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R80 Disk Drive Service Manual

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of
Digital Equipment Corporation

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CHAPTER 1
INTRODUCTION

1.1 SCOPE OF MANUAL

This service manual provides the information needed to implement the R80 Disk Drive corrective maintenance procedures. Chapter 1 provides a list of the R80 field replaceable units (FRUs) and reference documentation. Chapter 2 describes the removal and replacement procedure for each R80 FRU. Chapter 3 describes how to perform the field adjustments. Chapter 4 explains how to use the operator control panel and the internal maintenance controls. Chapter 4 also provides a list of the fault codes displayed on internal and external indicators. Chapter 5 contains the fault isolation procedures that Field Service engineers use to troubleshoot the disk drive.

1.2 R80 MAINTENANCE FEATURES

The R80 Disk Drive has been designed with great emphasis placed on serviceability. The drive incorporates the maintenance features listed below.

- Quick access to all field-replaceable parts
- Fault reporting by the operator control panel
- Built-in maintenance controls and indicators
- Drive-resident diagnostic and utility routines
- Read/write diagnostic tracks inside the disk guard band
- No head alignments
- No preventive maintenance procedures
- No special tools

1.3 R80 MAINTENANCE PHILOSOPHY

The repair philosophy for the R80 is "Intelligent Module Replacement." This philosophy is accomplished by use of the drive-resident diagnostics. The Field Service engineer uses these diagnostics to isolate fault conditions to the FRU level. In addition to the drive-resident diagnostics, host-level diagnostics are available to support and verify corrective maintenance decisions.

R80-trained Field Service engineers will find the *R80 Disk Drive Pocket Service Guide* to be a helpful quick reference tool. The pocket service guide provides an abbreviated form of the troubleshooting information found in the service manual. The pocket service guide is not intended to replace the service manual, which is the complete source of corrective maintenance procedures.

1.4 R80 FRU LIST AND PART NUMBERS

Table 1-1 is a list of R80 Disk Drive FRUs. Since these FRU part numbers change occasionally, use the *R80 Disk Drive Illustrated Parts Breakdown* as your primary source of part numbers.

Table 1-1 R80 FRU List

Part No.	FRU Description
H766A	Drive power supply, 120 V – 60 Hz
H766B	Drive power supply, 220 V – 50 Hz
10-16924-00	Motor start capacitor, 115 V
10-17217-00	Motor start capacitor, 220 V
12-09403-02	Drive power supply fan, 117 Vac
12-10719-03	Front bezel fan, 117 Vac
12-12635-03	Belt, 60 Hz
12-12635-04	Belt, 50 Hz
12-12691-00	ID 0/READY switch cap
12-12691-01	ID 1/READY switch cap
12-12691-02	ID 2/READY switch cap
12-12691-03	ID 3/READY switch cap
12-12691-04	ID 4/READY switch cap
12-12691-05	ID 5/READY switch cap
12-12691-06	ID 6/READY switch cap
12-12691-07	ID 7/READY switch cap
12-12714-00	RUN/STOP switch cap
12-12714-01	WRITE PROT switch cap
12-12714-02	FAULT switch cap
12-12714-30	STAT 1 switch cap
12-12714-31	STAT 2 switch Cap
12-12716-00	Wedge lamp, 6.3 V
12-14011-00	Belt tension microswitch
12-16817-00	HDA speed sensor (optical switch)
12-16870-00	HDA thermal switch
12-17072-00	Gas spring assembly
29-23187-00	Spare parts case
54-13596-00	Read/write module
54-13641-00	Operator control panel module
54-14012-00	Microprocessor module
70-18783-00	I/O cable assembly
70-16215-00	Brush ground assembly
70-16225-00	Head disk assembly (HDA)
70-16230-00	Wing pivot assembly
70-16723-00	Motor/brake assembly, 115 V – 60 Hz
70-16723-01	Motor/brake assembly, 220 V – 50 Hz
70-16724-00	Motor actuator assembly
70-16732-00	Logic dc power cable assembly
70-16733-00	Logic ac power harness assembly
70-16735-00	Servo preamp cable
70-16737-00	40 conductor data cable (personality module)
70-16737-01	40 conductor data cable (servo module)
70-16738-00	20 conductor data cable (personality module)
70-16738-01	20 conductor data cable (read/write module)
70-16739-00	50 conductor read/write cable
70-16740-00	Operator control panel cable
70-16742-00	Shock mount

CHAPTER 2
REMOVAL AND REPLACEMENT PROCEDURES

2.1 INTRODUCTION

This chapter describes the R80 part removal and replacement procedures. The chapter begins with the power precautions that should be observed before replacing field replaceable units (FRUs). The remainder of the chapter supplies the detailed procedures that are used for FRU replacement.

2.2 POWER PRECAUTIONS

Since hazardous voltages are present inside this equipment, servicing should be performed only by qualified service representatives. Bodily injury or equipment damage may result from improper servicing.

NOTE

Always remove power from the unit before replacing internal parts or cables.

2.3 POWER SUPPLY LOCATION AND CONTROLS

The R80 Disk Drive power supply (H766) is located at the rear of the drive assembly chassis as shown in Figure 2-1. One circuit breaker (CB1) controls the ac power to the power supply.

2.4 REMOVING POWER FROM THE R80 DISK DRIVE

Before replacing assemblies in the R80 Disk Drive, the disk should be spun down and power removed. Different procedures are followed, depending on whether a drive internal assembly or the H766 power supply is replaced.

2.4.1 Removing Power from the Drive Internal Assemblies

To remove power to the drive internal assemblies, switch off CB1 at the rear of the R80 Disk Drive.

2.4.2 Removing Power from the H766 Power Supply

To remove power to the H766 power supply, unplug the ac cord from the switched ac receptacle on the system cabinet.

2.5 REPLACEMENT SEQUENCE

This chapter describes the removal and replacement procedures for the R80 FRUs. The following diagrams give an overview of the order in which FRUs should be removed. Figure 2-2 shows the FRUs that can be removed by raising the logic access cover. Figure 2-3 shows the FRUs that can be removed by raising the drive logic chassis. Figure 2-4 shows the removal sequence for the operator control panel lamps. Paragraph numbers are provided in these figures to assist in the location of each procedure.

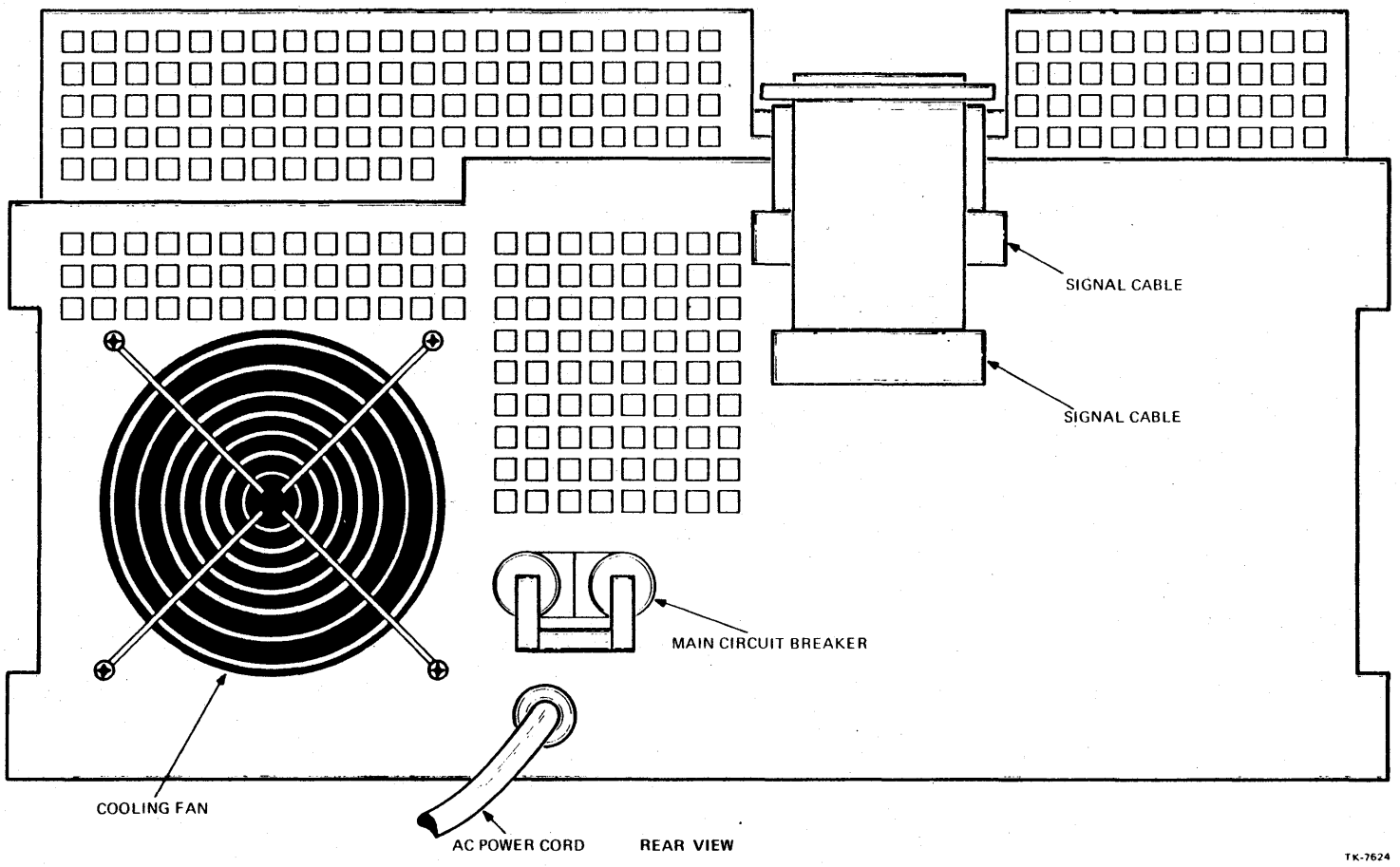

Figure 2-1 Location of Disk Drive Power Controls

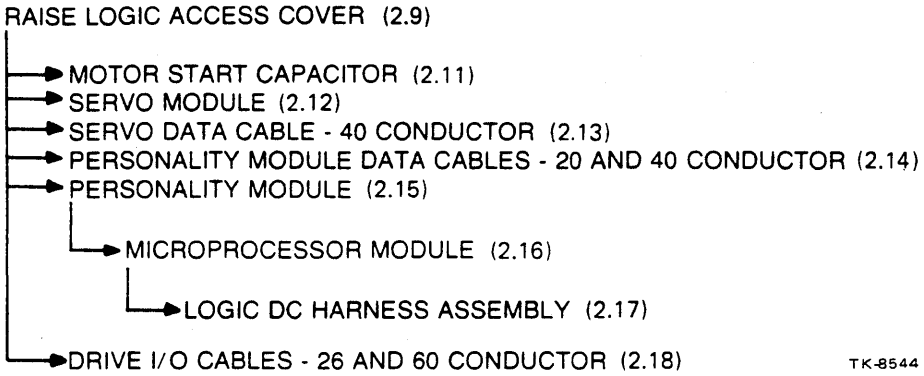

Figure 2-2 FRUs Accessed by Raising the Logic Access Cover

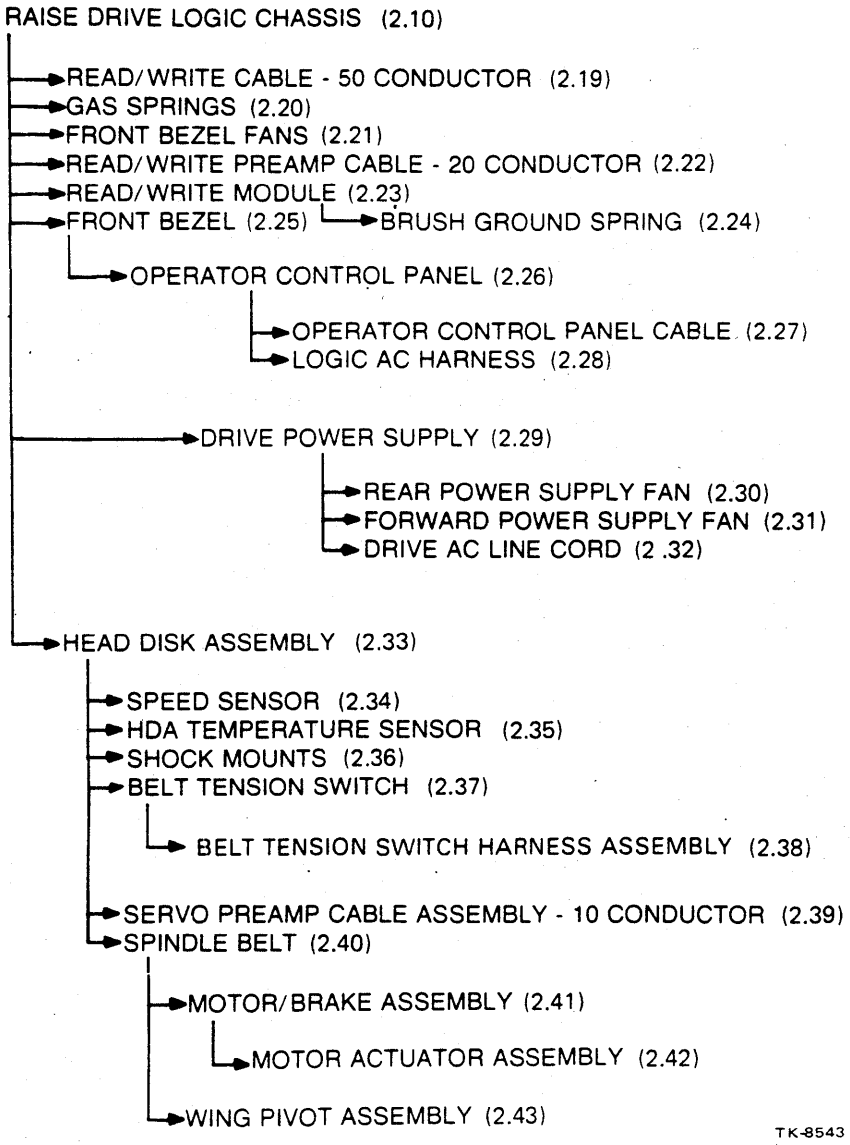

Figure 2-3 FRUs Accessed by Raising the Drive Logic Chassis

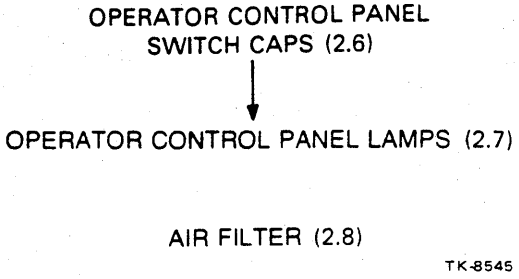

Figure 2-4 Outside Accessible Parts

2.6 OPERATOR CONTROL PANEL SWITCH CAPS

Removal procedure:

The switch caps are removed by prying them off with a screwdriver as shown in Figure 2-5. Be sure to use paper or some other material to pry against to prevent chipping the paint on the front bezel.

Replacement procedure:

The switch caps are replaced by pushing them on. Only a small amount of pressure is needed to snap them into place.

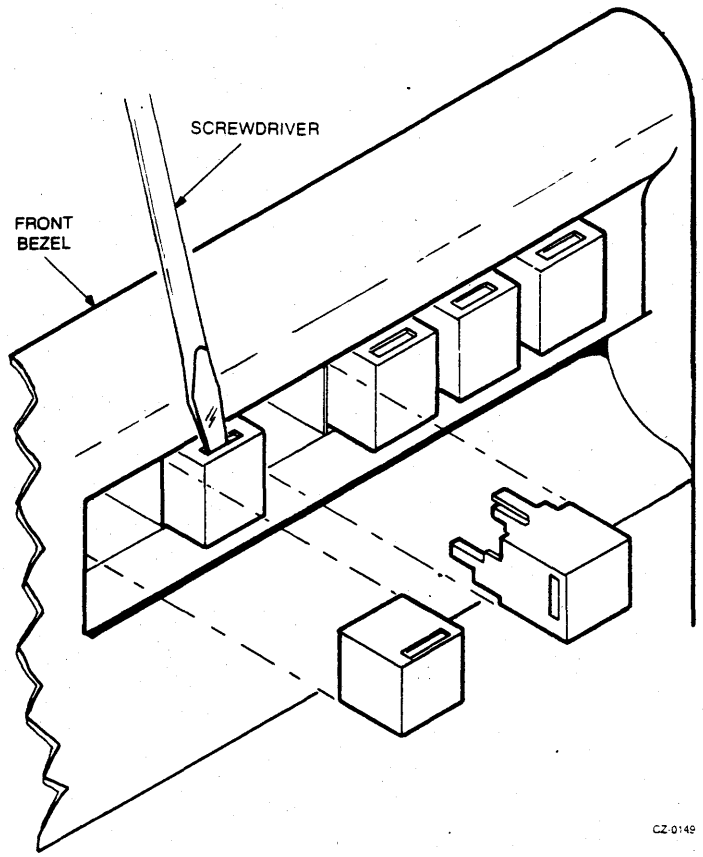

Figure 2-5 Operator Control Panel Switch Cap Replacement

2.7 OPERATOR CONTROL PANEL LAMPS

Removal procedure:

1. Remove the switch cap on the lamp that has burned out (Paragraph 2.6).

2. Reach into the switch opening and pull the metal slide forward. The lamp will pop out as the slide is pulled. Refer to Figure 2-6.

