HP 9000 Series 200 Computers
Model 226/236

HEWLETT PACKARD

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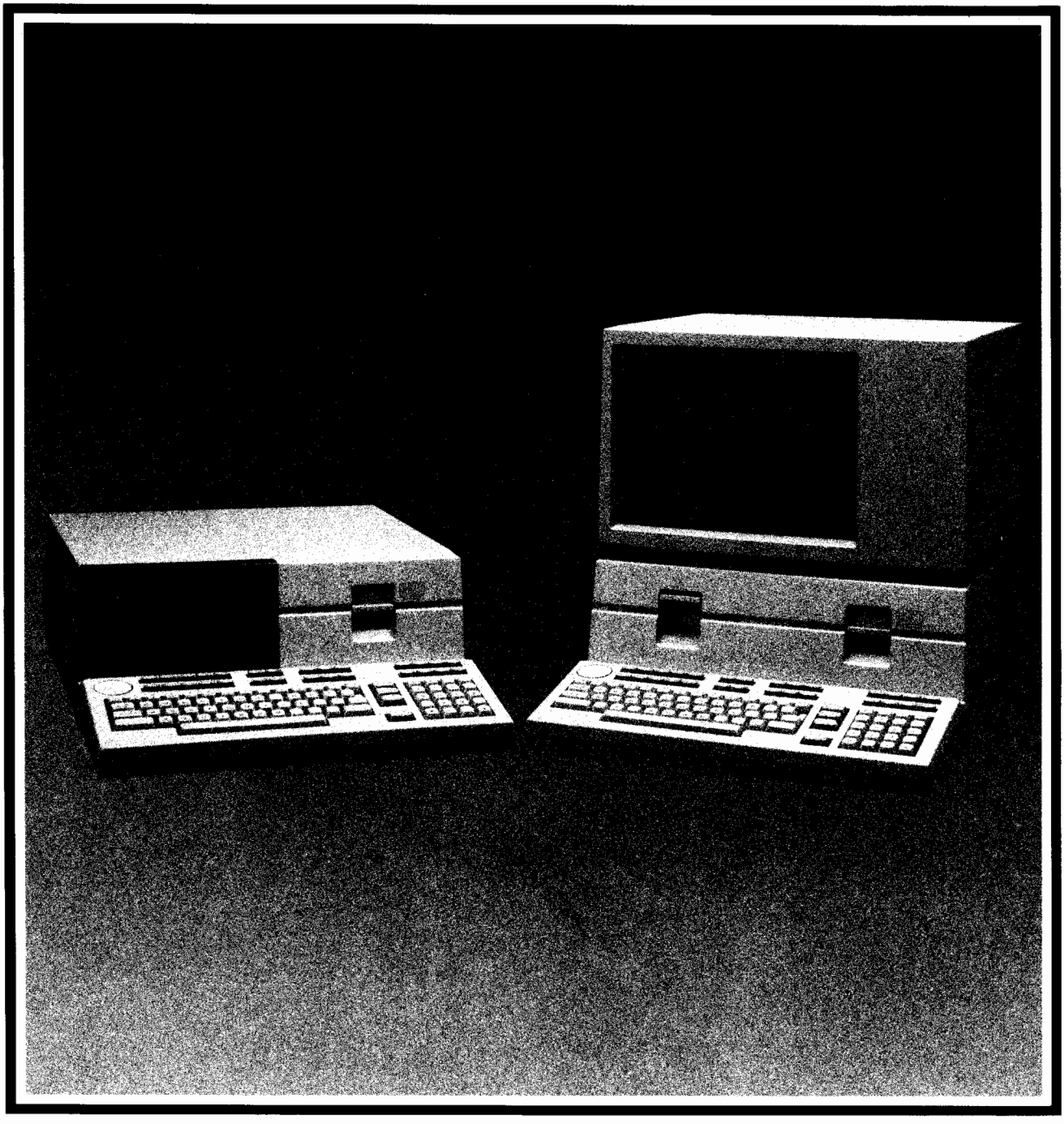
Service Manual



Service Manual

for the HP 9000 Series 200
Model 226/236 Computer

Manual Part No. 09836-90030
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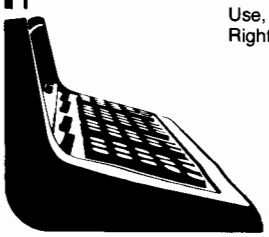

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Printing History

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.

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

March 1983...First Edition: Supercedes 09826-90030 and includes material for Model 9836C.
June 1983...Updated pages: ii, vii, viii, 43, 44, 91, 92, 113-122, 147-174.
December 1983...Second Edition: Updated to include information for Model 226/236 Computer

Warranty Statement

Hewlett-Packard products are warranted against defects in materials and workmanship. For Hewlett-Packard Fort Collins Systems Division products sold in the U.S.A. and Canada, this warranty applies for ninety (90) days from the date of delivery.* Hewlett-Packard will, at its option, repair or replace equipment which proves to be defective during the warranty period. This warranty includes labor, parts, and surface travel costs, if any. Equipment returned to Hewlett-Packard for repair must be shipped freight prepaid. Repairs necessitated by misuse of the equipment, or by hardware, software, or interfacing not provided by Hewlett-Packard are not covered by this warranty.

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Safety Considerations

General

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

Safety Symbols

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the product or personnel.

Indicates hazardous voltages.

Indicates earth (ground) terminal (sometimes used in manual to indicate circuit common connected to grounded chassis).

WARNING

The WARNING sign calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

Safety Earth Ground

This is a safety class I product and is provided with a protective earthing terminal. An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

Before Applying Power

Verify that the product is configured to match the available main power source per the input power configuration instructions provided in this manual.

Servicing

Any servicing, adjustment, maintenance or repair of this product must be performed only by service-trained personnel.

Adjustments described in this manual may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside this product may still be charged even when disconnected from its power source.

To avoid a fire hazard, only fuses with the required current and voltage rating and of the specified type (normal blow, time delay, etc.) are to be used for replacement.

Chapter 1
General Information

Introduction

This manual contains all the servicing information for HP 9000 Model 226 and Model 236 computers except the disc drive.

Although this manual covers Models 226 and 236 with and without color, they will be referred to by their product numbers, that is, 9826, 9836A and 9836C, or by the term "computer" when it is not necessary to specify which computer. The term "9836" is used when the discussion applies to both the 9836A and 9836C.

Hewlett-Packard supports repairing 9826 and 9836 computers only to the assembly level, that is, isolating the problem to the most basic assembly. Then the defective assembly is exchanged for a new or rebuilt assembly.

Although component level repair is not supported here, a theory of operation keyed to a comprehensive block diagram is provided later in this manual. This information will assist the customer's technician in isolating the problem to the defective assembly. Note that Hewlett-Packard assumes no responsibility for customer modifications or repair at the component level.

Also included in this chapter is service support information and a list of the documentation available for 9826/9836 computers.

Additional information in this manual includes:

- Installation and Operating Procedures
- Theory of Operation
- Access and Assembly Procedures
- Troubleshooting Procedures and Charts
- Repair and Replaceable Parts

Service Support

Hewlett-Packard provides service support in three ways: on-site repair, service center repair and customer repair.

On-site Repair

For on-site repair[1], an HP Field Service Engineer goes to the customer's site and troubleshoots and repairs the computer at the assembly level. The defective assembly is then exchanged for a new or reconditioned assembly. This is the fastest way to get the computer up and running.

Service Center Repair

For service center repair, the customer returns the defective computer to an HP Regional Repair Center. An HP Service Engineer repairs the computer to the assembly level and returns it to the customer.[1]

Customer Repair

Customer repair is the third choice. Customers have the option of repairing their own computers. Hewlett-Packard offers a "cooperative support program" which provides the information, training and support to help customers maintain their products. Local sales and support offices can provide further details on this program.

Support Packages

Tools and parts for effective support of the 9826/9836 are organized into Service Support Packages. A variety of Service Support Packages are available. Table 1-1 lists them with the part number for use by HP personnel. Customers should contact their HP Sales and Service Office for details of materials and courses available to customers.

Table 1-1. 9826/9836 Service Support Packages

HP Part No.	Description
09826-67100	Product support package
09836-67198	9836C service upgrade kit
09130-67100	Disc drive product support package
09130-67197	Disc drive field service inventory

A listing of the contents of each Support Package is located in Chapter 6.

1 Contact your nearest HP Sales and Service Office for typical turn-around time and shipping instructions.

9826/9836 Documentation

A wide range of documentation is available for the 9826 and 9836 Computers. The following paragraphs list both user and service documentation.

9826/9836 Installation Manual (09836-90000). This manual contains installation instructions for the 9826/9836 Computer. In addition to the basic computer installation information, this manual includes installation instructions for add-on memory and interface cards. The Installation Manual is available as both a stand-alone manual (09836-90000) and as part of the complete service manual kit (09836-90030).

BASIC Language Manuals

Users of the 9826 Computer range from beginners to advanced programmers and engineers. A variety of information is available from Hewlett-Packard to help the beginner as well as the more experienced user. The following paragraphs describe the BASIC language documents. Contact your nearest HP Sales and Service Office for more information concerning available documentation.

Table 1-2. BASIC Programming Language Manuals

Manual Part Number	Description
09826-90011	BASIC Programming Techniques
09826-90015	BASIC Graphics Techniques
09826-90020	BASIC Interfacing Techniques
09826-90051	BASIC 2.0 Condensed Reference
09826-90056	BASIC Language Reference

9826/9836 BASIC Programming Techniques (09826-90011). This manual introduces the beginning or intermediate programmer to the varied tasks of programming in BASIC language on the 9826/9836. The manual starts with "Entering Program Lines" and ends with information on "Getting the Most from Your Computer". This manual will help you write and debug your first BASIC programs.

BASIC Graphics Techniques (09826-90015). This manual introduces the intermediate or advanced programmer to the graphics statements in Series 200 BASIC, as well as how to orchestrate them to produce highly readable and aesthetically pleasing output.

9826/9836 BASIC Interfacing Techniques (09826-90025). This manual introduces the general input/output operations available for controlling peripheral devices, and shows how to connect and control devices via each interface card. For details on controlling printers, plotters and mass storage devices, however, see BASIC Programming Techniques.

9826/9836 BASIC Language Reference (09826-90056). This manual is the A to Z technical reference of the BASIC language. It is structured and written in alphabetic order for quick access to details on any BASIC keyword or parameter.

BASIC 2.0 Condensed Reference (09826-90051). This is a pocket reference to the BASIC language, and contains all the infomation in the above manual in a brief form.

HPL Language Manuals

The HPL manuals currently available are listed below. Contact your nearest HP Sales and Service Office for more information concerning manuals.

Table 1-3. HPL Language Manuals

Manual Part Number	Description
09826-90040	HPL Operating Manual & Programming Update
09826-90045	HPL Quick Reference
09825-90022	9825 Matrix Programming
09825-90060	HPL I/O Concepts Guide
09825-90200	9825 Operating & Programming Reference
09825-90210	9825 I/O Control Reference
09825-90220	9825 Disc Programming

HPL Operating Manual & Programming Update (09826-90040). The 9826/9836 HPL Language System is very similar to 9825 HPL. This manual explains how to install and operate the 9826/9836 with HPL and details those differences between 9826/9836 HPL and 9825 HPL.

9826/9836 HPL Quick Reference (09826-90045). This is an A to Z listing of the 9826/9836 HPL language, in a pocket-sized format.

Pascal Language Manuals

The Pascal Language System manuals currently available are listed below. Contact your nearest HP Sales and Service office for more information concerning these manuals.

Table 1-4. Pascal Language Manuals

Manual Part Number	Description
98615-90020	HP 9826/9836 Pascal Language System User's Manual
09826-90074	HP 9826/9836 SID (available May, 1982)
09826-90072	An Introduction to Programming and Problem Solving with Pascal
09826-90071	The Pascal Handbook
09826-90073	MC68000 16-Bit Microprocessor User's Handbook
09826-90075	Pascal Procedure Library User's Manual

HP 9826/9836 Pascal Language System User's Manual (98615-90020). This manual documents the Pascal Operating System, and those features which are unique to the 9826/9836 Pascal System.

HP 9826/9836 System Internals Documentation (09826-90074). This manual is for the person who needs a detailed description of the internal structure of the 9826/9836. It provides information for modifying the operating system or building a new one, and for building interface cards.

An Introduction to Programming and Problem Solving with Pascal (09826-90072). This book describes programming techniques for Pascal.

The Pascal Handbook (09826-90071). This manual is an A to Z technical reference for the Pascal language. It is structured and written in alphabetical order for quick access to the details on any Pascal identifier, reserved word or concept.

MC68000 16-Bit Microprocessor User's Handbook (09826-90071). This manual provides a description of the 68000 machine language. It is useful for anyone who wishes to write and assemble machine-language programs.

HP Series 200 Pascal Procedure Library User's Manual (09826-90075). This manual contains the concepts and techniques needed to use the graphics and I/O libraries supplied with the Pascal 2.0 Language System.

9826/9836 Service Documentation

9826/9836 Service Manual (09836-90030). This is the primary service document for the 9826/9836 Computer. Individual installation manuals are available for the various add-on interface boards. Table 1-5 lists those manuals currently available.

Table 1-5. Interface Installation Manuals

Manual Part Number	Interface
98620-90000	98620A DMA
98622-90000	98622A GPIO
98623-90000	98623A BCD
98624-90000	98624A HP-IB
98625-90000	98625A Disc
98626-90000	98626A RS-232
98627-90000	98627A Color
98628-90000	98628A Datacomm
98028-90000	98628A, 98029A and 98629A Shared Resource Management

The manual supplied with each interface card shows how to configure and install the card.

9826/9836 Customer Engineer Handbook Section (09826-90039). This is the CE Handbook section covering the 9826/9836. It is a condensation of the Service manual.

9130K Service Manual (09130-90030). This is the service document for the built-in disc drive mechanism.

Chapter 2
Installation

Introduction

Installing the computer is covered in the 9826/9836 installation manual (09836-90000) supplied with the 9826/9836 Service Manual (09836-90030). Keep this and any other operation and installation notes here for future reference.

The 9826/9836 Installation manual contains installation and operation instructions for the 9826/9836 computer. In addition to the basic computer installation information, this manual includes installation instructions for add-on memory and interface cards. Operating information includes putting the computer into operation, loading the operating languages, an overview of the BASIC operating commands and how to interpret error messages. A chapter is also devoted to using flexible discs.

The data sheet for the BASIC 2.1 Language System contains the technical specifications for the 9826 and 9836 computers. Rather than reprint this information, the data sheet is supplied with the 9826/9836 service manual. Keep it here, or at the front of the manual just after the Table of Contents.

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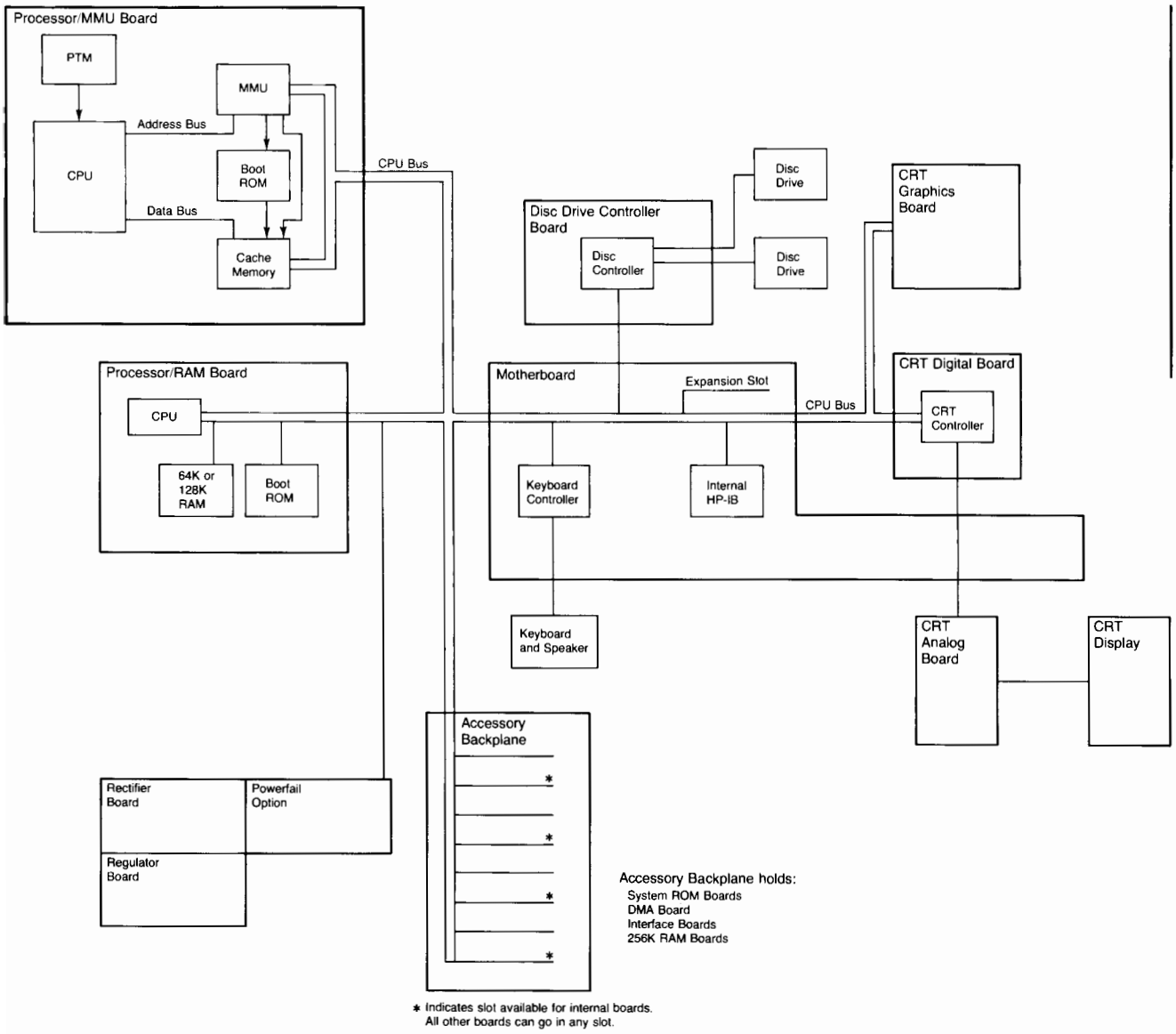

Figure 3-2. 9836A Basic Block Diagram.

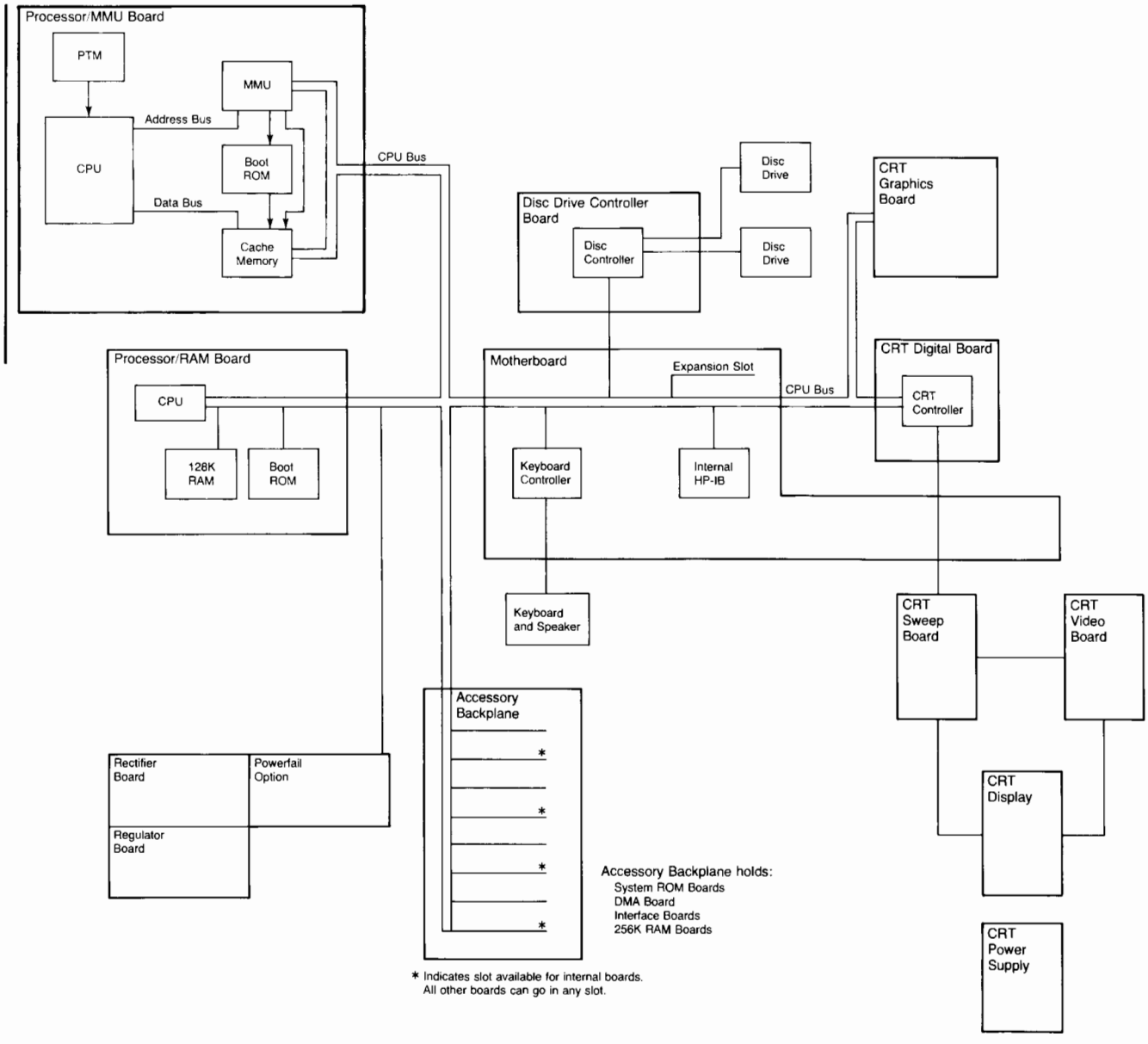

Figure 3-3. 9836C Basic Block Diagram.

Chapter 3
Theory of Operation

Introduction

This chapter describes the theory of operation of the 9826 and 9836 computers. Despite their outward appearances, the two are quite similar internally. The theory of operation may be easier to follow if you locate the various components on the basic block diagram, Figures 3-1, 3-2 and 3-3.

The 9826 and 9836 consist of these functional units:

- Processor board
- Disc drive
- CRT display
- Keyboard
- Motherboard
- Accessory backplane
- Power supply

The function of these units is as follows:

Processor Board

The processor board contains the central processing unit (CPU) of the computer, along with some related circuitry.

There are two versions of the processor board, a RAM memory version and a memory management (MMU) version. They have the same CPU, but are quite different otherwise.

The CPU is a Motorola MC68000 microprocessor, with 32-bit data and address registers, 16 megabyte direct addressing range, 56 instruction types and memory-mapped I/O. The processor board controls a bus with 23 address lines, 16 data lines and 17 control lines. Control signals allow asynchronous communication with a variety of memory and I/O devices, and allow for different bus masters, interrupt operation, and selective byte or word addressing.

Processor/RAM Board
The processor/RAM board contains the CPU, 64K or 128K bytes of auto-locating RAM, the boot ROM and control circuitry buffers.

The 64K byte RAM uses dynamic RAM ICs which are one bit wide by 16K bits long. 16 RAM ICs are placed in parallel to form a bank 16 bits wide and 16K bits long. Two such banks form a block 16 bits wide and 32K bits long. This block is system-addressed to reside in the first empty 64K byte space in the top eight megabytes of the memory space.

The 128K byte RAM is composed of two of these blocks.

Additional 64K and 256K byte blocks are available as options, and are switch-selected to reside in any 64K or 256K byte space in the top eight megabytes of memory space.

The boot ROM contains 16K bytes of instructions. These are the first instructions executed by the CPU at start-up, and serve to initialize the 9826/9836 and load the language system.

Some versions of the processor/RAM board contain system and power-up configuration registers and self test LEDs.

The system configuration register is a PROM which contains information about the configuration of the system as well as the machine serial number. The power-up configuration register is an eight-segment switch block which allows the user to define a power-up configuration for the software. The eight self test LEDs report the status of the self test and any errors encountered by the self test.

Processor/MMU Board

The processor/MMU board contains the CPU, the boot ROM, a system configuration register, a power-up configuration register, self test LEDs, a memory management unit, a programmable timer module, a cache memory and control circuitry buffers.

The boot ROM contains 48k bytes of instructions. These are the first instructions executed by the CPU at start-up, and serve to initialize the 9826/9836 and load the language system.

The system configuration register is a PROM which contains information about the configuration of the system as well as the machine serial number. The power-up configuration register is an eight-segment switch block which allows the user to define a power-up configuration for the software. The eight self test LEDs report the status of the self test and any errors encountered by the self test.

The memory management unit provides virtual memory capabilities to the computer. The programmable timer provides periodic interrupts to the CPU for multi-tasking purposes. The cache memory provides the capability for the CPU to operate at a higher speed than the peripheral devices in the computer.

Disc Drive

The function of the disc drive is to store and retrieve data on a flexible mini-disc.

The disc drive provides approximately 270k bytes of mass storage on a flexible mini-disc. It uses modified frequency modulation to encode data on the disc. There are 35 tracks available on each side of the disc, but only 66 of the 70 available tracks are used, four tracks being spared in case a defective track is found. Each track is divided into 16 sectors. Disc handling and read/write functions are handled by the disc drive mechanism. There is one disc drive mechanism in a 9826, two in a 9836. A separate disc drive controller board handles the data encoding and decoding and also interfaces the disc drive to the CPU bus. Specifications of the disc drive are located at the front of this manual.

The disc drive consists of these assemblies:

- disc drive controller board
- disc drive mechanism (one in the 9826, two in the 9836)

The disc drive controller board receives data from the CPU via data lines BD8 to BD15. It buffers this data, then stores it in an on-board RAM. At the appropriate time data stored in the RAM is read out and sent to the designated disc drive mechanism to be stored on a disc. The controller board also receives control information via data lines BD8 to BD15. This information is stored in a latch, and is used to control the operation of the disc drive mechanism.

The disc drive mechanism receives serial data from the control board, along with control signals directing how it is to be written onto the disc. All mechanical functions are located on the disc drive mechanism. All electronic functions are on the controller board except a servo control board which controls the drive motor speed and a drive electronics board which controls movement of the read/write heads, reads and writes the data and interprets and generates control signals such as write protect sense, index hole sense and track 0 sense.

The disc drive mechanism reads data from the disc and sends it to the controller board, which stores it in the on-board RAM, and then sends it to the CPU via data lines BD8 to BD15. The mechanism also sends status information which is stored in a latch and then sent to the CPU via BD8 to BD15.

The disc drive is selected by a chip select located on the motherboard.

There are two adjustments on the controller board:

- read margin
- read recovery oscillator frequency

9826 and 9836A CRT Display

The function of the CRT display is to receive data from the CPU, buffer it in RAM, then display it on the CRT screen.

The 9826 and 9836A CRT display is a memory mapped, raster scan CRT. 256 characters can be displayed, including all 128 ASCII characters, as well as the HP Roman extension set and Japanese Katakana characters. The bottom of the screen may be set up to display in half-bright, inverse video, on a line-by-line basis. This feature is used to visually separate softkey labels from the remainder of the screen.

The CRT display consists of these assemblies:

- digital board
- graphics board
- analog board
- CRT/yoke assembly

The functions of these boards are:

Digital Board

The digital board receives data from the CPU via data lines BD0 to BD7 in the 9826 and BD0 to BD15 in the 9836A. It buffers this data, then either stores it in an on-board RAM or passes it on to the graphics board. At the appropriate time, data stored in the RAM is read out and sent to the character generator, which then goes to a video mixer which provides half-bright and full-bright video to a video amp on the analog board.

The digital board functions are controlled by a 6845 CRT controller chip. Interface logic and timing and control logic are also included on the board.

The digital board is selected by a chip select located on the motherboard.

9826. The digital board also produces the drive for the yoke vertical deflection coils. Potentiometers on the digital board control vertical size and vertical position.

The digital board provides a signal to the analog board for horizontal deflection. A rotary switch on the digital board controls horizontal position.

9836A. The digital board produces a vertical deflection signal. The vertical drive is produced by the analog board.

The digital board provides a horizontal deflection signal to the analog board.

There are no adjustments on the 9836A digital board.

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Graphics Board

The functions of the graphics board are similar to some of the digital board functions. It receives data from data lines BD0 to BD7 in the 9826 and BD0 to BD15 in the 9836A and stores it in a RAM. At the appropriate time, data stored in the RAM is read out and sent to a parallel-to-serial converter. Serial data is sent to the video mixer on the digital board.

The graphics board also includes interface, timing and control logic. No refresh circuitry is required, since the graphics data access rate is greater than the refresh rate.

There are no adjustments on the graphics board.

The graphics board is selected by a chip select located on the motherboard.

9826. The graphics board mounts on the top edge of the digital board, and all signals going to and from the graphics board pass through the digital board.

9836A. The graphics board mounts over the CRT digital board and is connected directly to the CPU bus.

Analog Board

The analog board receives half-bright and full-bright video from the digital board. It amplifies the video to the voltage level required to drive the CRT electron gun.

It receives a horizontal retrace signal from the digital board and produces the current required for horizontal deflection of the cathode ray. An adjustable coil on the analog board controls the display width.

The analog 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 analog board control the focus and intensity of the CRT display.

9826. The analog board also receives the two vertical deflection signals from the digital board. It does not affect them in any way, but acts only as a pathway to the yoke.

9836A. The analog board receives the vertical deflection signal from the digital board and provides the drive needed by the vertical deflection coils. Potentiometers on the analog board adjust the vertical linearity and height.

CRT/Yoke Assembly

The CRT/yoke assembly displays the video signals. The resulting 9826 display is 25 lines by 50 characters per line. 9826 graphics display is 300 dots by 400 dots. The 9836A display is 25 lines by 80 characters per line. 9836A graphics is 390 dots by 512 dots.

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

9836C CRT Display

The function of the CRT display is to receive data from the CPU, buffer it in RAM, then display it on the CRT screen.

The 9836C CRT display is a memory mapped, raster scan CRT. 256 characters can be displayed, including all 128 ASCII characters, as well as the HP Roman extension set and Japanese Katakana characters. The bottom of the screen may be set up to display in half-bright, inverse video, on a line-by-line basis. This feature is used to visually separate softkey labels from the remainder of the screen.

The CRT display consists of these assemblies:

- digital board
- graphics board
- video board
- sweep board
- CRT/yoke assembly
- display power supply
- display motherboard

The functions of these boards are:

Digital Board

The digital board receives data from the CPU via data lines BD0 to BD15. It buffers this data, then either stores it in an on-board RAM or passes it on to the graphics board. At the appropriate time, data stored in the RAM is read out and sent to the character generator, which converts it into the appropriate dot pattern, and to the alpha pipeline, which adds blinking, underline and inverse video attributes and separates the alpha into red, green and blue video streams.

The digital board also contains a color map driven by the graphics memory, and three digital-to-analog convertors. The color map can simultaneously generate any 16 of 4096 available colors. The D-to-A convertors convert the digital output of the color map (and also the red, green and blue alpha video streams, which are not colormapped) into red, green and blue analog signals suitable for the video board.

The digital board also produces horizontal and vertical sync signals for the sweep board.

The digital board functions are controlled by a 6845 CRT controller chip. Interface logic and timing and control logic are also included on the board.

The digital board is selected by a chip select located on the motherboard.

The 50/60 Hz select jumper is mounted on the 9836C digital board. There are no other adjustments on it.

Graphics Board

The functions of the graphics board are similar to some of the digital board functions. It receives data from data lines BD0 to to BD15 and stores it in a RAM. At the appropriate time, data stored in the RAM is read out and sent to the color map on the digital board.

The graphics board also generates a vertical blanking signal for use by the sweep board.

The graphics board also includes interface, timing and control logic. No refresh circuitry is required, since the graphics data access rate is greater than the refresh rate.

The graphics board contains no adjustments, except that the user intensity assembly is connected to it.

The graphics board is selected by a chip select located on the motherboard.

Video Board

The video board receives red, green and blue video streams from the digital 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 from the digital board and vertical blanking from the graphics 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. 9836C graphics is 390 dots by 512 dots.

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 100-240 Vac into filtered, regulated dc levels of +5 V, +12 V, +75V and −12 V, and to provide overcurrent and overvoltage protection.

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

The optional powerfail circuit does not provide battery back-up power to the 9836C display unit.

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

Motherboard and Keyboard

The motherboard contains the keyboard/real-time clock controller, the 10 MHz clock, the chip select decoder and the built-in HP-IB interface.

The keyboard/real-time clock controller scans the keyboard, rotary control knob and language and configuration jumpers.

The jumpers and all the keys except SHIFT and CONTROL are scanned by an 8 by 13 scan matrix. When a key is pressed, the controller decodes the row/column pair into key information and places it on the CPU bus. The SHIFT and CONTROL keys and the rotary control knob are connected to the controller by separate lines.

The 10 MHz clock is the time base for the disc drive control board and the 9826 CRT display. It is divided by two and becomes the time base for the keyboard/real-time clock and the HP-IB.

The chip select decoder decodes address lines BA16 to BA18 into chip select lines for the keyboard, built-in HP-IB, the disc drive, the CRT digital board and the CRT graphics board.

The built-in HP-IB interface contains all the circuitry required to communicate via an HP-IB cable. Direct Memory Access (DMA) electronics is included, so that DMA via HP-IB is possible if the DMA card is installed in the accessory card cage.

The motherboard also contains an expansion slot with pin-outs similar to the slots in the accessory backplane.

Accessory Backplane

The accessory backplane contains eight connectors for adding ROM or RAM boards or for interface cards used for connecting peripherals.

Power Supply

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

The power supply consists of these assemblies:

- Rectifier board
- Regulator board
- Transformer
- Capacitor
- Fan

Line voltage selection switches on the rectifier board select the correct winding of the power transformer primary. Ac from the secondary is rectified and passed through a 15 amp fuse to the regulator board.

Three separate pulse width modulators on the regulator board convert the raw dc to +5 V, +12 V and -12 V. All three have overcurrent protection and the +5 V and +12 V modulators have overvoltage protection. The +5 V and +12 V levels are adjusted by one potentiometer and the -12 V level is adjusted by another potentiometer.

The power up circuit is also located on the regulator board.

The 9826 fan is an ac fan, and runs off the power transformer primary. The 9836 fan is a dc fan, and runs off the -12 V supply.

An optional powerfail circuit provides battery back-up power in case of momentary interruptions in the ac line. It also provides power for a real-time clock.

Chapter 4
Access and Assembly

Introduction

This chapter describes how to access and remove the various assemblies from the 9826 and 9836 computers, and how to reassemble the computer. Despite their outward appearances, the two computers are constructed quite similarly. For convenience, the removal procedures are presented in logical groups (e.g., Card Cage Group, Disc Drive Group, etc.).

A list of prerequisite assembly removals is located at the beginning of each removal procedure. Note that it is not necessary to remove each of the preceding assemblies, only those listed as prerequisite.

Where applicable, photographs show the assembly being removed. To reassemble the computer, reverse the removal procedure. As an aid in reassembly, refer to the "Reassembly Hints" provided later in this chapter.

All assemblies are referenced by assembly number. These assembly numbers correspond with the assembly reference designations listed in the Replaceable Parts List provided later in this manual. Table 4-1 lists all the major assemblies and printed circuit boards in the computer. Figures 4-1, 4-2 and 4-3 show these major assemblies.

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Table 4-1. Computer Configuration Chart

Description	9826	9836A	9836C
Base Motherboard	09826-66501	09826-66502 9836-66502	09836-66502
Display Motherboard	none	none	09836-66503
Backplane Connectorboard	09826-66581	09826-66581	09826-66581
Rectifier board	09826-66552 09826-66554	09826-66554	09826-66554
Regulator board	09826-66551 09826-66553	09826-66553	09826-66553
Display Power Supply	none	none	09836-66550
Disc Drive Controller board	09826-66561 09826-66562	09826-66562	09826-66562
Disc Drive Mechanism	09130-66600	09130-66600	09130-66600
Keyboard Assembly	09826-68012	09826-68012	09826-68012
Processors			
Processor board	09826-66511		
Processor/RAM boards	09826-66514 09826-66515 09826-66516	09826-66515 09826-66516	09826-66516
Processor/MMU board	09826-66517	09826-66517	09826-66517
Graphics board	09826-66575	09826-66577	09836-66573
Digital board	09826-66573	09826-66576	09836-66572
Analog board	09826-66571	09826-66580	none
Video board	none	none	09836-66542
Sweep board	none	none	09836-66540
CRT Assembly	09826-67921	09826-67922	09836-67924

Table 4-2. Computer Options Chart

Description	9826	9836A	9836C
Powerfail board	09826-66555	09826-66555	09826-66555
64k RAM	09826-66522	09826-66522	09826-66522
	09826-66523	09826-66523	09826-66523
256k RAM	09826-66524	09826-66524	09826-66524

WARNING

REMOVE ALL AC POWER TO THE COMPUTER BEFORE REMOVING ANY ASSEMBLY.

CAUTION

INTEGRATED CIRCUITS CAN BE DAMAGED BY ELECTROSTATIC DISCHARGE. USE THE FOLLOWING PRECAUTIONS:

DO NOT WEAR CLOTHING SUBJECT TO STATIC CHARGE BUILDUP, SUCH AS WOOL OR SYNTHETIC MATERIALS.

DO NOT HANDLE INTEGRATED CIRCUITS IN CARPETED AREAS.

DO NOT REMOVE AN INTEGRATED CIRCUIT FROM ITS CONDUCTIVE FOAM PAD UNTIL YOU ARE READY TO INSTALL IT.

AVOID TOUCHING CIRCUIT LEADS. HANDLE BY THE PLASTIC PACKAGE ONLY.

HANDLE BOARDS BY THE EDGES WHENEVER POSSIBLE.

TOUCH THE BACKPLATE METAL EACH TIME BEFORE TOUCHING A BOARD OR IC.

BOARDS SHOULD BE SHIPPED IN BLACK POLY BAGS. DO NOT REMOVE A BOARD FROM ITS BAG UNTIL YOU ARE READY TO INSTALL IT.

Table 4-3 lists the tools required to service the computer.

Table 4-3. Servicing Tools

HP Part No.	Description
5040-7433	Key Cap Puller
8710-0004	Longnose Pliers
8710-0650	#1 Pozidriv (long blade)
8710-0900	#2 Pozidriv (short blade)
8710-0948	#2 Pozidriv (long blade)
8710-0675	CRT Alignment Tool
8710-0797	9/32" Nutdriver (7.13 mm)
8710-0860	#2 Phillips Screwdriver
8710-1120	5.5 mm Nutdriver
8710-1219	5mm Nutdriver (.197")
8720-0001	3/16" Nutdriver (4.76 mm) (9836 only)

NOTE

The CRT/high voltage cover fasteners are #1 Pozidriv screws. All other screws are #2 Pozidriv screws.

Table 4-4 lists the instruments needed to service the computers.

Table 4-4. Service Equipment

Digital Voltmeter	
Oscilloscope	
Light Meter	Photodyne 19XE or Tektronics J16 with J6503 probe
Alignment Discs	09836-10604 and 09836-10605

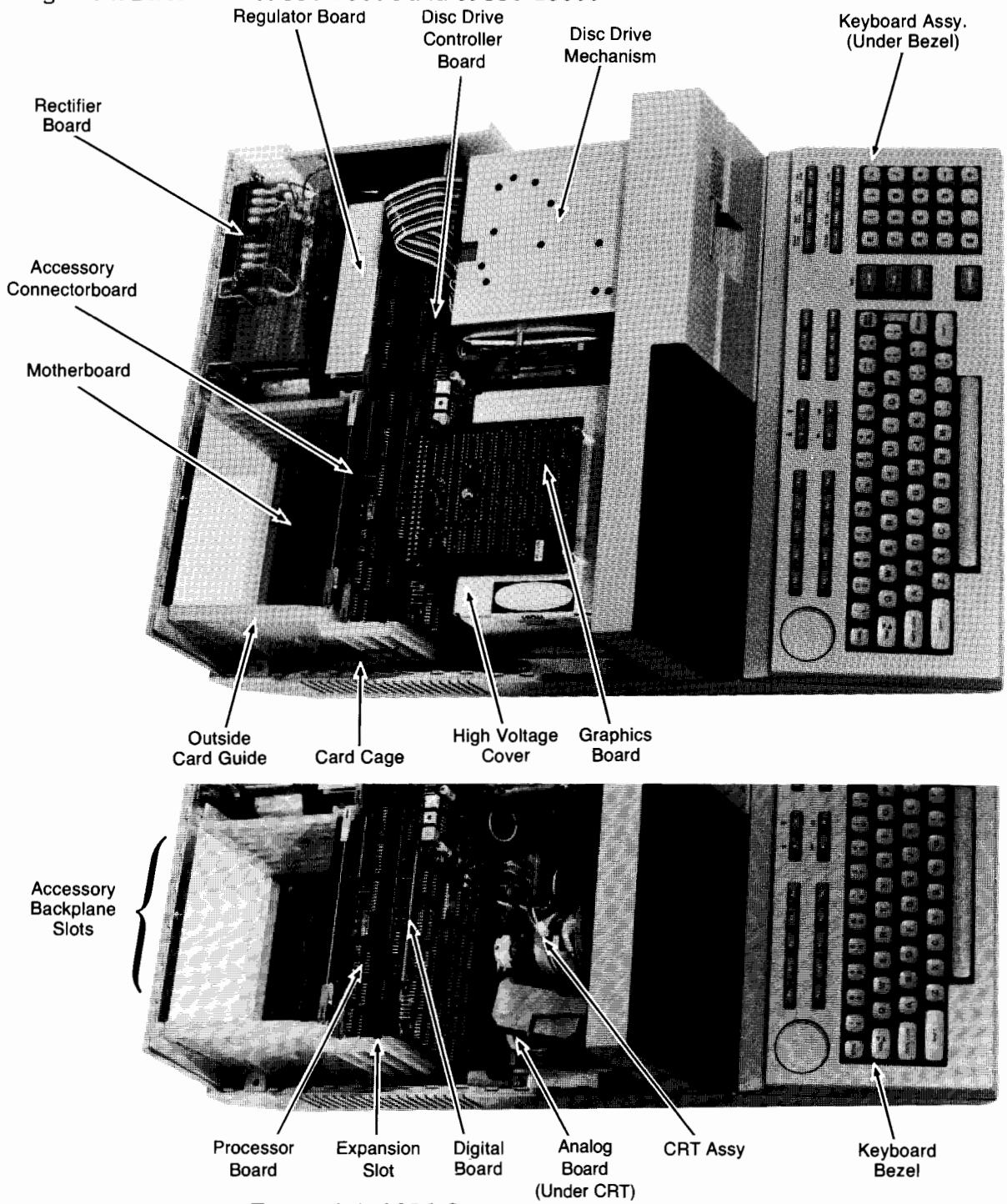


Figure 4-1. 9826 Computer Assembly Locations

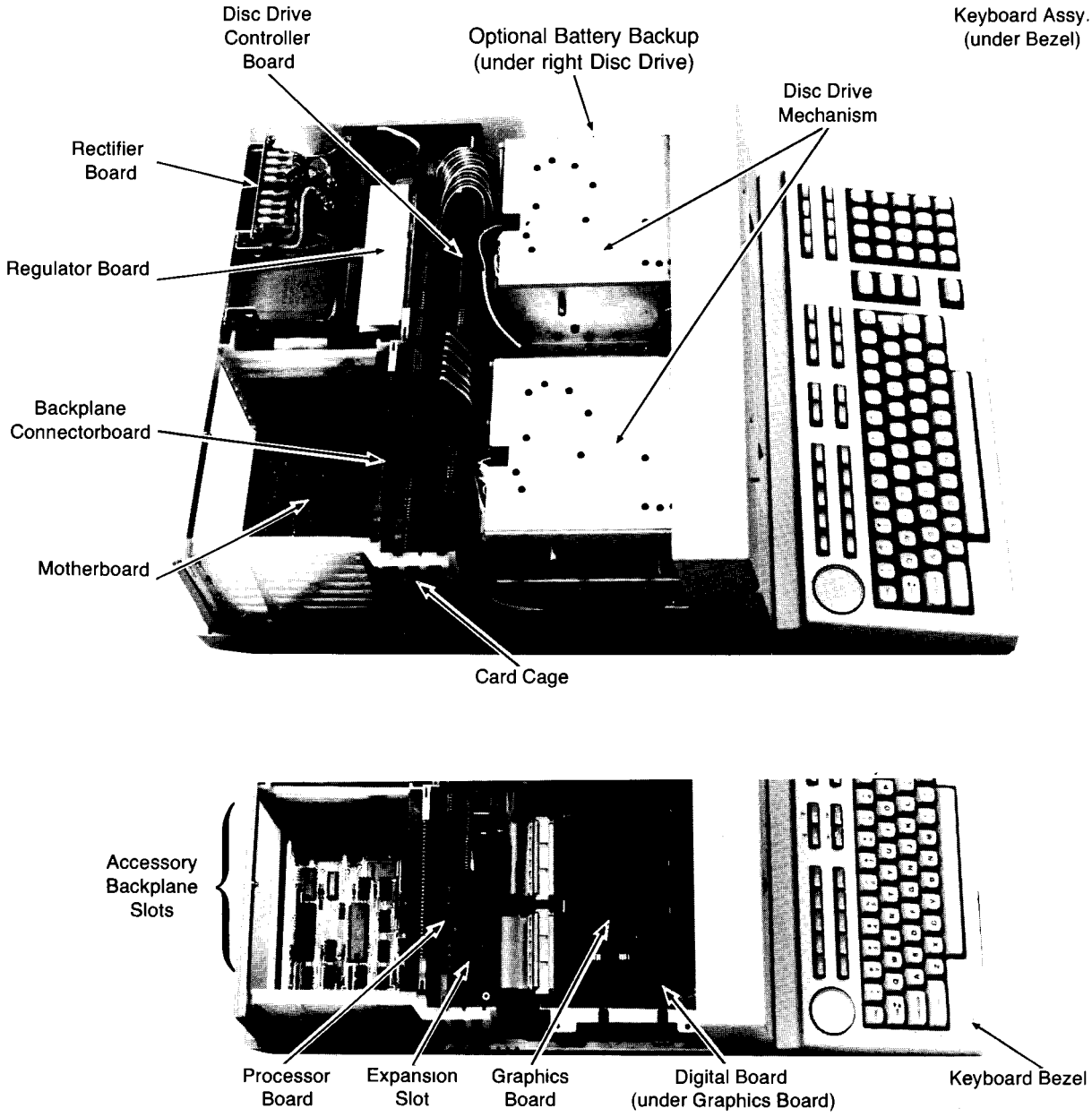


Figure 4-2. 9836 Base Assembly Locations

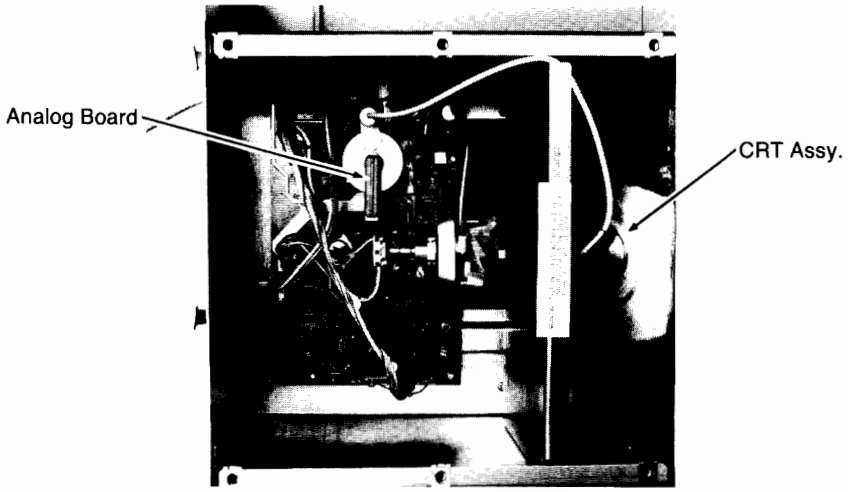


Figure 4-3A. 9836A Display Assembly Locations

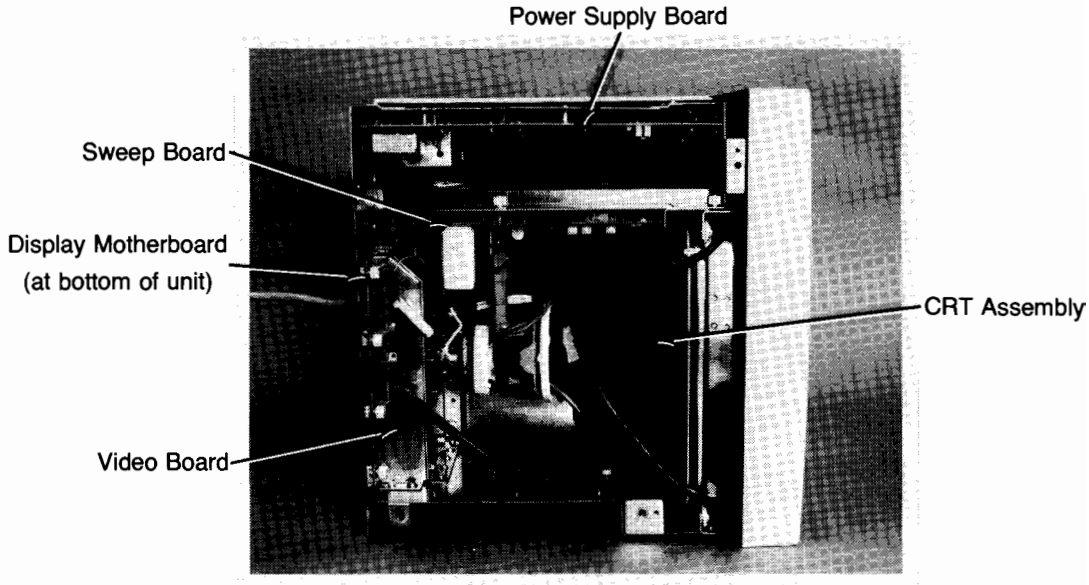


Figure 4-3B. 9836C Display Assembly Locations

9836 Display Unit Removal

The 9836 display unit is mounted on the top cover of the base unit. Therefore, it must be removed in order to obtain access to the assemblies in the base unit. To remove the display unit, follow these instructions:

1. Turn the power switch off and unplug the display unit cable from the back of the base unit.
2. Release the display unit latch by pulling back on the latch handle.
3. Lift the display unit up and off.

The base unit may be safely operated with the display unit disconnected. If you wish to operate the display unit while it is removed from the base unit, set it on its side.

Base Cover Removal

Obviously, base cover removal is a prerequisite to all base unit removal procedures. As such, it is only mentioned here. To remove the top cover, proceed as follows:

1. Remove all ac power to the computer.
2. Place the computer on its side on a smooth, flat surface.
3. Remove the four screws shown in Figure 4-4.
4. Remove the base cover.

Note

As an alternate method, place the computer on the edge of a desk so that the four screws are exposed, two at a time. Remove the first two screws, then expose the second pair of screws and remove them.

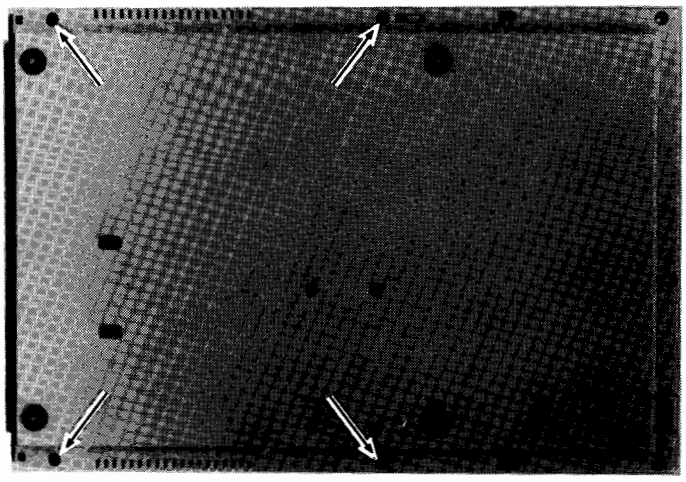


Figure 4-4. Base Cover Removal Screws

Display Unit Cover Removal

The display unit cover must be removed to access any asssembly in the display unit. To remove the cover, follow these directions:

1. Remove all ac power to the computer.
2. Turn the two quarter-turn fasteners shown in Figure 4-5 one-quarter of a turn counter-clockwise.
3. Lift the cover up and off.

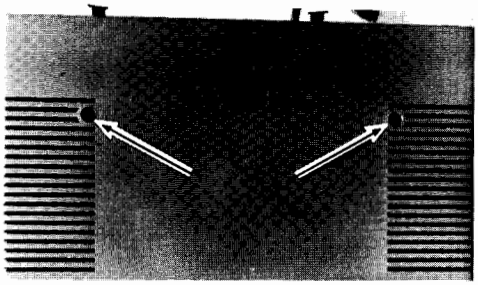


Figure 4-5. Display Unit Cover Fasteners

Card Cage Group

With the base cover removed, the following printed circuit boards installed in the card cage are accessible (see Figures 4-1, 4-2, and 4-3.)

- Backplane Connectorboard
- Regulator board
- Processor board

Note

When replacing an 09826-69516 or 09826-69517 board, remove the configuration and identification PROM from the defective board and install it on the replacement board. If you fail to do so, there will be no indication except that the power-up display will no longer include the serial number and the computer will no longer run secured software.

Prerequisite Removals

- None

Circuit Board Removal Procedure

The basic removal procedure for all printed circuit boards in the card cage is the same:

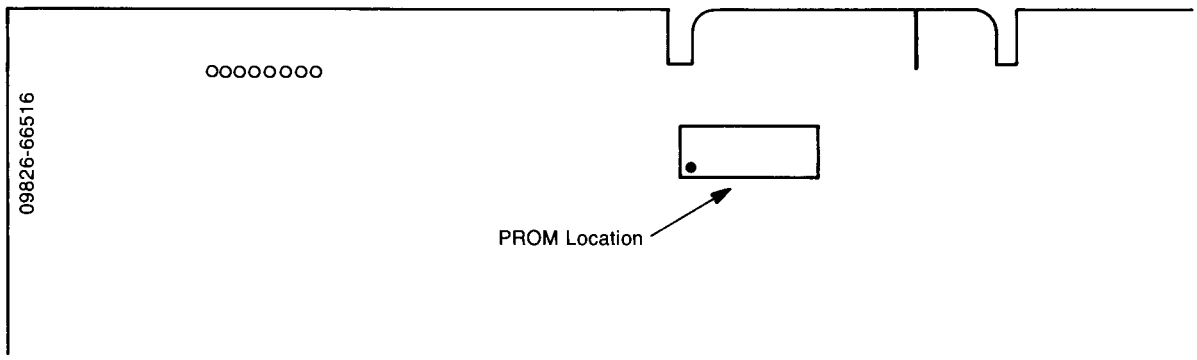
1. Remove the card cage cover by pulling straight up on the center.
2. Pull outward on the board retainer/extractors to pop the board loose.
3. Pull straight up on the board retainer/extractors.
4. Remove the printed circuit board.

Note

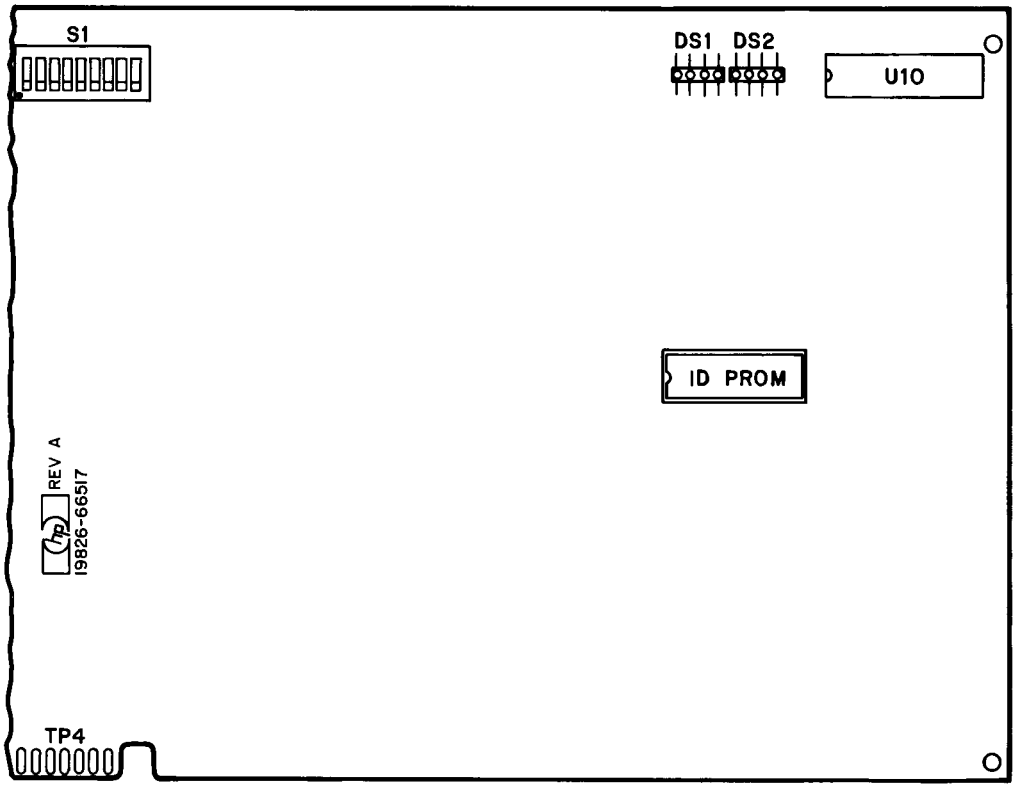
On the 9836 Regulator board, disconnect the dc fan connector before removing the board.

ID PROM

Some processor boards contain a removeable part, the ID PROM. When replacing an 09826-69516 or 09826-69517 processor board, this part must be removed and installed on the replacement board. The following figures show how to locate the ID PROM.



Locating the ID PROM on an 09826-69516 Board.



Locating the ID PROM on an 09826-69517 Board.

