

**NCR**

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Personal  
Computer

Hardware  
Maintenance  
and Service

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## SCOPE

The NCR PERSONAL COMPUTER Model 4 *HARDWARE MAINTENANCE AND SERVICE* Manual is designed for use by field engineers, engineers and other technical personnel who intend to perform preventive and/or corrective maintenance procedures upon the NCR PERSONAL COMPUTER Model 4.

This publication provides specific information for problem isolation, trouble-shooting, component servicing, and repair.

All diagnostic routines supplied and supported by NCR are discussed, with particular emphasis on the Service Diagnostics (Level 1), for which this manual is the primary reference.

Extensive detailed instructions on disassembly and reassembly of the NCR PERSONAL COMPUTER Model 4 are given, along with appendices which contain information on configuration switch settings, subassembly placement, part numbers and connection and logic diagrams.

This manual is part of a library of NCR PERSONAL COMPUTER Model 4 documentation. Packaged with the computer are the "GETTING STARTED" pamphlet (PN:150-0000257); the NCR Personal Computer *OWNER'S MANUAL* (PN:150-0000179); the *NCR-DOS* Manual (PN:150-0000177); and the *GW™-BASIC* Manual (PN:150-0000180). Available separately are the *NCR-DOS PROGRAMMER'S MANUAL* NCR order number G6B1-0204-0000); the NCR Personal Computer *TECHNICAL REFERENCE* Manual (PN:150-0000230, (NCR order number D1-0162-A); and this *HARDWARE MAINTENANCE AND SERVICE* Manual (PN:150-0000231, NCR order number D1-0163-A).

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**First Edition, August 1984**

It is the policy of NCR Corporation to improve products as new technology, components, software, and firmware become available. NCR Corporation, therefore, reserves the right to change specifications without prior notice.

All features, functions, and operations described herein may not be marketed by NCR in all parts of the world. In some instances, photographs are of equipment prototypes. Therefore, before using this document, consult your NCR representative or NCR office for information that is applicable and current.

# Hardware Maintenance and Service

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## *NCR-Supported Diagnostics*

NCR supplies and supports three separate sets of diagnostic routines for the NCR PERSONAL COMPUTER Model 4. The three sets perform progressively more comprehensive testing. The simpler diagnostics are run automatically; the more complex diagnostics are run when the user of the computer either chooses to run them for preventive maintenance purposes or must run them in order to isolate and correct a machine failure (or apparent failure).

Each type of diagnostics is described in detail in either this manual or the NCR Personal Computer *OWNER'S MANUAL*. The three types of diagnostic routines are:

- Power-on Diagnostics, also referred to as level 0 diagnostics
- User Level Diagnostics
- Service Diagnostics, also referred to as level 1 diagnostics

### **POWER-ON DIAGNOSTICS (LEVEL 0)**

Power-on diagnostic routines are contained in Read-Only Memory (ROM) built into the NCR Personal Computer. These diagnostics are initiated before any other activity is attempted each time the computer is turned on.

Power-on diagnostics perform a cursory check of the memory and other components of the Main Processor Board (MPB). When the tests are successfully completed, the ROM program initiates system booting. After the boot routine reads in the operating system (NCR-DOS or other) from diskette (or hard disk), the computer is ready for processing activity. The system prompt (A> or other) is displayed to the operator.

If the power-on test of the MPB is not successfully passed, system booting does not occur. The user then must either follow the procedures detailed in the *Troubleshooting Non-Operative Systems*

chapter of this manual or call or visit a field service or technical representative to have extended diagnostic testing or troubleshooting procedures performed.

## USER DIAGNOSTICS

Diagnostic procedures which any user can run as desired or necessary are contained on the USER DIAGNOSTICS diskette. This diskette is in the back of the NCR Personal Computer *OWNER'S MANUAL* packed in the original carton with the computer.

This set of diagnostics is an intermediate set in terms of complexity and thoroughness of testing, more comprehensive than the Power-on Diagnostics but less comprehensive than the SERVICE DIAGNOSTICS.

USER DIAGNOSTICS routines isolate system malfunctions down to a major subsystem level; that is, a specific controller or expansion adapter card, the video (CRT) display, etc. The user can then decide whether to replace the defective subsystem, or to perform or have performed the extended field service problem isolation and system repair procedures.

The operation and functioning of USER DIAGNOSTICS are detailed in the *Troubleshooting* chapter of the *OWNER'S MANUAL*. USER DIAGNOSTICS are not further described in this manual.

## SERVICE DIAGNOSTICS (LEVEL 1)

These routines are contained on the SERVICE DIAGNOSTICS diskette which is in the back of this manual. These diagnostics are selected through a set of detailed menu screens, and perform, for all the major subsystems of the NCR Personal Computer, the most comprehensive testing available.

A set of utility functions, for error log maintenance, updates to documentation, formatting disks, for positioning the head of the fixed disk for relocation, and for CRT and flexible disk alignment, is also provided as part of these diagnostics.

SERVICE DIAGNOSTICS are a major subject of this manual, along with Disassembly/Assembly instructions and related information, such as a Parts Catalog, to enable the engineer or technical person using this manual to perform the service for which the diagnostic routines indicate the need.

## GUIDE TO THIS MANUAL

This first chapter of this manual, *NCR-Supported Diagnostics*, has presented an overview of the various levels of diagnostic testing routines which are available from and supported by NCR for the NCR PERSONAL COMPUTER Model 4.

The second chapter, *System Setup/Checkout/Alignment*, reviews in detail the procedures for installing the system. Similar procedures were presented in the "Installing Your Computer" section of the *Exploring Your Computer* chapter of the *OWNER'S MANUAL*. The chapter also includes a section on "Video (CRT) Specifications and Adjustments" and indicates what diagnostic testing should be performed at installation time.

The third chapter, *Troubleshooting Non-Operative Systems*, presents a very structured sequence of procedures to follow when either the system is unable to run diagnostics or the level 0 (power-on) diagnostics fail.

The fourth chapter, *Level 0 (Power-On) Diagnostics*, details the specific tests that are performed during the automatic power-on diagnostic testing, and the actions to take if the tests are not successfully completed.

The fifth chapter, *Level 1 Diagnostics Operation*, tells how to run the SERVICE DIAGNOSTICS set of routines. The loading of the diskette, the selection of the desired function from the menu screens, and the termination of the testing are described. The contents of each menu screen, and the results of each selection path chosen by the operator, are shown.

The sixth chapter, *Level 1 Diagnostics Error Returns*, decodes and explains all of the error messages which can be returned to the operator on the CRT screen or otherwise during the performance of the SERVICE DIAGNOSTICS. The general format for error messages, the major error codes, and the detail and supporting error codes within each major code, are all listed and discussed. For each major code/detail code condition, suggested corrective action or further testing is described.

The seventh chapter, *Disassembly/Assembly*, describes how to remove and replace the major assemblies of the NCR PERSONAL COMPUTER Model 4, with particular emphasis on the necessary precautions which must be observed to ensure safety and avoid electrical shock or implosion of the CRT.

Appendix A, *Configuration Switch Settings*, defines the various settings of the configuration switches in switch blocks 1 and 2 (SW1/SW2) on the MPB and in the switch block on the optional Memory Expander Card. The location, meaning and use of the header jumpers for drive selection on the flexible disk drives are also described.

Appendix B, *Subassembly Placement*, contains an exploded drawing which shows the relative placement of the major subassemblies of the NCR Personal Computer as an aid in identifying and locating desired components.

Appendix C, *Parts Catalog*, lists the description and NCR Part Number for each orderable assembly, subassembly, component or option kit.

Appendix D, *Connection And Logic Diagrams*, contains a system connection diagram, diagrams showing pin assignments for the MPB connectors, and logic diagrams for the MPB, CRT adapter cards, flexible and hard disk controller cards, memory expander card, keyboard and power supply.

## System Setup/Alignment/Checkout

This chapter presents installation, setup, and alignment instructions for use by the Field Engineer or Service Technician. Some of the instructions repeat information from the *OWNER'S MANUAL* and other NCR Personal Computer publications for completeness. This volume, *HARDWARE MAINTENANCE AND SERVICE*, also presents the material in greater detail or in a different organizational concept from other manuals.

### INSTALLING THE SYSTEM

Before proceeding further, review the detailed instructions in this section for site (location) selection and preparation and for unpacking, connection, power-on procedures and diagnostic testing of the computer.

Review also the instructions in the following sections, "Care Of The Computer", "Relocating The Computer" and "Possible Radio/TV Interference" for advice that may apply to the particular situation.

### SITE SELECTION AND PREPARATION

Select a "permanent" location for the NCR Personal Computer that has:

- No heavy traffic or dust
- No extremes in temperature or humidity
- No direct sunlight or close-by heating system (sunlight and excessive heat can damage the unit and the diskettes)
- Room for sufficient airflow for cooling the unit
- An adequate number of electrical outlets for the computer and any associated peripheral units

- Properly grounded electrical outlets (3-hole receptacles)
- Adequate circuit capacity (circuit breaker or fuse rating less current required for lights and other devices plugged into circuit)
- If possible, no radio or TV receivers on same circuit
- Room to put the power cables and interconnecting cables out of the way
- A work surface strong enough to support the weight of the computer and peripherals
- Enough work surface and storage space for work in progress and finished work

## UNPACKING

If the computer is still packed in the original carton, or has been properly repacked for transportation to a service or other location, the following instructions apply:

1. Remove components and packing as shown in Figure 2-1.
  - Open the main carton (3).
  - Lift out the long box labeled "Documentation and Accessories" (4).
  - Lift out the keyboard and its protective foam pads.
  - Lift out the cardboard strip with the foam blocks attached (1).
  - Remove the main unit (2) from the carton and set it on a desk or table. You may tip the carton so that the screen faces up and slide the unit out.
  - Save the carton with all packaging material inside (3), including the cardboard in case you need to move the computer later.
  - Open the long box labeled "Documentation and Accessories" (4) and remove the power cord and the three manuals.

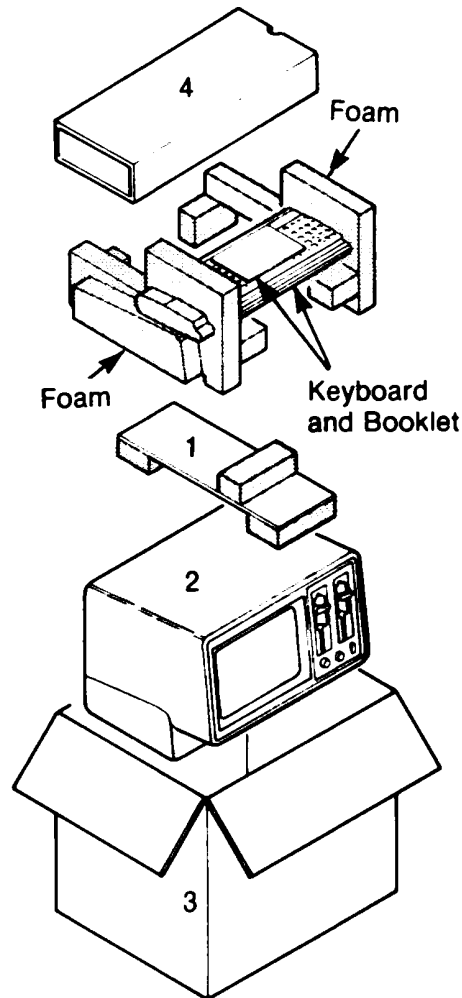


Figure 2-1 Unpacking

2. If any damage was found either when the package was received or as you unpacked the unit, report it immediately to your dealer or NCR representative.
3. Arrange the components on the workspace in such a manner that it is convenient to reach over and behind them.
4. Before plugging in any power cords, make certain the power switch on the lower right front corner of the unit is turned OFF. (Press the bottom of the switch.)

## CONNECTION

If the units are not already connected, the following sequence is recommended:

1. Turn the main display unit on the work surface so that the rear panel faces toward you.

2. Place the keyboard next to the display unit and connect the keyboard cable to the main unit.
3. Connect the power cord to the main unit, THEN to a properly grounded outlet.
4. Arrange the components of the computer for comfortable use.

NOTE: Since some models of printers may cause the work surface to vibrate, it may be desirable to set the printer (if any) on a separate surface or a soft pad to isolate the vibrations.

5. Remove the cardboard insert from the flexible disk drive or drives after turning the drive access lever to the vertical position.

### POWER-ON PROCEDURES

Closely observe the "Power-on self-test" which is performed by the program in the computer's ROM memory each time the machine is turned on. The following is an abbreviated description of the self-test. For a more thorough description, refer to the *Level 0 (Power-On) Diagnostics* chapter of this manual.

1. Insert the NCR-DOS (or other) operating system diskette in drive A and close the drive access lever.
2. Turn the power switch ON. (Press the top of the switch.)
3. When power is turned on, the program performs a self-diagnosis that is primarily a memory check.
4. A whirring motor noise from the disk drive is normal.
5. A memory test display and then a blinking cursor appears on the screen.
6. You should hear a beep and, after a momentary delay, see the system prompt (A> or other) displayed. This indicates that the system has completed its power-on self-test and that the operating system has been booted from the diskette. If you hear nothing, or if the system prompt does not appear, or if you hear sounds other than those described:
  - Turn the power switch OFF.
  - Check that your wall outlet is working properly (with a lamp that you know works.)

- Repeat the power-on self-test procedure.
  - If the test is still not successful, turn to the *Troubleshooting Non-Operative Systems* chapter of this manual and follow the procedures detailed there.
7. If the test is successful, and optional equipment is to be installed:
- Follow the instructions packaged with the option.
  - Turn to the *Installing Options* chapter in the *OWNER'S MANUAL*, if available, and follow the instructions given there.
  - Return to this section and continue.
8. Now perform a whole system power-on test. The NCR Personal Computer is now fully assembled and arranged for operation. This test, plus the diagnostic testing in the next section, assures that all components are functioning.
- Turn the display brightness control completely clockwise for best cursor visibility.
  - Turn the processing unit power switch ON.
  - Turn ON any other installed devices.
  - Watch and listen for the following indications:
    - The cursor ( \_ ) appears on the display screen.
    - Memory is checked again. The beep sounds.
    - Messages may appear on the screen. (Ignore for now.)
    - Sounds may come from your optional equipment. (Ignore for now.)
    - The operating system is booted from the diskette, and the system prompt (A> or other) is displayed.
  - If the above indications did not all occur, turn to the *Troubleshooting Non-Operative Systems* chapter in this manual.

- If all tests are successful to this point, readjust the brightness control for comfortable viewing and proceed.

## DIAGNOSTIC TESTING

Diagnostic testing should be performed:

- The first time the computer is powered-up in its "permanent" location.
- Whenever it is moved to another location.
- Periodically, as a preventive maintenance procedure. Once a month is suggested for a computer with moderate use, weekly or bi-weekly for a computer used regularly much of the day in a business environment.
- When a hardware problem is suspected. When this is the case, follow the directions below and in the *Level 1 Diagnostics Operation* chapter of this manual.

The USER DIAGNOSTICS in the *OWNER'S MANUAL* may also be used for several of the functional tests if desired. USER DIAGNOSTICS and SERVICE DIAGNOSTICS, contained in this book, have several similarities of organization. The SERVICE DIAGNOSTICS, however, are more detailed and extensive.

To perform preventive diagnostic testing:

1. Take the SERVICE DIAGNOSTICS diskette from the back of this manual.
2. Turn the processing unit power switch OFF. Turn all other devices OFF.
3. Turn the drive access lever counterclockwise to open drive A.
4. Insert the diskette into drive A.
5. Turn the drive access lever clockwise to enable drive A.
6. Turn the main processor power switch ON.
7. Turn all other devices ON.

8. Compare the displays on the CRT screen with those shown in the *Level 1 Diagnostics Operation* chapter of this manual. If any differences exist which indicate problems, you will be given servicing directions.

## CARE OF THE COMPUTER

### GOOD OPERATING HABITS

Practice a regular routine of care when using the computer, and when practical inform the computer user of the same care. Train yourself to be conscious of the little details that could affect the NCR Personal Computer's performance.

- Never remove or insert the plug when the power switch is ON.
- Do not eat, drink, or smoke in the computer environment.
- Store the diskettes after each use. Always store them in their protective envelopes and try to keep them in some type of closed cabinet.
- Cover the computer and any peripherals if the system will not be in use for an extended period of time.
- Do not touch the exposed parts of the diskettes.
- Do not bend the diskettes.
- Do not write on the diskette labels with anything but a soft felt-tip pen.
- Keep the diskettes clear of small particles such as dust, food, tobacco, etc.
- Keep the diskettes away from other equipment that may have magnetized components. There are many possibly magnetized items that may be in the computer environment: radios, charm bracelets, telephones, electric pencil sharpeners, etc.

### PERIODIC CHECKS

A few points to consider as periodic checks are:

- Are the connections secure?

- Has any magnetized hardware been moved into the computer environment? Magnetized objects might damage the diskettes and can affect the computer's memory. Even jewelry can have magnetic properties.
- Is the computer environment still as static free as possible?
- Are the air circulation vents uncovered? They should be exposed at all times.
- Is the computer near a window or heater, or something else that could seasonally affect the environment?

### **PREVENTIVE MAINTENANCE**

Although the computer should be repaired only by a qualified technician, there are steps any user can take to keep the unit in working order. Anyone can remove dust that could get into the computer and affect its performance by cleaning the unit periodically. The user should clean the display and the cabinets as needed using the following steps:

1. Turn off the unit.
2. Wipe the screen with a soft cloth and an ammonia-based glass cleaner, a very mild detergent solution, or a water dampened cloth. Dry the screen with a soft cloth.
3. Wipe the cabinet with a cloth slightly dampened by a mild detergent solution, but be careful not to damage the unit by allowing liquid to get inside the cabinet.

Disk heads should be cleaned once a month. More frequent cleaning may be necessary depending on how much the system is used. If an abrasive cleaning diskette is used, cleaning time should not exceed 30 seconds. High-quality industry recognized cleaning diskettes are recommended for the operation. The cleaning diskettes are often available from the suppliers of blank diskettes.

### **RELOCATING THE COMPUTER**

#### **PREPARATION**

This section describes the necessary steps to be taken before moving an NCR Personal Computer. Whether a short distance or a long distance move is planned, the same initial preparations to the system are suggested.

If the system has both a flexible disk drive and a fixed disk drive, each of them needs to be prepared differently before moving.

### Preparing The Flexible Disk Drive(s)

1. Find the cardboard insert(s) that were in the flexible disk drive(s) when the system was first unpacked. If the insert(s) are not available, old "scrap" diskette(s) maybe used in place of the cardboard insert(s).
2. Insert the cardboard piece(s) or scrap diskette(s) in the drive(s), just as a diskette would be inserted.
3. Turn the drive access lever(s) to the horizontal position. This causes the read/write head(s) to rest on the insert or diskette and keeps the head(s) from vibrating.

NOTE: If you do not protect the head(s) with the cardboard insert(s) or the "scrap" diskette(s), the head(s) could be severely damaged during the move.

### Preparing The Fixed Disk Drive

To prepare the fixed disk drive for moving, the SERVICE DIAGNOSTICS diskette from this manual or the USER DIAGNOSTICS diskette from the back of the *OWNER'S MANUAL* may be used. Take the diskette out of the manual, then proceed according to the following directions:

1. Insert the diskette into drive A.
2. Turn the power switch ON.
3. Follow the screen directions and select the test from the menu to "Prepare to Relocate Fixed Disk".

NOTE: This causes the disk read-write head to move over track 270, the position designated for moving the system.

4. Exit the diagnostics by following the screen directions.
5. Remove the diskette from drive A.

## CAUTION

Do not move a unit which contains a fixed disk drive for at least 30 seconds after turning the power off. This time interval allows the read-write heads to land without crashing.

### Preparing The Rest Of The System

1. Turn the power switches OFF on all units.
2. Disconnect the processing unit cable from the wall outlet; then disconnect all the cables from the rear of the unit. Note where the cables are connected as you pull them off to facilitate reconnection and set-up at the new location.
3. Protect the connectors by wrapping them with suitable material such as foam sheets, heavy paper, etc.
4. Coil the cables, and tape them securely to the top of the display unit.

### MOVING A SHORT DISTANCE

If the NCR Personal Computer is being moved a short distance (that is, within the same building), each unit can be carried by one or two people; however, using a cart may be preferable.

When moving the system, keep the following points in mind:

- Each unit should be handled separately without carrying more than one piece at a time.
- Lift the units with both hands.
- Have an extra person available to open doors, or to call the elevator.

### MOVING A LONG DISTANCE

During a long distance move, the original cartons and packing materials in which the NCR Personal Computer arrived should be used to provide the best protection for the system.

Pack the unit in the original carton and packing material using the following procedure:

1. Place each unit in a plastic bag.
2. Position the cushioning material on each unit, and carefully place the unit in its packing box.

3. Check to be sure that the cushioning material is correctly positioned around the unit, and make sure that the equipment is secured inside the packing box. To avoid damage, the unit must be packaged so that it won't slide around in the box. Add more cushioning if necessary.
4. Tape the boxes shut with strong packing tape.

### **SET UP AT THE NEW LOCATION**

After the NCR Personal Computer has arrived at its new location, carefully unpack, set up, and cable the system according to the instructions given in the "Installing The System" section of this chapter.

### **POSSIBLE RADIO/TV INTERFERENCE**

The following excerpt from section 15.838, Chapter I, Title 47-Telecommunications, published by the U.S. Federal Communications Commission, applies to the NCR Personal Computer Model 4:

This equipment generates and uses radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient the receiving antenna.

Relocate the computer with respect to the receiver.

Move the computer away from the receiver.

Plug the computer into a different outlet so that computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional sug-

gestions. The user may find the following booklet prepared by the Federal Communications Commission helpful:

“How to Identify and Resolve Radio-TV Interference Problems”.

This booklet is available from the U.S. Government Printing Office, Washington, DC 20402, Stock No. 004-000-00345-4.

## **VIDEO (CRT) DISPLAY SPECIFICATIONS AND ADJUSTMENTS**

This section describes the maintenance and adjustments for the two types of video displays, monochrome and color/graphics, which are installed in standard models of the NCR Personal Computer.

Information is presented defining: (1) all of the controls and adjustments for each display type; and (2) maintenance and adjustment procedures for each type of display.

### **MONOCHROME DISPLAY**

#### **Description**

The monochrome display for the NCR Personal Computer is a solid-state driven, raster-scan CRT display. The display is composed of many small picture elements or pixels. A deflection or analog circuit board interfaces with the display tube and activates an electron beam. The beam travels through a standard pattern of scan lines that sweep the screen horizontally and vertically. When energized, the beam scans the phosphor surface of the tube causing the CRT screen dots to glow. Illuminated pixels form alphanumeric dot or graphic characters on the screen.

Three cables connect the display to the Deflection Board: a signal cable, which connects the direct drive interface to the display; a deflection cable which provides the sweeps to the yoke and a high voltage cable for electron beam generation. Two other cables connect to the deflection board: the cable to the front panel brightness control, and the harness to 12 volts at the main processor board and to the adapter board.

**Physical Description** — Components of the monochrome raster-scan display are a monochrome cathode ray tube (CRT) and a monochrome deflection or analog circuit board. These work in conjunction with the video adapter board which is plugged into the

Main Processor Board. Figure 2-2 illustrates the relative position of these components.

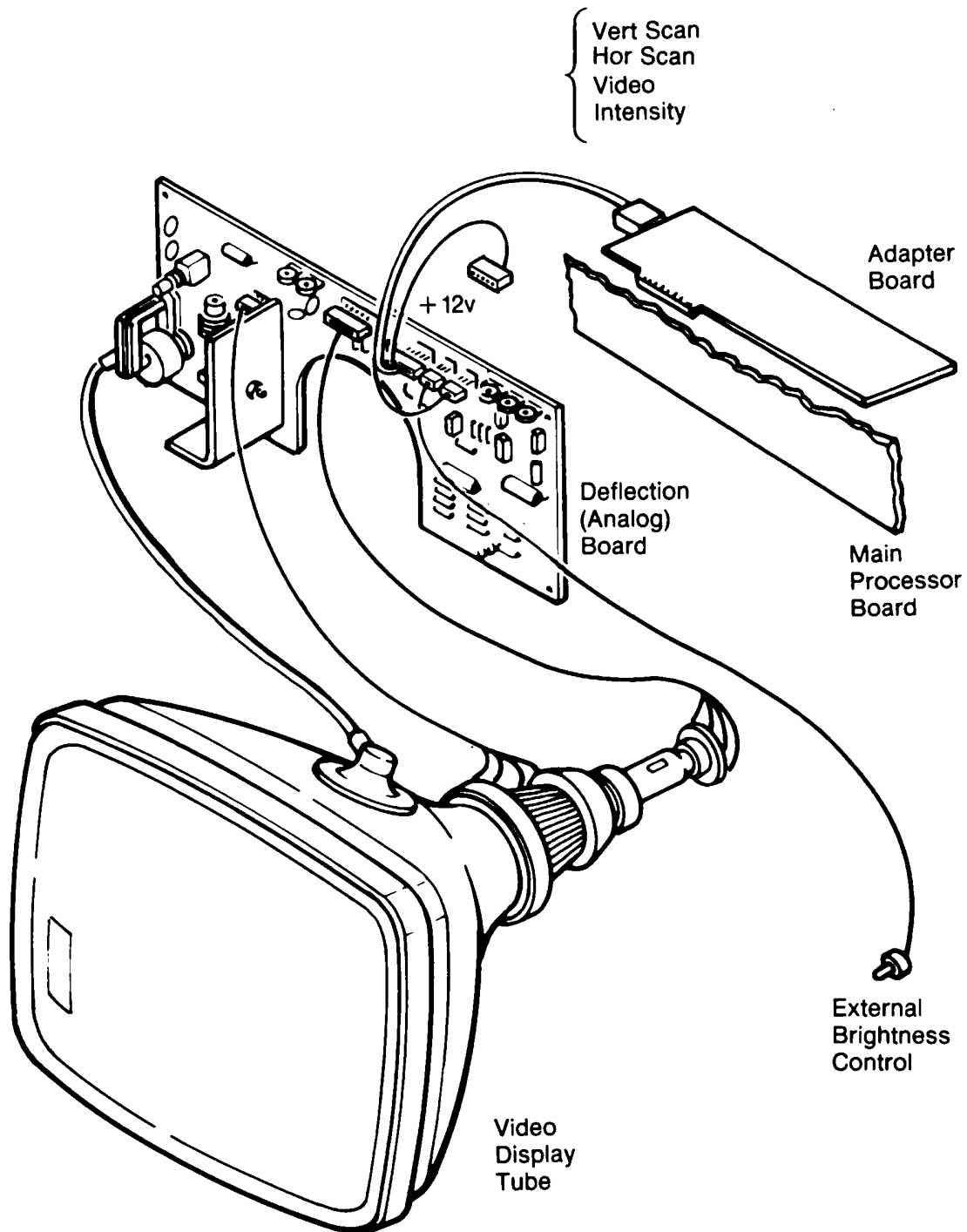


Figure 2-2 Monochrome CRT and Deflection (analog) Board

CRT features include:

- 12-inch diagonally measured screen (295 millimeters)
- 90° deflection angle

- P39 phosphor

**Functional Description** — The monochrome video display interfaces with the monochrome analog circuit board. The monochrome adapter board accepts input signals from the MPB and generates the signals necessary to produce the characters.

The analog circuit board receives four signals from the display adapter board. The signals are the vertical sync, the horizontal sync, the video information and high intensity control. These signals can be examined with an oscilloscope at the cable connector to verify their presence. A representation of the waveshapes is included as part of Figure 2-3. Signals are TTL level circuitry. Twelve volts and ground are supplied at this connector.

The Monochrome Display Adapter Board determines when the beam will be energized, and also its scan rate.

The screen is refreshed at a rate of 200 lines, 50 times per second.

### **Specifications**

Figure 2-3 presents all of the pertinent operating specifications for the monochrome display.

Monochrome Functional Area	Measurement	Value	Remarks
Video Input	Amplitude	4.0 $\pm$ 1.5V	Into internal 500 ohms or less contrast control TTL
	Rise Time	10ns	Maximum leading edge (10-90%)
	Fall Time	10ns	Maximum trailing edge (90-10%)
	Frequency	Up to 20MHz Data Rate	Standard Unit
	Maximum Bandwidth	16.257 MHz	
	Duty Cycle	50% Minimum	
Horizontal Drive Input	Amplitude	4.0 $\pm$ 1.5V	Sync Positive
	Rise/Fall Times	40ns maximum	
	Frequency Resolution	18.40 $\pm$ .01 KHz 18.432KHz/ 640 PIXEL Resolution	
	Pulse Width Blanking Time	44.289 $\mu$ Sec. Max., 9.965 $\mu$ Sec.	
Vertical Drive Input	Amplitude	4.0 $\pm$ 1.5V	Sync negative
	Rise/Fall Times	40ns Maximum	
	Frequency Resolution	49.95 $\pm$ 0.05 Hz 50Hz/200 PIXEL Resolution	
	Refresh Rate	200 lines 50 times per second	
	Pulse Width Blanking Time	18.935 ms. Max. 1.085 ms	
	Input Power	Voltage/ Amperage Requirements Maximum Ripple	+ 12 Volts $\pm$ 5% 1.25 amps nom 1.50 amps max.
100mv p-p			
10mv p-p  50mv p-p			
Controls	Internal (Factory Preset)	Vertical Linearty Height	PC Label below:  Vertical Linearity Height

Figure 2-3 Monochrome Display Specifications (1 of 3)

Monochrome Functional Area	Measurement	Value	Remarks
	External (Front Panel)	Horizontal Linearity Width Focus Brightness (Limiting) Contrast Brightness	"LIN" "WIDTH" "FOCUS"  BRT CTRS 100K ohm potentiometer
CRT Display Characteristics	Diagonal Measurement Deflection Angle CRT Type High Voltage Useable Screen Area Horizontal Resolution Linearity  Screen Surface Characters Per Line Number of Lines: Character Boxes	12 inches 90° 20 Inch 13.0KV 6.7 x 9.0 inches 800 @ 70 cd/m <sup>2</sup> 650 @ 70 cd/m <sup>2</sup> 10% Maximum Height/Width Variance 20% Maximum Height/Width Variance P39 Green Phosphor 80 25 9 dots x 14 dots	Spherical Radius Nominal  Center Corners Adjacent Characters  All Screen Characters
Mechanical Specification	Weight Height Width Depth	10.0 lbs. (4.54 kg) 7.49 in. 11.1 in. 11.4 in.	
Environment	Ambient Temperature  Humidity (Non-condensing) Altitude (Maximum)	5° to 50° C (41° to 131° F) -40° to 65° C (-40° to 150° F) 5% to 90%  10,000 ft. (3,048 km) 30,000 ft. (9,144 km)	Operating Non-operating Operating/Non-operating  Operating Non-operating

Figure 2-3 Monochrome Display Specifications (2 of 3)

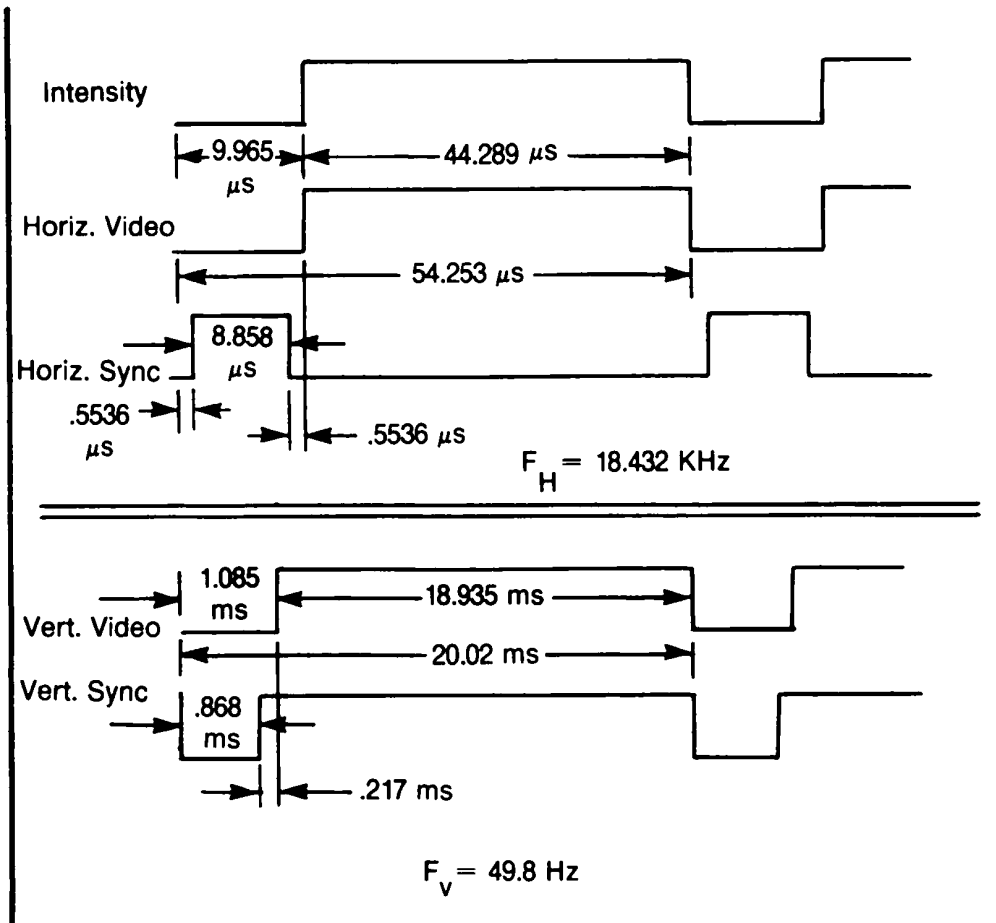


Figure 2-3 Monochrome Display Specifications (3 of 3)

### Alignment Procedures

The monochrome display controls illustration (Figure 2-4) shows the locations of controls for the monochrome display. All factory/field service settings are located on the video display board. The external control (user setting) for brightness is located on the front panel of the computer.

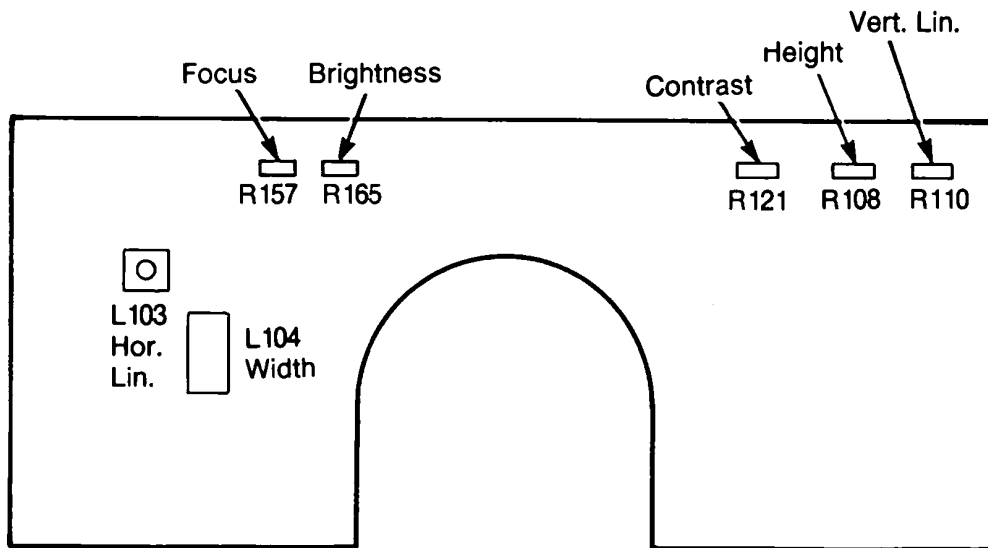


Figure 2-4 Monochrome Display Controls

The following subsections contain the procedures for performing the standard alignments for the monochrome display. The chapter on *Disassembly/Assembly* tells how to remove the cabinet and any necessary major assemblies to reach the analog board. The need and the procedure for discharging the CRT anode voltage are also described in that chapter. The following warnings and cautions found in the *Disassembly/Assembly* chapter are critical enough that they are also stated here:

### WARNING

Disconnect the power supply cord before removing the cabinet. Dangerous voltages are present when working on the computer with the cover removed.

**ONLY TRAINED ENGINEERS AND NCR TRAINED SERVICE PERSONNEL SHOULD ATTEMPT TO WORK ON THE COMPUTER WITH THE COVER REMOVED AND THE POWER ON.**

It is recommended that the first operation after removing the cover should be to discharge the CRT anode voltage.

### WARNING — HIGH VOLTAGES

High voltages may be present on the CRT anode even when the display is not operating. *Always* discharge the CRT high voltage anode before servicing any part of the CRT assembly. Refer to the "CRT Discharge Procedure" section of the "Monochrome CRT And Analog Board" section of the

*Disassembly/Assembly* chapter. Always assume that a CRT is charged until you discharge it. Any conductive material (tools, service personnel, etc.) placed near the flyback transformer can cause an arc to jump the gap between the transformer and the conductive material.

### CAUTION

Electrostatic discharge can cause damage to some solid-state components used in the computer. Use special wrist-ground straps and integrated circuit handling procedures. Avoid touching the components or the circuit paths; handle printed circuit boards by their edges.

The SERVICE DIAGNOSTICS supply some screen patterns such as a grid, dot pattern and raster designs which are useful in the alignment procedures. See the "Alignment Utilities" section of the *Level 1 Diagnostics Operation* chapter for descriptions of the Linearity (grid), Focus (dot pattern — actually "#")s, and Raster check screens.

**Sync** — Horizontal and vertical synchronizing are preset using fixed resistors, and no adjustment is provided.

**Raster Adjustment** — The deflection yoke and ring magnets are factory set and sealed and should not require readjustment. However, if adjustment becomes necessary, the following procedures apply:

(Refer to Figure 2-5 for parts positioning.)

1. Loosen the clamp on the neck of the tube slightly.
2. Rotate the yoke around the neck of the tube as required to make the raster horizontal and not tilted. The yoke should be fully forward against the bell of the CRT.
3. Tighten the clamp snug but without undue stress on the neck.
4. Center the raster by rotating the ring magnets slowly around the neck of the tube. The spring holds the ring magnets in position.

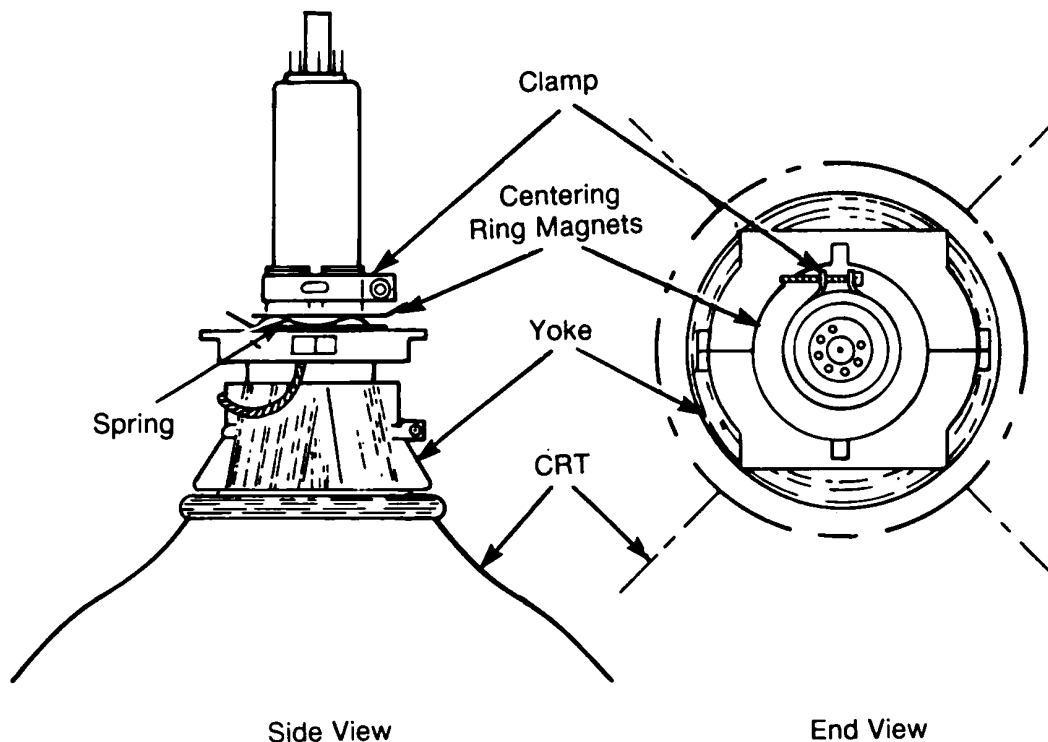


Figure 2-5 Monochrome Magnet Set Placement

**Brightness** — Two steps are required:

1. Set the external brightness control for maximum brightness.
2. Adjust the brightness (BRT) control (R165) to the setting where the raster becomes extinguished.

**Contrast** — Adjust the front panel brightness control for the desired light level and set contrast using CONTRAST control R121.

**Vertical Linearity** — Adjust the Vertical Linearity (VERT LIN) control (R110) to the point where characters at the top and at the bottom of the screen have equal height.

**Height** — Adjust the Height (HEIGHT) control (R108) to the setting where the raster just fills the CRT display area.

**Horizontal Linearity/Width** — Four steps are required, most easily done while displaying a grid or dot pattern:

1. Adjust the Horizontal Linearity (HOR LIN) control (L103) so that the display on the screen is at maximum horizontal width.

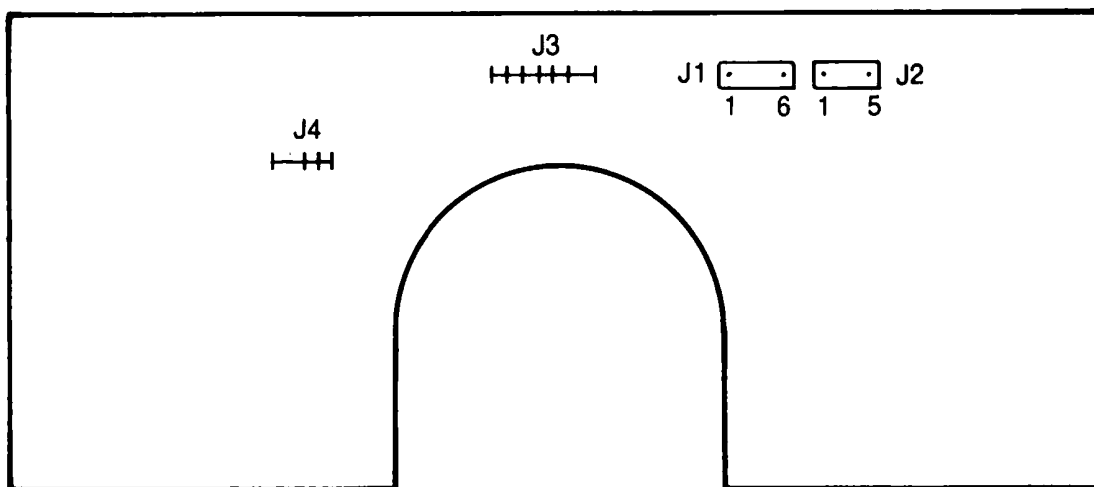
2. Readjust the Linearity control for the best overall horizontal linearity while retaining as much width as possible.
3. Adjust the Horizontal Width (WIDTH) control (L104) so that the display on the screen is at the desired width.
4. Repeat step 2 to readjust the display for the best overall linearity.

**Focus** — Two steps are required:

1. Verify that the light setting, established in the “Contrast” section, has not been changed.
2. Set the Focus (FOCUS) control (R157) for the best overall focus for both the center and the corners of the display. This is most easily done while displaying a dot pattern.

### **Physical Connections/Pin Assignments**

Figure 2-6 shows the pin connections on the monochrome deflection (analog) board for the alignment adjustments.



J1-1 Gnd  
 2 Vert. Sync\*  
 3 Video\*  
 4 +12 VDC  
 5 Hor. Sync\*  
 6 Intensity \*

J2-1 Remote Brightness W  
 2 Remote Brightness LO  
 3 Remote Brightness HI  
 4 Gnd  
 5 470Ω@0.5W to + 12VDC (for External LED)

\*Signals from Monochrome Adapter Card  
 (Use 9 Pin "D-Type" Connector)

Note: J1 Etc. Are Identified As  
 J101 Etc. on Board Markings

J3-1 Cathode  
 2 Key  
 3 Heater  
 4 Grid 4 (Pin 7)  
 5 Heater  
 6 Grid 1 (Pin 1)  
 7 Grid 2 (Pin 6)

J4-1 Vertical Deflection  
 2 Vertical Deflection  
 3 Horizontal Deflection  
 4 Key  
 5 Horizontal Deflection

Figure 2-6 Monochrome Deflection Board Pin Assignments

## COLOR/GRAPHICS DISPLAY

### Description

**Physical Description** — The color display for the NCR Personal Computer consists of a 12-inch CRT, a deflection, or analog board and a video driver board. A brightness control knob is mounted on the front of the computer; there are no other operator-adjustable controls. Input to the color display is through a cable from the color/graphics adapter board plugged into the main processor board. The analog board then converts these input signals into output signals to the color guns on the CRT. The analog board is located in front of the MPB, parallel to the face of the CRT. The video driver board is attached to the back of the CRT. Figure 2-7 shows the color display CRT and its associated components.

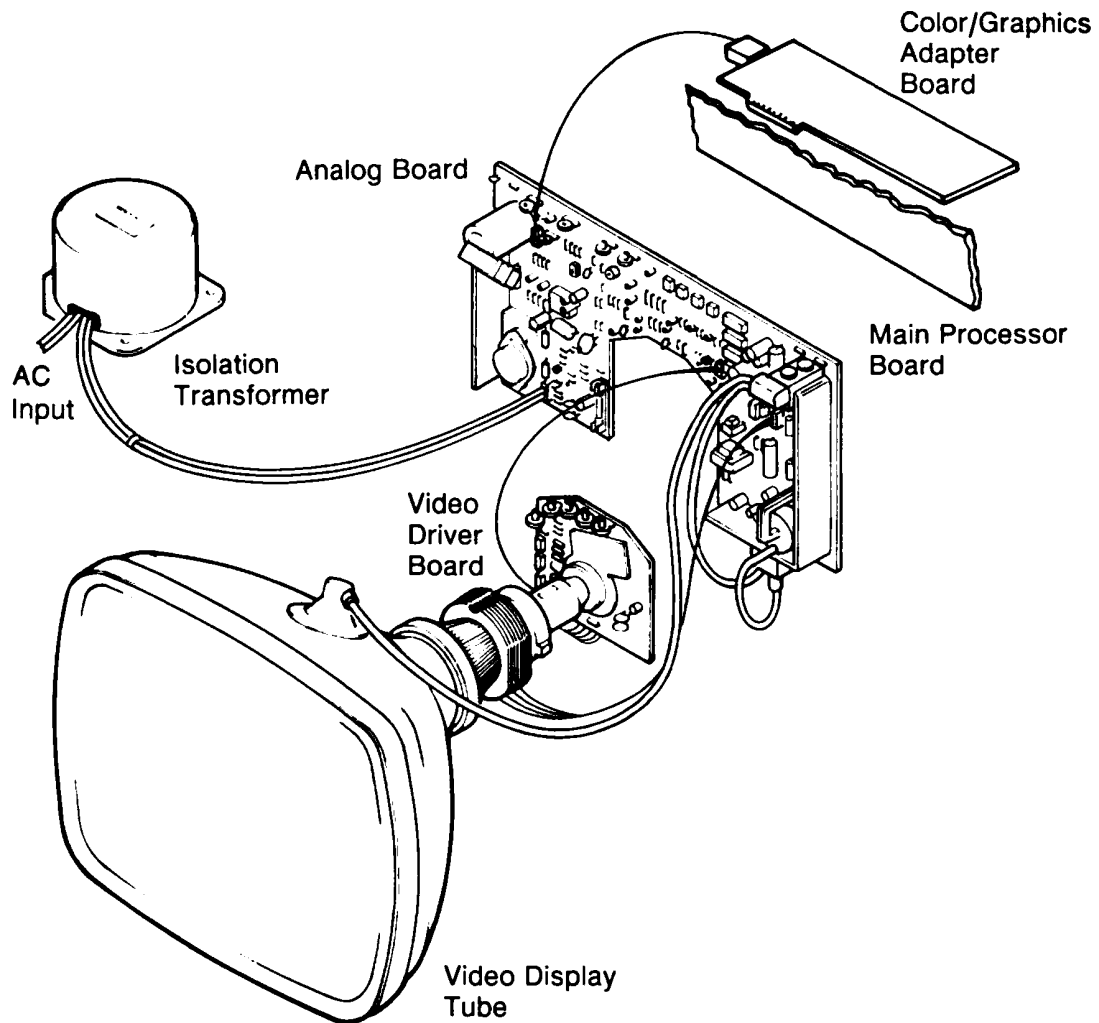


Figure 2-7 Color CRT and Boards

**Functional Description** — The analog board processes signals that it receives from the color/graphics adapter board, converts them to proper sweep and color signals, and then sends them on to the CRT for display. Signals, including color, horizontal sweep, vertical sweep, and intensity level, are received through a 7-pin in-line connector attached to a short cable from the color/graphics adapter board.

**R, G, B Signals** — The R, G, and B signals are received by a video processing buffer on the analog board and then fed to a second buffer. These buffers prevent any possibility of high voltage back-feeding that could cause damage to the system. From the buffers the R, G, and B signals are then fed to the R, G, and B drivers, where they are amplified and fed to the R, G, and B driver board.

**Horizontal/Vertical Signal** — The horizontal and vertical signals are fed to the first buffer; from this buffer, they are fed to the sync

processor. The sync processor separates the horizontal and vertical signals.

The vertical signal is fed to both the vertical output circuit and the vertical blanking circuit. The vertical output signal is amplified by the deflector amplifier and sent to the yoke on the CRT. The vertical blanking circuit imposes retrace blanking on the vertical signal and feeds it through the horizontal blanking circuit to the video amplifier. The video amplifier amplifies both the horizontal and vertical blanked signals and sends them to the R, G, and B drivers on the video driver board. The horizontal signal is amplified by the horizontal drive and horizontal output circuits and fed to the flyback transformer/high voltage rectifier (FBT/HVR) circuit. These circuits pass the horizontal signal to the horizontal blanking circuit, which imposes retrace blanking on the signal. The blanked horizontal and vertical signals are sent to the video amplifier, which amplifies both signals and sends them to the R, G, and B drivers on the video driver board. The horizontal signal is sent to the deflector amplifier, which amplifies the signal and sends it to the yoke on the CRT. The flyback transformer and high voltage rectifier generate a signal to the brightness limiter as well as the high voltage output (with focus control) to the CRT. The brightness limiter controls the output of the video amplifier; this prevents abnormal screen brightness.

**Intensity Signal** — The intensity signal controls the brightness of the video images generated by the R, G, and B drivers. The signal may be at one of three levels: off (no signal); medium (low intensity); or high (high intensity). The signal is received directly from the color/graphics display adapter card, processed by the intensity control, and sent to the R, G, and B drivers, where it controls the intensity level of each of the driver signals.

**Video Driver Board** — The video driver board receives the R, G, and B driver signals and the horizontal and vertical signals (with blanking imposed) from the video amplifier. It feeds these signals to the color guns on the CRT to produce the image.

### Specifications

Figure 2-8 presents the pertinent operating specifications for the color/graphics display.

<b>CRT:</b>	12-inch diagonal, 90 degree deflection, in-line gun, black matrix, .31 mm dot pitch, non-glare surface
<b>SCREEN DIMENSIONS:</b>	11" (28.1 cm) wide x 8.7" (22.2 cm) high x 12.7" (32.2 cm) diagonal
<b>OPERATOR CONTROLS:</b>	Brightness adjustment, located on front panel
<b>INPUT SIGNAL:</b>	Independent R, G, B channels, intensity, horizontal sync, vertical sync; all positive TTL levels
<b>INPUT CONNECTOR:</b>	7-pin in-line male connector
<b>VIDEO BANDWIDTH:</b>	15MHz
<b>SCAN FREQUENCIES:</b>	Horizontal 15.75KHz Vertical 60Hz
<b>HIGH VOLTAGE</b>	24.0 KV
<b>RESOLUTION:</b>	Software-selectable High — 640 x 200; max. 2 colors (B&W) Medium — 320 x 200; max. 4 colors Low — 160 x 100; max. 16 colors
<b>COLOR SELECTION:</b>	16 colors max. (black, blue, green, cyan, red, magenta, yellow, white; each with two intensity levels)
<b>CHARACTERS:</b>	80 x 25 (normal) 40 x 25 (double-size) 8 x 8 dots for both; 16 colors max.
<b>POWER SOURCE:</b>	120VAC, 60Hz; supplied by isolation transformer located in NCR PC
<b>POWER USE:</b>	70 watts

Figure 2-8 Color/Graphics Display Specifications

### Alignment Procedures

The color display controls available for factory and service adjustment on the deflection board are illustrated in Figure 2-9. Controls on the video driver board are illustrated in Figure 2-10. For access remove the cabinetry required as described in the chapter on Disassembly/Assembly.

### WARNINGS

The warnings and cautions presented under “Monochrome Alignment Procedures” are also applicable to color unit servicing. They should be reviewed for safety before proceeding further.

SERVICE DIAGNOSTICS supply some screen patterns such as grid, dot, and raster designs that are useful in the alignment procedures. See the “Alignment Utilities” section of the *Level 1 Diagnostics Operation* chapter for descriptions of the Linearity (grid), Focus (dot pattern — actually “#”s), Raster, and Color Bars check screens.

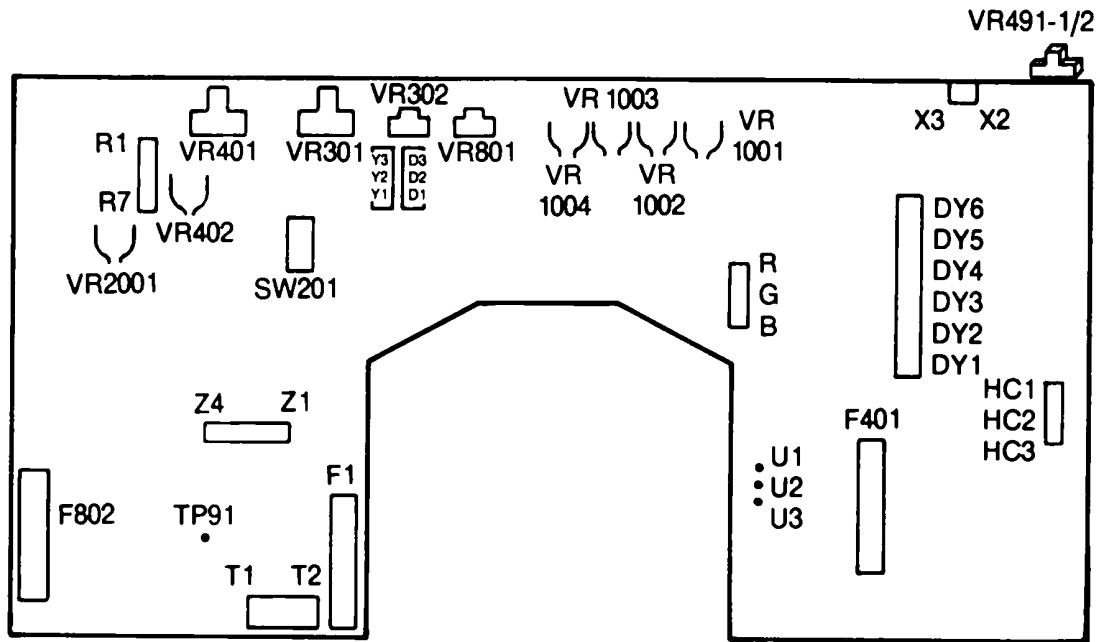


Figure 2-9 Color Deflection Board — Fuse, Connector, and Potentiometer Placement

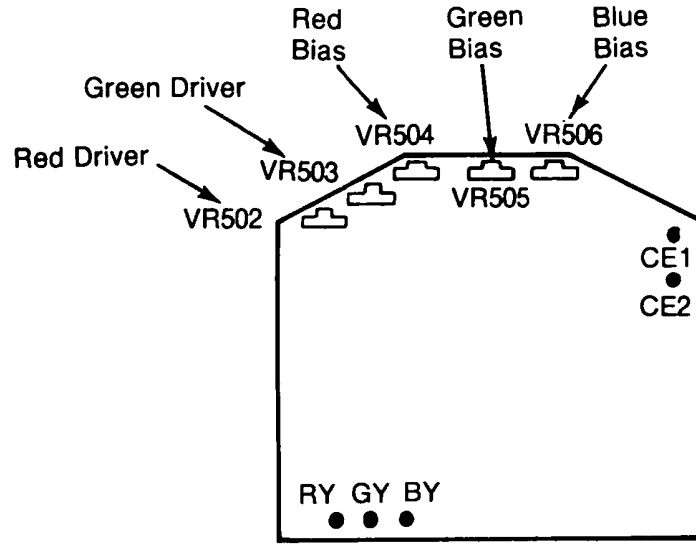


Figure 2-10 Color Video Driver Board — Potentiometer and Connector Placement

Locations of the following fuses, connectors, potentiometers, etc., are illustrated in Figure 2-9.

<b>Fuses</b>	
F1	Main fuse, AC in. 3 Amp. 250V SLO-BLO
F401	12 V DC, 0.5A FAST-BLO
F802	115 V DC, 0.5A FAST-BLO
<b>Connectors</b>	
T1, T2	120 VAC
Z1 — Z4	Degaussing Coil
R1 — R7	Control Signals
Y1 — Y3	Bias and Drive Control
D1 — D3	External Brightness Control
DY1 — DY6	Deflection Yoke
X2, X3	DC to Amplifier Board
HC1 — HC3	CRT Heater
R, G, B	Red, Green, Blue Guns
U1 — U3	Vertical Centering
<b>Potentiometers</b>	
VR 301	Vertical Height
VR 302	Vertical Hold
VR 401	Horizontal Hold
VR 402	Horizontal Centering
VR 801	115 VDC Adjust
VR 1001	Intensity Drive
VR 1002	Red Intensity Drive
VR 1003	Green Intensity Drive
VR 1004	Blue Intensity Drive
VR 2001	High Voltage Control
VR 491-1	Focus
VR 491-2	Screen
SW 201	Test Switch
TP 31	Horizontal Hold
TP 91	115 V DC Test Point

Figure 2-11 Component Identification

**B+ Voltage** — Connect a DC voltmeter of 150 volt range to TP 91 and to ground. Adjust VR 801 for 115 volts. Remove the meter.

**Horizontal Hold** — Ground TP 31 and adjust VR 401 until display is vertical (not slanted) but still rolling. Remove ground.

**Vertical Hold** — Adjust VR 302 to the position where the display is stable.

**Vertical Height** — Display a grid pattern on the screen and adjust VR 301 for maximum height of the pattern.

**Horizontal Position** — Adjust VR 402 to center the display left to right.

**Focus** — Using a display such as a dot pattern, adjust VR 491-1 for the sharpest image.

**White Balance** — The following controls are used:

VR 504	Red Bias
VR 505	Green Bias
VR 506	Blue Bias
VR 502	Red Drive
VR 503	Green Drive
VR 491-2	Screen
SW 201	Service Switch

1. Disconnect the 7 pin header, R1-R7, control signal connector. The screen should become lighted.
2. Rotate VR 504, VR 505, VR 506, and VR 491-2 all fully counterclockwise.
3. Rotate VR 502, and VR 503 to the center of adjustment.
4. Switch SW 201 to “service” position.
5. Rotate VR 491-2 clockwise slowly until a slight horizontal line is displayed.
6. Estimate which color is least bright and rotate that bias slowly clockwise until a white horizontal line is obtained. It may be necessary to adjust more than one bias.
7. Rotate VR 491-2 slowly clockwise to brighten the horizontal line of the dimmest color.
8. Return the switch SW 201 to “normal”.
9. Adjust the red and green drives for a white color.
10. Assure that the white color remains at both low and high brightness levels.
11. Reconnect the R1-R7 connector.

## Purity

1. The magnets should be positioned along the neck of the tube approximately as shown in Figure 2-12. If they are not, carefully mark or record the original position and reposition them as indicated below. The original position may be useful for later comparison. An easy way to record the position is to draw a single line with a felt tip pen across all of the members of the set and onto the tube.

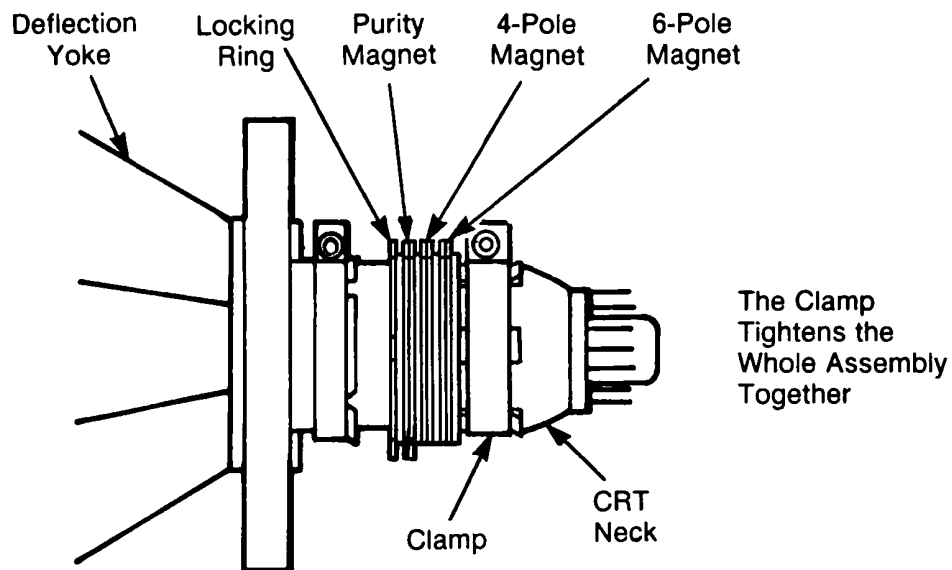
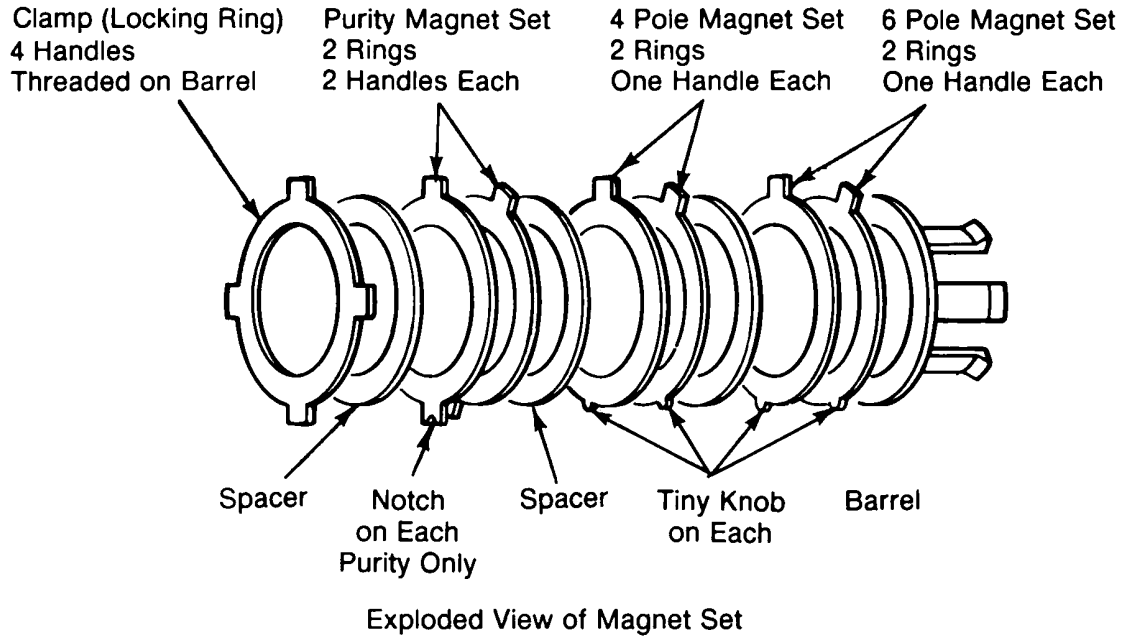


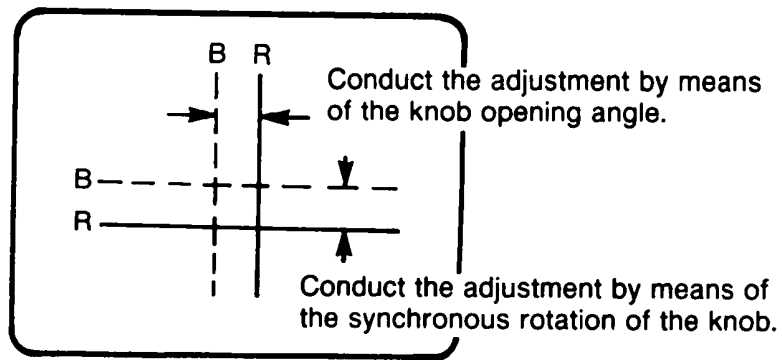
Figure 2-12 Magnet Set Placement

2. Disconnect the G connection from the R, G, B set on the deflection board. This will display magenta color.

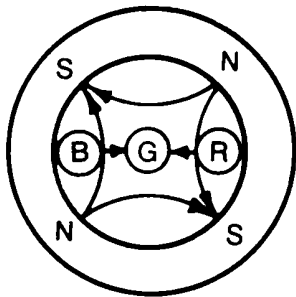
3. Unscrew the locking ring of the magnet set slightly to free the set for adjustment. The ring has four handles and is the one nearest the screen on the neck of the tube.
4. Turn the purity magnet handles (second from the screen) slowly together or apart for the best magenta color. They should be approximately the same angle from vertical on opposite sides.
5. Replace the G connector.

### Static Convergence

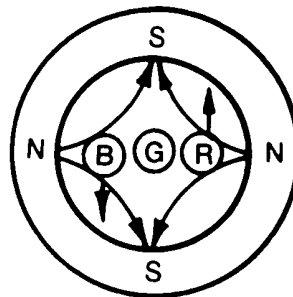
1. Display a grid pattern on the screen.
2. Disconnect the G connector from the R, G, B set on the deflection board.
3. Rotate the handles of the four-pole magnets (third set from the screen) together or apart to make the red and blue vertical lines coincide. Figure 2-13 indicates the effect of the four-pole magnets and their design.
4. The two handles should be at the same angle from vertical to keep the red and blue horizontal lines coincident.
5. Replace the G connector on the R, G, B set on the deflection board.
6. Rotate the handles of the six-pole magnets (fourth set from the screen) together or apart to make the red and blue lines at the center of the screen coincide. Figure 2-14 indicates the effect of the six-pole magnets and their designs.
7. Keeping the same angle between the two handles, rotate them as one, to make the horizontal red and blue lines coincide with the green.
8. Touch up the vertical line coincidence if needed by moving the handles slightly together or apart.
9. Lock the magnet set by retightening the lock ring at the end of the magnet set nearest the screen.



Effect of position change



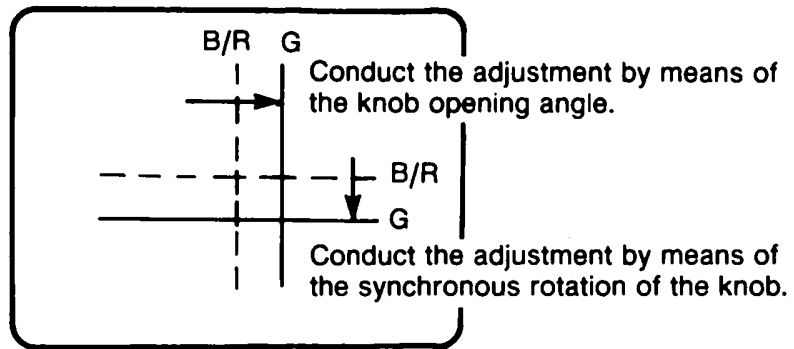
Effect of opposite rotation of magnet pair



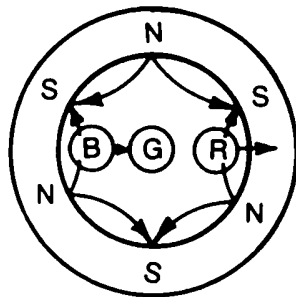
Effect of synchronous rotation of magnet pair

Four-pole magnet adjustment

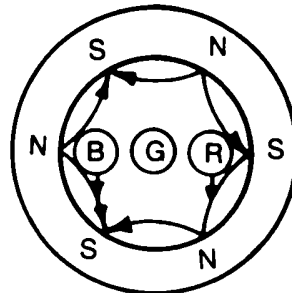
Figure 2-13



Effect of position change



Effect of opposite rotation of magnet pair



Effect of synchronous rotation of magnet pair

Six-pole magnet adjustment

Figure 2-14

# Troubleshooting Non-Operative Systems

This chapter presents a structured sequence of operations to follow when either the system is unable to run diagnostics or the level 0 (power-on) diagnostics fail. The actions recommended in the text are summarized in the flowchart in Figure 3-1. The flowchart is intended as an overall guide and is necessarily abbreviated in some areas. It cannot, therefore, be considered to be complete or all inclusive in every respect.

## TRY TO TURN MACHINE ON

### POWER ON

#### Power Cords And Switches

- 1-1. Make certain the power cord is plugged into the back of the processing unit.
- 1-2. Make certain that the processing unit power cord is plugged into a properly grounded wall outlet.
- 1-3. Make certain that the power cords for any currently-attached external devices (printer, etc.) that have separate power cords are plugged into properly grounded wall outlets.
- 1-4. Insert an NCR "User Diagnostics" diskette, for which a backup diskette exists, into drive A. Do not use a diskette which has not been copied to a backup, since the slight possibility always exists that a problem might occur which could result in the loss of software and data recorded on the diskette.

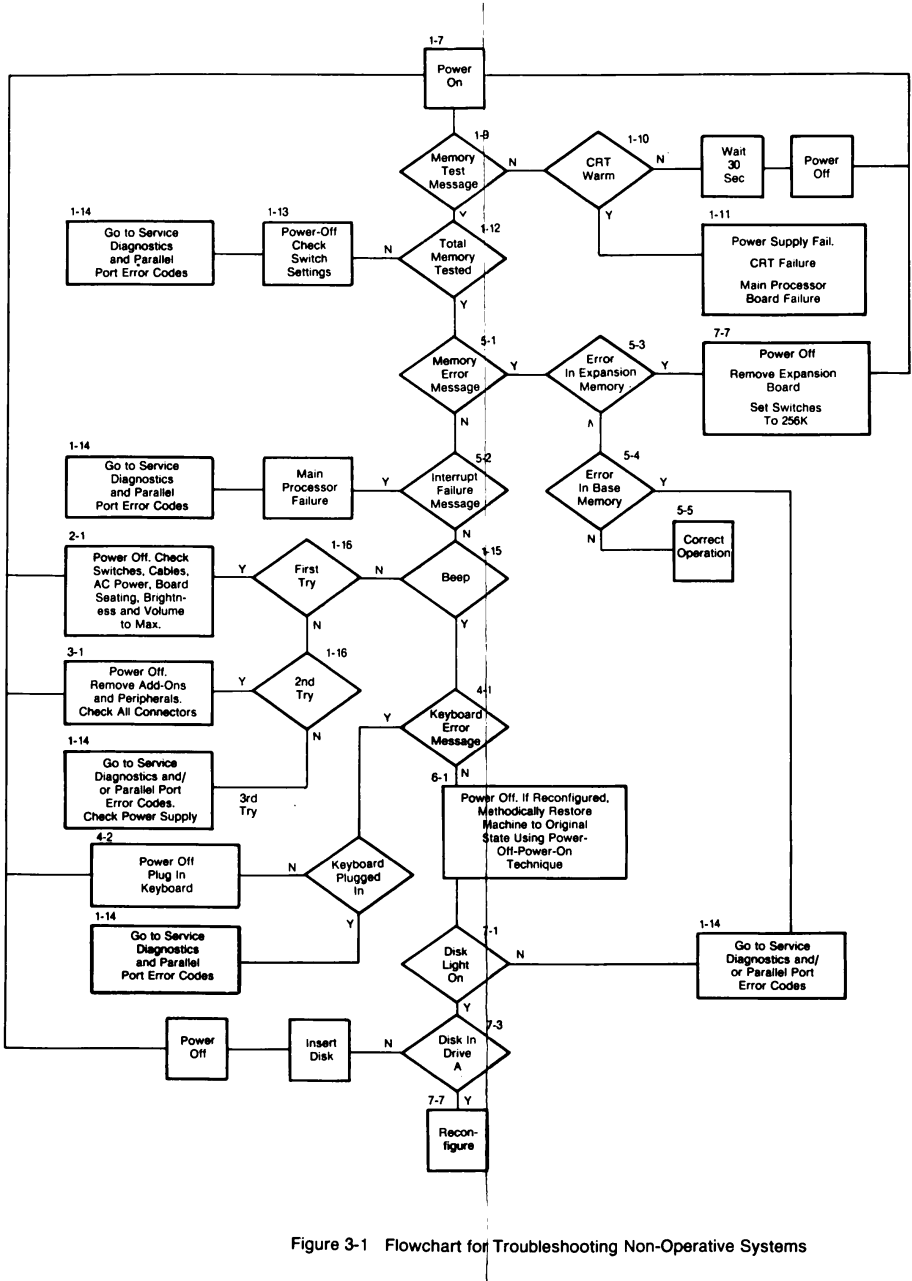


Figure 3-1 Flowchart for Troubleshooting Non-Operative Systems

- 1-5. Turn the drive access lever to horizontal position to enable the drive.
- 1-6. Turn ON any currently-attached external devices that have separate power cords and switches (unless the device installation instructions specified that the device be turned on *after* the processing unit).
- 1-7. Turn the processing unit power switch ON. Turn the volume control and brightness to maximum.
- 1-8. Turn ON any currently-attached external devices that were specified to be turned on after the processing unit.