Replacement procedure:

1. Insert the new lamp so that its rear flat portion will enter the lamp holder in the horizontal position.

2. Replace the switch cap.

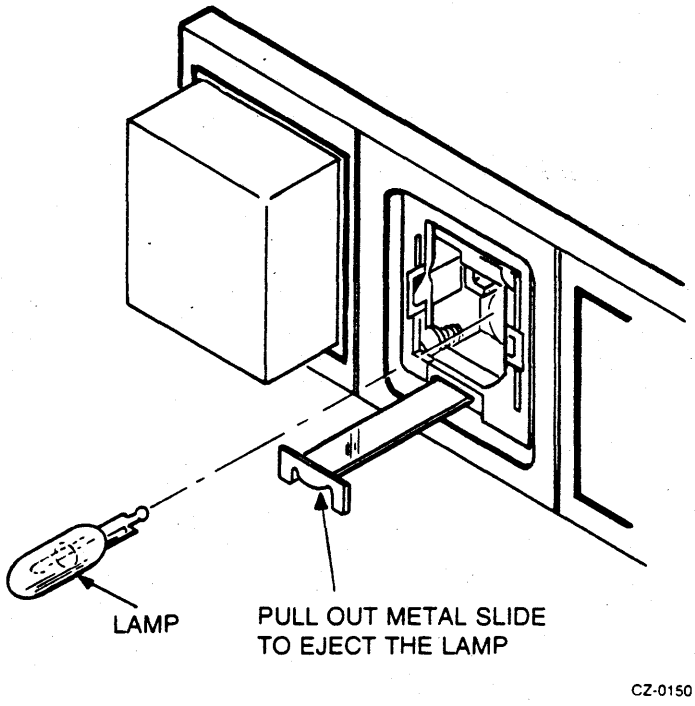

Figure 2-6 Operator Control Panel Lamp Replacement

2.8 AIR FILTER

Removal procedure:

1. Locate the door latch on the front bezel. Refer to Figure 2-7.
2. Press up on the door latch and lower the door to its horizontal position.
3. Remove the air filter by pulling down the top half of the filter first, and then lifting the filter out.

Replacement procedure:

Reverse the removal procedure.

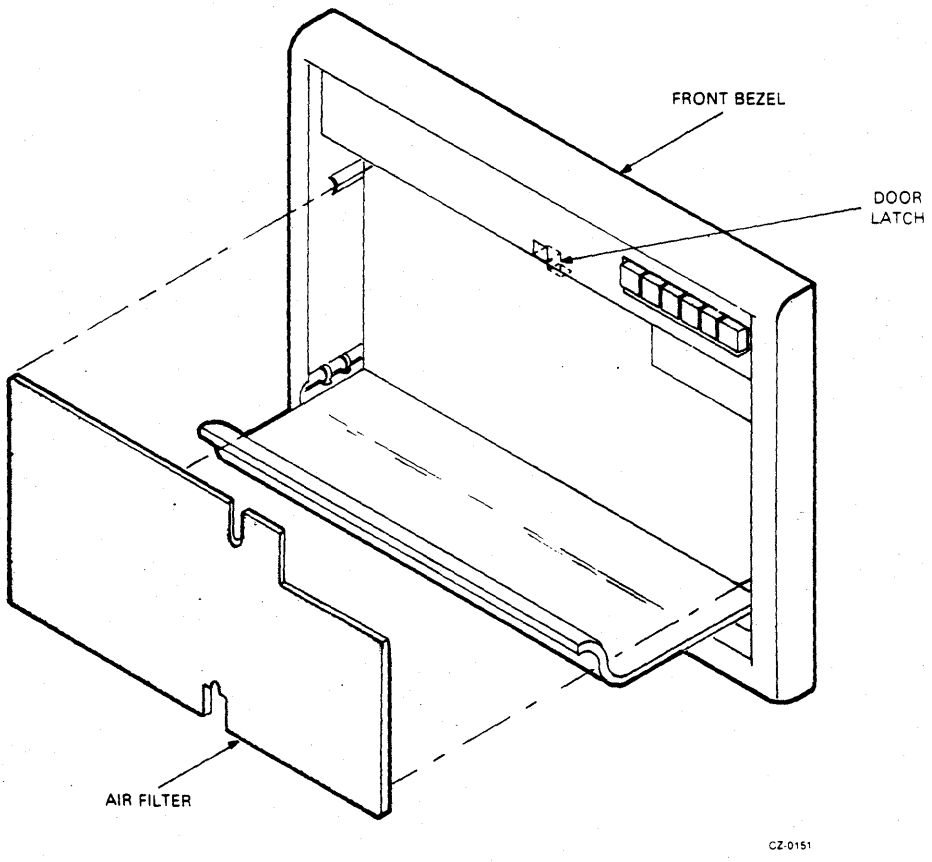

Figure 2-7 Air Filter Replacement

2.9 RAISING THE LOGIC ACCESS COVER

Raise procedure for early model drives:

Turn the cover lock 90° counterclockwise while placing downward pressure on the cover. The cover will pop up slightly once the latching mechanism is released. The cover can then be raised. (See Figure 2-8a.)

Raise procedure for late model drives:

Insert screwdriver blade between metal tab and outer edge of slot. Tilt screwdriver toward side of drive until cover pops up. Repeat procedure for opposite side. The cover can then be raised (Figure 2-8b).

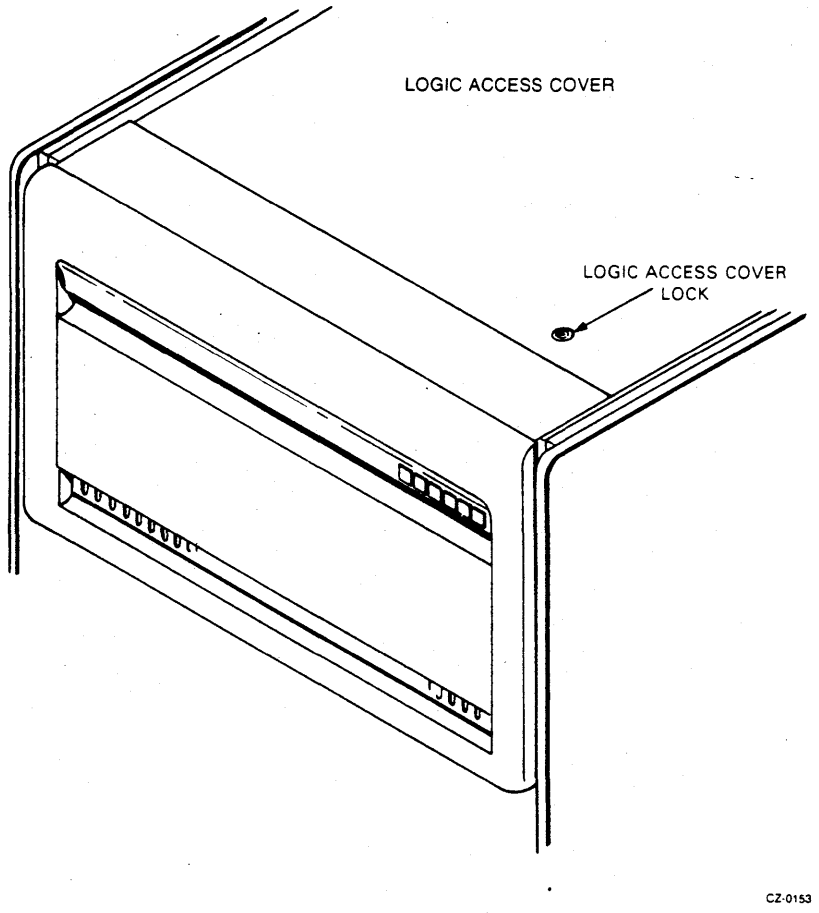

Figure 2-8a Raising the Logic Access Cover (Early Model)

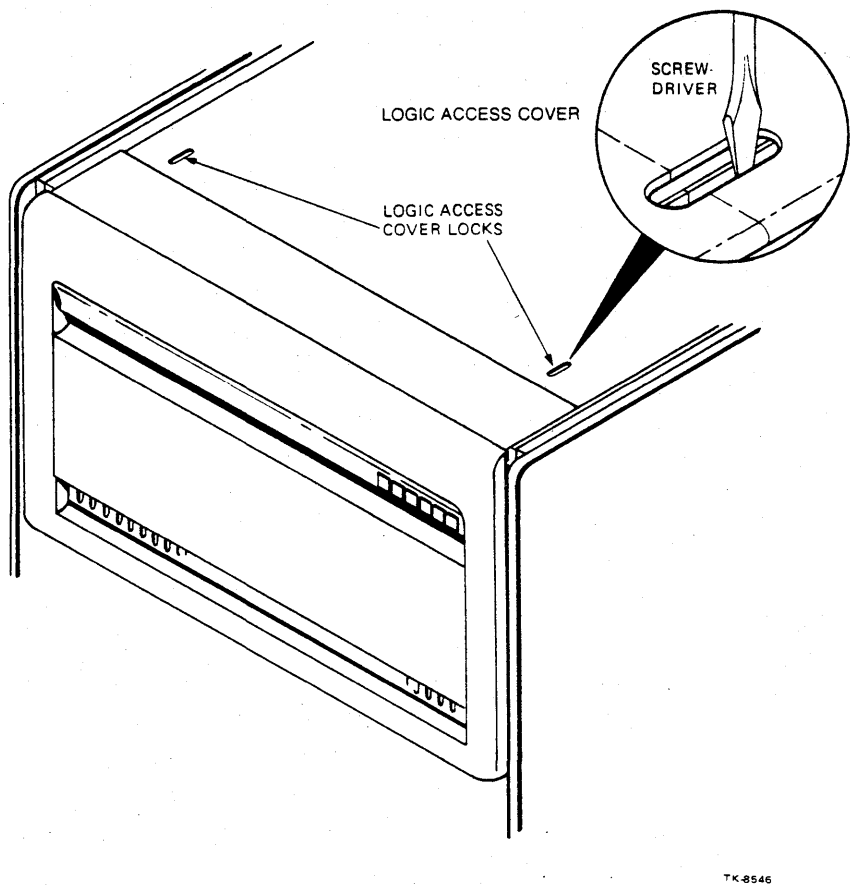

Figure 2-8b Raising the Logic Access Cover (Late Model)

2.10 RAISING THE DRIVE LOGIC CHASSIS

Raise procedure:

1. Locate the latch behind the center slots of the front bezel. Refer to Figure 2-9.
2. Push in on the latch with a flat-bladed screwdriver and raise the drive logic chassis.

2.11 MOTOR START CAPACITOR

Removal procedure:

1. Raise the logic access cover (Paragraph 2.9).
2. Place a screwdriver between the capacitor body and the bracket as shown in Figure 2-10 Bend the bracket back and lift the capacitor out.
3. Remove the cap from the capacitor body. Refer to Figure 2-11.
4. Remove the two quick-connect terminals from the capacitor lugs.

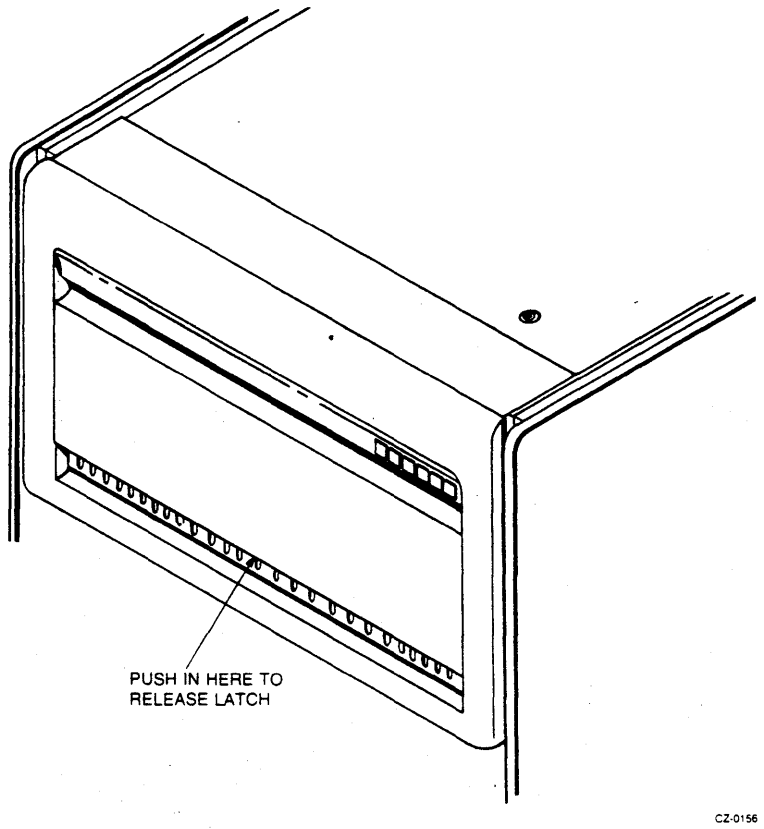

Figure 2-9 Raising the Drive Logic Chassis

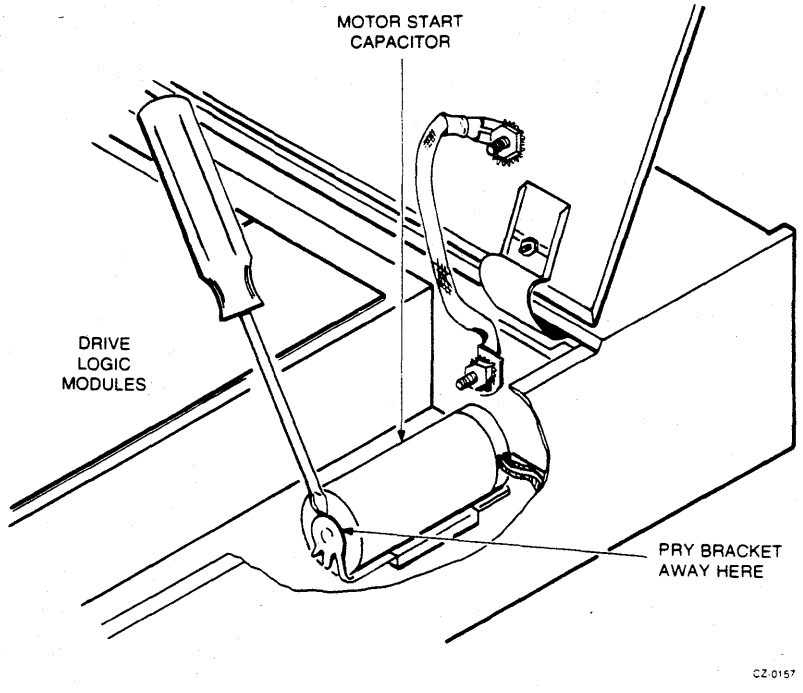

Figure 2-10 Motor Start Capacitor Removal

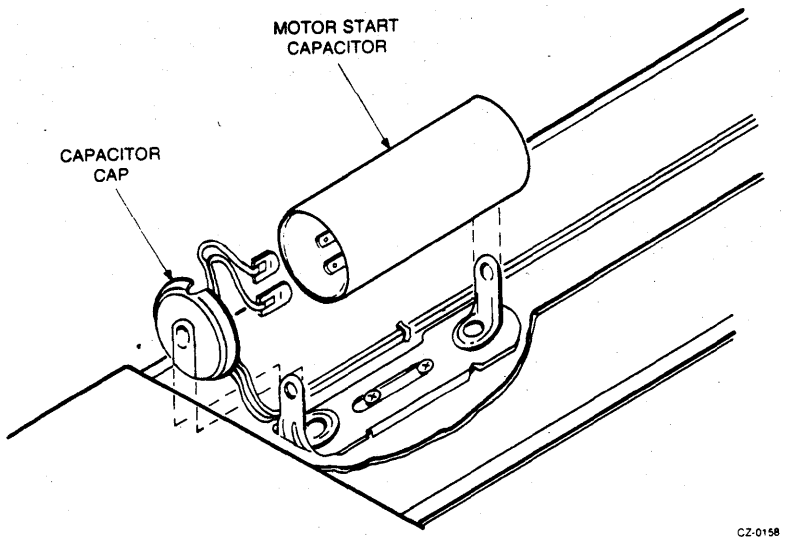

Figure 2-11 Capacitor Cap Removal

Replacement procedure:

1. Push the quick-connect terminals onto the lugs of the new capacitor.
2. Replace the capacitor cap.
3. Insert the cap end of the capacitor into the bracket while aligning the slots on the ends of the capacitor with the bracket. As shown in Figure 2-12, place a screwdriver blade under the bracket. Otherwise, the bracket bends downward, preventing the capacitor from locking into place.
4. Lock the capacitor into the bracket by pushing the capacitor down.

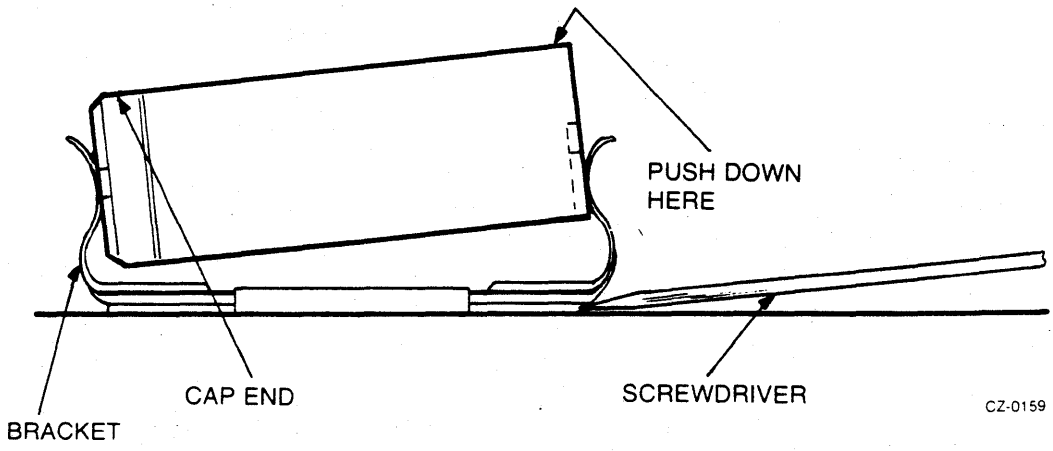

Figure 2-12 Motor Start Capacitor Replacement

2.12 SERVO MODULE

Removal procedure:

1. Raise the logic access cover (Paragraph 2.9).
2. Raise the servo module. Refer to Figure 2-13.
3. Unplug connectors P401, P402, P403 and P404.
4. Slide the cable to connector P401 out from under the cable clamp on the servo module.
5. Move the module to the vertical position. Push the module towards the rear and lift out. Refer to Figure 2-14.

Replacement procedure:

Reverse the removal procedure.