Disc Drive Group

The Disc Drive Group consists of these assemblies:

- Disc Drive Controller board
- Disc Drive Mechanism (one in the 9826, two in the 9836)

Prerequisite Removals

- None

Removal Procedure

To remove the Disc Drive Group, proceed as follows:

1. Disconnect the Disc Drive Controller board from the rear of the Disc Drive Mechanisms.
2. Pull board straight up, and out of the computer.
3. Locate and remove the black and white wire pairs running from the rear of the disc drive mechanisms to the drive indicator LEDs in the bezel.

Note

Record which way the connector plugs into the rear of the disc drive mechanism.

---

4. On the Motherboard, disconnect the four-pin connectors running from the disc drive mechanisms to the Motherboard.
5. Remove the six screws securing the right-hand disc drive mechanism shown in Figure 4-6.
6. Slide the right-hand disc drive mechanism out of the computer as shown in Figure 4-7.
7. Remove the four screws securing the left-hand disc drive mechanism shown in Figure 4-6.
8. Slide the left-hand disc drive mechanism out of the computer as shown in Figure 4-7.

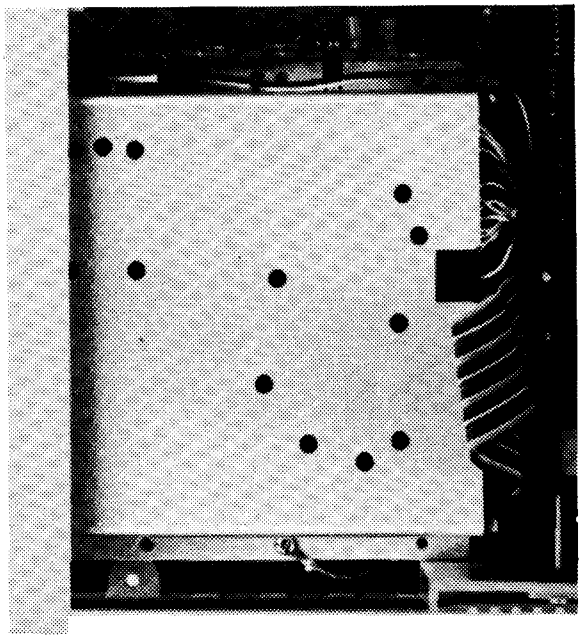


Figure 4-6. Disc Drive Screws

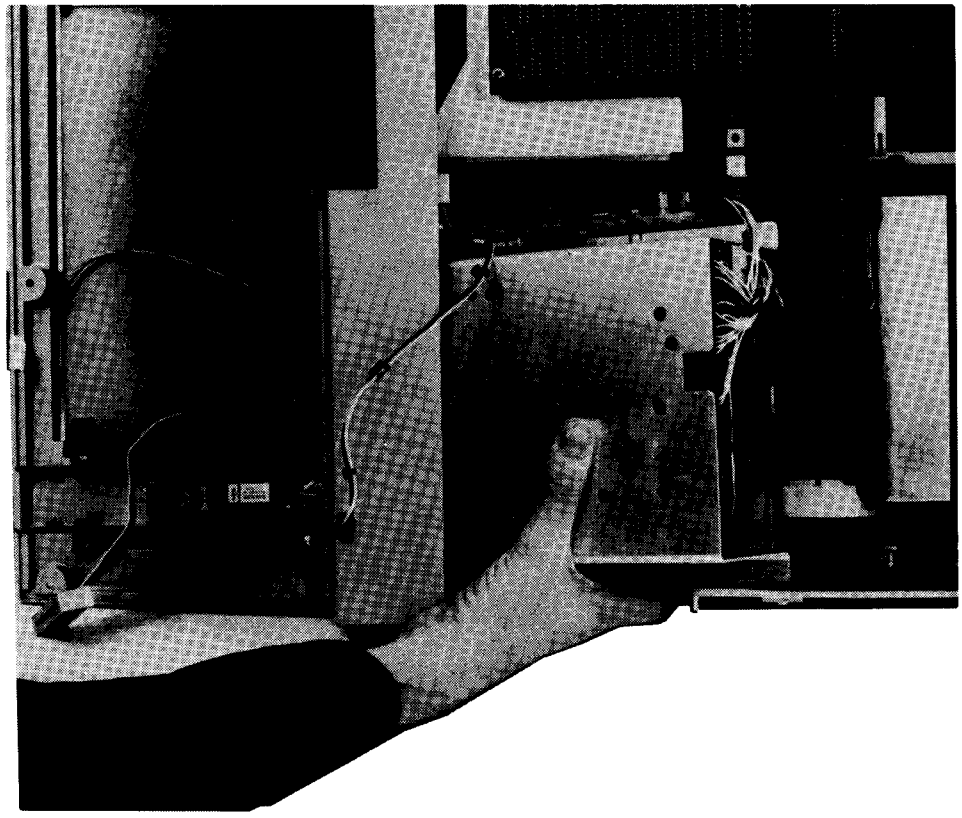


Figure 4-7. Removing the Disc Drive Mechanism

Display Group

The display group consists of those assemblies which drive the cathode ray tube (CRT). The following assemblies comprise the display group:

- Graphics board
- Digital board
- Analog board
- Video board
- Sweep board
- Display Power Supply board
- Display Motherboard
- CRT/High Voltage Cover
- CRT/yoke Assembly

CRT Safety Precautions

Observe the following safety precautions whenever you are working with or near the CRT. (See Figure 4-8 for CRT designations.)

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 the CRT is dropped.
- When the CRT is removed from the chassis, place it face down on a thick, soft pad.
- When storing the CRT, place it where it can not 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.

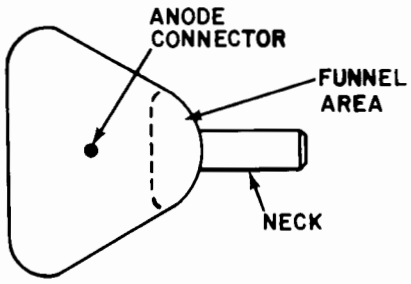


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Figure 4-8. CRT Designations

CRT Packaging

Store the new CRT in its packing box until it is installed in the computer. Use the same packing box when disposing of the defective CRT.

WARNING

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

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

CAUTION

DO NOT HANDLE THE CRT BY ITS NECK.

9826 Graphics Board Removal Procedure

1. Prerequisite removals:
   - None
2. Remove the three screws securing the Graphics board to the CRT/high voltage cover.

Note

Do not remove the two screws holding the rubber feet.

3. Remove the Graphics board by pulling it straight up. The connector on the back of the Graphics board should easily disengage from the top of the Digital board.

9826 Digital Board Removal Procedure

1. Prerequisite removals:
   - Graphics board
2. Pull the Digital board up and out of the computer.

9826 CRT/High Voltage Cover Removal Procedure

1. Prerequisite removals:
   - None
2. Remove the CRT/high voltage cover by turning the four quarter-turn fasteners (shown in Figure 4-9) one-quarter of a turn counterclockwise with a #1 pozidriv.
3. Remove the cover by pulling it straight up and out of the machine, while prying the Graphics board loose from the Digital board.

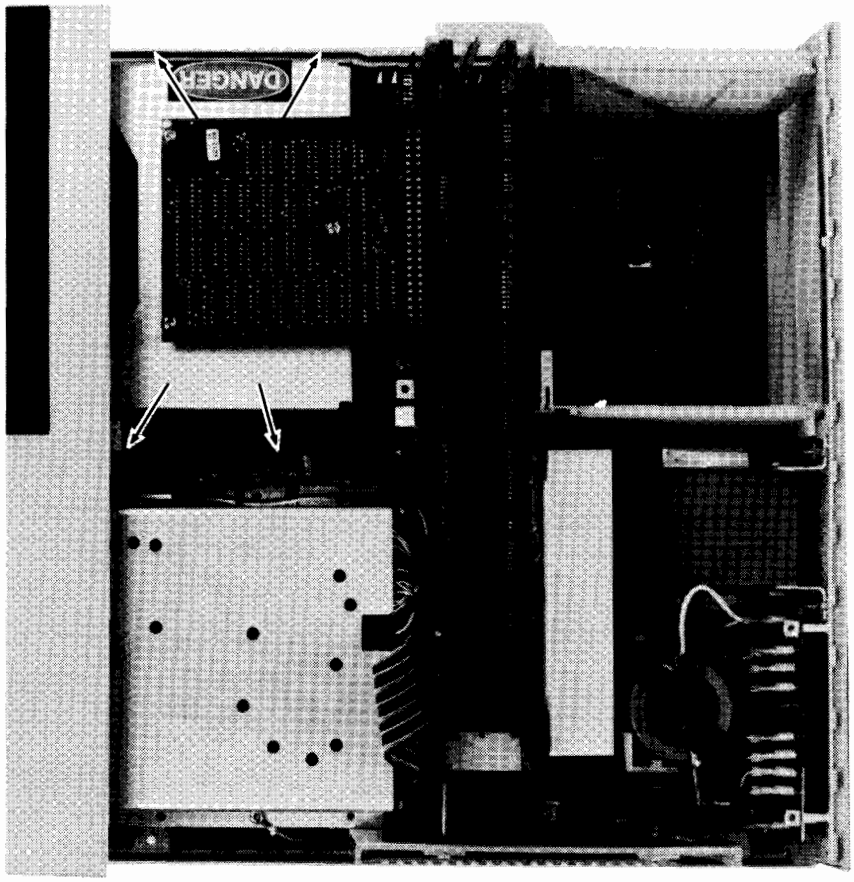

Figure 4-9. 9826 CRT/High Voltage Cover Fasteners.

9826 CRT Removal Procedure

1. Prerequisite removals:
   - Graphics board
   - CRT/High voltage cover

WARNING

ALLOW THE CRT ENVELOPE TO DISCHARGE FOR AT LEAST ONE MINUTE BEFORE TOUCHING THE CRT ANODE CONNECTOR. THEN GROUND THE ANODE WITH A SCREWDRIVER.

2. Remove the cathode cable from the CRT cathode.
3. Disconnect the yoke cable from the analog board.
4. Lift the plastic insulating disc on the anode connector from the surface of the CRT. It may be necessary to pry it up with a small screwdriver if a vacuum has formed.

Note

The anode voltage bleeds off in about 10 seconds.

5. Press the anode connector to one side with your forefinger. Then rotate it out of the CRT (see Figure 4-10).
6. Remove the top screw holding the grounding spring fastened across the back of the CRT envelope. Hold onto the spring to keep it from flying around.

WARNING

DO NOT ALLOW THE CRT TO FALL ONTO THE ANALOG BOARD.

7. Remove the three remaining screws fastening the CRT clamp to the bezel.
8. Lift the CRT and the CRT clamp up and out of the computer.

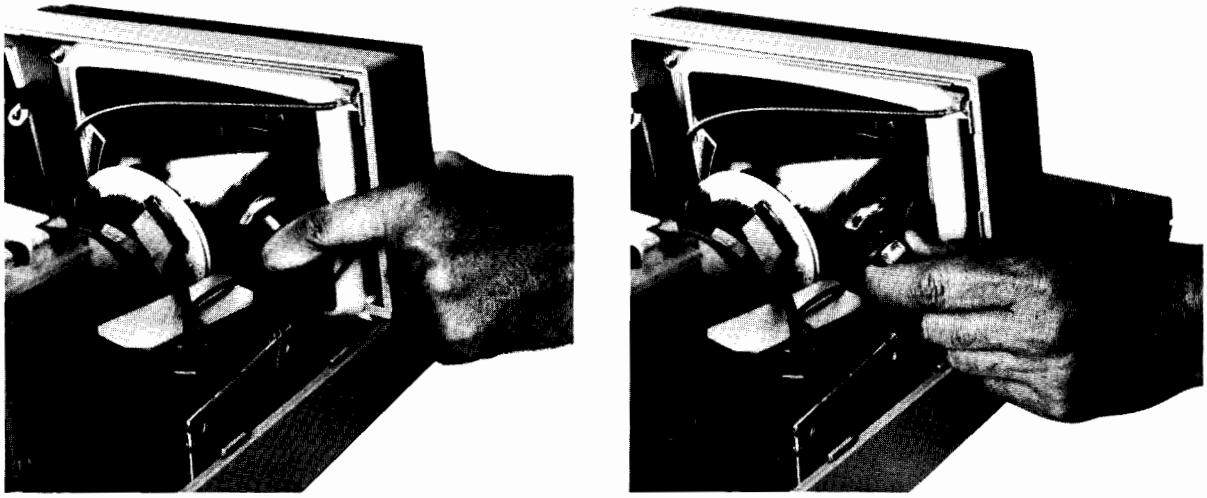

Figure 4-10. Removing the 9826 CRT Anode Connector.

9826 Analog Board Removal Procedure

The Analog board is located under the CRT assembly and is difficult to remove.

1. Prerequisite removals:
   - Graphics board
   - CRT/High Voltage Cover
   - Digital board
   - Disc drive control board
   - Processor board
2. Unplug the following connectors from the Analog board:
   - CRT Yoke Connector
   - CRT Anode Connector
   - CRT Cathode Connector
   - CRT Clamp Ground Wire
   - Motherboard-to-Analog board Jumper
3. Remove the five screws fastening the analog board to the base of the CRT/high voltage cover.
4. Lift the edge of the Analog board straight up until the operator intensity knob clears the edge of the base.
5. Slide the Analog board toward the rear and twist it up. The components on the printed circuit board should just clear the underside of the CRT assembly.

9836A Graphics Board Removal Procedure

1. Prerequisite removals:
   - Left-hand Disc Drive Mechanism
2. Remove the four screws securing the Graphics board to the base.
3. Swing the Graphics board partway up, then pull it loose from the cable connectors.

9836A Digital Board Removal Procedure

1. Prerequisite removals:
   - Left-hand Disc Drive Mechanism
   - Graphics board
2. Swing the Digital board partway up, then pull it loose from the cable connectors.

9836A CRT/High Voltage Cover Removal Procedure

1. Prerequisite removals:
   - Display Unit Cover
2. Turn the six quarter-turn fasteners (shown in Figure 4-11) one-quarter of a turn counterclockwise with a #1 pozidriv. Then lift the CRT/High Voltage Cover straight up.

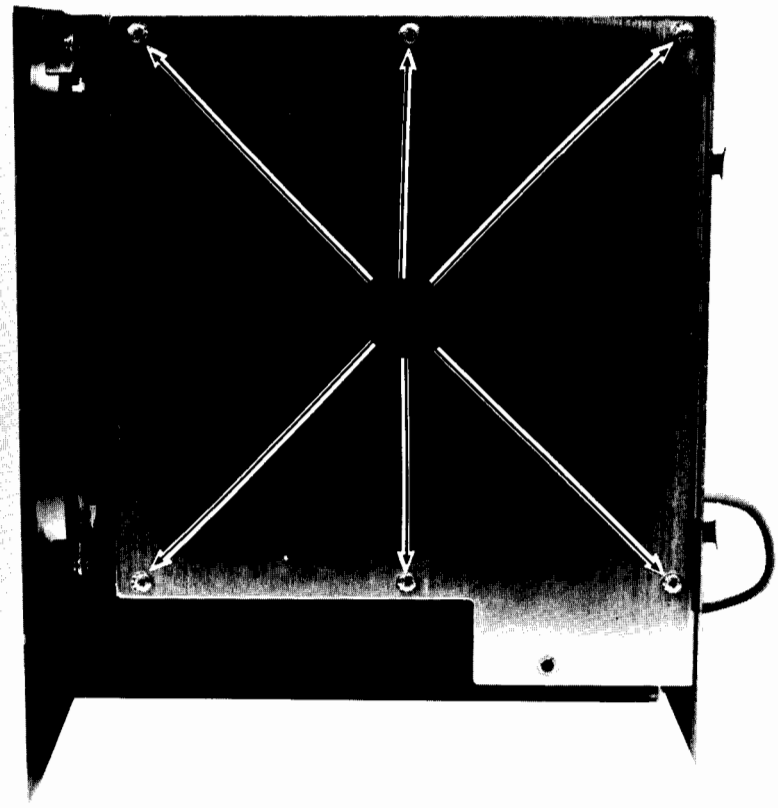

Figure 4-11. 9836A CRT/High Voltage Cover Fasteners

9836A Display Unit Bezel Procedure

1. Prerequisite removals:
   - Display unit top cover
2. Remove the four screws fastening the bezel to the chassis. Be sure to hold the bezel to prevent it from falling when the last screw is removed.

9836A CRT Removal Procedure

1. Prerequisite removals:
   - CRT/High voltage cover
   - Dispay unit bezel

WARNING

ALLOW THE CRT ENVELOPE TO DISCHARGE FOR AT LEAST ONE MINUTE BEFORE TOUCHING THE CRT ANODE CONNECTOR. THEN GROUND THE ANODE WITH A SCREWDRIVER.

2. Remove the cathode cable from the CRT cathode.
3. Disconnect the yoke cable from the analog board .
4. Lift the plastic insulating disc on the anode connector from the surface of the CRT. It may be necessary to pry it up with a screwdriver if a vacuum has formed.

Note

The anode voltage bleeds off in about 10 seconds.

5. Press the anode connector to one side using your thumb. Then rotate it out of the CRT (see Figure 4-12).
6. Remove the three remaining screws fastening the CRT clamp to the bezel.
7. Lift the CRT and the clamp up and out of the display unit.

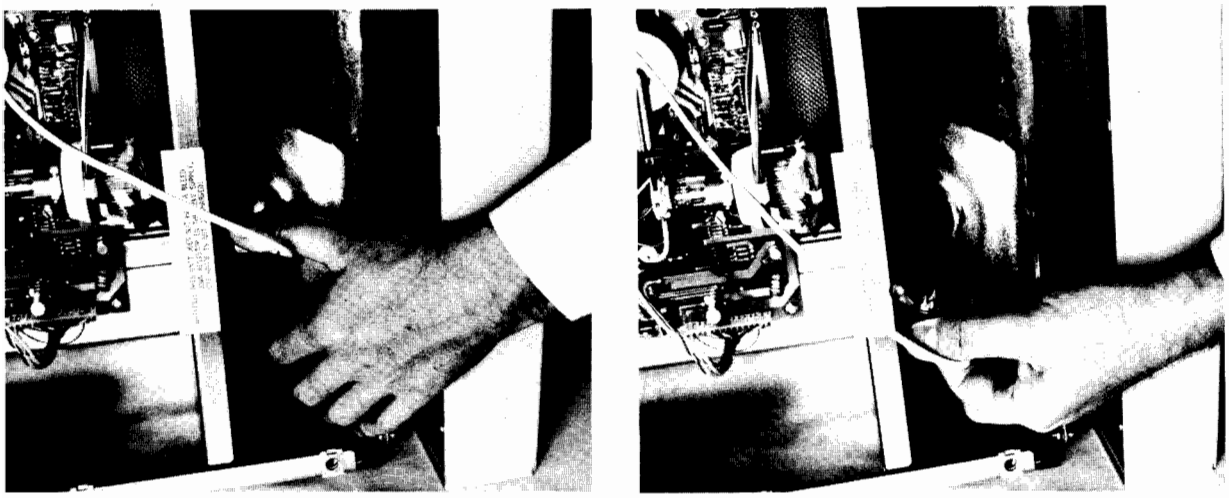

Figure 4-12. Removing the 9836A CRT Anode Connector.

9836A Analog Board Removal Procedure

The Analog board is located under the CRT assembly and is quite easy to remove.

1. Prerequisite removals:
   - Display Unit Cover
   - CRT/High Voltage Cover
2. Unplug the following connectors from the Analog board:
   - CRT Yoke Connector
   - CRT Anode Connector
   - CRT Cathode Connector
   - CRT Clamp Ground Wire
   - Base Unit to Display Unit Cable
   - Intensity Control Connector
3. Remove the four screws fastening the analog board to the base of the display unit.
4. Slide the Analog board toward the rear and twist it up.

9836C Graphics Board Removal Procedure

1. Prerequisite removals:

   - Left-hand Disc Drive Mechanism

2. Disconnect the operator intensity control from the left-hand edge of the Graphics board.
3. Remove the four screws securing the Graphics board to the base.
4. Swing the Graphics board partway up, then pull it loose from the cable connector.

9836C Digital Board Removal Procedure

1. Prerequisite removals:

   - Left-hand Disc Drive Mechanism
   - Graphics board

2. Disconnect the video cable from the Digital board.
3. Swing the Digital board partway up, then pull it loose from the cable connector.

9836C Fan Shroud Removal Procedure

1. Prerequisite Removals:

   - Display Unit Cover

Pull the three black pop-out fasteners toward the front of the unit. Pliers may be helpful. Then pull the fan shroud off the rear panel.

9836C CRT/High Voltage Cover Removal Procedure

1. Prerequisite removals:

   - Fan Shroud
   - Display Unit Power Cord

2. The CRT/high voltage cover is fastened with nine screws. In either case, remove the fasteners (shown in Figure 4-13). Then lift the CRT/High Voltage Cover straight up.

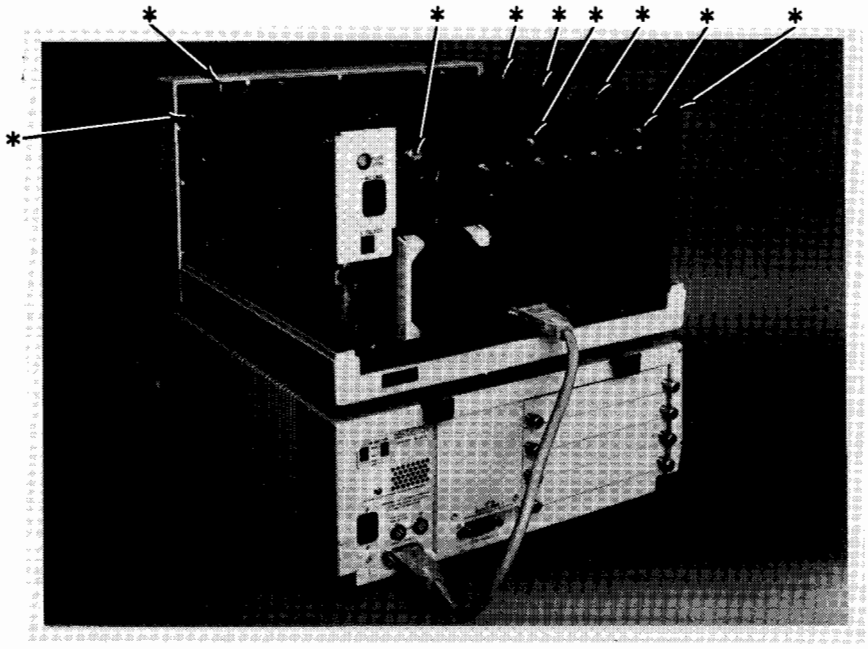

Figure 4-13. 9836C CRT/High Voltage Cover Fasteners

9836C Display Unit Bezel Procedure

1. Prerequisite removals:

   - Display Unit Top Cover

2. Remove the four screws fastening the bezel mounting flanges to the chassis. Be sure to hold the bezel to prevent it from falling when the last screw is removed.

9836C CRT Power Supply Removal Procedure

The CRT Power Supply is located at the right side of the display unit.

1. Prerequisite removals:
   - CRT/High Voltage Cover
2. Remove the five screws fastening the Power Supply to the chassis.
3. Pull the board straight up about fifty mm (two inches). It may be necessary to pry it loose by inserting a screwdriver in the holes at the top corners of the board and levering against the chassis.
4. Unplug the two cables connected to the board.
5. Pull the board straight up and out of the chassis (see Figure 4-14).

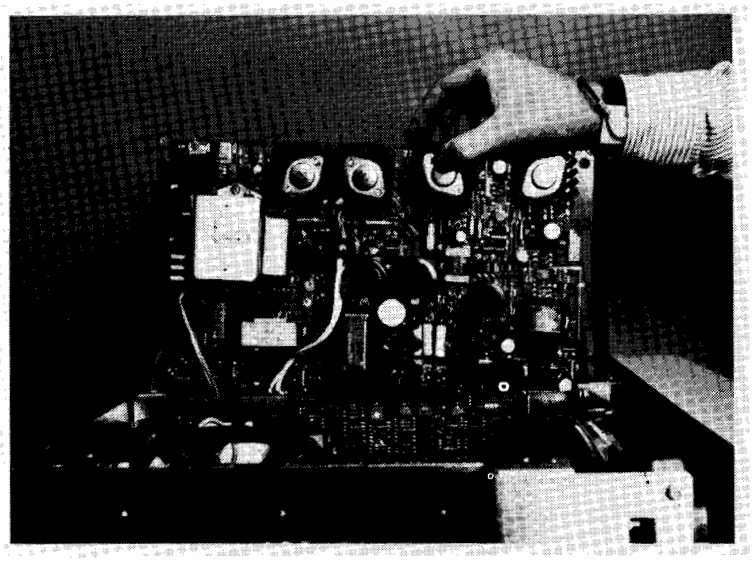

Figure 4-14. Removing the CRT Power Supply.

9836C Sweep Board Removal Procedure

The Sweep board is located to the right of the CRT assembly.

1. Prerequisite removals:
   - CRT/High Voltage Cover
2. Unscrew the black connector between the flyback transformer and the Video board.
3. Unplug the red connector between the flyback transformer and the video board.
4. Lift the plastic insulating disc on the anode connector from the surface of the CRT. It may be necessary to pry it up with a small screwdriver if a vacuum has formed.

Note

The anode voltage bleeds off in about 10 seconds.

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5. Press the anode connector to one side with your forefinger. Then rotate it out of the CRT (see Figure 4-15).

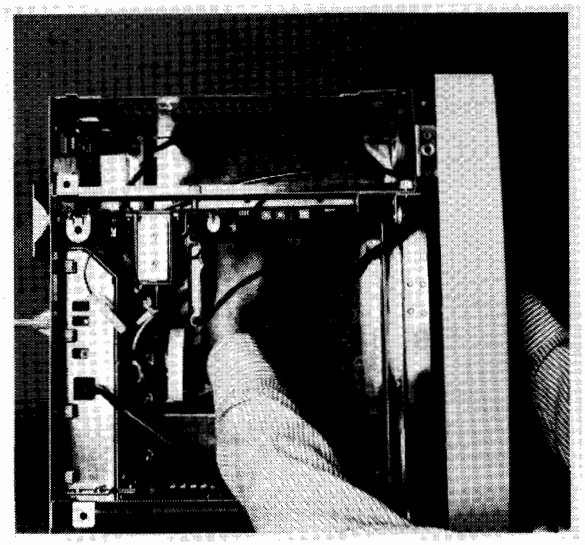

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Figure 4-15. Removing the 9836C Anode Connector.

6. Unscrew the captive fastener on the chassis behind the Sweep board.
7. Pull the Sweep board straight up about 50 mm (two inches).
8. Remove the two connectors on the Sweep board.
9. Pull the Sweep board up and out of the chassis (see Figure 4-16).

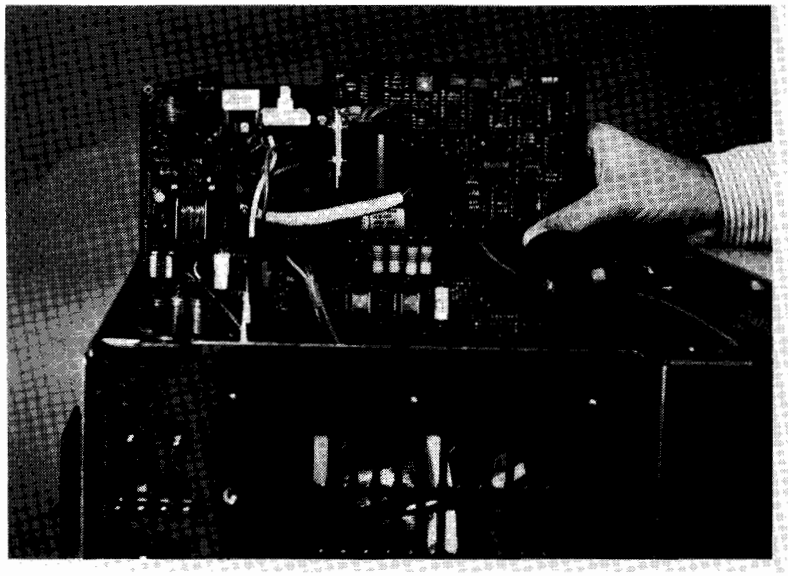

Figure 4-16. Removing the Sweep Board.

9836C Video Board/CRT Unit Removal Procedure

The Video board is mounted on the CRT/yoke assembly in such a way that it is impossible to remove either from the chassis except as a unit. They may be separated after the unit is removed.

The CRT/yoke replacement assembly comes complete with the degaussing cable and mounting flanges attached.

CAUTION

WHEN HANDLING THE CRT/YOKE ASSEMBLY, BE SURE NOT TO TOUCH THE AREA AROUND THE YOKE. THESE ADJUSTMENTS ARE MADE AT THE FACTORY AND ARE EXTREMELY DELICATE.

1. Prerequisite removals:
   - Display Unit Bezel
   - Sweep Board
2. Unplug the degaussing cable from the Power Supply and pass it through the hole in the chassis.
3. Loosen the two fasteners holding the CRT/yoke assembly to the chassis. These are a screw in the upper left-hand corner and a captive fastener in the upper right-hand corner. The bottom two fasteners are actually swivels. You can swing the assembly up and out of the chassis on the swivels.
4. Disconnect the black ground cable from the top of the Video board.
5. Disconnect the three-conductor cable between the Video board and the Motherboard.
6. Remove the four screws, spacers and nuts fastening the Video board to the chassis.

Note

Some early units have an EMI shield around the Video board. It is held in place by 15 captive fasteners. Be sure they are all completely loose, as even one can prevent you from removing this assembly.

The EMI shield is no longer necessary. If you have four each of the screws, spacers and nuts for fastening the Video board to the chassis, the EMI shield may be discarded.

7. Prepare a place to set the CRT/yoke assembly. You should set it face down on a non-scratching surface. A magazine or upholstered chair is adequate.
8. Reach underneath the CRT with your left hand and tip the entire assembly forward on the two swivels while guiding the Video board with your right hand.

WARNING

KEEP AWAY FROM THE ANODE CONNECTOR ON THE RIGHT SIDE OF THE CRT/YOKE ASSEMBLY.

9. When the Video board is clear of the chassis, put your right hand on the CRT face (see Figure 4-17). Continue to swing the assembly up and you can pull it straight up out of the swivels. Then place it face down on a non-scratching surface.
10. The Video board can now be carefully pried loose from the CRT/yoke assembly.

Figure 4-17. Removing the Video Board/CRT Unit.

Display Unit Motherboard

The Motherboard is located at the bottom of the display unit chassis.

1. Prerequisite removals:
   - CRT Power Supply
   - Video Board/CRT Unit
2. Remove the two screws fastening the base-to-display cable to the display unit Motherboard.
3. Pull the Motherboard up off the three stand-offs, and out of the chassis.

Motherboard Removal

The Motherboard contains most of the interconnecting circuitry between the printed circuit boards in the computer. In addition, the Motherboard contains the following logic circuitry:

- Chip Select Circuit
- Internal HP-IB Circuit
- Keyboard Logic Circuit

Prerequisite Removals

- Backplane Connectorboard
- Regulator board
- Disc Drive Controller board
- Processor board
- Digital board [1]
- Graphics board [1]

Removal Procedure

1. Unplug the following connectors from the Motherboard:
   - Keyboard Cable
   - Motherboard-to-Analog board Jumper Cable (9826)
   - Display Unit Cable (9836)
   - Disc Drive Mechanism Power Cable(s)
   - Internal HP-IB Cable (if installed)
   - Powerfail Option Cable (if installed)
2. Remove the outside card guide and the 9836 inside card guide (see Figure 4-1).
3. Using a 9/32'' nutdriver, remove the two screws fastening the internal HP-IB connector to the rear panel of the computer.
4. If a 9836, use a 3/16 inch nutdriver to remove the two screws fastening the display unit connector to the rear panel of the computer.
5. Remove the seven screws fastening the Motherboard to the base of the computer.
6. Slide the Motherboard out the left side of the computer (see Figure 4-18). It may be necessary to flex the board slightly.

1 Not prerequisite in the 9836.

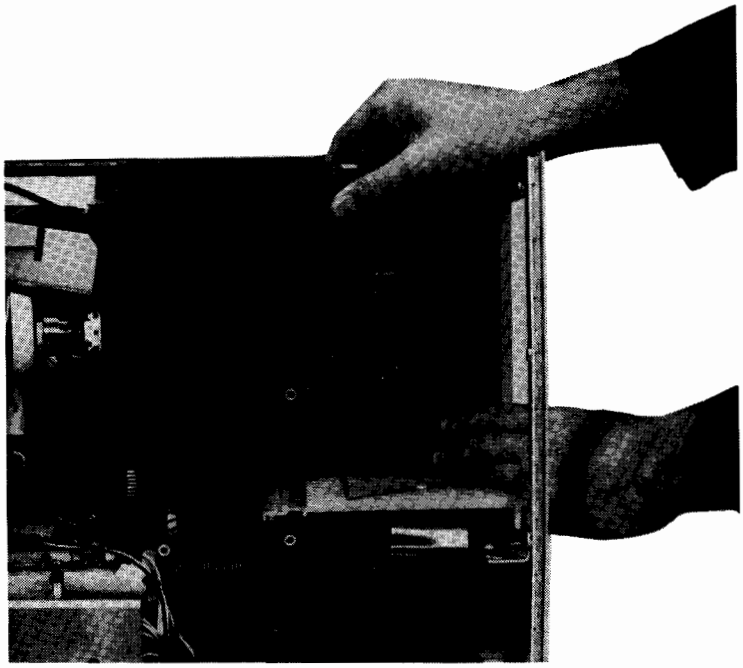

Figure 4-18. Removing the Motherboard

Rectifier Board Removal

WARNING

REMOVE ALL AC POWER TO THE COMPUTER BEFORE REMOVING ANY ASSEMBLY.

Prerequisite Removals

- None

Removal Procedure

When removing the Rectifier board, disconnect as many wires as necessary to gain access to the board. Refer to the Rectifier board wiring chart provided in the "Reassembly Hints" section later in this chapter.

To remove the Rectifier board, proceed as follows:

1. Remove the two screws holding the plastic insulating cover and remove the cover.
2. Remove the spade clip wires from the Rectifier board (refer to Table 4-5 for wire locations during reassembly).
3. Remove the three screws fastening the rectifier board to the rear panel (see Figure 4-19).
4. Lift straight up on the board and remove it from the computer.

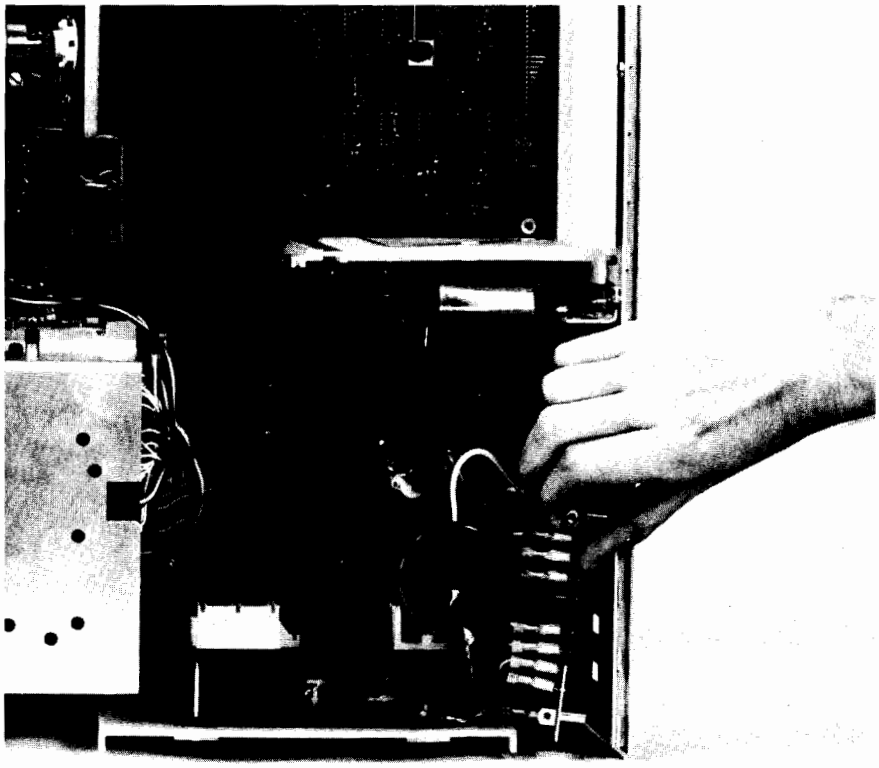

Figure 4-19. Removing the Rectifier Board

Discrete Ac Hardware

Prerequisite Removals

- (Refer to individual procedure)

Power Transformer Removal

1. Disconnect the power transformer leads from the Rectifier board. (Refer to Table 4-5 for Rectifier board wiring during reassembly.)
2. Remove the four screws holding the transformer to the rear panel.
3. Remove the two screws holding the transformer to the base of the computer.

Power Capacitor Removal

1. Cut the two cable ties fastening the capacitor to the right printed circuit guide.
2. Disconnect the wires at the capacitor.

Fan Removal

The fan mount and the right printed circuit guide are each fastened to the base with two screws. These screws are accessible after the regulator board, the disc drive controller board and the processor board are removed.

1. Prerequisite removals:
   - Regulator board
   - Disc Drive Controller board
   - Processor board
2. Disconnect the two wires providing power to the fan motor. If a 9836, note which wire goes to each terminal, as this is a dc motor.
3. Remove the two screws fastening the fan mount to the base of the computer.
4. Remove the two screws fastening the right-side printed circuit guide to the base of the computer.
5. Remove the entire fan assembly (including the right-side printed circuit guide).

Ac Line Filter/Fuse Holder Removal

1. Prerequisite removals:
   - Rectifier board
2. Remove the two nuts holding the ac line filter to the studs with a 5.5mm nutdriver.
3. Unsolder the wires from the fuseholders.
4. Remove the large nut fastening each fuse holder body to the rear panel of the computer.

On/Off Power Switch Removal

1. Prerequisite removals:
   - Keyboard
2. Using pliers, squeeze the two plastic arms together (see Figure 4-20).
3. Pull the on/off actuator out the front of the computer.
4. Unsnap the plastic case from around the outside of the switch.
5. Remove the switch by pulling it out the back side of the plastic switch case.
6. Unsolder the wires on the switch, or remove the power cable harness.

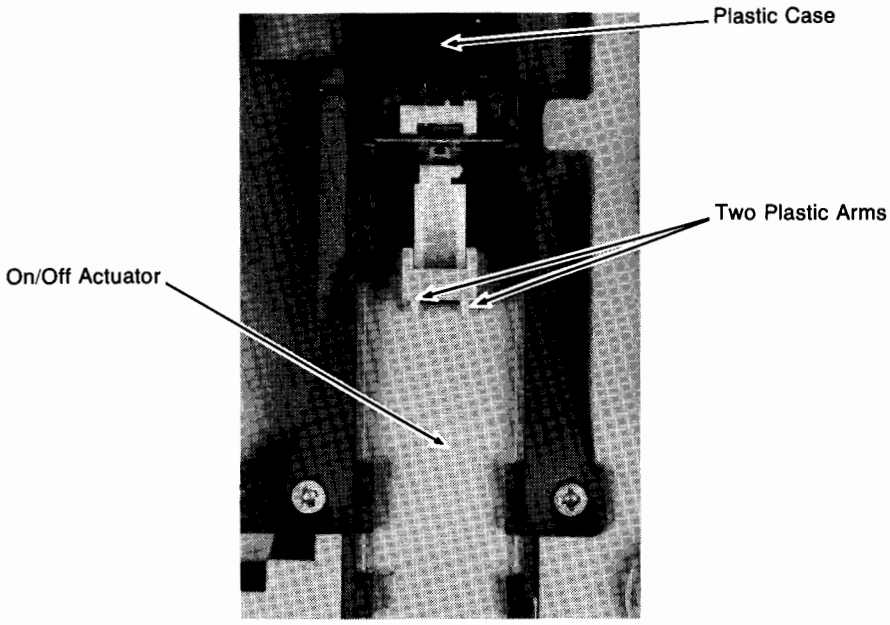

Figure 4-20. On/Off Power Switch Removal

Keyboard

Keyboard Removal

Any repairs to the keyboard assembly, other than replacing keycaps, requires removing the keyboard from the computer. Use the following procedure to remove the keyboard.

1. Prerequisite removals:
   - None
2. Place the computer on the desk or workbench with the keyboard hanging over the edge.
3. Remove the five screws shown in Figure 4-21.
4. Lift the keyboard/bezel assembly straight up to remove it from the computer (the ribbon cable is still connected).
5. Disconnect the ribbon cable from the keyboard printed circuit board connector.
6. Disconnect the rotary pulse generator cable from the Keyboard.
7. Remove the seven screws fastening the Keyboard to the bezel.
8. Lift the Keyboard out of the bezel.

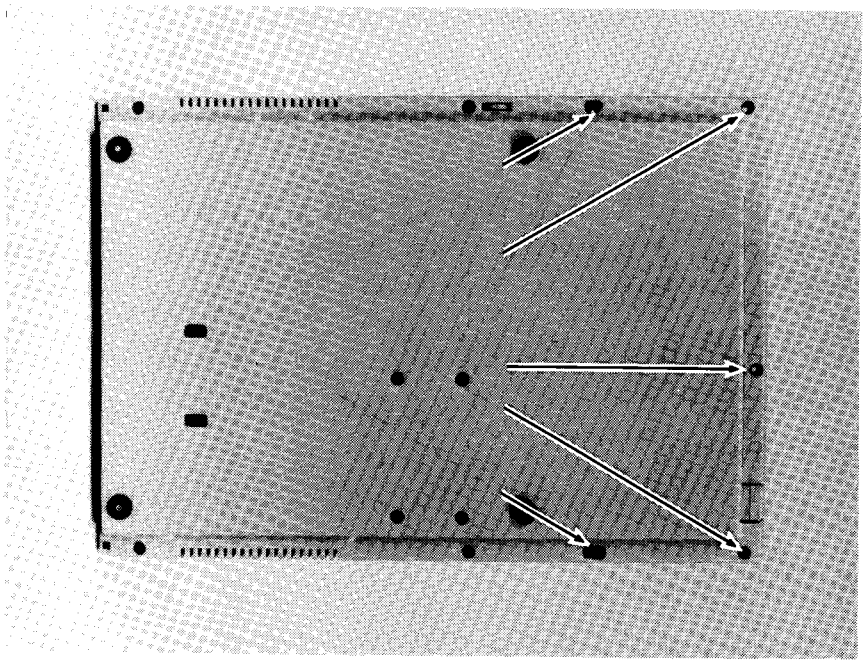

Figure 4-21. Keyboard Screws

Rotary Control Knob Removal

1. Prerequisite removals:
   - Rotary Knob
   - Keyboard Assembly
2. Unplug the rotary control knob connector at the Keyboard.
3. Remove the nut holding the rotary control knob to the keyboard bezel.
4. Remove the rotary control knob.

CRT Window

WARNING

THE CRT WINDOW FUNCTIONS AS A SAFETY FACEPLATE. DO NOT OPERATE THE COMPUTER WITHOUT THE CRT WINDOW.

9826 CRT Window Removal Procedure

1. Prerequisite removals:
   - Keyboard Assembly
2. Remove the two screws at the bottom of the window.
3. Lift the window straight up and remove it.

9836 CRT Window Removal Procedure

1. Prerequisite removals:
   - CRT Bezel
2. Remove the four screws fastening the window to the bezel.
3. Lift the window up and out.

Base Bezel

Normally, the bezel should not be removed unless it is being replaced due to damage. All other assemblies are accessible without removing the bezel.

9826 Base Bezel Removal Procedure

1. Prerequisite removals:
   - Keyboard Assembly
   - Disc Drive Group
   - CRT/High Voltage Cover
   - On/Off Power Switch

Note

The CRT may be removed, or it can be left attached to the bezel and removed later.

2. Disconnect the following from the CRT:
   - CRT Yoke connector
   - CRT Cathode connector
   - CRT Anode connector
   - CRT Ground wire.

3. Remove the two screws fastening the On/Off Power Switch to the base of the computer.
4. Remove the screws fastening the bezel to the base of the computer. Old style bezels have five screws and new style bezels have two screws.
5. Lift the CRT bezel straight up and out of the computer.

9836 Base Bezel Removal Procedure

1. Prerequisite removals:
   - Keyboard Assembly
   - Disc Drive Group
   - Graphics Board
   - On/Off Power Switch
2. Remove the two screws fastening the bezel to the base of the computer.
3. Lift the CRT bezel straight up and out of the computer.

Reassembly Hints

The 9826/9836 Computer is quite easy to reassemble. In most cases, reversing the disassembly procedure is adequate. Refer to the following suggestions during reassembly.

Motherboard Reassembly

1. Slide the motherboard into place. It may be necessary to flex the board slightly.

2. Install the two HP-IB mounting screws. Be sure to align the screws and washers carefully, to avoid cross-threading.

Note

This will align the motherboard and help hold it in place.

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3. Replace the seven screws fastening the motherboard to the base.

Printed Circuit Guide Installation

When reinstalling printed circuit guides, slide a circuit board into the guide before tightening the screws. This will help align the guides and hold them in place while they are tightened down.

Rotary Control Knob

The rotary control knob cable may be connected with either side up.

Keyboard Cable

When attaching the keyboard cable to the motherboard, turn the ribbon cable under to make the 90 degree turn.

Disc Drive Reassembly

When installing the Disc Drive Controller board, connect the ribbon cable(s) to the Disc Drive Mechanism(s) before sliding the Controller board into the card cage.

9826 Graphics Board Installation

When reinstalling the graphics board, make sure the edge connector is bottomed onto the digital board. Merely tightening the hold-down screws does not guarantee that the edge connector will make contact on every pin.

Intensity Control

If the display is incorrect after changing the digital board, try adjusting the intensity control underneath the left-hand side of the base. If the intensity control has no effect, you have neglected to reattach it to the digital board.

Rectifier Board Wiring

When reinstalling the rectifier board, use the wiring diagram shown in Figure 4-21 and the wire list shown in Table 4-5.

Table 4-5. Rectifier Board Terminal Wiring

Terminal	Wire Function	Color	Color Code
1	Transformer Secondary	Brown	1
2	Capacitor, negative	Brown	1
3	Regulator Bd., ground	Brown	1
4	Batt., neg (Powerfail Op.)	Brown	1
5	Power Switch	Gray	8
6	Transformer Primary	Orange	3
7	Transformer Primary	Orange/black	3/0
8	Transformer Primary	Black/green	0/5
9	Fan (9826)	Black	0
10	Transformer Primary	Black/yellow	0/4
11	Transformer Primary	Black	0
12	Power Switch	White/red/gray	9/2/8
13	Transformer Primary	Black/red	0/2
14	Fan (9826)	Black	0
15	Capacitor, positive	Yellow	4
16	15 A Fuse	Yellow	4
17	Batt., pos. (Powerfail Op.)	Yellow	4
18	Regulator Board	White/yellow/grey	9/4/8
19	Transformer Secondary	Red	2
20	Transformer Secondary	Red	2

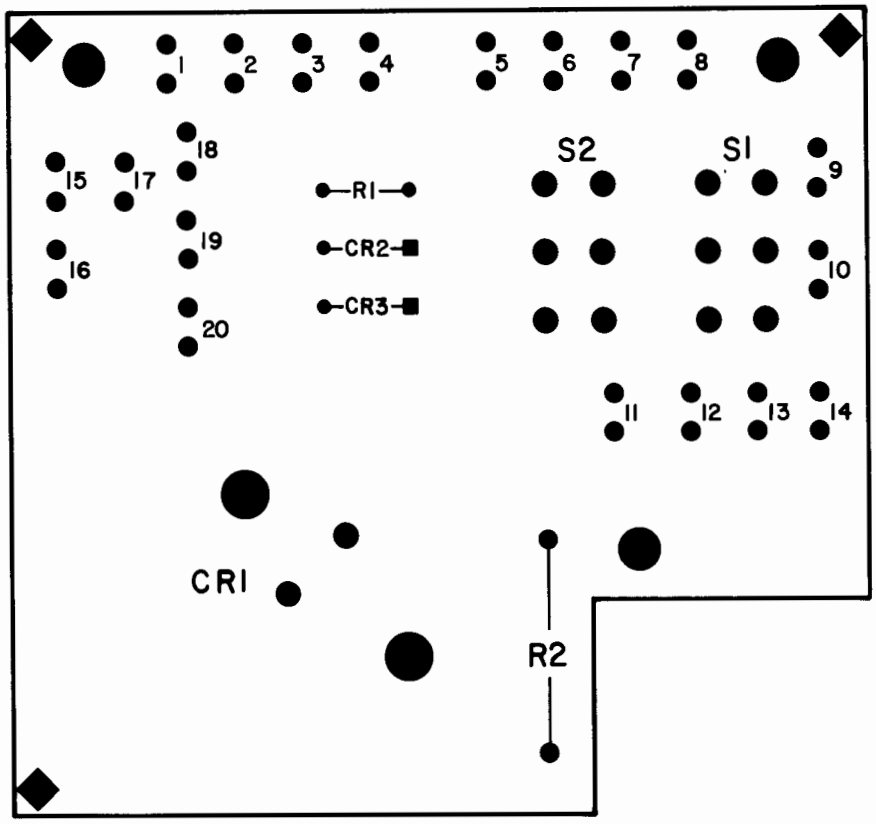


Figure 4-22. Rectifier Board Wiring

Cleaning the Computer

Clean the computer case and keyboard using a soft, damp cloth and a mild detergent. Do not use cleansers or other harsh abrasives which might harm the finish of the computer.

CAUTION

UNPLUG THE COMPUTER WHILE CLEANING IT. DO NOT ALLOW ANY WATER TO GET INSIDE THE COMPUTER.

Clean the CRT window with a soft, damp cloth. Do not use detergents or cleaners of any kind, since the CRT window surface scratches very easily.

Cleaning the Disc Drive Heads

Disc drive read/write heads should be cleaned periodically to ensure trouble-free operation. A head-cleaning kit is available from HP with accessory number 92193A. HP does not recommend use of other head-cleaning discs or equipment.

CAUTION

DO NOT ATTEMPT TO CLEAN THE DISC READ/WRITE HEADS MANUALLY OR WITH MATERIALS OTHER THAN THOSE SUPPLIED BY HP. HEADS COULD BECOME DAMAGED OR MISALIGNED.

To clean the disc read/write heads:

1. Switch the computer off.
2. Insert the 9826/9836 System Test Disc in the disc drive and close the door.
3. Switch the computer on. The system test program is loaded automatically.
4. When the initial system test menu is displayed, press either CLEAN HEADS softkey (k2 or k7). Then follow the instructions presented on the display.

Chapter 5
Troubleshooting and Repair

Introduction

This chapter contains information to repair the 9826/9836 computer. Each section presents a flowchart and procedure for troubleshooting the computer to a specific level.

The various sections of the chapter cover:

Initial Troubleshooting Procedure. This section covers how to quickly determine what level to start at. It tells you which procedure to start with, rather than going through each procedure until the problem is diagnosed.

Dead Unit Procedure. This section covers troubleshooting a unit which will not power up at all. Dead units typically have problems in the power supply.

Live Unit Procedure. This section covers troubleshooting a unit which has correct power supply voltages but will not execute any instructions. Live units typically have problems with the processor, boot ROM, RAM or CPU bus.

System Test Procedure. This section covers troubleshooting a unit which can execute at least some instructions but has a problem accepting, storing or outputting data. The system test procedure can use either the test card or the system test disc, depending on how much of the unit is operational. Defective assemblies typically are the disc drive, keyboard, CRT, RAM and system ROM.

Individual Test Mode. This section covers in-depth testing and exercising of specific functions, such as the CRT or disc drive.

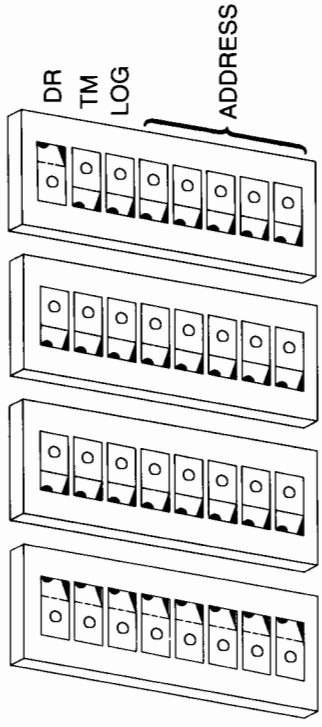
Initial Troubleshooting Procedure

The different levels of troubleshooting require different portions of the computer to be functional. Here is a summary of the functions needed by each procedure:

Procedure	What MUST Operate Properly
Dead unit	Nothing
Live unit	Power supply
System test (test card)	Power supply, processor, boot ROM, first 64k RAM, CPU bus
System test (disc)	Power supply, processor, boot ROM, first 64k RAM, CPU bus, disc drive, CRT, keyboard
Individual test mode	Entire computer, except specific area being tested

In order to choose the best approach to start with, obtain as much information as possible from the user. If the user indicates that the unit is not working at all, the dead unit procedure is a good place to start. If the user indicates that most of the unit is operating properly, the system test procedure may be a good place to start. If the user's information is not conclusive, use the following procedure to determine the problem area. The Initial Troubleshooting Flowchart in Figure 5-1 summarizes this procedure.

1. Turn the computer on and check for air flow through the base fan.
2. If the fan is not running, go to the dead unit procedure.
3. If the fan is running, set the switches on the test card according to the figure:



4. Turn the computer off and install the test card in any empty slot in the accessory backplane. If there are no empty slots, remove an interface card from the backplane.
5. Turn the computer back on and check whether the LED indicator on the test card is counting through the tests. If it is, the system test procedure is a good place to start.
6. If the test card stalls on zero, or if the LED display does not display anything, remove the base cover and check the +5V and +12V test points on the regulator board.
7. If the voltages are correct, refer to the live unit procedure. If they are incorrect, refer to the dead unit procedure.

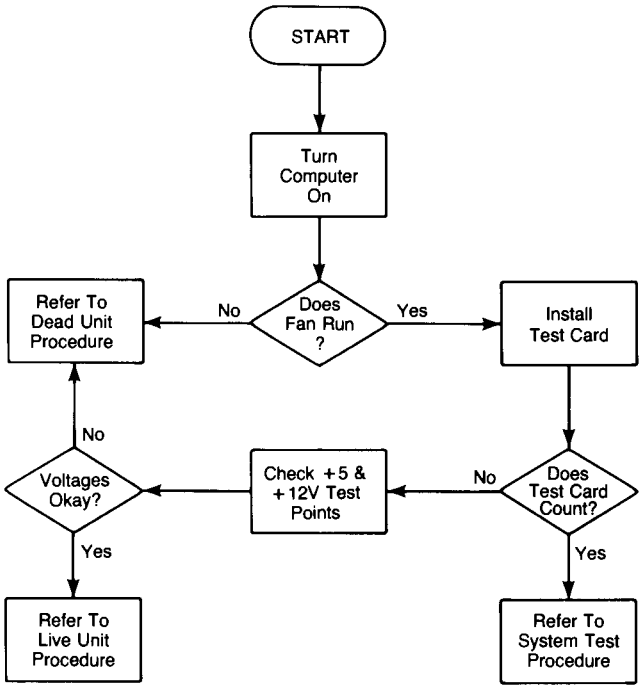


Figure 5-1. Initial Troubleshooting Flowchart

Dead Unit Procedure

A dead unit is one which does not appear to function at all. This is usually due to the power supply voltages being incorrect. It typically has a defective or incorrectly adjusted power supply, although problems in the load can affect the supply voltages.

The power supply consists of these assemblies:

09826-66552	Rectifier board (9826)
09826-66554	Rectifier board
09826-69551	Regulator board (9826)
09826-69553	Regulator board
09826-67905	Transformer assembly (9826)
9100-4242	Transformer (9836)
0180-2895	Capacitor
3160-0311	Ac Fan (9826)
3160-0377	Dc Fan (9836)

The regulator boards are exchange items. The others are non-exchange items.

The "54" rectifier board is a replacement for the "52" rectifier board, and can be installed in either a 9826 or a 9836. The "52" rectifier board can only be installed in a 9826. The two boards can be distinguished by the fact that the "54" board has holes in it for air flow.

The "53" regulator board is a replacement for the "51" regulator board, and can be installed in either a 9826 or a 9836. The "51" regulator board can only be installed in a 9826. The two boards can be distinguished by the fact that the "51" board has three transistors in the heat sink and the "53" board has four.

Power Supply

The power supply is located at the rear of the computer. The assemblies and components included in the power supply are pointed out in Figure 5-2.

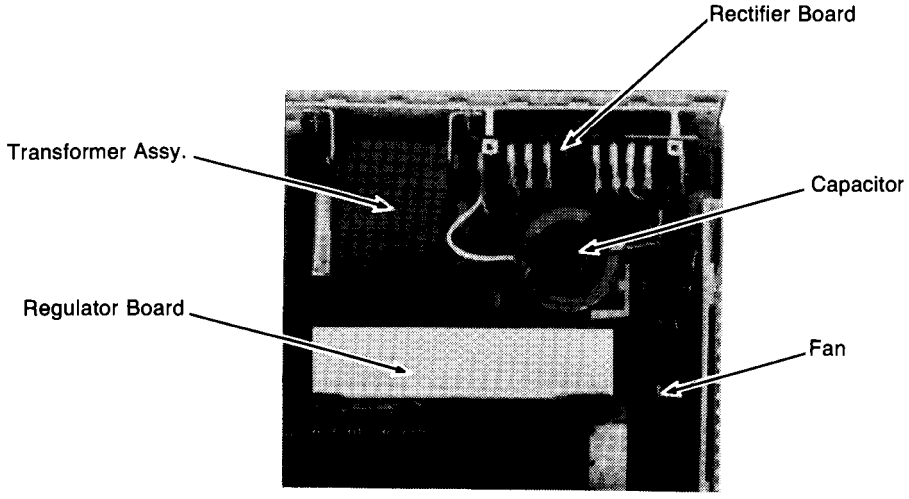


Figure 5-2. Power Supply Assemblies

Troubleshooting a Dead Unit

Nearly all dead units have one of three basic problems:

- Defective components
- External short causing power supply to go into overcurrent mode
- Improperly adjusted supply voltages

Follow the dead unit procedure to isolate the problem to one of those possibilities. If a component is defective, the procedure indicates which assembly should be replaced to eliminate the problem. The procedure determines whether an external short is causing the power supply to go into overcurrent mode. The procedure also corrects any improperly adjusted supply voltages. (Refer to Figure 5-3 for a flowchart of this procedure.)