### Memory Test Messages

- 1-9. In a properly operating system the Procedure will result in the display "Memory Test" on the screen and then rapidly step through the 64K increments of memory installed. An audible tone or "beep" will follow and then the display "Loading", or "Test Done." Then the prompt A> (or other) will appear. The following few steps treat anomalies of that sequence.
- 1-10. If the CRT does not display a message the tube may not have been warmed up in time. Wait approximately 30 seconds for the tube to warm and then power-OFF and power-ON for a retry.
- 1-11. If there is no display after the CRT is warm, a CRT failure, a power supply failure, or a main processor failure is suspected. Proceed to repair or replace as appropriate. Power supply voltage checks should be made before disassembly. The main processor board Parallel Port Error Codes can be checked with an oscilloscope as described in Chapter 4. If CRT failure is indicated review and observe all safety precautions of Chapter 7 for servicing the display. Check that electrical connections are secure and circuit boards are properly seated before disassembly.
- 1-12. The procedure of step 1-9 should result in a display "Memory Test". The installed amount of memory should be indicated by steps in increments of 64K each.

- 1-13. If the correct amount of memory is not indicated, power-OFF and check the switch settings for the correct positions.
- 1-14. Proceed now to use either of the diskette-based sets of diagnostics:
- The “User Diagnostics” diskette is in the back of the NCR Personal Computer *OWNER’S MANUAL*. Its use is described in the *Troubleshooting* chapter of that manual.
  - The “Service Diagnostics” diskette is in the back of this manual. Its use is described in the *Level 1 Diagnostics Operation* chapter of this manual. Messages which may result from running these routines are defined, along with corrective actions, in the *Level 1 Diagnostics Error Returns* chapter.
  - The Parallel Port Error Codes of Chapter 4 may also be applied for main processor board diagnosis.
- 1-15. If the procedure of step 1-12 resulted in a display indicating the correct amount of memory was tested, a tone or “beep” should be heard. The “beep” indicates that the test procedure has cycled through the complete number of increments. The success of testing each memory increment is indicated by the screen message.
- If there was no “beep” proceed to step 1-16.
- If there was a “Keyboard Error” message, proceed to step 4-1.
- If there was a “Memory Error” message, proceed to step 5-1.
- 1-16. If this was the first attempt to power up the computer, go to step 2-1 in the “After First Attempt” section.
- If this was the second attempt to power up the computer, go to step 3-1 in the “After Second Attempt” section.
- If this was the third attempt, this procedure has failed to locate the problem. Disassemble the computer and check the power supply. If no problem is found there, go on to step (1-14).

## After First Attempt

- 2-1. Turn OFF the power switches for any external devices (printer, etc.).
- 2-2. Turn the processing unit power switch OFF.
- 2-3. Unplug the processing unit power cord from the wall outlet. If any external devices have separate power cords, unplug them too.
- 2-4. Unplug the power cord from the back of the processing unit.
- 2-5. Take out any adapter card which is in the top slot and which interferes with access to the Main Processor Board (MPB) configuration switch blocks SW1 and SW2 (see Figures 3-2 and 3-3). Many production models have the display (CRT) adapter card in this slot.

Refer to the section "Remove Adapter Cards" in the *Disassembly/Assembly* chapter for instructions on removing the access door from the back of the computer and on removing an adapter card.

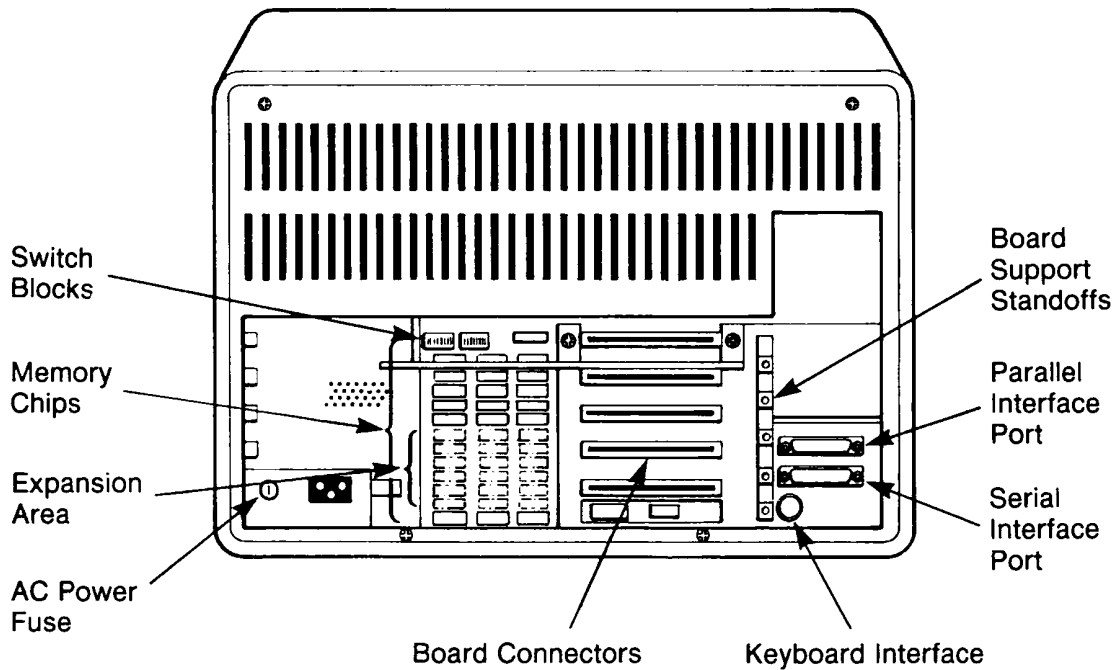


Figure 3-2 Main Processor Board (with access door removed)

NOTE Depress End of Rocker Switch Which Corresponds with Indicated Setting.

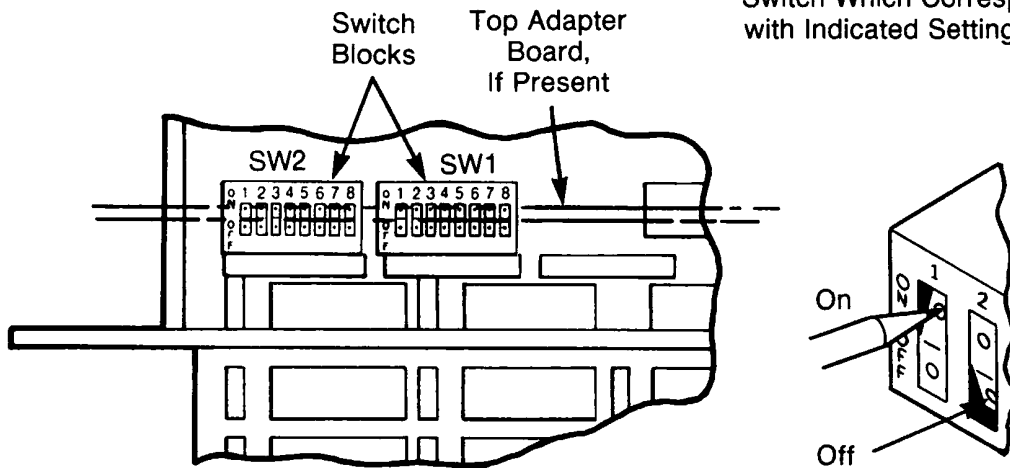


Figure 3-3 MPB switch blocks (detail)

- 2-6. Check *all* configuration switch settings. Refer to the diagrams in Appendix A, *Configuration Switch Settings*, and to Figures 3-2 and 3-3 for location and details of the switches.
- 2-7. Check the attachment and condition of all cables.
- 2-8. Check the AC power source. (Use a lamp that you know works to make certain that outlet(s) have power.)

- 2-9. Check the AC power fuse, located to the left of the power cord plug as shown in Figure 3-2. It should be 3 amp, 250 volts; replace if blown.
- 2-10. Check that the card-edge connectors of all adapter cards mounted in the computer are properly seated in the MPB board connector slots.
- 2-11. Turn the Brightness and Volume control knobs on the front of the computer fully clockwise to their maximum settings.
- 2-12. Replace the top adapter card, if it was removed to reach the switches:
- Touch a finger to the frame of the computer or one of the board support standoffs to discharge any static.
  - Remove the retaining screw from the board support standoff.
  - Plug the cable (if any) back into the connector on the end of the card and tighten the two connector screws.
  - Align the card with the board support standoff on the right side and with the corresponding guide slot on the left side.
  - Push the card in gently but firmly until the card-edge connector is securely plugged into the board connector on the MPB.
  - Replace the card retaining screw. Make certain that it is tight, but do not overtighten.
- 2-13. Return to step 1-1 to retry the power up process.

### After Second Attempt

- 3-1. Turn OFF power and unplug power cords as detailed in steps 2-1 through 2-4.
- 3-2. Take out all *expansion* adapter cards (for any features which have been added to the original basic machine).

Refer to the section "Remove Adapter Cards" in the *Disassembly/Assembly* chapter for instructions on removing the access door from the back of the computer and on removing each pertinent adapter card.

The adapter cards that remain will be:

- The flexible disk drive controller card (the short board normally in the bottom slot).
- The monochrome or color/graphics display adapter card (normally in the top slot — see step 2-5).
- The fixed disk drive controller card (if the computer is a model 3284-1103 or 3284-1203).

If a fixed disk built into the processing unit cabinet is present on any other model, it has been added as an expansion kit. Remove its controller card and detach the two flat ribbon cables.

Any external fixed disk drive is also an expansion feature; remove and disconnect its adapter card.

- 3-3. Disconnect each printer or other peripheral device which is connected to either the parallel or serial port connector in the lower right rear corner of the MPB.
- 3-4. Take out any adapter card which is in the top slot and which interferes with access to the MPB configuration switch blocks SW1 and SW2, as in step 2-5.
- 3-5. Set the configuration switches in switch block 2 (SW2) for the minimum 128 KB memory size (see Appendix A for proper switch settings).

If any device is disconnected from the MPB serial port in step 3-3, the serial port switches in switch block 2 (SW2) must be changed to show the port disabled.

- 3-6. Check all internal and external connectors that are visible and reachable for the devices that remain installed on the computer. Make certain that the connections are tight and proper.

- 3-7. Replace the top adapter card, if removed in step 3-4, following the instructions in step 2-12.
- 3-8. Return to step 1-1 to retry the power up process.

## CHECK KEYBOARD

- 4-1. Check whether the keyboard cable is properly plugged into the 5-pin connector on the back of the MPB.  
  
If it is, then this is not the problem; proceed to use either of the diskette-based sets of diagnostic routines as discussed in step 1-14.  
  
If the keyboard is not properly plugged in, go to the next step (4-2).
- 4-2. Turn power OFF as detailed in steps 2-1 through 2-4.
- 4-3. Plug the keyboard cable connector into the keyboard interface on the MPB.
- 4-4. Return to step 1-1 to retry the power up process.

## CHECK FOR DIAGNOSTICS ERRORS

- 5-1. Check the CRT screen to see whether the power-on diagnostics routines have detected and indicated the presence of any memory errors.  
  
If not, and there is an interrupt failure message, go to step 5-2.  
  
If any errors are indicated, go on to next step 5-2).  
  
If the computer has been reconfigured for the purpose of this troubleshooting procedure, it is necessary to restore the machine step-by-step to full configuration, retesting at each incremental buildup to determine whether the addition of any specific component causes any malfunction.  
  
The computer has been reconfigured if any of the following steps in the preceding "Try To Turn Machine On" section were performed:

- If any configuration switch settings were changed as a result of the check in step 2-6.
- If any expansion adapter cards were removed in step 3-2.
- If any parallel or serial port devices were disconnected in step 3-3.
- If any configuration switches were changed to restrict the memory test to the minimum 128 KB in step 3-5.

If the computer was reconfigured, and has not yet been restored to and retested at full configuration, go to step 6-1 in the "Restore Full Configuration" section.

If the computer was not reconfigured, or has been restored step-by-step to full configuration and retested, go on to step (5-3).

- 5-2. If the message "Interrupt Failure" is displayed, a main processor board failure is indicated. See Chapter 4 and "Service Diagnostics" to further diagnose the condition.
- 5-3. If the message "Error in Expansion Memory" is displayed on the screen at this point, hardware parity must be checked by removing the expansion memory board and testing each 64K increment separately. The procedures of step 7-7 of this chapter are helpful in implementing the process.
- 5-4. If the message "Error in Base Memory" is displayed, the procedure of step 5-3, modified for base memory, should be followed for the main processor board.
- 5-5. If the computer now appears to be functioning properly in all respects at full configuration (the power-on diagnostics have displayed no error messages, the operating system has been booted from the diskette, and the system prompt, **A>** or other, has been displayed), the procedure to recover from a non-operative condition has been completed successfully; proceed to use the machine normally.

If the computer is still not functioning properly, this procedure has not been successful; proceed to use either of the diskette-based sets of diagnostic routines as discussed in step 1-14.

## RESTORE FULL CONFIGURATION

### TEST TOTAL MEMORY

- 6-1. If the configuration switches indicating the amount of memory were set to the minimum 128 KB in step 3-5, raise the setting in 64 KB increments until the actual total amount of memory installed in this computer is indicated. Retest after each 64 KB higher setting to determine whether any problem exists with any specific bank of memory.

If the amount of memory indicated and tested at this point is less than the total amount installed, go to the next step (6-2).

If all memory installed in the computer has been successfully tested, go on to step 7-1 in the "Test CRT And Disk Drives" section.

- 6-2. Increment the amount of memory indicated by the configuration switches by 64 KB and retest by performing the following sequence of actions:
- Turn power OFF as detailed in steps 2-1 through 2-4.
  - Take out any adapter card which is in the top slot and which interferes with access to the MPB configuration switch blocks SW1 and SW2, as in step 2-5.
  - Set the configuration switches to indicate the next 64 KB higher amount of memory (see Appendix A for proper switch settings).
  - Replace the top adapter card, if removed for access to the switches, following the instructions in step 2-12.
  - Return to step 1-1 to repeat the power up process.

## TEST CRT AND DISK DRIVES

- 7-1. Observe whether any characters and/or the cursor are displayed on the CRT screen.

If nothing is displayed, this procedure has not been successful; proceed to use either of the diskette-based sets of diagnostic routines as discussed in step 1-14.

If the cursor and/or characters (other than a diagnostic error message) are displayed, go on to the next step (7-2).

- 7-2. If a fixed disk drive unit is installed, and currently attached (it might be temporarily disconnected as a result of step 3-2), observe whether the disk drive active light is on and listen for the whirring noise that the drive makes when it is rotating. The drive should be rotating and active all the time the processing unit is turned on.

If the fixed disk drive (installed *and* attached) is not active and running as it should be, this procedure has not been successful; proceed to use either of the diskette-based sets of diagnostic routines as discussed in step 1-14.

If no fixed disk drive is installed and attached, or if the drive is active and running properly, go on to the next step (7-3).

- 7-3. Check whether a diskette was inserted in diskette drive A, with the drive access lever turned to enable the drive, prior to the start of the current test pass. If so, observe whether the drive active light is on.

If the drive is loaded and active, go on to step 7-5.

If no diskette is in the drive, or if the drive or the drive active light is not on, go on to the next step (7-4).

- 7-4. Restart the test with the diskette drive properly loaded by performing the following steps:

- Turn the processing unit power switch OFF.
- Insert an NCR-DOS (or other) operating system diskette, for which a backup diskette exists, into diskette drive A. Do not use a diskette which has not

been copied to a backup, since this is a procedure to determine why the computer is not working and the problem could result in the loss of software and data recorded on the diskette.

- Turn the drive access lever to enable the drive.
- Return to step 1-1 to repeat the power up process.

7-5. Observe whether any indication of a problem (error message on the CRT screen or other) exists at this point. At the conclusion of the power-on diagnostics, the operating system should be booted into the computer and the system prompt (A> or other) should be displayed.

If any problem is visible, or if the operating system is not properly booted in, go to step 7-6 to retry the process with the backup diskette.

If everything appears to be working properly, go to step 7-7 to continue the process of restoring the machine to full configuration.

7-6. If this step has previously been performed (that is, the backup diskette has already been used), the procedure has not been successful; proceed to use either of the diskette-based sets of diagnostic routines as discussed in step 1-14.

If this is the first time this step is encountered, and a backup copy of the operating system diskette (or a diskette for a different operating system) is available, perform the following sequence of actions:

- Turn the processing unit power switch OFF.
- Insert the backup (or alternate) operating system diskette into diskette drive A.
- Turn the drive access lever to enable the drive.
- Return to step 1-1 to repeat the power up process.

## **REINSTALL EXPANSION ADAPTER CARDS/PERIPHERALS**

- 7-7. To return the computer to full configuration step-by-step, reinstall the expansion adapter cards and peripheral devices removed or disconnected in steps 3-2 and 3-3 one at a time. This procedure will permit isolation, to the one adapter card or peripheral device, of any problem which appears. The technique requires reiteration of this and other steps as many times as there are expansion adapter cards or port-connected peripherals.

If some action taken during the procedure, such as making connections secure or correcting configuration switch settings, has cleared up the problem(s) which required this effort, eventually the logic in steps 5-2 through 5-4 of the "Check For Diagnostics Errors" section will result in successful completion of the troubleshooting procedure.

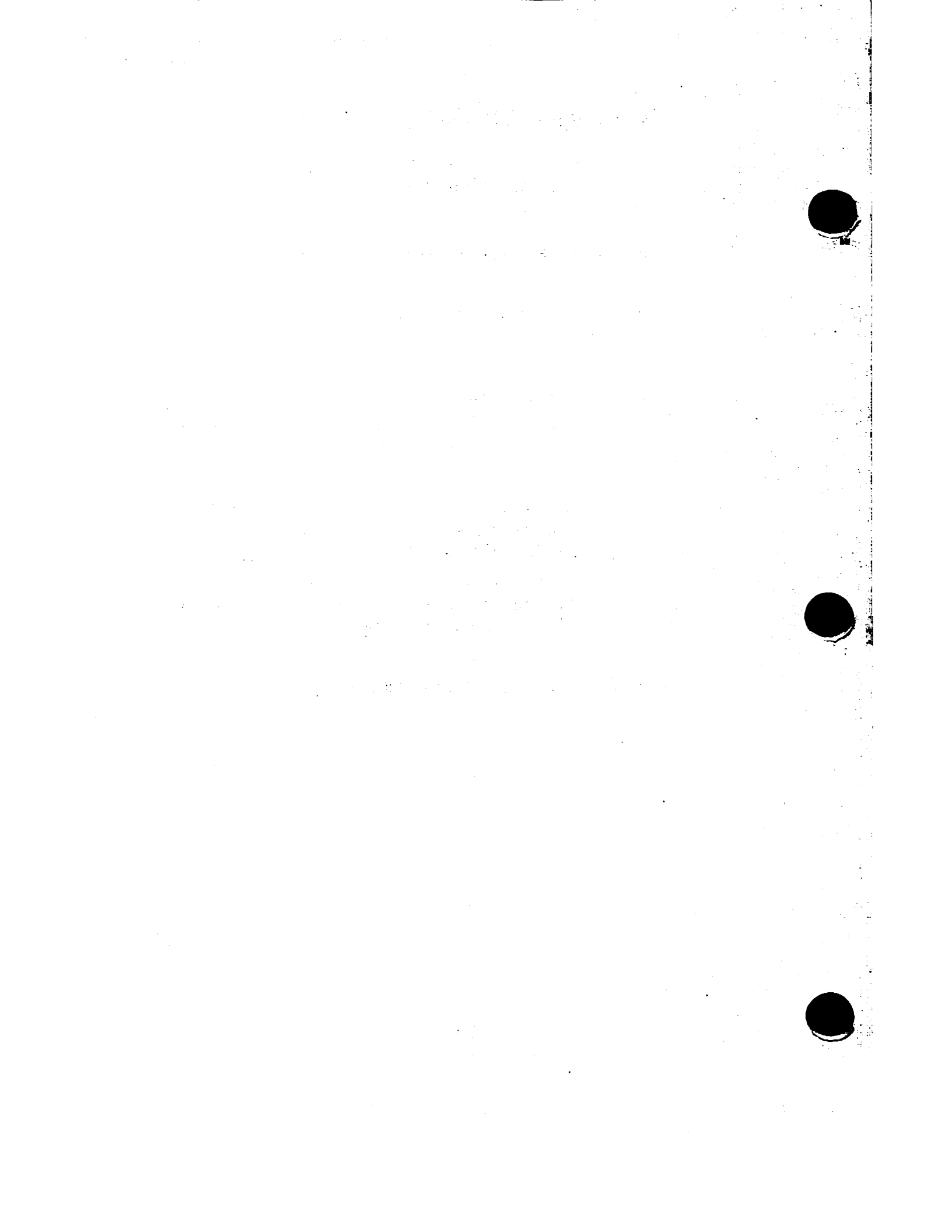
A recommended sequence for reinstalling expansion adapter cards and/or peripheral devices is:

- Memory Expander Card, if it was not reinstalled in step 6-2. Follow the instructions in step 6-2 for accessing the additional memory in 64 KB increments.
- Flexible Disk Drive expander kit, if a second expansion drive was disconnected during the testing. Note that this may require changing of the configuration switch settings.
- Fixed Disk Drive adapter card and connections to the drive(s).
- Printer connected to the parallel port.
- Printer or other device connected to the serial port. Note that this requires changing of the configuration switch settings to show the port enabled as COM1.
- Asynchronous Communications Adapter Card and attached peripheral(s).

- Any other expansion adapter board.

When reinstalling an expansion adapter card or port-connected peripheral, perform the following sequence of actions:

- Turn power OFF as detailed in steps 2-1 through 2-4.
- For an adapter card, follow the instructions in step 2-12.
- For a port-connected peripheral, plug the cable connector back into the appropriate MPB connector and tighten the two connector screws.
- If the configuration switches must be changed: refer to the instructions in step 2-5 for removing the top adapter card, if necessary; refer to Appendix A for the proper switch settings; and refer to the instructions in step 2-12 for replacement of the top adapter card, if removal was necessary.
- Return to step 1-1 to repeat the power up process.



## *Level 0 (Power-On) Diagnostics*

This chapter details the tests that are performed during the execution of the automatic power-on diagnostic routines that are contained in the Read-Only Memory (ROM) of the NCR PERSONAL COMPUTER Model 4. These diagnostics are initiated before any other activity is attempted each time the computer is turned on. Normal messages and error messages which may be displayed on the CRT are shown. Error codes which are output through the Main Processor Board (MPB) parallel port, to assist in troubleshooting if the CRT error messages are not displayed for some reason, are listed. The action to take for each specific error condition is suggested.

### **NORMAL POWER-ON PROCEDURE**

#### **POWER CORDS AND SWITCHES**

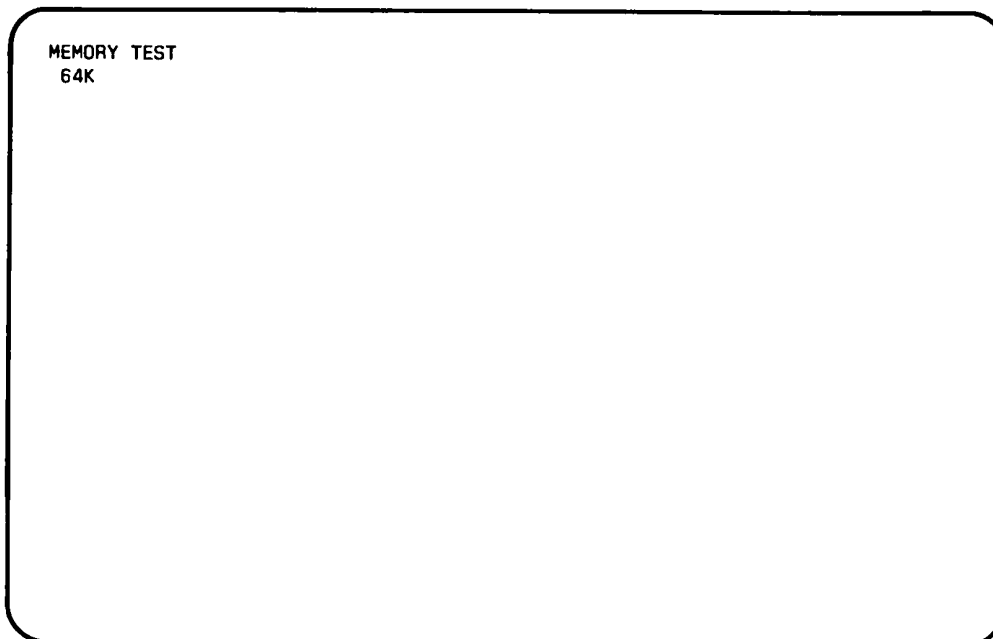
1. Make certain the power cord is plugged into the back of the processing unit.
2. Make certain that the processing unit power cord is plugged into a properly grounded wall outlet.
3. Make certain that the power cords for any currently-attached external devices (printer, etc.) that have separate power cords are plugged into properly grounded wall outlets.
4. Insert an NCR-DOS (or other) operating system diskette, for which a backup diskette exists, into diskette drive A. Do not use a diskette which has not been copied to a backup, since the slight possibility always exists that a problem might occur which could result in the loss of software and data recorded on the diskette.
5. Turn the drive access lever to the right to enable the drive.

6. Turn ON any currently-attached external devices that have separate power cords and switches (unless the device installation instructions specified that the device be turned on *after* the processing unit).
7. Turn the processing unit power switch ON.
8. Turn ON any currently-attached external devices that were specified to be turned on after the processing unit.

### MEMORY TEST

Each time the power is turned on, the ROM program performs a self-diagnosis that is primarily a check of the Dynamic Random Access Memory (DRAM) resident on the MPB and on the Memory Expander Card, if present. Other MPB components are tested. The keyboard interface is also tested. The following occurrences are normal:

1. A whirring motor noise from the disk drive is heard.
2. A blinking cursor appears on the screen.
3. The memory test is conducted in 64 KB increments. In normal operation, the upper boundary of the bank of memory tested is displayed in the upper left-hand corner of the CRT screen; at successful completion of the test of each bank, the following screens appear:



MEMORY TEST  
128K

MEMORY TEST  
192K

\* See Note Following

MEMORY TEST  
640K

\* See Note Following

- \* Memory banks higher than 128K are tested, and their upper boundaries displayed, only if the configuration switches (switches 1, 2, 3, 4 and 5 of switch block 2 — SW2 — on the MPB) are set to indicate that a higher total amount of memory is present.

The memory diagnostic routine tests up to the size set in the switches.

If a Main Processor Board error is found or a software memory error is identified in the first 64K, the system halts. If this occurs, turn to the *Troubleshooting Non-Operative Systems* chapter of this manual and follow the procedures detailed there.

If a software memory error is found above 64K, the message **MEMORY ERROR** is displayed and the memory size in the diagnostic routine work area is set to the size of the error-free amount of RAM (in 64K bank increments) and the next test in the diagnostic routines is started.

Hardware parity errors found during load are identified as **ERROR IN BASE MEMORY** if the error(s) occur in the first 64K of memory, or as **ERROR ON EXPANSION CARD** if the error(s) occur anywhere above 64K. Hardware parity errors cause the system to halt.

4. The speaker within the computer (on the MPB) should sound a single audible tone (“beep”) to indicate conclusion of the memory test and start of the initialization and booting phase.  
If no beep is heard, turn to the *Troubleshooting Non-Operative Systems* chapter and follow the procedures given.

## OTHER MPB TESTS

5. Other MPB components are tested. These include:
  - The 8088 Central Processing Unit (CPU) chip.
  - The 2764 Erasable-Programmable Read-Only Memory (EPROM) chip. This chip contains the Basic Input-Output System (BIOS). BIOS has two major sets of components: the power-on diagnostics/initialization routines; and the device handling routines. Since this is a ROM chip, testing can not include writing to the chip. The test, therefore, consists of reading the chip, calculating a checksum, and comparing the checksum with that recorded on the chip when it was programmed.

- The 8237A Direct Memory Access (DMA) Controller.
  - The 8253 Timer.
  - The 8259A Programmable Interrupt Controller.
6. The keyboard interface is tested to verify that a keyboard which can communicate with the processor is attached.

## INITIALIZATION AND BOOTING

7. If all the above tests have been successfully completed, a beep and the message TEST DONE (or LOADING) appears to signify the initialization portion of the power-on routines is begun. The initialization includes:
- Zeroing of DRAM memory
  - Setting up in DRAM memory the tables and control information (flags, vectors) needed by the operating system.
  - Booting (loading) the operating system from the diskette in drive A (normally) and transferring control to the operating system coding.
8. At the conclusion of the initialization and booting process, the operating system should display the system prompt (A> or other). The computer is now ready to run any desired application or other software.

**NOTE:** The message **DISK ERROR, INSERT SYSTEM DISK AND PRESS ANY KEY TO TRY AGAIN** is displayed if the boot disk is missing or improperly formatted.

## ERROR RETURNS

If *no* activity (disk drive motor noise, blinking cursor, memory test) occurs after the machine and peripherals are turned on, try the following:

1. Turn the power switch OFF.
2. Check that your wall outlet is working properly (use a lamp that you know works).

3. Repeat the power-on self-test procedure.
4. If the test is still not successful, turn to the *Troubleshooting Non-Operative Systems* chapter of this manual and follow the procedures detailed there.

If an audible tone (“beep”) is heard after the memory test, and the system prompt is not displayed (or if the message **KEYBOARD ERROR** is displayed), go to the “Check Keyboard” section of the *Troubleshooting Non-Operative Systems* chapter.

### SCREEN MESSAGES

The following is a listing of the messages that can be displayed on the CRT during the power-on diagnostics/initialization routines, including error messages:

Test Description	Message	(Notes)
RAM Test	Memory Test 64K	
RAM Test	Memory Test 128K	(Each 64K Upper Boundary Up to the Total Amount of Memory Indicated by Switches 1, 2, 3, 4 and 5 of SW2 Is Displayed As the Corresponding Memory Bank Is Tested.)
● ●	● ●	
RAM Test	Memory Test 640K	
RAM Test	Memory Error	(Test Halts If Error in First 64K; Test Displays Message, Reconfigures Maximum Memory and Continues If Above 64K.)
Interrupt	Interrupt Failure	
Parity	Error in Base Memory	(In First 64K.)
Parity	Error on Expansion Card	(Above 64K.)
Keyboard	Keyboard Error	End of Test
Test Done		
Boot	Disk Error, Insert System Disk and Hit Any Key to Try Again	

### PARALLEL PORT ERROR CODES

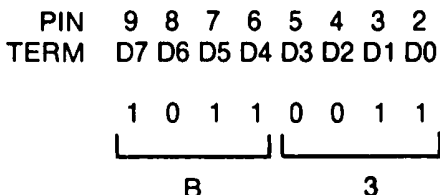
The power-on diagnostics/initialization routines also output a set of two-character hexadecimal codes to the MPB parallel port. These enable a field engineer, who has a scope available to attach to the parallel port to display these codes, to obtain an indication of hardware problems and status. This technique is quite valuable when, for any reason, the programs are unable to display messages on the CRT.

Test Description	Error Code	(Notes)
Processor	AA	(Test Halts)
Eprom Checksum	B1	(Test Halts)
DMA	B2	(Test Halts)
Timer	B3	(Test Halts)
RAM	B4	(Test Halts IF <64K) Else MEMORY ERROR Is Displayed.
Interrupt	B5	INTERRUPT FAILURE Is Displayed.
RAM Parity	B6	(Test Halts) Either ERROR IN BASE MEMORY or ERROR ON EXPANSION CARD Is Displayed.

(Note That If All Tests Pass, the Parallel Port Will Contain Code BB.)

The error, or AA, code is output to the parallel port as two hexadecimal digits over the 8 data lines, D0-D7 (PINS 2-9 — refer to “Main Processor Board-Parallel Printer Connector” diagram in Appendix D). D0 is LSD, D7 is MSD.

Example: Code B3 Output —



## SUGGESTED ACTION

For some of the error conditions which can occur during the automatic running of the power-on diagnostics routines, the indication has been given in this chapter to go to the *Troubleshooting Non-Operative Systems* chapter of this manual.

This tactic is generally appropriate when the problem appears to be in RAM memory, or if the problem may be in any component added to the original main processing unit either by addition of an expansion adapter card or by plugging a cable into either the parallel port or the serial port on the MPB.

The *Troubleshooting Non-Operative Systems* chapter gives detailed instructions for removing add-on memory and/or other devices to return the machine to original status, then for restoring the machine to full configuration one step at a time. This procedure can isolate problems to a specific device.

Where the problem is indicated to be in one of the key MPB chips (Processor, EPROM, DMA controller, Timer, Interrupt controller), the procedures in the *Troubleshooting Non-Operative Systems* chapter are not likely to help.

Rerun the power-on process from completely OFF as described in this chapter two or three additional times to make certain that the error indication is hard (that it consistently repeats the identical message, code, etc.).

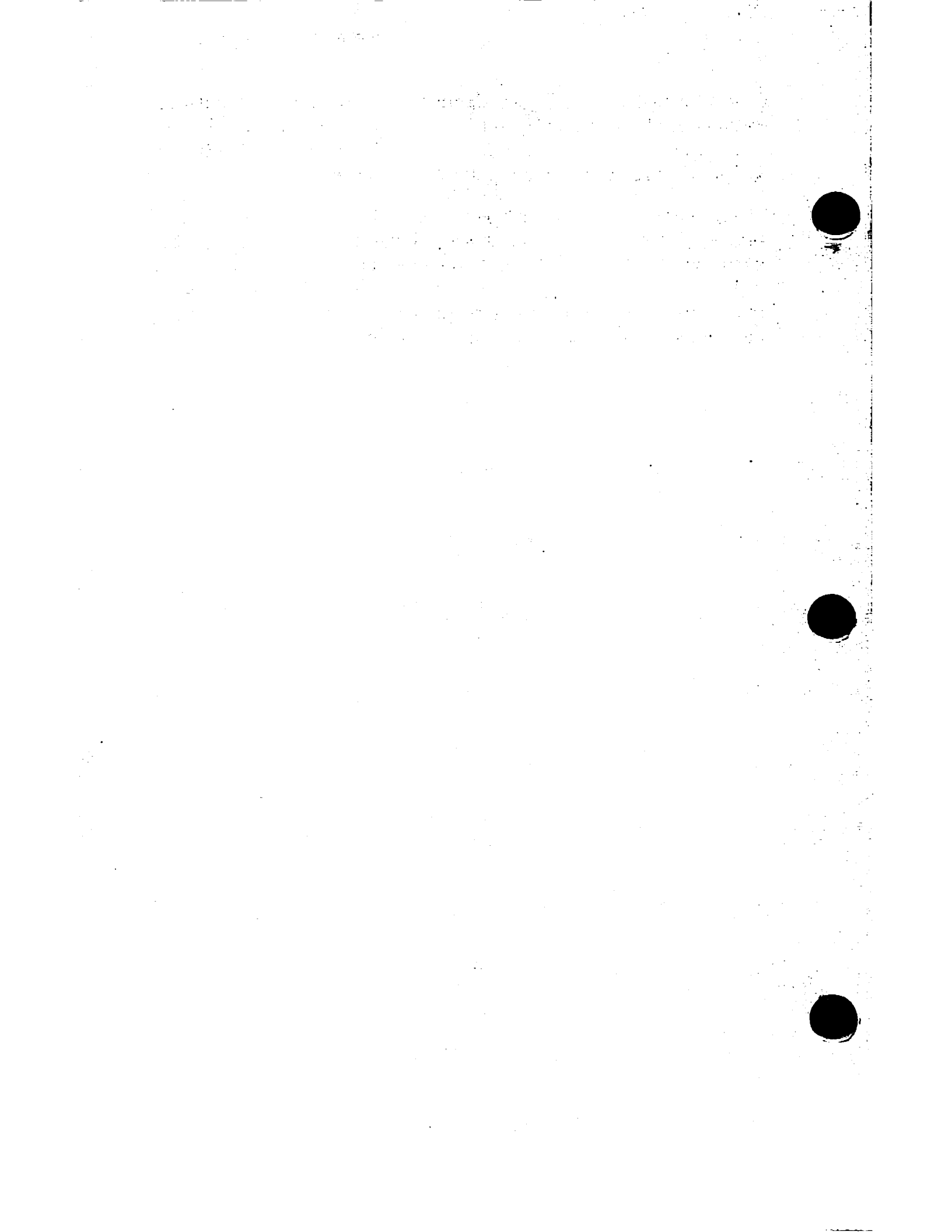
When a problem appears to be solidly located in one of the pluggable MPB chips (Processor, EPROM, DMA controller), the next step is to disassemble the unit by removing the cabinet as shown in the *Disassembly/Assembly* chapter of this manual. Read and heed all warnings and cautions in that chapter before working on the computer with the cabinet removed.

In some cases, more positive seating of the chip can be accomplished either by gently but firmly pushing on it (discharge static first by touching a finger to the frame or to a board support standoff) or by very carefully removing the chip, inspecting and, if necessary, straightening the pins, and reinserting the chip in its socket. After reassembling the cabinet, retry the power-on procedure.

If the attempt to improve chip seating does not help, or if a solid error is indicated in a soldered-in chip (Timer, Interrupt controller), then the MPB must be removed from the computer and either replaced or repaired.

Follow the instructions in the “Cabinet” and “Main Processor Board” sections of the *Disassembly/Assembly* chapter. When the MPB has been removed, it can be taken to an NCR service facility or NCR-authorized dealer for repair or replacement.

(Repair of the MPB can only be successfully done by a well-trained field engineer or technician, since it involves unsoldering the bad component from a multi-layer printed circuit board and then soldering the new component into the same location on the same multi-layer PCB. The danger that the heat of unsoldering/soldering may damage the printed circuits is considerable.)



## *Level 1 Diagnostics Operation*

This chapter tells how to use the SERVICE DIAGNOSTICS diskette which is in the back of this manual. These diagnostics, also referred to as Level 1 Diagnostics, are the most comprehensive set of test routines supplied and supported by NCR for the NCR PERSONAL COMPUTER Model 4.

Following the instructions in this chapter, the field engineer or technician interacts with the SERVICE DIAGNOSTICS software to test all or selected components of the computer. The software presents a hierarchy of menu selection screens on the CRT to simplify the choice of tests to perform. For all menu screens, corresponding HELP screens are available to further explain the purposes of the tests which may be selected.

Each menu and HELP screen is shown in this chapter, along with the results of each selection path chosen (the next level menu screen, or a completion screen). How to begin the testing, and how to terminate it, are described.

### **HOW TO BEGIN TESTING**

#### **LOAD THE DISKETTE**

1. Make certain the power cord is plugged into the back of the processing unit.
2. Make certain that the processing unit power cord is plugged into a properly grounded wall outlet.
3. Make certain that the power cords for any currently-attached external devices (printer, etc.) that have separate power cords are plugged into properly grounded wall outlets.
4. Insert the SERVICE DIAGNOSTICS diskette into diskette drive A.

5. Turn the drive access lever to the horizontal position to enable the drive.
6. Turn ON any currently-attached external devices that have separate power cords and switches (unless the device installation instructions specified that the device be turned on *after* the processing unit).
7. Turn the processing unit power switch ON.
8. Turn ON any currently-attached external devices that were specified to be turned on after the processing unit.

The BIOS ROM power-on diagnostics/initialization routines perform the power-on testing that occurs each time the machine is turned on, then the initialization routines boot in the SERVICE DIAGNOSTICS software from the diskette in drive A. When control is transferred to the booted software, the main menu is displayed.

### **COPY THE DISKETTE**

Before the SERVICE DIAGNOSTICS diskette is used for the first time, it should be copied to a second diskette. The best way to copy these diagnostics is to use the Generate Diagnostics Disk function of the Utilities in this software.

When the main menu is displayed, enter "D" to select the Utilities menu. Then enter "3" to select the Generate Diagnostics Disk function. Insert a diskette, formatted or unformatted, upon which the copy is to be made, into either drive A or drive B. (The SERVICE DIAGNOSTICS diskette from which the routines were loaded can be removed at any time after the diagnostics are booted into the system, and can be left out during the remainder of the process.)

Enter drive designation "A" or "B" when prompted; then enter "Y" or "N" in response to the **FORMAT DRIVE (Y,N)?** question. Also enter "Y" or "N" in response to **VERIFY DISK (Y/N)?**. After formatting, copying and verifying are finished, the display reads as follows:

```

GENERATE DIAGNOSTIC DISK UTILITY
ENTER DRIVE (A,B):a
FORMAT DISK (Y,N)? y
VERIFY DISK (Y,N)? y
PASSED
F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU_

```

Press F2 to return to the main menu; press F3 to return to the Utilities menu.

(Alternately, the diskette can be copied using the NCR-DOS DISKCOPY command.)

The copied diskette should be labeled as the SERVICE DIAGNOSTICS for normal use, kept in the back of this manual or in a covered diskette storage container, and used for all testing. The original diskette should be kept as a backup, and used only for making copies. It also should be kept in a covered diskette storage container.

## MAIN MENU

The main menu is displayed each time the SERVICE DIAGNOSTICS diskette is booted in, and each time the user chooses to return to the main menu at the completion of a specific test. The main menu gives the operator the following categories of choices:

- Run All Tests (Menu item 1)
- Test A Specific Component (or type) (Menu items 2 — B)
- Check Configuration Switch Settings (Menu item C)
- Run Utilities (Menu item D)

- View Main Menu HELP screen (Press F1)
- Initiate A Continuous Test Run (Press Alt and item number 1 thru B)

The following diagram illustrates the primary main menu choices:

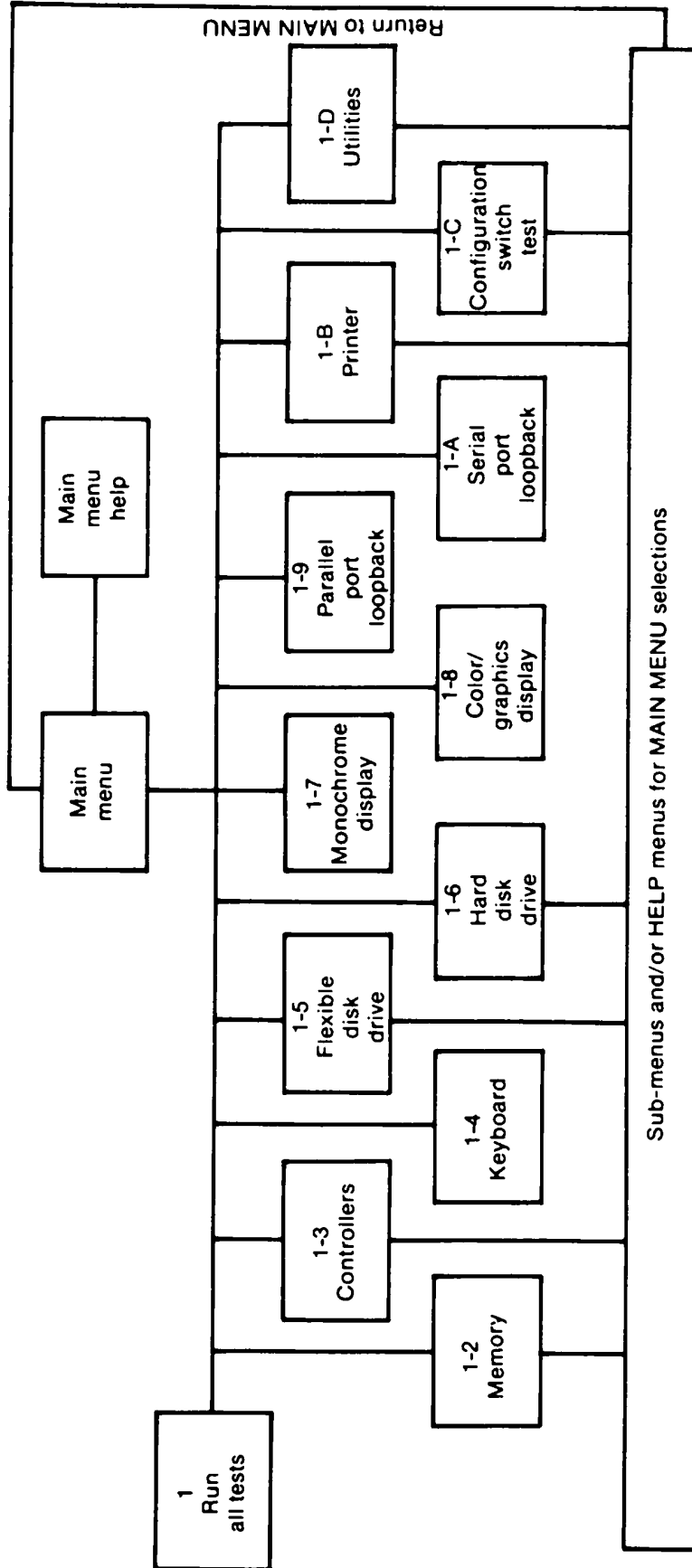


Figure 5-1 Menu Organization

The Main Menu, as displayed on the CRT screen, looks like:

```
The NCR Personal Computer Model 4
Field Service Diagnostics Version 1.0
Copyright 1984 NCR Corp.

      MAIN MENU

1  Run All Tests
2  Memory
3  Controllers (Circuit Devices)
4  Keyboard
5  Flexible Disk Drive
6  Hard Disk Drive
7  Monochrome Display
8  Color/Graphics Display
9  Printer Port Loopback
A  Serial Port Loopback
B  Printer
C  Configuration Test

D  Utilities

Enter selection number:_

F1=HELP,ALT and TEST 1 through C=CONTINUOUS RUN,F2=STOP CONTINUOUS RUN
```

If selection number "1" is entered, each test (2 through B) listed on the menu is automatically run in sequence, starting with the memory test. The test for any device (hard disk, color/graphics display, etc.) which is found by the diagnostic routines to be not present is skipped. Any specific test is selected by entering the number or letter for the desired test.

If the number for a specific test is entered while the ALT key is being held down, that test will be run continuously until F2 is pressed. If the number "1" is entered while the ALT key is being held down, the series of tests 2 through B is repeated continuously until F2 is pressed.

Enter the letter "D" to access a set of utility routines. These utilities perform functions that are related to or needed during diagnostic and/or maintenance operations. The utility functions available include:

- Error Log Maintenance
- Updates To Documentation
- Generate Diagnostics Disk
- Format Flexible Disk

- Format Hard Disk
- Position Head For Relocation
- Alignment Utilities (for CRT's and Flexible Disk Drives)

## MAIN MENU HELP SCREENS

To obtain more information about main menu choices without referring back to this chapter while running the diagnostics, press the F1 key. The first main menu HELP screen is displayed, followed by the second HELP screen, if desired.

The contents of the main menu HELP screens are:

Run All Tests - Runs each test in sequence automatically.

Memory - Allows a RAM pattern, RAM address, RAM parity and ROM checksum.

Controllers - Allows a CPU, DMA, interval timer, interrupt, PPI, CRT, serial, flexible disk and hard disk test.

Keyboard - Tests the keyboard port, each keyboard key and its associated code.

Flexible Disk Drive - Allows a read only and a read/write test of each flexible drive.

Hard Disk Drive - Allows a read/write of the maintenance track, a read only of sector 0, a read only and a read/write of the entire disk.

Monochrome display - Test the CRT RAM, cursor addressing, the ASCII character set, the scroll register and various terminal attributes.

F2=EXIT TO MAIN MENU,ANY KEY TO CONTINUE\_

Color/Graphics Display - Tests the CRT RAM, cursor addressing, the ASCII character set, the scroll register and various terminal attributes.

Printer Port Loopback - Performs an internal and external loopback test on the printer port.

Serial Port Loopback - Performs an internal and external loopback test on the serial port and checks the configuration switches for COM1.

Printer - Allows a generic and a PC-compatible printer test.

Configuration Test - Displays the current value of the configuration switches and additional installed baseline devices.

Utilities - Allows selection of error log maintenance, updates to documentation, generate disk utility, format disk utility, position the hard disk head for relocation and alignment utilities.

Depression of the ALT key with a "selection number" will execute a test continuously until F2 is entered.

F2=EXIT TO MAIN MENU\_

## TEST COMPLETION DISPLAYS

When a specifically-selected test is completed, the diagnostics routines display either a **PASSED** message or a detailed coded error message. The next chapter, *Level 1 Diagnostics Error Returns*, explains all of the possible error messages and the suggested action to take for each.

Examples of completion displays are:

### Successful Completion

\_\_\_ RAM ADDRESS  
PASSED  
F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU\_

In this example, the RAM Address test, selection 2 of the Memory menu accessed when the Memory test (selection 2 of the main menu) is chosen, has completed successfully. Press F3 to return to the last previous menu (the Memory test menu) or F2 to return to the main menu.

### Unsuccessful Completion

```

__ READ ONLY - DRIVE B

*** ERR: 12:80          (Note: This line is displayed in inverse video)
   DV RTY ST0 ST1 ST2 C  H  R  N
*** 01 05 21 00 00 01 01 09 02
F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU_

```

In this example, the Read Only — Drive B test, selection 3 of the Flexible Disk Drive test menu accessed when the Flexible Disk Drive test (selection 5 of the main menu) is chosen, has failed because the flexible disk controller (FDC) failed to respond (in this example, drive B is actually disconnected). Pressing F3, F2 or F1 gives the same results as in the previous example (except that F3 returns to the Flexible Disk Drive menu, which was the last previous menu).

The major error codes (12 = flexible disk error) and detail error codes (80 = FDC failed to respond), and the abbreviations and values on the next two lines, are explained in the next chapter.

## EXITING FROM DIAGNOSTICS

No specific menu selection for exiting from the SERVICE DIAGNOSTICS is displayed at any time. To end execution of the diagnostics, disable disk drive A by turning the drive access lever counterclockwise, remove the diagnostics diskette, and turn the processing unit power OFF. A recommended good operating practice is to perform this shutdown only from the main menu (unless the machine has a problem that prevents return to the main menu), just as shutting down from NCR-DOS operations should normally be done only when the system prompt (A>) is being displayed. The practice ensures that processing is not halted in the middle of an operation, with possible abnormal hardware statuses and possible loss of data currently in memory.

## DIAGNOSTIC SELECTIONS

The following sections describe the results of each selection path chosen from the main menu. Specific device, or device type, menus, HELP screens accessed from the device menus, and each test chosen from a device menu, are shown. Remember that the display upon completion of each test or sub-test has the **PASSED** or **ERR** line(s) and the function key choices (F1, F2, F3) as discussed in the "Test Completion Displays" earlier in this chapter.

### RUN ALL TESTS (MAIN MENU LINE 1)

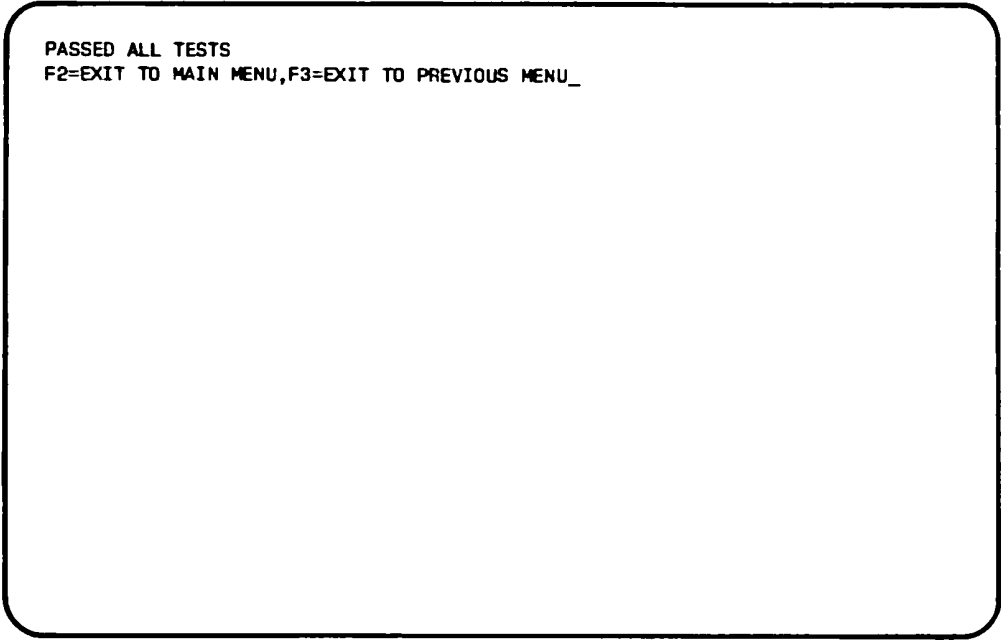
When selection number "1" is chosen from the main menu screen, the separate tests for specific devices (selections 2 through B) are automatically run in sequence. The test for any device (hard disk, color/graphics display, etc.) which is determined by the diagnostic routines to be not present is skipped.

### Automatic Completion

The most significant difference between this testing and the use of separate tests in the same sequence is that the program does not display the message **PASSED** after successful completion of each test or sub-test. All sub-tests within a device menu are indicated on one screen, as shown in the screen displays below. An error message, if appropriate, is displayed after the test or sub-test during which the error is detected; however, the program does not stop.

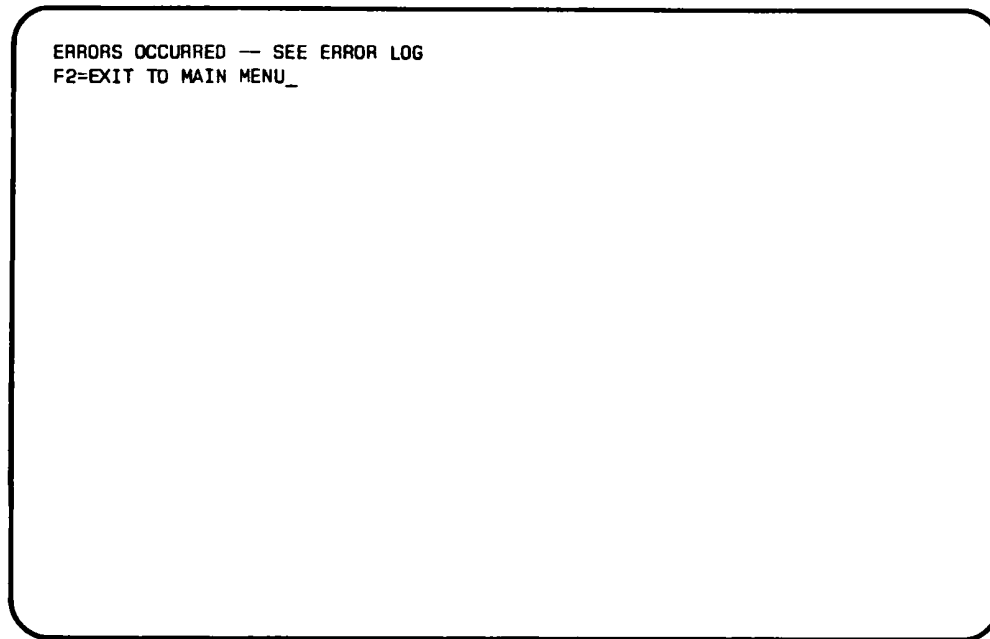
After the first screen, the program runs to successful or unsuccessful completion of all tests regardless of test results. To stop the process at the end of a device test (all sub-tests for the device will still be completed), press F2. The diagnostics will return to the main menu upon completion of the current test or group of tests.

Upon successful completion, the display is:



```
PASSED ALL TESTS
F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU_
```

If any error(s) were detected, the display is:



Press F2 to return to the main menu. To see the errors, select the utilities function (selection number "D", then select Error Log Maintenance ("1"), then Display Error Log (also "1").

**First Screen — CAUTION**

The first screen displayed after selection number "1" is entered is the only one to which a response is requested:

Insert wrap plugs in the printer and serial ports.  
Leave the diagnostics disk in drive A.  
Insert a formatted scratch disk in drive B.

F2=EXIT TO MAIN MENU,ANY KEY TO CONTINUE\_

**CAUTION**

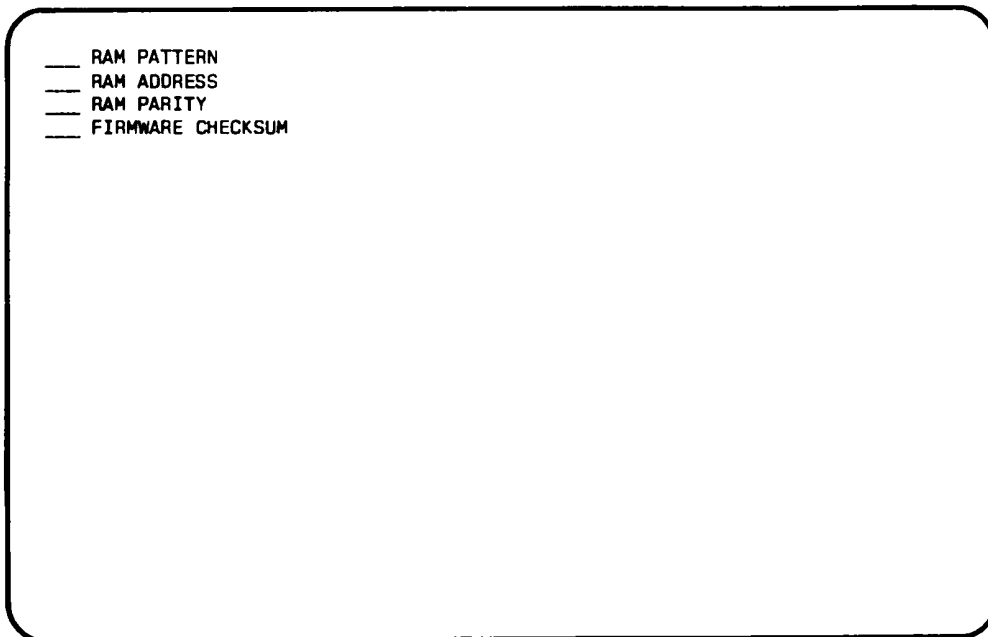
The flexible disk diagnostic tests are destructive to any disk other than the diagnostics disk. **BEFORE CONTINUING**, make certain that no diskettes other than the diagnostics diskette and/or formatted scratch diskette(s) are inserted in the flexible disk drive(s). If any other diskette is left in, data and/or programs on it will be written over by test patterns. The program does not stop again after this point.

If no formatted disks are available, and one or two are needed at this point, press F2 to return to main menu, select the Utilities function **(D)** and, from the Utilities menu, select Format Flexible Disk **(4)**. Then restart the Run All Tests function.

## Normal Screen Displays

Press the space bar or any alphabetic or numeric key to continue. The following screen displays are representative of those that will appear. This set of displays is for a computer with two flexible disk drives, one hard disk, one integrated monochrome display and one external color/graphics display, and no printer attached. Note that on the first two screens, the lines are displayed one at a time as each sub-test is completed; on the third screen, the information for drive B is not displayed until the tests on drive A are completed. The displays are:

(Memory Tests)



### (Controllers and Keyboard Tests)

- \_\_\_ CPU
- \_\_\_ DMA
- \_\_\_ FLEXIBLE DISK
- \_\_\_ INTERVAL TIMER
- \_\_\_ INTERRUPT CONTROLLER
- \_\_\_ PPI
- \_\_\_ CRT, MONO
- \_\_\_ CRT, COLOR
- \_\_\_ SERIAL
- \_\_\_ HARD DISK
- \_\_\_ KEYBOARD PORT

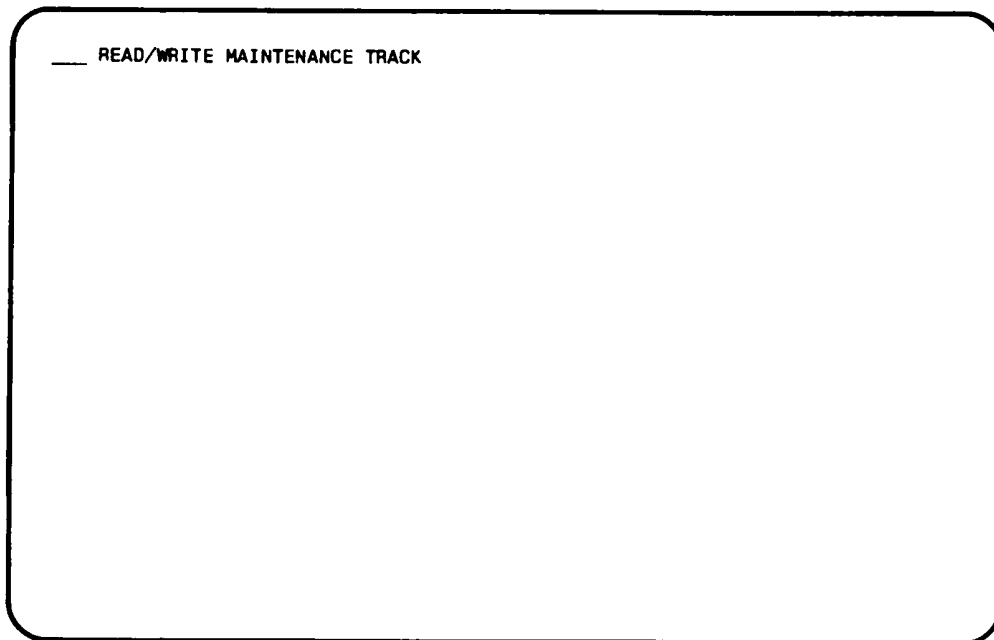
### (Flexible Disk Drive Tests)

\_\_\_ READ/WRITE - DRIVE A  
**WARNING** — This test is destructive to any disk other than the diagnostic disk.  
Insert disk to be used in drive under test.

\_\_\_ READ/WRITE - DRIVE B  
**WARNING** — This test is destructive to any disk other than the diagnostic disk.  
Insert disk to be used in drive under test.

(Hard Disk Drive Tests)

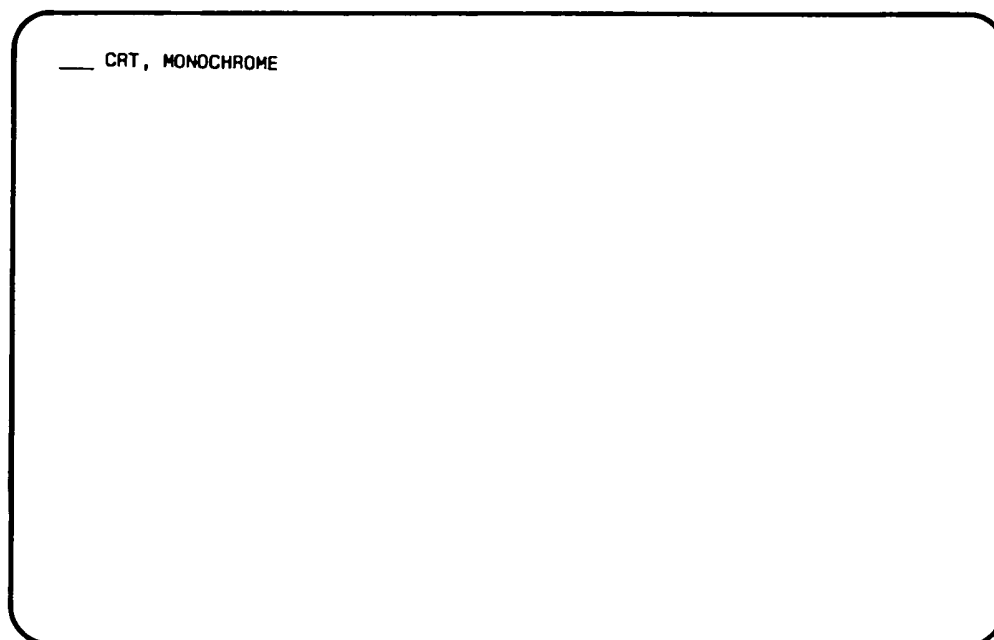
READ/WRITE MAINTENANCE TRACK



NOTE: This is a non-destructive test; the destructive hard disk test can be selected only from the Hard Disk Drive Tests menu.

(Monochrome Display Tests)

CRT, MONOCHROME



— CRT RAM

(A pattern of all characters which can be generated is briefly displayed on the screen.)

— CRT ATTRIBUTES

(Several lines, each demonstrating one or a combination of attributes such as normal video, inverse video, underlining, blinking and high intensity, are displayed.)

\_\_\_ CHARACTER SET

(A pattern of all characters which can be generated  
is briefly displayed on the screen.)

\_\_\_ SCROLL TEST

These lines should scroll from bottom to top

(These two lines start at the bottom of the screen and  
scroll until they reach the top.)

(Color/Graphics Display Tests)

\_\_\_ CRT, COLOR/GRAPHICS

\_\_\_ CRT RAM

(A pattern of all characters which can be generated  
is briefly displayed on the screen.)

\_\_\_ CRT ATTRIBUTES

(Several lines, each demonstrating one or a combination of attributes such as normal video, inverse video, blinking, high intensity, blue highlight, white on blue/red/green, blue/red/green on white, are displayed.)

\_\_\_ CHARACTER SET

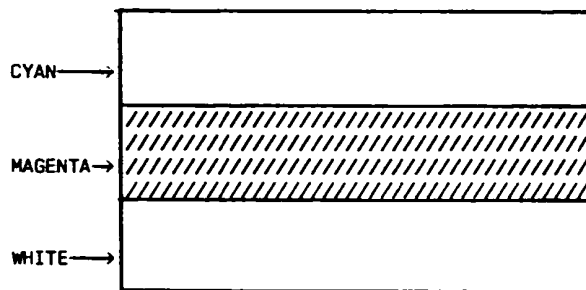
(A pattern of all characters which can be generated is briefly displayed on the screen.)

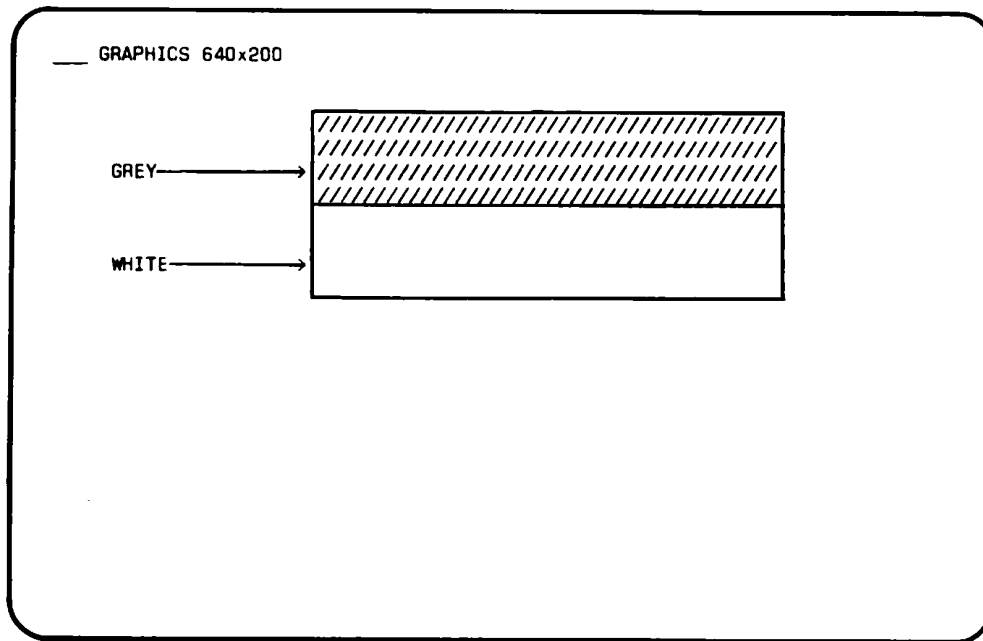
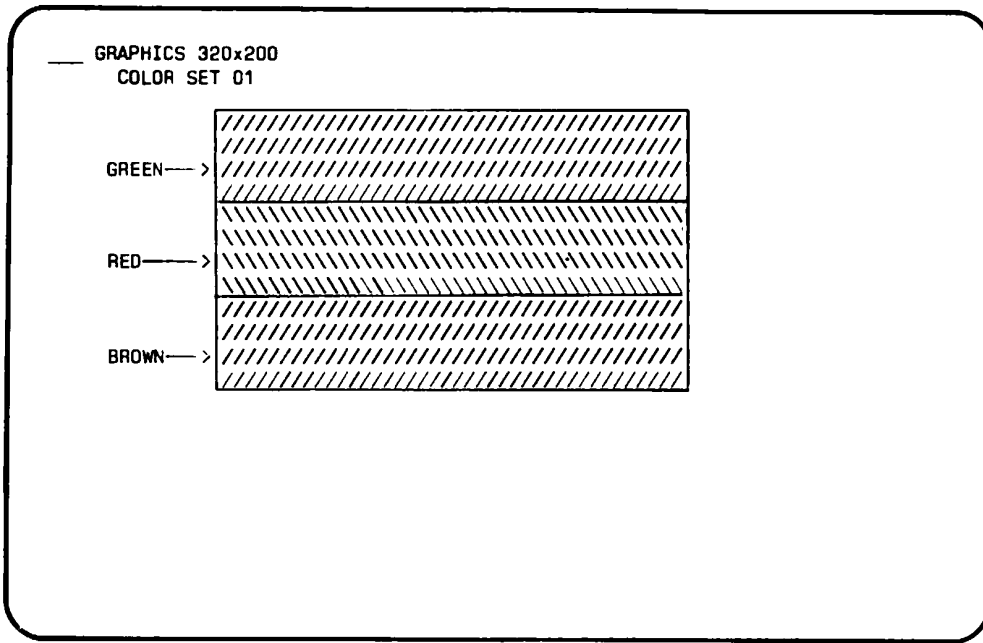
— SCROLL TEST

These lines should scroll from bottom to top

(These two lines start at the bottom of the screen and scroll until they reach the top.)

— GRAPHICS 320x200  
COLOR SET 00





GRAPHICS 40 X 25

(A pattern of all characters which can be generated  
is briefly displayed on the screen.)

(Printer Port Loopback Tests)

\_\_\_ PRINTER PORT  
Insert wrap plug in printer port

## (Serial Port Loopback Tests)

```
___ SERIAL PORT
Insert wrap plug in serial port
Set configuration switches on SW2: 6 on, 7 off, 8 on.
```

After all tests are completed (unless Continuous Run was chosen), the appropriate termination message(s) as described previously in the "Automatic Completion" section of this chapter are displayed.

## MEMORY (MAIN MENU LINE 2)

When selection number "2" is chosen from the main menu screen, the Memory tests menu screen is displayed:

```
The NCR Personal Computer Model 4
Field Service Diagnostics Version 1.0
Copyright 1984 NCR Corp.

      MEMORY

1  RAM Pattern
2  RAM Address
3  RAM Parity
4  ROM Checksum

Enter selection number: _

F1=HELP,F2=EXIT TO MAIN MENU
ALT and TEST 1 through 4=CONTINUOUS RUN,F2=STOP CONTINUOUS RUN
```

Each of the four available tests is selected by entering the corresponding number (1 through 4). If the number for a specific test is entered while the ALT key is being held down, that test is run continuously until F2 is pressed. When F2 is pressed, the program returns to the main menu.

### Memory Test HELP Screen

To obtain more information about the available memory tests, press F1 to see the HELP screen:

RAM Pattern - Writes test pattern to check DRAM, data path and control circuitry.

RAM Address - Tests both segment addressing and low order addressing capabilities.

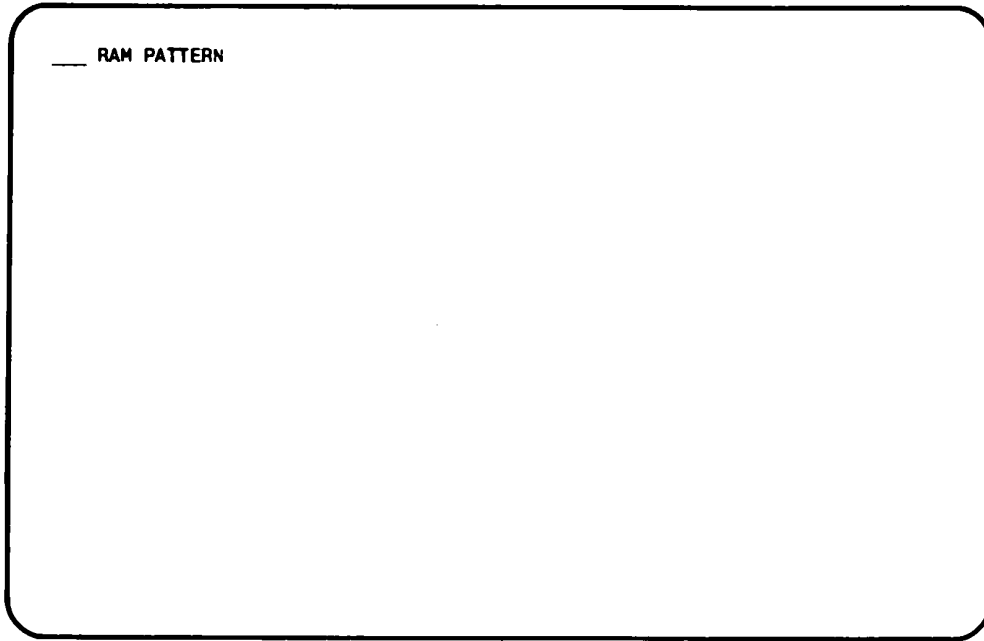
RAM Parity - Writes checkerboard patterns to all installed parity DRAM.

ROM Checksum - Verifies the firmware checksum.