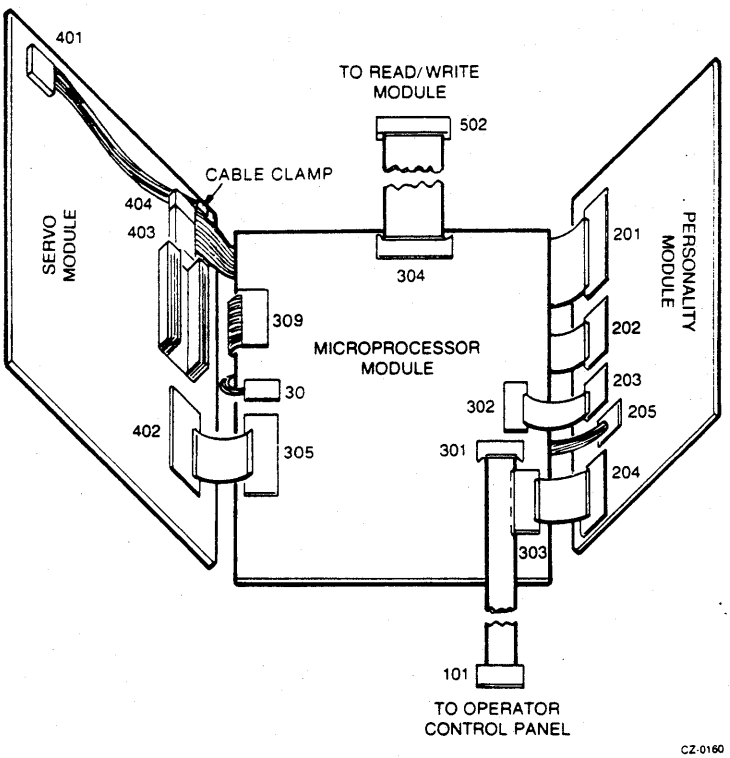

Figure 2-13 Module Connector Locations

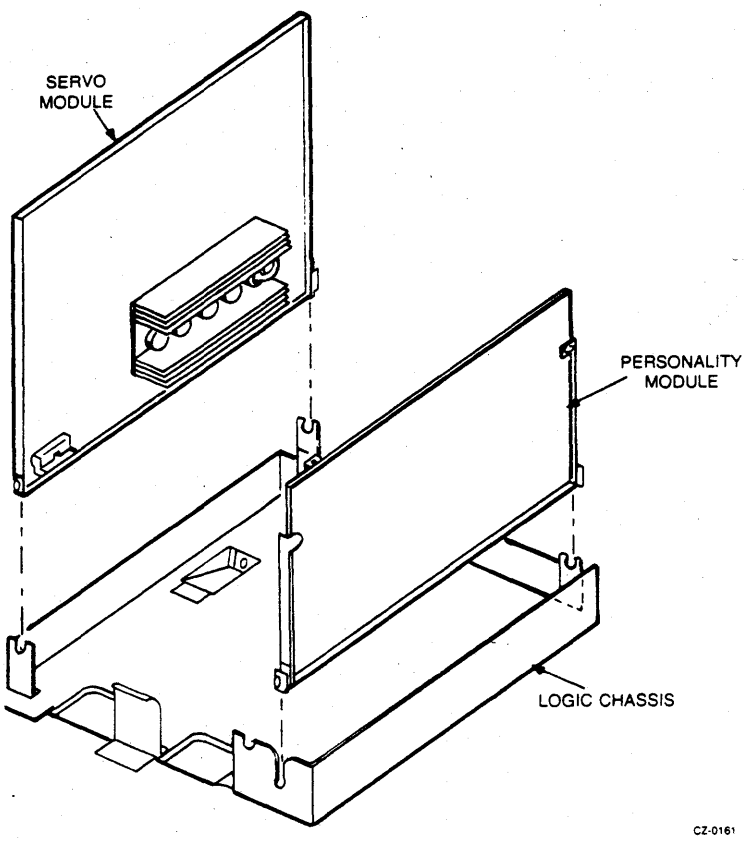

Figure 2-14 Servo and Personality Module Replacement

2.13 SERVO DATA CABLE - 40 CONDUCTOR

The servo data cable connects J305 on the microprocessor module to J402 on the servo module.

Removal procedure:

1. Raise the logic access cover (Paragraph 2.9).
2. Raise the servo module. Refer to Figure 2-13.
3. Unplug P402 from the servo module.
4. Unplug P305 from the microprocessor module.

Replacement procedure:

Reverse the removal procedure.

2.14 PERSONALITY DATA CABLES – 20 AND 40 CONDUCTOR

The 20 conductor data cable connects J302 on the microprocessor module to J203 on the personality module. The 40 conductor data cable connects J303 on the microprocessor module to J204 on the personality module.

Removal procedure:

1. Raise the logic access cover (Paragraph 2.9).
2. Raise the servo module. Refer to Figure 2-13.
3. Raise the personality module.
4. Unplug P203 from the personality module for 20 conductor cable replacement. Unplug P204 from the personality module for 40 conductor cable replacement.
5. Move the personality module to its vertical position and lift it out of the pivot brackets. Move it to the side just far enough to allow access to the connectors on the microprocessor module. Refer to Figure 2-14.
6. Unplug connector P302 or P303 from the microprocessor module. Refer to Figure 2-13.

Replacement procedure:

Reverse the removal procedure.

2.15 PERSONALITY MODULE

Removal procedure:

1. Raise the logic access cover (Paragraph 2.9).
2. Raise the servo module. Refer to Figure 2-13.
3. Raise the personality module.
4. Unplug connectors P201, P202, P203, P204, and P205 from the personality module.
5. Move the module to its vertical position and remove it from the drive. Refer to Figure 2-14.

Replacement procedure:

Reverse the removal procedure.

2.16 MICROPROCESSOR MODULE

Removal procedure:

1. Raise the logic access cover (Paragraph 2.9).
2. Raise the servo module. See Figure 2-13.
3. Remove the personality module (Paragraph 2.15).
4. Unplug all cables from the microprocessor module.
5. Lift up the five pushpins that secure the microprocessor module in place. See Figure 2-15.
6. Lift the microprocessor module out of the logic chassis.

NOTE

There is a nylon washer under the microprocessor module at each pushpin. These five washers are needed for reassembly. These washers are glued in place on later microprocessor modules.

Replacement procedure:

Reverse the removal procedure.

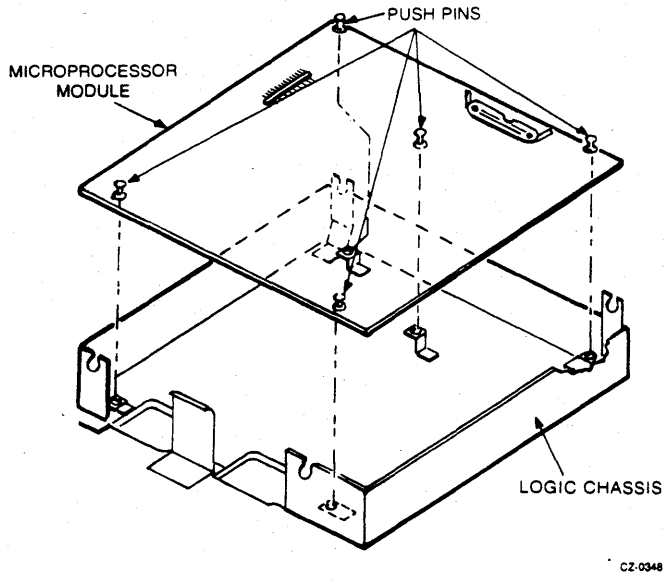

Figure 2-15 Microprocessor Module Replacement

2.17 LOGIC DC POWER HARNESS ASSEMBLY

Removal procedure:

1. Raise the logic access cover (Paragraph 2.9).
2. Raise the servo module. Refer to Figure 2-13.
3. Remove the personality module (Paragraph 2.15).
4. Remove the microprocessor module (Paragraph 2.16).
5. Raise the drive logic chassis (Paragraph 2.10).
6. Remove connectors P701, P702, and P703 from the inside panel of the power supply. Refer to Figure 2-16.

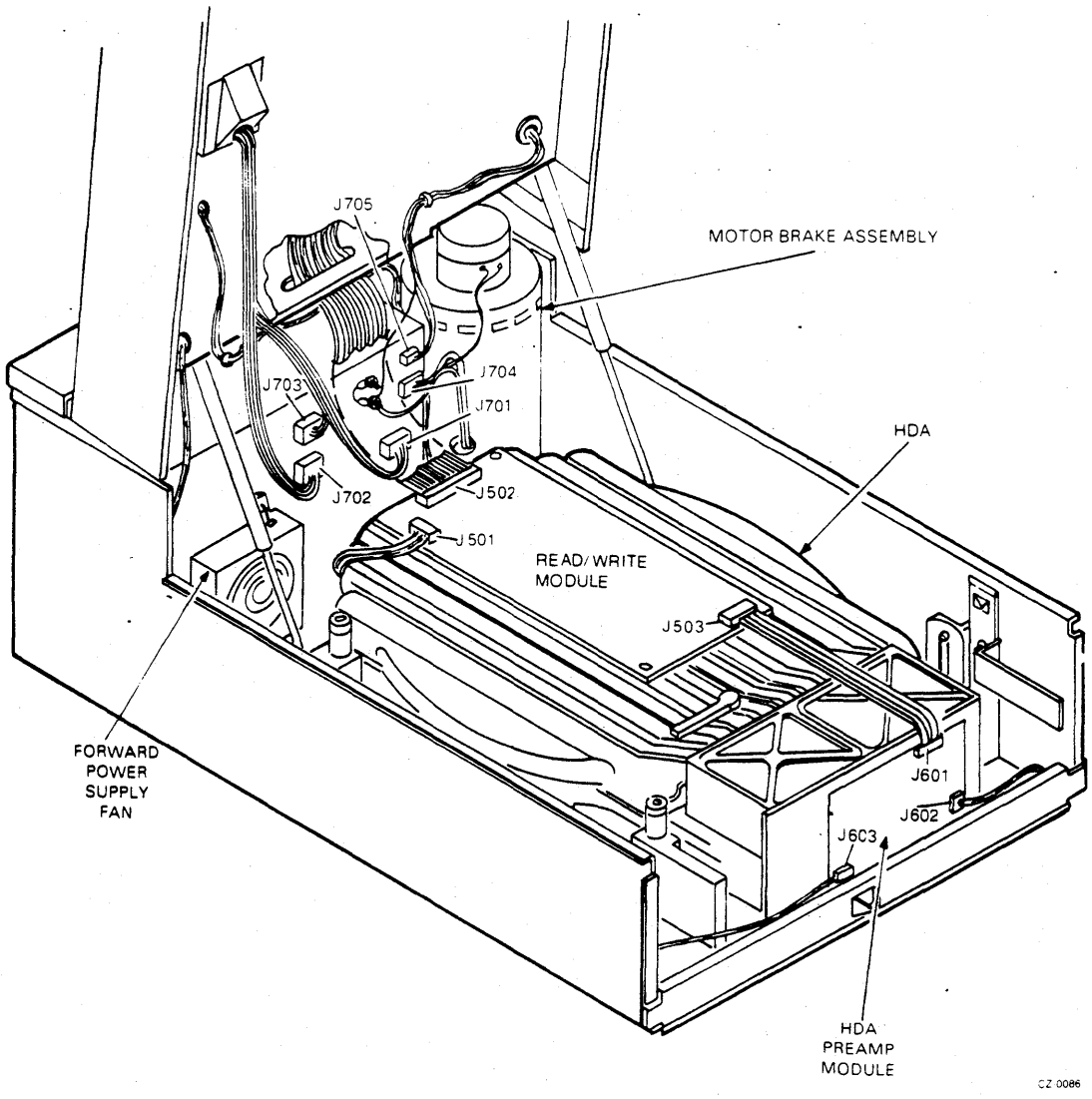

Figure 2-16 Lower Chassis Connector Locations

7. Remove the two screws that hold the feed-through bracket in place.

8. Pull out the metal feed-through bracket and slide the rubber grommet out of its retainer.

9. Remove the two screws inside the logic chassis that hold the dc power harness clamps. Be careful when removing the screw closest to the feed-through bracket, since it has a washer and nut underneath as shown in Figure 2-17.

10. Remove the logic dc power harness.

Replacement procedure:

Reverse the removal procedure.

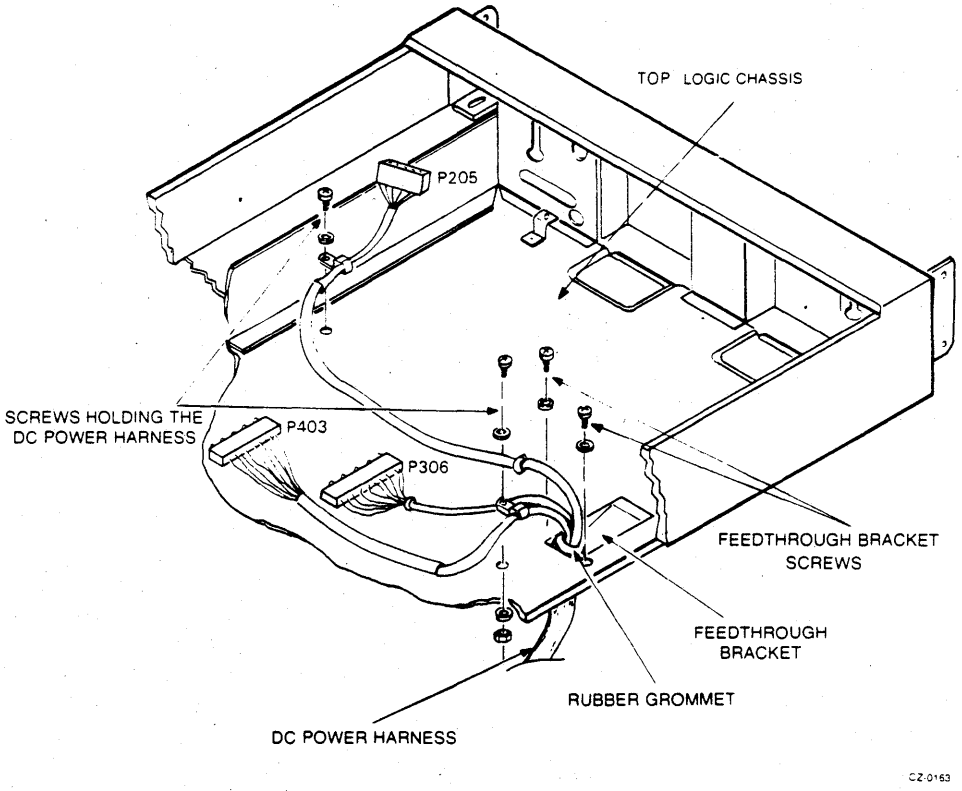

Figure 2-17 Logic DC Power Harness Replacement

2.18 DRIVE I/O CABLES - 26 AND 60 CONDUCTORS

Each of the 20 and 60 conductor drive I/O cables consists of two sections joined together at the rear of the drive with an in-line connector. The top half section consists of the two separate cables (26 and 60 conductor) which connect the personality module with the bottom half section. The bottom half section consists of an I/O cable assembly (which includes the 26 and 60 conductor) which connects the top half section with the system disk controller. These in-line connectors and drive I/O cables are illustrated in Figure 2-18.

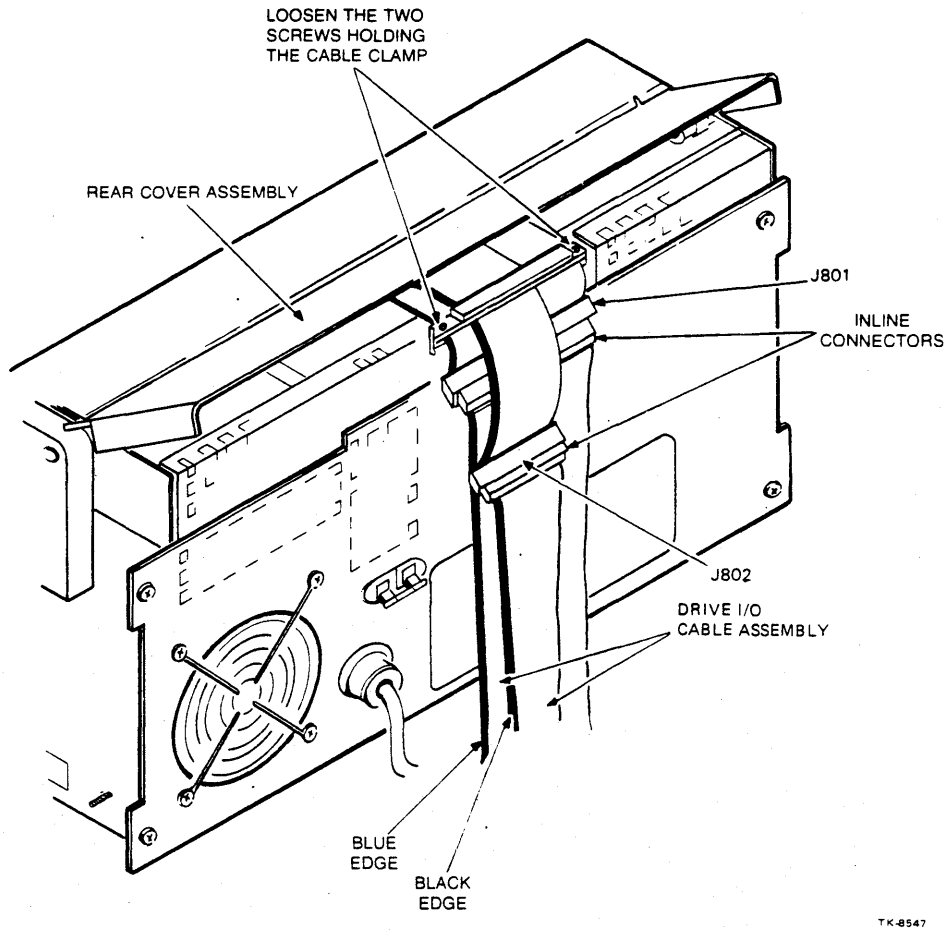

Figure 2-18 Drive I/O Cable Replacement

2.18.1 Drive I/O Cables

Removal procedure:

1. Unplug the drive I/O cables at the in-line connectors as shown in Figure 2-18.
2. Raise the rear cover assembly shown in Figure 2-18.
3. Loosen the two screws that hold the rear cable clamp.
4. Raise the logic access cover (Paragraph 2.19).
5. Raise the servo module. Refer to Figure 2-13.
6. Remove the personality module (Paragraph 2.15).
7. Remove the microprocessor module (Paragraph 2.16).