WARNING

HAZARDOUS VOLTAGES ARE PRESENT IN THE UNIT WHEN IT IS TURNED ON. TURN THE UNIT OFF BEFORE PLACING METER LEADS, CHECKING FUSES OR REMOVING OR REPLACING ASSEMBLIES.

1. Check for the voltage selection switches for the correct settings. Refer to page 1-3 in the Basic Operating Manual.
2. Check that the two fuses are good and the correct value. Refer to page 1-4 in the Operating Manual. If either fuse is open, replace it.
3. Turn the computer on, then turn it off and recheck the fuses. If either fuse is open, continue with Step 4. If both fuses are okay, skip to Step 8.
4. If only the fuse on the right (the 15 Amp fuse) is open, either the regulator board or the load is defective. Check the resistance to ground of the +5 V, +12 V and −12 V test points. If either is greater than 100 ohms, there is an open in that supply line. A good place to check is in or near the power supply connector on the motherboard. Otherwise, the regulator board is defective.
5. If the fuse on the left (the 2A 4A or 5A fuse) is open, either the rectifier board or the ac input hardware is defective. Remove the two red wires connecting the transformer to the rectifier board. (Make sure they do not touch each other or anything else.)
6. Replace the fuse and turn the computer on for a few seconds.
7. Check the fuse again. If it is okay, the rectifier board is defective. Otherwise, either the power transformer, the voltage selection switches, the fan or the ac input wiring are defective.
8. If both fuses are okay, check the voltage on the fan terminals. It should be 110 Vac for the 9826 and −9.5 Vdc for the 9836. If the voltage is okay, the fan is defective.
9. If the 9826 fan voltage is not 110 Vac, the 9826 rectifier board or ac input wiring is defective.
10. If the 9836 fan voltage is not −9.5 Vdc, continue with the Voltage Check and Adjustment Procedure.

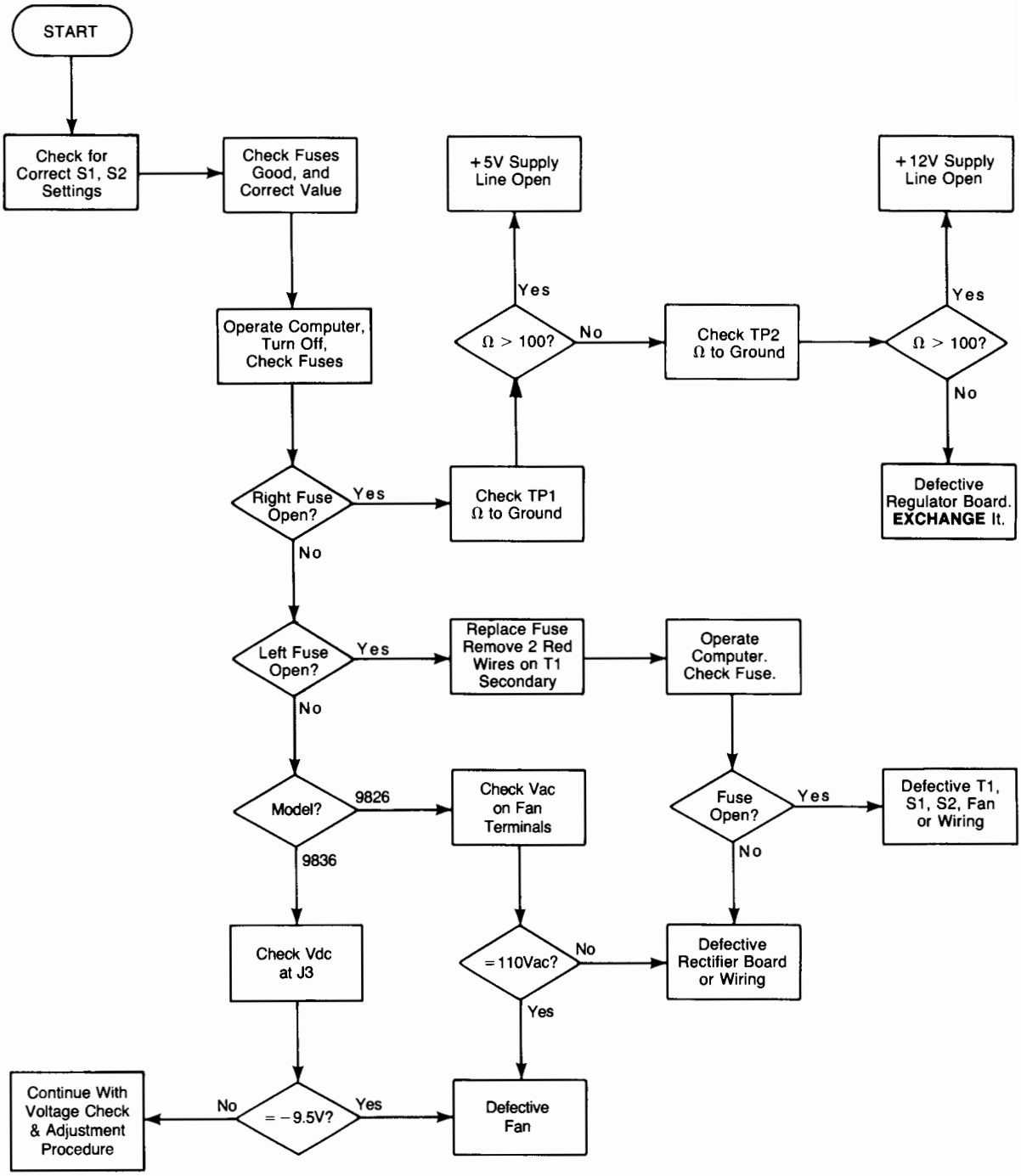


Figure 5-3. Dead Unit Troubleshooting Flowchart

Power Supply Voltage Check and Adjustment Procedure

Many problems in electronic equipment can be traced to a low or unstable supply voltage. If the power supply is functioning but you suspect a problem with a voltage level, check the test points on the top edge of the regulator board (see Figure 5-6). The various voltages should be within the specifications listed in Table 5-1. Table 5-1A lists specifications for the "51" regulator board and Table 5-1B lists specifications for the "53" regulator board.

Table 5-1A. "51" Board Specifications

Voltage	Voltage Tolerance	Maximum Current	Ripple	Used By
−12 V	−11.76 to −12.24 V	1.32 A	75 mV	Digital board Disc drive control I/O cards (RS-232)
+5 V	4.95 to 5.05 V	13.5 A	45 mV	All assemblies
+12 V	11.7 to 12.3 V	3.15 A	75 mV	Analog board Digital board Disc drive control Disc drive mechanism I/O cards (RS-232)

Table 5-1B. "53" Board Specifications

Voltage	Voltage Tolerance	Maximum Current	Ripple	Used By
−12 V	−11.82 to −12.18 V	1.32 A	75 mV	Digital board Disc drive control I/O cards (RS-232)
+5 V	5.05 to 5.11 V	18.9 A	50 mV	All assemblies
+12 V	11.84 to 12.16 V	3.74 A	85 mV	Analog board Digital board Disc drive control Disc drive mechanism I/O cards (RS-232)

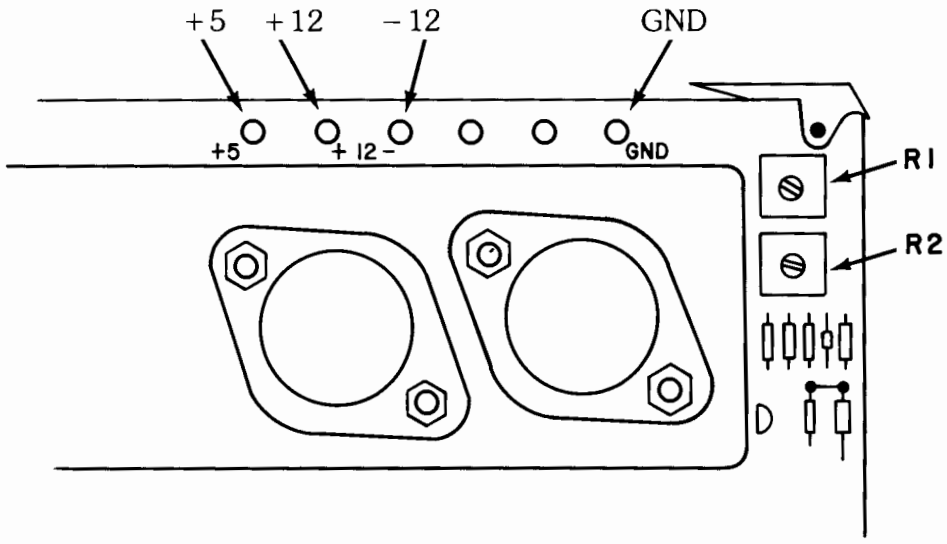


Figure 5-4. "51" Regulator Board Test Points

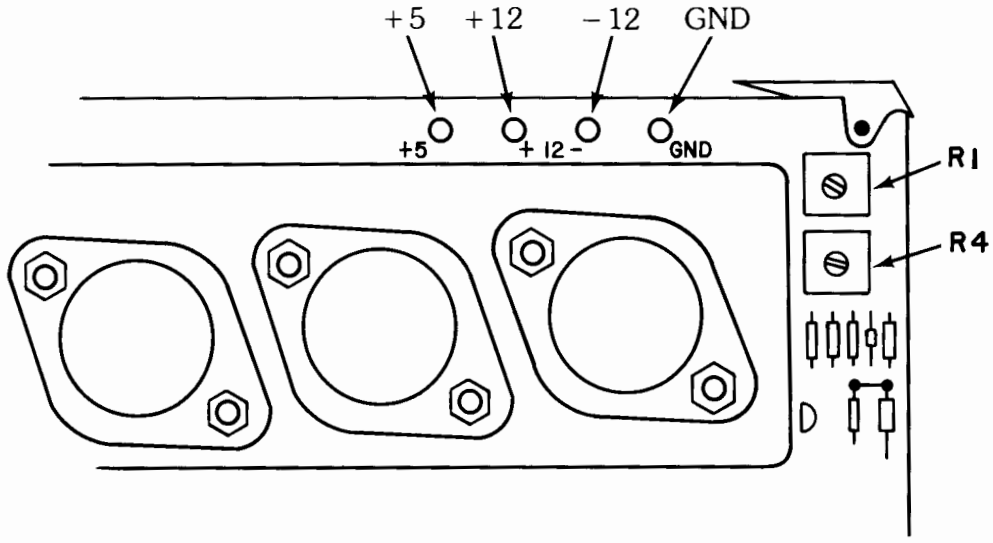


Figure 5-5. "53" Regulator Board Test points

Some of the power supply voltages affect others, so the voltage adjustment procedure checks the voltage levels in an order which minimizes interaction between supply lines. In addition to this, the following procedure checks for overcurrent conditions and some defective components.

Some of the power supply voltages affect others, so the voltage adjustment procedure checks the voltage levels in an order which minimizes interaction between supply lines. In addition to this, the procedure checks for defective components.

The power supply adjustments for the "51" regulator board are R1 and R2, shown in Figure 5-4. The adjustments for the "53" board are R1 and R4, shown in Figure 5-5. See Figure 5-6 for a flowchart of this procedure.

1. Check the dc voltage at the −12 V test point. If it is correct, skip to step 4.
2. If the −12 V test point is between 0 V and −10.5 V, swap the regulator board and recheck the test point. If it is now nearly correct, the regulator board was defective. If it is still between 0 V and −10.5 V, there is an external short forcing the regulator into overcurrent mode. Swap one board at a time until the test point reading returns to normal.
3. If the voltage is around −12 V, adjust the −12 V potentiometer (R2 in the "51" board, R4 in the "53") to read −12 V on the test point. If R2 (or R4) has no effect on the test point reading, swap the regulator board and adjust R2 (or R4). If it now adjusts the −12V, the regulator board was defective. If it still has no effect, there is an external short forcing the regulator into overcurrent mode. Swap one board at a time until the test point reading returns to normal.
4. Check the dc voltage at the +12 V test point. If it is correct, skip to step 7.
5. If the +12 V test point is between 0 V and +10.5 V, swap the regulator board and recheck the test point. If it is now nearly correct, the regulator board was defective. If it is still between 0 V and +10.5 V, there is an external short forcing the regulator into overcurrent mode. Swap one board at a time until the test point reading returns to normal.
6. If the voltage is around +12 V, adjust R1 to read +12 V on the test point. If R1 has no effect on the test point reading, swap the regulator board and adjust R1. If it now adjusts the +12 V, the regulator board was defective. If it still has no effect, there is an external short forcing the regulator into overcurrent mode. Swap one board at a time until the test point reading returns to normal.
7. Check the dc voltage at the +5 V test point. If it is correct, skip to step 11.
8. If the +5 V test point is between 0 V and +4.4 V, swap the regulator board and recheck the test point. If it is now nearly correct, the regulator board was defective. If it is still between 0 V and +4.4 V, there is an external short forcing the regulator into overcurrent mode. Swap one board at a time until the test point reading returns to normal.
9. If the voltage is around +5 V, adjust R1 to read +5 V on the test point. If R1 has no effect on the test point reading, swap the regulator board and adjust R1. If it now adjusts the +5 V, the regulator board was defective. If it still has no effect, there is an external short forcing the regulator into overcurrent mode. Swap one board at a time until the test point reading returns to normal.
10. Note that R1 adjusts both the +5 V line and the +12 V line. If you adjusted R1 for the +5 V line, you may have affected the +12 V line as well. Return to the +12 V test point and check that the reading is between +11.7 V and +12.3 V. If it is not, the regulator board is defective.
11. Check the operation of the computer. If it is still defective, refer to the live unit procedure.

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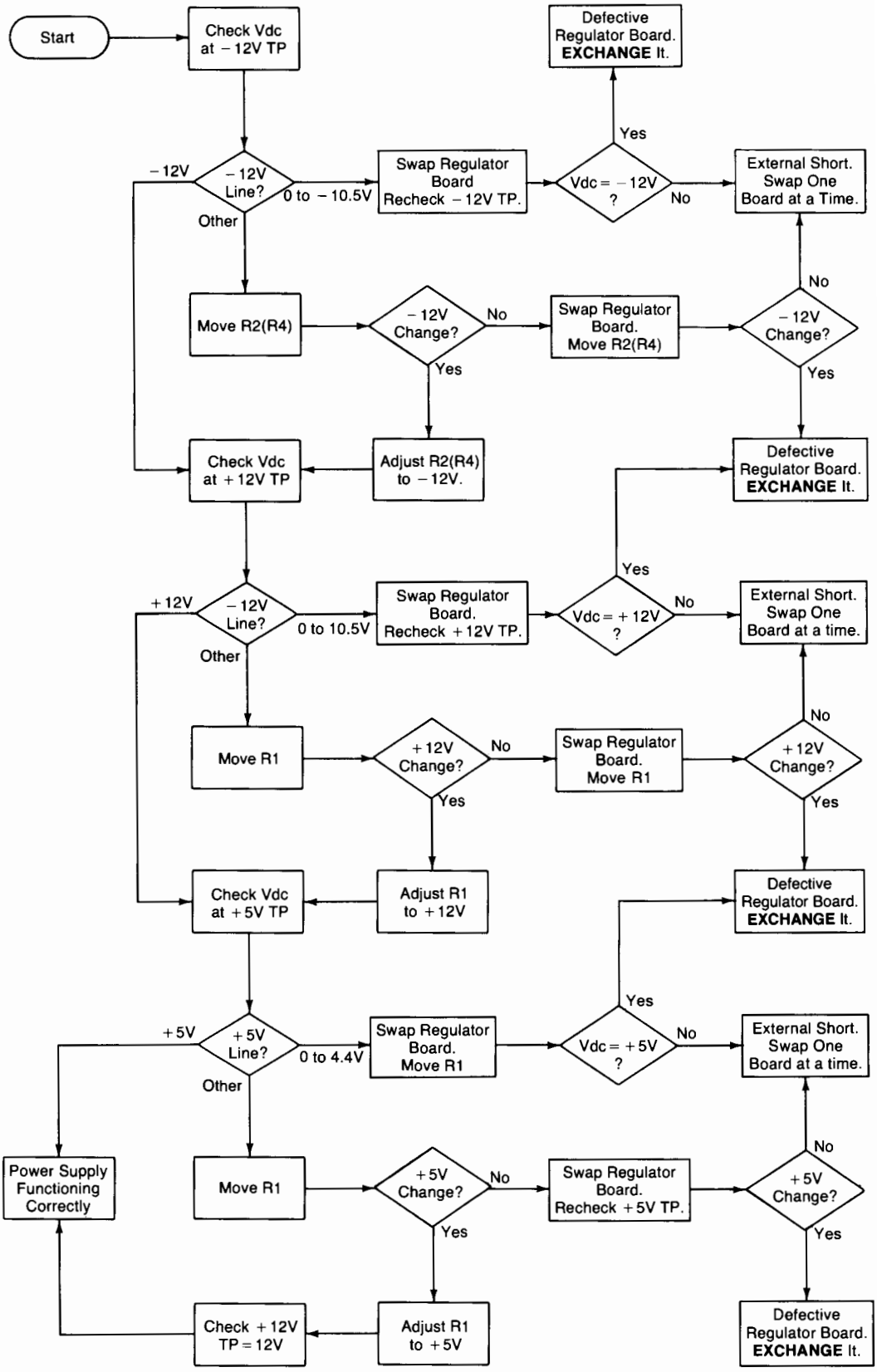


Figure 5-6. Voltage Check and Adjustment Procedure

Live Unit Procedure

A live unit is one which has a properly functioning power supply, but will not execute any instructions at all. It typically has a defective processor, boot ROM, RAM or CPU bus. Live units often are very difficult to troubleshoot, since a problem with the CPU bus anywhere in the computer can shut the entire bus down and prevent the execution of any instructions, even those from the test card.

The live unit procedure is a method for finding the defective assembly which is preventing the unit from executing instructions. It assumes that the power supply has been checked and found to be operating properly, and that the test card has been installed in an accessory slot and will not operate (that is, it stalls on 0 or gives meaningless results).

If the power supply has not been checked or is not operating properly, refer to the dead unit procedure. If the test card operates (that is, it starts with 0 and counts at least to 1), refer to the system test procedure.

This procedure, and other procedures in this chapter, are based on a test routine stored in ROM on the test card (98206A). The test card was used instead of the test stimulus board because it will diagnose a 9826, 9836A or 9836C, whereas the test stimulus board will only diagnose a 9826 or 9836A. Operation of the test stimulus board while diagnosing a 9826 or 9836A is quite similar to that of the test card as documented in this chapter. Any differences are explained in the section titled Test Card Notes. The test card ROM code is also available on a System Test Disc, operation of which is identical to the test card.

The live unit procedure is presented here as a series of steps, and in Figure 5-7 as a flowchart.

To troubleshoot a live unit, follow these steps:

1. Turn the computer off.
2. Reduce the computer to the minimum configuration. The minimum configuration is the power supply, the motherboard and the processor board. Although the keyboard, CRT analog board, powerfail board and disc drive power connectors are attached to the motherboard, they do not connect directly to the CPU bus. Thus, they may be left attached unless you strongly suspect them of causing the problem.

   In the minimum configuration, the test card runs normally except for two differences:

   - It produces many error messages and incorrect status messages generated by the missing assemblies. Ignore these messages until the computer has been reassembled.
   - Some tests run more slowly, since functions which normally respond immediately must be timed out.
   - Some tests run more quickly, since there are fewer functions to be checked.

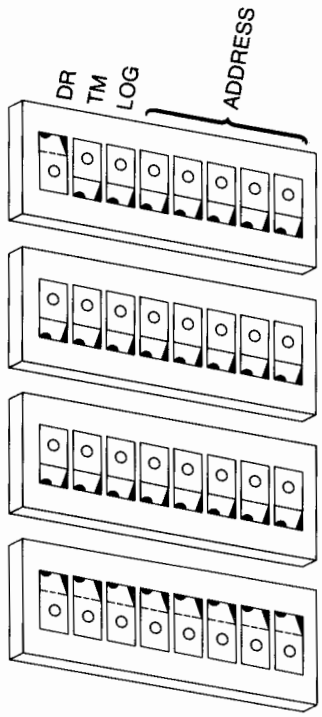
   To reduce the computer to the minimum configuration, remove these items:

   - The disc drive controller board
   - The CRT digital board and the CRT graphics board
   - All the boards in the backplane, plus the backplane connectorboard.

Note

The test card requires that 64k of RAM be installed at addresses FF0000 to FFFFFF. This will automatically be present if the processor board is a 69514, 69515 or 69516 board. If it is a 69511 or 69517 board, leave the RAM board addressed FF in the computer. It must go into the backplane connectorboard. Make sure that the component side is facing forward.

3. Set the switches on the test card according to this figure:



4. Install the test card in the expansion slot. Make sure that the components are facing forward.
5. Turn the computer on and check whether the test card counts. Give it plenty of time, as it must time-out all functions which are now missing from the computer. Also, ignore all error messages, since these are being generated when the test card senses that an assembly is missing.
6. If the test card remains stalled on 0, either the processor board or the motherboard is defective. Swap the processor board for a good one, then attempt to run the test card. If it counts, the processor board is defective. If it still will not count, the motherboard is defective.
7. If the test card counts at least to 1, reinstall the CRT Digital board, then rerun the test. If the test card stalls, the digital board is defective. If the test card counts, detach the flat cable from the processor board, then exchange the processor board.

8. If the test card counts, the problem is in one of the boards still removed. Reinstall one board at a time, running the test card after each assembly is reinstalled. The defective assembly is the one which prevents the board from counting. Reinstall the assemblies in this order:
    a. Disc drive controller board
    b. Graphics board
    c. Backplane connectorboard
    d. RAM boards
    e. Interface and accessory cards

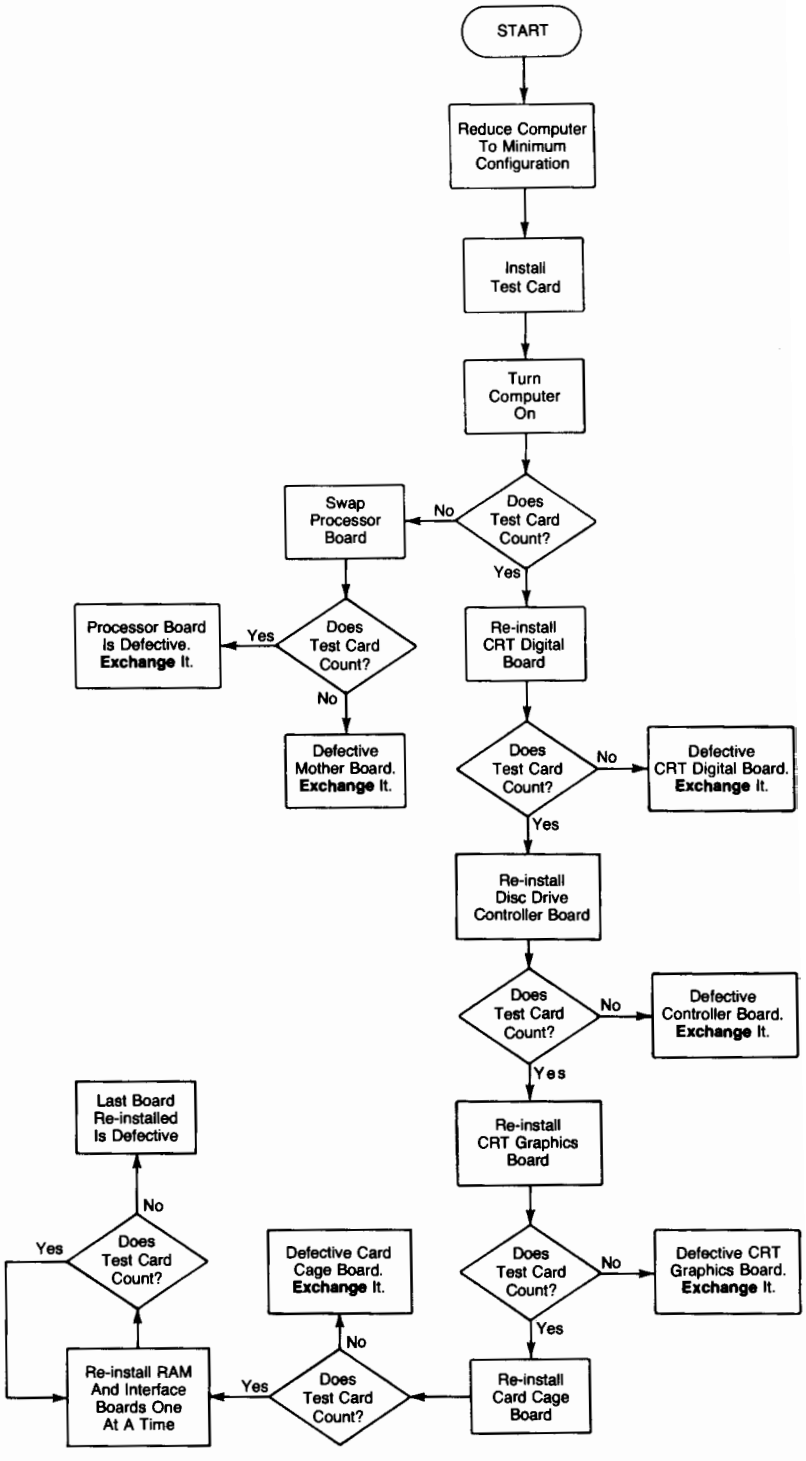


Figure 5-7. Live Unit Flowchart

System Test Procedure

Use the system test procedure to troubleshoot a unit which can execute some instructions, but can not accept, store or output data correctly. This means that the basic elements of the computer are functioning. The basic elements include the power supply, processor, CPU bus, boot ROMs and at least the first 64k bytes of RAM. If any of these are not known to be functional, refer to the initial problem isolation section and flowchart.

The system test procedure runs tests on many portions of the computer and produces error and status messages on the CRT and internal HP-IB. It also produces patterns for checking the CRT display. These tests and patterns are contained on both a disc and a ROM. The disc version is on the system test disc and the ROM version is on the test card. The test code is nearly the same on either media. The system test disc loads through the disc drive and requires some operator input, while the test card runs automatically once it is installed in the CPU bus. It would be a good idea to familiarize yourself with the operation of both versions on a known good unit before attempting to repair a defective unit.

This procedure, and other procedures in this chapter, are based on a test routine stored in ROM on the test card (98206A). The test card was used instead of the test stimulus board because it will diagnose a 9826, 9836A or 9836C, whereas the test stimulus board will only diagnose a 9826 or 9836A. Operation of the test stimulus board while diagnosing a 9826 or 9836A is quite similar to that of the test card as documented in this chapter. Any differences are explained in the section titled Test Card Notes. The test card ROM code is also available on a System Test Disc, operation of which is identical to the test card.

The system test disc requires more of the computer to be functional. The disc drive assembly and disc drive controller board must be functional in order to load the disc, and the keyboard must be functional in order to get the test started. Both versions can log error and status messages on an external printer if the CRT is defective. The disc version, however, still needs the CRT to display softkey definitions. Also, the test card contains an LED display which indicates the number of the test being run. This allows the user to draw conclusions as to the problem area even if the CRT is not functioning.

The system test disc is more useful for checking to make sure that a given unit is operating properly, while the test card does the actual diagnosis of a defective unit. It is left up to the troubleshooter to decide which is most convenient in a given situation. A good idea might be to start with the system test disc and if problems are encountered, go to the test card.

System Test Sequence

The system test consists of a sequence of tests which check individual sections of the computer. The sequence is the same for both methods. The names of the tests and the characters displayed on the test card are as follows:

Displayed Characters	Test
00	Processor test
01	ROM checksum test
02	RAM pattern test
26	I/O configuration test
03	CRT character test
04	Keyboard test
05	Disc drive test
07	CRT graphics test
20	Powerfail test
25	Memory management unit and programmable timer module test
27	Cache memory test
28	Serial interface test
29	Memory management unit, programmable timer module and cache memory test

This test sequence runs continuously until it is terminated by the operator or it stalls due to a defective assembly. The number of the test which the sequence stalled on is indicated by the LED display on the test card.

While the test sequence is running, it generates status and error messages and test patterns which are displayed on the CRT. If you suspect the CRT is defective and need more information than the LED display on the test stimulus board, refer to the section on External Error Logging. The test card should continue to count at least to 3, even if the CRT is defective.

Running the System Test Procedure

The system test disc and the test card contain similar test code but are implemented in different ways. This section explains how to use each one.

System Test Disc. Use the following procedure to run the system test from the disc. See Figure 5-8 for a flowchart of this procedure.

1. Remove the test card, if it is installed.
2. Select the disc containing the mainframe tests, install it in a drive and close the door.
3. Turn the computer on. You should hear the drive click as it loads the program. If it does not load, press reset. If it still does not load, use the test card procedure.
4. The system test procedure will start immediately upon being loaded. No operator action is needed.
5. If the test routine produces error messages, go to the section of the test mode procedure which covers that portion of the computer, or use the test card for further investigation.

6. If the test routine produces status messages but not error messages, it is unable to detect any problems with the unit.
7. If neither status messages nor error messages are produced, refer to the initial troubleshooting section.

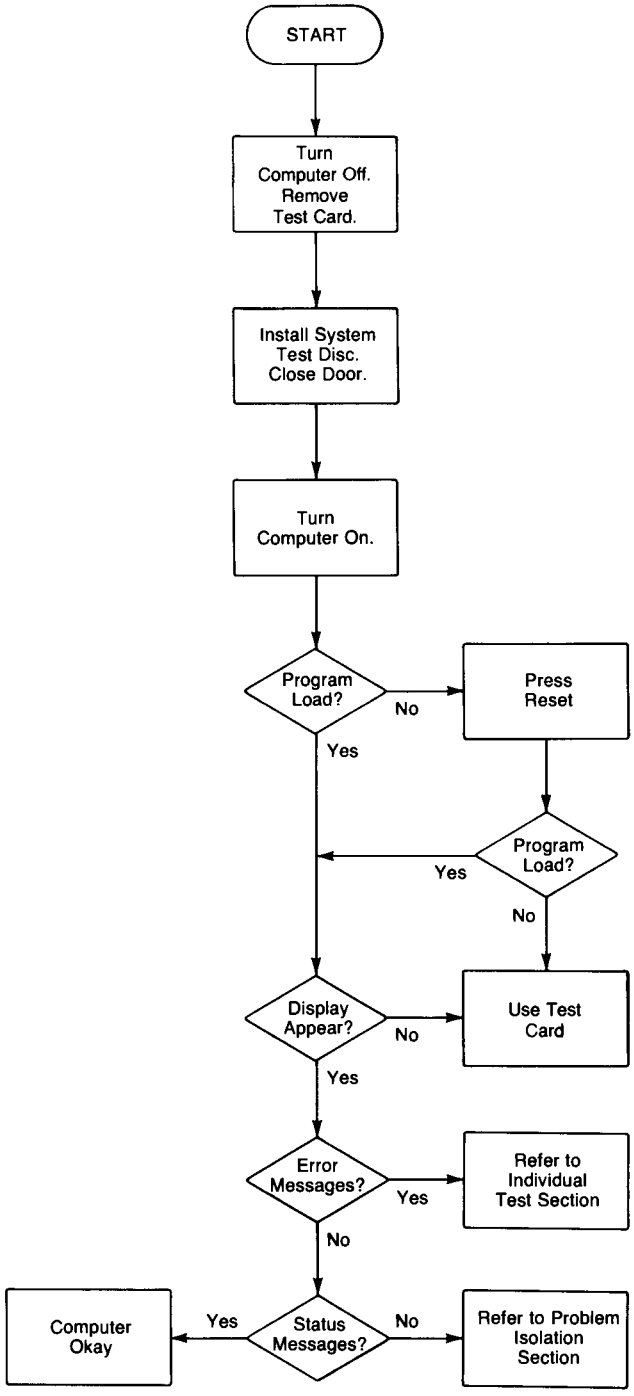


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Figure 5-8. System Test Procedure Flowchart (Disc)

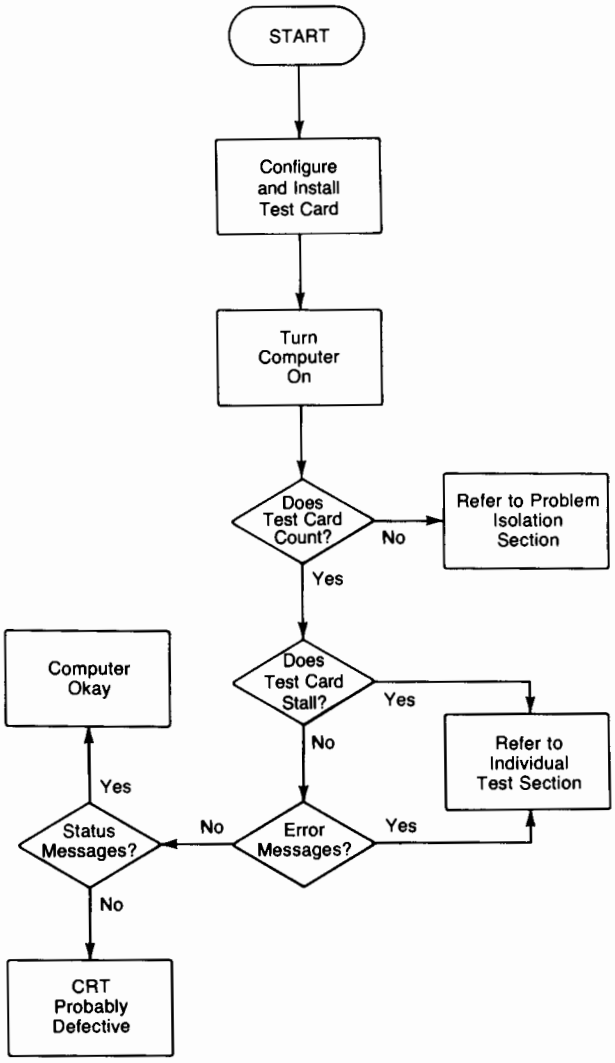
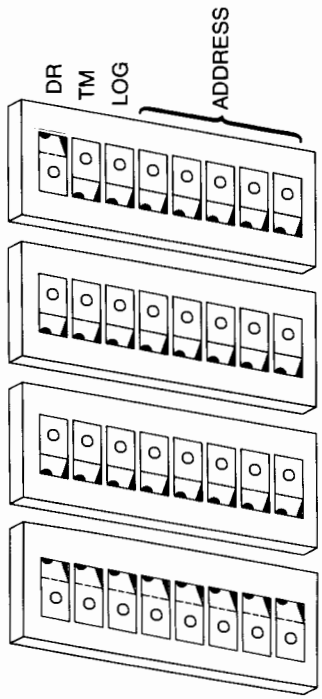


Figure 5-9. System Test Procedure Flowchart (ROM)

Test Card. Use the following procedure to run the system test from ROM. See Figure 5-10 for a flowchart of this procedure.

1. If the test card is not installed, set the switch segments according to the following figure:



2. Turn the computer off and install the test card in any empty accessory slot. If no slots are empty, remove an interface card.
3. Turn the computer on and check whether the test card is counting. If it remains on zero or displays no character, not enough of the computer is functioning for the system test procedure to produce results. Refer to the initial troubleshooting procedure.
4. If the test card stalls on a character other than zero or generates error messages, a hardware problem exists. The defective section is indicated by the displayed character according to this chart:

Displayed Character	Section
00	Processor
01,40 to 7F	ROM Memory
02,80 to FF	RAM Memory
03,07	CRT
04	Keyboard
05	Disc Drive
20	Powerfail
25,27,29	Memory Manager
26,28	I/O

Refer to the appropriate section of the individual test mode procedure for further information on isolating the problem.

5. If the test routine produces error messages, go to the section of the individual test mode which covers that portion of the computer.
6. If the test card increments but no error or status messages or test patterns are generated, the CRT is probably defective.

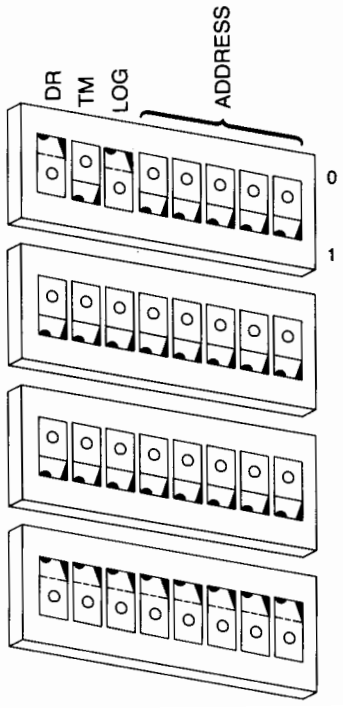
External Error Logging

If you suspect that the CRT is defective or wish to have a hard copy of the CRT display, an external printer connected to the internal HP-IB may be used to log status and error messages.

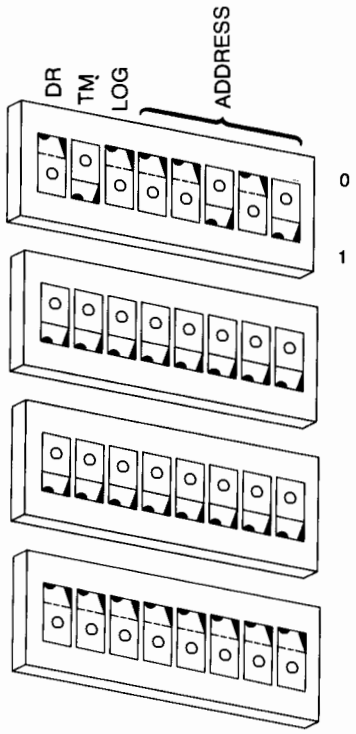
Test Card

To use an external printer with the test card, follow these steps:

1. Connect the printer to the rear panel HP-IB connector.
2. Check that the system controller jumper on the motherboard is in the system controller position. This jumper is at the rear of the motherboard, at the bottom center of the backplane card cage. The controller position means that the jumper connects the center pin to the right-most pin as you face the rear of the computer.
3. Move the LOG switch on the test card to the 0 position.



4. Convert the HP-IB address of the printer into binary and set that number into the four address switches on the test card. Addresses from 0 to 15 can be accomodated. Place the least significant digit on the right. A switch placed in the 1 position is on, and a switch in the 0 position is off. For instance, if the HP-IB address is 05, the switches are set as follows:



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5. Run the system test procedure as described above. The error and status messages will be logged on the external printer as well as on the CRT.

System Test Disc. To use an external printer with the system test disc, connect the printer to the rear panel HP-IB connector.

If the CRT is defective, setting up an external printer is more difficult because the CRT is used for prompts. It can be done, however, by making the proper response to the prompt which should be on the CRT at any given time. Follow this procedure:

1. Obtain an HP-IB compatible printer and set its address to 1.
2. If you cannot set the address to 1, set the printer's Listen Always switch to enable Listen Always. Some printers require that power be cycled after changing the switch position.
3. Turn the computer off, and connect the printer to the rear panel HP-IB connector.
4. Check that the system controller jumper on the motherboard is in the system controller position. This jumper is at the rear of the motherboard, at the bottom center of the backplane card cage. The controller position means that the jumper connects the center pin to the right-most pin as you face the rear of the computer.
5. Install the System Test Disc in the disc drive and close the door.

6. Turn the computer on. You should hear the drive click as it loads the system test program. If it does not click, use the test card.
7. Press RESET, then press k15 (shift k5) then k16.
8. The system test should now start, and print all status and error messages on the external printer. If it does so, the problem is located in the CRT. If it does not function, there are more extensive problems. Use the test card.

Individual Test Mode

Individual test mode consists of eleven tests, the seven numbered tests plus the powerfail test in the system test procedure and three others too lengthy to be included. The eleven tests are on both the system test disc and the test card. Thus, going back and forth between them and the system test procedure is convenient.

This procedure, and other procedures in this chapter, are based on a test routine stored in ROM on the test card (98206A). The test card was used instead of the test stimulus board because it will diagnose a 9826, 9836A or 9836C, whereas the test stimulus board will only diagnose a 9826 or 9836A. Operation of the test stimulus board while diagnosing a 9826 or 9836A is quite similar to that of the test card as documented in this chapter. Any differences are explained in the section titled Test Card Notes. The test card ROM code is also available on a System Test Disc, operation of which is identical to the test card.

The individual test mode is entered from the system test procedure by pressing the (RESET) (shift pause) key. The message TEST MODE will appear on the CRT. In test mode, the softkeys are defined to perform specific tests when pressed. The softkey definitions are as follows:

(k0) - Processor test
(k1) - ROM checksum test
(k2) - RAM pattern test
(k3) - CRT character test
(k4) - Keyboard test
(k5) - Disc drive test
(k6) - Extended RAM test
(k7) - CRT graphics test
(k8) - Extended CRT graphics test
(k9) - Disc drive diagnostic test
(CTRL) (k0) (k20) - Powerfail board
(CTRL) (k1) (k21) - CPU PROM test
(CTRL) (k3) (k23) - 60 Hz CRT alignment patterns
(CTRL) (k4) (k24) - 50 Hz CRT alignment patterns
(CTRL) (k4) (k25) - MMU and PTM test
(CTRL) (k6) (k26) - I/O configuration test
(CTRL) (k7) (k27) - Cache memory test
(CTRL) (k8) (k28) - Serial interface test
(CTRL) (k9) (k29) - MMU, PTM and cache memory test

Refer to the individual sections in this chapter for a description of each test listed above. The seven tests in the system test procedure are identical to the above tests with the same name. Also, the number displayed by the test card LEDs is the digit of the softkey.

In addition to these softkey definitions, there are some definitions using the SHIFT and CONTROL keys in conjunction with the softkeys. These definitions are as follows:

k15 (SHIFT k5) Toggles the HP-IB error log function. k15 is similar to the LOG switch on the test card. Refer to the section on error logging in the system test procedure.

k16 (SHIFT k6) Causes the diagnostic procedure to exit from test mode and return to the system test procedure (turn-on mode).

k17 (SHIFT k7) Causes the diagnostic procedure to exit from test mode and branch to the boot ROMs. This will allow any operating system installed to begin executing. If the system test disc is installed, it will start over with the first test.

k18 (SHIFT k8) Executes the selected test sequence once.

k19 (SHIFT k9) Executes the selected test sequence continuously.

k39 (SHIFT CONTROL k9) Provides the operator a method for sending a message to the error reporting device (CRT or external printer). The operator presses k18 for one line of text, or k19 for several lines, then enters a line of text and presses the CONTINUE key after each line.

These softkey definitions provide a means of selecting a test or sequence of tests which would assist the user in the diagnostic process. An example of how to use these softkey definitions might be the following:

k3 CRT character test
k7 CRT graphics test
k8 Extended CRT graphics test
k19 Execute the above sequence continuously

This "program" will continuously execute the three CRT tests. A pass count is displayed on the CRT after each pass.

The "program" can be aborted by using RESET (SHIFT PAUSE).

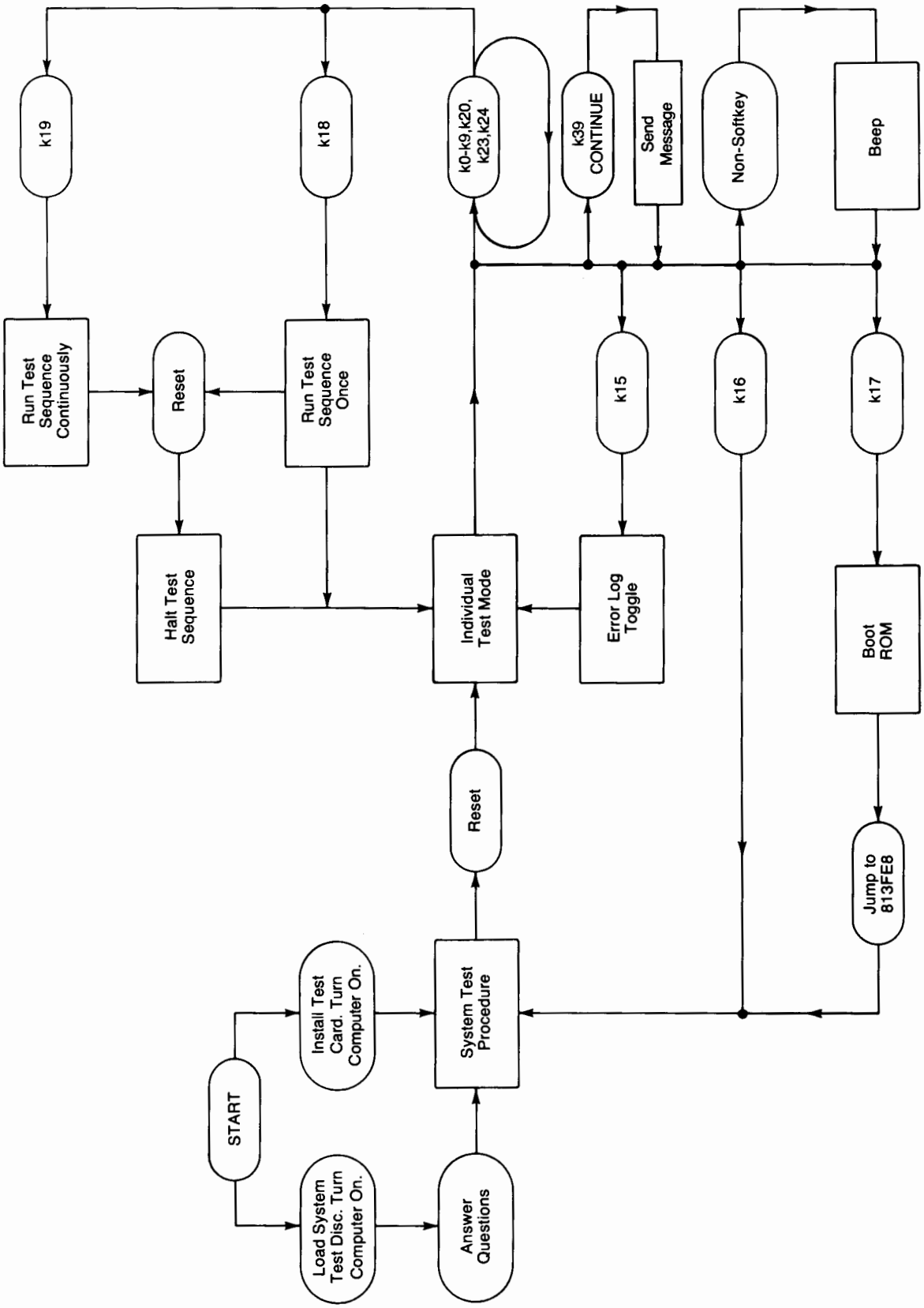

Figure 5-10. Individual Test Mode Softkey Assignment Flowchart

Processor Test

The entire processor section is contained on the processor board. Here is a list of the computer assemblies involved:

09826-69511	Processor board (9826)
09826-69514	Processor/RAM board (9826)
09826-69515	Processor/RAM board (9826 or 9836A)
09826-69516	Processor/RAM board
09826-69517	Processor/MMU board

The "15" board is intended as a replacement for the "14" board. They are identical except for the boot ROMs. The "14" board boot ROMs will not operate in a 9836.

The "16" board is intended as a replacement for both the "14" and the "15" boards, and can be used in a 9826, 9836A or 9836C. The "15" board boot ROMs will not operate in a 9836C.

The "17" board contains a memory management unit in addition to the processor. It is not a replacement for the other processor boards.

All processor boards are exchange boards.

Note

When replacing an 09826-69516 or 09826-69517 board, remove the configuration and identification PROM from the defective board and install it on the replacement board. If you fail to do so, there will be no indication except that the power-up display will no longer include the serial number and the computer will no longer run secured software.

Processor Test (k0)

The processor test is the first test run in the system test procedure. The number 0 appears on the LED display on the test card, but no message appears on the CRT. It takes less than a second to complete.

The processor test exercises each 68000 instruction at least once. It checks all of the effective addressing modes with a selected set of instructions. The TRAP and exception processing are tested. Both ROM and RAM memory references are made in this test.

If the processor test passes, the LED display will change to the next test number.

If the processor test fails, the LED display will remain on 0. However, problems other than the processor test can cause the display to remain on 0. Here are the possible causes:

- There is no RAM at the top of memory (location FF0000 to FFFFFF).
- The boot ROMs are defective.
- The CPU bus is locked up by some device connected to it.
- The power supply voltages are incorrect or missing.
- The processor is actually defective.

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The fastest way to isolate the problem to one of these causes is to remove the base cover of the computer and check the +5 V and +12 V test points on the top edge of the regulator board. If they are correct, refer to the live unit procedure; if they are incorrect, refer to the dead unit procedure.

ROM Memory Test

The ROM pattern test checks all ROM in the computer, including the ROM on the test card. Here is a list of the computer assemblies involved:

09826-69511	Processor board (contains the boot ROM) (9826)
09826-69514	Processor board (contains the boot ROM) (9826)
09826-69515	Processor board (contains the boot ROM) (9826 or 9836A)
09826-69516	Processor board (contains the boot ROM)
09826-69517	Processor board (contains the boot ROM)
98206-66541	Test card (contains test ROM)
98261-665XY	Language ROM boards

There are two types of Language ROM boards, one which holds 128k bytes of ROM and one which holds 512k bytes of ROM. The two boards are similar in appearance, but can be differentiated using information presented in this section.

Note

When replacing an 09826-69516 or 09826-69517 board, remove the configuration and identification PROM from the defective board and install it on the replacement board. If you fail to do so, there will be no indication except that the power-up display will no longer include the serial number and the computer will no longer run secured software.

ROM Test (k1)

The ROM test is included in the system test procedure. The number 1 appears in the LED display, but no CRT message is displayed until the conclusion of the test. The ROM test takes less than one second to complete.

The ROM test performs a checksum on all ROMs present in the computer. This includes option ROMs, language ROMs, the boot ROMs and the test card ROMs. Checking is done on a byte addressing basis because the data in the upper and lower bytes are not in the same ROM part. Data is added to form a checksum. The test fails if the checksum is not FFFF.

When the ROM test is finished, the LED display changes to the next test and the CRT displays the message

ROM @ 08Kb; XXXXXX 16Kb; XXXXXX, 64Kb: XXXXXX

which is a memory map of the ROMs present in the computer. 08Kb, 16Kb and 64Kb refer to the size of the individual ROM chips, and one address is presented for each PAIR of ROM ICs in the computer. The 128k byte ROM board is composed of 16k byte ROMs and the 512k byte ROM board is composed of 64k byte ROMs. Note that ROM may be present at locations other than language ROM boards.

If the ROM test fails, any of the following messages may appear on the CRT:

Error Message	Possible Causes	What to Do
ROM @ XXXXXX REVERSED	ROM ICs at location XXXXXX reversed	Refer to section on locating ROM boards
ROM CHECKS XXXX @ YYYYYY		
ROM ADDR HAD XXXXXX @ YYYYYY	ROM IC installed on wrong board	Refer to section on locating ROM boards
ROM # has XXXX not YYYY @ ZZZZZZ	ROM IC installed out of sequence	
ROM L = " "@XXXXXX	Language ROM IC installed on wrong board	
UNABLE TO DRIVE	CPU or backplane defective	Replace processor board
UNABLE TO REMOVE DRIVE		Replace backplane
CPU BOARD PROM SIZE ERROR YY	ID PROM too large	Replace ID PROM
CPU BOARD PROM CHK_SUM YYYY @ 5F0001	ID PROM failed checksum	Replace ID PROM
NO PROM TESTING - KBD BAD?	Keyboard timer defective	Replace motherboard

If the test card is unable to detect the presence of a ROM, no error message is generated. Therefore, if you suspect a problem with ROM, particularly a language board, check that there is an entry in the ROM map for each ROM pair at a particular address. This can be done by physically counting the ROMs on a language board and comparing them to the addresses listed in the ROM map.

ROM Addressing

The various ROM locations in the computer are addressed by a six digit hexadecimal number. The boot ROM is located between 000000 and 003FFF. Language and option ROMs are located between 020000 and 3FFFFF. The ROM on the test card starts at 810000.

Option ROM Board Addressing

The memory space between the boot ROM and address 400000 is dedicated to language and option ROM. This space is arranged in blocks of 128k bytes. For the sake of simplicity, the boot ROM is allotted a 128k byte block. Since 128k bytes is 20000 in hexadecimal, there is room for 31 blocks, with the first block addressed from 020000 to 03FFFF (000000 to 01FFFF are allotted to the boot ROM) and succeeding blocks starting with multiples of 20000.

Each 128k byte ROM board contains one block. Each 512k Byte ROM board contains four consecutive blocks, with the number of the first block being a multiple of four.

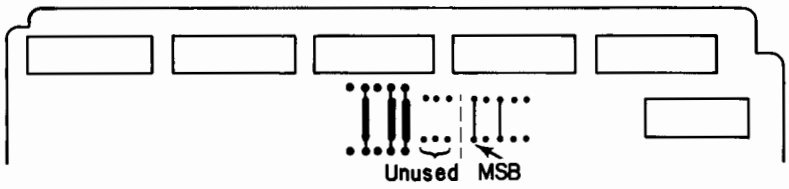
128k Byte ROM Board

A five segment jumper location determines which of the 31 blocks a given board represents. The jumper location is a binary representation of the block number. A jumper present represents a zero and a jumper absent represents a one.

Checking an Option ROM Board Address

Each block of ROM is contained on a ROM board, with a five segment jumper location determining which of the 31 blocks a given board represents. The jumper location is a binary representation of the block number. A jumper present represents a zero and a jumper absent represents a one.

For instance, a ROM board has jumpers installed like this:



The jumpers read 01011. 01011 in binary converts to 0B in hexadecimal.

To determine the ROM address space occupied by a 128k byte board, multiply the block number by 20000 (hexadecimal). For instance, in the previous example, B multiplied by 20000 is 160000. Therefore, this ROM board starts with address 160000 and ends with 17FFFF (one block).

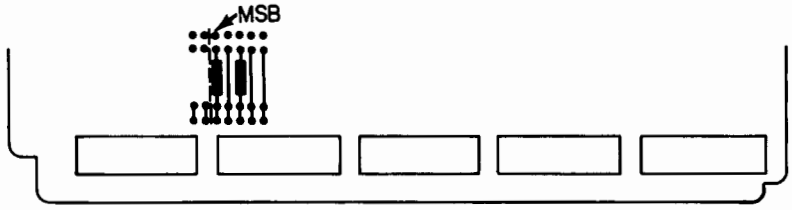
An alternative to hexadecimal multiplication is to locate the jumper arrangement in this chart:

512k Byte Board Jumpers	Block	128k Byte Board Jumpers	Starting Address	Ending Address
	1	00001	020000	03FFFF
	2	00010	040000	05FFFF
	3	00011	060000	07FFFF
00100	4	00100	080000	09FFFF
	5	00101	0A0000	0BFFFF
	6	00110	0C0000	0DFFFF
	7	00111	0E0000	0FFFFF
01000	8	01000	100000	11FFFF
	9	01001	120000	13FFFF
	A	01010	140000	15FFFF
	B	01011	160000	17FFFF
01100	C	01100	180000	19FFFF
	D	01101	1A0000	1BFFFF
	E	01110	1C0000	1DFFFF
	F	01111	1E0000	1FFFFF
10000	10	10000	200000	21FFFF
	11	10001	220000	23FFFF
	12	10010	240000	25FFFF
	13	10011	260000	27FFFF
10100	14	10100	280000	29FFFF
	15	10101	2A0000	2BFFFF
	16	10110	2C0000	2DFFFF
	17	10111	2E0000	2FFFFF
11000	18	11000	300000	31FFFF
	19	11001	320000	33FFFF
	1A	11010	340000	35FFFF
	1B	11011	360000	37FFFF
11100	1C	11100	380000	39FFFF
	1D	11101	3A0000	3BFFFF
	1E	11110	3C0000	3DFFFF
	1F	11111	3E0000	3FFFFF

512k Byte ROM Board

A five segment jumper/pull-up resistor location determines which four of the 31 blocks a given board represents. The jumper/resistor location is a binary representation of the number of the lowest address block. A jumper represents a zero and a pull-up resistor represents a one.

For instance, a ROM board has jumpers installed like this:



The segment location reads 10100. 10100 in binary converts to 14 in hexadecimal.

To determine the ROM address space occupied by a 512k byte board, multiply the block number by 20000 (hexadecimal). For instance, in the above example, 14 multiplied by 20000 is 280000 and ends with 2FFFFF (four consecutive blocks).

An alternative to hexadecimal multiplication is to locate the jumper/resistor arrangement in the chart on the previous page.

Locating a Defective ROM

The ROM tests have error messages containing addresses of the form MNPQRS, where MNPQRS is a hexadecimal number. MNPQRS is generally the first location in a ROM IC, therefore it is usually of the form MNP000 or MNP001. An example might be:

ROM CHECKS 1B4F @ 2D4001

If the address is 000XXX, the error message refers to the boot ROM.

If the address is 810XXX, the message refers to the test card ROM.

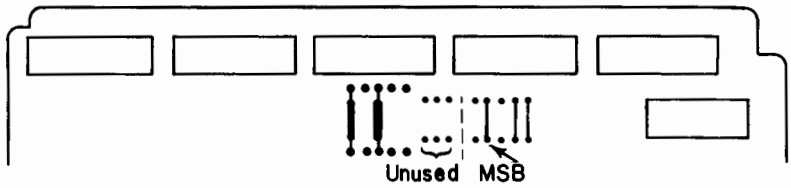
If the address lies between 020000 and 3FFFFF, the message refers to a language or option ROM located on an option ROM board. The defective board is located using the procedure in the next paragraph.

Locating a Defective Option ROM Board

A defective option ROM board is located by reversing the procedure presented in the section on Checking a ROM Board Address. Divide the address MNPQRS by 20000, ignoring any remainder. Convert the resulting hexadecimal number into binary, and find a ROM board with jumpers matching the binary number. For instance, the message

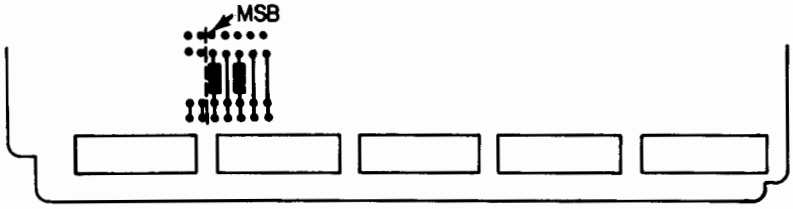
ROM CHECKS 1B4F @ 294001

appears on the CRT. 294001 divided by 20000 is 14 with a remainder of 14001. 14 in hexadecimals is 10100 in binary. Find a ROM board with jumpers matching this number. A 128k byte ROM board will look like this:



An alternative to hexadecimal division is to locate the address in the chart on the previous page.