F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU\_

### RAM Pattern Test

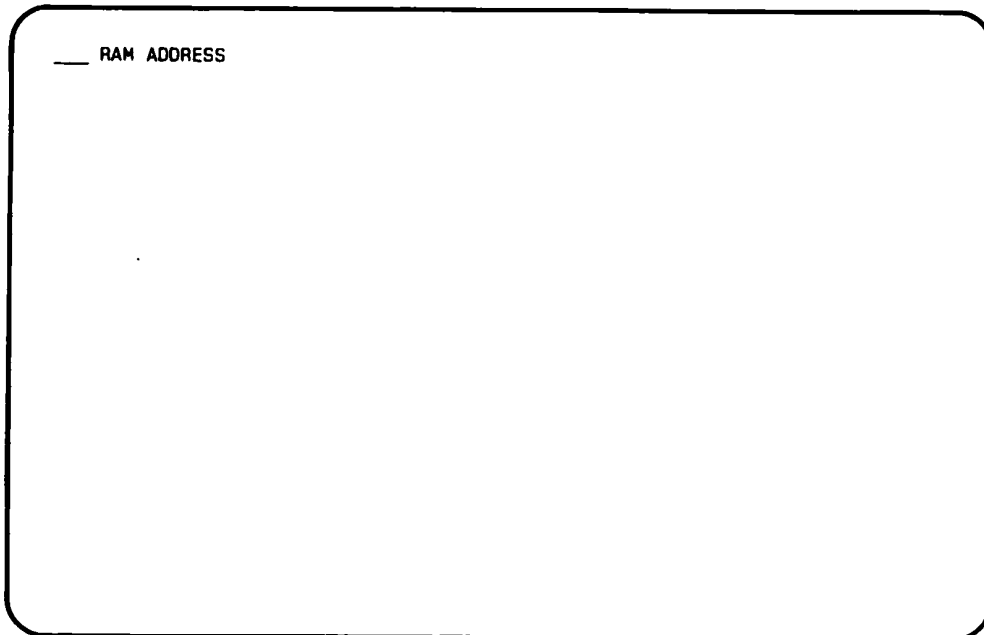
If selection 1 of the Memory test menu is chosen, the RAM Pattern test is run. The name of the test is displayed while the test is in progress:



Upon completion of the test, either the **PASSED** message or an **ERR...** message is added to the display, as previously discussed in the "Test Completion Displays" section of this chapter.

### **RAM Address Test**

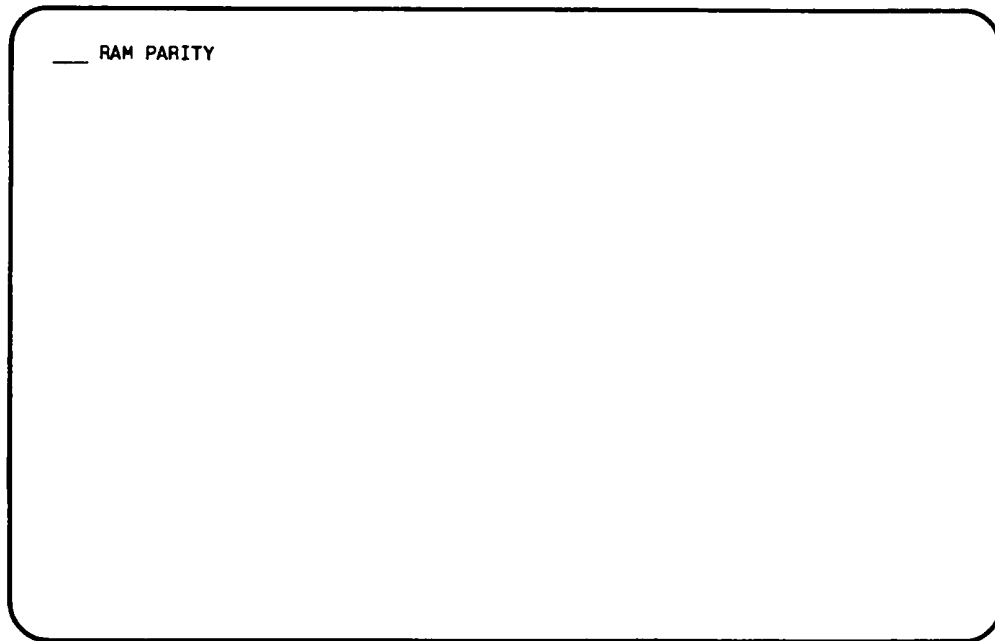
If selection 2 of the Memory test menu is chosen, the RAM Address test is run; the name of the test is displayed:



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### RAM Parity Test

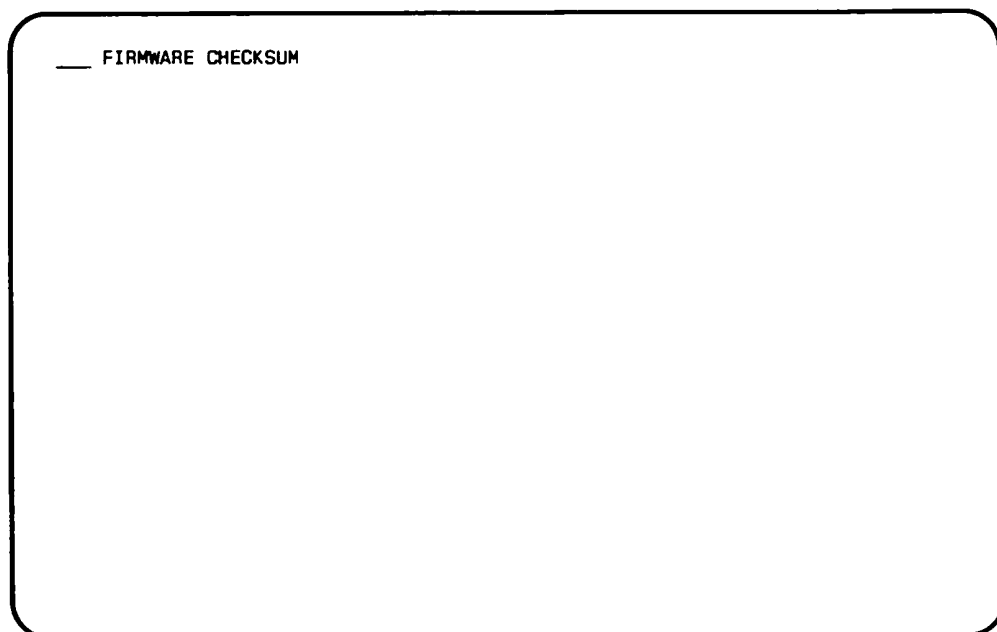
If selection 3 of the Memory test menu is chosen, the RAM Parity test is run:



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### ROM Checksum Test

If selection 4 of the Memory test menu is chosen the ROM Checksum test is run:



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### **CONTROLLERS (CIRCUIT DEVICES) (MAIN MENU LINE 3)**

When selection number "3" is chosen from the main menu screen, the Controllers test menu screen is displayed:

```
The NCR Personal Computer Model 4
Field Service Diagnostics Version 1.0
Copyright 1984 NCR Corp.

CONTROLLERS

1 CPU - 8088
2 DMA - 8237
3 Flexible Disk - 8272
4 Interval Timer - 8253
5 Interrupt - 8259
6 PPI - 8255
7 Monochrome CRT - 6845
8 Color CRT - 6845
9 Serial - 8250
A Hard Disk

Enter selection number:_

F1=HELP,F2=EXIT TO MAIN MENU
ALT and TEST 1 through A=CONTINUOUS RUN,F2=STOP CONTINUOUS RUN
```

Each of the ten available controller tests is selected by entering the corresponding number or letter (1 through A). If the number for a specific test is entered while the ALT key is being held down, that test is run continuously until F2 is pressed. When F2 is pressed, the program returns to the main menu.

### **Controllers Test HELP Screen**

To obtain more information about the available tests of the various Main Processor Board (MPB) and adapter card controller chips, press F1 to see the HELP screens:

CPU - Tests execution of the instruction set.

DMA - Verifies the DMA controller can be accessed and performs a partial functionality test.

Flexible Disk - Verifies the flexible disk controller can be accessed and performs a partial functionality test.

Interval Timer - Verifies the interval timer can be accessed and performs a partial functionality test.

Interrupt - Verifies the interrupt controller can be accessed and performs a partial functionality test.

PPI - Verifies the PPI controller can be accessed and performs a partial functionality test.

CRT - Verifies the CRT controller can be accessed and performs a partial functionality test.

F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU,ANY KEY TO CONTINUE\_

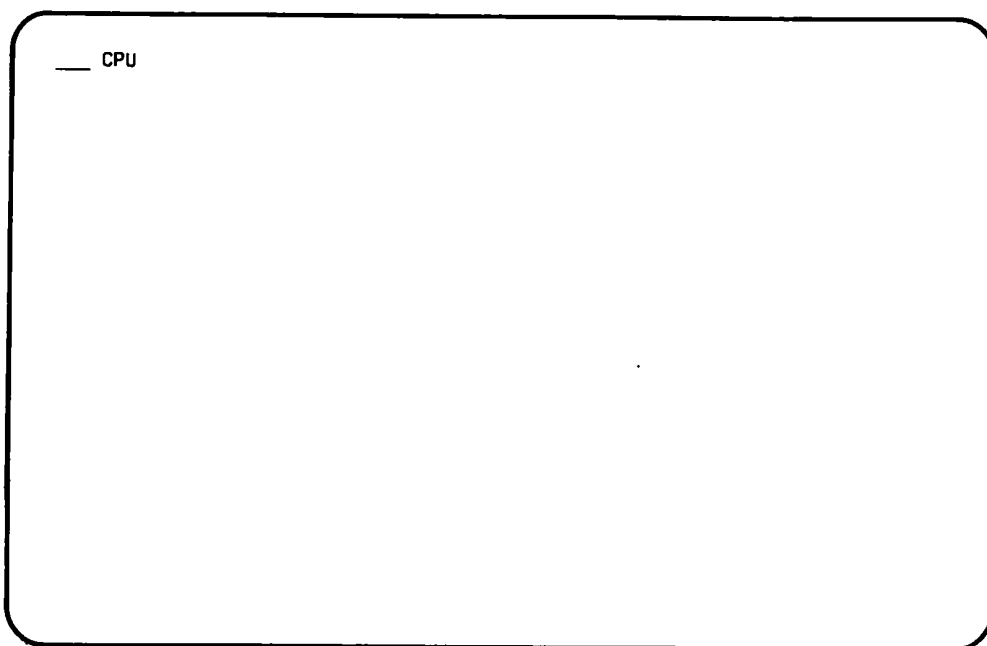
Serial - Verifies the serial controller can be accessed and performs a partial functionality test.

Hard Disk - Performs a walking 0 and walking 1 pattern test, writes into and reads from the sector buffer and performs any internal diagnostic tests that the controller supports.

F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU \_

### CPU Test

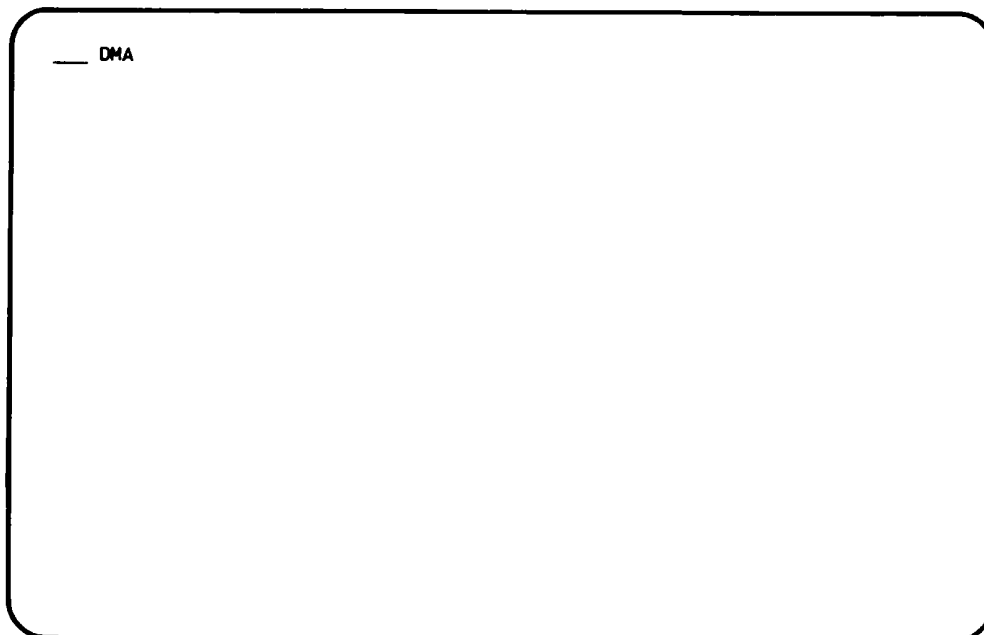
If selection 1 of the Controllers test menu is chosen, the CPU test is run. The name of the test is displayed while the test is in progress:



Upon completion of the test, either the **PASSED** message or an **ERR...** message is added to the display, as previously discussed in the "Test Completion Displays" section of this chapter.

### **DMA Controller Test**

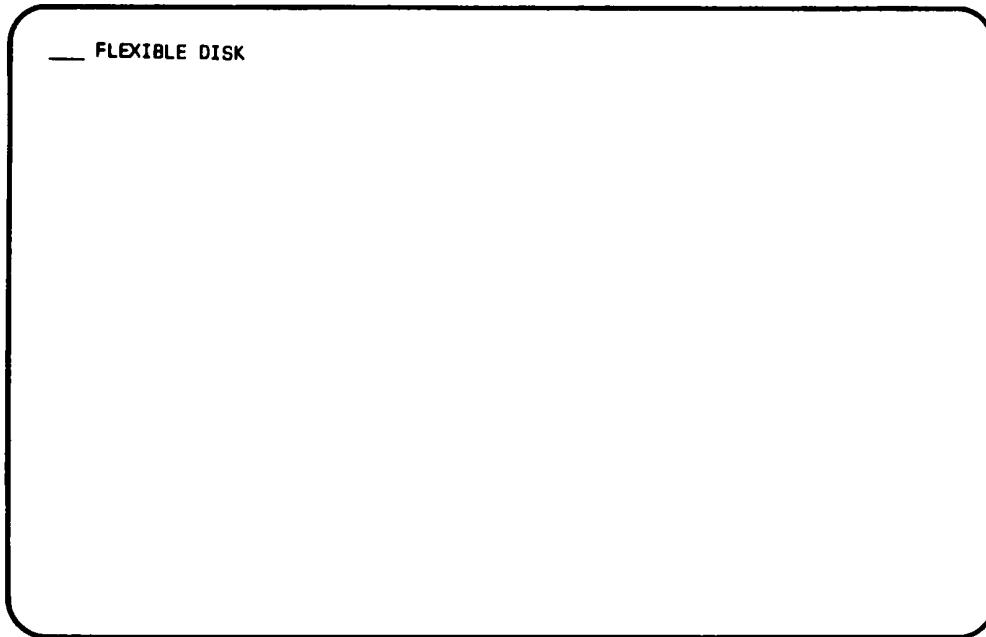
If selection 2 of the Controllers test menu is chosen, the DMA Controller test is run; the name of the test is displayed:



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### Flexible Disk Controller Test

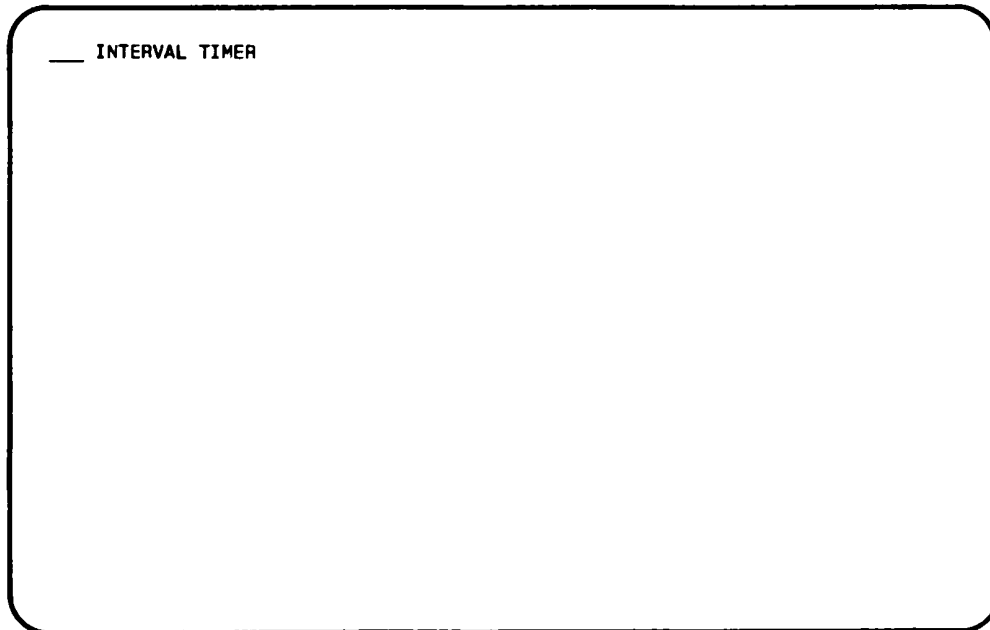
If selection 3 of the Controllers test menu is chosen, the Flexible Disk Controller test is run:



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### Interval Timer Test

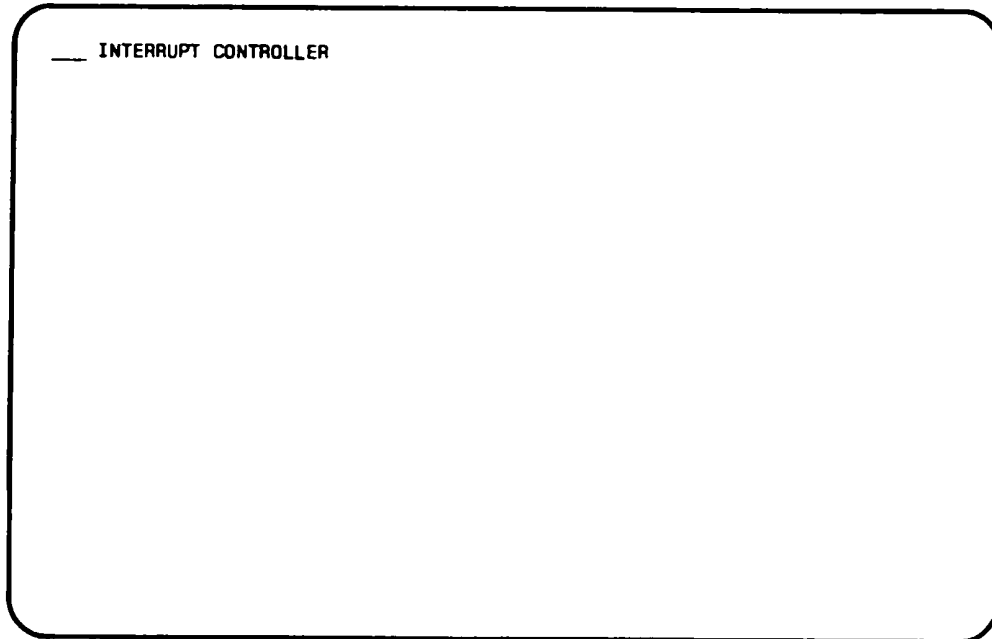
If selection 4 of the Controllers test menu is chosen, the Interval Timer test is run:



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### **Interrupt Controller Test**

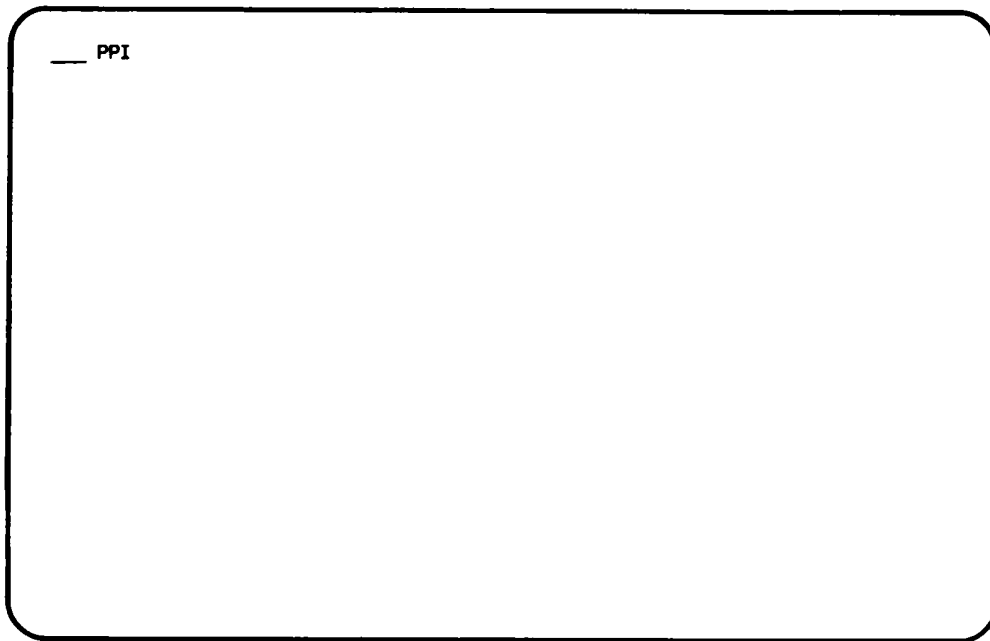
If selection 5 of the Controllers test menu is chosen, the Interrupt Controller test is run:



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### **Programmable Peripheral Interface (PPI) Test**

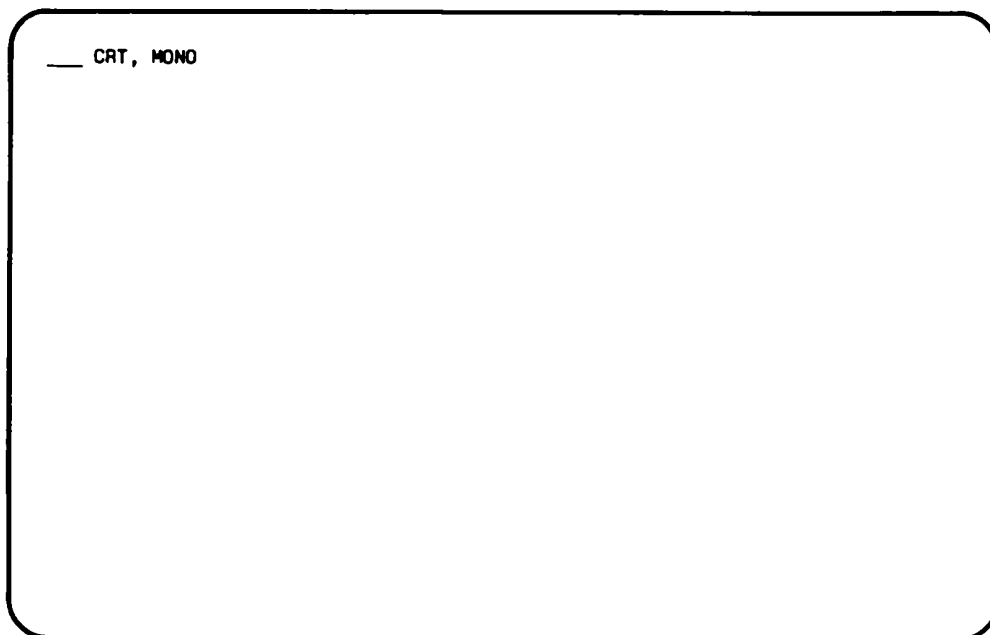
If selection 6 of the Controllers test menu is chosen, the PPI test is run:



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### **Monochrome CRT Controller Test**

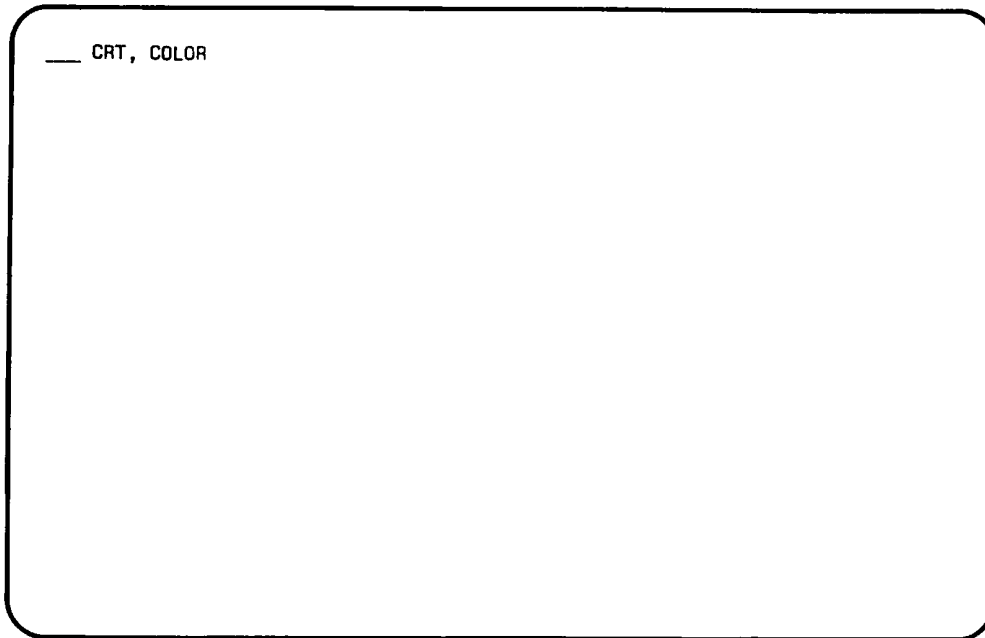
If selection 7 of the Controllers test menu is chosen, the Monochrome CRT Controller test is run, if the program senses the presence of a monochrome display (if not, the program redisplay the Controllers test menu):



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### **Color/Graphics CRT Controller Test**

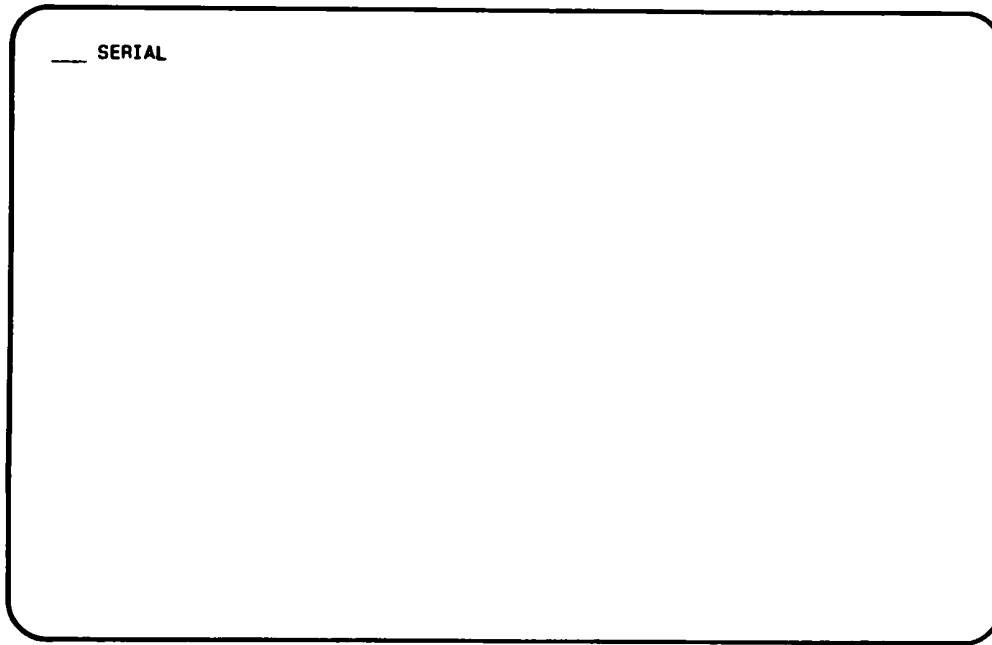
If selection 8 of the Controllers test menu is chosen, the Color/Graphics CRT Controller test is run, if the program senses the presence of a color/graphics display (if not, the program redisplay the Controllers test menu):



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### **Serial Asynchronous Communications Controller Test**

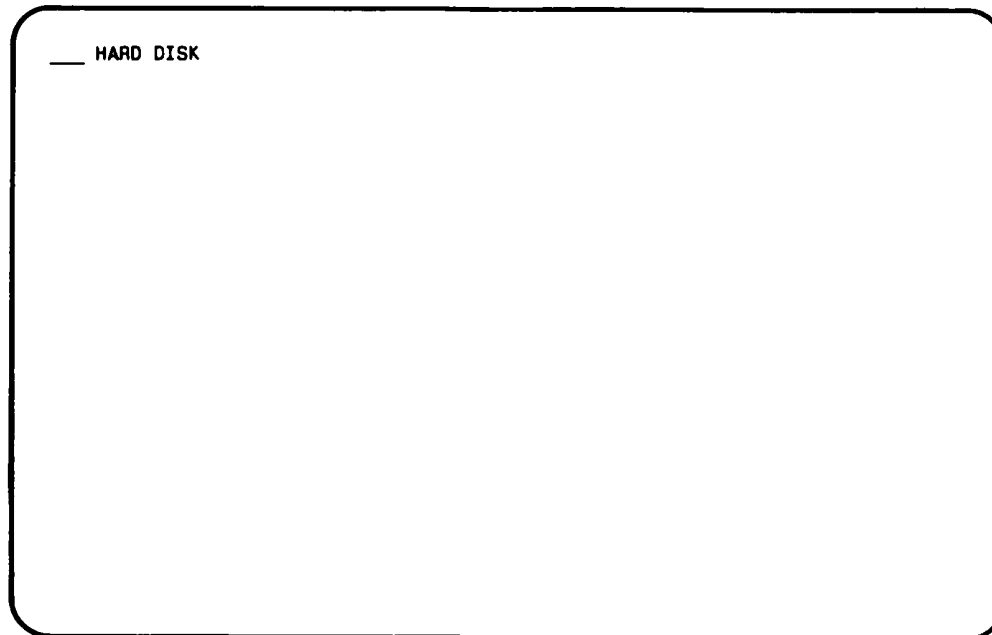
If selection 9 of the Controllers test menu is chosen, the Serial Asynchronous Communications Controller test is run:



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### Hard Disk Controller Test

If selection A of the Controllers test menu is chosen, the Hard Disk Controller test is run:



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### KEYBOARD (MAIN MENU LINE 4)

When selection number "4" is chosen from the main menu screen, a line indicating a test of the keyboard port is displayed, followed by a line indicating a test of the keyboard and a pattern of rectangular blocks representing the positions of keys on the keyboard. The operator presses any or all keys while visually verifying that for each key the proper key value appears at the proper location in the pattern.

The last line in the display directs the operator to **ENTER F1 AND F10 IN SEQUENCE TO EXIT TEST**. Whether any other keys have been pressed or not, pressing these two causes one more line to be displayed. After all keys have been pressed, followed by the F1/F10 entry, the display looks like:

```

___ KEYBOARD PORT
___ KEYBOARD

F1 F2  ESC 1  2  3  4  5  6  7  8  9  0  -  =  BS      DEL PU    NL    SL
F3 F4  TAB Q  W  E  R  T  Y  U  I  O  P  [  ]  CR  CTL  END PD  HM ↑  PU -
F5 F6  CTL A  S  D  F  G  H  J  K  L  ;  '  `      ↑    ←  5  →
F7 F8  ↑  \  Z  X  C  V  B  N  M  ,  .  /  ↑  PS  ←  HM →  END ↓  PD +
F9 F10 ALT                SP                CL INS      ↓    INS  DEL CR

ENTER KEY CODES TO BE TESTED AND VERIFY THAT THE
CORRECT CODE APPEARS ON THE CRT DISPLAY.
ENTER F1 AND F10 IN SEQUENCE TO EXIT TEST.
DO THE CHARACTERS AND CODES DISPLAYED MATCH THE ONES ENTERED? [Y/N]_
    
```

An entry of "Y" indicates a successful completion of the test and results in the **PASSED** display described in the "Test Completion Displays" section of this chapter. An entry of "N" indicates unsuccessful completion and results in an **ERR...** display. Pressing F2 or F3 after the **PASSED** or **ERR...** display returns the program to the main menu, since that was the last previous menu.

### FLEXIBLE DISK DRIVE (MAIN MENU LINE 5)

When selection number "5" is chosen from the main menu screen, the Flexible Disk Drive test menu screen is displayed:

The NCR Personal Computer Model 4  
 Field Service Diagnostics Version 1.0  
 Copyright 1984 NCR Corp.

FLEXIBLE DISK DRIVE

- 1 Read Only - Drive A
- 2 Read/Write - Drive A
- 3 Read Only - Drive B
- 4 Read/Write - Drive B

Enter selection number: \_

F1=HELP, F2=EXIT TO MAIN MENU  
 ALT and TEST 1 through 4=CONTINUOUS RUN, F2=STOP CONTINUOUS RUN

Each of the four available tests is selected by entering the corresponding number (1 through 4). If the number for a specific test is entered while the ALT key is being held down, that test is run continuously until F2 is pressed. When F2 is pressed, the program returns to the main menu.

### Flexible Disk Drive Test HELP Screen

To obtain more information about the available flexible disk drive tests, press F1 to see the HELP screen:

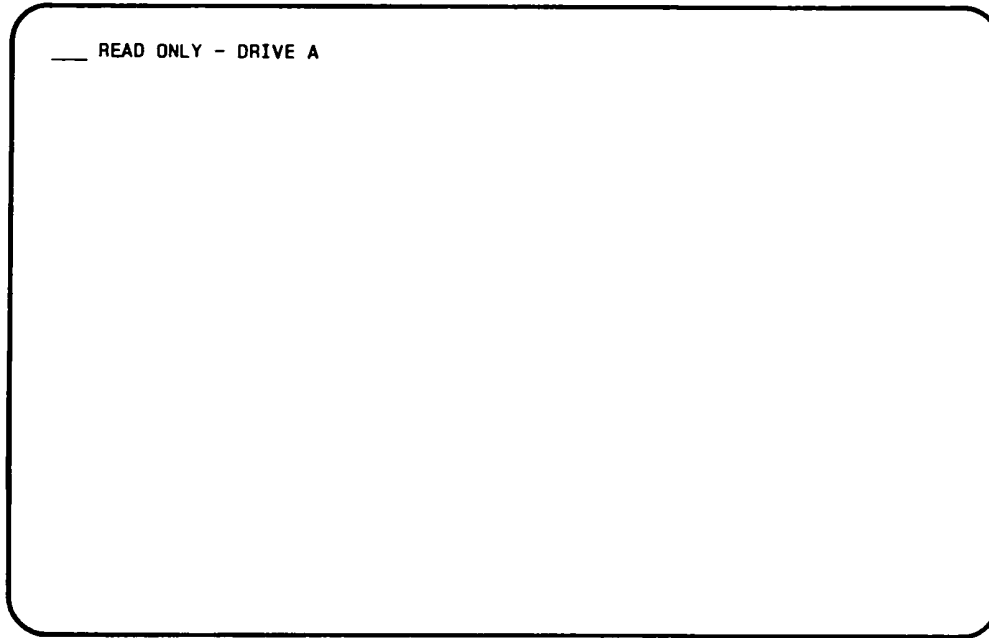
Read Only - Verifies an entire NCR-PC standard format disk.

Read/Write - Performs a format, write and read on selected sectors. Using the diagnostic disk, the test is non-destructive; with any other disk, the test is destructive.

F2=EXIT TO MAIN MENU, F3=EXIT TO PREVIOUS MENU\_

### Read Only — Drive A Test

If selection 1 of the Flexible Disk Drive test menu is chosen, the Read Only test is run on drive A. The name of the test is displayed while the test is in progress:



Upon completion of the test, either the **PASSED** message or an **ERR...** message is added to the display, as previously discussed in the "Test Completion Displays" section of this chapter.

### Read/Write — Drive A Test

If selection 2 of the Flexible Disk Drive test menu is chosen, the Read/Write test is run on drive A:

\_\_\_ READ/WRITE - DRIVE A  
**WARNING** — This test is destructive to any disk other than  
the diagnostic disk.  
Insert disk to be used into drive under test.  
F2=EXIT TO MAIN MENU, ANY KEY TO CONTINUE\_

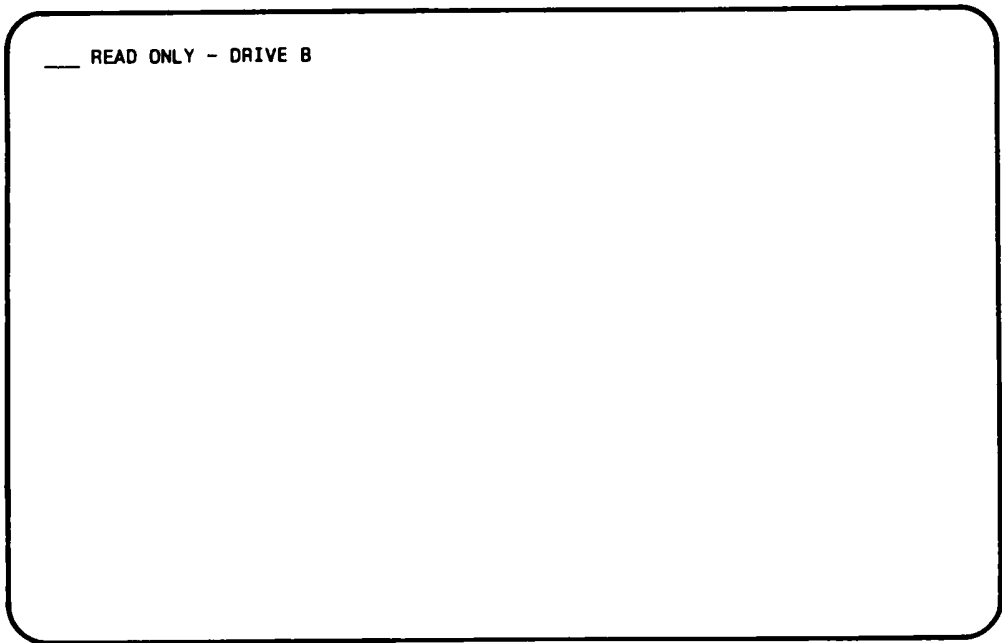
### CAUTION

The flexible disk diagnostic tests are destructive to any disk other than the diagnostics disk. **BEFORE CONTINUING**, make certain that no diskette other than the diagnostics diskette and/or a formatted scratch diskette is inserted in flexible disk drive A. If any other diskette is left in, data and/or programs on it will be written over by test patterns.

Press the space bar or any alphabetic or numeric key to continue. Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### Read Only — Drive B Test

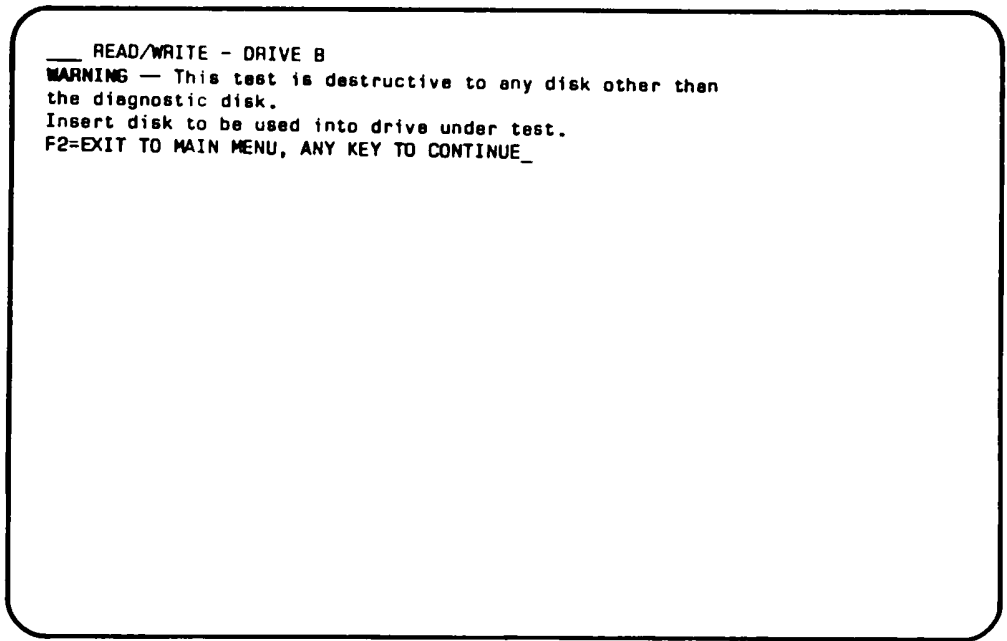
If selection 3 of the Flexible Disk Drive test menu is chosen, the Read Only test is run on drive B, if the configuration switches indicate the presence of two drives. The name of the test is displayed while the test is in progress:



Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### **Read/Write — Drive B Test**

If selection 4 of the Flexible Disk Drive test menu is chosen, the Read/Write test is run on drive B, if the configuration switches indicate the presence of two drives:



**CAUTION**

The flexible disk diagnostic tests are destructive to any disk other than the diagnostics disk. **BEFORE CONTINUING**, make certain that no diskette other than a formatted scratch diskette is inserted in flexible disk drive B. If any other diskette is left in, data and/or programs on it will be written over by test patterns.

Press the space bar or any alphabetic or numeric key to continue. Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

**HARD DISK DRIVE (MAIN MENU LINE 6)**

When selection number "6" is chosen from the main menu screen, the Hard Disk Drive test menu screen is displayed:

```

The NCR Personal Computer Model 4
Field Service Diagnostics Version 1.0
Copyright 1984 NCR Corp.

      HARD DISK DRIVE

1  Read/Write Maintenance Track
2  Read Only Sector 0
3  Read Only Entire Disk
4  Read/Write Entire Disk

Enter selection number:_

F1=HELP,F2=EXIT TO MAIN MENU
ALT and TEST 1 through 4=CONTINUOUS RUN,F2=STOP CONTINUOUS RUN

```

Each of the four available tests is selected by entering the corresponding number (1 through 4). If the number for a specific test is entered while the ALT key is being held down, that test is run continuously until F2 is pressed. When F2 is pressed, the program returns to the main menu.

**Hard Disk Drive Test HELP Screen**

To obtain more information about the available hard disk drive tests, press F1 to see the HELP screen:

Prior to executing each specific test, the controller test is performed.

Read/Write Maintenance Track - Formats, writes, and reads the maintenance track.

Read Only Sector 0 - Verifies sector 0 of every track on the disk.

Read Only Entire Disk - Verifies an entire disk.

Read/Write Entire Disk - Writes and reads the entire disk. This is a destructive test.

F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU\_

### Read/Write Maintenance Track

If selection 1 of the Hard Disk Drive test menu is chosen, the Read/Write Maintenance Track test is run. The name of the test is displayed while the test is in progress:

\_\_\_ READ/WRITE MAINTENANCE TRACK

Upon completion of the test, either the **PASSED** message or an **ERR...** message is added to the display, as previously discussed in the "Test Completion Displays" section of this chapter.

### Read Only Sector 0

If selection 2 of the Hard Disk Drive test menu is chosen, the Read Only Sector 0 test is run:

```
___ READ/WRITE MAINTENANCE TRACK
```

Upon completion of the test, either **PASSED** or **ERR...** is displayed as above.

### Read Only Entire Disk

If selection 3 of the Hard Disk Drive test menu is chosen, the Read Only Entire Disk test is run:

```
___ READ ONLY ENTIRE DISK
F2=EXIT TO MAIN MENU, F4=STOP TEST
```

```
Drive___00          Function___ READ
Head___0n
Track___0nnn       Cycle_____ 0001
Sector___nn
```

```
Surface errors:
Soft errors___0000
Hard errors___00
```

```
Total errors:
Soft errors___0000
Hard errors___00
```

```
F2=EXIT TO MAIN MENU, ANY KEY TO CONTINUE_
```

In the above display, the drive number is 00 for the integrated hard disk drive, if present, or for the first external hard disk drive if no integrated drive is present. Head number begins at 00 and is incremented to 03 as the test proceeds. Track number begins at 0000 for each head and is incremented to 0305, then is reset to 0000 for the next head. Sector number is incremented from 01 to 17 for each track.

Cycle number is 0001 if this test is being run just once; if continuous run was chosen, cycle number begins at 0001 and is incremented by 1 for each complete test cycle until F2 is pressed to stop the continuous run, or until F4 is pressed.

Pressing F2 at any time during the test causes the program to return to the main menu. Pressing F4 at any time during this test causes the test to be stopped; the last line shown on the display is displayed. The last line is also displayed at the completion of a non-continuous test cycle.

If "any key" (space bar or any alphabetic or numeric key or some special characters) is pressed, the Hard Disk Test Summary screen is displayed:

```

*** HARD DISK TEST SUMMARY
Test cycles: 0001
Hard errors: 00
Soft errors: 0000

Surface: 00      Error  Track  Sector  Cycle  Soft errors
                NO ERROR
                NO ERROR
                NO ERROR
                NO ERROR
Surface: 01      NO ERROR
                NO ERROR
                NO ERROR
                NO ERROR
Surface: 02      NO ERROR
                NO ERROR
                NO ERROR
                NO ERROR
Surface: 03      NO ERROR
                NO ERROR
                NO ERROR
                NO ERROR
    
```

At the end of this display, either **PASSED** or **ERR...** is displayed as above.

### Read/Write Entire Disk

When selection 4 of the Hard Disk Drive test menu is chosen, the warning screen of the Read/Write test is displayed:

```

___ READ/WRITE ENTIRE DISK
WARNING — This is a destructive test. Data on the entire fixed
              disk will be destroyed. A backup of the disk should be
              done before executing this test
F2=EXIT TO MAIN MENU, ANY KEY TO CONTINUE_

```

The word **WARNING** is in inverse video and blinking. After any (space, alphabetic, numeric, special character) key is pressed, the program gives the operator one more chance to avoid potentially disastrous destruction of fixed disk data. A verification question is added to the display:

```

___ READ/WRITE ENTIRE DISK
WARNING — This is a destructive test. Data on the entire fixed
              disk will be destroyed. A backup of the disk should be
              done before executing this test
F2=EXIT TO MAIN MENU, ANY KEY TO CONTINUE_

Are you sure ???
F2=EXIT TO MAIN MENU, ANY KEY TO CONTINUE_

```

When “any” key is pressed again, the write pass of the test begins. The information displayed is almost identical to the Read Only Entire Disk test; the main difference is that the Function **\_\_\_WRITE** is indicated:

```

___ READ/WRITE ENTIRE DISK
F2=EXIT TO MAIN MENU, F4=STOP TEST

Drive___00          Function___ WRITE
Head___0n
Track___0nnn       Cycle___ 0001
Sector___nn

Surface errors:
Soft errors___0000
Hard errors___00

Total errors:
Soft errors___0000
Hard errors___00

F2=EXIT TO MAIN MENU, ANY KEY TO CONTINUE_

```

In the above display, the drive number is 00 for the integrated hard disk drive, if present, or for the first external hard disk drive if no integrated drive is present. Head number begins at 00 and is incremented to 03 as the test proceeds. Track number begins at 0000 for each head and is incremented to 0305, then is reset to 0000 for the next head. Sector number is incremented from 01 to 17 for each track.

After a complete WRITE cycle, the Function is changed to READ, and the complete READ cycle is begun. The display values start over at 00(00) or 01 and are incremented to maximum values as above.

Cycle number is 0001 if this test is being run just once; if continuous run was chosen, cycle number begins at 0001 and is incremented by 1 for each complete test cycle (WRITE and READ) until F2 is pressed to stop the continuous run, or until F4 is pressed.

Pressing F2 at any time during the test causes the program to return to the main menu. Pressing F4 at any time during this test causes the test to be stopped; the last line shown on the display is displayed. The last line is also displayed at the completion of a non-continuous test cycle.

If "any key" (space bar or any alphabetic or numeric key or some special characters) is pressed in response to the last line, the Hard Disk Test Summary screen is displayed:

```

*** HARD DISK TEST SUMMARY
Test cycles: 0001
Hard errors: 00
Soft errors: 0000

Surface: 00      Error  Track  Sector  Cycle  Soft errors
                NO ERROR
                NO ERROR
                NO ERROR
                NO ERROR
Surface: 01      NO ERROR
                NO ERROR
                NO ERROR
                NO ERROR
                NO ERROR
Surface: 02      NO ERROR
                NO ERROR
                NO ERROR
                NO ERROR
                NO ERROR
Surface: 03      NO ERROR
                NO ERROR
                NO ERROR
                NO ERROR
                NO ERROR

```

At the end of this display, either **PASSED** or **ERR...** is displayed as above.

### MONOCHROME DISPLAY (MAIN MENU LINE 7)

When selection number "7" is chosen from the main menu screen, the Monochrome Display test begins by briefly displaying the test name:

```

___ CRT, MONOCHROME

```

Then, before stopping, the test displays the question:

```
IS THE CURSOR A SOLID BLOCK AND POSITIONED HERE? (Y/N)→■
```

If "N" is entered, an **ERR...** message and choices similar to those described in the "Unsuccessful Completion" section of the "Test Completion Displays" section of this chapter are displayed.

If "Y" is entered, the program briefly displays:

```
___ CRT RAM  
  
  (A pattern of all characters which can be generated  
  is briefly displayed on the screen.)
```

Then, before stopping, the test displays:

\_\_\_ CRT ATTRIBUTES

(Several lines, each demonstrating one or a combination of attributes such as normal video, inverse video, underlining, blinking and high intensity, are displayed.)

Are the correct attributes displayed? (Y/N)\_

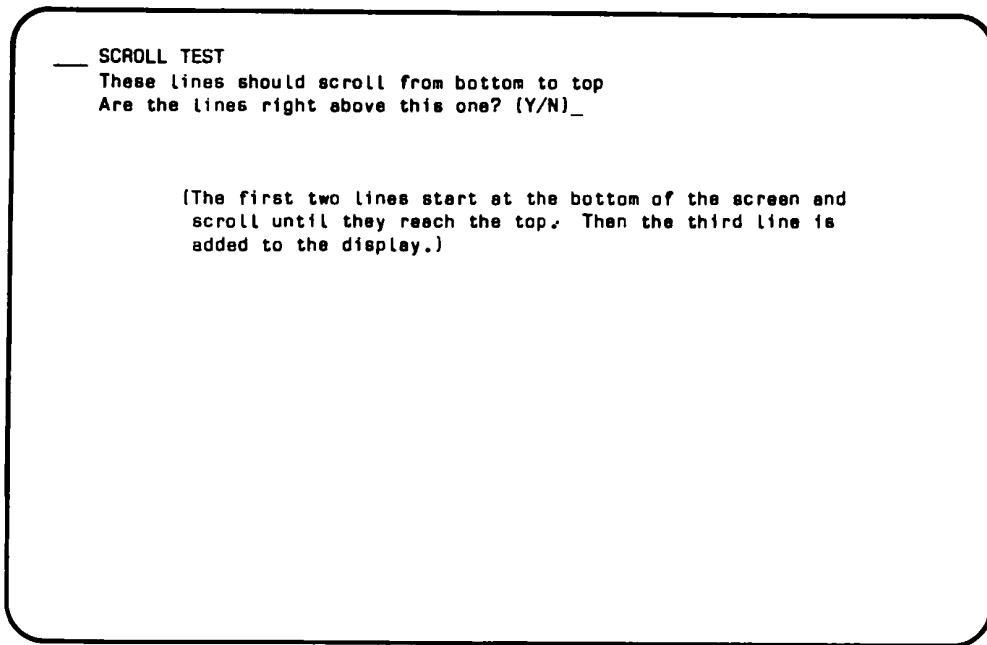
If "N" is entered, an **ERR...** message is displayed, as above. If "Y" is entered, the next screen is displayed:

\_\_\_ CHARACTER SET

(A pattern of all characters which can be generated is briefly displayed on the screen.)

Is the character set correct? (Y/N)\_

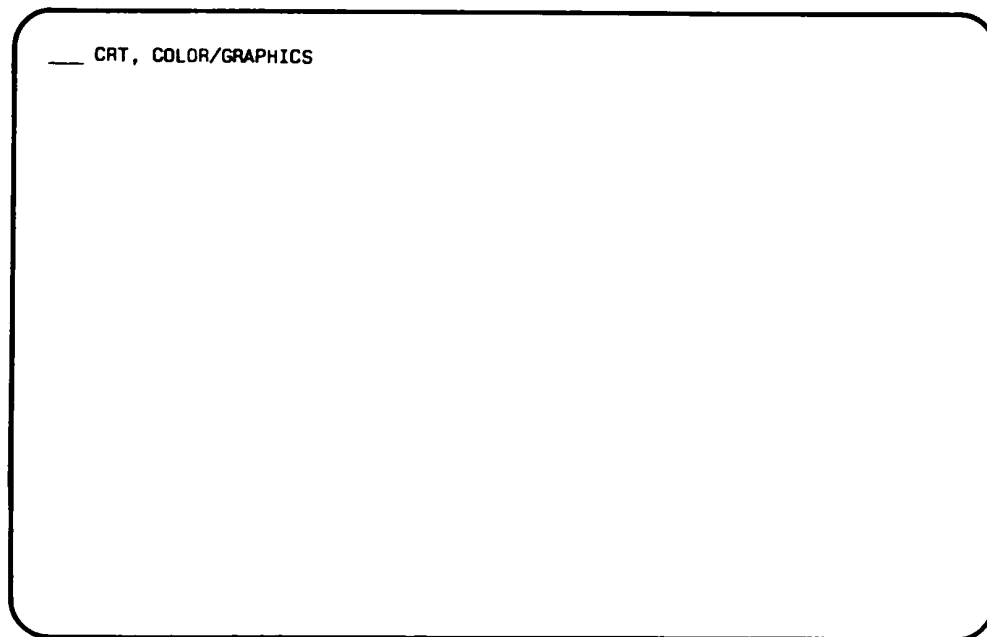
If "N" is entered, an **ERR...** message is displayed, as above. If "Y" is entered, the next screen is displayed:



If “N” is entered, an **ERR...** message is displayed, as above. If “Y” is entered, the test has been successfully completed, and the program returns to the main menu.

### **COLOR/GRAPHICS DISPLAY (MAIN MENU LINE 8)**

When selection number “8” is chosen from the main menu screen, the Color/Graphics Display test begins by briefly displaying the test name:



Then, before stopping, the test displays the question:

IS THE CURSOR A SOLID BLOCK AND POSITIONED HERE? (Y/N)→ ■

If “N” is entered, an **ERR...** message and choices similar to those described in the “Unsuccessful Completion” section of the “Test Completion Displays” section of this chapter are displayed.

If “Y” is entered, the program briefly displays:

\_\_\_ CRT RAM

(A pattern of all characters which can be generated  
is briefly displayed on the screen.)

Then, before stopping, the test displays:

\_\_\_ CRT ATTRIBUTES

(Several lines, each demonstrating one or a combination of attributes such as normal video, inverse video, blinking, high intensity, blue highlight, white on blue/red/green, blue/red/green on white, are displayed.)

Are the correct attributes displayed? (Y/N)\_

If "N" is entered, an **ERR...** message is displayed, as above. If "Y" is entered, the next screen is displayed:

\_\_\_ CHARACTER SET

(A pattern of all characters which can be generated is briefly displayed on the screen.)

Is the character set correct? (Y/N)\_

If "N" is entered, an **ERR...** message is displayed, as above. If "Y" is entered, the next screen is displayed:

— SCROLL TEST  
 These lines should scroll from bottom to top  
 Are the lines right above this one? (Y/N)\_

(The first two lines start at the bottom of the screen and scroll until they reach the top. Then the third line is added to the display.)

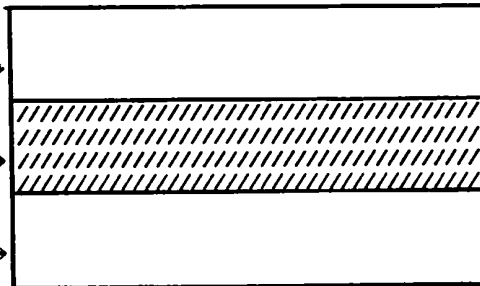
If “N” is entered, an **ERR...** message is displayed, as above. If “Y” is entered, the next screen is displayed:

— GRAPHICS 320x200  
 COLOR SET 00

CYAN →

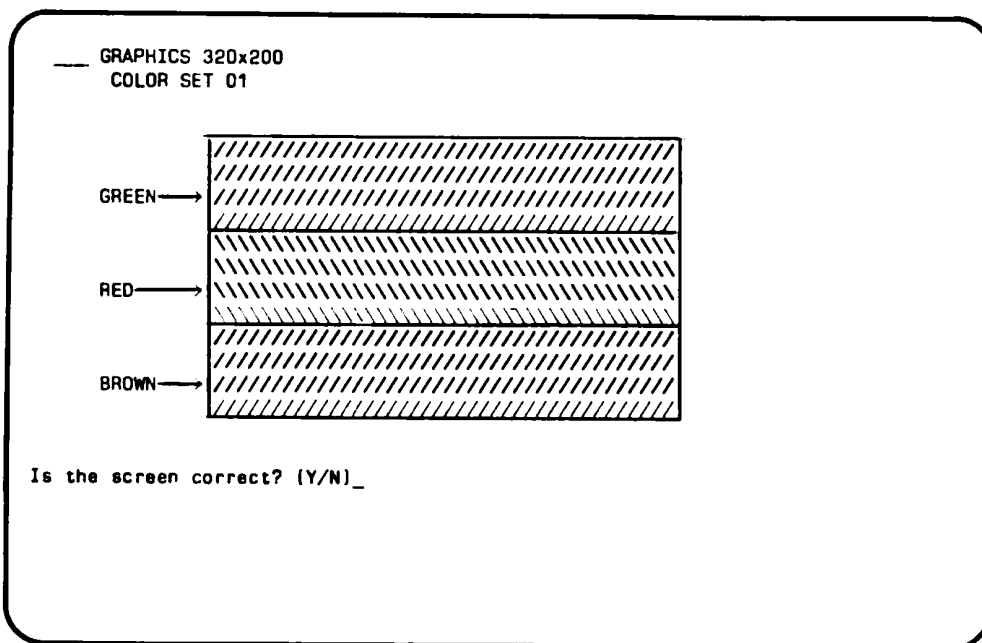
MAGENTA →

WHITE →

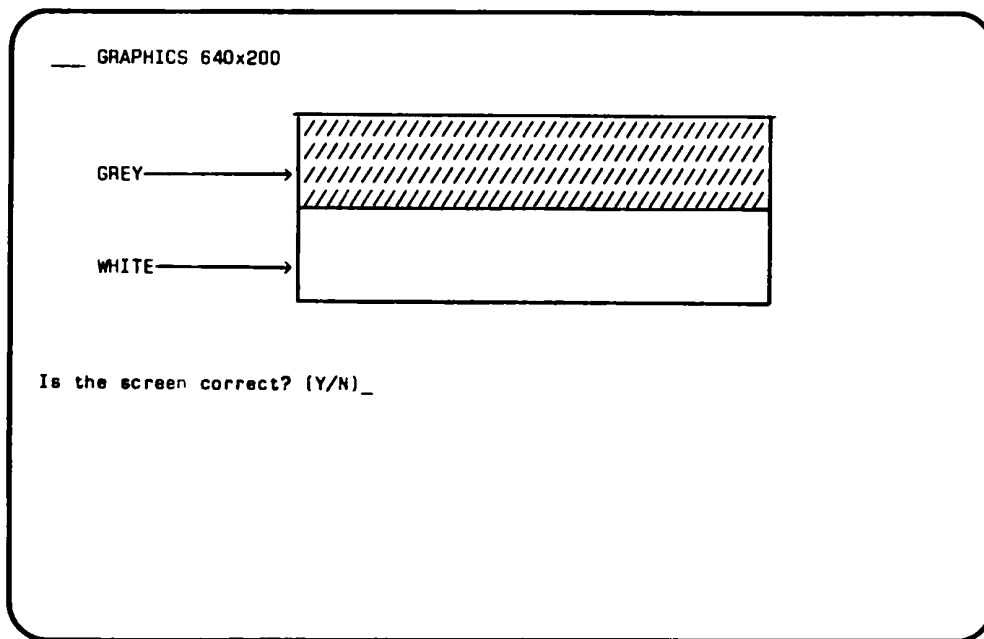


Is the screen correct? (Y/N)\_

If “N” is entered, an **ERR...** message is displayed, as above. If “Y” is entered, the next screen is displayed:



If "N" is entered, an **ERR...** message is displayed, as above. If "Y" is entered, the next screen is displayed:



If "N" is entered, an **ERR...** message is displayed, as above. If "Y" is entered, the next screen is displayed:

```

G R A P H I C S   4 0  X  2 5

      (A pattern of all characters which can be generated
      is briefly displayed on the screen.)

Is the character set correct? (Y/N)_
    
```

If "N" is entered, an **ERR...** message is displayed, as above. If "Y" is entered, the next screen is displayed:

```

___ LIGHT PEN
Is light pen attached? (Y/N)
    
```

If "N" is entered, the Color/Graphics Display test has been successfully completed and the program returns to the main menu. If "Y" is entered, additional lines for testing light pen performance are added to the display:

\_\_\_ LIGHT PEN  
Is light pen attached? (Y/N)

Place light pen tip at center of  
displayed block and activate light pen.  
F4=NO RESPONSE FROM PEN.  
F2=EXIT TO MAIN MENU

-

If F2 is pressed, the Color/Graphics Display test has been successfully completed and the program returns to the main menu. If F4 is pressed, an **ERR...** message is displayed as above.

### PRINTER PORT LOOPBACK (MAIN MENU LINE 9)

When selection number "9" is chosen from the main menu screen, the Printer Port Loopback test is performed:

\_\_\_ PRINTER PORT  
Insert wrap plug in printer port  
F2=EXIT TO MAIN MENU, ANY KEY TO CONTINUE\_

Upon completion of the test, either the **PASSED** message or an **ERR...** message is added to the display, as previously discussed in the "Test Completion Displays" section of this chapter.

**SERIAL PORT LOOPBACK (MAIN MENU LINE A)**

When selection "A" is chosen from the main menu screen, the Serial Port Loopback test is performed:

```
___ SERIAL PORT: COM1
Insert wrap plug in serial port
Set configuration switches on SW2: 6 on, 7 off, 8 on.
F2=EXIT TO MAIN MENU,ANY KEY TO CONTINUE_
```

Upon completion of the test, either the **PASSED** message or an **ERR...** message is added to the display, as previously discussed in the "Test Completion Displays" section of this chapter.

**PRINTER (MAIN MENU LINE B)**

When selection "B" is chosen from the main menu screen, the Printer tests menu screen is displayed:

The NCR Personal Computer Model 4  
Field Service Diagnostics Version 1.0  
Copyright 1984 NCR Corp.

PRINTER

- 1 Generic Printer
- 2 PC-Compatible Printer

Enter selection number: \_

F1=HELP, F2=EXIT TO MAIN MENU  
ALT and TEST 1 through 2=CONTINUOUS RUN, F2=STOP CONTINUOUS RUN

**NOTE:** These tests are for a printer attached to the printer (parallel) port of the MPB.

Any parallel printer can be tested using the "generic" printer test. Only a printer which is designed to respond to PC-specific control codes for additional functional capability can be tested using the "PC-Compatible" printer test.

Each of the two available tests is selected by entering the corresponding number (1 or 2). If the number for a specific test is entered while the ALT key is being held down, that test is run continuously until F2 is pressed. When F2 is pressed, the program returns to the main menu.

### Printer Test HELP Screen

To obtain more information about the available printer tests, press F1 to see the HELP screen:

Generic Printer - Prints the ASCII character set on the parallel printer.  
PC-Compatible Printer - Prints the ASCII character set and PC-specific control codes on a PC-compatible printer.  
F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU\_

### Generic Printer Test

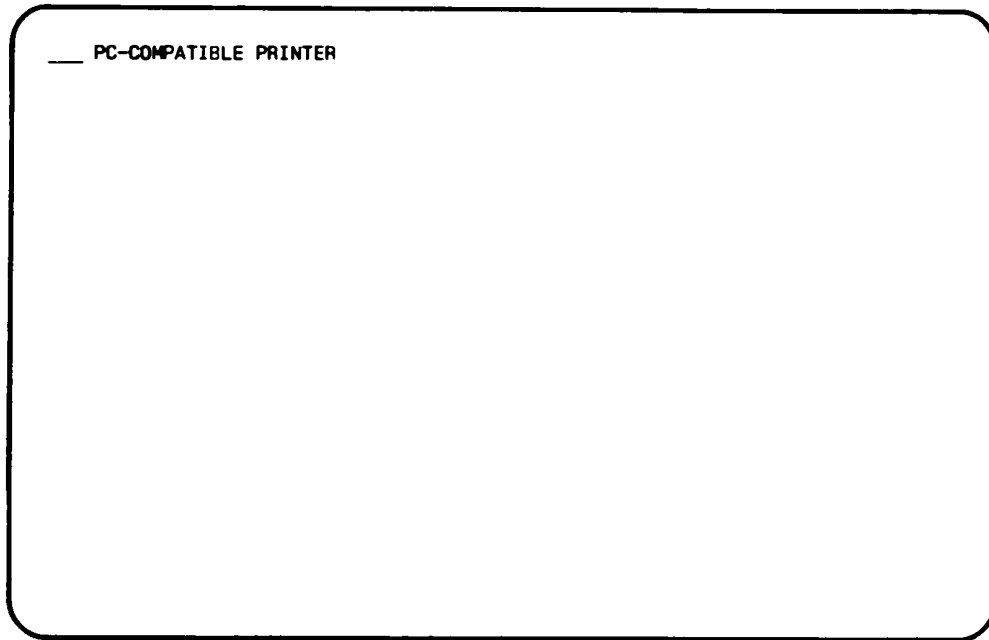
If selection 1 of the Printer test menu is chosen, the Generic Printer test is run. The name of the test is displayed while the test is in progress:

\_\_\_ GENERIC PRINTER

Upon completion of the test, either the **PASSED** message or an **ERR...** message is added to the display, as previously discussed in the "Test Completion Displays" section of this chapter.

### PC-Compatible Printer Test

If selection 2 of the Printer test menu is chosen, the PC-Compatible Printer test is run. The name of the test is displayed while the test is in progress:



Upon completion of the test, either the **PASSED** message or an **ERR...** message is added to the display, as previously discussed in the "Test Completion Displays" section of this chapter.

### CONFIGURATION TEST (MAIN MENU LINE C)

When selection "C" is chosen from the main menu screen, the configuration switches on the Main Processor Board are read and decoded by the program. The program also tests for the presence of adapter cards for an external monitor or hard disk. The results of these tests are displayed:

```

CONFIGURATION TEST

SW1=7D          SW2=E6

SW1:
Coprocesor_____OFF
Switches 3,4____OFF
Monitor Mode____MONO
Drives_____02

SW2:
Memory Capacity___256K
Serial Port_______COM1
Serial Interrupt___COM1

ADDITIONAL DEVICES:
Monitor_____GRAPHICS
Hard Disk_____INSTALLED

F1=HELP,F3=RETURN TO PREVIOUS MENU,F4=REPEAT TEST_

```

### Configuration Test HELP Screen

To obtain more information about the configuration tests, press F1 to see the HELP screen:

```

To decode switches, if bit is 0, switch is ON; if bit is 1, switch
is OFF. If switches are not correct, change the switches and press
F4. The switches will be scanned and the new translation of the
switches will be displayed.
F2=EXIT TO MAIN MENU,F4=REPEAT TEST_

```

### UTILITIES (MAIN MENU LINE D)

When selection "D" is chosen from the main menu screen, the menu screen for the Utility functions available on the diagnostics diskette is displayed:

The NCR Personal Computer Model 4  
Field Service Diagnostics Version 1.0  
Copyright 1984 NCR Corp.

UTILITIES

- 1 Error Log Maintenance
- 2 Updates To Documentation
- 3 Generate Diagnostics Disk
- 4 Format Flexible Disk
- 5 Format Hard Disk
- 6 Position Head For Relocation
- 7 Alignment Utilities

Enter selection number: \_

F1=HELP,F2=EXIT TO MAIN MENU

### Utilities HELP Screen

To obtain more information about the available utility functions, press F1 to see the HELP screen:

Error Log Maintenance - Allows the error log to be displayed, written to disk, printed, or deleted.

Updates to Documentation - Provides additional information which may not be present in the documentation. The information may be displayed or printed.

Generate Diagnostics Disk - Generates a diagnostic disk on a new flexible disk. The new disk will be formatted.

Format Flexible Disk - Formats a flexible disk.

Format Hard Disk - Formats a hard disk.

Position Head For Relocation - Positions the hard disk head for relocation.

Alignment Utilities - Allows alignment of the monochrome CRT, color CRT, and flexible disk drives.

F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU\_

### Error Log Maintenance

If selection 1 of the Utilities menu is chosen, the Error Log Maintenance menu screen is displayed:

The NCR Personal Computer Model 4  
 Field Service Diagnostics Version 1.0  
 Copyright 1984 NCR Corp.

ERROR LOG MAINTENANCE

- 1 Display Log
- 2 Display Log From Disk
- 3 Write Log to Disk
- 4 Print Log
- 5 Delete Log

Enter selection number: \_

F1=HELP,F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU

Each of the five available functions is selected by entering the corresponding number (1 through 5). If F3 is pressed, the program returns to the Utilities menu. If F2 is pressed, the program returns to the main menu.

### Error Log Maintenance HELP Screen

To obtain more information about the available Error Log Maintenance functions, press F1 to see the HELP screen:

Display Log - Displays the memory resident error log one screen at a time.

Display Log From Disk - Displays the error log one screen at a time from the diagnostics disk.

Write Log to Disk - Writes the error log to a specified disk.

Print Log - Prints the memory resident error log.

Delete Log - Deletes the memory resident error log.

F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU\_

## Updates To Documentation

If selection 2 of the Utilities menu is chosen, the Updates To Documentation menu screen is displayed:

```
The NCR Personal Computer Model 4
Field Service Diagnostics Version 1.0
Copyright 1984 NCR Corp.

      UPDATES TO DOCUMENTATION

1  Display Updates
2  Print Updates

Enter selection number:_

F1=HELP,F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU
```

Each of the two available tests is selected by entering the corresponding number (1 or 2). If F3 is pressed, the program returns to the Utilities menu. If F2 is pressed, the program returns to the main menu.

## Updates To Documentation HELP Screen

To obtain more information about the available Updates To Documentation functions, press F1 to see the HELP screen:

Display Updates - Displays updates to documentation.  
Print Updates - Prints updates to documentation.  
F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU\_

### **Generate Diagnostic Disk**

If selection 3 of the Utilities menu is chosen, the procedure to generate a copy of the diagnostic disk by writing from the diagnostic code already loaded into memory onto a scratch disk is performed.

### **Format Flexible Disk**

If selection 4 of the Utilities menu is chosen, the procedure to format a flexible disk is performed.

### **Format Hard Disk**

If selection 5 of the Utilities menu is chosen, the procedure to format a hard disk is performed. Note: this is a hardware format, not a DOS format.

### **Position Head For Relocation**

If selection 6 of the Utilities menu is chosen, the procedure to position the head of a hard disk drive for relocation is performed.

### **Alignment Utilities**

If selection 7 of the Utilities menu is chosen, the Alignment Utilities menu screen is displayed:

The NCR Personal Computer Model 4  
Field Service Diagnostics Version 1.0  
Copyright 1984 NCR Corp.

ALIGNMENT UTILITIES

- 1 Monochrome Alignment
- 2 Color Alignment
- 3 Disk Alignment - Drive A
- 4 Disk Alignment - Drive B

Enter selection number: \_

F1=HELP,F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU

Each of the four available tests is selected by entering the corresponding number (1 through 4). If F3 is pressed, the program returns to the Utilities menu. If F2 is pressed, the program returns to the main menu.

**Alignment Utilities HELP Screen** — To obtain more information about the available Alignment Utility functions, press F1 to see the HELP screen:

Monochrome Alignment - Allows check for linearity, focus and raster.

Color Alignment - Allows check for linearity, focus, raster and color bars.

Disk Alignment - Performs a disk alignment test using a digital alignment diskette NCR part number 603-9009167. Tests performed include linearity, hysteresis, azimuth rotation, eccentricity, and head alignment. After the test completes, the radial offsets for track 5 will be scanned continuously allowing head alignment adjustment.

F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU\_

**Monochrome Alignment** — If selection 1 of the Alignment Utilities menu is chosen, the Monochrome Alignment menu screen is displayed:

```
The NCR Personal Computer Model 4
Field Service Diagnostics Version 1.0
Copyright 1984 NCR Corp.

      MONOCHROME ALIGNMENT

1 Linearity
2 Focus
3 Raster

Enter selection number:_

F1=HELP,F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU
```

Each of the three available tests is selected by entering the corresponding number (1 through 3). If F3 is pressed, the program returns to the Alignment Utilities menu. If F2 is pressed, the program returns to the main menu.

**Monochrome Alignment HELP Screen** — To obtain more information about the available Monochrome Alignment functions, press F1 to see the HELP screen:

Linearity - Displays a grid pattern to check for linearity.

Focus - Displays a full screen of "#" to check focus.

Raster - Displays a full screen of white.

F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU\_

**Linearity** — If selection 1 of the Monochrome Alignment menu is chosen, a full-screen grid pattern is displayed. The message **PRESS ANY KEY TO RETURN TO MENU** is superimposed over the grid. When any key is pressed, the program returns to the Monochrome Alignment menu.

**Focus** — If selection 2 of the Monochrome Alignment menu is chosen, a full-screen pattern of “#” is displayed. The message **PRESS ANY KEY TO RETURN TO MENU** is superimposed over the pattern. When any key is pressed, the program returns to the Monochrome Alignment menu.

**Raster** — If selection 3 of the Monochrome Alignment menu is chosen, a full screen of white (actually green on the integrated monochrome CRT) is displayed. The message **PRESS ANY KEY TO RETURN TO MENU** is superimposed over the screen. When any key is pressed, the program returns to the Monochrome Alignment menu.

**Color Alignment** — If selection 2 of the Alignment Utilities menu is chosen, the Color Alignment menu screen is displayed:

The NCR Personal Computer Model 4  
 Field Service Diagnostics Version 1.0  
 Copyright 1984 NCR Corp.

COLOR ALIGNMENT

- 1 Linearity
- 2 Focus
- 3 Raster
- 4 Color Bars

Enter selection number: \_

F1=HELP,F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU

Each of the four available tests is selected by entering the corresponding number (1 through 4). If F3 is pressed, the program returns to the Alignment Utilities menu. If F2 is pressed, the program returns to the main menu.

**Color Alignment HELP Screen** — To obtain more information about the available Color Alignment functions, press F1 to see the HELP screen:

Linearity - Displays a grid pattern to check for linearity.

Focus - Displays a full screen of "#" to check focus.