8. Slide the drive I/O cables from under the cable clamps in the logic chassis tray. Refer to Figure 2-19.

9. Remove the drive I/O cables through the rear of the drive.

Replacement procedure:

Reverse the removal procedure.

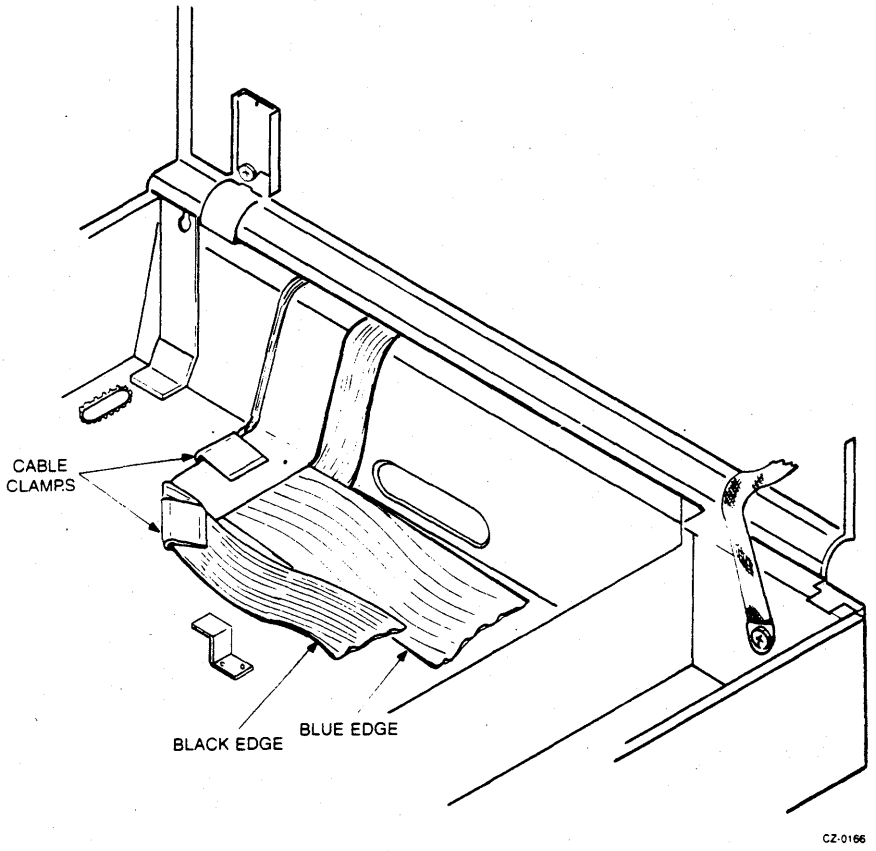

Figure 2-19 Routing the Drive I/O Cables

2.18.2 Drive I/O Cable Assembly

Removal and replacement procedures:

Since these procedures are system specific, refer to the appropriate system manual (user or service).

2.19 READ/WRITE CABLE – 50 CONDUCTOR

The read/write cable connects J304 on the microprocessor module to J502 on the read/write module.

Removal procedure:

1. Raise the logic access cover (Paragraph 2.9).
2. Remove the microprocessor module (Paragraph 2.16).
3. Push the read/write cable through the grommet at the back of the logic chassis.
4. Raise the drive logic chassis (Paragraph 2.10).
5. Unplug P502 from the read/write module and remove the cable. Refer to Figure 2-16.

Replacement procedure:

Reverse the removal procedure.

2.20 GAS SPRINGS

Removal procedure:

1. Raise the drive logic chassis (Paragraph 2.10).
2. Remove the screw that holds the bottom bracket of the gas spring, while placing a little upward pressure on the logic chassis. Refer to Figure 2-20.
3. Loosen the screw that holds the top bracket of the gas spring to the logic chassis. Lift the top bracket up and out.

WARNING

The logic chassis will fall if not supported. One gas spring is not sufficient to support the weight of the drive logic chassis.

4. Lower the logic chassis to its normal position.
5. Remove the upper bracket from the gas spring by removing the hitch pin and the clevis pin. Refer to Figure 2-21.
6. Remove the bottom bracket from the gas spring by removing the clevis pin.

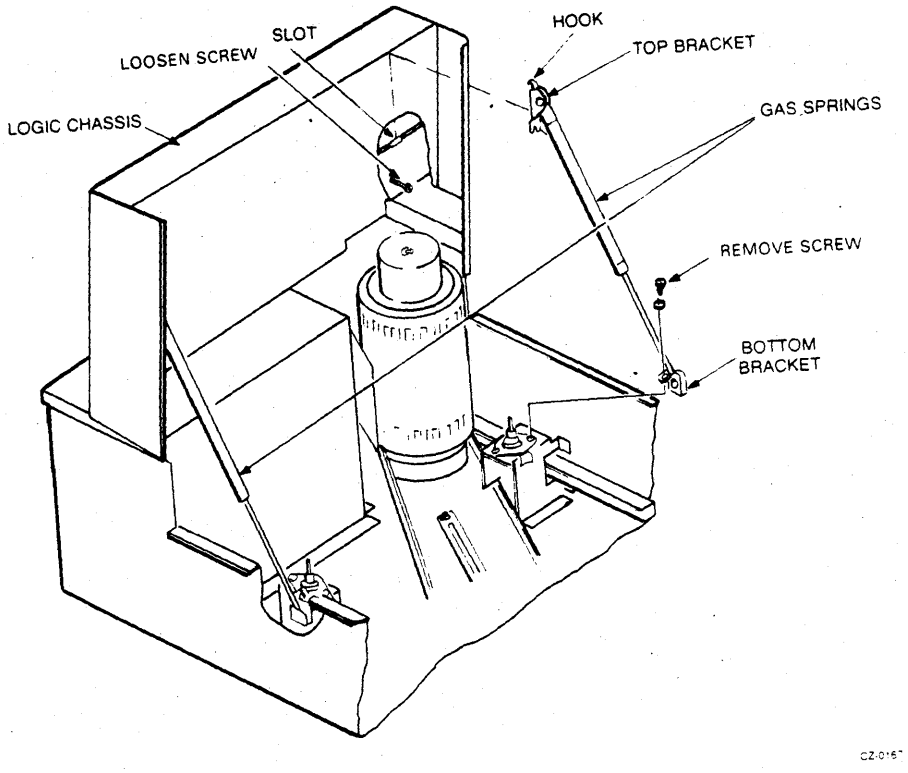

Figure 2-20 Gas Spring Replacement

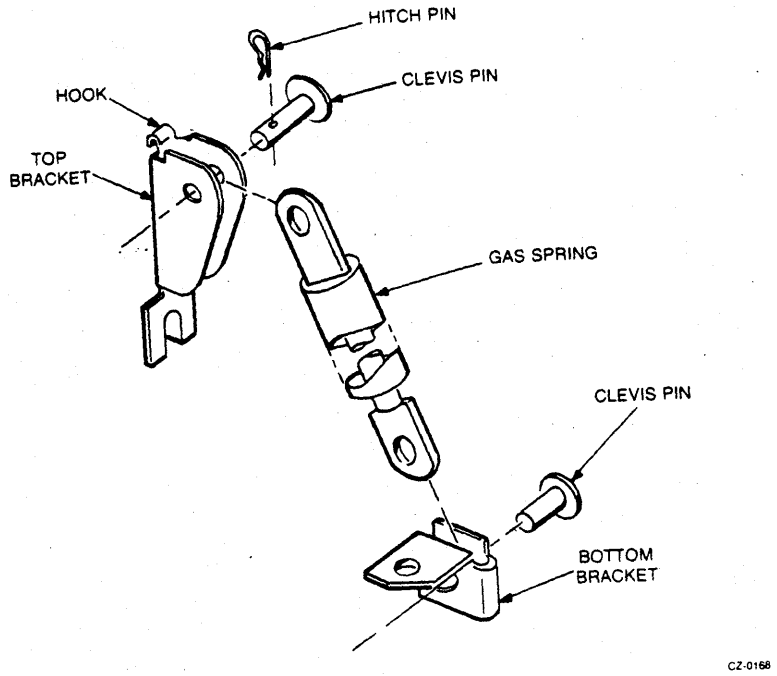

Figure 2-21 Gas Spring Bracket Replacement

Replacement procedure:

Reverse the removal procedure.

NOTE

The head of the bottom clevis pin should be against the chassis wall to prevent the pin from falling out.

CAUTION

When replacing the gas spring assembly, be sure that the hook on the top bracket is placed in the slot on the bottom of the logic chassis. See Figure 2-20.

2.21 FRONT BEZEL FANS (TWO FANS)

Removal procedure:

1. Raise the drive logic chassis (Paragraph 2.10).

2. Remove the two screws that hold the fan bracket in place, on the bottom side of the logic chassis. Refer to Figure 2-22.

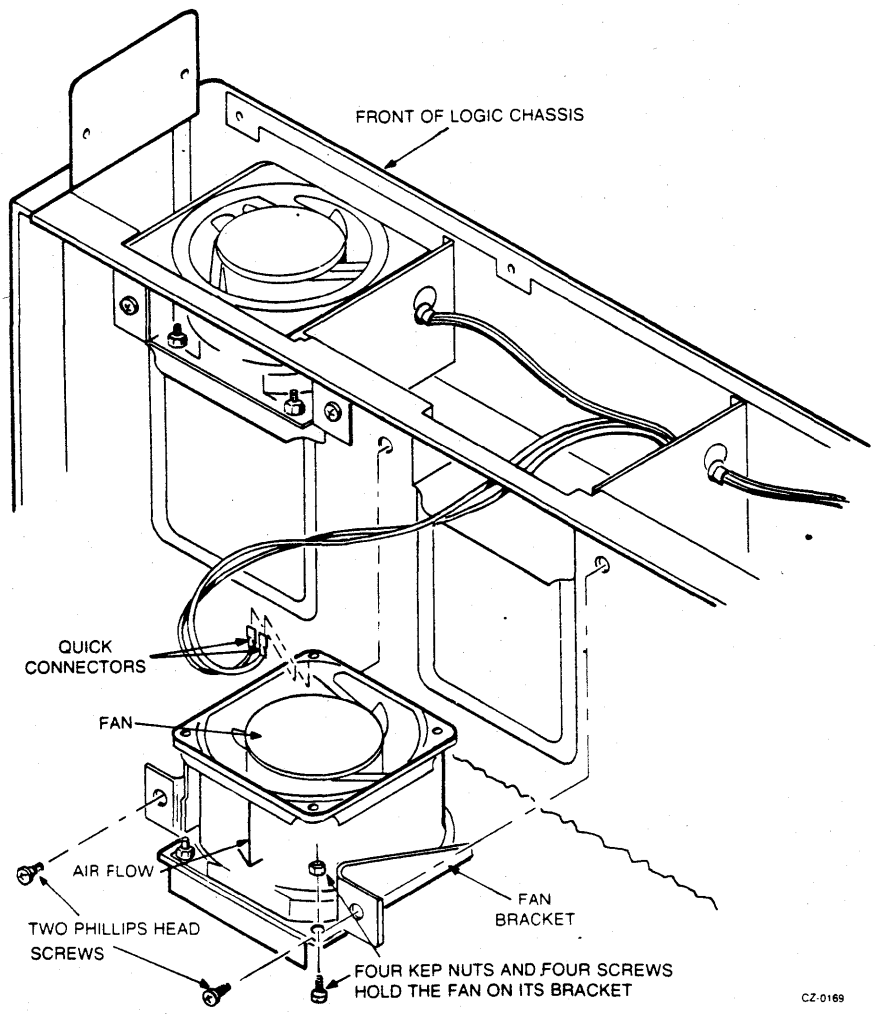

Figure 2-22 Front Bezel Fan Replacement

3. Slide the fan assembly down enough to remove the quick-connector terminals from the fan.

4. Unplug the two quick-connector terminals.

5. Remove the four screws and kep nuts that hold the fan to the bracket.

6. Separate the fan from the bracket.

Replacement procedure:

Reverse the removal procedure.

CAUTION

When sliding the fans back into place, make sure the wires are not pinched between the fan and the logic chassis. If the wires are pinched while bolting down the fan, AC power may be shorted to the chassis.

2.22 READ/WRITE PREAMP CABLE – 20 CONDUCTOR

The read/write preamp cable connects J503 on the read/write module to J601 on the HDA preamp module.

Removal procedure:

1. Raise the drive logic chassis (Paragraph 2.10).

2. Unplug P503 from the read/write module. Refer to Figure 2-23.

3. Unplug P601 from the HDA preamp module and remove the cable.

Replacement procedure:

Reverse the removal procedure.

2.23 READ/WRITE MODULE

Removal procedure:

1. Raise the drive logic chassis (Paragraph 2.10).

2. Unplug connector P501, P502, and P503 from the read/write module. Refer to Figure 2-23.

3. Remove the four retaining screws and flat washers, then lift the read/write module off the HDA.

Replacement procedure:

Reverse the removal procedure.

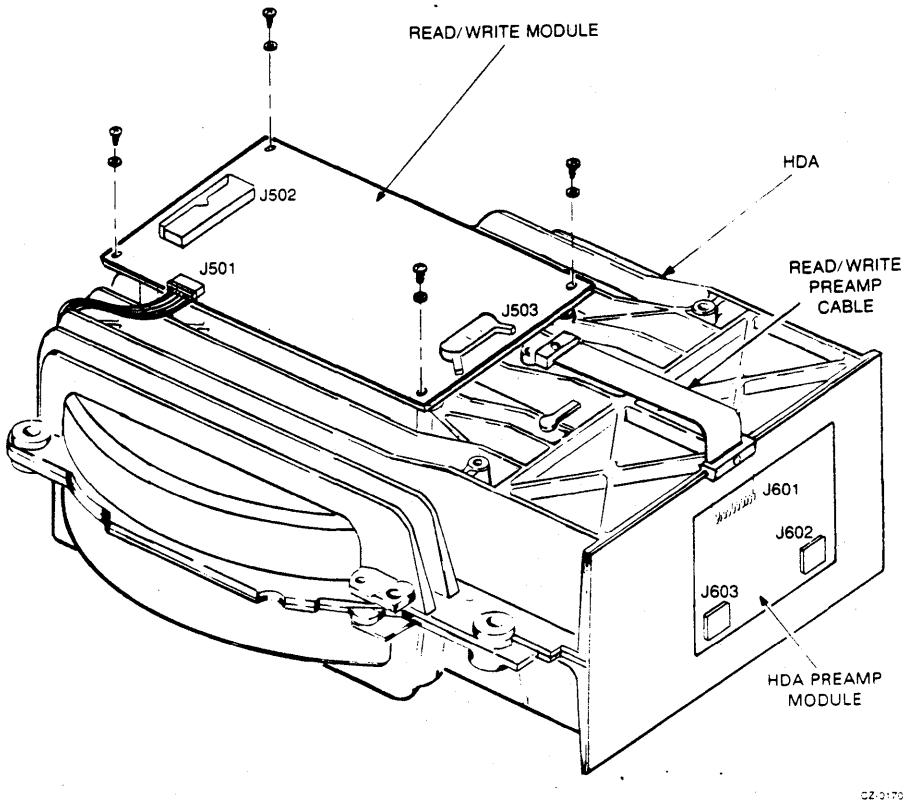

Figure 2-23 Read/Write Module Replacement

2.24 BRUSH GROUND SPRING

Removal procedure:

1. Raise the drive logic chassis (Paragraph 2.10).
2. Remove the read/write module (Paragraph 2.23).
3. Remove the retaining ring on top of the brush ground spring. Refer to Figure 2-24.
4. Remove the brush ground spring with a screwdriver.

Replacement procedure:

Reverse the removal procedure.

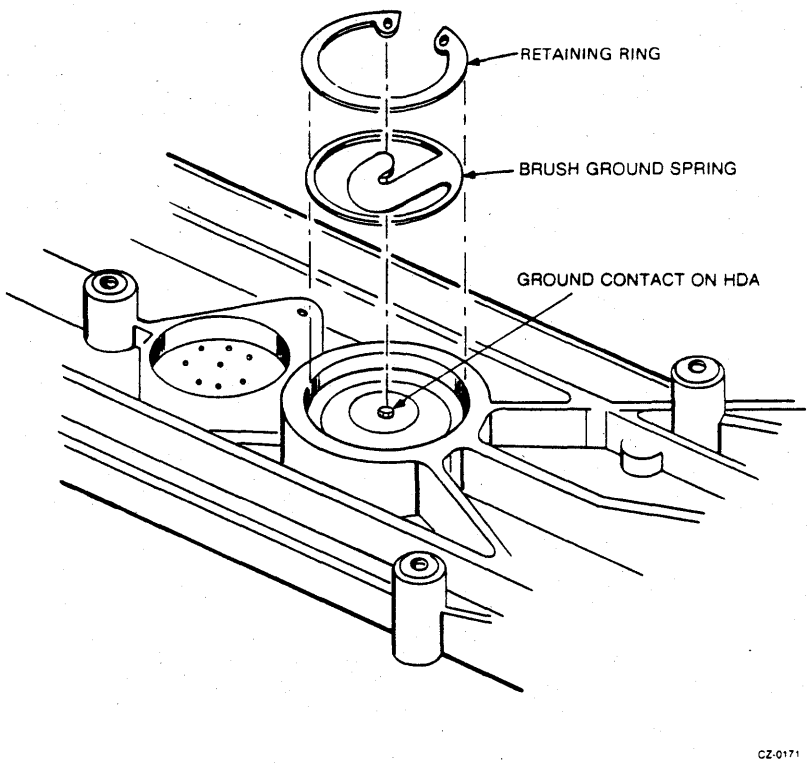

Figure 2-24 Brush Ground Spring Replacement

2.25 FRONT BEZEL

Removal procedure:

1. Raise the drive logic chassis (Paragraph 2.10).
2. Remove the eight screws that secure the front bezel to the logic chassis. Refer to Figure 2-25.
3. Lift off the front bezel.

Replacement procedure:

Reverse the removal procedure:

NOTE

When replacing the front bezel, align the top of the bezel so that it is flush with the top of the logic chassis. Then check that the operator control panel switches do not rub on the front bezel when pushed. If the switches rub when pushed, adjust the operator control panel. Loosening the two bottom screws that secure the operator control panel bracket allows the bracket to move horizontally. Loosening the four screws that secure the operator control panel to its bracket allows the panel to move vertically.