A 512k byte ROM board will look like this:



RAM Memory Tests

The RAM memory tests check all system RAM in the computer; that is, all RAM not dedicated to a specific purpose, such as the display. Here is a list of the computer assemblies involved:

09826-69514	Processor/64k RAM board (9826)
09826-69515	Processor/64k RAM board (9826 or 9836A)
09826-69516	Processor/128k RAM board
09826-69522	64k RAM board
09826-69524	256k RAM board

All of these are exchange items.

Note

When replacing an 09826-69516 or 09826-69517 board, remove the configuration and identification PROM from the defective board and install it on the replacement board. If you fail to do so, there will be no indication except that the power-up display will no longer include the serial number and the computer will no longer run secured software.

RAM Pattern Test (k2)

The RAM pattern test is included in the system test procedure. The test takes about 20 to 30 seconds to complete, depending on the number of RAM boards installed. This test will isolate many common hard errors, such as stuck RAM bits, addressing and refresh problems. If you suspect you are having RAM problems even though this test passes, run the extended RAM test.

The RAM Pattern test exercises all system RAM present in the computer with a series of patterns. These patterns are:

- 55AA (0101010110101010)
- AA55 (1010101001010101)
- sequential data for addressability

In addition, a dynamic RAM refresh is done. An addressability check is made using byte and word addressing modes.

When the RAM Pattern test is finished, the LED display changes to the next test number and the CRT displays the message

RAM @ 256Kb: XX0000, 64Kb: XX0000, CPUbd: XX0000

This message forms a memory map of the RAMs.

If the RAM pattern test fails, any of the following messages may appear on the CRT:

Error Message	Possible Causes	What to Do
RAM @ XXXXXX had YYYYYYYY not ZZZZZZZZ	RAM IC at location XXXXXX defective	Refer to section on locating RAM boards
RAM RFSH @ XXXXXX had YYYYYYYY not ZZZZZZZZ	↓	↓

Error Message	Possible Causes	What to Do
RAM CNFIG @ XXXXXX		
RAM W/B @ XXXXXX		
RELOCATE FAILURE @ XXXXXX		
BUS SPEED YYYY @ XXXXXX (ZZZZ,WWWW)		
MEMORY SPEED YYYY @ XXXXXX		
PON RAM @ XXXXXX had YYYYYYYY not ZZZZZZZZ		
NO RAM AT FF	No RAM at location FFXXXX	
NO RAM SPEED @ XXXXXX-KBD BAD?	Keyboard timer defective	Replace motherboard
BUS ERROR @ XXXXXX IN K2	RAM IC at location XXXXXX	Check RAM addressing missing
NO PASS-PASS REFRESH -KBD BAD?	Keyboard timer defective	Replace motherboard
TOP 64K NOT TESTED	RAM at FFXXXX missing	Check RAM addressing

Extended RAM Test (k6)

The extended RAM test is included in the individual test mode, but not in the system test procedure. It is much more comprehensive than the RAM pattern test and is much more likely to catch intermittent errors and addressing problems.

The test runs all of the k2 RAM pattern test, then performs a test on all system RAM except for the RAM located on the test card. The test may be aborted by pressing RESET (SHIFT PAUSE) anytime except while testing the first 64k bytes of RAM. When the extended RAM test is finished, the LED display changes to the next test number and the CRT displays the message

RAM @ 256Kb: XX0000, 64Kb: XX0000, CPUbd: XX0000

This message forms a memory map of the RAMs.

If the extended RAM test fails, the following messages may appear on the CRT in addition to any message from the RAM pattern test:

Error Message	Possible Causes	What to Do
RAM @ XXXXXX had YYYY not ZZZZ	RAM IC at location XXXXXX defective	Refer to section on locating RAM boards
BUS ERROR @ XXXXXX IN K6	RAM IC at XXXXXX missing	

RAM Addressing

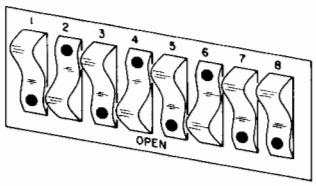
System RAM is addressed by a six digit hexadecimal number. It is arranged in blocks of 64k bytes at the top of memory, with the top address being FFFFFF. Since 64k is 10000 in hexadecimal, the top block includes addresses from FF0000 to FFFFFF. Each additional block covers the 64k below the preceding block. The RAM blocks must be contiguous.

One 64k block is located on the Processor/64k RAM board. Each optional 64k RAM board contains one block, and each optional 256k RAM board contains four blocks. The address block of the 64k and 256k RAM boards is switch-selected. The address block of the RAM on the Processor/64k RAM board is determined by the CPU to be the first unused address block.

Checking a RAM Board Address

RAM blocks cover addresses from MN0000 to MNFFFF, where M and N are hexadecimal numbers. This address block is determined by a switch on the RAM board.

64k RAM Boards. An eight segment switch is used to determine the address block. Segments 8 through 5 determine the value of M and segments 4 through 1 determine the value of N. An open segment represents a 1 and a closed segment represents a 0. The binary number is read directly from the switch segments and converted to hexadecimal. For instance, this switch is set to 11010101:

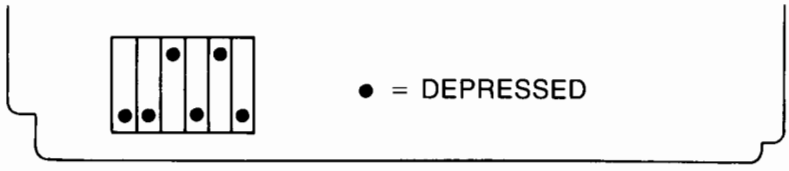


Binary	Hexadecimal
1101	D
0101	5

Thus, this RAM board covers the addresses from D50000 to D5FFFF.

256k RAM Boards

Since these boards contain four 64k blocks, only six segments are needed to determine the address. The left-most four segments of a six segment switch determine the value of M, and the other two segments (and two implied segments) determine the values of N. For instance, this switch is set to 110101:



Binary	Hexadecimal
1101	D
01XX	4, 5, 6, 7

Thus, this RAM board includes the addresses from D40000 to D7FFFF.

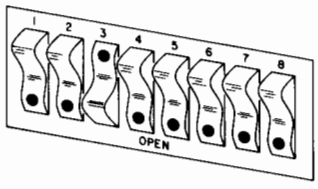
Locating a Defective RAM Board

The RAM tests have error messages containing addresses of the form MNPQRS (hexadecimal). The RAM board causing an error is easily found using the paragraph above on Checking a RAM Board Address. Any RAM address MNPQRS is located on the board containing the address block MN0000 to MNFFFF. Convert the MN digits into binary, then find a RAM board with switch settings which match the binary number.

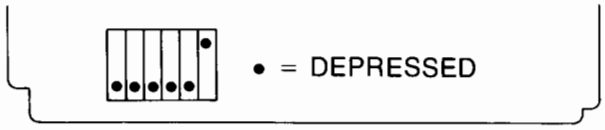
For instance, in the error message

RAM @ FB53A9 had F58A8C2C not F78A8C2C

the defective RAM is on a board with a starting address of FB0000. FB in binary is 11111011. Thus the switch setting of the defective board would be:



if a 64k RAM board, or:



if a 256k RAM board.

Locate the board with this switch setting.

Keyboard Test

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The keyboard section is made up of these assemblies:

09826-69501	Motherboard (9826)
09826-69502	Motherboard (9836A)
09836-69502	Motherboard (9836C)
(see Table 6-1)	Keyboard Assembly
09826-67910	Rotary Control Knob Assembly

The motherboard is an exchange assembly. The keyboard assembly is repaired by changing the keycaps and keyswitches. The rotary control knob is to be replaced, but not returned to the factory.

The keyswitch assembly contains no active components, only switches. All keyboard electronics are mounted on the motherboard.

Keyboard Test (k4)

The keyboard test is included in the system test procedure.

This test checks whether the keyswithches are operating properly. It does this by displaying a diagram of the keyboard on the CRT (see Figure 5-11, 5-12), and waiting five seconds for the user to press a key. Pressing a key changes the display of tht key from an open box to an area of inverse video. Pressing the same key a second time returns the display to an open box. The keys may be pressed in any order desired. To check the CONTROL key or the two SHIFT keys, press each in combination with any other key. They will light on any keystroke where they are pressed with another key, and will go out as soon as a key is pressed without pressing the shift or control key. The rotary control knob controls the movement of the large cursor at the bottom of the CRT screen.

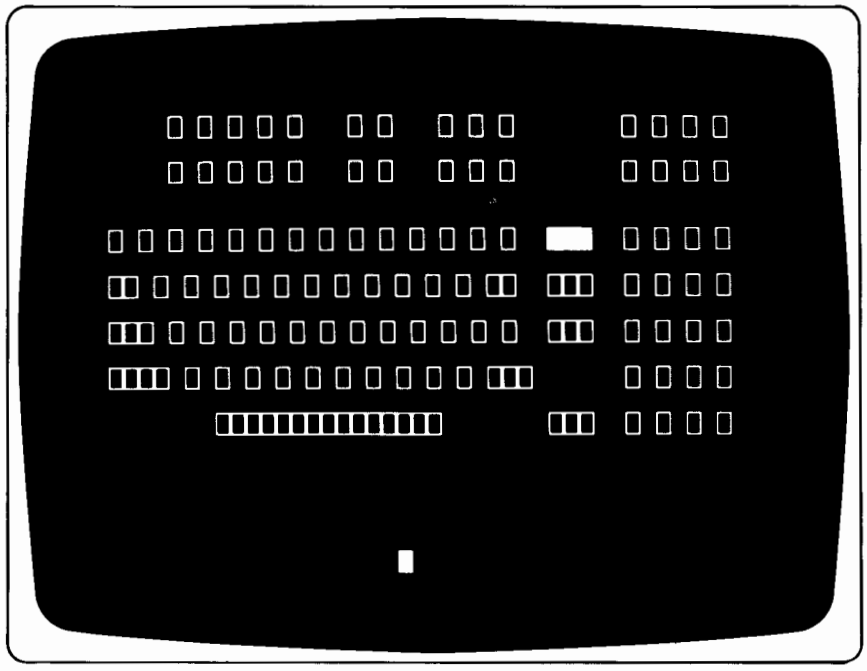

Figure 5-11. 9826 Keyboard Test CRT Display.

Figure 5-12. 9836 Keyboard Test CRT Display.

The keyboard test does not test the beeper. It can be checked by entering test mode and pressing character keys. Each key will produce a different pitch.

The keyboard test checks the keyboard electronics, which are located on the motherboard. If the electronics fails the test, one of these messages will appear on the CRT:

Error Message	Possible Causes	What to Do
LVL 1 INT XX YY ZZ[1] KBD FAILED SLFTST KBD STS XX NOT 71 KBD DATA XX NOT 8E KBD NOT RDY, XXXXXX KBD NOT INT W/DATA KBD INT NO CAUSE XX KBD INT STATUS XX KBD INT MASK KBD TIMER SLOW OR NO INT YY (ZZ,WW) KBD TIMER FAST YY (ZZ,WW) NO KBD NMI KBD REAL TIME CLK BAD, XXXXDAYS, YYYYYYX10ms KBD KEY CODE YY, STATUS ZZ	Keyboard controller IC	Replace Motherboard
LVL 2 INT IN k4	Drive board defective Keyboard controller IC defective	Replace drive board Replace motherboard

1 See Level One Interrupt note.

If a language or system jumper is installed in the keyboard, one of these messages should occur:

LANG JMPR = X	1 French
	2 German
	3 Swedish/Finnish
	4 Spanish
	5 Japanese (Katakana)
	6 System jumper 9
	7 System Jumper 10
	8 System jumper 11
SYS JMPR = X	1 System jumper 1
	2 System jumper 2
	3 System jumper 3
	4 System jumper 4
	5 System jumper 5
	6 System jumper 6
	7 System jumper 7
	8 System jumper 8

The keyboard test can be terminated in any one of several ways. If no keys are pressed, the test terminates in five seconds. If one or more keys are pressed, the test terminates one minute after the last key is pressed. Pressing CONTROL k0 terminates the test immediately.

Level One Interrupts

The keyboard test reports keystrokes and rotary control knob movements made during other tests that are not required by the other tests. These are reported as level one interrupts, with the error message

LEVEL 1 INT XX YY ZZ

This error message can also indicate a problem. To tell the difference, look at ZZ. If ZZ is 10, there is a problem, probably in the motherboard, keyboard or an interface card. If ZZ is 20, look at the first X. If it is 7 or less, a timer problem is indicated, probably with the motherboard. Other numbers indicate keystrokes or rotary control knob movements, according to this chart:

First X	Cause
8	Shift, control, key pressed
9	Control, key pressed
A	Shift, key pressed
B	Key pressed
F	Rotary control knob moved

Keyboard Troubleshooting

Bad keys indicated in the keyboard test can be isolated to either a bad keyswitch or bad row and column logic on the printed circuit board. If only one key indicates bad, the keyswitch is probably defective. It can be replaced using the procedure in Chapter 4.

If several keys indicate bad, the row and column logic on the printed circuit board is probably at fault. Figure 5-13 shows the row and column pattern for each key. If the printed circuit board is defective, replace the entire keyboard assembly. Make sure that the replacement assembly has keycaps for the correct language. Refer to the list of keyboards in Chapter 6, Replaceable Parts.

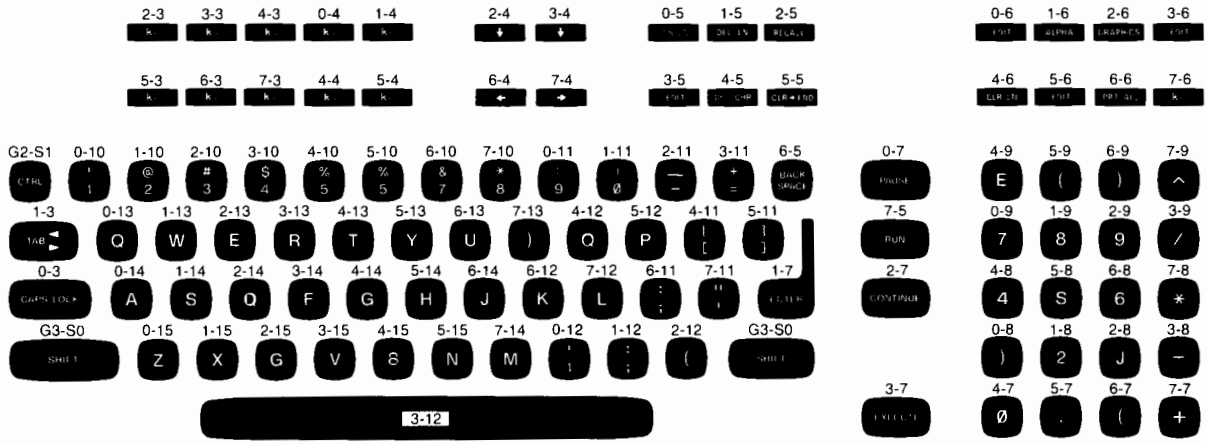

Figure 5-13. Keyboard Row and Column Diagram

Space Bar Parts

Several parts are used in the space bar to produce smooth operation. These include left and right guides, stems which slide into the guides and a metal rod connecting the guides. There are two versions of this hardware: early version and late version. Late version hardware part numbers are listed in Table 6-24 and Figure 6-1.

Unfortunately, late version hardware is not backward-compatible to the early version (except for the space bar, which is compatible). If you need to replace a part in an early version space bar (other than the space bar itself), you must order a complete set of late version hardware. This includes: one left guide, one right guide, two stems, one rod and one space bar. Part numbers can be found in Table 6-24 and Figure 6-1.

To determine whether you have an early or late version, look at the space bar rod. Early version hardware has a visible rod, whereas the late version rod is hidden by the space bar.

Disc Drive Tests

The disc drive is composed of these assemblies:

09826-66561	Disc Drive Control board (9826)
09826-66562	Disc Drive Control board
09130-69600	Disc Drive Mechanism

The disc drive mechanism is an exchange item, the others are non-exchange items.

The "62" drive board is a replacement for the "61" board and can be used in either the 9826 or the 9836. The "61" board can only be used in the 9826.

When replacing the disc drive mechanism, be sure to remove the drive power connector, the sheet metal cover and the jumper shunt block from the defective drive, and install them on the replacement drive.

The right-hand drive is designated drive 0 and the left-hand drive is drive 1.

Disc Drive Test (k5)

The disc drive test is included in the system test procedure. It checks several functions of the disc drive. Some of the checks can be made with no disc in the drive, some require a disc, and some require a special disc to be installed.

The disc drive test begins with a check of the 256 bytes of memory located in the drive controller. The drive motor is turned on and then turned off. The track 0 switch, track, data and sector registers are checked. If a disc is installed in the drive, the time between index pulses is measured and head selection, read address, CRC and margin error are checked. If the disc is initialized and write-enabled, and contains the proper ASCII file called TROMDATA, test patterns are written, then read and checked for accuracy.

When the disc drive test is finished, the LED display will change to the number of the next test.

If the disc drive test fails, any of the following messages appear on the CRT:

Error Message	Possible Causes	What to Do
RAM @ 44EXXX had 000000YY not 000000ZZ	Disc drive RAM IC at location 44EXXX	Replace disc drive controller board
DRV D FAST XXXX DRV D SLOW XXXX	Disc drive D	Refer to 9130K service manual Replace disc drive
DRV D TRK REG had XX not YY DRV D SEC REG had XX not YY DRV D DAT REG had XX not YY DRV D CLR EXSTS FAILED RAM HOLD @ XXXXXX had YY not ZZ	Disc drive controller	Replace disc drive controller board

Error Message	Possible Causes	What to Do
DRV D DISC STS XX CMD XX XCMD XX TRXX SECXX[1]	Disc drive D	Replace disc drive
	or	or
DRV D NO INT AFTER RES	Disc drive controller	Replace disc drive controller board
DRV D LVL 2 INT		
DRV D DISC WRT XX RD YY		
DRV D TRK REG had XX not YY AFTER ZZ STS WW		
DRV D NO TR00 AFTER XX		
DRV D TR00 TRUE AFTER XX		
DRV D BUSY XXXXXX		
DRV D TIMEOUT XXXXXX		
DRV D MOTOR OFF & RDY		
DRV D NO INDEX		
DRV D DISC FDC		

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1 Due to disc controller access timing differences between this test routine and the operating system, one disc status error per hour is acceptable.

Error Message	Possible Causes	What to Do
DRV D MARGIN DRV D READ ADD DRV D CRC	Defective disc Disc drive D Disc drive controller	Use another disc Replace this disc Replace disc drive controller board
DRV D WRT PROCT	Disc is write protected Disc drive D Disc drive controller	Use write enabled Replace disc drive Replace disc drive controller board
DRV D NO DISC OR NOT RDY	No disc in drive Disc drive D Disc drive controller	Insert disc Relace disc drive Replace disc drive controller board
DRV D NO FILE OR NOT ASCII	No ASCII file on disc	Refer to software manual
DRV D FILE SMALL	File is less than 80 records long	Refer to software manual
NO RAM SPEED @ XXXXXX -KBD BAD? DRV D NO MOTOR SPEED -KBD BAD?	Keyboard controller IC defective	Replace motherboard

All errors except DRV D NO DISC OR NOT RDY, DRV D NO FILE OR NOT ASCII, DRV D FILE SMALL, DRV D MARGIN and DRV D NO INDEX may cause discs to be incorrectly written and thus unuseable.

DRV D MARGIN and DRV D NO INDEX can cause read errors or prevent writes from occurring.

Disc Drive Diagnostic (k9)

The individual test mode contains an extensive diagnostic of the disc drive. The disc drive diagnostic should be used for in-depth troubleshooting of the drive assembly.

To enter the diagnostic from test mode, press softkeys k9 and k18 (SHIFT k8). Upon entering the test, the drive motor is turned on and a restore command is executed. Then the softkeys are used to perform the following operations:

k0 Step in with update command.

k1 Step out with update command.

k2 Head select toggle in the extended command.

k3 Restore command.

k4 Unused in 9826. Drive toggle in 9836.

k5 Read address command, with six bytes returned. Information returned includes: track, head, sector, block length and CRC. It is displayed in the form: READ ADD, TRKXX, HDXX, SECXX, BL01, CRCXXXX.

k6 Read sector command, causing a prompt requesting the sector number to be displayed (DUMP SEC?). When a sector number (0 to 9 or A to F) is entered, a read sector command is given. This returns 256 bytes of data, which are displayed in hexadecimal. Data which decodes into ASCII is displayed in ASCII on the right side of the CRT.

k7 Read full track, with the data displayed 256 bytes at a time. The display will advance every four seconds unless the PAUSE key is pressed (causing the display to stop until the CONTINUE key is pressed), or the CONTINUE key is pressed (causing the display to advance quickly). To ensure that the data is not scrambled, short the VFOE test pin to the LOCK test pin. These are both located in the upper left hand corner of the drive control board.

k8 Exit to test mode. The motor is turned off and the program returns control to test mode. Softkey k8 is the same as RESET (SHIFT PAUSE).

k9 Unused.

Extended command refers to instructions sent by the disc drive controller to the disc drive mechanism. Extended status refers to status information sent to the controller by the drive mechanism.

The following messages are displayed on the CRT in conjunction with the softkey operations:

CMD XX, EXCMD YY, STS ZZ, EXSTS WW	This message displays command and status information about the previous operation. The command was XX, the extended command was YY, the status result was ZZ and the extended status result was WW.
REGs: TRK XX, SEC YY, DAT ZZ	This message displays register contents information about the previous operation. The contents of the (physical) track register was XX, sector register was YY and data register was ZZ.
READ ADD TRK XX, HD YY, SEC ZZ, BL WW, CRC VVV	This message is displayed when a read address is done during the disc drive diagnostic. The (logical) track is XX, the (logical) head is YY, the sector is ZZ, the block length is WW and the CRC is VVVV.
DUMP SEC? XX	This is a message prompting the operator to enter a number from 0 to F (hex) which selects a sector to be dumped to the CRT. The sector numbered on the track and side selected earlier.
DUMP FULL TRACK OF XXXX	This message tells how many bytes were read when the read full track command was executed.

STARTS @ XXXX — This message shows where you are in the dump of a read full track.

xx xx xx xx xx xx xx xx xx xx xx xx yyyyyyyyyyyy

This is the format of the read sector and read full track dump. ASCII characters with codes of 00 to 1F are converted into the ASCII character and printed in the "y" section of the dump.

Powerfail Test

The powerfail/real-time clock section is made up of these assemblies:

09826-69555 Powerfail/real-time clock board 1420-0303 18V battery

The powerfail board is an exchange assembly. The battery is to be replaced, but not returned to the factory.

Powerfail Test (k20)

The powerfail test is included in the system test procedure, and is run if the test code detects the presence of the powerfail option (or if switch 95 of the test card is enabled and auto-configure is disabled).

This test checks the 8041 processor self test results, the CMOS RAM and the CMOS clock counter. The battery, non-maskable interrupt and relay are not tested.

If the powerfail unit is detected, this message appears on the CRT on the first pass through the system test procedure:

PF: OPTION

If this test fails, any of the following messages may appear on the output device:

Error Message	Possible Causes	What to Do
PF FAILED SLFTST WW	Powerfail 8041 IC	Replace powerfail board
PF RAM DATA was YY not ZZ @XX	Powerfail RAM	
PF CLK FAST WWWW (YYYY,ZZZZ)	Real-time clock or shift register	
PF CLK SLOW WWWW (YYYY,ZZZZ)		
PF IBF/OBF/F1	Powerfail 8041 IC	
PF TIMEOUT @ XXXXXX		

Memory Manager Tests

The memory manager consists of three sections — the memory management unit (MMU), the programmable timer module (PTM) and the cache memory.

The test code checks the memory manager with three tests. It checks the MMU and PTM together (k25), the cache memory by itself (k27) and the cache memory simultaneously with the MMU and PTM (k29).

All three tests are included in the system test procedure, but are only executed if the computer being tested contains a memory manager (that is, an 09826-66517 processor board) or if switch 96 on the test card is enabled while auto-configure is disabled.

MMU and PTM Test (k25)

This test checks the memory management unit (MMU) and programmable timer module (PTM) together. The number 25 appears in the test card LED display.

The MMU portion of this test checks the MMU user and supervisor segment pointer registers, segment table access, access violations, and translator look-aside buffer purge and selective purge. It uses system RAM down to address F00000 (if present).

The PTM portion of this test checks the write/read registers, interrupt on level 6, counter operation, status and counter 3 input from the output of counter 2.

If the MMU and PTM test fails, any of the following messages may appear on the CRT:

Error Message	Possible Causes	What to Do
NO MMU	MMU defective or missing	Replace processor board
MMU SYS REG was YYYY not ZZZZ	MMU defective	↓
MMU USER REG was YYYY not ZZZZ	↓	↓
MMU CMD WW, STS Y	↓	↓
MMU CMD WW, STS Y/Z	↓	↓
MMU CMD WW, STS Y/Z, LA LLLLLL, BUS ERR @ XXXXXX	↓	↓
MMU CMD WW, STS Y/Z, LA LLLLLL, NO BE @ XXXXXX	↓	↓
MMU CMD WW, STS Y/Z, LA LLLLLL, SUP TBL REPLACE	↓	↓
MMU CMD WW, STS Y/Z, LA LLLLLL, SEG TBL ACC	↓	↓
MMU CMD WW, STS Y/Z, LA LLLLLL, PAGE TBL ACC	↓	↓
MMU CMD WW, STS h/Z, LA LLLLLL, NO TLB PURGE	↓	↓
MMU CMD WW, STS Y/Z, LA LLLLLL, NO REF BIT	↓	↓
MMU CMD WW, STS Y/Z, LA LLLLLL, NO TLB REPLACE	↓	↓
MMU CMD WW, STS Y/Z, LA LLLLLL, SUP TLB REPLACE	↓	↓

Error Message	Possible Causes	What to Do
MMU CMD WW, STS Y/Z ,BUSS ERR @ XXXXXX MMU CMD WW, STS Y/Z, NO BE @ XXXXXX MMU CMD WW, STS Y/Z, LA LLLLLL, DATA NNNN/MMMM BUS ERROR @ 5F8001 PTM STATUS was YY not ZZ after RESET PTM STATUS was YY not ZZ after CLR INT PTM STATUS was YY not ZZ after COMMAND WW. PTM REGN was YYYY not ZZZZ IN 10ms PTM CR1 WENT FROM FFFF to NNNN (F542-F736) PTM CR2 VALUES 0-7, PRESET NNNN PTM CR3 VALUES 0-7, PRESET NNNN PTM CR3 SPEED ERROR NNNN (0-2) PTM DUAL 8 CR3 NNNNNNNN YYYY, ZZ NO PTM INTERRUPT PTM INTERRUPT WHEN NOT EXPECTED	PTM defective	
NO PTM SPEED - KBD BAD?	Keyboard controller IC defective	Replace motherboard

Cache Memory Test (k27)

This test checks the cache memory by itself. The number 27 appears in the LED display on the test card.

This test checks the following cache functions: the ability of the cache to hold data, memory speed with and without cache, purge of the cache and whether I/O is cached.

If the cache memory test fails, any of the following messages may appear on the CRT:

Error Message	Possible Causes	What to Do
CACHE STATUS was YYYY not ZZZZ CACHE DATA was YYYY not ZZZZ @ XXXXXX CACHE DATA was YY not ZZ @ XXXXXX CACHE IN I/O SPACE CACHE SPEED YYYY, ZZZZ	Cache memory defective	Replace processor board
NO RAM SPEED @ XXXXXX - KBD BAD?	Keyboard controller IC defective	Replace motherboard

MMU, PTM and Cache Memory Test (k29)

This test checks the cache memory simultaneously with the MMU and PTM. The number 29 appears in the LED display on the test card.

This test maps the following memory areas: boot ROM, CRT alpha and graphics, flexible disc, 64k bytes of system RAM and the area of memory where the test code resides. The test operates in user mode and is interrupted by the PTM. Logical addresses are assigned at random and changed five times while the test is executing.

If the MMU, PTM and cache memory test fails, any of the following messages may appear on the CRT:

Error Message	Possible Causes	What to Do
BOOTROM CHECKSUM ERROR, LA FLLLLL, PA PPPPPP	Cache memory defective	Replace processor board Boot ROM defective
MMU BUS ERROR IN K29	Cache memory defective	
DATA YYYYYYYY/ ZZZZZZZZ, LA LLLLLL, PA PPPPPP		
TOO MANY PTM INTs IN K29		

Display Tests

The display assemblies are listed below:

	9826	9836A	9836C
Digital board	09826-66573	09826-66576	09836-66572
Graphics board	09826-66575	09826-66577	09836-66573
Analog board	09826-66571	09826-66580	–
CRT/yoke assembly	09826-67921	09826-67922	09836-67924
Video board	–	–	09836-66542
Sweep board	–	–	09836-66540
Display motherboard	–	–	09836-66503
Display power supply	–	–	09836-66550

The 9826 and 9836A graphics boards are exchange assemblies. The other 9826 and 9836A assemblies are to be replaced but not returned to the factory for repair.

All the 9836C assemblies are exchange assemblies except the display motherboard and the CRT/yoke assembly.

When replacing the CRT/yoke assembly, the defective CRT should be disposed of in the shipping container the replacement was received in.

CRT Character Test (k3)

The CRT character test is included in the system test procedure.

This test is designed for examining and adjusting the CRT. It places five patterns on the screen and holds them there for four seconds each. Pressing the PAUSE key holds the pattern until the CONTINUE key is pressed. Here is a description of the patterns used:

1. full cell: a full screen of full cell characters
2. focus: all rows, every other column of the symbol "$\overset{h}{p}$" in the 9826, alternating columns of the symbol "$\overset{h}{p}$" and the character "e" in the 9836
3. grid (9826 only): a full screen of rectangles
4. characters: all displayable characters arranged in rectangles; plus one line of all possible attribute combinations in the 9836
5. scroll: the characters display scrolls up, then down

Patterns 1 and 3 are used for CRT pincushioning and for adjusting width, vertical size, vertical position and horizontal position, and for checking whether there are bad phosphor spots on the CRT.

Pattern 2 is used for adjusting focus.

Pattern 4 is used to check the character ROM; and the display attributes in the 9836.

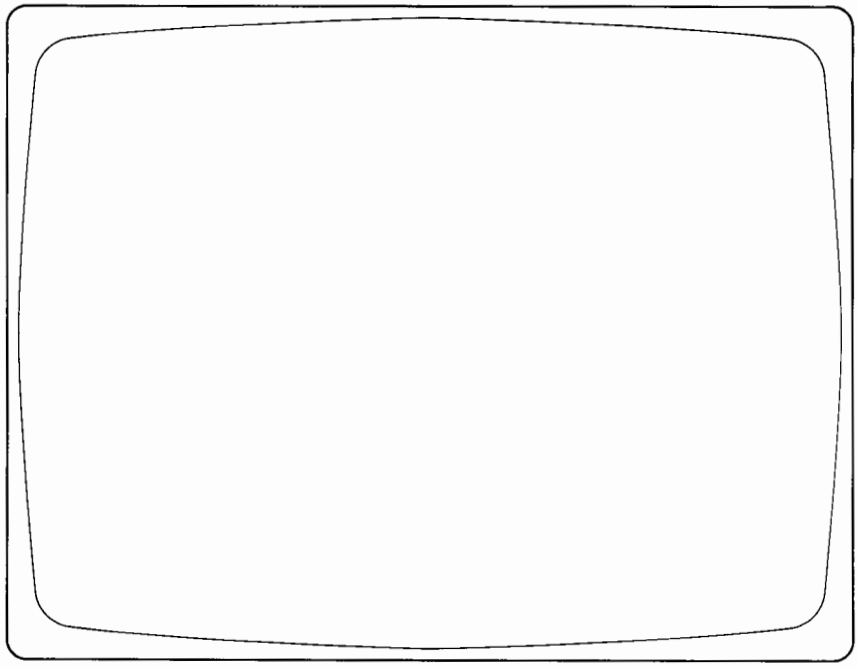

Figure 5-14A. 9826 CRT Character Test: Full Cell

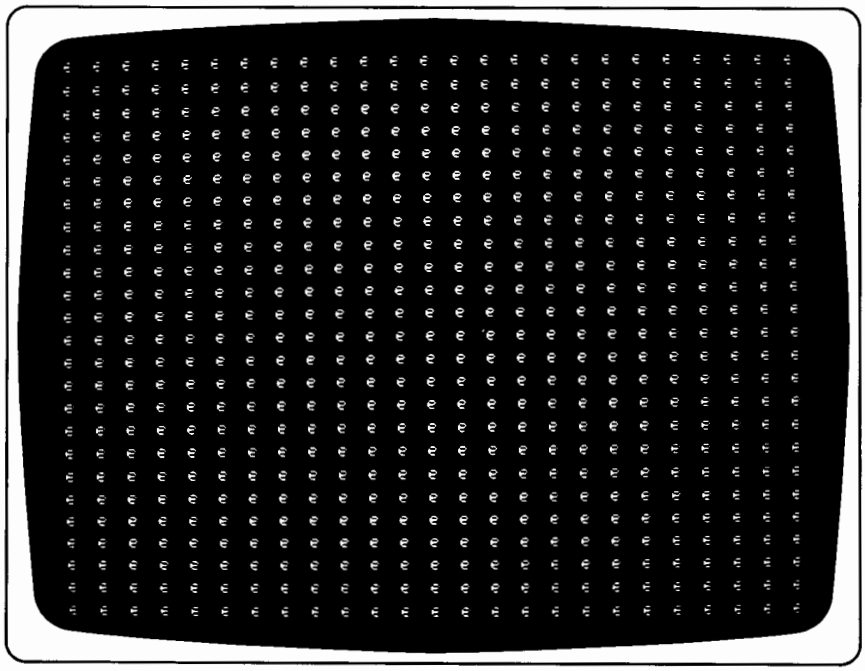

Figure 5-14B. 9826 CRT Character Test: Focus

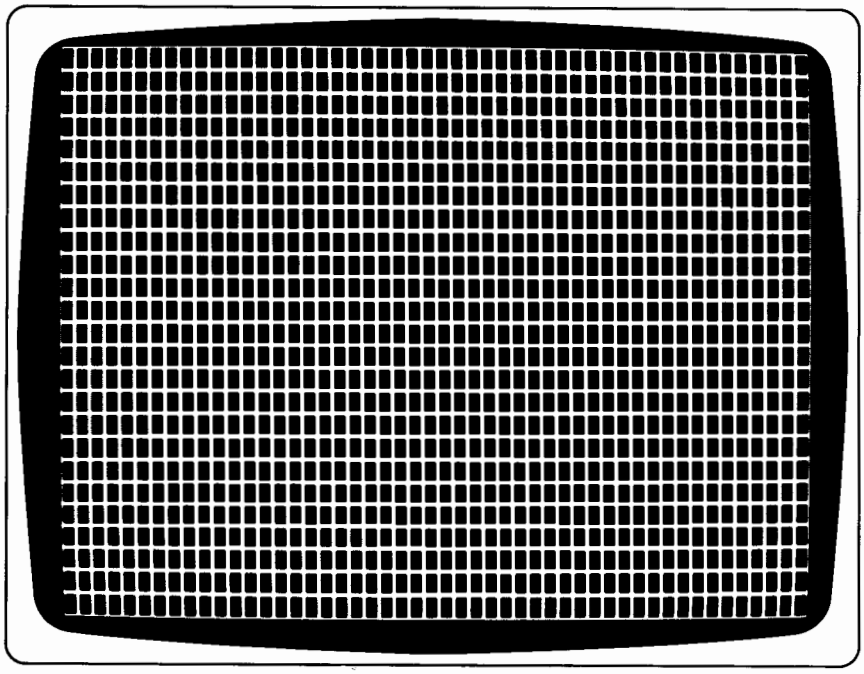

Figure 5-14C. 9826 CRT Character Test: Grid

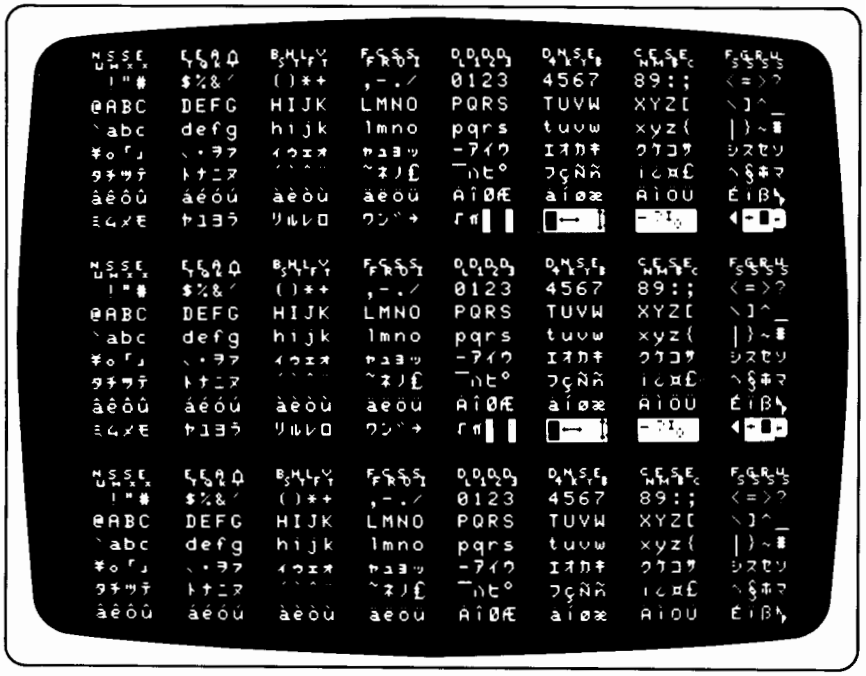

Figure 5-14D. 9826 CRT Character Test: Characters

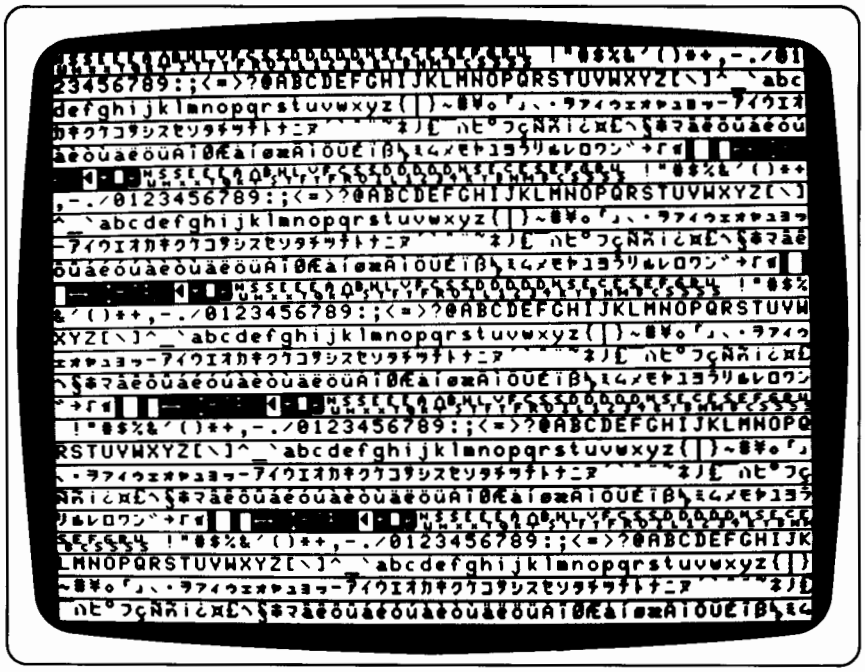

Figure 5-14E. 9826 CRT Character Test: Scroll

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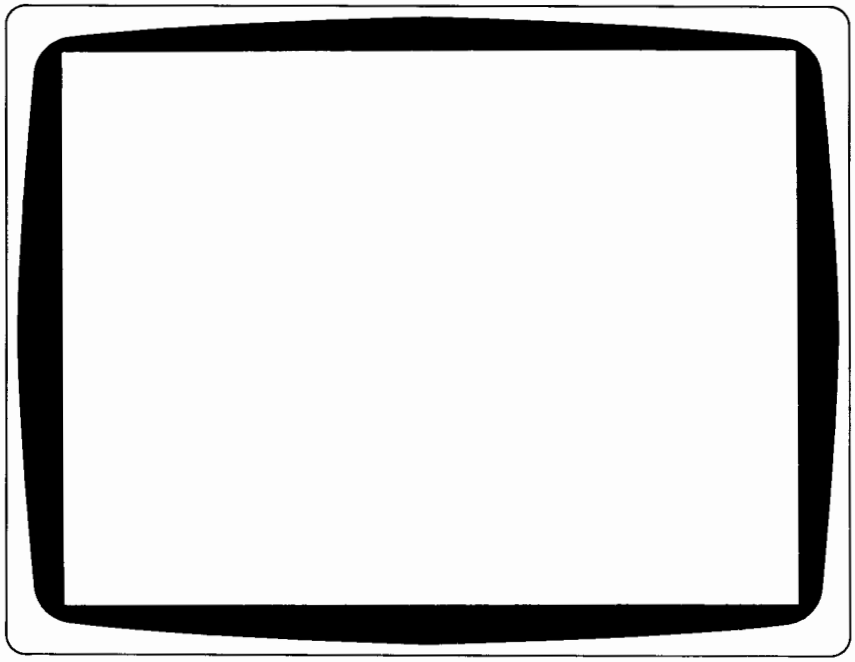

Figure 5-15A. 9836 CRT Character Test: Full Cell

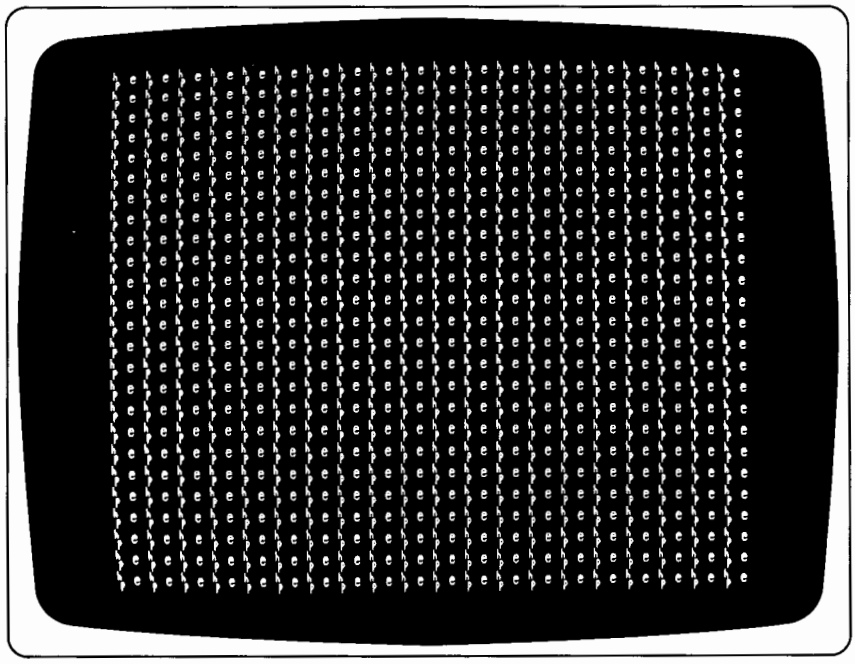

Figure 5-15B. 9836A CRT Character Test: Focus

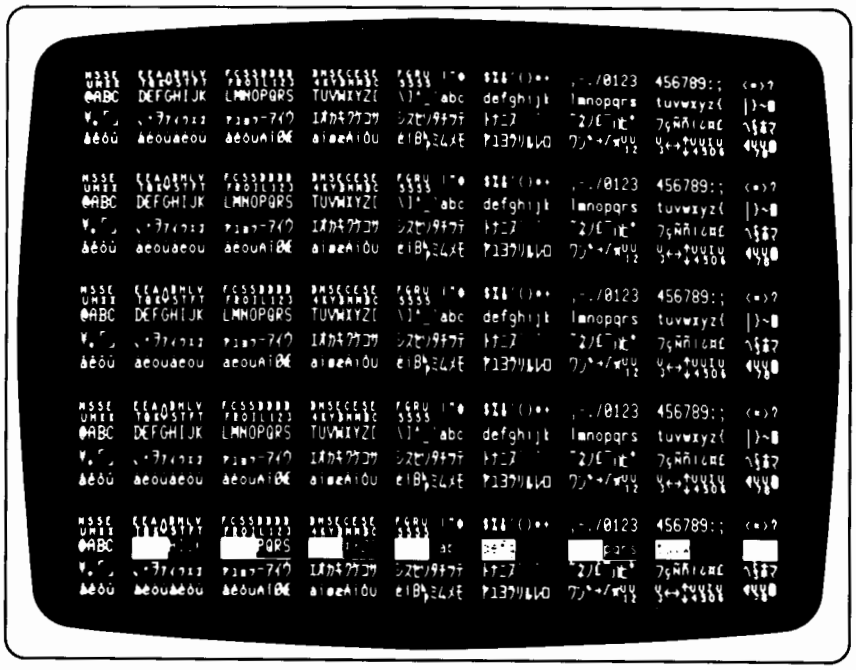

Figure 5-15C. 9836A CRT Character Test: Characters and Attributes

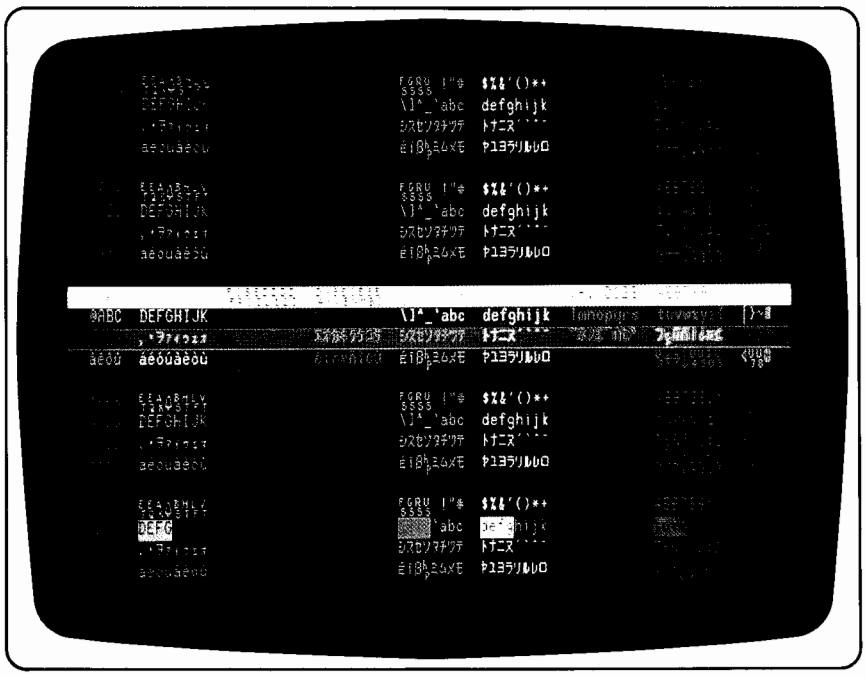

Figure 5-15D. 9836C Character Test: Characters and Attributes

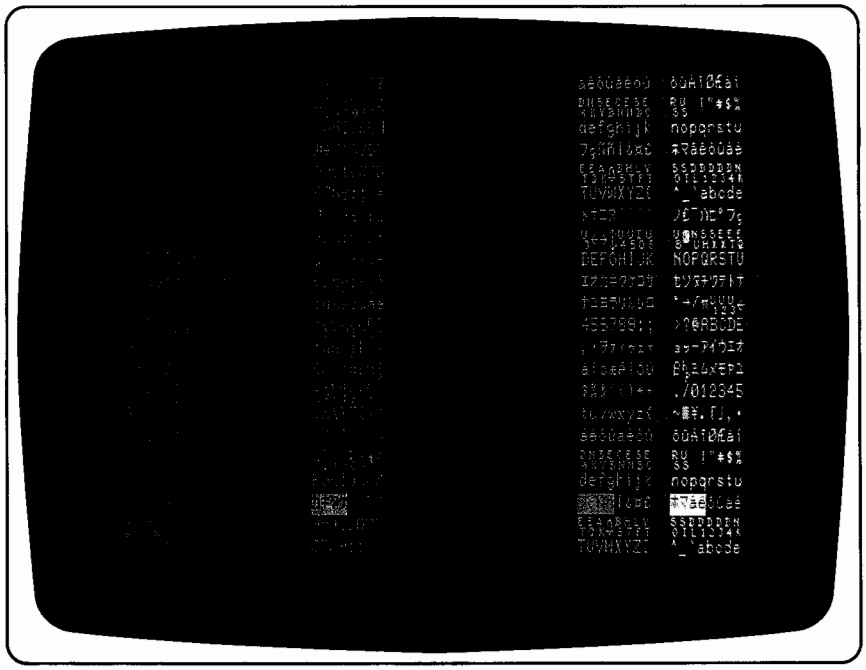

Figure 5-15E. 9836C Character Test: Scroll

Included in this test is an extended test of the display RAM. It will cause the screen to flash for several seconds while the RAM is being checked.

If this test passes, the LED display will change to the next test number.

If the test code is unable to access the alpha RAM, the following message may appear on the CRT:

Error Message	Possible Causes	What to Do
NO ALPHA IN K3	Digital board defective	Replace digital board
	Graphics board defective	Replace graphics board

If the display RAM fails this test, one of the following messages may appear on the CRT:

Error Message	Possible Causes	What to Do
RAM @ 51XXXX had YY not ZZ	CRT alpha RAM IC at location 51XXXX	Replace digital board
RAM @ 51XXXX had YYYY not ZZZZ		
RAM HOLD @ 51XXXX had YY not ZZ		
RAM HOLD @ 51XXXX had YYYY not ZZZZ		

CRT Graphics Test (k7)

The CRT graphics test is included in the system test procedure. This test checks the graphics RAM using a bit isolation test, an addressability test and a refresh test. During the refresh test, the character display is turned on for viewing. A box, 400 dots wide and 300 dots high, is displayed (see Figure 5-16). This pattern has a diagonal line descending at a 45 degree angle from the top left corner to the bottom. This line passes through two characters. One is a full cell located in the upper left-hand corner. The other is located in the softkey area. The character display should align correctly with the graphics display (the diagonal line). Compare the display to Figures 5-16 and 5-17.

This test pattern will remain on the screen for four seconds. To keep the test pattern on the screen, press the PAUSE key. The test pattern will remain on the screen until the CONTINUE key is pressed.

If this test passes, the LED display will change to the next test number. No message will be displayed on the CRT.

If the test card is unable to access the graphics RAM, the following message may appear on the CRT:

Error Message	Possible Causes	What to Do
NO GRAPHICS IN K7	Graphics board	Reset graphics board connector Replace graphics board
	Digital board	Replace digital board

If this test fails, any of the following messages may appear on the CRT:

Error Message	Possible Causes	What to Do
COLOR MAP @ 53XXXX had YYYY not ZZZZ	Graphics board defective	Replace graphics board
VERTICAL BLANK STUCK HIGH	Digital board defective	Replace digital board
VERTICAL BLANK STUCK LOW		
VBLANK TIME YY (ZZ,WW)		

If the graphics RAM fails this test, one of the following messages may appear on the CRT:

Error Message	Possible Causes	What to Do
RAM @ 53XXXX had YYYY not ZZZZ	Graphics IC at location 53XXXX	Reseat graphics board connector
RAM @ 53XXXX had YY not ZZ		
RAM RFSH @ 53XXXX had YY not ZZ	Graphics board	Replace graphics board
RAM RFSH @ 53XXXX had YYYYYYYY not ZZZZZZZZ		

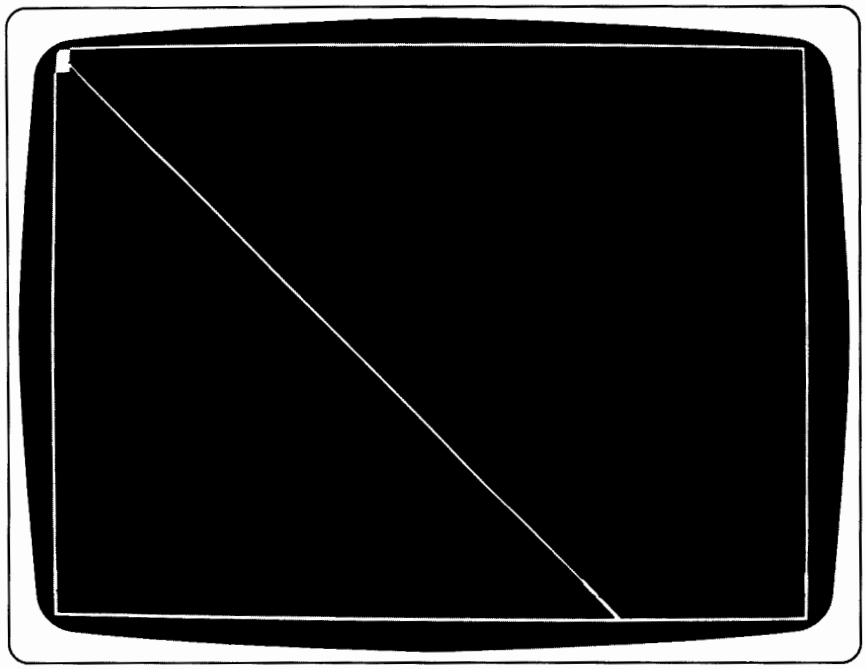

Figure 5-16. 9826 CRT Graphics Test Pattern

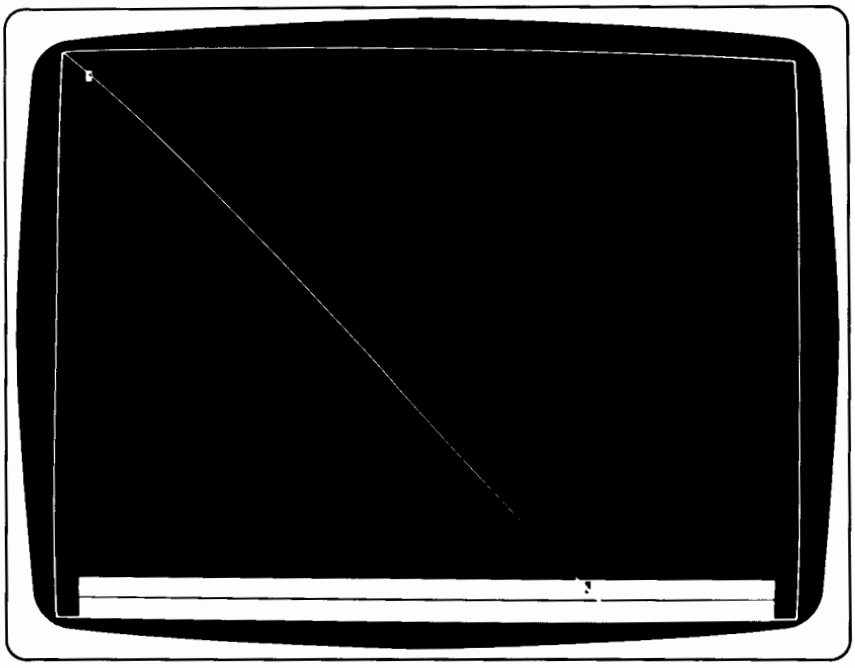

Figure 5-17. 9836A CRT Graphics Test Pattern

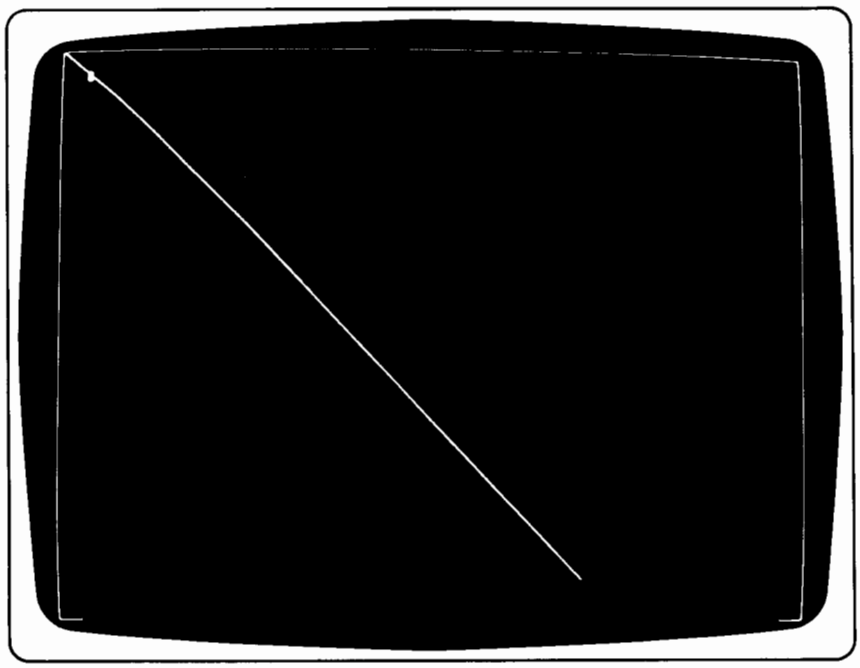

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Figure 5-18. 9836C CRT Graphics Test Pattern

CRT Alignment Test (k23)

The CRT alignment test is a convenient method for aligning the CRT. It consists of all of the CRT display patterns in the CRT character test and the CRT graphics test. It does not include a test of the display or graphics RAMs. Thus, the operator can run through the tests without waiting for lengthy RAM tests to execute. If running in a 9836, an extra alignment pattern (k23) is included (see Figure 5-19). If running in a 9836C, a 50Hz version of k23 is presented in k24.

This test is selected by pressing the CONTROL key and the k9 softkey together. Each pattern remains on the screen for about four seconds. Pressing the PAUSE key keeps the pattern on the screen until the CONTINUE key is pressed.

This test produces no error messages, nor does it produce any pass/fail indications.

