips are invisible to the operating system.

### IOP Finstrate

The IOP finstrate performs I/O processing and drives the I/O bus. The IOP finstrate actually consists of two parts: the finstrate assembly itself and an attached printed circuit board. The pc board is attached to the finstrate by a 50-pin connector. Clamps and screws ensure a solid physical connection.

The clock buffer and the I/O processor chip are on the finstrate. The pc board contains the five bi-directional buffer TTL packages that drive the I/O bus. The pc board also contains several resistor packages and a transistor package. The resistor paks terminate the I/O bus with its characteristic impedance. The transistor pak holds the reset signal on the I/O bus during a power up/power down sequence, and drives the self-test LED on the stack motherboard.

### RAM Boards

There are three types of RAM boards available for use in the stack. They can be combined in any combination, but the 1 Megabyte boards must be used in pairs. The 256K byte RAM is a finstrate. The 512K byte and 1 Megabyte boards are polystrates. Each board has a memory controller, RAM chips, and clock buffers.

### Load Board

The Load Board consists of load resistors to ensure the correct power supply load for certain stack configurations. The load board will be used when:

- The stack consists of one CPU, one IOP, and one 512K RAM board.
- The stack consists of one CPU, one IOP, and six or less 1 Megabyte RAM boards.

## Stack Motherboard

The stack motherboard interconnects the 12 board slots via the memory processor bus. The two 25-pin connectors at the bottom of the stack provide power and some control signals to the stack motherboard. The stack motherboard has 12 LEDs that indicate the status of the boards when module self-tests are executed.

## Clock Board

The clock board provides clock signals to the processor. This board electrically interconnects to the stack motherboard via a 9-pin connector. The clock board attaches to the stack motherboard with two screws.

## Power Interlock Switch

A power interlock microswitch causes power supply shutdown if the stack door is opened with power on. Shutdown results in all RAM data being lost. The power switch must be cycled to power up the computer. The power interlock switch prevents damage to boards caused by their removal or insertion with power on.

## Cooling

A dc box fan is mounted at one end of the stack to draw cooling air through the stack. An air controller is mounted in the stack. The air controller blocks air from circulating through the open area if the stack is not filled with boards and ensures that most of the cooling air is circulated between the boards.

The fan has three speeds which are varied according to the temperature sensed on the secondary board heat sink in the power supply assembly. Refer to the preceding Power Supply Assembly description for details on fan speeds and temperature thresholds.

## Memory

This subsection describes the organization of RAM memory within the stack. It also describes error detection and correction, mapping, and healing.

### Memory Organization - 256K Byte RAM Board

Up to 10 RAM boards can be configured in a processor stack. Each board has a Memory Controller (MC) and 256K, 512K, or 1 Megabyte of RAM. This section will cover the theory of operation of the 256K board (Figure 2-8), and following sections will cover the other RAM boards.

The MC interfaces the memory on the RAM board to the MPB. The MC uses 27 bits of the MPB logical address to locate the physical memory address on the RAM board. 12 bits of the MPB address are used as part of the X and Y addresses. The other 15 bits select a mapper Content-Addressable Memory (CAM) register. The mapper CAM register output is used to provide Chip Select (CS) lines and 3 more Y address bits for block selection. One of four chip select lines selects one of four rows of RAM. Each row of RAM has four 4K word blocks of memory, for a total of 16K words (four 8 bit bytes per word). The row is actually comprised of five 16K by 8 bit RAM chips. Each word has 32 data bits and 7 checkbits for error detection and correction. Data and check bits are transmitted on the Memory Data Bus.

The 8-line Memory Address Bus multiplexes 15 address bits. The lower 8 bits comprise the X address and are transmitted from the MC first. The next 7 bits make up the Y address and are transmitted next. The most significant bit of the Y address is ignored in the RAM.

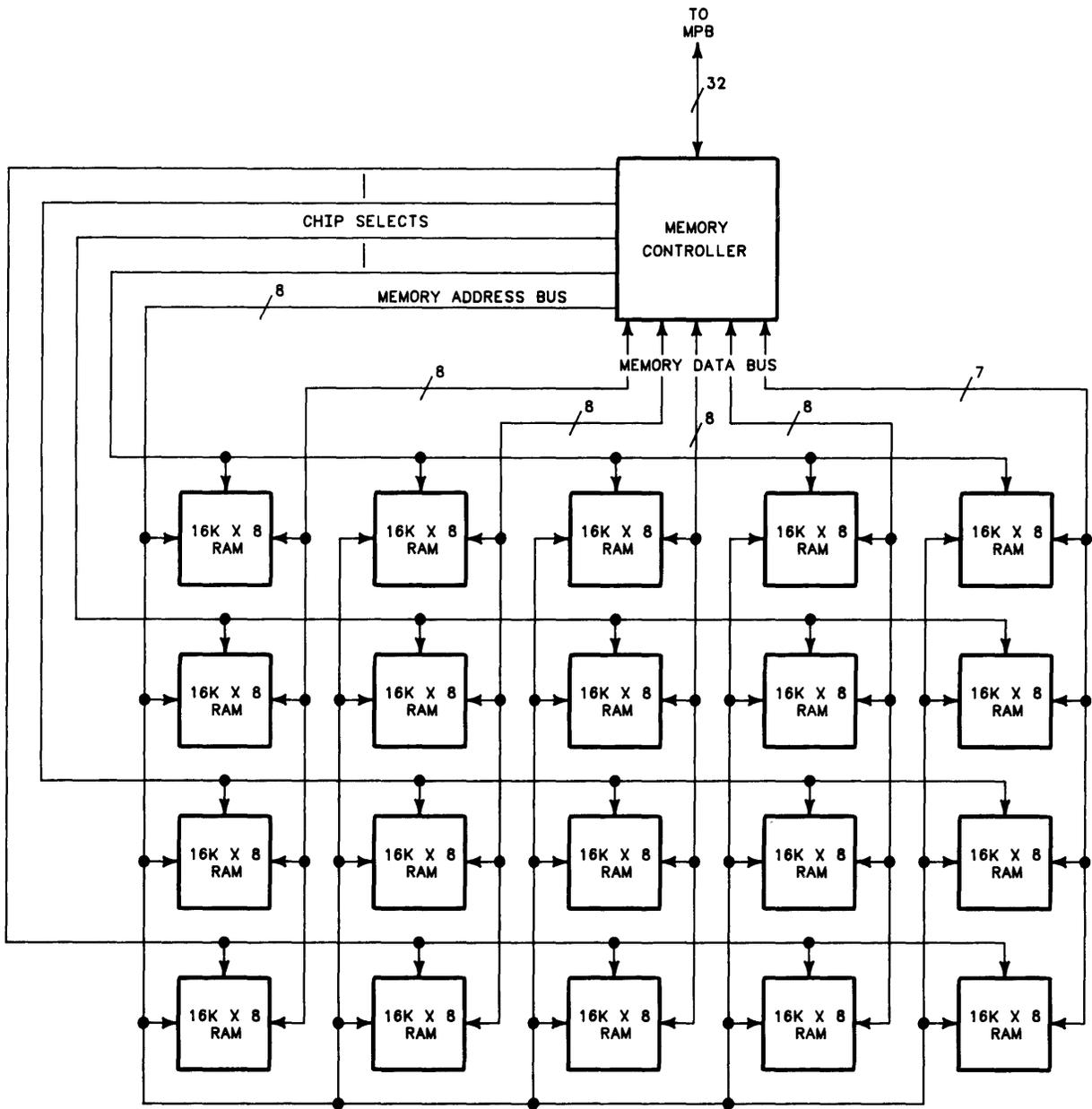


Figure 2-8. 256K RAM Finstrate Block Diagram

### Memory Mapping

The Memory Controller has a memory mapping capability which provides a translation of logical addresses on the MPB to physical addresses in RAM. Mapping memory addresses from the logical address space of the MPB to the physical address space of the memory itself allows each MC to respond to only those addresses of memory under its control. It also allows logical addresses to be independent of physical addresses. The MC has 32 mapper CAM registers. Each register is associated with one 4K block of RAM.

Each row of memory is logically divided into four blocks of 4K words per block, 32-bits per word (Figure 2-9). Thus selecting a mapper CAM register selects a particular block of 4K words. The X and Y address bits then select a particular word in the block. Because the 256K byte RAM board has 64K words, only 16 mapper CAM registers are used. As shown in Figure 2-9, the registers that are used are 0-3, 8-11, 16-19, and 24-27. The remaining registers (4-7, 12-15, 20-23, and 28-31) are not used and their Map Out bits (bit 0) should be set. The Map Out bit is described in a following paragraph.

MAPPER CAM REGISTER ADDRESS	CS SELECTED ROW	Y ADDRESS SELECTED BLOCK NUMBER	X AND Y ADDRESS SELECTS WORD WITHIN THE BLOCK				
			4K WORDS	4K BYTES	4K BYTES	4K BYTES	4K BYTES
0	3	0	4K WORDS	4K BYTES	4K BYTES	4K BYTES	4K BYTES
1	3	1	4K WORDS	4K BYTES	4K BYTES	4K BYTES	4K BYTES
2	3	2	4K WORDS	4K BYTES	4K BYTES	4K BYTES	4K BYTES
3	3	3	4K WORDS	4K BYTES	4K BYTES	4K BYTES	4K BYTES
4			NOT USED				
5							
6							
7							
8	2	0	4K WORDS	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM
9		1	4K WORDS				
10		2	4K WORDS				
11		3	4K WORDS				
12			NOT USED				
13							
14							
15							
16	1	0	4K WORDS	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM
17		1	4K WORDS				
18		2	4K WORDS				
19		3	4K WORDS				
20			NOT USED				
21							
22							
23							
24	0	0	4K WORDS	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM
25		1	4K WORDS				
26		2	4K WORDS				
27		3	4K WORDS				
28			NOT USED				
29							
30							
31							

Figure 2-9. 256K Memory Mapping Organization

The 32-bit memory address word on the MPB is shown in Figure 2-10. Bits 0-2 contain the function code, and bits 30 and 31 are used for half-word and byte modes, respectively. Bits 3-29 are the 27 bits that specify the logical memory address. The least significant 12 bits of the incoming address are not mapped. These point to individual locations within the 4K blocks. Eight of the 12 bits (MPB bits 22-29) comprise the X address. The remaining four bits (MPB bits 18-21) comprise bits 4-7 of the Y address. The 15 most significant bits are gated into the MC address mapper.

Bits 3-17 of the MPB logical memory address are compared with bits 3-17 of each mapper CAM register in the MC address mapper. If the compare is unsuccessful, nothing happens. If a compare is successful, bit 0 of the register is then checked. If bit 0 (the Map Out bit) is set, the addressed RAM block is considered nonexistent and cannot be accessed. This allows defective memory blocks to be removed from use and assures that no logical address will be mapped onto an empty block of memory.

If an address compare occurs and the mapper CAM register Map Out bit is clear, the MC produces a 19-bit physical memory address. The address mapper sets one of four Chip Select lines to select one of four chip rows. It also outputs three bits which are joined with MPB bits 18-21 to form the 7-bit Y address. MPB bits 22-29 are gated in as the 8-bit X address. The most significant bit of the Y address is not used. The next two bits select the 1-of-4 block number. The lower four bits of the Y address and the eight X address bits select one of 4K words in the block.

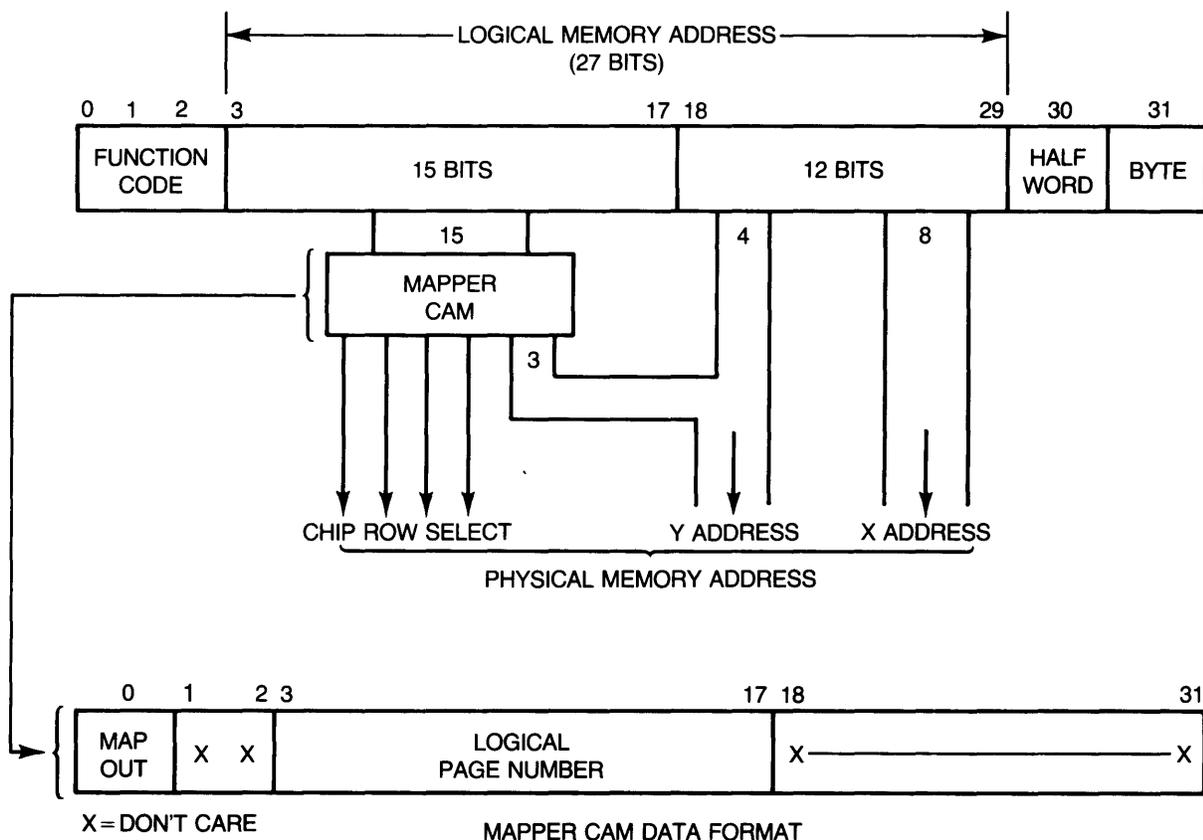


Figure 2-10. 256K Memory Mapping Operation

**Error Detection and Correction**

The Memory Controller detects and corrects single-bit errors in data read from RAM. It also detects double-bit errors. Each 32-bit word written to memory has a 7-bit Hamming code attached to it. When the data word is read, a single-bit or double-bit error is detected.

Any single-bit error that is detected is automatically corrected before the word is transferred to the MPB. No additional time is required for the correction. At the same time that a single-bit error is detected and corrected, the corrected data word is written into a healer location. Subsequent accesses of that location are to the healer location rather than to the memory location.

A double-bit error is detected but not corrected. A double-bit error causes the system to halt, preventing continuation of a program with bad data.

Healing is described in the following paragraphs.

**Memory Healing**

Each Memory Controller contains 32 words each of CAM and RAM which are used to replace up to 32 failed memory words (Figure 2-11). The physical address of a failed word is put in the healer CAM, the corrected data is placed in the corresponding healer RAM location, and bit 0 in the CAM is set to enable the address to match. Subsequent accesses to this physical address are to the healer RAM instead of the failed memory, causing the healer word to replace the failed word. Healing in no way affects the timing of the memory operation. Except for the healer, no record of healing is stored in memory.

All mapped addresses are sent to the healer CAM which compares each mapped address to all addresses of failed locations. Healer CAM addresses of failed locations have bit 0 set.

When all 32 locations of the healer are full, no further healing or automatic changes to the healer CAM occur on that Memory Controller. When all healer locations have been used, the healer overflow bit in the MC status register is set.

When all healer locations are full, the operating system checks each healed location to determine if the location is still faulty. If the location fault was caused by a momentary failure, the overflowed CAM can be cleared and reused by the operating system.

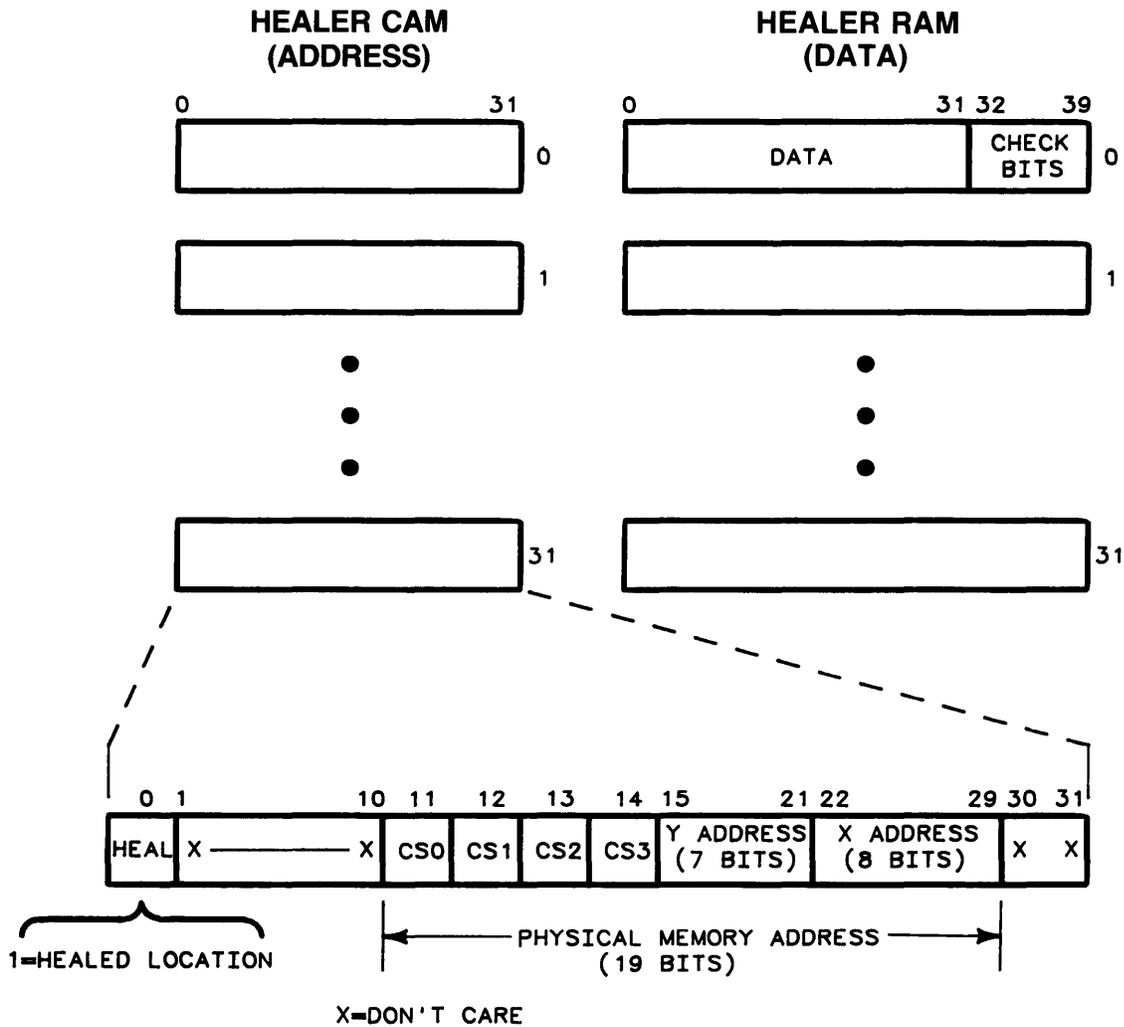


Figure 2-11. 256K Memory Healing

### Memory Organization - 512K Byte RAM Board

The 512K RAM board is similar to the 256K RAM finstrate. The board itself is a polyimide board instead of a finstrate. It contains twice as many RAM chips on the board as the 256K RAM finstrate (Figure 2-12). The RAM chips are the same as used on the 256K byte board.

The MC on the RAM board develops eight chip select lines, four even and four odd chip select lines. Each chip select line selects one row of 16K word RAM (note that a chip select line in Figure 2-12 goes to every other chip in each row. The effect is for a five chip row instead of ten chips, and the chip select goes to either the odd numbered chips or the even numbered chips.) Each word is still 32 data bits and 7 check bits, and the specific word that is addressed is selected within the block, by the X and Y address bits.

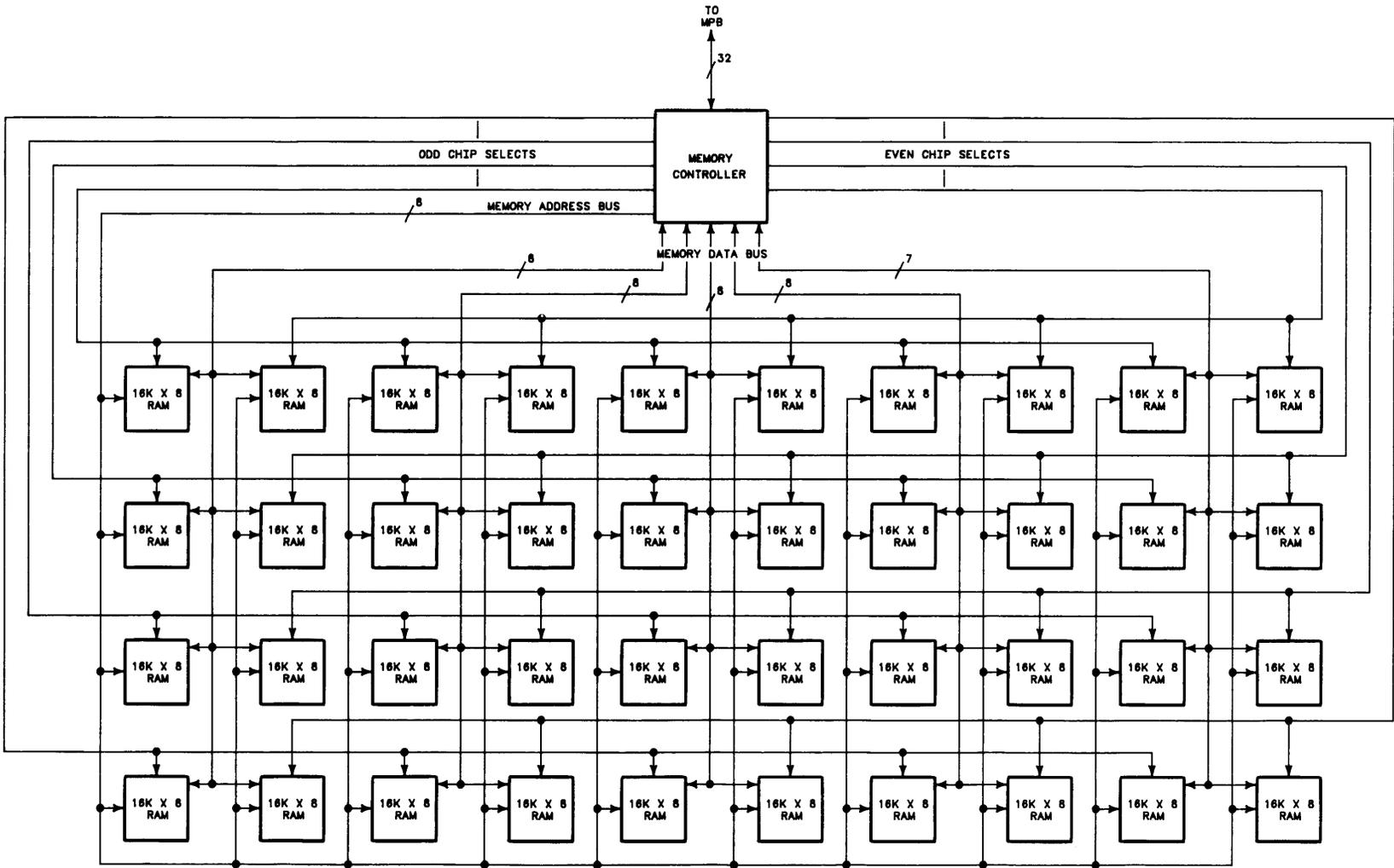


Figure 2-12. 512K RAM Board Block Diagram

## Memory Mapping

The Memory Controller has the same memory mapping capability of translating logical addresses on the MPB to physical addresses in RAM as the 256K RAM Memory Controller. The difference is in the number of mapper CAM registers that are used to produce Chip Select signals for row selection, and the use of the most significant Y bit for determining whether the row is odd or even.

The 256K RAM used 16 of the 32 mapper CAM registers to produce chip select lines for selecting rows. The 512K RAM uses all 32 mapper CAM registers for selecting 8 rows instead of 4 rows (Figure 2-13). This is accomplished by multiplexing the Chip Select output of the mapper CAM, and using the most significant bit of the Y address to determine whether the multiplexed output is an odd numbered row or an even numbered row (Figure 2-14). The RAM chips still do not use the most significant bit of the Y address. It is only used by the multiplexer inside the Memory Controller.

MAPPER CAM REGISTER ADDRESS	CS SELECTED ROW	Y ADDRESS SELECTED BLOCK NUMBER	X AND Y ADDRESS SELECTS WORD WITHIN THE BLOCK				
			4K WORDS	4K BYTES	4K BYTES	4K BYTES	4K BYTES
0	7	0	4K WORDS	4K BYTES	4K BYTES	4K BYTES	4K BYTES
1	7	1	4K WORDS	4K BYTES	4K BYTES	4K BYTES	4K BYTES
2	7	2	4K WORDS	4K BYTES	4K BYTES	4K BYTES	4K BYTES
3	7	3	4K WORDS	4K BYTES	4K BYTES	4K BYTES	4K BYTES
4	6	0	4K WORDS	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM
5		1	4K WORDS				
6		2	4K WORDS				
7		3	4K WORDS				
8	5	0	4K WORDS	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM
9		1	4K WORDS				
10		2	4K WORDS				
11		3	4K WORDS				
12	4	0	4K WORDS	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM
13		1	4K WORDS				
14		2	4K WORDS				
15		3	4K WORDS				
16	3	0	4K WORDS	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM
17		1	4K WORDS				
18		2	4K WORDS				
19		3	4K WORDS				
20	2	0	4K WORDS	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM
21		1	4K WORDS				
22		2	4K WORDS				
23		3	4K WORDS				
24	1	0	4K WORDS	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM
25		1	4K WORDS				
26		2	4K WORDS				
27		3	4K WORDS				
28	0	0	4K WORDS	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM	16K BYTE RAM
29		1	4K WORDS				
30		2	4K WORDS				
31		3	4K WORDS				

Figure 2-13. 512K Memory Mapping Organization

As in the 256K RAM, the MC uses 27 bits of the MPB logical address to locate the physical memory address on the RAM board (Figure 2-14). 12 bits of the MPB address are used as part of the X and Y addresses. The other 15 bits select a mapper Content-Addressable Memory (CAM) register. The mapper CAM register output is used to provide Chip Select (CS) lines and 3 more Y address bits for block selection. One of four chip select lines is input to the multiplexer where it is further modified by the most significant bit of the Y address to select one of four rows of odd, or one of four rows of even numbered RAM. Each row of RAM has four 4K word blocks of memory, for a total of 16K words (four 8 bit bytes per word). The row is actually comprised of five 16K by 8 bit RAM chips. Each word has 32 data bits and 7 check bits for error detection and correction. Data and check bits are transmitted on the Memory Data Bus.

The 8-line Memory Address Bus multiplexes 15 address bits. The lower 8 bits comprise the X address and are transmitted from the MC first. The next 7 bits make up the Y address and are transmitted next.

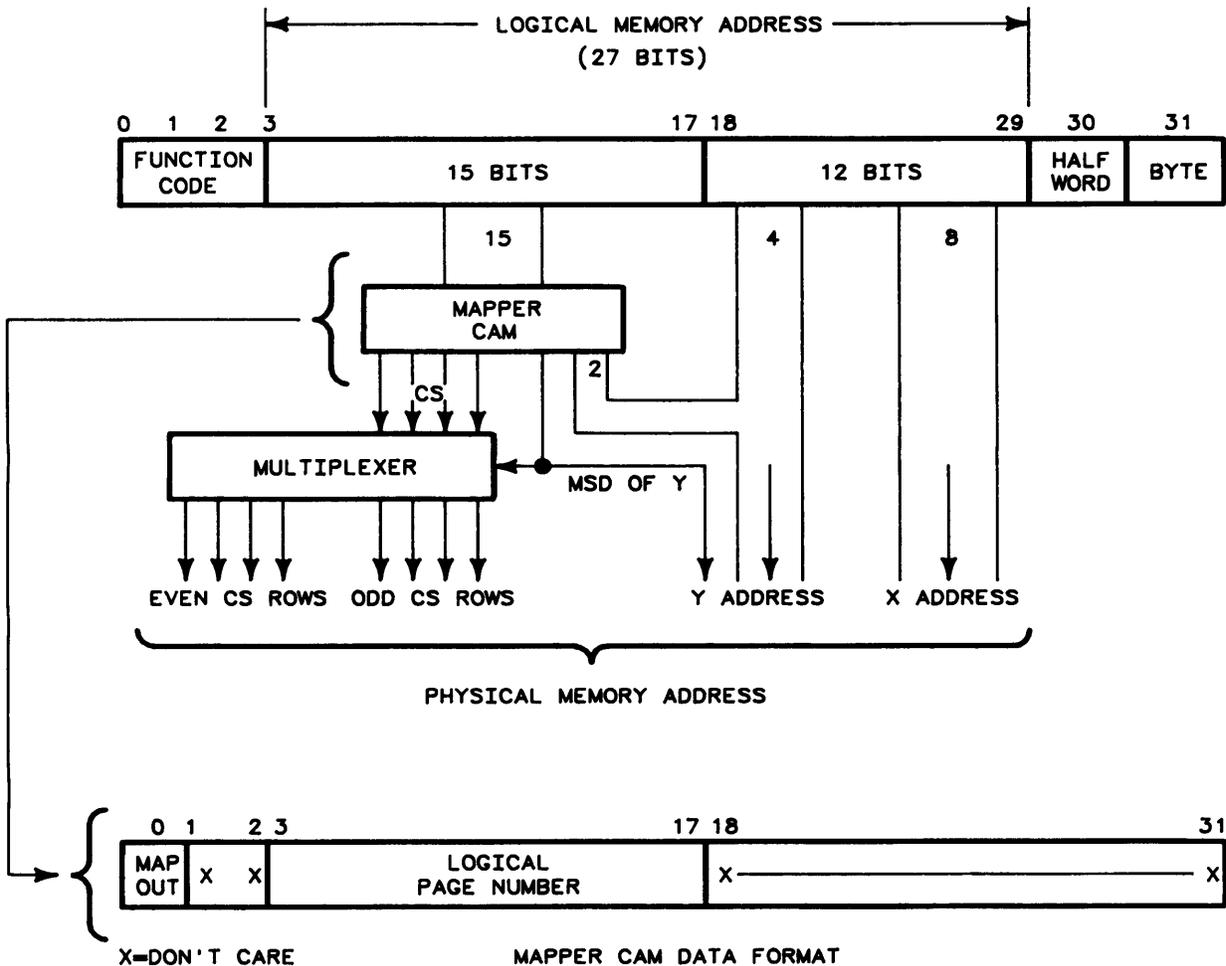
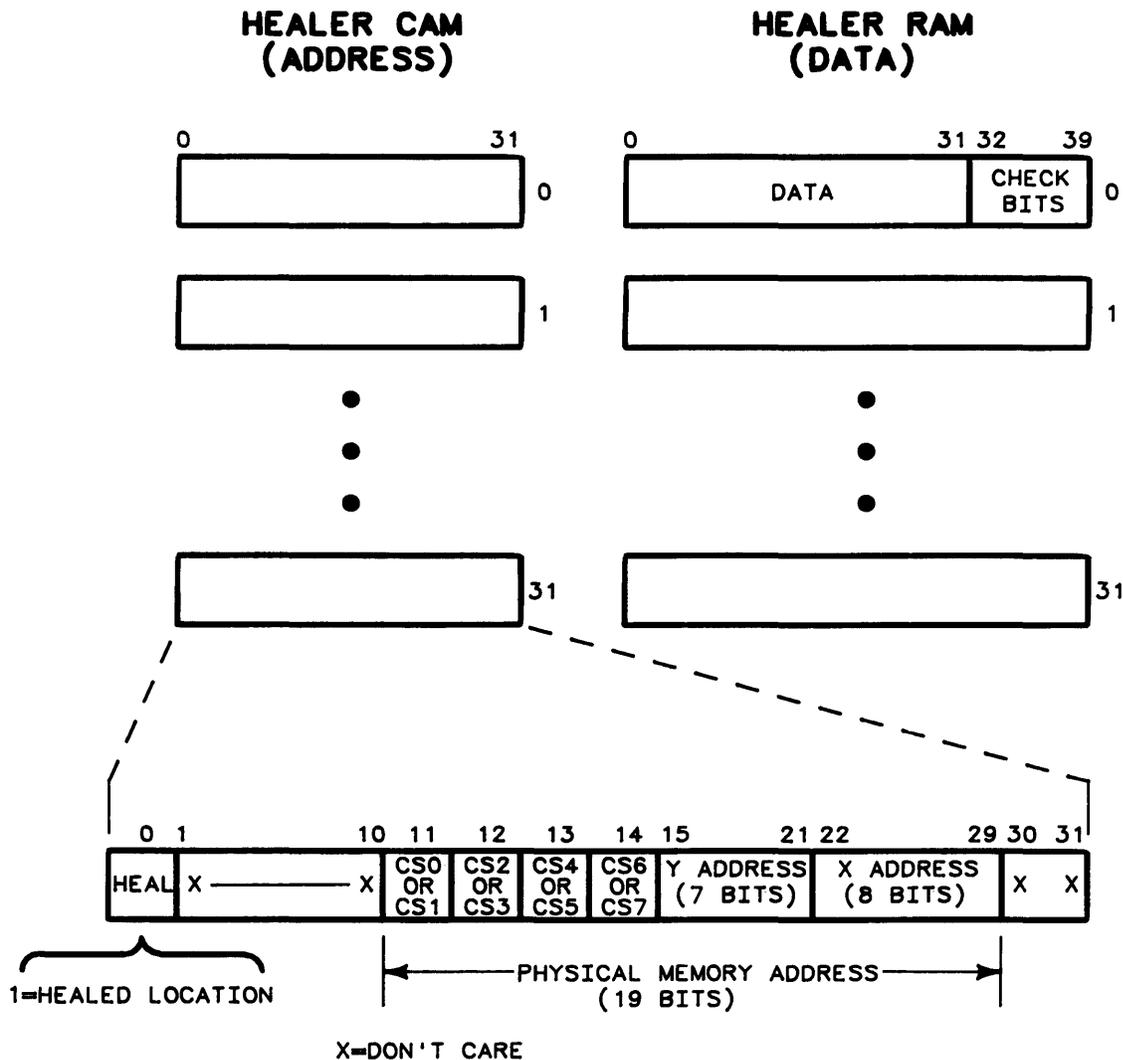


Figure 2-14. 512K Memory Mapping Operation

**Error Detection, Correction, and Memory Healing**

Error detection and correction is the same for the 256K RAM and the 512K RAM. The only differences are in the physical memory address in the healer CAM. The chip select portion of the address uses eight chip select lines instead of four.

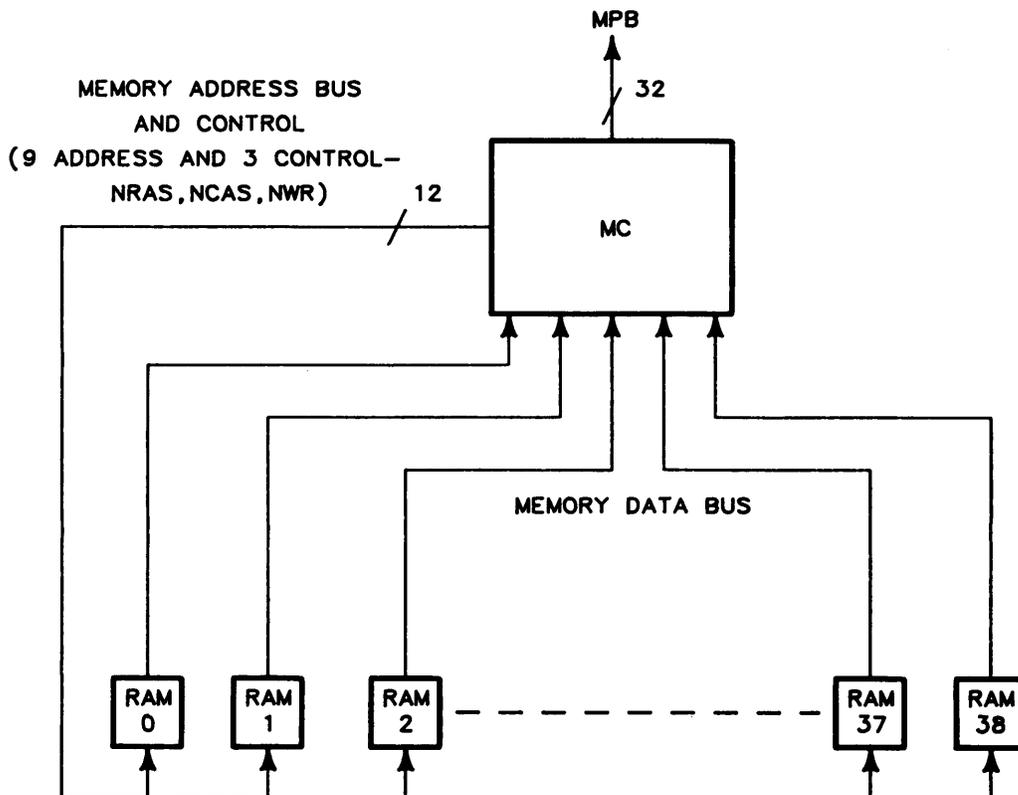


**Figure 2-15. 512K Memory Healing**

## Memory Organization - 1 Megabyte RAM Board

The 1 Megabyte RAM board is a polyimide board which uses thirty-nine 256K by 1 bit chips. This allows an organization consisting of 256K words (four bytes per word) which can be addressed without the use of chip select lines, or "blocks" of RAM (Figure 2-16). The word stored in the RAM is 32 bits in length with 7 check bits.

The MC on the RAM board develops eighteen physical address bits from the logical address bits on the MPB, nine X address bits and nine Y address bits. The multiplexed physical addresses are routed to each chip by the Memory Address Bus. The X address is output first, with the the Y address following. Three control lines go to each RAM chip: Row Address Select (NRAS) - X address, Column Address Select (NCAS) - Y address, and Read/Write status (NRW).



RAM CHIPS ARE 256K X 1 BIT

Figure 2-16. 1 Megabyte Memory Organization

### Memory Mapping

The Memory Controller, as on other RAM boards, has the memory mapping capability of translating logical addresses on the MPB to physical addresses in RAM. The difference is the controller output (Figure 2-17). There is only one mapper Cam on the 1 Megabyte board. The mapper CAM uses bit zero for the Map Out bit to indicate whether the memory card is capable of storing data or is mapped out. Bits 3 through 11 are used for determining whether this 1 Megabyte board is being addressed by the logical memory on the MPB. If the MPB logical address bits 3 to 11 match the bits in the mapper CAM, the operational transaction is for this board. As all memory chips are addressed without the requirement for Chip Select signals or block addressing, the nine bits of X, and the nine bits of Y address are all that are required to locate the desired information in the RAM chips. The MC controls when the chips are addressed by output of the NRAS and NCAS control signals, along with the output of the X or Y address on the Memory Address Bus.

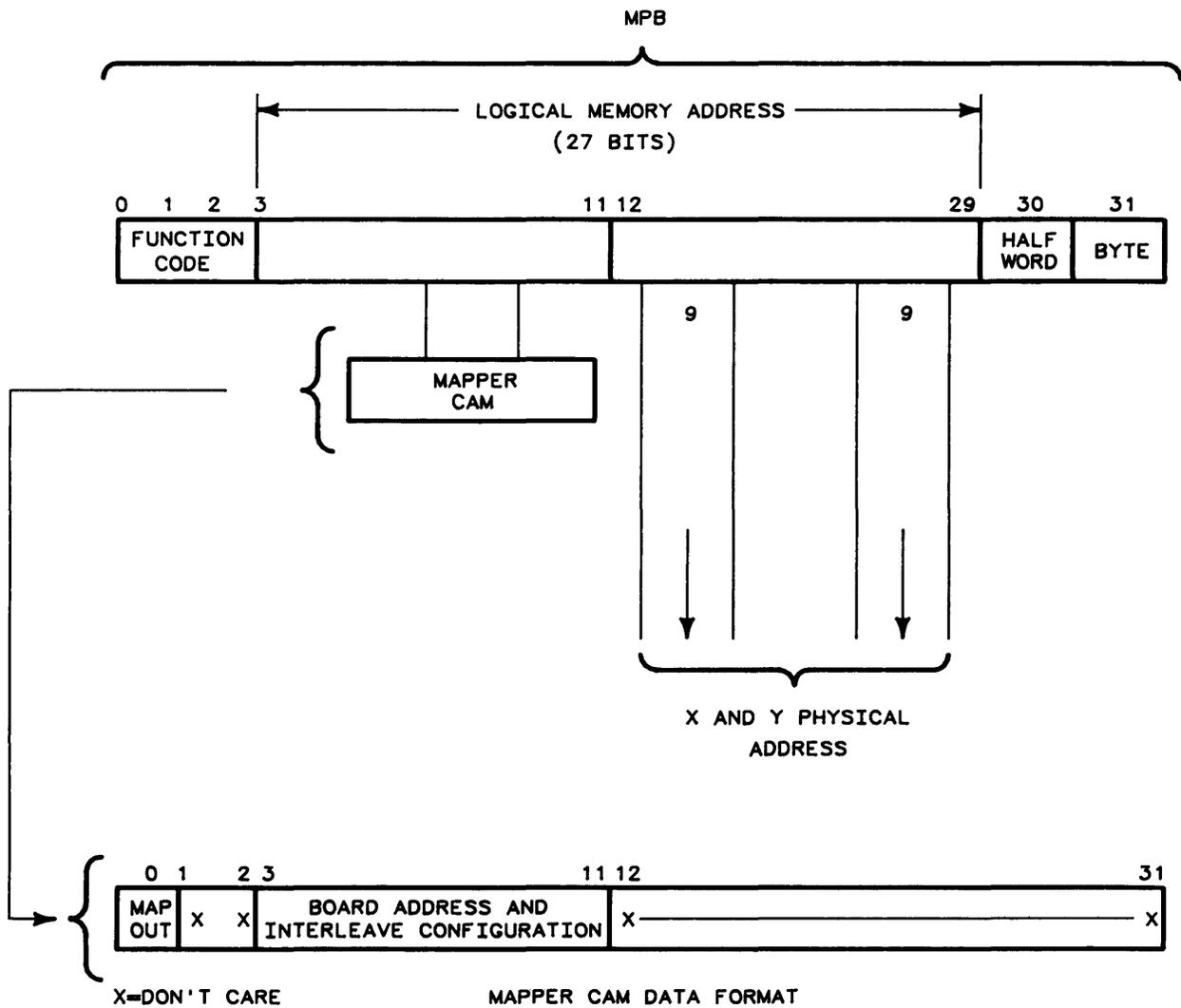


Figure 2-17. 1 Megabyte Memory Mapping Operation

When using the 1 Megabyte RAM boards, a unique feature is employed. The Ram boards are interleaved for better efficiency in memory access. This interleaving means that consecutive addresses are found on different 1 Megabyte boards. Interleaving can be between 2, 4, or eight boards. Whenever 1 Megabyte boards are used they will be used in pairs so this feature can be utilized to its best advantage. The stack can support up to ten 1 Megabyte boards and the appropriate interleave method for each configuration will be implemented automatically. If two boards are used, all the odd numbered addresses are on one board and the even numbered addresses are on the other board. Consecutive addresses will alternate between the boards. If four boards are used, consecutive addresses move from one board to the next. For example: address 0 may be on board one; address 1 on board two; address 2 on board three; address 3 on board four; and address 4 on board one; etc. It is not necessary to change anything on the boards, as the operating system automatically controls the set-up of interleaving for the best operation of the computer regardless of the number of RAM boards or the mixture of 256K, 512K, or 1 Megabyte boards. Mapper CAM data bits 9, 10, and 11 are used to ensure that the mapper CAM responds to the correct interleave method implemented by the operating system.

Even with the interleaving, the program speed of the 1 Megabyte RAM boards may be slightly slower on some programs, when compared to the program speed using the 256K or 512K RAM boards. This is due to the slower access time of the 1 Megabyte RAM boards.

### **Error Detection and Correction**

As in the other memory boards, the Memory Controller detects and corrects single bit errors in data read from RAM. It also detects double bit errors. Each 32 bit word written to memory has a 7 bit Hamming code attached to it. When the data word is read, a single bit or double bit error is detected.

Any single bit error that is detected is automatically corrected before the word is transferred to the MPB. No additional time is required for the correction. At the same time that a single bit error is detected and corrected, the correct data is written into a healer location.

A double bit error is detected but not corrected. A double bit error causes the system to halt, preventing continuation of a program with bad data.

### **Memory Healing**

Each Memory Controller contains 32 words each of CAM and RAM which are used to replace up to 32 failed memory words (Figure 2-18). The physical address of a failed word is put in the healer CAM, and the corrected data is put in the corresponding healer RAM location. Bit 0 in the CAM is set to enable the address to be matched. Subsequent accesses to this physical address are to the healer RAM instead of the failed memory, causing the healer word to replace the failed word. Healing does not affect the timing of the memory operation. Except for the healer, no record of healing is stored in memory.

All mapped addresses are sent to the healer CAM, which compares each mapped address to all addresses of failed locations. Healer CAM addresses of failed locations have bit 0 set.

When all 32 locations of the healer are full, no further healing or automatic changes to the healer CAM occur on that Memory Controller. When all healer locations have been used, the healer overflow bit in the MC status register is set. When all healer locations are full, the operating system checks each healed location to determine if the location is still faulty. If the location fault was caused by a momentary failure, the overflowed CAM can be cleared and reused by the operating system.

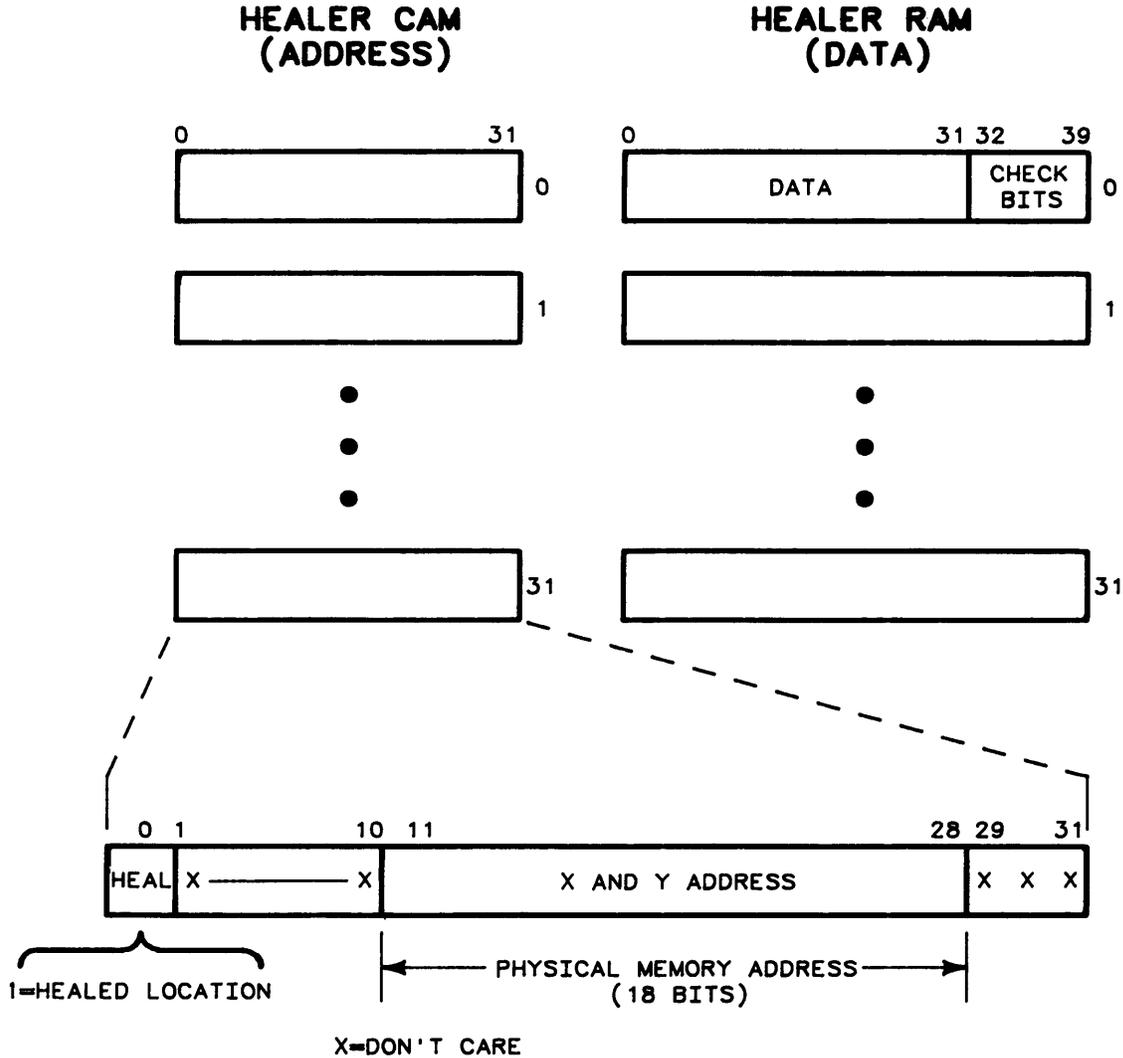


Figure 2-18. 1 Megabyte Memory Healing

## IOP Bus

The 50-conductor IOP ribbon cable interconnects the motherboard with the IOP finstrate in slot #2. The IOP finstrate handles internal peripherals as well as the I/O backplane. With eight select codes per IOP and a full complement of internal peripherals, four select codes (select codes 2-5) are available to the user at the four I/O backplane slots. The slots are physically numbered to correspond to the select codes. Select codes have been programmed to the following defaults:

Select Code	Usage
0	Display Alphanumeric
1	Display Graphics
2	I/O Slot #2
3	I/O Slot #3
4	I/O Slot #4
5	I/O Slot #5
6	Keyboard, Printer, Real-Time Clock, Beeper, Optional Input Device
7	Internal Mass Storage

Select code 6 services the keyboard, printer, real-time clock, beeper, and optional input device via a single interface. The beeper is a write-only device with programmable frequency. Data can be sent to the printer via DMA by enabling select code 6 for DMA. Select code 6 is enabled for keyboard and printer interrupts at all times. The real-time clock is set and read via program-controlled transfers.

One or two additional IOP finstrates can be added. Each is connected by a 50-conductor ribbon cable to a connector mounted on the processor stack door. The ribbon cable provides the IOP bus from the finstrate to the connector. A 97098A I/O Expander can then be connected to the stack. The I/O expander provides eight I/O slots with required signal buffering and power supplies. The select code configuration at the I/O backplane is unaffected by additional IOPs. Select Codes 8-15 are assigned to the first additional IOP; select codes 16-23 are assigned to the second additional IOP.

## Keyboard

The keyboard is a microprocessor-controlled assembly consisting of two boards, a keyboard electronics board and a keyswitch board (Figure 2-19). The assembly plugs into three ribbon cable connectors mounted in the base of the computer. The assembly connectors are as follows:

- C – 50-pin; IOP bus
- PC – 50-pin; power and miscellaneous signals
- TB – 14-pin; optional input device interface

The keyboard electronics board and keyswitch board are physically interconnected by screws and a 20-pin ribbon cable. The ribbon cable is the keyboard bus which functionally interconnects the boards.

The keyswitch board contains the keyswitches and minimal electronics needed to scan the key matrix. The keyboard electronics board contains an 8048 microprocessor which scans the key matrix, the real-time clock/non-volatile memory (RTC/NVM), the programmable tone generator (beeper) the optional input device, and the IOP bus interface.

Select code 6 (SC6) provides access to the printer, keyboard, RTC/NVM, optional input device, and the beeper. Each of these devices has one or more interface register(s) assigned to it. The device can be read from or written to by accessing the assigned interface register. The interface registers are designated as RX registers.

To eliminate bus conflicts with the printer, which has its own bus interface circuitry, the IOP bus drivers are enabled only when registers R1, R3, R9, R10, R11, R12, and R15 are accessed. The printer's bus drivers are enabled when registers R0, R1, R2, R4, R5, R6, and R7 are accessed. R1 is shared, with the keyboard driving the lower 12 bits and the printer driving the upper 4 bits. For R12, only the lower 8-bit bus buffer is enabled on the keyboard for both reads and writes.

NSTATUS and NFLAG for all of select code 6 are driven from the keyboard. Printer STATUS and FLAG are sent to the keyboard on the 50-pin ribbon cable carrying power to both assemblies.

The keyboard electronics board contains a nickel-cadmium (NICAD) battery assembly to maintain the RTC/NVM data during periods of no mainframe power. The battery assembly has a minimum life expectancy of approximately 4 years. It can maintain the data during a power-off condition for a minimum of 10 days.

The keyboard circuitry, contained on the keyboard electronics board, can be divided into six main subsections. Five of these subsections interface to a common internal bi-directional data bus. The remaining subsection interfaces the data bus to the IOP bus. The six subsections are:

- IOP Bus Interface
- Miscellaneous Status and Control
- Keyboard and Input Device Scanning
- Beeper
- RTC/NVM Logic and Enable
- Power-Up/Power-Down Sense Circuitry

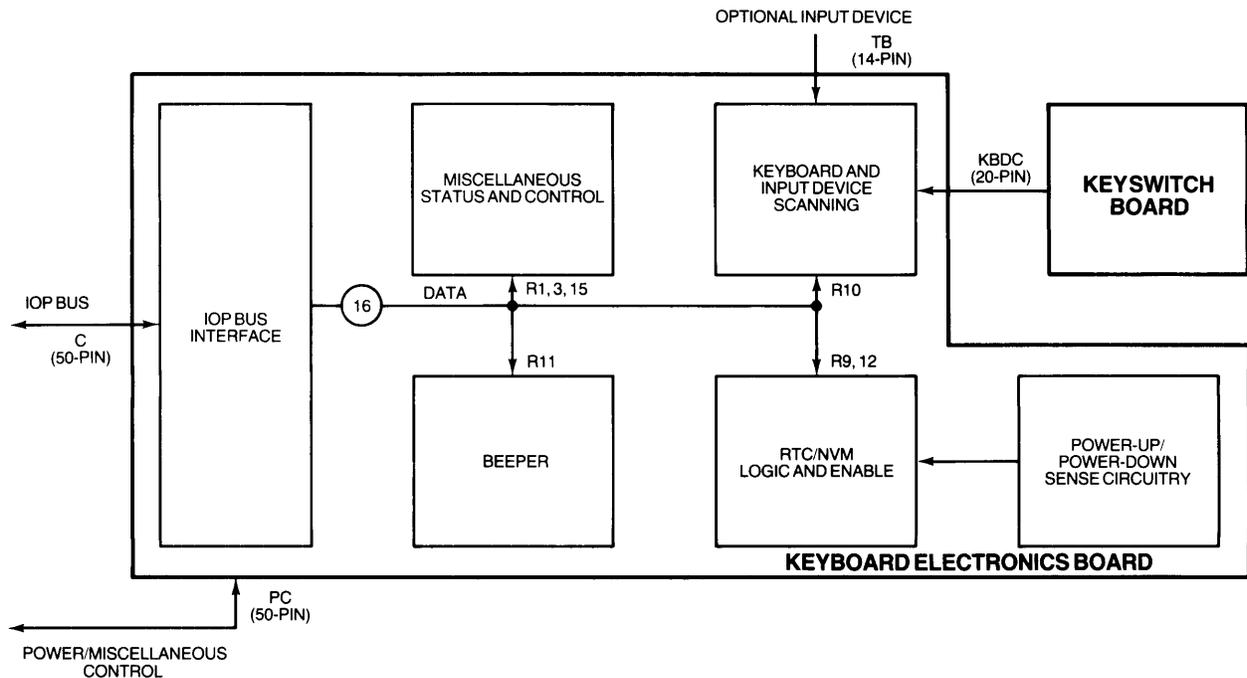


Figure 2-19. Keyboard Block Diagram

## IOP Bus Interface

The IOP bus data and control lines are buffered and interpreted at the interface circuitry. Sixteen data lines and 14 control lines are present on the interface.

Four register select lines from the IOP indicate the assigned interface register on SC6 and therefore determine the circuitry to be accessed.

Three peripheral address lines from the IOP must match the hard-wired SC6 decode circuitry to access any keyboard circuitry.

## Miscellaneous Status and Control

The following miscellaneous status and control circuits are discussed below: keyboard ID register, status buffer, service request latch, and bus test latches.

When the IOP requests a read of interface register 3 (R3) on SC6, the keyboard ID register sets data bus bit 1 to a 1. With 0's on the other 7 lines of the lower 8 bits, the IOP recognizes that the keyboard is present.

The status buffer presents three bits of status to the IOP upon reading of R1. The bits are as follows:

- bit 0 – keyboard interrupt pending
- bit 1 – power fail warning
- bit 2 – (not used)
- bit 3 – battery failure

The keyboard service request latch is set when the keyboard microprocessor outputs a keycode to the output register. Then, on the next polling cycle, bit 6 on the IOP bus is set, signifying to the processor that a peripheral on SC6 is requesting service.

Two 8-bit bus test latches have their inputs and outputs tied to the bus. At power-up, operating system code tests data path integrity by writing data into and then reading the data from these latches via R15.

## Keyboard and Input Device Scanning

The keyswitch board scans 15 columns of keys with 8 keys per column. It interconnects with the keyboard electronics board via a 20-pin ribbon cable and the electronics board bus connector (KBDC).

The keyboard microprocessor, which resides on the keyboard electronics board, has 1K bytes of ROM and 64 bytes of RAM. The microprocessor constantly scans, or interrogates, the keyswitch board. It sends the 4-bit column address to the keyswitch board. That board responds by sending the status of all 8 keys of the specified column to the microprocessor, which processes the data. It then sends the next column address, and the process continues.

When a new key is pressed, the microprocessor translates the address of the key into a 7-bit keycode which it then shifts into a holding register along with two status bits: Shift and Control. A service request signal is then sent to the IOP bus. The IOP responds by reading R10. Lockout logic prevents overwriting of the keycode in the holding register for a maximum of 2.25 ms, enabling it to be read by the IOP.

The keyboard microprocessor controls the two LEDs on the keyboard and the initial delay and repeat rate of keys which are held down. When a key is pressed on the keyboard which requires an LED change, that keycode is sent to the IOP which in turn responds by updating all LEDs and the auto-repeat rate by writing to R10.

The auto-repeat rate determines the initial delay and repeat interval of keys that are continuously held down. The default is 500-millisecond delay and 20-millisecond repeat interval. Another 30 combinations can be selected.

The desired keyboard language is determined by the insertion/deletion of four resistors on the keyboard electronics board. This 1-of-16 language code is translated by the operating system to select the predetermined language. A replacement keyboard electronics board is configured for ASCII and has all resistors in place. Refer to Chapter 4 for the language/resistor combinations and Chapter 5 for language/keycap configurations.

Buffers on the processor board provide isolation for signals from the optional input device. The input device plugs into connector TB located at the right front of the computer, under the keyboard.

## Beeper

The keyboard contains a programmable tone generator (beeper) that can play any of 255 tones between 194 Hz and 50 kHz.

This circuitry takes a 200-kHz clock from the microprocessor and divides it by two twice. The resultant 50-kHz signal is then divided by an 8-bit divide-down value that has been previously loaded into R11 by the IOP. When the count goes to 0, the desired output feeds a control chip which provides an output square wave to the beeper at the desired frequency. The divide-down byte is then reloaded from the buffer registers, and the process continues.

The IOP turns off the beeper by writing a divide-down byte of all 1's to R11. The circuitry senses this and inhibits the beeper. The beeper is a transistor amplifier with a diode for protection from inductive feedback.

## RTC/NVM Logic and Enable

The real-time clock (RTC) chip contains 16 four-bit locations that store clock and date information that is initially loaded from the IOP. A 32.768 KHz crystal oscillator provides the time base. A 4-bit multiplexed data bus provides I/O for the RTC chip.

Writing to R12 loads a 4-bit register address in the chip. The RTC data is then accessed by reads or writes of R9, either reading data from the addressed location or writing data to it. Once the initial address is accessed, succeeding reads or writes cause automatic increments of the address. This enables blocks of data to be read or written without updating the address from the IOP.

The non-volatile memory (NVM) chip contains 2048 eight-bit bytes of CMOS RAM used to store configuration and service data. Writing a 16-bit address to R12 in complemented form loads the address of the NVM location. The data in that location is then accessed by a read or write of R13.

RTC and NVM contents are listed in Chapter 3.

During power-off states, a nickel-cadmium (NICAD) battery assembly provides power to the RTC and NVM chips for a minimum of 10 days. The circuitry which controls battery operation is described in following paragraphs.

The accuracy of the RTC is partially dependent on the configuration, environment, and usage of the computer. Worst-case clock deviation varies between 40 seconds per month and 3 minutes per month depending on these factors.

## Power-Up/Power-Down Sense Circuitry

The RTC and NVM chips must be disabled when power is coming up or going down. Otherwise, spurious data could be written onto the chips. When the power supply senses that the power output is out of specification, it sends an interface clear signal to disable the IOP bus. This signal is translated on the keyboard electronics board and disables the chips.

When the chips are disabled, the circuitry enables battery input to the chips, maintaining the memory data and keeping the clock running. During normal operation, the battery is being charged by the +12V supply.

A sample and hold circuit checks the voltage level of the battery assembly at power-up. When power is off, a capacitor is charged to the battery level. When power comes back on, the voltage level of the capacitor is automatically read. If the level is below 3 volts, the RTC and NVM data may be invalid and should be restored by the IOP. This fault condition is indicated to the IOP by the battery failure status bit in the status buffer. This bit must be read within four seconds of power-up.

## Display

One of the following displays is installed on the computer:

- 98770A High-Performance Color Graphics Display
- 98780A Monochromatic Display
- 98760A Standard Color Graphics Display

The 98770A and 98780A displays have their own service manuals that include theory of operation. The 98760A display theory of operation follows in this chapter.

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### Note

Ignore references to ROMs in the following manuals. The ROMs do not apply to the HP 9000 computer.

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For theory of operation of the 98770A or 98780A display, refer to the applicable service manual:

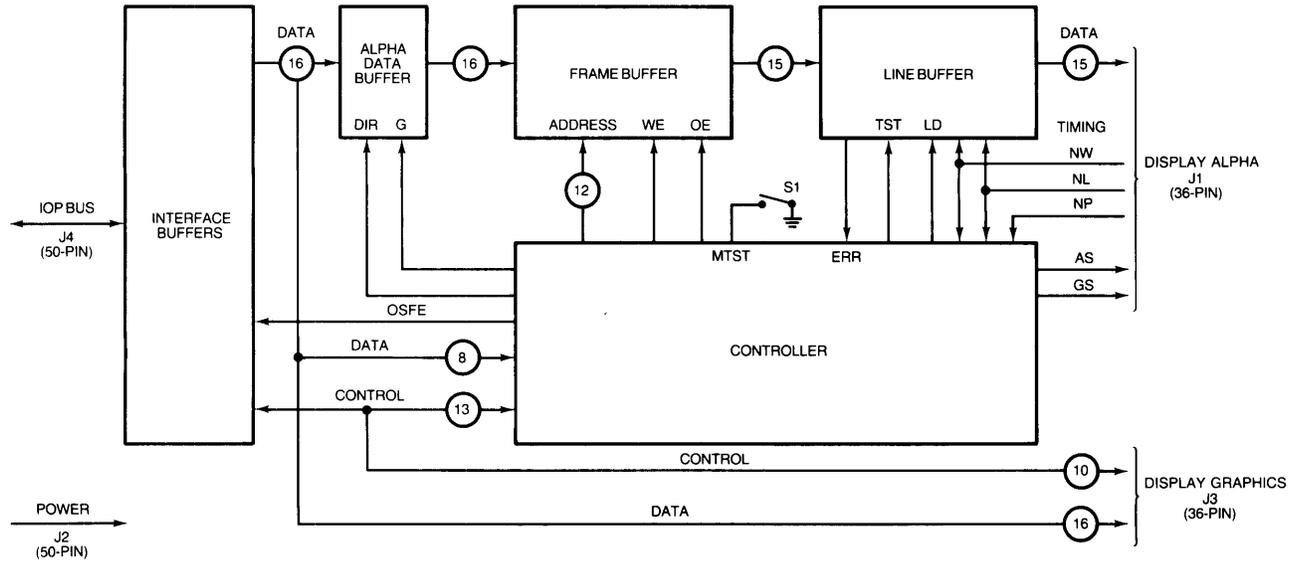
- 98770A Color Graphics Display Service Manual
- 98780A Monochromatic Display Service Manual

The 98770A and 98780A displays have an associated Display Interface Module (DIM) mounted below the display. The DIM is described below. The 98760A display theory of operation follows the DIM description.