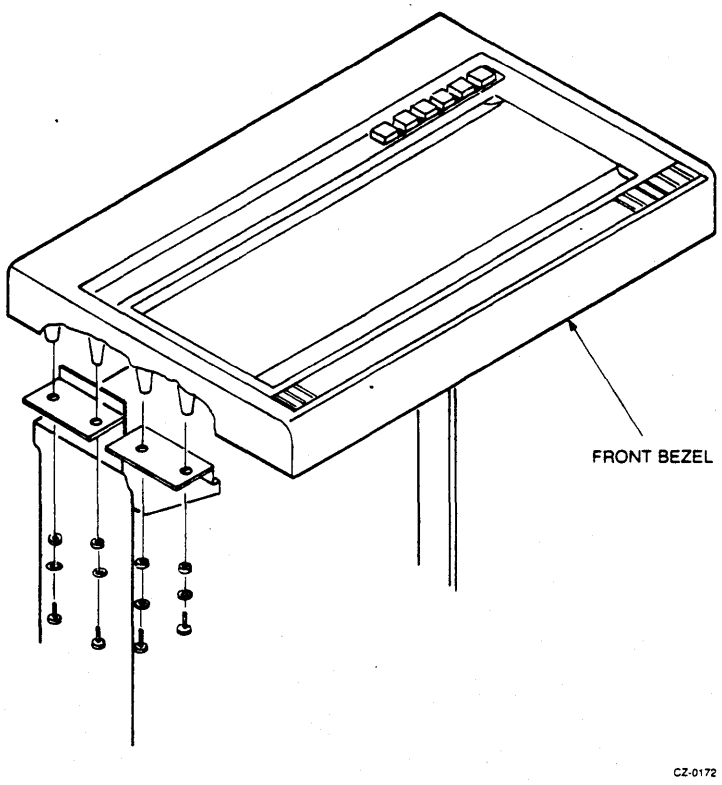

Figure 2-25 Front Bezel Replacement

2.26 OPERATOR CONTROL PANEL

Removal procedure:

1. Raise the drive logic chassis (Paragraph 2.10).
2. Remove the front bezel (Paragraph 2.25).
3. Remove the two screws and washers, located under the logic chassis, that secure the operator control panel bracket. Refer to Figure 2-26.
4. Pull the operator control panel bracket out and unplug P101 from the top.
5. Separate the operator control panel from the bracket by removing the four screws.

Replacement procedure:

Reverse the removal procedure.

CAUTION

When replacing the operator control panel cable, make sure that the decal side of the connectors faces away from the module.

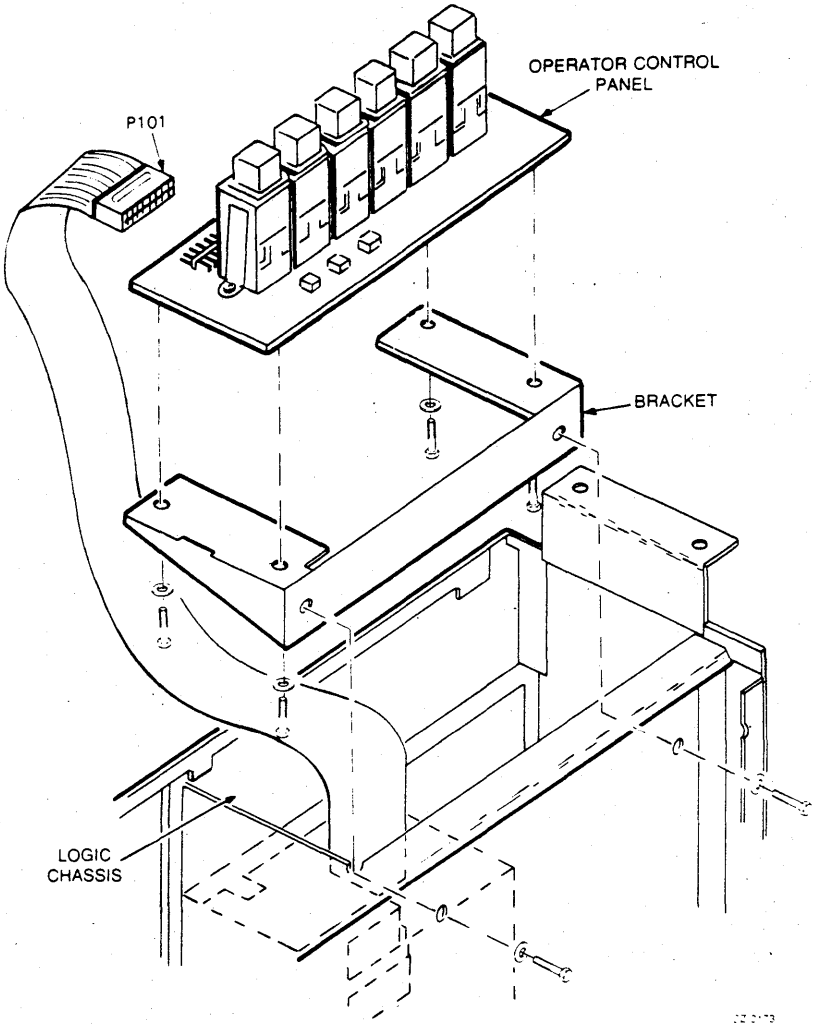

Figure 2-26 Operator Control Panel Replacement

2.27 OPERATOR CONTROL PANEL CABLE

Removal procedure:

1. Raise the drive logic chassis (Paragraph 2.10).
2. Remove the front bezel (Paragraph 2.25).
3. Remove the two screws and washers, located under the logic chassis, that secure the operator control panel bracket. Refer to Figure 2-26.
4. Pull the operator control panel bracket out and unplug P101 from the top.
5. Raise the logic access cover (Paragraph 2.9).
6. Raise the servo and personality modules.
7. Unplug the operator control panel cable from J301 on the microprocessor module. Refer to Figure 2-13.
8. Remove the cable and connector through the grommet in the logic chassis.

Replacement procedure:

Reverse the removal procedure.

CAUTION

When replacing the operator control panel cable, make sure that the decal side of the connectors faces away from the module.

2.28 LOGIC AC HARNESS ASSEMBLY

Removal procedure:

1. Raise the drive logic chassis (Paragraph 2.10).
2. Remove the front bezel (Paragraph 2.25).
3. Remove the two screws and washers, located under the logic chassis, that secure the operator control panel bracket. Refer to Figure 2-26.
4. Pull the operator control panel bracket out and unplug P101 from the top.
5. Remove the front bezel fans (Paragraph 2.21).
6. Raise the logic access cover (Paragraph 2.9).
7. Remove the wires from the motor start capacitor (Paragraph 2.11).
8. Cut the cable clamp that secures the ac harness inside the capacitor compartment. Refer to Figure 2-27.

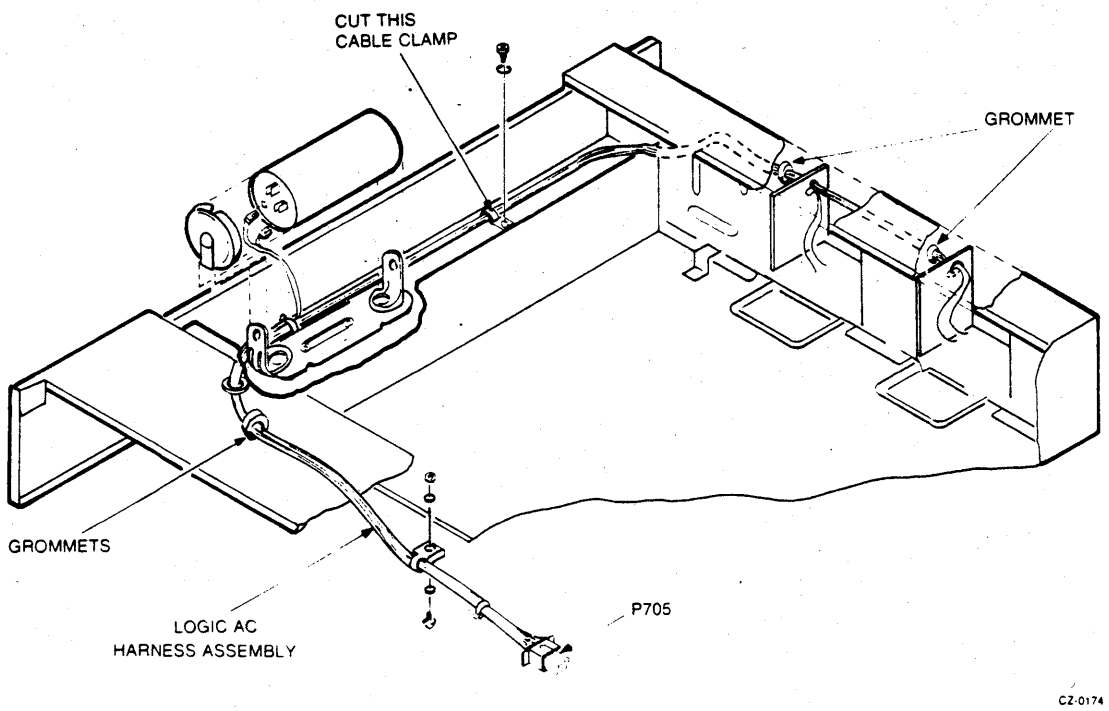

Figure 2-27 Logic AC Harness Replacement

9. Remove the screw that holds the cable clamp to the bottom of the logic chassis.
10. Unplug P705 from the power supply. Refer to Figure 2-28.
11. Free the two grommets from their holes in the front of the logic chassis. See Figure 2-27.
12. Pull the cable and grommets through the front frame of the logic chassis.
13. Pull the grommet and harness through the chassis hole at the rear of the capacitor compartment.

Replacement procedure:

Reverse the removal procedure and replace the cable clamp in the capacitor compartment.

2.29 DRIVE POWER SUPPLY

Removal procedure:

1. Unplug the drive ac power plug from the top of the system cabinet.
2. Raise the drive logic chassis (Paragraph 2.10).
3. Unplug P701, P702, P703, P704, and P705 from the drive power supply. See Figure 2-28.

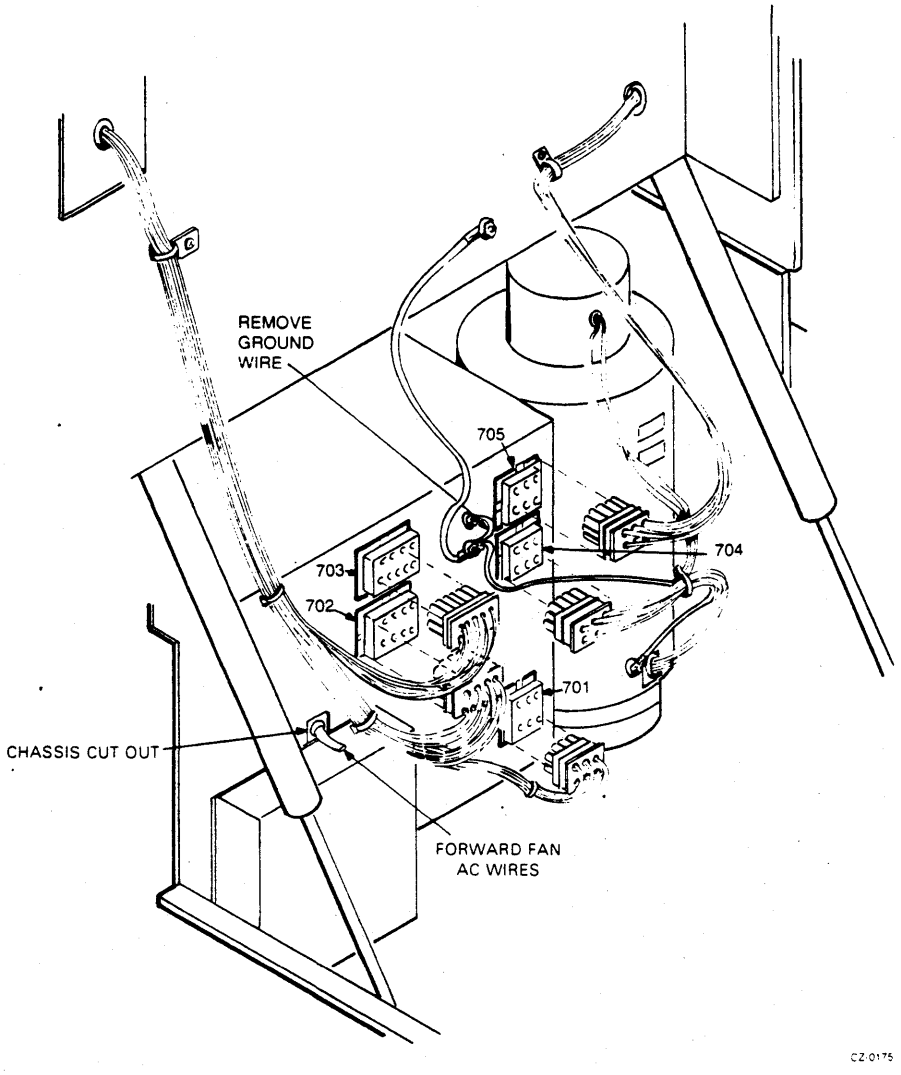

Figure 2-28 Drive Power Supply Connectors

4. Remove the ground wire from the top ground terminal on the front of the power supply.

5. Unplug the two ac wires from the top of the forward power supply fan.

6. Remove the six HEX head slotted screws and washers that hold the power supply in place. Refer to Figure 2-29.

7. Pull the power supply out of the rear of the drive, guiding the two fan wires through the chassis cut-out.

Replacement procedure:

Reverse the removal procedure.

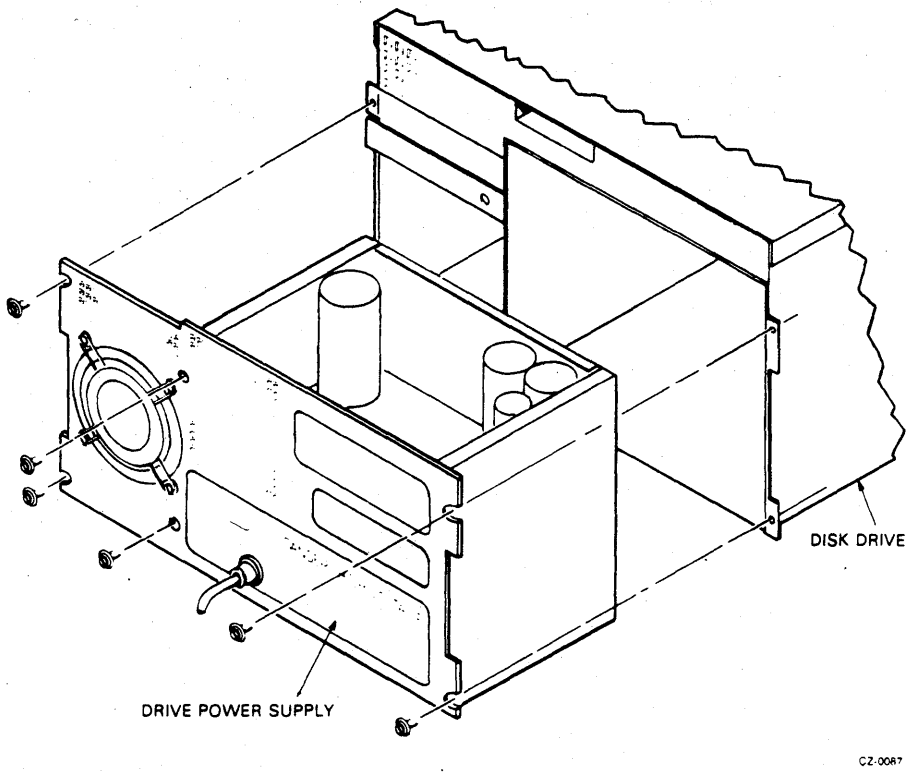

Figure 2-29 Drive Power Supply Replacement

2.30 REAR POWER SUPPLY FAN

Removal procedure:

1. Remove the drive power supply (Paragraph 2.29).
2. Disconnect the two ac wires from the side of the fan. Refer to Figure 2-30.
3. Remove the four screws and washers that hold the fan in place.
4. Remove the four Tinnerman nuts from the old fan and install them on the new fan.

Replacement procedure:

Reverse the removal procedure. Make sure that the fan airflow moves in the direction indicated in Figure 2-30.

2.31 FORWARD POWER SUPPLY FAN

Removal procedures:

1. Remove the drive power supply (Paragraph 2.29).
2. Unplug the two ac wires from the top side of the fan. Refer to Figure 2-30.