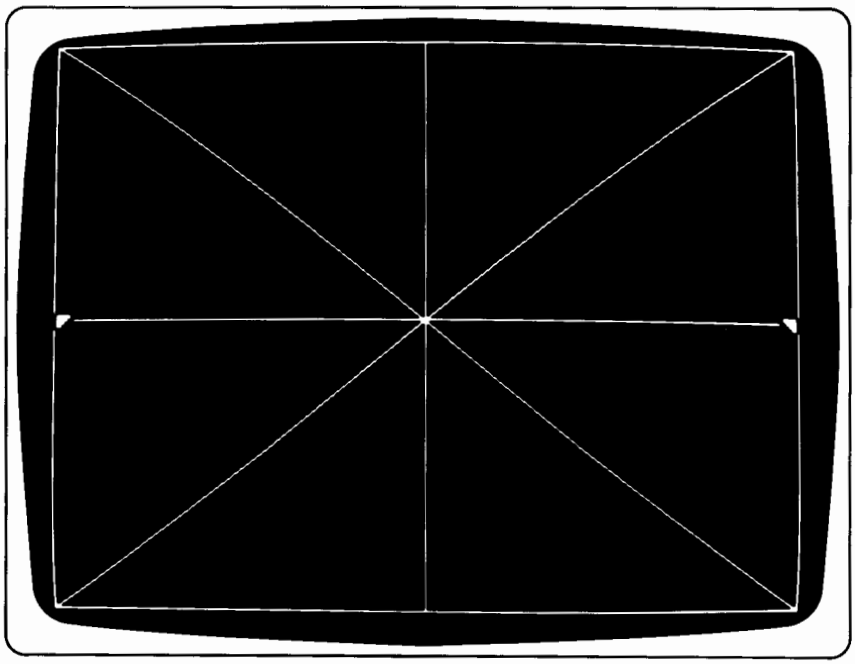


Figure 5-19. k23 Alignment Pattern

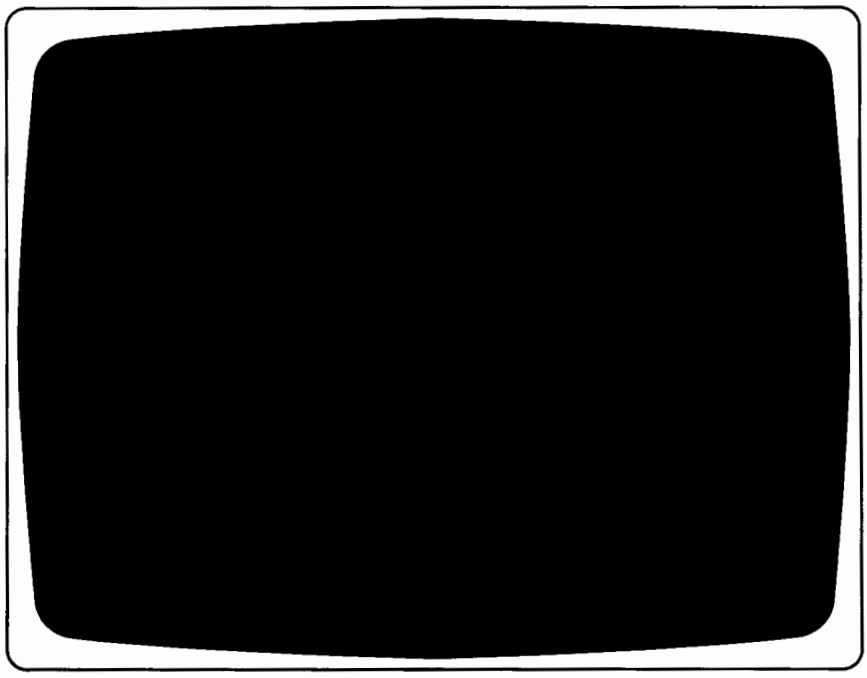


Figure 5-20. 9836C Level 1 Raster

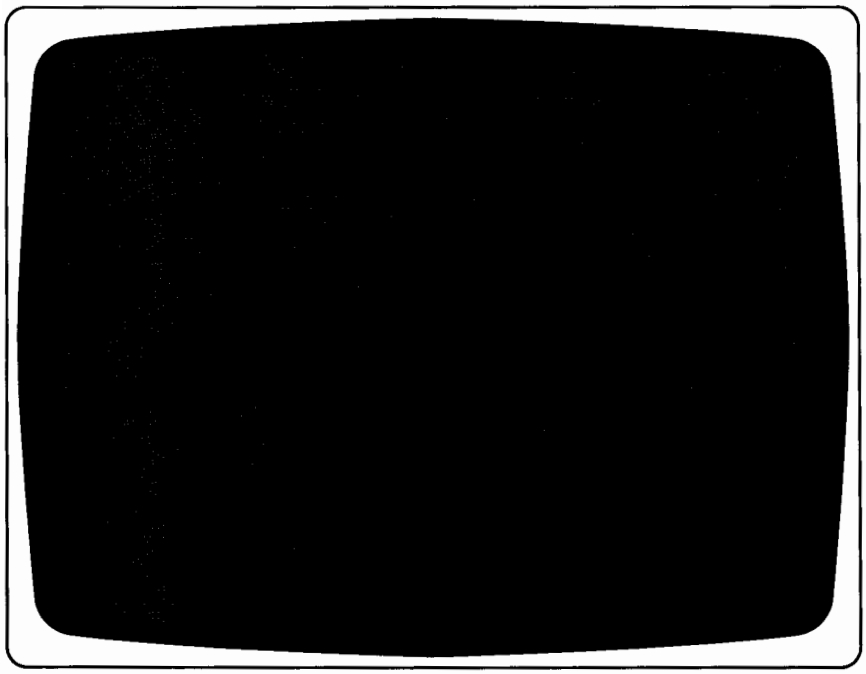


Figure 5-21. 9836C Level 15 Raster

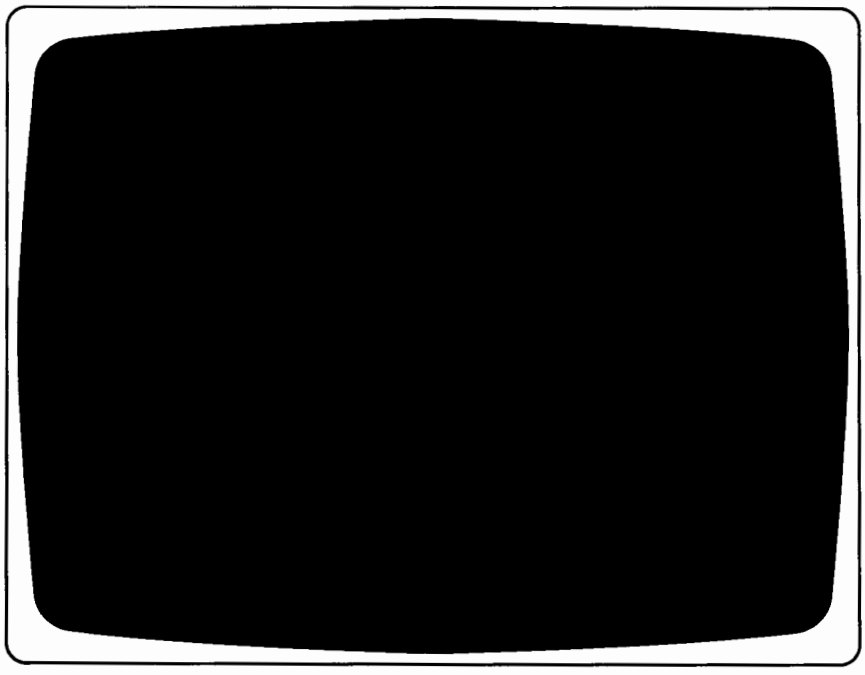


Figure 5-22. 9836C Graduated Raster

Extended CRT Graphics Test (k8)

The extended CRT graphics test is included in the individual test mode but not in the system test procedure.

This test is much more comprehensive than the CRT graphics test and is much more likely to catch intermittent and addressing problems.

It takes about 100 seconds to complete.

The test runs the k7 CRT graphics test, then performs an extended test on the graphics RAM.

If this test passes, the LED display will change to the next test number. No message will be displayed on the CRT.

If the test card is unable to access the graphics RAM, the following message will appear on the CRT:

Error Message	Possible Causes	What to Do
NO GRAPHICS IN K8	Graphics board	Reseat graphics board connector
		Replace graphics board
	Digital board	Replace digital board

If the graphics RAM fails this test, one of the following messages will appear on the CRT:

Error Message	Possible Causes	What to Do
RAM @ 53XXXX had 0000YYYY not 0000ZZZZ	Graphics RAM IC at location 53XXXX	Reseat graphics board connector
RAM @ 53XXXX had 000000YY not 000000ZZ		
RAM RFSH @ 53XXXX had 0000YYYY not 0000ZZZZ	Graphics board defective	Replace graphics board
RAM RFSH @ 53XXXX had YYYYYYYY not ZZZZZZZZ		

If you get more than one graphics RAM error message, bear in mind that one RAM IC can produce more than one error. In fact, one RAM IC can produce up to 16,384 error messages, since it contains 16k bits, each at a different address.

CRT Display Focus

The focus should be checked whenever a CRT assembly has been changed.

Note

Make all 9826 CRT adjustments with the CRT shield in place, as it affects the adjustments.

9826. The focus control is located on the analog board, but is accessible through a hole in the high voltage safety cover. See Figure 5-23A.

9836A. The focus control is located on the analog board. See Figure 5-23B.

9836C. The focus control is located on the sweep board. See Figure 5-23C.

WARNING

THE ANALOG AND SWEEP BOARDS CONTAIN HAZARDOUS VOLTAGES. USE EXTREME CAUTION WHEN MAKING ADJUSTMENTS TO THEM. ALWAYS USE A NONCONDUCTING ADJUSTMENT TOOL.

Display a full raster pattern of characters using k3, the CRT character test. The focus display was specifically chosen for focus. Adjust the focus control with the screwdriver end of a CRT tool to sharpen the appearance of the displayed characters.

It may not be possible to focus all areas of the display at a particular control setting; in this case, set the focus control at the point that gives the best overall appearance.

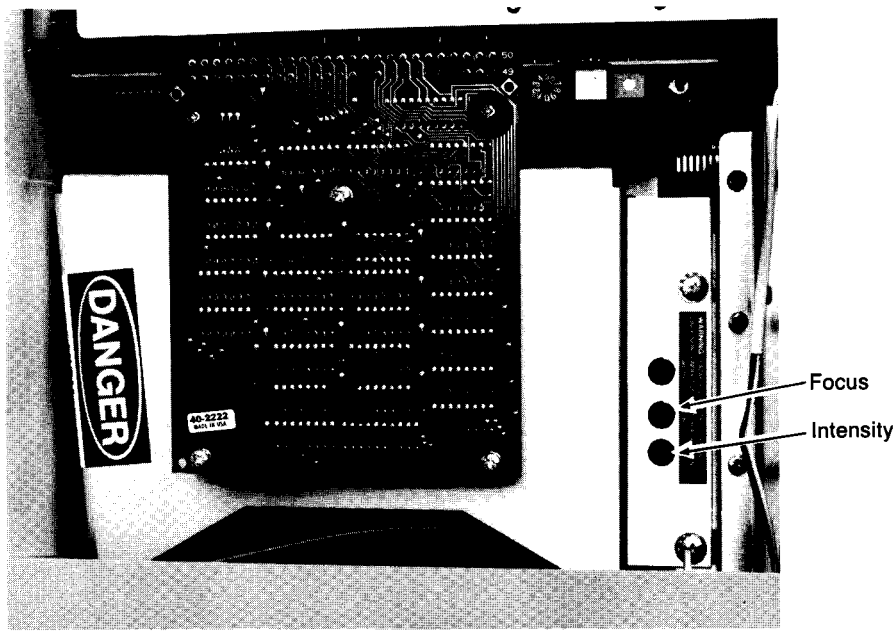


Figure 5-23A. 9826 CRT Intensity and Focus Adjustments.

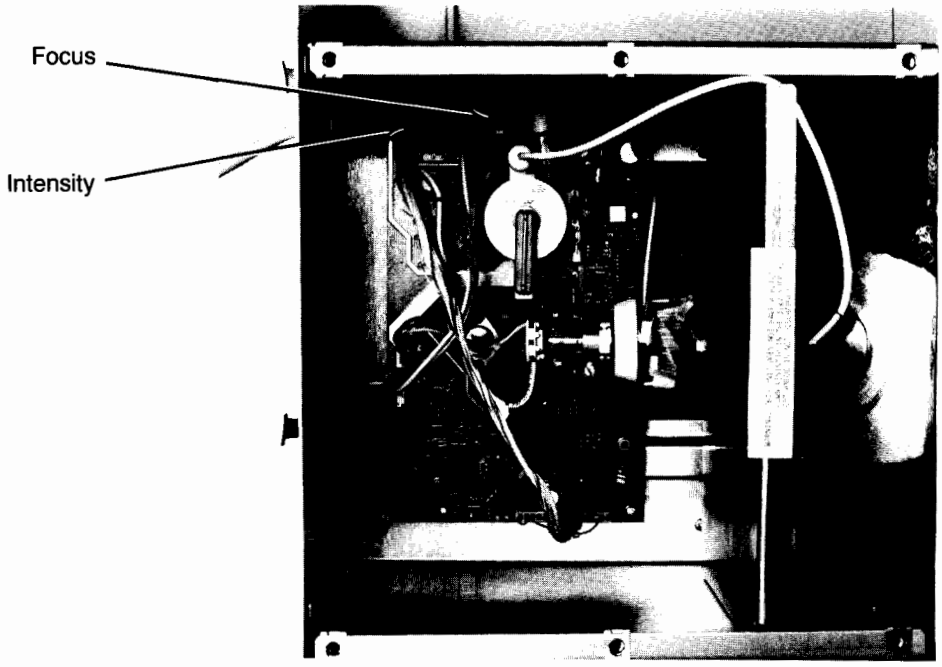


Figure 5-23B. 9836A CRT Intensity and Focus Adjustments.

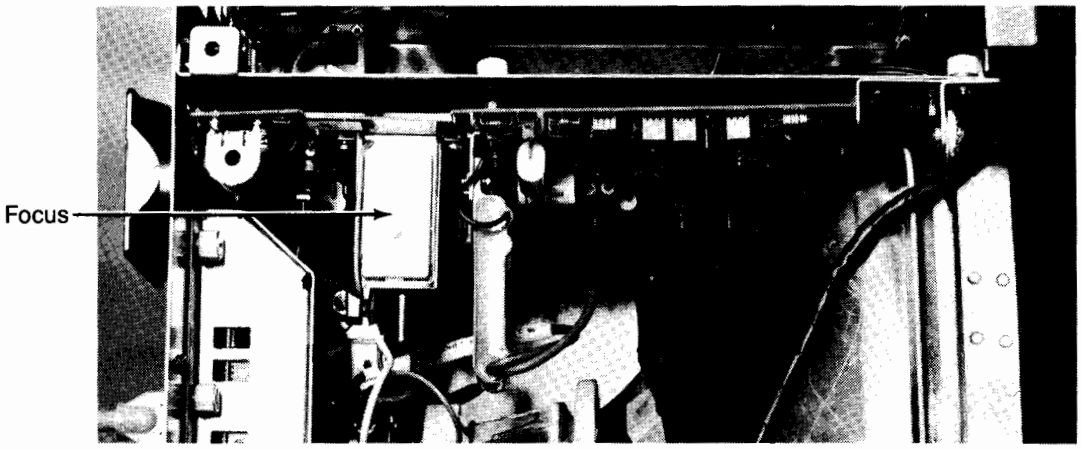


Figure 5-23C. 9836C CRT Focus Adjustments.

CRT Intensity

The intensity should be checked whenever a CRT assembly has been changed. The 9826/9836A has two intensity controls: an internal control and an operator control. The 9836C has only one.

9826. The internal control is located on the analog board and is accessible through a hole in the high voltage safety cover. The operator control is located underneath the left side of the computer.

9836A. The internal control is located on the analog board. The operator control is located on the rear panel of the display unit.

9836C. The intensity control is located underneath the left side of the computer.

Instructions for adjusting the intensity on the 9826 and 9836A are given here. Due to the complexity of color alignment, 9836C intensity adjustment is presented as a separate subject following the Other CRT Adjustments section.

9826 and 9836A CRT intensity can be adjusted with a photometer or by eye.

WARNING

THE ANALOG BOARD CONTAINS HAZARDOUS VOLTAGES. USE EXTREME CAUTION WHEN MAKING ADJUSTMENTS TO THE ANALOG BOARD. ALWAYS USE A NON-CONDUCTING ADJUSTMENT TOOL.

To adjust the CRT intensity by eye, follow this procedure:

1. Display a full screen of characters using k3, the CRT character test.
2. Turn the operator's intensity control all the way up.
3. Adjust the internal control with the screwdriver end of a CRT tool until the border area just disappears.
4. Adjust the operator's control for the desired intensity.

Hewlett-Packard has qualified two photometers for adjusting the intensity, the Tektronics J16 photometer (with the J6503 probe) and the Photodyne 19XE radiometer. The J16 photometer reads in foot-lamberts and the 19XE radiometer reads in steradians. The 19XE has the additional feature of being self-adjusting.

To adjust the CRT intensity with a photometer, follow this procedure:

1. Display a full white raster using k3, the CRT character test.
2. Turn the operator's intensity control all the way up.
3. Place the photometer at the center of the CRT window.
4. Adjust the internal control with the screwdriver end of a CRT tool until you obtain this reading on the photometer:

	foot-lamberts		μW/M²-str	
	50 Hz	50 Hz	50 Hz	60 Hz
9826	32-36	38-43	.740-.770	.870-.900
9836A	13.5-15.5	16-18	.375-.395	.445-.465

5. Adjust the operator's control for the desired intensity.

Other CRT Adjustments

Several CRT functions which rarely need adjusting have controls built in just in case. These functions are listed here and indicated in Figure 5-24.

9826. The horizontal width adjustment is located on the analog board. The horizontal position, vertical size and vertical position adjustments are located on the digital board.

9836A. The horizontal width, vertical linearity and height adjustments are located on the analog board.

9836C. The horizontal and vertical adjustments are located on the sweep board.

Adjusting these functions is similar to adjusting intensity or focus. Display a full raster using k3, the CRT character test and adjust the appropriate control to get the best display. The width adjustment is made with a CRT alignment tool, the others are made with the screwdriver end of a CRT alignment tool.

WARNING

THE ANALOG BOARD CONTAINS HAZARDOUS VOLTAGES. USE EXTREME CAUTION WHEN MAKING ADJUSTMENTS TO THE ANALOG BOARD. ALWAYS USE A NON-CONDUCTING ADJUSTMENT TOOL.

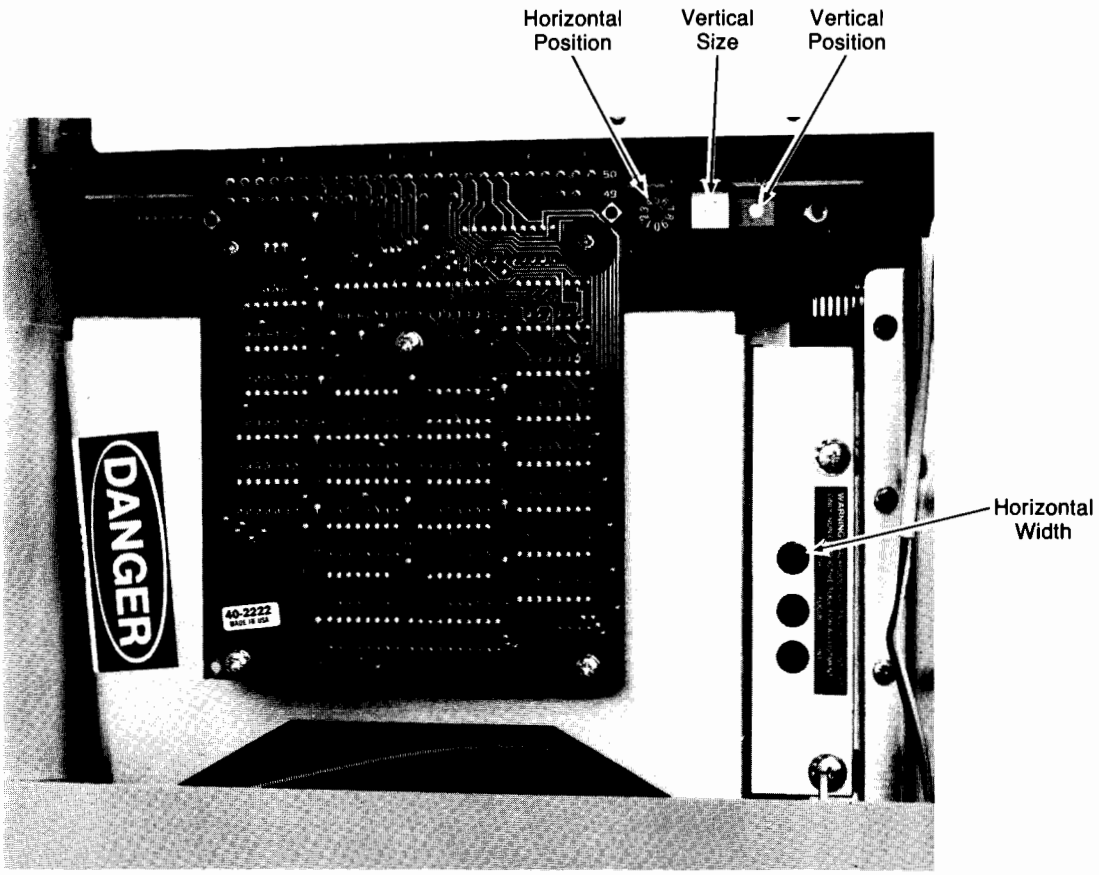


Figure 5-24A. 9826 Additional CRT Adjustments.

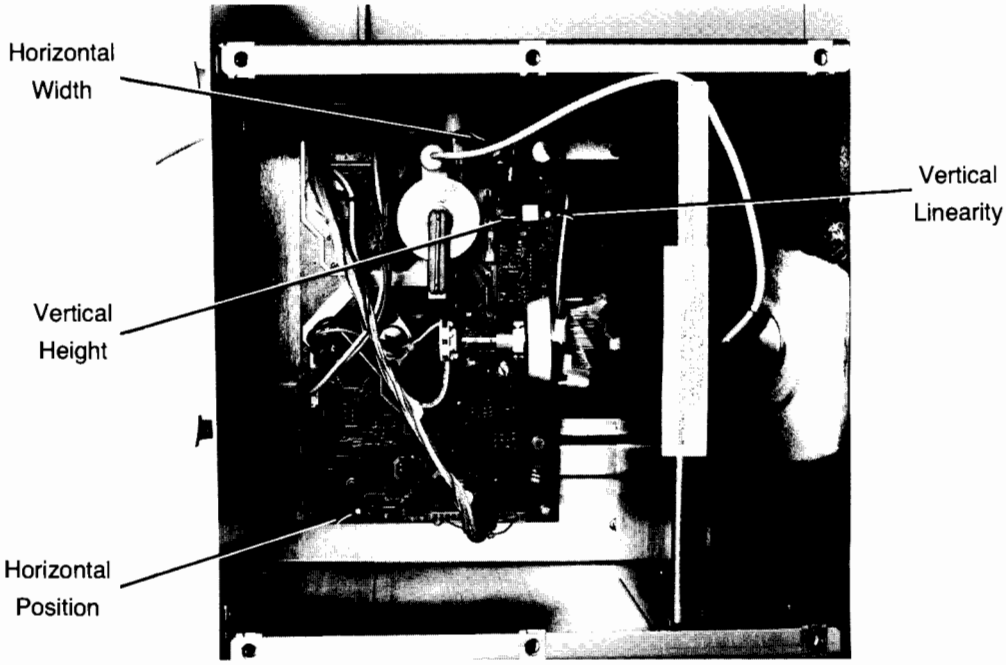


Figure 5-24B. 9836A Additional CRT Adjustments.

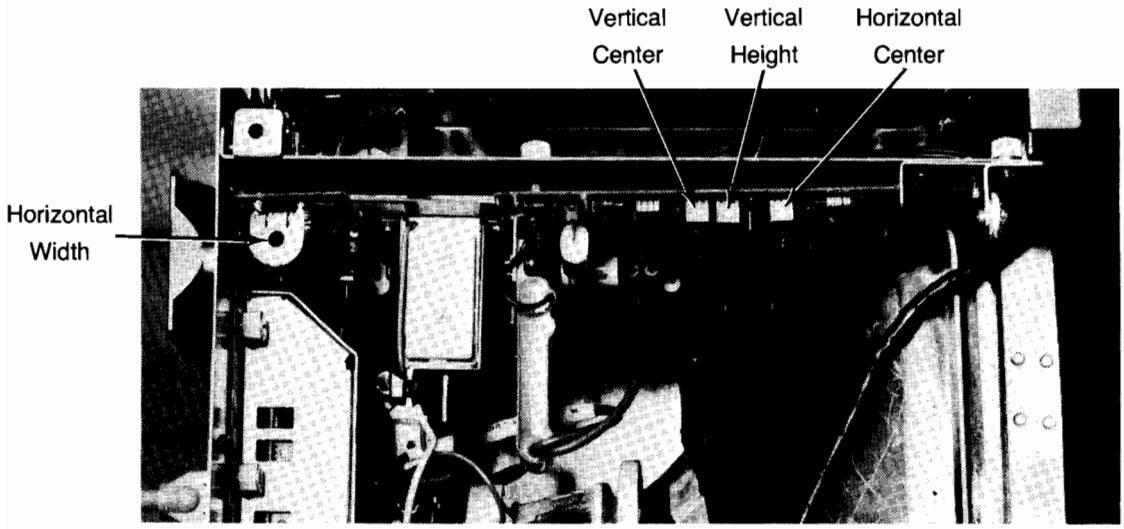


Figure 5-24C. 9836C Additional CRT Adjustments.

9836C Color Intensity Alignment

A critical aspect of 9836C 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 one 9836C display does not "look" like another 9836C display. 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 9836C 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 (grid 2).

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 customer points out that a given graphics display differs from 9836C to 9836C. This is an indication that at least one of them is out of adjustment.

Selecting a Photometer

There are many grades of photometers or light meters available. When selecting one to use in this alignment procedure, make sure that it operates over a wide range and is accurate to within 10% of the reading (not 10% of the full scale). Ordinary photographic light meters are generally not accurate enough.

Hewlett-Packard has qualified two photometers for adjusting the intensity, the Tektronics J16 photometer (with the J6503 probe) and the Photodyne 19XE radiometer. The J16 photometer reads in foot-lamberts and the 19XE radiometer reads in steradians. The 19XE has the additional feature of being self-adjusting.

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 9836C to face directly away from the nearest windows or cover them with opaque drapes. The CRT bezel decreases sensitivity to ambient light, so leave it installed. The numbers given later on assume that the bezel is in place.

Temperature. The temperature should be maintained at 60 to 80 degrees during the adjustment process, with the unit powered on for at least 15 minutes beforehand. If the unit was brought from a location with a different temperature, it should be powered on for a proportionately longer time, as much as an hour for extreme temperatures.

How It Works

Here is some background information on how CRT tube biasing works, and how the intensity adjustment affects it.

A color CRT tube differs from a monochrome tube in that it has three separate cathodes, one for each primary color. The rest of the tube is pretty much the same. The 9836C tube has three screen grids (grid 2), but they are connected in parallel, with one adjustment affecting all three.

In order to obtain a certain spot size on the CRT face, we set the lowest cut-off cathode to 0 V and adjust the screen grid voltage to achieve cut-off. This defines where the actual threshold of visibility for each gun is (it will be different for each gun).

Then the cathode clamp pots are used to set the midpoint between signal step 0 and step 1 to be equal to the threshold of visibility. The gain pot is then adjusted to obtain the proper step 15 intensity. Since the gain pot slightly affects the midpoint between step 0 and step 1, and the clamp pot also affects intensity, it is necessary to repeat the process at least once (that is, set the clamp, set the grain, reset the clamp, reset the gain) in order to obtain satisfactory results.

We then repeat this procedure 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.

The adjustment procedure requires that you display several different rasters. These are available in the graphics patterns in k23 (or k24 for 50 Hz areas) of the test card or system test disc, or you can use the 9836C Color Alignment Discs.

Graphics Patterns. To use the graphics patterns, install the test card or disc and turn the computer on. Press (RESET) (shift pause) and select test k23 (or k24) from the menu. The test displays a threshold raster containing the three basic colors in horizontal segments (resembling Neapolitan ice cream). The phrase

VERIFY THAT USER BRIGHTNESS IS SET TO MAXIMUM

appears on the raster. Pressing (PAUSE) holds this pattern until the (CONTINUE) key is pressed.

The next pattern displayed is a black raster. Pressing the (SHIFT) key while rotating the RCK knob dsiplays a one-color step 1 raster. Rotating the RCK knob chooses between a red, green, blue and white step 1 raster. Pressing the (SHIFT) key while rotating the RCK knob causes a one-color step 15 raster to be displayed. Again, the RCK knob chooses between a red, green, blue and white level 15 raster. Pressing the (SHIFT) key while rotating the RCK knob shifts back to the black raster.

Alignment Discs. All of the rasters needed for the alignment are available in an interactive, user-friendly form on a pair of discs called the 9836C Color Alignment Discs. They can be obtained under part numbers 09836-10604 and 09836-10605. To use them, install the BASIC disc in the right-hand drive and the alignment patterns disc in the left-hand drive. The patterns contain instructions for performing the alignment.

Due to the extreme ease of use provided by these discs, anyone needing to perform the alignment procedure is strongly encouraged to obtain them. The instructions presented differ slightly from those in the written procedure, however the end result will be the same.

The intensity adjustment procedure requires performing six tasks:

1. Set up the test conditions.
2. Determine the cathode cut-off points.
3. Adjust the screen grid.
4. Adjust the clamp and gain pots for the low cut-off gun (two iterations).
5. Repeat Task 4 for the middle cut-off gun.
6. Repeat Task 4 for the high cut-off gun.

Note that it is absolutely essential that the Tasks be performed in the above order. Each Task affects those which follow it.

The alignment program on the Color Alignment Discs has a convenient feature which allows you to "back up" to a previous task if you make a mistake. The program requires you to input test data at frequent intervals. The data needed will always be positive. If you wish to back up, simply enter negative data. The program will back up to the previous task. If you wish to back up two tasks, enter negative data to back up one task, then enter negative data again to back up another task.

Note

The alignment procedure can be performed while the computer is operating at either 50 or 60 Hz. If done at 50 Hz, the computer will operate correctly at 50 or 60 Hz. If done at 60 Hz, it may not operate correctly at 50 Hz.

Task 1, Set Up. Turn the machine on to warm it up. If it is facing a window, move it so that it is facing away or close the drapes. Get all of the equipment ready. Remove the display cover and high voltage shield. Familiarize yourself with the location of the adjustment pots and test points. Figure 5-25 shows the location of these. Also, position the intensity control at maximum. The intensity control is located under the left-hand edge of the base. Turn the control toward the front until it stops.

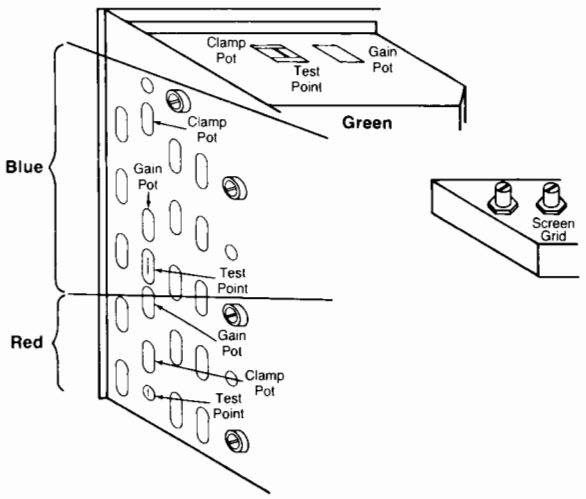


Figure 5-25. Video Adjustment Pots and Test Points.

Note

The display chassis is coated with a non-conducting substance which makes it a poor ground. Therefore, attach the ground lead to the base-to-display cable connector hardware or the ground terminal provided on the rear panel of the base unit.

Task 2, Cut-off Points. The second Task, is to determine the cut-off points of the three cathodes. Use the following procedure to do so. When setting a raster to cut-off, check the upper left corner and all edges.

1. Turn all clamp and gain pots fully clockwise.
2. Display a Neapolitan (three-color) raster.
3. Set the screen grid pot so that each color is dim, but visible.
4. Display a step 1 red raster.
5. Turn the blue and green clamp pots fully counter-clockwise.
6. Adjust the red clamp pot to just barely extinguish the raster.
7. Measure and record the voltage on the red test point.
8. Display a step 1 green raster.
9. Turn the red and blue clamp pots fully counter-clockwise.
10. Adjust the green clamp pot to just barely extinguish the raster.
11. Measure and record the voltage on the red test point.
12. Display a step 1 blue raster.
13. Turn the red and green clamp pots fully counter-clockwise.
14. Adjust the blue clamp pot to just barely extinguish the raster.
15. Measure and record the voltage on the blue raster.

You now know which cathode has the low, middle and high cut-off voltage.

Task 3, Screen Grid. Set the voltage on the screen grid by using the following procedure:

1. Set the clamp pot for the low cut-off cathode fully clockwise.
2. Set the other two clamp pots fully counter-clockwise.
3. Leave the gain pots fully clockwise.
4. Display a black raster.
5. Adjust the screen grid pot to just barely extinguish the raster.

Task 4, Low Cut-off. Adjust the cathode with the low cut-off point with the following procedure:

Note

This procedure includes instructions for zeroing your photometer. If your meter has an auto-zero feature, skip steps 9 to 11. The Photodyne 19XE has the auto-zero feature.

1. Display a black raster.
2. Adjust the clamp pot to just cut-off the raster.
3. Measure and record the voltage on the test point for that clamp pot (call it V1).

Note

V1 will be 0V (clamp pot fully clockwise) on the first pass through the low cut-off gun.

---

4. Display a step 1 raster for the cathode being aligned.
5. Adjust the clamp pot to just cutoff the raster.
6. Measure and record the voltage on the test point for that clamp pot (call it V2).
7. Add V1 to V2 and divide by two. The resulting voltage is the desired one for the test point (call it Vset).
8. Set the clamp pot so that the test point reads Vset.
9. Temporarily unplug the display power cord. Leave the base plugged in. If your meter has the auto-zero feature, skip to step 12. The 19XE auto-zeros.
10. Place the photometer in the center of the CRT and zero it.
11. Reconnect the display power cord and confirm the black raster is still present.
12. Display a step 15 raster for the cathode being aligned.
13. Measure the brightness in the center of the screen.
14. Adjust the gain pot until you obtain the meter reading listed in this table:

	foot-lamberts		$\mu W/M^2sr$*	
Color	50 Hz	60 Hz	50 Hz	60 Hz
red	4.4	5.2	.135	.160
green	11.2	12.8	.165	.195
blue	2.0	2.2	.180	.215

* All values + or − .005.

15. Now repeat steps 4 through 14. This is necessary because the clamp and gain pots interact to a small degree. The pots should need only a small amount of adjustment. If any require a large amount, you have probably done something wrong.

Task 5, Middle Cut-off. Repeat Task 4 for the cathode with the middle cut-off.

Task 6, High Cut-off. Repeat Task 4 for the cathode with the high cut-off.

Computer Museum

9836C Display Troubleshooting

Introduction

This portion of the Troubleshooting chapter contains information to troubleshoot the 9836C display. Each section presents a flowchart and procedure for troubleshooting the display to a specific level.

The various sections of the chapter cover:

Initial Display Troubleshooting Procedure. This section covers how to quickly determine what level to start at. It tells you which procedure to start with, rather than going through each procedure until the problem is diagnosed.

Turn-on Troubleshooting Procedure. This section covers what to do when the display does not appear to turn on when the base unit is turned on. The problem typically is with the path for the base +12 V, which the display power supply uses as a turn-on signal.

Dead Display Unit Procedure. This section covers troubleshooting a display unit which will not power up at all. Dead display units typically have problems in the power supply.

Sweep Troubleshooting Procedure. This section covers troubleshooting a display unit which has correct power supply voltages but will not properly display any color. These display units typically have problems with the CRT/yoke assembly, sweep board, digital board or interconnections.

Video Troubleshooting Procedure. This section covers troubleshooting a unit which can display at least one color but is missing at least one color. These display units typically have problems with the CRT/yoke assembly, video board, digital board or interconnections.

Initial Display Troubleshooting Procedure

In order to choose the best approach to start with, make sure that the non-video portions of the unit are operating properly, such as the base power supply and processor. Then make your best guess as to the problem area. If the CRT correctly displays at least one color, you can be sure that the power supply and sweep functions are operating correctly, and the video troubleshooting procedure would be a good place to start. If the information obtained from the display is not conclusive, use the following procedure to determine the problem area. The Initial Display Troubleshooting Flowchart in Figure 5-26 summarizes this procedure.

1. Turn the computer on while listening for the display power supply relays to click. This can be heard through the right-hand air vents in the display.
2. If the relays do not click, go to the turn-on troubleshooting procedure.
3. If the relays click, examine the display to see if it correctly displays any of the basic colors, red, green or blue. The system test disc, test card or a simple program can be used to display colors.
4. If one or two colors are correctly displayed, go to the video troubleshooting procedure. (Of course, if all three colors are correctly displayed, there is no problem.)
5. If no colors are displayed, check the display power cord to make sure that it is correctly plugged in to both the display and a power source. The 9836C is different from previous computers in that it requires two power cords.

6. Turn the unit off and check the display unit fuse. If it is open, go to the dead display unit procedure.
7. If the fuse is good, turn the unit on and check for the high voltage being on. There are two ways to do this. You can listen for the high voltage crackle through the left-hand air vents in the display, or you can check the green LED on the top edge of the sweep board by removing the CRT high voltage shield.
8. If the high voltage does not come on, go to the sweep troubleshooting procedure.
9. If the high voltage does come on, turn the intensity potentiometer all the way up. Then carefully mark the position of the screen grid (grid 2) potentiometer on the sweep board. Observe the display and turn it up (clockwise).
10. If you can see lines on the display, go to the video troubleshooting procedure. If you cannot see lines, go to the sweep troubleshooting procedure. In either case, turn the screen pot back to its original position, as you may damage the video board by leaving the screen pot turned up.

CAUTION

MAKE SURE THAT THE SCREEN POTENTIOMETER IS TURNED BACK TO ITS ORIGINAL POSITION. FAILURE TO DO SO MAY DAMAGE THE VIDEO BOARD.

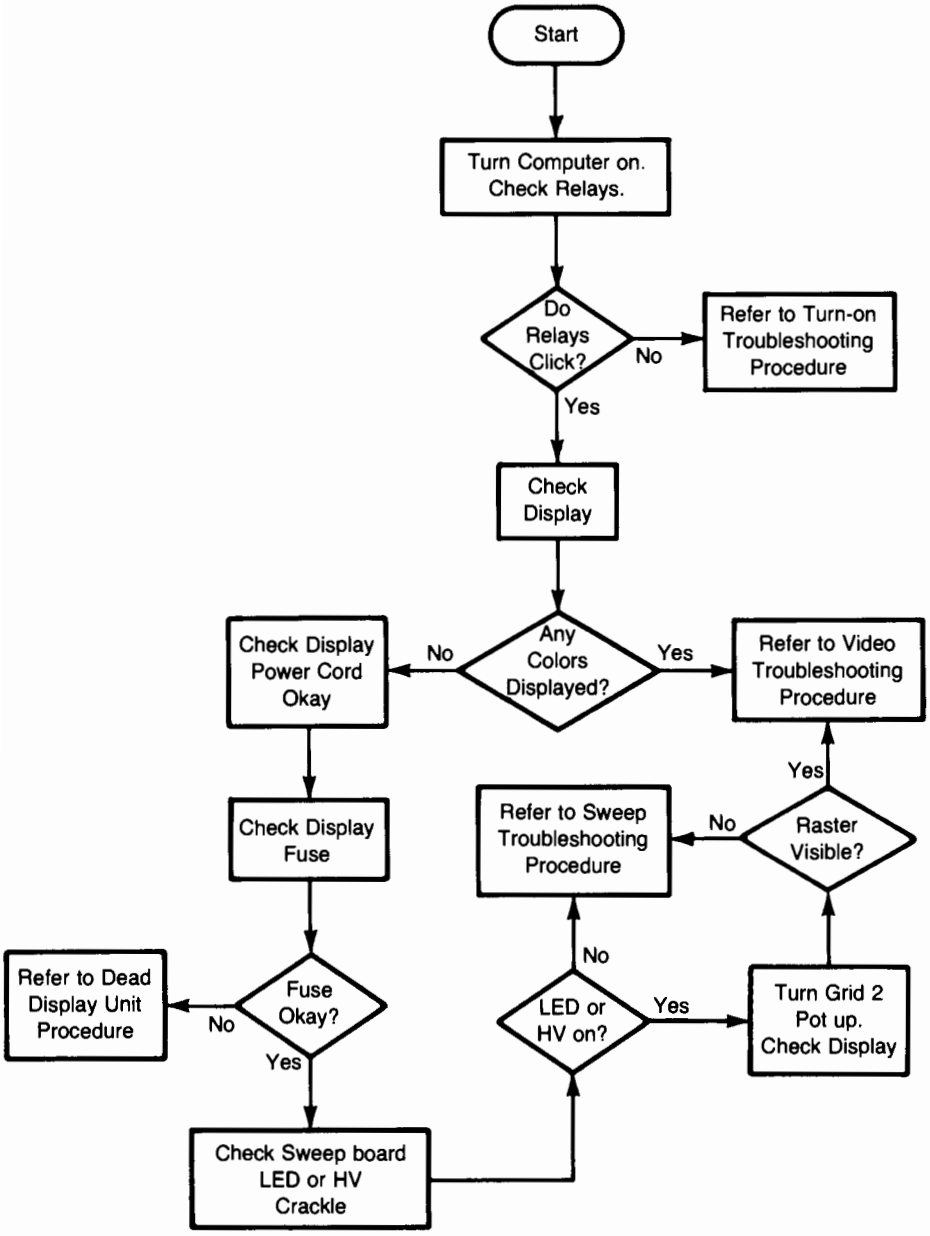


Figure 5-26. Initial Display Troubleshooting Flowchart

Turn-on Troubleshooting Procedure

The turn-on troubleshooting procedure is used when the relays which energize the display power supply fail to act. The relays sense the base +12 V supply and connect the display power supply to the ac line. If the base +12 V supply is not connected to the display, the relays cannot act. The following procedure is used to check the base +12 V supply line. The Turn-on Troubleshooting Procedure in Figure 5-27 summarizes this procedure.

1. Recheck the base-to-display cable to make sure that it is properly connected. If it is, turn the unit on and wiggle the cable while listening for the relays to click. If they click intermittently, you may be able to trace the problem to a defective connector.
2. If the cable checks out, disconnect it from the base. Then turn the unit on and check the base +12 V line at the connector. This is done by reading the dc voltage between pins 7 and 4 in the connector.
3. If you do not read +12 V, remove the base cover and check the +12 V test point on the top edge of the power supply. If it reads +12 V, the base motherboard is defective. If it does not read +12 V, refer to the dead unit procedure for the base power supply.
4. If you do read +12 V at the connector, reconnect the cable and remove the display power supply board. Then check the dc voltage between pins A1 and A2 in the motherboard connector.
5. If you read +12 V, the display power supply is defective.
6. If you do not read +12 V, disconnect the cable from the display and read the dc voltage between pins 7 and 4 in the cable.
7. If you read +12 V, the display motherboard is defective. If you do not read +12 V, the cable is defective.

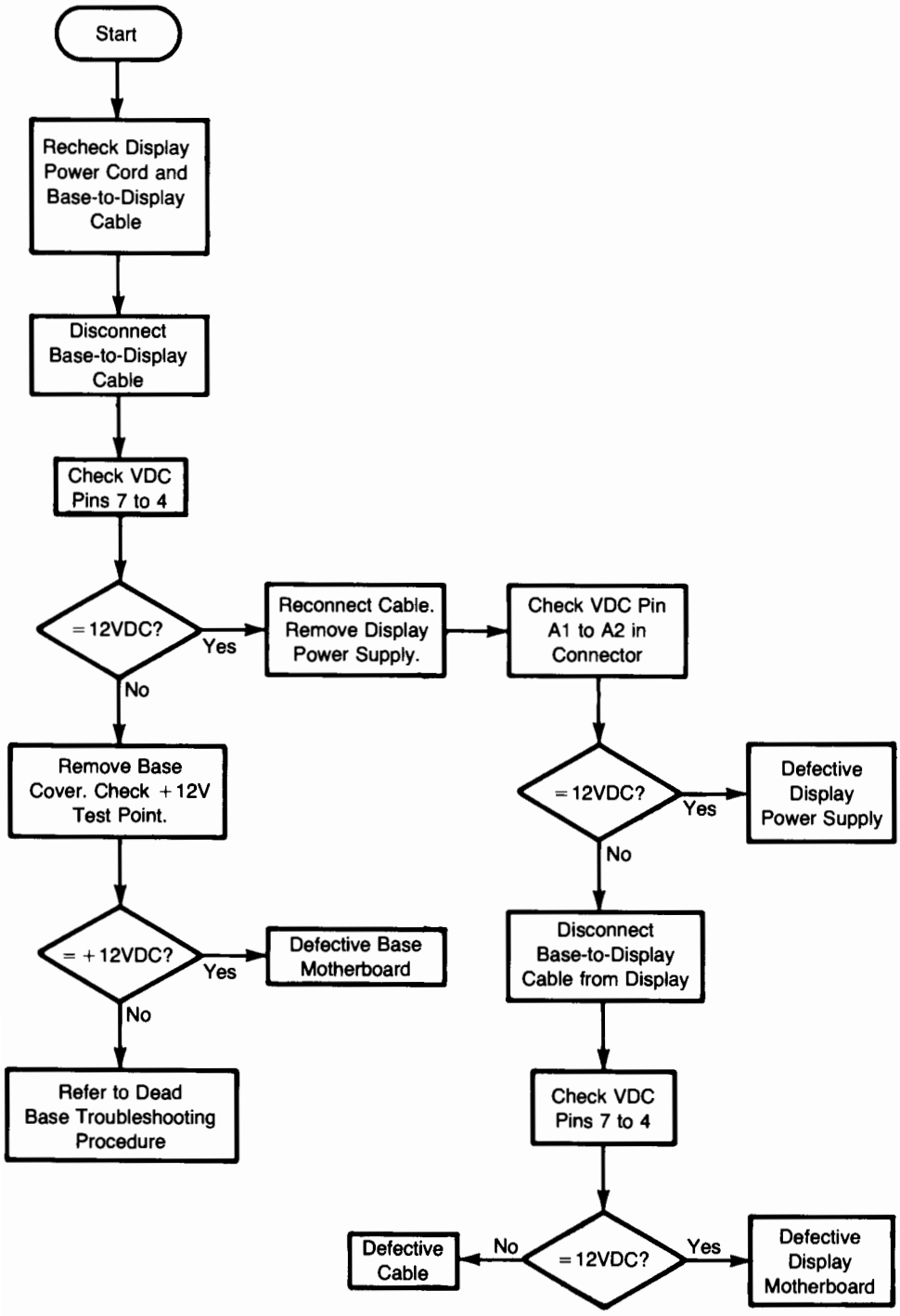


Figure 5-27. Turn-on Troubleshooting Flowchart

Dead Display Unit Procedure

A dead display unit is one which does not appear to function at all, although it is sensing the base +12 V supply line. The most usual symptom is an open fuse in the display power supply. Use the following procedure to troubleshoot a dead display unit. The Dead Display Unit Flowchart in Figure 5-28 summarizes this procedure.

WARNING

HAZARDOUS VOLTAGES ARE PRESENT IN THE UNIT WHEN IT IS TURNED ON. TURN THE UNIT OFF BEFORE PLACING METER LEADS, CHECKING FUSES OR REMOVING OR REPLACING ASSEMBLIES.

1. Disconnect the fan and degauss cables from the display power supply. Replace the fuse, operate the computer momentarily and recheck the fuse. If the fuse is open, skip to step 3.
2. If the fuse is good, reconnect the fan. Then operate the computer momentarily and recheck the fuse. If it is still good, the degauss cable is defective. If it is now open, the fan is defective.
3. Replace the display power supply assembly and check the operation. If the computer operates properly, check the adjustment of the display.
4. If operation is not proper, replace the sweep board and check the operation. If the computer operates properly, continue with the adjustment procedures.
5. If operation is not proper, replace the video board and check the operation. If the computer operates properly, continue with the adjustment procedures.
6. If operation is not proper, replace the CRT/yoke assembly and continue with the adjustment procedures.

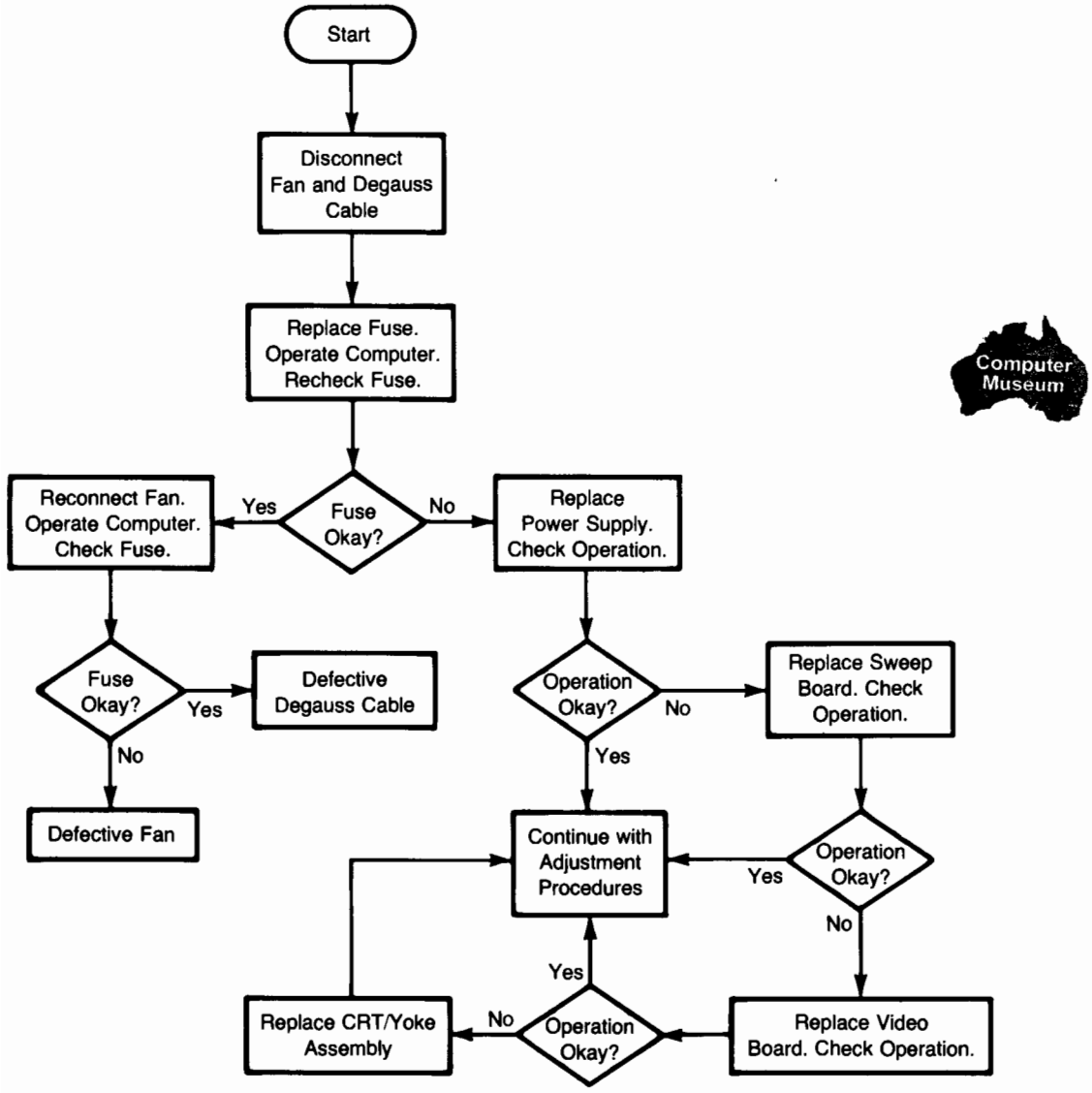


Figure 5-28. Dead Display Unit Troubleshooting Flowchart

Checking the Display Power Supply

Many problems in electronic equipment can be traced to a low or unstable supply voltage. If the display power supply is functioning but you suspect a problem with a voltage level, check the test points on the power supply (see Figure 5-29).

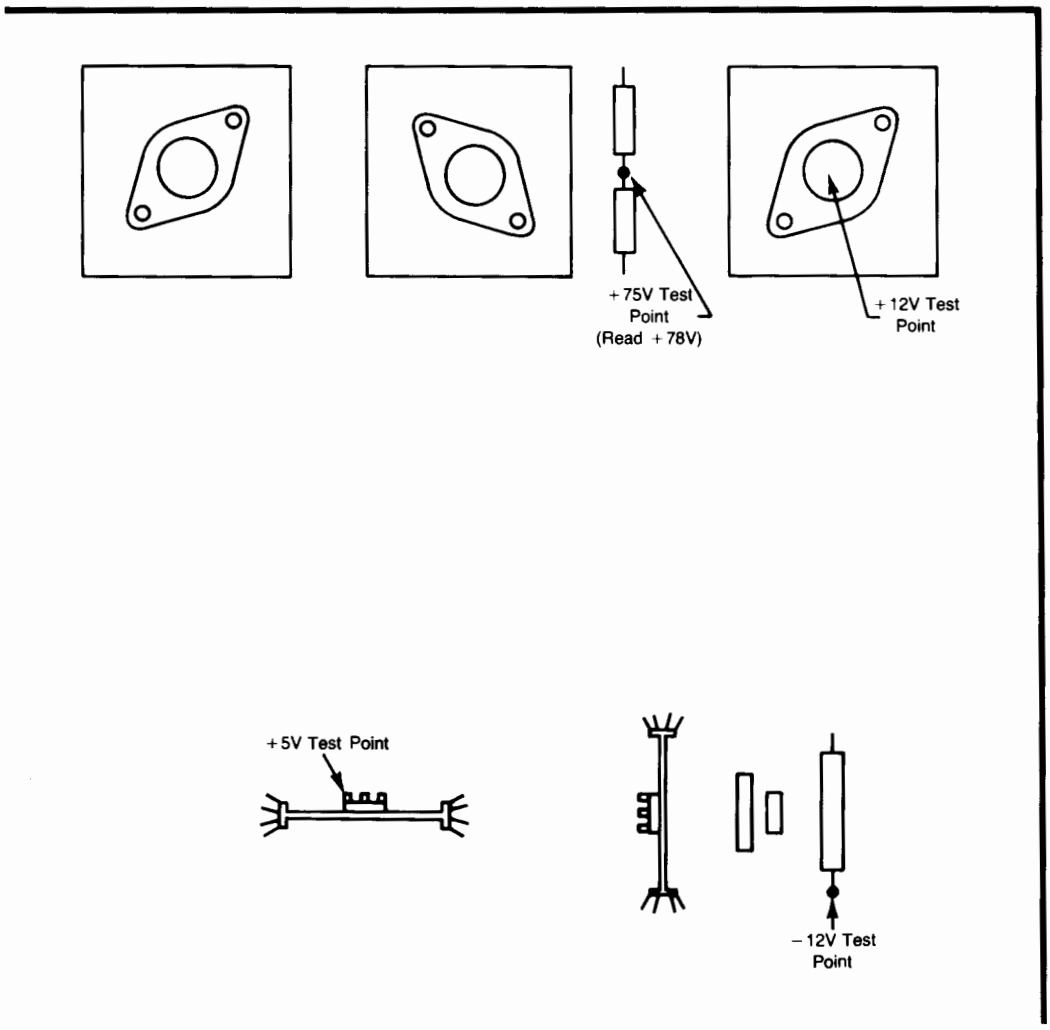


Figure 5-29. Display Power Supply Test Points.

Sweep Troubleshooting Procedure

Use the sweep troubleshooting procedure when you suspect a problem with the sweep circuitry. Symptoms might be: no raster, no high voltage or the sweep board LED not turning on. Use the following procedure to check the sweep circuitry. The Sweep Troubleshooting Flowchart in Figure 5-30 summarizes this procedure.

1. Start by confirming that the display power supply is producing the correct voltage supplies. Do this by checking the test points listed in the section on the display power supply. If they are correct, skip to step 4.
2. If the supply voltages are incorrect, the power supply may be defective or the sweep board may be putting it into overcurrent mode. Remove the sweep board and recheck the voltages.
3. If they are now correct, the sweep board is defective. Replace it and continue with the adjustment procedures. If they are still incorrect, the power supply is defective.
4. If the power supply voltages were originally correct, disconnect the base-to-display cable and check pins 11, 14 and 15 with an oscilloscope for the horizontal and vertical sync and vertical blanking signals. If they are present, skip to step 6.
5. If they are not present, check the digital board connector pins 42, 43 and 47 for the horizontal and vertical sync and vertical blanking signals (see Appendix C for location of these pins). If they are present, the base motherboard is defective. If not, either the digital board or the graphics board is defective.
6. Disconnect the base-to-display cable from the display and reconnect it to the base. Then check pins 11, 14 and 15 in the connector for the horizontal and vertical sync and vertical blanking signals. If they are not correct, the cable is defective.
7. If they are present, remove the sweep board and check the motherboard connector pins A1, B1 and B10 for the horizontal and vertical sync and vertical blanking signals. If they are not correct, the motherboard is defective.
8. If they are present, install a new sweep board and check the operation. If it is correct, continue with the adjustment procedure. If operation is not correct, the problem probably lies with the CRT/yoke assembly or the video board. Continue with the video troubleshooting procedure.