### 98770A and 98780A Display Interface Module (DIM)

A Display Interface Module (DIM) is mounted to the bottom of the 98770A or 98780A display to interface the IOP bus from the processor with the display. The DIM is described in the following paragraphs.

Figure 2-20 is a block diagram of the DIM. DIM translates the general IOP interface from the computer mainframe into the specialized alphanumeric bus required by the display. DIM contains a full screen buffer of alphanumeric characters along with refresh sequencing hardware. DIM also buffers the I/O bus before sending it to the graphics sections of the display. DIM's primary function is to refresh the alphanumeric display. DIM contains sufficient memory to store all the alphanumeric data for one full frame. Only characters which are changed need to be written to DIM.



**Figure 2-20. Display Interface Module (DIM)**

Connectors J1 and J3 interface DIM to the display, and connectors J2 and J4 interface DIM to the computer mainframe. The connectors are as follows:

- J1 – 36-pin; alpha data to the display
- J2 – 50-pin; power to the DIM
- J3 – 36-pin; graphics data to the display
- J4 – 50-pin; IOP bus to the DIM

### Interface Buffers

The interface buffers between the IOP bus and the combined alpha/graphics minimize capacitive loading on the IOP signal lines. Data and control signals from the buffers split into an alpha path and a graphics path.

Graphics data and control information are transferred directly to the display. Alpha data is gated into the alpha data buffer.

Control signals are also exchanged between the interface buffers and the controller. The output-status-flag-enable (OSFE) signal enables Status and Flag to the IOP bus.

The lower 8 lines of the data bus provide an 8-bit-wide data path between the interface buffers and the controller. This path is used to transfer address, control, and data information.

### Alpha Data Buffer

The alpha data buffer provides isolation between the interface buffers and the frame buffer when the display is being refreshed or the line buffer is being loaded.

With DIR, the controller determines the direction of data through the buffer. Data is normally written to the buffer from the IOP. However, the IOP bus can read data from frame buffer memory via the alpha data and interface buffers to test data integrity.

The G signal is a disable signal that isolates the output of the alpha data buffer from the frame buffer.

### **Frame Buffer**

The frame buffer is composed of four static RAM chips that provide 2480 16-bit words. This allows storage of 31 rows of 80 alphanumeric characters, or one full display data frame. The frame buffer is normally written from the IOP, but can be read for diagnostic purposes. Data transfer can occur both in DMA or direct I/O modes.

The controller accesses frame buffer locations with 12 address lines. The location may be accessed to load updated information from the IOP or to transfer data to the line buffer.

The WE line is a write-enable that is high for a write to the frame buffer, and low when a buffer read is required.

OE is the output-enable and is high when the frame buffer is being written or when data is being transferred to the line buffer.

### **Line Buffer**

The line buffer is an NMOS-II chip that provides a dual line buffer function. It consists of a word counter, two 80-character shift registers, self-test circuitry, and support logic. Although there are 16 data paths on the chip, the display requires that only 15 be used.

The line buffer transfers an 80-character row from shift register 1 to the display while loading shift register 2 with another 80-character row from the frame buffer. When the transfer is complete, the buffer toggles the registers and begins shifting the contents of shift register 2 to the display while reloading shift register 1 from the frame buffer. This process continues until an entire frame has been transferred to the display.

Timing signals from the display control the loading and shifting of the line buffer registers. NW (new word) signifies next character, NL (new line) signifies next row, and NP (new page) signifies next frame. NP controls the address counters in the controller to ensure that the frame buffer is correctly accessed.

LD is a clock from the controller that enables data into the appropriate shift register from the frame buffer during load times.

The test signal (TST) puts the line buffer into self-test mode when it goes true. Self-test mode can be entered in two ways: 1) by pressing switch S1, a momentary pushbutton switch mounted on DIM and accessible at the bottom of the display, or 2) by software diagnostics. If the switch is used, the manual test signal (MTST) goes true. In either case, the TST line goes true. The line buffer has a counter that generates a self-test pattern to the display in response to TST. An error in the test pattern can be easily detected. The ERR line to the controller goes true when a line buffer error is detected.

**Controller**

The controller regulates the entire interface between the IOP bus and the display. The controller operates in two basic modes: display mode and IOP mode. In display mode, the controller transfers data from the frame buffer to the line buffer. Display mode occupies the controller approximately 12% of the time. For about 88% of the time the controller is in IOP mode, responding to the IOP, requesting frame buffer updates, and controlling the updates.

**98760A Standard Color Graphics Display**

The 98760A display receives data from the CPU, buffers it in RAM, and displays it on the CRT screen.

The display is a memory mapped, raster scan CRT. A total of 256 characters can be displayed, including all 128 ASCII characters. The display uses either the English or Japanese Katakana character set, depending on which ROM is selected and inserted at the factory. Character display matrix is 720 dots (horizontal) by 390 dots (vertical).

The bottom of the screen can be set up to display in half-bright, inverse video, on a line-by-line basis. This feature visually separates softkey labels from the remainder of the screen.

The CRT display consists of these assemblies:

- Alpha/Interface Board
- Graphics/Digital Video Board
- Video Board
- Sweep Board
- CRT/Yoke Assembly
- Display Power Supply

**Alpha/Interface Board**

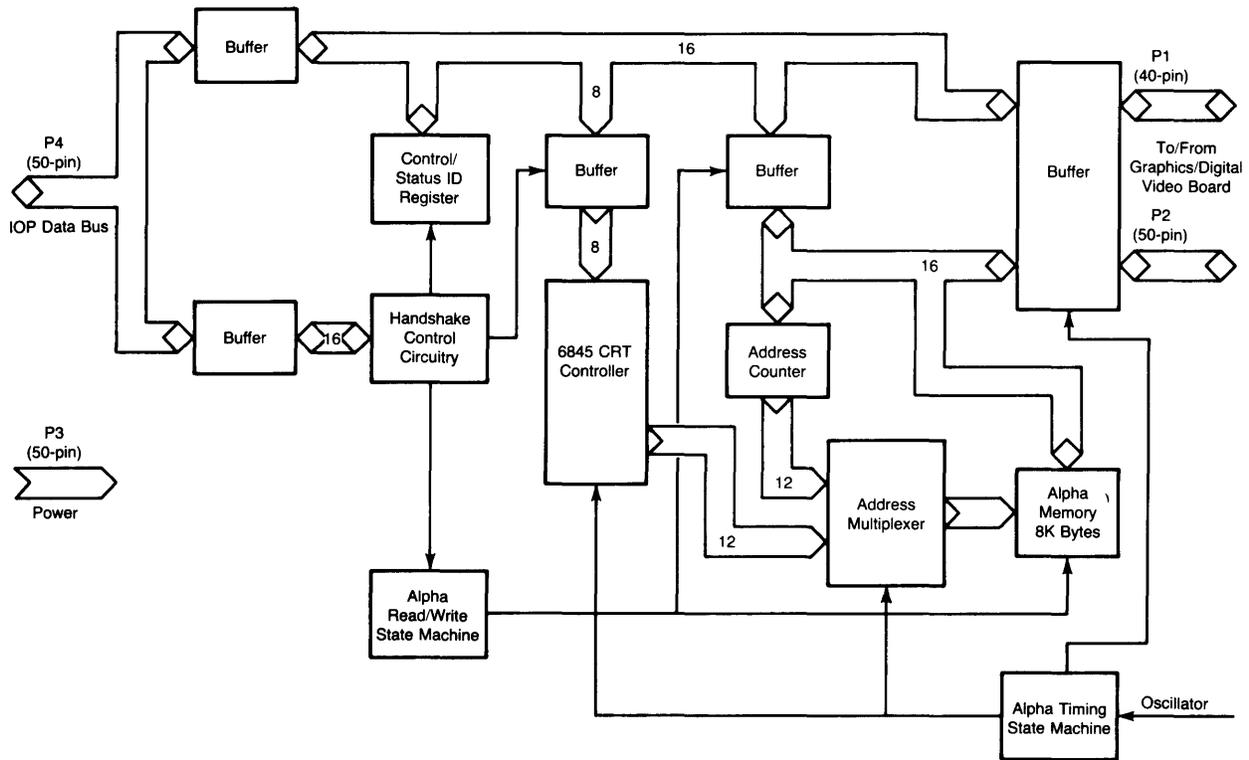
The alpha/interface board is mounted to the bottom of the display to interface the IOP bus from the processor with the graphics/digital video board in the display (Figure 2-21). Connectors P1 and P2 interface the two boards. Connectors P3 and P4 interface the alpha/interface board to the computer mainframe. The connectors are as follows:

- P1 – 40-pin; data/control to graphics/digital video board
- P2 – 50-pin; data/control to graphics/digital video board
- P3 – 50-pin; power to alpha/interface board
- P4 – 50-pin; IOP bus to alpha/interface board

The alpha/interface board receives data from the IOP via data lines IOD0 through IOD15. It buffers this data, then either stores it in the alpha memory or passes it on to the graphics/digital video board. At the appropriate time, data stored in the RAM is read out and sent to the character and attribute ROMs on the graphics/digital video board.

The alpha/interface board functions are controlled by a 6845 CRT alpha controller chip. Functions include interface logic, timing, and control logic. Alpha timing signals are provided to the graphics/digital video board.

A 50/60 Hz select switch is mounted on the alpha/interface board and can be accessed through a hole in the display casting. This sliding switch should be preset at the factory as appropriate.



**Figure 2-21. Alpha/Interface Board Block Diagram**

### Graphics/Digital Video Board

The graphics/digital video board has an attribute ROM and an English or Katakana character ROM (Figure 2-22). The board receives the alpha signals from the alpha/interface board, generates appropriate characters and attributes (blinking, underline, and inverse), and produces the red, green, and blue analog video streams for the video board. Alpha characters have 1-of-8 colors.

The graphics/digital video board has a graphics display controller which receives graphics data from the alpha/interface board and shifts it into graphics memory. At the appropriate time, data stored in the RAM is read out and sent to the color map. The color map has 16 locations of 12 bits each, four bits per gun. Therefore, at any given time, the color map can store 16 of a possible 4096 colors (16 red by 16 green by 16 blue).

The graphics/digital video board also has a 51 MHz crystal oscillator which provides timing signals to both the alpha/interface and graphics/digital video boards. The board has a sync generator circuit which provides the vertical and horizontal sync signals and the vertical blanking signal to the video board.

Three digital-to-analog converters on the graphics/digital video board convert the 12-bit digital output of the graphics color map, and the red, green, and blue alpha video streams which are not colormapped, into red, green, and blue analog signals suitable for the video board.

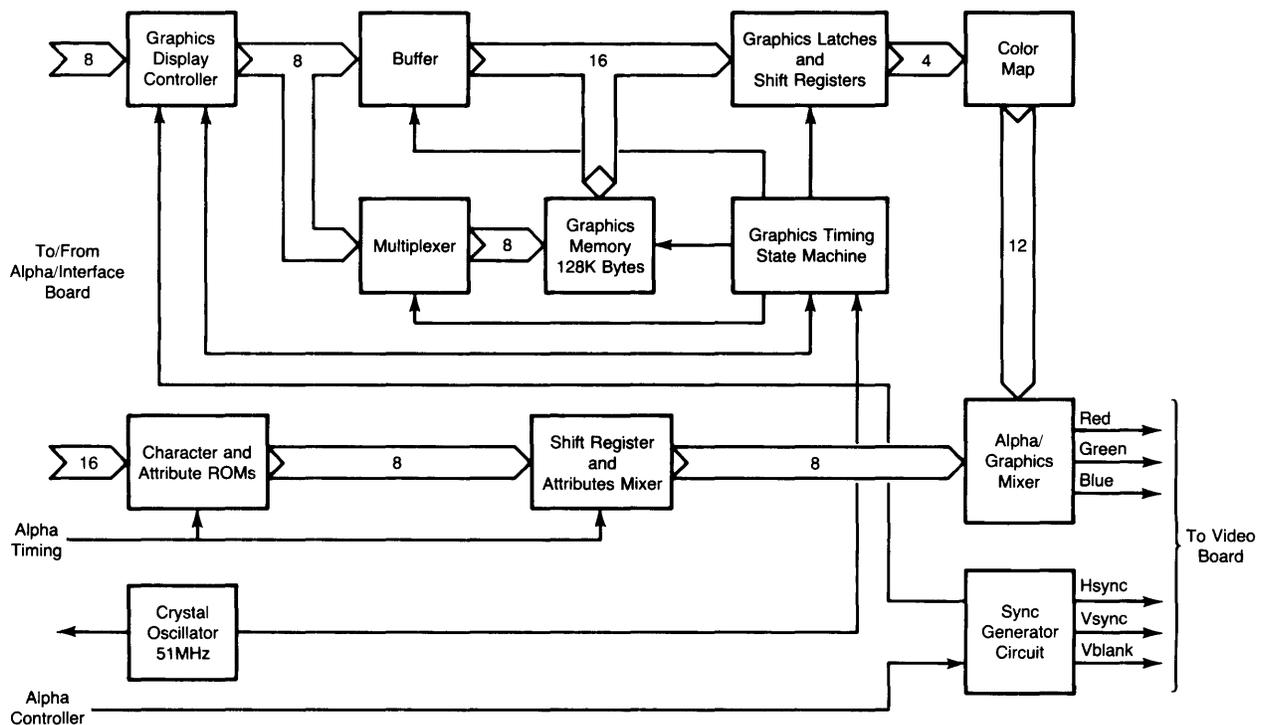


Figure 2-22. Graphics/Digital Video Board Block Diagram

### **Video Board**

The video board receives red, green, and blue video streams from the graphics/digital video board. It contains three identical video amps which amplify each video stream to the voltage level required to drive a CRT color gun.

Adjustments on the video board include black level and white level for each of the video streams: red, green, and blue.

### **Sweep Board**

The sweep board receives horizontal and vertical sync signals and vertical blanking from the graphics/digital video board, and produces the current required for horizontal and vertical deflection of the electron beam.

The sweep board generates the voltages required by the CRT control grids and for accelerating and focusing the electron beam. A flyback transformer is utilized for this function.

Potentiometers on the sweep board control the focus, intensity, vertical centering and height, and horizontal centering of the CRT display. A coil on the sweep board controls the horizontal width.

### **CRT/Yoke Assembly**

The CRT/yoke assembly displays the video signals. The resulting display is 25 lines by 80 characters per line. The graphics is 512 dots horizontal by 390 dots vertical.

The CRT/yoke assembly has adjusting magnets for pincushioning. They are set at the factory and normally do not need adjusting.

### **Display Power Supply**

The function of the power supply is to change 100-240V ac into filtered, regulated dc levels of +5V, +12V, +75V, and -12V, and to provide overcurrent and overvoltage protection.

The display has an ac fan which runs off the power transformer primary.

The display power supply remains turned off until it senses the +12V supply line in the base. It turns on and remains on until the base +12V supply drops.

## Thermal Printer

The thermal printer is an assembly composed of printhead, motor, switches, chip modules, and four boards. Figure 2-23 is a block diagram of the printer. The boards in the printer are as follows:

- Logic Board
- Motor Drive Board
- Paper Sensor Board
- Printhead Interconnect Board

The printer is a modular assembly that can be removed from the computer by loosening two captive fasteners, disconnecting the safety ground wire, and lifting the printer from the computer. The printer receives power and I/O signals via two 50-pin connectors mounted in the computer base. Two guide pins with these connectors enable alignment of the printer as it is installed in the base. When the printer is mechanically seated in the computer, it is also electrically connected.

Two character sets are available in the printer: 1) Roman Extended, and 2) Katakana. The set is selected by command from the processor as determined by the keyboard language resistors configuration. Refer to Chapter 4 for additional information on keyboard language configurations.

A stream of ASCII bytes enters the printer through the I/O interface. The bytes are then separated into normal ASCII characters which can be buffered or ASCII control codes which must be processed immediately. Normal ASCII characters are entered into an 80-byte print buffer which is printed upon receipt of the 81st byte or upon receipt of an appropriate control code.

The printer responds to a subset of ASCII lower and upper control codes as soon as it receives them. Undefined control codes are ignored and do not contribute to the character count in the internal print buffer.

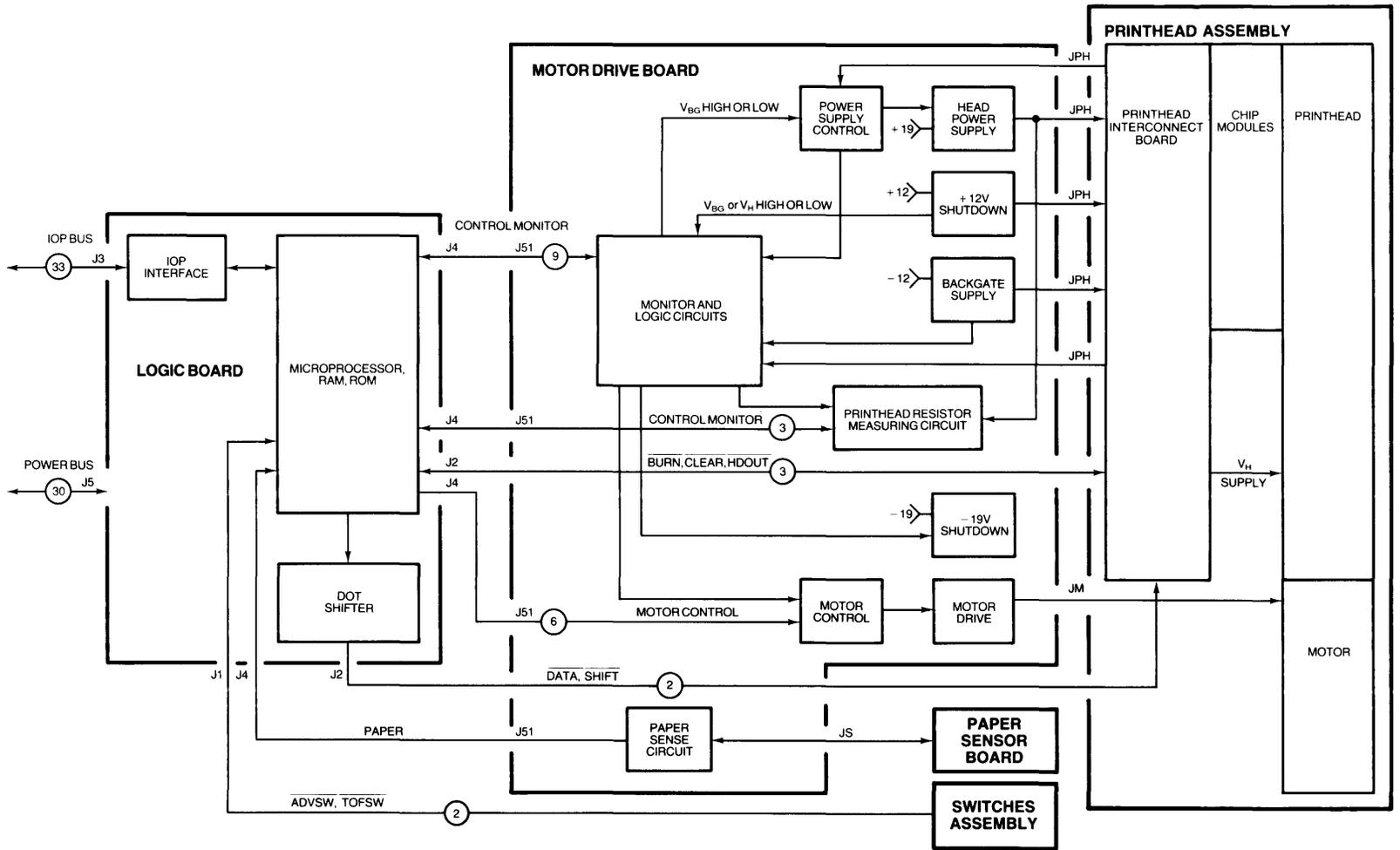
Escape sequences are printer commands that are embedded within the normal print data stream. An escape sequence begins with the Escape character code (code 27) and normally ends with a capital letter. Escape sequences are not unique to the printer, but are used to control a variety of peripheral devices. The escape sequences not applicable to the printer are ignored.

The following paragraphs describe printer components and their main functional blocks as shown in Figure 2-16. Critical signal lines and interfaces are described.

### Logic Board

The logic board is the printer's control board, containing all the critical digital logic. This board contains the IOP interface, the microprocessor, and RAM and ROM. This board controls all printer functions. It is suspended between the side plates of the printer so that when the printer is installed the two 50-pin connectors on the logic board mate with the connectors mounted in the computer base. Connector J3 on the logic board mates with the connector on the IOP cable. Logic board connector J5 mates with the power bus connector mounted in the base.

Figure 2-23. Printer Block Diagram



The IOP cable provides the standard I/O bus and logic ground to the printer. The power bus provides +19, -19, +12, -12, and +6 voltages and dirty ground to the printer. Status (PSTS) and flag (PFLG) signals are also provided via the power bus.

A 50-conductor ribbon cable interconnects the logic board with the motor drive board. This cable interconnects connector J4 on the logic board with J51 on the motor drive board. This cable provides all power voltages to the motor drive board and provides signals to control the motor, control and monitor motor drive board circuits, and perform resistor measurement.

Connector J2 on the logic board is cabled to the printhead interconnect board on the printhead. This cable provides four data and control lines to the printhead and returns printhead data to the logic board for test purposes.

A three-conductor cable interconnects connector J1 on the logic board with the Top of Form and Paper Advance switches. Two are signal lines and one is ground.

### **IOP Interface**

The IOP interface has 33 signal lines that provide all data and control lines between the printer and the IOP. An input data register and an output data register are used for data write and read operations, respectively.

The printer shares select code 6 (SC6) with the keyboard, RTC/NVM, optional input device, and beeper. The printer's bus drivers are enabled when interface registers R0, R1, R2, R4, R5, R6, and R7 are accessed. R1 is shared, with the printer driving only the upper 4 bits of R1.

Writes to R0, R2, R4, R5, R6, and R7 clock data from the IOP into the data register. Interface commands are specified by writes to R5. The command is written to R5, and command parameters are written to R7.

The IOP reads printer status by a read of R0, R2, R4, R5, R6, or R7. The printer responds by presenting the status byte to the interface.

### **Microprocessor, RAM, and ROM**

The microprocessor has 64 bytes of internal RAM, but no internal ROM.

An 8K external ROM has 4K bytes reserved for microprocessor firmware and 4K for characters. The 4K bytes of character fonts are composed of 512 characters of 8 bytes each. Two character sets are contained in every printer ROM: Roman Extended and Katakana. Each set has 256 characters. The character set is selected by processor command as determined by the keyboard language configuration.

Characters to be printed are buffered in a 256-byte RAM. The printer prints 80 characters at a time. Therefore, this buffer has 160 bytes reserved for print characters, 80 for the characters themselves and 80 for control codes. An additional 91 bytes enables the user to redefine up to 7 characters (12 bytes of font information plus one control byte per character) for printing of special, user-defined characters.

### **Dot Shifter**

The dot shifter serially shifts data into the 560-bit shift register in the printhead. This process, and the two signals the dot shifter uses, NDATA and NSHIFT, are described in the printhead description which follows.

## Motor Drive Board

The motor drive board performs several functions. It supplies power to the printhead, drives the printer motor, measures printhead resistor values, and monitors paper status.

The motor drive board interconnects with the logic board via a 50-pin ribbon cable. The cable interconnects J51 on the motor drive board with J4 on the logic board.

The printhead power cable is a 15-conductor cable that goes from connector JPH on the motor drive board to the printhead interconnect board in the printhead.

Connector JM provides the 6-conductor motor drive cable to the printer motor.

The paper sensor cable from the paper sensor board has four conductors and connects at JS on the motor drive board.

### Head Power Supply and Control

The head power supply supplies the printhead with +10 volts. This voltage is applied to the print resistors to enable dot burning on the paper. This circuitry derives +10 volts from the +19 volts provided to it.

### Backgate Supply

The backgate supply reduces -12 volts to -3 volts. It then provides the -3 volts to the substrates of the NMOS driver chips.

### +12V Shutdown

This circuitry shuts down the power to the printhead drivers if the head voltage or backgate supply voltage goes out of specification. This averts damage to the printhead circuitry. When the printer goes into idle state, this circuitry is also enabled. The idle state also reduces the motor current to one-third of normal power, and shuts off the current to the paper sensor LED.

### Motor Drive, Control, and Shutdown

This circuitry provides voltage and control signals to the printer stepper motor. Five control signals from the microprocessor on the logic board feed the motor control circuitry. Three signals select one of eight current drive levels to be applied to one of the four sets of motor windings chosen by the other two signals. By applying these signals in the proper sequence with proper timing the microprocessor accelerates, moves, and decelerates the motor.

When the printer is in the idle state, a signal is asserted which causes the motor to draw minimal current.

### Paper Sense Circuit

This circuit provides a signal to the microprocessor on the logic board which indicates the presence or absence of paper as detected by the paper sensor board. The paper sensor board is described in a following section.

### Printhead Resistor Measuring Circuit

The printhead resistor measuring circuit operates during power-up self-test. Each of the 560 printhead resistors which is in range is measured for resistance value. This information is provided to the microprocessor on the logic board which computes the average resistance and uses the result to determine the burn time and the number of dots per burn.

The logic board sends an initiating signal, RTEST, and controls the test through RAMPDN, SIGN, and VCLO.

### **Monitor and Logic Circuits**

These circuits control and monitor several functions. Lines between this circuitry and the logic board enable the microprocessor to monitor head voltage, backgate voltage and current, head temperature, and head supply power transistor temperature. The logic board provides the go-down signal (GODOWN), used to shut down the printhead power supplies on the motor drive board.

If the backgate voltage or the head voltage is out of specification (too high or too low), this circuitry shuts down the power to the head.

### **Paper Sensor Board**

The paper sensor board is mounted on the printer to detect the presence or absence of paper. A cable from the paper sensor board connects to JS on the motor drive board. The board has an LED and a photo-conducting transistor. When paper is present and interrupts the light flow from the LED, the transistor does not conduct, and the resulting signal from the motor drive board to the logic board indicates paper present. The absence of paper causes the transistor to conduct and results in a signal indicating that no paper is in the printer or that the hole in the paper is over the sensor. This provides for registration of paper in the printer and for form feed capability.

### **Printhead Interconnect Board**

The printhead interconnect board is an integral part of the printhead assembly. The board is cabled to both the logic board and the motor drive board. A single 22-pin connector provides these connections. A 16-pin section of the connector is cabled to motor drive board connector JPH, providing power to the printhead. A 6-pin section is cabled to logic board connector J2, routing data and control signals to the printhead.

Power is supplied by the printhead interconnect board to the head substrate on the printhead by a head voltage supply cable. Elastomeric connectors transmit data and control from the printhead interconnect board to the chip modules where the signals are translated and provided to the head substrate via elastomeric connectors for dot burning.

### **Printer Operation**

Integrated circuits on the chip modules contain a 560-bit shift register, 560 latches, and 560 output drivers (dot drivers). The printhead contains 560 resistors that, when heated, darken the thermal-sensitive paper. The output drivers are open-drain field effect transistors (FETs). The resistors are tied high to the head voltage from the motor drive board. Each resistor, nominally 100 ohms, is connected to a FET output driver.

Four lines from the logic board control the transfer of data to the printhead: NCLEAR, NDATA, NSHIFT, and NBURN. NCLEAR clears the shift register. NSHIFT shifts data (NDATA) one bit at a time into the shift register. NBURN turns on the FETs (output or dot drivers) for the selected data bits, causing the appropriate resistors to print in the 560-bit row. Another line, head data out (NHDOOUT), returns the serial data from the printhead to the logic board for test purposes.

The printer operates in either character mode or graphics mode. Character fonts are 7 bits wide by 12 bits high. Because the printhead is 560 bits wide, up to 80 characters are printed across the width of the head. Graphics data is printed in 8-bit groups, so up to 70 groups are printed at a time.

In character mode, character codes from the IOP are loaded into the RAM buffer on the logic board. When the 81st character is input, or when a Carriage Return, Line Feed, or Backspace occurs, the buffer is dumped. Each character code is examined in turn, and the character ROM is accessed to determine the 7-bit pattern for the particular row being printed. If 80 characters are being printed, the ROM is accessed 80 times for each row. The 560 bits are serially shifted into the printhead and printed. Not all dots may be burned in one pass. Two or more passes may be required, depending on the number of dots to be burned and the average resistance value. Then, the next row is constructed for the same 80 characters. The process continues until all rows of all 80 characters have been printed. More character codes from the IOP are then loaded into the RAM buffer, and the process continues.

## Mass Storage

Two 5-1/4-inch mass storage devices can be used with the computer. One is a flexible disc drive and the other a fixed disc drive. The drives and their disc capacities are as follows:

- 9130K Flexible Disc Drive      264K bytes
- Winchester Fixed Disc Drive      10M bytes

The 9130K Flexible Disc Drive must be installed in the upper physical space to the right of the printer. The Winchester Fixed Disc Drive must be installed in the lower space.

Additional service information for the 9130K can be found in the HP 9130K Flexible Disc Drive Service Manual, Part No. 09130-90030.

The I/O backplane has three mass storage controller slots located below the four I/O slots (Figure 2-1). These slots contain the appropriate controller cards for the selected mass storage configuration. Only two of these slots have connectors.

The 9130K Flexible Disc Drive controller card plugs into 70-pin connector P10 on the I/O backplane. A 34-conductor ribbon cable connected to the outside edge of the controller card provides drive signals to the flexible disc drive.

The Winchester Fixed Disc Drive controller assembly consists of a card (Winchester I/O card) and a board (Winchester disc controller) physically interconnected in piggyback fashion. The card plugs into I/O backplane connector P11. The attached board occupies the bottom slot space without being plugged in. The card and board are functionally interconnected by a 50-conductor ribbon cable and a two-wire power cable. Two connectors on the left edge of the board are interconnected by ribbon cables to connectors at the front edge of the card. Ribbon cables are routed from the card connectors to the Winchester Fixed Disc Drive. One is a 20-conductor data cable, and the other a 34-conductor control cable.

The Winchester disc controller contains bootstrap loader circuitry. This is the same circuitry as on the bootstrap loader card which is used if there is no Winchester disc drive. The circuitry is described under Bootstrap Loader Card in the I/O Backplane section which follows in this chapter.

The flexible disc controller card shares select code 7 with either the fixed disc controller assembly or bootstrap loader card. Circuitry on the fixed disc controller assembly or bootstrap loader card switches between the assembly or card and the flexible disc controller card. Only one of the select code 7 assembly/cards is activated at one time. The IOP controls the select code sharing logic by setting or clearing bit 8 in register 8. A dedicated backplane signal indicates whether or not the flexible disc controller card is activated.

Motherboard connectors J53 and J54 provide power and ground signals to the flexible disc drive and/or fixed disc drive.

An "N" preceding a signal name in the following text corresponds to an overbar in the diagram; both indicate a negative true condition.

### 9130K Flexible Disc Drive Controller Card

Figure 2-24 is a block diagram of the 9130K Flexible Disc Drive controller card. All IOP signals are on the left side of the diagram, and all disc signals are on the right side.

The PA and Register Decode circuitry inputs the NPA (peripheral address), NIC (register select), and READ lines to enable the appropriate register on the controller when the correct select code (PA state) is applied.

The Buffers, Latches, and ID Response circuitry is the electrical interface for the 16 data lines to and from the IOP. One of 16 input/output registers can be selected by the four NIC lines; however, only three registers are implemented – R0, R1, and R3.

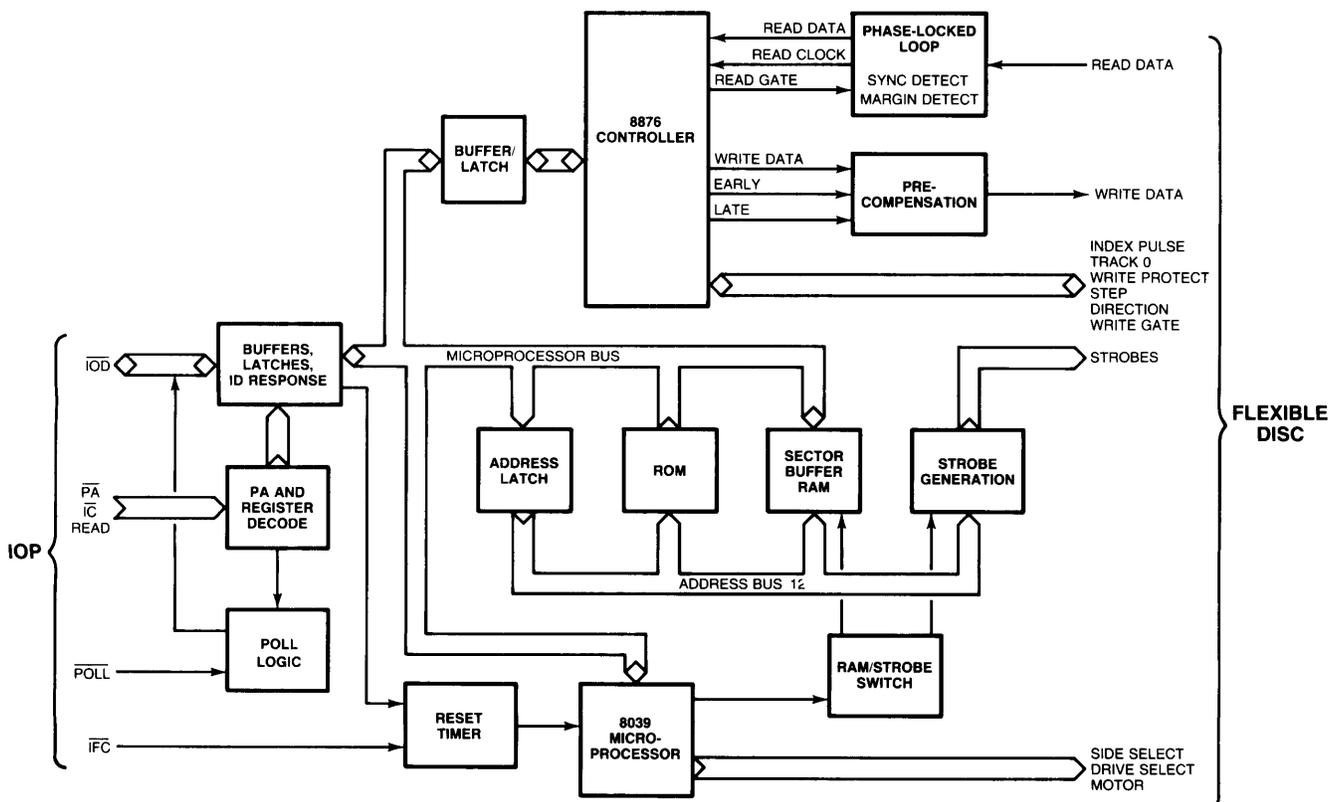


Figure 2-24. Flexible Disc Drive Controller Card Block Diagram

The Poll Logic indicates when the controller is ready with or for data. It responds on the NIOD line corresponding to its select code when prompted by the NPOLL line. Synchronization logic assures that this response does not begin during a poll cycle.

The Reset Timer is a shift register which functions as a digital one-shot to reset the microprocessor and then all resettable devices. Reset is initiated by either the NIFC (interface clear) line or by the setting of NIOD bit 5 of output register R1.

Residing on the 8-bit microprocessor bus are the 8039 microprocessor, I/O registers, the 8876 controller via buffers, the ROM containing microprocessor instructions, and RAM to hold one sector's worth of data. When data is written to the disc, it is moved from the IOP to the output register latch from where the microprocessor reads it and places it in the sector buffer RAM. After the sector buffer is filled, the microprocessor reads the data from the RAM and sends it to the 8876 where it is serialized and sent to the disc. Data is read from the disc by reversing the process.

All elements on the microprocessor bus communicate with the move-external instruction of the processor. Strobe lines go to all of the elements on the bus except the RAM and selectively enable these elements at the appropriate time. Other strobes clock or clear various flip-flops. When the processor accesses RAM, strobe generation is disabled and RAM is selected via the RAM/Strobe Switch circuitry. Then the same move-external instruction accesses any of the 256 bytes of RAM.

The 8876 controller chip controls all of the serialization/de-serialization and ID field verification on the disc. The Pre-Compensation circuitry inputs the serial write data produced by the 8876 and pre-distorts it to correct for shifts in the apparent position of pulses on the disc.

The Phase-Locked Loop (PLL) reconstructs a clock from the encoded pulses coming from the disc. This reconstructed read clock and the original data pulses are sent to the 8876. The sync detect circuitry switches the PLL from its free-running, nominal condition to tracking mode when a sync field in the data pulses is detected. Margin detect circuitry detects when read pulses are out of their nominal position during disc formatting.

## **Winchester Fixed Disc Drive I/O Card**

Figure 2-25 is a block diagram of the Winchester Fixed Disc Drive I/O Card. All IOP signals are on the left side of the diagram, and all Winchester disc controller signals are on the right side.

The functions of the I/O card are 1) to interface to the IOP, decoding and interpreting commands; and 2) to interface to the Winchester disc controller, buffering data to and from the controller. A 50-pin ribbon cable interconnects the I/O card and the disc controller.

IOP interface lines NIOD0 through NIOD7 are buffered. NSTS, NFLG, and NBR are also driven with buffers. The direction and enable lines are READ (direction) and MYPA (enable). MYPA is generated by the ANDing of PA2, PA1, PA0, NPOLL, NIC4, and DEV1. The Winchester interface is assigned to select code 7. NPOLL disables MYPA if a poll is occurring. NIC4 prohibits the generation of MYPA during a select code change. DEV1 ensures that device #1 (Winchester) is selected as required due to select code sharing.

An interface clear signal (IFC) from the IOP resets all logic on the interface including the microprocessor. IFC also resets the select code sharing hardware, indicating that device #1 is enabled to use select code 7.

The I/O card has a 16-deep FIFO (first-in, first-out) buffer in order to enable byte-burst DMA. In the DMA-out direction, the IOP byte-bursts data into the FIFO. The FIFO is then conditioned so that the microprocessor or disc controller can read the data out of it. When the FIFO is empty, it is again conditioned so the IOP can refill it. For a DMA-in operation, the microprocessor or disc controller fills the FIFO. The FIFO is then conditioned so the data can be byte-burst into the IOP.

The FIFO manager consists of a 16-bit bi-directional shift register which monitors the contents of the FIFO during a burst transfer. This enables the logic to deassert burst request (BR) at the right time and avoid data overrun or underrun.

The message register enables the IOP to inform the disc controller of the type of transaction to be performed. The control register allows the microprocessor to control the IOP interface logic and the FIFO manager.

The 8039 microprocessor operates at 10 MHz, has 128 bytes of internal RAM, and supports up to 4K bytes in an 8K-byte external program ROM. The microprocessor 1) performs a self test of the interface after a reset, 2) performs the boot load function for the computer (including ID ROM operation for protection of software rights), 3) sends command/data information to/from the disc controller per the commands from the IOP, 4) enables/disables the DMA control logic that permits data to be DMA'ed directly between the disc controller and the FIFO, and 5) controls the FIFO manager via the control register/message register.

The interface between the FIFO/microprocessor and the disc controller consists of several latches, buffers, and handshake logic.

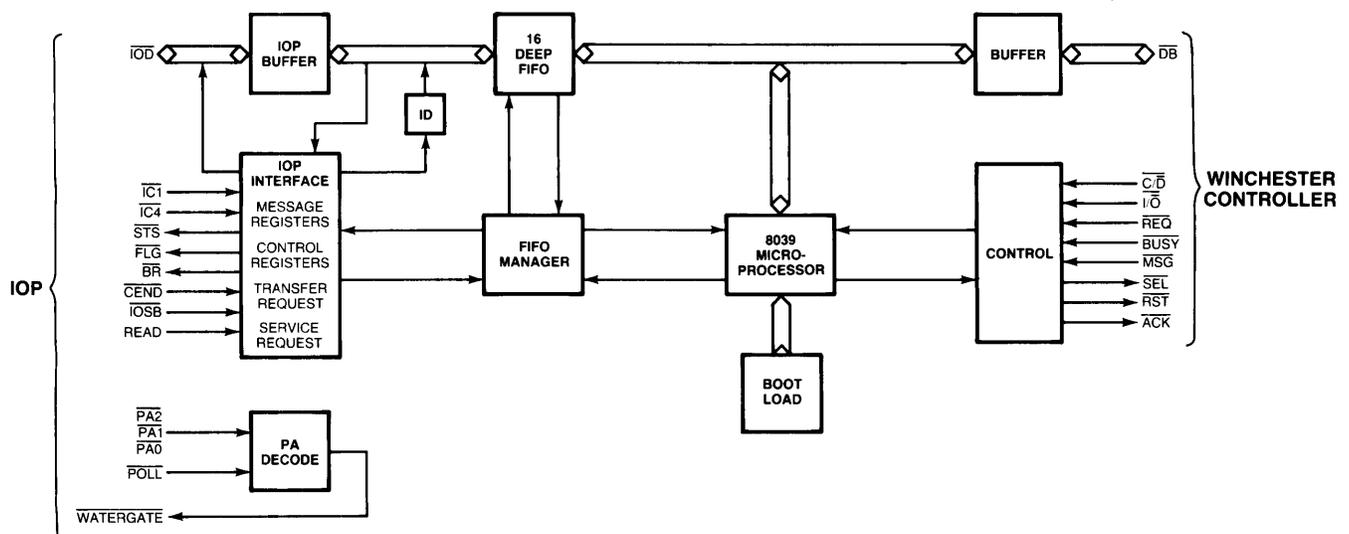


Figure 2-25. Winchester Fixed Disc Drive I/O Card Block Diagram

## Motherboard

The motherboard is positioned in the base of the computer. The motherboard has six layers, with one layer used for the ground plane. Although the motherboard has no active components, it is the primary element of the power and IOP bus distribution network.

The motherboard has 14 shrouded pin headers. Modules and cables that plug into the motherboard have receptacle headers.

### Power Supply

The power supply plugs directly into the motherboard. The motherboard interconnects the power supply boards, distributes power and voltage sense lines from the supply, and provides logic and sequencing signals to the supply.

The power supply interconnects with the motherboard via six motherboard connectors. Each of the three power supply boards plugs into two motherboard connectors. The boards and the associated motherboard connectors are as follows:

Primary Board:	J42 (12-pin) J43 (70-pin)
Secondary Board:	J46 (36-pin) J47 (50-pin)
Supervisor Board:	J44 (24-pin) J45 (50-pin)

### Processor Stack

The processor stack plugs directly into the motherboard via two 25-pin motherboard connectors, J48 and J49. The motherboard distributes power and power-up sequencing signals to the stack.

### Fans

A 7-pin motherboard connector, J52, distributes power and ground signals to the three cooling fans.

### Mass Storage

The motherboard has two 8-pin connectors, J53 and J54, to send power and ground signals to the flexible disc drive and/or fixed disc drive.

### I/O Backplane

The I/O backplane plugs directly into the motherboard connector J40. This 96-pin connector ties the IOP bus signals and power and ground signals to the backplane for distribution to various modules.

## Printer and Keyboard

The motherboard distributes power to the printer and the keyboard. A ribbon cable from 50-pin connector J51 on the motherboard has two parallel connectors mounted on the computer base. The printer plugs into and obtains its power from one connector, and the keyboard from the other.

The ribbon cable from the IOP card in the stack connects to the motherboard via 50-pin connector J50. Another ribbon cable from this connector has two parallel connectors mounted in the base. The printer plugs into one for its IOP bus, and the keyboard plugs into the other.

The I/O bus signals from connector J50 are provided via traces to J40 for presentation to the I/O backplane as described above.

## I/O Backplane

The I/O backplane plugs directly into the motherboard and has 14 connectors. It has several functions as follows:

- Provides power and signal connections from the motherboard to the:
  - a. Display
  - b. I/O cards
  - c. Mass storage controller cards
  - d. Bootstrap loader card
  - e. Other connections reserved for future use
- Translates between the IOP and I/O cards
- Provides a connection for the I/O door interlock switch

The backplane plugs into the motherboard via 96-pin receptacle header J12. Most of the motherboard signals are routed to the display, the four I/O slots, and the two mass storage slots.

## Display

Backplane connectors P1 and P2 provide power and I/O signals, respectively, to the display. All signals come from the motherboard connector. P1 and P2 are both 50-pin ribbon headers.

## I/O Bus

Four 80-pin headers, P3 through P6, provide interconnection for up to four I/O cards and/or device adapters. The backplane terminates some signal lines with resistor networks. Other signals are derived on the backplane with resistors and chips. A 14.7456 MHz clock signal is produced on the backplane.

Several types of I/O cards can be used in the computer. Refer to the documentation provided with the card/adaptor for more information.

## Mass Storage Bus

Two 70-pin header connectors, P10 and P11, provide the mass storage bus to the controller card(s). The bootstrap loader card plugs into P11 if there is no Winchester Fixed Disc Drive in the computer.

## Bootstrap Loader Card

The bootstrap loader card plugs into 70-pin connector P11 on the I/O backplane and shares select code 7 with the 9130K Flexible Disc Drive controller card. The bootstrap loader card is designated Unit 1, and the controller card is designated Unit 0.

The bootstrap loader card contains up to 8K bytes of ROM which holds loader code and machine ID information for protection of software rights. The card provides a boot loader when there is no Winchester fixed disc drive in the computer. If the Winchester is present, the boot loader circuitry is located on the Winchester disc controller.

Figure 2-26 is the bootstrap loader card block diagram. The card has three main functional blocks: 1) 8K bytes of loader ROM, 2) a 16-bit counter for addressing, and 3) system control logic. The loader ROM is configured for byte addressing only. The 16-bit counter consists of two dual 4-bit counters which address the ROM directly. The counter is automatically incremented after reading a byte of data from the ROM. The counter is reset to address 0 with the IFC signal or by reading FR3, the ID register. The control logic determines which data to place on the I/O lines, which direction the data flows, and the proper clock signals for latching data.

## Boot Loader ROM

If the Processor Stack contains 1 Megabyte RAM boards, Boot Loader ROM Rev. B (09020-80001) must be used, and UNIX 4.0 or basic 2.0 software must be used.

Boot Loader ROM 09020-80000 can be used with UNIX 4.0 or Basic 2.0 (or any previous software versions) as long as the stack **DOES NOT** contain a 1 Megabyte RAM board.

Boot Loader ROM Rev. B (09020-80001) can be used with any RAM configuration but **MUST** use UNIX 4.0 or Basic 2.0 software. (Any earlier versions of software cannot be used with this boot loader.)

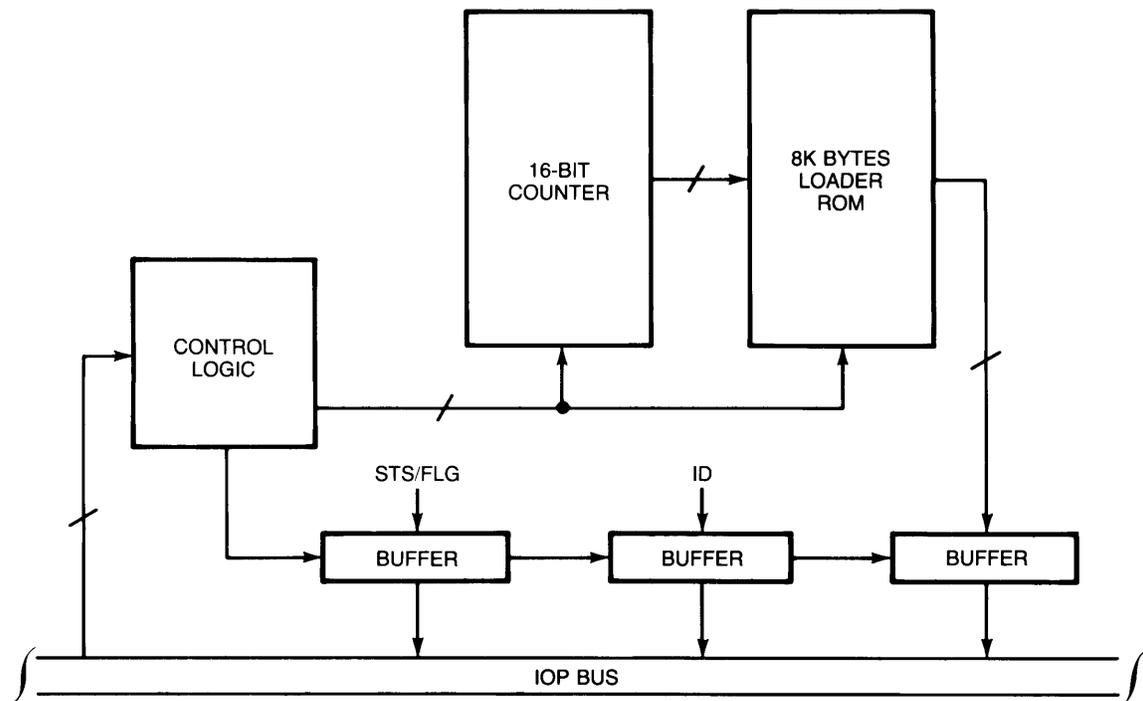


Figure 2-26. Bootstrap Loader Card Block Diagram

### Reserved Bus

Connectors P7 through P9 are 60-pin headers which provide three plug-in slots. Power and signal lines are provided at the connectors. P13 is a 50-pin ribbon cable connector. All four connectors are reserved for future use.

### I/O Door Interlock

A switch mounted on an I/O card guide is connected by a cable to P14, a 2-pin plug on the I/O backplane. When the I/O door is opened, a signal is sent through P14 to the motherboard. The motherboard passes the signal to the power supply which then shuts down power to the computer.



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# Testing and Troubleshooting

**Chapter****3**

## Introduction

This chapter contains information to help you test the computer and diagnose failures. The information includes descriptions of the types of failures that occur and the indications that result. The replaceable module self-tests, self-test supervisory code, and system functional tests are also described in this chapter.

This chapter first describes the computer troubleshooting and repair strategy. Initial problem isolation procedures are provided next. Then, descriptions of the three levels of diagnostics are followed by 98760A color alignment procedures and early warning/fault tolerance features.

## Troubleshooting and Repair Strategy

To troubleshoot a failing computer, first make sure you understand the power-up sequence (Figure 3-1). Then perform the initial problem isolation procedures provided below. These procedures determine whether the computer is operational enough to run diagnostics. If the initial isolation procedures indicate that the computer can run diagnostics, continue troubleshooting by performing the module self-tests and system functional tests as described in Appendix B.

The troubleshooting procedures and diagnostics are designed to enable fast fault isolation to a replaceable module. Almost every replaceable module in the computer can be replaced within 15 minutes from fully assembled machine, through disassembly and replacement, back to fully assembled machine. Exceptions are the motherboard and I/O backplane, which may take longer to replace.

## HP-CIO Troubleshooting

The HP-CIO Technical Reference Binder (HP 27132A) provides detailed information for the HP-CIO Interface Card product line. This package is not required for the installation of the HP-CIO interface cards because a brief manual provided with each card serves this purpose. However, the 27132A does provide a greater level of information on sophisticated control, diagnosis or modification of the cards.

### 3-2 Testing and Troubleshooting

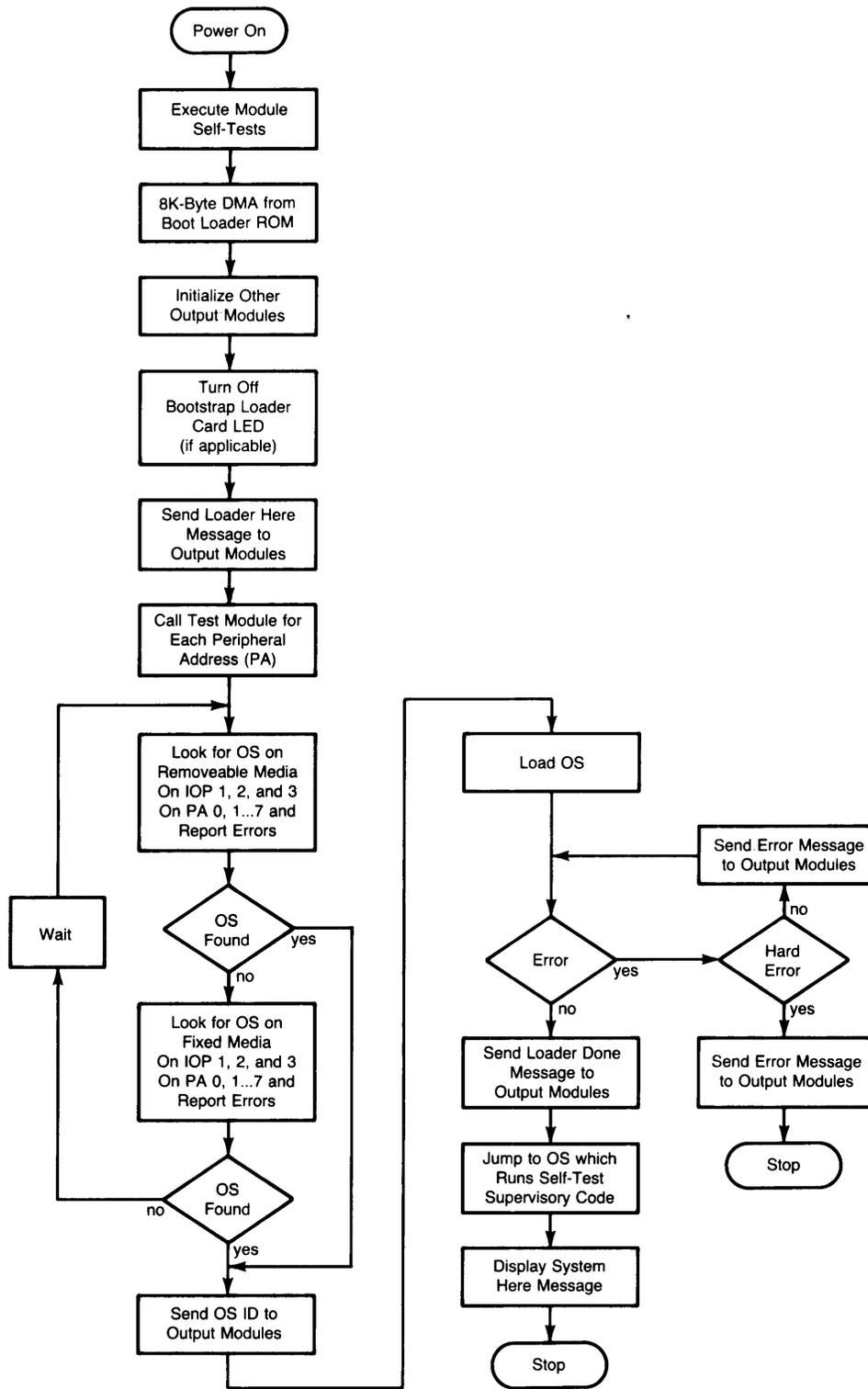


Figure 3-1. Power-up Sequence

## Features

Typical sections of the 27132A:

- General information (description, identification, specifications, supported functions)
- Configuration and Start Up
- Principles of Operation
- Programming
- Maintenance
- Replacement Parts
- Schematic Diagrams

## Repair

Chapter 4 contains the procedures to access and replace failed modules in the computer. All replaceable parts are listed in Chapter 5, where parts-ordering information is also included.

## Problem Isolation

1. Turn the computer on and check at the rear of the computer for fans running. If one or more of the fans are running, observe the module self-test indicators and run the module self-tests and system functional tests as described in Appendix B. If none of the fans are running, continue with step 2.
2. Look directly through the center exhaust fan at the rear of the computer. Two LEDs, one yellow and the other one green, should be lit. If only the green LED is lit, continue with steps 3 and 4. If neither LED is lit, continue with steps 5 and 6.
3. Remove the front cover and observe the **DOORS OPEN**, **STACK TEMP**, and **SEC BOARD** LEDs.
  - a. If **DOORS OPEN** is lit, close processor stack door and/or I/O door, and cycle power.
  - b. **STACK TEMP** lit indicates overtemperature in processor stack. Allow computer to cool, check for obstructions to airflow in front and back, and cycle power. Check processor stack fan.
  - c. **SEC BOARD** lit indicates power supply assembly overtemperature; failure of the +12MM mass storage supply; or a defective, shorted, or grounded load. Allow computer to cool, check for airflow obstructions, cycle power, and check power supply fan. If **SEC BOARD** remains lit and overtemperature condition is unlikely, check the +12V power supply and its load.
4. Observe the other power supply LEDs. One or more lit indicates a defective supply or defective, shorted, or grounded load.
5. Check ac components for proper operation. Components include power cord, line filter, on/off power switch/circuit breaker, and wiring harness. Check power and ground connections between ac module and power supply.
6. Check the input line voltage and frequency and ensure they are within the following ranges:
  - 110V: 90-132 Vac
  - 220V: 198-250 Vac
  - FREQUENCY: 48-66 Hz

## Self-Tests and Diagnostics Overview

Three overlapping levels of diagnostics provide the primary service support tool for the computer. These are the module self-tests, the self-test supervisory code (STSC), and the system functional tests. The module self-tests and STSC are executed at powerup. The system functional tests are contained on the System Functional Test Discs which can be loaded by the customer engineer. Procedures for running module self-tests and STSC are contained in Appendix B. Procedures for running the System Functional Test are contained in the System Functional Test User's manual.

A power-up condition or a SCRATCH ALL or LOAD BIN causes the power supply to generate a signal to the processor stack that puts the stack in self-test mode. When stack self-test is completed, the stack signals all internal modules on the I/O interface to begin their self-tests. The STSC begins executing its tests when the module self-tests are completed.

### Module Self-Tests

The first level of diagnostics consists of the module self-tests. Self-tests are contained in the replaceable modules and are initiated on powerup. (The BASIC language system SCRATCH ALL or LOAD BIN command causes the execution of all module self tests, except the processor stack tests. No equivalent HP-UX commands exist.) The user can initiate execution of some self-tests on an individual basis. In most cases, LEDs on the modules indicate the results. On some modules, more information is available via a self-test status register which is accessible via the operating system.

Module self-tests provide low level diagnostics which can diagnose a problem to the replaceable module level even if the CPU or IOP bus has also failed. Each module's self-test is independent of the functionality of other modules.

### Self-Test Supervisory Code

The STSC is resident in the operating system. The device driver calls the STSC for each module, and the STSC reports the status of the module. The STSC resides in the device driver itself in some cases, verifying the integrity of the interface and passing the test results to the operating system.

The STSC verifies the I/O interconnection between the IOP and the internal I/O devices, reads the self-test status registers of those modules, and reports any errors to the user. The code enhances the module self-tests by further module testing.

Several output devices indicate successful completion of the tests. Thus, the failure of a single output device can be distinguished from the failure of another device's self-test.

### System Functional Tests

System Functional tests are compiled programs that run on the BASIC 2.0 operating system. (The tests can also run on a special test operating system that is on the discs with the tests. This is for HP use only). The programs are capable of testing all internal computer hardware and I/O cards to at least a 95% confidence level. The information returned is detailed enough to enable isolation to a field-replaceable module. The programs reside on flexible discs, and the procedures are in the System Functional Test User's manual.

## Module Self-Tests

The following paragraphs describe the module self-tests and how they are called.

### Power Supply

The power supply contains overvoltage and undervoltage protection circuitry for all voltages. In addition, a peak power detecting circuit shuts down the supply if any voltage or combination of voltages violates the peak power specification. A power switch/circuit breaker provides primary circuitry fusing.

Two LEDs are visible through the rear of the computer. The green LED is tied to the +16V bias supply and, when lit, indicates that power is applied to the supply and bias voltage is available from the primary board. The yellow LED, when lit, indicates that no voltage failures have been detected and that the supervisor board is enabled and capable of detecting faults and shutting down the power supply.

Other LEDs available to service personnel are on top of the power supply. They are labeled and visible with the front cover removed. Each voltage has a corresponding LED that lights to indicate voltage out of specification. LEDs also indicate the following conditions: overvoltage (**OV**), peak power out of specification (**PWR**), processor stack overtemperature (**STACK TEMP**), processor stack or I/O door open (**DOORS OPEN**), and power supply overtemperature or +12MM mass memory power supply failure (**SEC BOARD**). Each LED is labeled and visible with the front top cover removed. Although the main voltages are shut down in the above situations, a power supply supervisory circuit latches the state of the LEDs and they continue to indicate as long as the line cord is plugged in and the power switch is on.

### Processor Stack

All of the processor stack boards have self-tests which are initiated by a sequence of NSYSPU and NPI triggered by powerup. LEDs visibly indicate the results of the self-tests. The LEDs are visible by removing the left cosmetic door covering the processor stack and looking through the window in the stack door.

The twelve LEDs backlight legends numbered **1** through **12**, from bottom to top. These numbers correspond to the twelve stack slots. Normal operation will be all LEDs on, followed one to two seconds later by all LEDs off. An LED that won't turn on or that turns on and won't turn off indicates a failure in the corresponding board.

Also, the CPU interrogates the self-test results of each board in the stack. The operating system displays a message on the display identifying any board which has failed its self-test. If the display does not work on powerup, the boards should be tested first, and then the other computer modules.

### CPU Finstrate

The CPU finstrate self-test checks internal registers and the memory processor bus (MPB). A passing self-test indicates a confidence in the CPU chip and MPB of greater than 95%. A passing self-test implies that the CPU does not have any detectable hardware failures, the CPU can communicate on the MPB, and all other channels on the MPB have completed successful self-tests. If the last condition is not true, the CPU starts executing the operating system in an attempt to list diagnostic information about the failure to an output device.

## 3-6 Testing and Troubleshooting

The CPU chip contains a revision identifier accessible by the operating system. The revision identifier is the microcode release date. The format is YYYYMMDD where YYYY is the year, MM is the month, and DD is the day.

### **IOP Finstrate**

Each IOP in the stack initiates its self-test. Internal hardware registers are tested for read/write ability, and the MPB interface is tested for the ability to communicate on the MPB. Successful completion of the self-test indicates a greater than 95% confidence in the IOP chip, board integrity, and MPB/IOP connection. The self-test does not test the printed circuit IOP buffer card which plugs into the IOP finstrate. This card is tested on powerup by the self-test supervisory code resident in the operating system.

The IOP chip contains a revision identifier accessible by the operating system. The revision identifier is the microcode release date. The format is YYYYMMDD where YYYY is the year, MM is the month, and DD is the day.

### **RAM Boards**

Each memory controller first performs a self-test and then a memory test in parallel with other memory controllers. The self-test checks all of the memory controller circuits, data paths, and operations except the sending of messages on the MPB which is deferred until after the memory test. The memory controller purposely introduces a double-bit failure so the CPU can test the error detection and notification process.

The memory test consists of pattern-testing the memory to distinguish between non-existent memory, good RAM, and RAM with hard failures. If a faulty location is detected, a flag is set to indicate that the 16K-byte memory block in which the failure was detected is suspect. The self-test supervisory code tests these blocks later to determine if the failure is correctable or if the block should remain "mapped out".