Raster - Displays a full screen of the chosen color(s).

Color Bars - Displays bars of white, blue, magenta, red, yellow and green.

F2=EXIT TO MAIN MENU,F3=EXIT TO PREVIOUS MENU\_

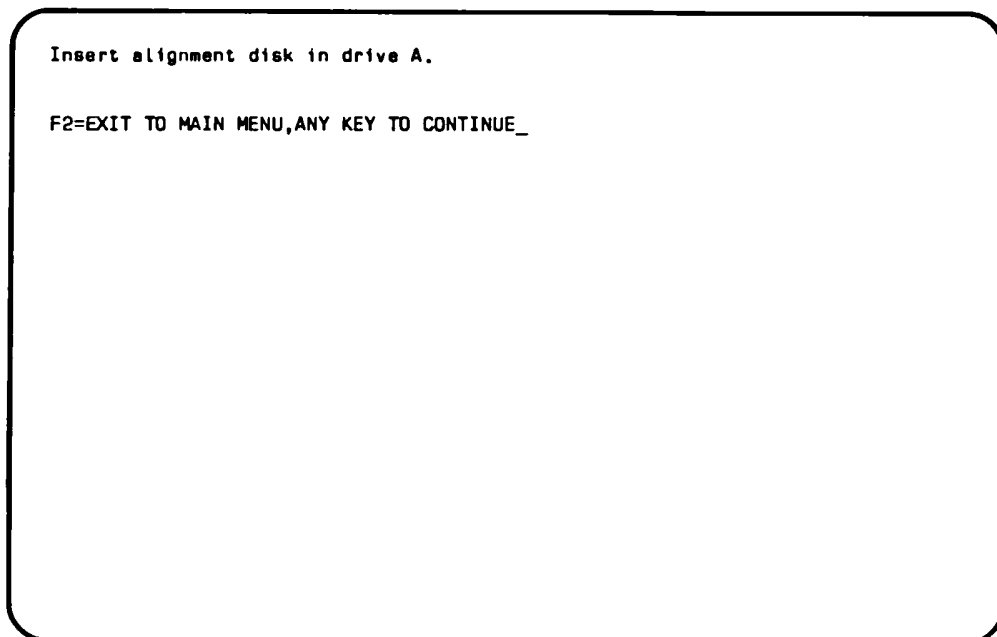
**Linearity** — If selection 1 of the Color Alignment menu is chosen, a full-screen grid pattern is displayed. The message **PRESS ANY KEY TO RETURN TO MENU** is superimposed over the grid. When any key is pressed, the program returns to the Color Alignment menu.

**Focus** — If selection 2 of the Color Alignment menu is chosen, a full-screen pattern of “#” is displayed. The message **PRESS ANY KEY TO RETURN TO MENU** is superimposed over the pattern. When any key is pressed, the program returns to the Color Alignment menu.

**Raster** — If selection 3 of the Color Alignment menu is chosen, a full screen of color is displayed. The message **PRESS ANY KEY TO RETURN TO MENU** is superimposed over the screen. When any key is pressed, the program returns to the Color Alignment menu.

**Color Bars** — If selection 4 of the Color Alignment menu is chosen, six horizontal bars of color fill the screen. The message **PRESS ANY KEY TO RETURN TO MENU** is displayed at the bottom of the screen. When any key is pressed, the program returns to the Color Alignment menu.

**Disk Alignment** — If selection 3 of the Alignment Utilities menu is chosen, the following screen is displayed:



If selection 4 of the Alignment Utilities menu is chosen, the same screen, except for drive designation B, is displayed.

Use the digital alignment diskette, NCR part number 603-9009167. When it is in the designated drive, press any key. Results of the alignment test are displayed in the pattern shown:

Digital Disk Alignment Check - A																					
Head 0								Head 1													
Eccentricity:																					
Degrees:	45	90	135	180	225	270	315	360		45	90	135	180	225	270	315	360				
Sum of + and - offsets:																					
7 mills	+00	+00	+00	+01	+00	+01	+00	+01		+01	-00	+00	+00	+00	+01	+00	+01				
8 mills	+00	+00	+00	+01	+00	+01	+00	+01		+01	-00	+00	+00	+00	+01	+00	+01				
9 mills	+00	+00	+00	+01	+00	+01	+00	+01		+01	-00	+00	+00	+00	+01	+00	+01				
Radial Offsets (in mills):																					
Track 00:	+12	-13	sum: -01							+12	-12	sum: 00									
Track 05:	+12	-13	sum: -01							+12	-12	sum: 00									
Track 16:	+12	-13	sum: -01							+12	-12	sum: 00									
Track 19:	+12	-13	sum: -01							+12	-12	sum: 00									
Track 30:	+12	-13	sum: -01							+12	-12	sum: 00									
Track 39:	+12	-13	sum: -01							+12	-12	sum: 00									
Hysteresis (in mills), seek from:																					
Track 18 to 19	+12	-13	sum: -01							+12	-12	sum: 00									
Track 20 to 19	+12	-13	sum: -01							+12	-12	sum: 00									
Track 00 to 19	+12	-13	sum: -01							+12	-12	sum: 00									
Track 39 to 19	+12	-13	sum: -01							+12	-12	sum: 00									
Azimuth Rotation (in minutes):																					
									+00	-00	sum: -00							+00	-01	sum: 00	
F1=HELP, F2=RETURN TO MAIN MENU, F3=RETURN TO PREVIOUS MENU, F4=REPEAT TEST																					

## *Level 1 Diagnostics Error Returns*

This chapter provides information needed to diagnose and repair the NCR PERSONAL COMPUTER Model 4. It is not the intent of this manual to educate the user in all aspects of computer operation. The material presented in this chapter is of a technical nature and the user should possess some experience with digital circuits before attempting any major repairs. However, this material can serve as a valuable tool in determining the most probable cause of system failure.

### **REPAIR GUIDELINES**

Before any attempts are made to repair the computer system, some guidelines need to be established. It is considered good practice to reduce the system to a basic configuration before troubleshooting begins. This can help eliminate problems that are not machine dependent but exist in some piece of peripheral equipment. If such a problem is detected, the peripheral equipment may be reinstalled a piece at a time (taking care to check the system for proper operation after each installation) until the defective equipment is found.

### **WARNING**

Power should be turned off before removing or installing any system components.

### **BASIC SYSTEM CONFIGURATION**

The basic system configuration should include the following:

1. Video monitor.
2. 1 or 2 flexible disk drives (hard disk if installed).
3. The flexible disk drive controller card (and hard disk controller card if installed ) properly seated in the expansion slot(s).

4. Video controller card properly seated in the expansion slot.

### **PRELIMINARY CHECKS**

After the system has been configured for troubleshooting, some checks should be performed:

1. Have all peripheral boards not needed for system operation been removed from the computer? Remove any excess equipment.
2. Are all cards remaining in the expansion slots correctly installed? Refer to the "After First Attempt" section of the *Troubleshooting Non-Operative Systems* chapter of this manual.
3. Check the switch settings on the main processor board; are they set properly for the system configuration? Refer to Appendix A if you need help with the switch settings.
4. Check all cables attached to the main processor board and cards in the expansion slots. Make sure that all cables are installed correctly.
5. Perform a visible inspection of the circuit components, checking for any obvious signs of damage: bad solder connections, shorts, missing or damaged resistors/capacitors etc.
6. Check the voltage levels to the Main Processor Board power connector. The system uses; 12v, -12v, 5v, -5v and ground. Make sure that all installed peripherals are receiving the correct voltages (this includes the disk drives and video power connectors).

### **MAIN PROCESSOR BOARD COMPONENTS**

For those not familiar with the Main Processor Board (MPB), it is recommended that some time be taken to learn the location of the major board components. Figure 6-1 shows the placement of all the major components used by the NCR Personal Computer. The factory-installed video controller card is usually located in the top expansion slot and the factory-installed flexible disk controller card is found in the bottom expansion slot.

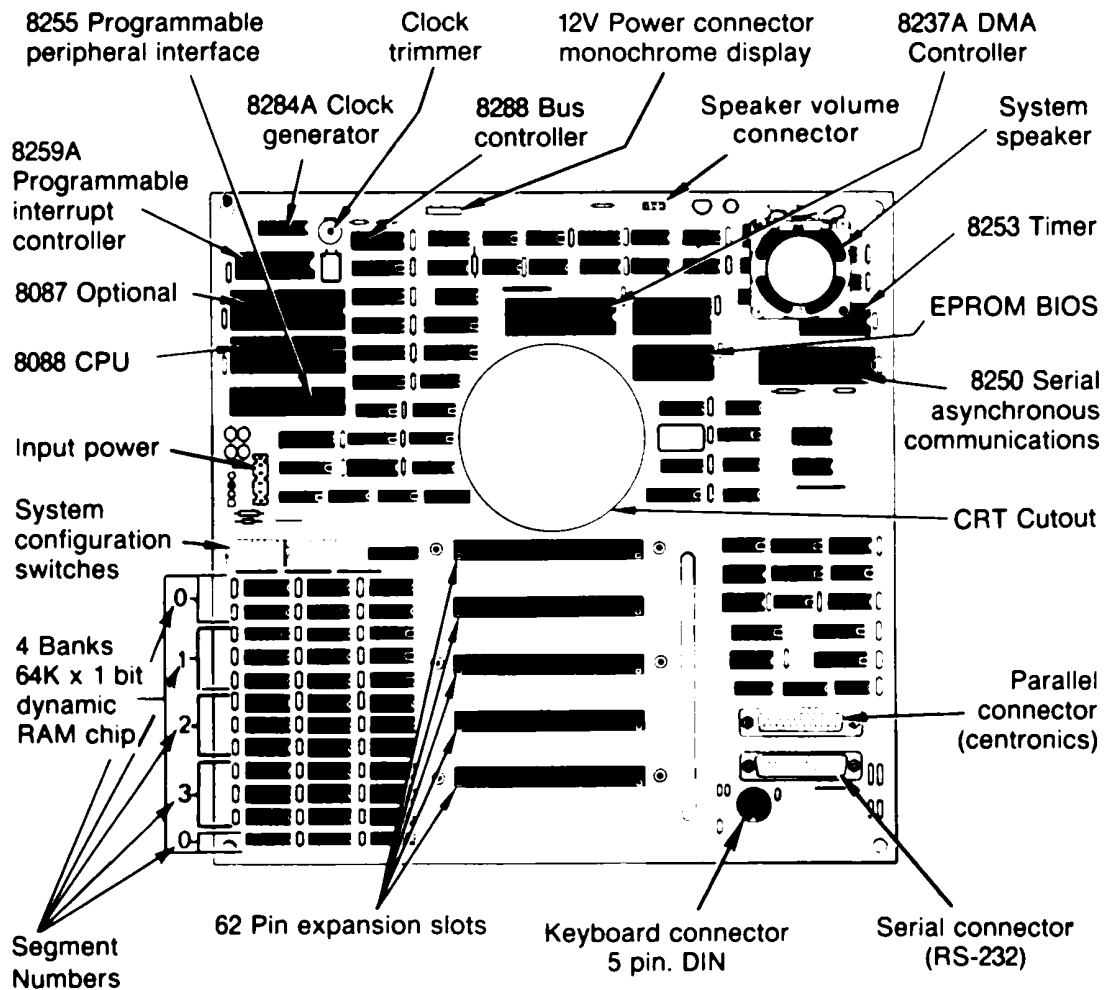


Figure 6-1 Main Processor Board

## MEMORY ADDRESSING

When using the diagnostic diskette, it is helpful to understand the method of memory addressing used by the 8088 microprocessor. The 8088 divides memory up into segments and allocates 64K bytes to each segment. Using this method of memory segmentation it is possible to address 1 megabyte of system memory. To address a memory location it is necessary to specify its segment base address and its segment offset value. A typical example of a segmented address specification is shown in Figure 6-2. Both segment code and offset value are given in hexadecimal notation. To access memory it is necessary to place a 0 to the right of the last digit in the segment base and add the offset value to form the 20 bit address, as shown in Figure 6-3. The address formed is the actual physical address of the memory location. A more thorough description of 8088 addressing can be found in one of the reference sources for the Intel 8088 microprocessor.

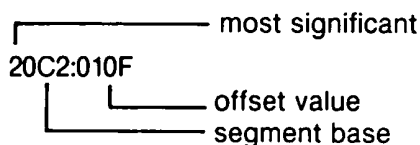


Figure 6-2 Segment Address

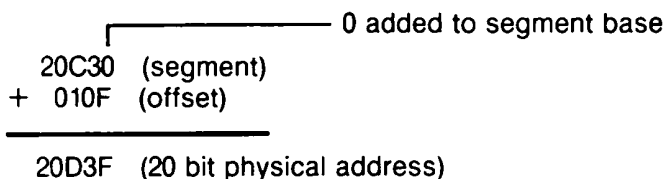


Figure 6-3 Physical Address Construction

There are two types of segmented address codes that are used by the diagnostic diskette to report failures. The first type of segment code is used to specify the address that was being executed in program memory when a failure occurred that terminated diagnostics prematurely. If this failure occurs then the RAM parity test should be run to determine if a RAM chip failed in the lower 64K allocated to program memory. It is possible that this error will result in total system failure. If this is the case, the system will not respond to any input and the system must be rebooted.

If the diagnostic program still operates after the error is detected, the use of the RAM test can help determine the problem. This type of failure will not occur very frequently and is often the result of some intermittent component failure.

The second type of segment code is returned by the diagnostics when an error is found while performing RAM memory checks. Using the memory test in the prescribed manner can isolate the RAM chip that failed. This is true whether the RAM is located on the main processor board or on the memory expander card in the expansion slot.

To isolate the faulty RAM chip the most significant hex digit in the segment code is used (refer to Figure 6-2). The value of the most significant digit identifies the segment within which the RAM is located. Figure 6-4 shows the physical locations of all the segments used by the NCR Personal Computer. Segments 0 through 3 are located on the MPB while segments 4 through 9 are located on the memory expander card.

Further explanation of specific segment code addresses will be given in the appropriate sections as they are required. It is only necessary to understand that two interpretations of segment address codes are required.



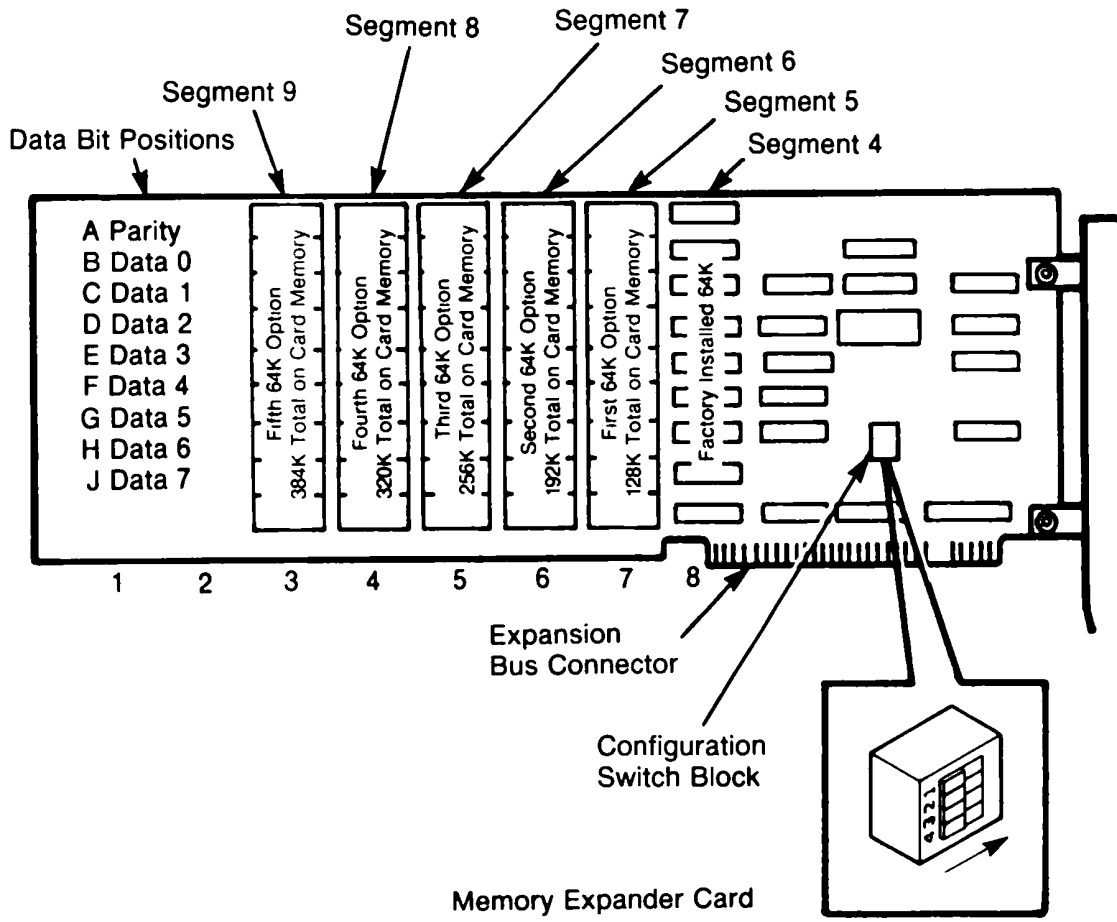
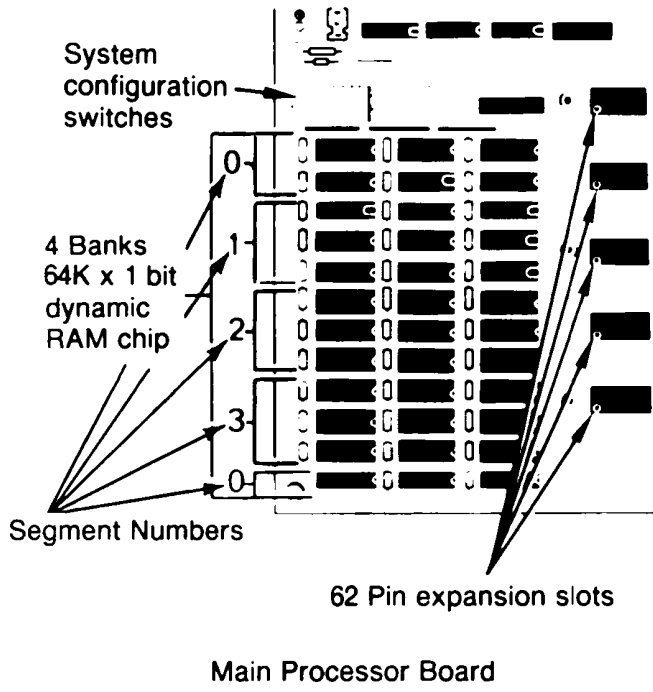


Figure 6-4 Memory Segment Locations

## ERROR CODES

This section describes the error reports from the NCR Personal Computer SERVICE DIAGNOSTICS program. The reports from the diagnostics are in coded form. This reduces the large overhead of program code required for text. Codes are exemplified in the accompanying text.

### RELATIONSHIP BETWEEN MAJOR CODES, DETAIL CODES AND REPAIR PROCEDURES

Error codes are broken down into MAJOR and DETAIL codes. In addition, ADDR(ess), EXP(ected) DATA, and OBS(erved) DATA information is also displayed where appropriate. The MAJOR codes are, in general, a description of the type of test being performed when an error was encountered. Each MAJOR code may have several DETAIL codes associated with it. The DETAIL codes are specific descriptions of the error and are displayed as hex values on the CRT. Data that is to be returned from a particular register or memory device is displayed in the EXP DATA and OBS DATA fields. If the OBS(erved) DATA does not match the EXP(ected) DATA then an error has been detected. The ADDR(ess) field is for memory related failures.

After every MAJOR CODE the "Repair Procedure" that is recommended to troubleshoot the faulty condition is presented. Additional "Repair Procedures" may follow specific DEVICE CODES. On the Main Processor Board (MPB), each semiconductor component is identified by a "U" number (Figure 6-5). The repair procedures specify components on the MPB by the appropriate "U" number. Equipment recommended for performing repairs includes: Multimeter, Digital Logic Probe, Oscilloscope (some repairs will only be possible with the aid of an oscilloscope).

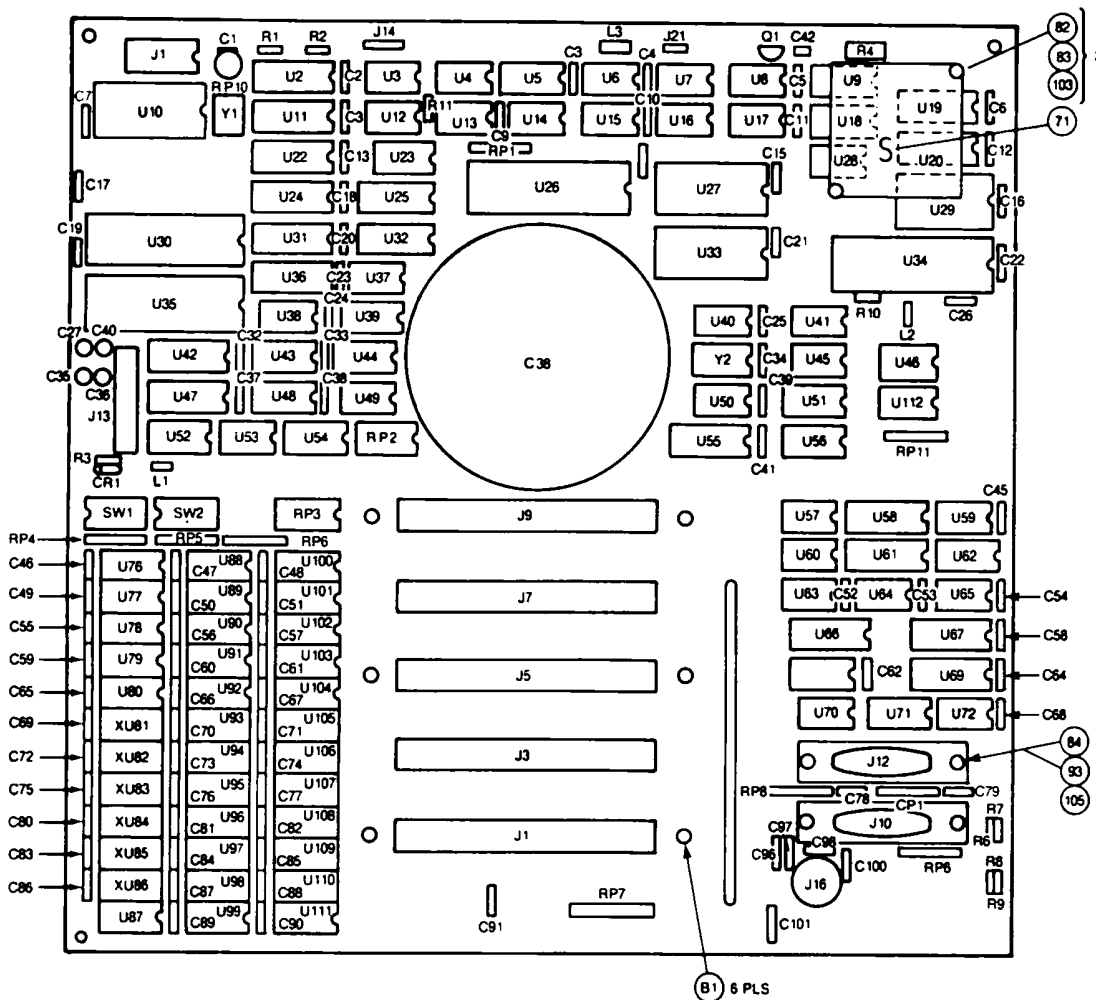


Figure 6-5 MPB Component Identification

## FORMAT OF DISPLAYED ERROR CODES

MAJOR CODE:DETAIL CODE, EXPECTED DATA:xx, OBSERVED DATA:yy

Examples:

\*\*\* ERR: 12:80

This code represents-

**MAJOR:** An error was returned while attempting to read a flexible disk drive.

**DETAIL:** FDC failed to respond, Time out on FDC.

**NOTE:** FDC is an abbreviation, used frequently in this chapter, for Flexible Disk Controller.

\*\*\* ERR: 17:00, EXP DATA: AA, OBS DATA: A8

This code represents-

**MAJOR:** An error was encountered in comparing data read from the FDC subsystem.

**DETAIL:** No detail error.

**EXP DATA:** The data pattern AA was expected.

**OBS DATA:** The data pattern A8 was observed.

**LIST OF MAJOR ERROR CODES**

Figure 6-6 is a list of the MAJOR CODES that are used and a brief description of each.

<b>CODE</b>	<b>DESCRIPTION</b>
This group of error codes are related to system memory.	
1	RAM PARITY ERROR
2	RAM PATTERN ERROR
3	RAM ADDRESS ERROR
4	ROM CHECKSUM ERROR
This group of error codes are related to the flexible disk drives.	
10	FDC RESET ERROR
12	FDC READ ERROR
13	FDC WRITE ERROR
14	FDC VERIFY ERROR
15	FDC FORMAT ERROR
17	FDC DATA ERROR
18	FDC RESET ERROR
This group of errors are related to miscellaneous peripherals	
20	SERIAL COMMUNICATIONS ERROR
21	CRT ERROR
22	CRT RAM ERROR
23	KEYBOARD ERROR
24	PRINTER PORT ERROR
25	PRINTER ERROR
This group of errors are related to major system controllers.	
30	CPU ERROR — 8088
31	RESERVED
32	INTERRUPT CONTROLLER ERROR — 8259
33	INTERVAL TIMER ERROR — 8253
34	DMA CONTROLLER ERROR — 8237
35	SYSTEM PARALLEL PORTS — 8255
36	SERIAL PORT — 8250
37	FLEXIBLE DISK CONTROLLER — 8272 (ON EXPANSION CARD)
38	CRT CONTROLLER — 6845 (ON EXPANSION CARD)
39	WINCHESTER CONTROLLER — (EXPANSION CARD)

Figure 6-6 Major Error Codes (1 of 2)

CODE	DESCRIPTION
------	-------------

This group of errors are related to the hard disk subsystem.

40	HARD DISK NOT READY
41	HARD DISK RECALIBRATE ERROR
42	HARD DISK FORMAT ERROR
43	HARD DISK SEEK ERROR
44	HARD DISK WRITE ERROR
45	HARD DISK READ ERROR
46	HARD DISK DATA ERROR
47	HARD DISK CONTROLLER ERROR
48	HARD DISK VERIFY ERROR
49	HARD DISK ERROR (INTERNAL)

The following range of codes are reserved for future expansion.

50-79

The following range of codes are reserved for the manufacturing test and peripheral bus test.

80-98

The following code is an internal check for data integrity of the diagnostic software.

99	DIAGNOSTIC PROGRAM CHECKSUM ERROR
----	-----------------------------------

Figure 6-6 Major Error Codes (2 of 2)

## DETAIL ERROR CODES AND REPAIR PROCEDURES

Not every MAJOR error code will have associated DETAIL codes. The remainder of this chapter lists the MAJOR codes in sequence, followed by the DETAIL codes (if any) associated with each MAJOR code or group of MAJOR codes, followed by the recommended "Repair Procedures".

### MEMORY ERROR CODES (00-04)

#### 01 RAM PARITY

Format of code:

\*\*\* ERR: 01:ww, ADDR: ssss:0000

Where,        ww     = DETAIL code  
               ssss    = Segment address of error

0000 = Offset address of error

DETAIL code:

- 01 Parity interrupt
- 02 Base RAM parity error
- 04 Expansion RAM error

These codes are logically "or"ed to present the final DETAIL code.

Example: 03 Parity error & interrupt from the base RAM  
or: 04 Parity detected from expansion RAM with no interrupt.

### Repair Procedure 01

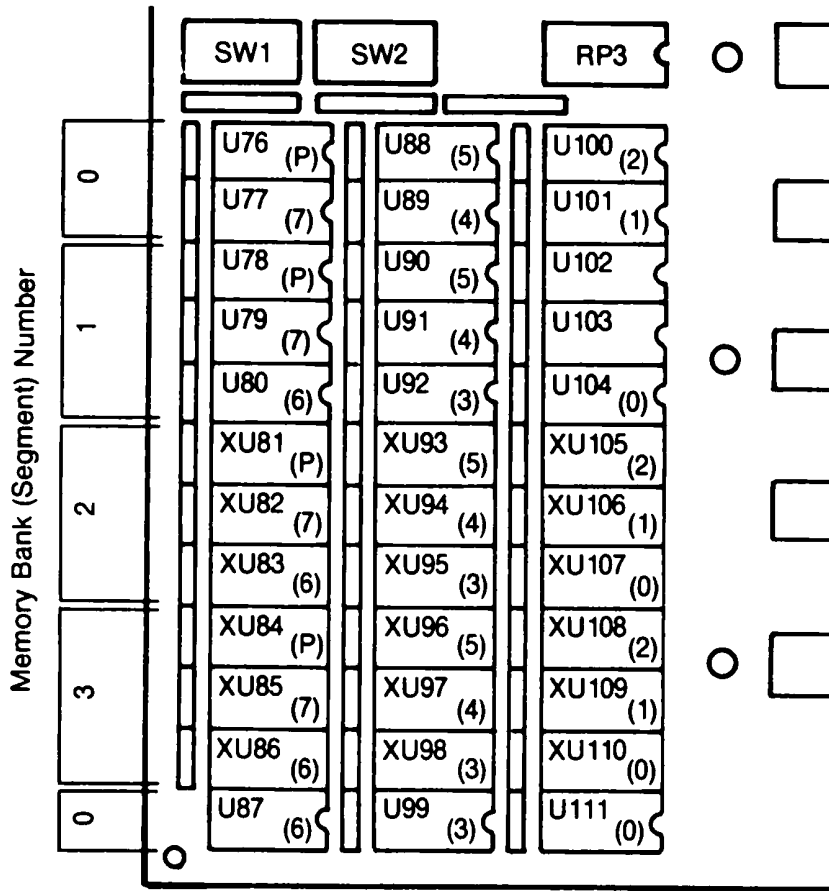
The detail code will give the location of a parity failure (base or expander memory). Use the most significant digit of the segment code to identify which bank contains the defective RAM chip. This can be done by using Figure 6-7. Locate the segment number in the table and find the data bit(s) that failed the RAM PATTERN TEST. The junction of the row and column will intersect the chip that is suspect. Numbers preceded by a 'U' are found on the Main Processor Board (MPB); all other RAMs are located on the Memory Expander Card. Memory bit chip locations on the MPB are shown in Figure 6-8. If the test indicates a parity failure and the RAM PATTERN TEST passes, then suspect the parity chip within the faulty segment.

Segment Code	Memory Range	Data Bit Position								Parity Chip
		7	6	5	4	3	2	1	0	
0000	64K	U77	U87	U88	U89	U99	U100	U101	U111	U76
1000	128K	U79	U80	U90	U91	U92	U102	U103	U104	U78
2000	192K	U82	U83	U93	U94	U95	U105	U106	U107	U81
3000	256K	U83	U86	U96	U97	U98	U108	U109	U110	U84
4000*	320K	J8	H8	G8	F8	E8	D8	C8	B8	A8
5000*	384K	J7	H7	G7	F7	E7	D7	C7	B7	A7
7000*	448K	J6	H6	G6	F6	E6	D6	C6	B6	A6
7000*	512K	J5	H5	G5	F5	E5	D5	C5	B5	A5
8000*	576K	J4	H4	G4	F4	E4	D4	C4	B4	A4
9000*	640K	J3	H3	G3	F3	E3	D3	C3	B3	A3

Memory Expander Card Main Processor Board

Figure 6-7 RAM Memory Chip Locations

Locate the segment number in the table and find the data bits that failed the RAM PATTERN TEST. The junction of the row and column intersects the location number of the bad RAM chip on the Main Processor Board or Memory Expansion Card. Numbers preceded by a "U" are located on the Main Processor Board. Segment numbers designated with \* denote RAM memory segments on the Memory Expander Card.



NOTE: Bit number is in parentheses — Ex: (5)  
(P) is parity bit

Figure 6-8 MPB Memory Chip Locations

To check errors that are reported on the Memory Expander Card, remove the expander card and set the configuration switches for maximum base memory (256K). If the system passes the parity check, then the problem is on the Memory Expander Card and diagnostics can proceed (with the expander card reinstalled) as described above. This technique can be used to isolate RAM failures within any 64K segment of memory. Set the configuration switches for the next lower 64K segment and run the diagnostics until the problem is no longer observed or the switches are set for only 64K of main board memory. This technique is used to isolate RAM chip failure within 64K segments of memory. Figure 6-4 shows the location of the 64K segments on the Main Processor Board and on the Memory Expander Card.

If the diagnostics report a PARITY ERROR after the suspect RAM memory chip has been replaced, then it is necessary to evaluate the

hardware associated with parity generation. Figure 6-9 shows the placement of all major RAM memory hardware components on the Main Processor Board. Check the parity generator (U50) for proper input/output conditions.

## 02 RAM PATTERN

Format of code:

\*\*\* ERR: 02:ww, ADDR: ssss:0000, EXP DATA: xxxx,  
OBS DATA: yyyy

Where,        ww     = DETAIL code  
              ssss    = Segment address of error  
              0000    = Offset address of error  
              xxxx    = Expected data  
              yyyy    = Observed data

DETAIL code:

01     Pattern Error Verified  
02     Intermittent Error, Duplicated  
04     Intermittent Error, Not Duplicated

These codes are NOT logically “or”ed.

### Repair Procedure 02

The RAM PATTERN TEST writes data patterns into memory and then reads the patterns back to verify that all the data bits in memory are functioning properly. This test will detect the presence of stuck data bits in a RAM chip or an intermittent bus driver. Comparing the expected data with the observed data will show the defective bit positions. If the segment address changes randomly with repeated execution of the RAM PATTERN TEST, then the problem is also associated with the addressing hardware and the RAM ADDRESS TEST should be used to provide further information. A pattern failure that reports a constant segment address can be checked using “Repair Procedure 01”. Intermittent failures that are reported as Not Duplicated will require reuse of the RAM PATTERN TEST to determine if there is an actual problem. Intermittent failures reported as Duplicated could be the result of the RAM chip or the data bus to the RAM chip. Figure 6-9 shows the location of RAM memory hardware on the Main Processor Board.

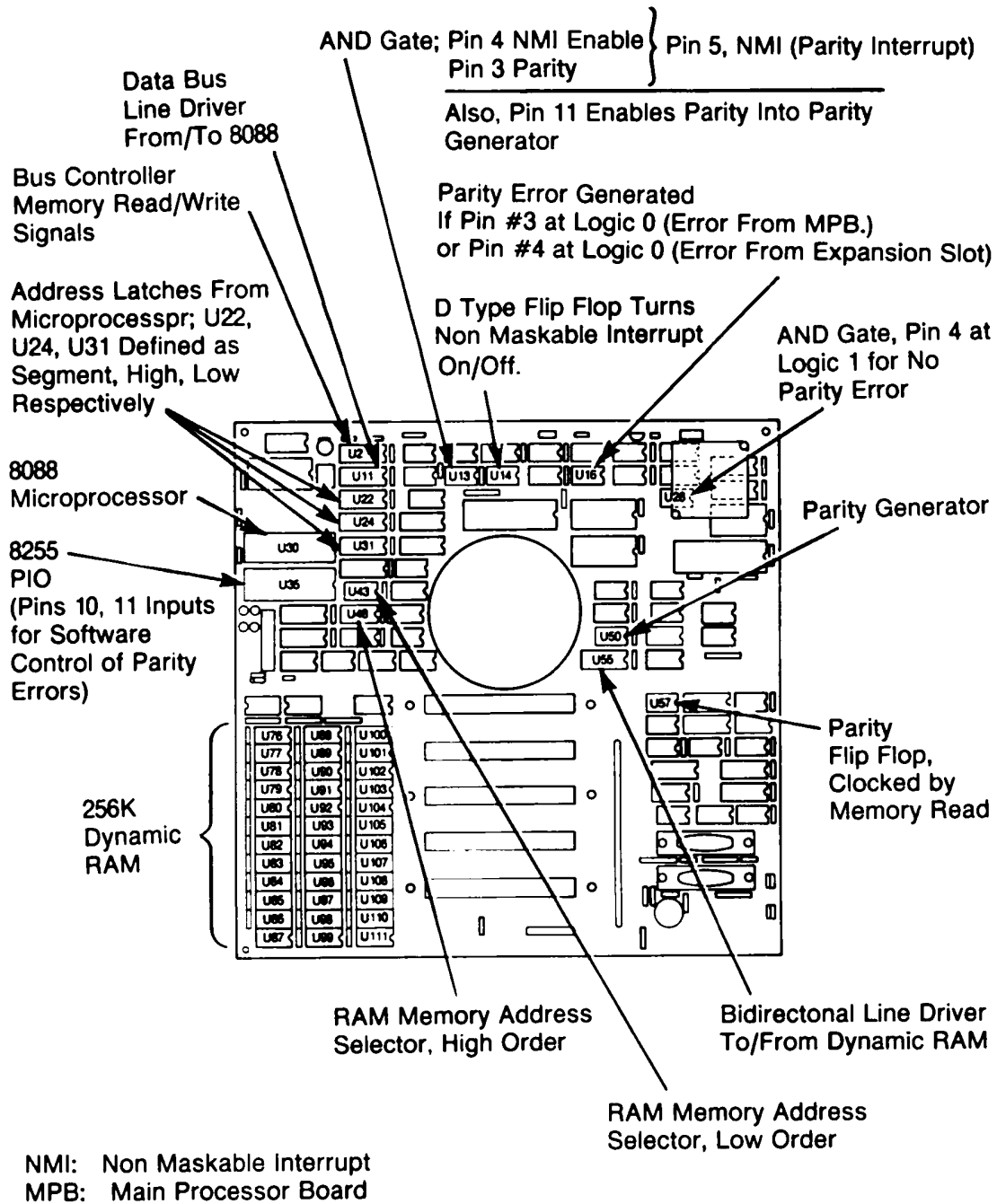


Figure 6-9 RAM Memory Components

**03 RAM ADDRESS ERROR**

Format of code:

\*\*\* ERR: 03:ww, EXP DATA: xxxx, OBS DATA: yyyy

or

\*\*\* ERR: 03:ww, ADDR: ssss:oooo, EXP DATA: xx(xx), OBS DATA: yy(yy)

Where,        ww     = DETAIL code

for DETAIL 01,

      xxxx    = Segment of expected address

      yyyy    = Segment of observed address

for DETAIL 02,

      ssss    = Segment address of error

      oooo    = Always zero

      xxxx    = Expected address (A8 — A15)

      yyyy    = Observed address (A8 — A15)

for DETAIL 03,

      ssss    = Segment address of error

      oooo    = Always zero

      xx      = Expected address (A0 — A7)

      yy      = Observed address (A0 — A7)

DETAIL code:

   01        Segment conflict (A16 — A20)

   02        Upper address conflict (A8 — A15)

   03        Low address conflict (A0 — A7)

**Repair Procedure 03**

RAM ADDRESS ERROR will return Detail codes that help isolate problems with the system address bus. The ADDRESS PATH is checked in the hardware for integrity along isolated bus components. The ADDRESS PATH is hardware divided as low order address (8 bits), high order address (8 bits), and segment address (4 bits). Each address path has its own data latches and bus drivers. The Detail code returned by the RAM ADDRESS TEST specifies the ADDRESS PATH in the hardware that could be defective. Comparing the expected address with the observed can provide indications of which address line(s) are failing. Figure 6-9 specifies the hardware components associated with each ADDRESS PATH. Evaluation of bus driver input/output characteristics is recommended; suspect intermittent chip failure.

## 04 ROM CHECKSUM ERROR

Format of code:

\*\*\* ERR: 04:00, EXP DATA: xx, OBS DATA: yy

Where,     xx       = Expected checksum  
          yy       = Calculated checksum

DETAIL code:  
      NONE

### Repair Procedure 04

Make certain that the EPROM BIOS chip (shown in Figure 6-1) is correctly inserted in its socket (U33 in Figure 6-5). If the ROM CHECKSUM ERROR still occurs replace the EPROM BIOS chip. Should the ROM test still report a checksum error then the problem probably exists in an intermittent address or data bus component that connects the ROM to the 8088 microprocessor. Figure 6-10 specifies the hardware components that are used by the EPROM.

## FLEXIBLE DISK DRIVE ERROR CODES (10-18)

### 10-18 FLEXIBLE DISK DRIVE ERRORS

(Refer to Figure 6-6.)

Format of code:

\*\*\* ERR: aa:ww, EXP DATA: xx, OBS DATA: yy

Where,     aa       = MAJOR code  
          ww       = DETAIL code  
          xx       = Optional expected data  
          yy       = Optional observed data

NOTE: The EXP DATA and OBS DATA fields are displayed on MAJOR code "17" only.

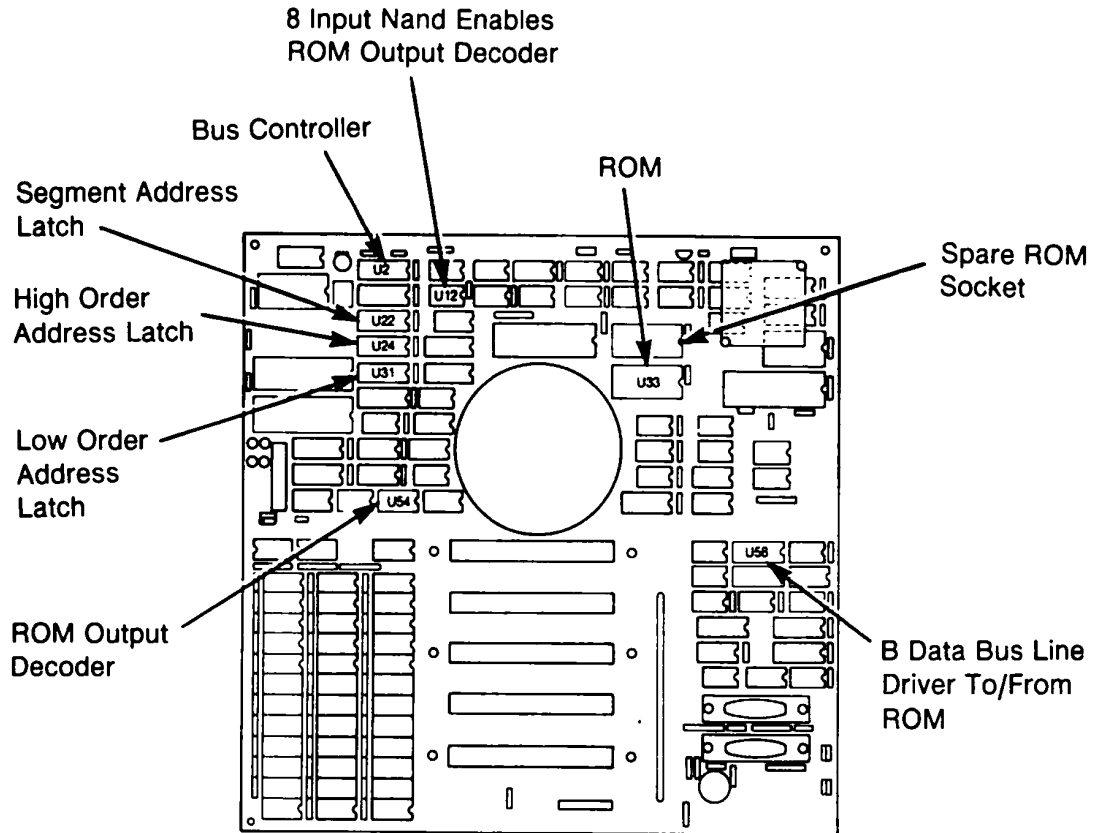


Figure 6-10 ROM Hardware Components

**DETAIL code:**

The following **DETAIL** codes apply to **MAJOR** codes 10 thru 16, and 18.

88	Disk drive not ready
80	FDC failed to respond
40	Seek operation failure
20	FDC failure
10	CRC error or reading
09	Attempt to read across 64k boundary (Internal error)
08	Data overrun error
04	Requested sector not found
03	Attempt to write a write protected disk
02	Address mark not found on track
01	Bad command (internal error)

**Accompanying message:**

**NOTE:** This message is not displayed for **MAJOR** code "17".

```

      DV  RTY  STO  ST1  ST2  C   H   R   N
***   XX   XX   XX   XX   XX  XX  XX  XX  XX

```

This data is the status returned from the FDC. Refer to Figure 6-11 for status code specifics.

	DV	= Drive number
	RTY	= Number of retry
STATUS CODE	STO	= Status register 0 from FDC
STATUS CODE	ST1	= Status register 1 from FDC
STATUS CODE	ST2	= Status register 2 from FDC
	C	= Cylinder (track) selected
	H	= Head 1 (H=0) or 2 selected
	R	= Record (sector) selected
	N	= Sector density (always 2)

### Repair Procedure 05

Failure in the Flexible Disk Drive system can be particularly hard to troubleshoot and repair. There is a general approach for solving disk drive problems that is applicable to most failures. Treatment of certain types of failures will follow the specified Device Code.

Bit Number	Status Byte 0	Status Byte 1	Status Byte 2
D7	D7 and D6 = 0 Normal Command Termination D7 = 0, D6 = 1 Abnormal Command Termination D7 = 1, D6 = 0 Invalid Command Issued D7 = 1, D6 = 1	Logic Level 1 Indicates That FDC Tried to Access a Nonexistent Sector	Not Used Logic 0
D6	Abnormal Termination, Ready Line Changed State During Command Execution	Not Used Logic 0	Logic 1 During Read by FDC an Deleted Data Address Mark was Encountered.
D5	Logic 1 Indicates Completion of the Seek Command	FDC Detected a Data Checksum (CRC) Error If Set to Logic 1	Logic 1 If CRC Error Found in Data Field (Bad Data)
D4	Set to Logic 1 If Fault Signal Received From FDD or Track 00 Not Found After 77 Step Pulses	Logic 1 Indicates That FDC Not Serviced by Main Systems During Data Transfer and the FDC Timed Out	Logic 1 If the Cylinder (Track) Is Not Found
D3	Set to Logic 1 If the FDD Is Not Ready When a Read/Write Command Is Issued	Not Used Logic 0	Logic 1 If Scan Command Is Satisfied (Equal)
D2	Indicates State or Read/Write Head on FDD at Interrupt	Logic 1 Indicates No Data Returned for Sector Not Found or Bad Address ID Field	Logic 1 If Scan Command Does Not Find the Sector on a Track
D1	Unit Select 1 Drive A D1 = 0 Drive B D1 = 0	Logic 1 If FDD Returns Write Protect During a Write Operation	Logic 1 Bad Track Information Detected
D0	Unit Select 2 Drive A D0 = 0 Drive B D0 = 1	Logic 1 If FDC Does Not Find the Address Mark After Detecting Index Mark Twice	Logic 1 If Data Address Mark Can Not Be Found

FDC: Flexible Disk Controller  
FDD: Flexible Disk Drive

Figure 6-11 Flexible Disk Drive Status Codes

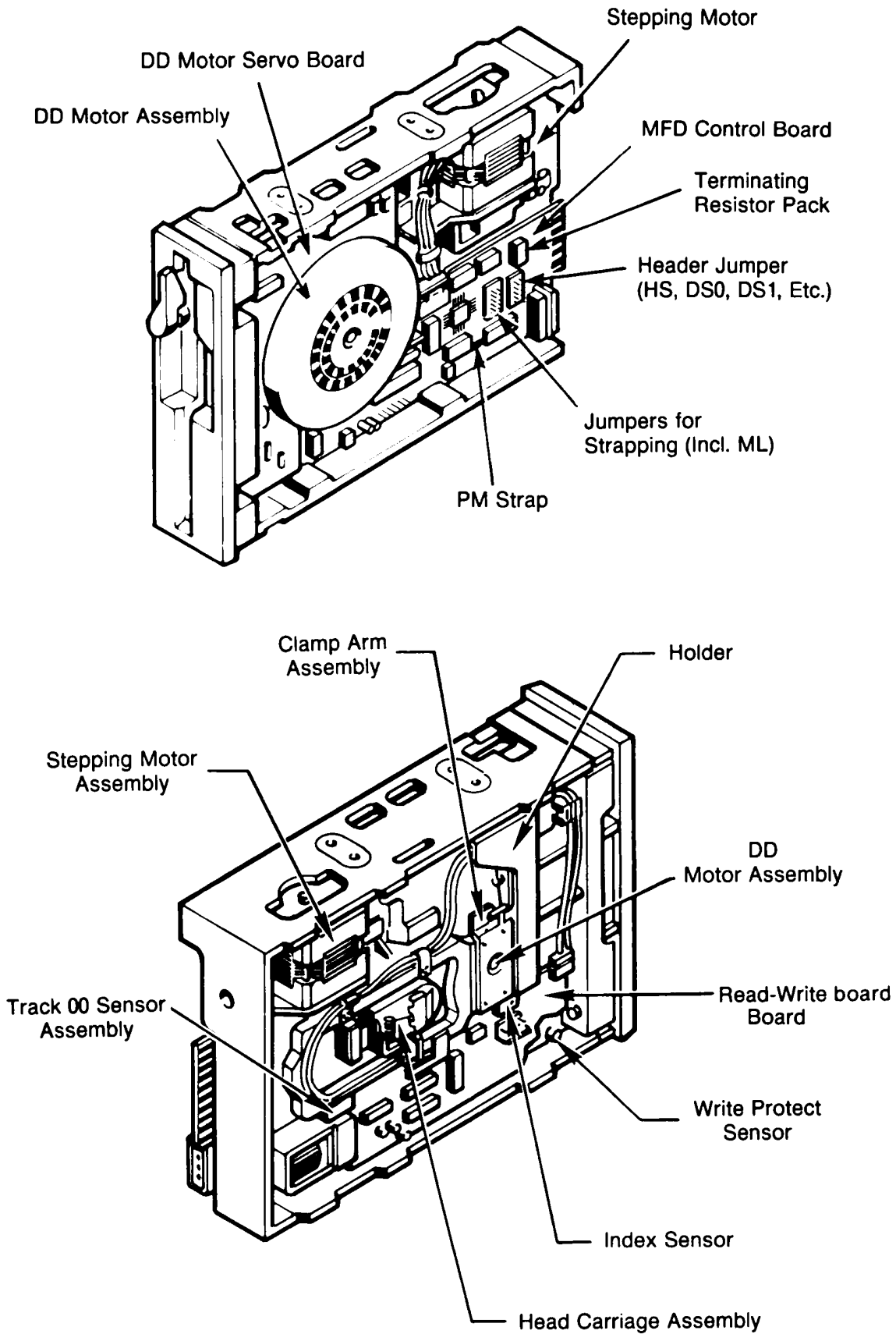


Figure 6-12 Flexible Disk Drive Components

There are three major subassemblies needed for correct disk drive operation. They are: Main Processor Board, Flexible Disk Controller card, and the Disk Drive unit. Refer to the "Basic System Configuration" section in this chapter before starting the troubleshooting session. Figure 6-12 shows the placement of components on the Flexible Disk Drive. As a general method of isolating flexible disk drive failures the following technique can be used.

If you have another controller card, try removing the old card and using the new one. If an extra controller card is not available, start with troubleshooting the disk drive units. Since the computer uses drive A as the primary system drive, its failure will prevent the computer from loading the operating system during any boot operation. For systems that have two Flexible Disk Drives the second drive can be strapped as drive A. Figure 6-13 shows in detail the header jumper and other strapping blocks found on the side of the disk drive (refer to Figure 6-12 for location). The NCR Personal Computer requires that three straps be installed. They are: PM, ML, and one drive select strap. Disk drives are configured as drive A,B,C or D by installing a strap on DS0,DS1,DS2 or DS3 respectively.

NOTE: To change the strapping it is necessary to remove the Flexible Disk Drive from the computer.

**CAUTION**

Do not remove the straps from 'PM' or 'ML'; they are required for proper drive operation.

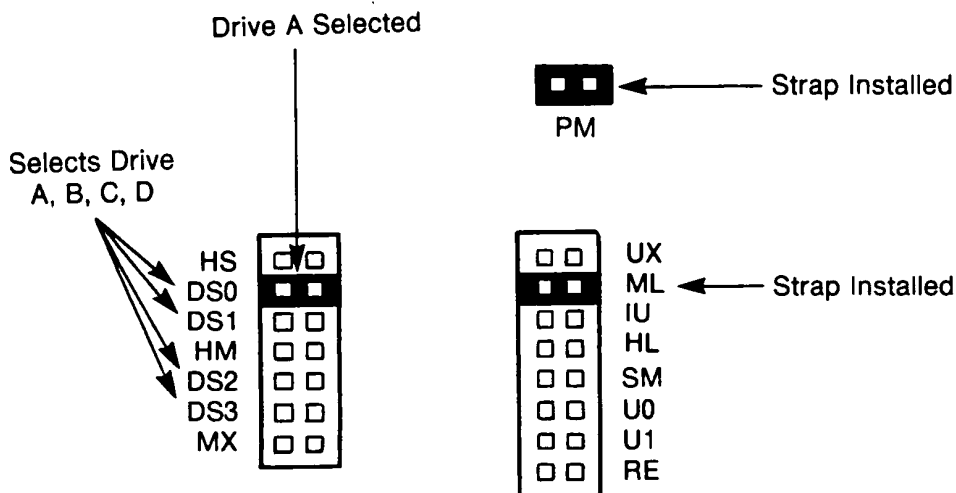


Figure 6-13 Disk Drive Strap Locations

To configure the second Flexible Disk Drive (drive B) as drive A remove the strap from DS1 and reinstall on DS0. Remove the strap from DS0 on drive A; this will prevent addressing conflicts.

**NOTE:** Do not install two disk drives that are both strapped as system drive A, address bus conflicts will result.

With drive B reconfigured to operate as drive A attempt to restart the computer system. If the Flexible Disk Drive still fails to respond, the failure is not likely to be in the drive unit. Replace the straps as they were originally (DS0 on drive A and DS1 on drive B) and insert the disk drives back into the computer cabinet. If switching the drives solves the problem then the specific Device Code may provide information as to the cause of the failure. Should it be necessary to return the disk drive unit to a service center for repairs the operational disk drive (configured as drive A) can be used to provide a working computer system.

**NOTE:** When changing the computer system configuration from two Flexible Disk Drives to one drive be sure to reset the system configuration switches on the Main Processor Board.

A terminating resistor pack must be installed on the disk drive attached to the last connected ribbon cable position. Figure 6-14 illustrates the ribbon cable. The location of the terminating resistor pack is shown in Figure 6-12. If only one Flexible Disk Drive is installed, the resistor pack must be inserted in that drive. For systems with two Flexible Disk Drives, only one resistor pack is used.

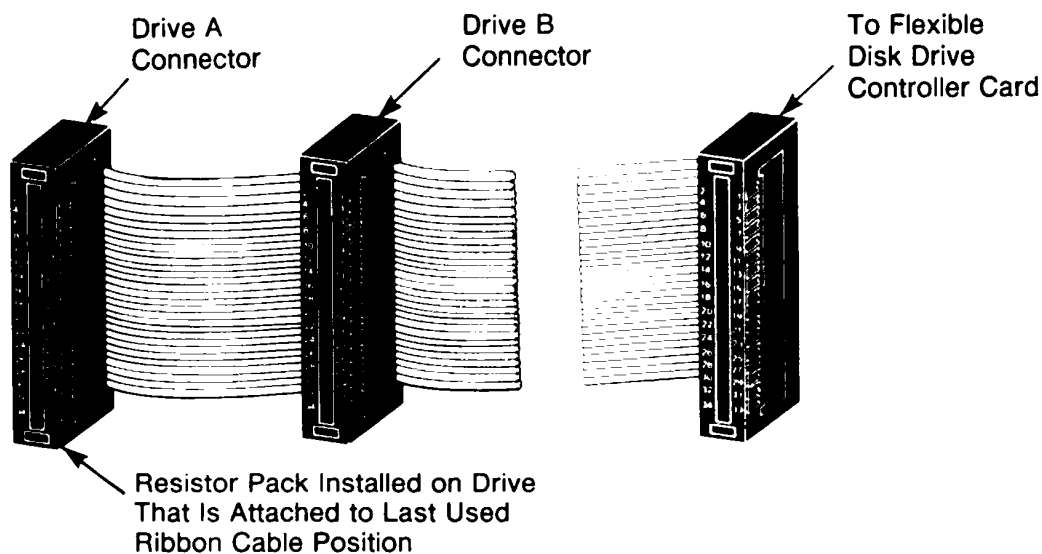
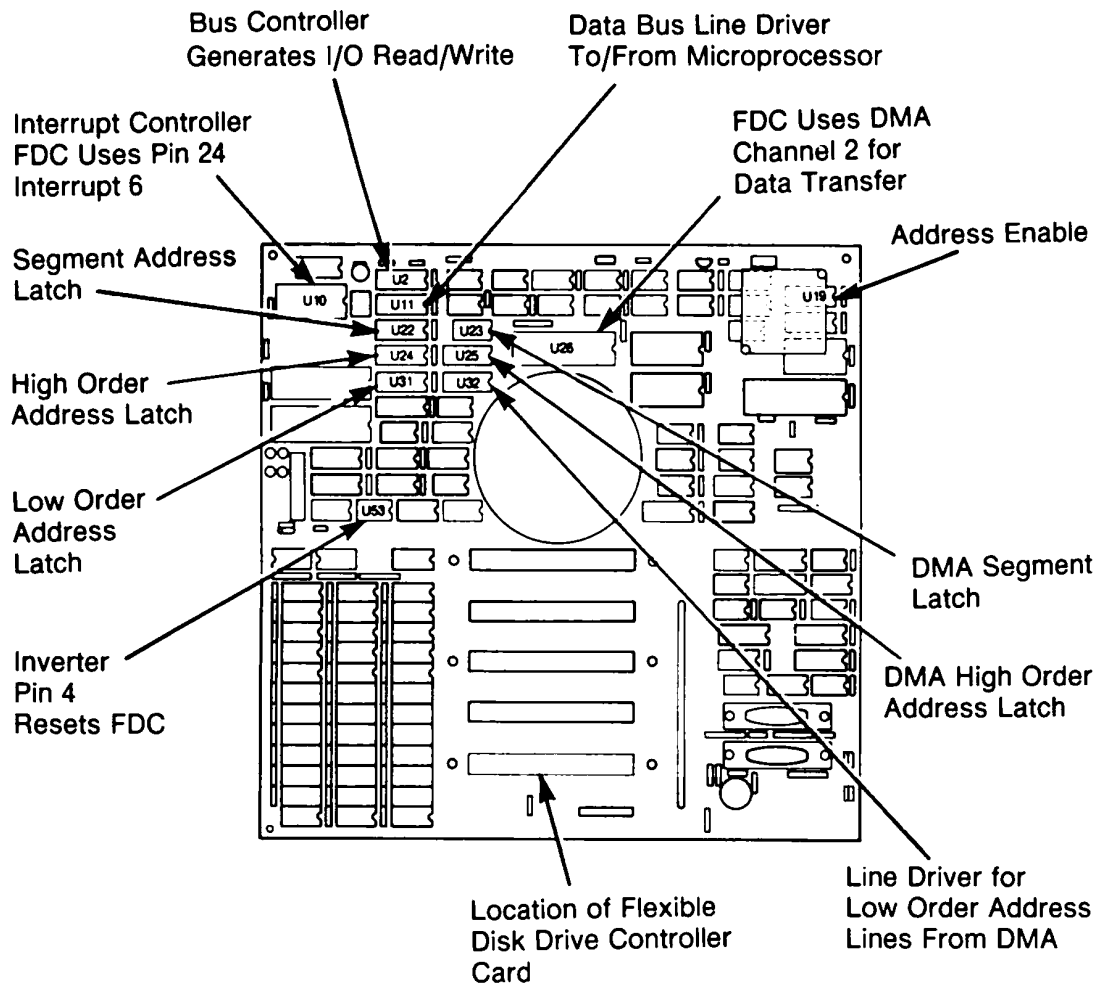


Figure 6-14 Ribbon Cable Termination



FDC: Flexible Disk Controller

Figure 6-15 Flexible Disk Related Hardware

**CAUTION**

Improper installation of the resistor pack will cause unexpected results in the disk drives' operation.

For more detailed information on troubleshooting the Flexible Disk Drive subassembly, refer to the specific detail code that was reported by system diagnostics.

**DETAIL CODE 88**

Suspect failure of disk drive unit. Refer to "Repair Procedure 05".

**DETAIL CODE 80**

Suspect intermittent failure of Flexible Disk Controller Card. Check control lines at the expansion slot. Recommend replacement of FDC.

**DETAIL CODE 40**

Suspect disk drive failure. Recommend "Repair Procedure 05".

**DETAIL CODE 20**

See device code 80.

**DETAIL CODE 10**

Suspect disk drive unit out of alignment or defective. Perform data read/write test on alternate Flexible Disk Drive (if installed) to verify condition. If both drives fail CRC check then suspect the Flexible Disk Drive Controller card.

**DETAIL CODE 09**

DMA segment addressing error, probably the result of a diagnostic software error. Suspect that the diagnostic disk is defective.

**DETAIL CODE 08**

Suspect Main Processor Board Failure. Check DMA channel 2 (DRQ 2) for intermittent operation.

**DETAIL CODE 04**

Suspect disk drive failure. Check index sensor on drive (Figure 6-12 shows the location) for obstruction. Refer to "Repair Procedure 05" for verifying drive failure.

**DETAIL CODE 03**

Suspect Defective write protect sensor on the disk drive unit (Figure 6-12 shows the location). Check sensor for obstruction. You can measure resistance from write protect sensor (photo resistor) with diskette installed that is write protected and then not write protected. Resistance should change from high to low if the sensor is operational. Refer to "Repair Procedure 05".

**DETAIL CODE 02**

Suspect defective drive; refer to "Repair Procedure 05". If the drive is not defective then the problem is probably a bad Flexible Disk Controller card.

**DETAIL CODE 01**

Software error. Reboot system and perform test again. Suspect bad diagnostics program disk.

**PERIPHERAL ERROR CODES (20-25)****20 SERIAL COMMUNICATIONS ERROR**

Format of code:

\*\*\* ERR: 20:ww, EXP DATA: xx, OBS DATA: yy

Where,        ww     = DETAIL code  
               xx     = Optional expected data  
               yy     = Optional observed data

**NOTE:** EXP DATA and OBS DATA are in reference to the registers in error. If a register is not in question these fields are not displayed.

**DETAIL CODE:**

The detail code is a bit sensitive code. It is displayed on the CRT as a hex code with bit 7 as the MSB and bit 0 as the LSB. An "x" represents the don't care state. The detail codes are used to construct the error code for all serial communication failures. Block 1 codes represent failures of the 8250 serial communications chip or the line drivers used to transmit or receive data from the serial (RS 232) port. To form the error code the detail codes for block 1 diagnostics are logically "or"ed. Observe that the following bit designations are used:

bits 0,1	communications channel selected
bits 2,3	error during transmit or receive
bit 4	internal/external loop back test
bits 5,6	control/status errors
bit 7	time out or receive data error

LEVEL 1 DIAGNOSTICS ERROR RETURNS

BLOCK 1	Bit	7	6	5	4	3	2	1	0
COM1 channel selected		x	x	x	x	x	x	0	1
Error on channel during transmit		x	x	x	x	0	1	x	x
Error on channel during receive		x	x	x	x	1	0	x	x
Channel loop back internal		x	x	x	1	x	x	x	x
Channel loop back external		x	x	x	0	x	x	x	x
LOOP MODEM CONTROL to status error		0	0	0	x	x	x	x	x
MODEM STATUS will not reset		0	0	1	x	x	x	x	x
MODEM STATUS will not set		0	1	0	x	x	x	x	x
LINE STATUS error		0	1	1	x	x	x	x	x
Channel time out error		1	0	0	x	x	x	x	x
Receive data error		1	0	1	x	x	x	x	x

Figure 6-16 contains information on status/control detail codes used by the serial communications chip.

	(LSB) Bit #0	Bit #1	Bit #2	Bit #3	Bit #4	Bit #5	Bit #6	(MAB) Bit #7
Receive Register (Read Only)	Data Bit 0	Data Bit 1	Data Bit 2	Data Bit 3	Data Bit 4	Data Bit 5	Data Bit 6	Data Bit 7
Transmit Register (Write Only)	Data Bit 0	Data Bit 1	Data Bit 2	Data Bit 3	Data Bit 4	Data Bit 5	Data Bit 6	Data Bit 7
Line Status Register	Logic 1 When Data Is Ready	Overrun Error	Data Parity Error When Set to Logic 1	Logic 1 Indicates No Stop Bit Error	Break Interrupt	Transmit Hold Register Empty Flag	Transmit Shift Register Flag	
Modem Control Register	Reflects the State of DTR Control Line	Reflects the State of RTS Control Line	User Defined Output	User Defined Output	Logic 1 Indicates Internal Loop Back Diagnostics			
Modem Status Register	Defines Receipt of CTS Control Signal	Reflects DSR Control Line Status	Ring Indicator Control Line Status	Receive Line Signal Detector Status	Complement of CTS Input Signal	Complement of DSR Input Signal	Complement of Ring Indicator Input	Complement of Receive Line Signal Input
Interrupt Enable Register	Logic 1 Enables Data Available Interrupt	Logic 1 Enables Transmit Register Empty Infr.	Logic 1 Enables Receive Line Status Interrupt	Logic 1 Enables Modem Status Interrupt				
Interrupt ID Register	Logic for Interrupt Pending	Interrupt ID 0	Interrupt ID 1					

Figure 6-16 Serial Communications Status

<b>BLOCK 2</b>								
Detail codes associated with block 2 are indicative of serial communications interrupt failures or a failure to select the serial communications chip completely.								
Channel interrupt error on wrong channel, Interrupting channel indicated.	1	1	1	0	0	0	x	x
eg.								
No COM interrupt	1	1	1	0	0	0	0	0
Channel interrupt on COM1	1	1	1	0	0	0	0	1
Channel interrupt on COM2	1	1	1	0	0	0	1	0
Bad INTERRUPT ID status before interrupt	1	1	1	0	0	1	x	x
Bad INTERRUPT ID status after interrupt on COM1	1	1	1	0	1	0	x	x
Select error COM1	1	1	1	0	1	1	0	1

NOTE: See Figure 6-16 for status/control definitions

### Repair Procedure 06

Before starting to troubleshoot the communications channel it is recommended that the system configuration switches be checked for the proper settings. It is also necessary to install a Loop Back connector on the RS-232 Port. If you do not have the Loop Back connector construct one using an RS-232 female connector with the pins jumpered as in Figure 6-17. If you have not already done so, refer to the "Basic System Configuration" section of this chapter. Most of the bit sensitive codes that are specified in the error message refer to the failure of the 8250 communications chip or one of the associated line drivers. This test can be used to determine if a peripheral device (modem, printer, etc.) connected to the serial (RS-232) port is defective. Figure 6-18 shows the location of hardware used by the serial communication port. To test the C Data Bus to the 8250 serial communications chip a printer can be attached to the computer's printer port (J12) and diagnostics check run on the printer. If the printer fails then the problem is probable an intermittent bus driver on the C data bus (U61). This test can be used since both printer and serial port use the C Data Bus.

NOTE: Remove any equipment attached to the RS-232 port and install the Loop Back connector BEFORE running the diagnostics test.

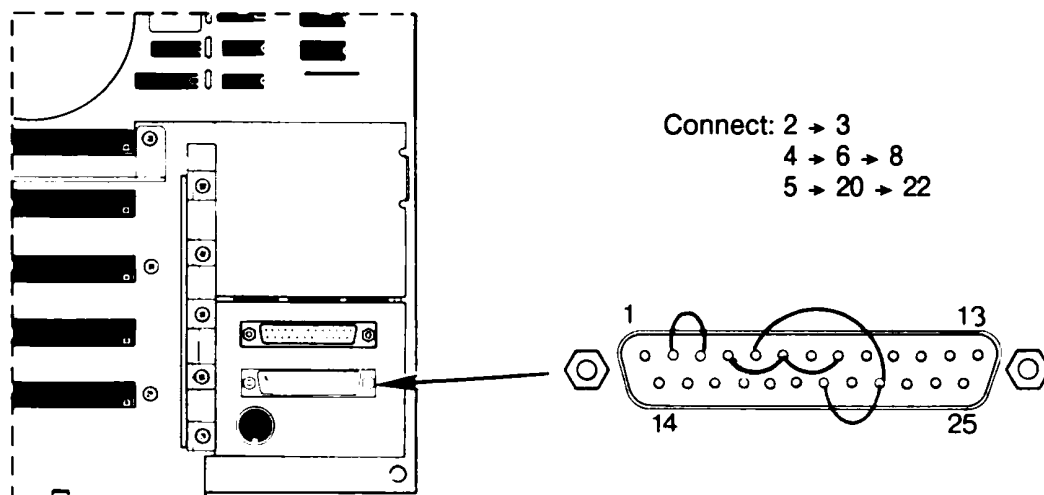


Figure 6-17 RS-232 Loop Back Connector

**DETAIL CODE (BLOCK 1)**

If an internal error is returned by the device code (bit 4 at logic 1) then suspect a failure of the 8250 serial communications chip. Errors that occur during external loop back checks require that the line drivers from/to the 8250 be checked for proper operation. Figure 6-16 provides more information for determining the actual cause of an internal failure.

**DETAIL CODE (BLOCK 2)**

The serial interrupt can be detected as the output of the tri state buffer U40. It is routed to the interrupt controller chip U10 through switch block 2 on the Main Processor Board. For interrupt failures check that the system configuration switches are set for COM1 interrupt (interrupt 4 on U10). If the switch is properly configured then proceed from the output of U40 (pin 10) to determine if the interrupt signal is operational (refer to Figure 6-18).

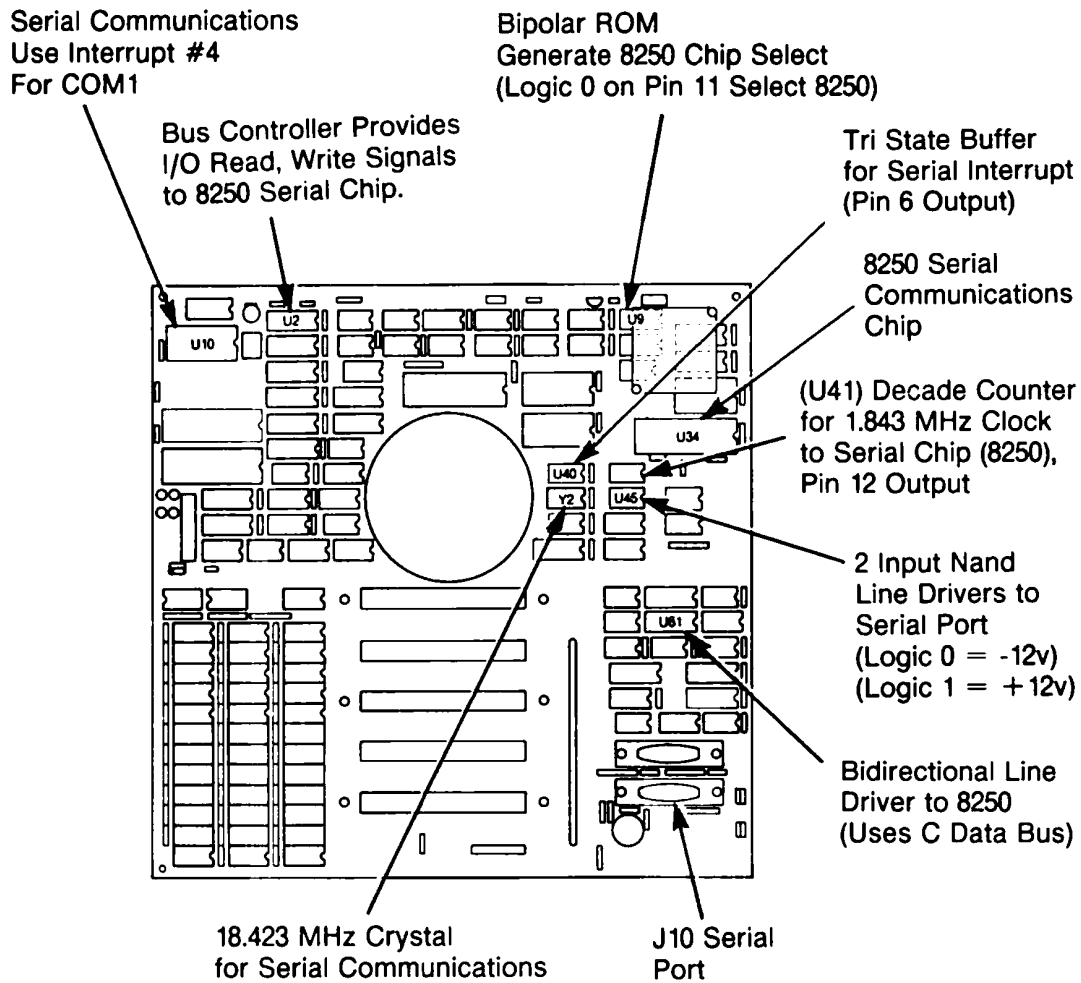


Figure 6-18 Serial Communications Port Hardware

## 21 CRT ERROR

Format of code:

\*\*\* ERR: 21:ww, EXP DATA: xx, OBS DATA: yy

Where,      ww      = DETAIL code  
               xx      = Expected data from register  
               yy      = observed data from register

DETAIL code:

- 01      Monochrome crtc register access error
- 02      Monochrome crtc cursor error
- 03      Monochrome crtc character set error
- 04      Monochrome crtc attribute error
- 06      Monochrome crtc scroll error
- 11      Color crtc register access error
- 12      Color crtc cursor error

13	Color crtc 80x25 character set error
14	Color crtc attribute error
15	Color 640x25 mode error
16	Color crtc scroll error
20	Color 320x200 graphics error — color set 0
21	Color 320x200 graphics error — color set 1
22	Color 640x300 graphics error
30	Color light pen test aborted (timeout)
31	Color light pen address failure

### Repair Procedure 07

Detail codes 01 through 06 refer to the errors that occur on systems that use a monochrome display. Detail codes 11 through 22 are associated with systems that use a color CRT.