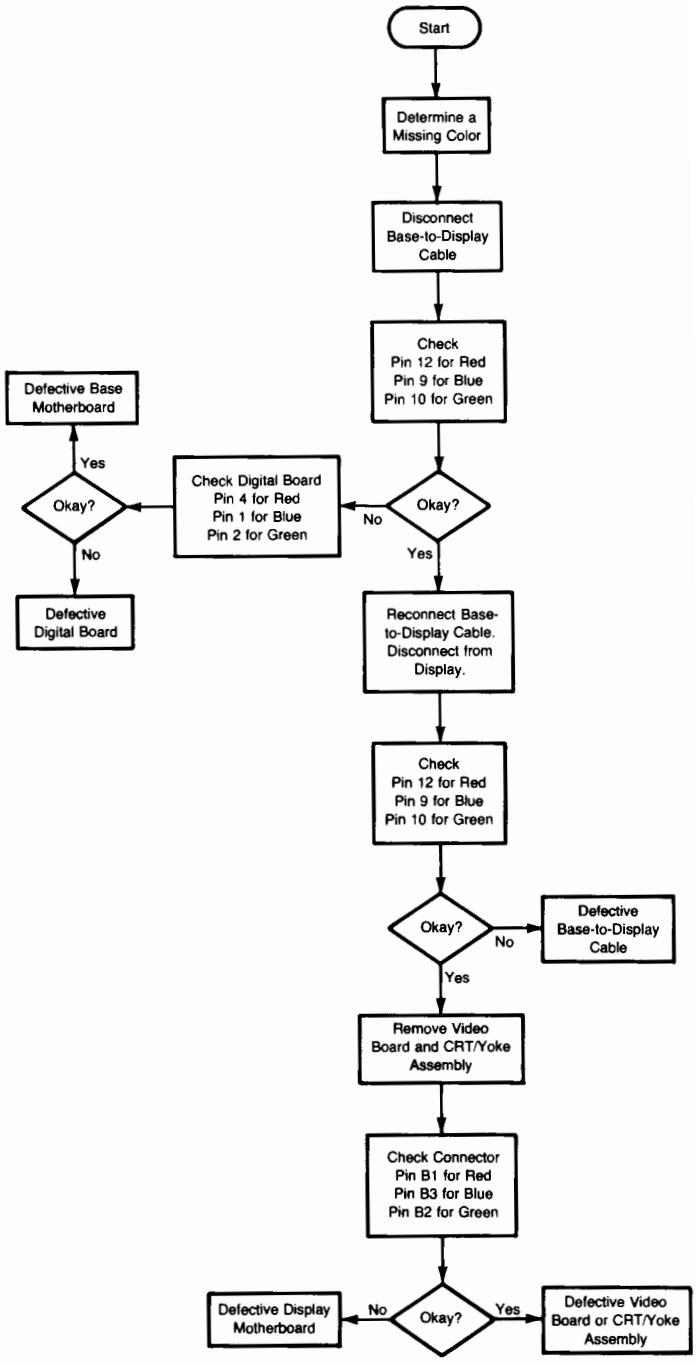


Figure 5-30. Sweep Troubleshooting Flowchart

Video Troubleshooting Procedure

Use the video troubleshooting procedure when you suspect a problem with the video circuitry. Symptoms usually are one or more of the primary colors (red, green and blue) missing, although three missing colors generally indicates a sweep or power supply problem. Use the following procedure to check the video circuitry. The Video Troubleshooting Flowchart in Figure 5-31 summarizes this procedure.

1. Start by determining a missing primary color (red, green or blue). The troubleshooting process is identical for all colors except that the pin numbers will be different. They will be represented in this procedure as red (green, blue).
2. Disconnect the base-to-display cable from the base and use an oscilloscope to check pin 12 (10, 9) for the correct video signal. If it is correct, skip to step 4. You must display the appropriate color in order to do this. The easiest way is to select the full rasters in the Graphics test (k7). Use the RCK to select among the colors.
3. If it is incorrect, check the digital board video connector pin 4 (2, 1) (see Appendix C for location of these pins). If the signal is correct, the motherboard is defective. If not, the digital or graphics board is defective.
4. Disconnect the base-to-display cable from the display and reconnect it to the base. Then check pin 12 (10, 9) in the connector for the video signal. If it is not correct, the cable is defective.
5. If it is correct, remove the video board and CRT/yoke assembly and check the motherboard connector pin B1 (B2, B3) for the correct video signal. If it is not correct, the motherboard is defective.
6. If it is correct, install a new video board and check the operation. If it is correct, continue with the adjustment procedure. If operation is not correct, install a new CRT/yoke assembly and continue with the adjustment procedure.

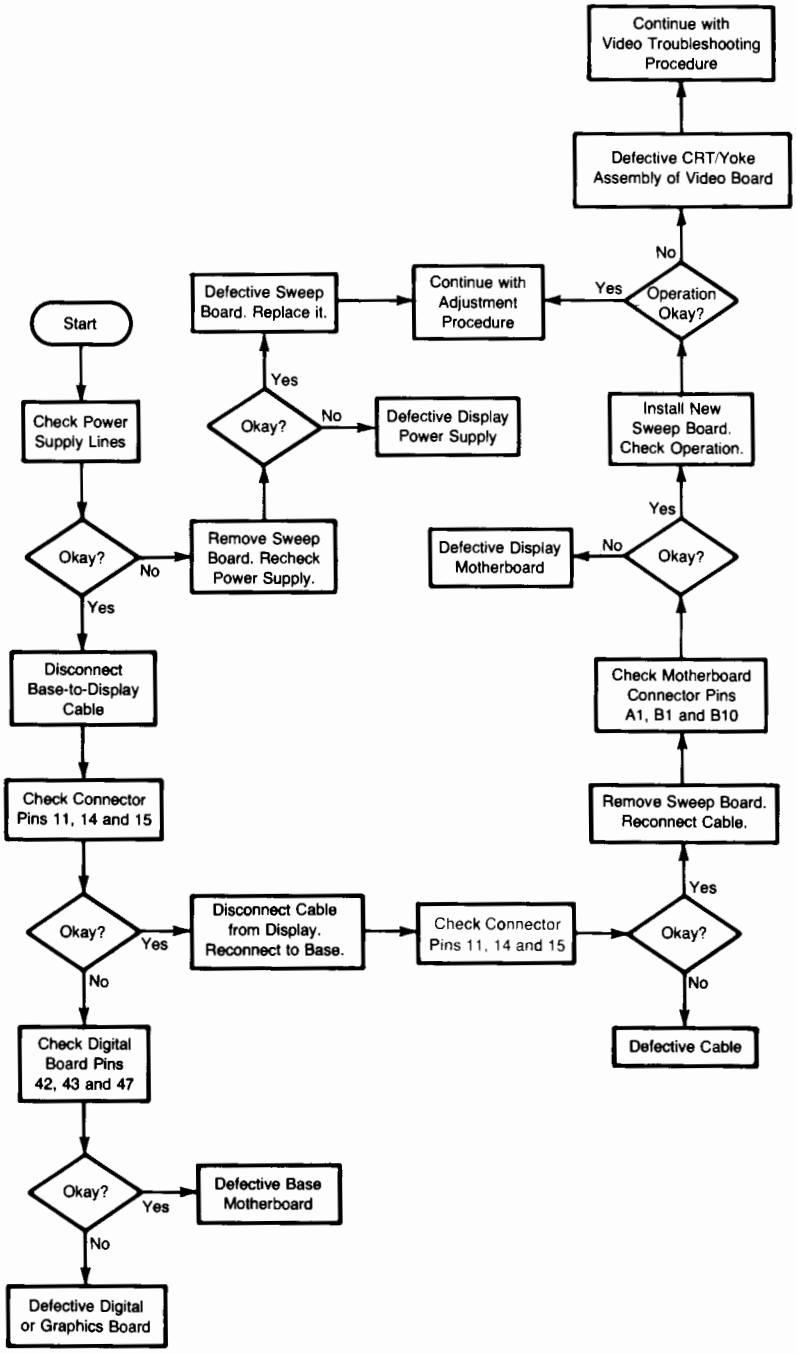


Figure 5-31. Video Troubleshooting Flowchart

Test Card Notes

Revision D is the fourth version of the System Test Code to be released. Previous revisions had different capabilities and have been released in several different forms. This section explains which revisions can diagnose what hardware and how to tell the revisions apart.

Capabilities

The test code runs on the processor board. Revised code was produced each time a new processor board was produced. This chart shows which processor boards can be diagnosed by the various revisions:

Revision A	Revision B	Revision C	Revision D
09826-66511	09826-66511	09826-66511	09826-66511
09826-66514	09826-66514	09826-66514	09826-66514
	09826-66515	09826-66515	09826-66515
		09826-66516	09826-66516
			09826-66517

Operational Differences

Available Tests

Tests were added as the code was revised. Here is a list of the tests added with each revision:

Revision A

Processor (k0)
ROM checksum (k1)
RAM pattern (k2)
CRT character (k3)
Keyboard (k4)
Disc drive (k5)
Extended RAM (k6)
CRT graphics (k7)
Extended CRT graphics (k8)
Disc drive diagnostic (k9)

Revision B

Powerfail board (k20)
60 Hz CRT alignment patterns (k23)
Keyboard message routine (k39)

Revision C

CPU PROM (k21)
RAM with speed messages (k22)
50 Hz CRT alignment patterns (k24)
I/O configuration (k26)
Serial interface (k28)

Revision D

Memory management unit and programmable timer module (k25)
Cache memory (k27)
Memory management unit, programmable timer module and cache memory (k29)

Error Messages

Many error messages have been updated from one revision to the next. However, messages found in earlier revisions are recognizably similar to the messages listed here. For example, none of the disc drive section messages in Revision A indicate which drive the message pertains to, due to the fact that the 9826 has only one drive. A margin error, for instance, produces the message "MARGIN" in Revision A, rather than the message "DRV D MARGIN".

Memory Maps

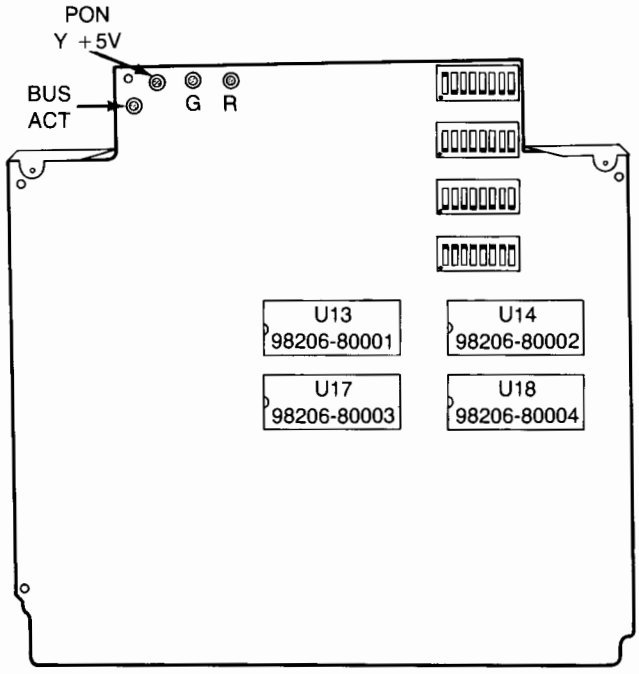
The memory maps displayed by earlier revisions are not as complete as later ones. Also, Revision A is unable to access any RAM memory boards which are not contiguous. For example, if a 9826 contained a "14" processor board and one 64k RAM board addressed FCXXXX, Revision A test code would only indicate 64k of RAM, the RAM on the processor board. Later revisions would indicate 128k, 64k at address FFXXXX and 64k at FCXXXX. This is not a drawback because the 9826 is unable to access non-contiguous RAM, either.

Physical Differences

Revisions A and B come packaged on a different circuit board than Revisions C and D. The boards can be distinguished by the fact that the early board is approximately square and has a ribbon cable attached to it. The later board has two corners cut out and has no ribbon cable.

Revision C and D cards differ only in that they have different EPROMs. The Revision D EPROMs have the same part numbers as the Revision C EPROMs. Revision D EPROMs obtained from the factory have a Rev. D sticker attached to them. If you are unsure as to which revision you have, install the card in a mainframe and look at the power-up display. The first line states the revision level.

To upgrade a Revision C card to a Revision D, order part number 98206-66502. Then install the EPROMs according to this diagram:



Socket	Marking
U13	98206-80001
U14	98206-80002
U17	98206-80003
U18	98206-80004

Turn-on Self Test Procedure

A turn-on self test contained in the 3.0 boot ROM can be used to troubleshoot a unit which can execute some instructions, but cannot accept, store or output data correctly. This means that the basic elements of the computer are functioning. The basic elements include the power supply, processor, CPU bus, boot ROMs and at least the first 16k bytes of RAM. If any of these are not known to be functional, refer to the initial problem isolation section and flowchart.

All 9836Cs contain the 3.0 boot ROM, as well as many 9826As and 9836As. To determine whether a computer has the 3.0 boot ROM, check the CRT display for the boot ROM version. If the CRT display is not functioning, remove the base cover and look at the processor board. If it is an 09826-66516 board, it has the 3.0 boot ROM.

The turn-on self test runs tests on many portions of the computer and produces error and status messages on the CRT. It also displays error codes on the self test LED display located on the top edge of the Processor board and annunciates the seven least significant digits of the error code on the speaker.

The LEDs are read with the most significant bit on the left. The speaker represents a zero with a low-pitched beep and a one with a high-pitched beep.

The self test starts by turning all of the self test LEDs on, then quickly turning them off from left to right. It then starts the tests of individual sections. If this routine does not occur, not enough hardware is operating for self test to be meaningful. Refer to the initial troubleshooting procedure.

The test sequence can be made to run continuously. This is accomplished by enabling the CST switch on the processor board. The CST switch is segment one of the switch block on the top edge of the Processor board. It is enabled by setting it to the closed position.

Self Test Sequence

The self test consists of a sequence of tests which check individual sections of the computer. The names of the tests and the numbers displayed on the LED display are as follows:

Test	LED display	Hex equivalent
Top 16k RAM test	0000 0100	04
CRT alpha test	0001 1110	1E
Keyboard test	0001 0010	12
PROM checksum	0000 1011	0B
Boot ROM checksum	0000 0011	03
CRT graphics test	0001 1111	1F
Powerfail test	1000 1010	1A
Disc Drive test	0001 0110	16
Internal HP-IB test	0001 0100	14
DMA Card test	0001 1000	18
I/O board test	001X XXXX	20 to 3F
ROM checksum test	0000 1101	0D
RAM test	0000 1001	09

This test sequence runs once upon turn-on, then returns control to the boot ROM if all hardware passed. If a failure was detected, one of two things happens. Self test will stall, with the number of the stalled test indicated in the LED display, or self test will complete and the LED display will indicate an error code for the highest priority failure encountered.

Running the Self Test

To run the turn-on self test, follow this procedure:

1. Turn the computer on and observe the LED display on the top edge of the processor board. All the LEDs should turn on, then turn off in sequence from left to right. Then they should start displaying test numbers. If the LEDs fail to go through this routine or display meaningless data, not enough of the computer is functioning for the self test to produce results. Refer to the initial troubleshooting procedure.
2. If the self test generates error messages or error codes, a hardware problem exists. The defective section is indicated in the following charts:

CRT Message	Refer to Section
BOOTROM X.Y Failed	Boot ROM Memory Test
ROM X at MNPQRS Failed	ROM Memory Test
ROM X at MNPQRS Ignored	ROM Memory Test
RAM Gone Above FFC000	RAM Memory Tests
RAM Failed Above FFC000	RAM Memory Tests
Memory Failed at XXXXXX W:ZZZZZZZZ, R:YYYYYYYY	RAM Memory Tests
Alpha Failed	Display Tests
Alpha Missing	Display Tests
Graphics Failed	Display Tests
Graphics Missing	Display Tests
Keyboard Failed	Keyboard Test
Keyboard Missing	Keyboard Test
HP-IB Failed	I/O Tests
HP-IB Missing	I/O Tests
HP9862Y at SC Failed	I/O Tests
HP9862Y at SC Missing	I/O Tests
DMA Failed	I/O Tests
DMA Missing	I/O Tests
Flexible Disc Failed	Disc Drive Test
Flexible Disc Missing	Disc Drive Test
Battery Failed	Powerfail/Real Time Clock Test

LEDs	Hexadecimal Equivalent	Refer to Section
0000 0000	00	No Failure
0101 0010	52	Keyboard Test
0101 0100	54	I/O Tests
0101 0110	56	Disc Drive Test
0101 1000	58	I/O Tests
0101 1010	5A	Powerfail/Real Time Clock Test
0101 1110	5E	Display Tests
0101 1111	5F	Display Tests
011X XXXX	60 to 7F	I/O Tests
1000 0001	81	Processor Test
1000 0011	83	Boot ROM Memory Test
1000 0100	84	RAM Memory Tests
1000 1001	89	RAM Memory Tests
1000 1010	8A	RAM Memory Tests
1000 1011	8B	PROM Memory Test
1000 1101	8D	ROM Memory Test
1001 0010	92	Keyboard Test
1001 0100	94	I/O Tests
1001 0110	96	Disc Drive Test
1001 1000	98	I/O Tests
1001 1010	9A	Powerfail/Real-time Clock Test
1001 1110	9E	Display Tests
1001 1111	9F	Display Tests
101X XXXX	A0 to BF	I/O Tests
1111 1111	FF	LEDs Never Accessed

3. If the self test LED display indicates that self test is running but no error or status messages are generated, one or more of the CRT assemblies is probably defective.

Processor Test

The entire processor section is contained on the processor board. Here is a list of the computer assemblies involved:

09826-69516	Processor/RAM board
09826-69517	Processor/MMU board

These boards are exchange assemblies.

Note

When replacing an 09826-69516 or 09826-69517 board, remove the configuration and identification PROM from the defective board and install it on the replacement board. If you fail to do so, there will be no indication except that the power-up display will no longer include the serial number and the computer will no longer run secured software.

The processor test does a write-read check of the CPU registers.

If the processor test fails, the following LED display and CRT message are presented:

LED Display	CRT Message	Probable Cause	What to Do
1000 0001	None	Defective CPU	Replace Processor Board

PROM Memory Test

The PROM is contained on the processor board. Here is a list of the assemblies involved:

09826-69516	Processor/RAM board
09826-69517	Processor/MMU board

These boards are exchange assemblies.

Note

When replacing an 09826-69516 or 09826-69517 board, remove the configuration and identification PROM from the defective board and install it on the replacement board. If you fail to do so, there will be no indication except that the power-up display will no longer include the serial number and the computer will no longer run secured software.

The Programmable Read-Only Memory (PROM) test performs a checksum of the PROM. While it is running, the LEDs display 0000 1011, and the CRT displays the product number (9836C) and the machine serial number, along with the Copyright Notice:

Copyright 1982, Hewlett-Packard Company. All Rights Reserved.

If the PROM test fails, the following LED display and CRT message are presented:

LED Display	CRT Message	Probable Cause	What to Do
1000 1011	PROM Failed	Defective PROM	Replace PROM Replace Processor Board

System ROM Memory Test

The system ROM test performs a checksum on system ROM contained on cards installed in the backplane.

This test searches the ROM space between 004000 and 010000 (hexadecimal). While it is running, the LEDs display 0000 1101. No message is displayed on the CRT.

If the system ROM test fails, the following LED display and CRT message are presented:

LED Display	CRT Message	Probable Cause	What to Do
1000 1101	ROM X at MNPQRS Failed	Defective ROM at address MNPQRS	Replace ROM System at MNPQRS Replace Processor Board

If the system ROM test encounters a system ROM which only supports a 50 character wide CRT, the following LED display and CRT message are presented:

LED Display	CRT Message	Probable Cause	What to Do
1000 1101	ROM at MNPQRS Ignored	ROM at address MNPQRS only supports 50 character wide CRT	Replace system ROM at address MNPQRS Ignore the Message

RAM Memory Tests

Random-Access Read/Write Memory (RAM) is contained on the processor/RAM board and on external boards which are installed in the backplane. Here is a list of the assemblies involved:

09826-69516	Processor/RAM board
09826-69526	256k RAM board

Both of these are exchange items.

Note

When replacing an 09826-69516 or 09826-69517 board, remove the configuration and identification PROM from the defective board and install it on the replacement board. If you fail to do so, there will be no indication except that the power-up display will no longer include the serial number and the computer will no longer run secured software.

Top RAM Test

The self test needs 16k bytes of RAM to operate properly. The top RAM test checks to see that there are 16k bytes of good RAM available at the top of memory. While it is running, the LEDs display 0000 0100.

If the top RAM test fails, the following LED displays and CRT messages are presented:

LED Display	CRT Message	Probable Cause	What to Do
1000 0100	NEED GOOD RAM ABOVE FFC000	Defective RAM in top 16k bytes	Check addressing of RAM
1000 1010		Insufficient RAM for self test	Replace processor board

RAM Pattern Test

The RAM pattern test check all system RAM in the computer; that is, all RAM not dedicated to a specific purpose, such as the display. It exercises the RAM with an up/down march test. While it is running, the LEDs display 0000 1001, and the CRT displays the message

TESTING MEMORY

If the RAM pattern test fails, the following LED display and CRT message is presented:

LED Display	CRT Message	Probable Cause	What to Do
1000 1001	Memory Failed at XXXXXX W:ZZZZZZZZ, R:YYYYYYYY	RAM incorrectly addressed	Check RAM addressing
		Defective RAM	Replace Processor board

Display Tests

The display assemblies are listed below:

	9826	9836A	9836C
Digital board	09826-66573	09826-66576	09836-66572
Graphics board	09826-66575	09826-66577	09836-66573
Analog board	09826-66571	09826-66580	–
CRT/yoke assembly	09826-67921	09826-67922	09836-67924
Video board	–	–	09836-66542
Sweep board	–	–	09836-66540
Display motherboard	–	–	09836-66503
Display power supply	–	–	09836-66550

The 9826 and 9836A graphics boards are exchange assemblies. The other 9826 and 9836A assemblies are to be replaced but not returned to the factory for repair.

All the 9836C assemblies are exchange assemblies except the display motherboard and the CRT/yoke assembly.

When replacing the CRT/yoke assembly, the defective CRT should be disposed of in the shipping container the replacement was received in.

CRT Alpha Test

The CRT alpha test checks the alpha board and does a check of the alpha RAM.

If the alpha board fails this test, the following message is displayed on the CRT:

LED Display	CRT Message	Probable Causes	What to Do
1001 1110	Alpha Failed	Defective Digital Board	Replace Digital Board
0101 1110	Alpha Missing	Defective Processor Board	Replace Processor Board

Note that if the digital board is defective, the CRT message probably will not appear. The LED display will provide the correct indication in any case.

CRT Graphics Test

The CRT graphics test checks the graphics board and does a check of the graphics RAM.

If the graphics RAM fails this test, one of the following messages will appear on the CRT:

LED Display	CRT Message	Possible Causes	What to Do
1001 1111	Graphics Failed	Defective Graphics Board	Replace Graphics Board
0101 1111	Graphics Missing	Defective Processor Board	Replace Processor Board

Keyboard Test

The keyboard section is made up of these assemblies:

09826-66501	Base Motherboard (9826)
09836-66502	Base Motherboard (9836)
(see Table 6-1)	Keyboard Assembly
09826-67910	Rotary Control Knob Assembly

The motherboards are exchange assemblies. The rotary control knob is to be replaced, but not returned to the factory.

The keyboard electronics are located on the motherboard. The keyboard assembly contains only switches.

The keyboard test only checks the electronics. If the electronics fails the test, one of these messages will appear on the CRT:

LED Display	CRT Message	Probable Cause	What to Do
1001 0010	Keyboard Failed	Defective Keyboard Electronics	Replace Motherboard
0101 0010	Keyboard Missing	Defective I/O Select Hardware	

The keyboard test checks the keyboard electronics located on the processor board. It does not check the keyswitches. To check these, use the System Test Disc.

Disc Drive Test

The disc drive is composed of these assemblies:

09826-66562	Disc Drive Control Board
09130-66600	Disc Drive Mechanism

The disc drive mechanism is an exchange assembly. The board is a non-exchange assembly.

When replacing the disc drive mechanism, be sure to remove the drive power connector, the sheet metal cover and the jumper shunt block from the defective drive, and install them on the replacement drive.

The right-hand drive is designated drive 0 and the left-hand drive is drive 1.

The disc drive test checks the drive buffer RAM, then determines how many drives there are and initializes them. While it is running, the LEDs display 0001 0110.

If the disc drive test fails, the following LED displays and CRT messages are presented:

LED Display	CRT Message	Probable Cause	What to Do
0101 0110	Flexible Disc Missing	Defective Drive Control Board	Replace Drive Control Board
1001 0110	Memory Failed at XXXXXX W:ZZZZZZZZ, R:YYYYYYYY		Replace Disc Drives
1001 0110	Flexible Disc Failed	Defective Drive Control Board Defective Disc Drive	

I/O Tests

The I/O section is made up of these assemblies:

09826-66501	Base Motherboard (9826)
09826-66502	Base Motherboard (9836A)
09836-66502	Base Motherboard (9836)
09836-66581	Backplane Connectorboard
	External I/O Boards

The I/O tests check the internal HP-IB interface and all external interfaces.

If any interface hardware fails the test, these LED displays and CRT messages are displayed:

LED Display	CRT Message	Probable Cause	What to Do
1001 0100	HP-IB Failed	Defective HP-IB Hardware	Replace Motherboard
0101 0100	HP-IB Missing	Defective I/O Select Hardware	
0101 1000		Defective DMA Card	Replace DMA Card
1001 1000		Defective I/O Select Hardware	Replace Motherboard Replace Backplane Connectorboard
101P QRST	HP9862Y at SC Failed	Defective I/O Board at select code SC (PQRST is the hexadecimal form of select code SC)	Replace I/O Board at select code SC
011P QRST	HP9862Y at SC Missing		Replace Motherboard Replace Backplane Connectorboard

Powerfail/Real-Time Clock Test

The powerfail/real-time clock assembly consists of one board:

09826-66555	Powerfail/Real-time clock board

The powerfail/real-time clock test checks the powerfail/real-time clock board. While doing so, the LEDs display 0001 1010. If the test fails, the following LED display and CRT message are presented:

LED Display	CRT Message	Probable Cause	What to Do
0101 1010	Battery Missing	Defective Powerfail Board	Replace Powerfail Board
1001 1010	Battery Failed		

Chapter 6
Replaceable Parts

Introduction

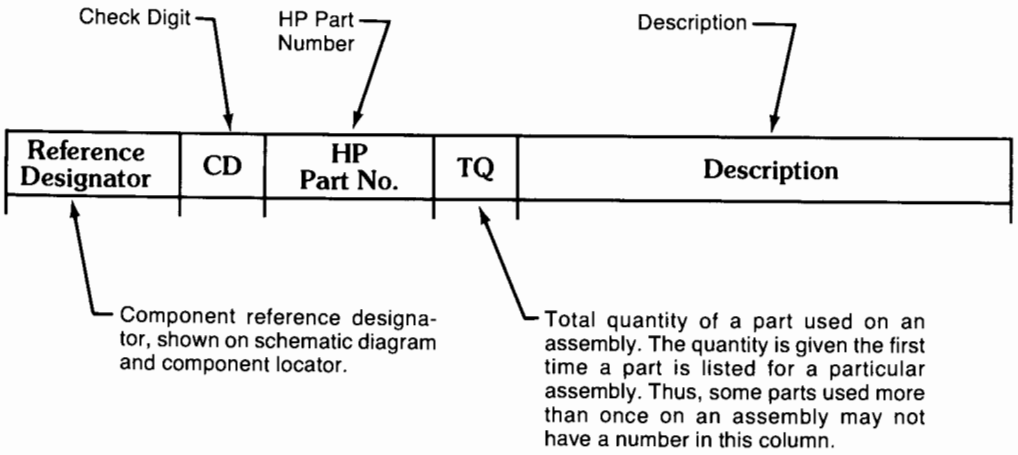
This chapter contains part number information for the 9826 and 9836 computers. This information is listed in the following manner:

1. Assemblies
2. Electronic parts by assembly
3. Keyboard and case parts
4. Support package contents
5. Miscellaneous items

Computer Museum

The part number information is presented in this manner:

Table 1 lists the replaceable parts. Here is a description of each table column.



Parts may be ordered from Corporate Parts Center. The address is:

Corporate Parts Center
333 Logue Avenue
Mountain View, California 94042

The telephone number is: (415) 968-9200

PC Boards. PC boards referred to in the parts lists are fully loaded boards. Empty PC boards are not available.

Rebuilt Assemblies. Part numbers of the form XXXXX-69XXX refer to rebuilt assemblies in the exchange program. Numbers of the form XXXXX-66XXX or -67XXX refer to new assemblies.

Processor Boards. Remember that the "15" .processor board is a direct replacement for the "14" board and can be used in both the 9826 and 9836A, and that the "16" board is a direct replacement for the "15" board and can be used in the 9826, 9836A and 9836C.

Disc Drive. When replacing the disc drive mechanism, be sure to remove the drive power connector, the sheet metal cover and the jumper shunt block from the defective drive, and install them on the replacement drive.

Case Parts. There are two types of case parts for the 9826, old tooling and new tooling. They are not generally compatible. Both sets of part numbers are included in this chapter. To determine which type of case you have, look at the bottom of the computer. New tooling has a plate for the powerfail battery, old tooling has a solid bottom with no plate. All 9836 computers are new tooling.

ID PROMs. ID PROMs are ordered through normal channels, that is, the repair order or Hot-Line to CPC for the CE and HP Order Processing for customers. However, two additional pieces of information are needed to order them, the serial number of the mainframe and the name of the contact (the CE or customer contact). These items should be added in the Comments section of the order.

Base Motherboards. The 09826-66502 motherboard includes a coax cable for the video signals. The 09836-66502 motherboard does not. It requires an 8120-4128 coax cable when used in a 9836A and an 8120-4070 coax cable when used in a 9836C.

RFI Shield. When replacing the Video board, remove the RFI shield from the defective board and install it on the replacement board.

Table 6-1. 9826/9836 Exchange Assemblies

Reference Designator	CD	HP Part No.	TQ	Description
	2	09826-69501	1	Motherboard (9826)
	3	09826-69502	1	Motherboard (9836A)
	4	09826-69511	1	Processor Board (9826)
	7	09826-69514	1	Processor/RAM (9826)
	8	09826-69515	1	Processor/RAM (9826 or 9836A)
	3	09826-69516	1	Processor/RAM board
	4	09826-69517	1	Processor MMU board
	7	09826-69522		64k RAM board
	9	09826-69524		256k RAM board
	2	09826-69551	1	Regulator board (9826)
	4	09826-69553	1	Regulator board
	0	09826-69575	1	CRT graphics board (9826)
	2	09826-69577	1	CRT graphics board (9836A)
	1	09130-69600		Disc drive mechanism
	6	09826-69555		Powerfail Real-Time Clock board
	1	09826-69576	1	CRT digital board (9836A)
	9	09836-69502	1	Base Motherboard
	5	09836-69540	1	Sweep Board
	7	09836-69542	1	Video Board
	7	09836-69550	1	Display Power Supply
	3	09836-69572	1	Digital Board
	4	09836-69573	1	Graphics Board (9836C)

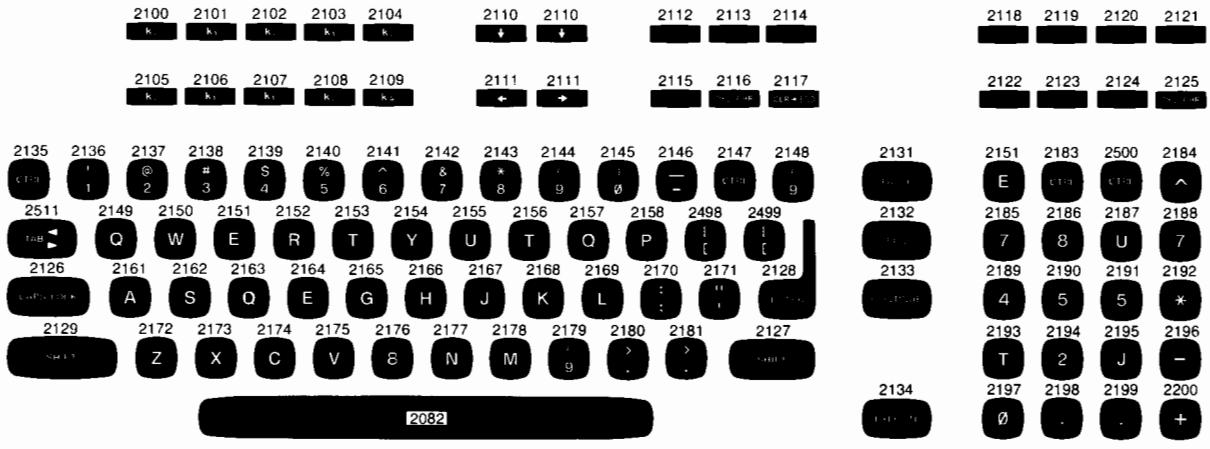
Table 6-2. 9826/9836 Non-exchange Assemblies

Reference Designator	CD	HP Part No.	TQ	Description
	7	09826-66552	1	Rectifier board (9826)
		09826-66554	1	Rectifier board
	8	09826-66561	1	Disc drive control board (9826)
	5	09826-66562	1	Disc drive control board
	2	09826-66573	1	CRT digital board (9826)
	0	09826-66571	1	CRT analog board (9826)
	8	09826-66580	1	CRT analog board (9836)
	2	09826-66581	1	Backplane connectorboard
	6	09826-67921	1	CRT/yoke assembly (pincushioned) (9826)
	7	09836-67922	1	CRT/yoke assembly (pincushioned) (9836A)
	3	09826-67910	1	Rotary control knob assembly
	0	9100-4140	1	Transformer assembly (9826)
	3	9100-4242	1	Transformer assembly (9836)
	7	0180-2895	1	Capacitor assembly
	9	3160-0311	1	Ac Fan assembly (9826)
	7	3160-0377	1	Dc Fan assembly (9836)
	6	09826-68002		Standard keyboard (old tooling)
	8	09826-68012		Standard keyboard (new tooling)
	7	09826-68003		Option 810 keyboard (old tooling)
	9	09826-68013		Option 810 keyboard (new tooling)
	1	09826-68007		Option 820 keyboard (old tooling)
	3	09826-68017		Option 820 keyboard (new tooling)
	2	09826-68008		Option 830 keyboard (old tooling)
	4	09826-68018		Option 830 keyboard (new tooling)
	0	09826-68006		Option 840 keyboard (old tooling)
	2	09826-68016		Option 840 keyboard (new tooling)
	9	09826-68005		Option 850 keyboard (old tooling)
	1	09826-68015		Option 850 keyboard (new tooling)
	4	09826-90300		Option ROM Boards
	0	09836-66503	1	Display Motherboard (9836C)
	1	09836-67924	1	CRT/Yoke Assembly (9836C)
	4	3160-0209	1	Display Fan
		8120-3642		Base-to-display Cable (9836A)
	8	8120-4098	1	Base-to-display Cable (9836C)

Assemblies listed in Table 6-1 and 6-2 can be located in Figure 6-7, 9826 Exploded View, Figure 6-9, 9836 Exploded View, Figure 4-1, 9826 Computer Assembly Locations or Figure 4-2, 9836 Computer Assembly Locations.

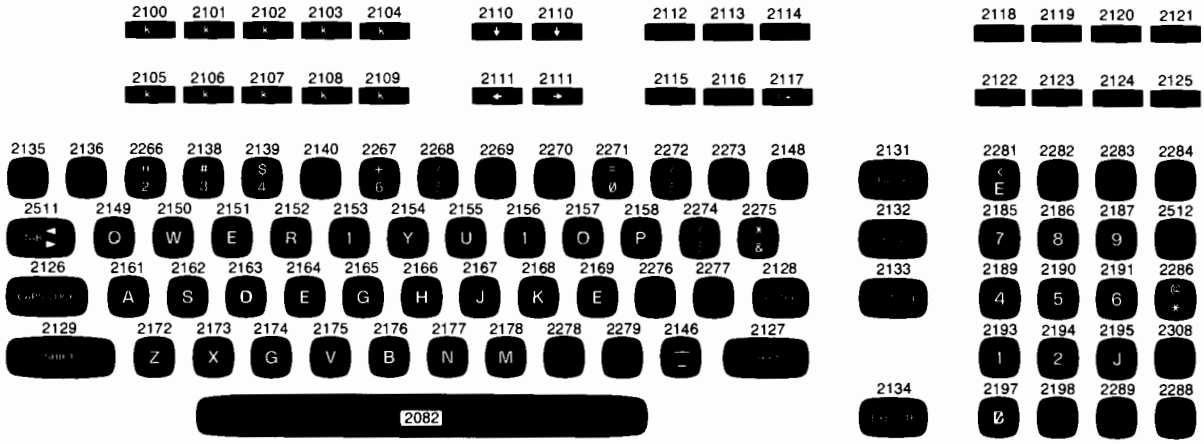
Table 6-3. Part Numbers for New Exchange Assemblies

Reference Designator	CD	HP Part No.	TQ	Description
	6	09826-66501	1	Motherboard (9826)
	7	09826-66502	1	Motherboard (9836)
	6	09826-66551	1	Regulator board (9826)
	8	09826-66553	1	Regulator board
	5	09130-66600		Disc drive mechanism
	4	09826-66575	1	CRT graphics board (9826)
	6	09826-66577	1	CRT graphics board (9836)
	5	09826-66576	1	CRT digital board (9836)
	0	09826-66555	1	Powerfail Real-Time Clock board
	8	09826-66511	1	Processor board (9826)
	1	09826-66514	1	Processor/RAM (9826)
	2	09826-66515	1	Processor/RAM (9826 or 9836A)
	1	09826-66522		64k RAM board
	3	09826-66524		256k RAM board
	9	09826-66516	1	Processor/RAM Board
	3	09836-66502	1	Base Motherboard
	9	09836-66540	1	Sweep Board
	1	09836-66542	1	Video Board
	1	09836-66550	1	Display Power Supply
	7	09836-66572	1	Digital Board
	8	09836-66573	1	Graphics Board
	0	09826-66517	1	Processor/MMU Board



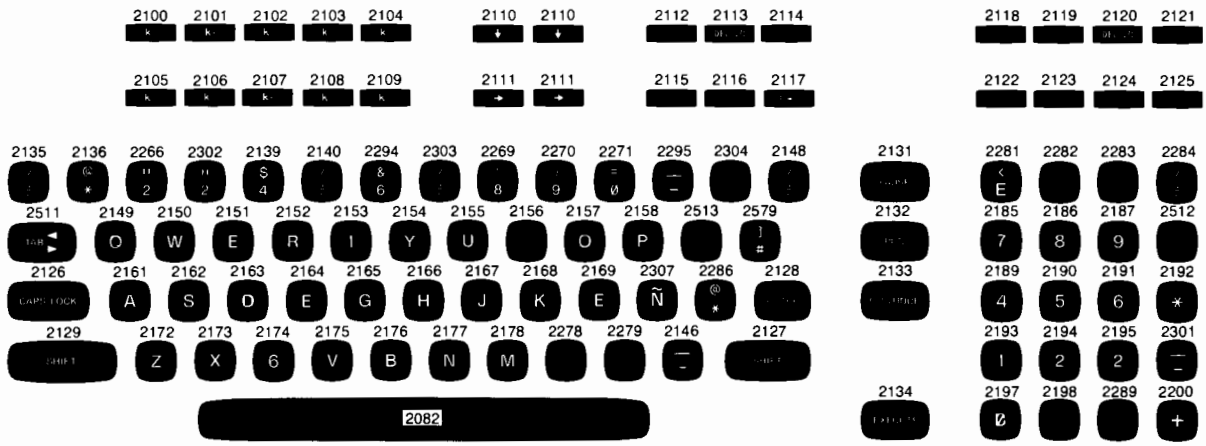
Keyboard part number is 09826-68002.
Keycap part number is 0371-XXXX.

Figure 6-1. Standard ASCII Keyboard Assembly



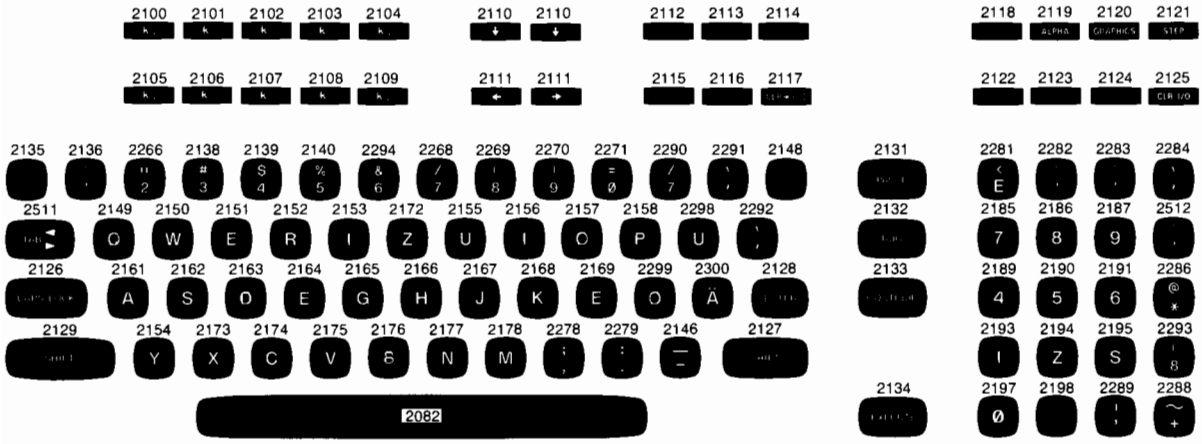
Keycap part number is 0371-XXXX.

Figure 6-2. Option 810, French Keyboard Assembly



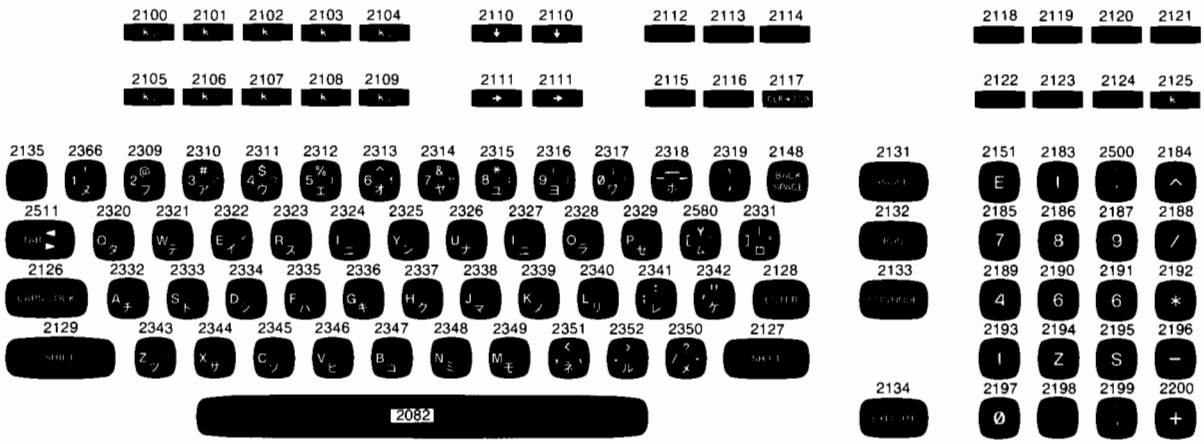
Keycap part number is 0371-XXXX.

Figure 6-3. Option 820, Spanish Keyboard Assembly



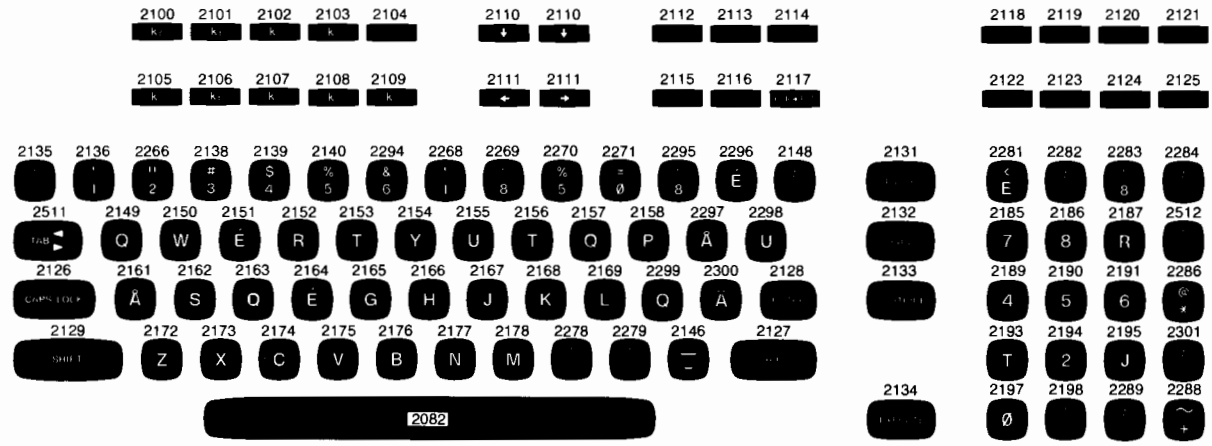
Keycap part number is 0371-XXXX.

Figure 6-4. Option 830, German Keyboard Assembly



Keycap part number is 0371-XXXX.

Figure 6-5. Option 840, Japanese Kana Keyboard Assembly



Keycap part number is 0371-XXXX.

Figure 6-6. Option 850, Swedish/Finnish Keyboard Assembly

Table 6-4. Keyboard Parts

Reference Designator	CD	HP Part No.	TQ	Description
	6	09826-68002		Standard keyboard (old tooling)
	8	09826-68012		Standard keyboard (new tooling)
	7	09826-68003		Option 810 keyboard (old tooling)
	9	09826-68013		Option 810 keyboard (new tooling)
	1	09826-68007		Option 820 keyboard (old tooling)
	3	09826-68017		Option 820 keyboard (new tooling)
	2	09826-68008		Option 830 keyboard (old tooling)
	4	09826-68018		Option 830 keyboard (new tooling)
	0	09826-68006		Option 840 keyboard (old tooling)
	2	09826-68016		Option 840 keyboard (new tooling)
	9	09826-68005		Option 850 keyboard (old tooling)
	1	09826-68015		Option 850 keyboard (new tooling)
	3	09826-67910	1	Rotary control knob assembly
	4	0150-0568	3	Button, Speaker mounting
	7	4040-2102	1	Guide, Space bar, Left
	8	4040-2103	1	Guide, Space bar, Right
	9	4040-2104	2	Stem, Space bar
	6	1460-1974	1	Rod, Space bar

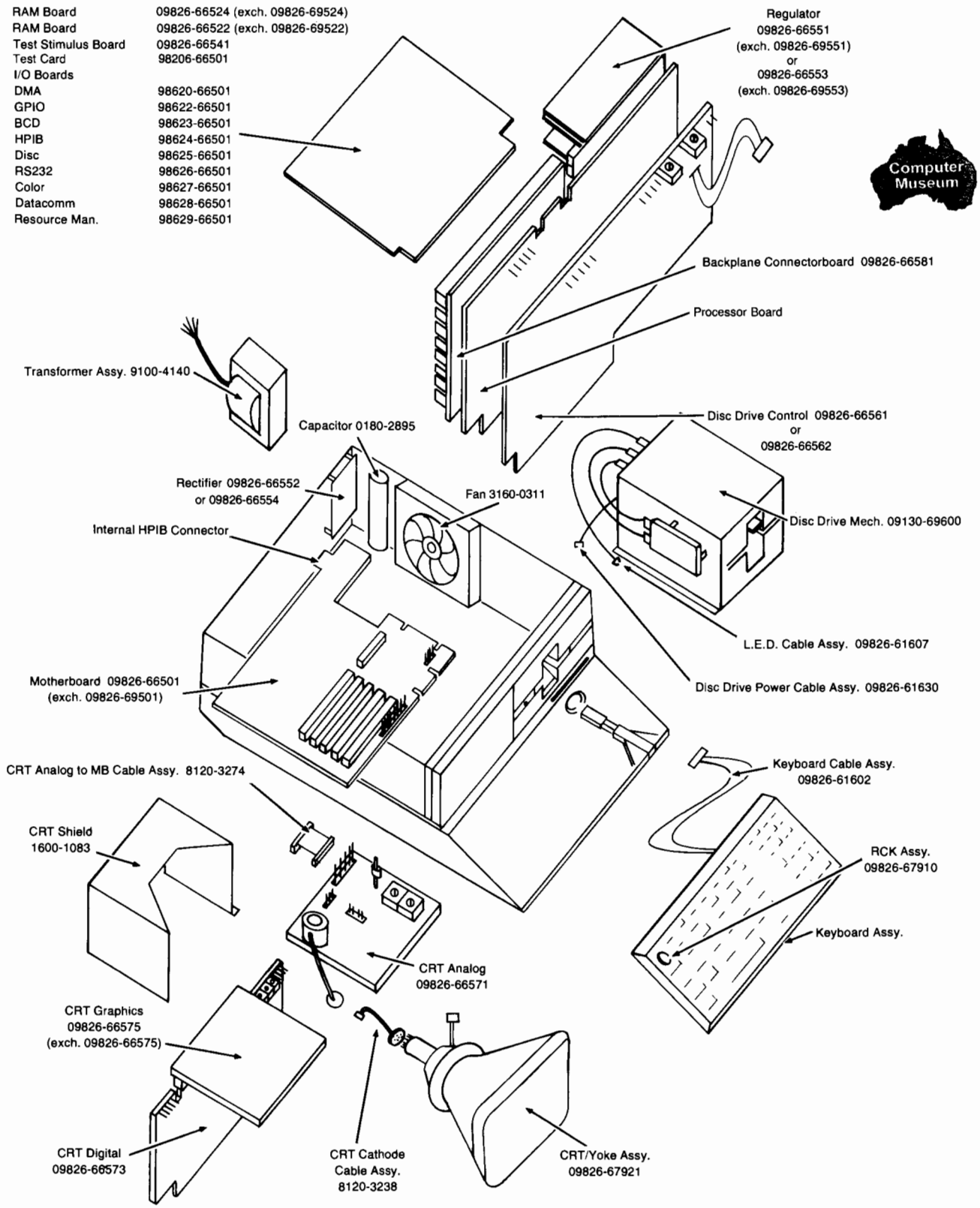
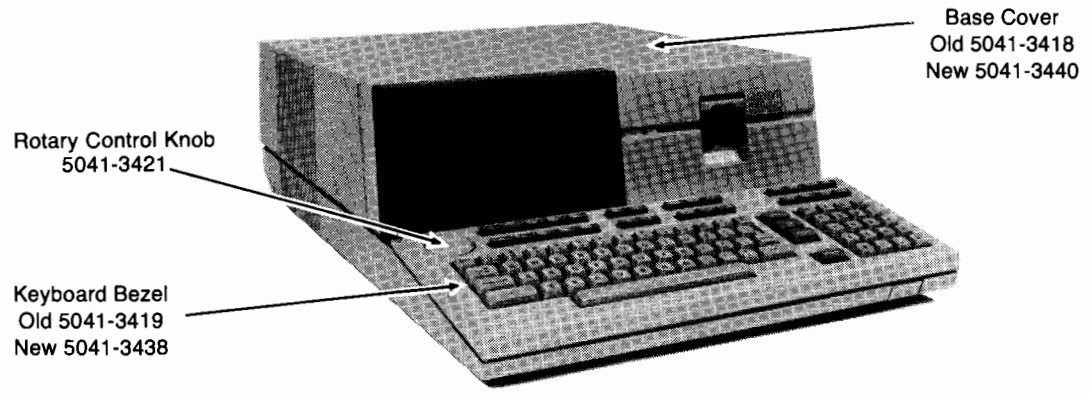


Figure 6-7. 9826 Exploded View



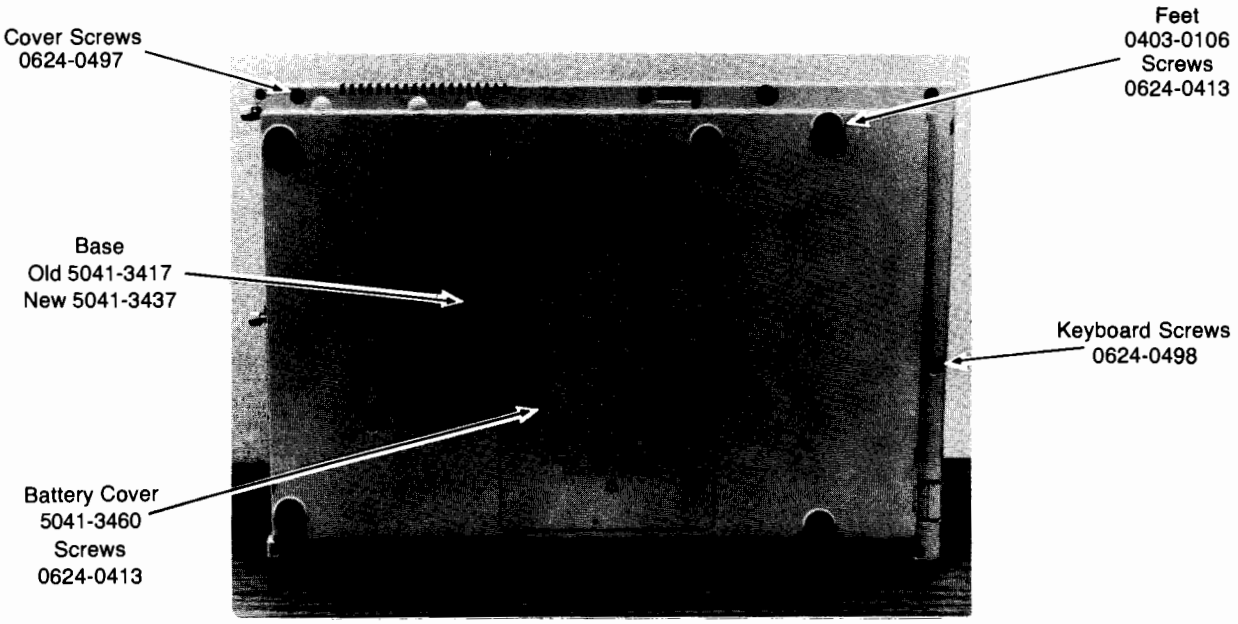


Figure 6-8. 9826 Case Hardware Part Numbers

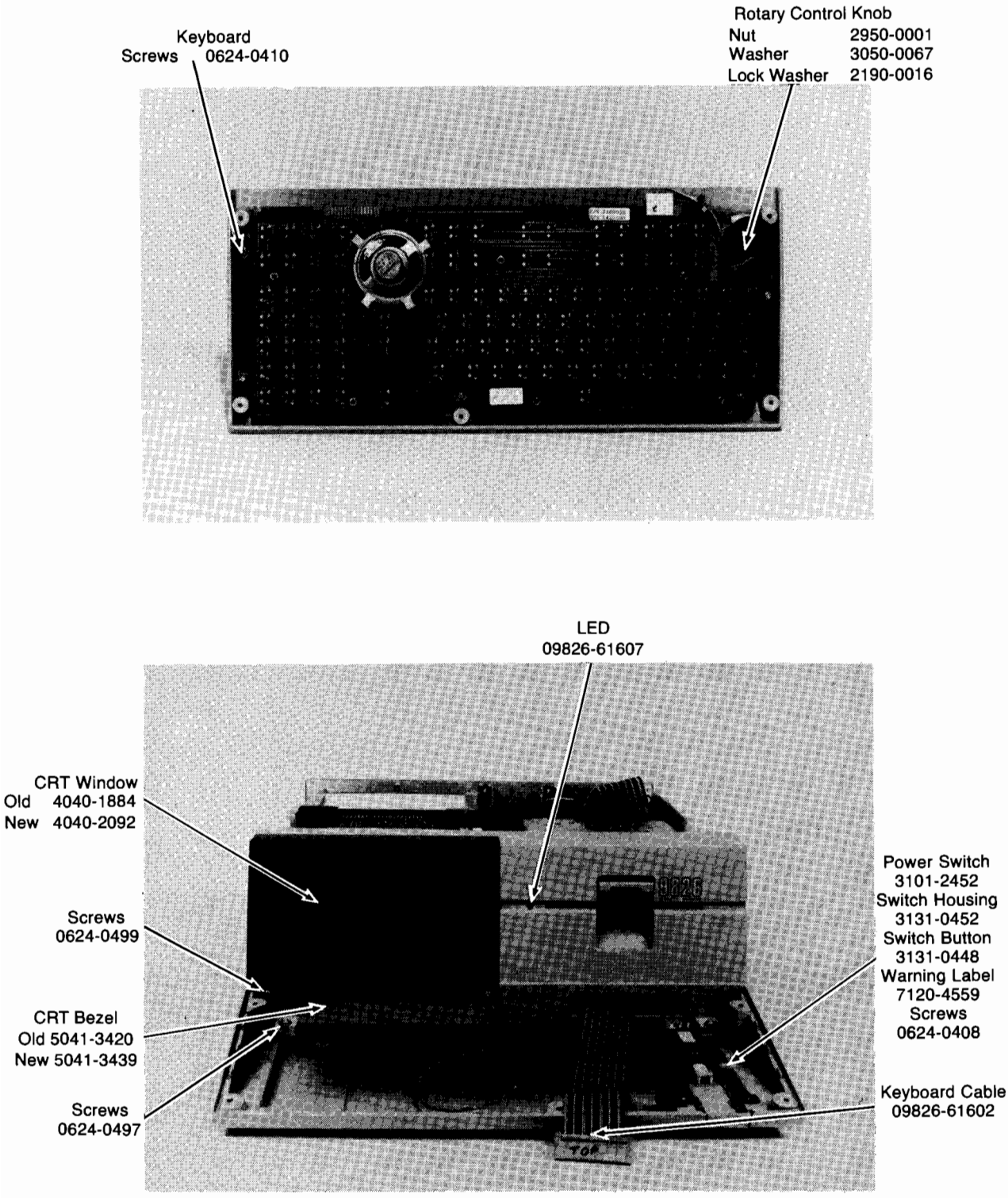


Figure 6-8. 9826 Case Hardware Part Numbers (Continued)