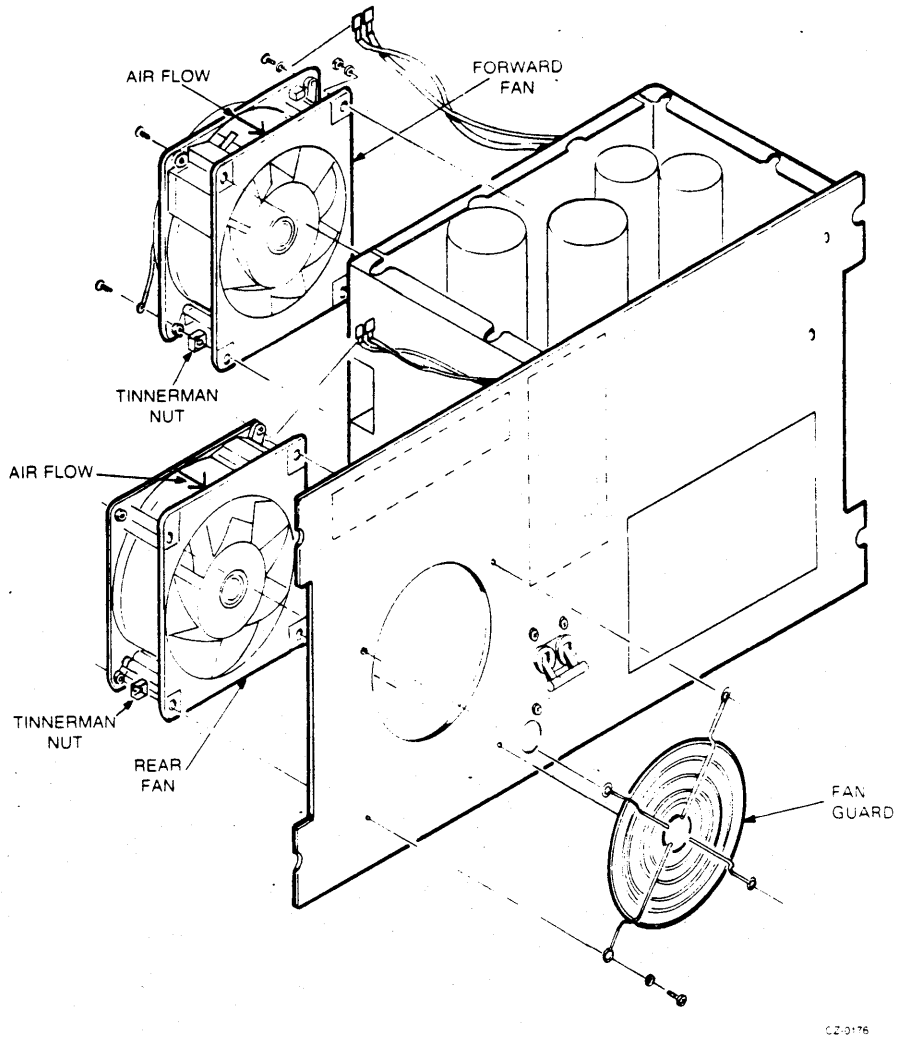

Figure 2-30 Power Supply Fan Replacement

3. Remove the fan guard by removing the four screws and washers that hold the fan guard in place.

4. Remove the four Tinnerman nuts and install them on the new fan.

5. Remove the four nuts that hold the fan on the power supply chassis.

6. Remove the fan from its mounting studs.

Replacement procedure:

Reverse the removal procedure. Make sure that the fan airflow moves in the direction indicated in Figure 2-30.

2.32 DRIVE AC LINE CORD

Removal procedure:

1. Remove the drive power supply (Paragraph 2.29).
2. Remove the four screws that hold the rear panel of the power supply. Refer to Figure 2-31.
3. Separate the rear panel from the chassis enough to reach the rear of the ac line cord feed-through.
4. Remove the molded feed-through around the ac power cord by pushing in on the plastic wings with a screwdriver. Refer to Figure 2-32.
5. Remove the green/yellow wire from the ground lug inside the power supply. Refer to Figure 2-32.
6. Remove the blue wire and brown wire from the ac filter by pulling them off the spade lugs.

Replacement procedure:

Reverse the removal procedure.

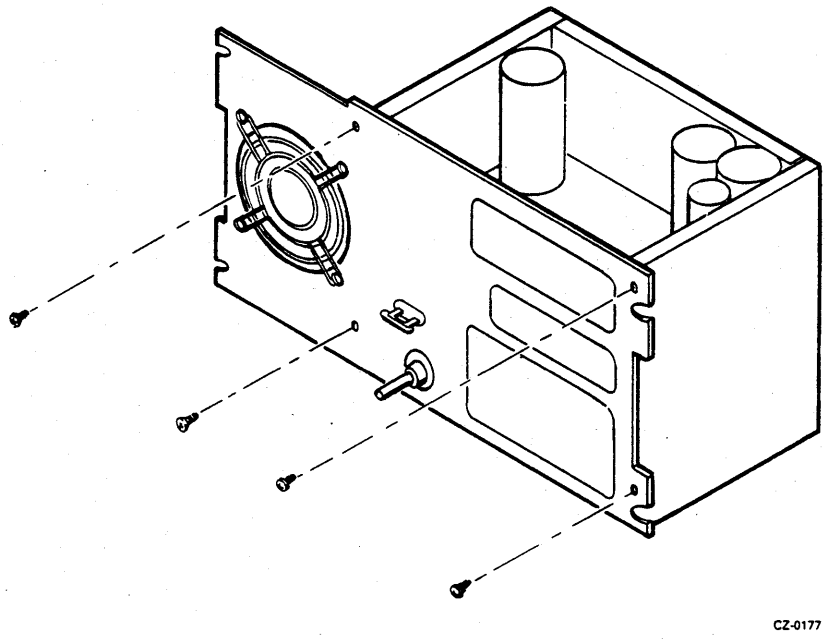

Figure 2-31 Drive Power Supply Rear Panel Removal

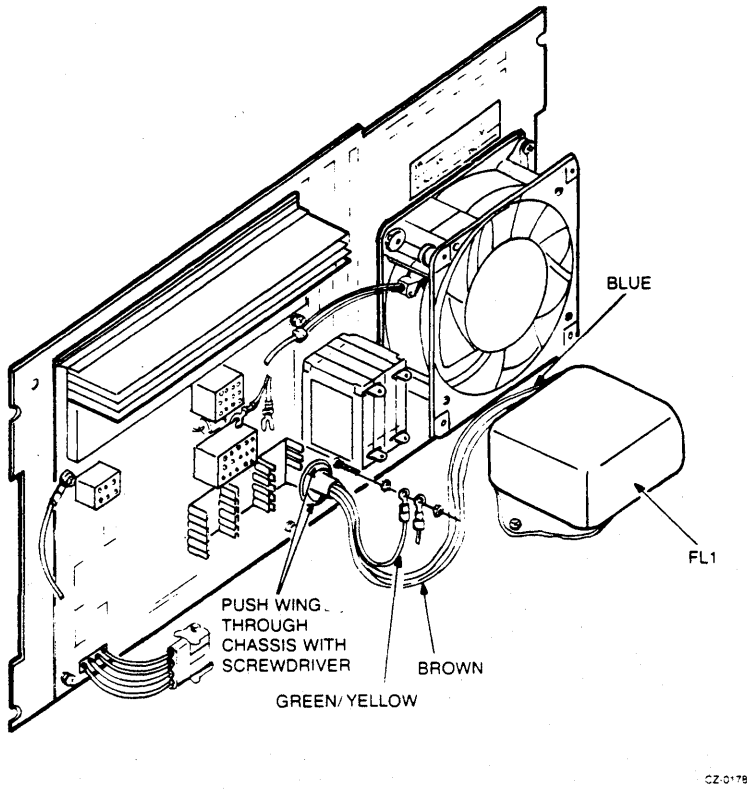

Figure 2-32 Drive AC Line Cord Replacement

2.33 HEAD DISK ASSEMBLY

The HDA replacement is separated into two procedures. The procedure in Paragraph 2.33.1 describes how to remove the HDA and read/write module as a unit. Paragraph 2.33.2 describes how to install a new HDA after the old one is removed. When installing a new HDA, the read/write module must be transferred to the new HDA.

2.33.1 HDA Removal

Removal procedure:

1. Raise the drive logic chassis (Paragraph 2.10).
2. Unplug P502 from the read/write module located on top of the HDA. Refer to Figure 2-33.
3. Unplug P602 and P603 from the HDA preamp module.
4. Place the belt tension lever in the released position (toward the rear of the drive).
5. Remove the four nuts and washers that hold the HDA on the shock mounts.

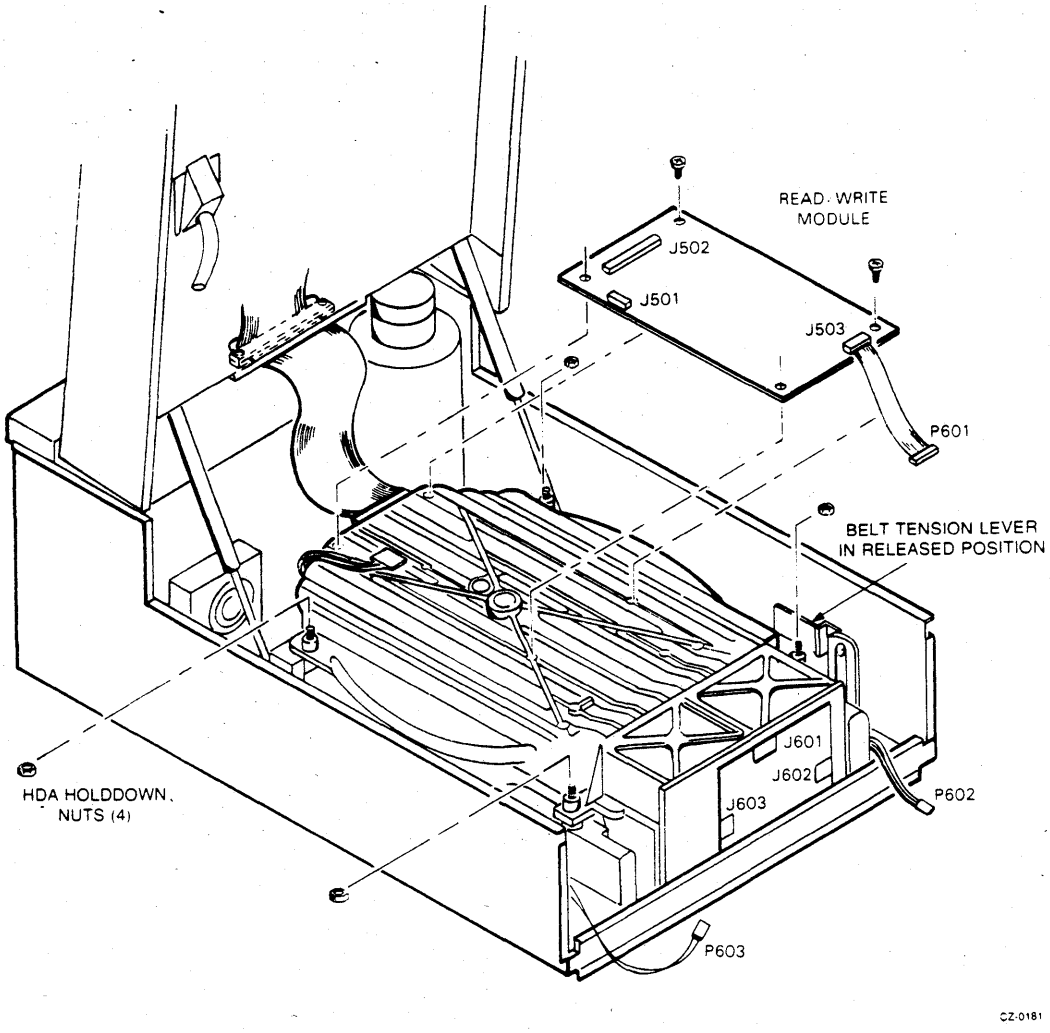

Figure 2-33 HDA Replacement

6. Place the HDA positioner lock lever in the LOCK position by moving the lever clockwise. Refer to Figure 2-34.

CAUTION
If Step 6 is not performed, the HDA may be damaged.

7. Place hands at diagonally opposite corners as shown in Figure 2-34.

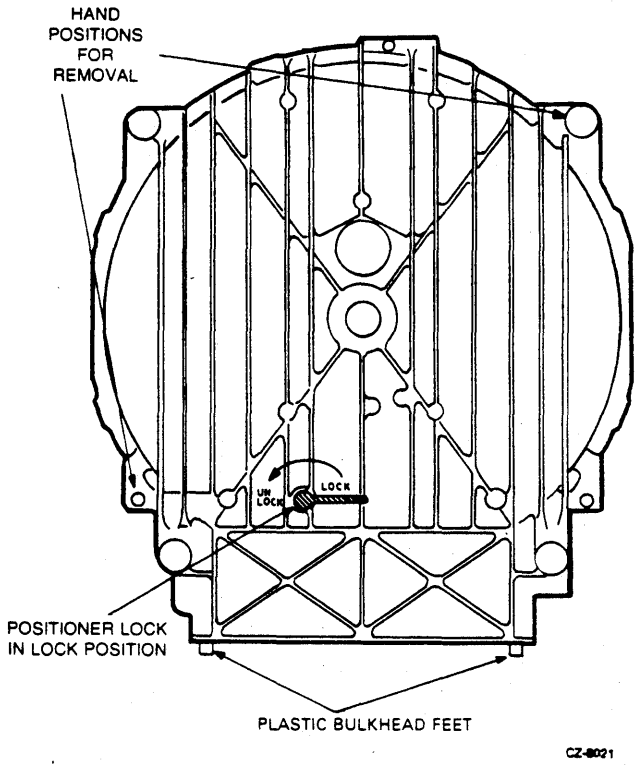

Figure 2-34 HDA Positioner Lock Lever

8. Carefully lift the HDA out of the cabinet and set it down in the vertical position on the plastic bulkhead feet.

CAUTION

Never set an HDA down on its spindle pulley. Head damage will occur if the HDA spindle pulley is rotated. Always tape the HDA spindle pulley in place before packaging for shipping.

9. Put the HDA down on its feet with the pulley side down.

Replacement procedure:

Before installing the HDA, make sure that the drive belt is centered on the motor pulley. The other end of the belt should be even with the top of the nylon rollers on the wing pivot assembly. Refer to Figure 2-35.

CAUTION

If the belt is not aligned properly before installing the HDA, damage to the nylon rollers, the belt or the HDA may result.

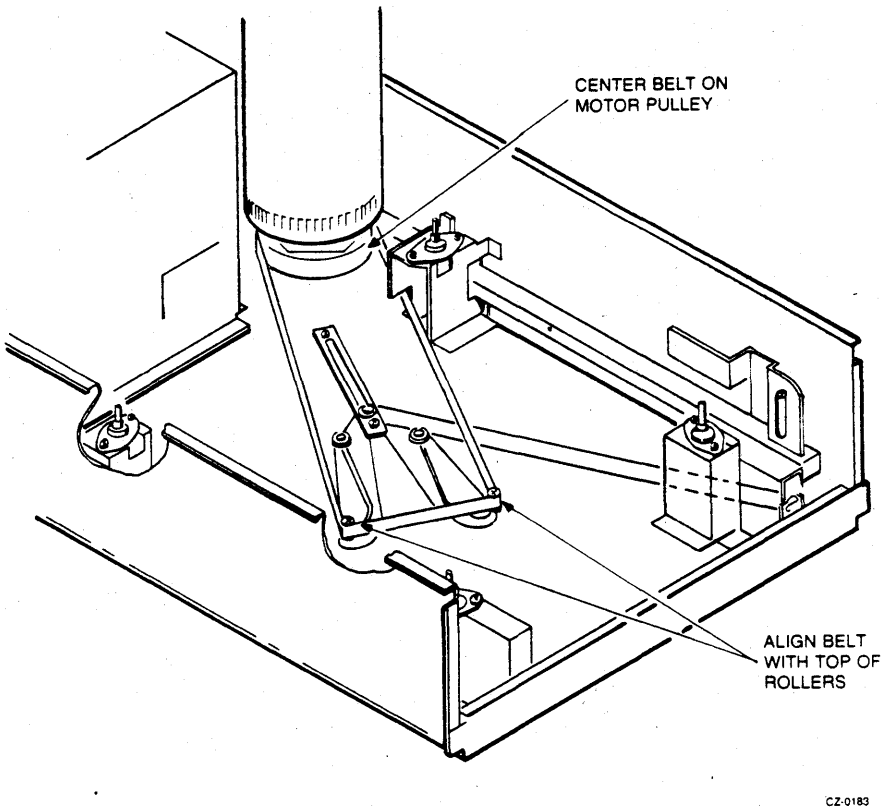

Figure 2-35 Belt Alignment on Wing Pivot Assembly

1. Lift the HDA by two diagonally opposite corners as was done in the removal procedure.
2. Position the HDA over the four mounting bolts and lower it onto the shock mounts.
3. Secure the HDA in position with the four nuts and washers.
4. Reconnect P602 and P603 to the preamp module on the front of the HDA.

CAUTION
Ensure that flat cables do not have a 180 degree twist when replacing them.

5. Reconnect P502 on the read/write module.
6. Place the belt tension lever in the full forward (locked) position.
7. Move the positioner lock lever to the unlock position by moving the lever counterclockwise.
8. Lower the logic chassis.

2.33.2 New HDA Installation

Removal procedure:

1. Remove the HDA (Paragraph 2.33.1).
2. Secure the spindle pulley on the bottom of the HDA with masking tape for shipping.
3. Unplug P501 from the read/write module located on top of the HDA. Refer to Figure 2-33.
4. Unplug P601 from the HDA preamp module.
5. Remove the four screws and flat washers that hold the read/write module to the top of the HDA.
6. Remove the read/write module and the attached cable from the HDA.

Replacement procedures:

Reverse the removal procedures.

2.34 SPEED SENSOR

Removal procedure:

1. Remove the HDA (Paragraph 2.33.1).
2. Place the HDA on the plastic bulkhead feet in the vertical postion as shown in Figure 2-36.

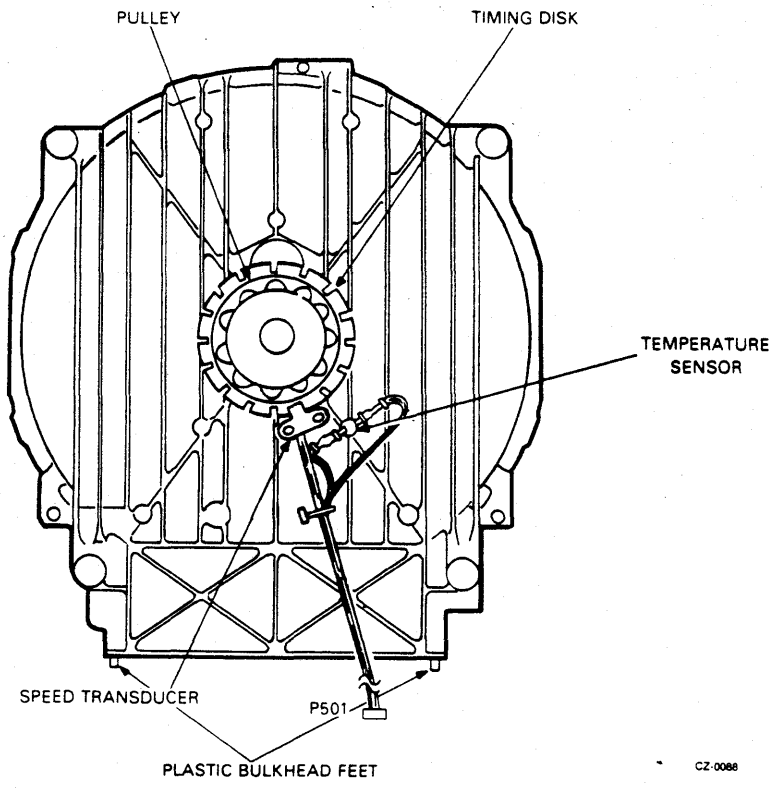

Figure 2-36 HDA Speed Sensor Replacement

3. Unplug P501 from the read/write module. Refer to Figure 2-33.

4. Remove the two quick-connect terminals from the temperature sensor on the bottom of the HDA. Refer to Figure 2-36.

5. Remove the two screws that hold the speed sensor on the bottom of the HDA.

6. Remove the speed sensor.

Replacement procedure:

Reverse the removal procedure.