The RAM boards provide 256K, 512K, or 1 Megabyte of RAM per board. The boards contain memory chips and a memory controller chip (MC). Double bit error detection and single bit correction require part of the memory chip capacity. There are enough memory chips on the board, so that 256K, 512K, or 1 Megabyte of memory is still available after the double bit and single bit requirements are met.

The MC interfaces the memory processor bus and memory. It also does error detection and correction, memory mapping, and memory healing. At powerup the MC does a self-test. The self-test supervisory code then tests RAM memory by executing writes and reads to each location. The MC does a Hamming code check. If an error occurs, the associated 16K-byte block of memory is mapped out.

If a single-bit error is detected during run time, the MC corrects the bit and sends the corrected word. The MC then performs the memory healing process by copying the corrected word into one of 32 healing locations within the MC. The corrected word is copied into a healing location. On subsequent accesses to the location which had produced the error, the MC reads the healer location instead. There is no degradation in memory access time.

## Printer

The printer self-test is initiated by powerup or by a SCRATCH ALL or LOAD BIN. This test shifts serial data through the shift register on the printhead chip modules and reads the output data, checks the value of each printhead resistor, checksums the program and character ROMs, and tests printer RAM. The printer checks each resistor for the proper resistance range and adjusts the burn time for each head dependent upon an average resistance of that head. If any resistors are out of specification, an error message is issued. Also, the printer logic board monitors the motor drive board, the head voltage, and the temperature of the printhead.

The printhead control lines are constantly monitored to prevent a sticking condition from destroying a printhead. In the case of a failure, the head voltage is shut down and the printer's status register reports the failure to the operating system. An LED on the printer's logic board also lights when a failure occurs. The LED is visible through the air vents under the keyboard.

Pressing the form feed and paper advance switches at the same time produces a printer output. This provides a quick confidence test of the printer, checking for missing dots and overall print quality.

## Keyboard

The keyboard processor turns the **CAPS** LED on and off and turns the **PRINT ALL** LED on at power-up. This test indicates that the processor is capable of executing code. When the BASIC operating system begins to run, it turns the **PRINT ALL** LED off and turns the **CAPS** LED back on. When HP-UX runs, both the **PRINT ALL** and **CAPS** LEDs are off. With an operating system installed, pressing (CAPS) and checking the toggling of the LED verifies keyboard operation. Successful keyboard operation means that the keyboard processor and scanning circuits are working. The self-test supervisory code tests the keyboard I/O later in the power-up sequence.

## Display Interface Module (DIM)

The display interface module (DIM) contains self-testing hardware which either verifies a greater than 95% confidence in the assembly or indicates a fault. The test hardware outputs a test pattern to the display. The test is initiated by pressing the self-test button underneath the display or by program request. The self-test supervisory code, described below, tests the display buffer memory of DIM.

### 98760A Standard Color Graphics Display

The green **SWEEP INDICATOR** LED lights at powerup to indicate that the vertical and horizontal scans are operating correctly. High voltage is enabled by proper scan functioning. The LED remains on as long as there is no scan fault condition. If the LED fails to light at powerup, a faulty scan is indicated.

### 98770A High Performance Color Graphics Display

The display contains its own power supply and can be tested when disconnected from the computer. A self-test connector and switch assembly enable the testing. The DIM must be removed for offline testing of the display. Offline testing is described in the 98770A Service Manual. Further testing must be done by the DIM or by the system integrity tests.

## 98780A Monochromatic Display

This display contains a switch to test internal functions by displaying inverse video blanks which fill the screen. The 98780A Service Manual contains additional information on offline testing of the display. Further testing must be done by the DIM or by the system functional tests.

## 9130K Flexible Disc Drive/Controller Card

A self-test of the drive, drive board, and controller card is initiated on powerup or on SCRATCH ALL or LOAD BIN. ROM, RAM, and the controller card chip registers are tested. If the tests pass, the drive access LED on the front panel lights. This indicates that the first part of the self-test has passed.

The second part of the test requires the installation of an initialized disc. This test reads ID fields from the disc and seeks various tracks on the disc. If the second part of the self-test passes, the controller card LED turns on and off once.

In addition to LED indication of self-test status, detailed information is available to the operating system. The STSC reads the information and displays the results. The STSC also verifies I/O bus integrity from the IOP to the controller card via loopback circuits on the controller board.

The media initialization routine provides another valuable self-test. Both writing and reading are necessary to verify the media. The drive and the controller card are verified by this process.

## Winchester Fixed Disc Drive/Controller Assembly

The controller assembly consists of an I/O card and controller board. The self-test is initiated at powerup or on a SCRATCH ALL or LOAD BIN. The I/O card is tested first. The test begins by verifying the internal operations of the 8039 microprocessor including internal RAM. Then the 8039 timer is tested. If successful, the 8039 then tests the message and control registers followed by the control logic for the FIFO buffers. Data patterns are then written to and read back from the FIFO buffers, ensuring data path integrity. Finally, a checksum is performed on the boot load ROM.

The controller board is then instructed to initiate its own internal diagnostic and RAM sector buffer diagnostic. The controller assembly then waits up to 19 seconds for the fixed disc drive to spin up and indicate "ready" status. The drive is then recalibrated to track 0 and the maintenance information is read from the maintenance track.

If the drive LED fails to go on, the controller assembly failed self-test. If the drive LED goes on, indicating the drive is being accessed, but the controller assembly LED fails to go off, a bad drive is indicated.

## Bootstrap Loader Card

The LED on the card indicates if the data in the loader ROM was correctly loaded to the system RAM. The LED goes on at system reset and goes off when FR1 is written with bit 7 = 0. If the LED goes on and then off, the bootstrap loader code has been properly downloaded to the system RAM.

If the LED fails to go off, the code has failed to load properly. This could also indicate an error in the code which directs the device to be disabled. A data transfer error would not disable the board, and the LED would go off.

## Self-Test Supervisory Code

The STSC verifies the integrity of the internal I/O bus, tests the interfaces on all of the internal modules, retests mapped-out memory blocks that previously failed the memory controller test, and reports the blocks that fail the retest. The STSC functionally tests modules that do not have self-tests and the associated interfaces.

The following paragraphs describe the tests that the STSC initiates in the computer.

### Internal I/O Bus

The internal I/O bus is connected to the first IOP. A ribbon cable carries the I/O signals from the IOP to the computer motherboard. From the motherboard the cable is routed to the printer and then to the keyboard. The motherboard transports the signals to the I/O backplane connector. The I/O backplane has three slots for mass storage controllers and four I/O card slots. A ribbon cable from the DIM connects to the top of the I/O backplane.

I/O bus failures generally fall into one of three major categories:

- One or more of the I/O lines is open. All interfaces beyond the open line(s) respond unpredictably.
- A component failure has occurred on a particular interface or interface control circuit. The particular module responds unpredictably.
- I/O lines are shorted. This failure affects every interface. Each interface must be unplugged in turn until the problem is isolated and the bus functions.

The I/O bus is tested immediately before the initialization of the I/O subsystem. The test determines whether or not the I/O bus is functional. Loopback sequences are initiated to each device before command sequences are initiated. A loopback test writes a data value to a register and then reads the value. More complex tests are initiated after loopback passes.

The I/O bus test progresses from the device which is electrically nearest to the IOP to the device which is the farthest away. The possible locations of an open are narrowed down to somewhere between the last device that passed and the first device which failed.

### Memory

At powerup, any blocks which were “mapped out” by the memory module self-test are re-tested to determine if they can be salvaged. If there are less than 32 single-bit hard errors, the memory healer compensates, and the block is mapped back in. If there are too many errors, the block is left “mapped out” and a message is issued that identifies the block that has failed.

The memory controller breaks up its physical memory space of 256 kilobytes into 16 logical blocks of 16 kilobytes each. Each logical block is operated on as a unit. Individual blocks can be mapped to any part of the logical address space of the MPB, or the blocks can be completely mapped out. Mapping out a block effectively makes it nonexistent by not responding to any logical address.

All memory controllers, in parallel, perform a memory test on the RAM plugged into their cards. Bit patterns are written into all RAM chips including the Hamming bits. The pattern is written into the entire memory, and then the pattern is read block by block. If an error occurs, or if the memory is physically absent, the block is automatically mapped out.

## 3-10 Testing and Troubleshooting

During system initialization all mapped-out blocks of RAM on each memory controller are checked. If a mapped-out block is non-functional, the message `Healer Overflow on MC #N` is displayed.

After system initialization is complete and the computer is in use, additional memory error management is performed. The operating system reports the memory controller number and the RAM location when a double-bit memory error occurs.

### **Printer**

The self-test supervisory code verifies the printer's connection to the I/O bus at powerup. It then reads the self-test status register. The code issues a message to the user if a failure is detected.

### **Keyboard**

The self-test supervisory code tests registers on the keyboard. I/O bus interconnect is tested via a special register on the keyboard. Data is written to and read from this register (loopback). Interface control lines are tested and keyboard self-test results are obtained by writing a command to the keyboard which causes it to report self-test results.

The code issues a message to the user if a failure is detected. System diagnostics perform further tests of the keyboard electronics.

### **Display Interface Module (DIM)**

The STSC tests the DIM interface to the I/O bus and initiates the self-test of the line buffer chip. The code also tests the display buffer memory. The code issues a message to the user if a failure is detected.

### **98760A Display Alpha and Graphics**

The STSC tests the alpha/interface board and the graphics/digital video board. The test initializes the alpha controller and checks status. It performs alpha memory tests with four patterns: all 0's, all 1's, alternating 1's and 0's, and alternating 0's and 1's.

The test checks graphics status and initializes the monitor. It checks the three memory functions: set, clear, and complement. It tests the vector generator in the graphics controller and then writes eight small vectors into each memory plane in each of the three memory functions. The test reads the words and checks them.

The STSC continually checks for timeout errors in both DMA and direct I/O modes. The code issues a message to the user if a failure occurs.

### **9130K Flexible Disc Drive/Controller Card**

The STSC tests the I/O bus and the 9130K controller card interface to the IOP. After verifying bus integrity, the code reads self-test status from the controller card's self-test register. The code issues a message to the user in case of a failure.

### **Winchester Fixed Disc Drive/Controller Assembly**

The STSC tests the I/O bus and the controller assembly interface to the IOP. After verifying bus integrity, the code reads self-test status from the controller assembly's self-test register. The code issues a message to the user in case of a failure.

## **System Functional Tests**

System functional tests are compiled programs that run with a special test operating system. The diagnostics are capable of testing all internal computer hardware and I/O cards to at least a 95% confidence level. The information returned is detailed enough to enable isolation to a field-replaceable module. The diagnostics reside on flexible discs provided with each computer and Tools Product Support Package. Information required to load and run the tests can be found in the System Functional Test User's manual (09020-11031).

## 98760A Display Color Alignment

A critical aspect of 98760A operation is the correct alignment of the brightness levels of the primary colors. Incorrect alignment can lead to a variety of problems including high failure rate, degraded performance, visible retrace lines, display not meeting specifications, lower intensities not visible and customer complaints that two 98760A displays differ in appearance. This section contains information needed to perform the adjustment as well as to determine when it must be done.

### Overview of the Alignment Process

The 98760A has 16 steps of brightness (intensity) for each of the three primary colors, red, green and blue. This makes possible 4096 different hues (16 times 16 times 16), but complicates the adjustment process since it is necessary to adjust the threshold of visibility as well as the brightness of the highest step. Each primary color has one potentiometer (the clamp pot) for the threshold of visibility and one pot (the gain pot) for the highest step (step 15). Note that the highest step equals the threshold plus the gain. In addition, there is one pot for the screen grid.

### When Needed

The intensity alignment must be performed whenever the video board, sweep board or CRT/yoke assembly are replaced. It should be performed even if the display looks acceptable to the eye, since reliability is significantly diminished in an incorrectly aligned display even if the CRT looks acceptable. In addition, the intensity adjustment should be made whenever a given graphics output differs from display to display.

### Required Equipment

The following equipment is required for 98760A color alignment:

- Voltmeter
- PHOTODYNE 19XE Radiometer
- CRT Alignment Tool (PN 8710-1388)
- System Functional Test Discs (PN 09020-10010)

### Test Conditions

The conditions under which the adjustment is made can affect the results. Here is how to optimize conditions for the most accurate results.

#### Light

Direct sun or light from a window can result in erroneous readings. Position the 98760A to face directly away from the nearest windows or cover them with opaque drapes. The CRT bezel decreases sensitivity to ambient light, so it must be installed. The alignment procedure assumes that the bezel is in place.

#### Temperature

The temperature should be maintained at 65 to 75 degrees fahrenheit during the adjustment process, with the unit powered on for at least 10 minutes beforehand. If the unit was brought from a location with a different temperature, it should be powered on for a proportionately longer time. (Storage of the unit at  $-40^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$  is possible without exceeding specifications. Stabilization time should be adjusted accordingly.)

## How It Works

A color CRT tube differs from a monochrome tube in that it has three separate cathodes, one for each primary color. Otherwise, the tubes are similar. The 98760A tube has three screen grids, but they are connected in parallel, with one adjustment affecting all three.

In order to obtain a certain spot size on the CRT face, the lowest cut-off cathode is set to 0V and the screen grid voltage adjusted to achieve cut-off.

Then the cathode bias is used to set the threshold of visibility for the low cut-off gun. The gain pot is then adjusted to obtain the proper step 15 intensity, since step 15 equals threshold plus gain. This procedure is then repeated for the cathode with the middle cut-off and once again for the cathode with the high cut-off.

## The Intensity Adjustment Procedure

Now that you know when to perform the intensity adjustment and how it works, you are ready to start the actual procedure.

Using the System Functional Test discs, first load the test operating system (Test O.S.). Then load the mainframe test disc and select AGRAPHICS, INTERACTIVE. Step through the procedures as directed. The video board contains all clamp pots, gain pots, and test points (Figure 3-2). The sweep board contains the screen grid adjustment (Figure 3-3), as well as several other adjustments.

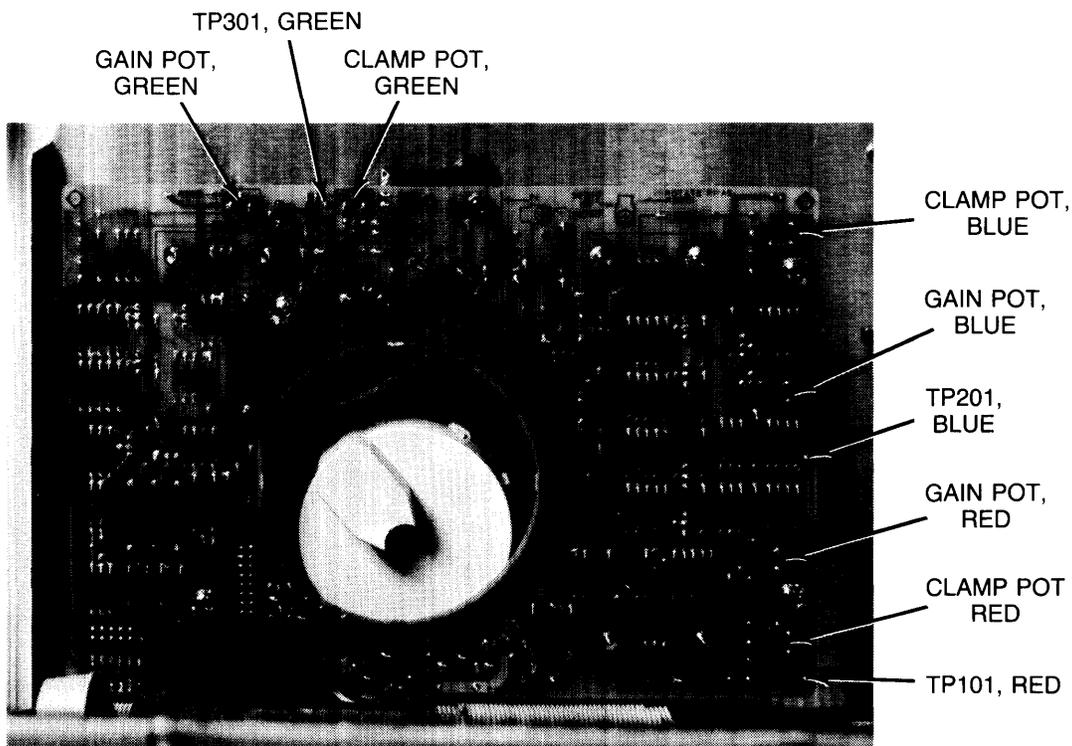


Figure 3-2. Video Board Pots and Test Points

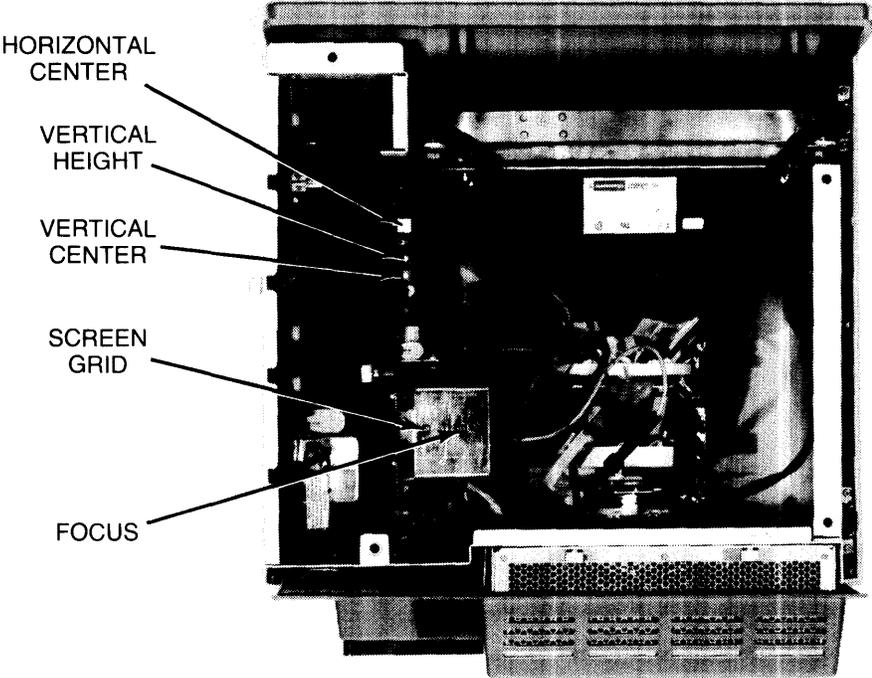


Figure 3-3. Sweep Board Adjustments

## Early Warning/Fault Tolerance

The computer provides early warning of several probable failures. These warnings enable the user to schedule maintenance at his convenience, reducing downtime due to unexpected failure. Early warning of machine failure is provided for overtemperature conditions and memory bit errors.

A battery assembly on the keyboard processor board protects the contents of the real-time clock and non-volatile memory (RTC/NVM). The battery assembly is fault tolerant in that four batteries comprise the assembly but the circuit requires only three batteries to maintain RTC/NVM data.

### Overtemperature

The computer contains three dc box fans. One fan is in the I/O card cage and operates at a single speed whenever power is applied. The other two fans have three speeds and are associated with the power supply and the processor stack.

The power supply and the processor stack CPU contain temperature sensors. The power supply temperature sensor controls the two three-speed fans. When the temperature in the power supply rises above 39°C, the power supply steps both fans from low to medium speed. When the temperature rises above 51°C, the fans are stepped from medium to high speed. When high speed is required for proper cooling, a message is issued to the user, providing notice that shutdown is imminent if temperature increase continues.

If the temperature at the power supply sensor exceeds 97°C or the processor stack CPU sensor senses a temperature greater than 100°C, the power supply shuts down and one of the over-temperature LEDs on the power supply lights (**STACK TEMP** or **SEC BOARD**). These LEDs are visible by removing the front cover.

### Memory Errors

The processor stack memory controller chip detects all single and double-bit RAM failures and corrects single-bit failures. These detection and correction procedures are done at run time.

When a double-bit or greater failure is detected, the CPU is notified and the entire system halts. A message is issued indicating which memory finstrate has failed.

When a single-bit failure is detected, the failure can be corrected and healed by pointing future accesses of that location to a location in the healer RAM of the memory controller chip. Each memory controller has 32 locations reserved for healing of RAM. When all 32 locations have been used, the CPU is notified that the healer is full. The operating system then tests each of the healed locations to determine if that location is still faulty or if a soft error caused the failure. Overflowed healer CAMs can be cleared and reused by the operating system.

## Real-Time Clock/Non-Volatile Memory (RTC/NVM)

The keyboard processor board contains the RTC and NVM chips and the battery assembly to maintain the chips during power-off states.

The RTC and NVM chips store a clock, system configuration data, and service information of significance to users and service personnel. The clock is initially loaded from the IOP and is updated by a crystal oscillator. The RTC chip stores clock and calendar data in 16 four-bit locations; the NVM chip has 2048 eight-bit locations and stores service and configuration data. RTC/NVM locations and contents are as follows:

Byte 0 –	Second
Byte 1 –	Clock Check Byte
Byte 2 –	Minute
Byte 3 –	Stack Size (two times number of boards)
Byte 4 –	Hour
Byte 5 –	Century
Byte 6 –	Day of Week
Byte 7 –	Day of Month
Byte 8 –	Month
Byte 9 –	Year
Bytes 10-13 –	Control Registers
Byte 14 –	Timer Resolution
Byte 15 –	Timeout Scan Resolution
Byte 16 –	Keyboard Initialization Data
Bytes 17-24 –	Default System Startup Subsystem
Bytes 25-44 –	Default Mass Storage Unit Specifier
Byte 45 –	Size of System I/O Buffer
Bytes 46-47 –	NVM Checksum
Bytes 48-53 –	Healer CAM Overflow Counter
Bytes 54-57 –	Last Double Bit Memory Failure Data
Bytes 58-60 –	Number of 10-Minute Periods Computer is On
Byte 61 –	Number of Overheat Cycles
Bytes 62-63 –	Number of Power-On Cycles

The keyboard processor board contains a nickel-cadmium battery assembly consisting of four batteries to maintain the RTC and NVM chips during a power-off condition. Because only three batteries are required, one is redundant. This enables the chips to operate without error if one of the batteries has a short circuit. The battery assembly maintains RTC and NVM data for a minimum of 10 days while power is off.

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# Assembly Access

**Chapter****4**

## Introduction

This chapter describes how to access all the replaceable computer assemblies. The table of contents of this manual lists the replaceable assemblies and the corresponding page numbers in this chapter where the access procedures are located. Read this introduction carefully before performing assembly access.

The procedures help you to disassemble the computer in order to access the assemblies. Reassembly procedures are the reverse of disassembly procedures. Special instructions required for reassembly are clearly noted.

This chapter is organized in several sections, as follows:

- General Safety Procedure
- Electrostatic Discharge
- Case Parts
- Replaceable Assemblies

The Case Parts subsection describes how to remove major case parts to provide access to replaceable assemblies. The Replaceable Assemblies subsection describes how to access and replace assemblies. Each replaceable assembly access procedure references one or more of the case part removal procedures.

The following tools are required to disassemble the computer:

- #1 Pozidriv screwdriver
- #2 Pozidriv screwdriver
- Flat-blade screwdriver
- 5/16-inch wrench
- 7/16-inch nutdriver
- 1/8-inch Allen wrench
- 4-millimetre Allen wrench
- Needlenose pliers
- Keycap puller, HP PN 5040-7433
- Power supply discharge tool, HP PN 09855-67004
- Antistatic kit, HP PN 9300-0794
- Paper Spindle Tool, HP Part Number 09815-20602

---

**WARNING**

UNPLUG COMPUTER POWER CORD FROM AC OUTLET BEFORE REMOVING ANY ASSEMBLY.

LETHAL VOLTAGES ARE PRESENT INSIDE THE COMPUTER. OBSERVE ALL WARNINGS IN THIS MANUAL, AND OBSERVE THE FOLLOWING SAFETY PROCEDURES.

---

## General Safety Procedures

The following simple precautions can save a life.

- Do all possible operations with the computer unplugged from the power source.
- If installation, maintenance, or repair must be done with the computer energized, take the following precautions:
  - a. Never work alone in high-voltage areas. In case of accidental shock, a life may depend on rapid removal from the energized source and appropriate first-aid action.
  - b. Employees working in high-voltage areas should know where to obtain respiratory resuscitation and/or cardiopulmonary resuscitation (CPR), in case a fellow worker needs assistance.
  - c. In case of burns, treat only after the person is breathing and has a normal heartbeat.
- If primary wiring change is made, perform continuity test between power cord ground and metal chassis. Record results on Repair Order.

---

**CAUTION**

THE COMPUTER HAS ASSEMBLIES AND COMPONENTS SENSITIVE TO ELECTROSTATIC DISCHARGE. READ THE FOLLOWING SECTION AND OBSERVE THE PROCEDURES TO AVOID DAMAGE TO THE COMPUTER AND ITS PARTS.

---

## Electrostatic Discharge

Electrostatic discharge (ESD) causes failure in many PC assemblies, other assemblies, and components. Processor stack finstrates are particularly vulnerable to ESD damage. Static electricity doesn't appear to be dangerous because much of the ESD that can cause component or assembly failure is too small to be felt. Humans can sense a minimum ESD of 3500-5000V. However, a discharge of 300V is enough to destroy some components.

Assemblies and equipment containing ESD-sensitive parts are often as sensitive as the most sensitive part they contain. Protective circuitry in these assemblies and equipment provides varying degrees of protection from ESD applied to their terminals. Such assemblies and equipment, however, are still vulnerable to induced ESD caused by strong electrostatic fields or by contact of electrical connections or paths with a charged object.

Static damage is not always catastrophic. Sometimes a part slowly degrades, resulting in deteriorating performance. For example, internal resistance changes cause speed or voltage changes. Results include intermittent or latching problems (for example, a line printer prints bad data).

When disassembling the computer, a portable conductive field service antistatic kit should be used to eliminate ESD when handling or temporarily setting aside ESD-sensitive parts. The kit contains a wrist strap, antistatic mat, and ground cable.

Carefully observe the following procedures when disassembling the computer:

- Components, PC assemblies, finstrates, other assemblies and equipment should always be stored, transported, and shipped in antistatic or conductive containers.
- ESD-sensitive items must never be handled by ungrounded personnel, nor should they ever be stored on nonconductive surfaces or near nonconductive materials.
- Field support should keep all replacement PC assemblies and components in antistatic or conductive bags. The customer engineer should be grounded when working on products. A field service antistatic kit is available; it includes a static-free work station, ground cords, wrist straps, and board storage space. The failed board should be placed in a static-free bag for return to manufacturing site.
- Removal of ESD-sensitive devices from an assembly must be done at a static-safe work station using all precautions. Suspect or rejected components, PC boards, and subassemblies are to be treated with the same care as good devices. Otherwise, further damage may result which prevents tracing the cause of the original failure.

Before removing devices from protective container:

- a. Clear work area of static hazards such as plastic cups, bags, envelopes, and papers.
  - b. Connect wrist strap.
  - c. Neutralize charges of ESD protective packaging containing an ESD-sensitive item and of tools by placing the packaged item on an ESD-grounded work bench surface to remove any charge prior to opening the packaging material. Alternately, charges can be removed by grounded personnel touching the package.
  - d. Ensure that the computer is properly grounded before inserting ESD-sensitive items.
  - e. Remove ESD-sensitive item from ESD protective packaging using finger or metal grasping tool only after grounding, and then place on the ESD-grounded work bench surface.
- Place PC boards, finstrates, and components on table mat when not in static-shielding bags or other protective containers.
  - Clothing must never contact ESD-sensitive parts. Wrist strap does not bleed off charges from clothing.
  - Personnel handling ESD-sensitive items should avoid physical activities which are static producing in the vicinity of those items. Such activities include wiping feet and removing or putting on jackets or sweaters.
  - Where ground straps cannot be used, personnel should ground themselves prior to removing ESD-sensitive items from their protective packaging.
  - Tools and test equipment used in ESD-protective areas should be properly grounded; hand tools should not contain insulation on the handles or, if used, tools with insulated handles should be treated with a topical antistat.

## 4-4 Assembly Access

- Ensure that all containers, tools, test equipment, and fixtures used in ESD-protective areas are grounded before and during use either directly or by contacting with a grounded surface. Grounding of electrical test equipment should be via a grounded plug, not through the conductive surface of the ESD-grounded work station.
- Do not assume that insulators are fully discharged when placed on a conductive work surface. Once the insulator is lifted off the surface, it retains its charge.
- All PC boards and finstrates are to be handled only by grounded personnel. If possible, they should be held only by the ejectors. If necessary, they can be handled by the side edges.

## Case Parts

The following paragraphs describe how to open and remove the side doors and remove the front and rear covers.

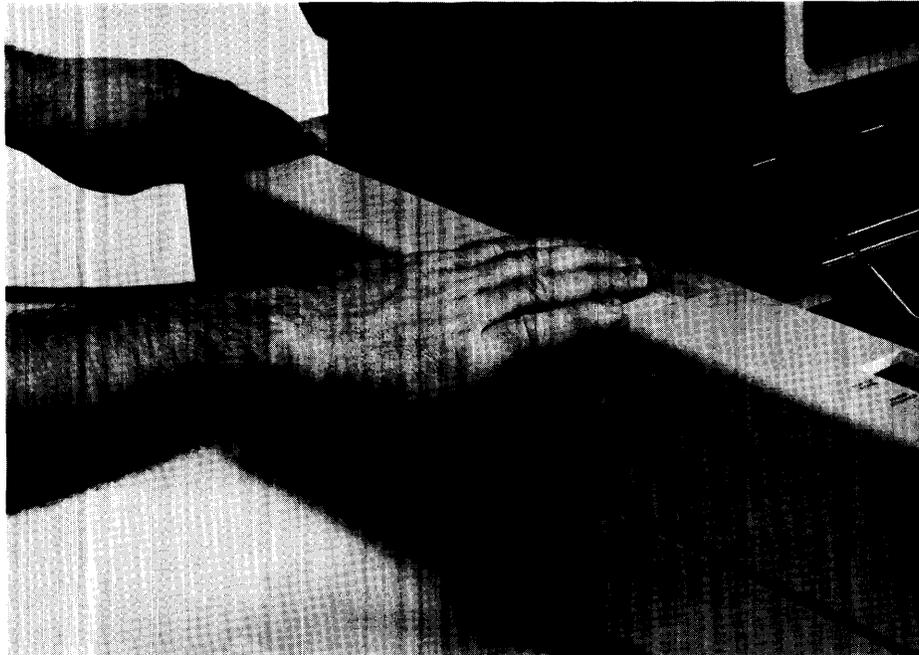
### Side Doors

Identical doors, one on each side of the computer, provide service access to the computer (Figure 4-1). The left side door, as viewed from the front of the computer, provides access to the processor stack. The right side door provides access to the I/O card and mass storage controller card area. Also, opening the doors provides access to attaching screws for front and rear covers.



Figure 4-1. Side Doors

To open a side door, UNPLUG COMPUTER POWER CORD FROM AC OUTLET. Then, grasp door as shown in Figure 4-2 and pull top of door away from the computer. Allow door to rest on its hinges in the open position. Close door by swinging it up and snapping it in place.

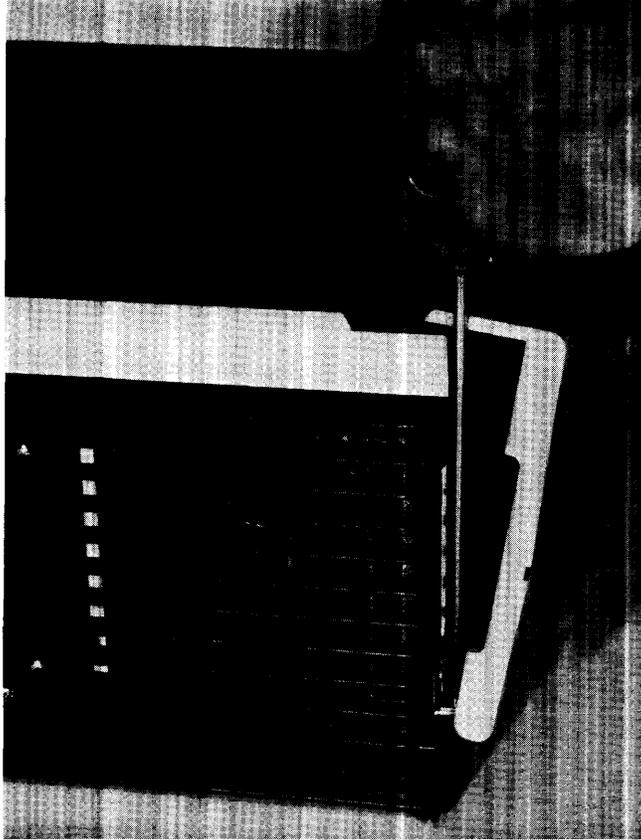


**Figure 4-2. Opening Side Door**

The left door must be removed to gain access to the bottom three processor stack slots. The right side door must be removed so that the mass memory controller cards and I/O backplane can be removed.

## 4-6 Assembly Access

To remove a side door, UNPLUG COMPUTER POWER CORD FROM AC OUTLET, and open door. Then, with flat-blade screwdriver, pry bottom of door away from hinge pins (Figure 4-3).



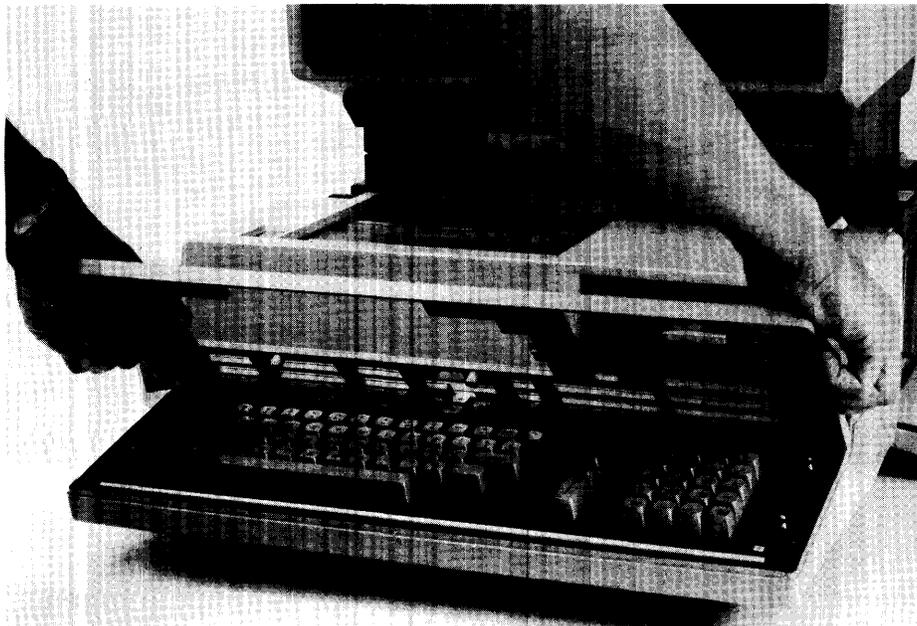
**Figure 4-3. Removing Side Door**

### **Front Cover, including Keyboard Bezel**

The front cover is removed to provide access to the keyboard, printer, mass storage devices, and other assemblies. To remove the front cover, perform the following procedures:

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Open both side doors as previously described.

3. Remove keyboard bezel by grasping as shown in Figure 4-4 and pulling up on bezel. Raise front of bezel until back of bezel clears front cover and bezel can be pulled out and away from computer.



**Figure 4-4. Removing Keyboard Bezel**

4. Loosen two #2 Pozidriv captive screws that hold front cover to computer (Figure 4-5).



\* #2 POZIDRIV CAPTIVE SCREW

**Figure 4-5. Releasing Front Cover**

5. Remove paper tray from under display.

6. Lift rear of front cover and slide cover forward and away from computer (Figure 4-6).



**Figure 4-6. Removing Front Cover**

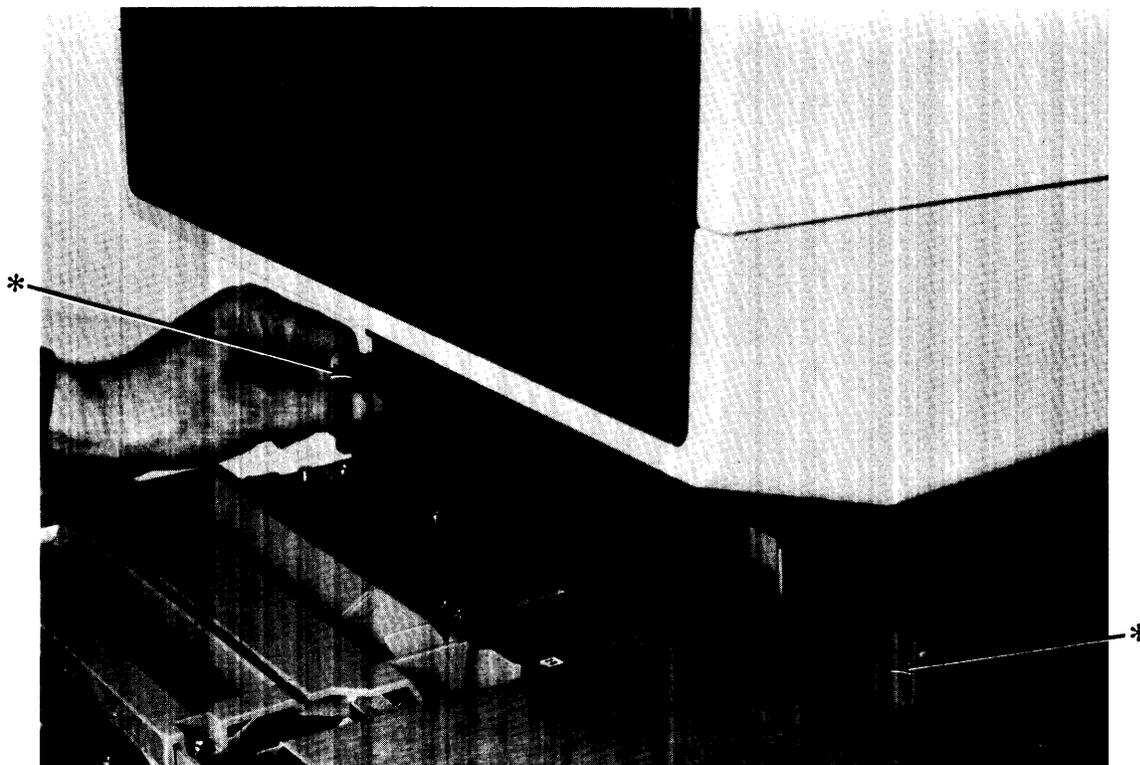
### **Rear Cover, including Display**

The rear cover is removed to provide access to the power supply, ac module, fans, and other assemblies. The display must be removed in order to remove the rear cover. To remove the display and rear cover, perform the following procedures:

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.

## 4-10 Assembly Access

2. Pull both display latches toward front of computer, unlatching display from support legs (Figure 4-7).



\* DISPLAY LATCH

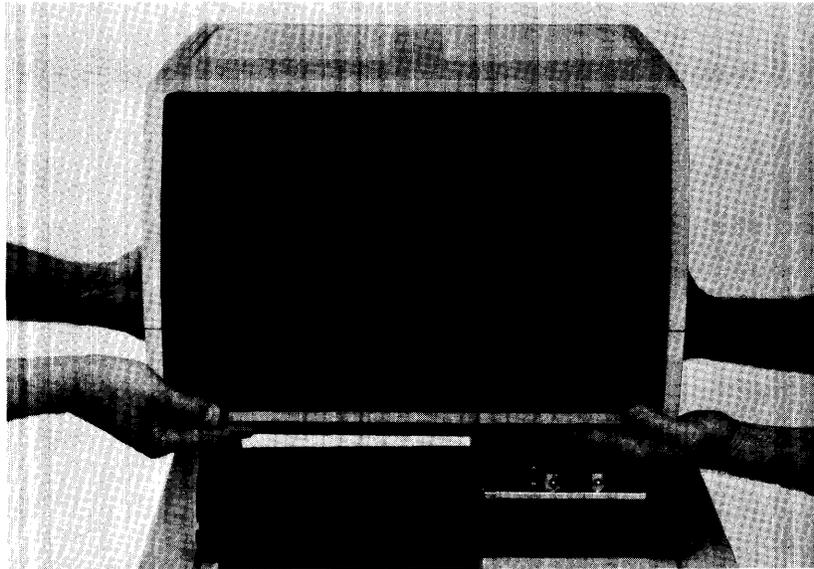
**Figure 4-7. Unlatching Display**

---

### WARNING

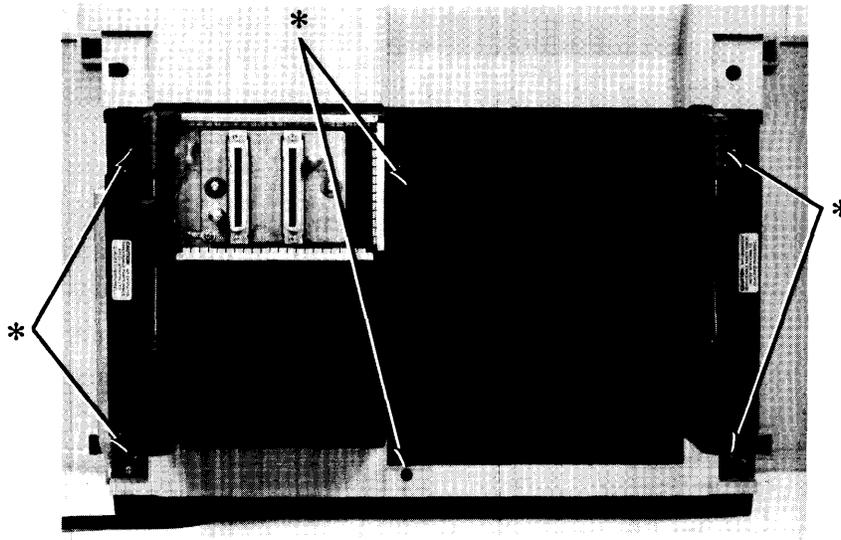
THE DISPLAY MAY BE HEAVY. TO AVOID PERSONAL INJURY OR DAMAGE TO EQUIPMENT, TWO PEOPLE MAY BE REQUIRED TO LIFT THE DISPLAY (FIGURE 4-8).

---



**Figure 4-8. Lifting Display**

3. Lift display from computer and place in a safe area where it does not interfere with continued disassembly.
4. Open both side doors as previously described.
5. Loosen six #2 Pozidriv captive screws that hold rear cover to computer (Figure 4-9).



**Figure 4-9. Removing Rear Cover**

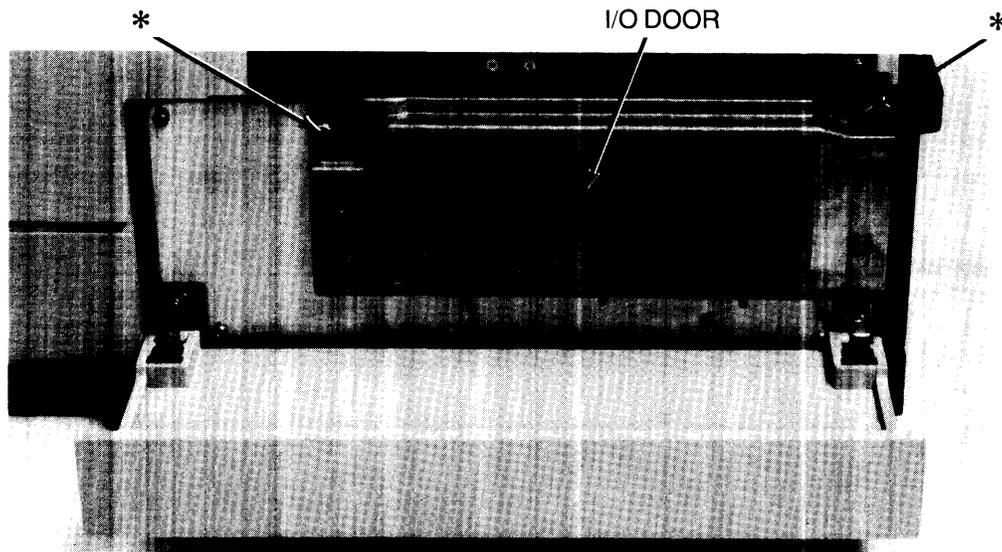
6. Lift rear cover off computer.

## Replaceable Assemblies

The following procedures describe the removal of replaceable assemblies. The reassembly procedures are the reverse of the removal procedures. If specific procedures are required for reassembly they are provided.

### I/O Cards

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Open right side door as previously described.
3. Loosen two captive thumbscrews on I/O door (Figure 4-10) and swing door open, allowing door to rest in open position. Use flat-blade screwdriver to loosen thumbscrews.



\* I/O DOOR CAPTIVE THUMB SCREW

Figure 4-10. Opening I/O Door

4. Disconnect I/O cable connector from I/O card to be replaced (Figure 4-11).

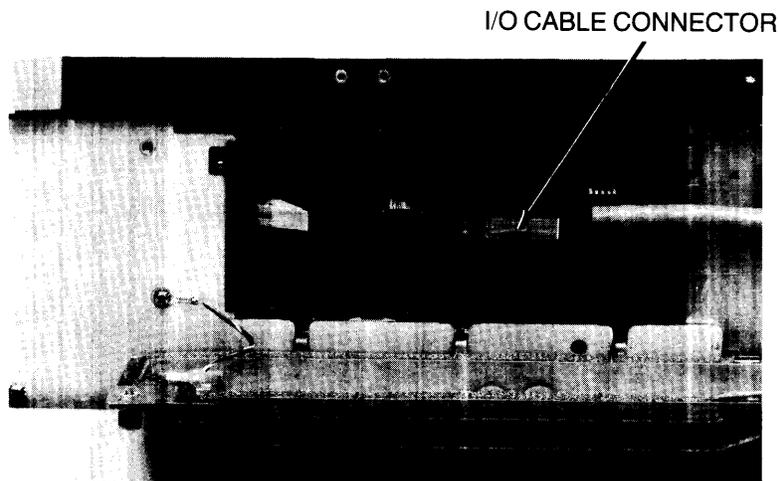


Figure 4-11. Disconnecting I/O Cable

---

**CAUTION**

CAREFULLY HANDLE I/O CARD TO PREVENT DAMAGE TO CARD FROM ELECTROSTATIC DISCHARGE OR OTHER CAUSES. HOLD BY EJECTORS OR SIDE EDGES ONLY. DO NOT TOUCH EDGE CONNECTORS OR CARD PLANES. IMMEDIATELY PLACE CARD IN ANTISTATIC BAG OR ON ANTISTATIC SURFACE.

---

5. Pull out on card ejectors to release card from I/O backplane and slide card out of slot.

---

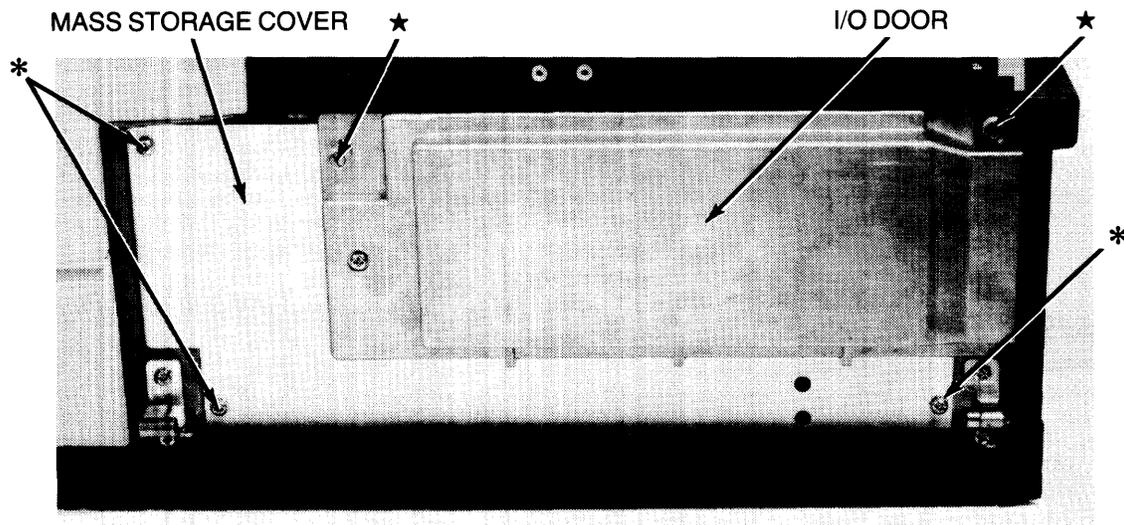
**Note**

Install replacement I/O card with ejectors partially open until ejectors clear front edges of card guides. Then push in firmly on the ejectors to seat card in I/O backplane. Ejectors should be flush with I/O card when card is fully seated.

---

**9130K Flexible Disc Drive Controller Card**

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove right side door as previously described.
3. Remove three #2 Pozidriv screws from mass storage cover (Figure 4-12).



- \* #2 POZIDRIV MASS STORAGE COVER SCREW
- ★ I/O DOOR CAPTIVE THUMB SCREW

**Figure 4-12. Removing Mass Storage Cover**

4. Loosen two captive thumbscrews on I/O door (Figure 4-12) and swing door open, allowing door to rest in open position. Use flat-blade screwdriver to loosen thumbscrews.
5. Slide mass storage cover toward front of computer, disengaging cover from slot in front card guide.
6. Lift mass storage cover with attached I/O door up and away from computer.

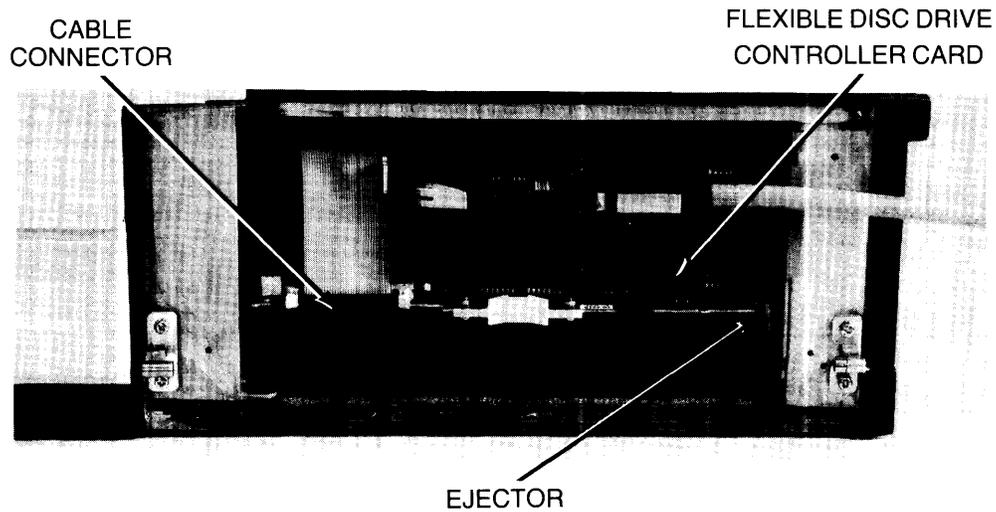
---

**CAUTION**

CAREFULLY HANDLE CARD TO PREVENT DAMAGE TO CARD FROM ELECTROSTATIC DISCHARGE OR OTHER CAUSES. HOLD BY EJECTORS OR SIDE EDGES ONLY. DO NOT TOUCH EDGE CONNECTOR CONTACTS OR CARD PLANES. IMMEDIATELY PLACE CARD IN ANTISTATIC BAG OR ON ANTISTATIC SURFACE.

---

7. Remove cable connector from card (Figure 4-13), unseat card from I/O backplane by pulling out on ejector, and slide card out of slot.



**Figure 4-13. Removing Flexible Disc Drive Controller Card**

---

**Reassembly Note**

Seat replacement controller card firmly in I/O backplane and push ejector and handle in to lock card in place.

---

## Winchester Fixed Disc Drive Controller Assembly

The Winchester Fixed Disc Drive Controller Assembly consists of an I/O card and a disc controller mounted together and interconnected by cables. The assembly must be removed from the computer as a unit. The I/O card or disc controller can then be removed from the assembly for replacement. All procedures follow.

### To remove controller assembly from computer:

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove right side door as previously described.
3. Remove three #2 Pozidriv screws from mass storage cover (Figure 4-12).
4. Loosen two captive thumbscrews on I/O door (Figure 4-12) and swing door open, allowing door to rest in open position. Use flat-blade screwdriver to loosen thumbscrews.
5. Slide mass storage cover toward front of computer, disengaging cover from slot in front card guide.
6. Lift mass storage cover with attached I/O door up and away from computer.

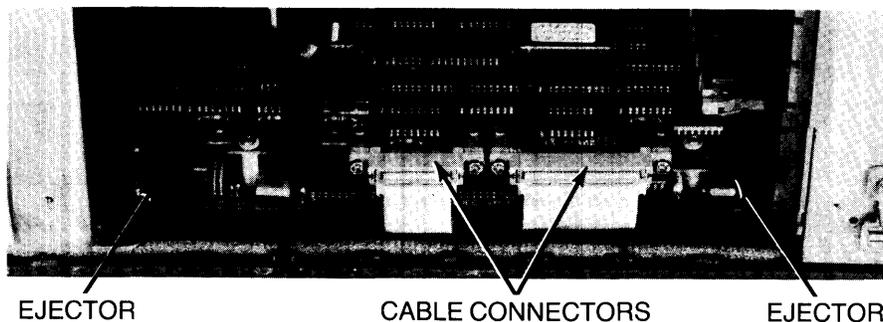
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### CAUTION

CAREFULLY HANDLE ASSEMBLY TO PREVENT DAMAGE FROM ELECTROSTATIC DISCHARGE OR OTHER CAUSES. HOLD BY EJECTORS OR SIDE EDGES ONLY. DO NOT TOUCH EDGE CONNECTOR CONTACTS OR CARD PLANES. IMMEDIATELY PLACE ASSEMBLY IN ANTISTATIC BAG OR ON ANTISTATIC SURFACE.

---

7. Remove both cable connectors from controller assembly (Figure 4-14), unseat assembly from I/O backplane by pulling out on ejectors, and slide assembly out of slot.



**Figure 4-14. Removing Fixed Disc Drive Controller Assembly**

---

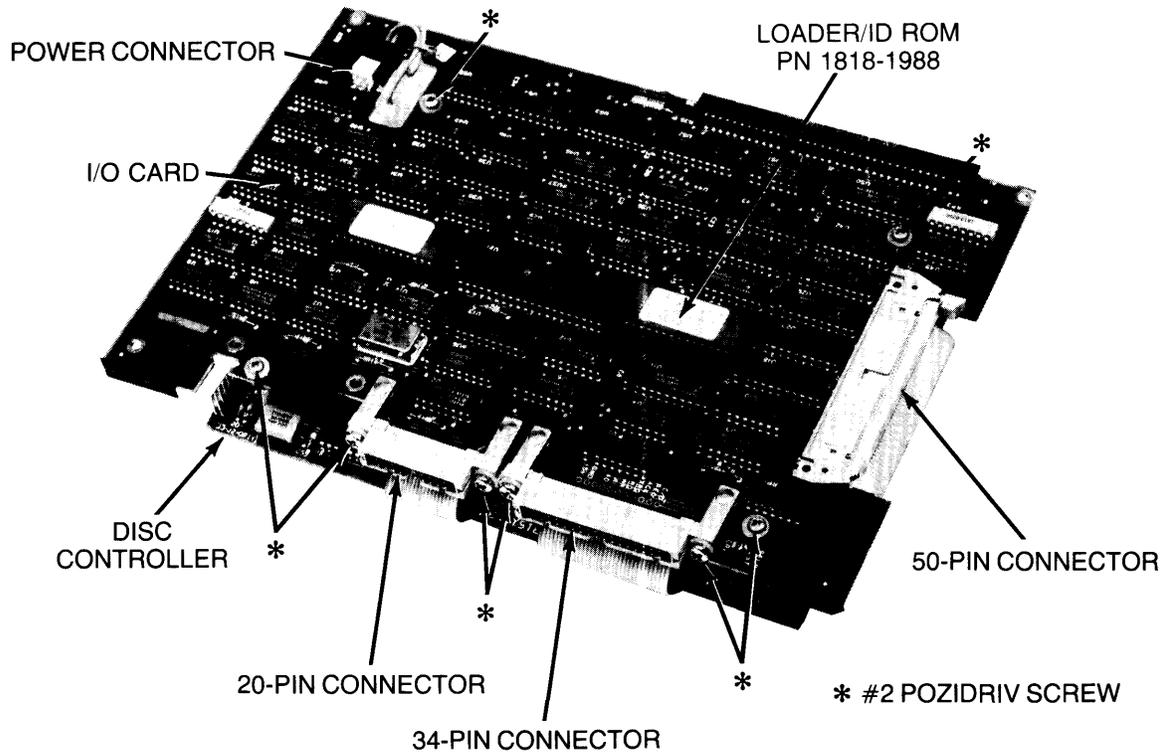
### Reassembly Note

Seat replacement controller assembly firmly in I/O backplane and push ejectors in to lock card in place.

---

**To remove I/O card from controller assembly:**

1. Disconnect power connector from I/O card (Figure 4-15).
2. Disconnect 50-pin connector from I/O card (Figure 4-15).
3. Disconnect 20-pin and 34-pin connectors from I/O card by removing the four #2 Pozidriv screws that attach the connectors to the card (Figure 4-15).
4. Remove four #2 Pozidriv screws that attach I/O card to assembly (Figure 4-15), and remove card.



**Figure 4-15. Disassembling Fixed Disc Drive Controller Assembly, View 1**

---

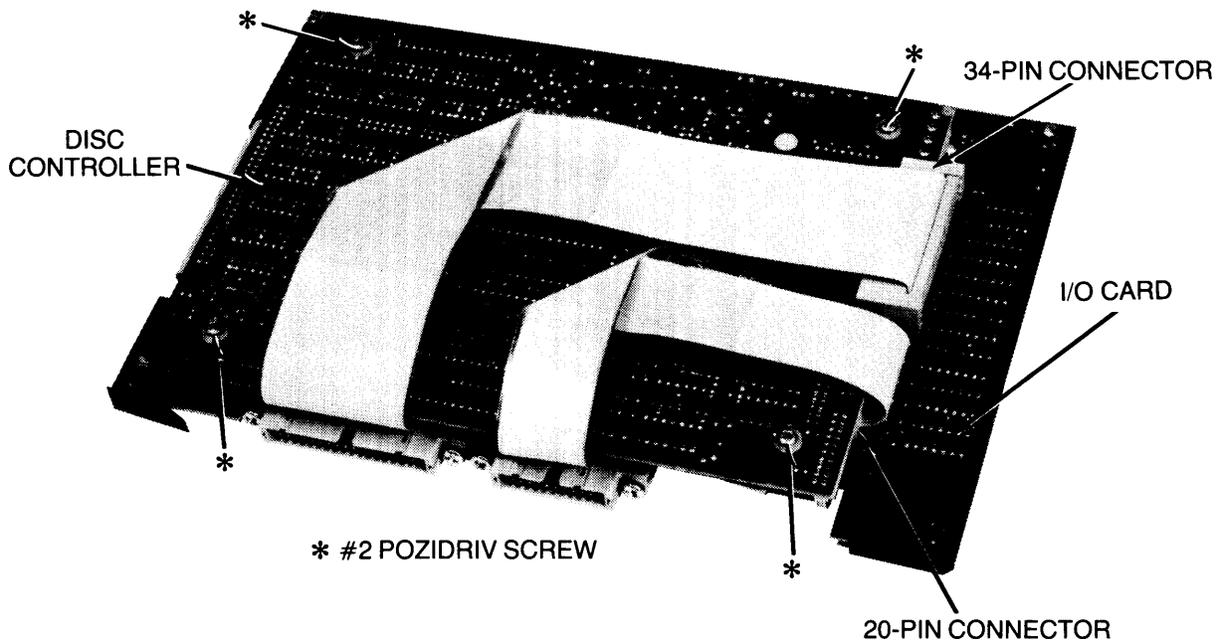
**CAUTION**

REMOVE THE LOADER/ID ROM FROM THE OLD CARD AND INSTALL IT ON THE NEW CARD, WHEN REPLACING THE I/O CARD. USE TOOL 8710-0585. IF ORDERING A NEW ID ROM, THE SERIAL NUMBER OF THE COMPUTER MUST BE PROGRAMMED INTO THE REPLACEMENT ID ROM. SEE THE REPLACEMENT PARTS LIST FOR THE CORRECT ROM PART NUMBER. RETAIN ALL CABLES AND SCREWS FOR INSTALLATION OF REPLACEMENT I/O CARD ON THE CONTROLLER ASSEMBLY.

---

**To remove disc controller from controller assembly:**

1. Disconnect power connector from I/O card (Figure 4-15).
2. Disconnect 50-pin connector from I/O card (Figure 4-15).
3. Remove four #2 Pozidriv screws that attach disc controller to controller assembly (Figure 4-16).
4. Remove disc controller just far enough to disconnect 20-pin and 34-pin connectors from controller (Figure 4-16).
5. Remove power cable and 50-pin cable from disc controller.

**Figure 4-16. Disassembling Fixed Disc Drive Controller Assembly, View 2**

---

**Note**

Retain all cables and screws for installation of replacement disc controller.

---

## Bootstrap Loader Card

Perform preceding procedures for Mass Storage Controller Cards. Step 7 does not require removal of cable connector(s).

---

### CAUTION

REMOVE THE LOADER/ID ROM FROM THE OLD CARD AND INSTALL IT ON THE NEW CARD, WHEN REPLACING THE BOOTSTRAP LOADER CARD. USE TOOL 8710-0585. IF ORDERING A NEW ID ROM, THE SERIAL NUMBER OF THE COMPUTER MUST BE PROGRAMMED INTO THE REPLACEMENT ID ROM. SEE THE REPLACEMENT PARTS LIST FOR THE CORRECT ROM PART NUMBER.

---

## Processor Stack

Several processor stack subassemblies are field-replaceable. These subassemblies, except the fan, are listed below, followed by their access procedures. Fan access procedures follow in this chapter.

- Boards
- Clock Board
- Motherboard

### Stack Boards

The processor stack has 12 slots. Access to the lower three slots requires procedures that differ from those necessary to gain access to the upper nine slots. Both procedures are documented below.

Slots 4-12

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Open left side door as previously described.
3. Disconnect IOP expander cables, if present, from processor stack door (Figure 4-17).
4. Loosen two captive thumbscrews on processor stack door (Figure 4-17) and swing door open, allowing door to rest in open position.