If you have another CRT Controller card, try installing it. Should this not solve the problem, remove the CRT Controller card from its Expansion slot location and reinstall it in another expansion slot location. This will correct a problem that is the result of a bad expansion slot connector. If the CRT is operational and will perform some functions (such as inverting the display) then the Character Generator ROM on the CRT Controller Card is probably defective. Errors that are reported for the Monochrome/Color CRT units are usually the result of a bad CRT Controller card. To check the possibility of a bad data path to the controller card from the Main Processor Board, a Memory Expander card can be placed into the expansion slot occupied by the video controller card and the diagnostics test for RAM failures can be executed. To use this technique a BCD display must be installed for error message output. If no error messages are generated, then the data path to the expansion slot is functional. If the CRT display is operational but the display does not stabilize, then refer to the "Video (CRT) Specifications And Adjustments" section of the *System Setup/Alignment/Checkout* chapter of this manual and perform the necessary adjustments to the CRT. Figure 6-19 shows the Main Processor Board hardware components required for proper CRT operation.

### WARNING

The CRT Analog Controller board contains HIGH VOLTAGE elements.

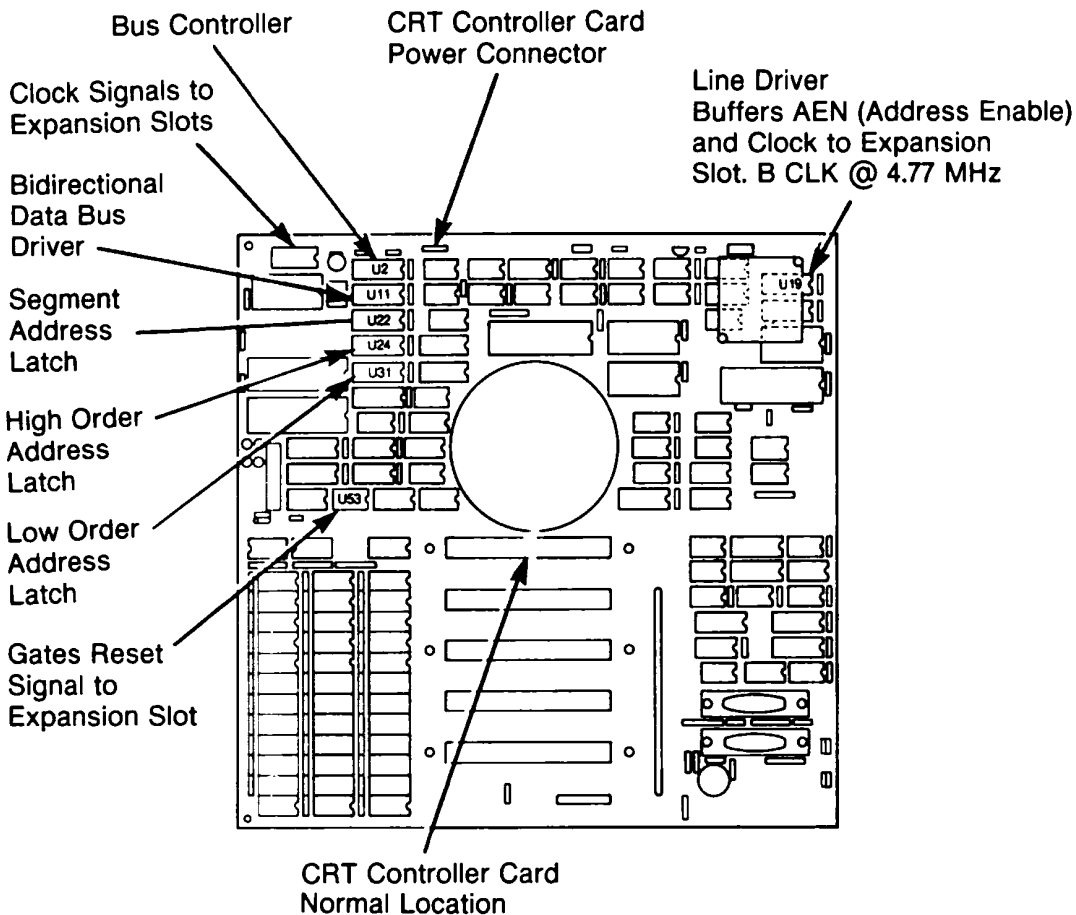


Figure 6-19 CRT Support Hardware

If the problem is the result of a bad video display unit and not the digital circuitry, then check for the proper voltages to the analog video circuits. If the display is out of alignment, refer to the "Video (CRT) Specifications And Adjustments" section of the *System Setup/Alignment/Checkout* chapter of this manual for more information.

**DETAIL CODES 01, 02, 06, 11, 12**

Suspect a defective CRT Controller card, probably the CRT Controller chip.

**DETAIL CODE 03, 13**

Suspect defective Character Generator ROM on the CRT Controller Card or defective Character Code RAM. Perform CRT RAM test to verify CRT character code integrity.

**DETAIL CODE 04, 14**

Recommend use of the CRT RAM Error diagnostics test to check for possible defective attribute RAM chip.

**DETAIL CODE 20, 21**

Check the color adjustment to the CRT.

**22 CRT RAM ERROR**

Format of code:

\*\*\* ERR: 22:01, ADDR: ssss:0000,EXP DATA: xxxx,  
OBS DATA: yyyy

Where,        ssss    = Segment address of error  
              0000    = Offset address of error  
              xxxx    = Expected data  
              yyyy    = Observed data

**DETAIL CODE:**

01        Monochrome pattern error  
02        Monochrome address error  
11        Color pattern error  
12        Color address error

**Repair Procedure 08**

Refer to "Repair Procedure 07". Use the Memory Expander Card to test the CRT Controller card data path. If the Memory Expander Card produces a RAM failure error, then the hardware data path to the Expansion Slot is suspected to have failed. Otherwise suspect a defective RAM chip on the CRT Controller card.

**DETAIL CODE 01 and 11**

These codes refer to the monochrome and color units respectively. They indicate an intermittent failure of a line driver to the RAM chip or a stuck data bit within the RAM. If the Flexible Disk Drive Controller or the Memory Expander Card (if installed) do not produce an error in the diagnostics test then the CRT RAM chip is most likely the cause of the error condition.

**DETAIL CODE 02 and 12**

Suspect intermittent failure of an address latch. Check the Address Bus to the Main Processor Board expansion slot for proper operation (particular attention should be given to address lines 18 and 19). The failure is probably the result of a defective component on the CRT Controller Card.

## 23 KEYBOARD ERROR

Format of code:

\*\*\* ERR: 23:ww, EXP DATA: xx, OBS DATA: yy

Where,        ww     = DETAIL code  
              xx     = Expected data from keyboard port  
              yy     = Observed data from keyboard port

DETAIL code:

- 01     Keyboard port will not reset
- 02     No interrupt on keyboard
- 03     Bad data on loop back of keyboard port
- 04     Bad data from keyboard

### Repair Procedure 09

Check that the keyboard is connected properly to the Main Processor Board connector. The pins of the keyboard connector should be checked for damage.

#### DETAIL CODE 01

Suspect that the serial to parallel converter (U42 on the MPB) is defective.

#### DETAIL CODE 02

The keyboard connector J16 should be checked for power to the keyboard. Pin 5 should read 5v and pin 4 should read 0v (ground). If the keyboard is receiving power then the keyboard is either not sending data to the Main Processor Board or the data path contains a defective component. Check the EXP and OBS DATA fields. If the OBS DATA returns a code of 55 then the keyboard is operational and the data path (to U42) is not defective. In this case suspect the interrupt latch (U57) to be defective. Check U57 for proper operation. Figure 6-20 shows the Main Processor Board components that comprise the keyboard interrupt signal path.

#### DETAIL CODES 03 and 04

These codes indicate an internal keyboard failure or failure of the serial to parallel converter. Check inputs to U42 and proper operation of the keyboard clock.

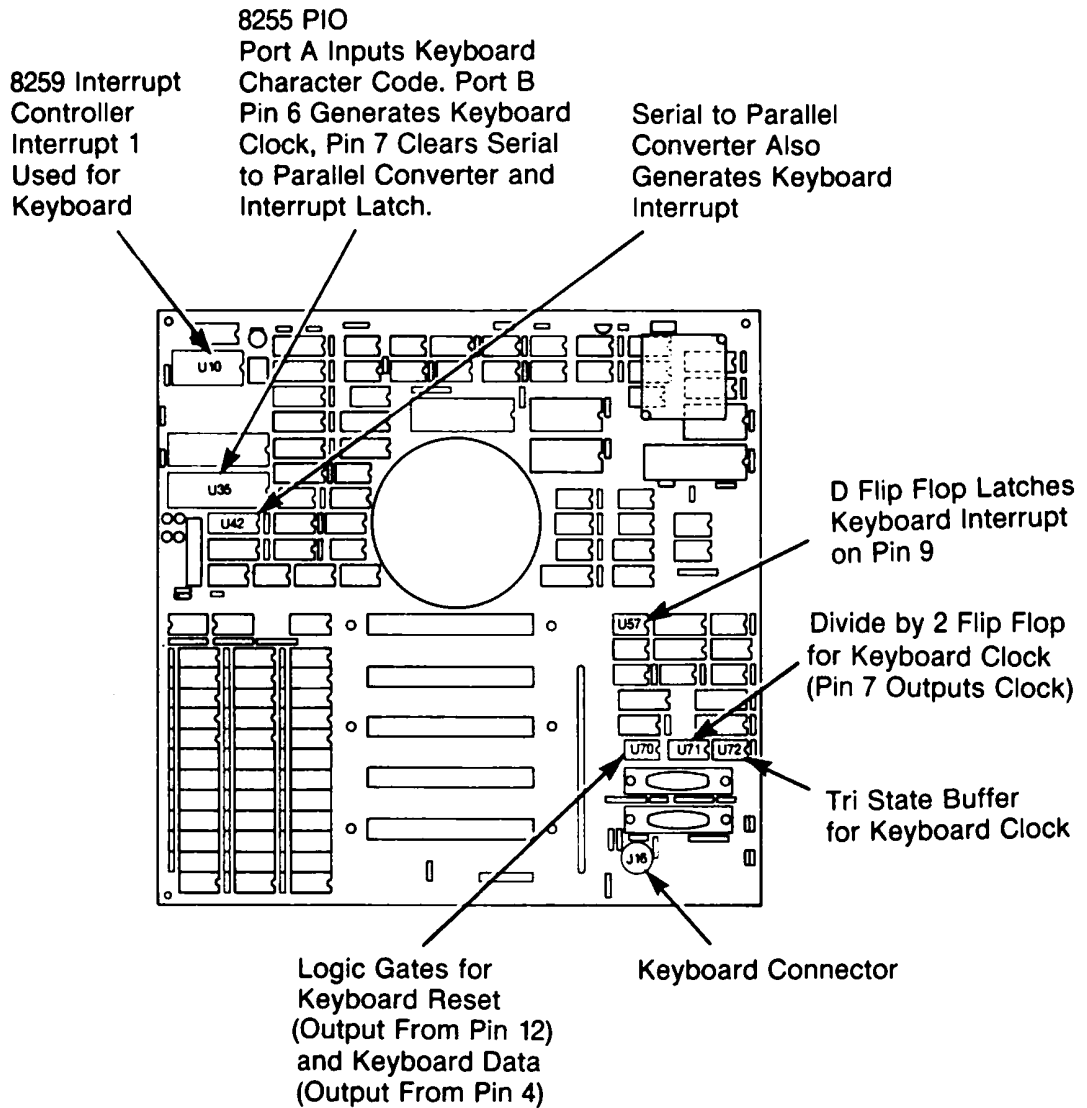


Figure 6-20 Keyboard Related Hardware

## 24 PRINTER PORT ERROR

Format of code:

\*\*\* ERR: 24:ww, EXP DATA: xx, OBS DATA: yy

Where,      ww      = DETAIL code  
                  xx      = Expected data  
                  yy      = observed data

DETAIL code:

- 01      Printer data port error
- 02      Printer control port error
- 03      Printer status port error
- 04      No interrupt on printer port

### Repair Procedure 10

To perform the diagnostics test on the printer port it is necessary to install a Loop Back connector . The construction of the Loop Back connector is shown in Figure 6-21. The location of hardware components used by the Printer Port is shown in Figure 6-22.

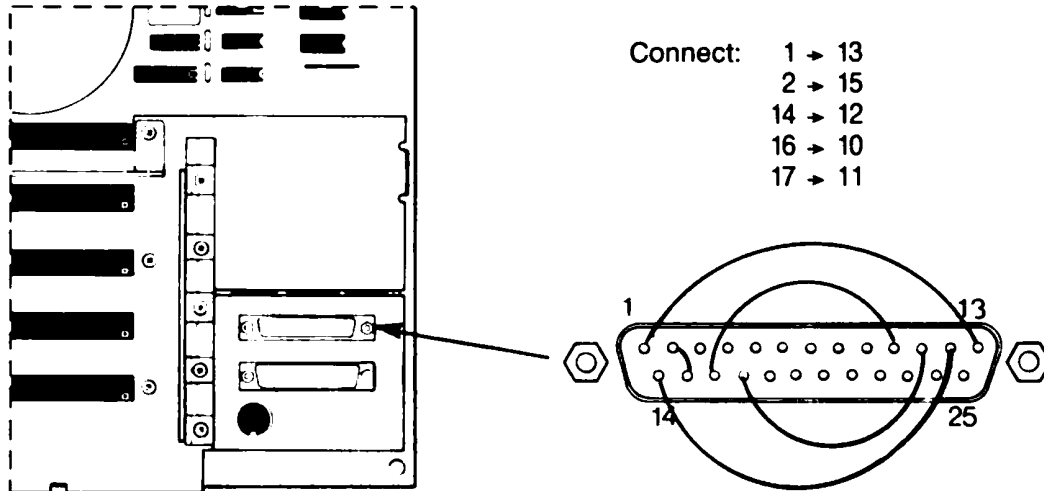


Figure 6-21 Printer Port Loop Back Connector

### DETAIL CODE 01

If the printer data path is defective the diagnostics test with Loop Back connector installed will show the failure (invalid data) in the EXP DATA and OBS DATA fields. For valid data the expected and observed fields will be the same. Should the test fail then the problem is resident on the Main Processor Board.

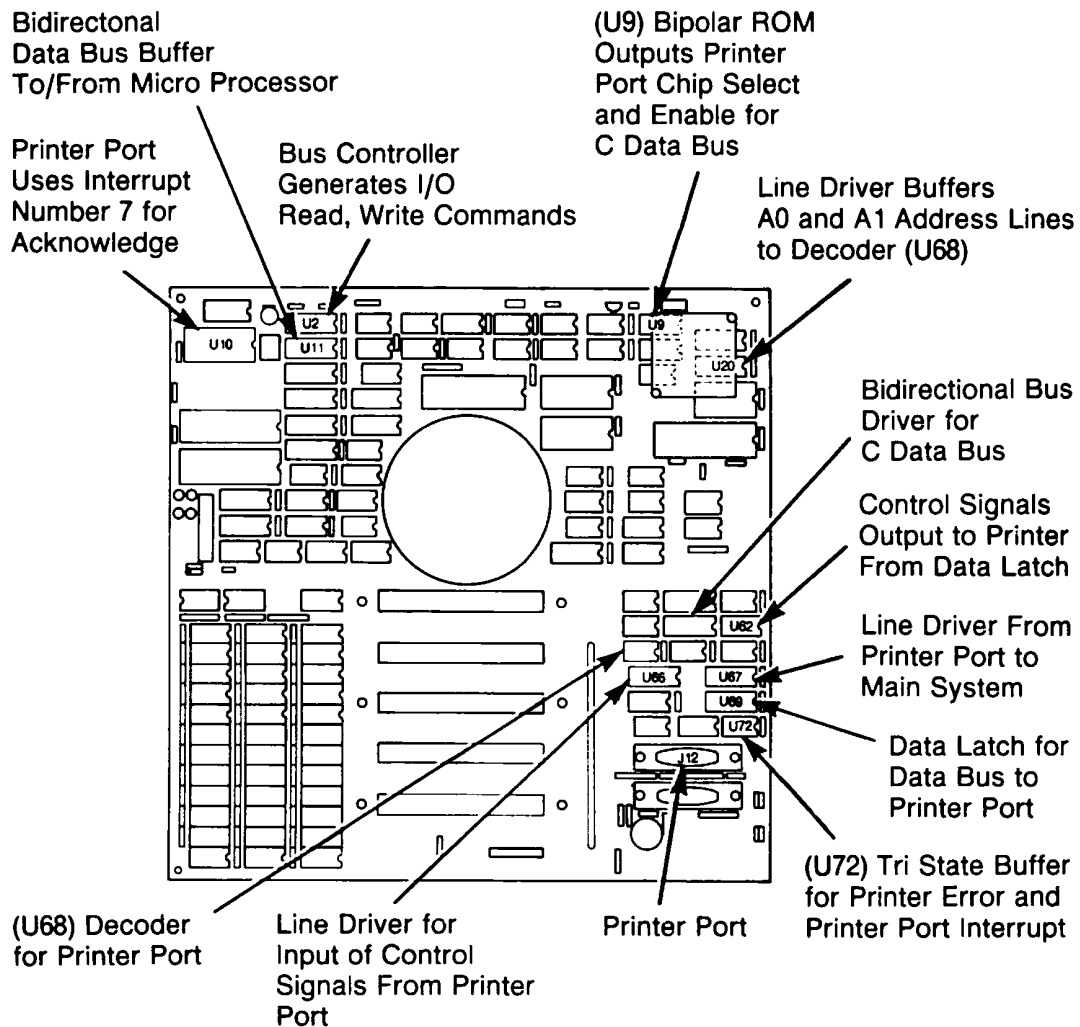


Figure 6-22 Printer Port Hardware Components

To check the integrity of the data bus used to communicate with the Printer Port a loop back connector can be placed on the RS 232 SERIAL PORT (J10) and diagnostics performed on the Serial Port. If the Serial Port also fails the diagnostics test then the problem is a bad Bipolar ROM (U9, which generates chip selects for serial and printer ports) or a defective component on the C Data Bus.

**DETAIL CODE 02 and 03**

Printer control and status is a Main Processor Board Failure and requires the analysis of printer port hardware. The problem might be a defective data bus line driver or data latch. Suspect the C data bus routed from the 8255 (PIO, U35) through line driver U61 and data latch U69 to the printer port. Refer to Detail Code 01.

**DETAIL CODE 04**

Suspect Interrupt #7 not operational at interrupt controller (8259, U10). Check the operation of -ACK from the printer port (J12 pin 10). Check U72 (tri state buffer for interrupt 7) for proper operation.

**25 PRINTER ERROR**

Format of code:

\*\*\* ERR: 25:ww

Where, ww = DETAIL code

DETAIL code:

- D0 ----- 1 = Printer time out
- D3 ----- 1 = I/O error
- D4 ----- 1 = Printer select
- D5 ----- 1 = Out of paper
- D6 ----- 0 = Ack (internal)
- D7 ----- 0 = Printer busy

**Repair Procedure 11**

Refer to "Repair Procedure 10". Check the installation of the printer; suspect bad cable connection or printer switch settings.

**MAJOR SYSTEM CONTROLLER ERROR  
CODES (30-39)**

Diagnostic Error Codes 30, 32, 33, 34, 35, 36 are associated with failures on the Main Processor Board. To analyze the error condition requires the use of an oscilloscope. However, some of the components are installed in sockets and can be removed. Replacement of defective socketted components may alleviate the error condition.

**CAUTION**

Care should be used in removing any socketted IC component or damage to the component/socket may result.

**30 CPU ERROR (8088)**

Format of code:

\*\*\* ERR: 30:00

DETAIL code:  
NONE

### Repair Procedure 12

Check the 8088 (U30) for correct installation. Determine if the ready line of U30 is active; this will suspend operation of the microprocessor. If this condition is observed then check RDY and DMA wait inputs into the clock generator (U1). If one of these two control lines is not active then suspect that the clock chip (U1) or the processor (U30) is defective.

NOTE: A control line attached to a defective input that is also attached to the inputs of other gates can produce unpredictable results and conditions that are difficult to troubleshoot.

### 32 INTERRUPT CONTROLLER (8259)

Format of code:  
for DETAIL 10,

\*\*\* ERR: 32:ww, EXP DATA: xx, OBS DATA: yy

Where,        ww     = DETAIL code  
              xx     = Expected data from register  
              yy     = Observed data from register

DETAIL code:

0x        Failed read/write to mask register (registers 2-15)

### Repair Procedure 13

Check the bus connections to the 8259 Interrupt Controller chip.

DETAIL CODE 10

Suspect 8259 (U10) data bus to processor (U30) connection; check data bus. The 8259 may be internally damaged resulting in intermittent failure.

DETAIL CODE 0x

Suspect intermittent failure of 8259 (U10); replace U10.

### 33 INTERVAL TIMER (8253)

Format of code:

\*\*\* ERR: 33:ww, EXP DATA: xxxx, OBS DATA: yyyy

Where,      ww    = DETAIL code  
             xxxx   = Expected data from register  
             yyyy   = Observed data from register

DETAIL code:

- 1x      Failed counter read/write test  
      x    = counter 2
- 2x      Timer too fast  
      x    = counter 0,1,2
- 3x      Timer too slow  
      x    = counter 0,1,2
- 5x      No output from timer 0  
      x    = counter 1,2

### Repair Procedure 14

DETAIL CODE 1x

Suspect intermittent failure of the 8253 timer chip (U29) or intermittent failure of line driver U58. Recommend check of the B data bus for proper operation.

DETAIL CODE 2x, 3x, 5x

Check the clock inputs to the 8253 (U29). Suspect U14 divide by 2 flip flop and the timer chip (U29).

### 34 DMA CONTROLLER (8237)

Format of code:

\*\*\* ERR: 34: ww, EXP DATA: xx, OBS DATA: yy

for DETAIL 1x thru 60,

Where,      ww    = DETAIL code  
             xx    = Expected data from register  
             yy    = Observed data from register

for DETAIL 70,

\*\*\* ERR: 34: ww, EXP DATA: xxxx, OBS DATA: yyyy

Where,      xxxx   = expected segment  
             yyyy   = observed segment

DETAIL code:

- 1x      DMA controller failed internal register read/write test  
      x    = register 2 thru 7

**Repair Procedure 15****DETAIL CODE 1x through 60**

Suspect intermittent failure of 8237 (U26) or line driver U58. Check B data bus connection to U26.

**DETAIL CODE 70**

DMA failed addressing test. Evaluate the EXP and OBS DATA fields to determine if the address failed along an eight bit address path. If the lower address bus (bits 0 — 7) has been altered then suspect line driver U32. For alterations of the high address bus (bits 8 — 15) suspect address latch U25. If Detail Code 70 is returned and the EXP and OBS data fields match then suspect U23.

**35 SYSTEM PIO (8255)**

Format of code:

\*\*\* ERR: 35:ww, EXP DATA: xx, OBS DATA: yy

Where,        ww     = DETAIL code  
               xx     = Expected data from port  
               yy     = Observed data from port

DETAIL code:

11        Port failed read/write test to port B

**Repair Procedure 16**

The system PIO uses port B for the following control functions: control the speaker on the Main Processor Board, enable RAM parity, read the sense switches, and keyboard control.

Because port B is used to control several different devices, the diagnostics test for those devices should return an error if there is a failure on one of its control lines. Run RAM PARITY TEST and KEYBOARD TEST using the diagnostics. To test the speaker depress any printing character key on the keyboard and hold. When the end of line is reached the speaker will click repeatedly until the key is released. The speaker should emit a constant tone. Intermittent failure is indicated by a random break in the tone. To test if the sense switches are being read properly, use the READ SWITCH option of the diagnostics. All of these tests should be run repeatedly to check for intermittent component failure. A failure detected by using this technique can isolate which line on the PIO is failing. Check 8255 (U35) Port B.

### 36 SERIAL PORT (8250)

#### FAILED LINE CONTROL REGISTER READ/WRITE TEST,

Format of code:

\*\*\* ERR: 36:ww, EXP DATA: xx, OBS DATA: yy

Where,        ww     = DETAIL code

DETAIL code:

- 01     Read/write to divisor latch hi
- 02     Read/write to divisor latch lo
- 03     Read/write to line control register
- 04     Read/write to modem control register

### Repair Procedure 17

Suspect defective 8250 (U34) or intermittent failure of C data bus. Perform the PRINTER PORT TEST. The printer uses the C data bus to communicate with the microprocessor. If the printer port passes (several runs of the test) then suspect the 8250 (U34) serial communications chip. A failure reported by the Printer Port Test indicates a failure of the C data bus; check line driver U61 for intermittent failure. Refer to "Repair Procedure 06" for troubleshooting the serial communications port.

### 37 FLEXIBLE DISK CONTROLLER (8272)

Format of code:

\*\*\* ERR: 37:ww, EXP DATA: xx, OBS DATA: yy

Where,        ww     = DETAIL code

              xx     = Expected data from register

              yy     = Observed data from register

DETAIL code:

- 10     No ready status from controller
- 11     Bad status returned after invalid command sent
- 12     Incorrect STATUS 0 returned from controller after  
          invalid command sent

### Repair Procedure 18

Suspect defective 8272 Flexible Disk Drive Controller chip. Replace 8272 or controller card. Refer to "Repair Procedure 05" for more information on troubleshooting Flexible Disk Drives.

**38 CRT CONTROLLER (6845)**

Format of code:

\*\*\* ERR: 38:ww, EXP DATA: xxxx, OBS DATA: yyyy

Where,        ww     = DETAIL code  
               xxxx   = Expected data from register  
               yyyy   = Observed data from register

DETAIL code:

0E     Cursor address register read/write error — 14 (mono)  
 0F     Cursor address register read/write error — 15 (mono)  
 1E     Cursor address register read/write error — 14 (color)  
 1F     Cursor address register read/write error — 15 (color)

**Repair Procedure 19**

Suspect defective 6845 CRT Controller chip. Replace the 6845 Controller chip or the CRT Controller Card. Refer to "Repair Procedure 07" for more information on troubleshooting Video (CRT) systems.

**39 WINCHESTER CONTROLLER**

Format of code:

\*\*\* ERR: 39:ww

Where,        ww = DETAIL code

DETAIL code:

01     Command error (internal)  
 02     Address error  
 04     Sector error  
 05     Reset error  
 07     Initialization error  
 09     DMA across 64K error (internal)  
 0B     Bad track  
 10     Uncorrectable data error  
 11     ECC soft error  
 20     Controller error  
 40     Seek error  
 80     Timeout error  
 BB     Undefined error (internal)  
 FF     Read status failed

Accompanying message:

```

      HEAD TRACK SECTOR CYCLE
***   XX   XXXX   XX   XXXX
    
```

### Repair Procedure 20

Check the power and ribbon cable connectors to the Hard Disk drive. Reinstall the Hard Disk Controller card in a different Expansion slot. Perform diagnostics test on the Flexible Disk Drive and the CRT unit. If both of these Expansion Slot devices pass the diagnostic test then the problem is a defective Hard Disk or Hard Disk Controller card.

Some error conditions can be corrected by reformatting the Hard Disk. If the Hard Disk Drive is reformatted all data previously stored on the drive is lost.

## HARD DISK ERROR CODES (40-49)

### 40-49 HARD DISK ERRORS

(Refer to Figure 6-6)

Format of code:

\*\*\* ERR: aa:ww

Where,      aa      = MAJOR code  
             ww      = DETAIL code

DETAIL code:

01	Command error (internal)
02	Address error
04	Sector error
05	Reset error
07	Initialization error
09	DMA across 64K error (internal)
0B	Bad track
10	Uncorrectable data error
11	ECC soft error
20	Controller error
40	Seek error
80	Timeout error
BB	Undefined error (internal)
FF	Read status failed

Accompanying message:

	HEAD	TRACK	SECTOR	CYCLE
***	XX	XXXX	XX	XXXX

### Repair Procedure 21

Major error codes 40 through 49 indicate failures that occur in the Hard Disk Drive assembly. (For failure of the Hard Disk Controller, a MAJOR error code of 39 is returned.) To verify the operation of the Main Processor Board bus signals insert another controller card (CRT, Memory Expander, Flexible Disk) in the expansion slot occupied by the Hard Disk Controller Card and perform diagnostics tests for the newly installed card. If the diagnostics tests pass then the problem resides on the Hard Disk Controller Card or the Hard Disk Drive subassembly. Check the Hard Disk Drive for proper installation and strapping.

#### DETAIL CODE 01

An invalid command was issued to the Hard Disk. Check the cable connections to the drive unit. Suspect failure of the Hard Disk Controller Card.

#### DETAIL CODE 02

Probable failure of the Hard Disk Controller Card.

#### DETAIL CODE 04

Suspect failure of the Hard Disk Drive. Reformatting the drive might correct the condition.

#### DETAIL CODE 05

Suspect failure of the Hard Disk Drive. Refer to "Repair Procedure 21" for checking the RESET signal to the expansion slot.

#### DETAIL CODE 07

Suspect failure of the Hard Disk Controller Card.

#### DETAIL CODE 09

Software failure. Repeat the test; if the test fails again, try another diagnostics diskette.

#### DETAIL CODE 0B

Suspect damage to Hard Disk Drive. Attempt to reformat the drive unit.

**DETAIL CODE 10**

Refer to DETAIL CODE 0B.

**DETAIL CODE 11**

Refer to DETAIL CODE 0B.

**DETAIL CODE 20**

The Hard Disk Controller Card failed while the diagnostics were testing the drive unit. Suspect defective Hard Disk Controller Card.

**DETAIL CODE 40**

Refer to DETAIL CODE 0B.

**DETAIL CODE 80**

The Hard Disk Drive failed to respond to the Hard Disk Controller. Check the drive for correct installation.

**DETAIL CODE BB**

Perform the diagnostics test again. Suspect failure of Hard Disk Controller Card or the diagnostics test diskette.

**DETAIL CODE FF**

Suspect failure of the Hard Disk Controller Card.

**FUTURE EXPANSION ERROR CODES (50-79)**

**50-79**

RESERVED for future expansion.

**MANUFACTURING TEST AND PERIPHERAL  
BUS TEST ERROR CODES (80-98)**

**80-98**

RESERVED for the manufacturing test and peripheral bus test.

**DIAGNOSTICS PROGRAM CHECKSUM ERROR  
CODE (99)**

**99 DIAGNOSTICS PROGRAM CHECKSUM ERROR**

The diagnostics program performs a check on itself after returning from a diagnostics test. If the program has been altered during the

last diagnostics test then this error is returned. The diagnostics disk must be rebooted. Perform a check of system memory to determine if a RAM chip is failing. The diagnostics program locates itself in the lowest 64K of RAM memory.

# *Disassembly/Assembly*

## **OVERVIEW**

This chapter describes how to remove and replace the major assemblies of the NCR Personal Computer.

## **WARNING**

Disconnect the power supply cord before removing the cabinet. Dangerous voltages are present when working on the computer with the cover removed.

**ONLY TRAINED ENGINEERS AND NCR TRAINED SERVICE PERSONNEL SHOULD ATTEMPT TO WORK ON THE COMPUTER WITH THE COVER REMOVED AND THE POWER ON.**

It is recommended that the first operation after removing the cover should be to discharge the CRT anode voltage.

## **CAUTION**

Electrostatic discharge can cause damage to some solid-state components used in the computer. Use special wrist-ground straps and integrated circuit handling procedures. Avoid touching the components or the circuit paths; handle printed circuit boards by their edges.

## **REMOVE ADAPTER CARDS**

### **ACCESS DOOR REMOVAL**

To gain access to adapter cards installed in the computer, first remove the access door which covers most of the bottom half of the back of the computer. Proceed as follows:

1. Make certain the power switches for any external devices (printer, etc.) are turned OFF.

2. Make certain the processing unit power switch is turned OFF.
3. Unplug the power cord from the wall outlet. If any external devices have separate power cords, unplug them too.
4. Unplug the power cord from the back of the processing unit.
5. Remove the access door screw shown in Figure 7-1.

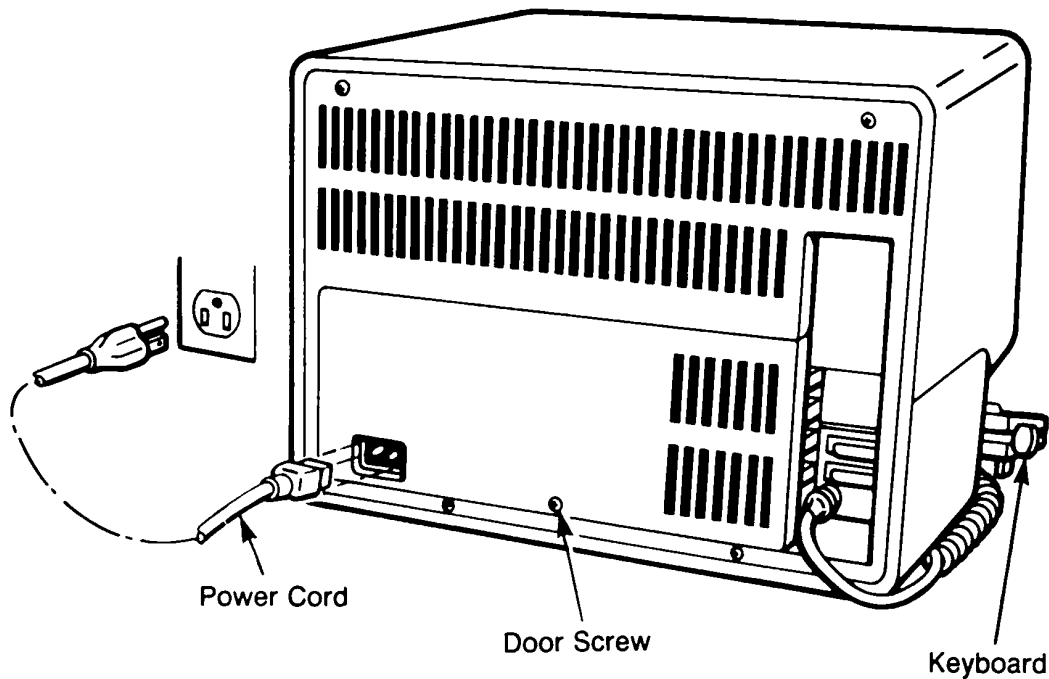


Figure 7-1 Access Door Removal

6. Grasp the right side of the access door and pull out at the bottom, then grasp the bottom corners and pull down gently. The top edge will come free as two formed-in lugs slide out of their matching slots in the back panel.

## REMOVAL OF ADAPTER CARDS

With the access door removed, the Main Processor Board (MPB) is now visible. The MPB is installed in a vertical position inside the cabinet of the NCR Personal Computer. Figure 7-2 shows a picture of the adapter card board slots with the access door removed.

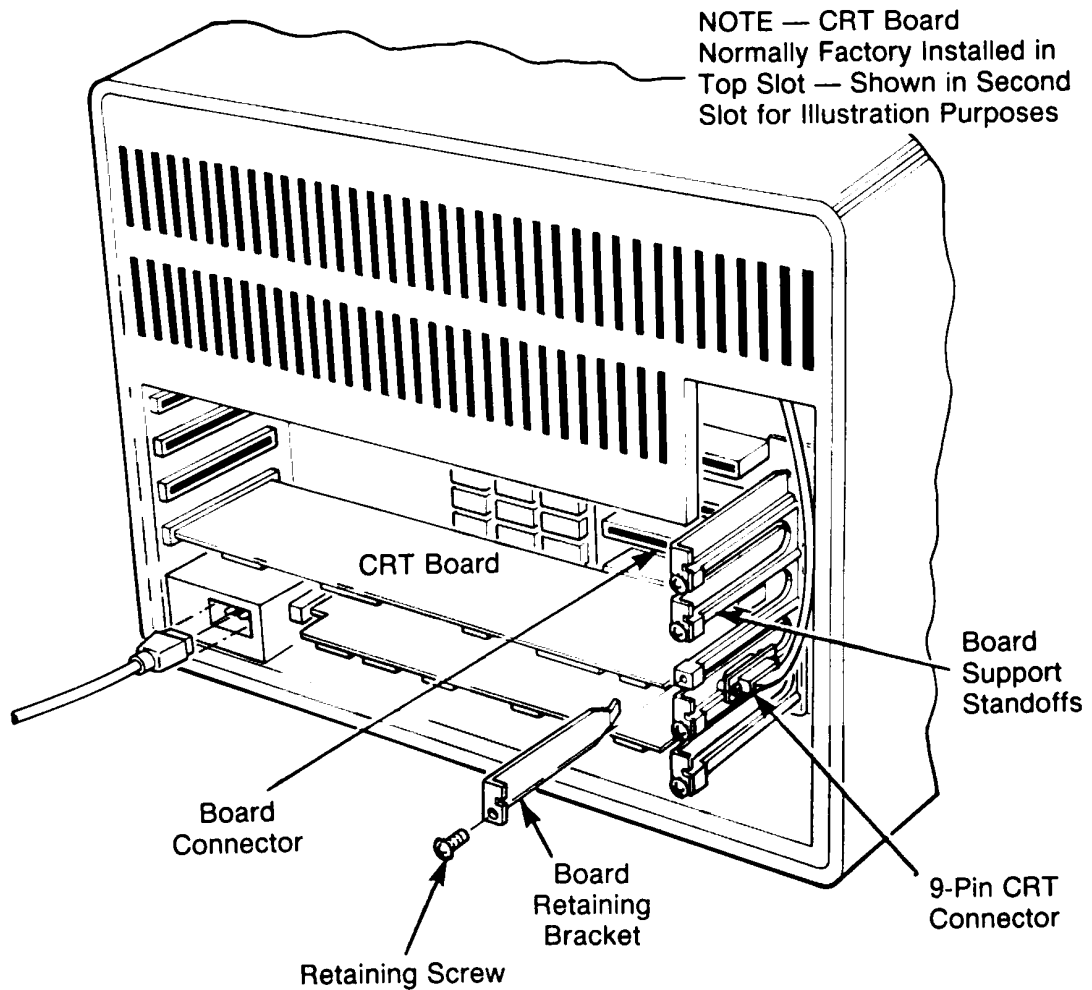


Figure 7-2 Adapter Card Slots

A unit with one or two flexible disk drives has a minimum of two adapter cards originally installed. The shorter bottom card with the flat ribbon cable attached to the left end is the flexible disk drive controller card; the longer card with the nine-pin connector on the right end is the monochrome or color/graphics CRT controller card.

A unit with a single flexible disk drive and a fixed disk drive has another longer card which is the fixed disk drive controller. This card has two flat ribbon cables attached.

Figure 7-3 shows a diagram of the portion of the MPB which is visible with the access door removed. The original memory chips, the expansion area which contains two sets of expansion memory sockets, and the five board connectors are indicated.

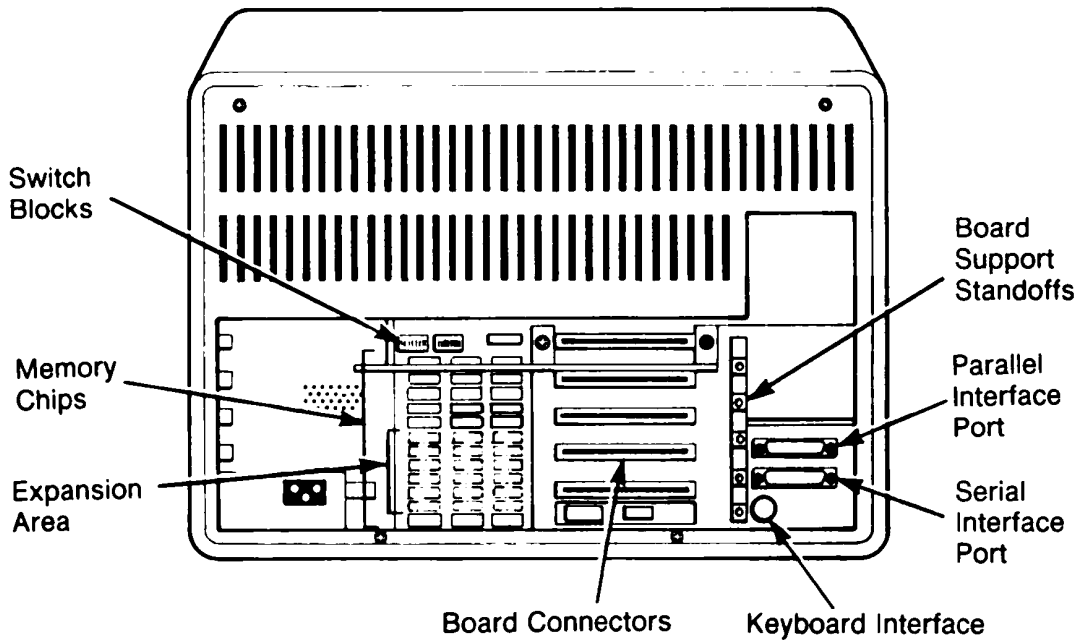


Figure 7-3 Main Processor Board

You need to remove all adapter cards installed in the computer if you are going to remove the cabinet. You may need to remove only the board, if any, in the top slot in order to reach the switches in switch block 1 or 2 (SW1 or SW2).

Remove each board gently but firmly after removing the retaining screw. If a cable is attached to a connector on the end of the board, unscrew the connector and unplug the cable.

To keep the retaining screw from getting lost, screw it loosely by hand back into the board support standoff.

## CABINET

### PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURE:

- Remove Adapter Cards

### PROCEDURE

**NOTE:** Systems having a Winchester disk drive and a flexible disk drive will have separate ribbon cables for each. When removing the ribbon cables from their respective controller cards, mark the cables to ensure proper reassembly (Winchester drive to Winchester card and flexible disk drive to flexible card). When returning an adapter card to the top bus expansion slot of the main processor board, it is easy to accidentally change the system

configuration switch setting of SW1 or SW2. Always verify these switch settings after installing a card in the top expansion slot.

1. Remove the two (2) cabinet-back screws at the top of the cabinet back.
2. Slowly pull the cabinet back towards you, away from the unit; guide the adapter card cables through the card cage area to prevent damage.
3. Remove the cabinet top by gently but firmly lifting the back edge of the cabinet top. The joint between the cabinet top and bottom should be opened approximately 1/2 inch to allow the cabinet alignment lugs to disengage.
4. Carefully slide the cabinet top forward, lifting, as required, to clear the components.

## KEYBOARD

### PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURE:

- None

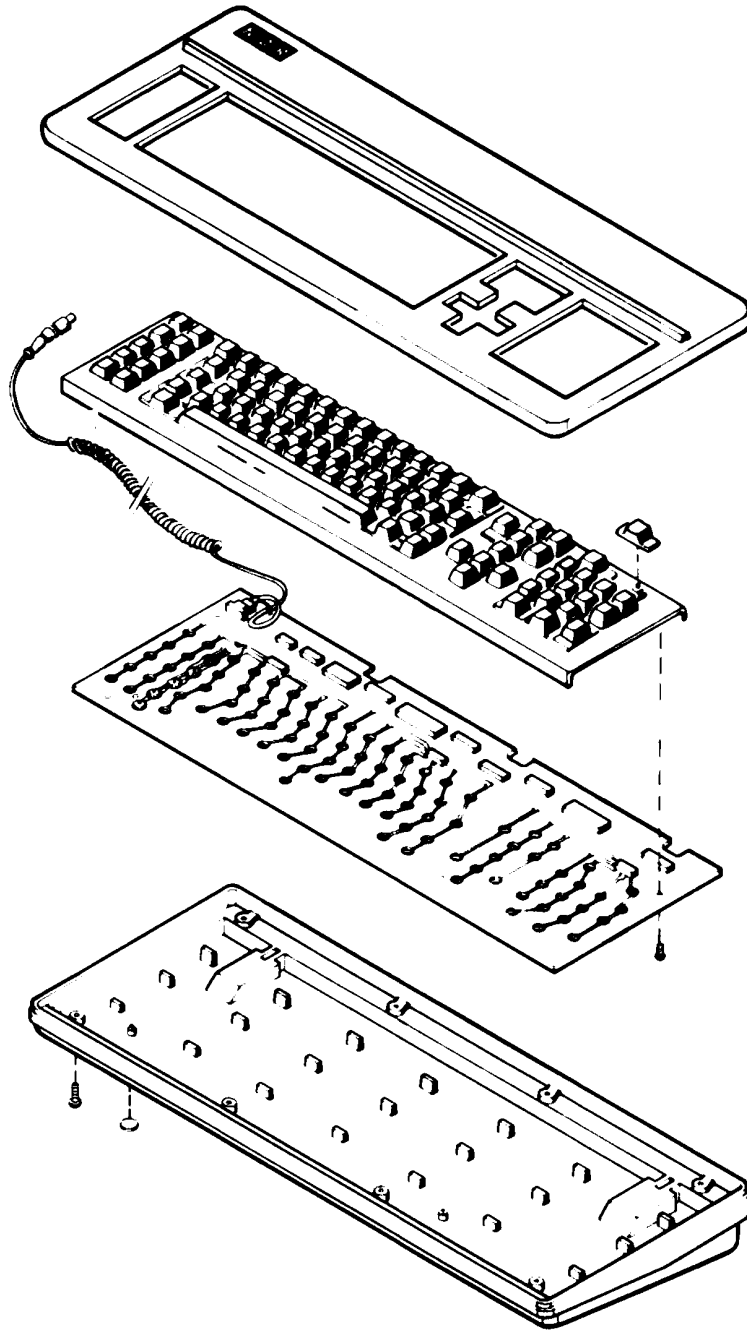


Figure 7-4 Keyboard Disassembly

### KEYCAP REPLACEMENT PROCEDURE

1. Disconnect Keyboard cord from the back of the unit.
2. Using a flat-bladed tool, gently pry the keycap up off the key stem.
3. To replace keycap, center the keycap on the key stem and press down until the keycap snaps in place.

## **KEYBOARD DISASSEMBLY PROCEDURE**

1. Disconnect keyboard cord from the back of the unit.
2. Turn keyboard over and remove the seven (7) screws on the back.
3. Holding the halves together, turn the keyboard key side up and lift off top cover.
4. Remove the four (4) screws holding the circuit assembly to the keyboard bottom.
5. Remove the key pad from the circuit board by removing the eight (8) screws located on the bottom (board side) of the assembly.

## **WINCHESTER DISK DRIVE**

### **PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURE:**

- Cabinet

### **PROCEDURE**

1. Disconnect the ribbon cables attached at the back of the Winchester disk drive.

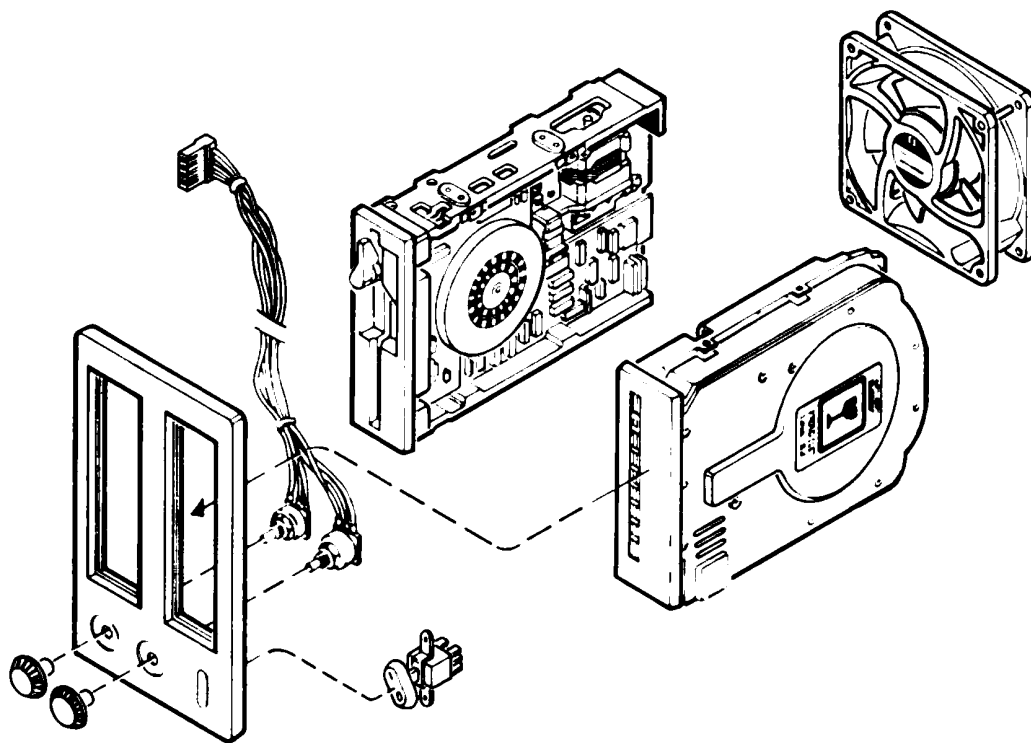


Figure 7-5 Disk Drive Removal

2. Disconnect the DC power plug from the Winchester disk drive.
3. Remove the three (3) drive retaining screws. Two screws are located on the top drive mounting bracket and the third screw is located on the underside of the bottom drive bracket near the control panel.

**NOTE:** The three (3) retaining screws for the Winchester disk are metric and the three (3) screws used to retain the flexible disk are SAE. Do not exchange these screws from one drive to another of a different type.

4. Carefully guide the drive out the front of the disk control panel bezel.

## FLEXIBLE DISK DRIVE

### PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURE:

- Cabinet

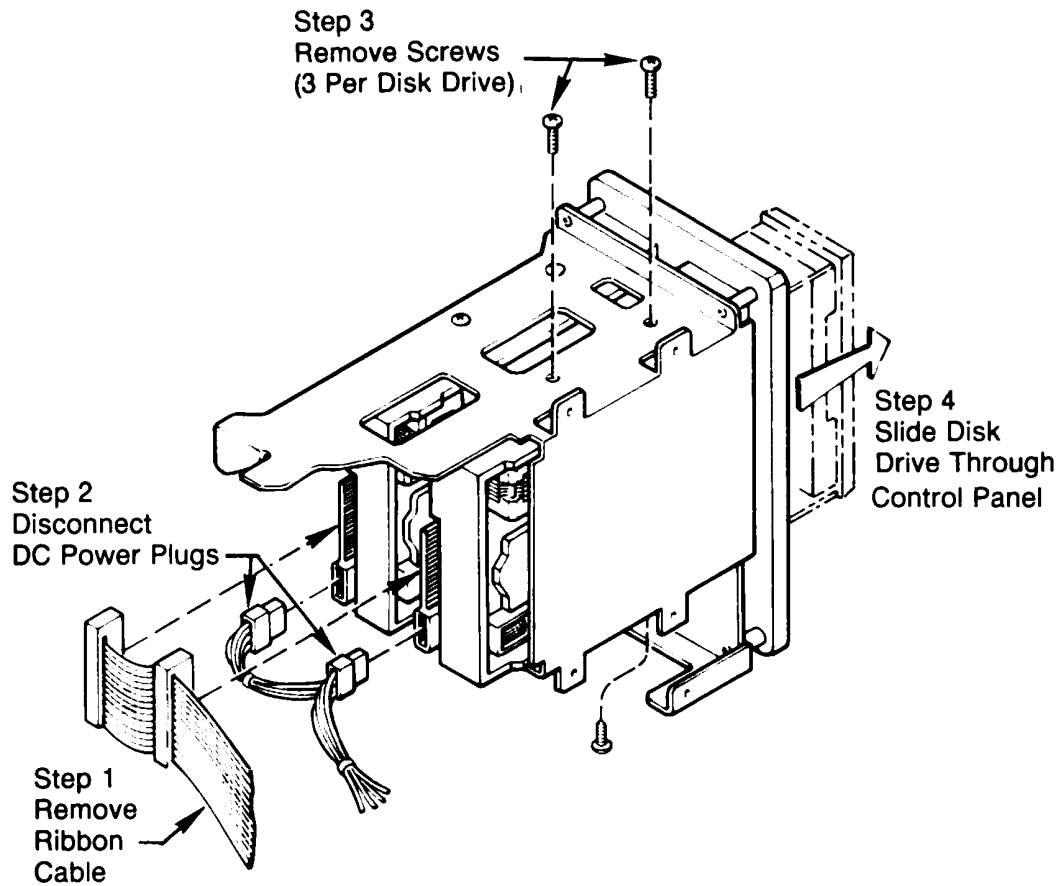


Figure 7-6 Flexible Disk Drive Removal

## PROCEDURE

1. Disconnect the ribbon cable attached at the back of the flexible drive(s).
2. Disconnect the DC power plug from the flexible disk unit(s).
3. Remove the three (3) drive retaining screws for the disk drive unit being serviced. Two screws are located on the top drive bracket and the third screw is on the underside of the bottom drive bracket near the control panel.
4. Slide the disk drive forward through the control panel.

## POWER SWITCH

### PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURE:

- Cabinet

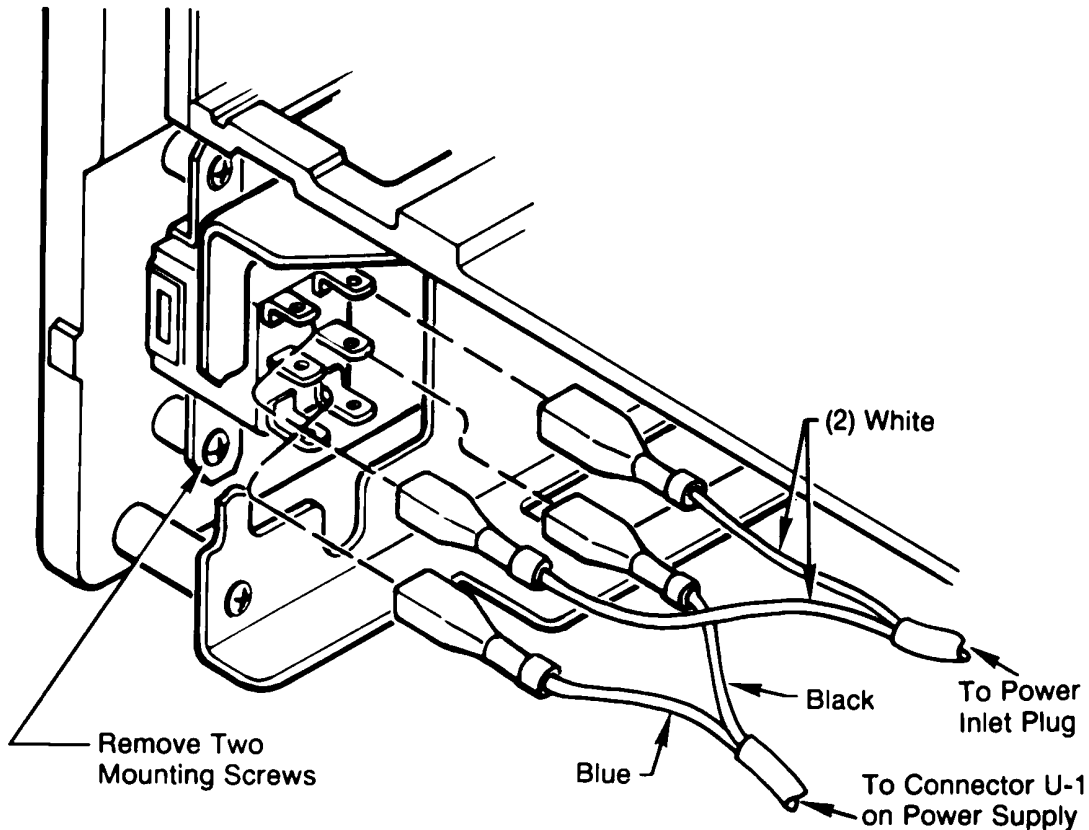


Figure 7-7 Power Switch Disassembly

## PROCEDURE

1. Verify that the power cord is disconnected from the back of the unit.
2. Remove the four (4) wire connectors from the back of the switch.
3. Remove the two (2) switch mounting screws located above and below the switch.
4. Push the switch back into the cabinet; it will clear the lowest bracket.

## BRIGHTNESS AND VOLUME CONTROLS

### PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURE:

- Cabinet

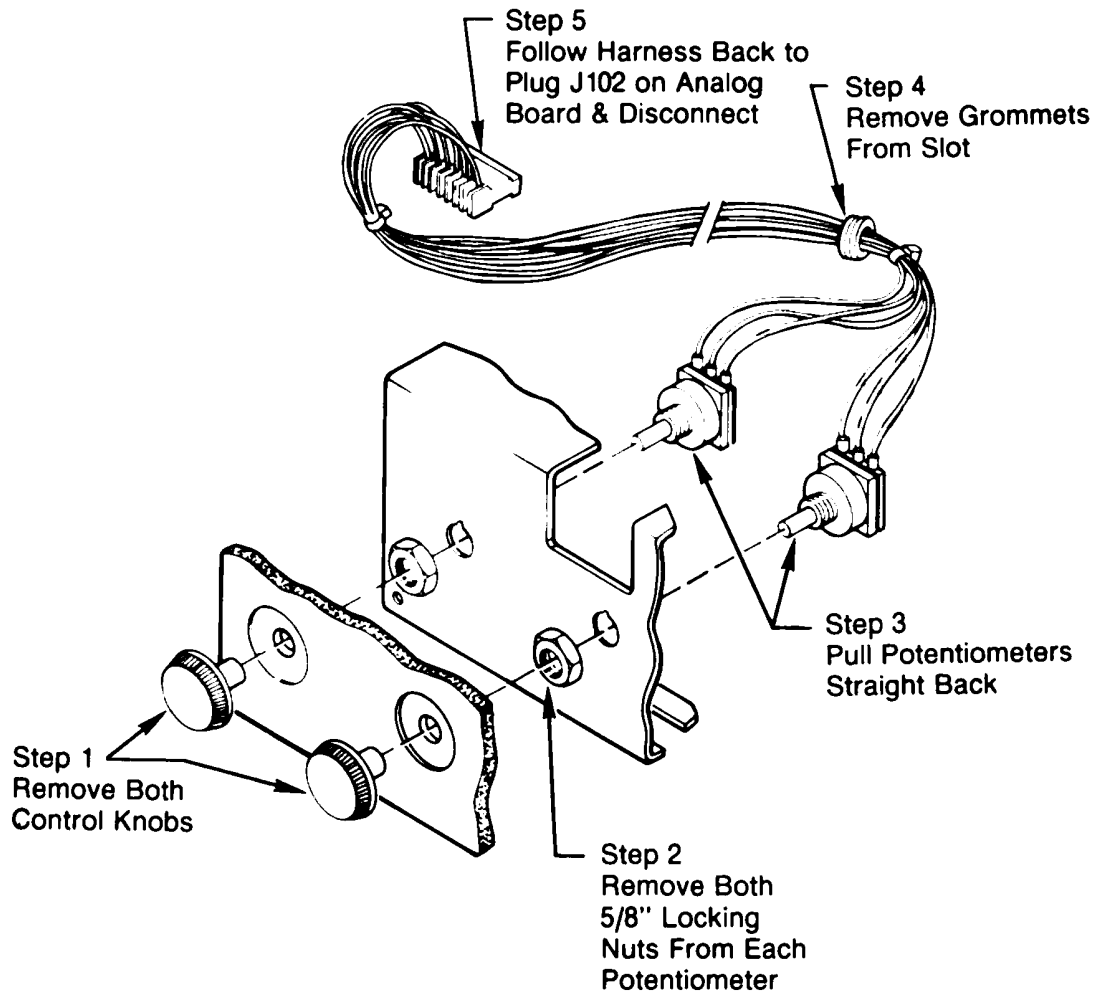


Figure 7-8 Brightness and Volume Controls Disassembly

## PROCEDURE

1. Remove the two (2) control knobs by pulling each away from the control panel.
2. Using a 5/8" open-ended wrench, back off the potentiometer locking nuts (located on the threaded shafts of each potentiometer).
3. Pull the potentiometers back, freeing them from the cover panel.
4. Remove the cable strain relief grommet by carefully pulling it down out of its slot.
5. Follow the wire harness back to the connector plug J102 on the CRT analog board; disconnect.

## FAN

### PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURE:

- Cabinet

### PROCEDURE

1. Remove the two (2) wire connectors from the bottom of the fan.  
Note that the blue wire connects to the positive (+) terminal.
2. Remove the two (2) fan mounting bolts.

## MONOCHROME CRT AND ANALOG BOARD

### PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURES:

- Cabinet
- Main Processor Board

### WARNING — HIGH VOLTAGES

High voltages may be present on the CRT anode even when the display is not operating. *Always* discharge the CRT high voltage anode before servicing any part of the CRT assembly. Refer to “CRT Discharge Procedure” in this disassembly section. Always assume that a CRT is charged until *you* discharge it. Any conductive material (i.e. tools, service personnel, etc.) placed near the flyback transformer can cause an arc to jump the gap between the transformer and the conductive material.

### WARNING — HIGH VACUUM

Cathode Ray Tube (CRT) “contains” a high vacuum. Minor damage from scratches or hits can result in CRT implosion and injuries can occur from flying glass. Observe the following safety procedures:

1. Wear safety glasses when installing or removing CRT's.
2. Do not carry CRT's by the neck — always carry CRT's by holding near the mounting support band.
3. Temporary storage of a CRT on the service bench should be accomplished by placing it screen-side down on a clean, thick pad or towel.

## MONOCHROME CRT DISCHARGE PROCEDURE

You will need a 12-18 inch insulated wire jumper with alligator clips on both ends; a flat-blade screwdriver with a long, thin shaft and a clean, insulated handle.

1. Disconnect power supply and adapter card plugs to the analog board.
2. Attach one end of the wire jumper to the aquadag spring (located on the tapered back of the Cathode Ray Tube).

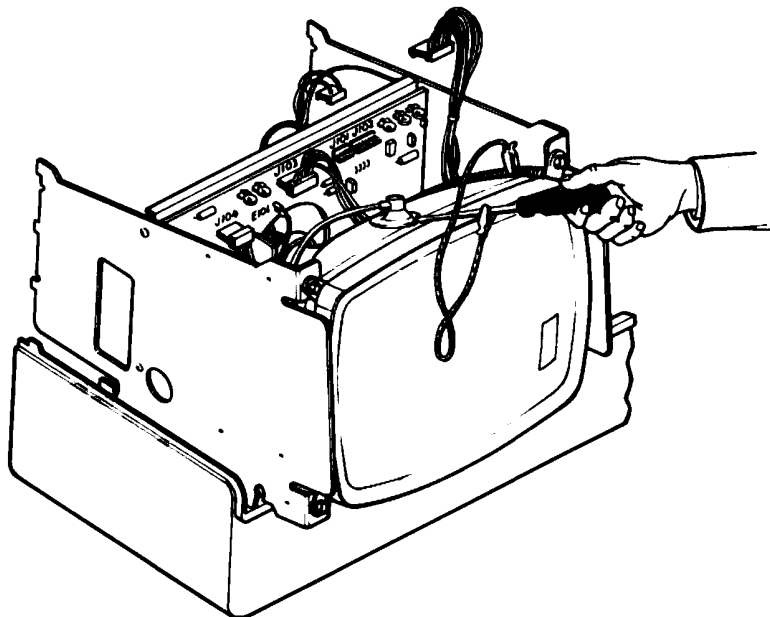


Figure 7-9 CRT Discharge Procedure

3. Attach the other end of the wire jumper to the center of the screwdriver shaft.
4. Grasp insulated handle well away from the screwdriver shaft.
5. Guard against electric shock. (See Warning)

### WARNING

There is a natural tendency to use *both* hands while performing the discharge procedure. However the possibility of electric shock increases greatly when using both hands. Therefore, keep your free hand in your pocket until the discharge procedure is completed.

6. Slip the screwdriver blade between the anode cap and the CRT. The anode cap may stick requiring you to twist the blade of the

screwdriver back and forth to “walk” it under the anode cap. Remember to keep your hand in your pocket.

7. Carefully push the blade of the screwdriver to the center of the anode lead under the anode cap; usually, a noticeable spark (3/8” to 1/2”) will result.
8. Maintain this screwdriver-to-anode contact for a minimum of 5 seconds.
9. Remove the anode cap.

### **MONOCHROME CRT REMOVAL**

1. Disconnect the green ground wire (attached to the aquadag spring) from the pin on the analog board.
2. Disconnect analog board plugs J104 and the plug on the neck of the CRT.
3. Remove the four (4) hex-head machine screws located at the “corners” of the screen mounting ring. Remember to support the CRT to prevent damage.
4. Move the CRT forward until the neck clears the analog board. Lift CRT clear and place screen side down on a clean, thick pad.

### **MONOCHROME ANALOG BOARD REMOVAL**

1. Disconnect the green ground wire (Pin E101) from the analog board. Disconnect analog board plugs J101, J102, J103, and J104.
2. Disconnect the plug on the neck of the CRT: guide the connector back through the analog board opening.
3. Remove the two (2) top analog bracket screws (located top right and top left). Locate the three (3) gray board clips holding the analog board to the top of the analog board bracket.
4. Carefully squeeze the two locking tabs on each clip and push them through the bracket.
5. Tilt the analog board and its bracket back until the analog board can clear the neck of the CRT. Remove the analog board.

## COLOR CRT AND ANALOG BOARD

### PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURES:

- Cabinet
- Main Processor Board

### WARNING — HIGH VOLTAGES

High voltages may be present on the CRT anode even when the display is not operating. *Always* discharge the CRT high voltage anode before servicing any part of the CRT assembly. Refer to “CRT Discharge Procedure” in this disassembly section. Always assume that a CRT is charged until *you* discharge it. Any conductive material (i.e. tools, service personnel, etc.) placed near the flyback transformer can cause an arc to jump the gap between the transformer and the conductive material.

### WARNING — HIGH VACUUM

The Cathode Ray Tube (CRT) “contains” a high vacuum. Seemingly minor damage from scratches or accidental bumps can result in CRT implosion and injuries can occur from flying glass. Observe the following safety procedures:

1. Wear safety glasses when installing or removing CRT's.
2. Do not carry CRT's by the neck — always carry CRT's by the mounting support band.
3. Temporary storage of CRT's on the service bench should be to place the screen side down on a clean, thick pad or towel.

### COLOR CRT DISCHARGE PROCEDURE

You will need a 12-18 inch insulated wire jumper with alligator clips on both ends; a flat-blade screwdriver with a long thin shaft and having a clean insulated handle.

1. Disconnect power supply and adapter card plugs to the analog board.
2. Attach one end of the wire jumper to the aquadag spring (located on the tapered back of the Cathode Ray Tube). Refer to Figure 7-9 in the “Monochrome CRT Discharge Procedure” section of this chapter for an illustration of this attachment.

3. Attach the other end of the wire jumper to the center of the screwdriver shaft.
4. Grasp insulated handle well away from the screwdriver shaft.
5. Guard against electric shock. (See Warning)

### WARNING

There is a natural tendency to use *both* hands while performing the discharge procedure. However, the possibility of electric shock increases greatly when using both hands. Therefore keep your free hand in your pocket until the discharge procedure is completed.

6. Slip the screwdriver blade between the anode cap and the CRT. The anode cap may stick requiring you to twist the blade of the screwdriver back and forth to "walk" it under the anode cap. Remember to keep your hand in your pocket.
7. Carefully push the blade of the screwdriver to the center of the anode lead under the anode cap; usually, a noticeable spark (3/8" to 1/2") will result.
8. Maintain this screwdriver-to-anode contact for a minimum of 5 seconds.
9. Remove the anode cap.

### COLOR CRT REMOVAL

1. Disconnect the green ground wire (attached to the aquadag spring) from the pin on the analog board.
2. Disconnect analog board plugs J104 and the plug on the neck of the CRT.
3. Remove the four (4) hex-head machine screws located at the "corners" of the screen mounting ring. Remember to support the CRT to prevent damage.
4. Move the CRT forward until the neck clears the analog board. Lift CRT clear and place screen side-down on a clean, thick pad.

## COLOR ANALOG BOARD REMOVAL

1. Disconnect the green ground wire (Pin E101) from the analog board. Disconnect analog board plugs J101, J102, J103, and J104.

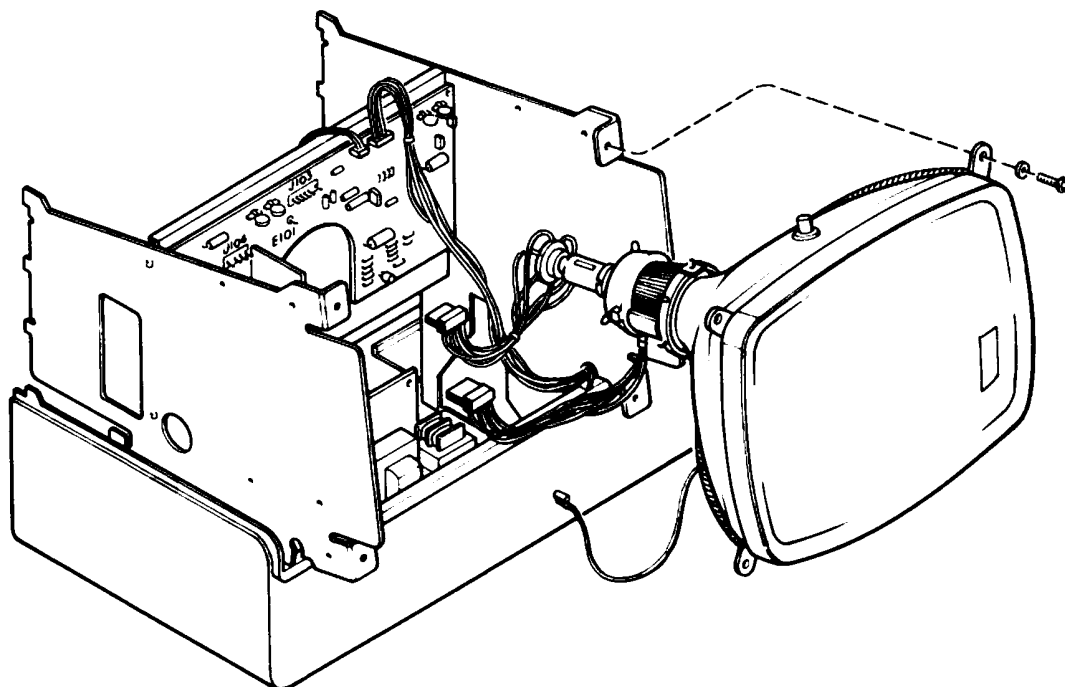


Figure 7-10 Color CRT Removal

2. Disconnect the plug on the neck of the CRT: guide the connector back through the analog board opening.
3. Remove the two (2) top analog bracket screws (located top right and top left). Locate the three (3) gray board clips holding the analog board to the analog board bracket.
4. Carefully squeeze the two locking tabs on each chip and push them through the bracket.
5. Tilt the analog board and its bracket back until the analog board can clear the neck connector of the CRT. Remove the analog board.

## MAIN PROCESSOR BOARD

### PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURE:

- Cabinet

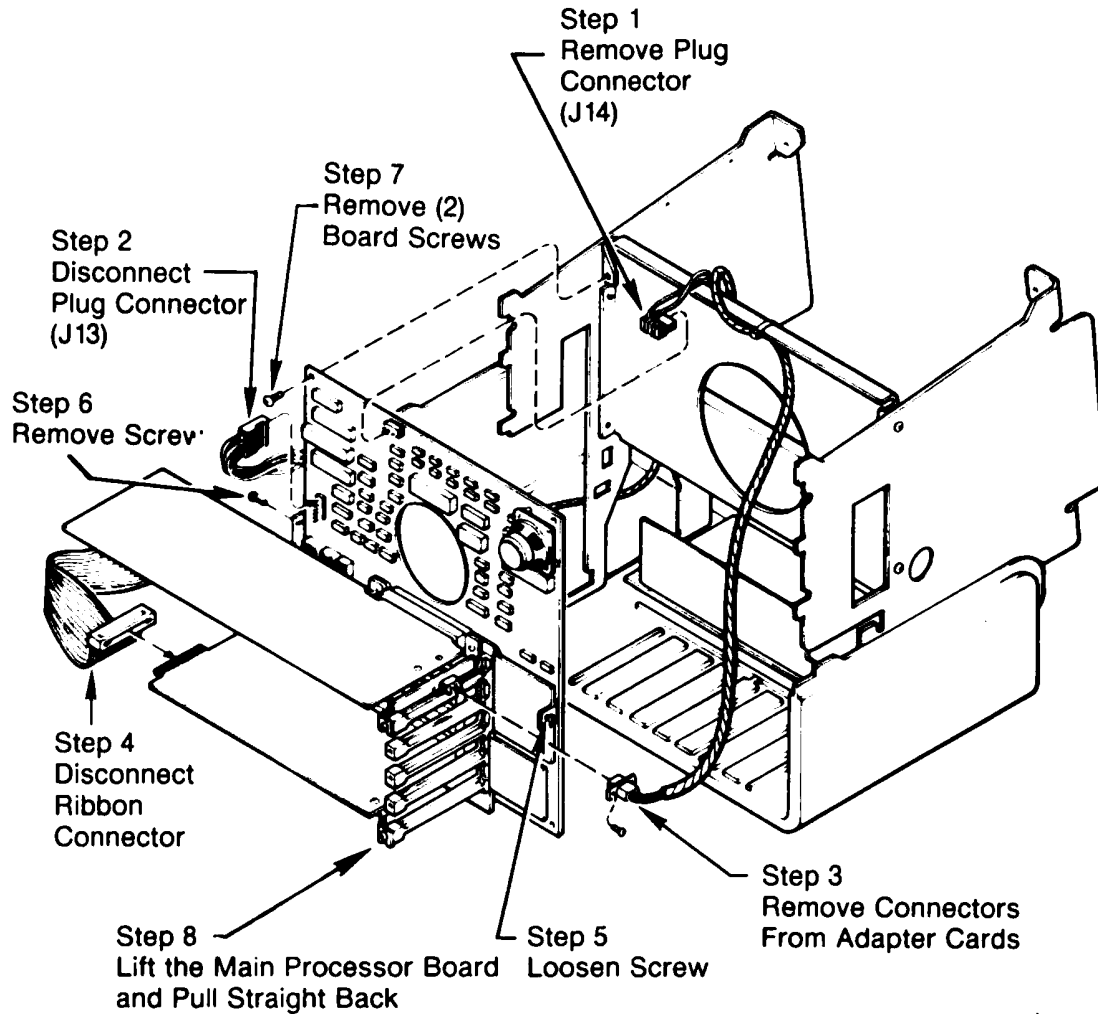


Figure 7-11 Main Processor Board Removal

## BOARD REMOVAL PROCEDURE

1. Disconnect the plug connector (J14), located at the top of the Main Processor Board.
2. Disconnect the plug connector (J13), located at the left side of the Main Processor Board.
3. Remove connectors from adapter cards (if adapter cards were not previously removed).
4. Disconnect ribbon connector(s) from adapter card(s) (if adapter cards were not previously removed).
5. Locate the far right bracket screw and loosen it.