2.35 HDA TEMPERATURE SENSOR

Removal procedure:

1. Remove the HDA (Paragraph 2.33.1).

2. Place the HDA on the plastic bulkhead feet in the vertical position as shown in Figure 2-36.

3. Remove the two quick-connect terminals from the temperature sensor on the bottom of the HDA.

4. Remove the temperature sensor by turning it counterclockwise.

Replacement procedure:

Reverse the removal procedure.

2.36 SHOCK MOUNTS

Removal procedure:

1. Remove the HDA (Paragraph 2.33.1).

2. Remove the two screws that hold the shock mount to the chassis. Refer to Figure 2-37.

Replacement procedure:

Reverse the removal procedure.

2.37 BELT TENSION INTERLOCK MICROSWITCH

Removal procedure:

1. Remove the HDA (Paragraph 2.33.1).

2. Remove the screw that holds the belt tension switch to the chassis sidewall. Refer to Figu 2-38.

3. Remove the microswitch from its plastic bracket.

4. Unplug the two quick-connect terminals from the microswitch.

Replacement procedure:

Reverse the removal procedure. Check that the microswitch leads are replaced as shown in Figure 2-3

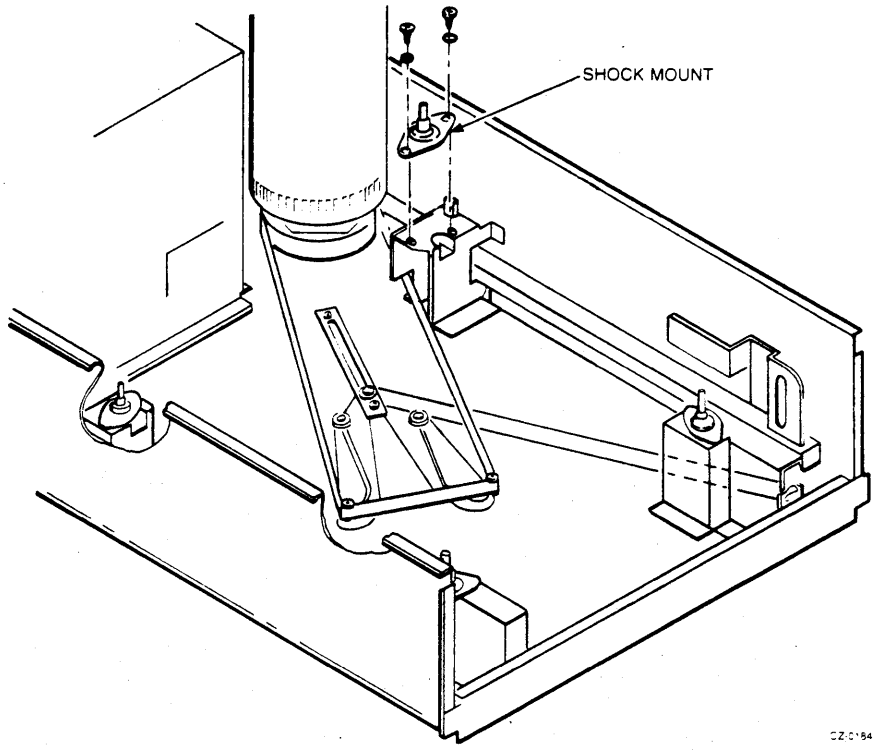

Figure 2-37 Shock Mount Replacement

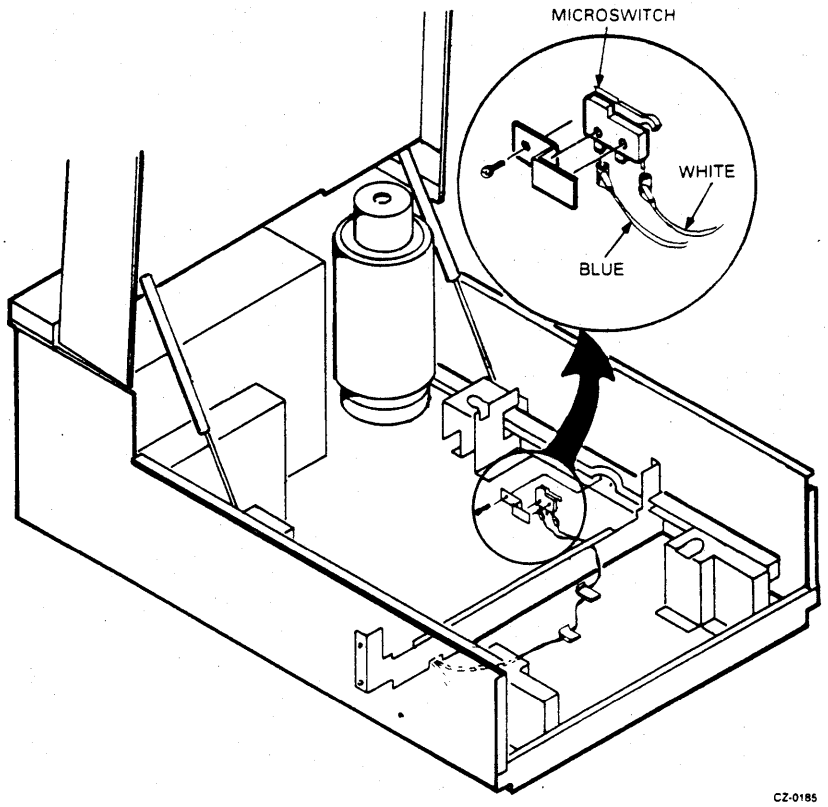

Figure 2-38 Belt Tension Interlock Microswitch Replacement

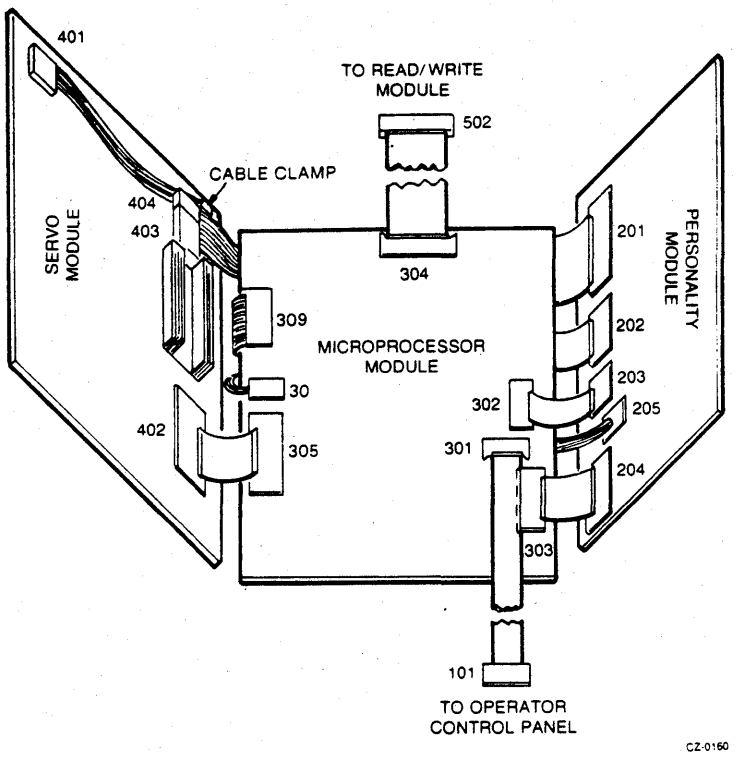

Figure 2-39 Module Connector Locations

2.38 BELT TENSION SWITCH CABLE HARNESS

Removal procedure:

1. Raise the logic access cover (Paragraph 2.9).
2. Raise the servo module.
3. Unplug P404 on the servo module. Refer to Figure 2-39.
4. Remove the personality module (Paragraph 2.15).
5. Remove the microprocessor module (Paragraph 2.16).
6. Raise the drive logic chassis (Paragraph 2.10).
7. Remove the HDA (Paragraph 2.33.1).
8. Remove the belt tension microswitch from the sidewall (Paragraph 2.36).
9. Disconnect the quick-connect terminals from the belt tension microswitch.
10. Pull the belt tension switch harness and the grommet through the bottom of the logic chassis. Refer to Figure 2-40.

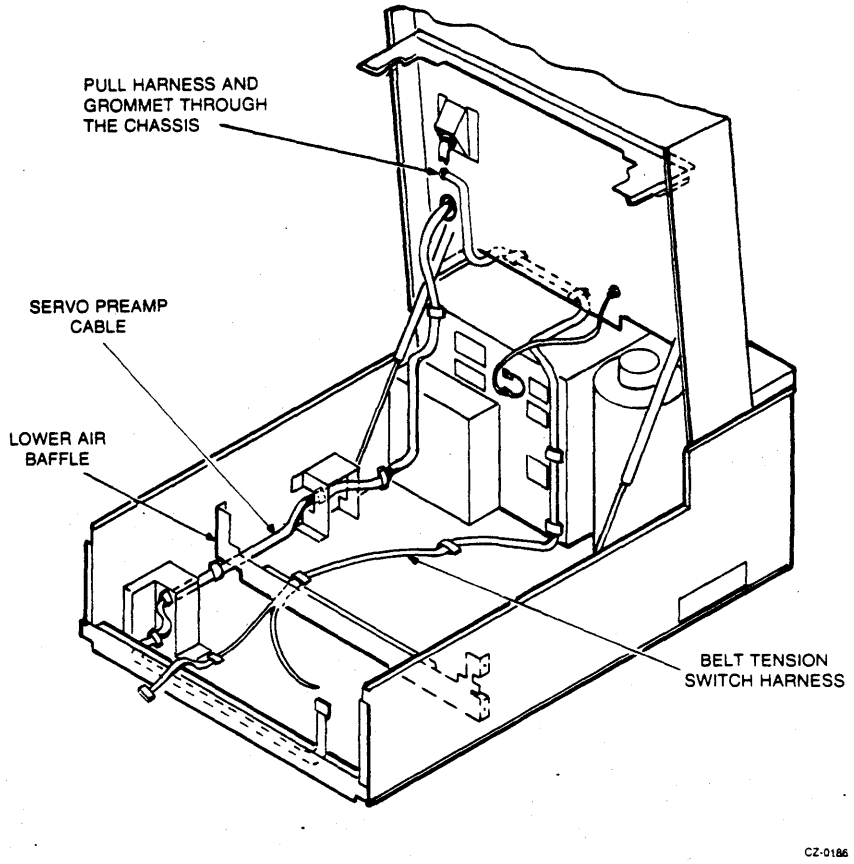

Figure 2-40 Lower Chassis Harness Replacement

11. Slide the cable harness from under the cable clamps.

12. Slide the cable from under the lower air baffle and remove it from the drive.

Replacement procedure:

Reverse the removal procedure.

NOTE

When installing the belt tension switch harness, route it under the ground wire between the power supply and logic chassis.

2.39 SERVO PREAMP CABLE ASSEMBLY - 10 CONDUCTOR

Removal procedure:

1. Raise the logic access cover (Paragraph 2.9).
2. Raise the servo module.
3. Unplug P401 on the servo module and slide cable out from cable clamp. See Figure 2-39.
4. Remove the personality module (Paragraph 2.15).
5. Remove the microprocessor module (Paragraph 2.16).
6. Raise the drive logic chassis (Paragraph 2.10).
7. Remove the HDA (Paragraph 2.33.1).
8. Slide the cable from under the cable clamps. Refer to Figure 2-40.
9. Slide the cable from under the lower air baffle.
10. Pull the cable down through the grommet on the bottom of the drive logic chassis and remove it from the drive.

Replacement procedure:

Reverse the removal procedure.

2.40 SPINDLE BELT

Removal procedure:

1. Remove the HDA (Paragraph 2.33.1).
2. Lift the belt off the wing pivot assembly. Refer to Figure 2-41.
3. Slide the belt off the motor pulley and pull it forward.

Replacement procedure:

1. Slide the belt under and around the motor pulley with the smooth side of the belt facing in.
2. Center the belt on the motor pulley.
3. Slide the other end of the belt over the two nylon roller bearings on the wing pivot assembly. The belt should be positioned so that the top of the belt is flush with the top of the nylon rollers.
4. Replace the HDA (Paragraph 2.33.1).

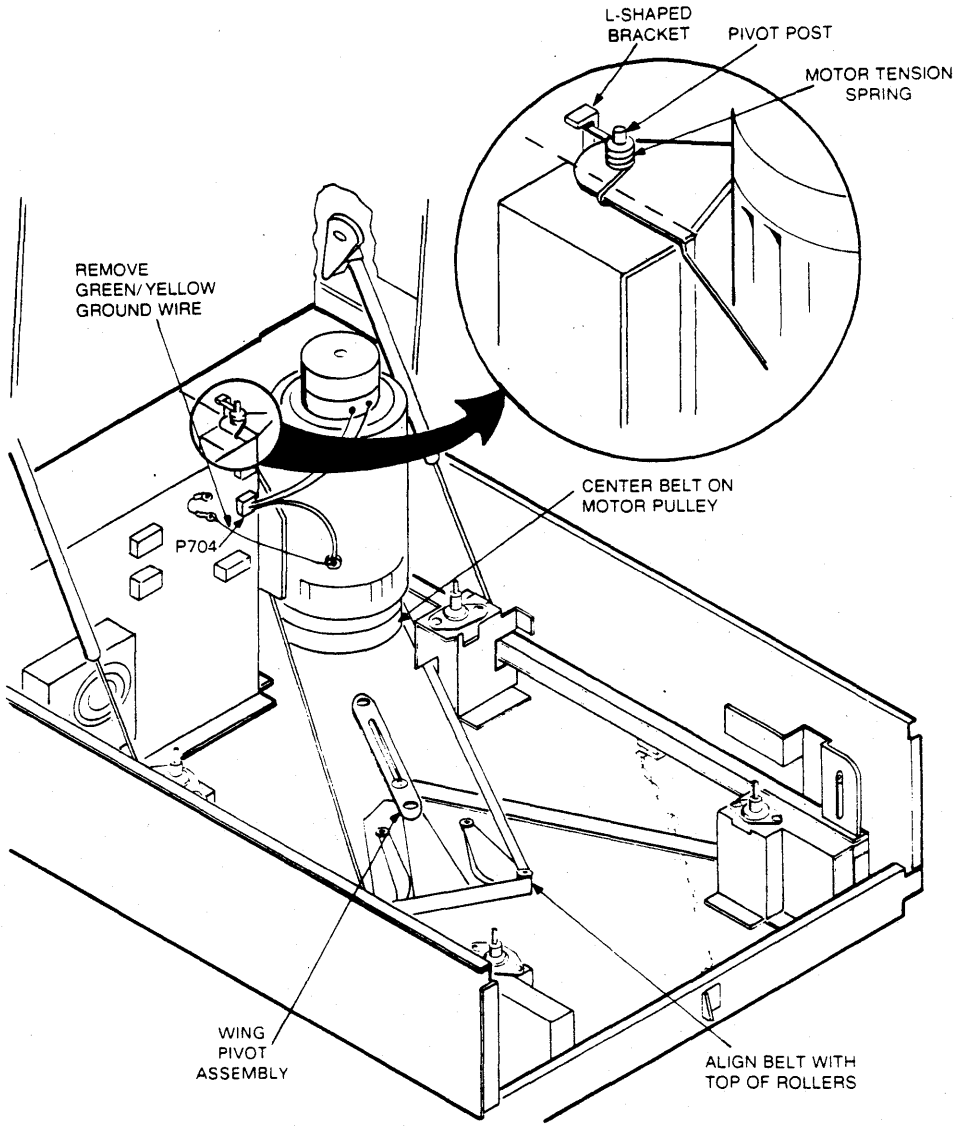

Figure 2-41 Motor/Brake Assembly Replacement

2.41 MOTOR/BRAKE ASSEMBLY

Removal procedure:

1. Remove the HDA (Paragraph 2.33.1).
2. Remove the lower of the two HEX nuts holding the green/yellow ground wire to the ground bolt on the power supply chassis. Refer to Figure 2-41.
3. Remove the motor ground wire from the ground bolt.
4. Unplug P704 from the power supply chassis.
5. Slide the belt off the wing pivot assembly and remove the belt from the motor pulley.
6. Remove the motor tension spring from under the L-shaped bracket with a pair of long-nose pliers.
7. Remove the motor/brake assembly from the drive by lifting it off the pivot posts.

Replacement procedure:

1. Place the motor/brake assembly on the pivot posts.
2. Replace the motor tension spring.
3. Replace the spindle belt with its smooth side facing in. The belt should be centered on the motor pulley. The other end of the belt should line up with the top of the nylon rollers on the wing pivot assembly.
4. Replace the green/yellow ground wire on the ground bolt.
5. Plug in P704 on the front of the power supply chassis.
6. Replace the HDA (Paragraph 2.33.1).

2.42 MOTOR ACTUATOR ASSEMBLY

Removal procedure:

1. Remove the HDA (Paragraph 2.33.1).
2. Remove the motor/brake assembly (Paragraph 2.40).
3. Remove the four kep nuts and flat washers that hold the bottom air baffle and remove the baffle. Refer to Figure 2-42.
4. Remove the three retaining rings and washers that hold the motor actuator assembly in place. Refer to Figure 2-43.

NOTE

The power supply may be removed for easier access to the rear retaining ring (Paragraph 2.29).