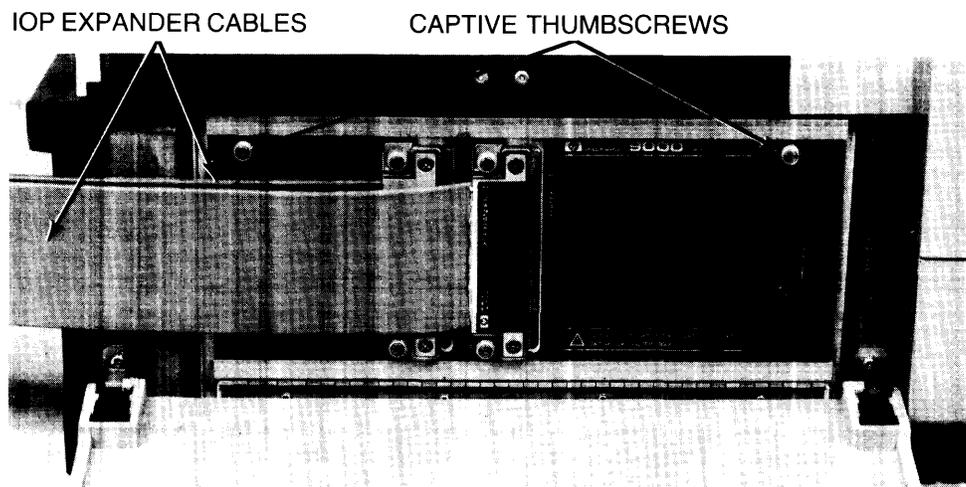


Figure 4-17. Removing Upper Board, View 1

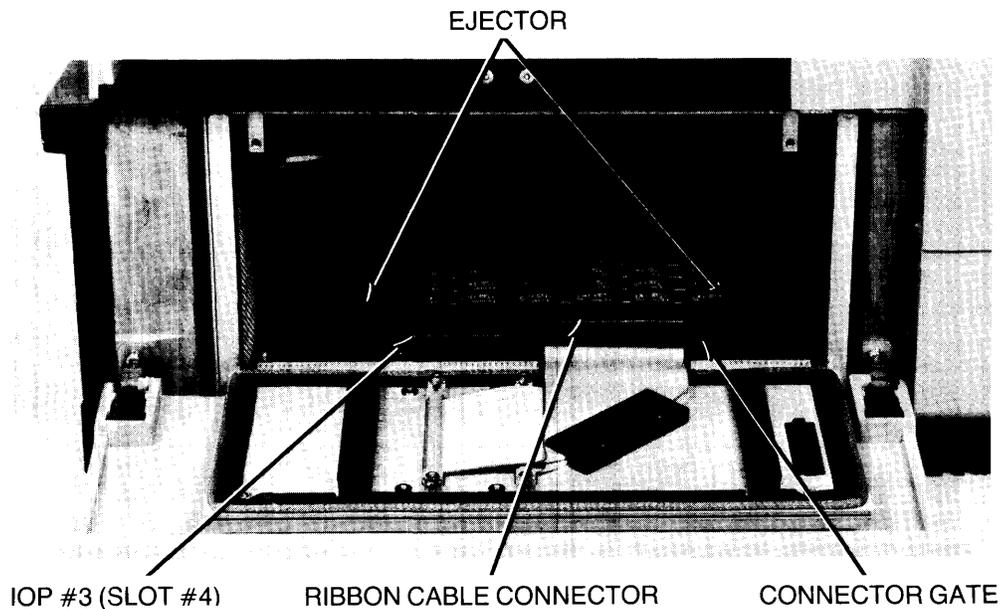
---

**CAUTION**

CAREFULLY HANDLE BOARDS TO PREVENT DAMAGE TO THEM FROM ELECTROSTATIC DISCHARGE OR OTHER CAUSES. HOLD BY EJECTORS OR SIDE EDGES ONLY. DO NOT TOUCH EDGE CONNECTOR CONTACTS OR BOARD PLANES. IMMEDIATELY PLACE BOARD IN AN ANTISTATIC BAG OR ON ANTISTATIC SURFACE.

---

5. Pull out on board ejectors to release board from stack motherboard (Figure 4-18) and slide the board out of the slot. If IOP finstrate (slot #4) is being removed, pull out on ejectors, slide board slightly out, open connector gate, remove ribbon cable connector (Figure 4-18), and then remove board from stack.



**Figure 4-18. Removing Upper Board, View 2**

---

**Reassembly Notes**

When installing board, hold by ejectors and use side edge of board to move air controller out of the way and onto board.

Insert board firmly in stack motherboard and push in by ejectors to lock board in place.

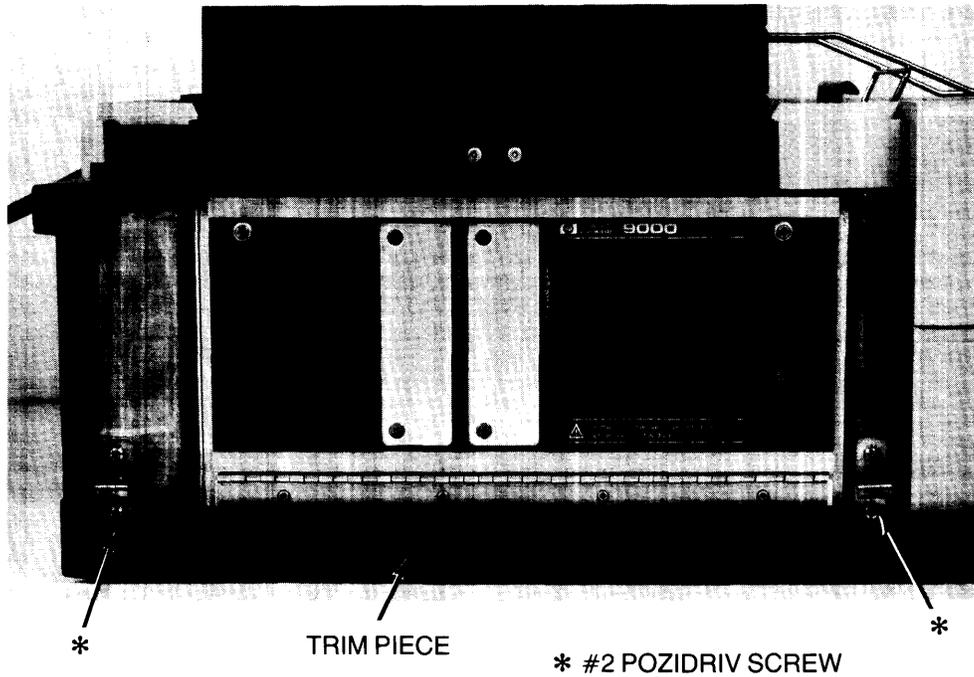
Firmly tighten stack door thumbscrews to prevent RFI radiation.

---

## 4-20 Assembly Access

### Slots 1-3

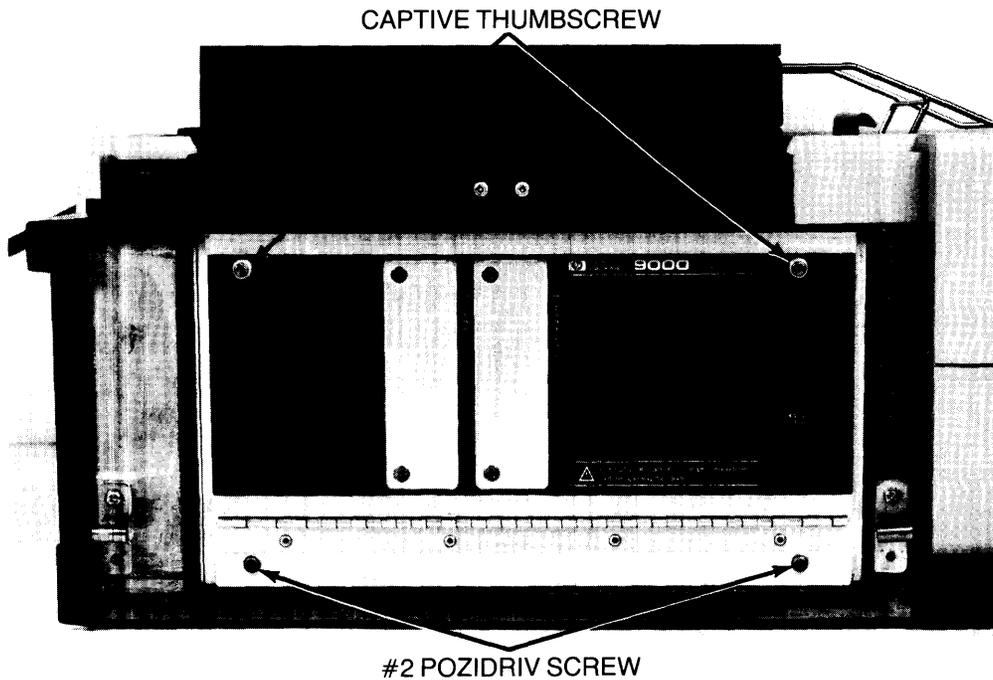
1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove left side door as previously described.
3. Loosen two #2 Pozidriv screws that hold trim piece to left side of computer (Figure 4-19) just far enough to remove trim piece. Remove trim piece by pulling straight off while leaving screws in place on computer.



**Figure 4-19. Removing Trim Piece**

4. Disconnect IOP expander cables, if present, from processor stack door (Figure 4-17).

5. Loosen two #2 Pozidriv captive screws at bottom of processor stack door (Figure 4-20).



**Figure 4-20. Removing Processor Stack Door**

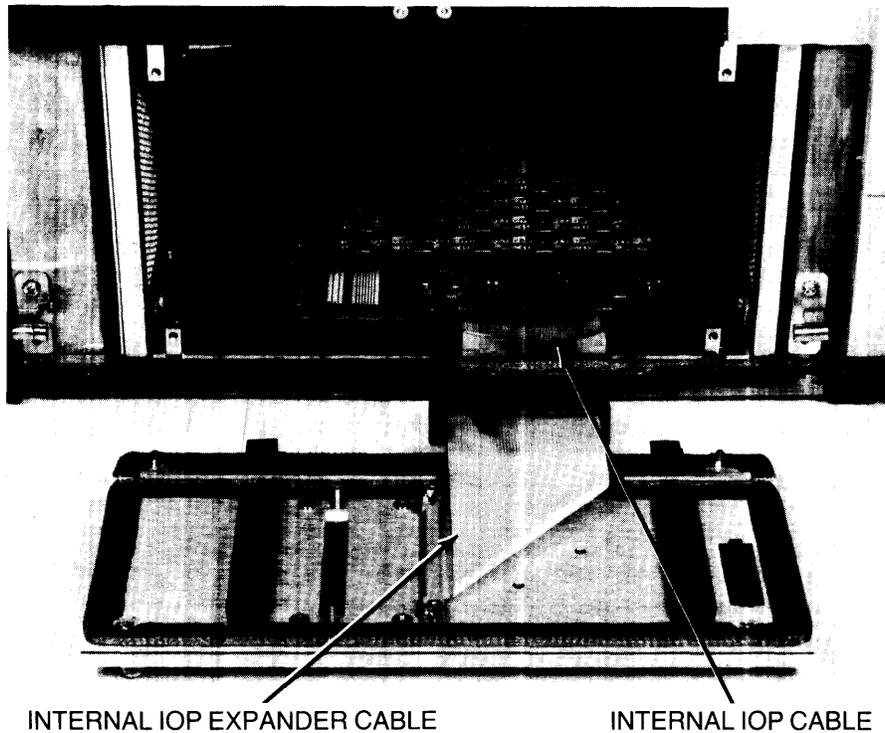
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**CAUTION**

BEFORE REMOVING PROCESSOR STACK DOOR AS DESCRIBED IN THE FOLLOWING STEP, NOTE THAT INTERNAL IOP EXPANDER CABLES MAY INTERCONNECT THE DOOR WITH ADDITIONAL IOP FINSTRATES. THESE CABLES MUST BE DISCONNECTED FROM THE FINSTRATES BEFORE THE DOOR CAN BE COMPLETELY REMOVED.

---

6. Loosen two captive thumbscrews on processor stack door (Figure 4-20) and remove door. Disconnect internal IOP expander cable(s), if present, from IOP finstrate(s) (Figure 4-21).



**Figure 4-21. Disconnecting IOP Cables**

---

**CAUTION**

CAREFULLY HANDLE BOARD TO PREVENT DAMAGE FROM ELECTROSTATIC DISCHARGE OR OTHER CAUSES. HOLD BY EJECTORS OR SIDE EDGES ONLY. DO NOT TOUCH EDGE CONNECTOR CONTACTS OR BOARD PLANES. IMMEDIATELY PLACE BOARD IN ANTISTATIC BAG OR ON ANTISTATIC SURFACE.

---

7. If board in slot #1 or #2 is being replaced, disconnect internal IOP cable from IOP finstrate in slot #2 (Figure 4-21).
8. Pull out on ejectors to release board from stack motherboard and slide board out of slot.

---

**Reassembly Notes**

When installing board, hold by ejectors and use side edge of board to move air controller out of the way and onto board.

Insert board firmly in stack motherboard and push ejectors in to lock it in place.

Reinstall processor stack door by first attaching with two thumbscrews at top of door and then installing two bottom screws. Firmly tighten all screws to prevent RFI radiation.

---

**Clock Board**

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Open left door as previously described.
3. Disconnect IOP expander cables, if present, from processor stack door (Figure 4-17).
4. Loosen two captive thumbscrews on processor stack door (Figure 4-20) and swing door open, allowing door to rest in open position.

---

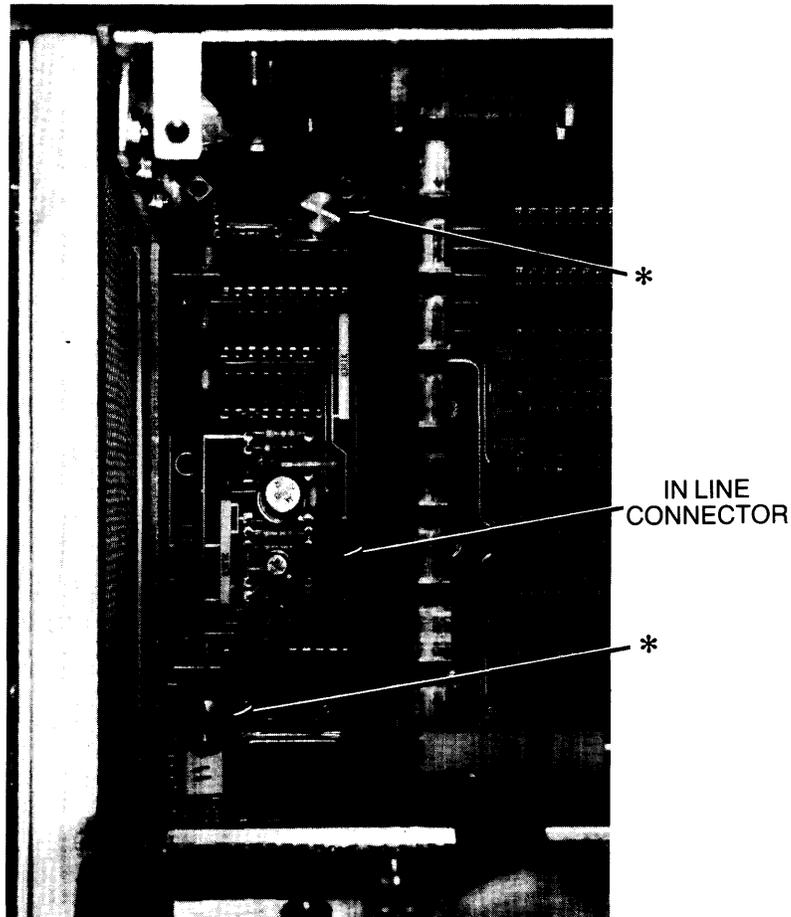
**CAUTION**

CAREFULLY HANDLE BOARD TO AVOID DAMAGE FROM ELECTROSTATIC DISCHARGE OR OTHER CAUSES. HOLD BY EJECTORS OR SIDE EDGES ONLY. DO NOT TOUCH EDGE CONNECTOR CONTACTS OR BOARD PLANES. IMMEDIATELY PLACE BOARD IN ANTISTATIC BAG OR ON ANTISTATIC SURFACE.

---

5. Remove boards in slots 5-12 by pulling out on ejectors to release boards from stack motherboard and sliding boards out of slots.
6. Loosen two slotted captive screws that hold clock board to stack motherboard (Figure 4-22).
7. Disconnect clock board from processor stack motherboard at inline connector (Figure 4-22).

8. Pull clock board straight out of motherboard and out of stack.



**Figure 4-22. Removing Processor Stack Clock Board**

---

**Reassembly Notes**

When installing board, hold by ejectors and use side edge of board to move air controller out of the way and onto board.

Insert board firmly in stack motherboard and push ejectors in to lock board in place.

The clock board connector and mating motherboard connector are not keyed; however, the clock board screws and motherboard holes do not align unless proper connection is made.

Firmly tighten stack door thumbscrews to prevent RFI radiation.

---

**Motherboard**

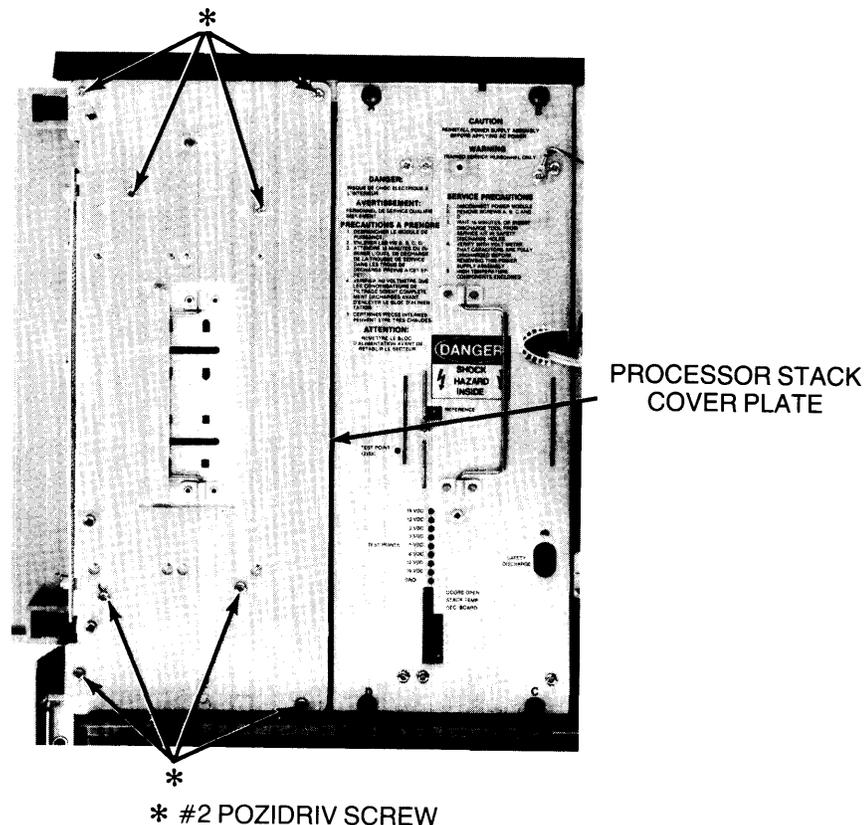
1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove left door as previously described.
3. Remove front and rear covers as previously described.

4. Loosen two #2 Pozidriv screws that hold trim piece to left side of computer (Figure 4-19) just far enough to remove trim piece. Remove trim piece while leaving screws in place on computer.
5. Disconnect IOP expander cables, if present, from processor stack door (Figure 4-17).
6. Loosen two #2 Pozidriv captive screws at bottom of processor stack door (Figure 4-20).

**CAUTION**

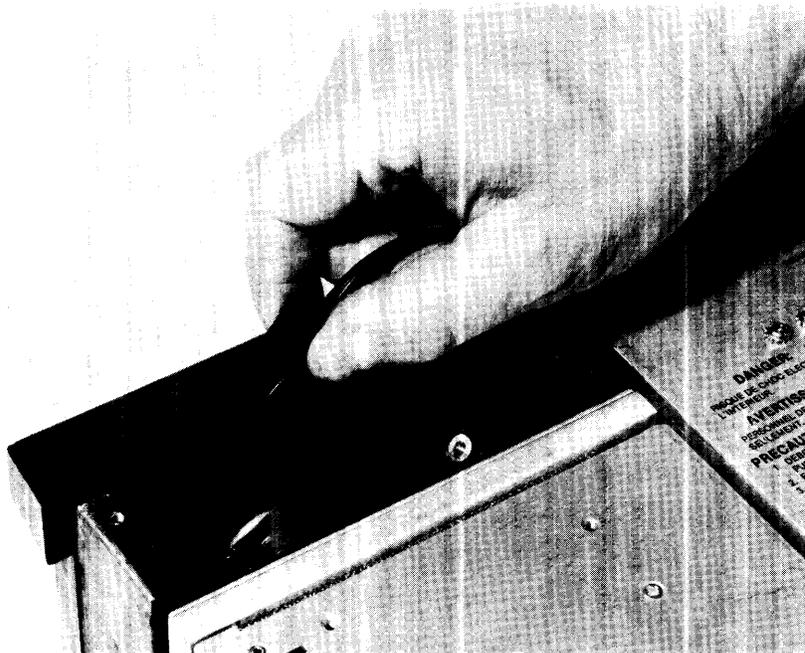
BEFORE REMOVING PROCESSOR STACK DOOR AS DESCRIBED IN THE FOLLOWING STEP, NOTE THAT INTERNAL IOP EXPANDER CABLES MAY INTERCONNECT THE DOOR WITH ADDITIONAL IOP FINSTRATES. THESE CABLES MUST BE DISCONNECTED FROM THE FINSTRATES BEFORE THE DOOR CAN BE COMPLETELY REMOVED.

7. Loosen two captive thumbscrews on processor stack door (Figure 4-20) and remove door. Disconnect internal IOP expander cable(s), if present, from IOP finstrate(s) (Figure 4-21).
8. Disconnect internal IOP cable from IOP finstrate in slot #2 (Figure 4-21).
9. Remove eight #2 Pozidriv screws that attach cover plate over processor stack, and remove cover plate (Figure 4-23).



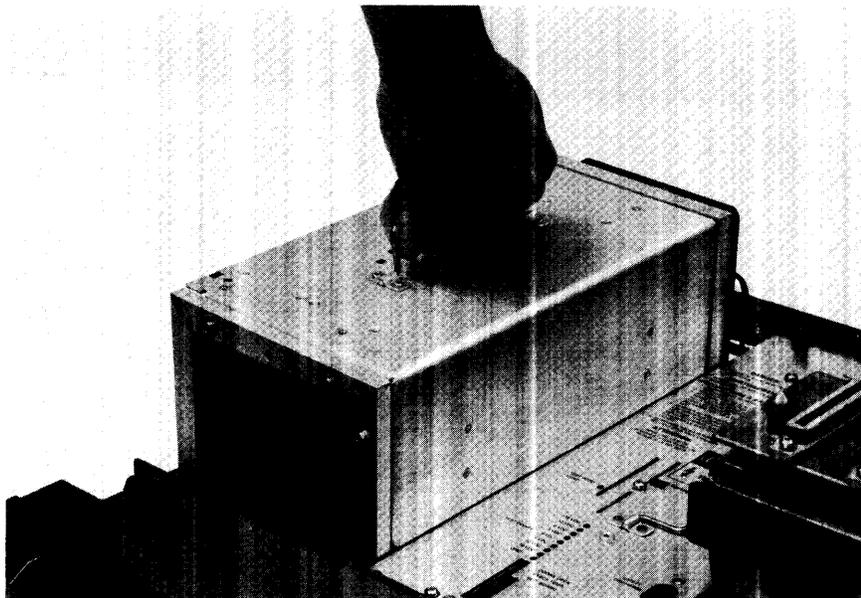
**Figure 4-23. Removing Processor Stack Cover Plate**

10. Disconnect fan cable from processor stack fan (Figure 4-24).



**Figure 4-24. Disconnecting Processor Stack Fan Cable**

11. Lift processor stack up and out of computer (Figure 4-25).



**Figure 4-25. Removing Processor Stack**

---

**CAUTION**

CAREFULLY HANDLE BOARD TO PREVENT DAMAGE FROM ELECTROSTATIC DISCHARGE OR OTHER CAUSES. HOLD BY EJECTORS OR SIDE EDGES ONLY. DO NOT TOUCH EDGE CONNECTOR CONTACTS OR BOARD PLANES. IMMEDIATELY PLACE BOARDS IN ANTISTATIC BAGS OR ON ANTISTATIC SURFACE.

---

12. Remove all boards by pulling out on ejectors to release boards from stack motherboard and sliding boards out of slots.
13. Remove 16 #1 Pozidriv screws, 8 from the top of the case and 8 from the bottom, that attach the 4 card guides to the case, and remove the card guides.
14. Loosen two slotted captive screws that hold clock board to stack motherboard.
15. Disconnect clock board from processor stack motherboard at inline connector.
16. Pull clock board straight out of motherboard and out of stack.
17. Remove four #1 Pozidriv screws, two at top and two at bottom, that attach motherboard to case. Do not remove the two middle screws. They attach the motherboard supports to the motherboard.
18. Remove eight #1 Pozidriv screws, four at bottom and four at back, that attach the connector tie bar to the case.
19. Remove the motherboard and its attached supports and connector tie bar from the case.
20. Remove the connector tie bar and motherboard supports from the motherboard. Retain for installation on the replacement motherboard.

## Display

The display must be removed before the rear cover can be removed. It must also be removed to service the display itself or to access the display interface module (DIM) or alpha/interface board. The DIM or alpha/interface board is mounted to the bottom of the display. The DIM is used with the 98770A and 98780A displays. The alpha/interface board is used with the 98760A display.

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Pull both display latches toward front of computer, unlatching display from support legs (Figure 4-7).

---

**WARNING**

THE DISPLAY MAY BE HEAVY. TO AVOID DAMAGE TO EQUIPMENT OR PERSONAL INJURY, TWO PEOPLE MAY BE REQUIRED TO LIFT THE DISPLAY (FIGURE 4-8)

---

3. Lift display from computer.

### Display Interface Module (98770A or 98780A Displays)

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove display as previously described and carefully place display on its top.

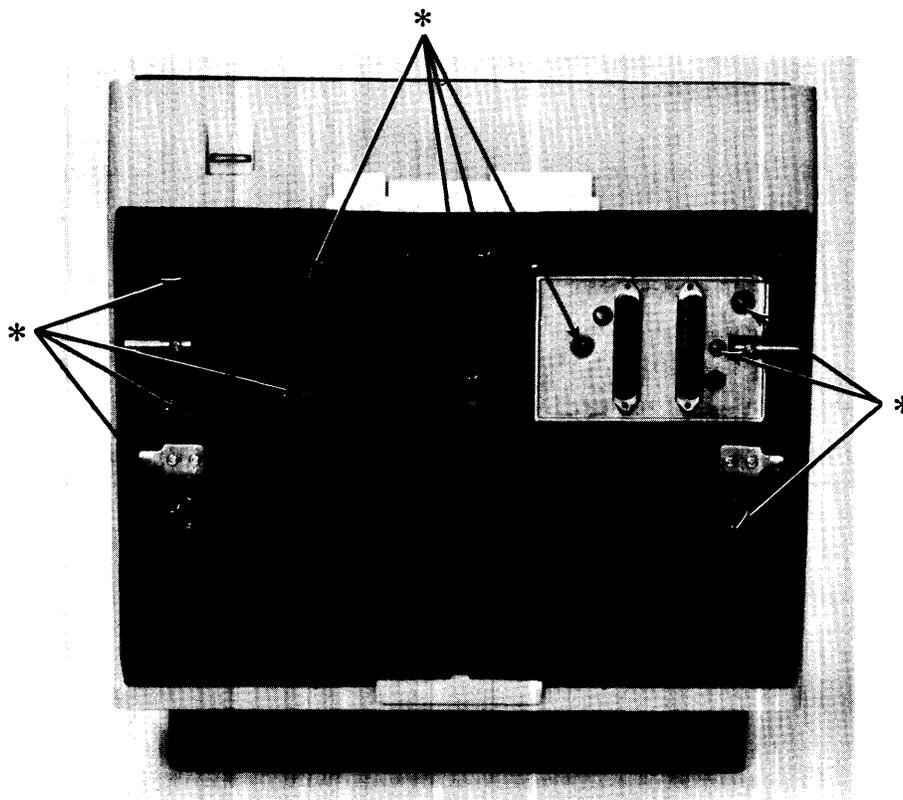
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**Note**

When performing the following step, leave screws in place in aluminum casting to avoid losing them.

---

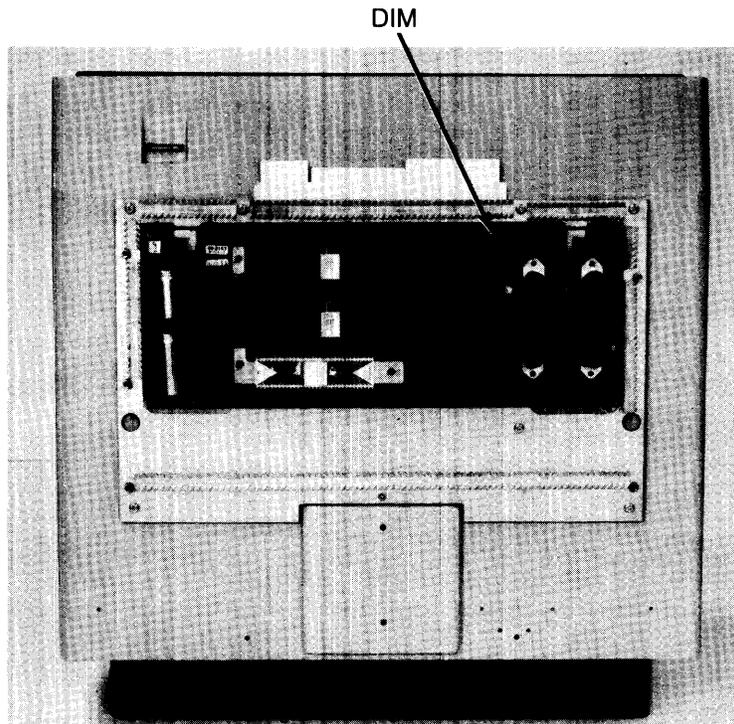
3. Loosen 11 #2 Pozidriv screws that attach aluminum casting to display and remove casting (Figure 4-26).



\* #2 POZIDRIV SCREW

Figure 4-26. Removing Casting

4. Pull display interface module (DIM) straight off of lid (Figure 4-27).



**Figure 4-27. Removing DIM**

---

**Reassembly Note**

Ensure that the DIM is properly aligned on the display lid before replacing the aluminum casting. Otherwise, casting screws do not align with lid holes.

---

### Display Alpha/Interface Board (98760A Display)

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove display as previously described and carefully place display on its top.

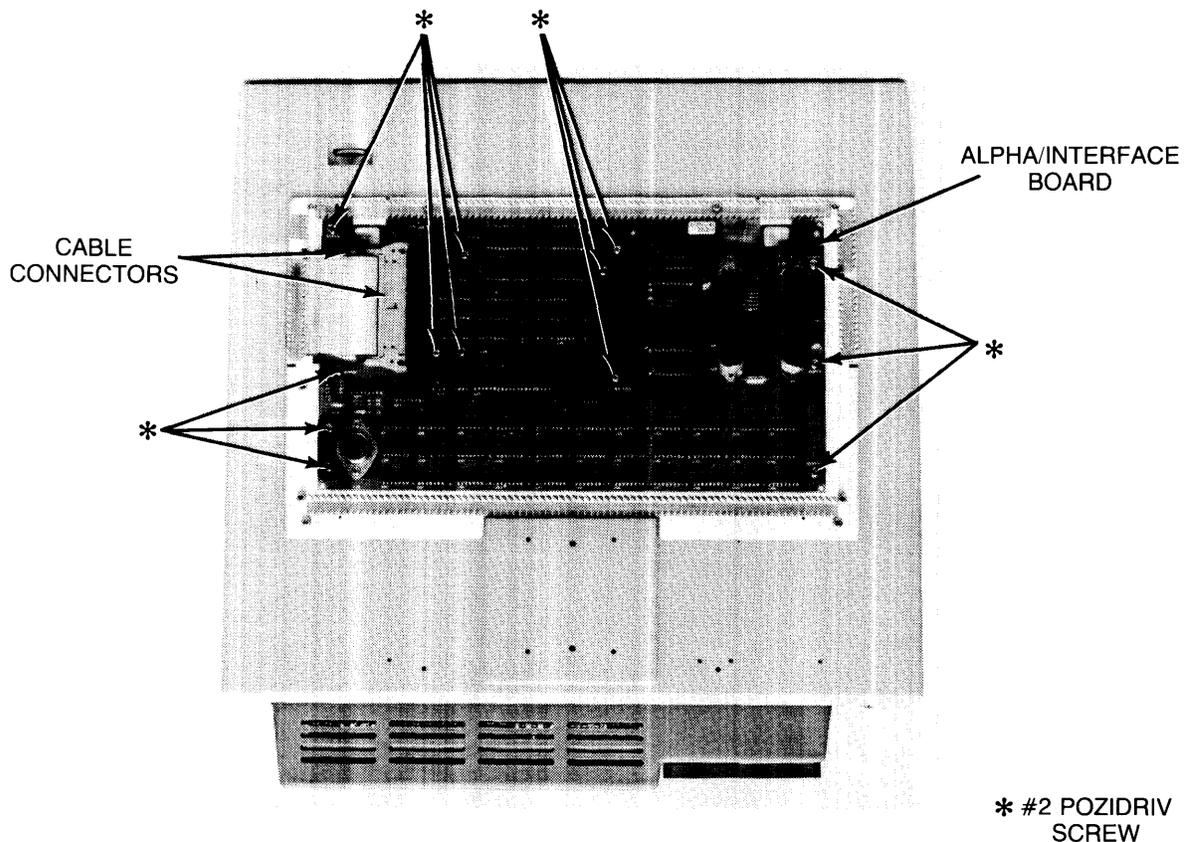
---

**Note**

When performing following step, leave screws in place in aluminum casting to avoid losing them.

---

3. Loosen 11 #2 Pozidriv screws that attach aluminum casting to display and remove casting (Figure 4-26).
4. Disconnect both cables and remove 13 #2 Pozidriv screws from the alpha/interface board (Figure 4-28).



**Figure 4-28. Removing Alpha/Interface Board**

5. Pull alpha/interface board straight off of lid.

---

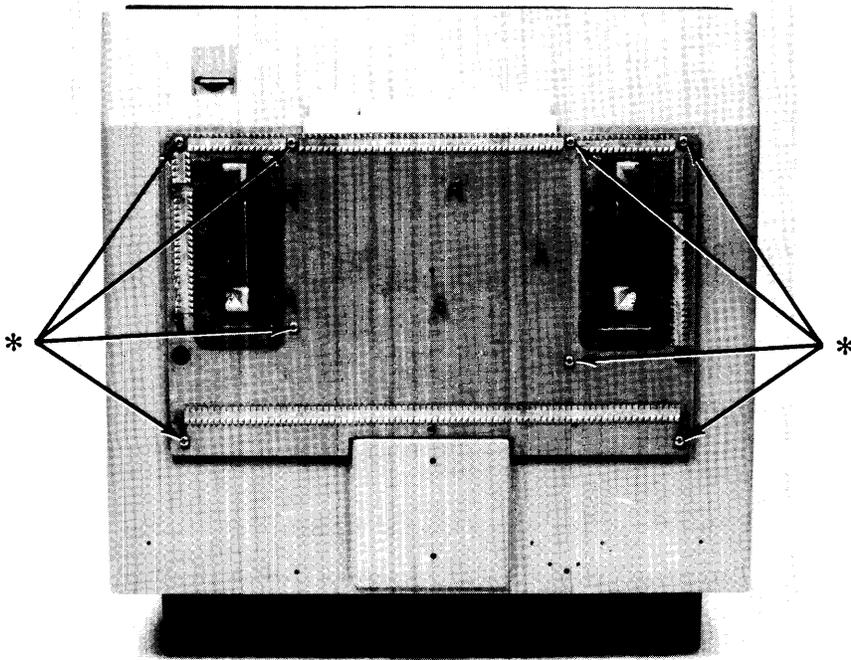
**Reassembly Note**

Ensure that the alpha/interface board is properly aligned on the display lid before replacing the aluminum casting. Otherwise, casting screws do not align with lid holes.

---

## Display Lid

The DIM or alpha/interface board is mounted to the display lid. To remove the lid, remove eight #2 Pozidriv screws and lift lid off of display (Figure 4-29).



\* #2 POZIDRIV SCREW

Figure 4-29. Removing Lid

## Keyboard

Several keyboard subassemblies are field-replaceable. These subassemblies are listed below, followed by their access procedures.

- Keycaps
- Keyswitch Board
- Keyboard Electronics Board
- Keyswitches
- Language Resistors
- Real-Time Clock/Non-Volatile Memory (RTC/NVM) Batteries

All subassemblies listed above, except keycaps, require that the keyboard be removed from the computer. To remove the keyboard from the computer proceed as follows:

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove front cover and keyboard bezel as previously described.
3. Disconnect ground strap connector at top left of keyboard from lug on computer (Figure 4-30).
4. Loosen four #2 Pozidriv captive screws that attach keyboard to computer (Figure 4-30).

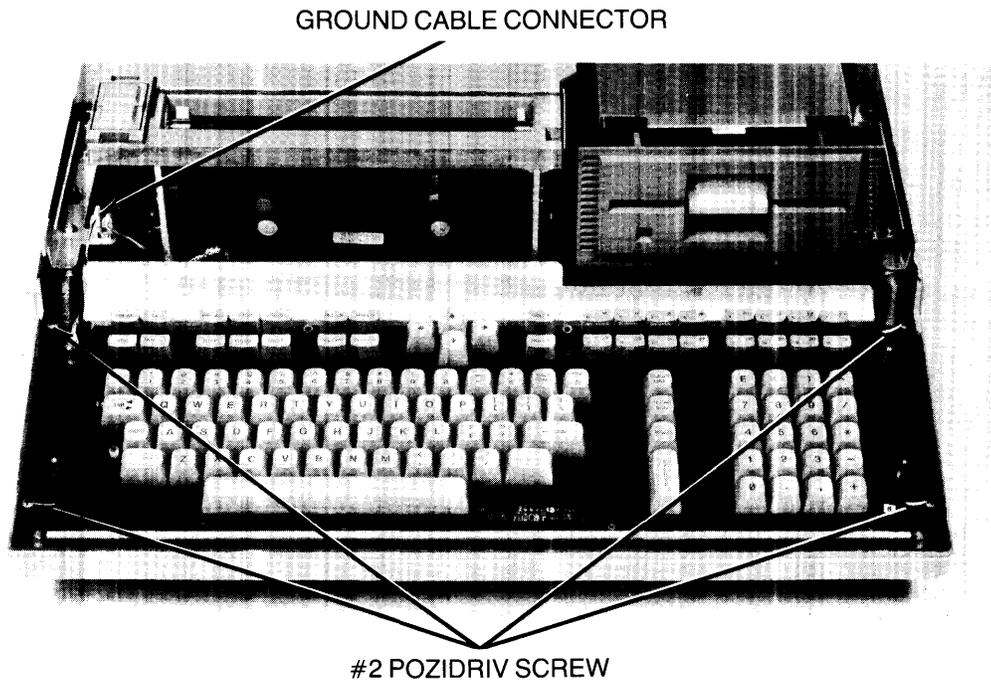


Figure 4-30. Releasing Keyboard

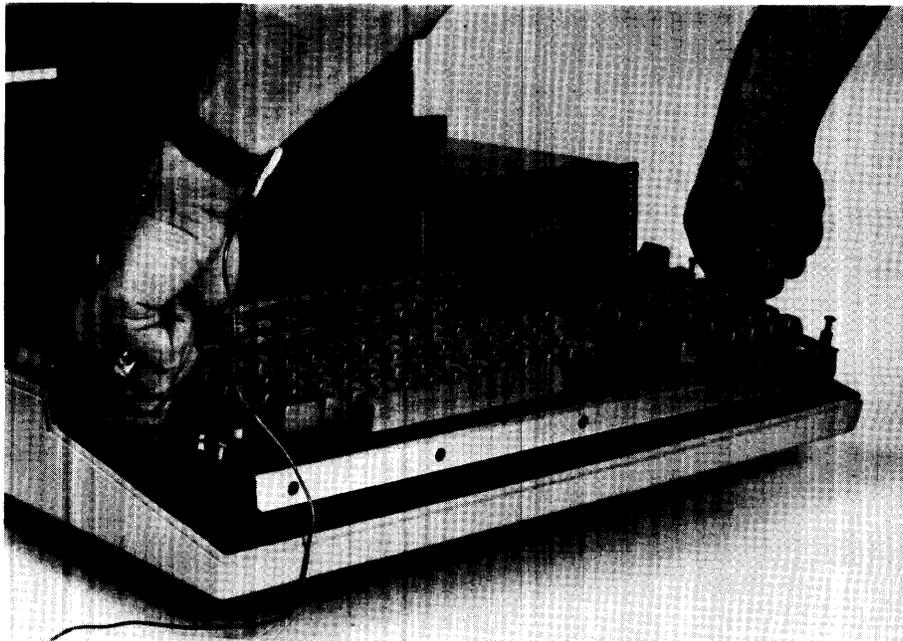
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**CAUTION**

REAL-TIME CLOCK/NON-VOLATILE MEMORY (RTC/NVM) BATTERIES ARE CONTAINED ON THE BOTTOM SIDE OF THE KEYBOARD. CAREFULLY HANDLE KEYBOARD TO AVOID LOSING RTC/NVM DATA.

---

5. Grasp keyboard by round handles as shown in Figure 4-31 and lift keyboard up and away from computer.



**Figure 4-31. Removing Keyboard**

### Keycaps

Computer disassembly is not required to replace a keycap.

1. Grasp keycap puller, HP PN 5040-7433, and insert beside keycap to be removed as shown in Figure 4-32.



**Figure 4-32. Removing Keycap**

2. Pull tool firmly upwards to remove keycap from keyswitch.

---

**Note**

Keycap part numbers and drawings of the various language keyboards are in Chapter 5.

---

---

**Reassembly Note**

Install the new keycap by pressing it firmly into place on the keyswitch.

---

### Keyswitch Board/Keyboard Electronics Board

To remove the keyboard and separate the keyswitch board from the keyboard electronics board, proceed as follows:

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove keyboard from computer as previously described. The keyboard consists of keyswitch board and keyboard electronics board.
3. Place keyboard upside down (keycaps down) on an antistatic surface (Figure 4-33).
4. Unplug keyboard electronics board cable from keyswitch board (Figure 4-33).
5. Remove seven #1 Pozidriv screws that interconnect keyswitch board and keyboard electronics board (Figure 4-33).
6. Lift keyboard electronics board off keyswitch board.

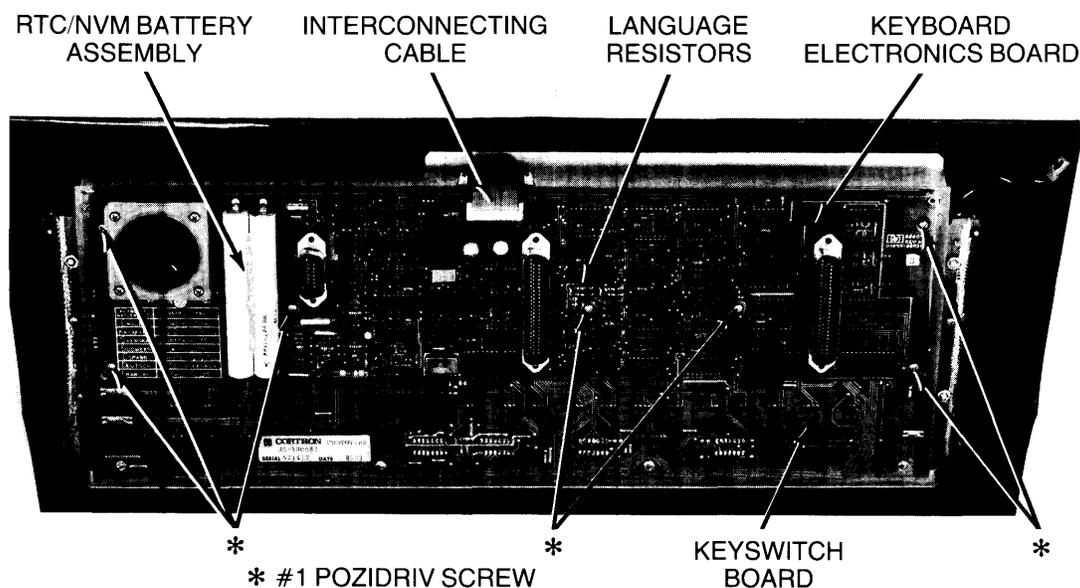


Figure 4-33. Disassembling Keyboard

### Keyswitches

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove keyboard from computer as previously described and place on antistatic surface.
3. Remove keycap from defective keyswitch.
4. Remove keyboard electronics board from keyswitch board as previously described.
5. Unsolder the defective switch from the keyswitch board (four solder joints per switch).
6. Press in on the two tabs that hold the keyswitch in place and pull the switch up and out of the switch mounting plate.

---

#### Reassembly Note

Ensure that the replacement keyswitch is the proper type. Install the replacement keyswitch with the proper orientation and solder the switch leads.

---

**Language Resistors**

To change the language configuration of the keyboard, perform the following procedures:

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove keyboard from computer as previously described.
3. Place keyboard upside down on an antistatic surface (Figure 4-33).
4. Determine current configuration by noting the resistors in place on the keyboard electronics board (Figure 4-33). Determine desired configuration according to Table 4-1. A “1” indicates a resistor is installed at that location; a “0” indicates there should be no resistor there. Add and/or remove resistor(s) to match the desired configuration. Resistor part number is 0698-3441.

**Table 4-1. Keyboard Language Resistor Configurations**

	R16	R17	R22	R23
English (ASCII)	1	1	1	1
Katakana (Japanese)	1	1	0	1
Svenska (Swedish)	1	0	1	1
Suomeks (Finnish)	1	0	1	1
Espanol (Spanish)	1	0	0	1
Deutsch (German)	1	1	1	0
Francais (French)	1	1	0	0

**Real-Time Clock/Non-Volatile Memory (RTC/NVM) Battery Assembly**

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove keyboard from computer as previously described.
3. Place keyboard upside down on an antistatic surface (Figure 4-33).
4. Cut battery connections and remove batteries (Figure 4-33).
5. Remove solder from board.

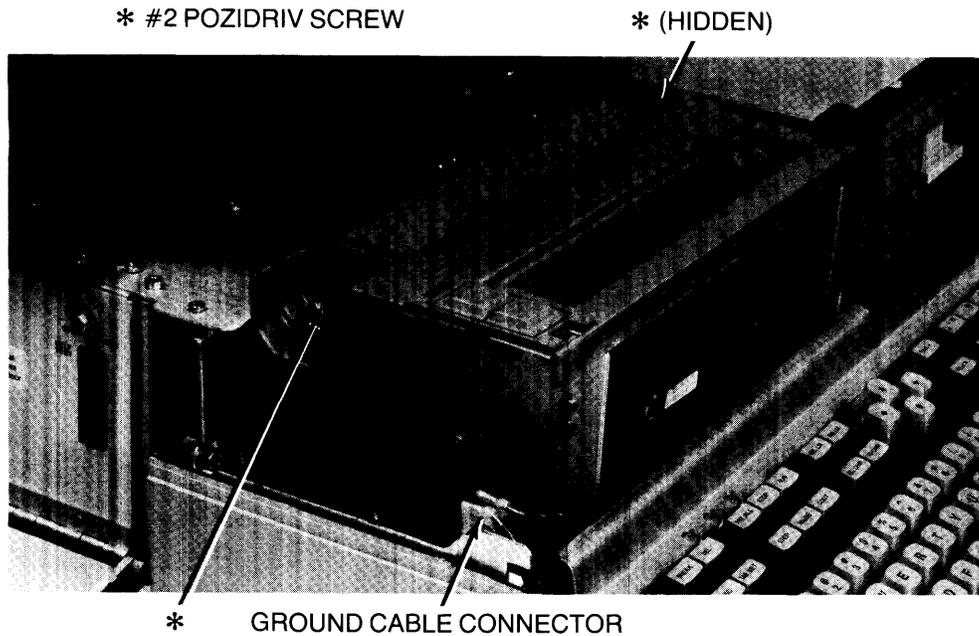
**Printer**

Several printer subassemblies are field-replaceable. These subassemblies are listed below, followed by their access procedures.

- Printhead
- Logic Board
- Motor Drive Board
- Paper Sensor Board
- Top-Of-Form/Paper Advance Switches Assembly

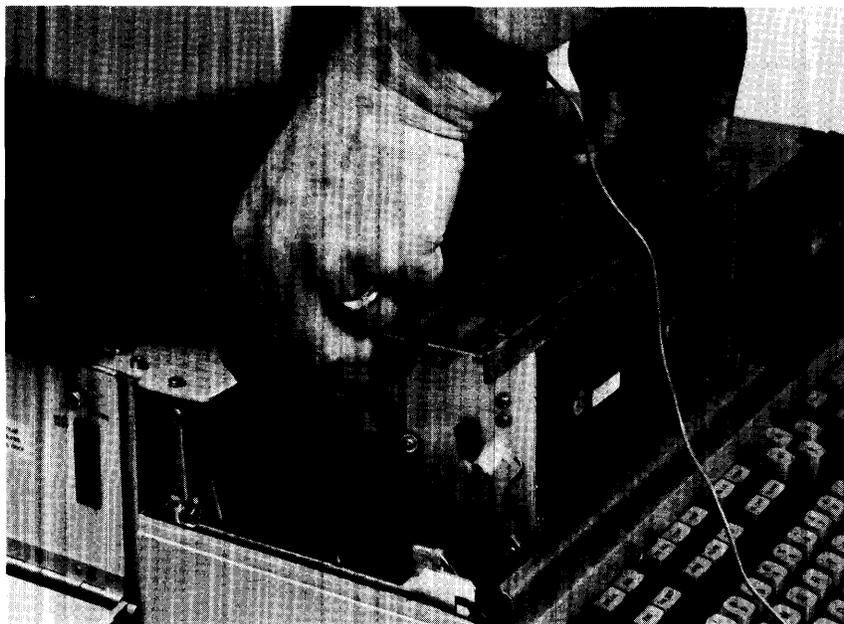
All subassemblies listed above require that the printer be removed from the computer. To remove the printer from the computer proceed as follows:

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove front cover as previously described.
3. Disconnect ground cable connector from lug on computer (Figure 4-34).



**Figure 4-34. Releasing Printer**

4. Loosen two #2 Pozidriv screws that attach printer to computer (Figure 4-34).
5. Grasp printer (Figure 4-35) and lift printer up and out of computer.



**Figure 4-35. Removing Printer**

### Printhead Assembly Removal

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove printer from computer as previously described, and set printer down in upright position.
3. From front of printer, completely remove two signal/power cables (Figure 4-36).
4. Remove #2 Pozidriv screw, washer, and nut that attach ground cable and strap to side of printer and remove ground cable (Figure 4-36).

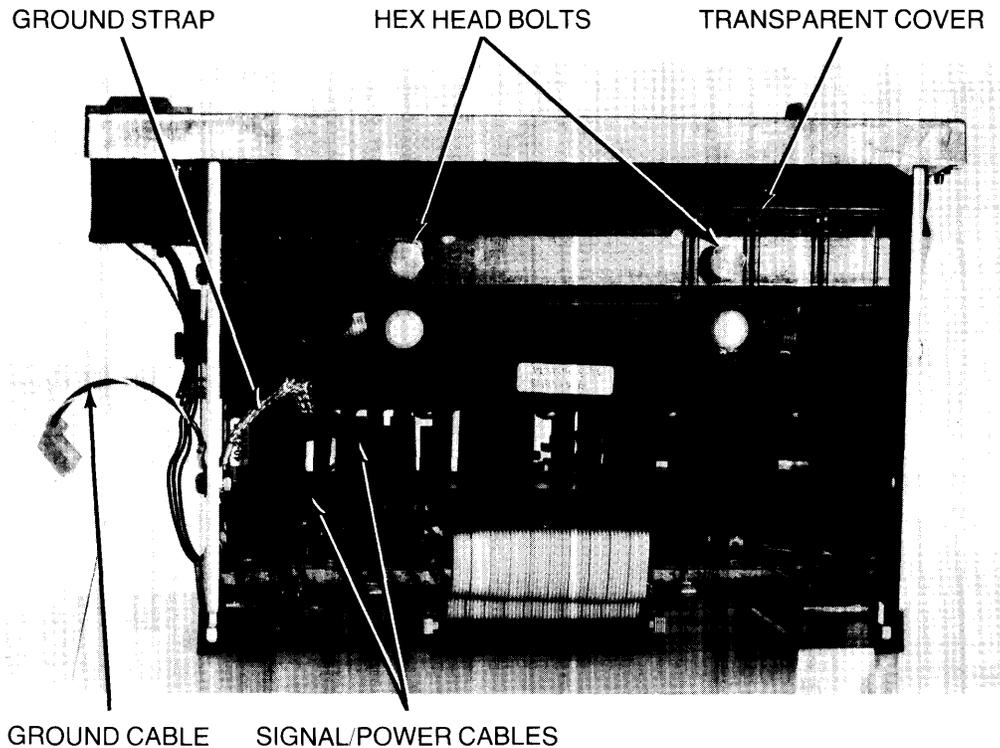


Figure 4-36. Disassembling Printer

5. Remove two 7/16-inch hex head bolts and associated springs that attach transparent cover to printer (Figure 4-36), and remove transparent cover (Figure 4-37).

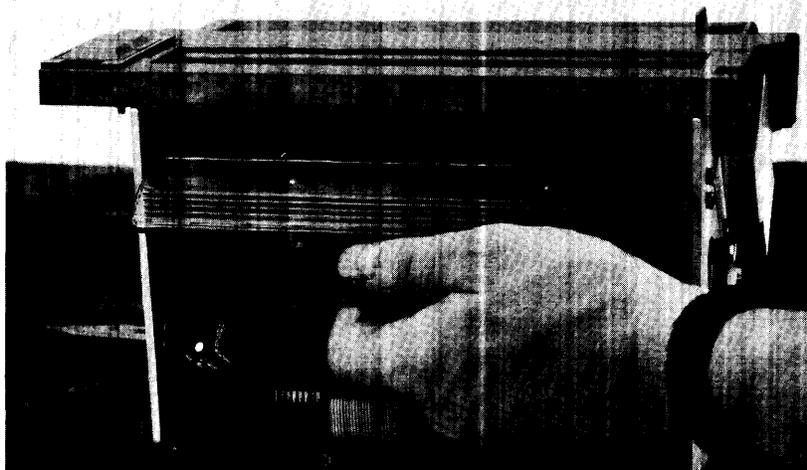


Figure 4-37. Removing Transparent Cover

- 6. Remove four #2 Pozidriv screws (two on each side of printer) that attach head load bar to printer (Figure 4-38) and remove head load bar (Figure 4-39).
- 7. Place printer on its back.

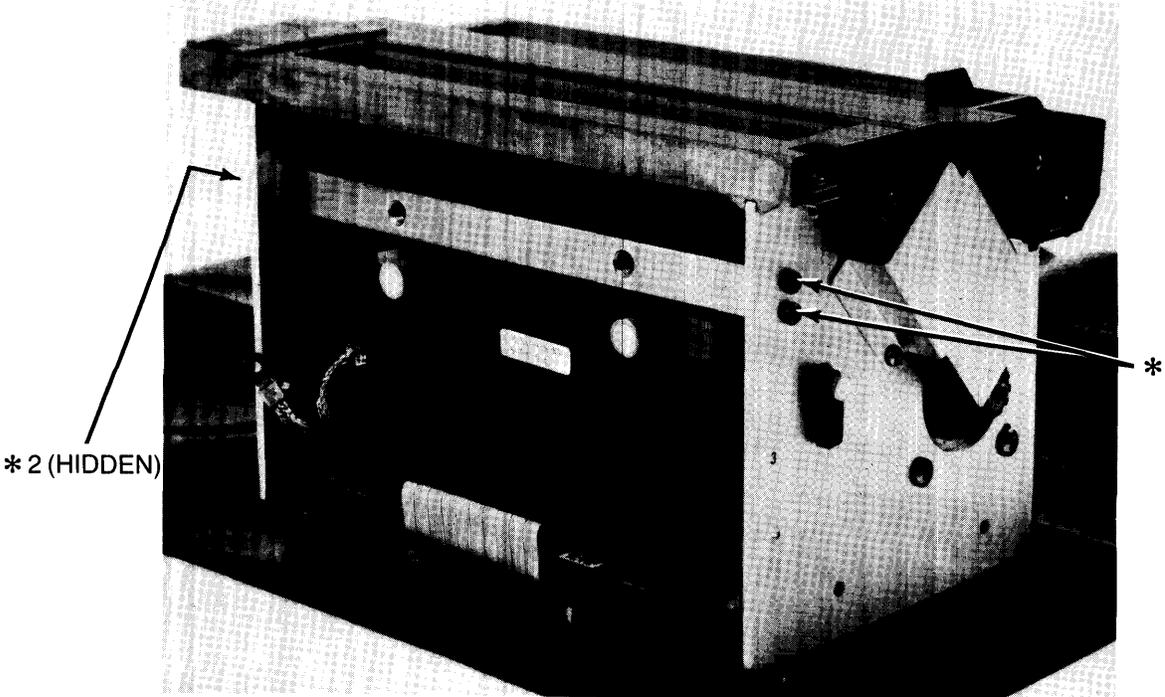


Figure 4-38. Releasing Head Load Bar

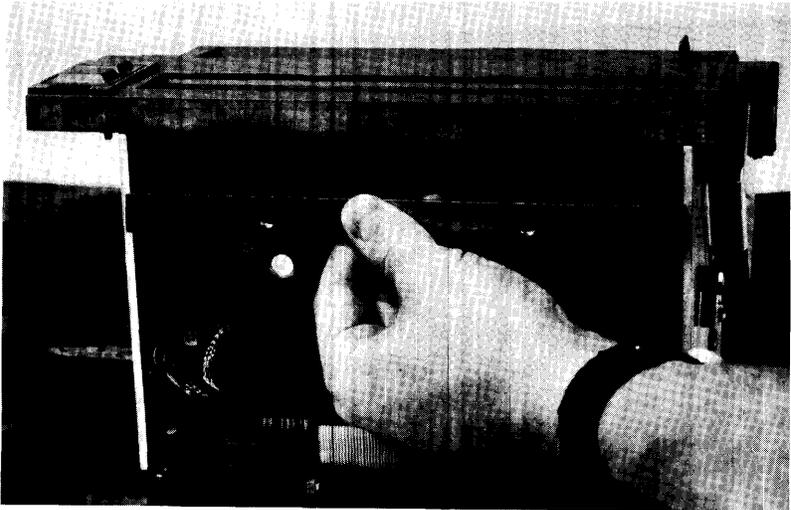


Figure 4-39. Removing Head Load Bar

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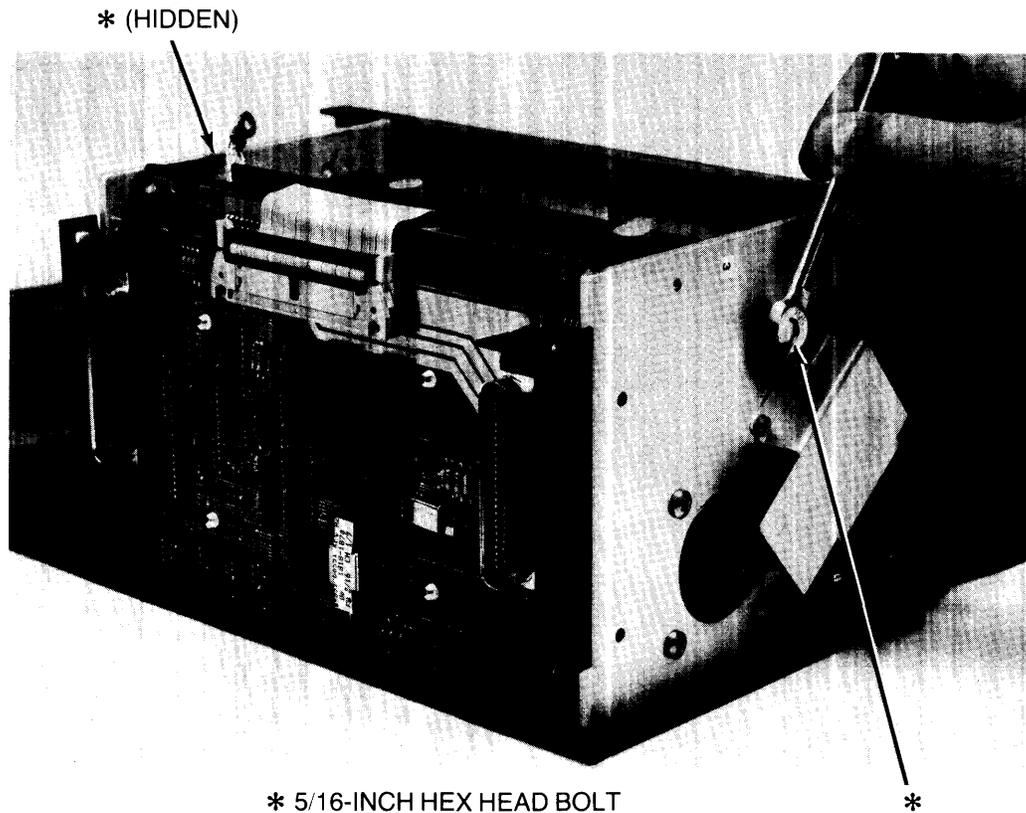
**CAUTION**

WHEN PERFORMING THE NEXT STEP, ENSURE THAT PRINT-HEAD ASSEMBLY DOES NOT DAMAGE MOTOR DRIVE BOARD BY SLIPPING OUT OF POSITION AND FALLING AGAINST BOARD.

DO NOT TOUCH PRINTHEAD RESISTOR AREA. DAMAGE TO THE PRINTHEAD COULD RESULT.

---

8. Remove two 5/16-inch hex head bolts (Figure 4-40), one from each side of printer, and pull printhead assembly straight out of printer.



**Figure 4-40. Removing Printhead**

---

**Reassembly Notes**

After installing printhead assembly and installing printer in the computer, set adjustment cams for optimum print quality.

Thoroughly clean transparent plastic cover before installing on printer. Underside of cover cannot be cleaned with cover in place.

---

### Printhead Assembly Access

The following procedure provides access to heat sinks, head backing plate, chip modules, printhead interconnect board, and the printhead.

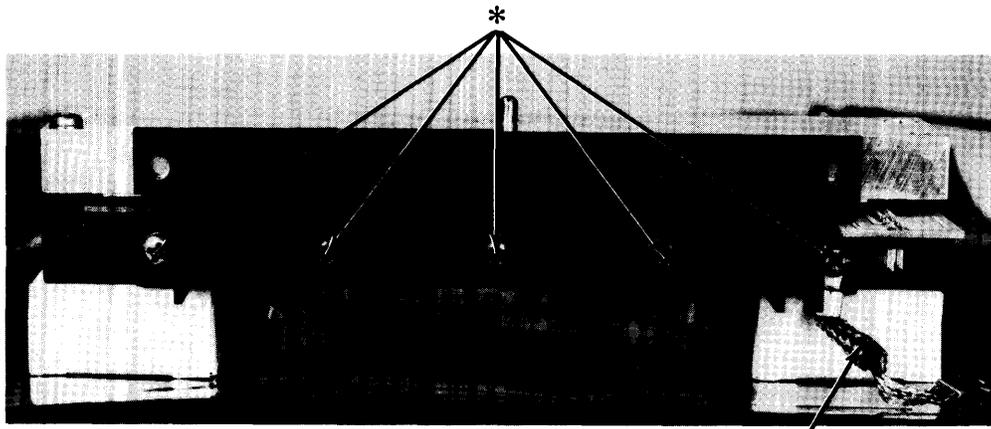
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#### CAUTION

DO NOT TOUCH PRINthead RESISTOR AREA WHEN PERFORMING THE FOLLOWING PROCEDURE OR DAMAGE TO THE PRINthead COULD RESULT.

---

1. Support printhead assembly at both ends for easy working access and to prevent damage to the capacitors (Figure 4-41).
2. Remove five #2 Pozidriv screws and lock washers that attach ground strap and two heat sinks to printhead assembly (Figure 4-41), and remove ground strap and heat sinks.