6. Locate the far left shelf bracket screw, located under the disk drive assembly, and remove.
7. Remove (2) board screws from upper corners of board.
8. Lift the main processor board and pull straight back.

## **BRACKET REPLACEMENT PROCEDURE**

1. Loosen adapter card bracket mounting screws (one (1) for each adapter card), remove cables (see NOTE below), and remove adapter cards, if not previously done.

NOTE: Systems having a Winchester disk drive and flexible disk drive will have separate ribbon cables for each. When removing the ribbon cables from their respective controller cards, mark the cables to ensure proper reassembly (Winchester drive to Winchester card and flexible disk drive to flexible card).

2. Remove the six (6) bracket screws located on the left and right of the bus expansion slots.
3. Remove the three (3) Card Holder bracket screws located on the back of the Main Processor Board.

## **IC CHIP REMOVAL**

### **PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURE**

- Main Processor Board

### **PROCEDURE**

1. Locate the removable socket-mounted IC's referenced in the following illustration:

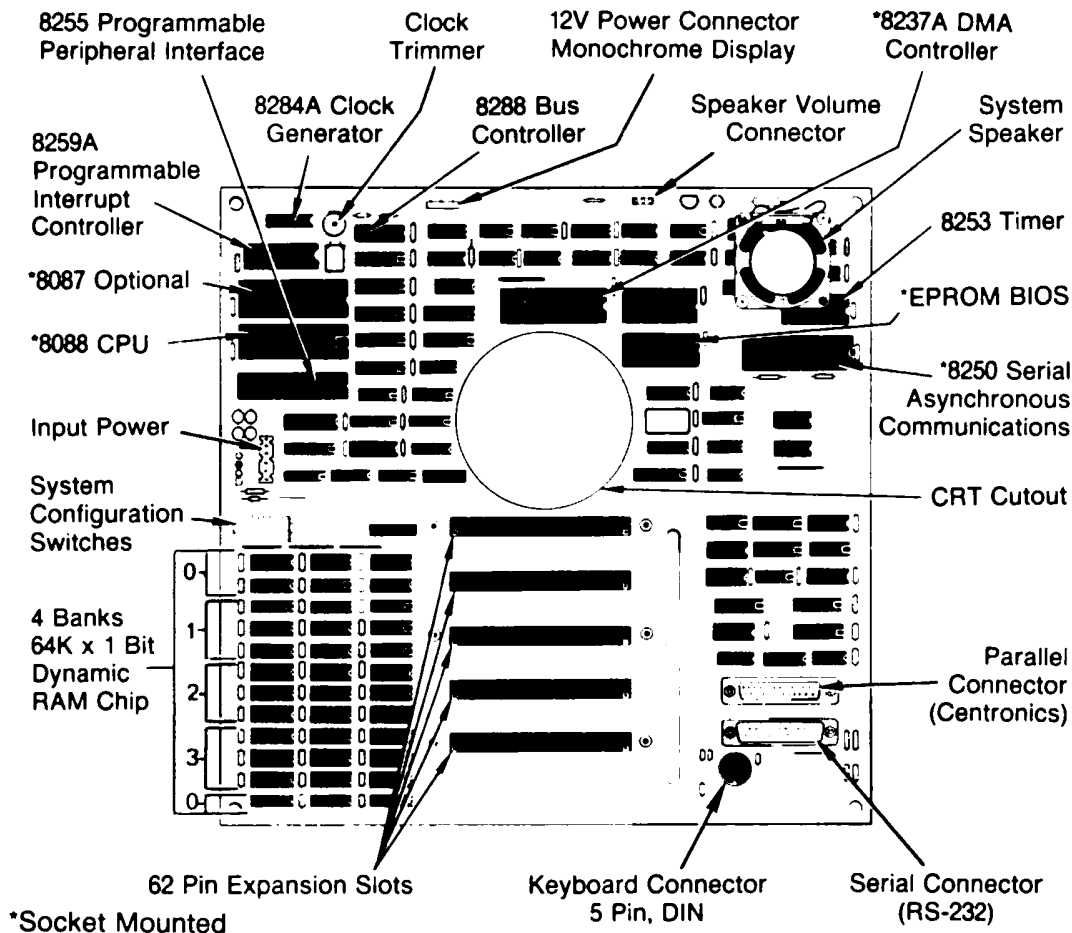


Figure 7-12 Main Processor Board (MPB) Components

Refer to Figure 6-5 in the Level 1 Diagnostics Error Returns chapter of this manual for MPB component location designations.

2. Use an IC insertion/removal tool to perform chip replacement.

## POWER SUPPLY

### PREVIOUSLY PERFORMED DISASSEMBLY PROCEDURES:

- Cabinet
- Main Processor Board

### WARNING

Due to the close proximity of the power supply to the High Voltage areas of the CRT, the following precautions must be followed:

1. Following the procedure outlined in the CRT disassembly, discharge the CRT anode voltage. Carefully observe all warnings

2. Do not bump, scratch, or strike the CRT vacuum tube with tools or jewelry; it can implode and cause injury. Wear safety glasses.

## PROCEDURE

1. Disconnect the primary DC power cable plug, located at the far right corner of the power supply board. Disconnect the secondary AC power harness plug, located at the left corner of the power supply board.

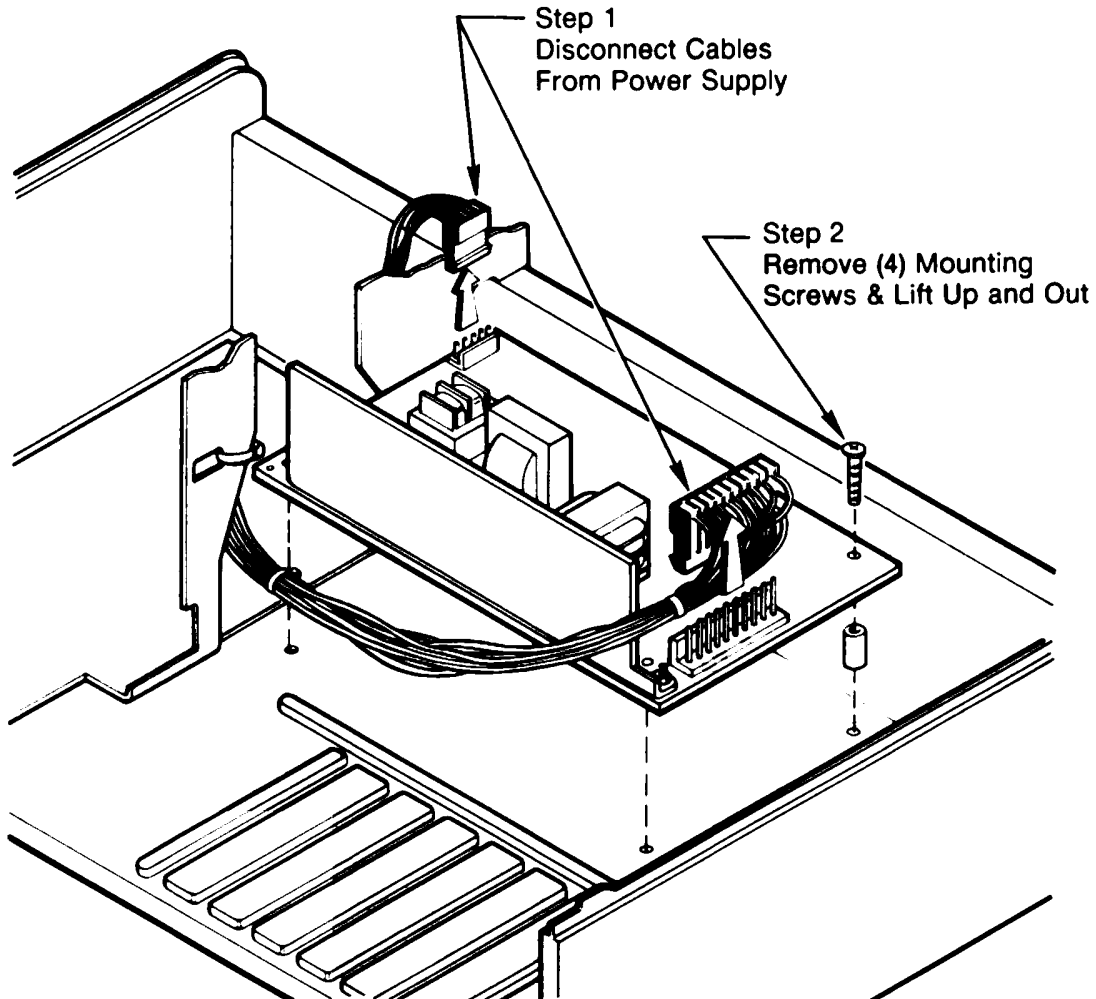


Figure 7-13 Power Supply Removal

2. Remove the four (4) power supply board mounting screws, located at each corner of the power board.
3. Slide the power supply board toward the back of the cabinet.
4. Remove the two (2) board screws located upper left and upper right corners of the Main Processor Board.

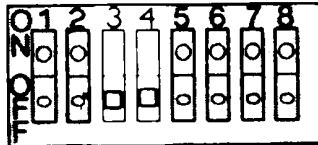
5. Grasp the adapter card bracket, lift the Main Processor Board vertically  $1/4 - 1/2$  inch and pull the board straight back and out of the unit.

# *Configuration Switch Settings*

## MAIN PROCESSOR BOARD SWITCH SETTINGS

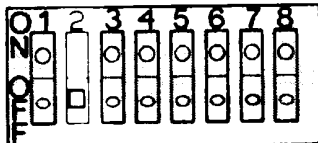
### Switch 1

#### Memory

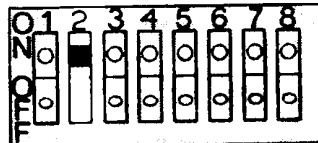


128K to 640K

#### Coprocessor

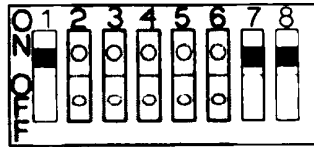


Coprocessor installed

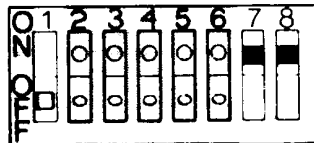


No coprocessor

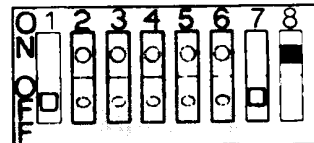
#### Drives



No drives

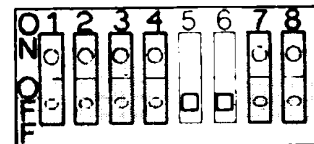


1 Drive

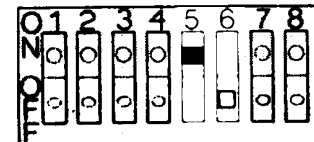


2 Drives

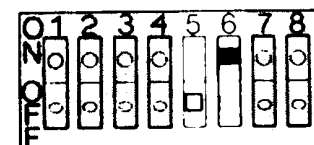
#### Displays



Monochrome

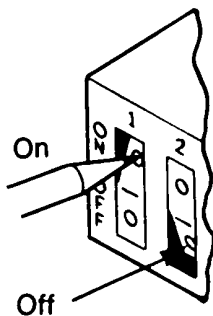


Color/graphics 80 x 25



Color/graphics 40 x 25

**NOTE:** Depress End of Rocker Switch Which Corresponds with Indicated Setting

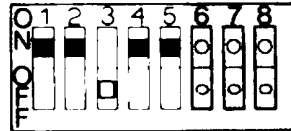


Switch 2

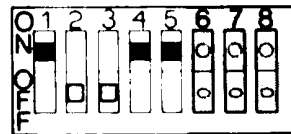
Total system memory



128K



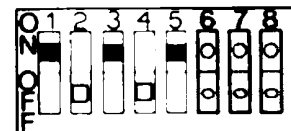
192K



256K



320K



384K



448K



512K

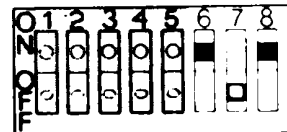


576K

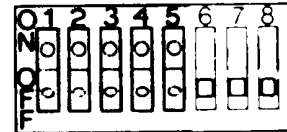


640K

Serial port



COM 1 Enabled



Serial Port Disabled

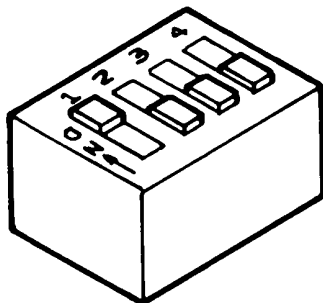
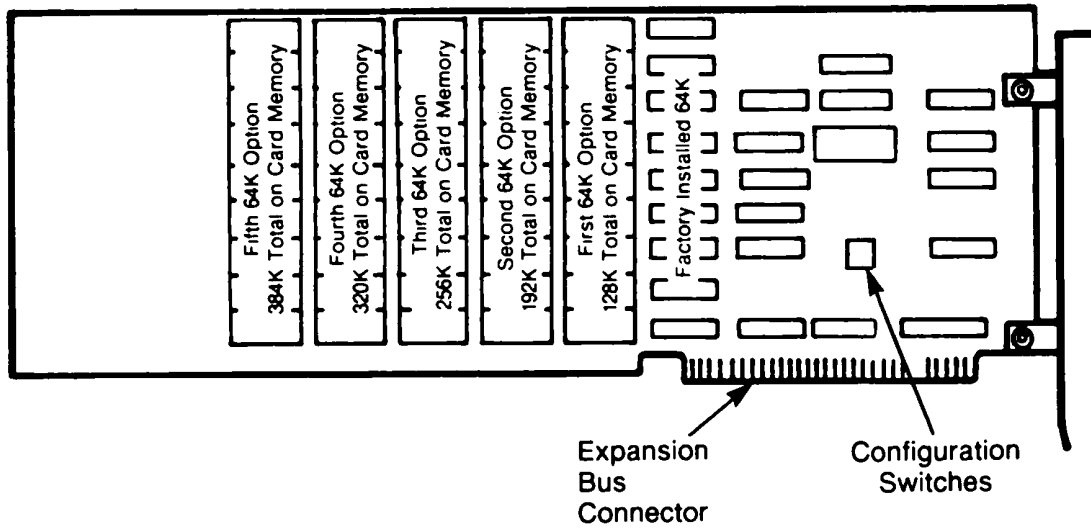
**System Switch Settings**

SW1				
Pos	1	7	8	Number of Flexible Disk Drives
	ON	ON	ON	None
	OFF	ON	ON	1 Flexible disk drive
	OFF	OFF	ON	2 Flexible disk drives
Pos	3	4	Memory	
	OFF	OFF	128 to 640 KB (see SW2)	
Pos	2	Coprocesor		
	OFF	Installed		
	ON	No Coprocesor		
Pos	5	6	Displays	
	OFF	OFF	Monochrome	
	ON	OFF	Color/Graphics 80 x 25	
	OFF	ON	Color/Graphics 40 x 25	

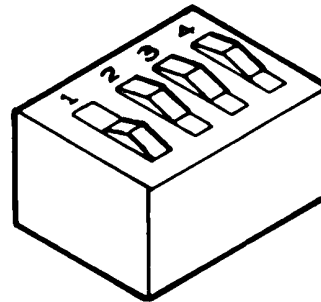
NOTE: If any monochromo display is connected to your system, switch positions 5 and 6 must always be OFF

SW2						
Pos	1	2	3	4	5	Memory
	ON	OFF	ON	ON	ON	128 KB
	ON	ON	OFF	ON	ON	192 KB
	ON	OFF	OFF	ON	ON	256 KB
	ON	ON	ON	OFF	ON	320 KB
	ON	OFF	ON	OFF	ON	384 KB
	ON	ON	OFF	OFF	ON	448 KB
	ON	OFF	OFF	OFF	ON	512 KB
	ON	ON	ON	ON	OFF	576 KB
	ON	OFF	ON	ON	OFF	640 KB
Pos	6	7	8	Serial Port		
	ON	OFF	ON	COM1 Enabled		
	OFF	OFF	OFF	Serial Port Disabled		

## EXPANSION MEMORY CARD SWITCH SETTINGS



Slide

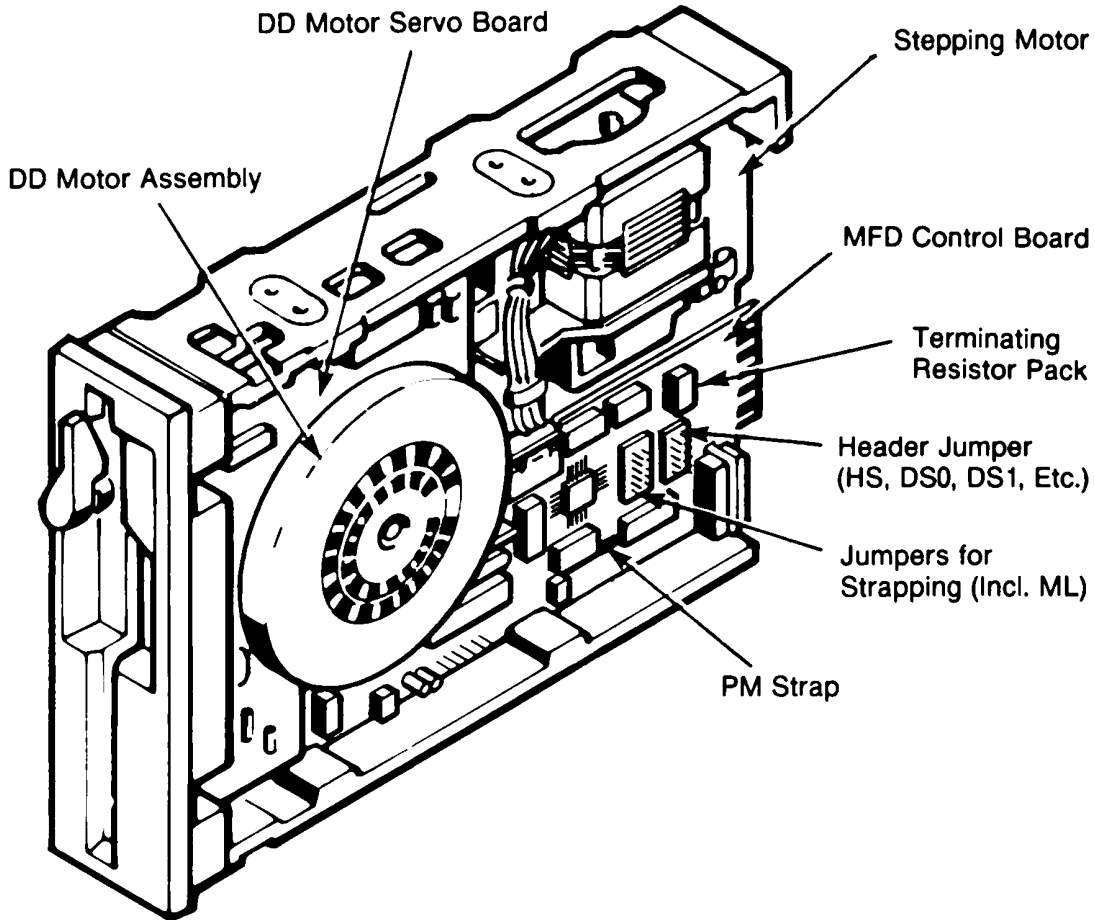


Rocker

Switch Position Settings				Total Memory on Board (in KB)	Total Memory in System with 256 KB on Main Pro- cessor Board
1	2	3	4		
On	On	On	On	64	320
Off	On	On	On	128	384
On	Off	On	On	192	448
Off	Off	On	On	256	512
On	On	Off	On	320	576
Off	On	Off	On	384	640

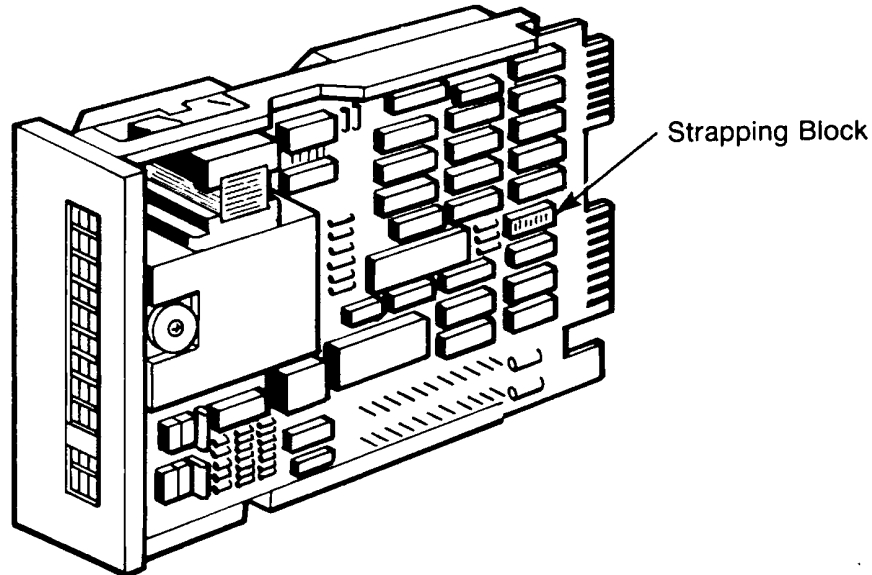
## FLEXIBLE DISK DRIVE HEADER JUMPERS

The flexible disk drives of the system are selected by connecting a jumper between certain contacts of the header jumper. The following diagrams illustrate the location of the header jumper on the flexible disk drive unit, a blow-up of the header jumper, and the meanings of the various jumper connections.



Header Jumper Connections	{	HS	Head Load on Drive Select (Jumper In)
		DS 0	Drive Select 0 Jumper in for Drive 0
		DS 1	Drive Select 1 Jumper in for Drive 1
		HM	Open
		DS 2	Open
		DS 3	Open
		MX	Open

## FIXED (WINCHESTER) DISK DRIVE STRAPPING



The fixed (Winchester) disk drive can be strapped as drive C, D, E or F. The "Option Shunt Block", or strapping block, is a 14-pin component inserted in a 16-pin location as shown (pin numbers are not printed on the board). Four Drive Select straps (DS1, DS2, DS3 and DS4) select the drive designation (C, D, E or F, respectively). The three Drive Select straps *not* in use must be cut with a small knife or screwdriver blade.

To select drive C (DS1), cut DS2 (7-10), DS3 (6-11) & DS4 (5-12).

To select drive D (DS2), cut DS1 (8-9), DS3 (6-11) & DS4 (5-12).

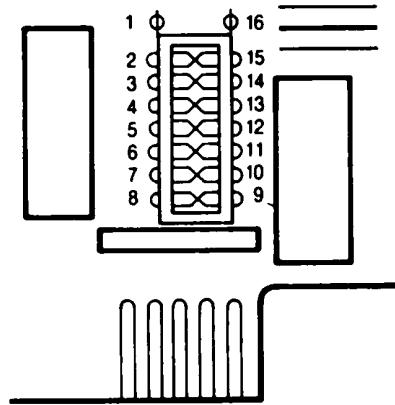
To select drive E (DS3), cut DS1 (8-9), DS2 (7-10) & DS4 (5-12).

To select drive F (DS4), cut DS1 (8-9), DS2 (7-10) & DS3 (6-11).

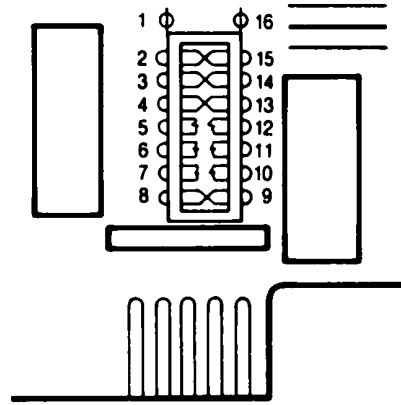
Bend one or both ends of each cut strap back away from the center of the block, to avoid any possibility of accidental contact.

CONFIGURATION SWITCH SETTINGS

- (1-16 R) N/A
  - 2-15 NC
  - 3-14 NC
  - 4-13 NC
  - 5-12 DS4
  - 6-11 DS3
  - 7-10 DS2
  - 8-9 DS1
- (R = Radial Operation)



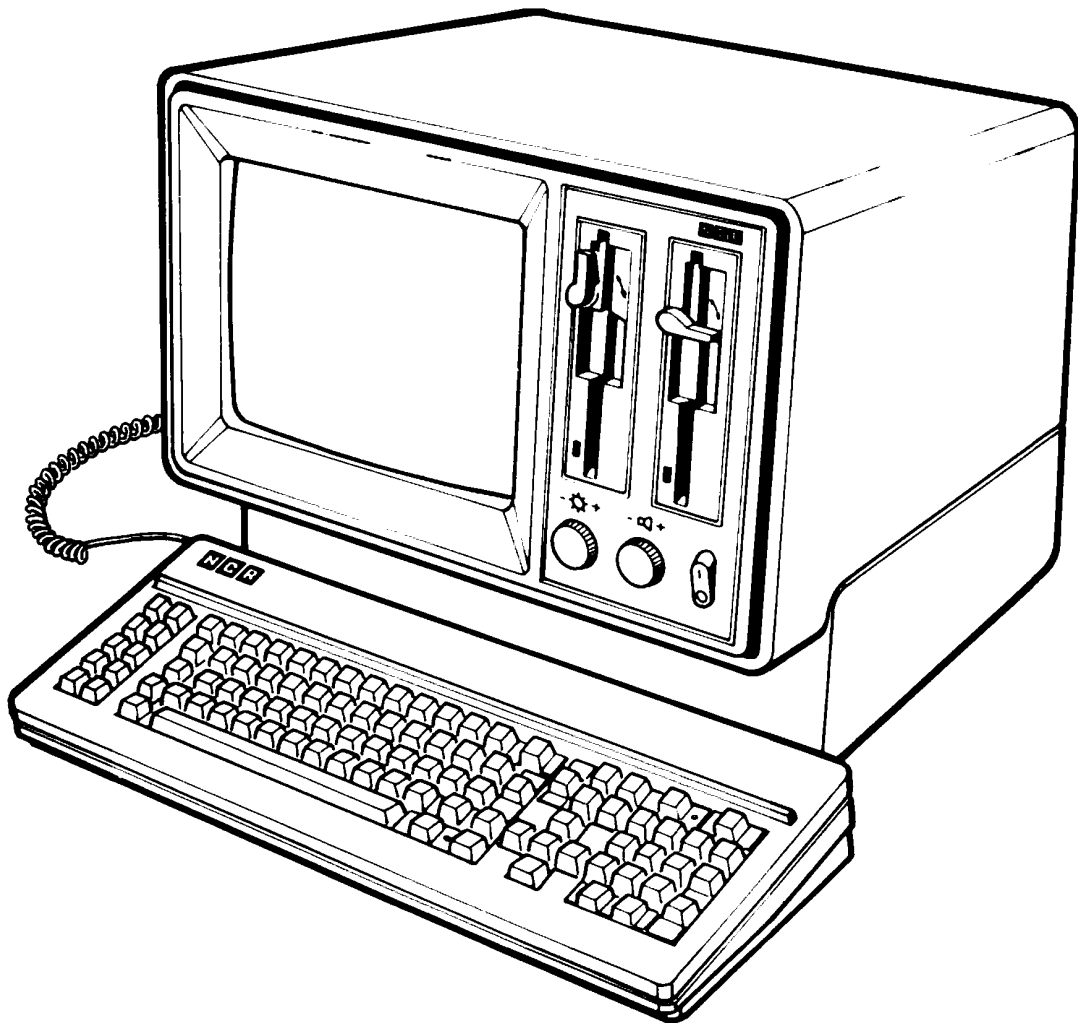
Strapping Block Uncut



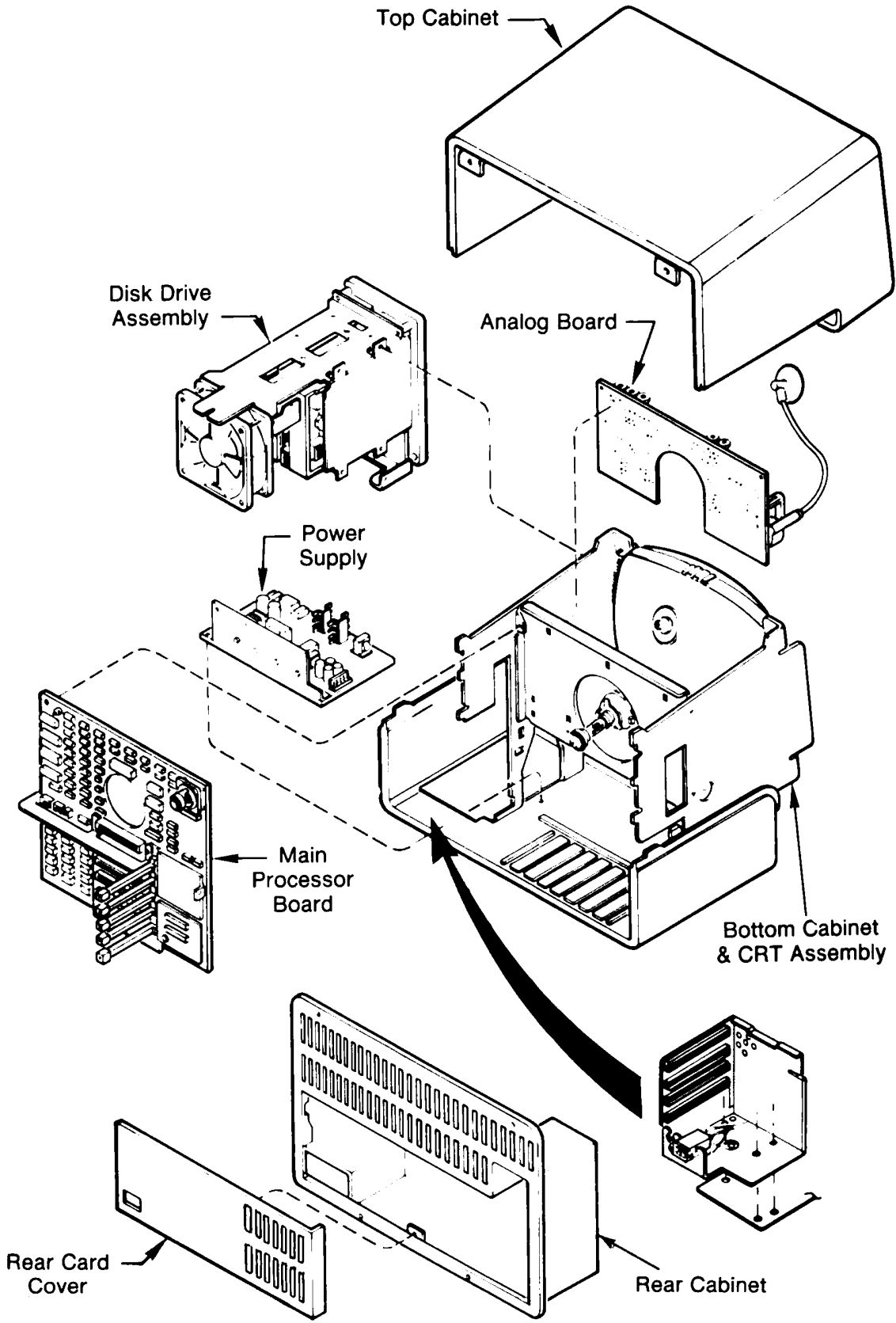
Strapped As Drive C

## Subassembly Placement

The Subassembly Placement drawing is designed as an aid in identifying and locating the subassemblies of the NCR PERSONAL COMPUTER, Model 4.



NCR PERSONAL COMPUTER Model 4



Subassembly Placement (Rear View)

# Parts Catalog

## STANDARD MODELS

<b>NCR Model Number</b>	<b>Model Description</b>
3284-1101-0000	Monochrome, Single Flex Drive
3284-1102-0000	Monochrome, Dual Flex Drive
3284-1103-0000	Monochrome, One Flex, One Fixed Drive
3284-1201-0000	Color, Single Flex Drive
3284-1202-0000	Color, Dual Flex Drive
3284-1203-0000	Color, One Flex, One Fixed Drive

## CABINET and KEYBOARD

<b>NCR Part Number</b>	<b>Part Description</b>
017-0033541	Cabinet Top
017-0033542	Cabinet Bottom
150-0000164	Back Panel
150-0000166	Access Panel
008-0072560	Keyboard w/Cord
150-0000156	Control Cover Panel

**CABINET and KEYBOARD (Continued)**

<b>NCR Part Number</b>	<b>Part Description</b>
150-0000157	Control Panel Escutcheon
007-9827317	NCR Logo
006-0088350	Main Power Switch
008-0084224	Control Knob

**MAIN PROCESSOR BOARD**

<b>NCR Part Number</b>	<b>Part Description</b>
150-0000211	Main Processor Board w/128K RAM
	<b>Plug-In Replacement Parts</b>
006-1062668	Intel 8088 16-Bit Microprocessor IC
007-1667710	DMA Controller IC
150-0000344	16K EPROM IC (2764)
006-1005365	Speaker

**NOTE:** The first 128K of memory is soldered to the CPU/Memory board. Additional memory IC chips are inserted into the memory bank sockets already on the processor board. Refer to the "Option Kits" section of this appendix for additional information.

**VIDEO DISPLAY**

**NCR  
Part Number**

**Part Description**

150-0000345

Monochrome CRT w/Analog Board

150-0000273

Monochrome Display Adapter Card

150-0000121

Color CRT w/Analog Board

006-1049321

Color Display Adapter Card

150-0000271

Video Display Cable — Monochrome

150-0000217

Video Display Cable — Color

**Options**

Kit No. 3284-K141 is required for an external monochrome display device. Refer to the "Option Kits" section of this Appendix for additional information.

Kit No. 3284-K140 is required for an external color display device. Refer to the "Option Kits" section of this appendix for additional information.

**STORAGE UNIT ASSEMBLY**

**NCR  
Part Number**

**Part Description**

150-0000149

Power-On Harness with brightness and volume controls — Monochrome

150-0000368

Power-On Harness with brightness and volume controls — Color

**STORAGE UNIT ASSEMBLY (Continued)**

<b>NCR Part Number</b>	<b>Part Description</b>
008-0068013	Cooling Fan, 12 VDC
	<b>Flexible Disk</b>
150-0000343	5 1/4" Flexible Disk Drive
150-0000312	Flexible Disk Controller Card
150-0000060	Cable, Disk Data Ribbon (Triple Header)
150-0000146	Cable, Disk to Card Logic (Double Header)
	<b>Options</b>
	Owners of single flexible disk drive systems may add a second flexible disk drive by ordering Kit No. 3284-K110. Refer to the "Option Kits" section of this appendix for additional information.
	<b>Winchester (Hard) Disk</b>
150-0000142	5 1/4" Winchester Disk Drive w/bezel
150-0000339	Winchester Disk Controller Card
	<b>Options</b>
	Owners of single flexible disk systems may add a Winchester Disk by ordering Kit No. 3284-K111. Refer to the "Option Kits" section of this appendix for additional information.

**POWER SUPPLY**

<b>NCR Part Number</b>	<b>Part Description</b>
801-0013900	Power Supply
006-0007164	Power Supply Cord
150-0000062	Primary AC Power Harness w/Filter and inline Fuse
150-0000063	Secondary AC Power Harness (Monochrome)
150-0000369	Secondary AC Power Harness (Color)
150-0000064	DC Power Harness

**OPTION KITS****NCR  
Kit Number****Part Description****CRT Display Adapter Cards**

3284-K140

External Color Display Kit. Kit supports one external color CRT device. Includes Video Display cable, Color Display Adapter Card, and instructions.

3284-K141

External Monochrome Display Kit. Kit supports one external monochrome CRT device. Includes Video Display cable, Monochrome Display Adapter Card, and instructions.

**Storage Unit Kits**

3284-K110

Integrated Flexible Disk Drive Kit. Includes 5 1/4 inch Flexible Disk Drive unit and installation instructions for adding a second flexible disk drive to single disk drive systems.

6097-6561

Free-standing Dual 8 inch Flexible Disk Drive Kit. Consists of assembled unit: (cabinet, power supply, disk assemblies), cables, and instructions.

**NOTE:** Since the flexible disk adapter can support a maximum of four flexible disk drives, this kit is intended for systems currently using one or two flexible disk units.

**OPTION KITS (Continued)**

<b>NCR Kit Number</b>	<b>Part Description</b>
6097-6661	Free-standing single 8 inch Flexible Disk Drive Kit.
6097-K820	Second flexible disk drive (only) to add to 6097-6661.
6097-K900	Cables for 6097-K820
3284-K111	Integrated Winchester Disk Drive Kit. Includes 5 1/4 inch 10 Megabyte disk unit, Winchester disk drive adapter card, cables, and installation instructions.
6097-K196	PC Model 4 Winchester Disk Drive installation instructions, boot maintenance diskette, host adapter card, SCSI cable.
6097-4341	Free-standing 11 Megabyte Winchester Disk Drive Kit. Consists of assembled unit (cabinet, power supply, disk assembly, SCSI controller) and instructions.
6097-4441	Free-standing 22 Megabyte Winchester Disk Drive Kit. Consists of assembled unit: (cabinet, power supply, dual 11 MB disk assemblies, SCSI controller) and instructions.
6097-5341	Free-standing 32 Megabyte Winchester Disk Drive Kit. Consists of assembled unit: (cabinet, power supply, 32MB disk assembly, SCSI controller) and instructions.
6097-5441	Free-standing 64 Megabyte Winchester Disk Drive Kit. Consists of assembled unit: (cabinet, power supply, dual 32 MB disk assemblies, SCSI controller) and instructions.

**OPTION KITS (Continued)**

<b>NCR Kit Number</b>	<b>Part Description</b>
6097-7241	Free-standing 32 Megabyte Winchester Disk Drive with 45 MB Streaming Tape Kit. Consists of assembled unit: (cabinet, power supply, 32MB disk assembly, tape assembly, SCSI controller) and instructions.
<b>Kits to Upgrade 6097-4341 or 6097-5341</b>	
6097-K852	11 MB fixed disk and mounting hardware.
6097-K858	32 MB fixed disk and mounting hardware.
6097-K785	1/4 in. Streamer Tape 45 MB and mounting hardware.
6097-K053	Tape controller.
6097-K903	Internal cables for disk add-on.
6097-K908	Internal cables for tape and tape controller add-on.
<b>Parallel And Serial Communication Kits</b>	
3284-K120	Parallel Printer Cable. Includes Centronics-type printer cable and instructions.
3284-K122	Asynchronous Communications Cable. Includes Cable and instructions.
3284-K121	Serial Printer Cable. Includes Serial (RS232C) Printer Cable, and instructions.

**OPTION KITS (Continued)**

<b>NCR Kit Number</b>	<b>Part Description</b>
3284-K130	<p>RS232C Asynchronous Communications Adapter Card Kit. This kit provides a second serial port to the CPU/Memory bus to support a modem, plotter, or serial printer. The kit includes Asynchronous Communication Adapter Card and User Guide.</p> <p>NOTE: This kit does not include cables; refer to the above cable option kits for the correct device (modem or serial printer) cable.</p>

**Memory Expansion Kits**

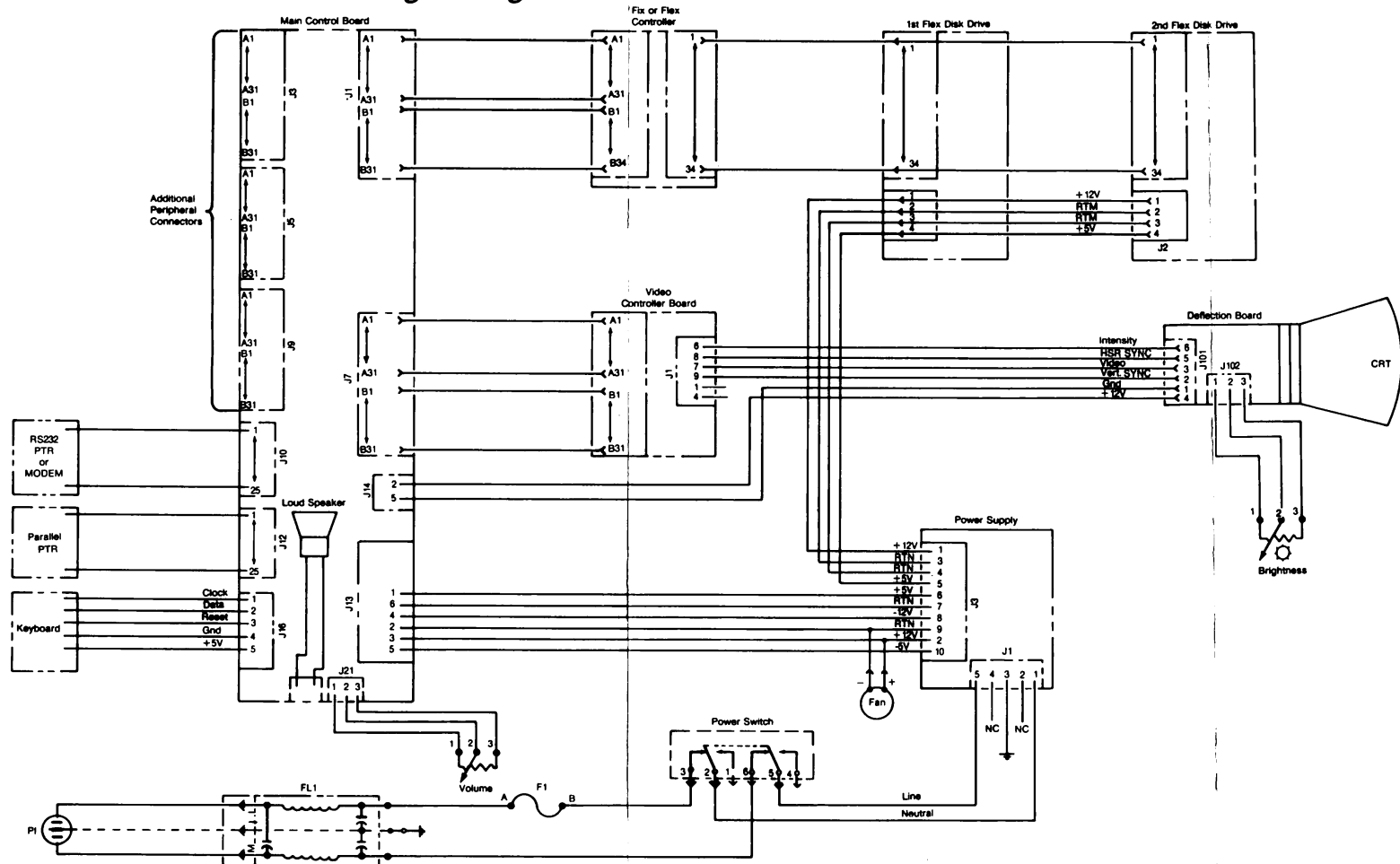
3284-K100	<p>64K RAM Kit includes nine 64K RAM ICs and installation instructions.</p> <p>NOTE: The first expansion of memory requires 2 kits added to the processor board, resulting in a memory configuration of 256K.</p>
3284-K102	<p>128K RAM Kit. Includes 18 64K RAM ICs and installation instructions.</p>
3284-K101	<p>Memory Expansion Card Kit. Includes instructions and a card populated with 64K.</p>

**NOTE:**

1. This card can be used only when the CPU/Memory board is at its maximum memory configuration of 256K.
2. Memory may be added to this card in 64K increments by ordering one of Kit No. 3284-K100 for each 64K desired.
3. This card has a maximum configuration of 384K (original card memory of 64K, plus five 64K Kits). The result is a system maximum of 640K.

Appendix D

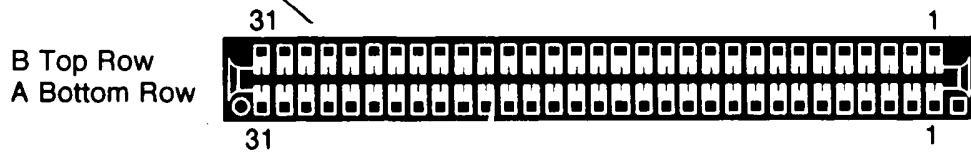
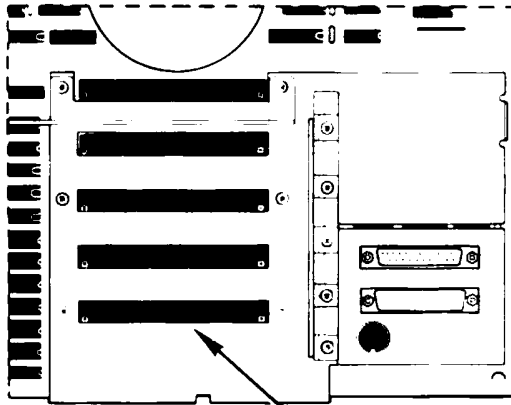
Connection And Logic Diagrams



## PHYSICAL CONNECTIONS/PIN ASSIGNMENTS

The following pages contain illustrations of the principal physical connectors on the Main Processor Board, along with listings of their individual pin assignments.

### Expansion Slot Connections

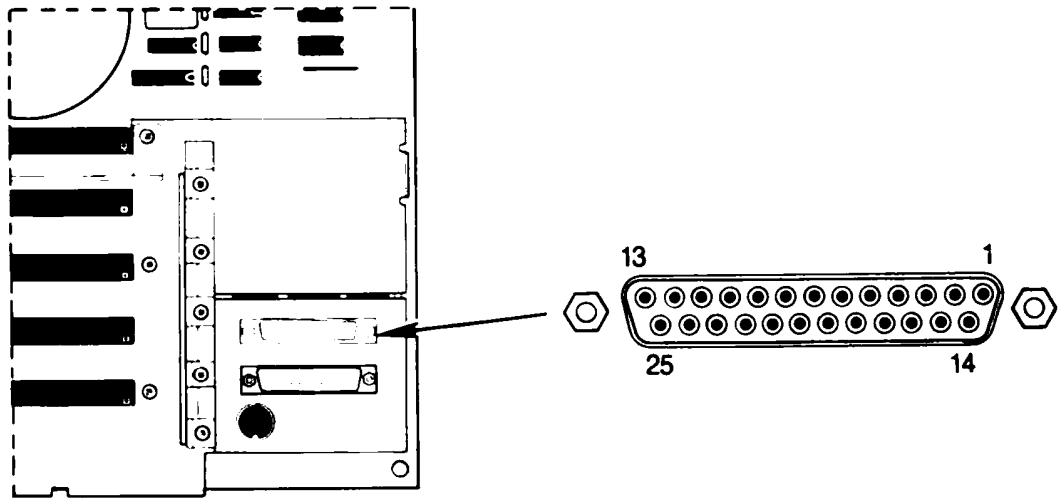
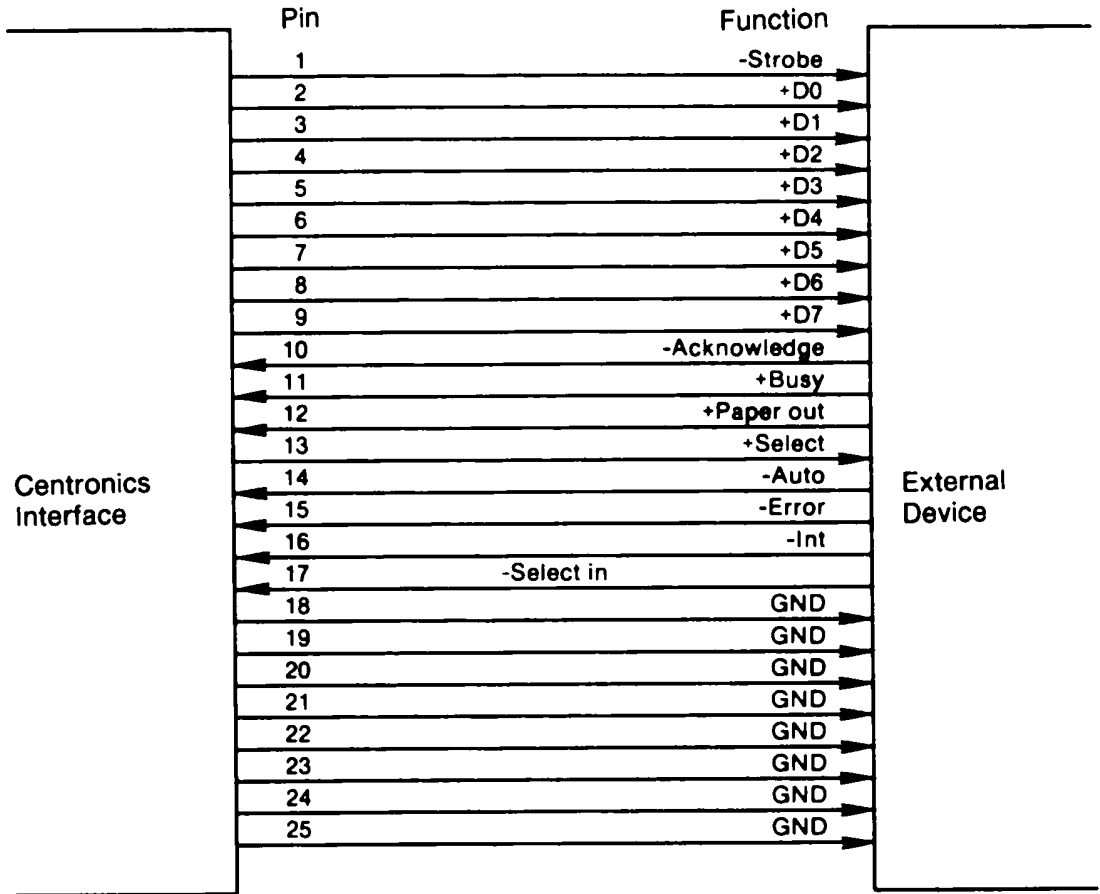


Main Processor Board — Expansion Slots

<b>B</b>	<b>FUNCTION</b>	<b>A</b>	<b>FUNCTION</b>
1	GND	1	-I/O CHECK
2	+RESET DRIVE	2	+D7
3	+5V	3	+D6
4	IRQ2	4	+D5
5	-5V	5	+D4
6	+DRQ2	6	+D3
7	-12	7	+D2
8	-HRQ I/O	8	+D1
9	+12V	9	+D0
10	GND	10	+I/O CH RDY
11	-MEMW	11	+AEN
12	-MEMR	12	+A19
13	-IOW	13	+A18
14	-IOR	14	+A17
15	-DACK3	15	+A16
16	+DRQ3	16	+A15
17	-DACK1	17	+A14
18	+DRQ1	18	+A13
19	-DACK0	19	+A12
20	+CLOCK	20	+A11
21	+IRQ7	21	+A10
22	+IRQ6	22	+A9
23	+IRQ5	23	+A8
24	+IRQ4	24	+A7
25	+IRQ3	25	+A6
26	-DACK2	26	+A5
27	+T/C	27	+A4
28	+ALE	28	+A3
29	+5V	29	+A2
30	+OSC	30	+A1
31	GND	31	+A0
			(-ASSERTS LOW) (+ASSERTS HIGH)

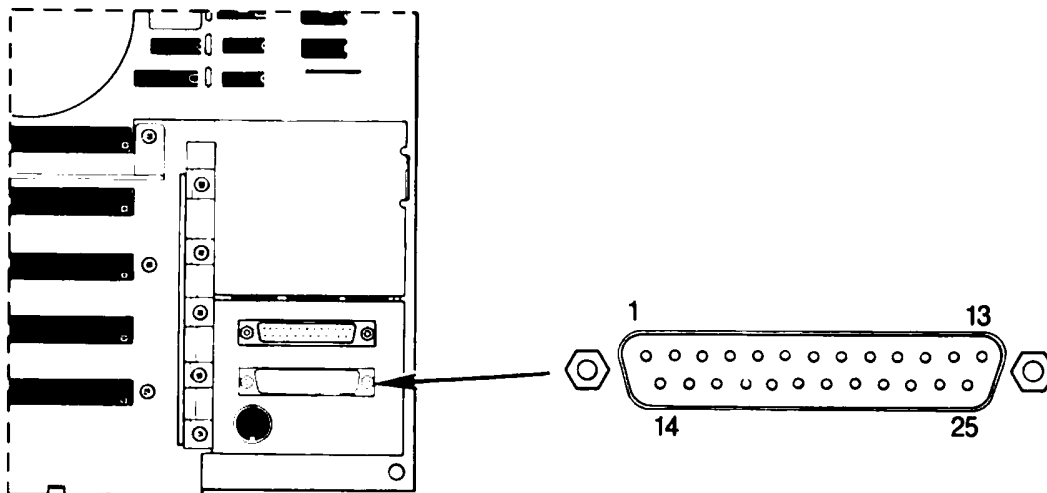
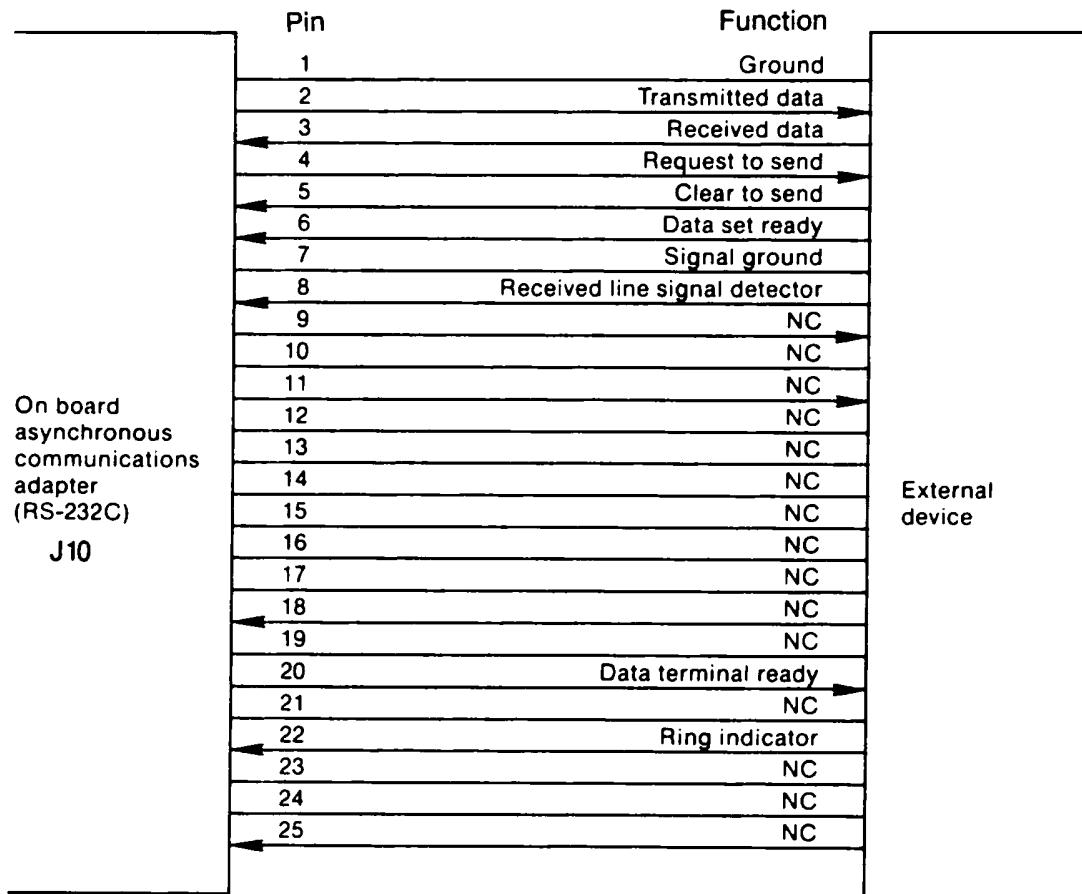
Expansion Slot Signals

### Main Processor Board Parallel (Centronics) Connector



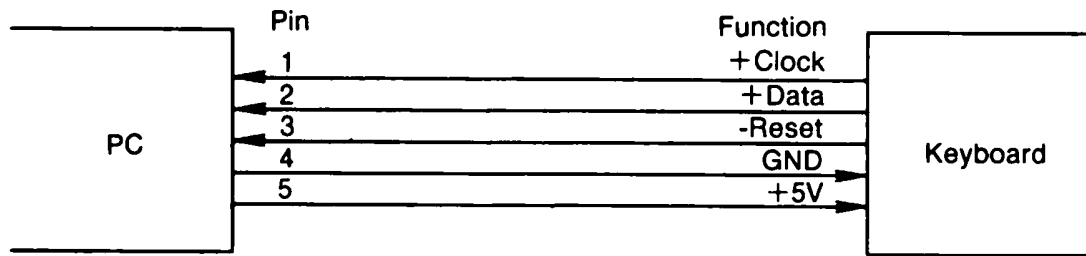
Main Processor Board — Parallel Printer Connector (Centronics)

### Main Processor Board Serial (RS 232) Connector

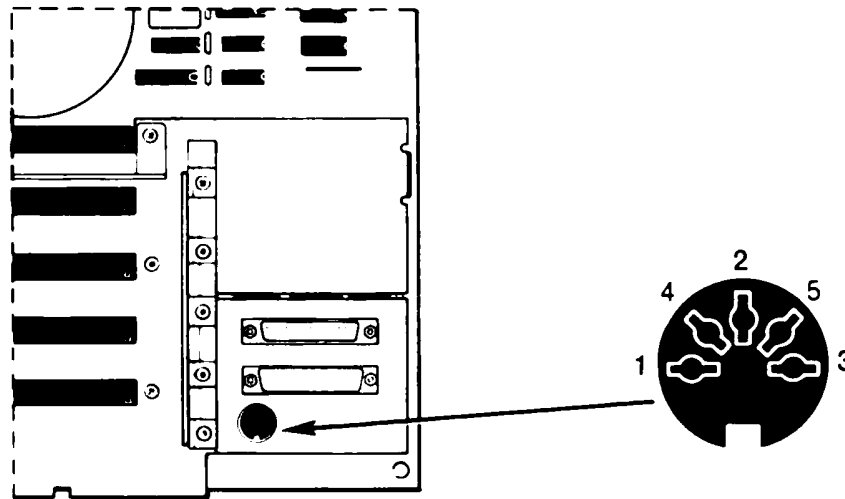


Main Processor Board — Serial Connector

## Main Processor Board Keyboard Connection

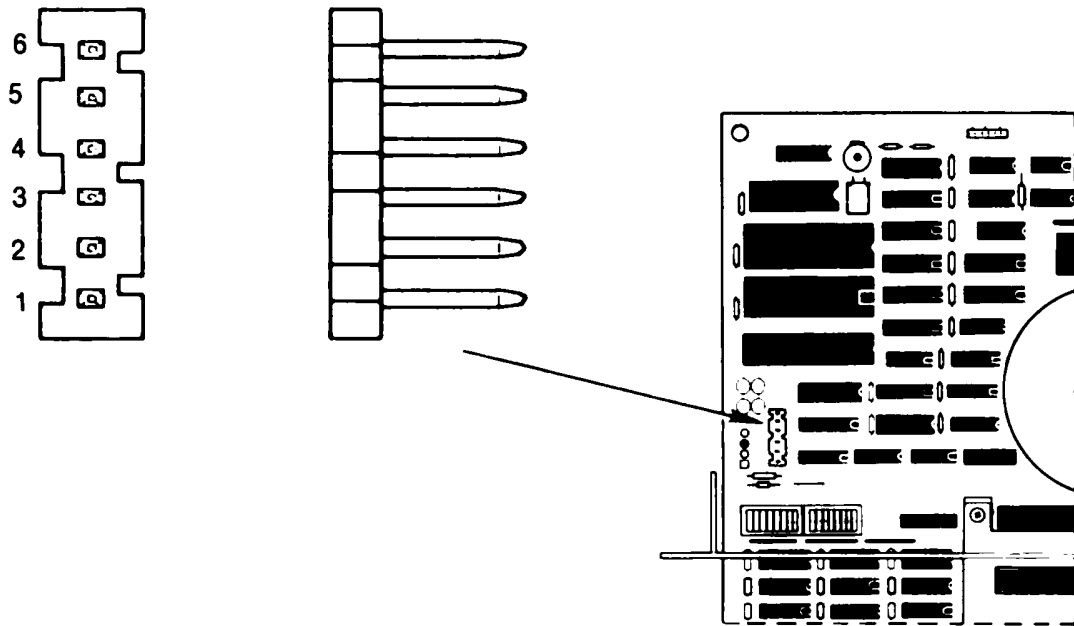


Keyboard Interface Signals

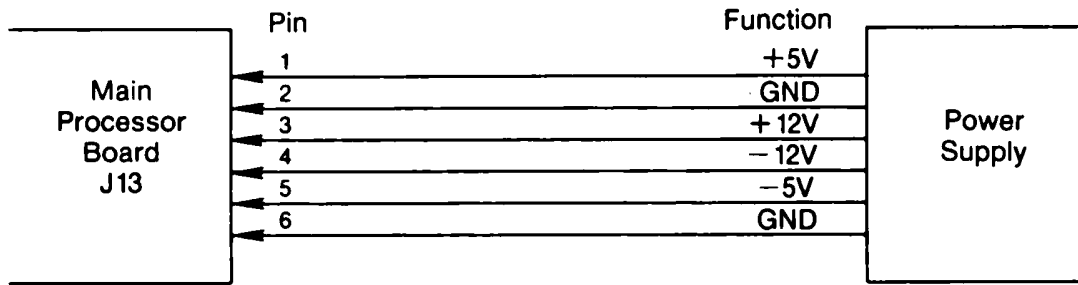


Main Processor Board — Keyboard Connector

### Main Processor Board Power Connector



Main Processor Board — D.C. Power Connector



D.C. Power Cable Voltages

Page	Title	Illustration Number
11	Main Processor — Logic	1 of 15
13	•	2 of 15
15	•	3 of 15
17	•	4 of 15
19	•	5 of 15
21	•	6 of 15
23	•	7 of 15
25	•	8 of 15
27	•	9 of 15
29	•	10 of 15
31	•	11 of 15
33	•	12 of 15
35	•	13 of 15
37	•	14 of 15
39	•	15 of 15
41	Display — Adapter Monochrome	2 of 6
43	•	3 of 6
45	•	4 of 6
47	•	5 of 6
49	•	6 of 6
51	Display — Adapter Color	2 of 7
53	•	3 of 7
55	•	4 of 7
57	•	5 of 7
59	•	6 of 7
61	•	7 of 7
63	Flexible Disk Controller	1 of 4
65	•	2 of 4
67	•	3 of 4
69	•	4 of 4
71	Flexible Disk Drive	1 of 8
73	•	2 of 8
75	•	3 of 8
77	•	4 of 8
79	•	5 of 8
81	•	6 of 8
83	•	7 of 8
85	•	8 of 8
87	Hard Disk Drive	1 of 2
89	•	2 of 2
91	Expanded Memory	1 of 3
93	•	2 of 3
95	•	3 of 3
97	Keyboard	1 of 1
99	Power Supply	1 of 2
101	•	2 of 2

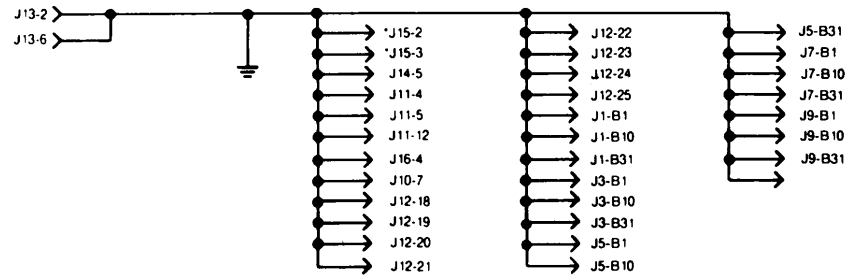
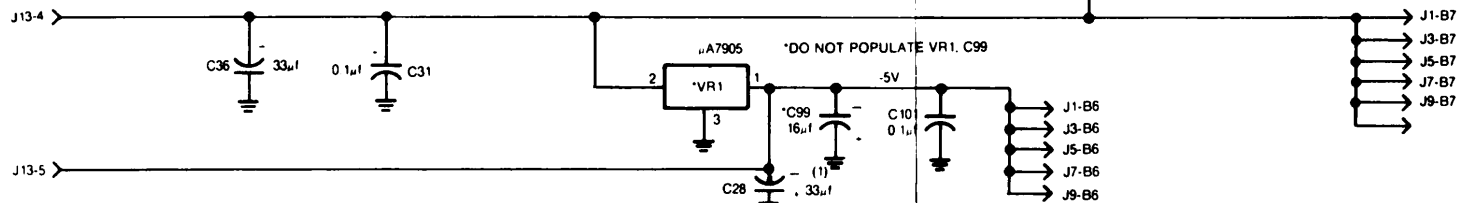
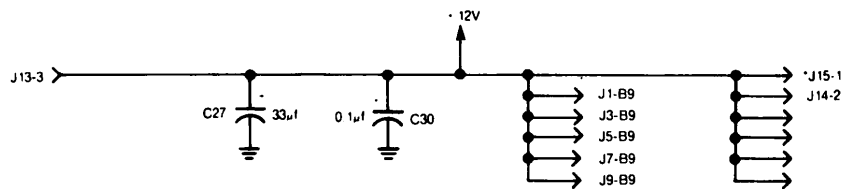
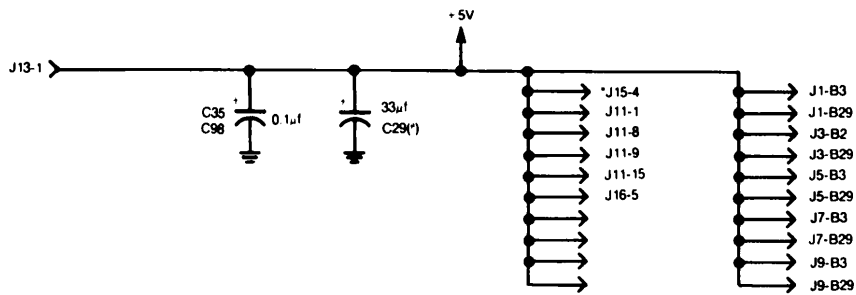
Logic Diagram Index

## LOGIC DIAGRAMS

Logic Diagrams for the NCR Personal Computer are presented in the following pages of this appendix.