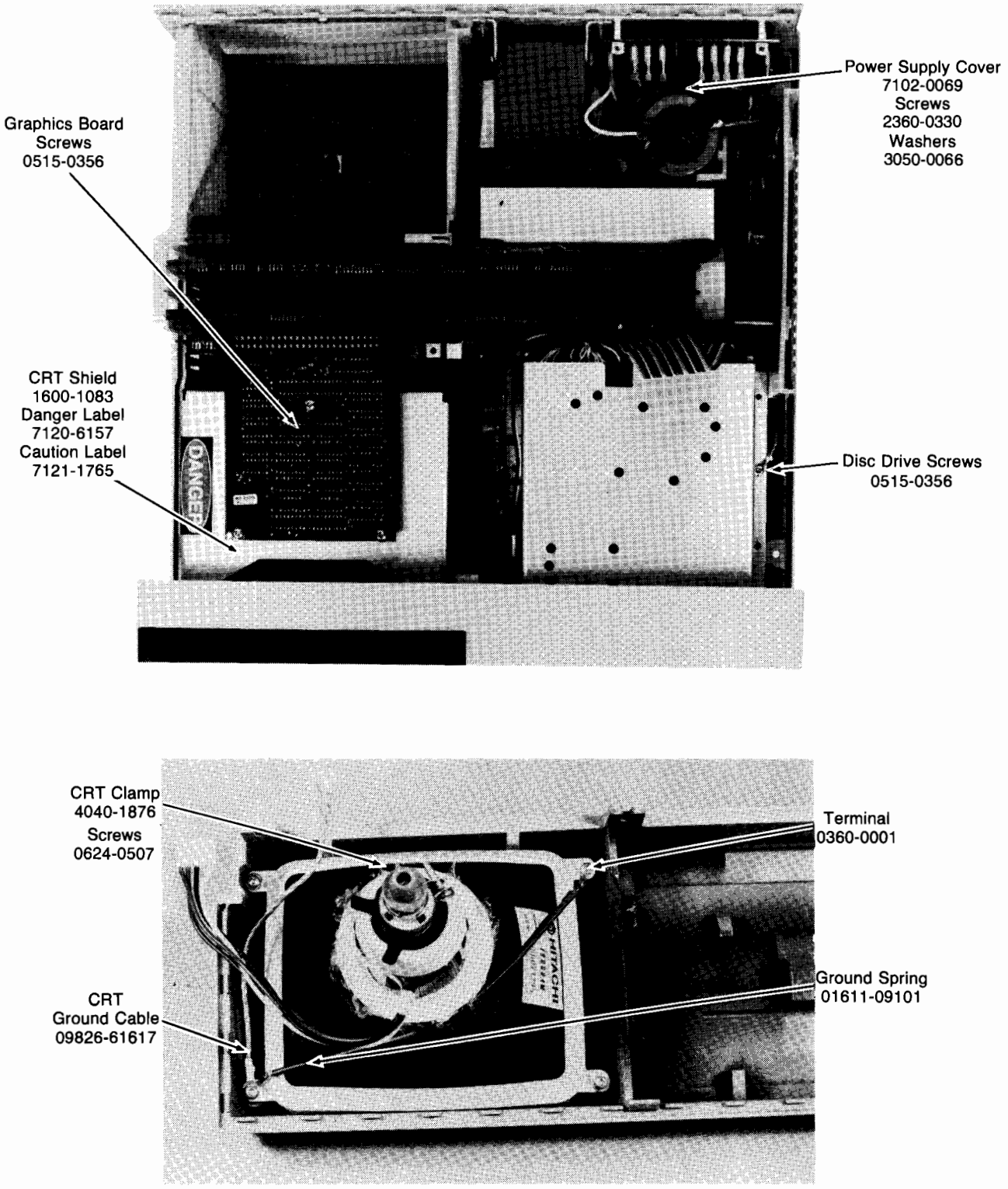
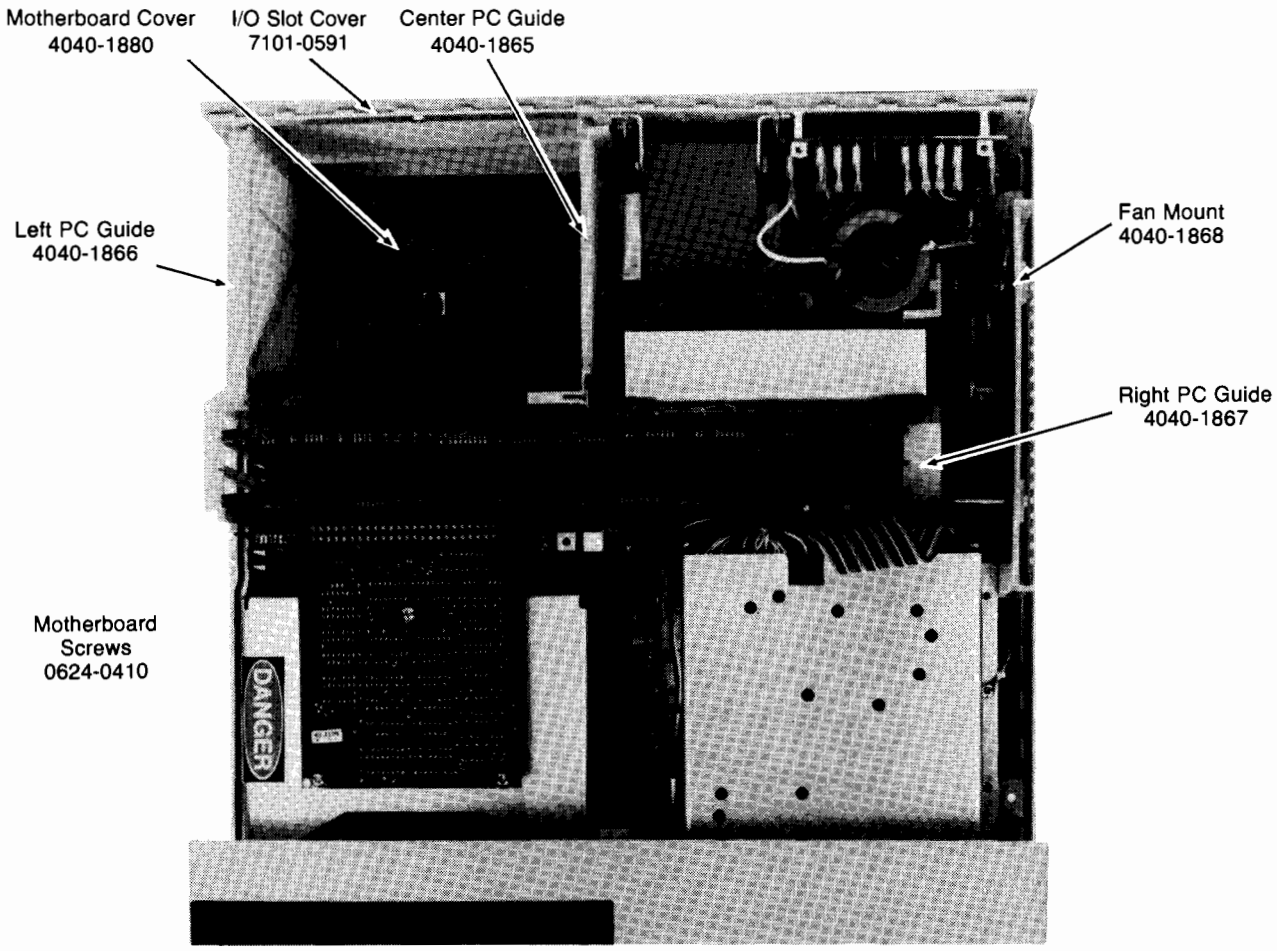


Figure 6-8. 9826 Case Hardware Part Numbers (Continued)



PC Guide Hardware:

Fasten to base with:
Screw 0624-0499
Fasten to rear panel with:
Screw 0624-0472

Fan Hardware:

Long Screws	0624-0559
Ground Connection Screw	2510-0099

Figure 6-8. 9826 Case Hardware Part Numbers (Continued)

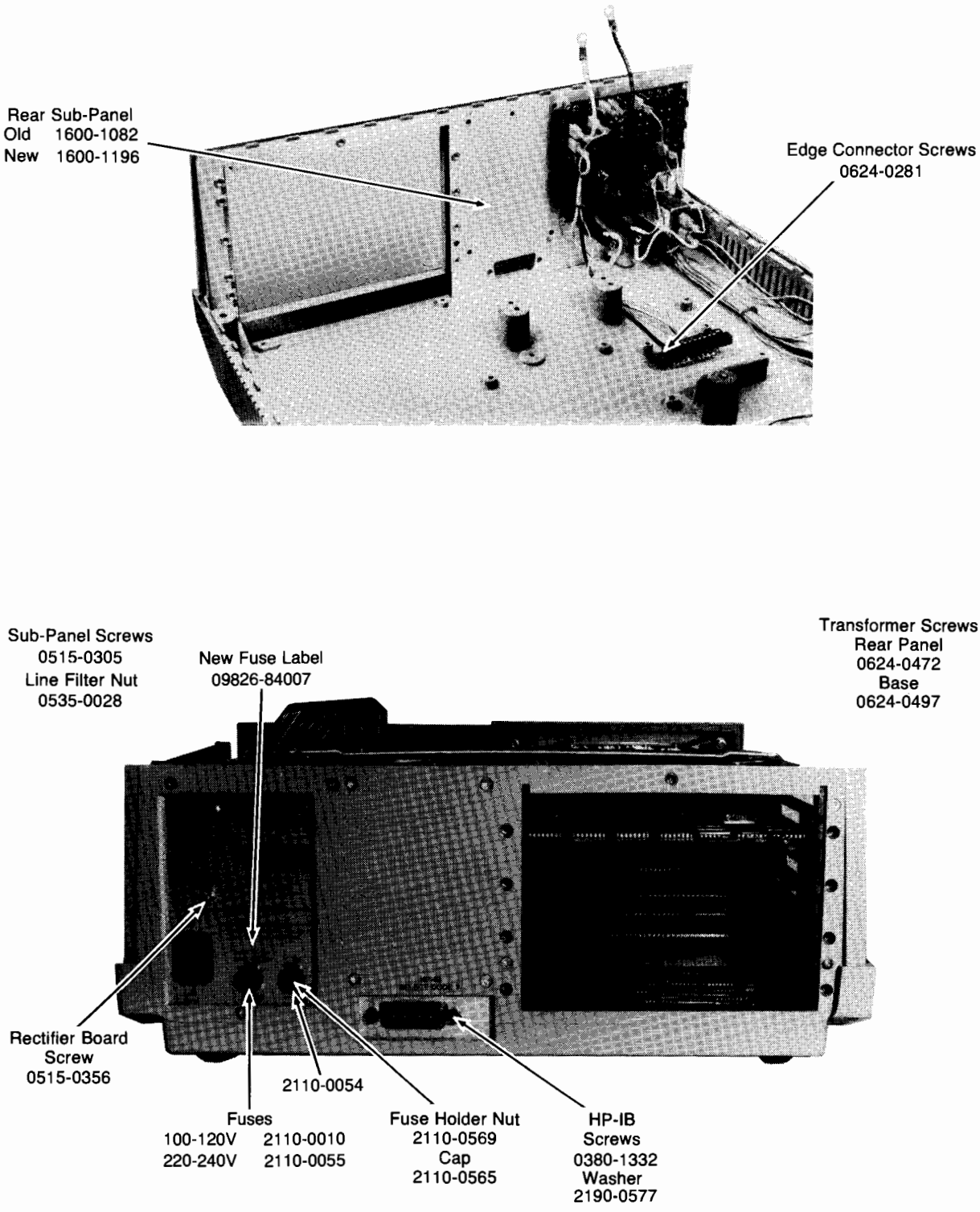


Figure 6-8. 9826 Case Hardware Part Numbers (Continued)

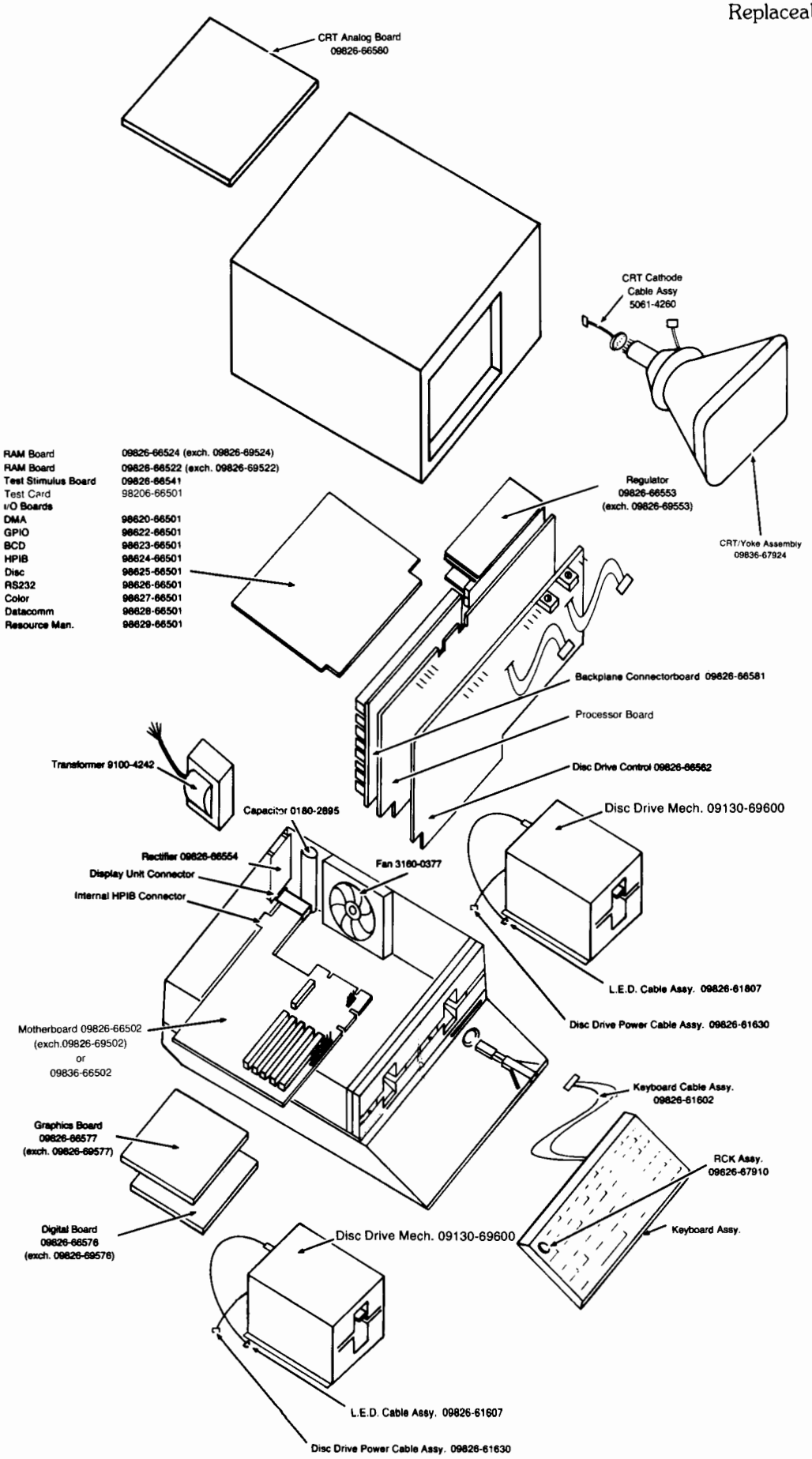
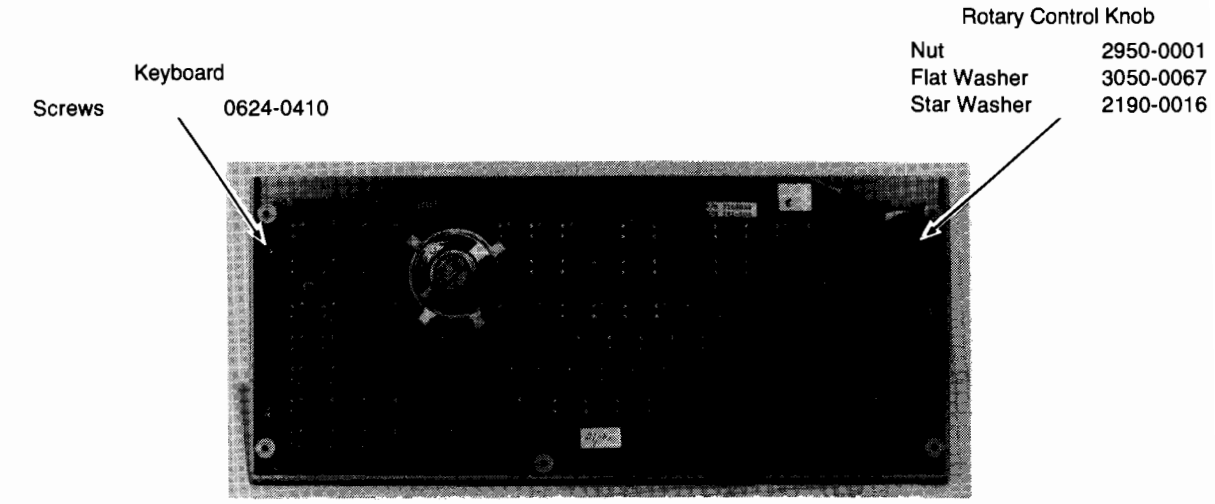


Figure 6-9. 9836A Exploded View



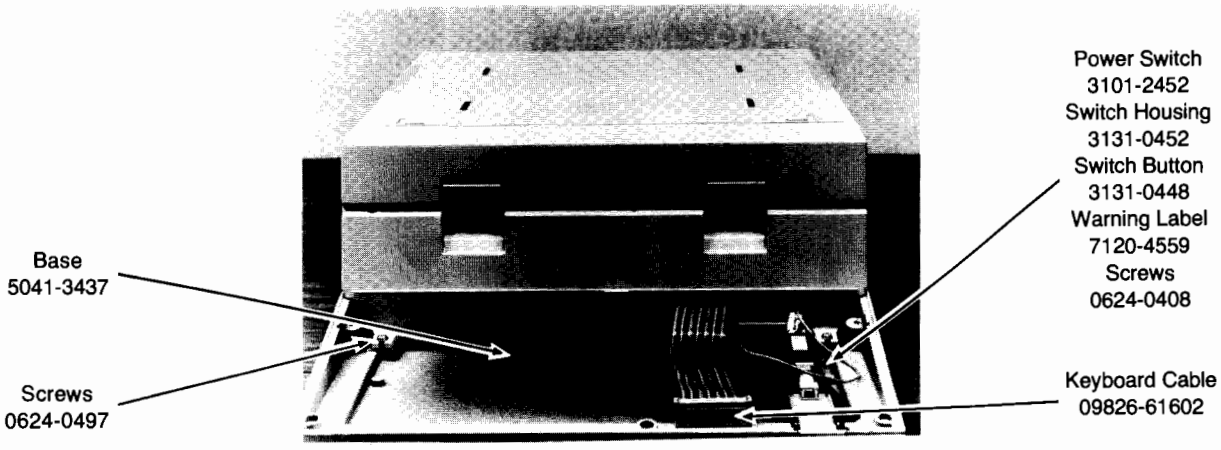
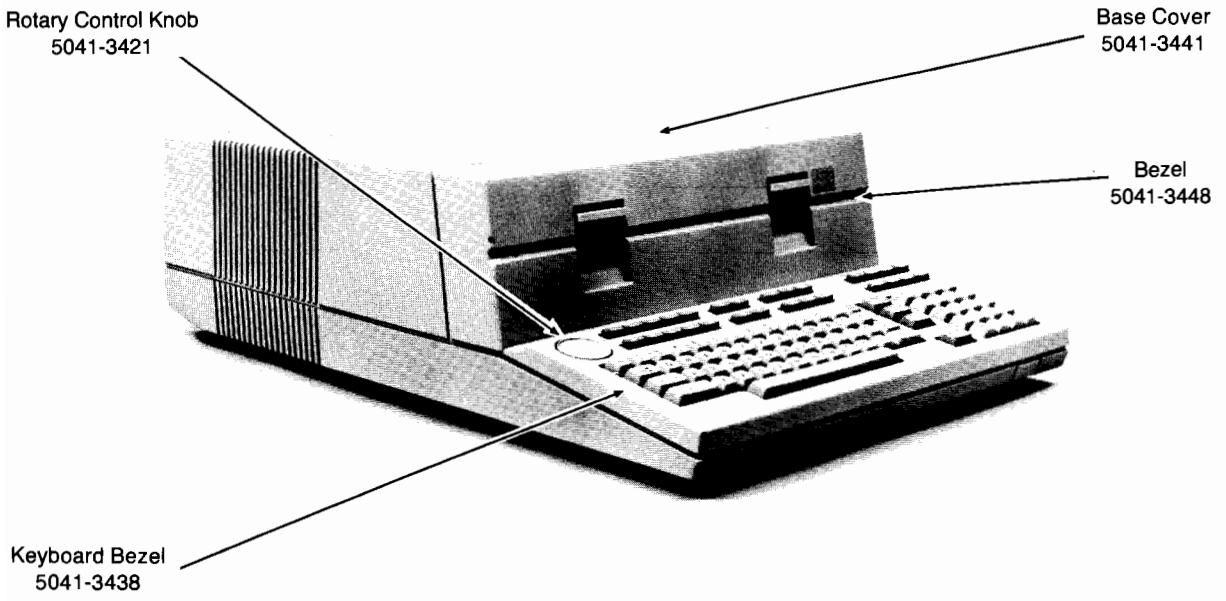


Figure 6-10. 9836A Case Hardware Part Numbers



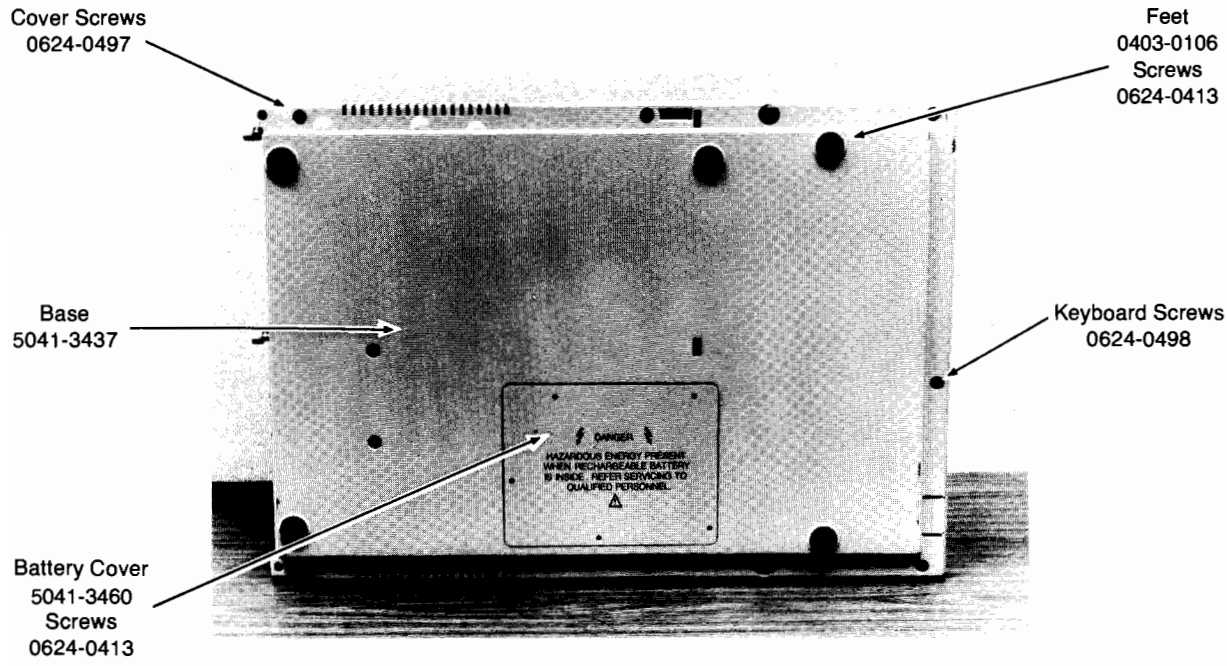
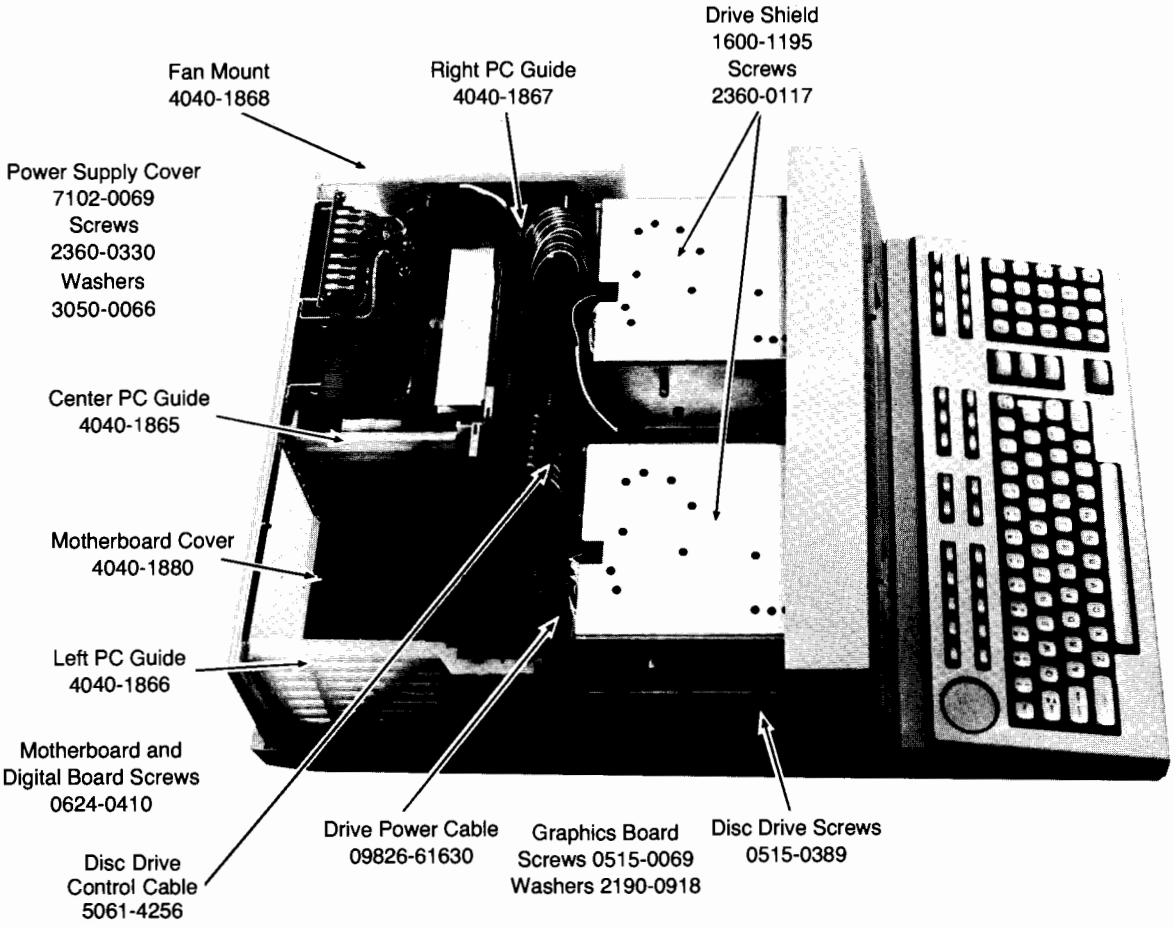


Figure 6-10. 9836A Case Hardware Part Numbers (Continued)



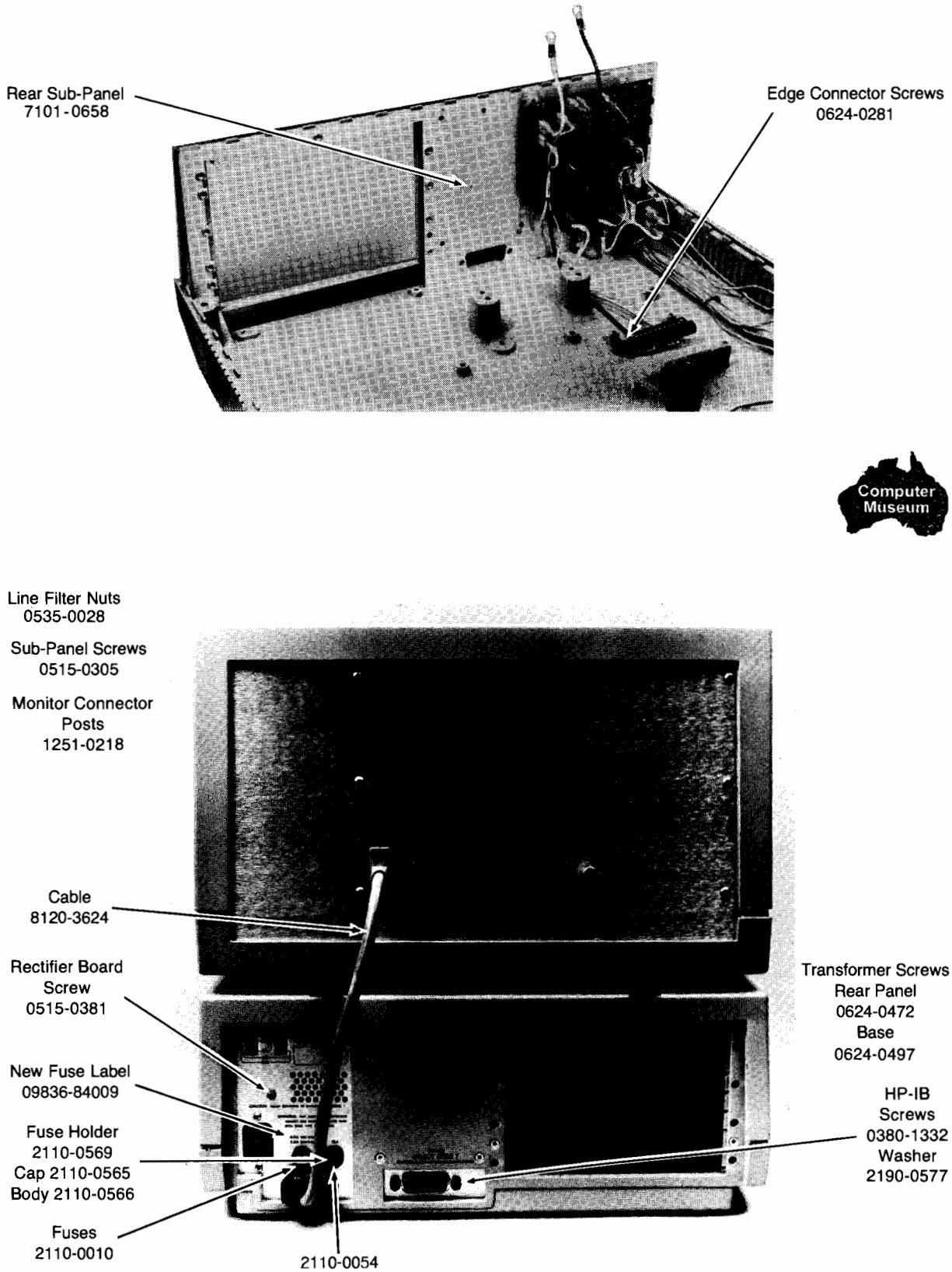
PC Guide Hardware:

Fasten to base with:
Screw 0624-0499
Fasten to rear panel with:
Screw 0624-0472

Fan Hardware:

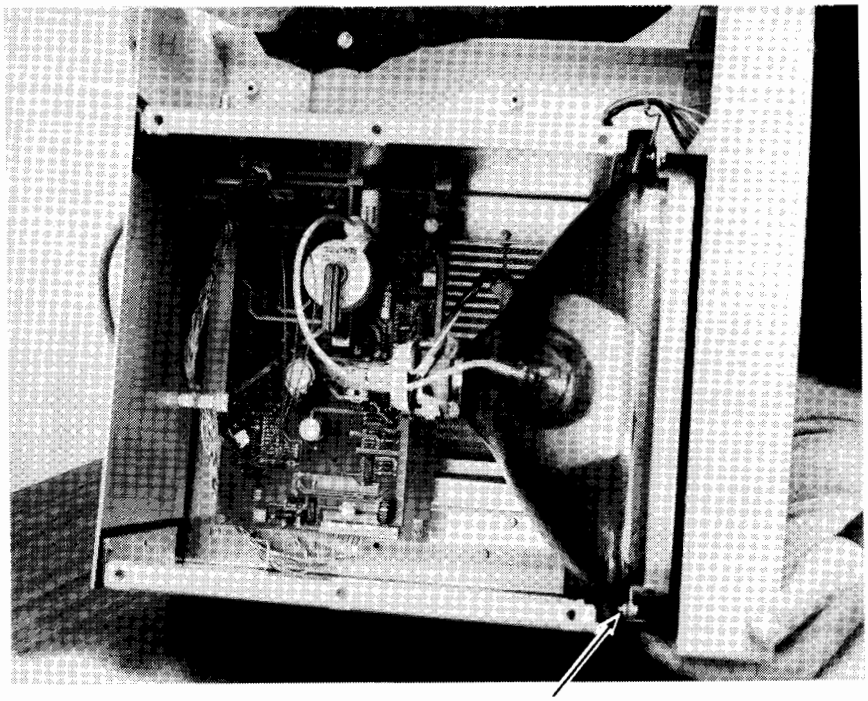
Long Screws	0624-0559
Base Screw	0624-0499
Ground Connection Screw	2510-0099

Figure 6-10. 9836A Case Hardware Part Numbers (Continued)



Computer Museum

Figure 6-10. 9836A Case Hardware Part Numbers (Continued)



Interconnect Cable
Clip
1600-1157
Ground Screw
0515-0389

Intensity Pot Assembly
09836-67902
Washer
2190-0027
Nut
2950-0006
Knob
0370-1121

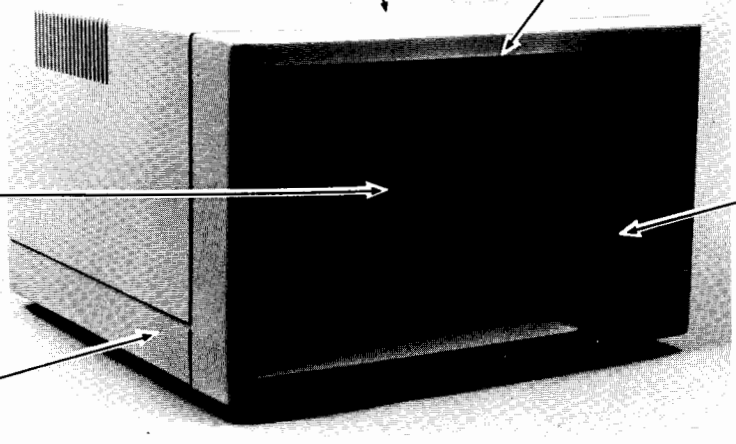
Analog Board Screws
0515-0389

CRT

Screws	0515-0389
Bushings	0340-0500
Metal Washers	3050-0257
Plastic Washers	2190-0860

CRT Cover
5041-3445
Fasteners 1390-0594
Clips 1390-0088

Dust Gasket
09836-46700
Clamp
09836-41200



CRT Window
1000-0640
Screws
0624-0410
Clamp
4040-0251

CRT Bottom
5041-3443
Screws
0624-0458

CRT Bezel
5041-3444
Screws
0624-0458

Figure 6-10. 9836A Case Hardware Part Numbers (Continued)

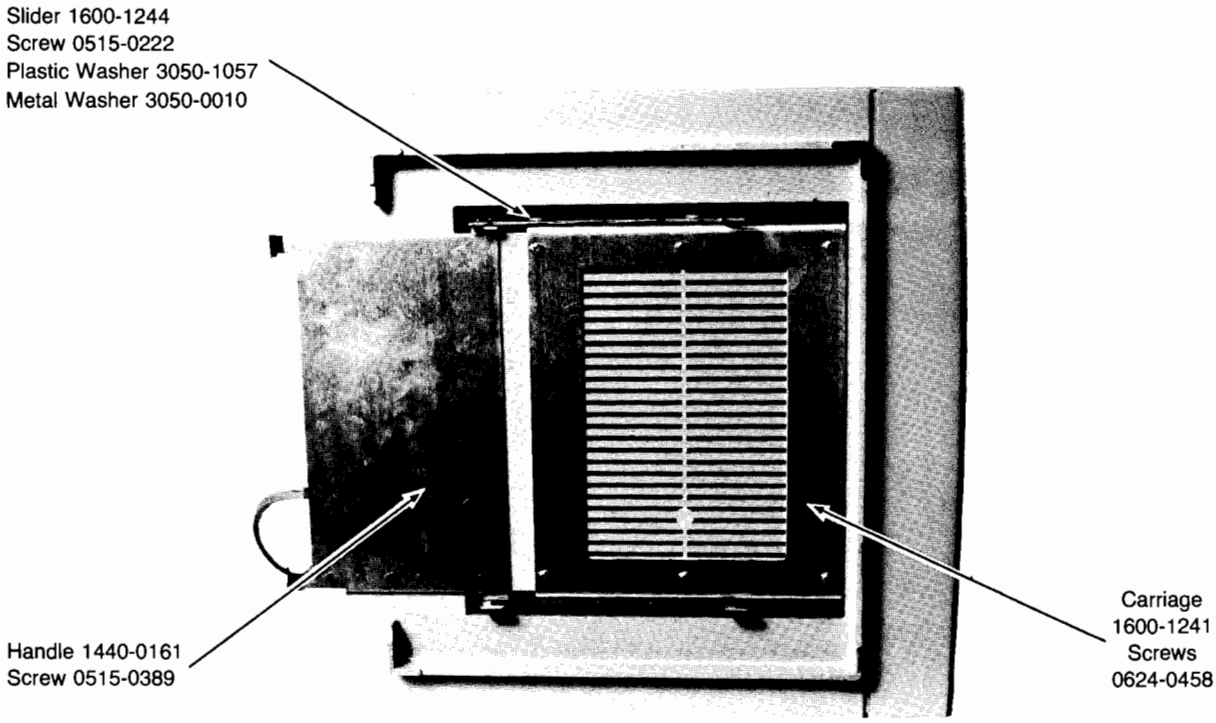


Figure 6-10. 9836A Case Hardware Part Numbers (Continued)

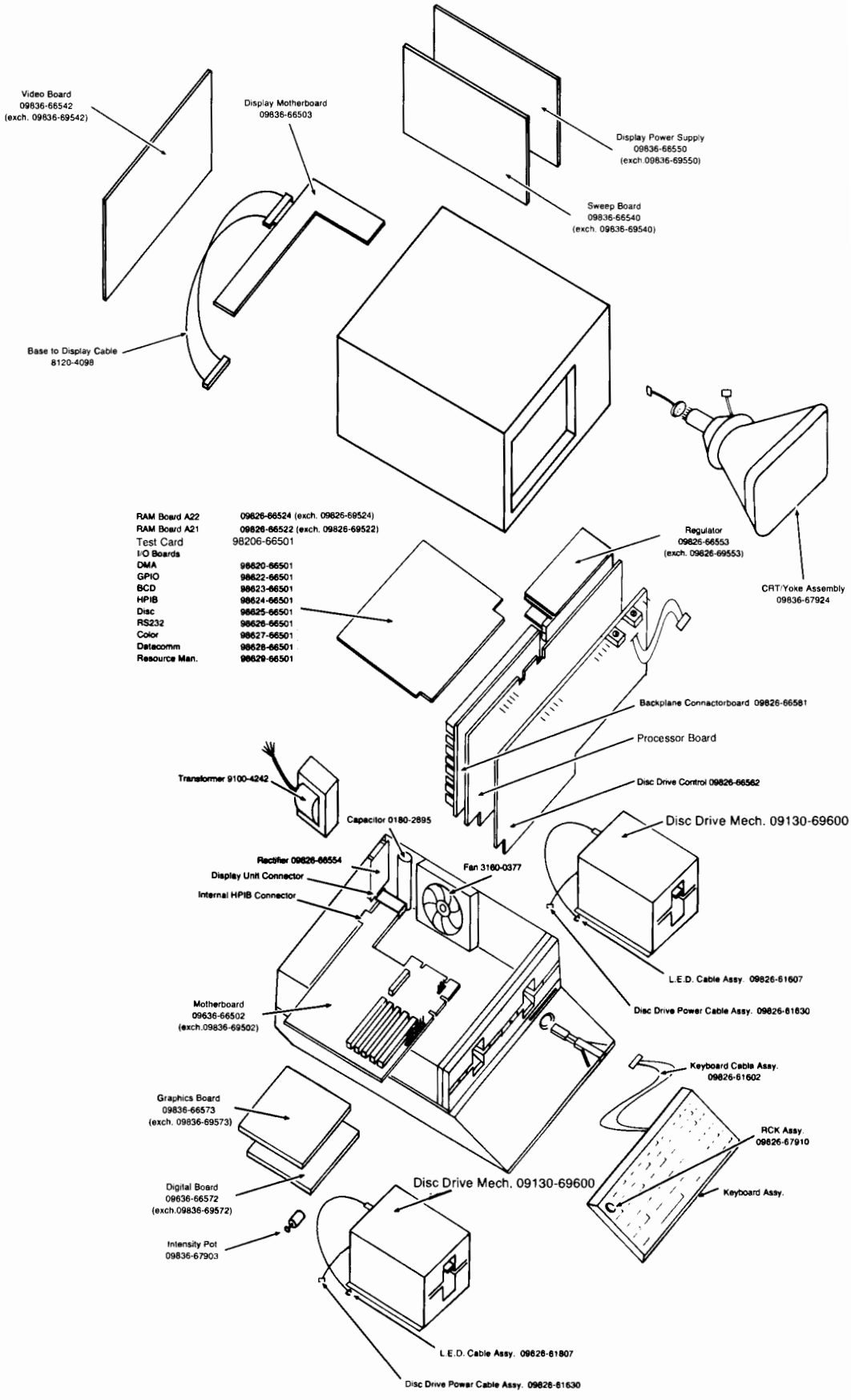
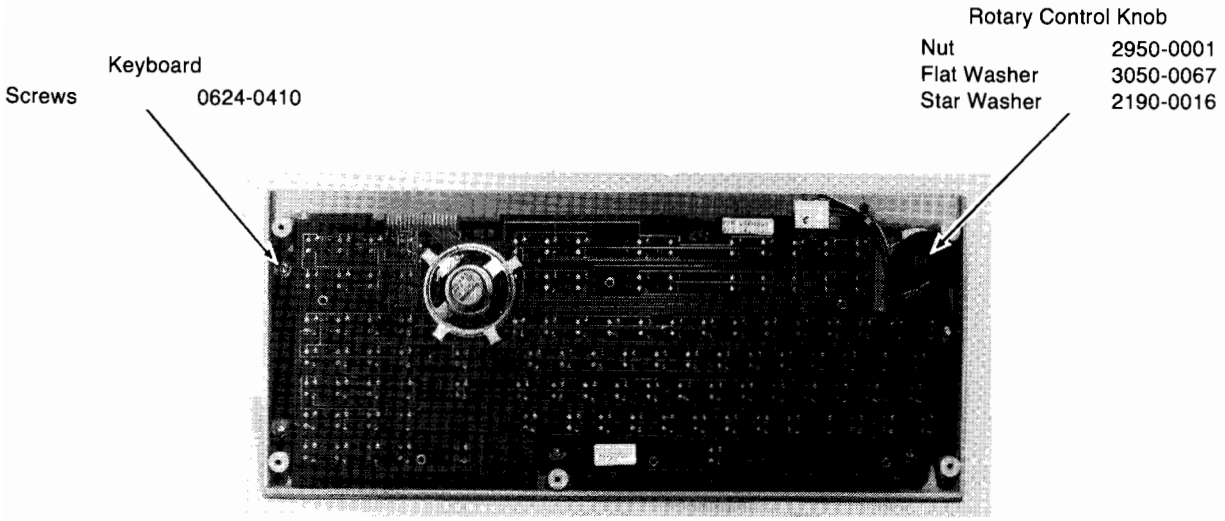


Figure 6-11. 9836C Exploded View



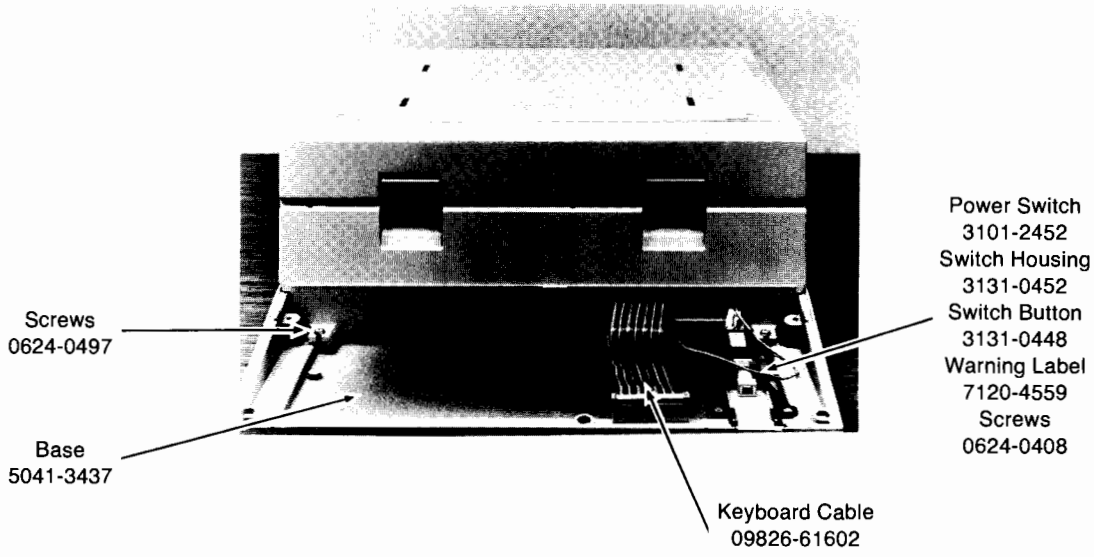
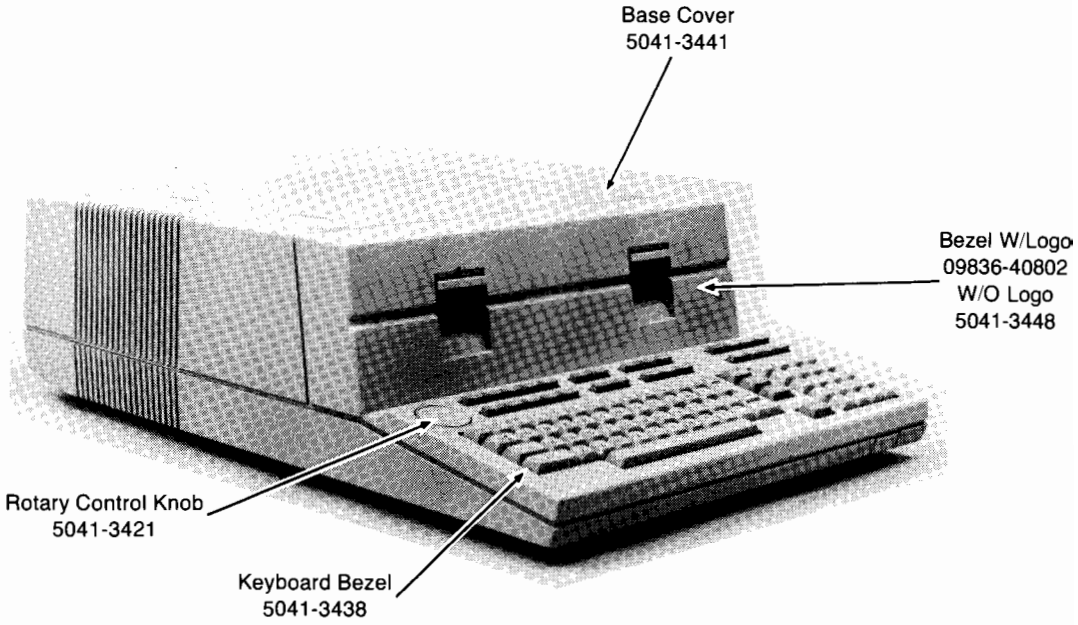


Figure 6-12. 9836C Case Hardware Part Numbers



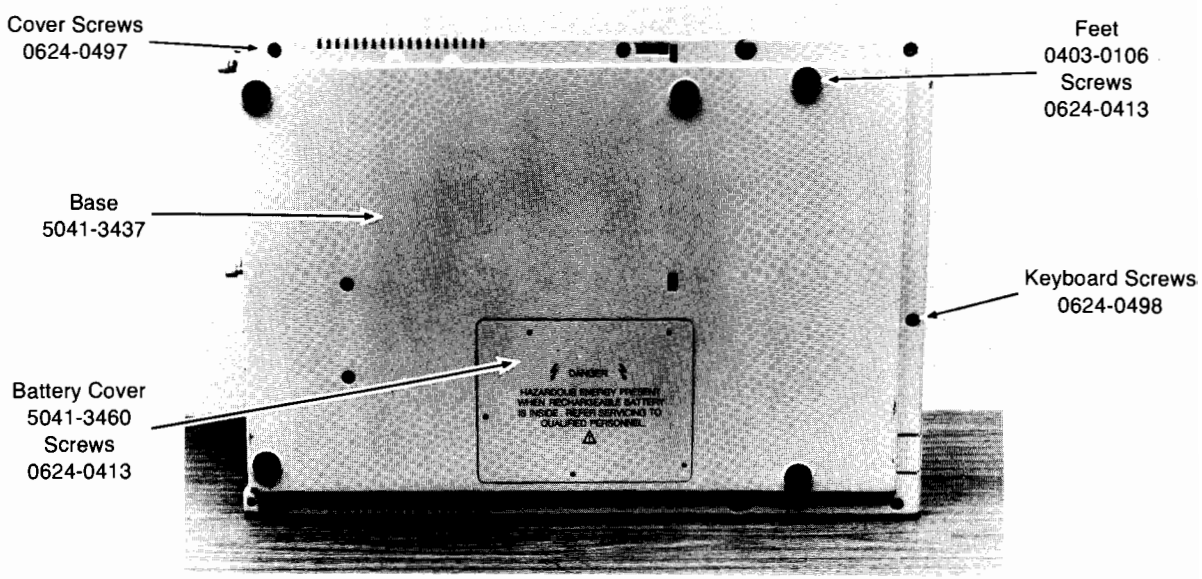
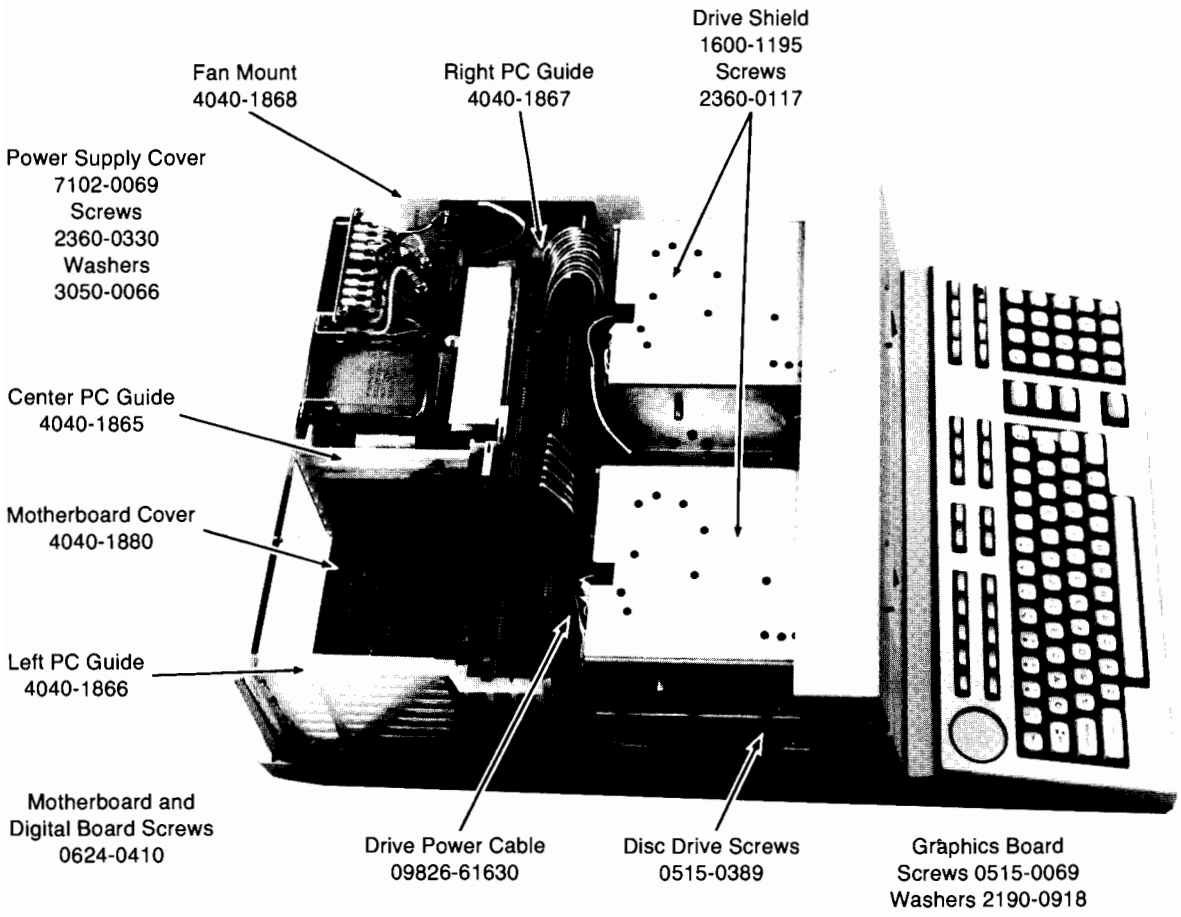


Figure 6-12. 9836C Case Hardware Part Numbers (Continued)



PC Guide Hardware:

Fasten to base with:
Screw 0624-0499
Fasten to rear panel with:
Screw 0624-0472

Fan Hardware:

Long Screws	0624-0559
Base Screw	0624-0499
Ground Connection Screw	2510-0099

Figure 6-12. 9836C Case Hardware Part Numbers (Continued)

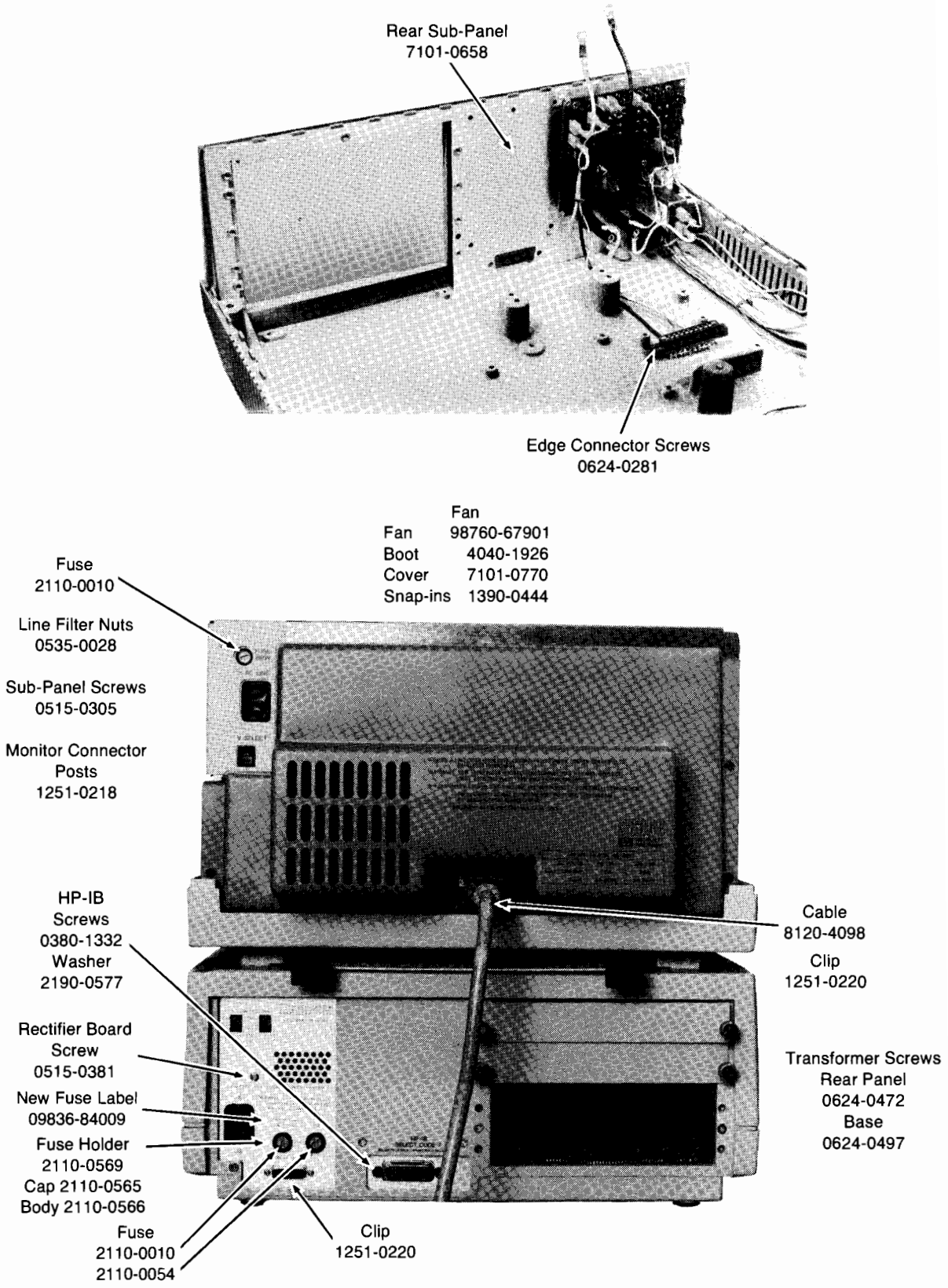
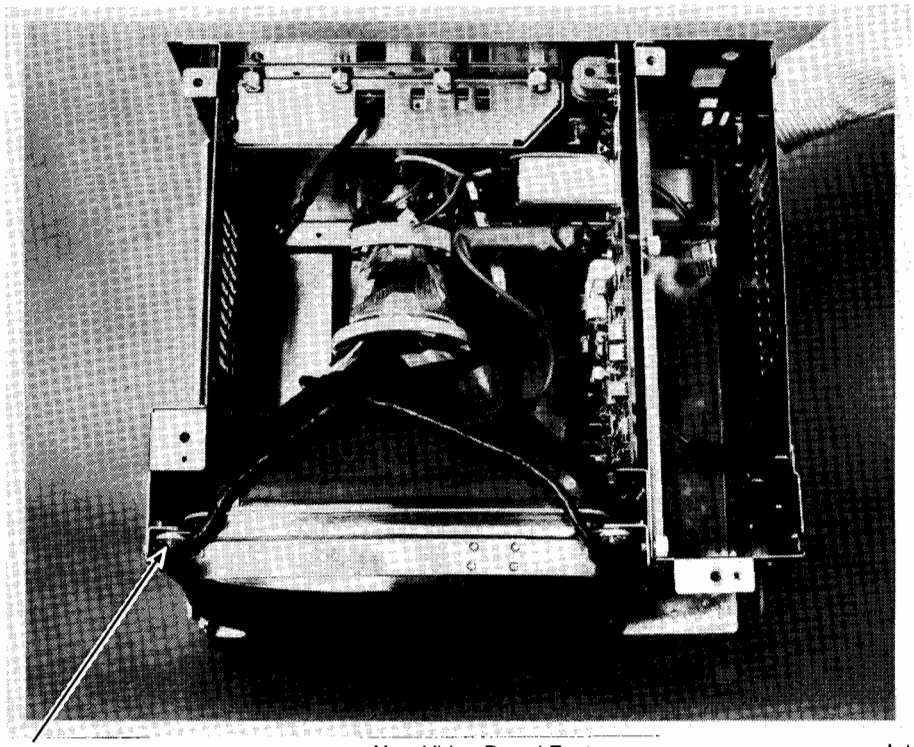