\* #2 POZIDRIV SCREW AND WASHER

GROUND STRAP

**Figure 4-41. Removing Heat Sinks**

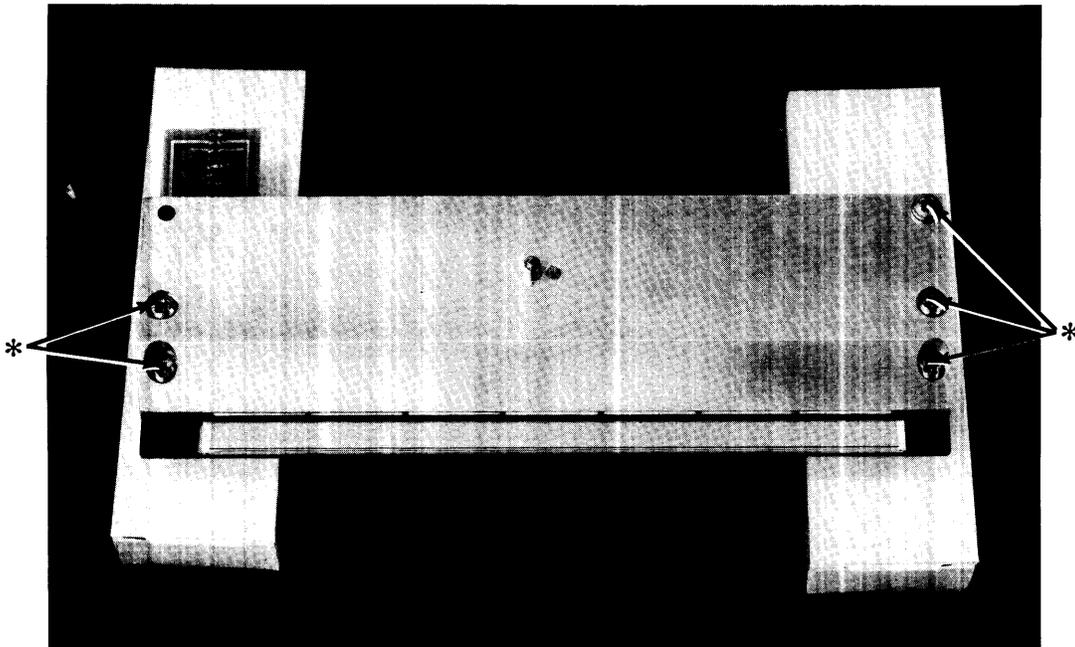
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**CAUTION**

AFTER REMOVING HEAD BACKING PLATE IN THE FOLLOWING STEP, TURN IT OVER AND PLACE IT ON ITS TOP. DAMAGE TO THE HEAD BACKING PLATE COULD RESULT FROM PLACING IT ON THE SURFACE THAT CONTACTS THE CHIP MODULES.

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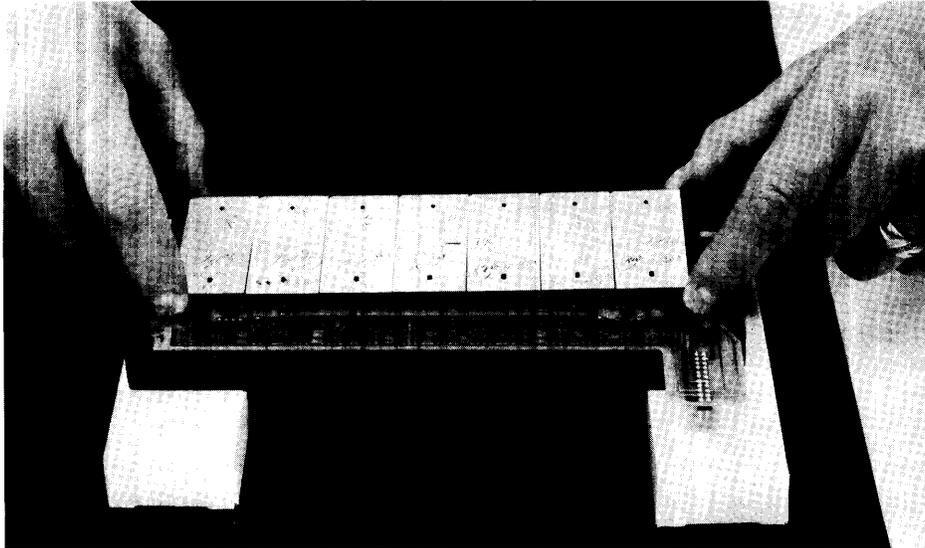
3. Remove five #2 Pozidriv screws and washers that attach head backing plate to printhead, and remove head backing plate (Figure 4-42). Turn head backing plate over and place on its top.



\* #2 POZIDRIV SCREW AND WASHER

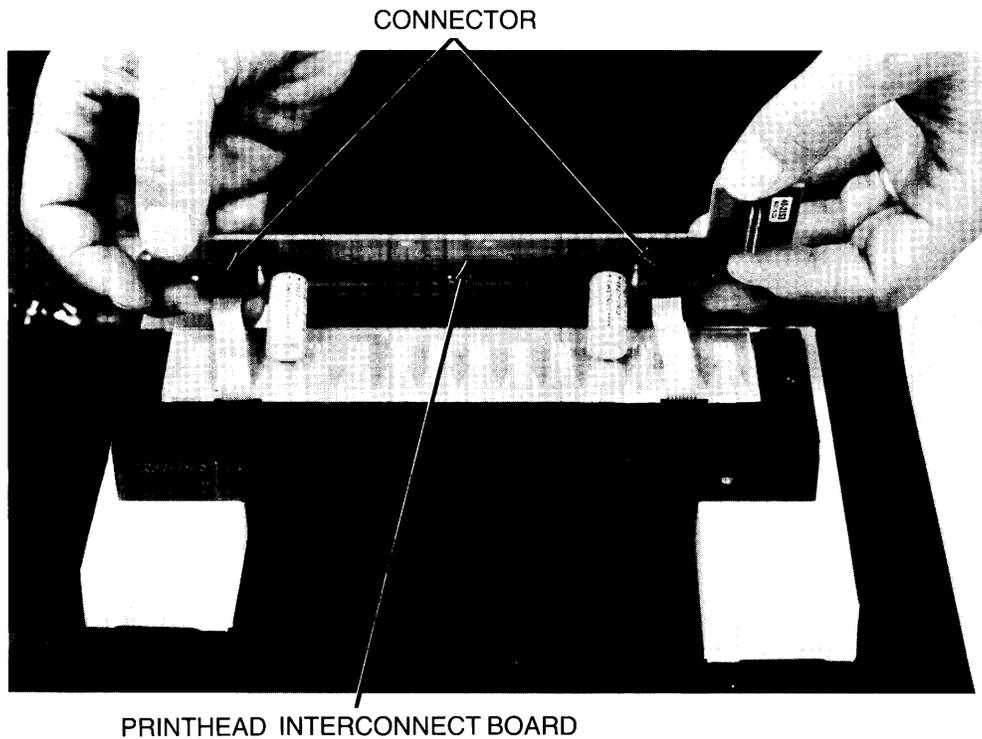
**Figure 4-42. Removing Head Backing Plate**

4. Remove chip carrier with chip modules in place by lifting at both ends (Figure 4-43).



**Figure 4-43. Removing Chip Carrier**

5. Remove printhead interconnect board by lifting at both ends and disconnecting two connectors from the board (Figure 4-44).



**Figure 4-44. Removing Printhead Interconnect Board**

---

**Reassembly Notes**

Two pins on bottom of chip module carrier must mate with two holes in printhead interconnect board. Otherwise, damage to chip modules could occur when head backing plate is replaced. Ensure chip modules are correctly seated and that chip module carrier and printhead interconnect board are flush with each other. Ensure that head backing plate is flush with chip modules before replacing screws. Do not force plate and modules to be flush or damage could result.

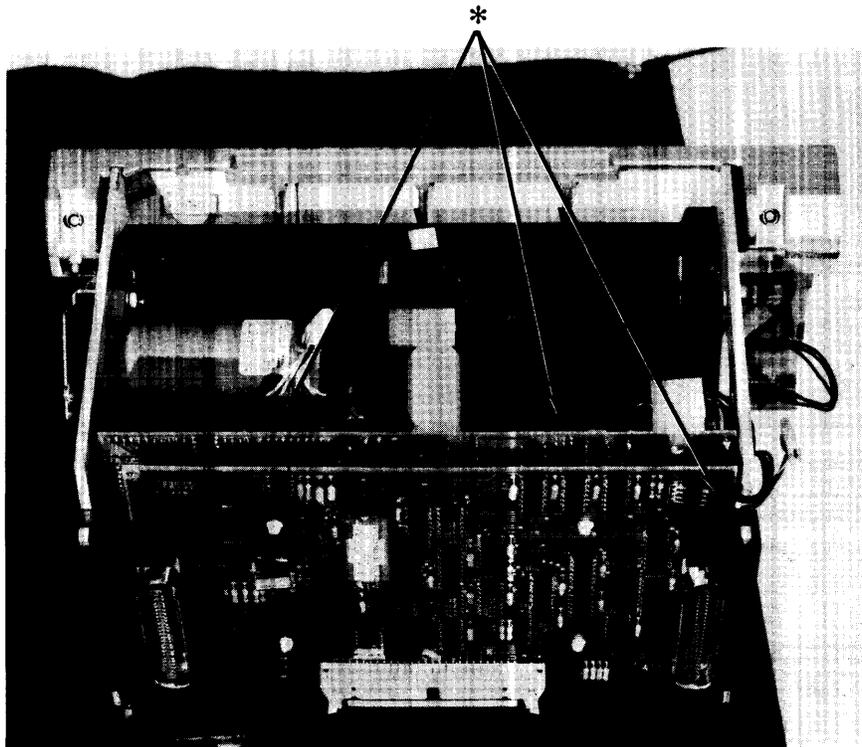
Remember to replace ground strap when installing heat sinks.

---

**Logic Board/Motor Drive Board**

To remove the printer and separate the logic board from the motor drive board, proceed as follows:

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove printer from computer as previously described.
3. From front of printer, disconnect two signal/power cables, one from each board (Figure 4-36).
4. Place printer on its front.
5. Disconnect three cables from the boards, two from motor drive board and one from logic board (Figure 4-45).



\* CABLE CONNECTOR

**Figure 4-45. Disconnecting Cables from Logic and Motor Drive Boards**

- 6. Pull the snap ends of the black plastic flanges slightly outward and slide boards up and out of printer (Figure 4-46).

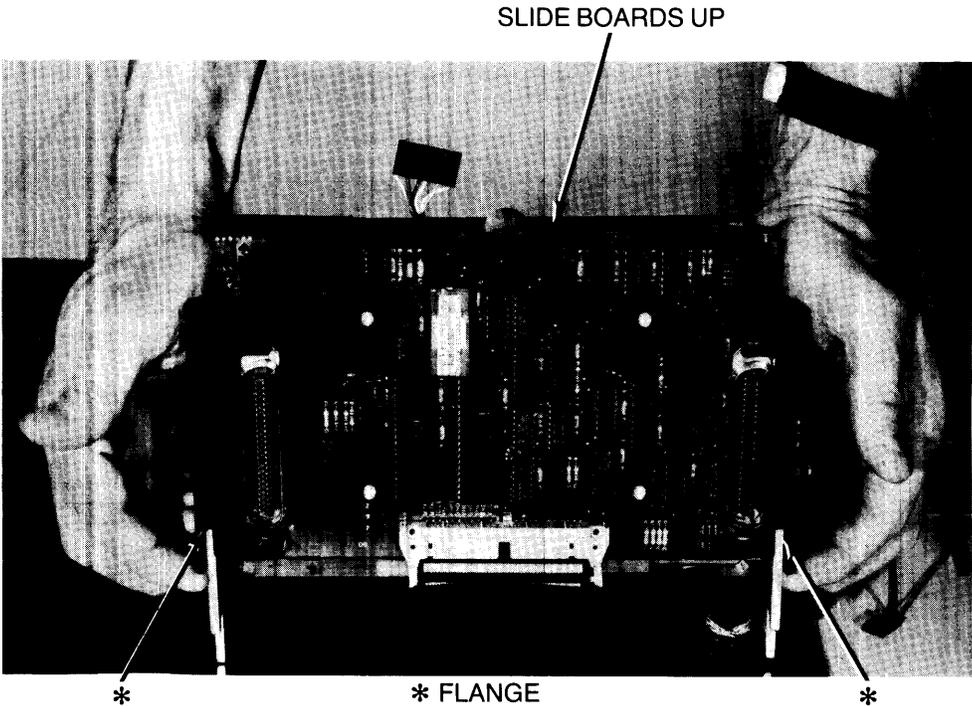


Figure 4-46. Removing Logic and Motor Drive Boards

- 7. Disconnect ribbon cable from logic board (Figure 4-47).
- 8. With needlenose pliers, squeeze four plastic pins that interconnect the two boards (Figure 4-47), force pins out of logic board, and lift logic board off motor drive board.

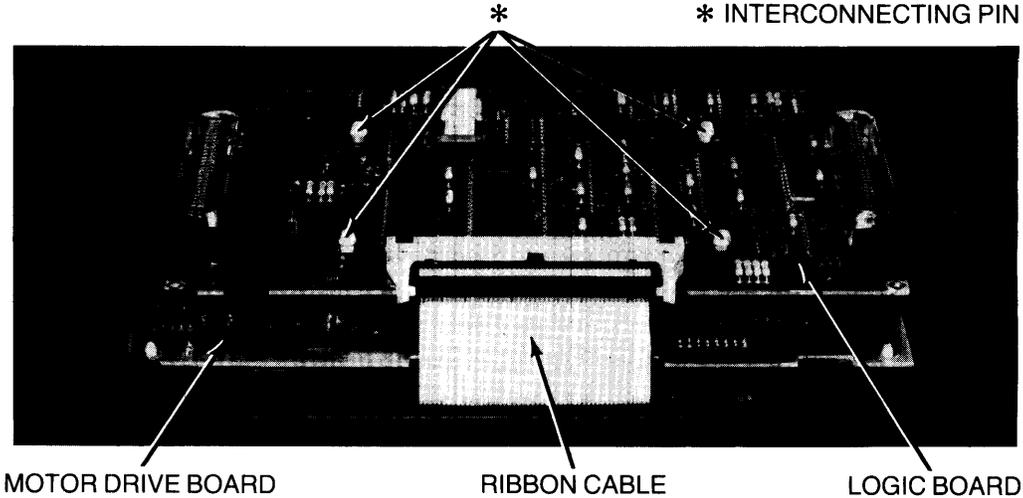


Figure 4-47. Separating Logic and Motor Drive Boards

### Paper Sensor Board

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove printer from computer as previously described.
3. From left side of printer, remove connector from paper sensor board (Figure 4-48).
4. Remove two #1 Pozidriv screws that attach paper sensor board to printer (Figure 4-48) and remove board.

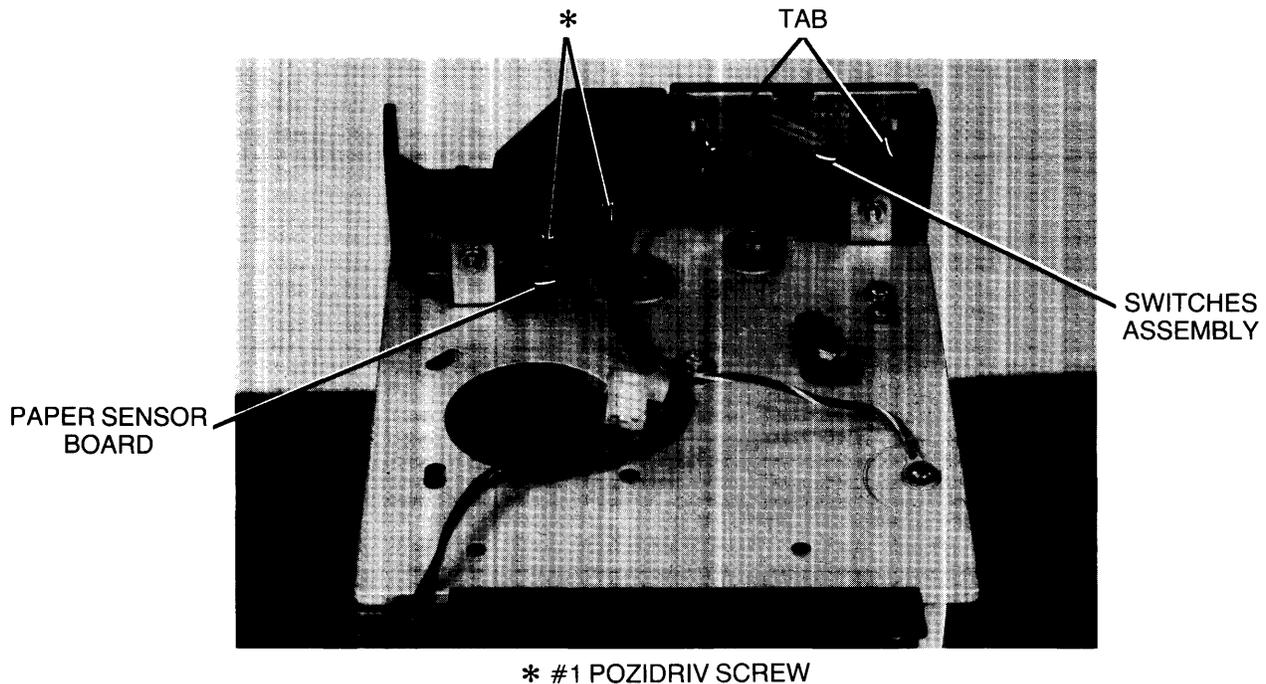


Figure 4-48. Removing Paper Sensor Board and Switches Assembly

### Top-Of-Form/Paper Advance Switches Assembly

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove printer from computer as previously described.
3. Disconnect cable connector from underside of switches assembly (Figure 4-48).
4. Squeeze in tabs on switches assembly to release tabs from slots, and slide switches assembly out of printer (Figure 4-48).

## 9130K Flexible Disc Drive

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove front cover as previously described.

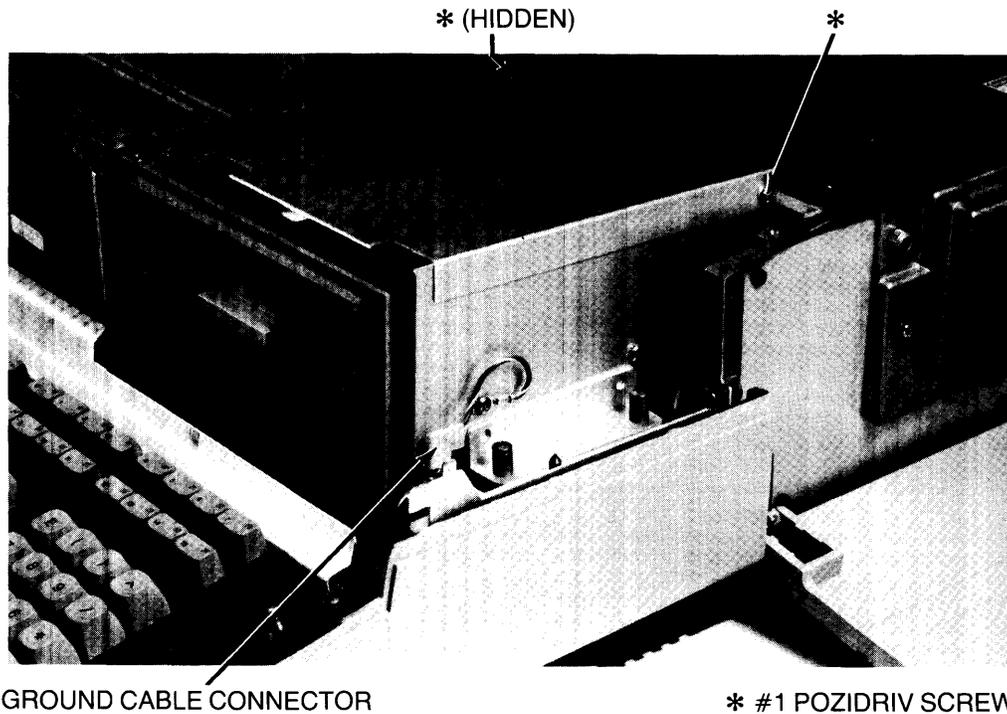
---

**Note**

Do not remove screws in following step. Loosen only far enough to remove top cover.

---

3. Loosen, but do not remove, two #1 Pozidriv screws that attach top cover to disc drive (Figure 4-49), and lift top cover off drive. Retain top cover for installation on replacement disc drive.
4. Disconnect ground cable from lug (Figure 4-49).



**Figure 4-49. Releasing Flexible Disc Drive**

5. Disconnect ribbon cable from drive and disconnect power cable from intermediate cable connector (Figure 4-50).
6. Loosen three #2 Pozidriv captive screws that attach disc drive to computer (Figure 4-50), and lift disc drive out of computer.

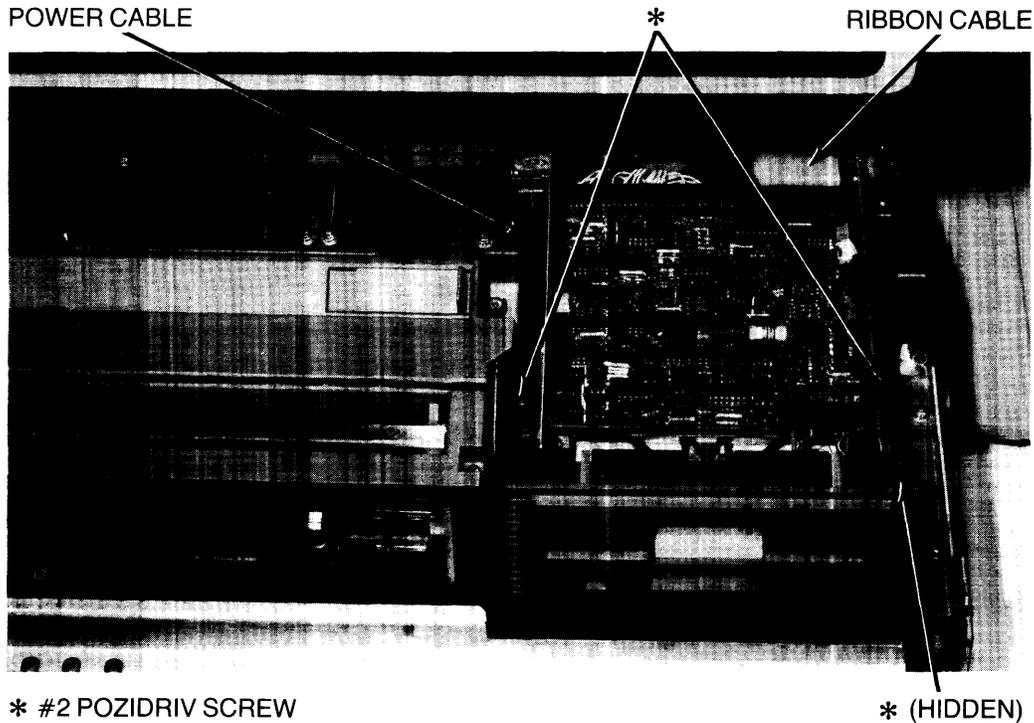


Figure 4-50. Removing Flexible Disc Drive

---

**Note**

If disc drive is being replaced, ensure that following three steps are performed. The top cover, bucket, power cable, ground cable, bezel, and all attaching screws are not shipped with replacement disc drive. These parts must be removed and retained for installation on the replacement drive.

---

---

**Note**

The screws removed in the following step are English. Keep these screws separate from other screws.

---

7. Remove four #2 Pozidriv screws (two per side) that attach bucket to drive (Figure 4-51) and lift drive out of bucket. Ground cable is removed in this step. Retain bucket, ground cable, and attaching screws for installation on replacement drive.

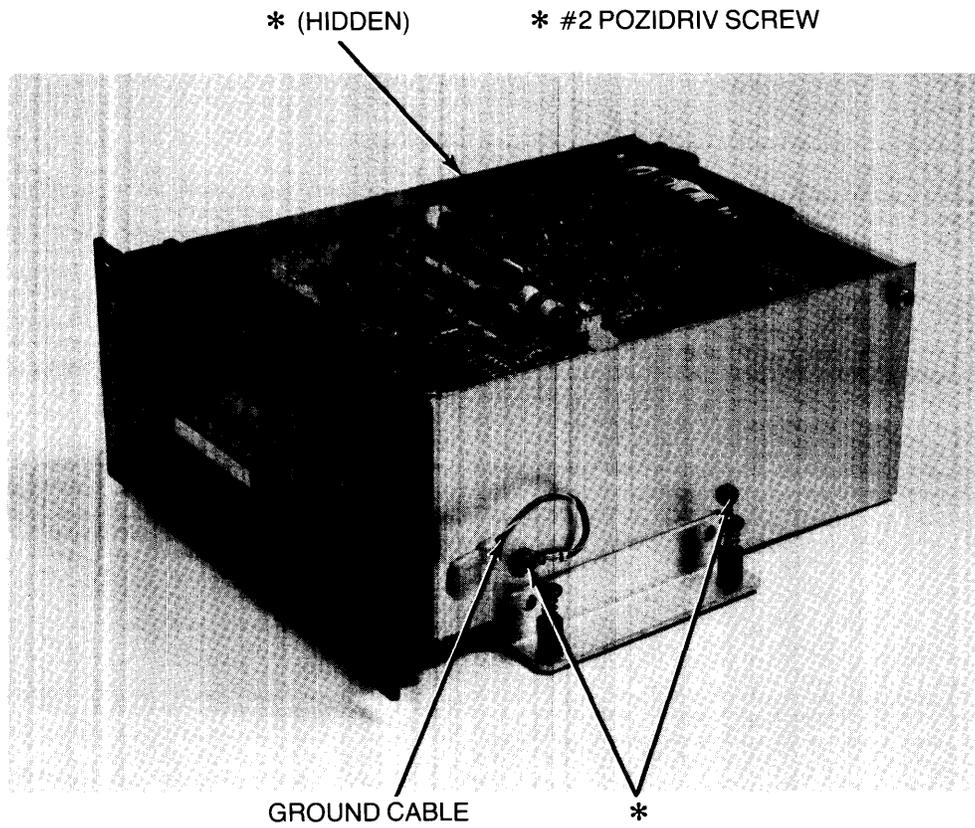
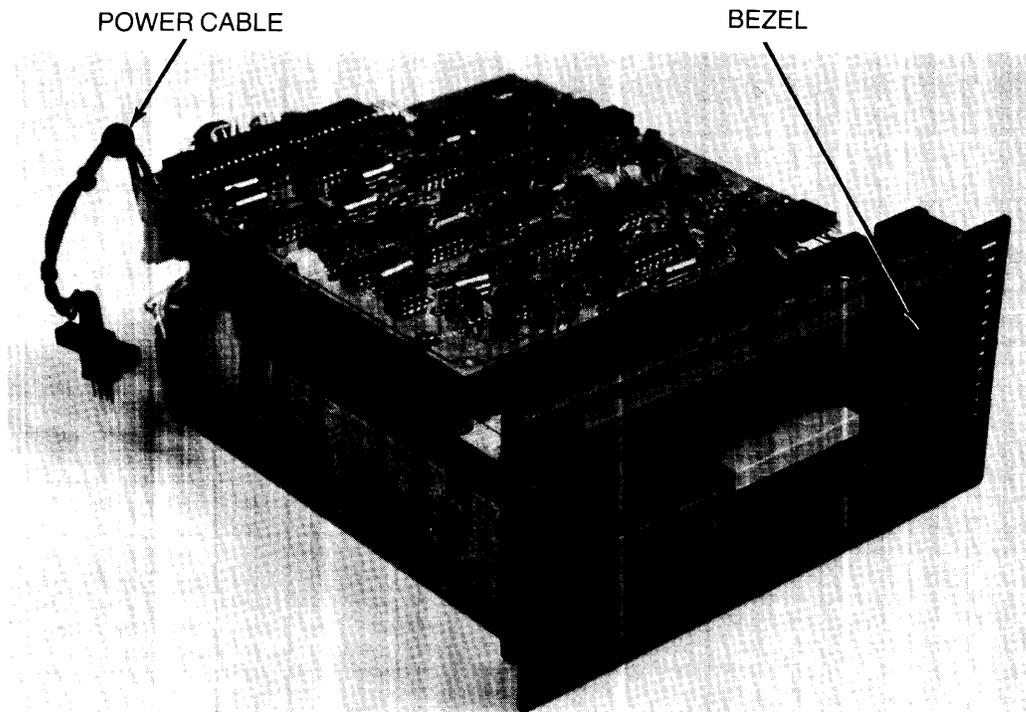


Figure 4-51. Disassembling Flexible Disc Drive, View 1

8. Remove bezel from drive (Figure 4-52) and retain for installation on replacement drive.
9. Remove power cable from drive board (Figure 4-52) and retain for installation on replacement drive.



**Figure 4-52. Disassembling Flexible Disc Drive, View 2**

---

**Reassembly Notes**

Cut and remove jumper wire on replacement disc drive before installing drive. Locate jumper wire on board at rear of drive. Cut wire near both connections, and remove and discard wire.

When installing disc drive, ensure that power cable is positioned so it is not pinched when the front cover is installed.

---

## Winchester Fixed Disc Drive

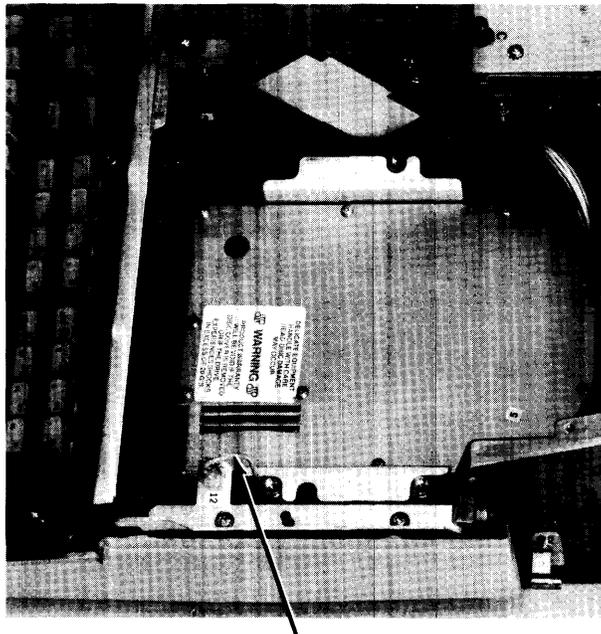
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**CAUTION**

THE WINCHESTER FIXED DISC DRIVE CAN BE DAMAGED WHEN SUBJECTED TO A SHOCK OF 10G OPERATING OR 20G NON-OPERATING. SHIP FAILED DRIVE IN PACKING MATERIAL AND CARTON USED FOR REPLACEMENT DRIVE.

---

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove the 9130K Flexible Disc Drive according to the preceding procedure.
3. Disconnect the Winchester Fixed Disc Drive ground cable from the chassis lug (Figure 4-53).



GROUND CABLE

**Figure 4-53. Releasing Fixed Disc Drive**

---

**CAUTION**

WHEN PERFORMING THE FOLLOWING STEP, MOVE DRIVE JUST FAR ENOUGH TO DISCONNECT CABLES. OTHERWISE, YOU COULD DAMAGE CONNECTORS.

---

4. Lift disc drive, disconnect power cable from motherboard and both ribbon cables from drive (Figure 4-54), and remove drive from computer.

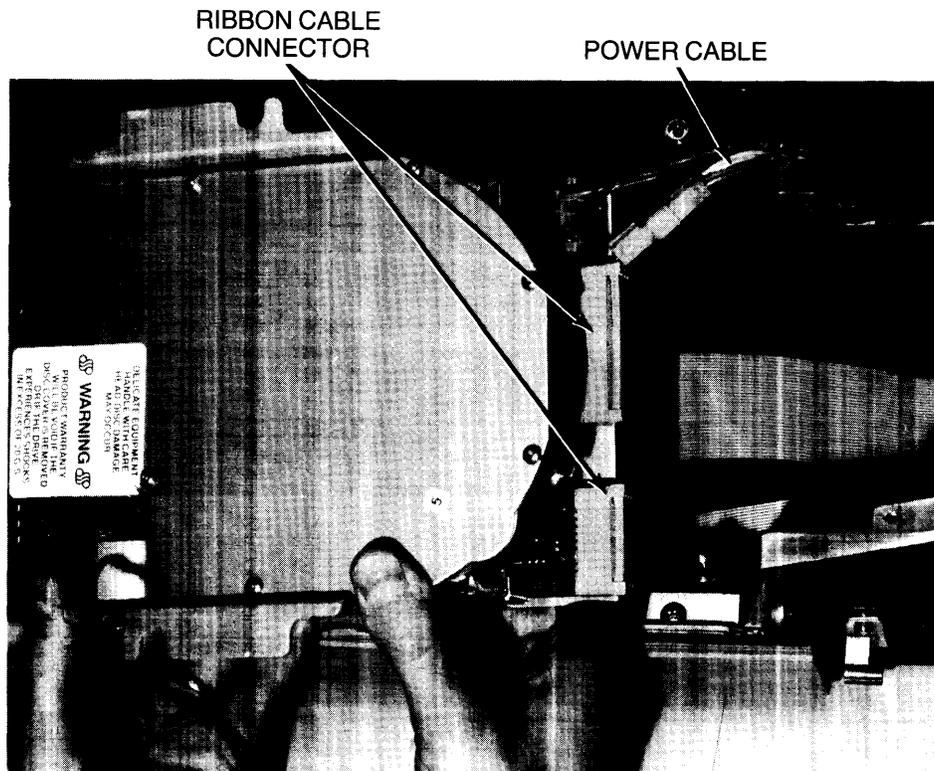


Figure 4-54. Removing Fixed Disc Drive

---

**Note**

If disc drive is being replaced, ensure that you perform the following step. The side mounting brackets, bottom plate, ground cable, and attaching screws are not shipped with replacement disc drive. These parts must be removed and retained for installation on the replacement drive.

---

5. Remove side mounting brackets and attached ground cable by removing the two #2 Pozidriv screws that attach each bracket to the drive (Figures 4-55 and 4-56). Remove bottom plate by removing the four #2 Pozidriv screws that attach plate to drive. Remove power cable by disconnecting both connectors (Figure 4-56). Retain brackets, ground cable, bottom plate, power cable, and attaching screws for installation on the replacement drive.

---

**Reassembly Note**

Ensure replacement disc drive is initialized after installation.

---

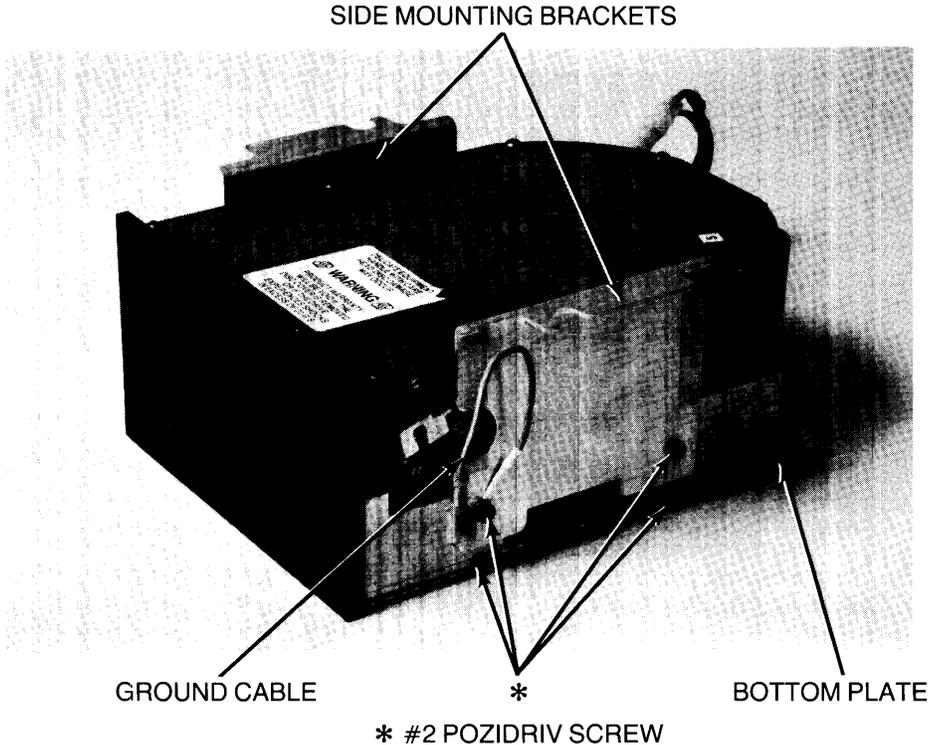


Figure 4-55. Disassembling Fixed Disc Drive, View 1

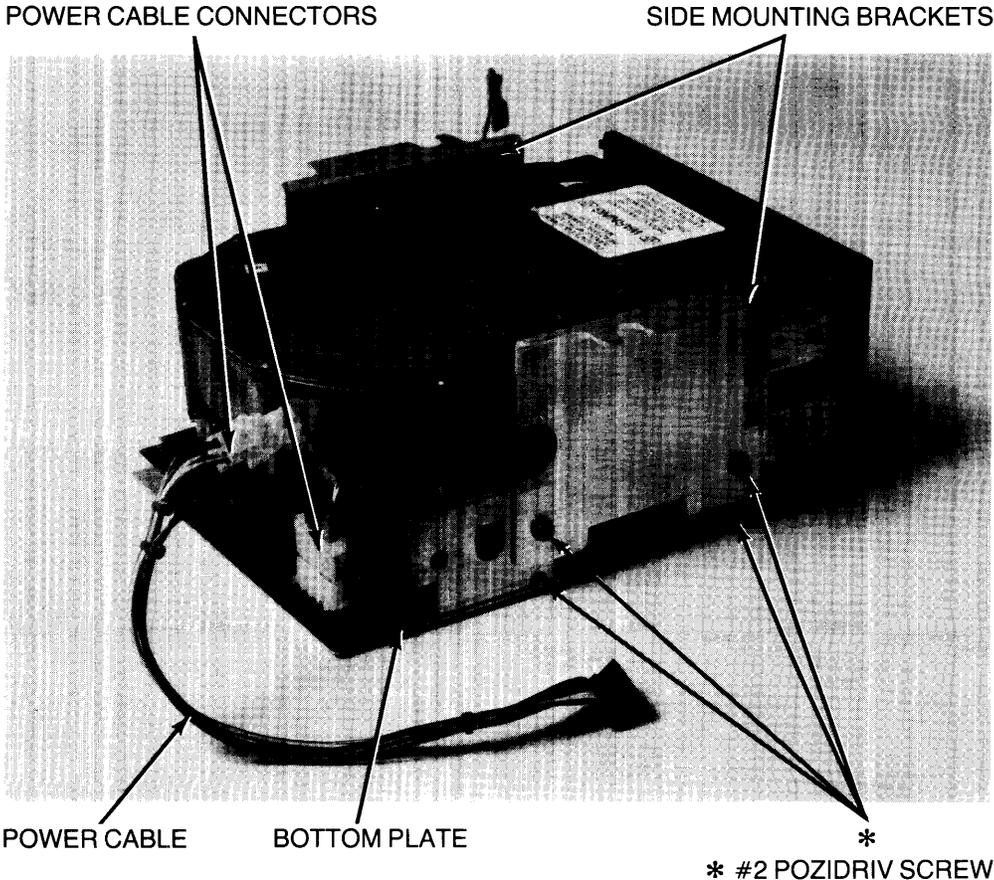


Figure 4-56. Disassembling Fixed Disc Drive, View 2

## Power Supply Assembly

---

**WARNING**

ENSURE THAT POWER SWITCH IS OFF AND THAT COMPUTER POWER CORD IS UNPLUGGED FROM AC OUTLET BEFORE REMOVING POWER SUPPLY.

---

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove front and rear covers from computer as previously described.

---

**WARNING**

WHEN POWER SUPPLY IS REMOVED FROM COMPUTER, YOU ARE EXPOSED TO LETHAL VOLTAGE FROM POWER SUPPLY CAPACITORS. DISCHARGE POWER SUPPLY CAPACITORS ACCORDING TO THE FOLLOWING STEPS. FAILURE TO FOLLOW THESE PROCEDURES COULD RESULT IN INJURY OR DEATH.

---

3. Familiarize yourself with the power supply discharge tool, HP PN 09855-67004, if you have not previously used it. The discharge tool consists of a meter and a switch-operated discharger. The meter indicates the approximate voltage across the energy storage capacitors in the power supply.

---

**WARNING**

WHEN PERFORMING THE NEXT STEP, ENSURE THAT NO METAL OBJECTS ARE IN YOUR HAND OR ON THE POWER SUPPLY. THE DISCHARGE TOOL PINS WILL HAVE HIGH VOLTAGE ACROSS THEM.

---

4. Carefully insert discharge tool pins directly into SAFETY DISCHARGE holes on top of power supply until tool rests on power supply lid (Figure 4-57). Little force is required if tool is straight when inserted. The meter gives an approximate indication of voltage across capacitors.

---

**WARNING**

ALTHOUGH THE DISCHARGE TOOL SWITCH CAN BE MOVED IN EITHER DIRECTION, THE TOOL DISCHARGES THE SUPPLY ONLY WHEN THE SWITCH IS PUSHED DOWN.

---

---

**CAUTION**

DO NOT USE DISCHARGE TOOL FOR MORE THAN TWO DISCHARGES IMMEDIATELY FOLLOWING ONE ANOTHER.

---

5. Push discharge tool switch down and hold down to discharge capacitors (Figure 4-57). Discharging takes a few seconds. Meter movement can be observed as switch is held down until capacitors are completely discharged.
6. Carefully remove discharge tool by pulling straight out of power supply.

---

**WARNING**

IF DISCHARGE TOOL IS NOT AVAILABLE, ALLOW 15 MINUTES FOR THE POWER SUPPLY TO DISCHARGE BEFORE CONTINUING.

---

PUSH SWITCH DOWN  
TO DISCHARGE  
POWER SUPPLY

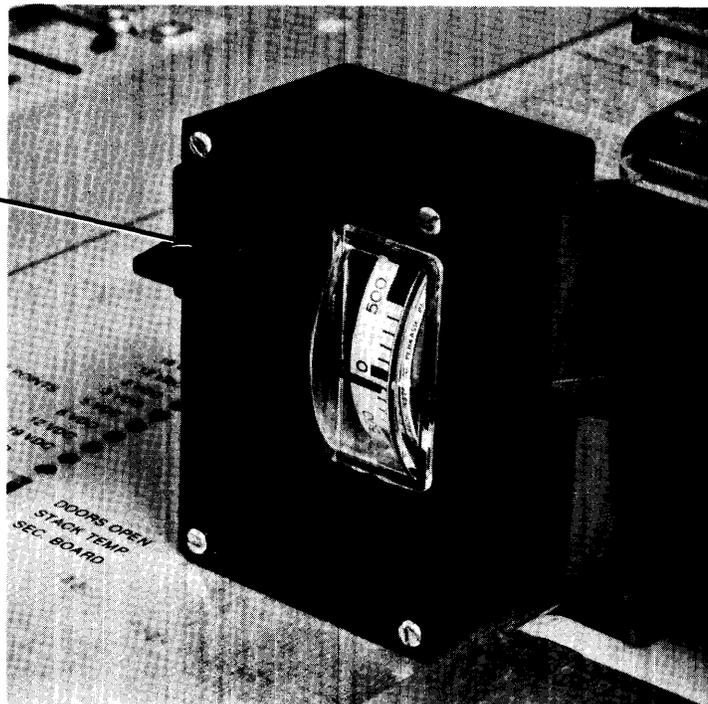


Figure 4-57. Discharging Power Supply Assembly

4-56 Assembly Access

7. Disconnect power supply cable from ac module (Figure 4-58).
8. Disconnect safety ground cable from lug on ac module (Figure 4-58).
9. Loosen four #2 Pozidriv captive screws that attach power supply to computer (Figure 4-58).

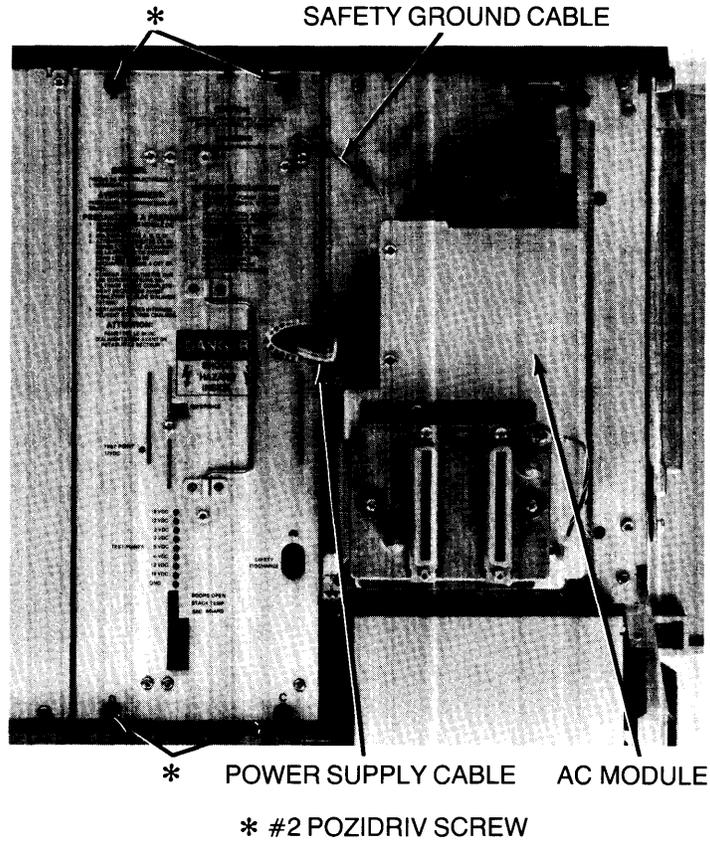


Figure 4-58. Releasing Power Supply Assembly

10. Lift power supply straight up and out of computer (Figure 4-59).

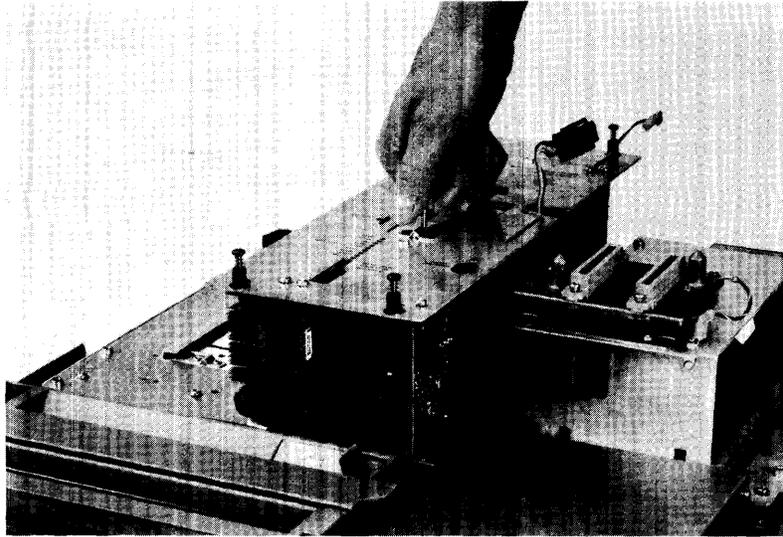


Figure 4-59. Removing Power Supply Assembly

## Power Cord

---

### Voltage Conversion Note

If you are converting from 110V to 220V or vice versa, the power cord, power switch assembly, and power cable must be changed. Refer to Chapter 5 for 110V and 220V part numbers for all parts.

---



---

### WARNING

AFTER REPLACING THE POWER CORD, PERFORM CONTINUITY TEST BETWEEN POWER CORD GROUND AND METAL CHASSIS. RECORD RESULTS ON REPAIR ORDER.

---

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove rear cover as previously described.
3. Remove #2 Pozidriv screw that attaches transparent plastic cover to ac module (Figure 4-60), and remove cover.
4. Remove three nuts that attach power cord wires to ac module terminals and remove power cord (Figure 4-60).

---

### WARNING

THE REPLACEMENT CORD MUST HAVE THE SAME POLARITY AS THE ORIGINAL. OTHERWISE, A SAFETY HAZARD FROM ELECTRICAL SHOCK TO PERSONNEL, WHICH COULD RESULT IN INJURY OR DEATH, MIGHT EXIST. IN ADDITION, THE EQUIPMENT COULD BE SEVERELY DAMAGED IF EVEN A RELATIVELY MINOR FAILURE OCCURRED.

---

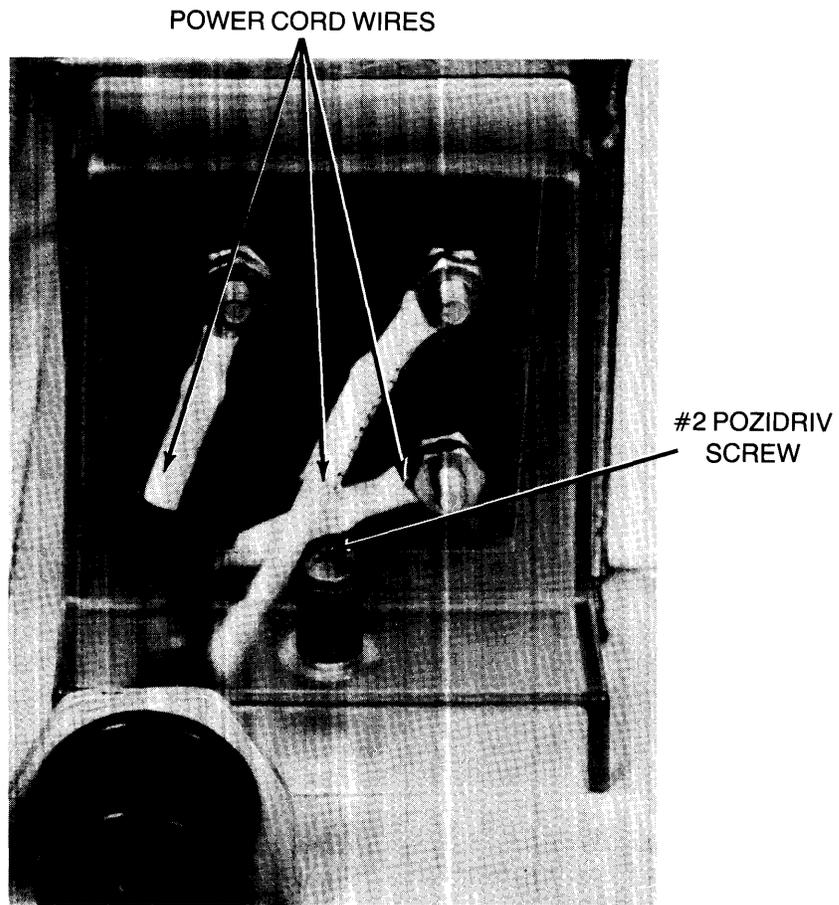


Figure 4-60. Removing Ac Power Cord

## Ac Module

---

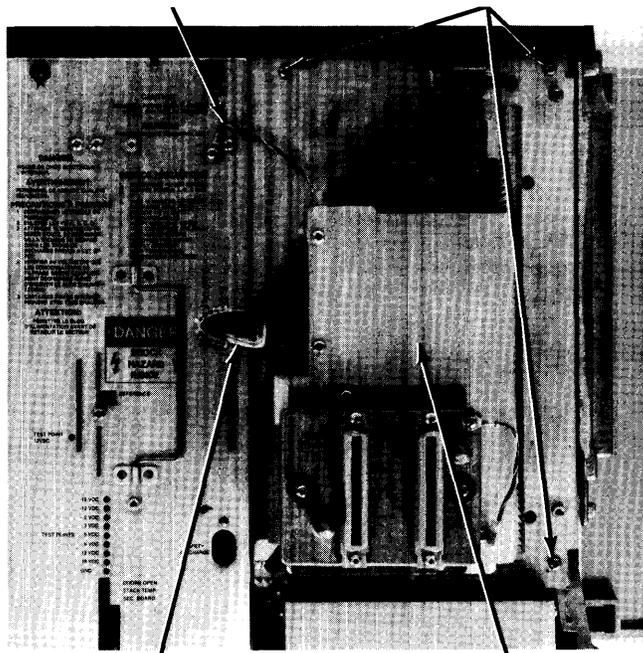
### WARNING

AFTER REPLACING THE AC MODULE, PERFORM CONTINUITY TEST BETWEEN POWER CORD GROUND AND METAL CHASSIS. RECORD RESULTS ON REPAIR ORDER.

---

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove front and rear covers as previously described.
3. Disconnect power supply cable and safety ground cable from ac module (Figure 4-61).

SAFETY GROUND CABLE #2 POZIDRIV SCREW



POWER SUPPLY CABLE

AC MODULE

**Figure 4-61. Releasing Ac Module**

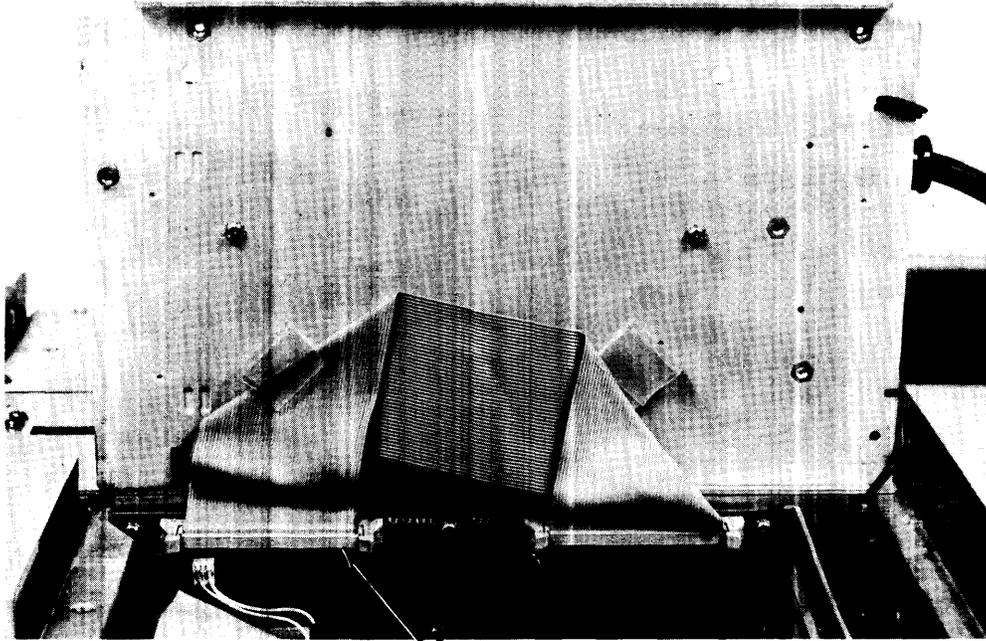
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### CAUTION

DO NOT LIFT AC MODULE UNTIL RIBBON CABLES HAVE BEEN DISCONNECTED FROM I/O BACKPLANE AS DESCRIBED IN THE NEXT TWO STEPS.

---

4. Remove three #2 Pozidriv screws that attach ac module to computer (Figure 4-61), and roll ac module onto its side.
5. Disconnect ribbon cable connectors from P1 and P2 on the I/O backplane (Figure 4-62), and remove ac module.



RIBBON CABLE CONNECTORS

**Figure 4-62. Removing Ac Module**

## Line Filter

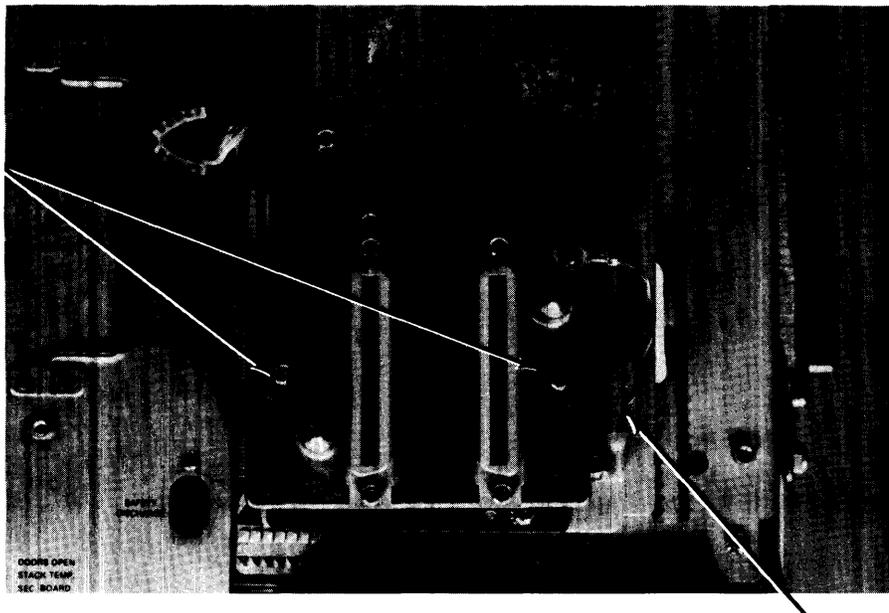
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### WARNING

AFTER REPLACING THE LINE FILTER, PERFORM CONTINUITY TEST BETWEEN POWER CORD GROUND AND METAL CHASSIS. RECORD RESULTS ON REPAIR ORDER.

---

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove front and rear covers as previously described.
3. Disconnect power cord from ac module as previously described.
4. Disconnect ground cable from ac module cover (Figure 4-63).
5. Remove two #2 Pozidriv screws that attach display connector assembly to ac module cover (Figure 4-63), and roll connector assembly onto top of power supply.

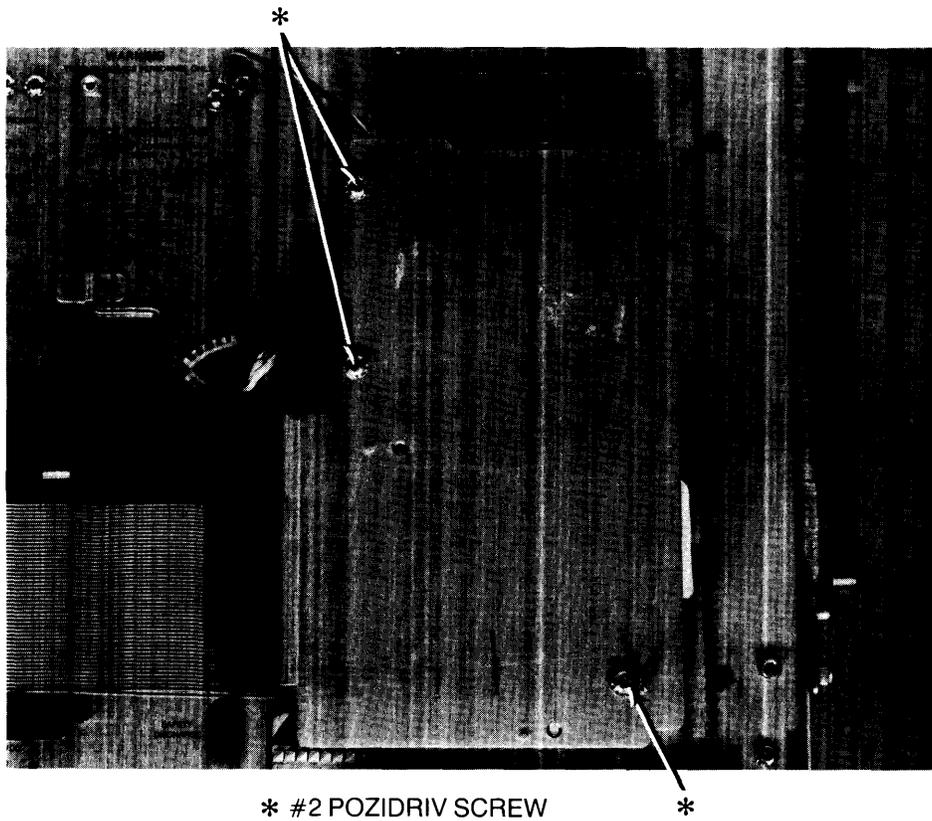


\* #2 POZIDRIV SCREW

GROUND CABLE

Figure 4-63. Removing Display Connector Assembly

6. Remove three #2 Pozidriv screws that attach top cover to ac module (Figure 4-64), and remove cover.



**Figure 4-64. Removing Ac Module Cover**

7. Disconnect two line filter wires from power switch assembly lugs (Figure 4-65). Note that blue wire is on top lug and brown wire on bottom lug.

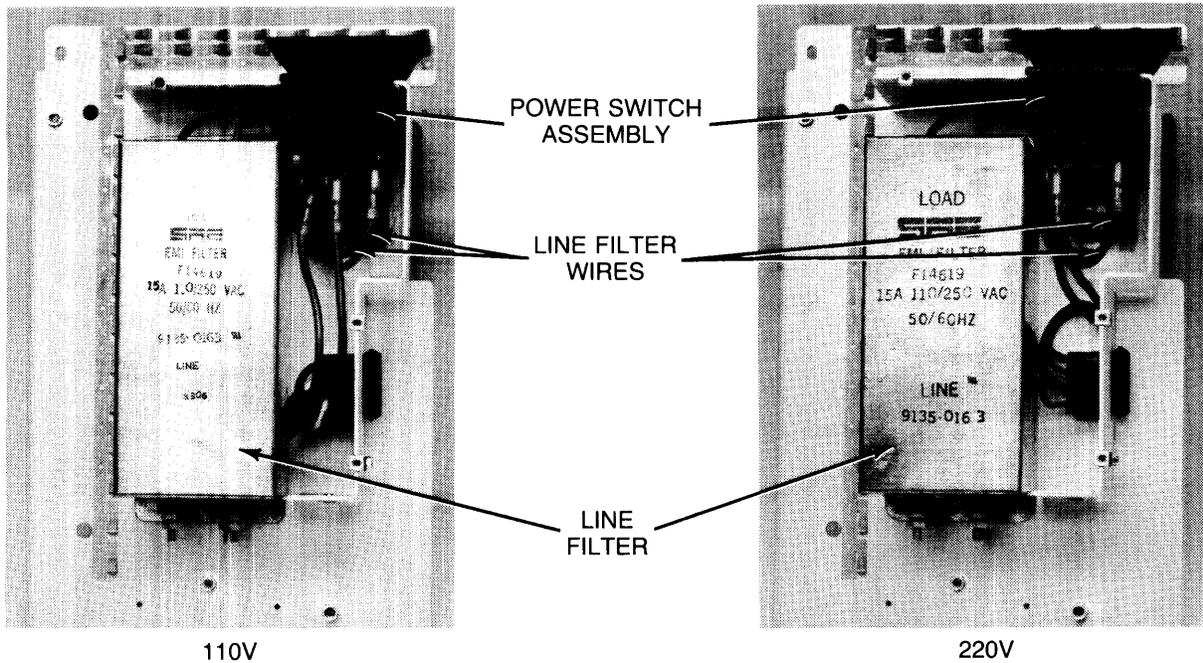
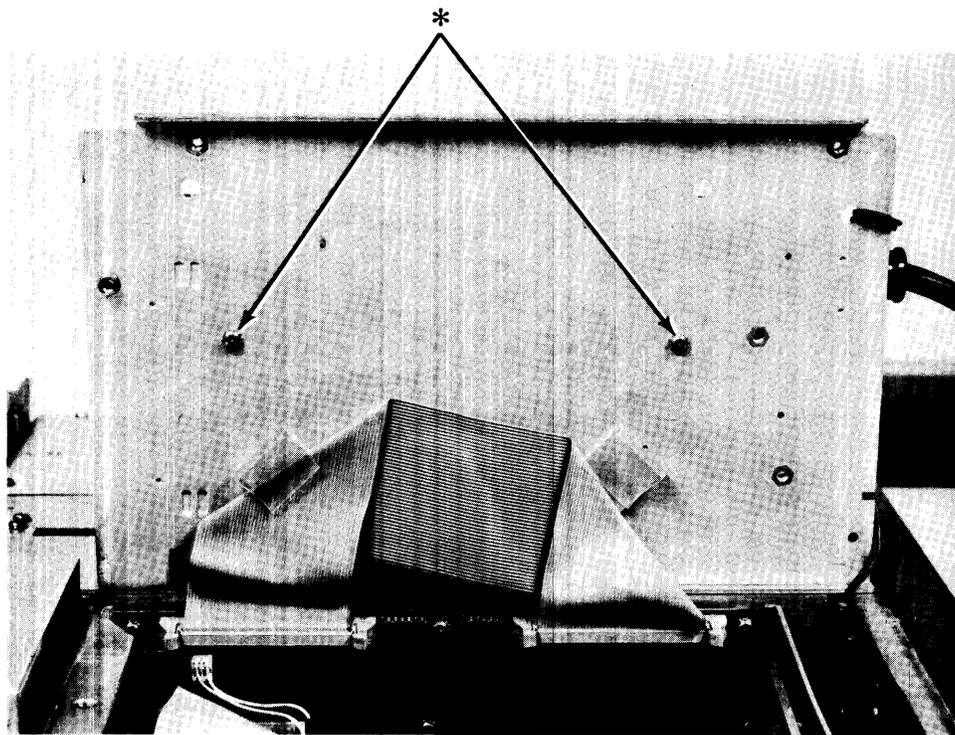


Figure 4-65. Disconnecting Line Filter Wires

8. Remove three #2 Pozidriv screws that attach ac module base to chassis (Figure 4-61), and roll ac module onto power supply.
9. Remove two #2 Pozidriv screws that attach line filter to ac module (Figure 4-66), and remove line filter.