CONNECTION AND LOGIC DIAGRAMS



Main Processor Board (1 of 15)

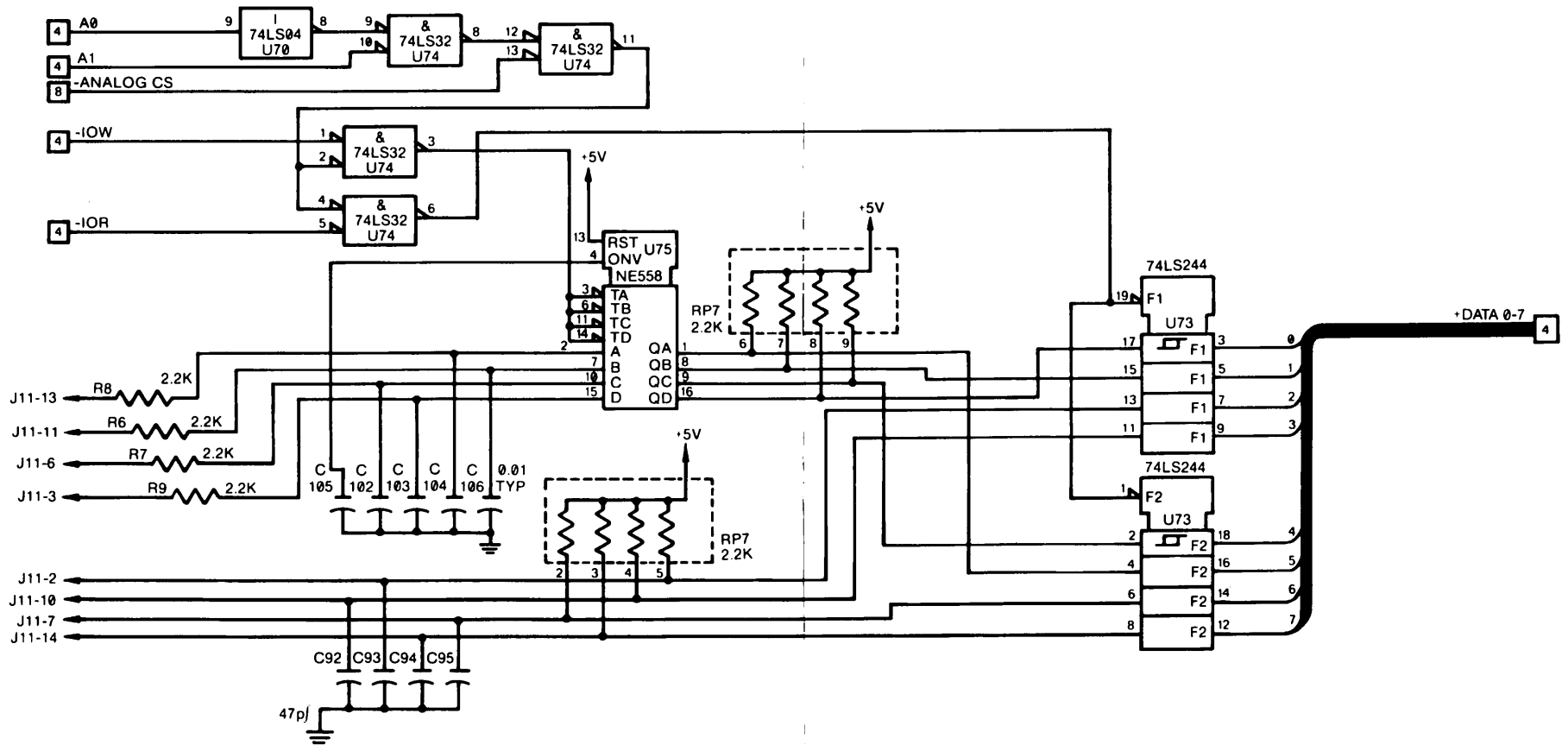
U Number	Pin Number	
	+5	GND
U44	16	8
U65	14	7
U38	14	7
U45	14	7
U112	14	7
U46	14	7
U74	14	7
U73	20	10
U9	16	8
U28	14	7

U Number	Pin Number	
	+5	GND
U49	14	7
U62	16	8
U54	16	8
U40	14	7
U64	14	7
U23	16	8
U68	16	8
U53	14	7
U63	14	7
U66	20	10
U22	20	10
U24	20	10
U25	20	10
U31	20	10
U72	14	7
U4	14	7
U17	14	7
U59	14	7
U70	14	7
U6	14	7
U13	14	7
U18	16	8
U39	16	8

U Number	Pin Number	
	+5	GND
U75	5	12
U1	18	9
U30	40	20,1
U2	20	10
U10	28	14
U21	40	1,20
U26	31.5	20
U76-111	8	16
U29	24	12
U35	26	7
U33	28	14
U27	28	14
U51	16	8
U56	16	8
U42	20	10
U34	40	20
U19	20	10
U20	20	10
U32	20	10
U47	20	10
U67	20	10
U11	20	10
U36	20	10
U55	20	10
U58	20	10
U61	20	10
U43	16	8
U48	16	8
U16	14	7
U3	14	7
U12	14	7
U52	16	8
U60	14	7
U69	20	10
U50	14	7
U41	5	10
U7	14	7
U37	14	7
U8	14	7
U14	14	7
U15	14	7
U57	14	7
U5	16	8
U71	16	8

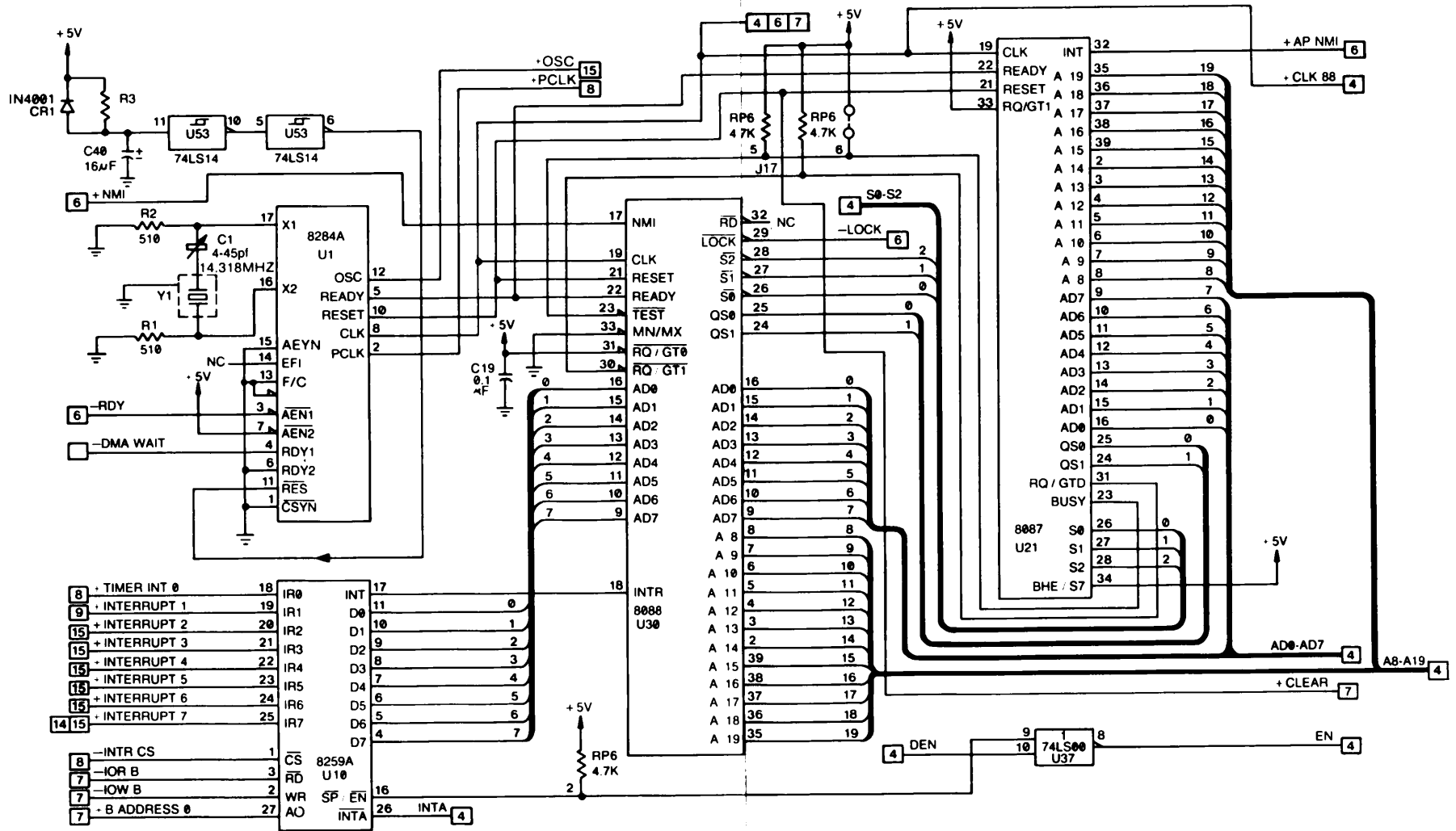
U Number	Unused Gates
U17	11-10 13-12
U65	13-12
U63	11-10 3-4
U36	6-14 7-13 8-12 9-11
U19	17-3 15-5 13-7
U15	4,2,3,1-5,6
U28	9,10,11-8
U71	12-10,11 13-15,14
U62	14-15
U40	9,10-8 12,13-11
U64	2,1-3 9,10-8 12,13-11
U56	6-11 5-12 4-13

CONNECTION AND LOGIC DIAGRAMS



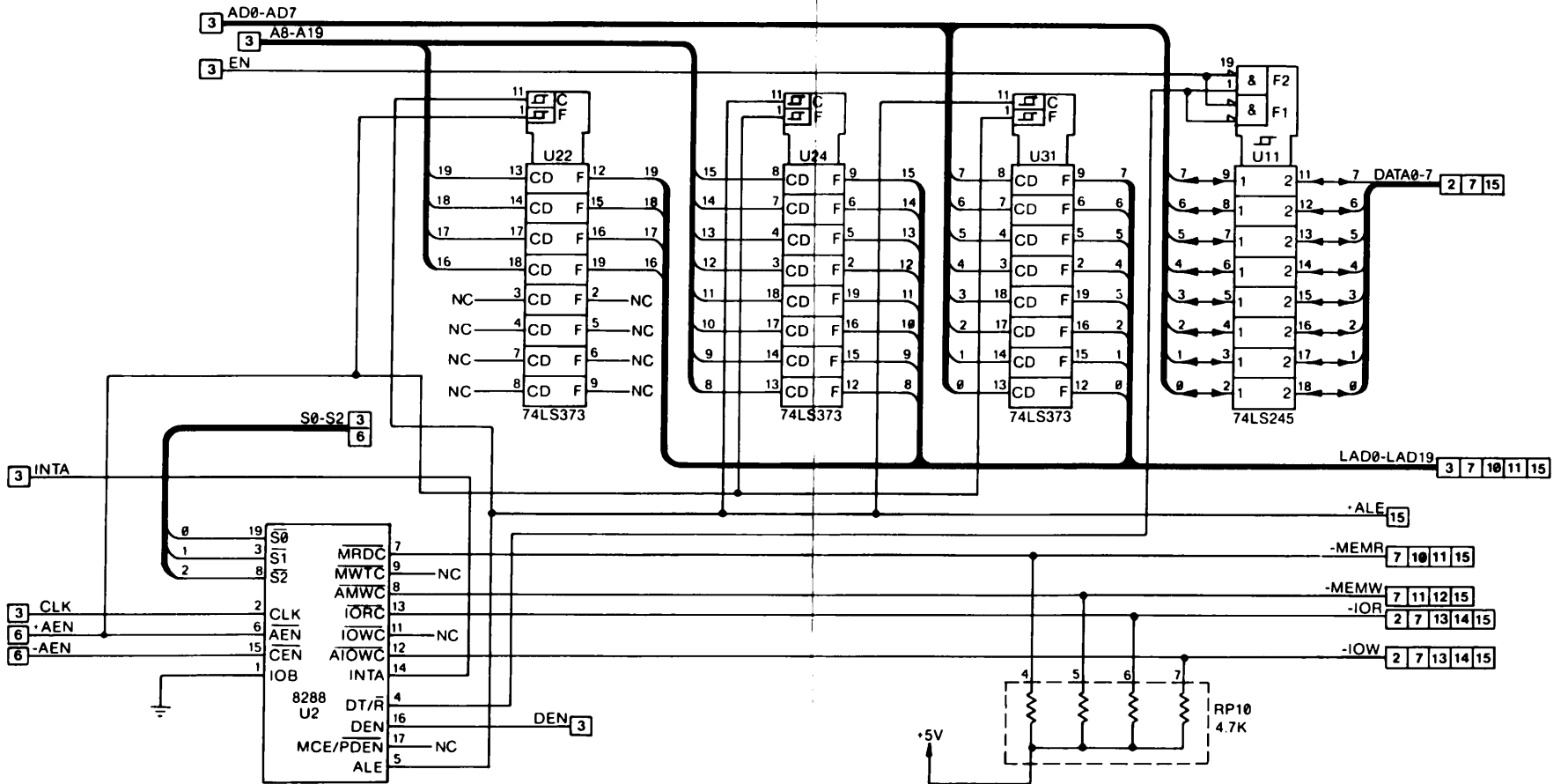
Main Processor Board (2 of 15)

CONNECTION AND LOGIC DIAGRAMS

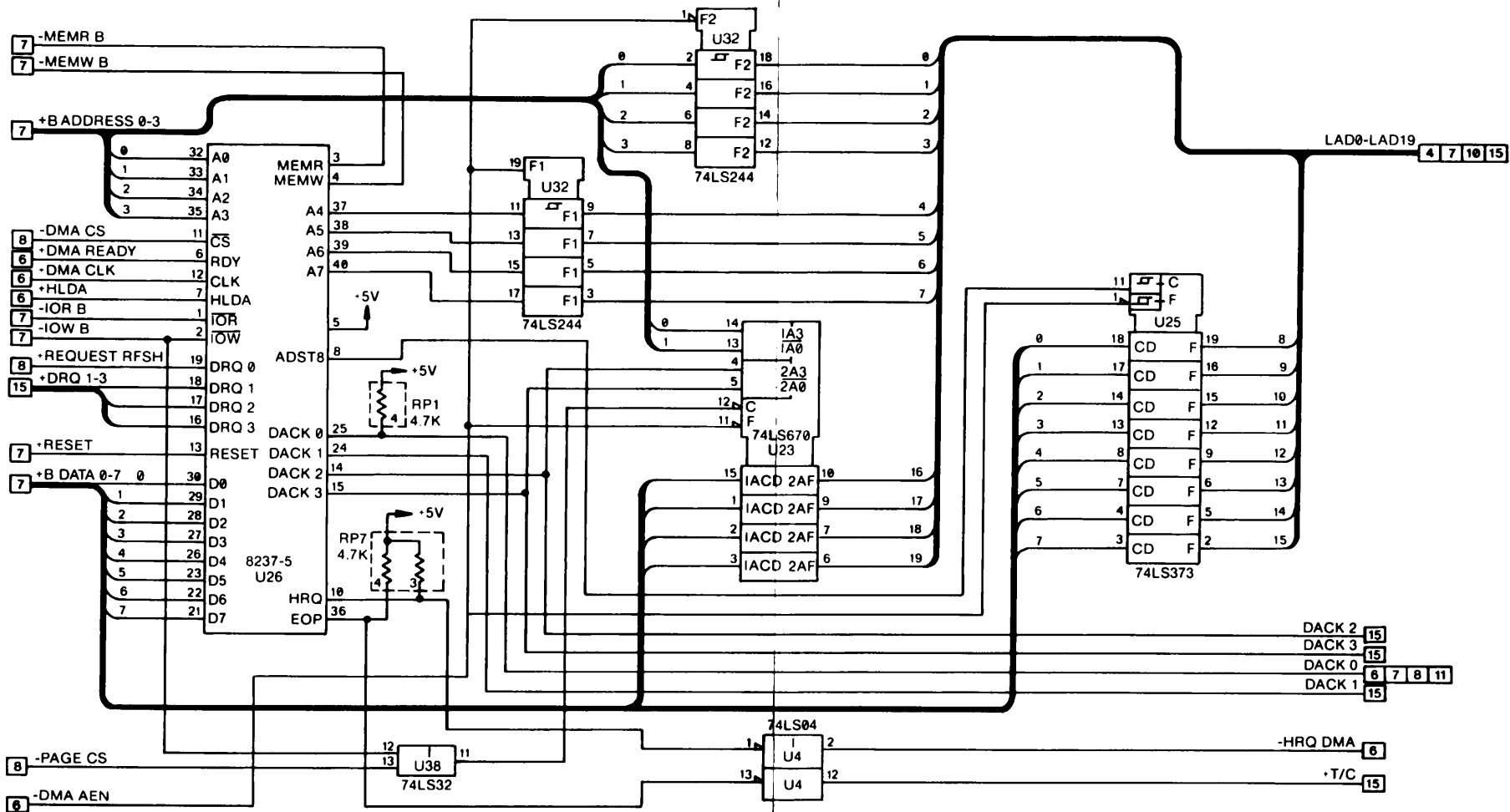


Main Processor Board (3 of 15)

CONNECTION AND LOGIC DIAGRAMS

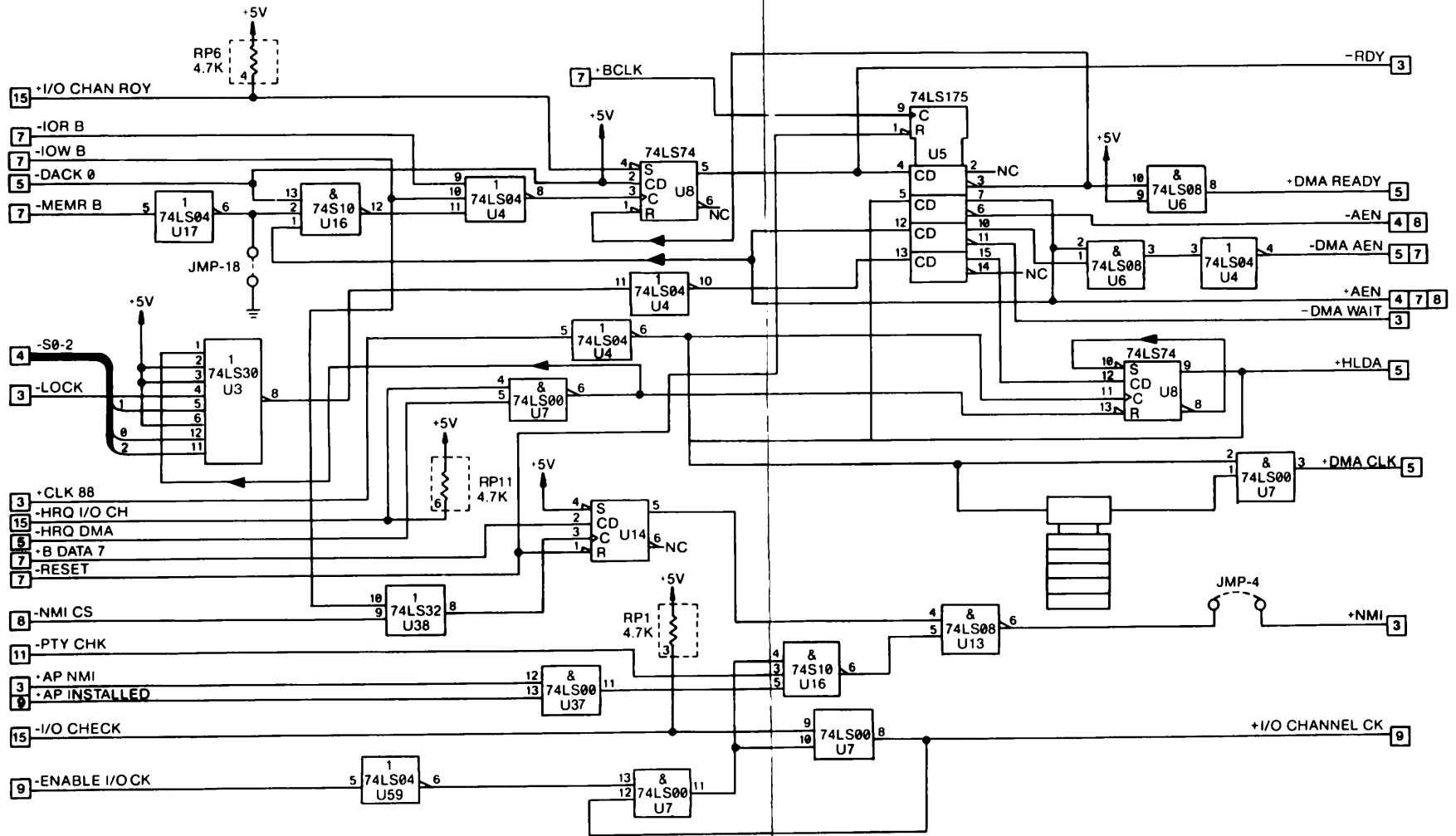


Main Processor Board (4 of 15)



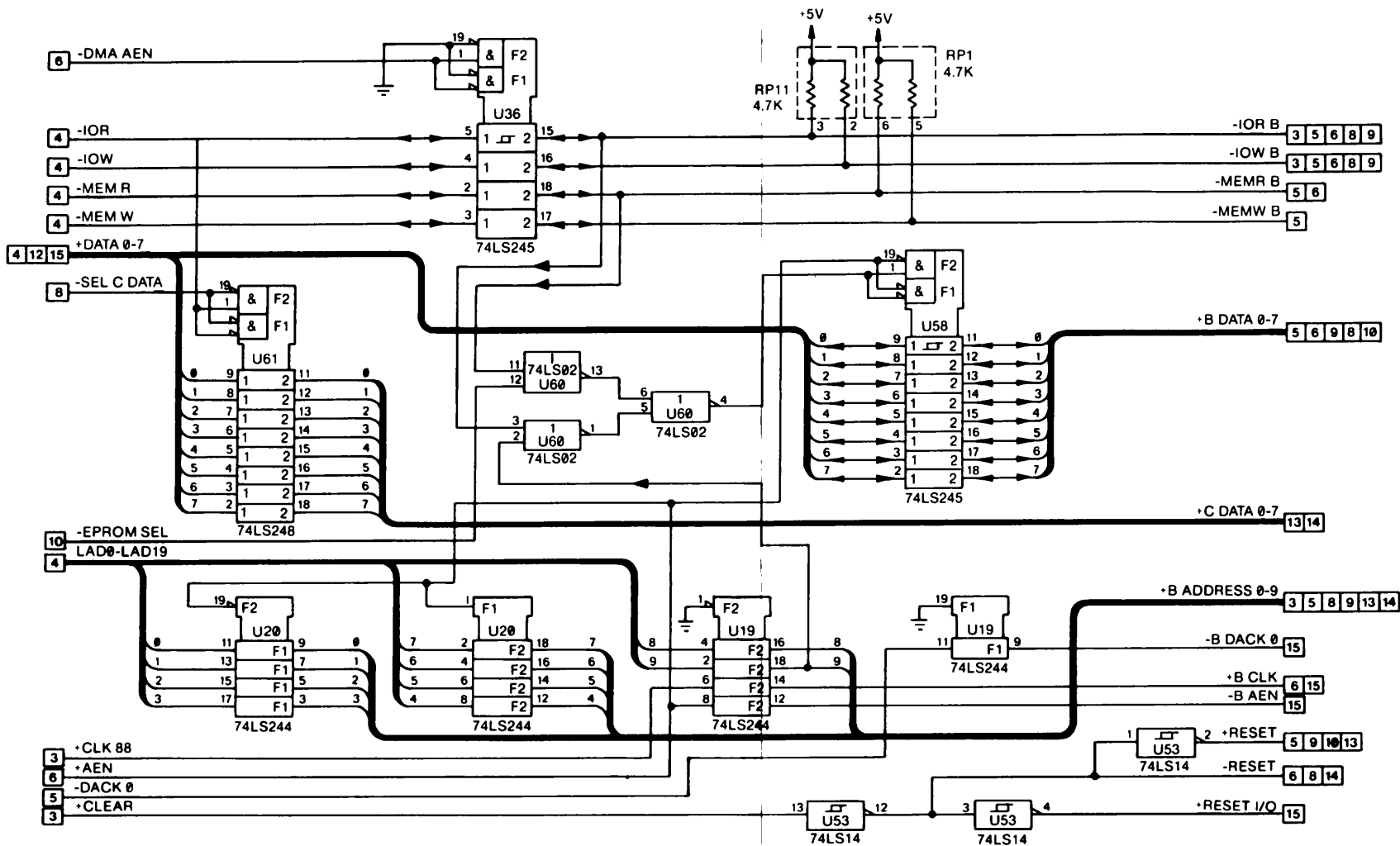
Main Processor Board (5 of 15)

CONNECTION AND LOGIC DIAGRAMS



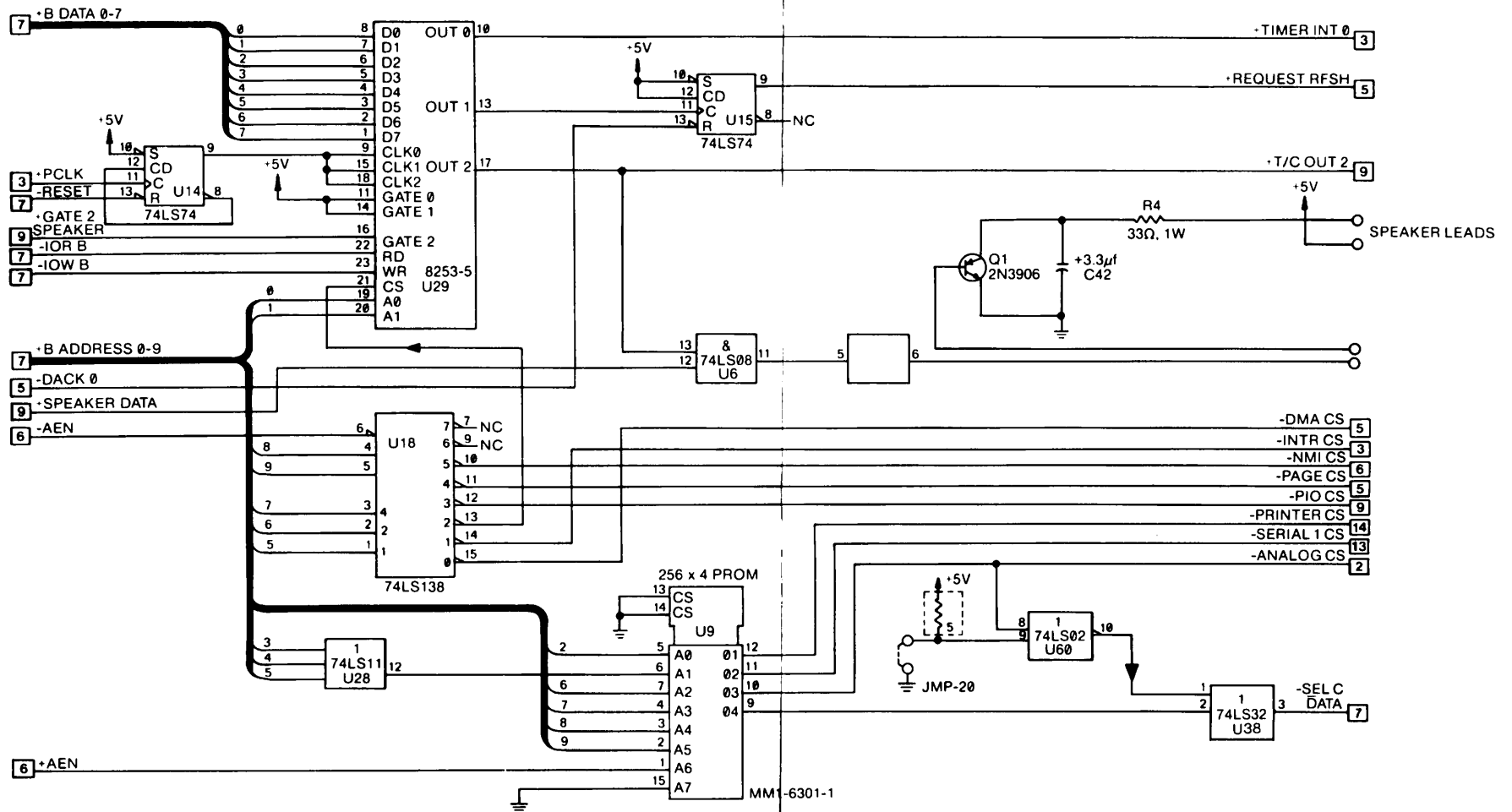
Main Processor Board (6 of 15)

CONNECTION AND LOGIC DIAGRAMS

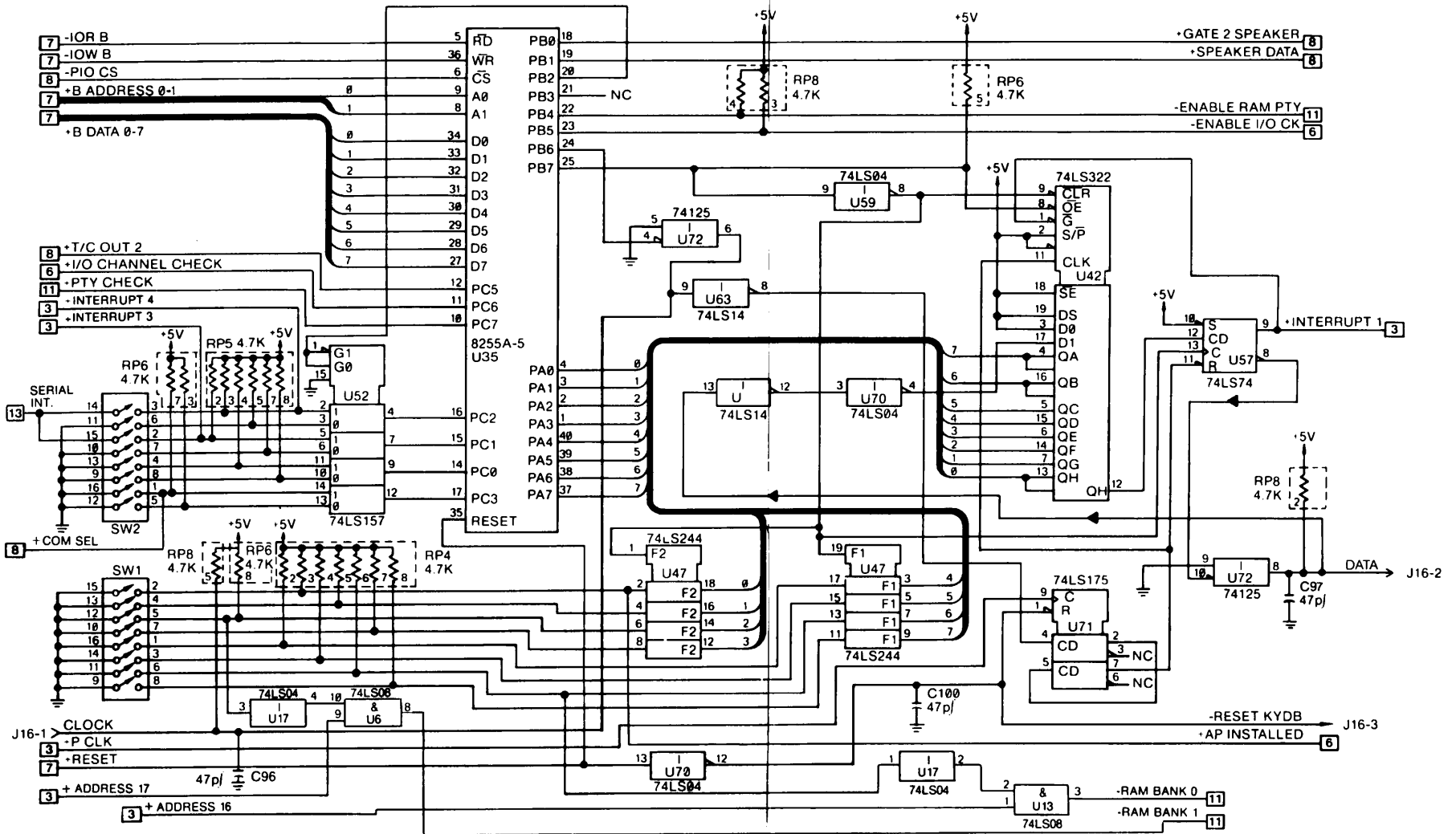


Main Processor Board (7 of 15)

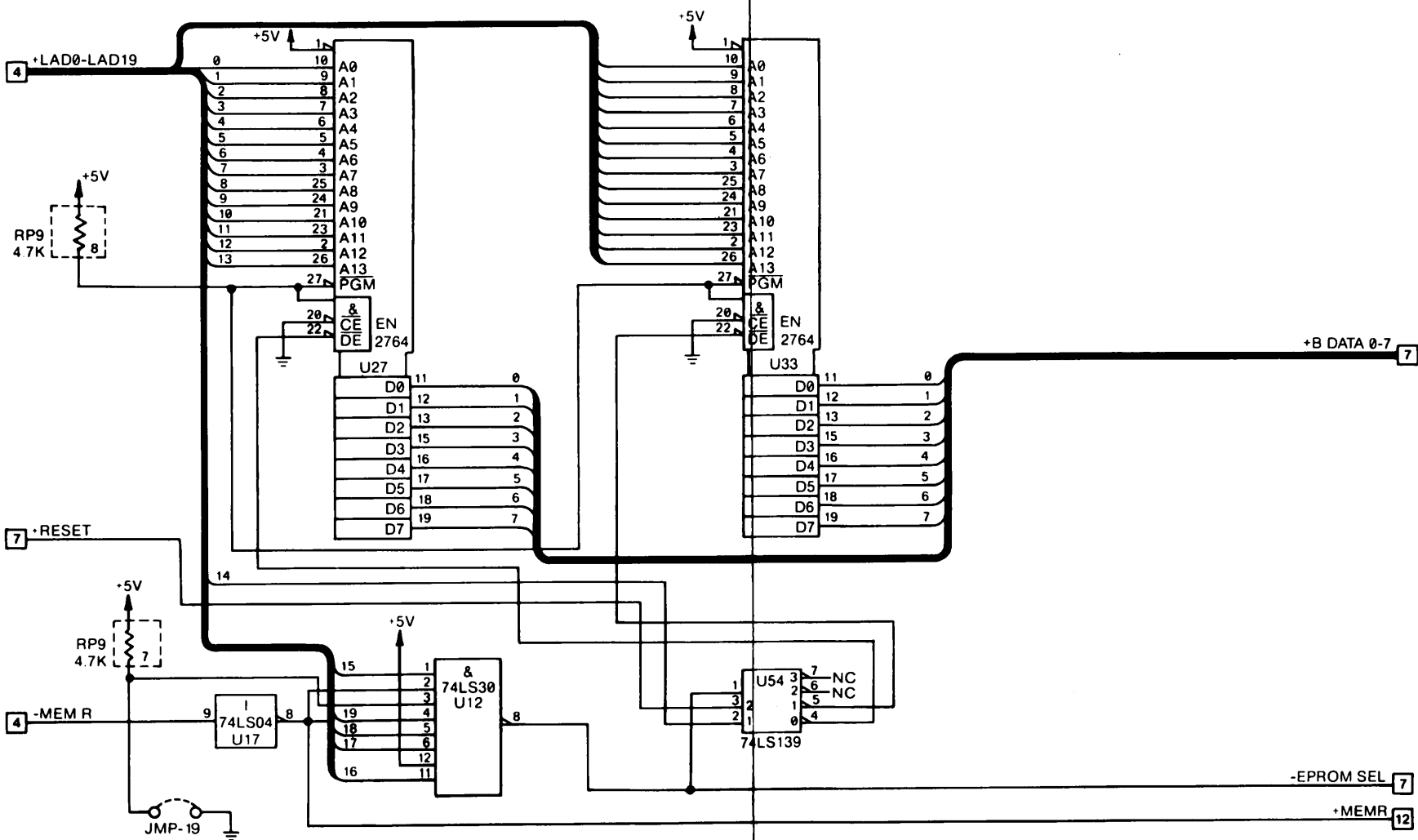
CONNECTION AND LOGIC DIAGRAMS



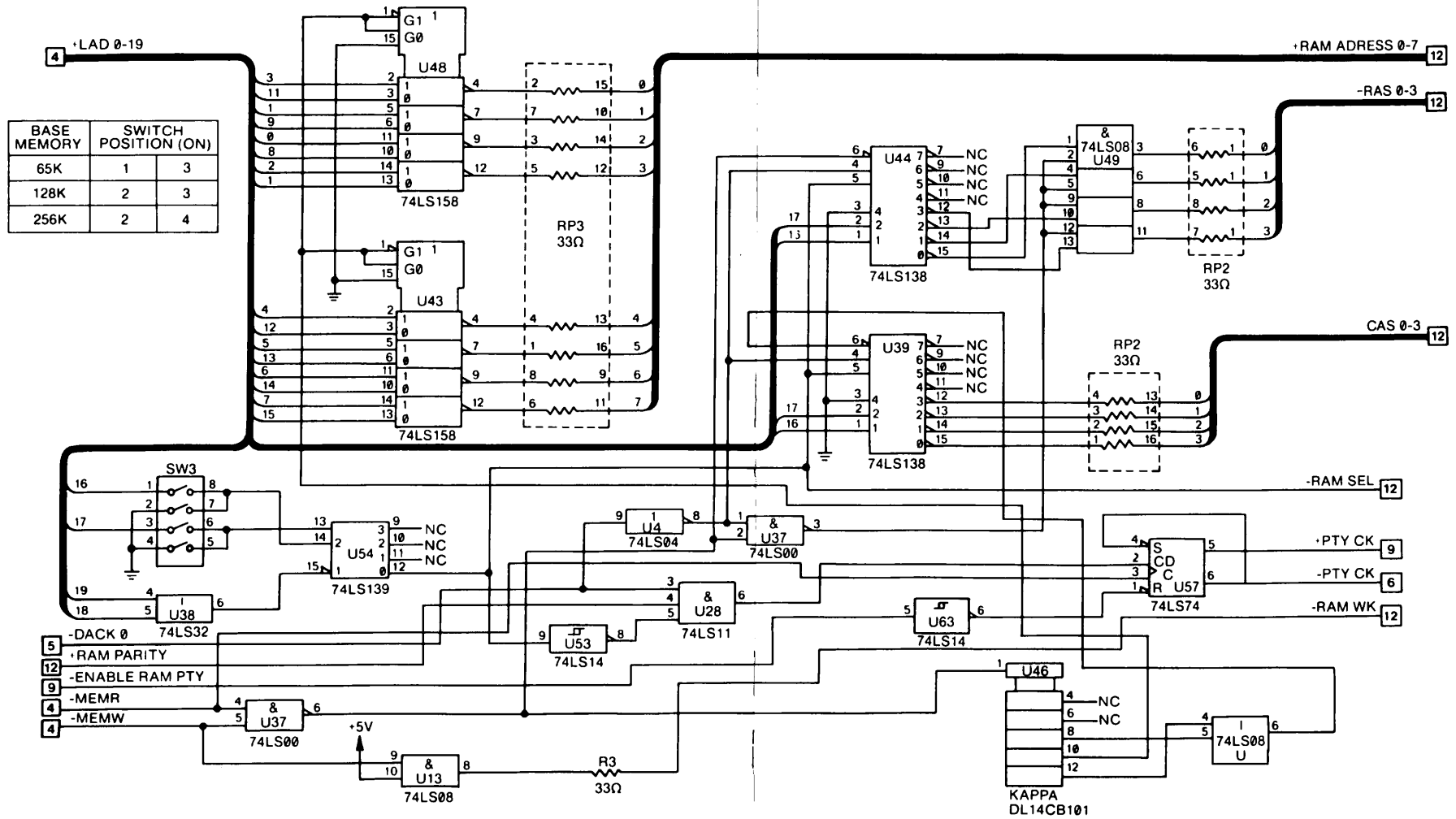
Main Processor Board (8 of 15)



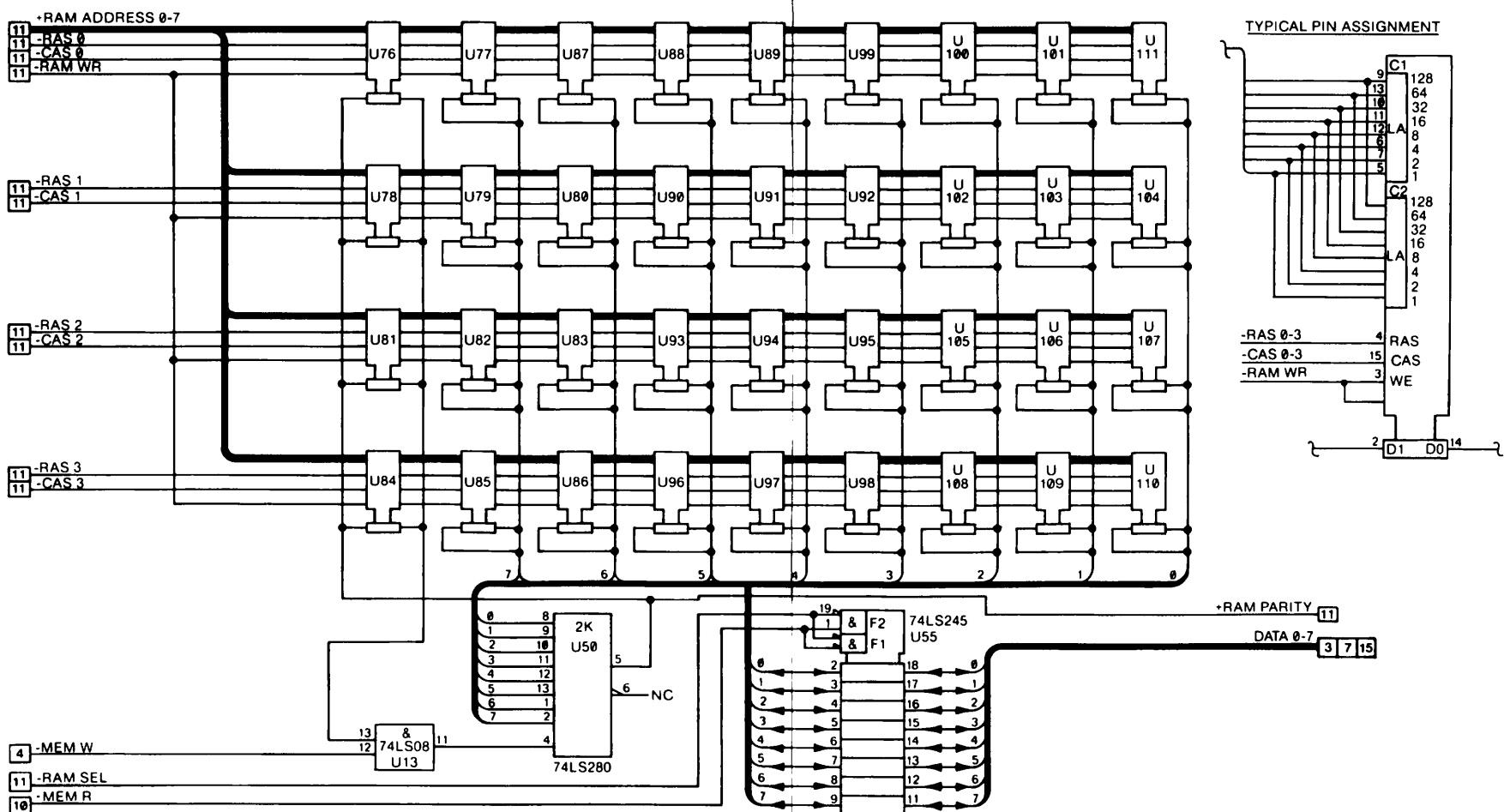
Main Processor Board (9 of 15)



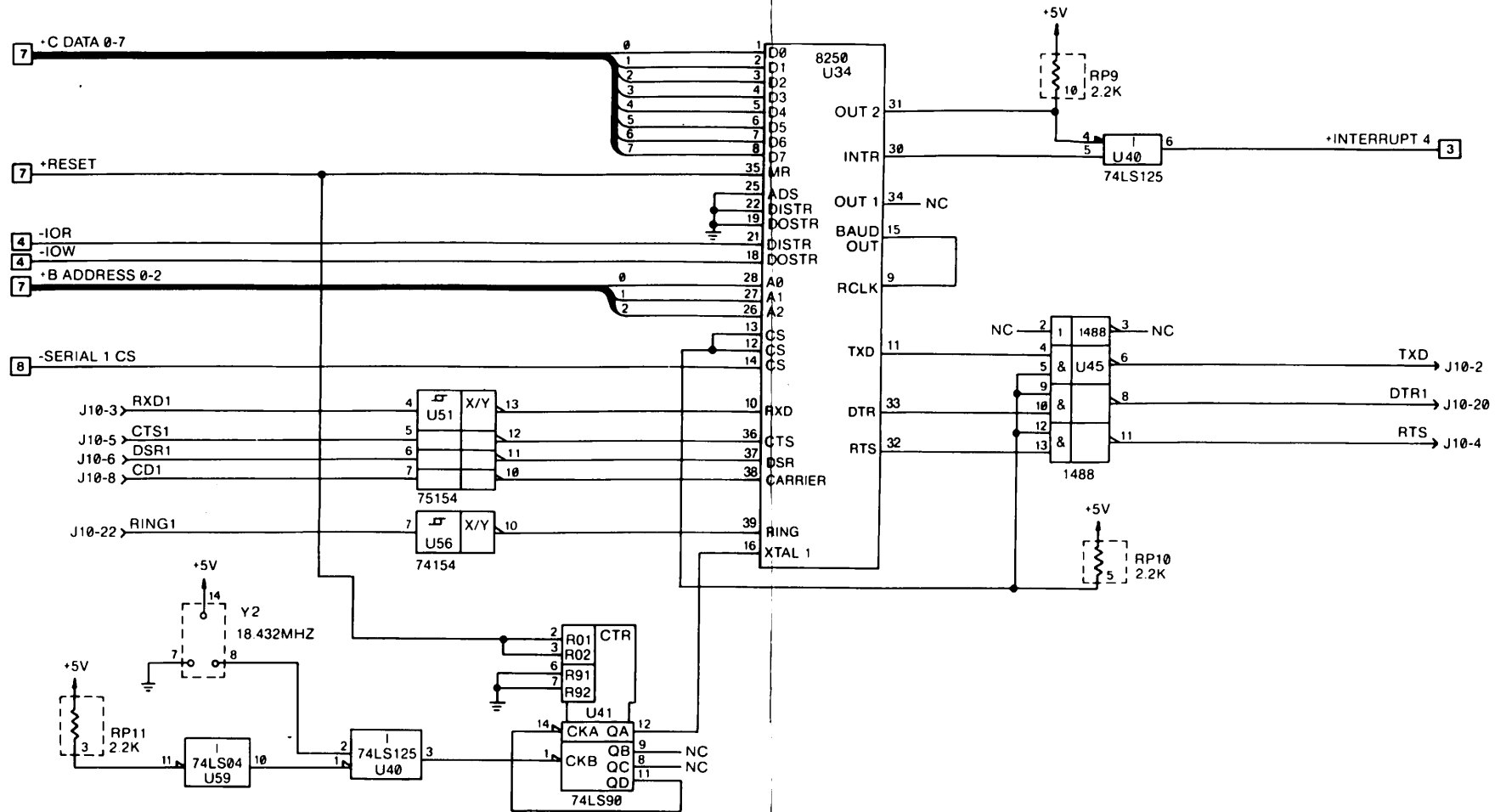
Main Processor Board (10 of 15)



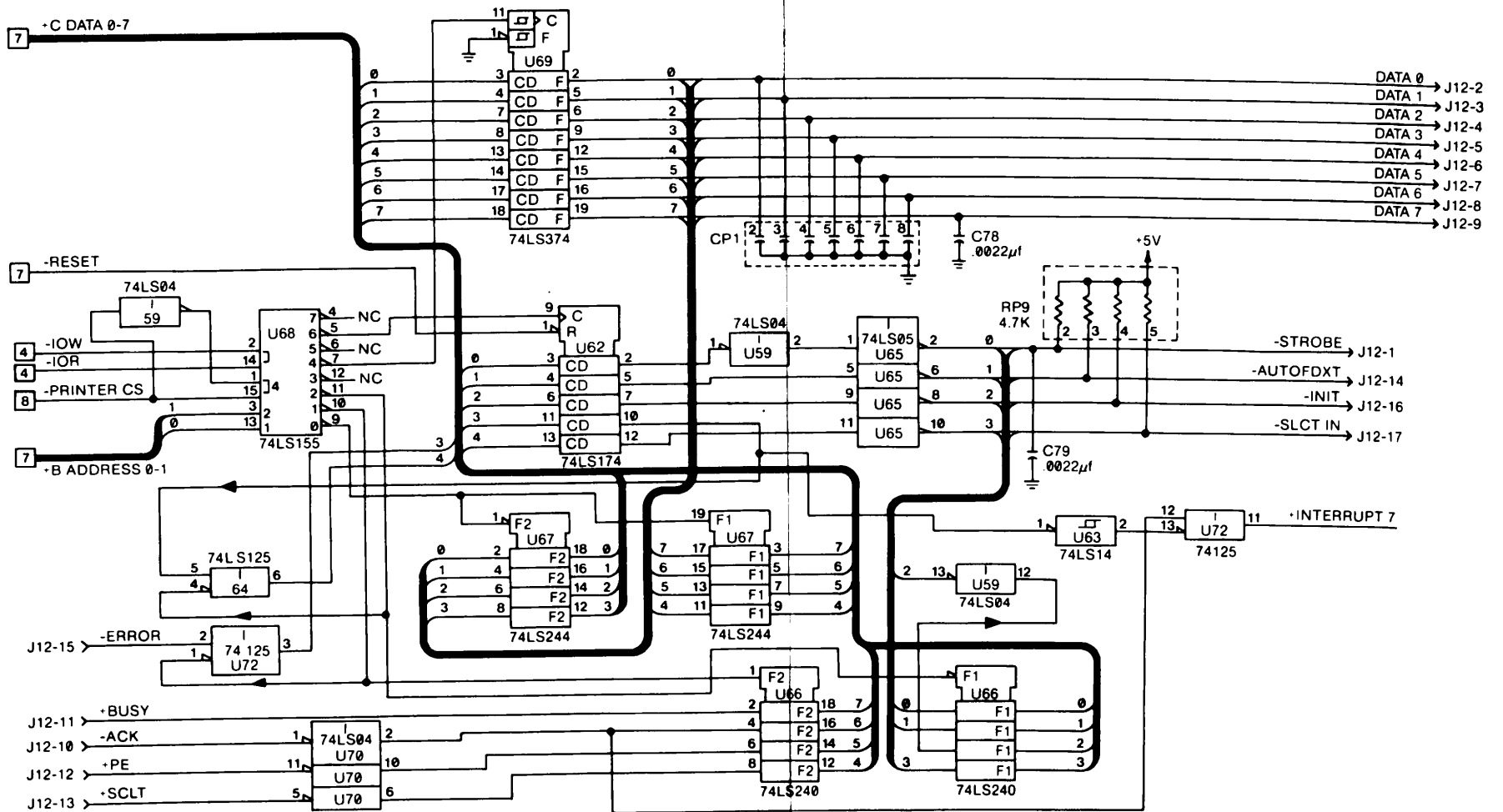
Main Processor Board (11 of 15)



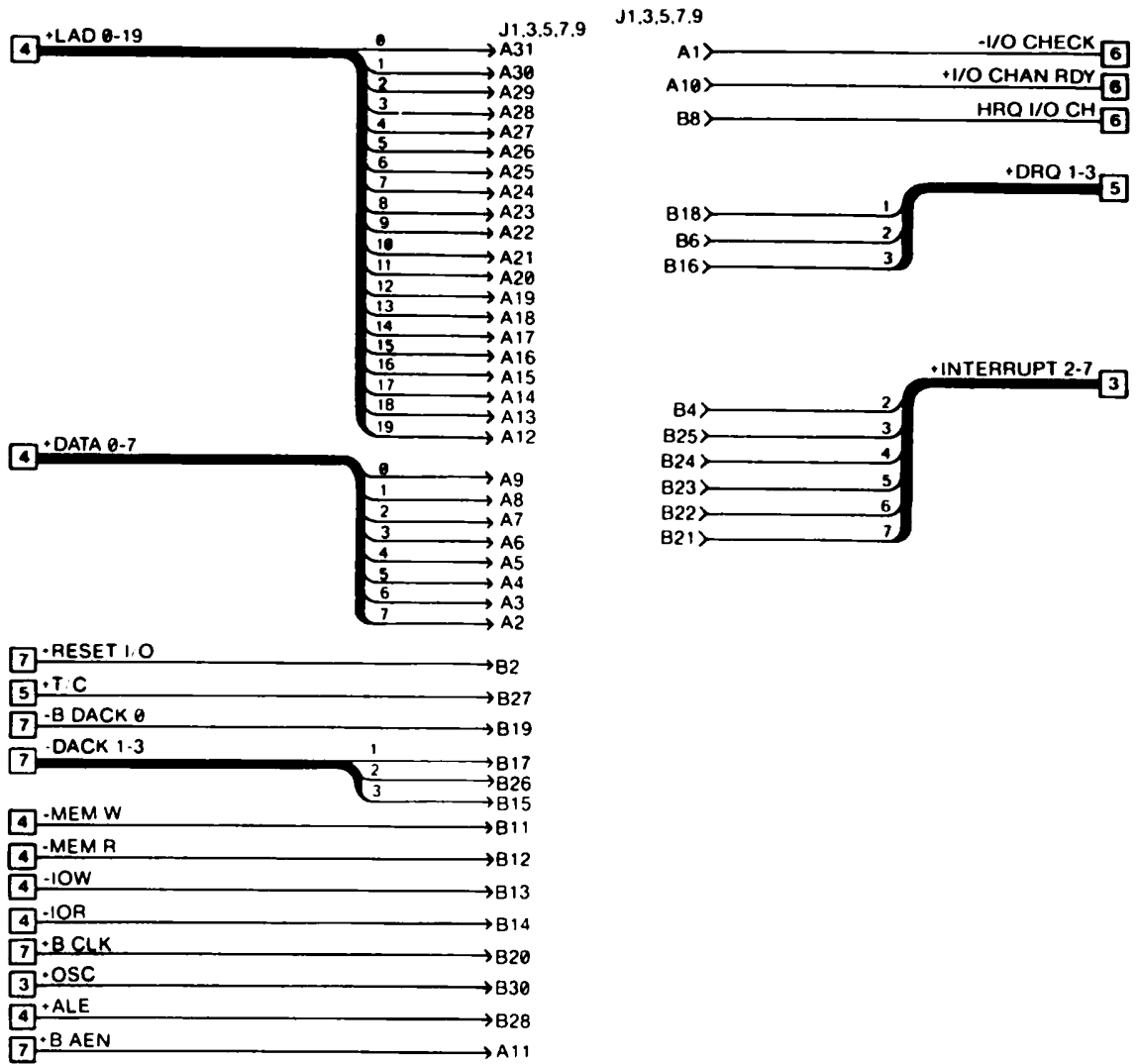
Main Processor Board (12 of 15)



Main Processor Board (13 of 15)

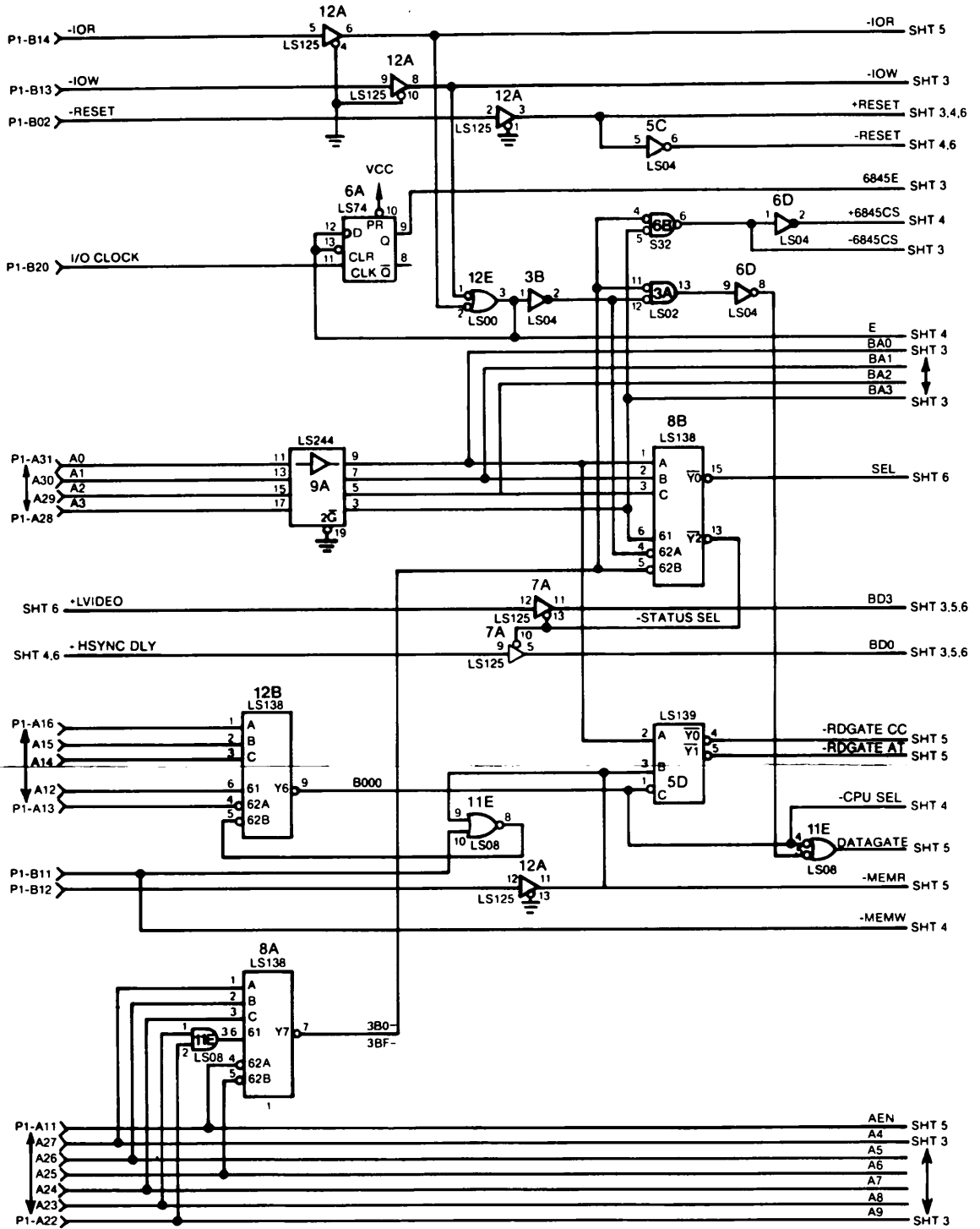


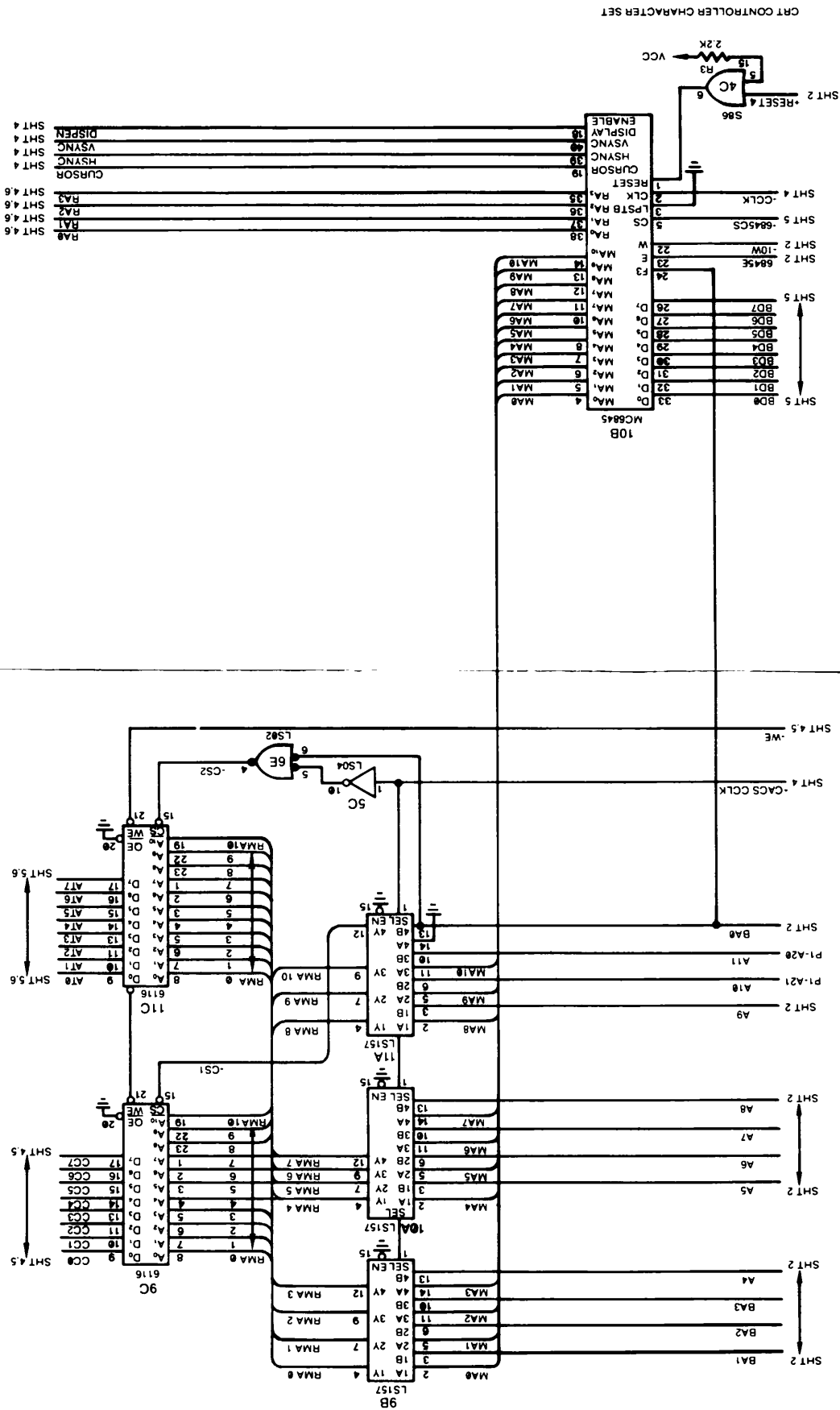
Main Processor Board (14 of 15)



Main Processor Board (15 of 15)

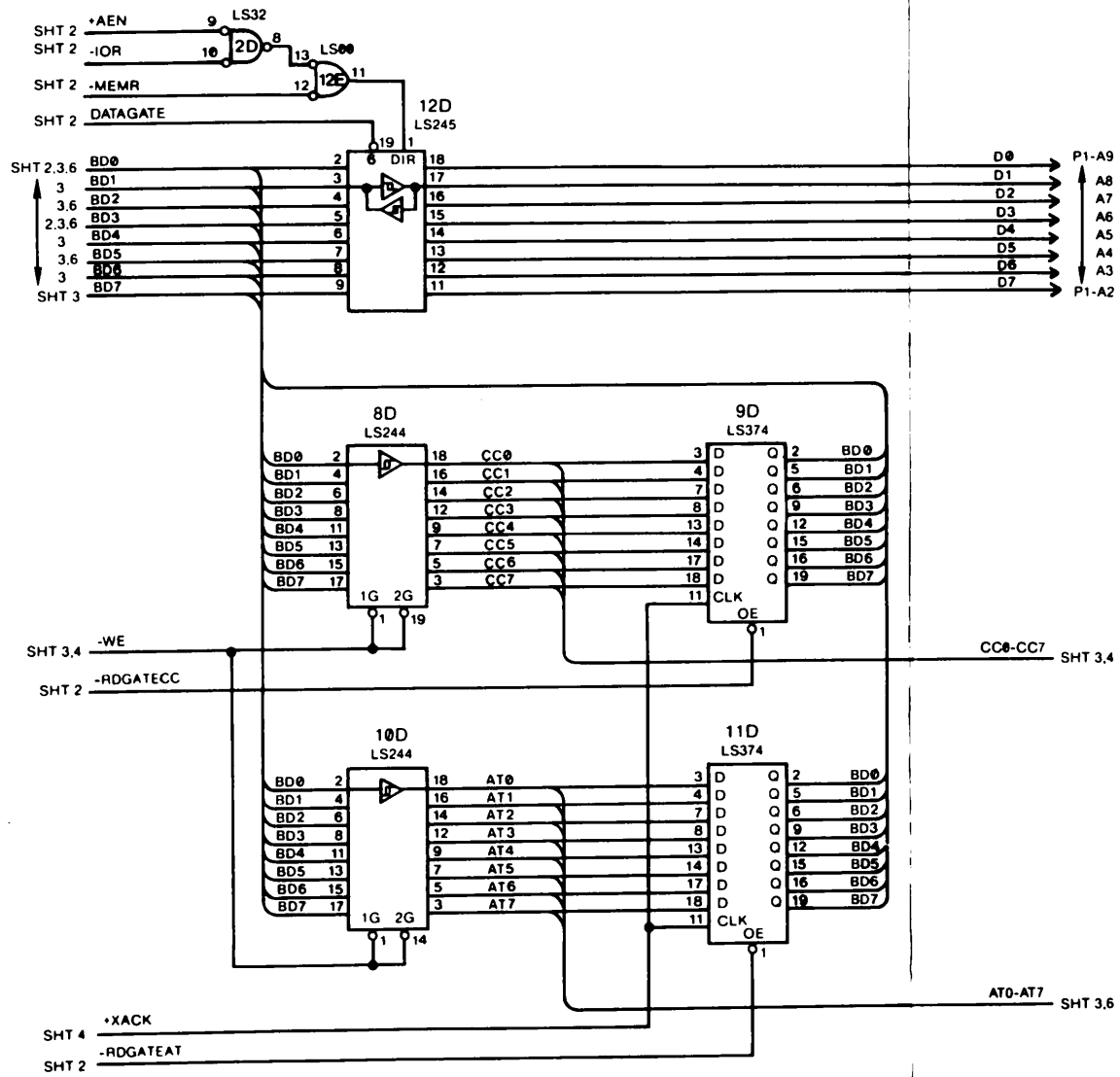
NOTE: Sheet 1 of 6 is Not Used  
Monochrome Display Adapter (2 of 6)





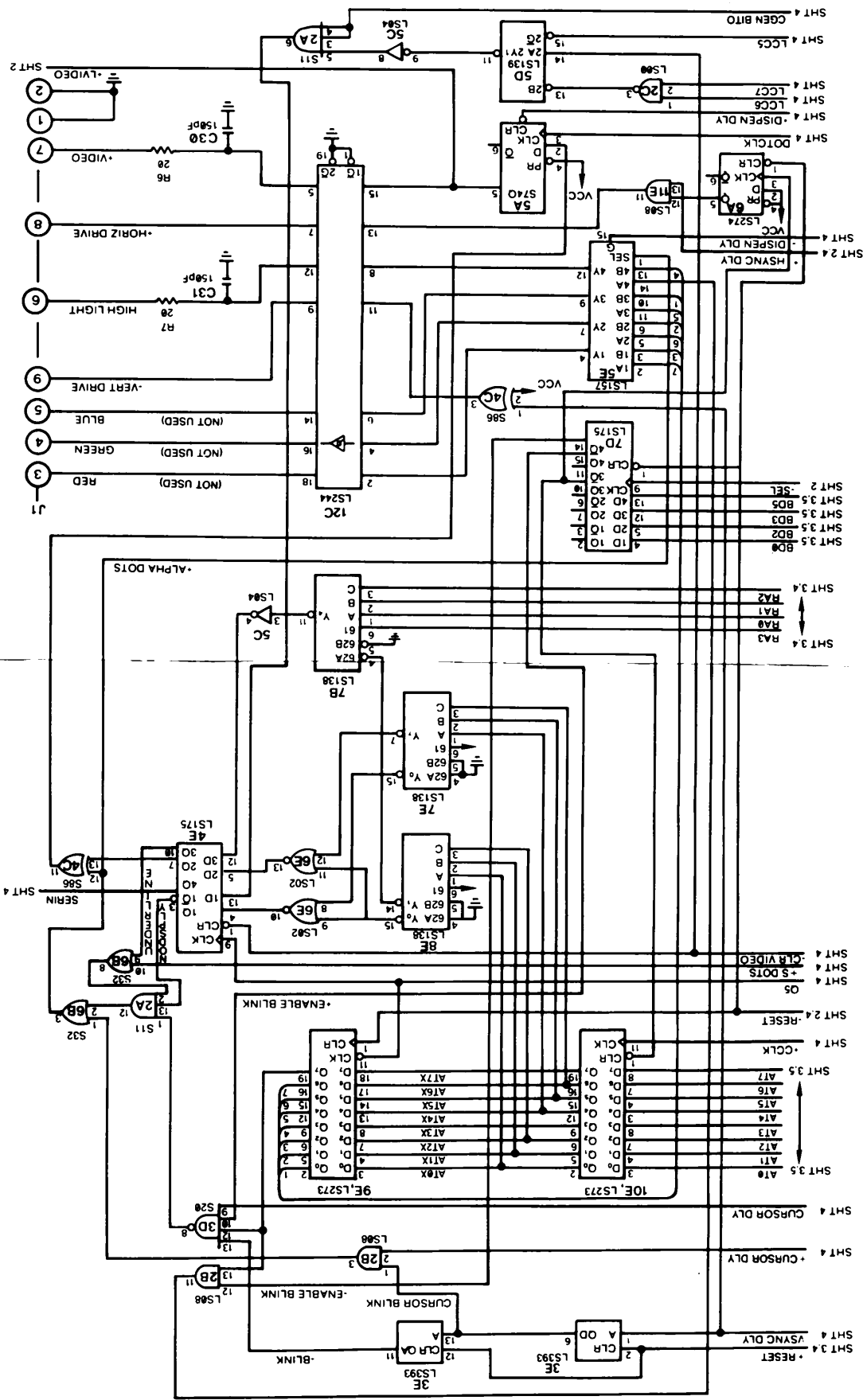
NOTE: Sheet 1 of 6 is Not Used  
Monochrome Display Adapter (3 of 6)





NOTE: Sheet 1 of 6 Is Not Used

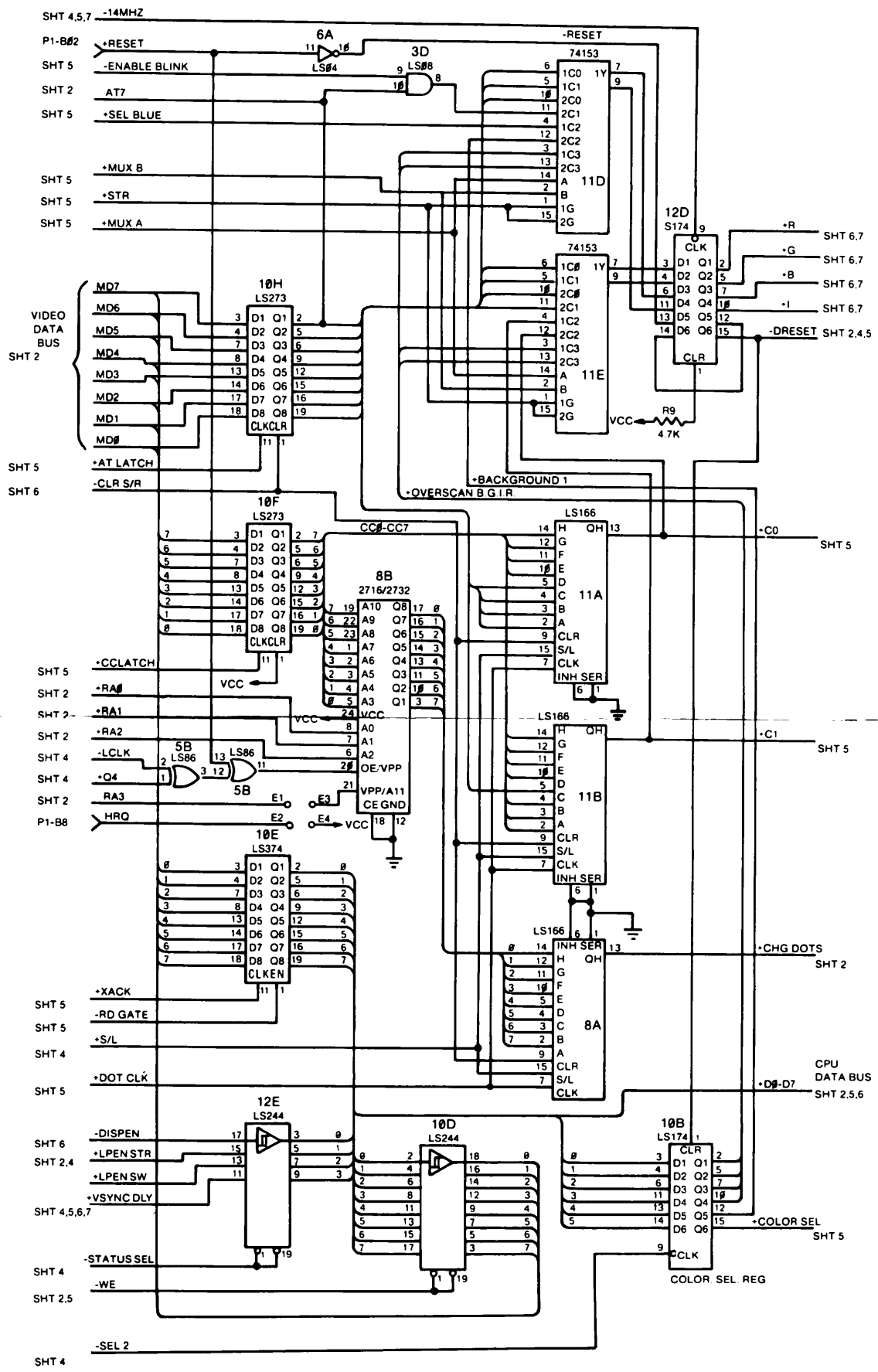
Monochrome Display Adapter (5 of 6)



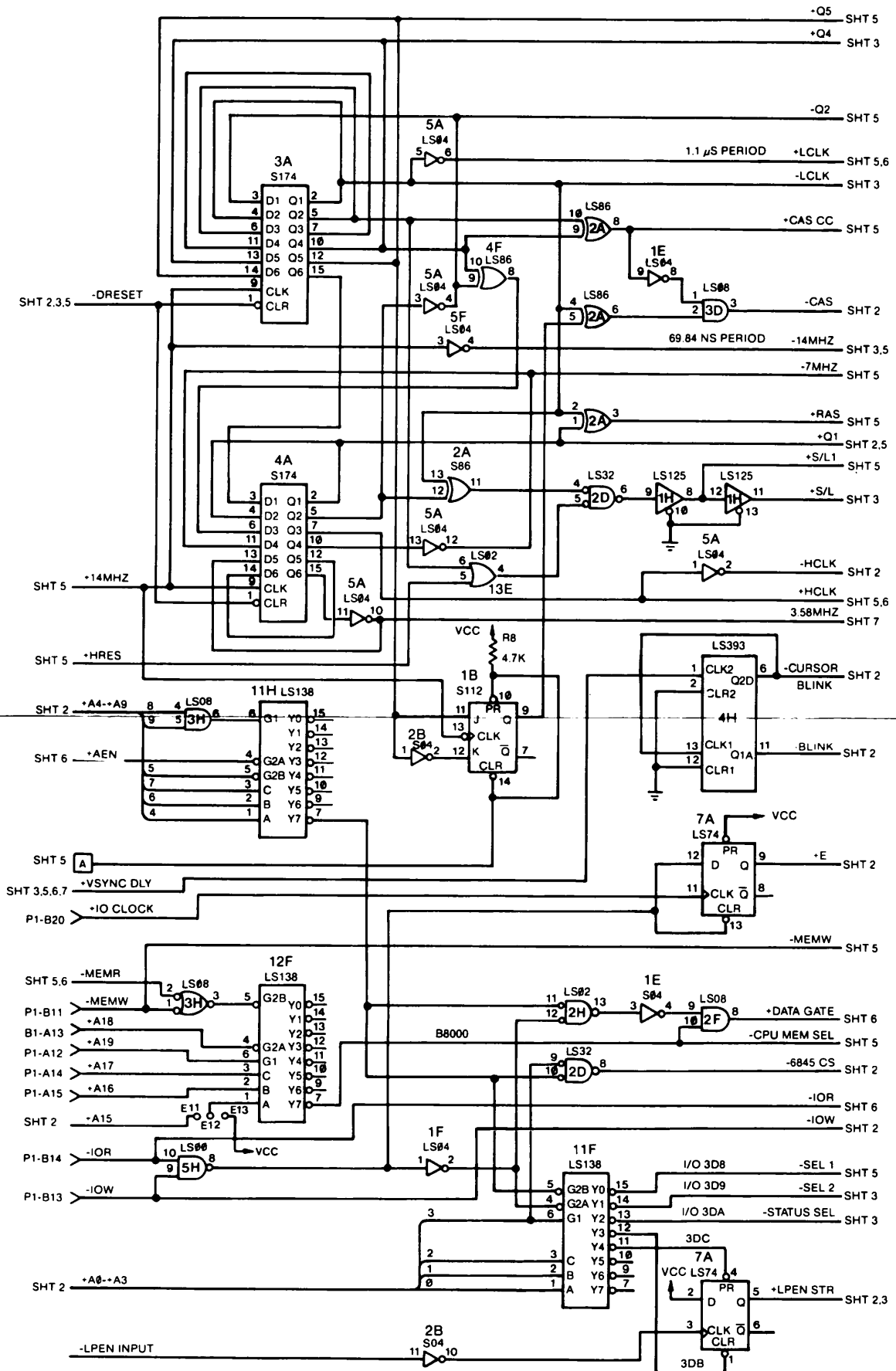
NOTE: Sheet 1 of 6 is Not Used  
Monochrome Display Adapter (6 of 6)



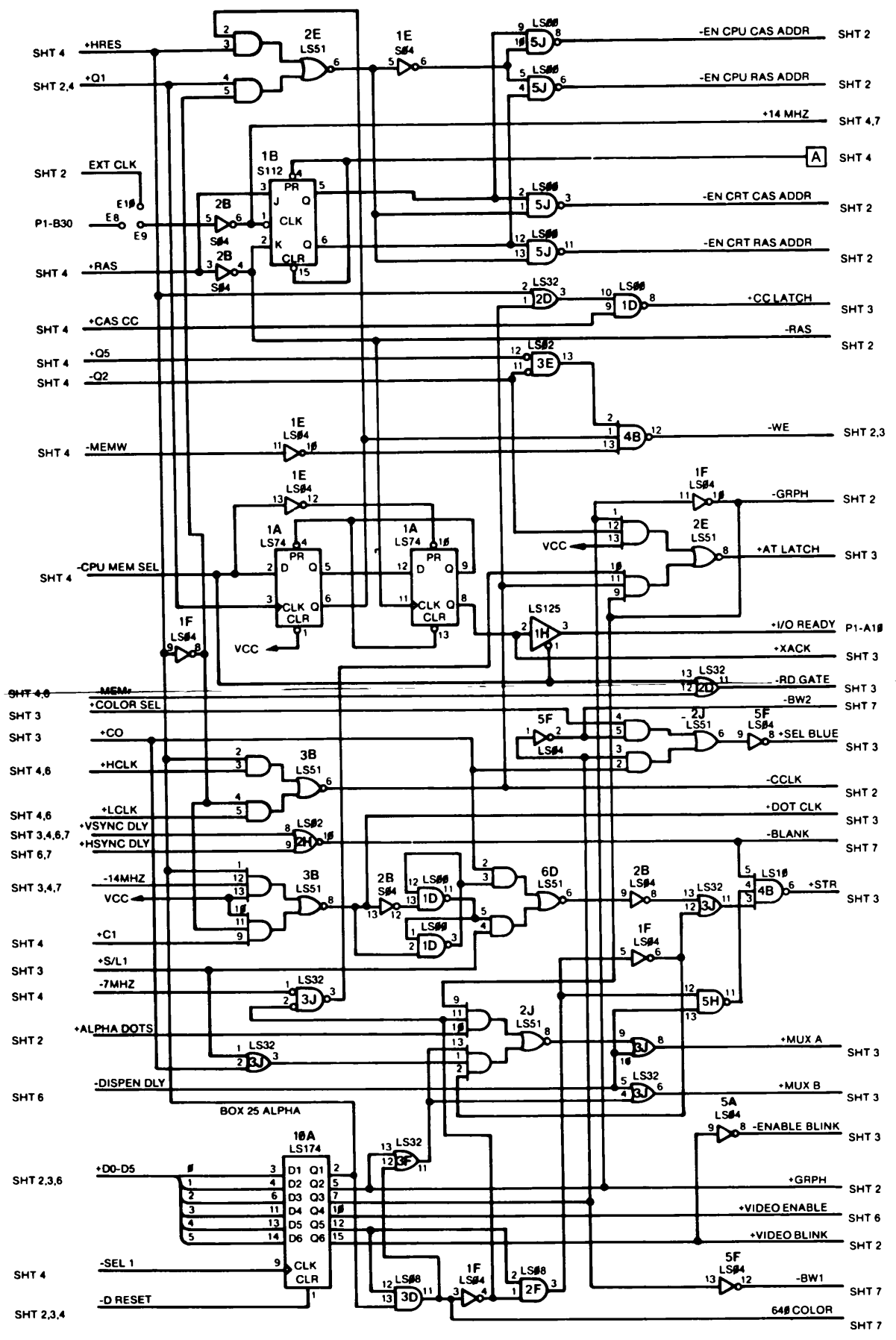
NOTE: Sheet 1 of 7 is Not Used  
Display Adapter — Color (3 of 7)