Figure 6-12. 9836C Case Hardware Part Numbers (Continued)



CRT

Screws	0515-0389
Bushings	0340-0500
Metal Washers	3050-0257
Nylon Washers	2190-0860
Nut	0535-0004
Insulator	1200-0081
Spring	1460-1915
Spring Washer	0360-0005

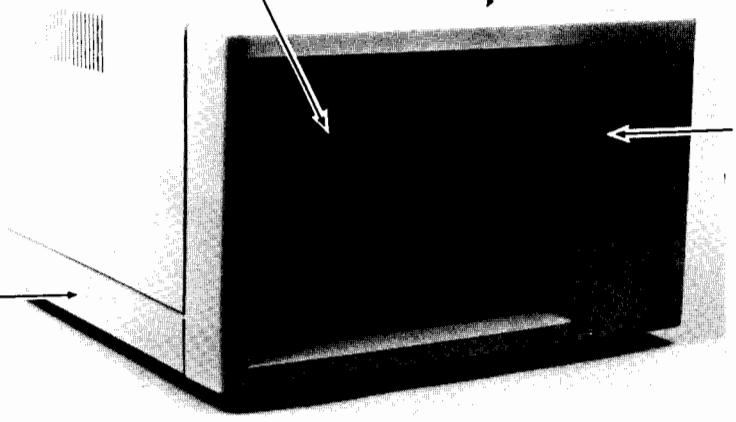
New Video Board Fasteners

Screws	0515-0825
Spacers	0380-1579
Nuts	0535-0043

Interconnect Cable
8120-4098

CRT Window
1000-0640
Screws
0624-0410
Clamp
4040-0251

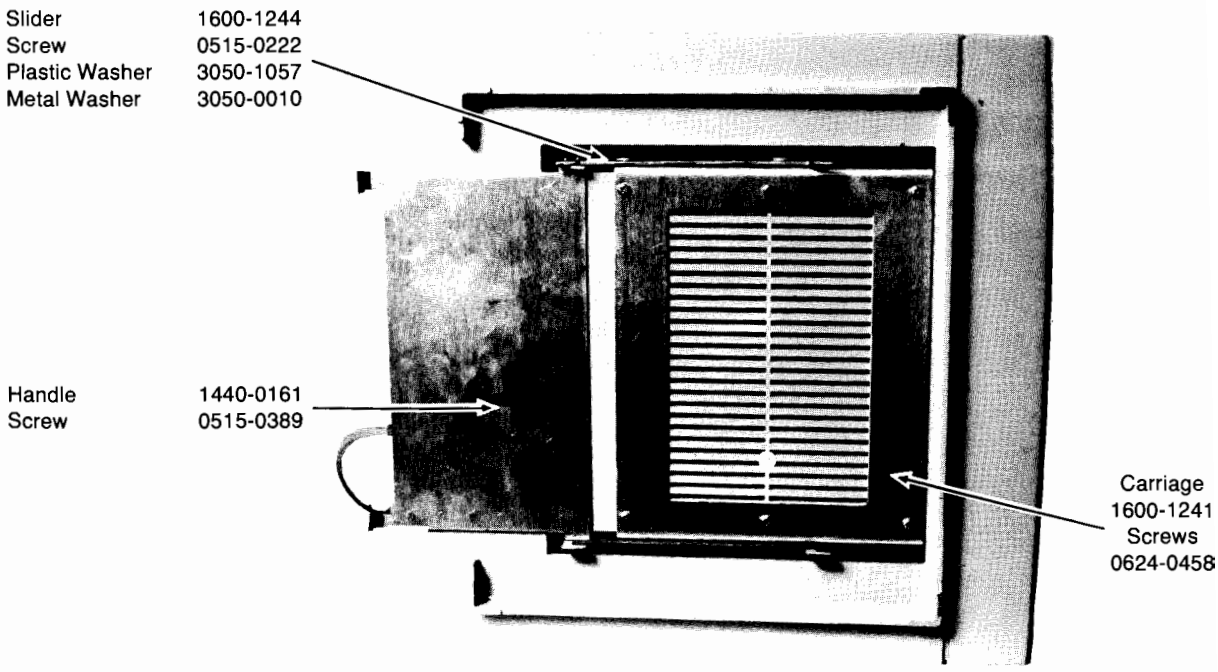
CRT Cover
5041-3445
Fasteners 1390-0594
Clips 1390-0088



CRT Bezel
5041-3444
Screws
0624-0458
Bracket
1600-1384
Screws
0515-0052
Star Washers
2190-0028
Flat Washers
3050-0803

CRT Bottom
5041-3443
Screws
0624-0458

Figure 6-12. 9836C Case Hardware Part Numbers (Continued)



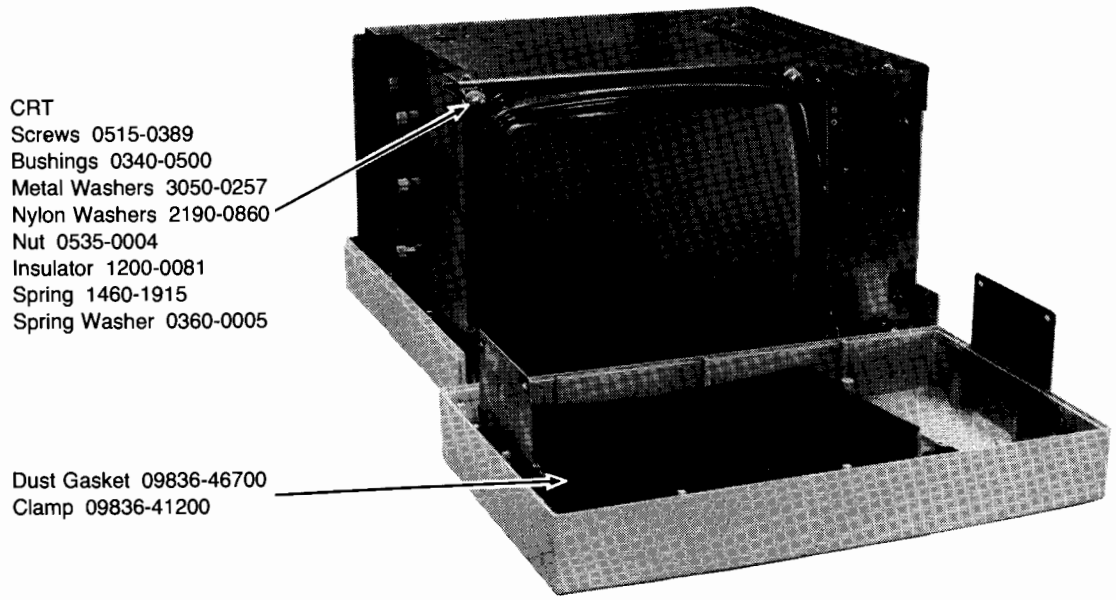


Figure 6-12. 9836C Case Hardware Part Numbers (Continued)

Table 6-5. Product Support Package (09826-67100)

HP Part No.	Description
98206-66501	Test Card
09826-66542	Processor Extender Board
09826-66543	Power Supply Extender Board
09826-66544	General Purpose 100-Pin Extender Board
8710-0580	IC Extractor
8710-1179	Keycap Remover
2110-0592	Spare Fuse (4 Amp, Quantity 2)
09826-90030	Service Manual
3101-2463	Spare Standard Keyswitch (Quantity 2)
98622-67950	GPIO Test Connector
98623-67950	BCD Test Connector
98626-67950	RS232 Test Connector

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Table 6-6. Disc Drive Product Support Package (09130-67100)

HP Part No.	Description
9164-0151	Alignment Disc
9164-0129	Blank Discs (10 Pack)
6040-0521	Molykote Grease
8710-1385	Spindle Motor Adjustment Tool
09130-90010	Shipping Disc

Table 6-7. Disc Drive Field Support Inventory (09130-67197)

HP Part No.	Description
09130-69600	Drive Mechanism with Servo
09130-66501	Drive Board
09130-66500	Servo Board
0950-0448	Drive Belt
09130-67920	Spindle Motor
7121-1451	Strobe Label
0510-0042	Retaining Clip
09130-90010	Shipping Disc
1600-1137	Media Lift Inhibitor
4040-1913	Operating Handle, Brown
4040-1914	Operating Handle, Grey
4040-1915	Bezel
7121-1631	Identification Label
92193A	Cleaner Kit

Table 6-8. Major Assemblies Unique to 9836C

HP Part Number	Description
09826-69516	Processor Board
09836-69502	Base Motherboard
09836-69540	Sweep Board
09836-69542	Video Board
09836-69550	Display Power Supply Board
09836-69572	Digital Board
09836-69573	Graphics Board
8120-4128	LKABLE Coax Cable

Table 6-9. Miscellaneous Items

Reference Designator	CD	HP Part No.	TQ	Description
	8	6010-0695		Touch-up paint (Pearl grey)
	2	09130-67910		Disc drive shipping carton
	5	9211-3621		CRT shipping carton (9826)
	2	9220-2209		CRT shipping pad (9826)
	1	9220-3462		CRT shipping pad (9826)
		98206-66502		Test Card Update ROMs (Rev. D)
	2	09836-80000		TSB update ROMs (Rev. B)
	5	9222-0682		Anti-static bags
	5	9300-0933		Anti-static workstation
	3	92193A		Head cleaning kit
		8500-2163		CRT window cleaner

Table 6-10. Language Systems

HP Part No.	Description
98261-66511	BASIC 1.0 (ROM), Board 1
98261-66512	BASIC 1.0 (ROM), Board 2
98261-66513	BASIC 2.0 (ROM) 98601A
98261-66514	BASIC 2.1 (ROM) 98602A
98261-66541	HPL 1.0 (ROM)
98261-66542	HPL 2.0 (ROM)
98611-10X04	BASIC 2.0 (Disc) 98611A
98612-11X24	BASIC Extensions (AP2.1, Graphics 2.1) (Disc) 98612A
09800-11X24	BASIC Extensions (SRM 2.1) (Disc) 98612A
98614-10X04	HPL 2.0 (Disc) 98614A
09800-10X59	HPL 2.0 (Disc) (Utilities) 98614A
98615-11354	Pascal 2.1 Boot (Disc) 98615A
98615-11355	Pascal 2.1 SYSVOL (Disc) 98615A
98615-11356	Pascal 2.1 ACCESS (Disc) 98615A
98615-11357	Pascal 2.1 CMPASM (Disc) 98615A
98615-11358	Pascal 2.1 LIB (Disc) 98615A
98615-11364	Pascal 2.1 CONFIG (Disc) 98615A

X refers to disc size: 3 for use in 3½ in. drives
5 for use in 5¼ in. external drives
6 for use in 5¼ in. internal drives

Table 6-11. Language System Updates

HP Part No.	Description	Notes
98261-69613	BASIC 1.0 to 2.0	ROM to ROM Return replaced boards
98261-69114	BASIC 1.0 to 2.0	ROM or disc to disc Return replaced boards or discs
98261-69144	HPL 1.0 to 2.0	ROM or disc to disc Return replaced board or disc
98261-69642	HPL 1.0 to 2.0	ROM to ROM Return replaced boards
98602-696X0	BASIC 2.0 to 2.1	ROM to ROM Return replaced board
98612-17X10	BASIC 2.0 to 2.1	Disc to disc

X refers to disc size: 3 for use in 3½ in. drives
5 for use in 5¼ in. external drives
6 for use in 5¼ in. internal drives

Appendix A

Boot ROM Errors

At power-up, the early 9826/9836A boot ROM tries to load a language system, and displays error messages if any problems are encountered. Many of the problems causing the error messages can be easily corrected by the user if instructions are given to them. The following list of error messages and likely causes are presented here to help you fix problems by telephone rather than in person.

Error Message	Likely Causes
MEMORY FAILURE AT XXMNPQRS	More than one RAM board is set to address MN0000. Refer to the section on Checking the RAM Board Address.
INSUFFICIENT USABLE MEMORY NOT ENOUGH MEMORY FOR SYSTEM NEED RAM ABOVE FF8000	The CPU cannot locate enough RAM to operate. The most likely cause is that there is a gap in RAM addressing. RAM boards must be addressed consecutively starting with FFXXXX. Refer to the section on Checking the RAM Board Address. If the RAM is correctly addressed, there is a CPU bus problem which cannot be fixed by the user.
KEYBOARD FAILED SELF-TEST	This occurs if more than one language or configuration jumper is installed under the keyboard or if several keys are held down when the machine is turned on. If these have been eliminated, the keyboard controller or chip select are defective.
FLOPPY ERROR #XX,YYY	The most likely cause of this error is bad media. Replace the disc with a known-good one. If the error remains, the drive is defective. Replace the drive with a known-good one.
FATAL FLOPPY ERROR #XX,YYY	The most likely cause of this error is a defective drive. Replace it with a known-good one. If the error remains, the disc drive controller is defective. Replace it with a known-good one.

Appendix B

System Test Error Codes

Appendix B contains an amplification of the error messages produced by the system test procedure.

Processor Section

NO RAM @ FF	No RAM was found at location FFXXXX. A bus error was detected. Testing is suspended unless the DRIVE switch is set.
UNEXPECTED LVL X INT W/SR = 2700	An unexpected level X interrupt occurred.
NO INTERRUPT ON LVL X	The test card presented the CPU a level X interrupt but the CPU did not respond properly.
GOT INT LVL Y EXPECTED X	The test card presented the CPU a level X interrupt and the CPU responded to a level Y interrupt.
SR was #Y## not #Z## AFTER INT	The CPU status register contained #Y## when it should have contained #Z## after a level Z interrupt.
SR was #Y## not #Z## AFTER INT ON STACK	The CPU status register contained #Y## when it should have contained #Z## after a level Z interrupt on the stack.
INT RTE ADDR was XXXXXX not YYYYYY.	The return address XXXXXX on the stack after an interrupt and should have been YYYYYY.
STACK POINTER was XXXXXX not YYYYYY.	The stack pointer was XXXXXX after an interrupt and should have been YYYYYY.

Memory Section

ROM @ XXXXXX REVERSED	The upper byte and lower byte ROMs are reversed. If the ROMs are in sockets, the two ROMs at that address should be switched, and the test re-run.

ROM CHECKS XXXX @ YYYYYY	A checksum error was detected in the ROM at address YYYYYY. If the address is even, the upper byte is defective; if it is odd, then the lower byte is defective. The value XXXX is the checksum found, rather than the correct one, FFFF.
ROM ADDR had XXXXXX @ YYYYYY	The ROM header ADDR parameter contains incorrect data (XXXXXX) at ROM address YYYYYY. This is due to a ROM being installed on the wrong board.
ROM # has XXXX not YYYY @ ZZZZZZ	The ROM header ROM number contains incorrect data (XXXX) instead of the correct data (YYYY) at location ZZZZZZ. This is due to a ROM being installed out of sequence on the correct board.
ROM L = " " @ XXXXXX	The ROM header 'language' parameter contains incorrect data (" "). This is due to a language ROM IC being installed at the correct spot on a board for a different language, for instance, a Pascal IC on an HPL board.
RAM W/B @ XXXXXX	Data was written at address XXXXXX, then read back. Data read back was not the same as data written.
RAM @ XXXXXX had YYYYYYYY not ZZZZZZZZ	The RAM located at address XXXXXX contained YYYYYYYY and should have contained ZZZZZZZZ.
RAM RFSH @ XXXXXX had YYYYYYYY not ZZZZZZZZ	The RAM located at XXXXXX did not refresh correctly. The data read was YYYYYYYY and should have been ZZZZZZZZ.
RAM CNFIG @ XXXXXX	There is an error in the RAM board addressing. RAM board addresses must be contiguous and non-overlapping.
RELOCATE FAILURE @ XXXXXX	An error occurred while shifting data into RAM location XXXXXX.
BUS SPEED XXXX @ YYYYYY (ZZZZ,WWWW)	A RAM IC at location YYYYYY is running at the wrong speed. The speed (XXXX) should be between ZZZZ and WWWW.
UNABLE TO DRIVE	The DRIVE signal did not replace the boot ROM with the test code.

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UNABLE TO REMOVE DRIVE	The DRIVE signal can not be replaced.
CPU BOARD SIZE ERROR YY	The ID PROM exceeds the maximum allowable size.
CPU BOARD SIZE XX00 @ 5F0001	The ID PROM has an improper size parameter.
CPU BOARD PROM CHK_SUM YYYY @ 5F0001	The ID PROM has a checksum error.
PON RAM @ XXXXXX had YYYYYYYY YYYYYYYY not ZZZZZZZZ	The RAM at location XXXXXX contained after write of ZZZZZZZZ.
MEMORY SPEED YYYY @ XXXXXX	A RAM IC at location XXXXXX had a speed of YYYY shortly before or after a RAM error. This error only appears in conjunction with an MMU processor board.
BUS ERROR @ XXXXXX IN K#	A bus error was detected at RAM location XXXXXX. K# is the test the error was detected in.
NO RAM AT FF	No RAM was found at location FFXXXX. A bus error was detected. Testing will be terminated unless the DRIVE switch is set.
NO RAM SPEED @ XXXXXX-KBD BAD?	RAM speed could not be checked because the keyboard timer failed.
NO PASS-PASS REFRESH - KBD BAD?	The pass to pass refresh test could not be done because the keyboard timer failed.
TOP 64K NOT TESTED	The code is unable to test the top 64k bytes of RAM because the soft test code is located there. This is not a true error message, since there are valid reasons for this to happen.

CRT Section

RAM @ 51XXXX had 000000YY not 000000ZZ	The display RAM located at address 51XXXX contained 000000YY and should have contained 000000ZZ.
NO GRAPHICS IN K#	This message is displayed if a bus error takes place when attempting to access the graphics RAM.
RAM @ 53XXXX had 0000YYYY not 0000ZZZZ	The graphics RAM located at address 53XXXX contained 0000YYYY and should have contained 0000ZZZZ.
RAM RFSH @ 53XXXX had 0000YYYY not 0000ZZZZ	The graphics RAM located at 53XXXX did not refresh correctly. The data read was 0000YYYY and should have been 0000ZZZZ.

Display Section

NO ALPHA IN K3	A bus error was detected while accessing the alpha RAM.
NO GRAPHICS IN K#	A bus error was detected while accessing the graphics RAM. K# is the test the error was detected in.
RAM @ 51XXXX had 000000YY not 000000ZZ	The alpha RAM located at address 51XXXX contained 000000YY and should have contained 000000ZZ.
RAM HOLD @ 51XXXX had YYYY not ZZZZ	The alpha RAM located at address 51XXXX contained YYYY a short wait period after ZZZZ was written.
RAM HOLD @ 51XXXX had YY not ZZ	The alpha RAM located at address 51XXXX contained YY a short wait period after ZZ was written.
COLOR MAP @ 53XXXX had YYYY not ZZZZ	The color map contained YYYY at location 53XXXX and should have contained ZZZZ.
VERTICAL BLANK STUCK HIGH	The vertical blank bit in the CRT bit register is stuck high.
VERTICAL BLANK STUCK LOW	The vertical blank bit in the CRT bit register is stuck low.
VBLANK TIME YY (ZZ,WW)	The vertical blank bit is not toggling at the correct rate. YY is not within the range set by ZZ and WW.
RAM RFSH @ 53XXXX had YYYY not ZZZZ	The graphics RAM did not refresh correctly. The data read was YYYY and should have been ZZZZ.
RAM RFSH @ 53XXXX had YYYYYYYY not ZZZZZZZZ	The graphics RAM did not refresh correctly. The data read was YYYYYYYY and should have been ZZZZZZZZ.
RAM @ 53XXXX had 000000YY not 000000ZZ	The graphics RAM located at address 53XXXX contained 000000YY and should have contained 000000ZZ.
RAM RFSH @ 53XXXX had 000000YY not 000000ZZ	The graphics RAM located at 53XXXX contained 000000YY a short wait period after 000000ZZ was written.

Keyboard Section

LVL 1 INT XX YY ZZ	The interrupt system was enabled and a level 1 interrupt occurred. No keyboard interrupts were expected. The keyboard controller generated the interrupt.

KBD FAILED SLFTST	A reset signal was sent to the keyboard but the keyboard did not respond with an interrupt status. A possible cause is a checksum error in the keyboard controller.
KBD STS XX NOT 71	The keyboard status after a reset was XX and should have been 71.
KBD DATA XX NOT 8E	The keyboard data after a reset was XX and should have been 8E.
KBD NOT RDY, XXXXXX	The keyboard status indicates that the keyboard was not ready to accept a command or data.
KBD NOT INT W/DATA	The keyboard was requested to interrupt and present data. The interrupt line or the keyboard controller may be defective.
KBD INT NO CAUSE XX	The keyboard interrupted when not expected. The status was 0.
KBD INT STATUS XX	The status obtained upon interrupt from the keyboard was incorrect, or bit 0 was not set. The status was XX.
KBD INT MASK	The data obtained upon keyboard interrupt for interrupt mask data was not the expected value of 1F (hex).
KBD TIMER SLOW OR NO INT YY (ZZ,WW)	The system 10 msec timer on the keyboard did not interrupt or was to slow. The problem could be the 8041 or the 10MHz crystal.
KBD TIMER FAST YY (ZZ,WW)	The system 10 msec timer interrupted, but was too fast. The problem could be the keyboard controller or the 10MHz crystal.
NO KBD NMI	The keyboard was requested to issue a non-maskable interrupt (NMI) after 10 msec. This is the fast handshake timeout interrupt. It did not take place. The problem could be the interrupt line, the keyboard controller or keyboard buffer.
KBD REAL TIME CLK BAD, XXXXDAYS, YYYYYYms	The real-time clock was set to zero then read, and the time read was not zero.

KBD KEY CODE YY, STATUS ZZ	An out-of-range key code was detected (or LOG is enabled).
LVL 2 INT IN K4	An unexpected level 2 interrupt was detected.
LANG JMPR = X	X refers to the number in this table: 1 French 2 German 3 Swedish/Finnish 4 Spanish 5 Japanese (Katakana) 6 System jumper 9 7 System Jumper 10 8 System jumper 11
SYS JMPR = X	X refers to the number in this table: 1 System jumper 1 2 System jumper 2 3 System jumper 3 4 System jumper 4 5 System jumper 5 6 System jumper 6 7 System jumper 7 8 System jumper 8

Disc Drive Section

RAM @ 44EXXX had 000000YY not 000000ZZ	The disc RAM located at address 44EXXX contained 000000YY and should have contained 000000ZZ.
DRV D DISC FAST YYYY (ZZZZ,WWWW)	The motor is turning too fast. The time between index pulses is too short.
DRV D DISC SLOW YYYY (ZZZZ,WWWW)	The motor is turning too slow. The time between index pulses is too long.
DRV D DISC STS XX CMD YY XCMD ZZ TRK WW SEC VV	Disc drive status is wrong. XX was read, YY was the most recent command, ZZ the extended command, WW the track and VV the sector.
DRV D NO INT AFTER RES	The disc drive was expected to interrupt after a reset, but failed to do so.
DRV D DISC WRT XX RD YY	The data written as XX was read back as YY.
DRV D WRT PROCT	The disc is write protected. The rest of the disc drive test will be skipped.

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DRV D TRK REG had XX not YY	The track register contained XX rather than YY.
DRV D TRK REG had XX not YY AFTER ZZ STS WW	The track register contained XX rather than YY. The last command given the drive was ZZ and the status returned was WW. This means that the heads did not properly step in or out and an incorrect track may have been written.
DRV D SEC REG had XX had YY	The sector register contained XX rather than YY.
DRV D DAT REG had XX not YY	The data register contained XX rather than YY.
DRV D NO TR00 AFTER XX	The track 0 switch was expected after the XX command, but did not occur.
DRV D TR00 TRUE AFTER XX	The track 0 switch was true after the XX command, but should not have been.
DRV D CLR EXSTS FAILED	The extended status bits 1 and 2 were to be cleared by a command, but one or both remain set.
DRV D DISC BUSY XXXXXX	The drive was busy when it should have been ready to receive the next command. The value XXXXXX is the address in the code where the command was given.
DRV D DISC TIMEOUT XXXXXX	The drive was given a command and failed to interrupt within a given period of time. The value XXXXXX is the address in the code where the command was given. The rest of the disc drive test will be skipped.
DRV D NO DISC OR NOT RDY	The ready status is required but there is no index pulse to enable it. No disc is installed or there is a disc failure. This message is displayed only once in a sequence of passes. The rest of the disc drive test is skipped.
DRV D MOTOR OFF & RDY	The drive remains ready although the motor is turned off.
DRV D NO INDEX	No index pulses are detected although the motor is running.
DRV D MARGIN	A margin error was detected while reading data from the disc.

DRV D READ ADD	An error was detected in a read address sequence.
DRV D CRC	The CRC read was not the same as the one generated by the program.
DRV D DISC FDC	The head load status indicator was not set.
DRV D NO FILE OR NOT ASCII	The "TROMDATA" file was not found on the disc or was the wrong type. The rest of the disc drive test will be skipped.
DRV D FILE SMALL	The "TROMDATA" file is too small. The "TROMDATA" must be of ASCII type and 80 records in length.
LVL 2 INT	An unexpected level 2 interrupt occurred.
RAM @ 44EXXX had 0000YYYY not 0000ZZZZ	The disc RAM located at address 44EXXX contained 0000YYYY and should have contained 0000ZZZZ.
NO RAM SPEED @ XXXXXX - KBD BAD?	Unable to test disc drive RAM due to a defective keyboard timer.
RAM HOLD @ 44EXXX had YY not ZZ	The disc RAM failed to hold data for one second.
RAM SPEED YYYY @ 44EXXX (ZZZZ,WWWW)	The speed YYYY of the disc RAM located at address 44EXXX was not within limits ZZZZ and WWWW.

Powerfail Section

PF FAILED SLFTST WW	The 8041 processor on the powerfail board failed its self test.
PS RAM @ XX had YY not ZZ @ XX	Powerfail RAM at location XX contained YY when it should have contained ZZ.
PF CLK FAST WWWW (YYYY, ZZZZ)	The powerfail clock is fast or the shift register is failing.
PL CLK SLOW WWWW (YYYY, ZZZZ)	The powerfail clock is slow or is not incrementing, or the shift register is failing.
PF IBF/OBF/F1	The powerfail 8041 IBF, OBF and F1 flags did not respond correctly.
PF TIMEOUT @ XXXXXX	A timeout occurred while attempting to talk with the powerfail at test code address XXXXXX.

Memory Manager Section

NO MMU	No MMU found even though switch 96 enabled on test card.
MMU SYS REG was YYYY not ZZZZ	Value YYYY was obtained from MMU system register when it should have been ZZZZ.
MMU USER REG was YYYY not ZZZZ	Value YYYY was obtained from MMU user register when it should have been ZZZZ.
MMU CMD WW, STS Y	The MMU status after command WW was Y.
MMU CMD WW, STS	The MMU status after command WW was Y when it should Y/Z have been Z.
MMU CMD WW, STS Y/Z, LA LLLLLL, BUS ERR @ XXXXXX	An unexpected bus error occurred in the code around address XXXXXX. The MMU status after command WW was Y and it should have been Z. The logical address was LLLLLL.
MMU CMD WW, STS Y/Z, LA LLLLLL, NO BE @ XXXXXX	An expected bus error in the code around address XXXXXX did not occur. The MMU status after command WW was Y and should have been Z. The logical address was LLLLLL.
MMU CMD WW, STS Y/Z, LA LLLLLL, SUP TBL REPLACE	The MMU status after command WW was Y when it should have been Z. The logical address was LLLLLL.
MMU CMD WW, STS Y/Z, LA LLLLLL, SEG TBL ACC	The MMU status after command WW was Y when it should have been Z. The logical address was LLLLLL. Something went wrong when accessing the segment table.
MMU CMD WW, STS Y/Z, LA LLLLLL, PAGE TBL ACC	The MMU status after command WW was Y when it should have been Z. The logical address was LLLLLL. Something went wrong when accessing the page table.
MMU CMD WW, STS Y/Z, LA LLLLLL, NO TLB PURGE	The MMU status after command WW was Y when it should have been Z. The logical address was LLLLLL. The translator look-aside buffer was not purged correctly.
MMU CMD WW, STS Y/Z, LA LLLLLL, NO REF BIT	The MMU status after command WW was Y when it should have been Z. The logical address was LLLLLL. The referenced bit in the page table was not set.
MMU CMD WW, STS Y/Z, LA LLLLLL, NO TLB REPLACE	The MMU status after command WW was Y when it should have been Z. The logical address was LLLLLL. The data in the translator look-aside buffer should have been replaced, but was not.

MMU CMD WW, STS Y/Z, LA LLLLLL, SUP TLB REPLACE	The translator look-aside buffer was filled with user accesses, then supervisor accesses were made. It should have been updated to the supervisor data, but was not.
MMU CMD WW, STS Y/Z ,BUSS ERR @ XXXXXX	An unexpected bus error occurred in the code around location XXXXXX. The MMU status after command WW was Y and it should have been Z.
MMU CMD WW, STS Y/Z, NO BE @ XXXXXX	An expected bus error in the code around location XXXXXX did not occur. The MMU status after command WW was Y and it should have been Z.
MMU CMD WW, STS Y/Z, LA LLLLLL, DATA NNNN/MMMM	The MMU status after command WW was Y when it should have been Z. The logical address was LLLLLL. The data was NNNN when it should have been MMMM.
BUS ERROR @ 5F8001	The programmable timer module did not respond at address 5F8001.
PTM STATUS was YY not ZZ after RESET	The status in PTM 1 after a reset was YY and should have been ZZ.
PTM STATUS was YY not ZZ after CLR INT	The status in PTM 1 after a clear interrupt was YY and should have been ZZ.
PTM STATUS was YY not ZZ after COMMAND WW.	The status in PTM 1 after command WW was YY and should have been ZZ.
PTM REGN was YYYY not ZZZZ	The data from PTM register N was YYYY and it should have been ZZZZ. YYYY was written to the corresponding latches and should have appeared at the counter outputs.
IN 10ms PTM CR1 WENT FROM FFFF to NNNN (F542-F736)	PTM counter 1 was set to FFFF in continuous mode. The counter should have counted down to between F542 and F736 in 10ms. It did count to NNNN.
PTM CR2 VALUES 0-7, PRESET NNNN	PTM counter 2 was set up to count continuous and must produce all integers from 0 to 7. It either did not produce all eight, or it produced out of range numbers.
PTM CR3 VALUES 0-7, PRESET NNNN	PTM counter 3 was set up to count continuous and must produce all integers from 0 to 7. It either did not produce all eight, or it produced out of range numbers.
PTM CR3 SPEED ERROR NNNN (0-2)	PTM counters 1 and 3 were set up to count in continuous mode. The two counter outputs should have stayed together, but did not.

PTM DUAL 8 CR3 NNNNNNNN YYYY, ZZ	PTM counter 3 was set up for dual 8 bit and count continuous mode with an initial value of 0107 (hex). NNNNNNNN is a bit map of the values received as the count down took place. YYYY is the last value received from counter 3. ZZ is the loop counter.
NO PTM SPEED - KBD BAD?	PTM speed could not be checked because the keyboard timer failed.
NO PTM INTERRUPT	A level 6 interrupt from the PTM was expected but did not occur.
PTM INTERRUPT WHEN NOT EXPECTED	An unexpected level 6 interrupt occurred.
CACHE STATUS was YYYY not ZZZZ	The status of the cache was YYYY when it should have been ZZZZ.
CACHE DATA was YYYY not ZZZZ @ XXXXXX	The data read at location XXXXXX was YYYY when it should have been ZZZZ.
CACHE DATA was YY not ZZ @ XXXXXX	The data byte read at location XXXXXX was YY when it should have been ZZ.
CACHE IN I/O SPACE	The cache was found to be operating in I/O address space.
CACHE SPEED YYYY, ZZZZ	The speed of memory with cache on or off was incorrect.
NO RAM SPEED @ XXXXXX - KBD BAD?	The speed of the RAM at location XXXXXX could not be checked because the keyboard timer failed.
MMU BUS ERROR IN K29	An unexpected bus error occurred.
BOOTROM CHECKSUM ERROR, LA LLLLLL, PA PPPPPP	A CRC error was found in the boot ROM address space. The logical address is LLLLLL and the physical address is PPPPPP.
DATA YYYYYYYY/ ZZZZZZZZ, LA LLLLLL, PA PPPPPP	The data read at logical address LLLLLL was YYYYYYYY when it should have been ZZZZZZZZ. The physical address was PPPPPP.
TOO MANY PTM INTs IN K29	Too many programmable timer module interrupts were detected in this test.

Other Error Messages

Some error messages do not occur in conjunction with a particular test, but may appear in any of several tests, or between tests. These messages are listed here.

ADDRESS ERR @ XXXXXX	Test stimulus board probably defective.
NO RAM @ FF	No RAM was found at FFXXXX and a bus error was detected.

PON RAM @ XXXXXX had YYYYYYYY not ZZZZZZZZ	ZZZZZZZZ was written to RAM location XXXXXX. It was read back as YYYYYYYY.
RAM BUS ERR XXXXXX	Bus error problem with RAM at location XXXXXX.
+ + + EXCEPTION XXXXXX	This is a catchall message which appears when the test stimulus board encounters a problem but is unable to specify what is wrong. XXXXXX is an address related to the problem. In some cases, many exception messages are produced. The test being run is terminated when an exception message occurs.

Appendix C

Motherboard Signals and Connectors

Appendix C is a detailed layout of the signals which pass through the motherboard and the connectors on the motherboard.

Figure C-1 is a drawing of the 9826 motherboard connectors in approximately the position they actually are, with each pin labelled with the mnemonic of the signal found on that pin.

Figure C-2 is a similar drawing for the 9836A motherboard connectors.

Figure C-3 is a similar drawing for the 9836C motherboard connectors.

Table C-1 is a list of motherboard signal lines and their mnemonics. It is presented as an aid to understanding what the mnemonics stand for.

Table C-2 is a list of motherboard signal lines and their mnemonics. It is presented as an aid to understanding what the mnemonics stand for.

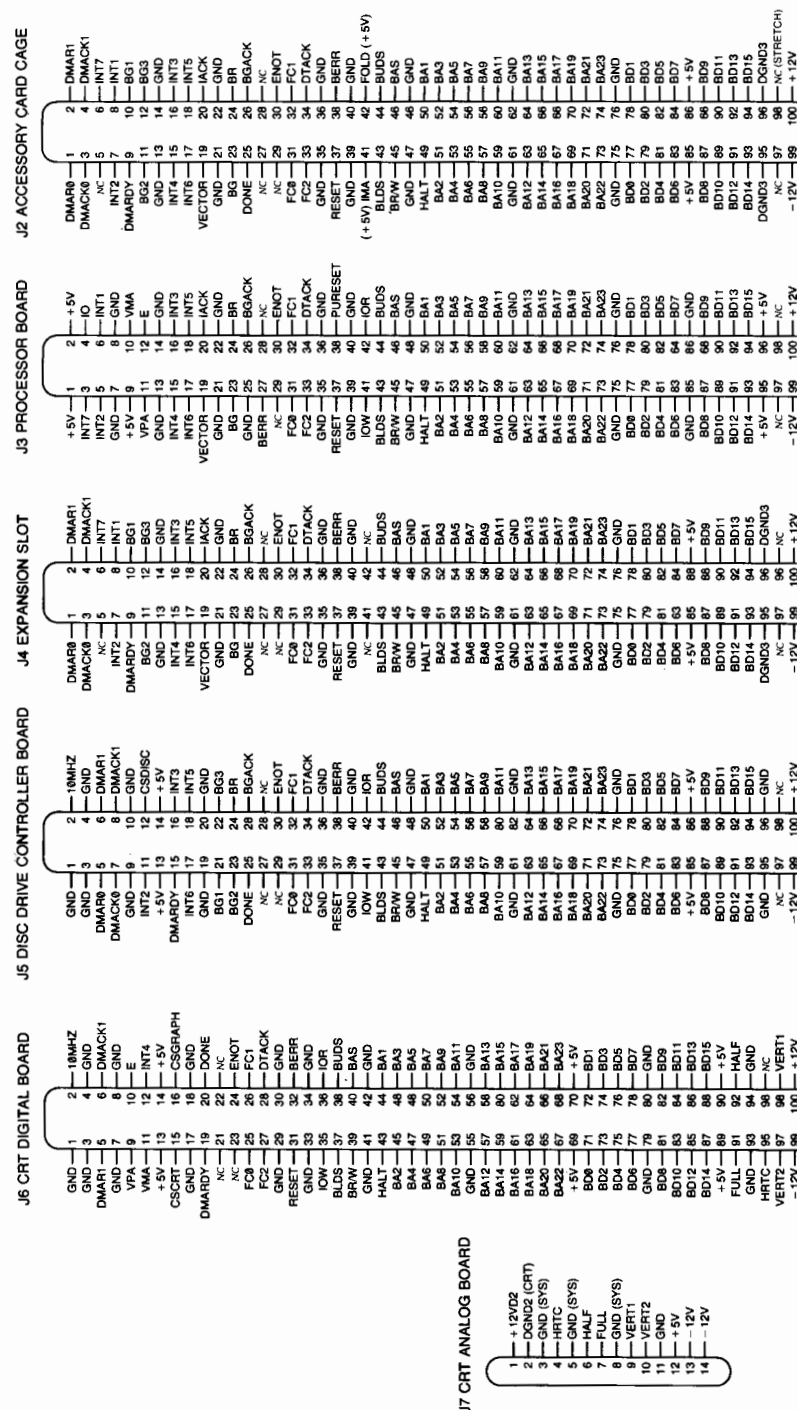

Figure C-1. 9826 Motherboard Connector Pin Assignments

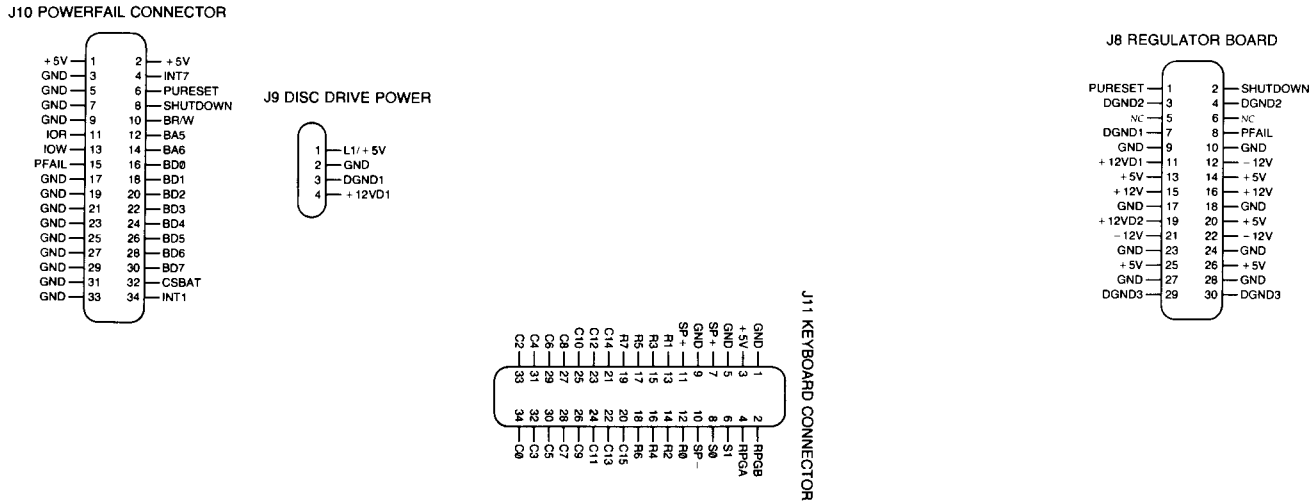

Figure C-1. 9826 Motherboard Connector Pin Assignments

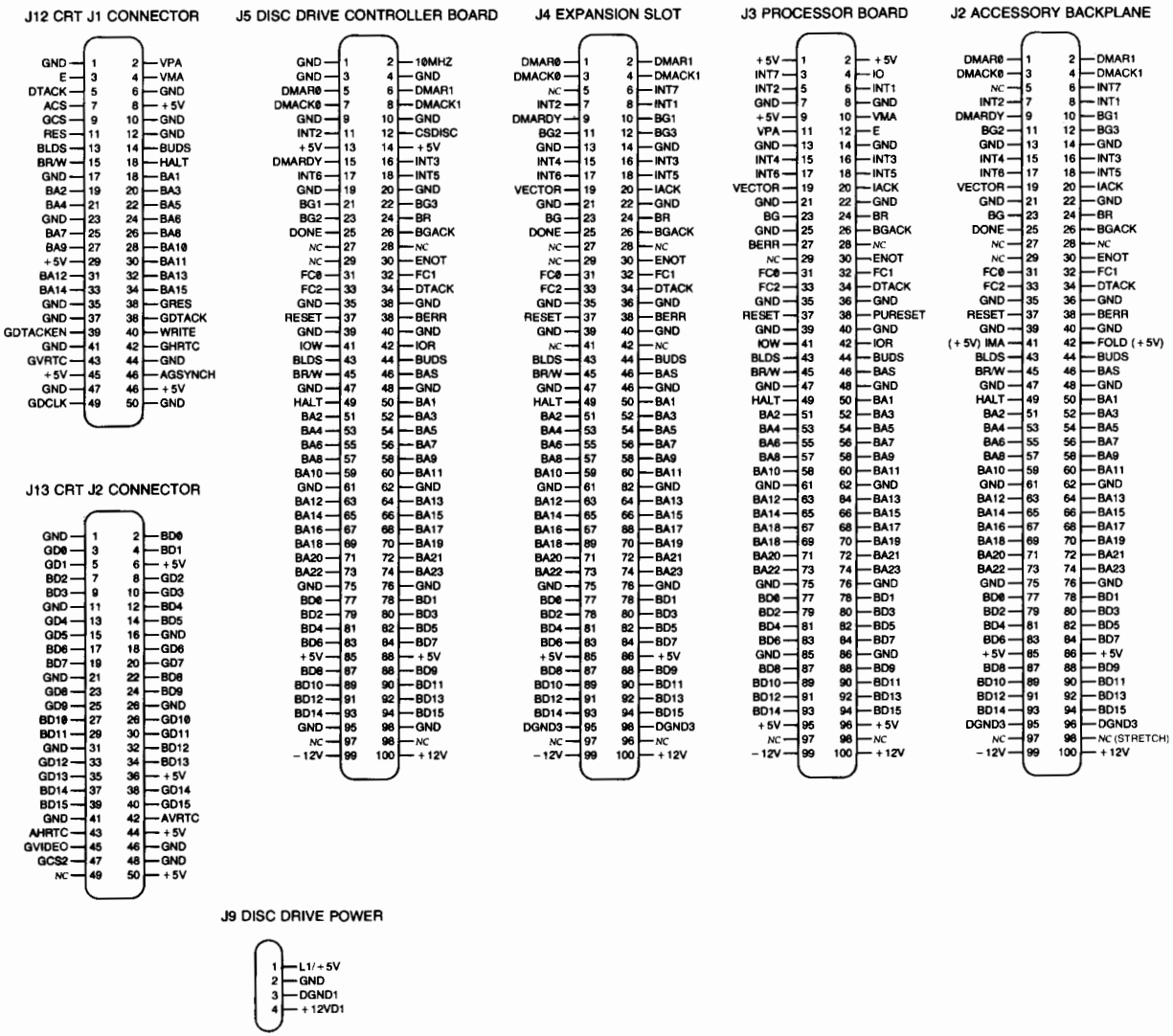

Figure C-2. 9836 Motherboard Connector Pin Assignments

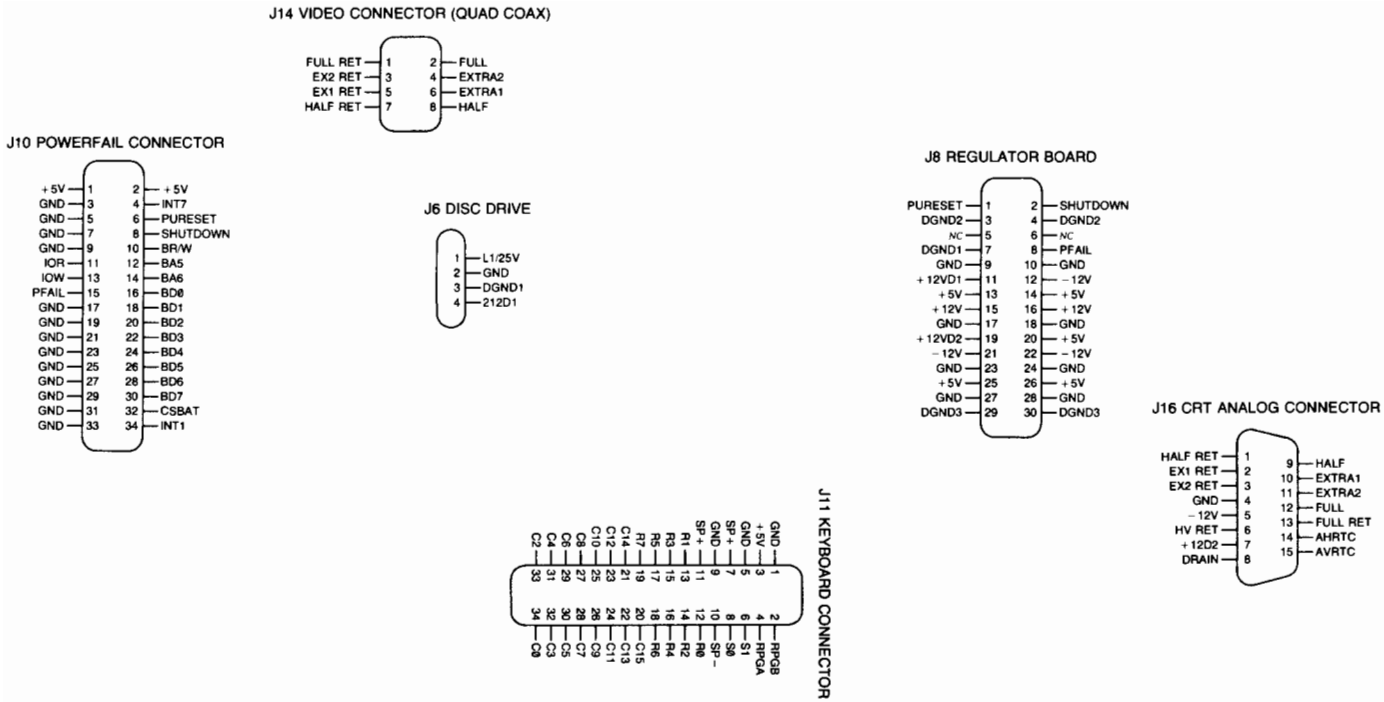

Figure C-2. 9836 Motherboard Connector Pin Assignments

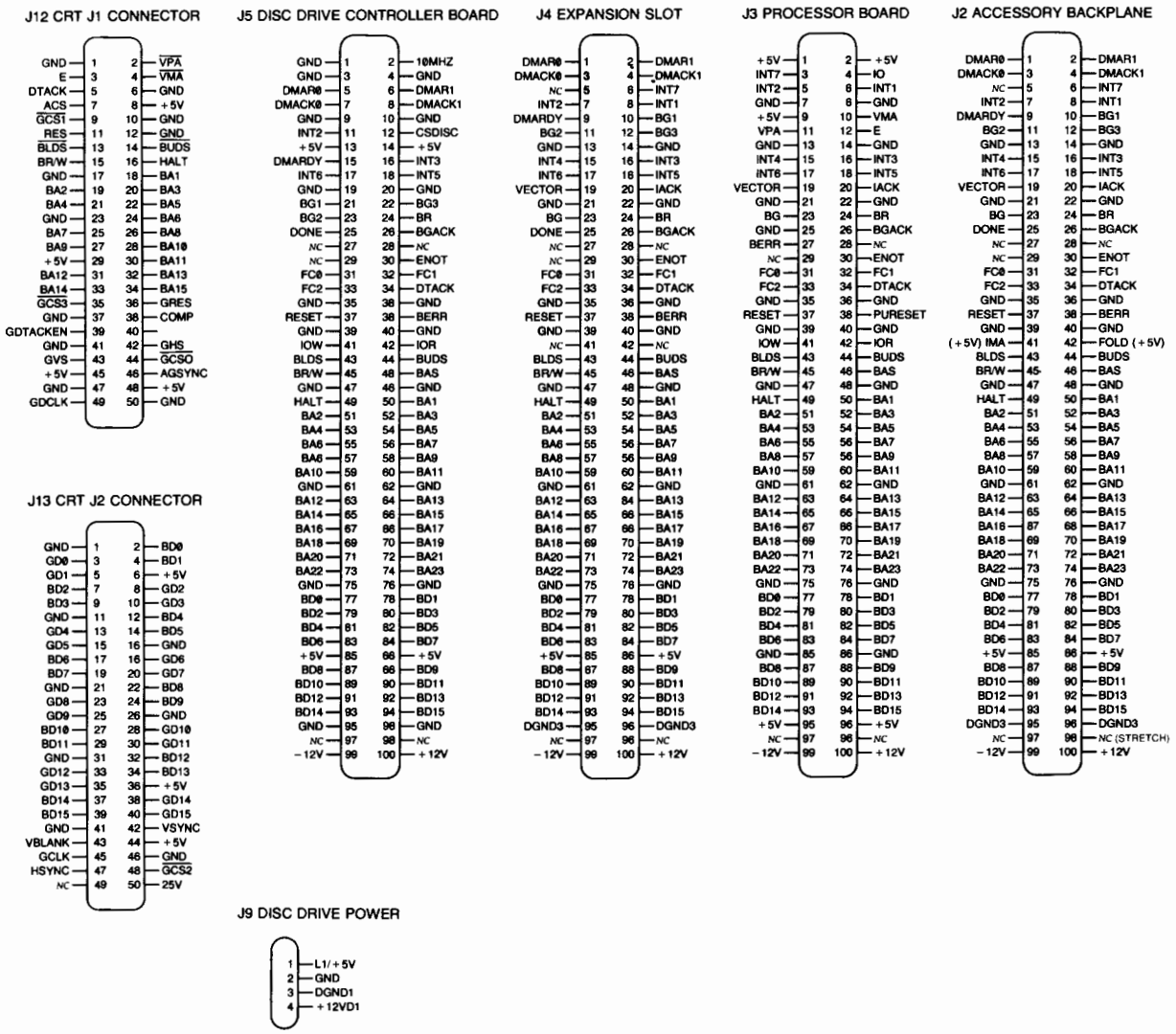

Figure C-3. 9836C Motherboard Connector Pin Assignments

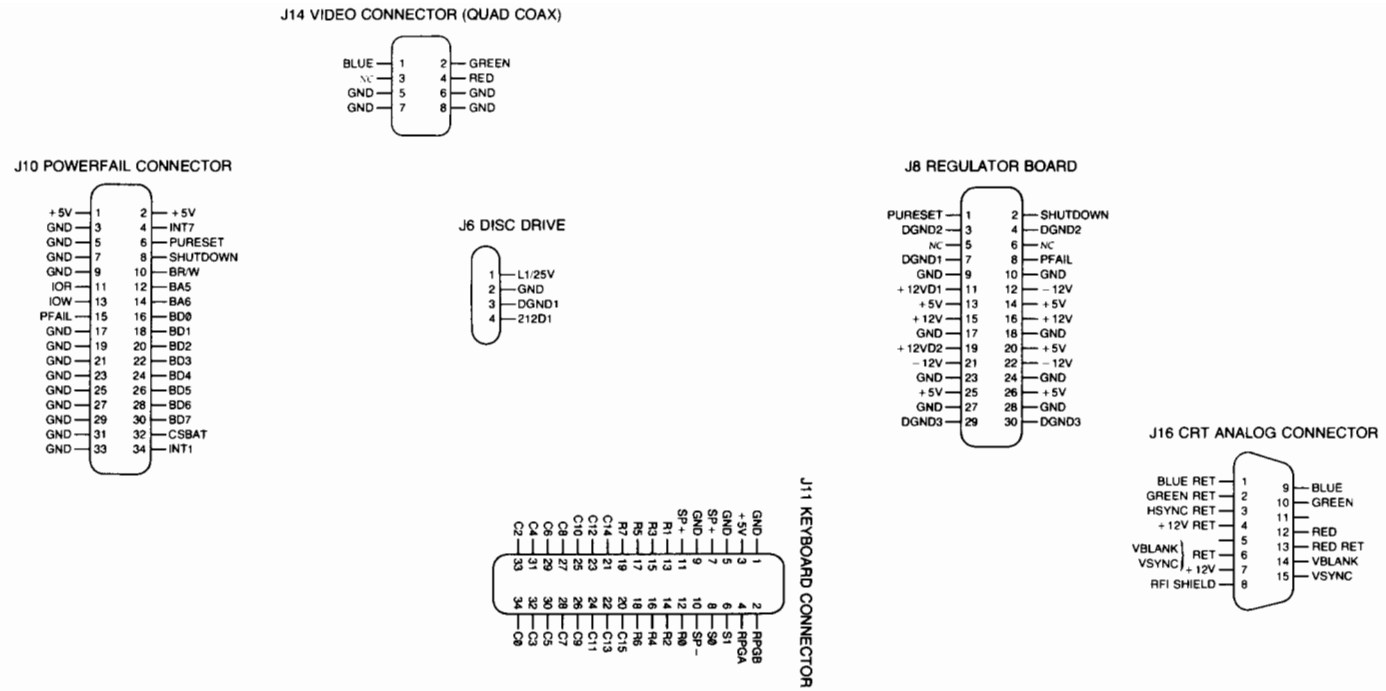

Figure C-3. 9836C Motherboard Connector Pin Assignments

Table C-1. Motherboard Signal Lines and Mnemonics

BA1-23	Buffered Address Lines 1-23—these 23 lines form a unidirectional, three-state bus for addressing during all cycles except interrupt cycles. During interrupt cycles, BA1-3 indicate what level of interrupt is being serviced and all other lines are tied high.
BAS	Buffered Address Strobe—indicates that there is a valid address on the address bus.
BD0-15	Buffered Data lines 0-15—these 16 lines form a bi-directional, three-state bus for data transfer.
BERR	Bus Error—informs the processor that there is a problem with the cycle being executed.
BG	Bus Grant—indicates to all potential bus master devices that the processor will release bus control at the end of the current bus cycle.
BG1-3	Bus Grant 1-3
BGACK	Bus Grant Acknowledge—indicates that some device other than the processor has become the bus master.
BLDS	Buffered Lower Data Strobe—controls the data on the lower byte of the data bus in conjunction with BR/W.
BR	Bus Request—indicates to the processor that some other device desires to become the bus master.
BR/W	Buffered Read/Write—defines the data bus transfer to be either a read or write cycle.
BUDS	Buffered Upper Data Strobe—controls the data on the upper byte of the data bus in conjunction with BR/W.
C0-15	Keyboard Columns 0-15
CSCRT	CRT Controller Chip and RAM Select
CSDISC	Disc Drive Controller Chip Select
CSGRAPH	Graphics RAM Chip Select
DGND1-3	Noisy ground 1-3
DMACK0-1	Direct Memory Access Acknowledge 0-1
DMAR0-1	Direct Memory Access Request 0-1
DMARDY	Direct Memory Access Ready (to/from I/O card)
DONE	Direct Memory Access Transfer Done
DTACK	Data Transfer Acknowledge—indicates to the processor that a data transfer is completed.
E	E (6800 cycle)—this is the standard enable signal for external devices.
ENDT	Enable DTACK (for 5 state access)
FC0-2	Function Code 0-2 (from 68000)—indicates the mode and cycle type currently being executed.

FOLD	Fold lower byte to upper byte (DMA)
FULL	Full-Bright Video
GND	Ground
HALF	Half-bright video
HALT	Halt—when driven by the processor, HALT indicates to external devices that the processor has stopped. When driven by an external device, HALT causes the processor to stop at the completion of the current bus cycle.
HRTC	Horizontal Retrace
IACK	Interrupt acknowledge
IMA	I'm Addressed (accessory backplane only)
INT1-7	Interrupt 1-7
IO	I/O Address Space Accessed
IOR	I/O read
IOW	I/O Write
PFAIL	Input power failed
PURESET	Power-up reset
R1-7	Keyboard rows 1-7
RESET	Reset—When driven by the processor, RESET causes all external devices to be reset without affecting the internal state of the processor. When driven by an external device, RESET resets the processor.
RPGA-B	Rotary Control Knob Lines
S0	Shift Key
S1	Control Key
SHUTDOWN	Shutdown
SP	Speaker
VECTOR	Vectored Interrupt Active
VERT1-2	CRT Vertical Deflection Current
VMA	Valid Memory Address (6800 cycle)—indicates to M6800 peripheral devices that there is a valid address on the address bus and the processor is synchronized to enable. This signal only responds to a VPA input.
VPA	Valid peripheral address (6800 cycle)—indicates that the device or region addressed is an M6800 family device and data transfer should coincide with the enable signal (E), and that the processor should use automatic vectoring for an interrupt.

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Table C-2. 9836A Alpha and Graphics Signals

ACS	Alpha Chip Select
AHRTC	Alpha Horizontal Retrace
AVRTC	Alpha Vertical Retrace
GCS	Graphics Chip Select
GD0-15	Graphics Data Lines 0-15
GDCLK	Graphics Data Clock
GDTACK	Graphics Data Transfer Acknowledge
GDTACKEN	Enable GDTACK
GHRTC	Graphics Horizontal Retrace
GRES	Graphics Reset
GVIDEO	Graphics Video
GVRTC	Graphics Vertical Retrace
RES	Reset
WRITE	Write