\* #2 POZIDRIV SCREW

Figure 4-66. Removing Line Filter

## Power Switch Assembly/Ac Module Cable

---

### Voltage Conversion Note

If you are converting from 110V to 220V or vice versa, the power cord, power switch assembly, and ac module cable must be changed. Refer to Chapter 5 for appropriate 110V and 220V part numbers for all parts.

---

---

### WARNING

AFTER REPLACING THE POWER SWITCH ASSEMBLY, PERFORM CONTINUITY TEST BETWEEN POWER CORD GROUND AND METAL CHASSIS. RECORD RESULTS ON REPAIR ORDER.

---

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove front and rear covers as previously described.
3. Disconnect ground cable from ac module cover (Figure 4-63).
4. Remove two #2 Pozidriv screws that attach display connector assembly to ac module cover (Figure 4-63), and roll connector assembly onto top of power supply.
5. Remove three #2 Pozidriv screws that attach top cover to ac module (Figure 4-64), and remove cover.
6. If removing power switch assembly, slide assembly up and onto top of ac module (Figure 4-67) and disconnect all wires from the back of power switch assembly.

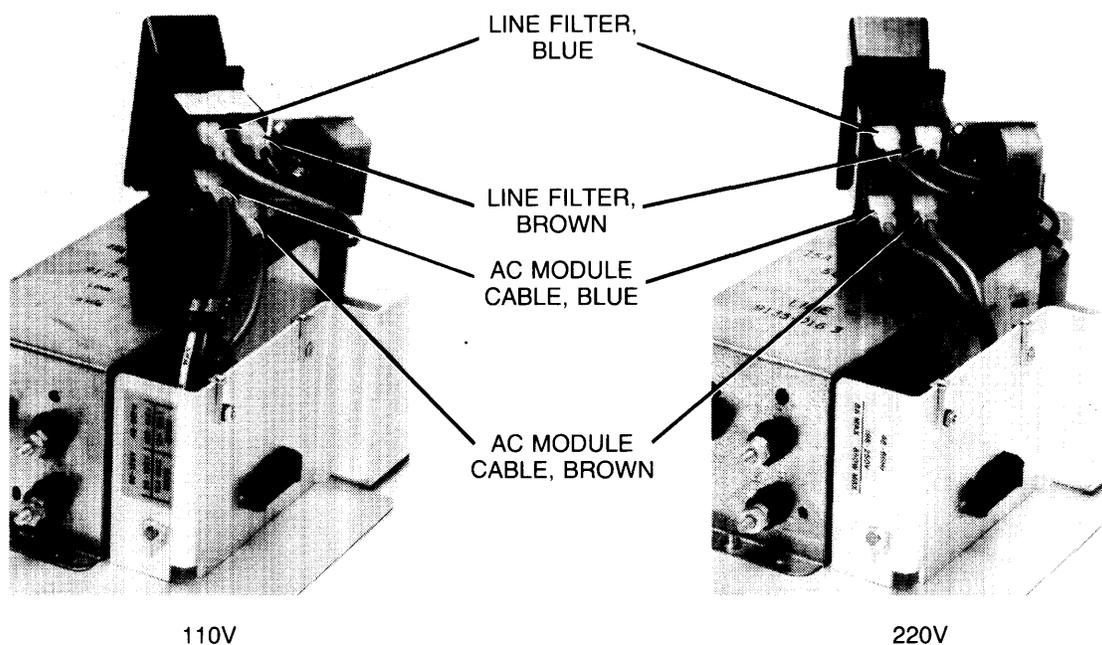


Figure 4-67. Removing Power Switch Assembly

7. If removing ac module cable, disconnect cable connectors from power switch assembly lugs (Figure 4-67) and remove cable.

---

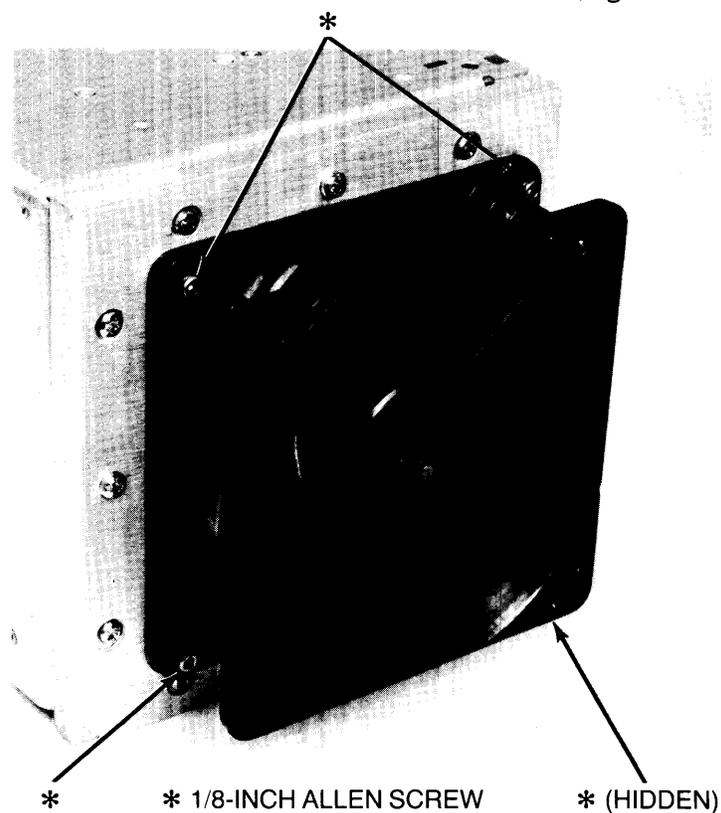
**Reassembly Note**

Ensure wires are attached to the replacement power switch assembly as shown in Figure 4-67.

---

## Processor Stack Fan

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove processor stack by performing steps 2 through 11 of the Processor Stack Motherboard procedure previously provided.
3. Remove four 1/8-inch Allen screws that attach fan to stack (Figure 4-68), and remove fan.



**Figure 4-68. Removing Processor Stack Fan**

---

**Reassembly Note**

Install replacement fan on stack with airflow direction arrow pointing out (away from stack) and plug receptacle in upper right corner of fan as viewed from rear of stack.

Ensure proper polarity of fan and fan cable.

---

## Power Supply Fan

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove power supply from computer as previously described.
3. Disconnect power cable plug from power supply fan (Figure 4-69).

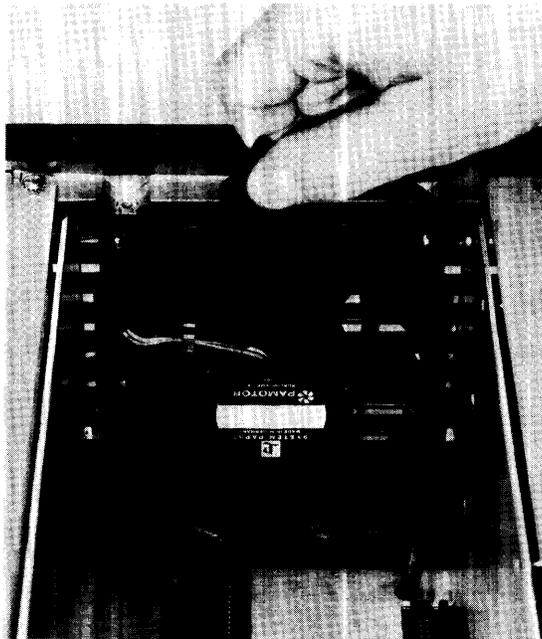
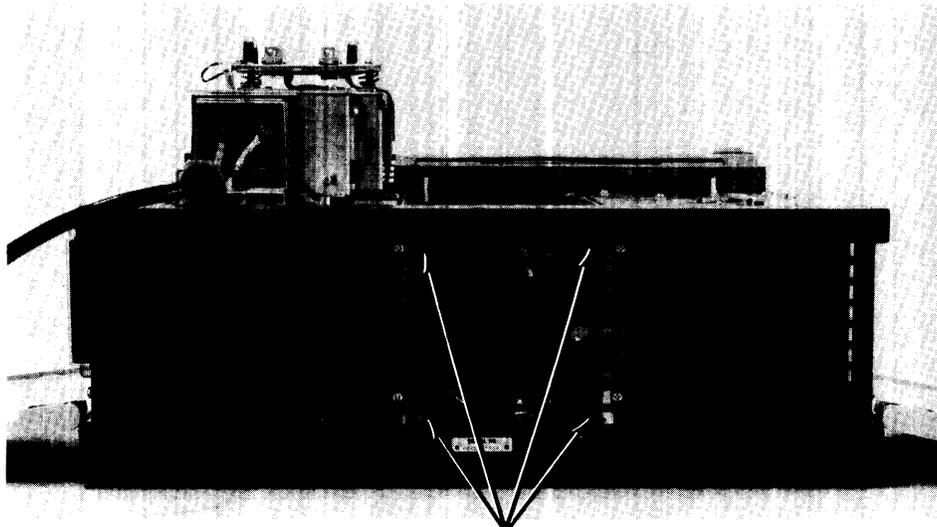


Figure 4-69. Disconnecting Power Supply Fan Cable

4. From rear of computer, remove four #2 Pozidriv screws that attach power supply fan to computer (Figure 4-70) and remove fan.
5. Remove four clips at corners of fan and retain for installation on replacement fan.



#2 POZIDRIV SCREW

Figure 4-70. Removing Power Supply Fan

---

**Reassembly Notes**

Attach four clips to corners of fan before attempting to install fan in computer.

Install replacement fan in computer with airflow direction arrow pointing toward rear of computer and plug receptacle at upper right corner of fan (as viewed from rear of computer).

Ensure proper polarity of fan and fan cable.

Ensure fan cable is not pinched when computer is reassembled.

---

**I/O Card Cage Fan**

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove front and rear covers as previously described.
3. Remove all cards from I/O area and mass storage controller area as previously described under I/O Cards and Mass Storage Controller Cards.
4. Disconnect power supply cable and safety ground cable from ac module (Figure 4-61).
5. Remove three #2 Pozidriv screws that attach ac module to computer (Figure 4-61), and rotate ac module onto its side.
6. Disconnect two ribbon cables from I/O backplane (Figure 4-62) and remove ac module.

---

**CAUTION**

THE REAR CARD GUIDE HAS THREE LOCATING PINS THROUGH THE I/O BACKPLANE BOARD AND TWO THROUGH THE FRONT CASTING. HANDLE GUIDE CAREFULLY TO AVOID BREAKING THE LOCATING PINS.

---

7. Remove rear card guide by pushing two front locating pins out of casting while pulling front of guide gently outward (Figure 4-71).

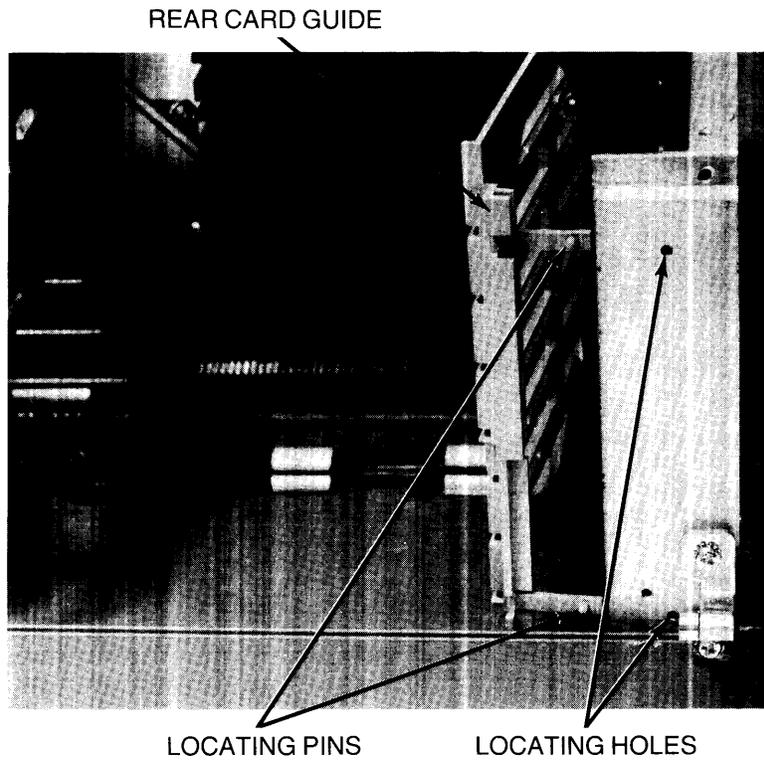


Figure 4-71. Removing Rear Card Guide

8. Disconnect power cable plug from I/O card cage fan (Figure 4-72).

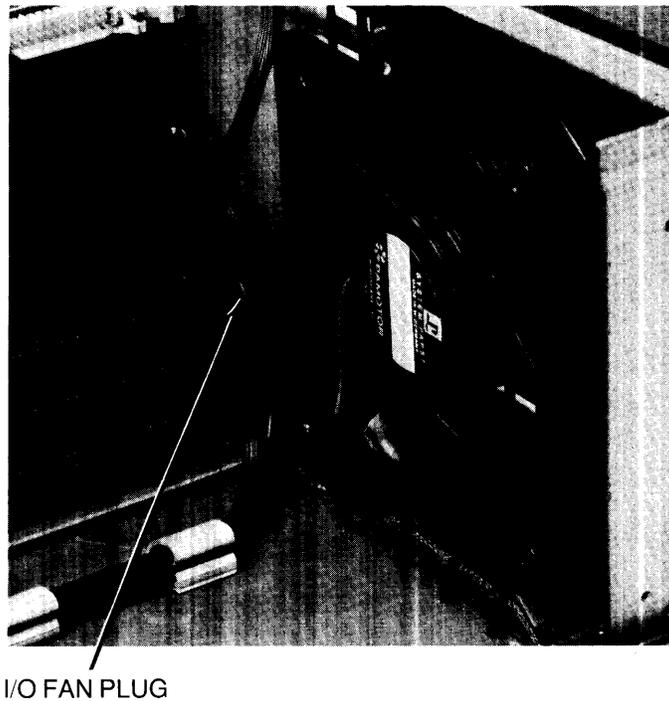
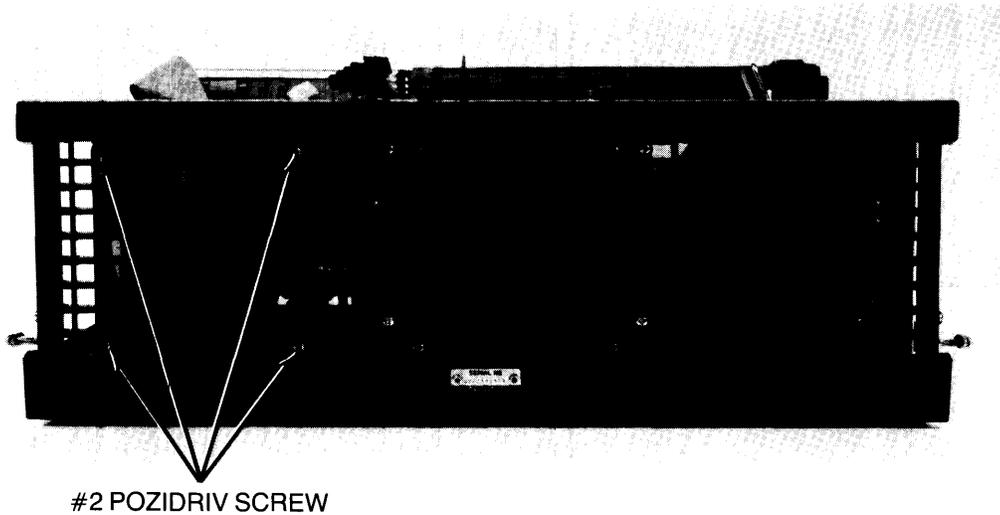


Figure 4-72. Disconnecting I/O Card Cage Fan Cable

9. From rear of computer, remove four #2 Pozidriv screws that attach I/O card cage fan to computer (Figure 4-73) and remove fan.
10. Remove four clips at corners of fan and retain for installation on replacement fan.



**Figure 4-73. Removing I/O Card Cage Fan**

---

#### Reassembly Notes

Attach four clips to corners of fan before attempting to install fan in computer.

Install replacement fan in computer with airflow direction arrow pointing toward rear of computer and plug receptacle at upper right corner of fan (as viewed from rear of computer).

Ensure proper polarity of fan and fan cable.

Ensure fan cable is not pinched when computer is reassembled.

Ensure ribbon cables are inserted in clips mounted on underside of ac module.

---

### I/O Backplane

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Perform steps 2 through 7 of the I/O Card Cage Fan procedure previously provided.
3. Disconnect I/O door interlock cable connector from I/O backplane (Figure 4-74).
4. Remove #2 Pozidriv screw that attaches front card guide to casting (Figure 4-74) and remove front card guide.

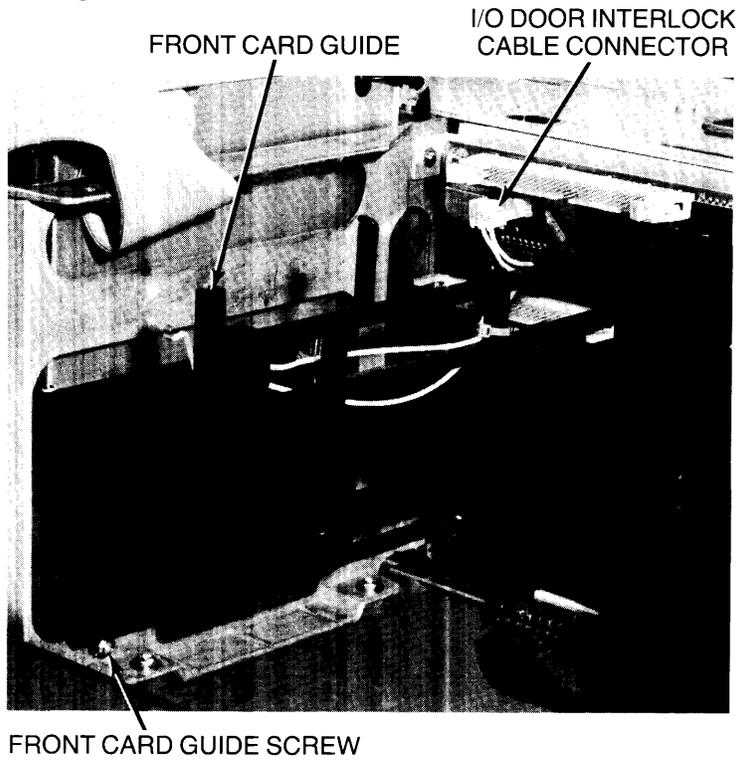


Figure 4-74. Removing Front Card Guide

5. Remove nine #2 Pozidriv screws that attach I/O backplane to power supply bucket (Figure 4-75).
6. Lift I/O backplane straight up and away from motherboard.

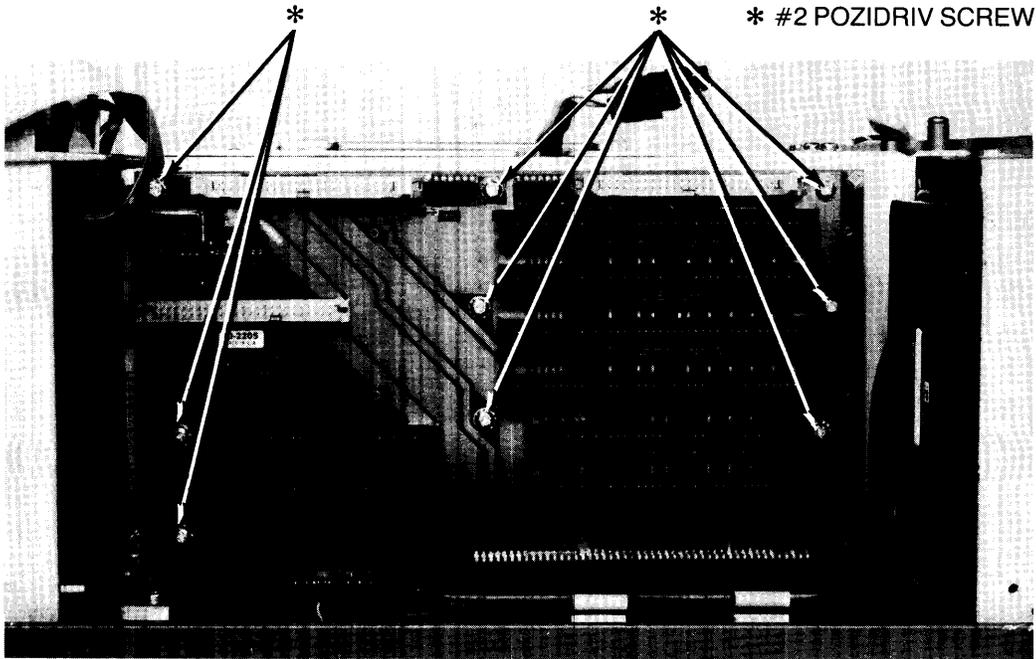


Figure 4-75. Removing I/O Backplane

## Motherboard

1. UNPLUG COMPUTER POWER CORD FROM AC OUTLET.
2. Remove front and rear covers as previously described.
3. Remove printer, disc drive(s), processor stack, power supply, and I/O backplane. All procedures are previously provided.
4. Disconnect power cables from power supply and I/O card cage fans.
5. Disconnect disc drive cable connector(s) from motherboard connectors J53 and J54 (Figure 4-76).
6. Remove two 4-millimeter Allen screws that attach two bus bars to "H" casting (Figure 4-76).
7. Remove two #2 Pozidriv screws that attach each of the two bus bars to the chassis (Figure 4-76), and move bus bars out of the way.
8. Remove nine #2 Pozidriv screws and flat washers that attach "H" casting to base (Figure 4-76), and lift "H" casting, which includes rear grill, fans, and power supply bucket out of chassis.

★ 4-MM ALLEN SCREW

\* #2 POZIDRIV SCREW

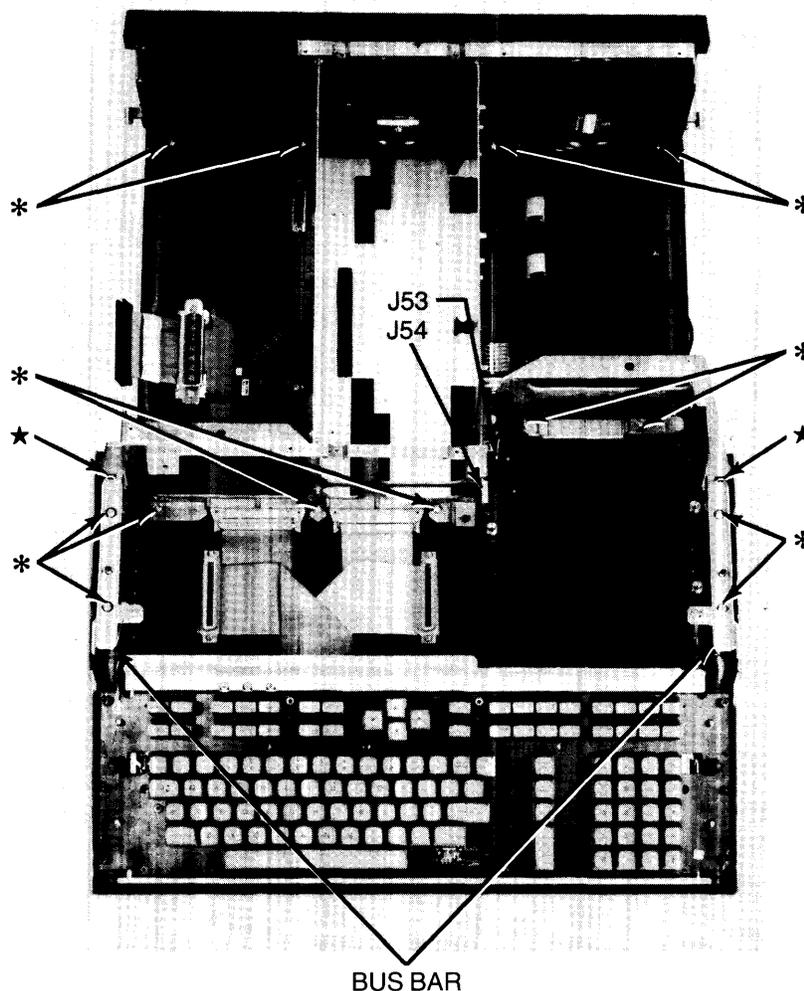
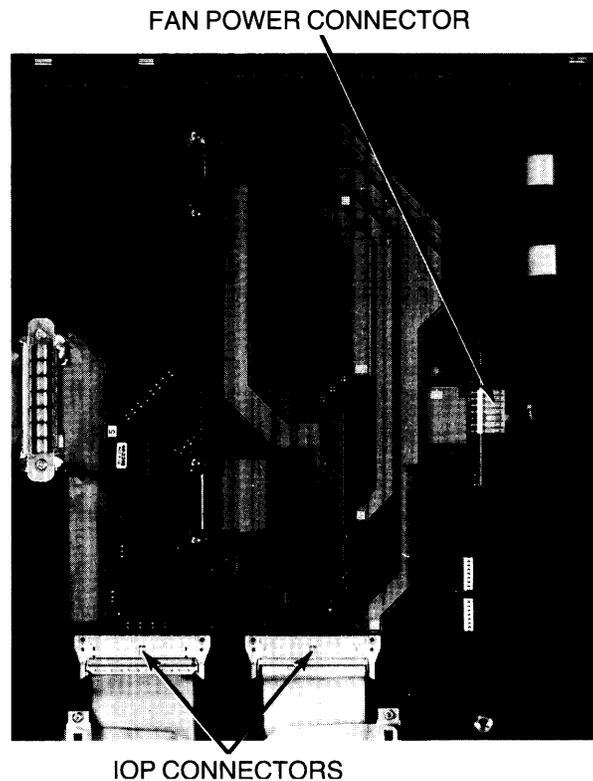


Figure 4-76. Removing "H" Casting

9. Disconnect two IOP connectors and fan power connector from motherboard (Figure 4-77), and lift motherboard out of chassis.



**Figure 4-77. Removing Motherboard**

---

**Reassembly Note**

Connect I/O backplane to motherboard, and attach I/O backplane to "H" casting power supply bucket before tightening screws that attach casting to chassis. Otherwise, the I/O backplane may not connect to the motherboard, or the connection may be stressed.

---

## HP 98760A Standard Color Graphics Display

This section contains assembly access procedures for the replaceable parts in the HP 98760A display. This manual provides these procedures because the 98760A does not have its own service manual. If the HP 98770A High-Performance Color Graphics Display or the HP 98780A Monochromatic Display is used with the computer, refer to the appropriate display service manual for access procedures.

The alpha/interface board is mounted to the bottom of the display. The procedure to remove the alpha/interface board is provided previously in this chapter.

This section contains assembly access procedures for the following replaceable assemblies:

- Display power supply board
- Sweep board
- Display motherboard
- RFI board
- Graphics/digital video board
- Video board
- CRT/yoke assembly
- Fan

---

### WARNING

THE PROCEDURES IN THIS SECTION ASSUME THAT THE AC POWER CORD HAS BEEN UNPLUGGED FROM THE DISPLAY AND THAT THE DISPLAY HAS BEEN REMOVED FROM THE COMPUTER. DISPLAY REMOVAL IS DESCRIBED PREVIOUSLY IN THIS CHAPTER.

---

### CRT Safety Precautions

Observe the following safety precautions whenever you are working with or near the CRT.

---

### WARNING

THE CRT CAN IMplode IF DROPPED, HIT BY A TOOL OR OTHER OBJECT, OR SUBJECTED TO STRESS EXCEEDING THE GLASS STRENGTH. THE MOST CRITICAL AREA OF THE ENVELOPE IS THE FUNNEL AREA. A BREAK IN THIS AREA WILL ALMOST ALWAYS RESULT IN AN IMplosion.

---

- Handle the CRT with care to avoid breakage and possible implosion of the CRT envelope.
- Always wear safety glasses.
- Use a protective shop jacket or coat.
- Use a rubber mat or carpet on the floor in the working area to reduce the possibility of breakage if dropped.
- When the CRT is removed from the chassis, place it face down on a soft pad, upholstered chair, or magazine, etc.

- When storing the CRT, place it where it cannot fall or be bumped.
- The CRT envelope acts as a big capacitor when the computer is turned off. Always allow a minute or two for the envelope to discharge before touching the anode connector.
- There is a bleeder resistor on the anode terminal. However, it is a good idea to ground the anode before touching it. Use a screwdriver to ground it to the Aquadag of the tube, or ground it to the chassis through a 1-megohm resistor. If the screwdriver draws a fat spark, the bleeder resistor is open.

---

**Note**

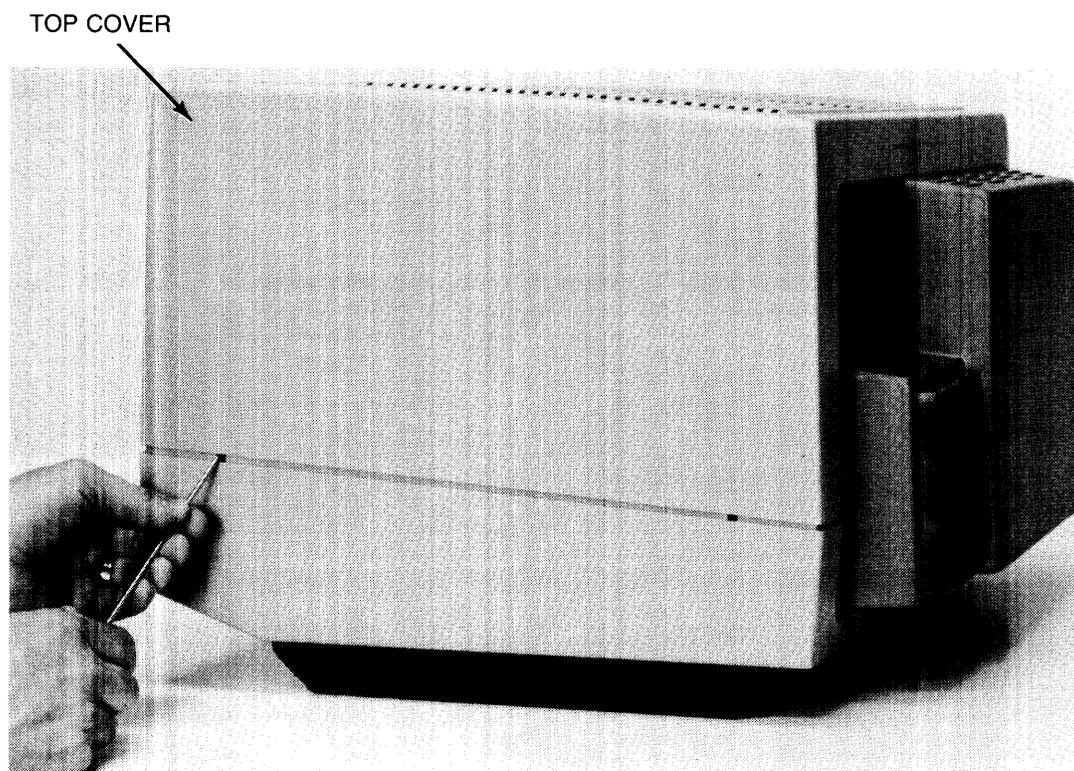
Leave the front bezel assembly in place unless its removal is required by CRT replacement or replacement of the bezel or its glass window.

---

**Top Cover and Rear Cover**

Remove the top cover to access any assembly in the display. Remove the rear cover to access the RFI board, graphics/digital video board, video board, CRT/yoke assembly, or fan. The top cover must be removed to remove the rear cover.

The top cover is attached by four tab locks, two on each side (Figure 4-78). Release the locks by pushing in with a narrow flat-blade screwdriver at a 45° angle. **Release both front locks first; then release the two rear locks.** Lift the top cover off of the display.



**Figure 4-78. Removing Top Cover**

Remove the rear cover by releasing the left side of the cover from the chassis, swinging the cover away from the chassis, and then releasing the right side.

### Display Power Supply Board

1. Remove top cover.

---

#### WARNING

WAIT AT LEAST 5 MINUTES FOR CAPACITOR DISCHARGE AFTER REMOVING POWER CORD.

---

2. Loosen four 1/4-turn #1 Pozidriv captive screws and remove top lid from display (Figure 4-79).

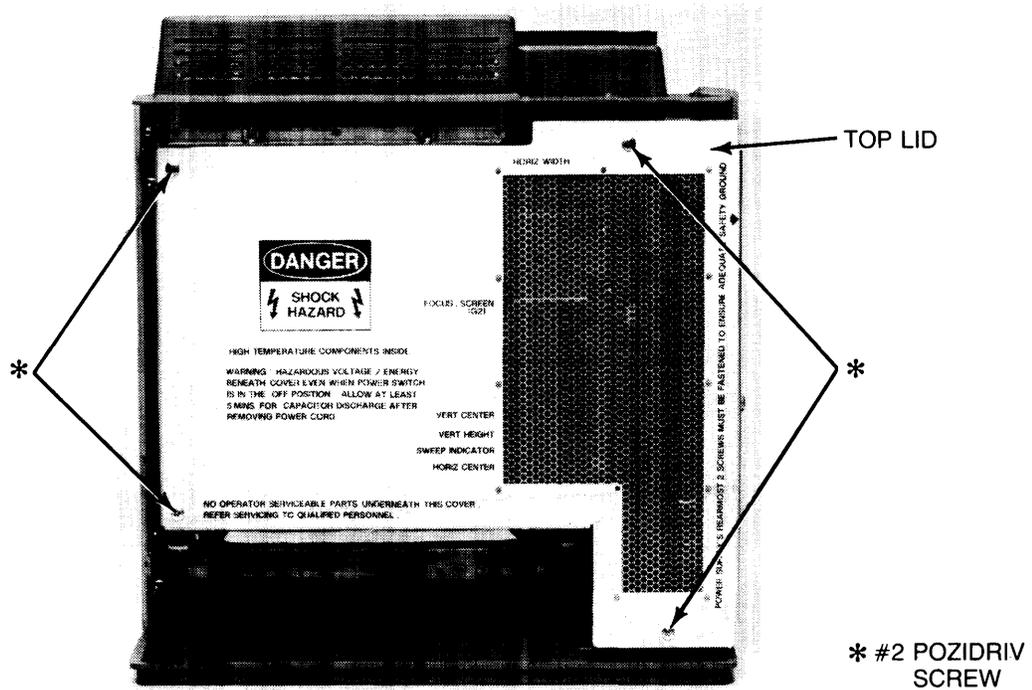
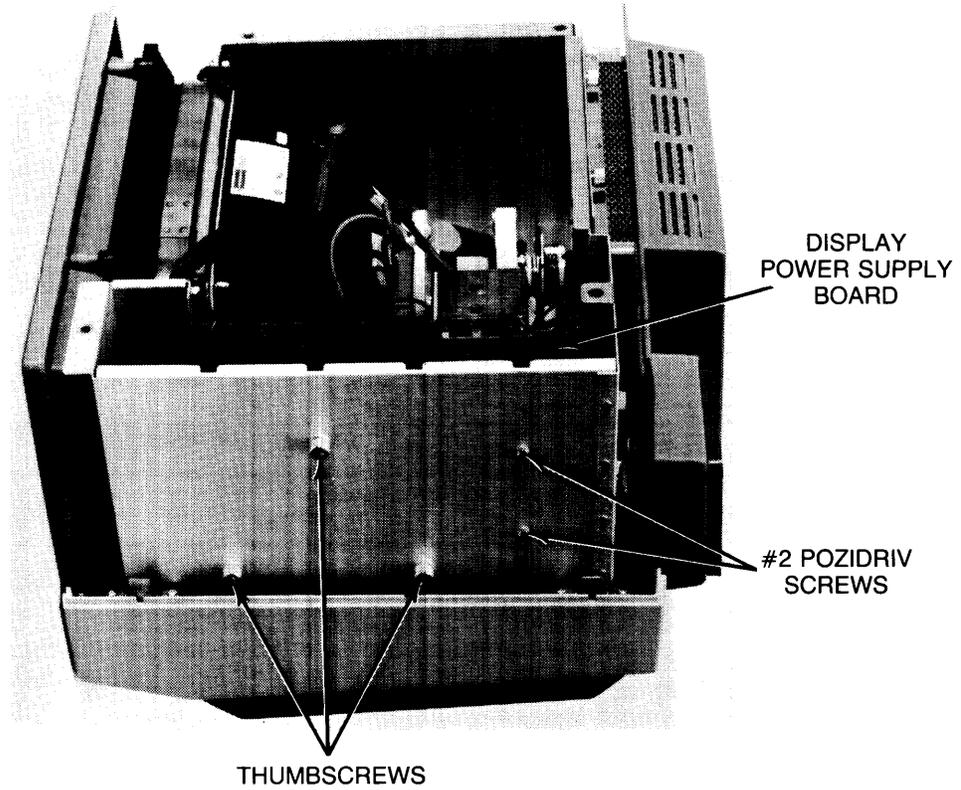


Figure 4-79. Removing Top Lid

3. Remove two #2 Pozidriv screws from right side of chassis (Figure 4-80).
4. Loosen three thumbscrews at right side of chassis (Figure 4-80).



**Figure 4-80. Releasing Display Power Supply Board**

5. Slowly lift display power supply straight up until two cable connectors are accessible (Figure 4-81).
6. Disconnect two cable connectors (Figure 4-81) and remove display power supply board from display.

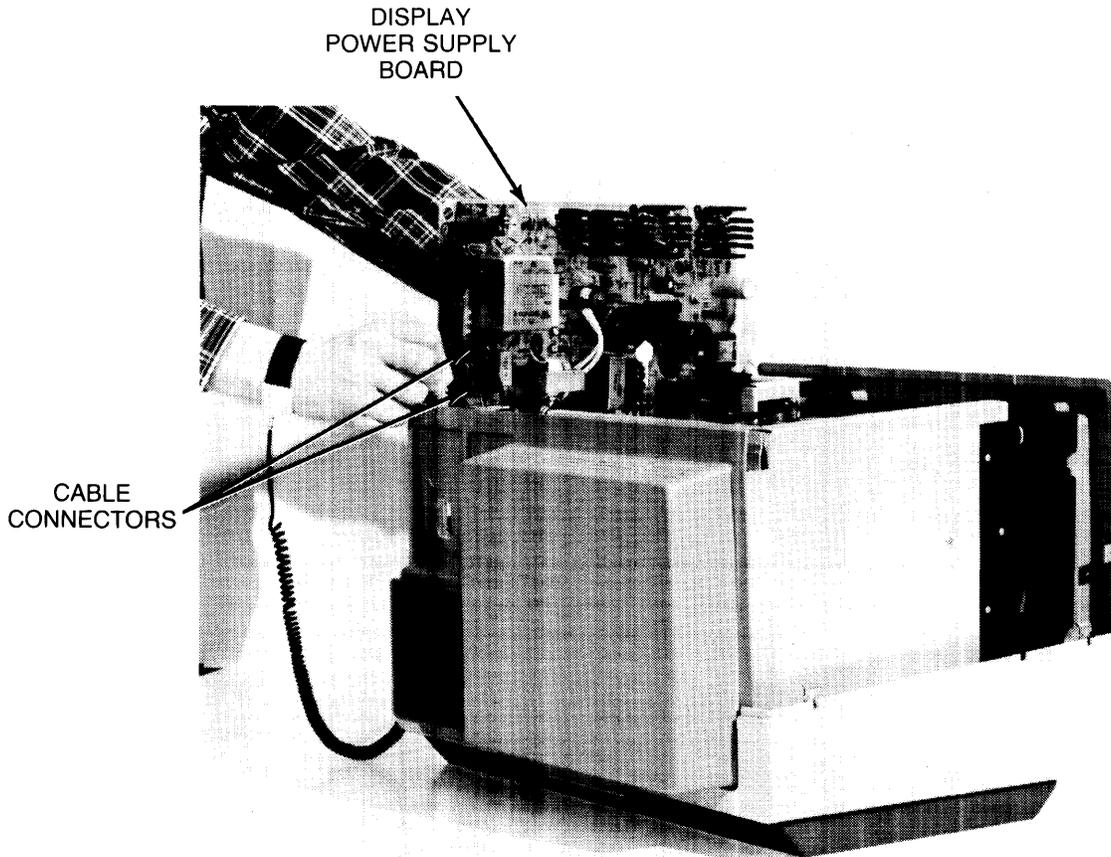


Figure 4-81. Removing Display Power Supply Board

### Sweep Board

1. Remove top cover.

---

**WARNING**

WAIT AT LEAST 5 MINUTES FOR CAPACITOR DISCHARGE AFTER REMOVING POWER CORD.

---

2. Loosen four 1/4-turn #1 Pozidriv captive screws and remove top lid from display (Figure 4-79).

---

**CAUTION**

HANDLE SINGLE-WIRE CONNECTORS BY CONNECTOR ONLY. OTHERWISE, WIRE MAY BREAK INSIDE THE CONNECTOR.

---

3. Disconnect two single-wire connectors (Figure 4-82).

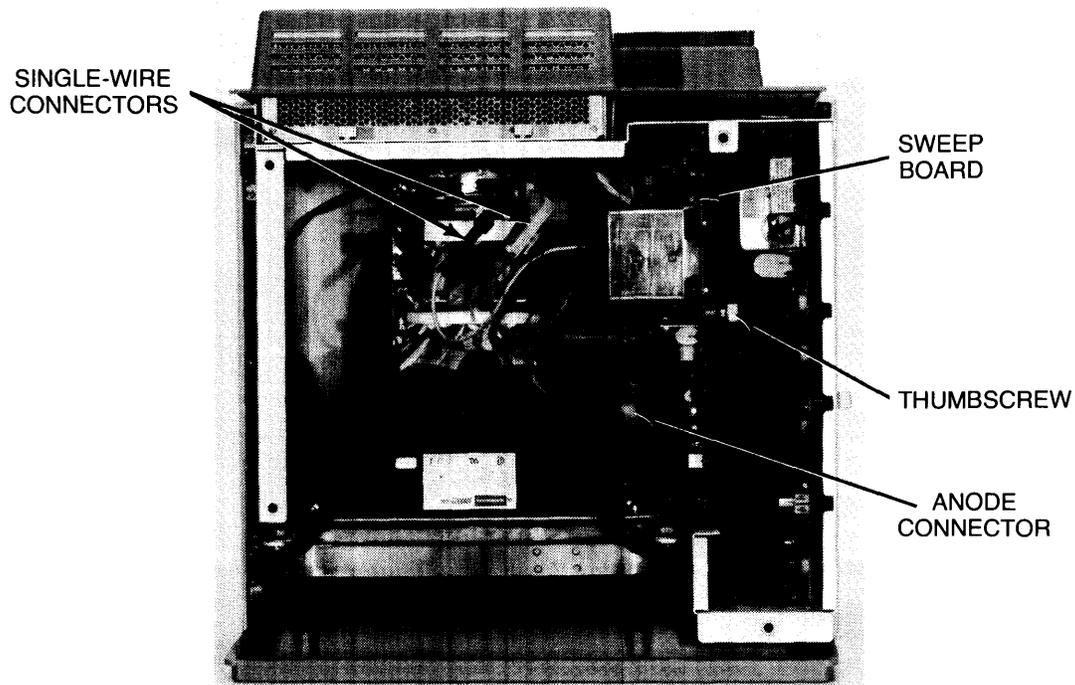
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**WARNING**

FAILURE TO PERFORM THE NEXT STEP COULD RESULT IN INJURY.

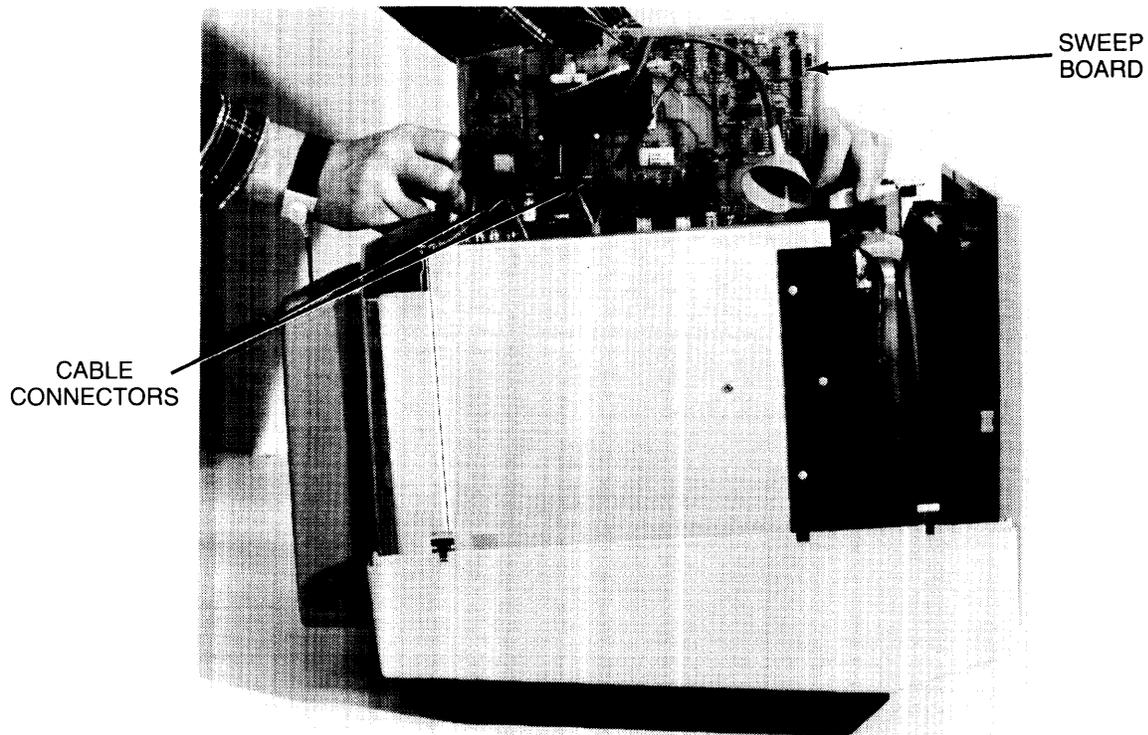
---

4. Fold back rubber from anode connector (Figure 4-82) and short circuit anode to chassis using screwdriver with insulated handle.



**Figure 4-82. Releasing Sweep Board**

5. With rubber folded back and anode visible, remove anode connector from CRT by pressing on one side of connector and tilting connector away from CRT.
6. Loosen thumbscrew that attaches sweep board to chassis (Figure 4-82).
7. Slowly lift board straight up until two cable connectors are accessible (Figure 4-83).
8. Disconnect two cable connectors (Figure 4-83) and remove sweep board from display.



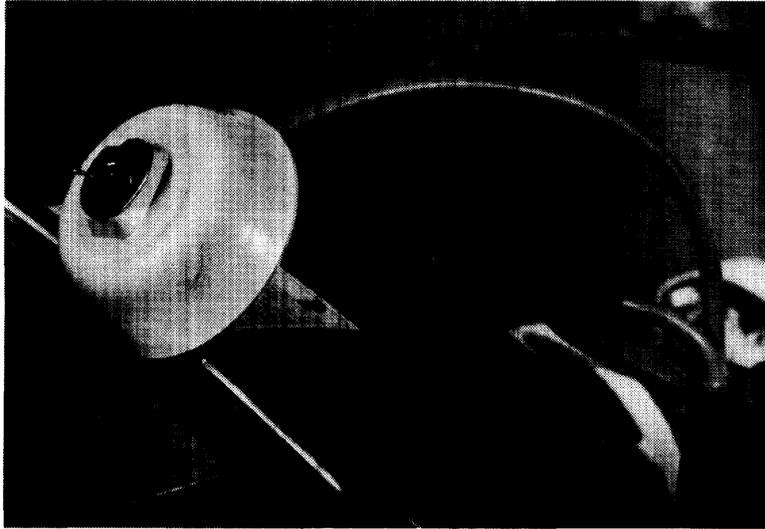
**Figure 4-83. Removing Sweep Board**

---

**Reassembly Note**

Ensure anode connector is oriented as shown in Figure 4-84 before connecting to CRT. Fold rubber back as shown and replace anode in CRT. Ensure that both anode prongs are fully seated and unfold rubber against CRT.

---



**Figure 4-84. Anode Orientation**

### Display Motherboard

1. Remove top cover.

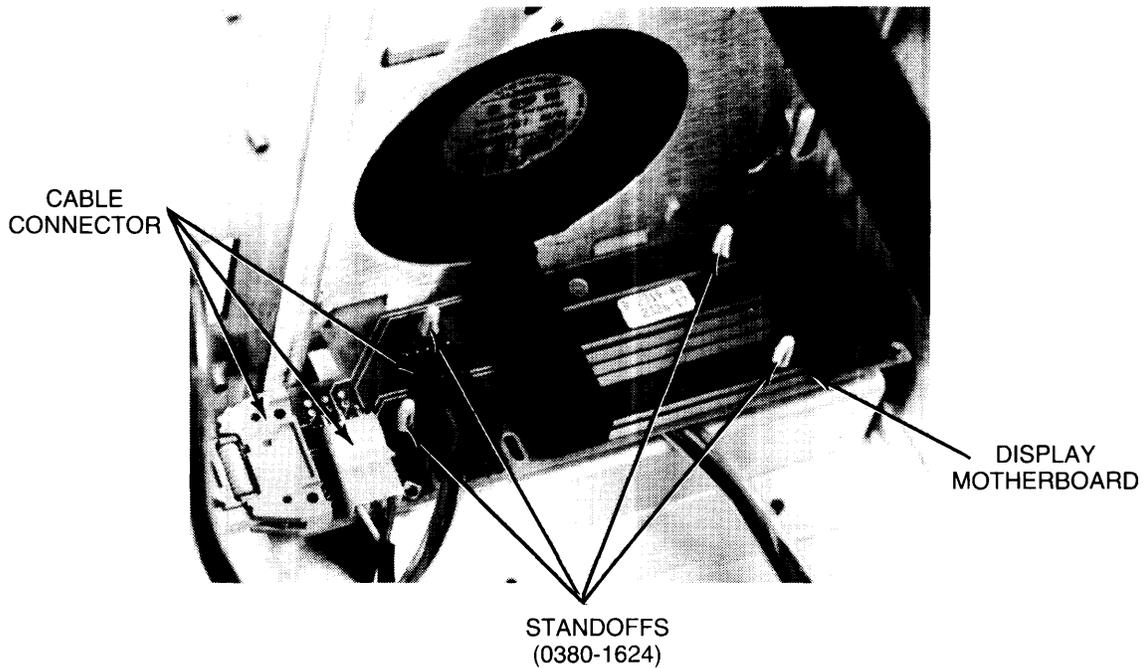
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**WARNING**

WAIT AT LEAST 5 MINUTES FOR CAPACITOR DISCHARGE AFTER REMOVING POWER CORD.

---

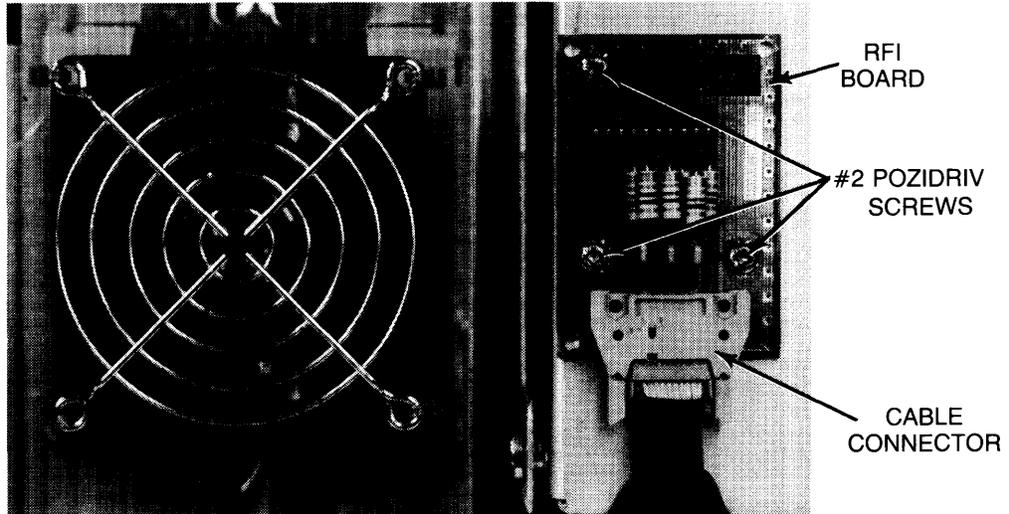
2. Loosen four 1/4-turn #1 Pozidriv captive screws and remove top lid from display (Figure 4-79).
3. Remove display power supply board and sweep board as previously described.
4. Disconnect three cable connectors from display motherboard (Figure 4-85).
5. Release display motherboard from plastic standoffs (Figure 4-85) by pushing paper spindle tool (09815-20602) over standoff while lifting up on motherboard.
6. Remove display motherboard from display.



**Figure 4-85. Removing Display Motherboard**

**RFI Board**

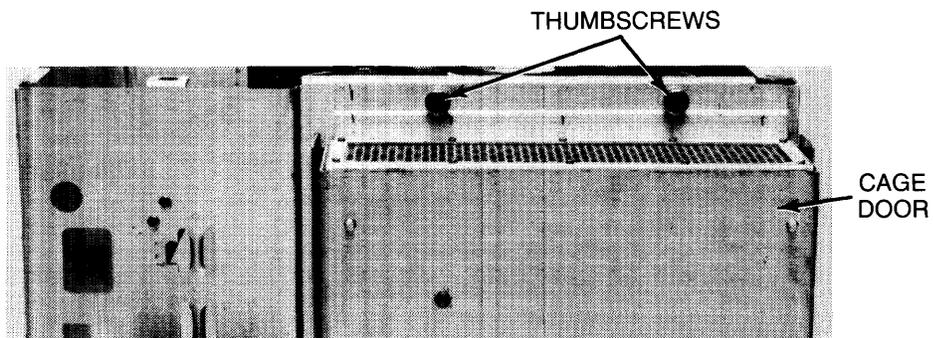
1. Remove top cover.
2. Remove rear cover.
3. Disconnect cable connector from RFI board (Figure 4-86).
4. Remove three #2 Pozidriv screws and washers from RFI board and remove board from cage door (Figure 4-86).



**Figure 4-86. Removing RFI Board**

**Graphics/Digital Video Board**

1. Remove top cover.
2. Remove rear cover.
3. Loosen two thumbscrews on cage door and open door (Figure 4-87). If necessary, carefully pry top of door away from chassis with flat-blade screwdriver.



**Figure 4-87. Opening Cage Door**

4. Disconnect three cable connectors from graphics/digital video board (Figure 4-88).
5. Remove eight #2 Pozidriv screws from graphics/digital video board (Figure 4-88).
6. Lift graphics/digital video board out of door.

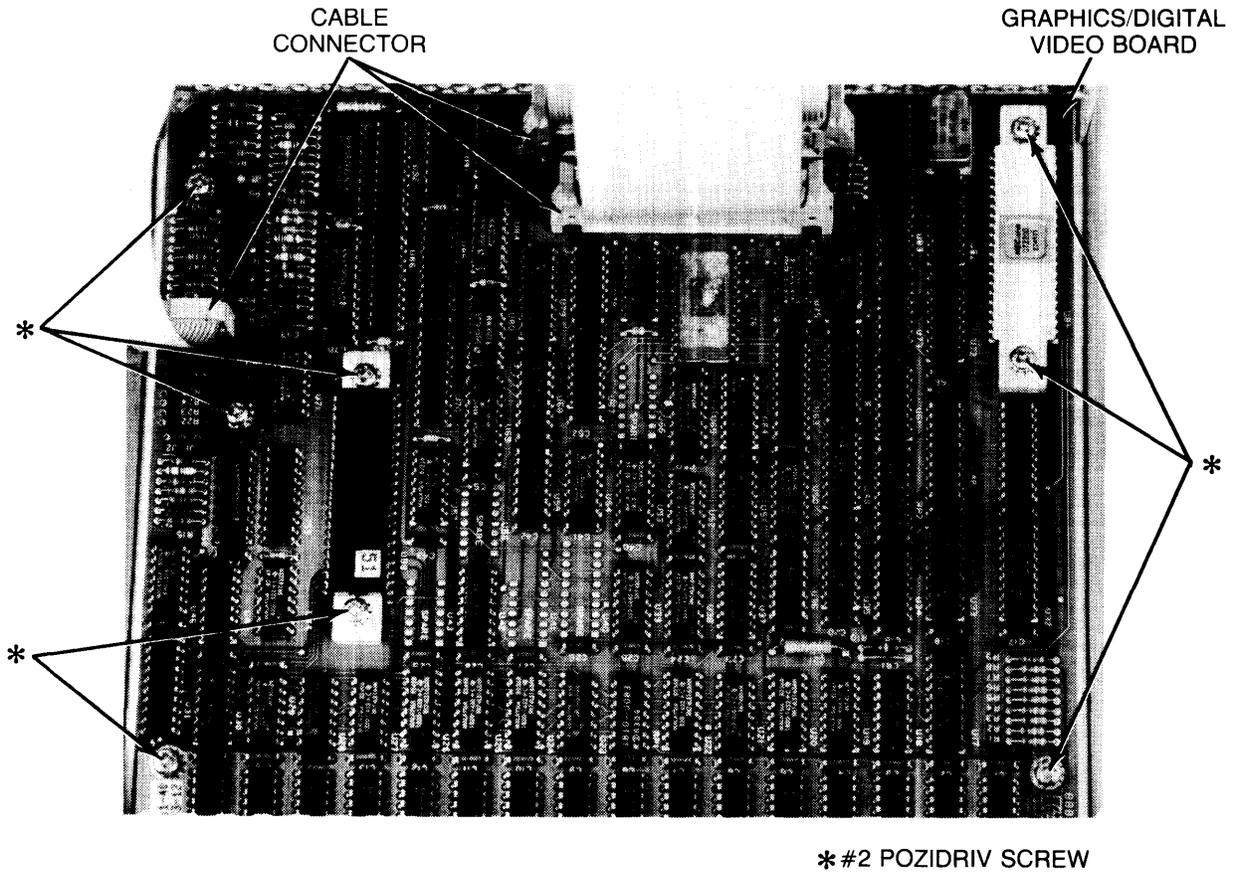


Figure 4-88. Removing Graphics/Digital Video Board

---

**REASSEMBLY CAUTION**

WHEN CLOSING THE CAGE DOOR, ENSURE THAT THE RFI GASKETING DOES NOT CATCH ON THE DOOR SIDES.

---

**Video Board**

1. Remove top cover.
2. Remove rear cover.

---

**WARNING**

WAIT AT LEAST 5 MINUTES FOR CAPACITOR DISCHARGE AFTER REMOVING POWER CORD.

---

3. Loosen four 1/4-turn #1 Pozidriv captive screws and remove top lid from display (Figure 4-79).

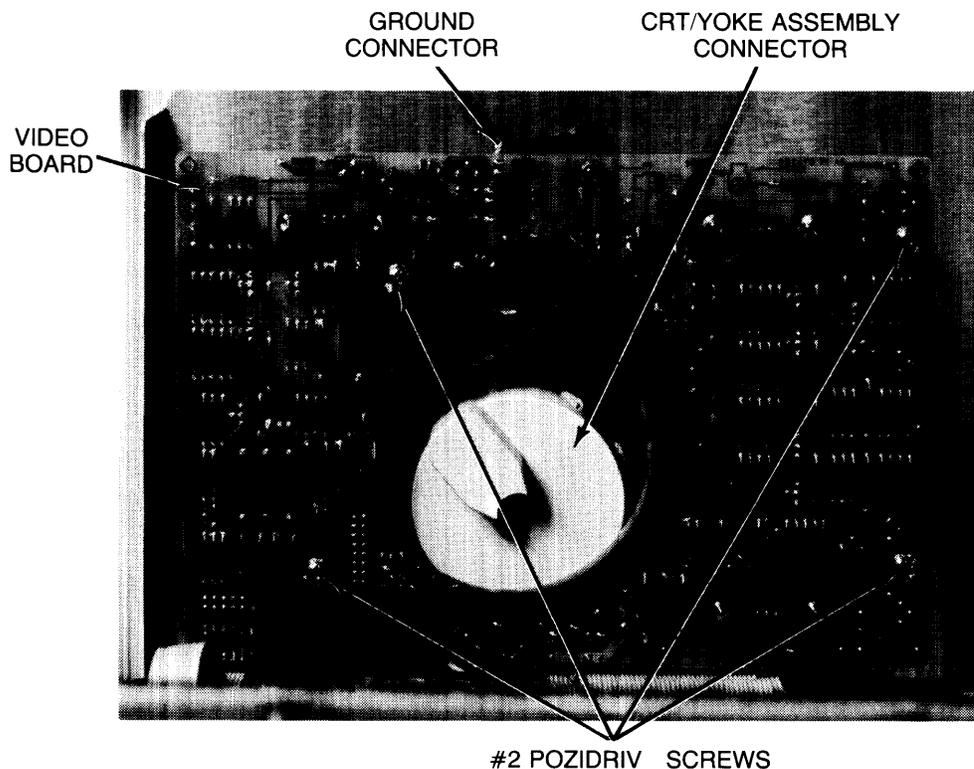
---

**CAUTION**

HANDLE SINGLE-WIRE CONNECTORS BY CONNECTOR ONLY. OTHERWISE, WIRE MAY BREAK INSIDE THE CONNECTOR.

---

4. Disconnect two single-wire connectors that interconnect video board and sweep board (Figure 4-82).
5. Loosen two thumbscrews on rear door and open door (Figure 4-87).
6. Disconnect the ground connector from the spade lug at rear top of video board (Figure 4-89).
7. Remove four #2 Pozidriv screws from video board (Figure 4-89).
8. Pull board slightly away from chassis and disconnect two cable connectors from rear of board.
9. Push two single-wire connectors through holes in chassis.
10. Disconnect CRT/yoke assembly connector (Figure 4-89) from CRT/yoke assembly and remove video board.



**Figure 4-89. Removing Video Board**

---

**REASSEMBLY CAUTION**

WHEN CLOSING THE CAGE DOOR, ENSURE THAT THE RFI GASKETING DOES NOT CATCH ON THE DOOR SIDES.

---

### **CRT/Yoke Assembly Removal**

If replacing the CRT/yoke assembly with a new assembly, store the new assembly in its packing box until it is installed in the computer. Use the same packing box when disposing of the defective assembly.

---

**WARNING**

WEAR SAFETY GLASSES. BEFORE REMOVING THE CRT/YOKE ASSEMBLY FROM ITS BOX, REMOVE ITEMS THAT COULD FALL OUT OF YOUR SHIRT POCKET AND STRIKE THE CRT.

---

To remove the CRT from its box, place the box on the floor with the top of the box up. Open the top of the box and hold the base of the box with your feet. Pull up on the cardboard insert surrounding the CRT and remove the insert with the CRT from the box.

---

**CAUTION**

WHEN HANDLING THE CRT/YOKE ASSEMBLY, DO NOT TOUCH THE AREA AROUND THE YOKE. HANDLE ONLY BY CRT (BOTTLE) PART OF THE ASSEMBLY. YOKE ADJUSTMENTS ARE MADE AT THE FACTORY AND ARE EXTREMELY DELICATE.