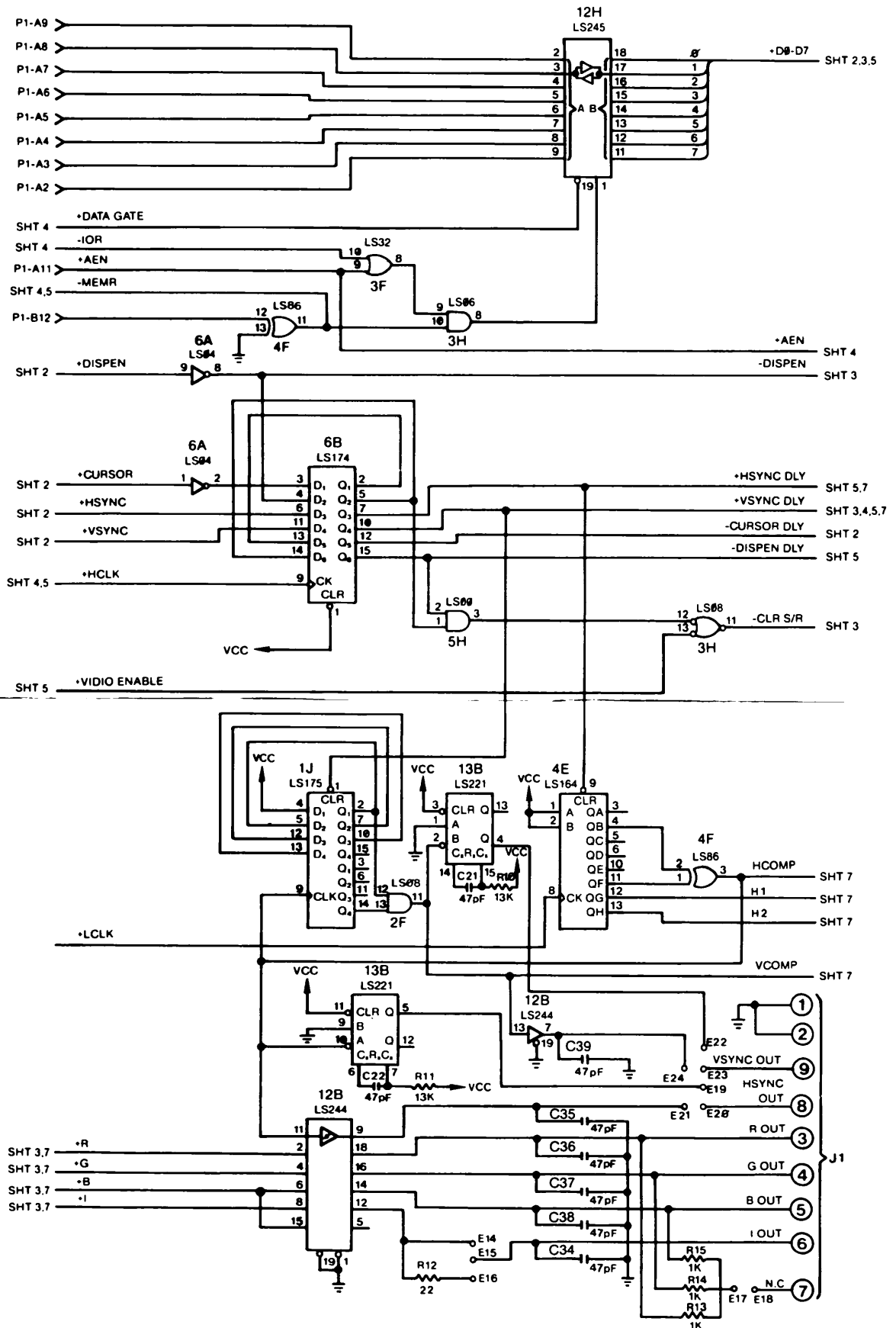
NOTE: Sheet 1 of 7 is Not Used  
Display Adapter — Color (4 of 7)



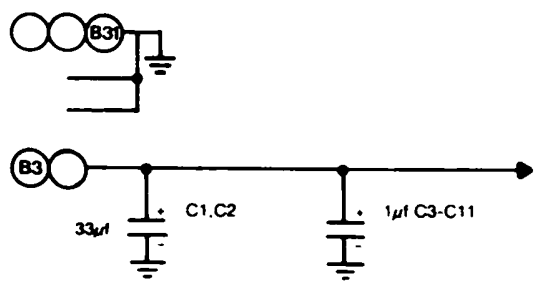
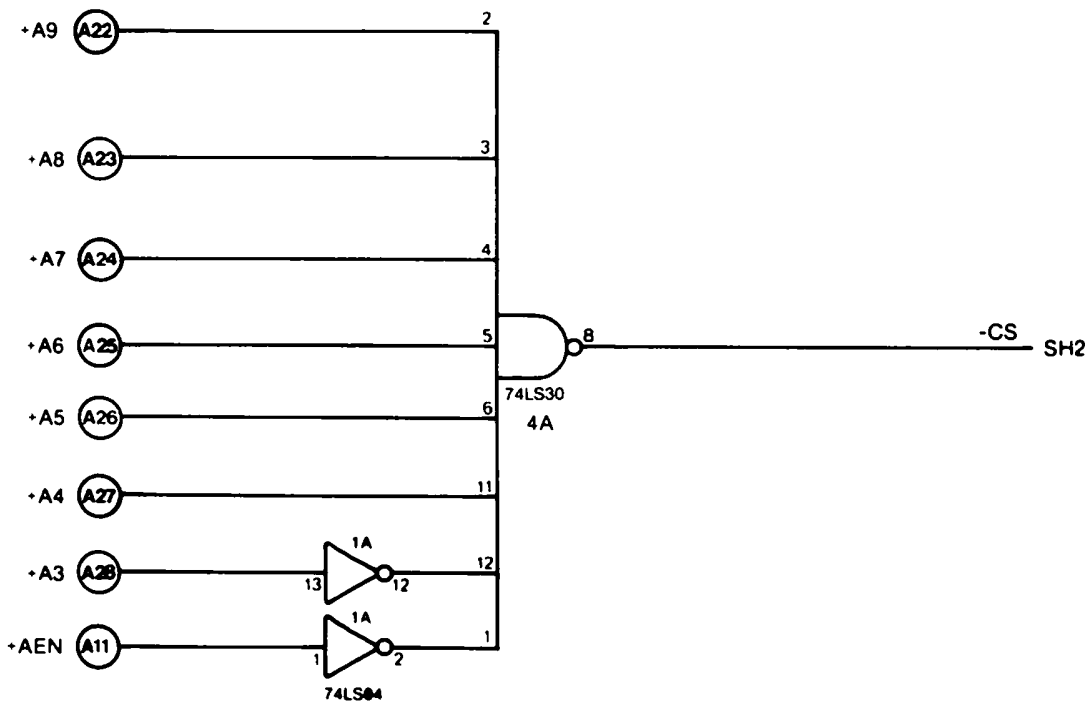
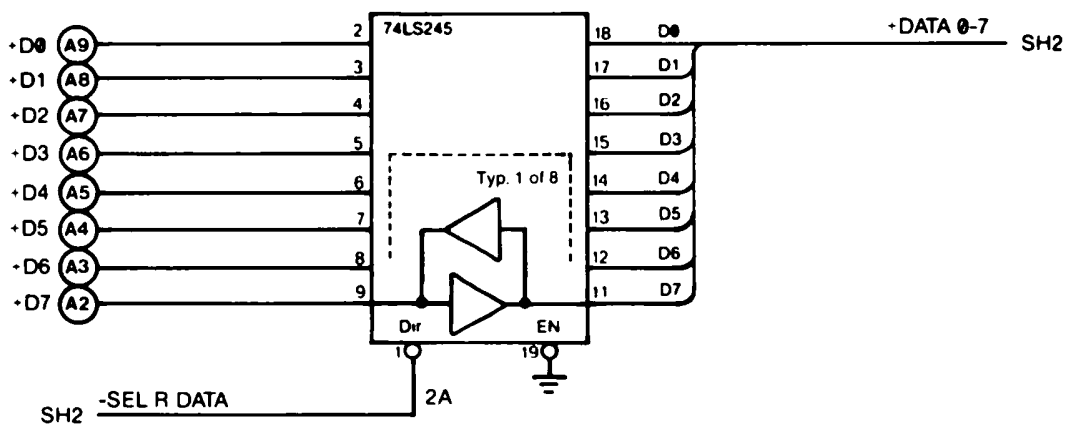
NOTE: Sheet 1 of 7 is Not Used  
Display Adapter — Color (5 of 7)



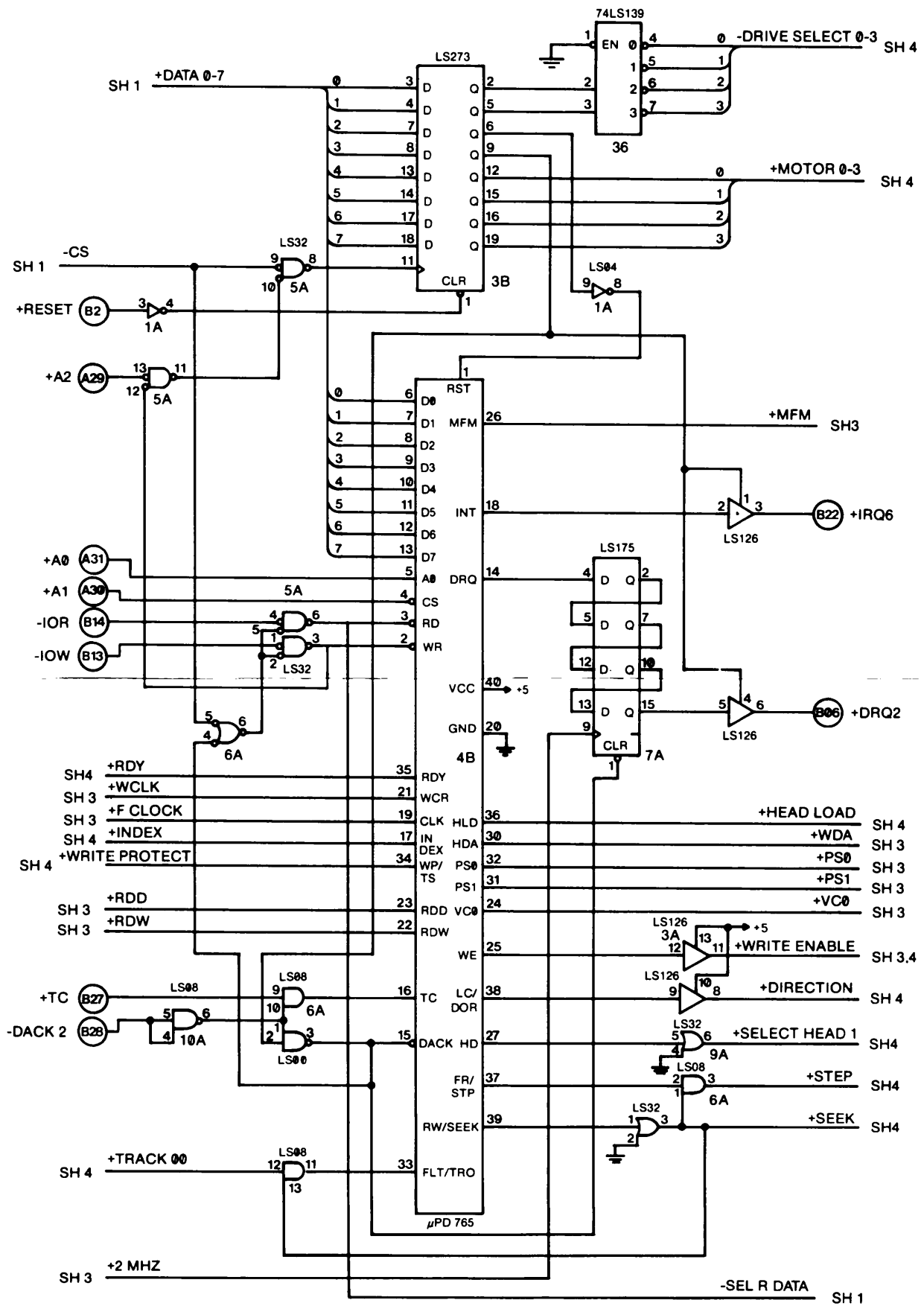
NOTE: Sheet 1 of 7 is Not Used  
Display Adapter — Color (6 of 7)



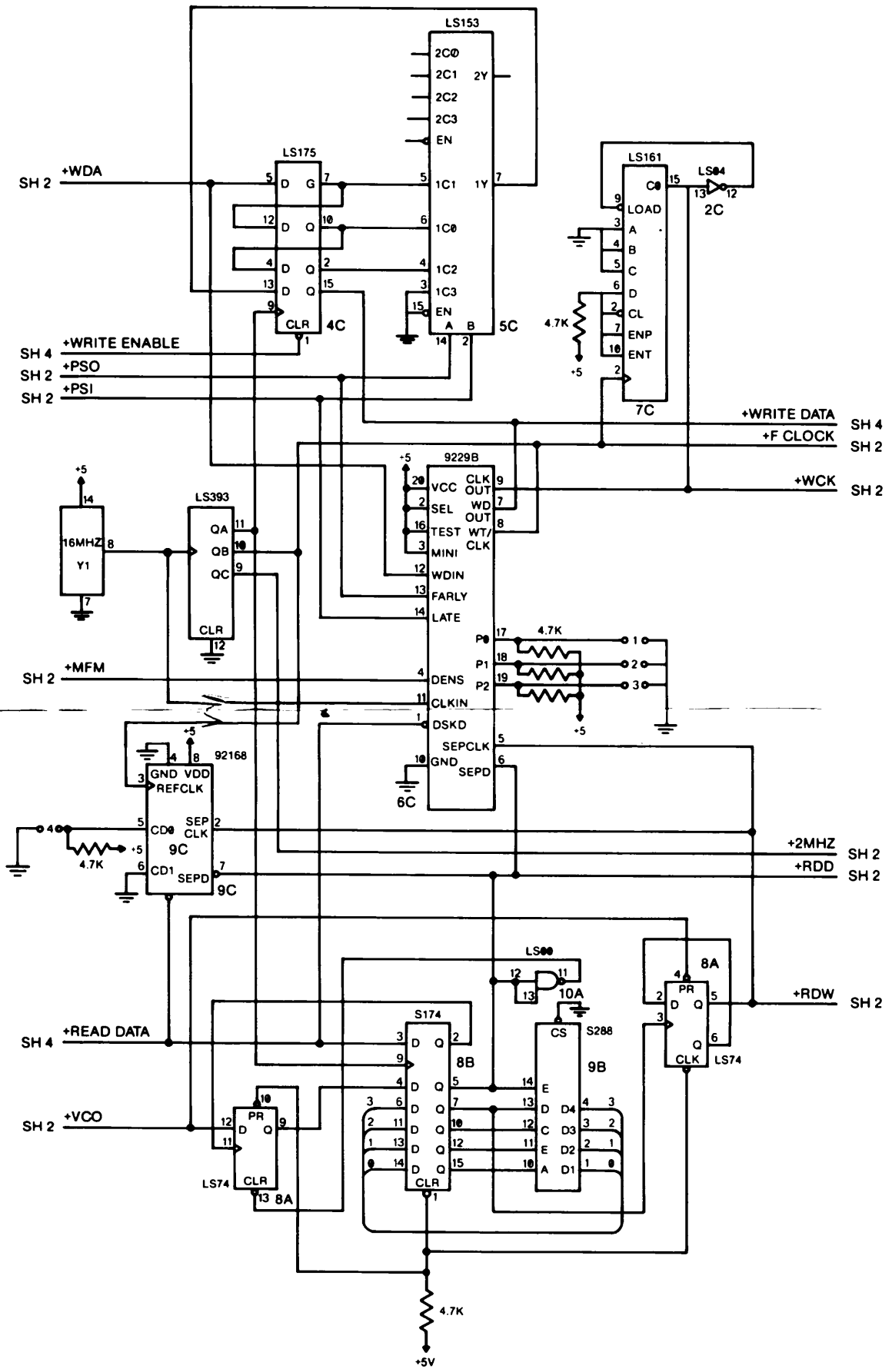


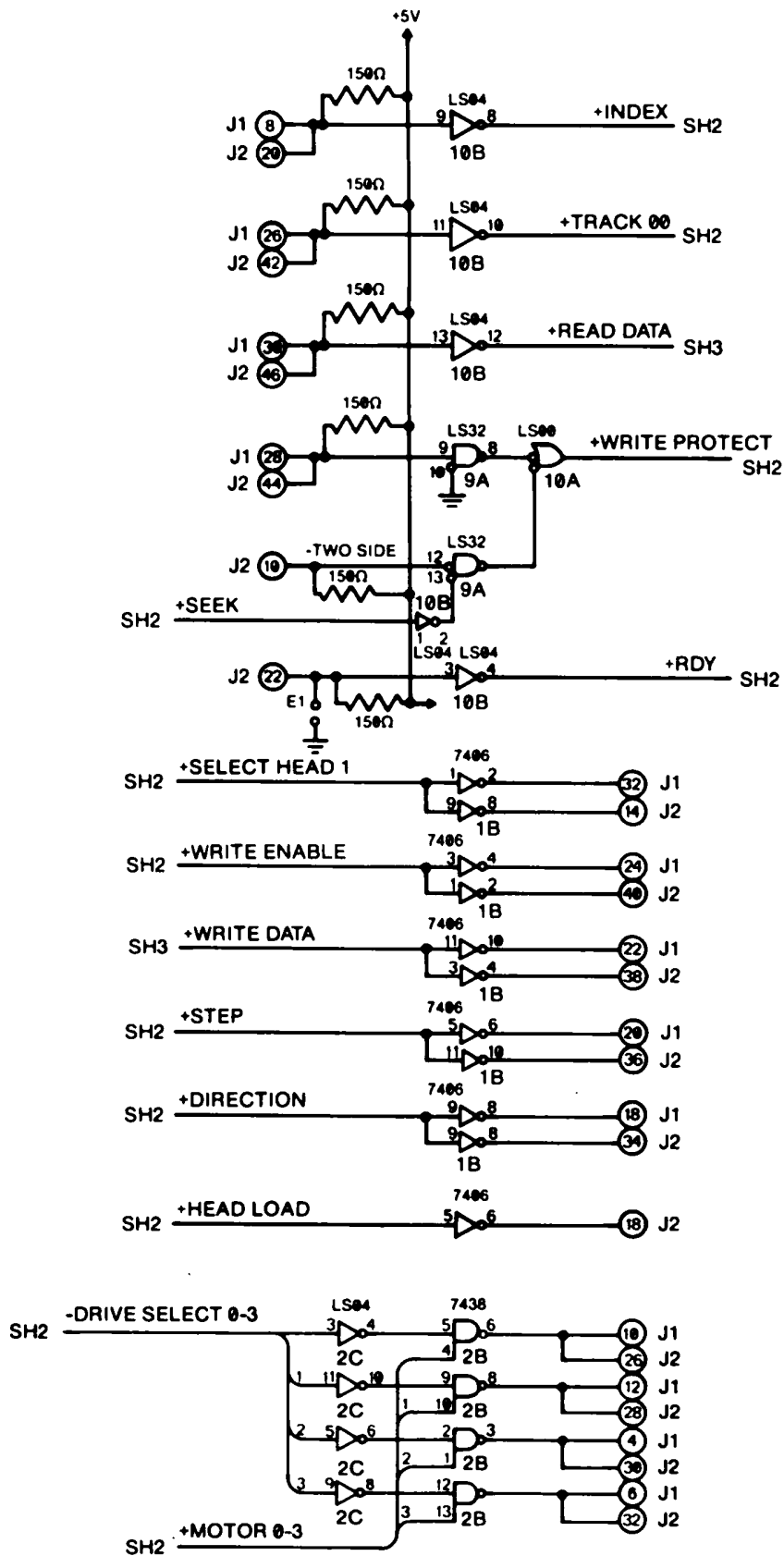


Flex Disk Drive Controller (1 of 4)



Flex Disk Drive Controller (3 of 4)



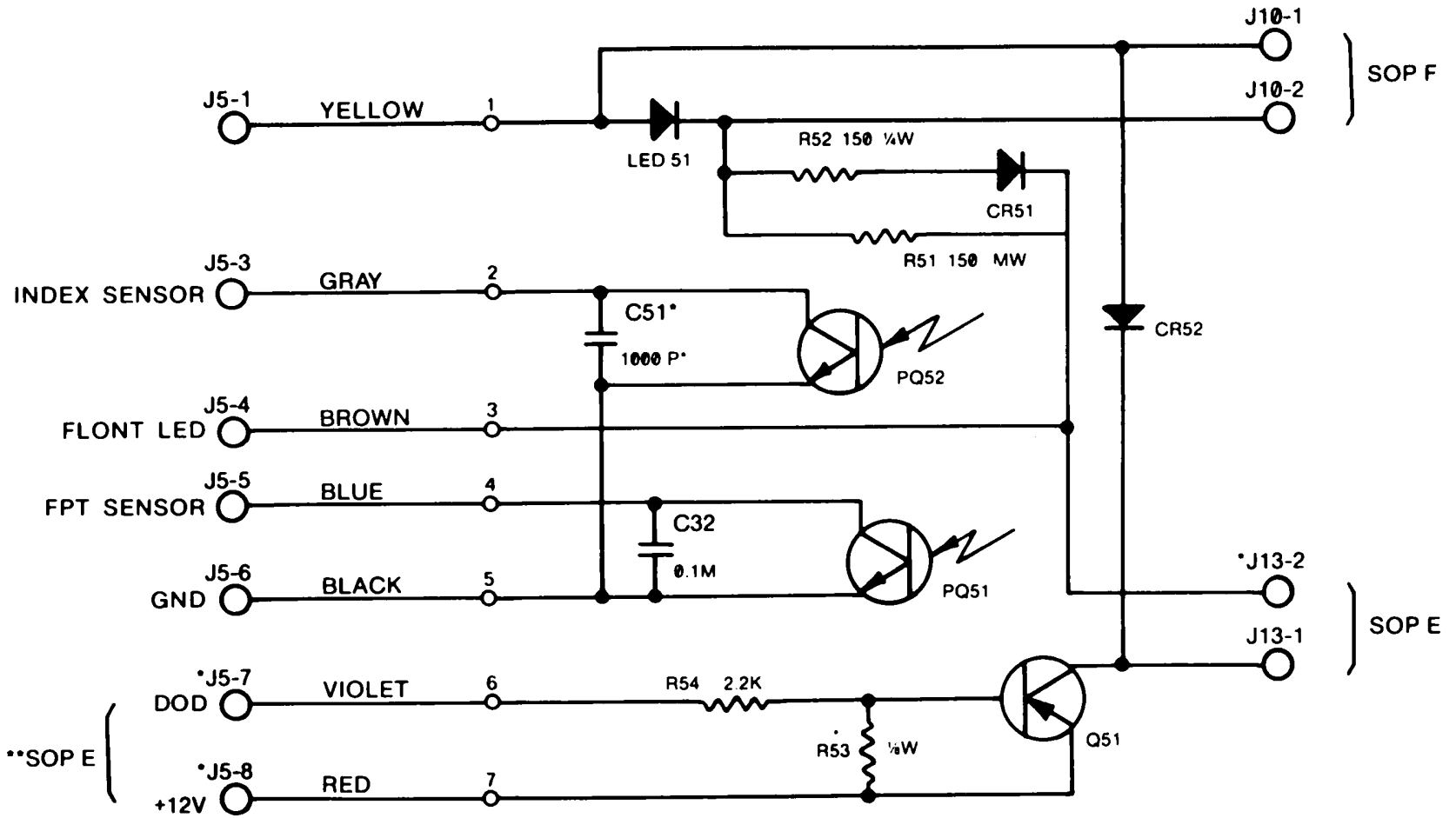


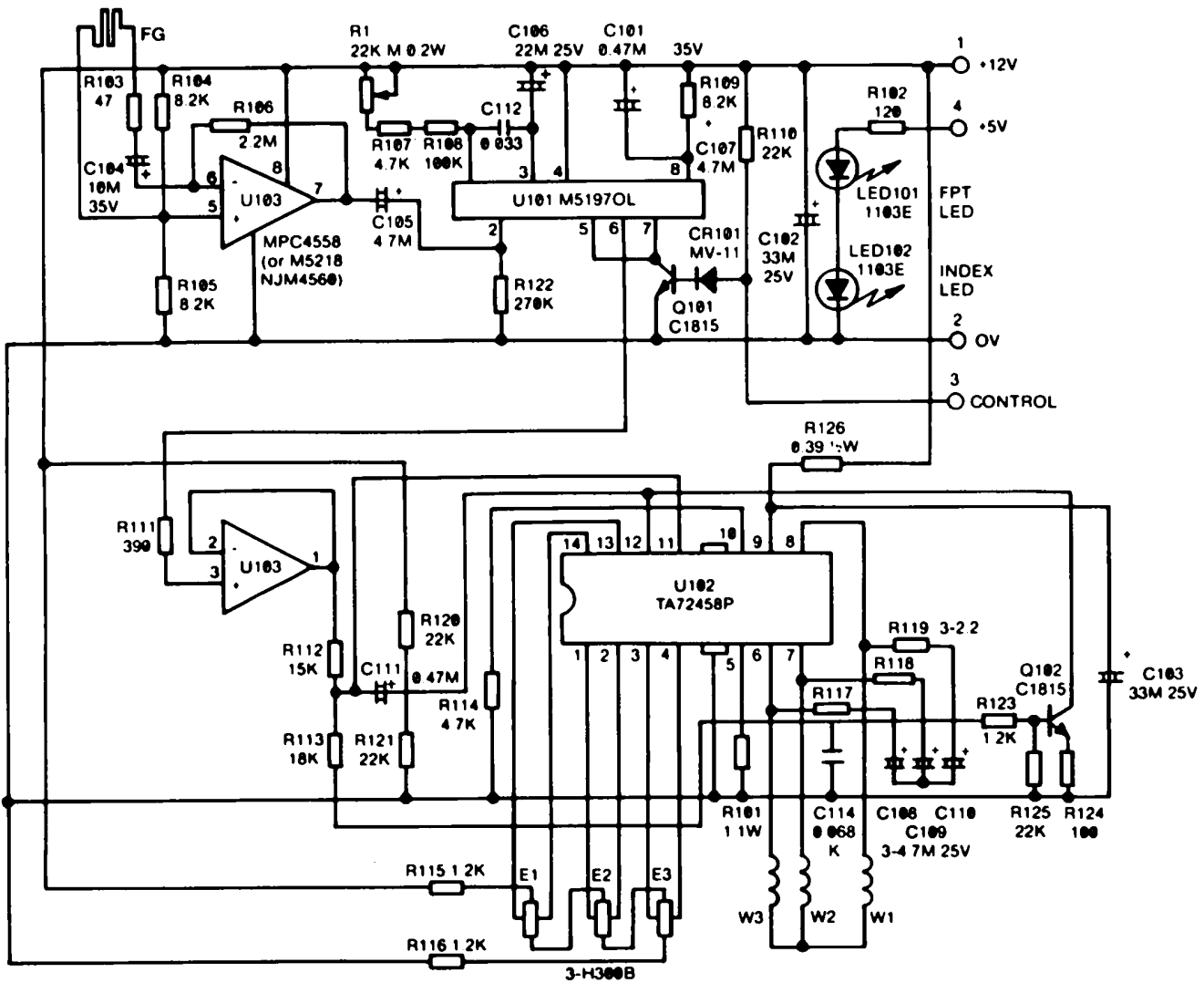
Note: J1 is a 34 pin connector. All odd pins are grounded.  
 J2 is a 50 pin connector. All odd pins are grounded.

Flex Disk Drive Controller (4 of 4)



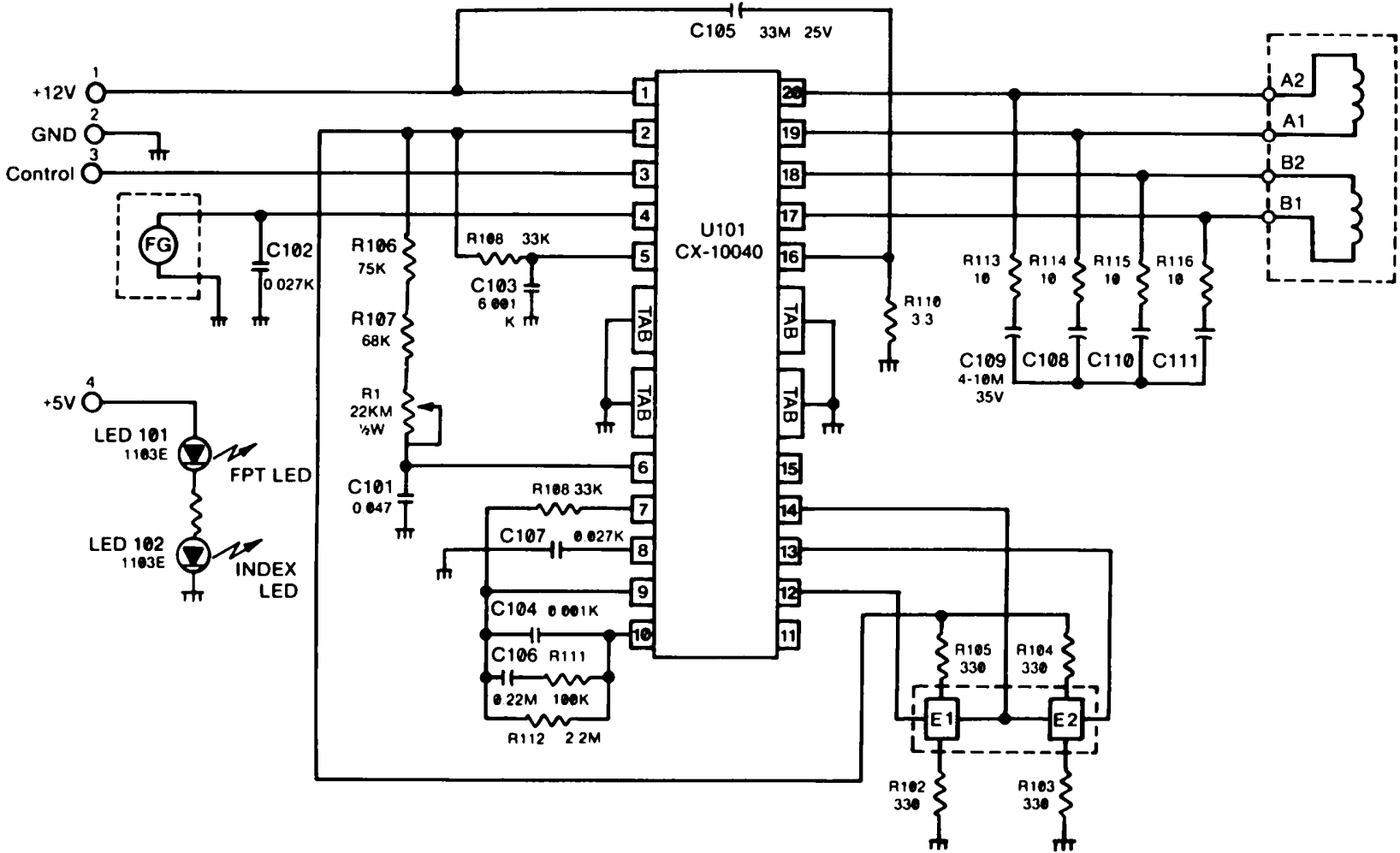
Flex Disk Drive (2 of 8)



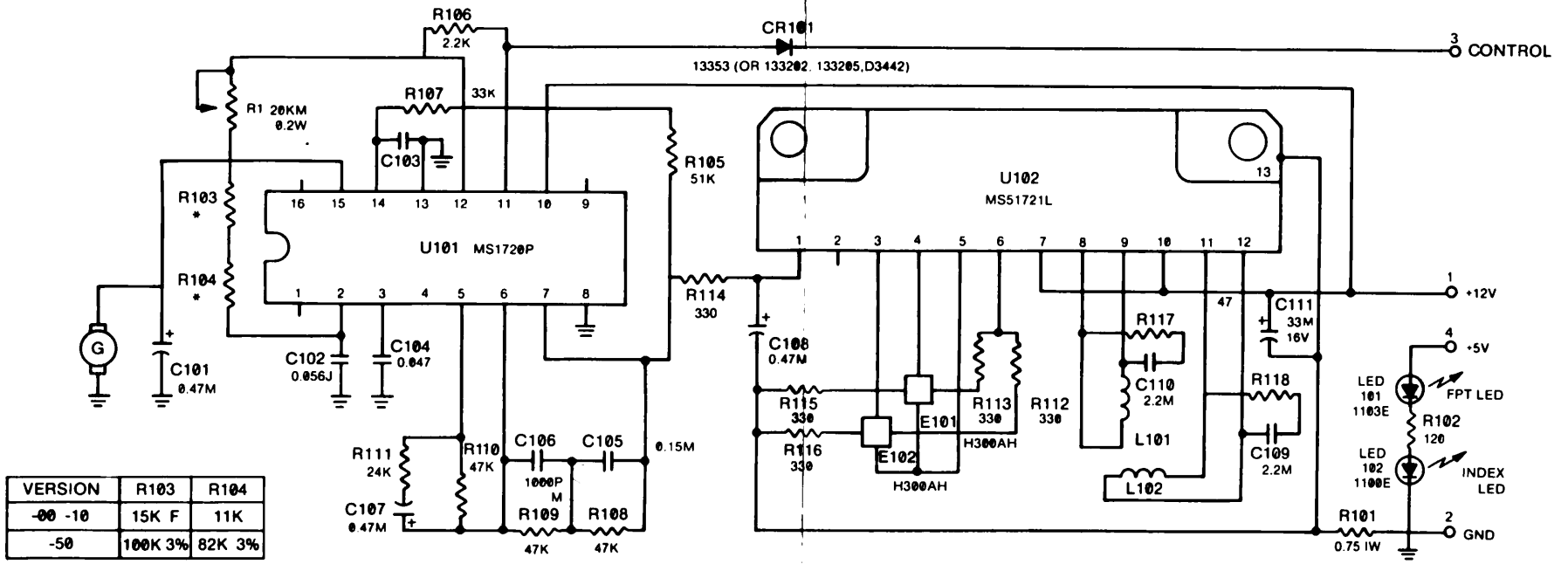


Flex Disk Drive (3 of 8)

Flex Disk Drive (4 of 8)







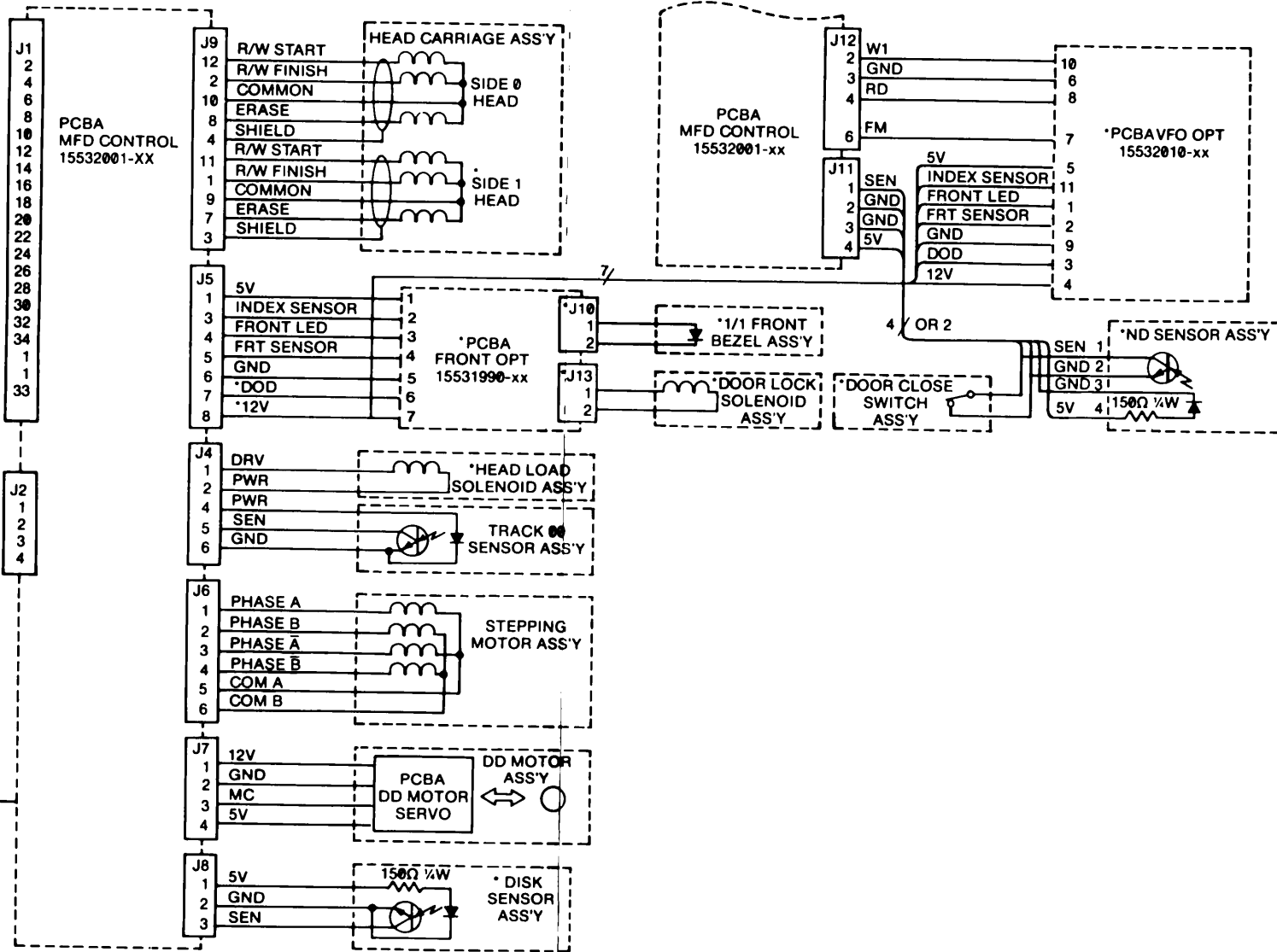
CONNECTION AND LOGIC DIAGRAMS

- \*\* RESERVED
- \*\* IN USE / HEAD LOAD
- \*\* DRIVE SELECT 3
- INDEX / SECTOR
- DRIVE SELECT 0
- DRIVE SELECT 1
- DRIVE SELECT 2
- MOTOR ON
- DIRECTION SELECT
- STEP
- WRITE DATA
- WRITE GATE
- TRACK 00
- WRITE PROTECT
- READ DATA
- SIDE ONE SELECT
- \*\* READY

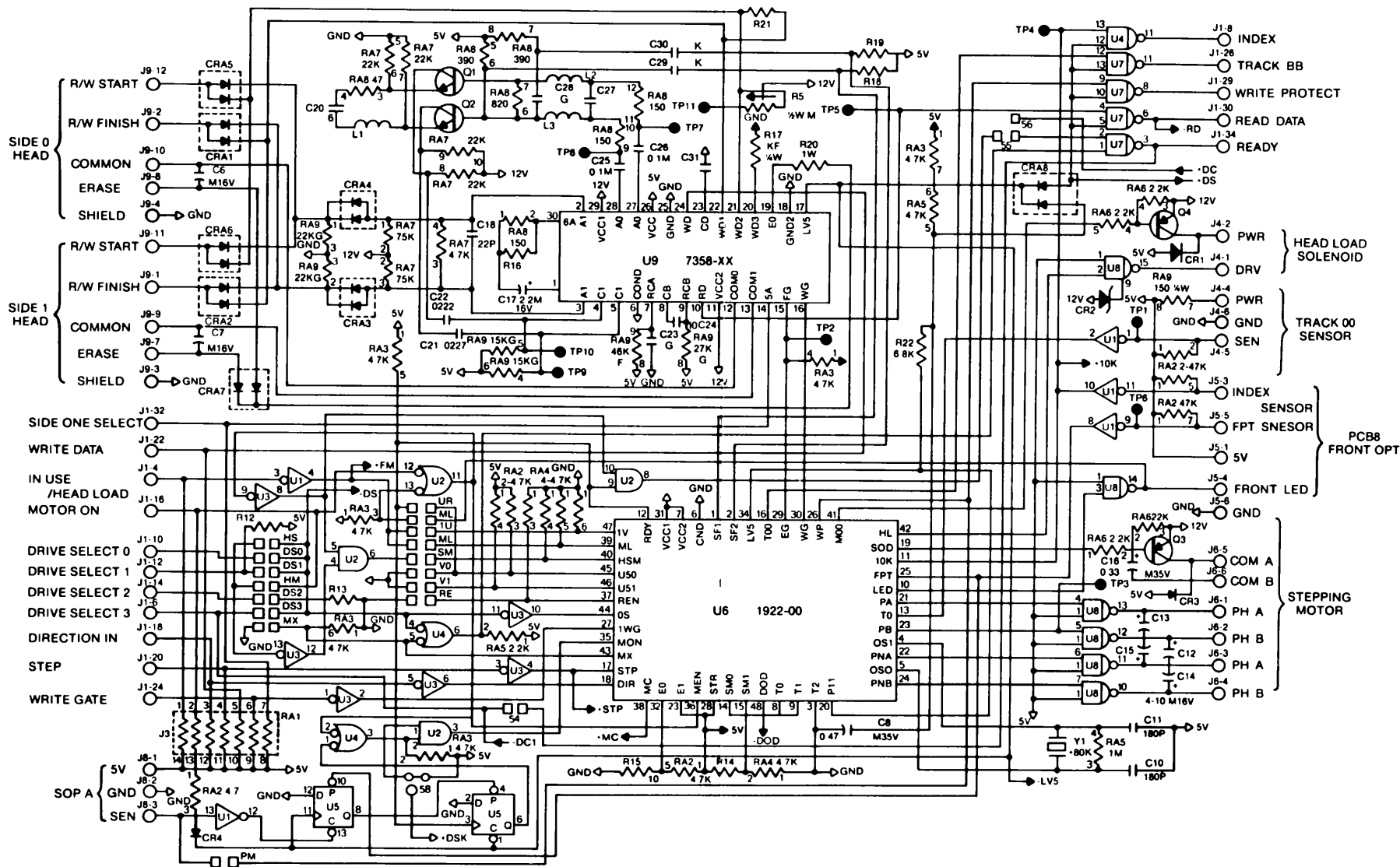
SIGNAL GND (000 NOS.)

+12V  
GND  
GND  
+5V

FRAME GROUND  
(FASTEN TAB)  
  
FRAME

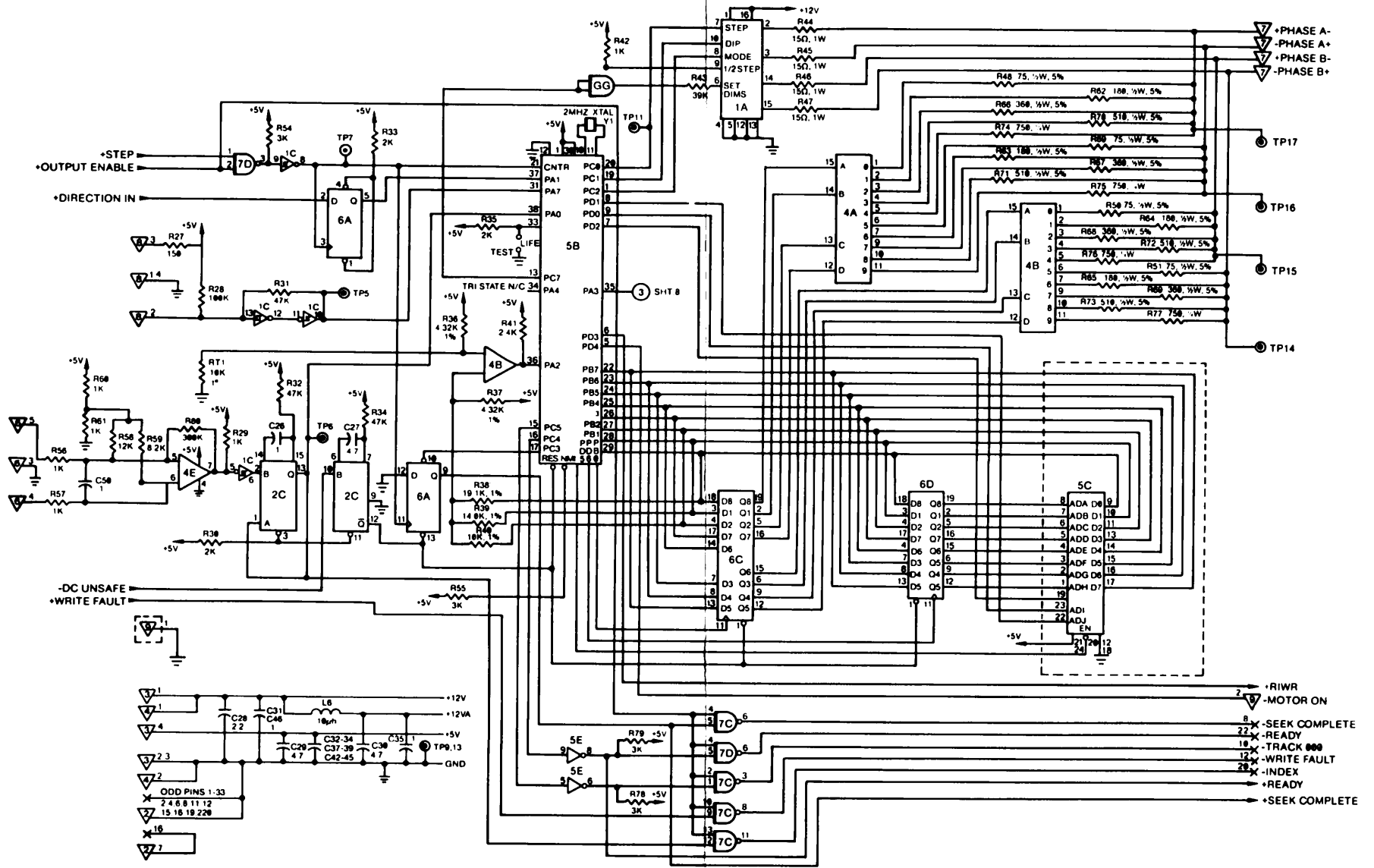


Flex Disk Drive (7 of 8)



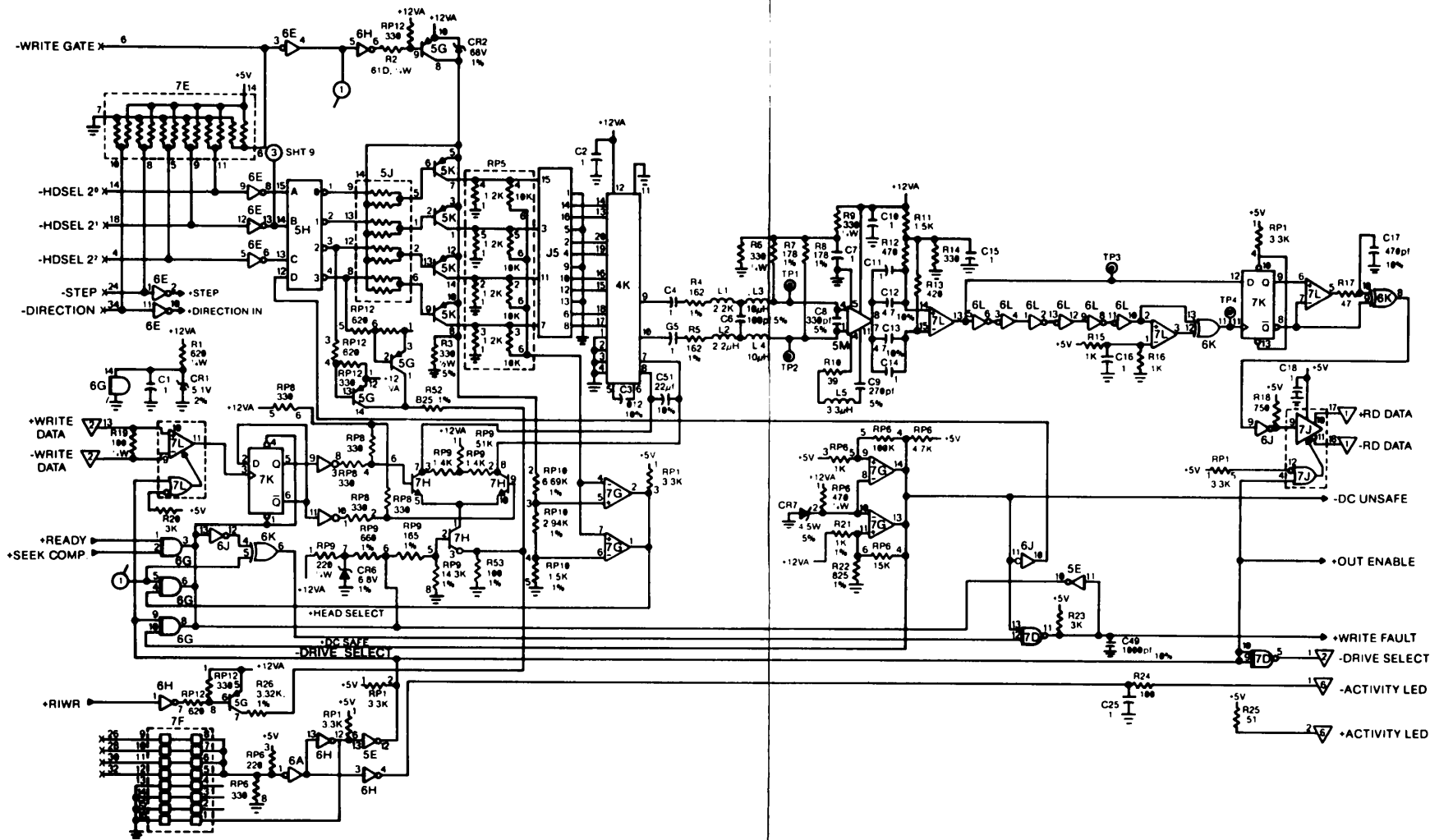
Flex Disk Drive (8 of 8)

CONNECTION AND LOGIC DIAGRAMS

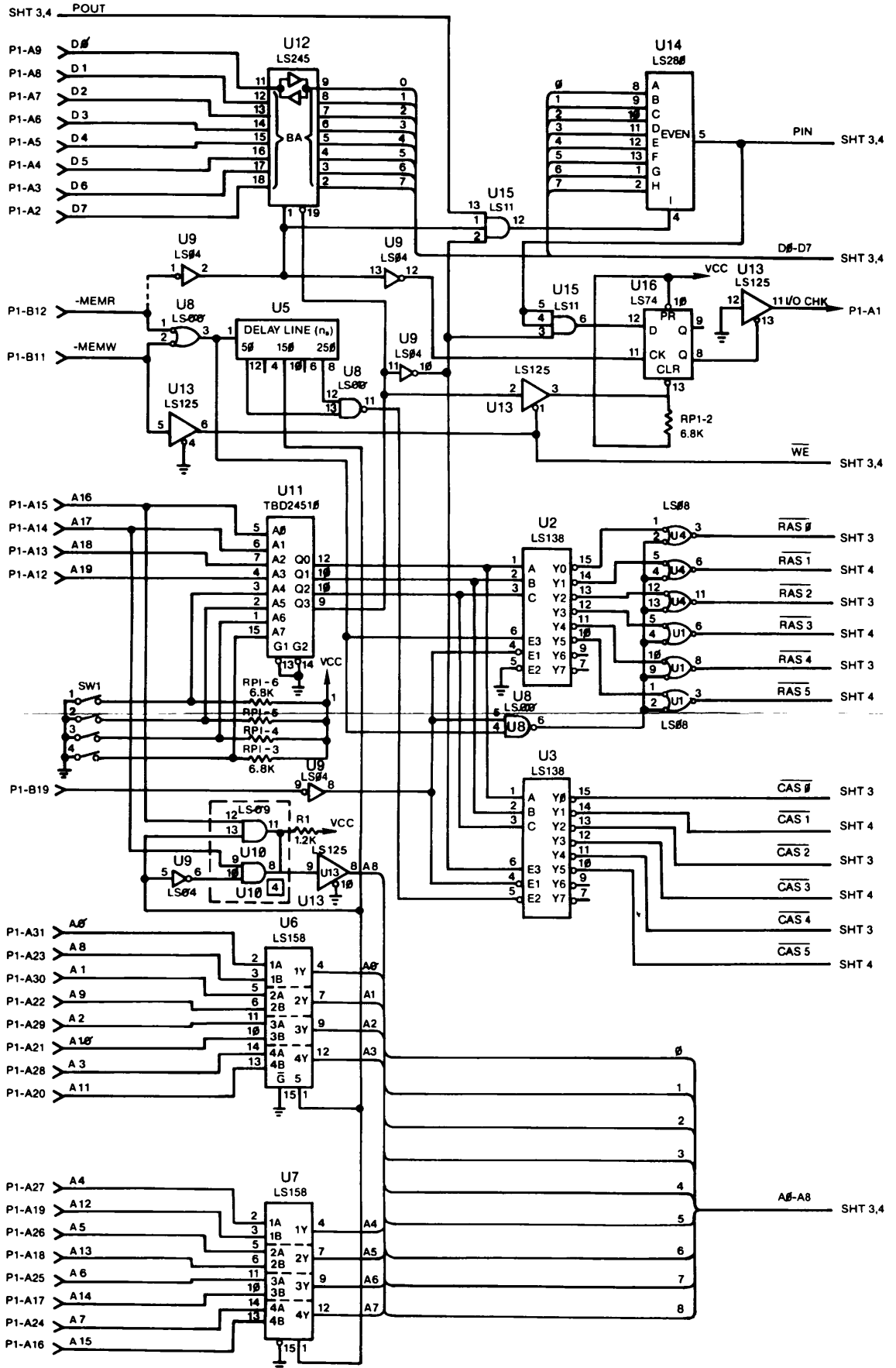


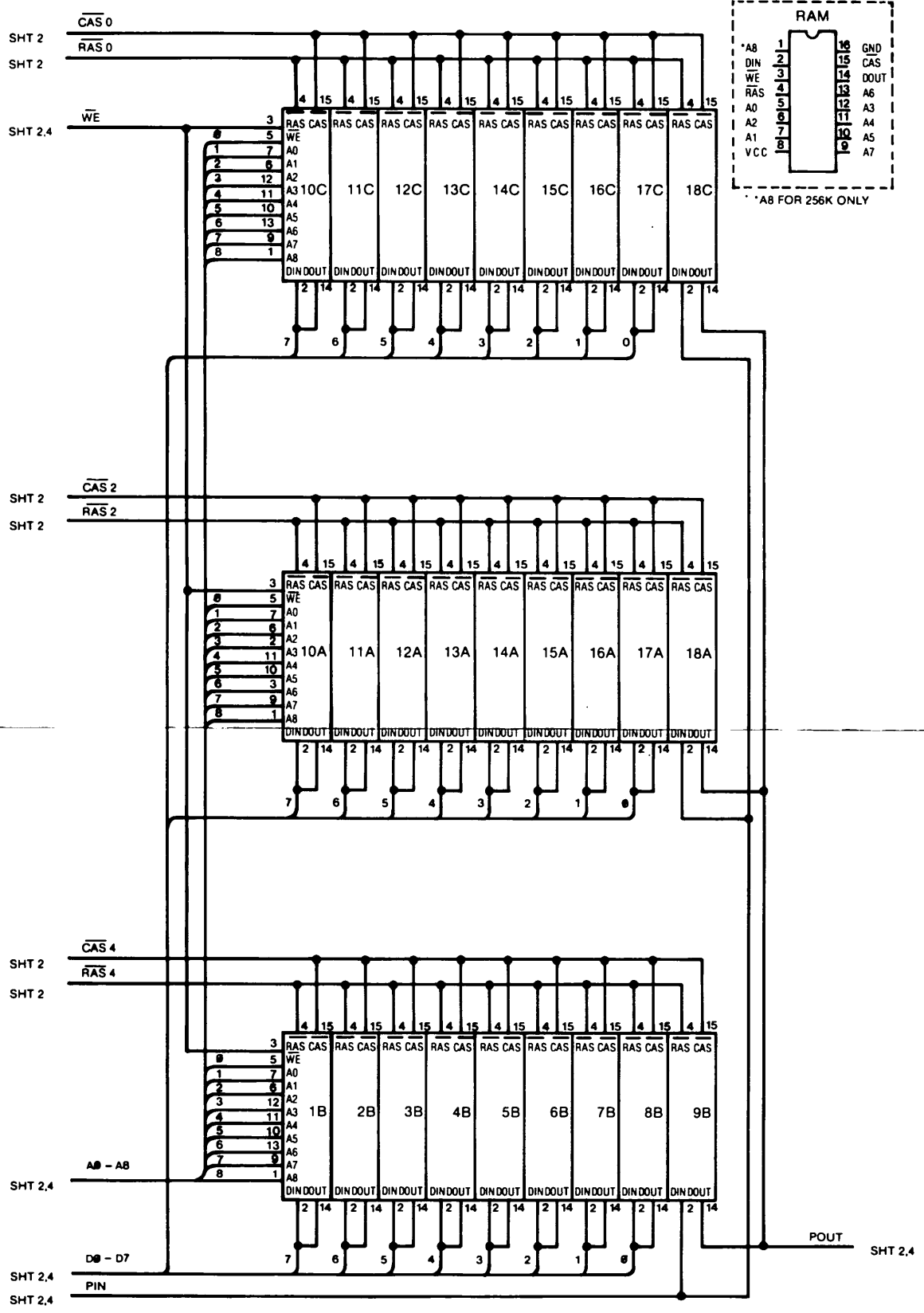
Hard Disk Drive (1 of 2)

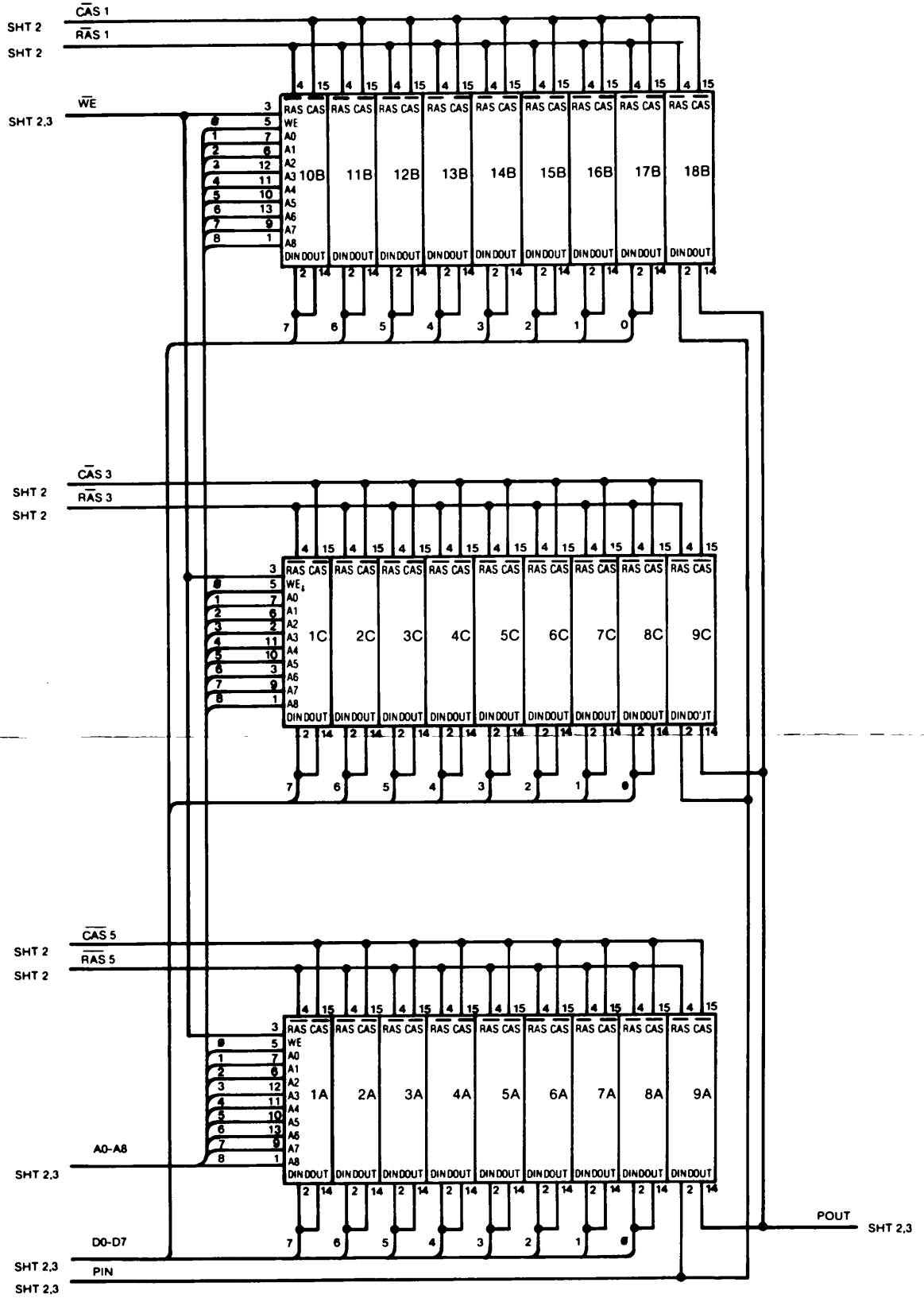
CONNECTION AND LOGIC DIAGRAMS



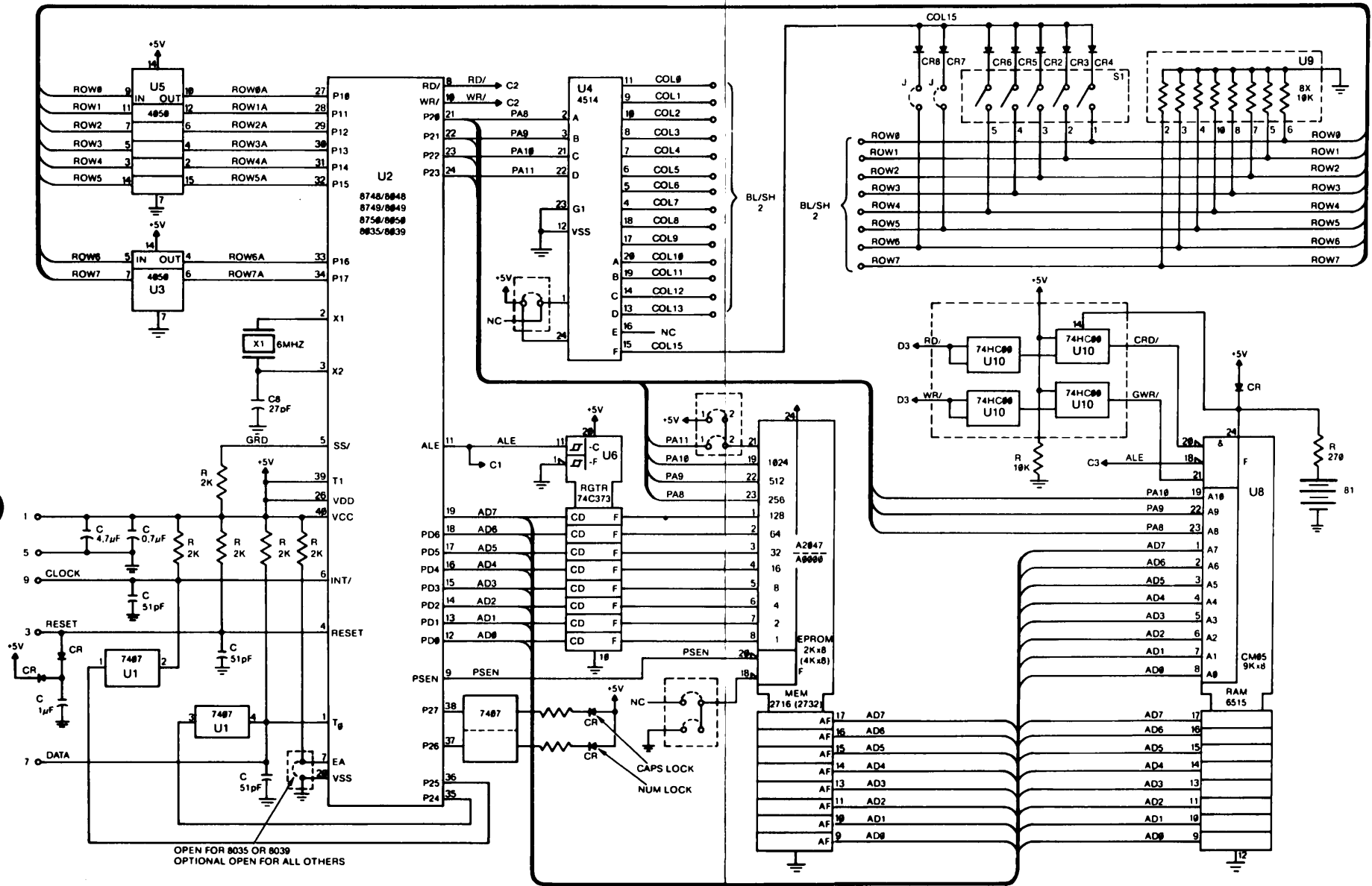
Hard Disk Drive (2 of 2)



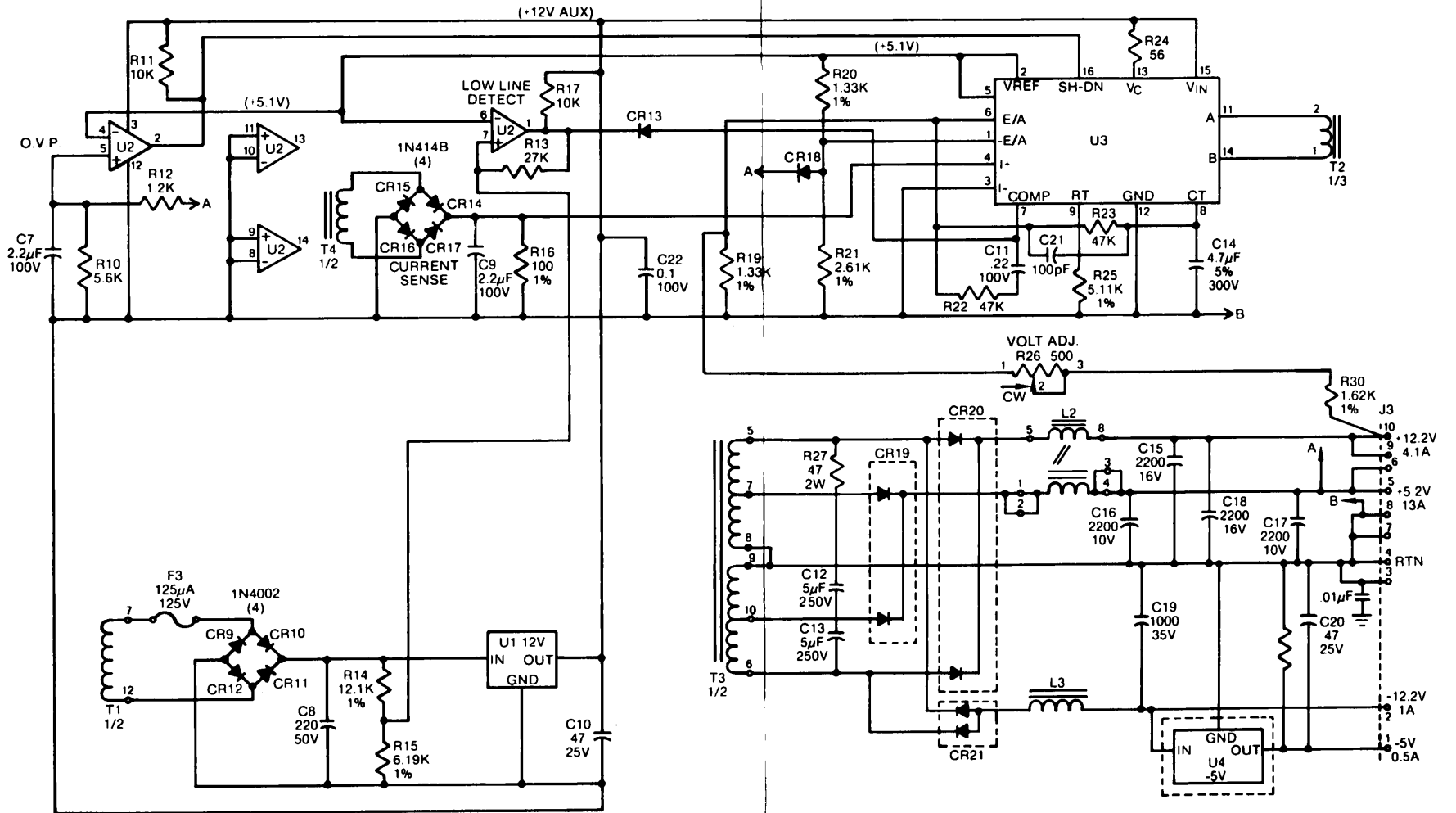




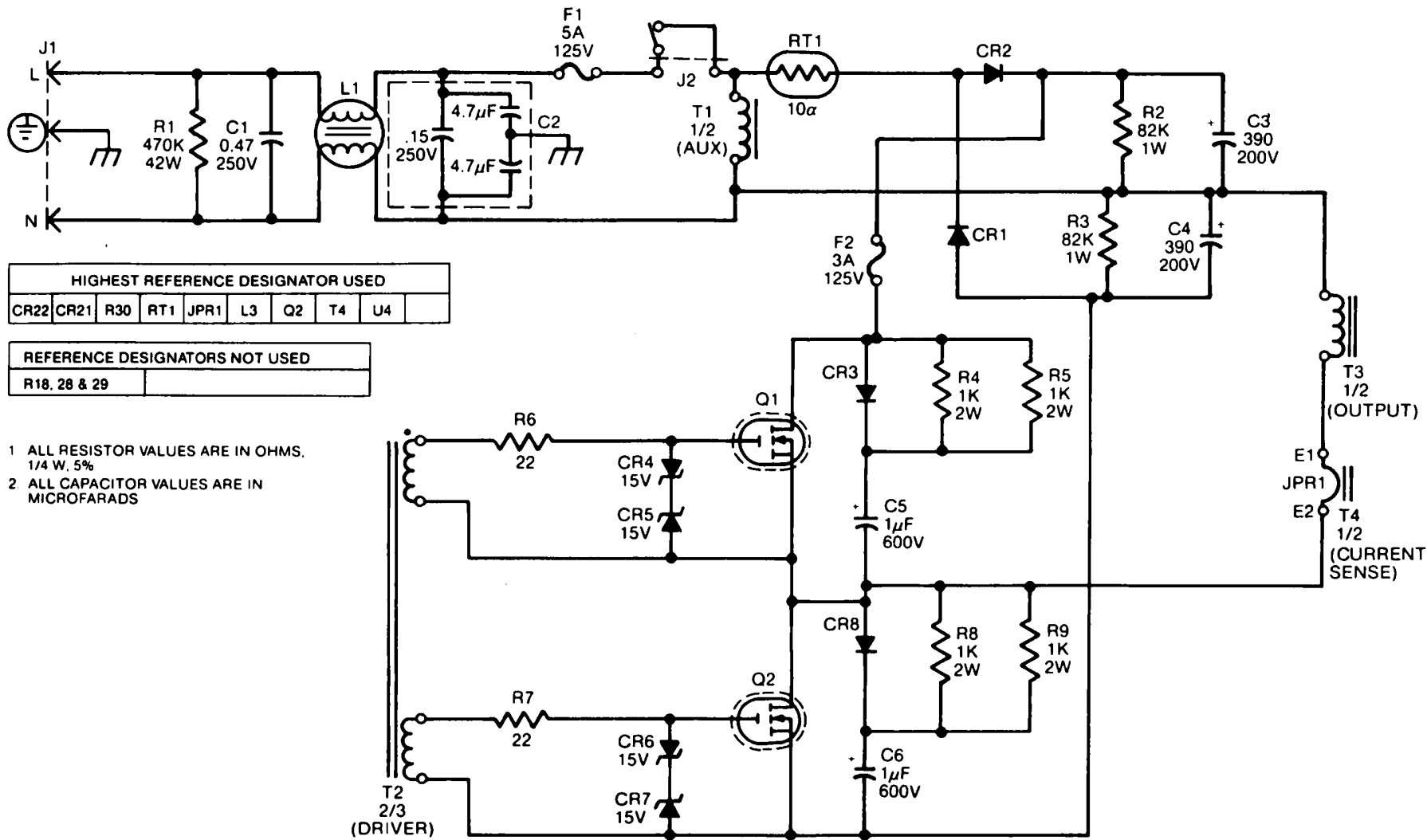
CONNECTION AND LOGIC DIAGRAMS



Keyboard



Power Supply (1 of 2)



HIGHEST REFERENCE DESIGNATOR USED							
CR22	CR21	R30	RT1	JPR1	L3	Q2	T4

REFERENCE DESIGNATORS NOT USED	
R18, 28 & 29	

- 1 ALL RESISTOR VALUES ARE IN OHMS, 1/4 W, 5%
- 2 ALL CAPACITOR VALUES ARE IN MICROFARADS



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**Hardware Maintenance & Service Manual**  
**NCR Part Number : 150-0000993**  
**MIRS Stock Number : D1-0163-A**

Name \_\_\_\_\_ Signature \_\_\_\_\_  
(Please type or print)

Company \_\_\_\_\_

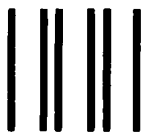
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