---

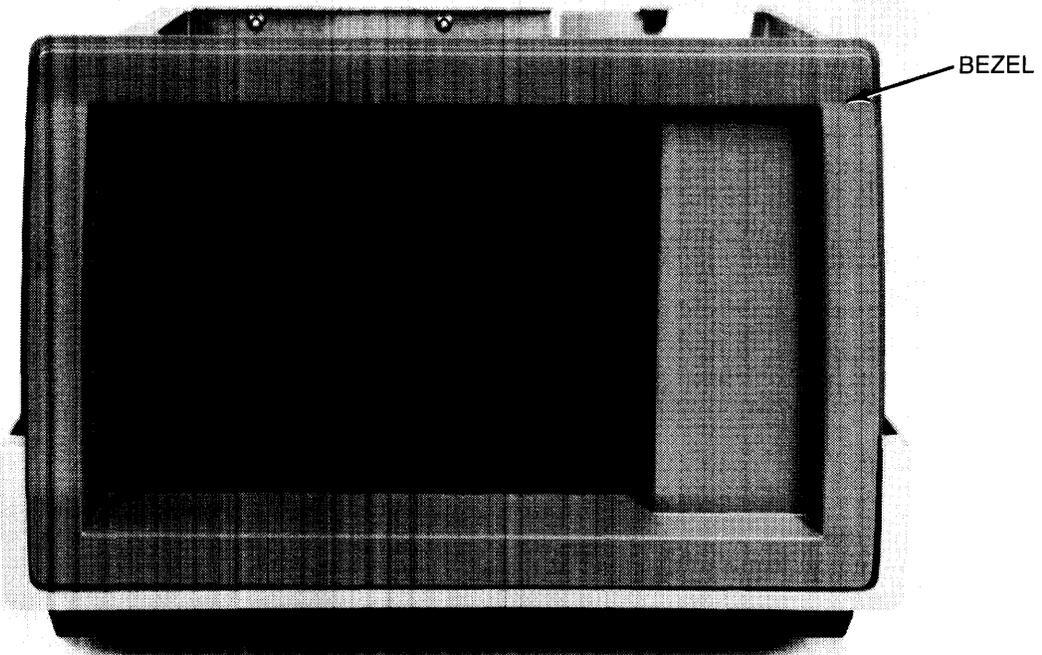
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**WARNING**

WAIT AT LEAST 5 MINUTES FOR CAPACITOR DISCHARGE AFTER REMOVING POWER CORD.

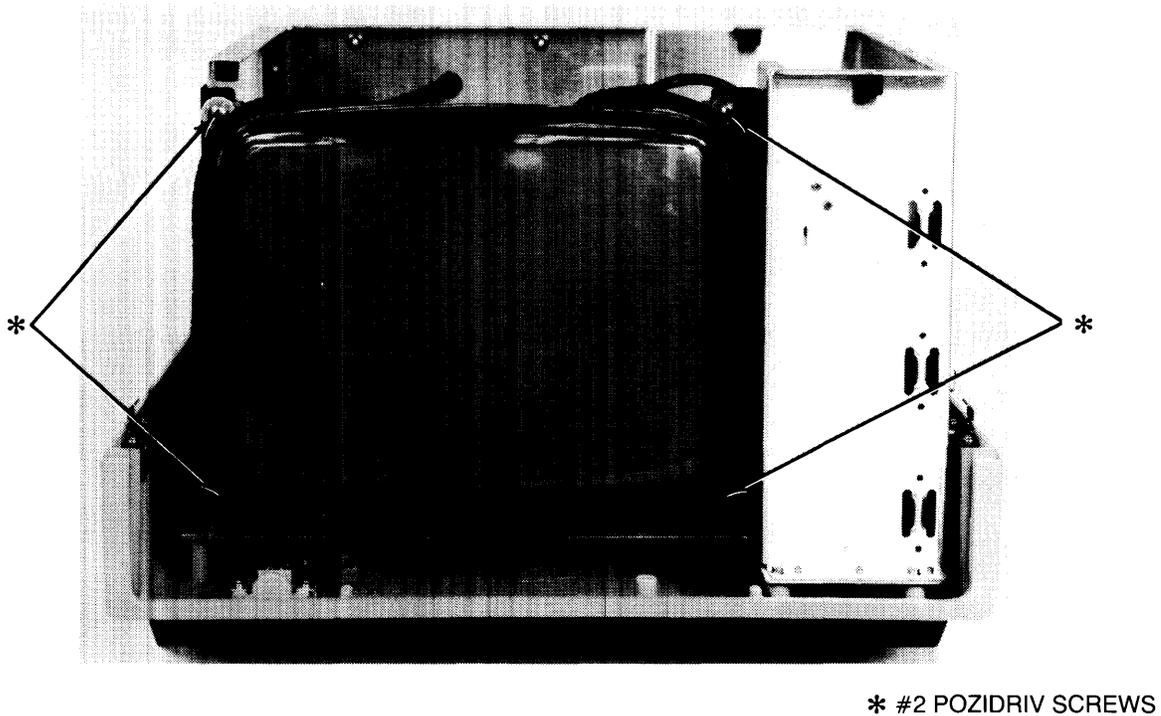
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1. Remove display power supply board.
2. Remove sweep board.
3. Remove video board.
4. Remove front bezel and attached CRT window from chassis (Figure 4-90).
5. Cut cable tie wrap at top of CRT and move all cables out of the way.
6. Prepare a place with a non-scratching surface to set the CRT/yoke assembly. A magazine, upholstered chair, or soft pad is adequate.



**Figure 4-90. Removing Front Bezel**

7. Remove four #2 Pozidriv screws that attach front of CRT to chassis (Figure 4-91)
8. Hold CRT/yoke assembly by CRT (bottle), pull slightly forward so yoke clears yoke support grommet, and remove assembly from chassis.



**Figure 4-91. Removing CRT/Yoke Assembly**

### CRT/Yoke Assembly Installation

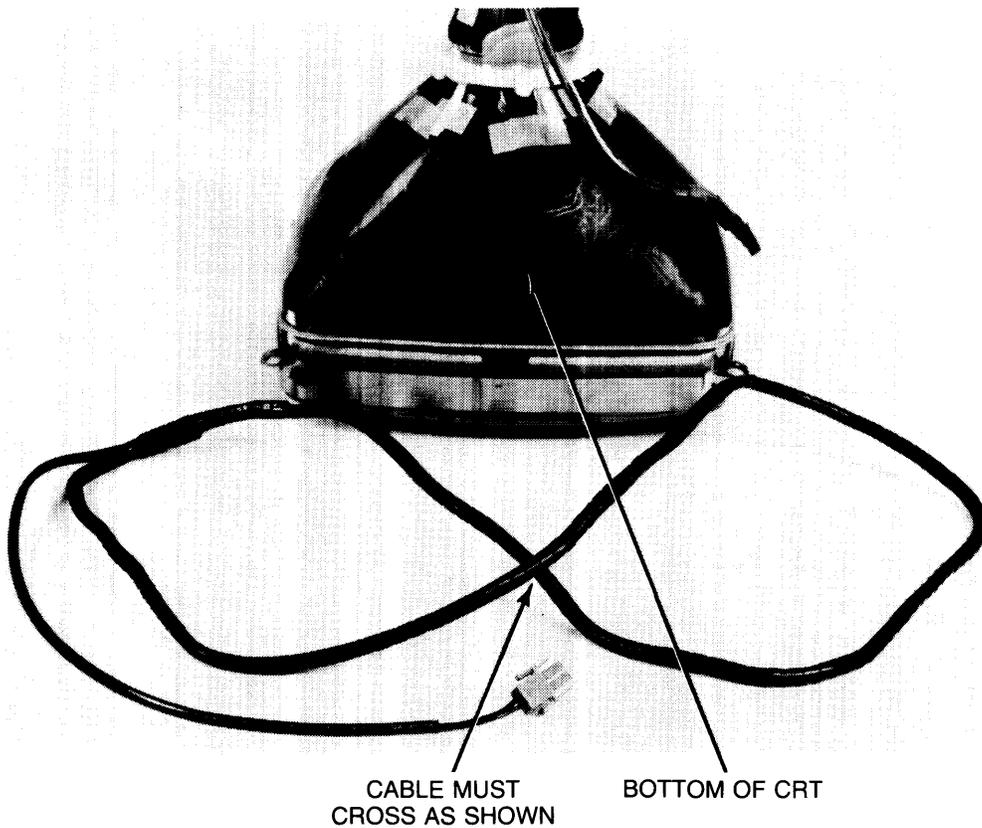
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**CAUTION**

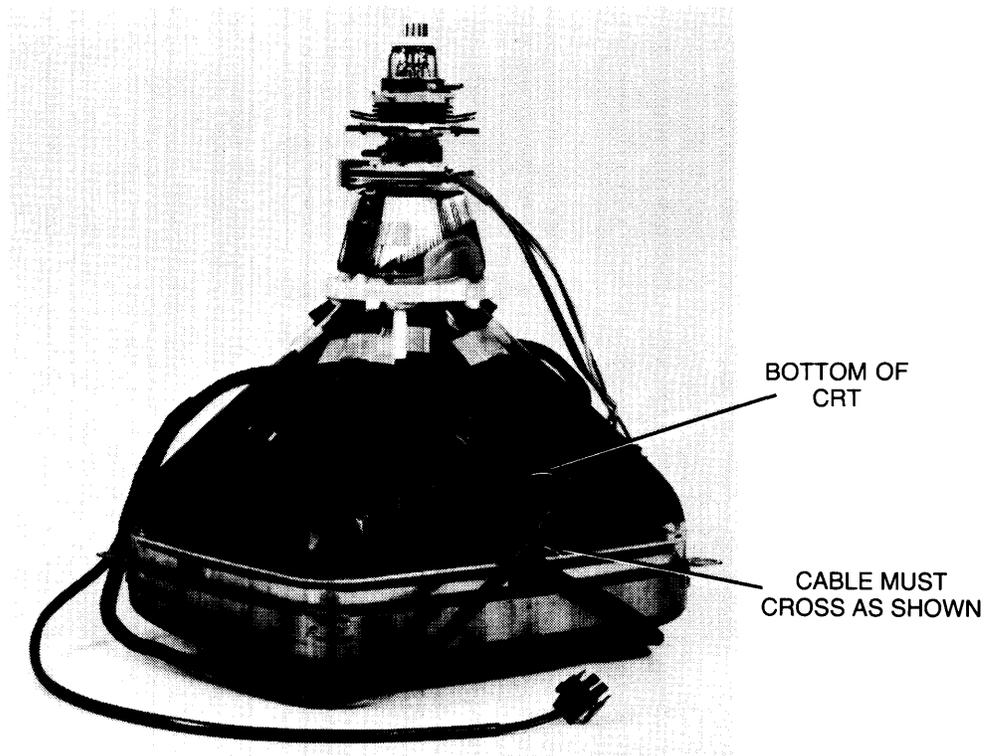
WHEN HANDLING THE CRT/YOKE ASSEMBLY, DO NOT TOUCH THE AREA AROUND THE YOKE. HANDLE ONLY BY CRT (BOTTLE) PART OF THE ASSEMBLY. YOKE ADJUSTMENTS ARE MADE AT THE FACTORY AND ARE EXTREMELY DELICATE.

---

1. Wrap degaussing cable around replacement CRT/yoke assembly exactly as shown in Figures 4-92 and 4-93.

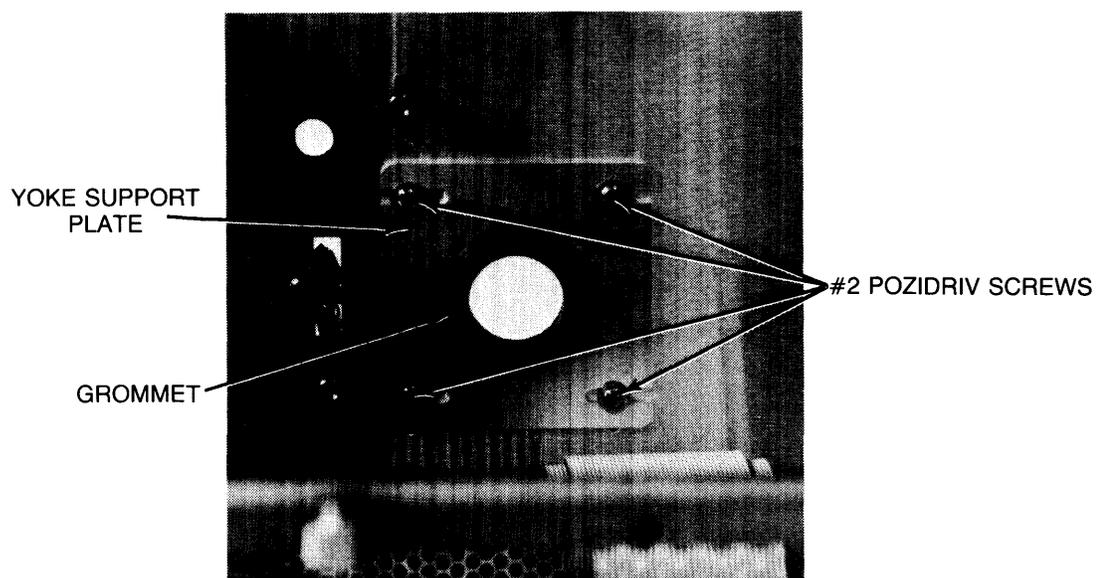


**Figure 4-92. Preparing Degaussing Cable**



**Figure 4-93. Placement of Degaussing Cable on CRT/Yoke Assembly**

2. Loosen the four #2 Pozidriv screws that hold the yoke support plate and grommet so that the plate “floats” (Figure 4-94).
3. Lift the CRT/yoke assembly by the CRT (bottle), slide the yoke through the yoke support plate grommet, and place in position.



**Figure 4-94. Yoke Support Plate**

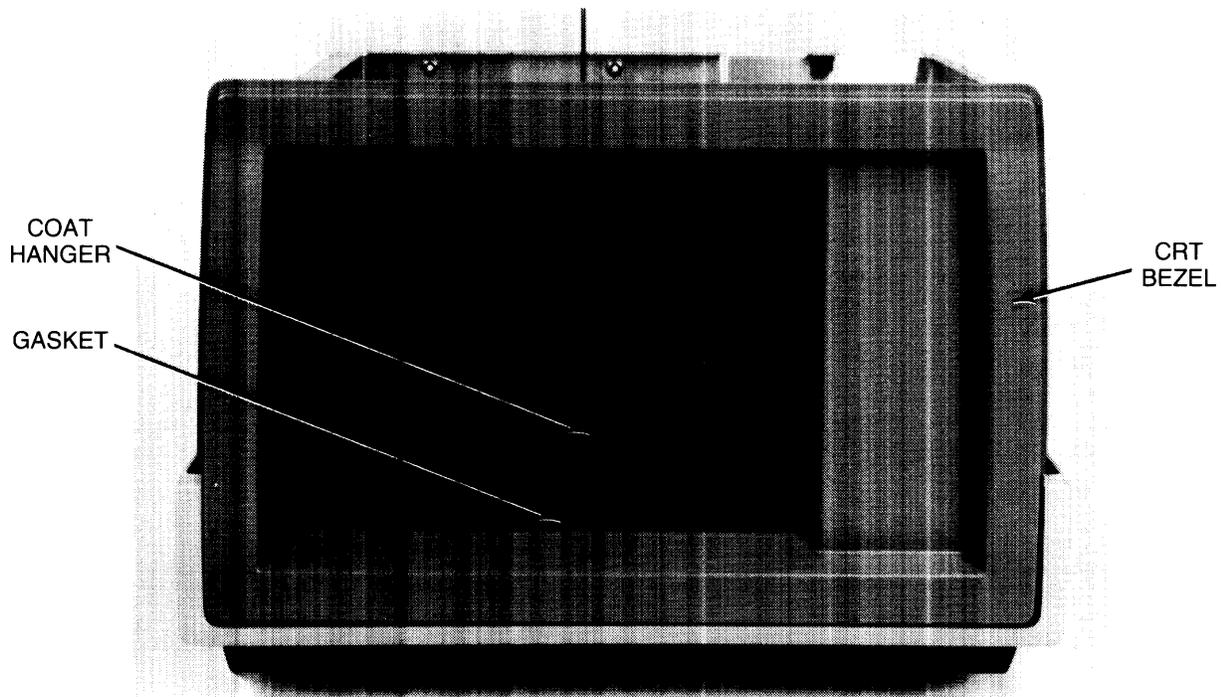
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**CAUTION**

WHEN PERFORMING THE NEXT STEP, ENSURE THAT THE FLAT WASHER IS BETWEEN THE SCREW HEAD AND THE LOCK WASHER.

---

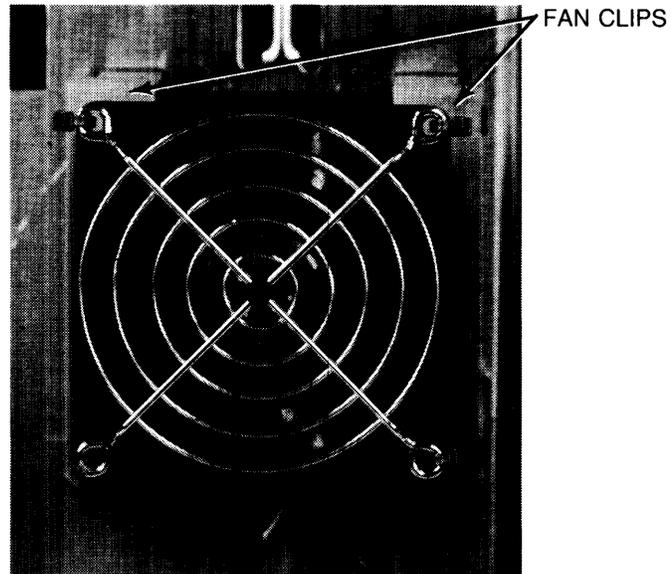
4. Tighten the four #2 Pozidriv screws that attach the CRT/yoke assembly to the chassis (Figure 4-91).
5. Tighten the four #2 Pozidriv screws that attach the yoke support plate to the chassis (Figure 4-94).
6. Tighten degaussing cable by tying cable together across top of CRT/yoke assembly with cable tie wrap.
7. Replace front bezel. Push CRT bezel gasket down by inserting a bent coat hanger or long flat-blade screwdriver between bezel and CRT and tamping down (Figure 4-95).
8. Replace video board.
9. Replace sweep board. Ensure anode connector is oriented as shown in Figure 4-84.
10. Replace display power supply board.



**Figure 4-95. Replacing Front Bezel**

**Fan**

1. Remove sweep board.
2. Remove rear cover.
3. Disconnect fan cable connector from display motherboard.
4. Remove both fan clips (Figure 4-96). To release clip, press in on top and bottom of clip from outside while pressing down on top tab from inside.
5. Remove fan and attached cable.



**Figure 4-96. Removing Fan**



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# Replaceable Parts

**Chapter****5**

## Introduction

This chapter lists all of the replaceable parts in the computer and provides information required to order replacement parts. This chapter is divided into the following sections:

- Exchange Parts
- Non-Exchange Parts
- Product Support Tools
- Extender Board
- Documentation
- Printer Paper
- Parts List
- Keyboard Configurations

Any part number is located by using the parts list and/or exploded view drawings. All parts listed can be ordered from the Corporate Parts Centers except for exchange assemblies, which are ordered from the Computer Support Division.

## Exchange Parts

The computer is repaired at an assembly replacement level. Items most commonly replaced are exchange parts and are on the Computer Support Division (CSD) exchange program. When an exchange part fails, it should be returned to CSD for repair, and a rebuilt part should be obtained for the defective computer. Table 5-1 lists the exchange parts for the computer.

**Table 5-1. Exchange Parts**

Fig. No.	Index No.	New Part Number	Rebuilt Part Number	Description
5-2	6	09855-67980	09855-69980	Power Supply Assembly
5-2	–	09855-66571	09855-69571	Display Interface Module
5-10	1	09855-66531	09855-69531	Keyboard Electronics Board
5-10	3	09855-67131	09855-69131	Keypad Board
5-3	5	09855-66552	09855-69552	Printer Motor Drive Board
5-6	8	09855-66561	09855-69561	9130K Controller Card
5-9	1	09130-67600	09130-69600	9130K Flexible Disc Drive
5-6	8	09855-66560	09855-69560	Winchester I/O Card
5-6	8	0950-0886	09855-69886	Winchester Disc Controller
5-8	1	09133-67102	09133-69102	Fixed Disc Mechanical Drive
5-8	2	09133-67101	09133-69101	Fixed Disc Electronics Board
5-11	1	09836-66550	09836-69550	98760A Power Supply Board
5-11	2	09836-66540	09836-69540	98760A Sweep Board
5-11	3	09836-66541	09836-69542	98760A Video Board
5-11	4	98760-66573	98760-69573	98760A Alpha/Interface Board
5-11	5	98760-66575	98760-69575	98760A Graphics/Digital Video Board, ASCII
5-11	5	98760-66576	98760-69576	98760A Graphics/Digital Video Board, Katakana
5-5	2	5061-6803	97043-69803	Floating Point CPU
5-5	2	5061-6806	97044-69806	IOP Finstrate (Rev. 3.1)
5-5	2	5461-4232	97040-69232	256K RAM Board
5-5	2	5061-6805	97047-69805	512K RAM Board
5-5	2	5061-7704	97046-69704	IM RAM Board

## Non-Exchange Parts

Table 5-2 lists the module-level non-exchange parts for the computer.

**Table 5-2. Non-Exchange Parts**

Fig.	Index	Part Number	Description
5-5	3	5061-4224	Processor Stack Clock Board
5-5	4	5061-4263	Processor Stack Motherboard
5-5	2	5061-6806	IOP Finstrate (Rev. 3.1)
5-5	2	5061-4228	IOP Buffer Assembly
5-5	2	5061-4235	CPU Board
5-5	2	5061-6803	Floating Point CPU
5-5	2	5061-4232	256K RAM Board
5-5	2	5061-6805	512K RAM Board
5-5	2	5061-7704	1M RAM Board
5-6	8	09855-66562	Bootstrap Loader Card
5-3	4	09855-66551	Printer Logic Board
5-3	7	09845-67163	Printhead
5-3	8	09855-66555	Printhead Interconnect Board
5-4	10	09845-67161	Printhead Chip Module
5-2	28	09855-66500	Motherboard
5-6	1	09855-66501	I/O Backplane
5-2	15	3160-0377	Fan
5-11	7	98760-66500	98760A Display Motherboard

## Product Support Tools

Table 5-3 lists the items that comprise the Product Support Tools. Standard customer engineering tools required to service the computer are listed in Chapter 4.

**Table 5-3. Product Support Tools**

Part Number	Description
09855-67004	Power Supply Discharge Tool
5040-7433	Keycap Removal Tool
09020-10010	Test Pack
09020-80038	HP 9000 Model 520 Computer Service Manual Package
09815-20602	Paper Spindle Tool

## Extender Board

**Table 5-4. Extender Board**

Part Number	Description
27116A	HP-CIO Extender

## Documentation

**Table 5-5. Product Support Documentation**

Part Number	Description
09020-80038	Service Manual Package, which includes: 09020-90037 Service Manual for the HP 9000 Model 520 09020-90012 Installation and Test for the HP 9000 Model 520 09000-90040 Series 500 Site Preparation Manual 98770-90030 Service Manual for the HP 98770A Display 98780-90030 Service Manual for the HP 98780A Display 5955-6587 Sales and Support Offices 9282-0989 2" 3-Ring Binder 09020-90007 Manual Assembly Instructions 9211-3778 Package Shipping Carton

## Printer Paper

HP replacement paper is available in either metric or English sizes, and in either blue or black print. One box of paper contains four packs of 330 pages each for a total of 1320 sheets per box. Call HP's toll-free order number, 800-538-8787, to order replacement paper. Table 5-4 lists the part numbers and descriptions of HP replacement paper.

**Table 5-6. HP Printer Replacement Paper**

<b>Part Number</b>	<b>Description</b>
9270-0640	English-dimensioned, black print
9270-0641	English-dimensioned, blue print
9270-0642	Metric-dimensioned, black print
9270-0643	Metric-dimensioned, blue print

## Parts List

The following figures and tables list all the replaceable parts for the computer except keycaps, which are listed separately at the end of this chapter.

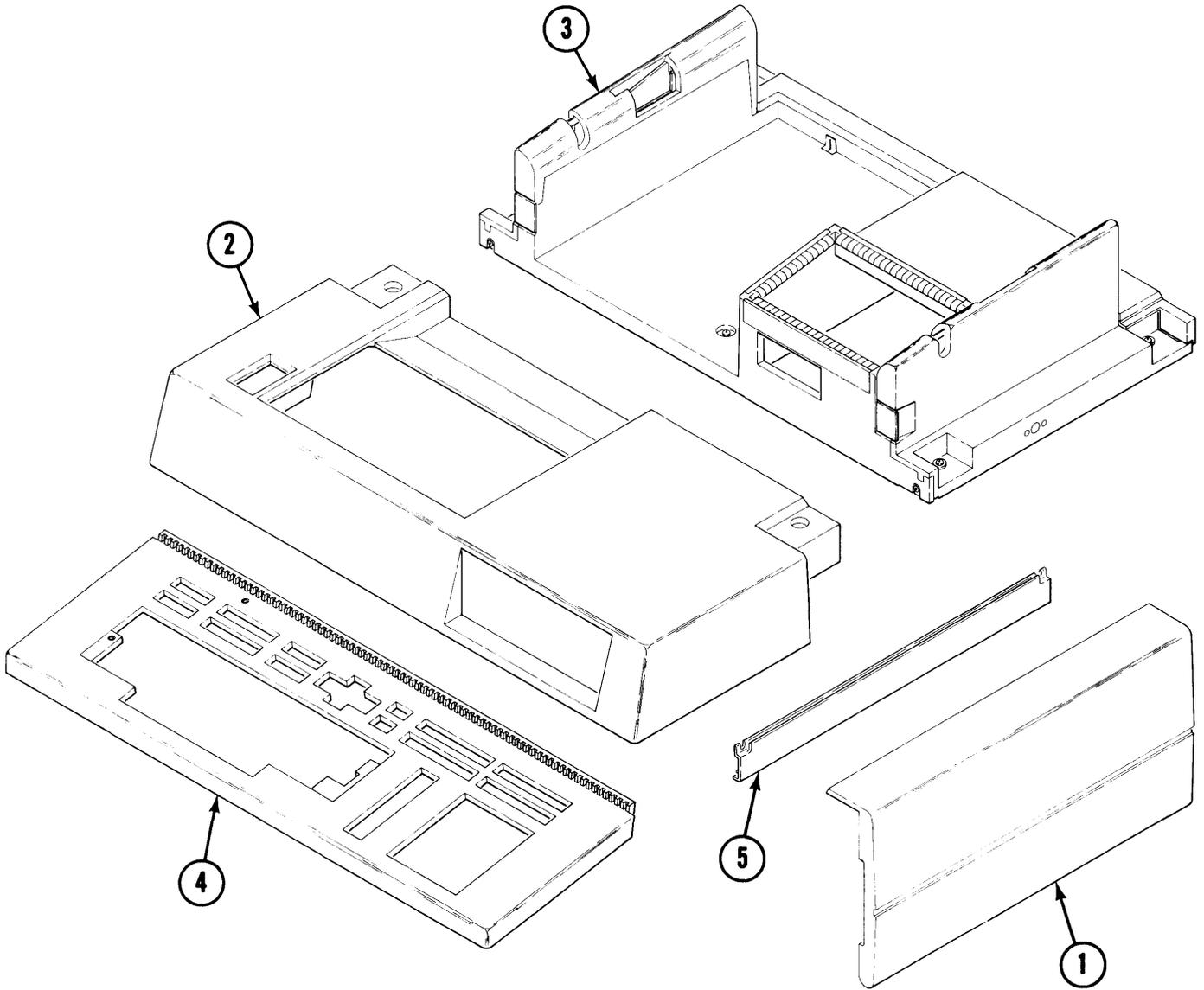


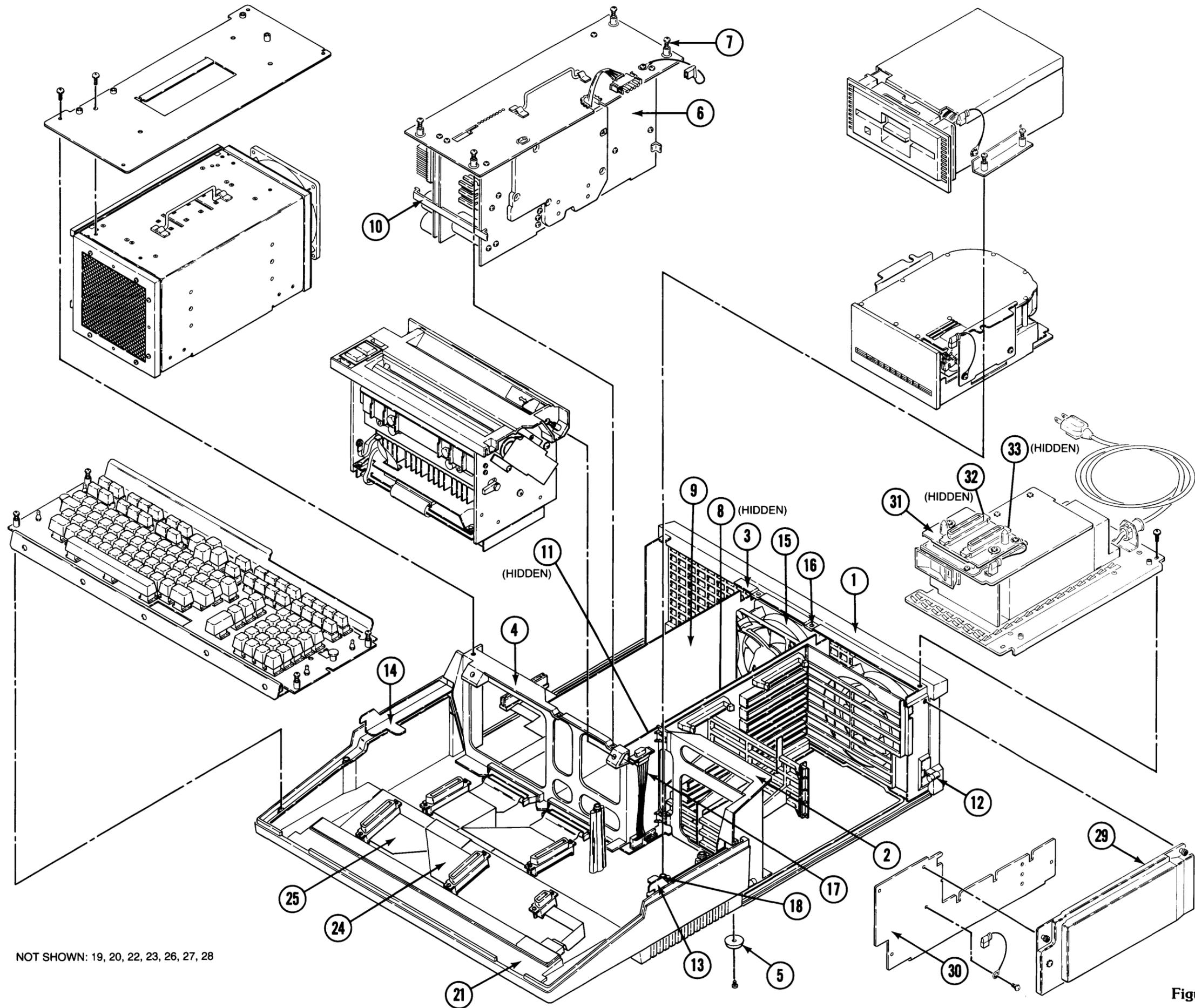
Figure 5-1. Covers

Table 5-7. Covers Parts List (Figure 5-1.)

Index Number	HP Part Number	Quantity	Description
1	5041-3449	2	Exterior Door
2	5041-3456	1	Front Cover
3	0403-0374	2	● Bumper, Square Self-Adhesive.
	09855-60371	1	Rear Cover
4	2190-0010	6	● Washer, Lock, Ext T.
	3050-0071	6	● Washer, Flat, MTLC.
	0905-0960	6	● O-Ring.
	5041-3455	1	Keyboard Bezel
	4040-2047	2	● LED Lens.
	0905-0129	2	● O-Ring 0.145-Inch.
	1390-0064	4	● Receptacle, Ball Stud.
5	5041-3450	1	● Filler Key, Left.
	5041-3451	1	● Filler Key, Right.
	7200-1698	2	Door Trim
	<b>Labels</b>		
	5955-8036	1	● FCC Computer Compliance Label
	7121-3107	1	● Special Function Key Label
	7121-3493	1	● Interlock Warning Label

**Table 5-8. Chassis Components Parts List (Figure 5-2.)**

Index Number	HP Part Number	Quantity	Description
<b>Miscellaneous Hardware</b>			
	0515-0389		Screw, Machine, M3.5.
	0515-0653		Screw, Tapping. 3.6 x 1.34.
<b>Components</b>			
1	09855-67904	1	Complete Casting.
2	0050-2096	1	Partial Casting, Right Front (as seen from front).
3	0050-2095	1	Partial Casting, Rear.
4	0050-2094	1	Partial Casting, Left Front (as seen from front).
5	0403-0106	5	Rubber Foot.
6	09855-69980	1	Power Supply Assembly.
7	1390-0595	4	Captive Screw.
8	4040-2050	1	Power Supply Guide (bottom of power supply bucket).
9	1600-1235	1	Power Supply Bucket.
10	4040-2040	2	Power Supply Side Clamp.
11	0330-0359	1	Long Mounting Foam Support (inside power supply bucket).
12	1600-1216	4	Door Hinge.
13	1600-1217	1	Left Strap.
14	1600-1218	1	Right Strap.
15	3160-0377	3	9.5 VDC Fan.
16	0590-1453	8	Fan Clip.
17	8120-3551	1	Flexible Disc Drive Power Cable.
18	8120-3599	1	Ground Cable.
19	1600-1210	1	Alternate Cursor Control Bracket.
20	1600-1230	1	No Printer Cover.
21	5041-3457	1	Base.
22	8120-3553	1	Fan Cable.
23	8120-3558	1	Alternate Cursor Cable Assembly.
24	8120-3559	1	Keyboard Power Cable.
25	8120-3562	1	Keyboard/IOP Bus Cable.
26	1531-0226	1	Roller/Bushing Assembly (under back of base).
27	1480-0051	2	Roller Axle.
28	09855-66500	1	Motherboard.
29	09855-60200	1	I/O Door Assembly.
30	1600-1226	1	Mass Memory Cover.
<b>98770A and 98780A Displays</b>			
	0050-2091	1	Casting
	09855-69571	1	Display Interface Module (DIM).
	1600-1237	1	Lid.
	1531-0231	2	Pivot.
31	09855-67903	1	Display Connector Plate.
32	8120-3556	1	Display Data Cable (Long Cable).
33	8120-3563	1	Display Power Cable (Short Cable).



NOT SHOWN: 19, 20, 22, 23, 26, 27, 28

Figure 5-2. Chassis

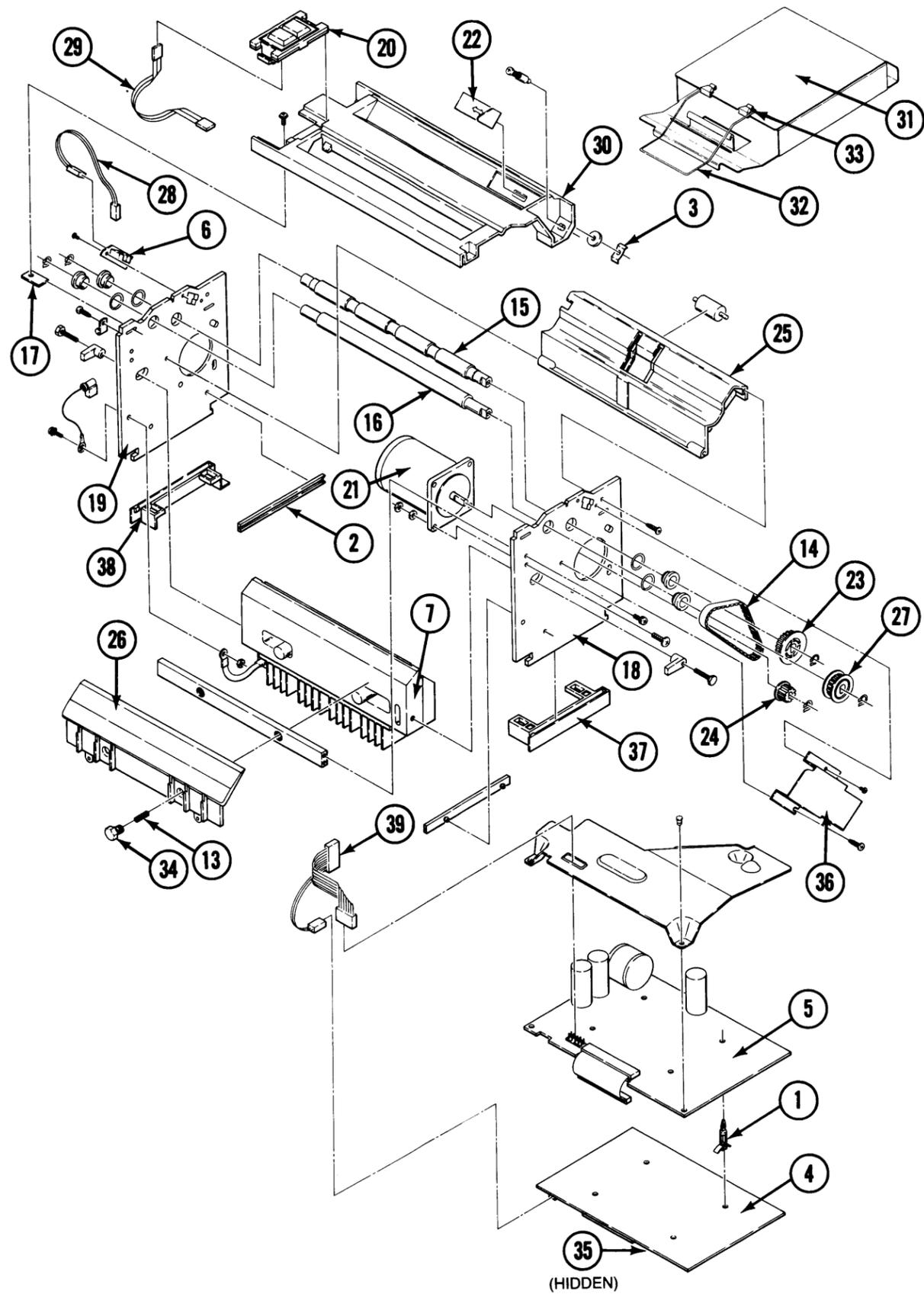


Figure 5-3. Printer

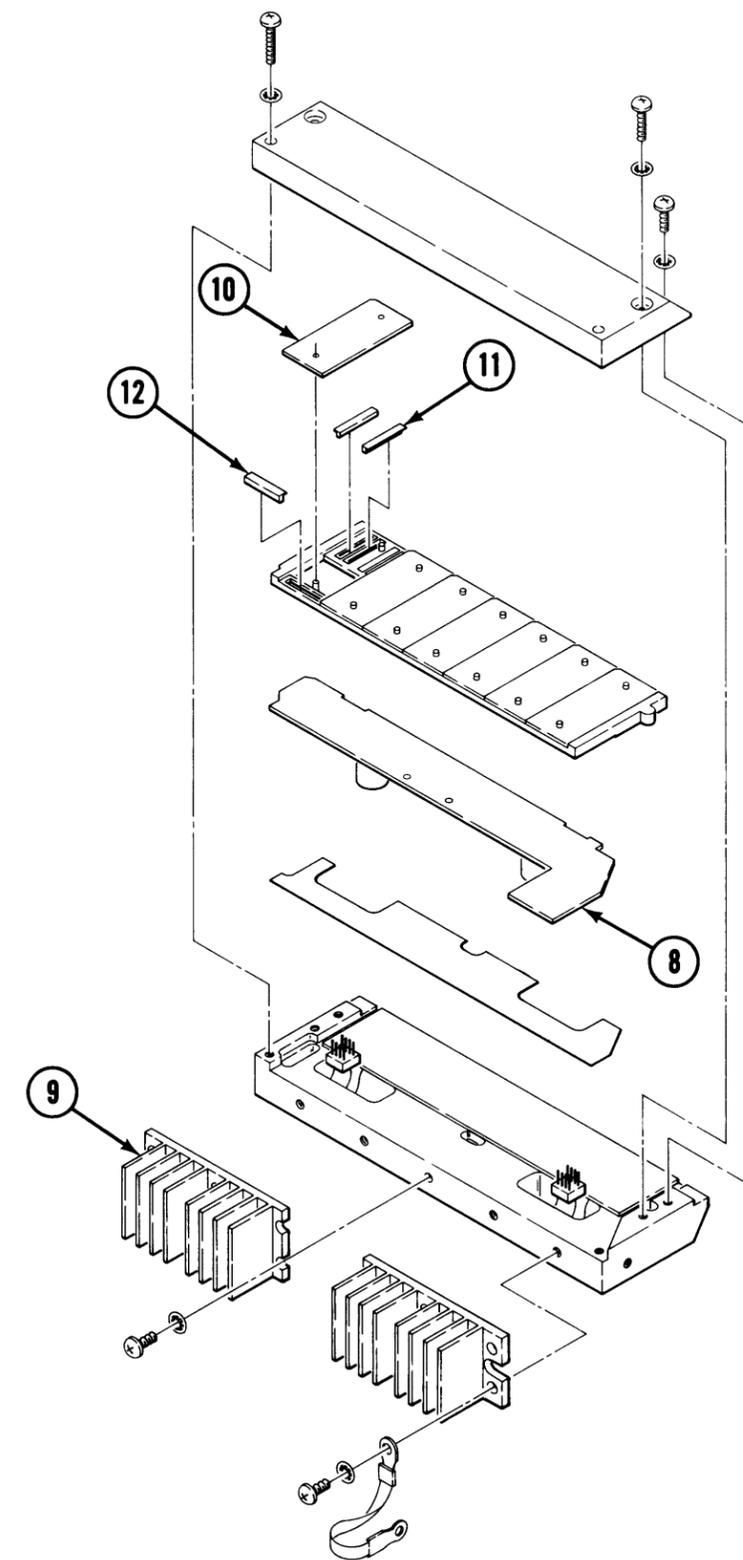


Figure 5-4. Printhead

Table 5-9. Printer Parts List (Figure 5-3, 5-4)

Index Number	HP Part Number	Quantity	Description
	09855-67950		Printer
1	0380-1502	4	PC Board Fastener
2	0403-0268	2	4.50 inch PC Board Guide
3	0510-1196	1	Slider Clip
4	09855-66551	1	Logic Board
5	09855-69552	1	Motor Drive Board
6	09855-66554	1	Paper Sense Board
7	09845-67163	1	Printhead
8	09855-66555	1	Printhead Interconnect Board
9	1205-0377	2	Printhead Heat Sink
10	09845-67161	7	Printhead Chip Module
11	1251-4819	28	Elastomate Connector, Long
12	1251-4820	7	Elastomate Connector, Short
13	1460-0636	2	Compression Spring
14	1500-0530	1	Drive Belt
15	1530-2025	1	Roller
16	1530-2026	1	Platen
17	1600-1201	4	Bezel Clamp
18	1600-1333	1	Right Side Plate
19	1600-1334	1	Left Side Plate
20	3101-2564	1	Switches Assembly
21	3140-0668	1	Stepper Motor and Connector
22	4040-2057	1	Paper Guide Slider
23	5040-8143	1	Roller Pulley
24	5040-8144	1	Motor Pulley
25	5041-1497	1	Lower Paper Guide
26	5041-1498	1	Tear Bar
27	5060-7463	1	Platen Assembly Pulley
28	8120-3560	1	Paper Sense Cable
29	8120-3564	1	Paper Advance Cable
30	7101-0689	1	Bezel
31	09855-67951	1	Paper Tray Assembly
32	1460-1948	1	Wire Paper Guide
33	4040-2038	2	Wire Guide Hinge
34	0380-1161	2	Hex Standoff
35	1818-1870	1	ROM
36	1600-1264	1	Belt Guard
37	4040-2079	1	Plastic Locator Guide, Right
38	4040-2080	1	Plastic Locator Guide, Left
39	8120-3994	1	Printhead Cable

5-12 Replaceable Parts

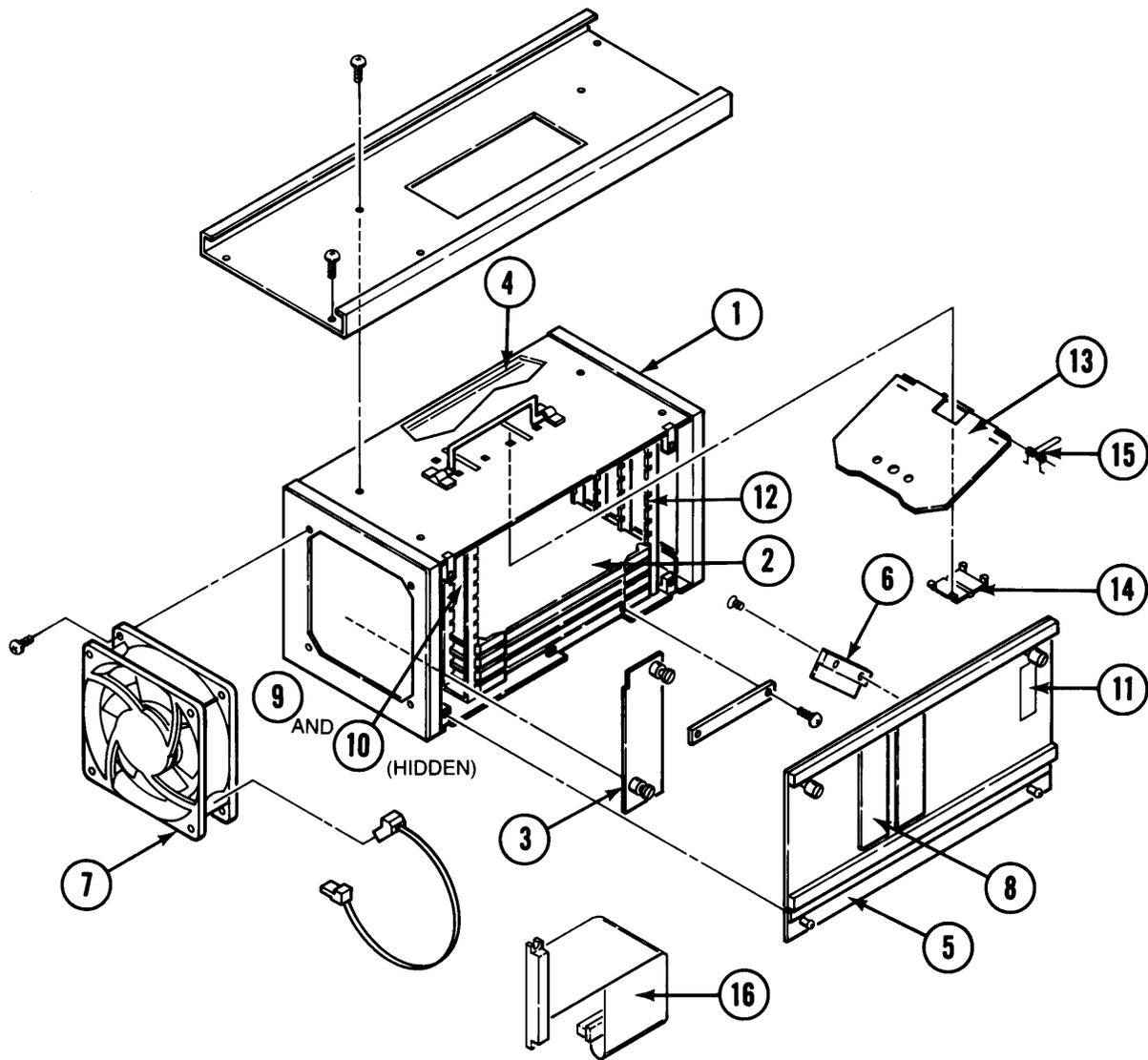


Figure 5-5. Processor Stack

Table 5-10. Processor Stack Parts List (Figure 5-5.)

Index Number	HP Part Number	Quantity	Description
1	97011-64403	1	Processor Cage (Without Cards or Clock)
2	<b>Stack Replacement Boards</b>		
	5061-4235	1	● CPU Board
	5061-6803	1	● Floating Point CPU (new)
	97044-69806	1	● IOP Board (Rev. 3.1) (exchange)
	5061-4228	1	● IOP Buffer Assembly
	5061-4232	1	● 256K RAM Board
	5061-6805	1	● 512K RAM Board
	97047-69805	1	● 512K RAM Board (exchange)
	97046-69704	1	● 1M RAM Board (exchange)
	5061-7704	1	● 1M RAM Board (new)
	09855-66525	1	● Load Board
3	5061-4224	1	Clock Board
4	5061-4263	1	Stack Motherboard
	5041-3463	2	● Motherboard Support
5	1600-1353	1	Stack Door
	5180-5201	1	Label, Door Seal
6	1400-1179	1	IOP Cable Clamp
7	3160-0377	1	Fan
8	1600-1353	1	IOP Connector Plate, Aluminum
	5041-3468	1	IOP Connector Plate, Black
9	3101-2565	1	Processor Interlock Switch
10	8120-3600	1	Processor Interlock Cable
11	4040-2101	1	LED Window
12	5041-3464	2	Card Guide
13	4040-2114	1	Air Controller
14	4040-2115	1	Air Controller Pivot
15	1460-1981	1	Air Controller Spring
16	8120-3806	1	IOP #2 Cable
	8120-3807	1	IOP #3 Cable

5-14 Replaceable Parts

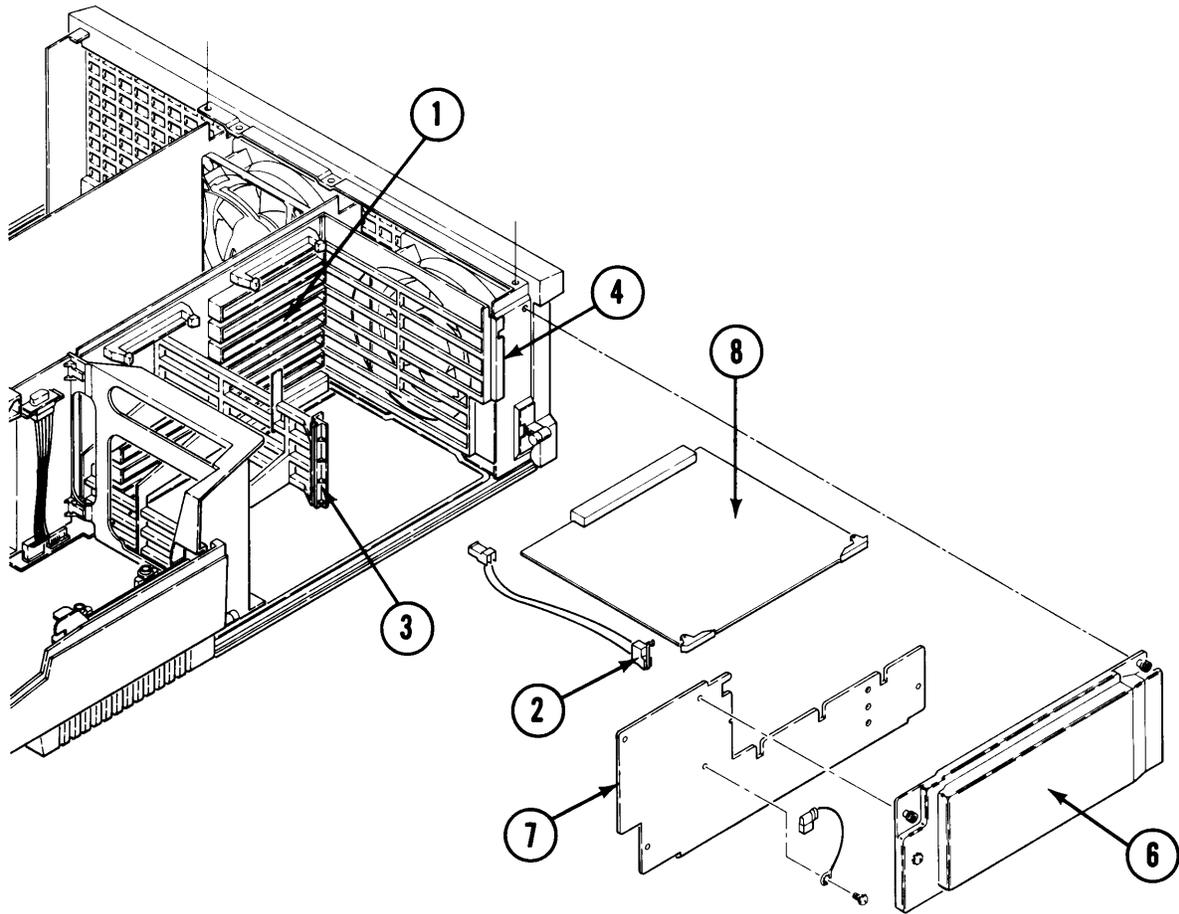


Figure 5-6. I/O Cage

Table 5-11. I/O Cage Parts List (Figure 5-6.)

Index Number	HP Part Number	Quantity	Description
1	09855-66501	1	I/O Backplane.
2	8120-4017	1	I/O Interlock Cable and Switch.
3	0403-0434	1	I/O Front Card Guide.
4	0403-0435	1	I/O Rear Card Guide.
5	7121-3061	1	I/O Card Guide Label (Select Codes).
6	09855-60200	1	I/O Door Assembly.
7	1600-1226	1	Mass Memory Cover.
8*	<b>I/O Cards and Parts</b>		
	09855-69560	1	Fixed Disc Drive I/O Card.
	8120-3801	1	● 2 Pin Controller Interconnect Power Cable.
	8120-3789	1	● 20 Pin Controller Interconnect Cable.
	8120-3788	1	● 34 Pin Controller Interconnect Cable.
	8120-3803	1	● 50 Pin Controller Interconnect Cable.
	0380-1562	4	● Fixed Disc Controller Standoffs.
	09855-69886	1	Fixed Disc Drive Controller.
	1818-1989	1	● Fixed Disc Drive Program ROM.
	09855-66562	1	Bootstrap Loader Card.
**	09020-80000	1	● Loader/ID ROM (for Fixed Disc Drive or Bootstrap Loader Card).
**	09020-80001	1	● Loader/ID ROM (for Fixed Disc Drive or Bootstrap Loader Card).
	09855-69561	1	9130K Flexible Disc Drive Controller.
	1818-1897	1	● Flexible Disc Controller ROM.

\* For Interface Card information, see the 520 Installation Manual, 09020-90011, Appendix A.

\*\* When ordering the Loader/ID ROM, the serial number of the computer must be given to the individual taking the order. The serial number is programmed into the replacement ID ROM. Boot Loader ROM 09020-80001 is required for systems using 1 Megabyte RAM boards and UNIX 4.0 or Basic 2.0. The Boot Loader ROM can be used with other RAM configurations if UNIX 4.0 or Basic 2.0 is used. Boot Loader ROM 09020-80000 can be used with UNIX 4.0 or Basic 2.0 (or any previous software) as long as the stack does not contain a 1 Megabyte board. The above part numbers are replacement part numbers. ROMs will be labeled: 1818-3467 (Rev. A) or 1818-3461 (Rev. B).

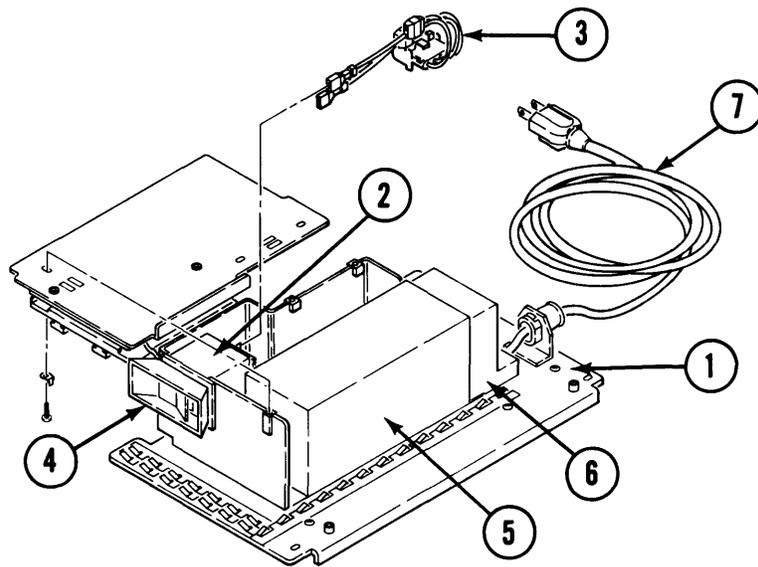


Figure 5-7. AC Module

Table 5-12. AC Module Parts List (Figure 5-7.)

Index Number	HP Part Number	Quantity	Description
1	09855-67901	1	110V Ac Module.
	09855-67902	1	220V Ac Module.
2	09855-67101	1	110V Ac Power Switch.
	09855-67102	1	220V Ac Power Switch.
3	8120-3554	1	110V Ac Module Cable.
	8120-3580	1	220V Ac Module Cable.
4	4040-2054	1	Switch Bezel.
5	9135-0163	1	Line Filter.
6	4040-2048	1	Ac Wiring Shield.
	7120-6157	1	Ac Danger Label.
	7121-3060	1	90-125V Line Voltage Label.
	7121-3062	1	220V Line Voltage Label.
	7121-2708	1	High Voltage Label.
7	<b>Ac Power Cords</b>		
	09855-61600	1	United States. 110V.
	09855-61601	1	Australia.
	09855-61602	1	Europe.
	09855-61603	1	CSA and United States. 220V.
	09855-61604	1	Switzerland.
	09855-61605	1	Great Britain.
	09855-61606	1	Denmark.

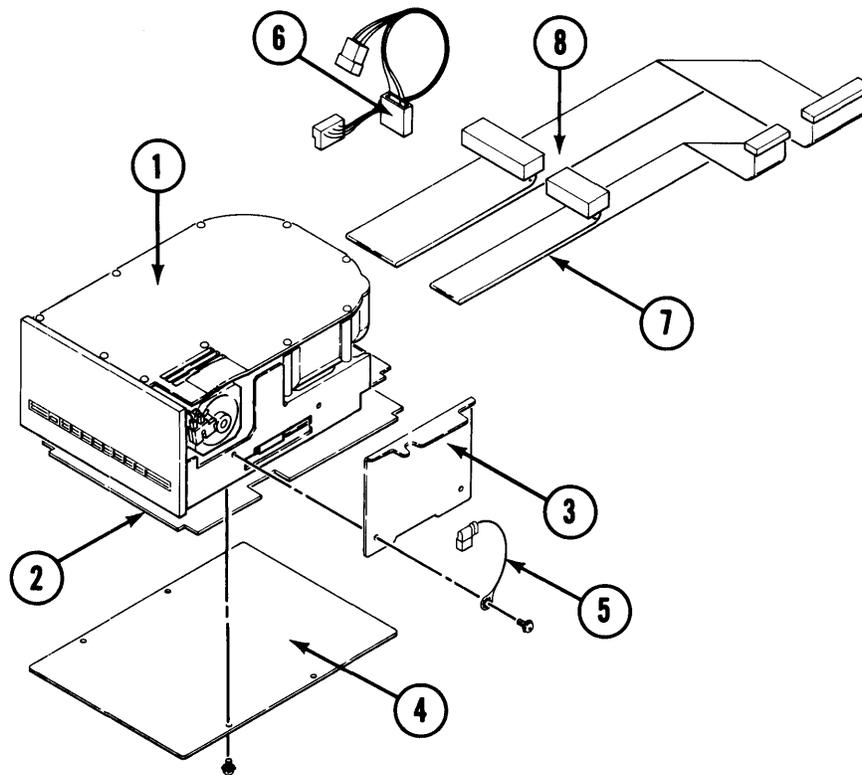


Figure 5-8. Winchester Fixed Disc Drive

Table 5-13. Winchester Fixed Disc Drive Parts List (Figure 5-8.)

Index Number	HP Part Number	Quantity	Description
1	09133-69102	1	Fixed Disc Mechanical Drive.
2	09133-69101	1	Electronics Board.
3	1600-1306	2	Mounting Bracket.
4	1600-1311	1	Bottom Cover.
5	8120-3598	1	Ground Cable.
6	8120-3800	1	Drive Power Cable.
7	8120-3786	1	20 Pin Drive Cable.
8	8120-3802	1	34 Pin Drive Cable.

(For information on controller card or I/O card, see the I/O Cage Parts List.)

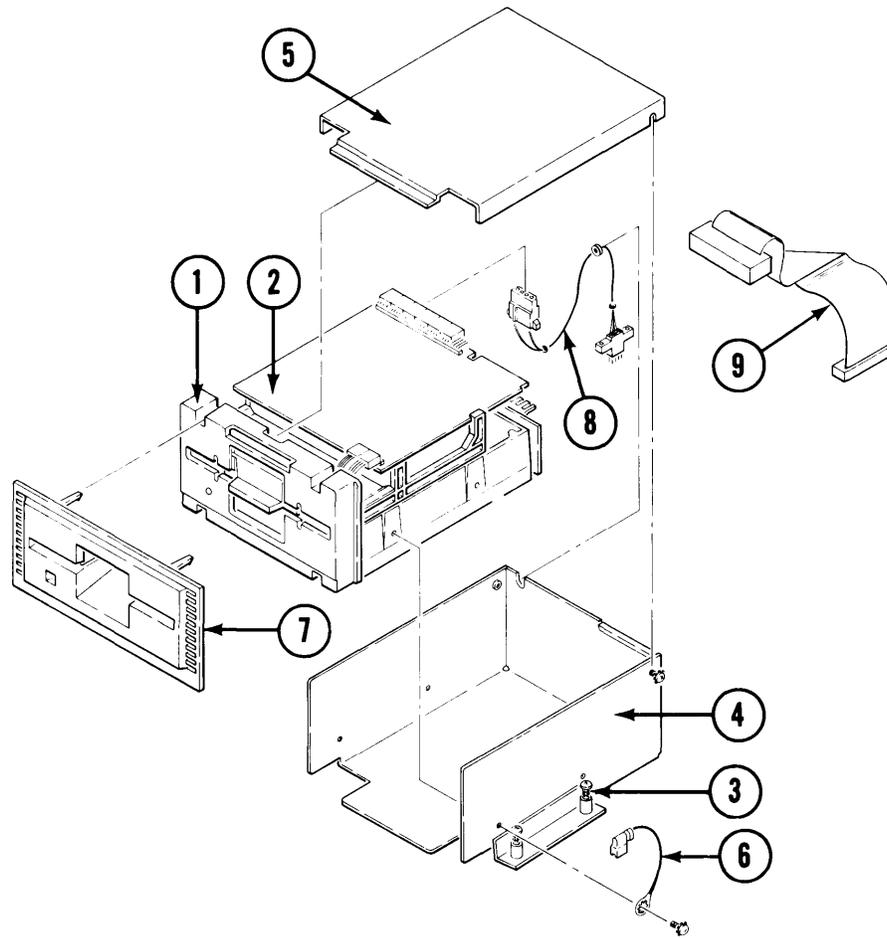


Figure 5-9. Flexible Disc Drive

Table 5-14. Flexible Disc Drive Parts List (Figure 5-9.)

Index Number	HP Part Number	Quantity	Description
1	09130-69600	1	9130K Flexible Disc Mechanical Drive.
2	09130-66501	1	Electronics Board.
*	09131-69600	1	9131G Flexible Disc Drive (with board).
3	1390-0596	3	Captive Screw.
4	1600-1212	1	Bucket Assembly.
5	1600-1228	1	Bucket Cover.
6	8120-3598	1	Ground Cable.
7	4040-2056	1	Appearance Bezel.
8	8120-3552	1	Power Cable.
9	8120-3555	1	Logic Cable.

\* 9020 serial number prefix 2422 uses this disc drive. The electronics board cannot be ordered separately.

(For information on the controller card, see the I/O Cage Parts List.)

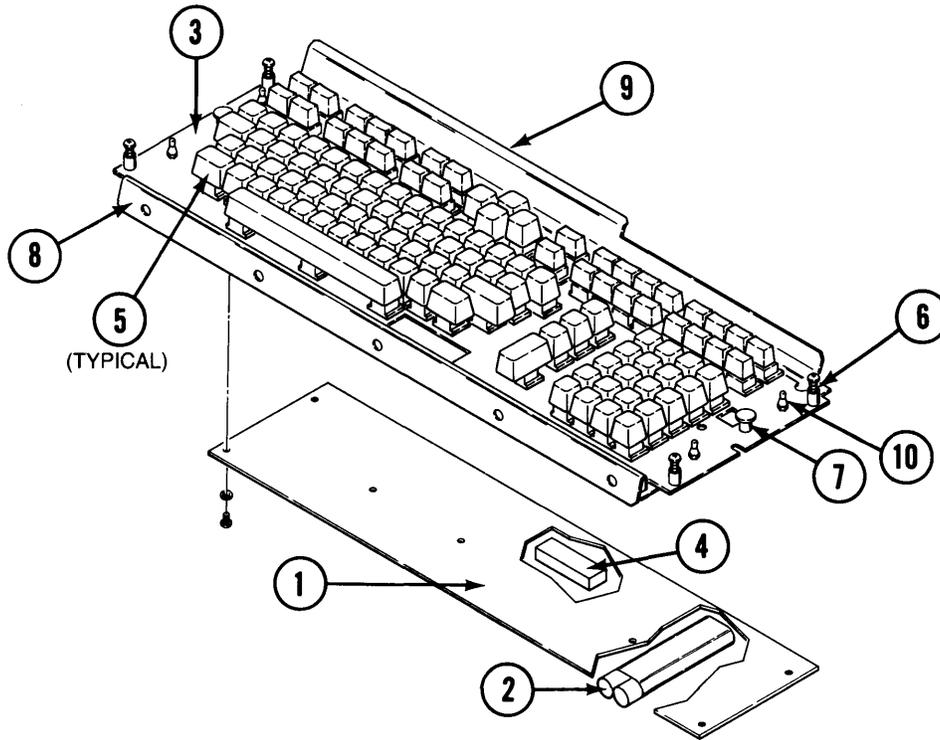


Figure 5-10. Keyboard

Table 5-15. Keyboard Parts List (Figure 5-10.)

Index Number	HP Part Number	Quantity	Description
	09855-67930	1	Keyboard (complete)
1	09855-69531	1	Keyboard Electronics Board.
2	1420-0302	1	4.8V RTC/NVM Battery Assembly.
3	09855-69131	1	Keyswitch Board.
4	1820-2707	1	Processor/ROM (8048 - Bottom of board).
5	3101-2595	—	Keyswitch, Micro.
	3101-2596	—	Keyswitch, Cortron.
6	1390-0448	4	Snap-in Fastener.
7	1440-0160	2	Pull Handle.
8	1600-1234	1	Structural Strip, Front.
9	1600-1236	1	Structural Strip, Rear.
10	1390-0448	4	Ball Stud.

Table 5-16. 98760 Display Parts List (Figure 5-11.)

Index Number	HP Part Number	TQ	Description
1	09836-69550	1	Power Supply Board - Exchange
2	09836-69540	1	Sweep Board - Exchange
3	09836-69542	1	Video Board - Exchange
4	98760-69573	1	Alpha/Interface Board - Exchange
5	98760-69575	1	Graphics/Digital Video Board (ASCII) - Exchange
5	98760-69576	1	Graphics/Digital Video Board (Katakana) - Exchange
	0515-0212	23	Screw, M3.5 X 0.6
6	98760-66501	1	RFI Filter Board
7	98760-66500	1	Motherboard
8	0380-1624	4	Standoff, Snap-in
9	8120-4102	1	Cable, Digital Interconnect (sheathed dual ribbons)
10	8120-4100	1	Cable, Video Power
11	8120-4157	2	Cable, Video Data/Filter Board
12	09836-61603	1	Cable, Flashover Ground (Aquadag)
13	1460-1915	1	Spring, Aquadag Ground
14	2090-0070	1	CRT/Yoke Assembly
15	09836-61601	1	Degaussing Cable
	1400-0482	1	Cable Tie Wrap
16	98760-04102	1	Yoke Support Plate
	0400-0025	1	Grommet
	3050-0066	2	Flat Washer
	2190-0918	4	Lockwasher
17	8120-4099	1	Intensity Pot
	0510-0595	2	Retaining Clip
	5040-8149	1	Thumbwheel
18	98760-67901	1	Fan (includes cable and grill)
19	4040-1926	2	Fan Clip (side bracket)
20	4040-1923	1	Fan Boot
21	98760-40101	1	Base Assembly (With Latch Assembly)
22			Latch Assembly
	1460-1982	4	• Latch Spring
	0624-0403	8	• Latch Screw
	1480-0083	4	• Latch Dowel Pin
	1600-1310	8	• Latch Angle Bracket
	1600-1327	4	• Latch Pawl
23	0050-2091	1	Casting, Alpha/Interface Board
	0515-0356	17	Screw, M3.5 with lock washer
	2190-0918	6	Lock Washer
24	1600-1214	2	Spring Plate
25	1531-0231	2	Pivot
26	98760-04101	1	Lid, Alpha/Interface Board
	8160-0392	0.25 ft	RFI Gasketing
	0624-0400	8	Screw, RPG 6-19
	8160-0389	1.42 ft	RFI Gasketing, Double Finger
	0363-0170	2	RFI Gasketing, RFI Cage
	0624-0402	2	Plastic Screw .25
27	98760-40801	1	Front Bezel
	1000-0650	1	OCLI Glass
28	98780-40015	1	Top Cover
29	98760-44101	1	Back Cover
30	98760-00601	1	Purity Shield
	98760-01201	1	Free Bracket (Left)
	2680-0105	4	10-32X.75 Screw
	0361-1096	1	Rivet

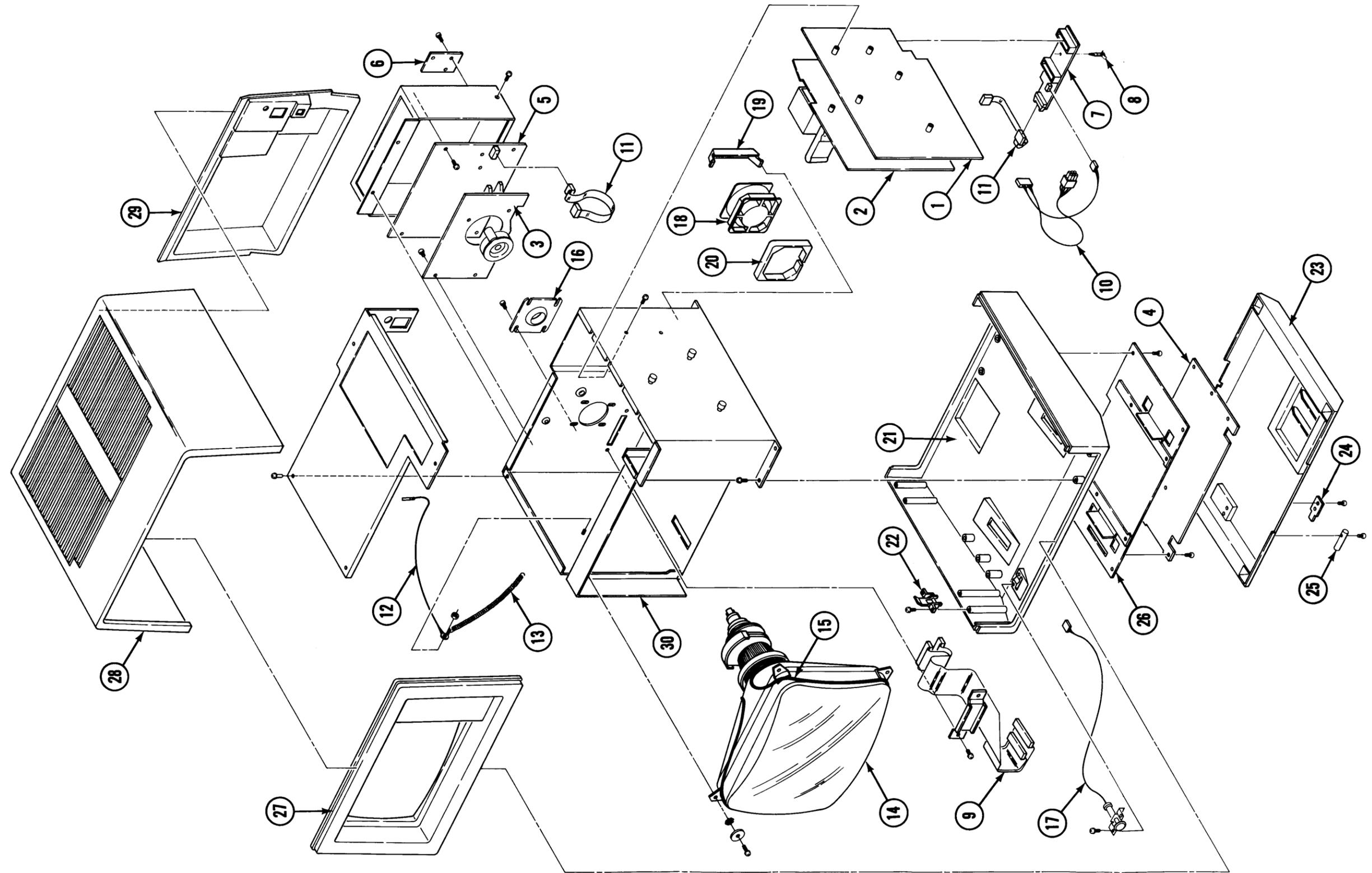


Figure 5-11. 98760 Display

## Keyboard Configurations

The computer keyboard can be configured to one of several languages. Reconfigurations can be done in the field. To reconfigure a keyboard: 1) change resistors on keyboard electronics board to desired configuration, and 2) change keycaps to desired configuration. Instructions for changing resistors and keycaps are provided in Chapter 4 under "Keyboard".

Figures 5-12 through 5-17 respectively illustrate the following keycap configurations: ASCII, French, Spanish, German, Katakana, and Swedish/Finnish. The last four digits of the keycap part number are provided for each keycap. The first four digits are always **0371**. For example, the "J" keycap is identified on Figure 5-12 as 2632. To order the "J" keycap, order part number 0371-2632.

All keycap configurations except ASCII have some keycaps highlighted. The shaded keycaps differ from the keycaps on the ASCII keyboard. The ASCII keyboard is the exchange assembly in case of keyboard failure. Before returning a failed non-ASCII keyboard, remove all non-ASCII keycaps from the failed board and place them on the replacement keyboard.

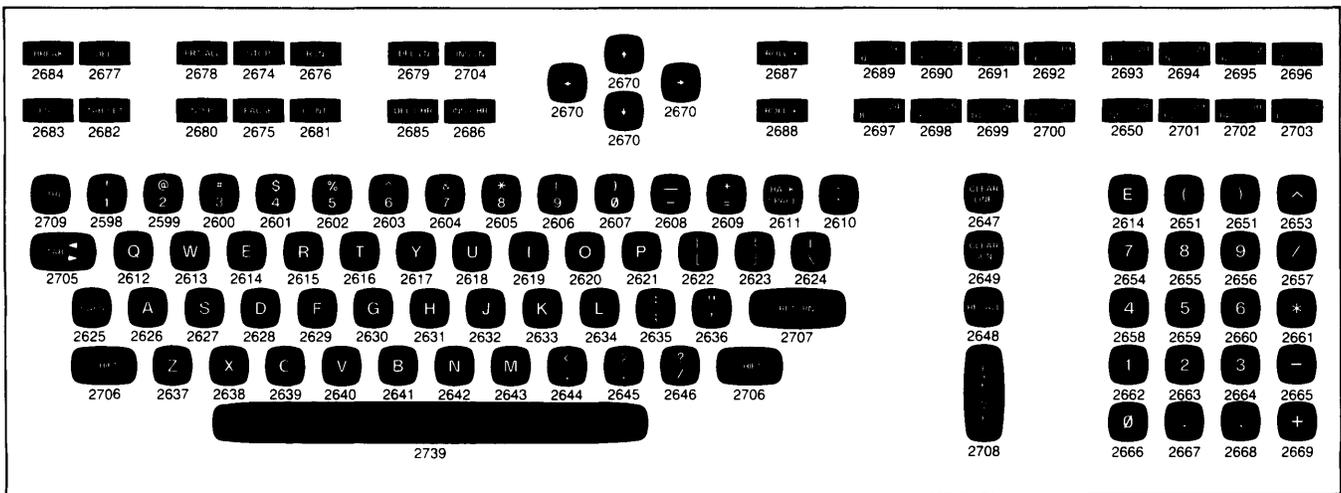


Figure 5-12. ASCII Keyboard (Prefix 0371)

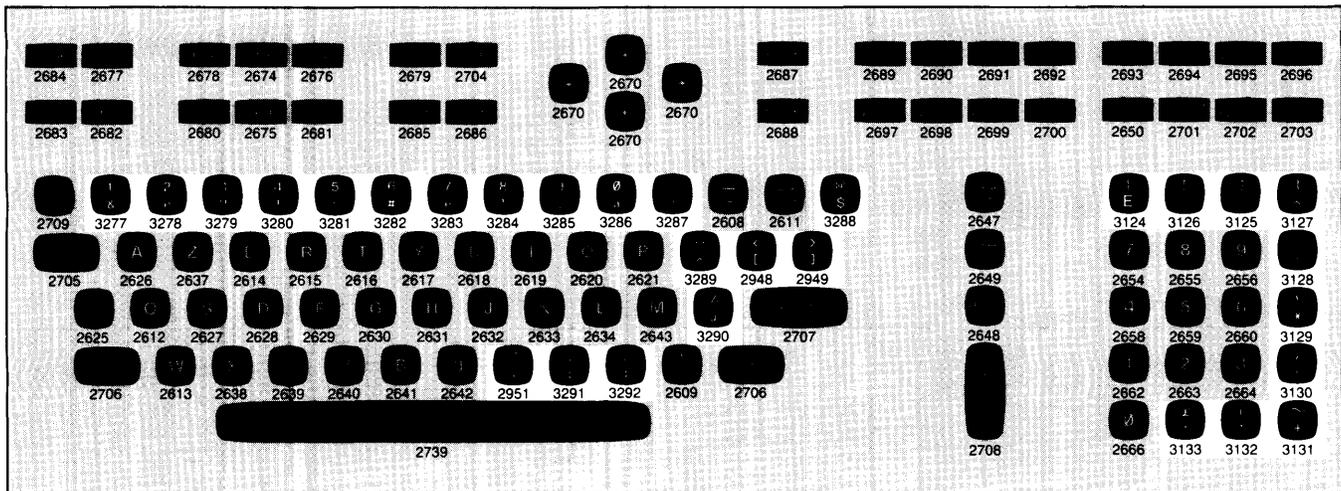


Figure 5-13. French Keyboard (Prefix 0371)

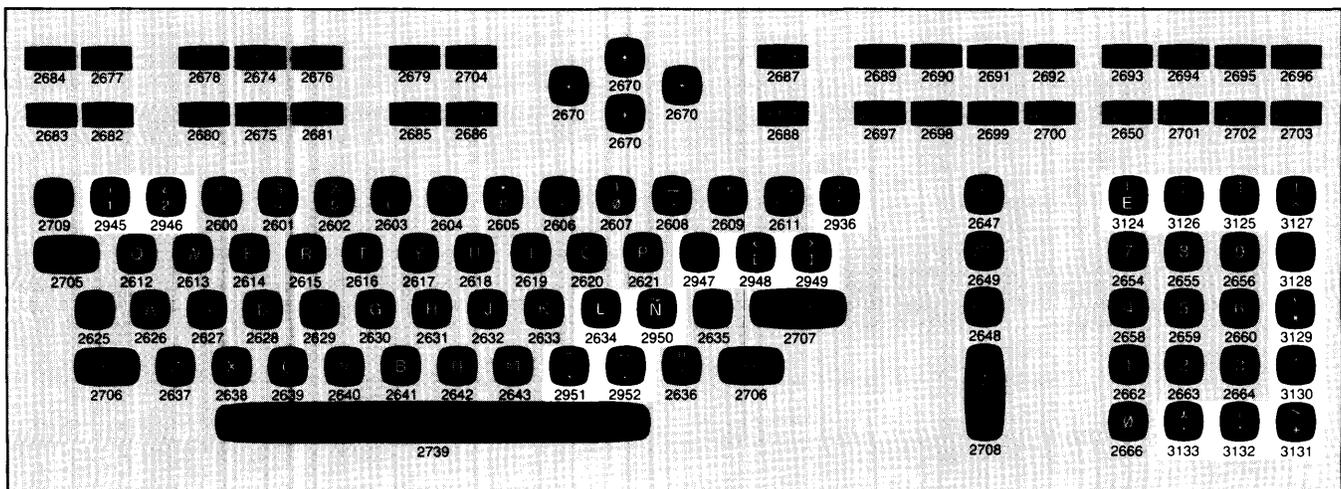


Figure 5-14. Spanish Keyboard (Prefix 0371)

5-24 Replaceable Parts

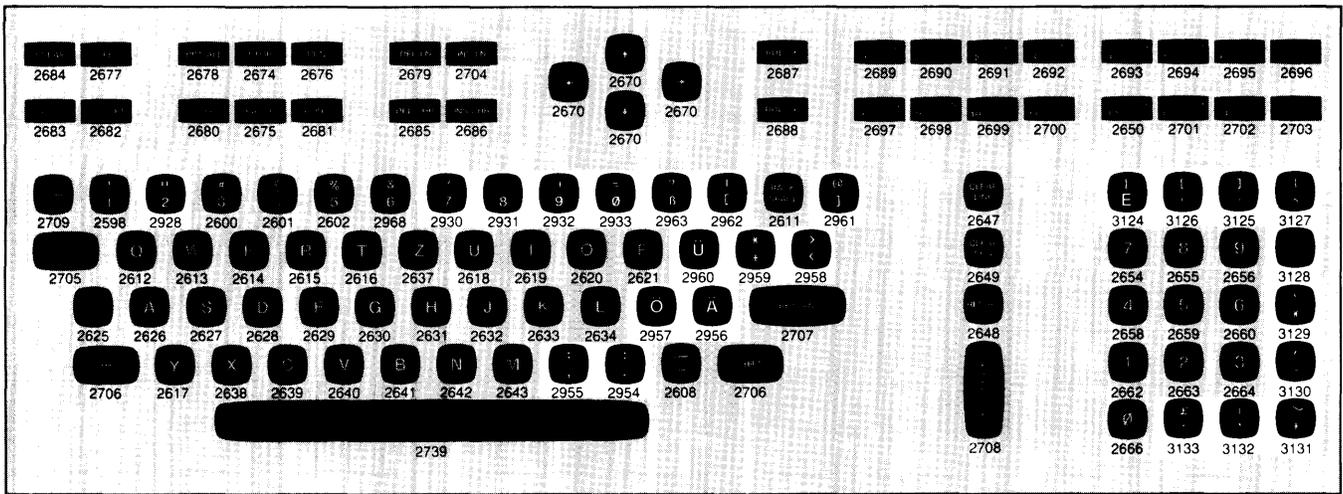


Figure 5-15. German Keyboard (Prefix 0371)

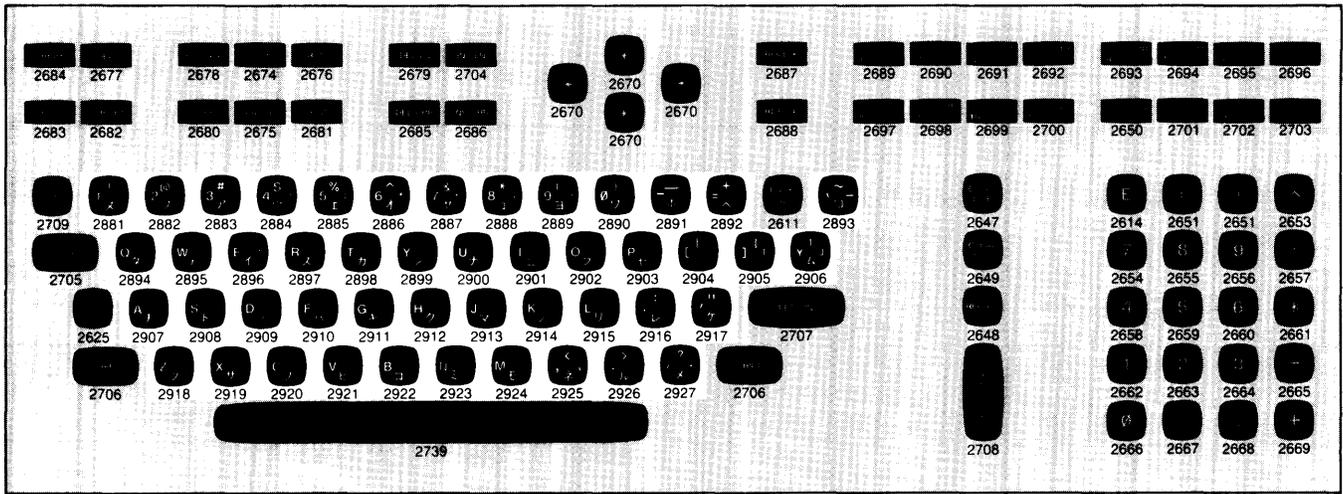


Figure 5-16. Katakana Keyboard (Prefix 0371)

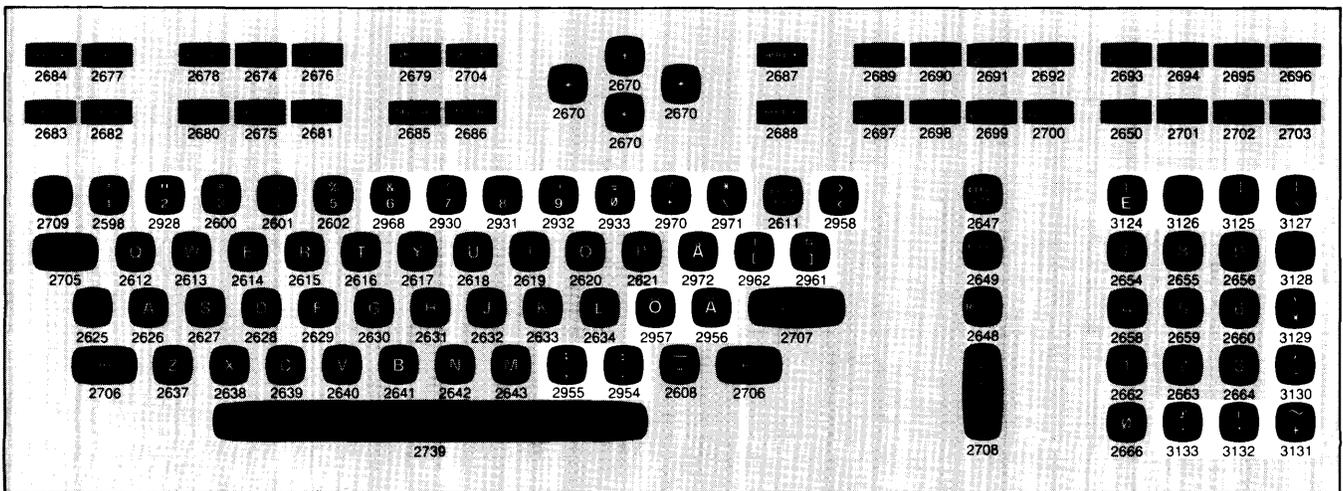


Figure 5-17. Swedish/Finnish Keyboard (Prefix 0371)

# Error Messages

Appendix

C

## Introduction

Several types of error messages are output to the display and/or printer. Other failures result in audible messages via the keyboard beeper. This subsection describes all computer error messages and indications.

The error messages and indications are listed below and individually described in the following paragraphs:

Beeping at 0.5-second repeat rate

Beeping at 2-second repeat rate

“Clock and date not set.”

“Self test error 1: IO address AA, SS STATUS: XXXXXXXX”

“Self test error 2: CHECKSUM for segment NN”

“Self test error 3: XXXX NN”

“Self test error 4: Memory reduced to: NNNNNNNN bytes. MCs: <mc list>”

“Self test error 5: Fewer finstrates were found than expected.”

“System halted due to double bit memory error on MC # NN CCCCCCCC”

“System halted: Incompatible IOPs”

“System halted: Insufficient memory to start system”

“System halted: System error”

## Fast Beep

### Audible Message

Beeping at 0.5-second repeat rate.

### Indicates

Major failure during system load.

### Action

Try different system discs.

## Slow Beep

### Audible Message

Beeping at 2-second repeat rate.

### Indicates

Insufficient memory for system being loaded.

### Action

Check stack self-test LEDs for RAM board failures, and replace defective RAM, if necessary. Verify that memory configuration is sufficiently large for system being loaded.

## Clock and Date

### Message

“Clock and date not set.”

### Indicates

Contents of real-time clock and non-volatile memory have been lost.

### Action

Set time/date with BASIC statement SET TIME/TIMEDATE. Example: SET TIMEDATE DATE(“1 JAN 1982”) + TIME(“15:20:00”)

## Self Test Error 1

### Message

“Self test error 1: IO address AA, SS STATUS: XXXXXXXX”

Where: AA = device address

- 0 = display alphanumeric
- 1 = display graphics
- 6 = keyboard and printer
- 7 = internal mass storage

SS = subaddress

With AA = 6:

- 0 = printer
- 2 = keyboard

With AA = 7:

- 0 = fixed disc
- 1 = flexible disc
- Y = (reserved)

XXXXXXXX = error code in hex

## Indicates

Table C-1 lists all error codes by device address (DA) and subaddress (SA), and defines them.

## Action

Determined by definitions in Table C-1.

**Table C-1. Self Test Error 1 Error Codes**

DA	SA	Error Code	Definition
			<b>Display</b>
0		00000001	Status line not asserted
0		00000002	Flag line not asserted
0		00000003	FR0 failed loopback
0		00000004	Weasel chip failed selftest
0		00000005	FR8 failed loopback
0		00000006	FR9 failed loopback
0		00000007	FR10 failed loopback
0		00000008	FR12 failed loopback
0		00000009	FR1 failed loopback
0		0000000A	Poll response asserted but not enabled
0		0000000B	Poll response not asserted when enabled
0		0000000C	Failed frame buffer memory test
0		0000000D	Failed space substitution test
0		0000000E	Failed display interrupt test
0		0000000F	Failed synchronous startup test
0		00000010	Failed window test
0		00000011	Failed reset test
0		00000012	Timed out while waiting for interrupt
0		00000013	Status false during frame buffer transfer
0		00000014	Timed out while waiting for DMA transfer
1		00000001	Status line not asserted
1		00000002	Flag line asserted when graphics disabled
1		00000003	Poll line asserted but not enabled
1		00000004	Flag line not asserted when graphics enabled
1		00000005	Poll line not asserted when graphics enabled
1		00000006	Graphics memory failure
1		00000007	Rubber band memory failure
1		00000008	Failed line drawing test
1		00000009	Erase memory failure
1		0000000A	Flag timeout while writing FR1
1		0000000B	Flag timeout while writing FR0
1		0000000C	Flag timeout while reading FR0
1		0000000D	Timed out while waiting for DMA termination

C-4 Error Messages

DA	SA	Error Code	Definition
			<b>Printer</b>
6	0	000XX00	Problem indicated by status byte XX defined below.
6	0	0000YY01	Timed out while waiting for printer to complete self test
6	0	0000YY02	Flag did not go false after reading FRO
6	0	0000YY03	Timed out while waiting for flag
6	0	0000YY04	Failed loopback test
6	0	0000YY05	Printer not responding to poll
6	0	0000YY06	Printer failed self test
6	0	0000YY07	Printer responds to polls when disabled
6	0	0000YY08	Printer status false
6	0	0000YY09	Printer enabled for poll response after reset
6	0	0000YY0A	Keyboard PFW interrupt cannot be cleared
<p>XX = Printer status byte in following format:            PSFL DSTF MSTF OOPP HDFL VHLO PTTH HDTH            where: PSFL = Power supply failure; motor drive board bad            DSTF = Dangerous self test failure; potential damage to printhead            MSTF = Minor self test failure; no potential damage to equipment            OOPP = Out of paper            HDFL = Printhead control line failure; BURN and/or CLEAR line stuck high or low            VHLO = Printhead supply voltage too low            PTTH = Power transistor on motor drive board too hot            HDTH = Printhead too hot; temperature in printhead exceeded 70°C            YY = Irrelevant</p>			

DA	SA	Error Code	Definition
			<b>Keyboard</b>
6	2	00000001	Failed loopback to FR15
6	2	00000002	Keyboard not responding to poll
6	2	00000003	Keyboard failed self test
6	2	00000004	Battery low condition detected
6	2	00000005	Keyboard not responding with SRQ bit
6	2	00000006	Keyboard not forcing status false
6	2	00000007	Reading FR10 did not clear keyboard poll response
6	2	00000008	Power fail warning bit set

DA	SA	Error Code	Definition
			<b>Fixed Disc Drive (SA = 0) or Flexible Disc Drive (SA = 1)</b>
7	X	00000001	Timeout waiting for self test
7	X	00000002	Failed poll response
7	X	00000003	Status false failure
7	X	00000004	Timeout in loopback
7	X	00000005	Failed loopback
7	X	00000006	Qstat timeout
7	X	00000007	Flag line stuck
7	X	00000008	Poll response stuck
7	X	00000009	Bad power on qstat
X = 0 for fixed disc drive = 1 for flexible disc drive			

DA	SA	Error Code	Definition
			<b>(Reserved)</b>
7	Y	00000001	Can't clear FR1 bits
7	Y	00000002	Can't set FR1 bits
7	Y	00000003	Reset doesn't clear FR1
7	Y	00000004	Get flop not cleared
7	Y	00000005	Failed loopback
7	Y	00000006	Get flop not set
7	Y	00000007	Status not set
7	Y	00000008	Flag not cleared
7	Y	00000009	Poll not cleared
7	Y	0000000A	Poll not cleared 2
7	Y	0000000B	Poll not set
7	Y	0000000C	Flag not cleared 2
7	Y	0000000D	Poll not cleared 3
Y = reserved			

## Self Test Error 2

### Message

“Self test error 2: CHECKSUM for segment NN”

Where NN indicates the code segment in which the error occurred.

### Indicates

An operating system failure.

### Action

Try different system discs or replace defective RAM.

## Self Test Error 3

### Message

“Self test error 3: XXXX NN”

Where XXXX = CPU#, IOP#, or MC#

NN = is the NNth of that board type, counting from the bottom of the stack

### Indicates

Board failure.

### Action

System operation can continue provided that the failed board is not required.

## Self Test Error 4

### Message

“Self test error 4: Memory reduced to NNNNNNNN bytes. MCs:<mc list>”

Where NNNNNNNN = number of bytes of RAM available to the system.

<mc list> is a list of memory controller numbers which had failures. Up to 10 MC numbers are printed in 10 two character fields with no intervening spaces. For example:

“MCs: 1 210” indicates that memory controllers 1, 2, and 10 have failed memory. Memory boards (and memory controllers) are numbered from 1, starting at the bottom of the stack.

### Indicates

Memory has been mapped out. Refer to Chapter 2 for additional information. System still runs with reduced RAM.

### Action

Replace defective RAM.

## Self Test Error 5

### Message

“Self Test Error 5: Fewer finstrates were found than expected.”

### Indicates

The number of boards detected at powerup is smaller than the number recorded in NVM.

### Action

Ensure board configuration meets system requirements. Chapter NVM as required. (If more finstrates were found than expected, NVM is automatically updated to match the actual configuration.)

## Double-Bit Error

### Message

“System halted due to double bit memory error on MC # NN CCCCCCCC”

Where NN = MC # counting from bottom of stack  
CCCCCCCC = last healer content in hex for MC # NN

“System halted due to double bit memory error on MC # No DBE found”.

Where “No DBE found” probably means the MC chip is faulty. Could also be CPU, IOP or clock board (in order of probable cause).

### Indicates

Double-bit error occurred. System halted.

### Action

Replace defective RAM card.

## Incompatible IOPs

### Message

“System halted: Incompatible IOPs”

### Indicates

Illegal combination of IOP finstrates was found at powerup. IOPs of Revision 2.1 and earlier are not compatible with IOPs of Revision 3.0 and later.

### Action

Reconfigure IOPs to legal combination.

## Insufficient Memory

### Message

“System halted: Insufficient memory to start system”

### Indicates

Too much system for available memory

### Action

Add RAM or reduce system.

## System Error

### Message

“System halted: System error”

### Indicates

System fault.

### Action

Try new revision of operating system. Analyze system dump which has been displayed and/or printed.

# Appendix D

## Motherboard Pinout Data

Figure D-1 is a layout drawing of the computer motherboard. It identifies all motherboard connectors and shows every pin and its corresponding signal name. Table D-1 lists every motherboard connector and its usage. Table D-2 alphanumerically lists all the signal names used on the motherboard and provides their definitions.

**Table D-1. Motherboard Connectors**

Designator	Connecting Assembly
J40	I/O Backplane
J42	Power Supply
J43	Power Supply
J44	Power Supply
J45	Power Supply
J46	Power Supply
J47	Power Supply
J48	Processor Stack
J49	Processor Stack
J50	IOP #1, Printer, Keyboard, J40
J51	Printer, Keyboard
J52	Three Fans
J53	Mass Storage Device
J54	Mass Storage Device

## D-2 Motherboard Pinout Data

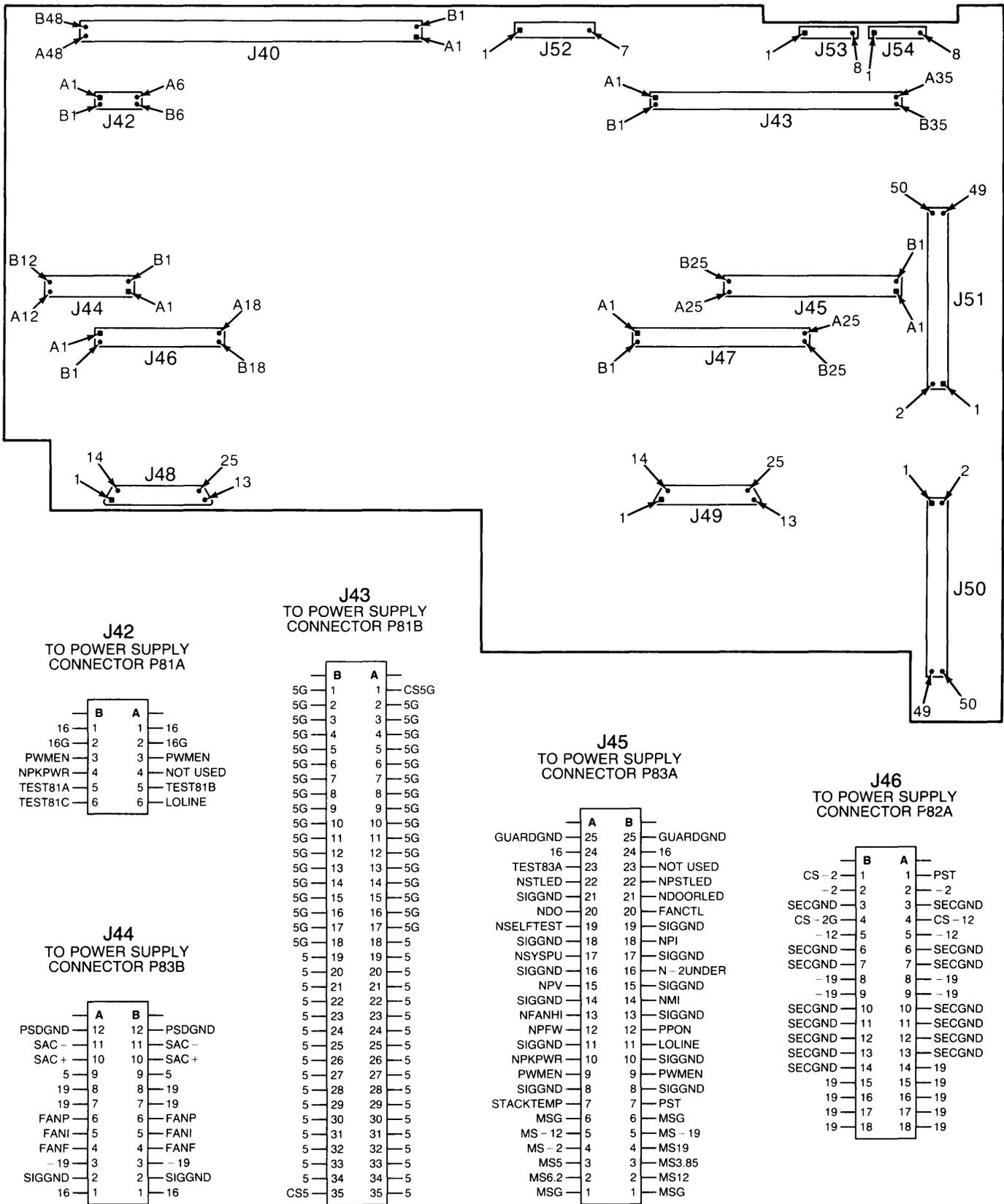


Figure D-1. Motherboard Connectors Locator Drawing (Sheet 1 of 2)

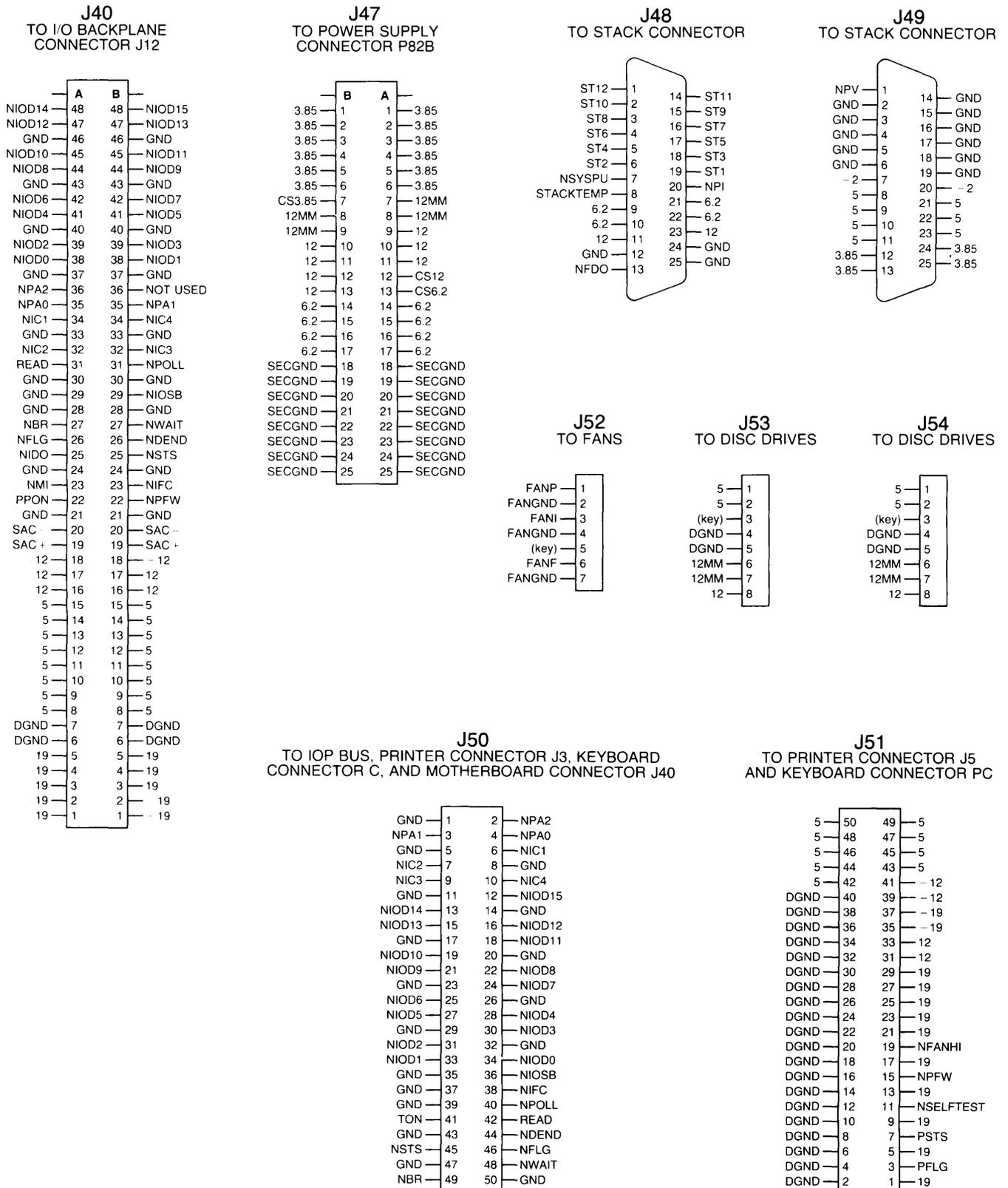


Figure D-1. Motherboard Connectors Locator Drawing (Sheet 2 of 2)

Table D-2. Motherboard Signal Definitions

Signal	Definition
(KEY)	Keyed hole in connector plug.
-12	-12 volt supply.
-19	-19 volt supply.
-2	-2 volt supply for processor stack back gate.
12	12 volt supply.
12MM	12 volt supply to mass storage devices only.
16	16 volt bias supply voltage.
16G	Ground for bias supply.
19	19 volt supply.
3.85	3.85 volt supply.
5	5 volt supply.
5G	5 volt supply ground.
6.2	6.2 volt supply.
CS-12	Control sense for -12 volt supply.
CS-2	Control sense for -2 volt supply.
CS-2G	Control sense for -2 volt supply ground.
CS12	Control sense for 12 volt supply.
CS3.85	Control sense for 3.85 volt supply.
CS5	Control sense for 5 volt supply.
CS5G	Control sense for 5 volt supply ground.
CS6.2	Control sense for 6.2 volt supply.
DGND	Dirty ground return.
FANCTL	Fan control. Connected to PST.
FANF	Power to processor stack fan (negative voltage).
FANGND	Fan ground return.
FANI	Power to I/O card cage fan (negative voltage).
FANP	Power to power supply fan (negative voltage).
GND	Ground plane of motherboard.
GUARDGND	Shields power supply supervisor board from primary and secondary boards.
LOLINE	Low line indication.
MS-12	Monitor sense for -12 volt under/over voltage.
MS-19	Monitor sense for -19 volt under/over voltage.
MS-2	Monitor sense for -2 volt under/over voltage.
MS12	Monitor sense for 12 volt under/over voltage.
MS19	Monitor sense for 19 volt under/over voltage.
MS3.85	Monitor sense for 3.85 volt under/over voltage.
MS5	Monitor sense for 5 volt under/over voltage.
MS6.2	Monitor sense for 6.2 volt under/over voltage.
MSG	Monitor sense ground.
N-2UNDER	-2 volt undervoltage (negative true).
NBR	I/O bus burst mode DMA request (negative true).
NDEND	I/O bus device end (negative true).
NDO	Door open (negative true). Wired OR of NFDO and NIDO.
NDOORLED	Door open (negative true).
NFANHI	Power supply fan at highest speed (negative true).
NFDO	Processor stack door open (negative true). OR'd with NIDO.
NFLG	I/O bus ready for data (negative true).

Signal	Definition
NIC1	I/O bus interface control bit 1 (negative true).
NIC2	I/O bus interface control bit 2 (negative true).
NIC3	I/O bus interface control bit 3 (negative true).
NIC4	I/O bus interface control bit 4 (negative true).
NIDO	I/O cage door open (negative true). OR'd with NFDO.
NIFC	I/O bus interface clear (negative true).
NIOD0	I/O bus input/output data bit 0 (negative true).
NIOD1	I/O bus input/output data bit 1 (negative true).
NIOD2	I/O bus input/output data bit 2 (negative true).
NIOD3	I/O bus input/output data bit 3 (negative true).
NIOD4	I/O bus input/output data bit 4 (negative true).
NIOD5	I/O bus input/output data bit 5 (negative true).
NIOD6	I/O bus input/output data bit 6 (negative true).
NIOD7	I/O bus input/output data bit 7 (negative true).
NIOD8	I/O bus input/output data bit 8 (negative true).
NIOD9	I/O bus input/output data bit 9 (negative true).
NIOD10	I/O bus input/output data bit 10 (negative true).
NIOD11	I/O bus input/output data bit 11 (negative true).
NIOD12	I/O bus input/output data bit 12 (negative true).
NIOD13	I/O bus input/output data bit 13 (negative true).
NIOD14	I/O bus input/output data bit 14 (negative true).
NIOD15	I/O bus input/output data bit 15 (negative true).
NIOSB	I/O bus data transfer strobe (negative true).
NMI	Non-maskable interrupt.
NPA0	I/O bus peripheral address bit 0 (negative true).
NPA1	I/O bus peripheral address bit 1 (negative true).
NPA2	I/O bus peripheral address bit 2 (negative true).
NPFW	Power fail warning (negative true).
NPI	Not pop in (negative true). Resets the stack.
NPKPWR	Shut down command indicator due to peak power (negative true).
NPOLL	I/O bus interface poll (negative true).
NPSTLED	Power supply overtemperature (negative true).
NPV	Not power valid; all outputs in spec (negative true).
NSELFTEST	Leading edge causes power supply to send stack into self-test via NSYSPU and NPI (negative true). Originates on keyboard.
NSTLED	Stack overtemperature (negative true).
NSTS	I/O bus status (negative true). Driven by keyboard.
NSYSPU	Not system pop unsynchronized (negative true). Used with NPI to cause stack to perform a self-test.
NWAIT	I/O bus lengthen IOSB (negative true).
PFLG	Printer's flag line; driven by keyboard.
PPON	Primary power on; all outputs in spec.
PSDGND	Power supply ground for 25 KHz and fan circuitry.
PST	Power supply temperature indicator; connected to FANCTL.
PSTS	Printer's status line.
PWMEN	Pulse width modulator enable.
READ	I/O bus data direction (positive true; high indicates data to IOP).

**D-6** Motherboard Pinout Data

<b>Signal</b>	<b>Definition</b>
SAC +	25 KHz ac sine wave from power supply.
SAC -	25 KHz ac sine wave from power supply.
SECGND	Ground on power supply secondary board.
SIGGND	Ground for logic on supervisor board.
SPARE	Spare line; no connection.
ST1	Processor stack self-test from slot 1.
ST2	Processor stack self-test from slot 2.
ST3	Processor stack self-test from slot 3.
ST4	Processor stack self-test from slot 4.
ST5	Processor stack self-test from slot 5.
ST6	Processor stack self-test from slot 6.
ST7	Processor stack self-test from slot 7.
ST8	Processor stack self-test from slot 8.
ST9	Processor stack self-test from slot 9.
ST10	Processor stack self-test from slot 10.
ST11	Processor stack self-test from slot 11.
ST12	Processor stack self-test from slot 12.
STACKTEMP	Processor stack temperature indicator.
TEST81A	Test point.
TEST81B	Test point.
TEST81C	Test point.
TEST83A	Test point.
TON	5 volts from IOP.

# Appendix E

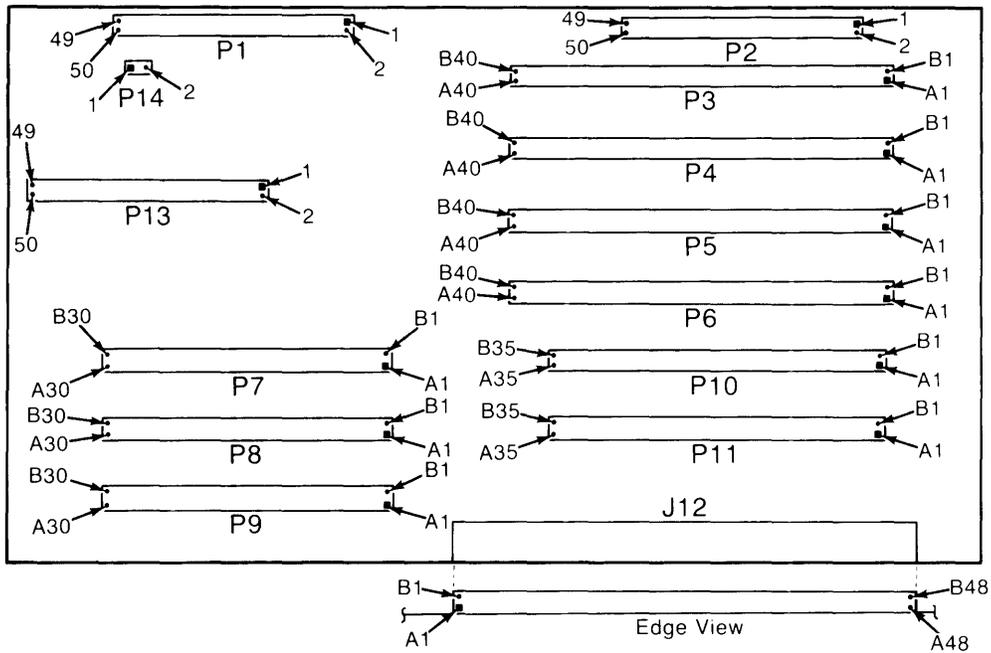
## I/O Backplane Pinout Data

Figure E-1 is a layout drawing of the computer I/O backplane. It identifies all I/O backplane connectors and shows every pin and its corresponding signal name. Table E-1 lists every I/O backplane connector and its usage. Table E-2 lists all the signal names used on the I/O backplane and their definitions.

**Table E-1. I/O Backplane Connectors**

Designator	Connecting Assembly
P1	Display Interface Module (Power)
P2	Display Interface Module (IOP)
P3	I/O Card
P4	I/O Card
P5	I/O Card
P6	I/O Card
P7	Reserved
P8	Reserved
P9	Reserved
P10	Mass Storage Controller Card
P11	Mass Storage Controller Card
J12	Motherboard
P13	Reserved
P14	I/O Cage Door Switch

E-2 I/O Backplane Data



**P1**  
TO DISPLAY INTERFACE  
MODULE CONNECTOR J2; POWER

SGND	50	49	SGND
SGND	48	47	SGND
SGND	46	45	SGND
SGND	44	43	SGND
18	42	41	18
18	40	39	18
-18	38	37	-18
DGND	36	35	DGND
DGND	34	33	DGND
DGND	32	31	DGND
DGND	30	29	DGND
DGND	28	27	DGND
12	26	25	12
12	24	23	-12
-12	22	21	5
5	20	19	5
5	18	17	5
5	16	15	5
5	14	13	5
5	12	11	5
5	10	9	5
5	8	7	5
5	6	5	5
5	4	3	5
5	2	1	5

**P2**  
TO DISPLAY INTERFACE  
MODULE CONNECTOR J4; IOP BUS

GND	50	49	NBR
NWAIT	48	47	GND
NFLG	46	45	NSTS
NRAMD	44	43	GND
READ	42	41	GND
NPOLL	40	39	GND
NIFC	38	37	GND
NIOBSB	36	35	GND
NIOD0	34	33	NIOD1
GND	32	31	NIOD2
NIOD3	30	29	GND
NIOD4	28	27	NIOD5
GND	26	25	NIOD6
NIOD7	24	23	GND
NIOD8	22	21	NIOD9
GND	20	19	NIOD10
NIOD11	18	17	GND
NIOD12	16	15	NIOD13
GND	14	13	NIOD14
NIOD15	12	11	GND
NIC4	10	9	NIC3
GND	8	7	NIC2
NIC1	6	5	GND
NPA0	4	3	NPA1
NPA2	2	1	GND

**P3**  
TO I/O CARD SLOTS

	A	B		
	5	40	40	5
	5	39	39	5
	12	38	38	12
	-12	37	37	-12
	AC +	36	36	AC +
	AC -	35	35	AC -
	GND	34	34	GND
	PPON	33	33	PPON
	NPFW	32	32	NNMI
NOT USED	31	31	31	NOT USED
NSW2	30	30	30	NOT USED
NSW0	29	29	29	NSW0
NDPA	28	28	28	NSTS
GND	27	27	27	GND
NMYPA	26	26	26	NIFC
NDBYT	25	25	25	NDEND
NBR	24	24	24	NARQ
GND	23	23	23	GND
CCLK	22	22	22	NIOBSB
GND	21	21	21	GND
SYNC	20	20	20	NPOLL
NIC2	19	19	19	NIC3
NIC1	18	18	18	NIC4
READ	17	17	17	NUAD
GND	16	16	16	GND
NPA0	15	15	15	NPA1
NPA2	14	14	14	NPA3
GND	13	13	13	GND
NIOD0	12	12	12	NIOD1
NIOD2	11	11	11	NIOD3
GND	10	10	10	GND
NIOD4	9	9	9	NIOD5
NIOD6	8	8	8	NIOD7
GND	7	7	7	GND
NIOD8	6	6	6	NIOD9
NIOD10	5	5	5	NIOD11
GND	4	4	4	GND
NIOD12	3	3	3	NIOD13
NIOD14	2	2	2	NIOD15
SGND	1	1	1	SGND

Figure E-1. I/O Backplane Connectors Locator Drawing (Sheet 1 of 3)

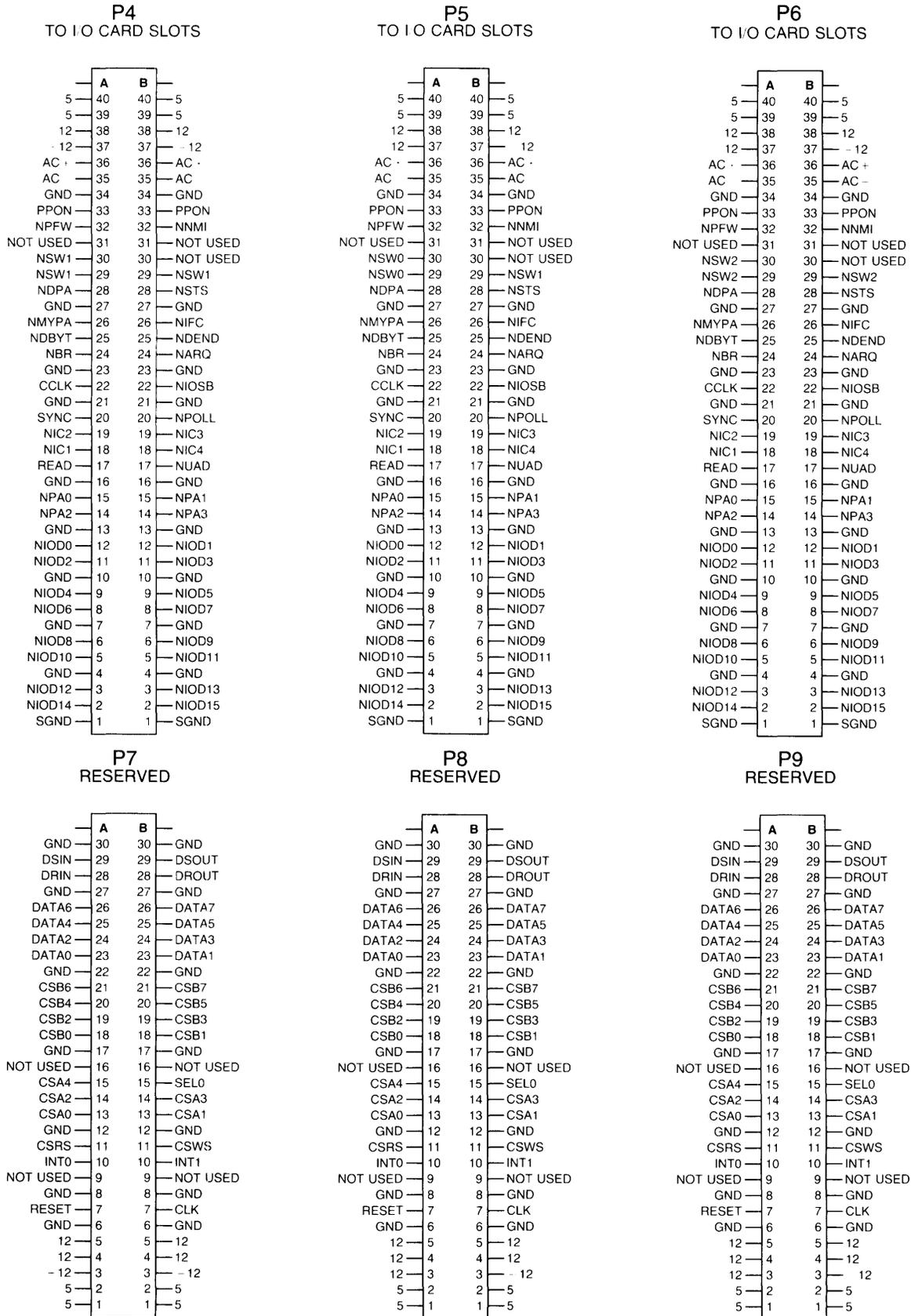
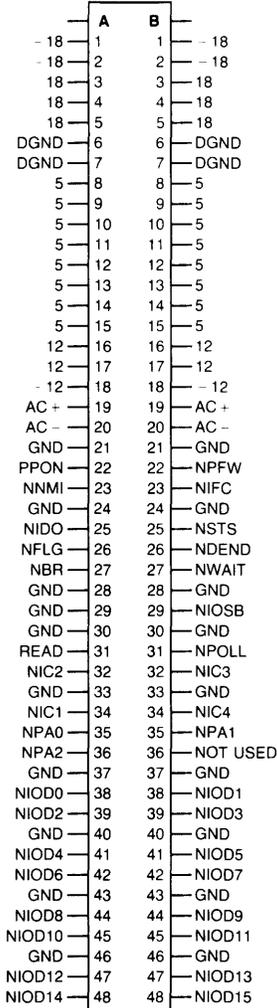


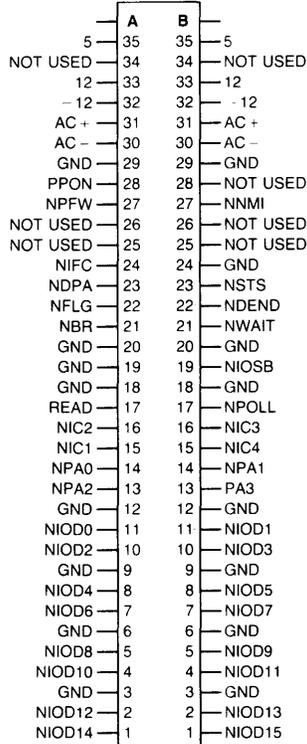
Figure E-1. I/O Backplane Connectors Locator Drawing (Sheet 2 of 3)

E-4 I/O Backplane Data

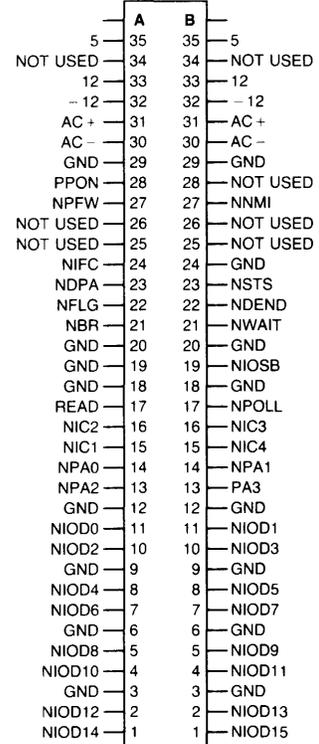
**J12**  
TO MOTHERBOARD CONNECTOR J40



**P11**  
TO MASS STORAGE  
CONTROLLER CARD SLOTS



**P10**  
TO MASS STORAGE  
CONTROLLER CARD SLOTS



**P13**  
RESERVED

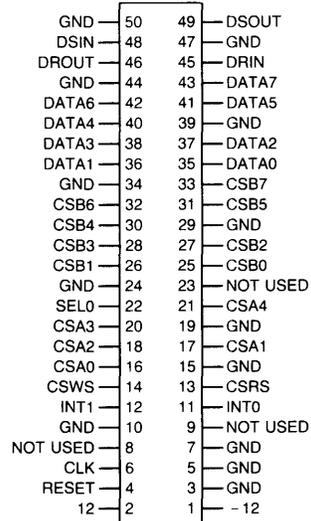


Figure E-1. I/O Backplane Connectors Locator Drawing (Sheet 3 of 3)

Table E-2. I/O Backplane Signal Definitions

Signal	Definition
- 12	- 12 volt supply.
- 18	- 18 volt supply.
12	12 volt supply.
18	18 volt supply.
5	5 volt supply.
AC -	25 KHz ac sine wave from power supply.
AC +	25 KHz ac sine wave from power supply.
CLK	Clock.
CCLK	Common clock.
CSA0	Reserved.
CSA1	Reserved.
CSA2	Reserved.
CSA3	Reserved.
CSA4	Reserved.
CSB0	Reserved.
CSB1	Reserved.
CSB2	Reserved.
CSB3	Reserved.
CSB4	Reserved.
CSB5	Reserved.
CSB6	Reserved.
CSB7	Reserved.
CSRS	Reserved.
CSWS	Reserved.
DATA0	Reserved.
DATA1	Reserved.
DATA2	Reserved.
DATA3	Reserved.
DATA4	Reserved.
DATA5	Reserved.
DATA6	Reserved.
DATA7	Reserved.
DGND	Dirty ground return.
DRIN	Reserved.
DROUT	Reserved.
DSIN	Reserved.
DSOUT	Reserved.
GND	Ground plane of I/O backplane.
INT0	Reserved.
INT1	Reserved.
NARQ	HP-IO card requests attention (negative true).
NBR	I/O bus burst mode DMA request (negative true).
NDBYT	I/O bus ready for data (negative true).
NDEND	I/O bus device end (negative true).
NDPA	Internal select code available (negative true).

E-6 I/O Backplane Data

Signal	Definition
NFLG	I/O bus ready for data (negative true).
NIC1	I/O bus interface control bit 1 (negative true).
NIC2	I/O bus interface control bit 2 (negative true).
NIC3	I/O bus interface control bit 3 (negative true).
NIC4	I/O bus interface control bit 4 (negative true).
NIDO	I/O cage door open (negative true).
NIFC	I/O bus interface clear (negative true).
NIOD0	I/O bus input/output data bit 0 (negative true).
NIOD1	I/O bus input/output data bit 1 (negative true).
NIOD2	I/O bus input/output data bit 2 (negative true).
NIOD3	I/O bus input/output data bit 3 (negative true).
NIOD4	I/O bus input/output data bit 4 (negative true).
NIOD5	I/O bus input/output data bit 5 (negative true).
NIOD6	I/O bus input/output data bit 6 (negative true).
NIOD7	I/O bus input/output data bit 7 (negative true).
NIOD8	I/O bus input/output data bit 8 (negative true).
NIOD9	I/O bus input/output data bit 9 (negative true).
NIOD10	I/O bus input/output data bit 10 (negative true).
NIOD11	I/O bus input/output data bit 11 (negative true).
NIOD12	I/O bus input/output data bit 12 (negative true).
NIOD13	I/O bus input/output data bit 13 (negative true).
NIOD14	I/O bus input/output data bit 14 (negative true).
NIOD15	I/O bus input/output data bit 15 (negative true).
NIOSB	I/O bus data transfer strobe (negative true).
NMYPA	HP-IO card recognized its address has been asserted (negative true).
NNMI	Non-maskable interrupt (negative true).
NPA0	I/O bus peripheral address bit 0 (negative true).
NPA1	I/O bus peripheral address bit 1 (negative true).
NPA2	I/O bus peripheral address bit 2 (negative true).
NPA3	I/O bus peripheral address bit 3 (negative true).
NPFW	Power fail warning (negative true).
NPOLL	I/O bus interface poll (negative true).
NSTS	I/O bus status (negative true).
NSW0	Select code switch 0 (negative true).
NSW1	Select code switch 1 (negative true).
NSW2	Select code switch 2 (negative true).
NUAD	Reserved.
NWAIT	I/O bus lengthen IOSB (negative true).
PA3	I/O bus peripheral address bit 3.
PPON	Primary power on; all outputs in spec.
READ	I/O bus data direction (positive true; high indicates data to IOP).
RESET	Reserved.
SELO	Reserved.
SGND	Safety ground.
SYNC	Synchronize.

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