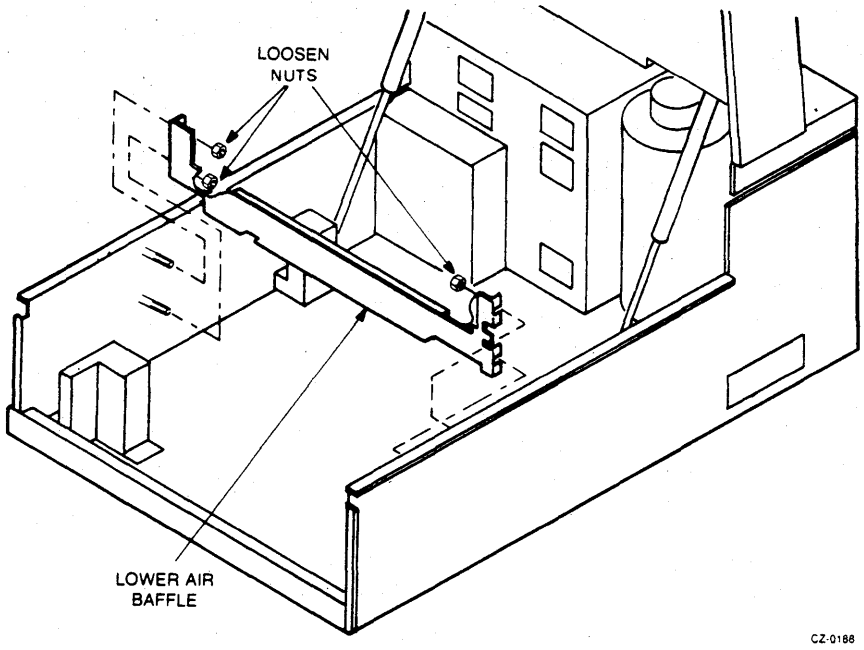

Figure 2-42 Lower Air Baffle Removal

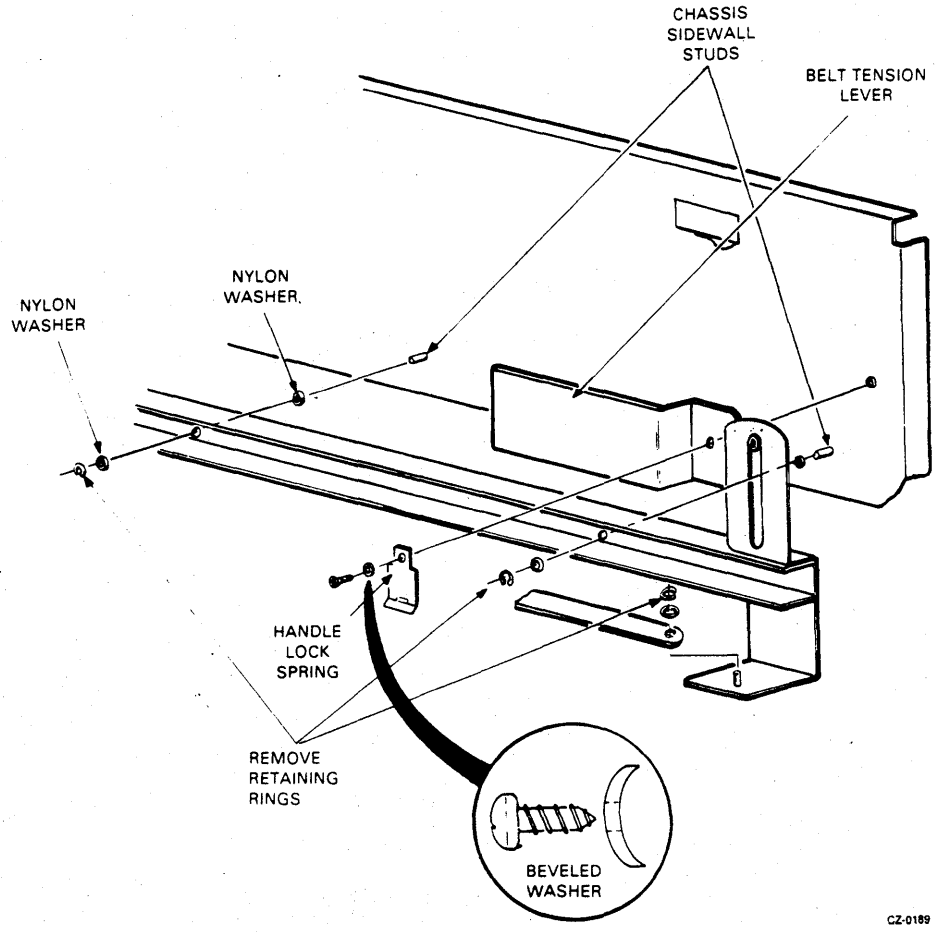

Figure 2-43 Motor Actuator Assembly Replacement

5. Remove the screw and the beveled washer securing the belt tension lever and the lock spring to the chassis sidewall.

6. Slide the motor actuator assembly off the chassis sidewall studs, and remove the assembly through the front of the drive.

Replacement procedure:

Reverse the removal procedure.

NOTE
When replacing the beveled washer, the hollow side of the washer is toward the lock spring.

2.43 WING PIVOT ASSEMBLY

Removal procedure:

1. Remove the HDA (Paragraph 2.33.1).

2. Lift the belt off the wing pivot assembly.

3. Remove the two screws, three retaining rings, and washers that hold the wing pivot assembly. Refer to Figure 2-44.

4. Lift the wing pivot assembly off the studs and slide it from under the lower air baffle.

Replacement procedure:

Reverse the removal procedure.

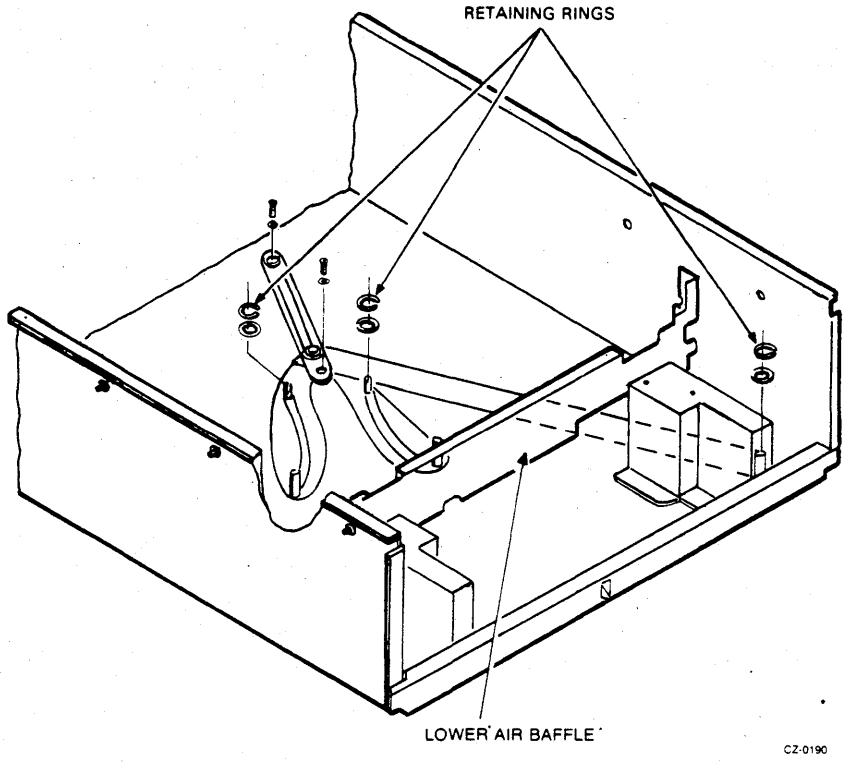

Figure 2-44 Wing Pivot Assembly Replacement

CHAPTER 3
ADJUSTMENTS

3.1 INTRODUCTION

This chapter describes the adjustment procedures for the R80 Disk Drive. Only two adjustments can be made, the belt tension adjustment and the servo adjustment.

3.2 BELT TENSION ADJUSTMENT

The belt tension should be checked whenever the motor, pulley, belt or HDA is replaced. Since the belt may stretch slightly with use, belt tension should also be examined anytime a drive corrective action call is made. To check or adjust belt tension, perform the following steps with the HDA in place.

Belt Tension Check-Out Procedure

1. Spin-down the HDA by releasing the RUN switch on the operator control panel.

2. Raise the drive logic chassis (Paragraph 2.10).

3. Examine the position of the brass-colored slider relative to the opening in the metal reference marker on the motor actuator assembly. When belt tension is adjusted properly, the end of the brass-colored slider should extend through the opening and be flush with the outside edge of the metal reference marker. Refer to Figure 3-1 to locate the belt tension adjustment mechanism. See Figure 3-2 for a close-up of the brass-colored slider and the metal reference marker.

Belt Tension Adjustment Procedure

If an examination of the belt tension mechanism reveals that the adjustment must be made, then switch off ac power to the drive at circuit breaker CB1 on the rear. Then perform the following steps.

1. Locate the belt tension adjustment screw at the base of the motor. Refer to Figure 3-1.

2. Loosen the locking nut on the adjustment screw.

3. Turn the adjustment screw clockwise to move the brass-colored slider toward the front of the drive. When adjusted properly, the end of the brass-colored slider should extend through the opening and be flush with the outside edge of the metal reference marker. Refer to Figure 3-2.

4. After the adjustment is made, tighten the locking nut on the adjustment screw.

5. Restore the ac power to the drive and spin-up the HDA.

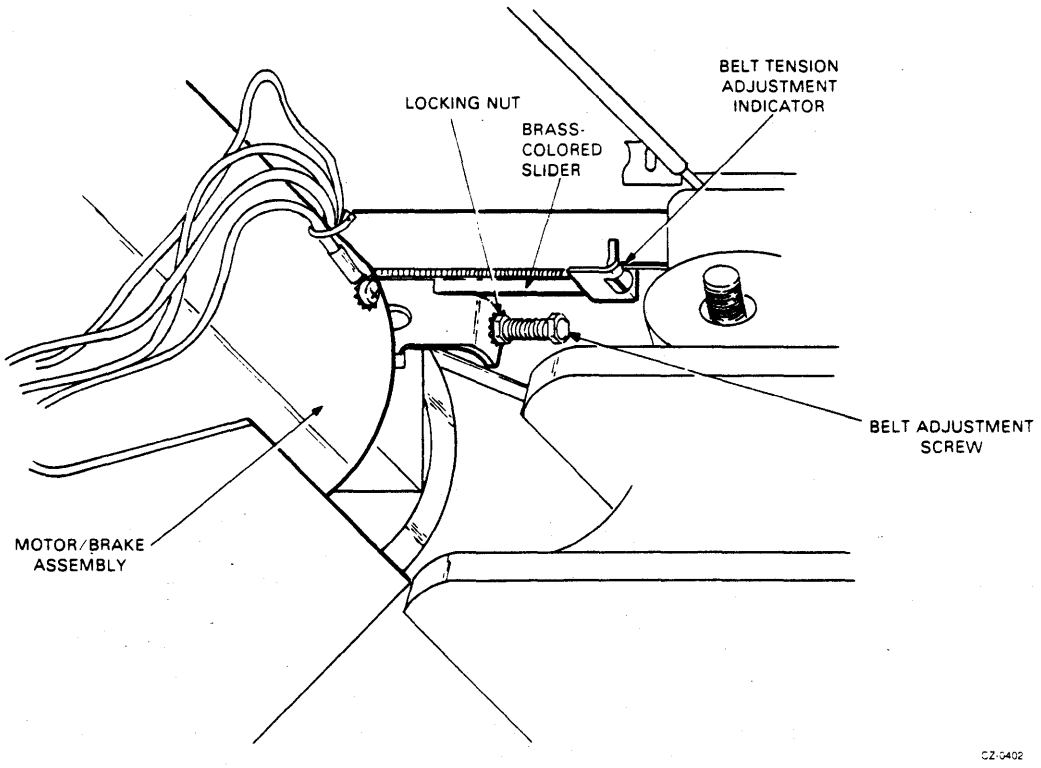

Figure 3-1 Location of Belt Tension Adjustment Mechanism

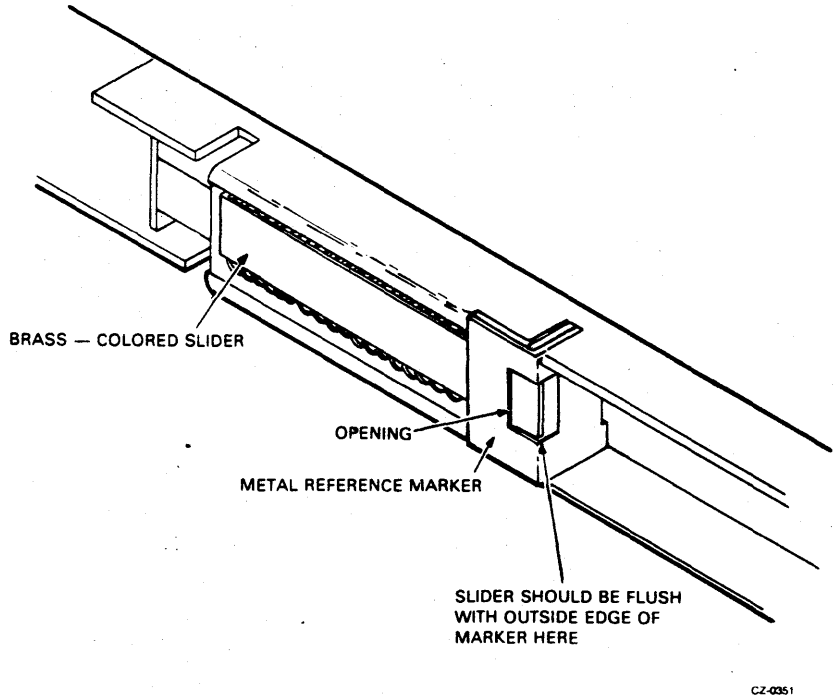

Figure 3-2 Close-Up of Belt Tension Adjustment Indicator

3.3 SERVO ADJUSTMENT

The servo adjustment must be performed after replacing a servo module or HDA. Use the following procedures to make this adjustment.

1. Remove power to the R80 drive using the circuit breaker at the rear of the H766 power supply.

CAUTION

Make sure that power is not applied to the drive during the following resistance measurements.

2. Use a multimeter to measure the resistance of the servo gain potentiometer (R284) on the servo module shown in Figure 3-3. The resistance of R284 should be 25K ± 500 ohms. If the resistance is not correct, adjust it.

3. Measure the resistance of the servo velocity potentiometer (R281) shown in Figure 3-3. Adjust R281 for a resistance value of 5K ohms.

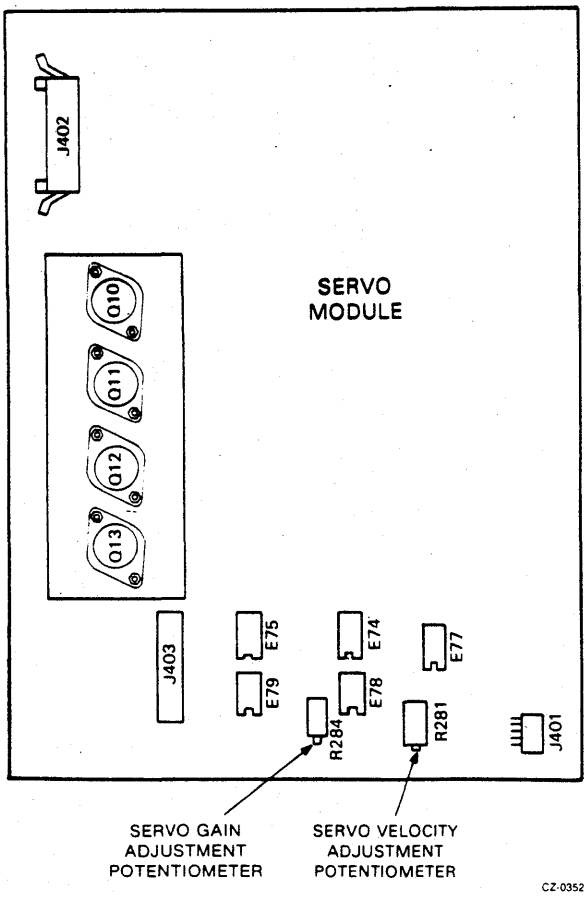

Figure 3-3 Location of Servo Adjustment Potentiometers

4. Remove the multimeter leads from the disk drive.

5. Switch on the circuit breaker at the rear of the H766 power supply.

6. Enter the diagnostic mode using the following procedure.

   a. Turn the thumbwheel switches to "FF".

   b. Push the ENTER switch. The LEDs will blink "FF".

   c. Push the ENTER switch again and the LEDs will display a steady state "FF".

   d. Turn the thumbwheel switches to "00".

   e. Push the ENTER switch. The LEDs will display a steady state "00".

   f. Push the ENTER switch again and the LEDs will display the blinking "EC" prompt.

7. Call the static servo test using the following procedure.

   a. Turn the thumbwheel switches to "27".

   b. Push the ENTER switch. The LEDs will momentarily display "27" and then "AA" when the test completes successfully. If an error code occurs, remove power from the drive, replace the servo module, and repeat Steps 2 through 7b. If the test ended with an "AA", then proceed to Step 7c.

   c. Push the ENTER switch again and the LEDs will display the blinking "EC" prompt.

8. Spin-up the disk using the following procedure.

   a. Turn the thumbwheel switches to "1E".

   b. Push the ENTER switch. The LEDs will momentarily display "1E" and then a steady state "E7".

   c. Push the RUN/STOP switch on the operator control panel. The drive will spin-up and the LEDs will display an "AA" when the spin-up is complete.

NOTE
The READY indicator will not be lit when the disks are spinning in diagnostic mode.

   d. Push the ENTER switch and the LEDs will display the blinking "EC" prompt.

9. Call the servo velocity adjustment utility using the following procedure.

   a. Turn the thumbwheel switches to "26".

   b. Push the ENTER switch. The LEDs will momentarily display "26" and then momentarily "E7"; one or two LEDs will remain lit. If the LEDs display an error code of "7C", "7D" or "7E", proceed to Step 9c; otherwise proceed to Step 9d.

   c. Perform one of the actions described below, as determined by the LED error code.

      - An error code of "7C" indicates that the servo is going too slow and requires that the R281 potentiometer be turned counterclockwise two revolutions. Then push the ENTER switch to return to the blinking "EC" prompt, and repeat Step 9.

      - An error code of "7D" indicates that there are too many seek errors. The servo module or the HDA may be defective.

      - An error code of "7E" indicates that the servo is going too fast and requires that the R281 potentiometer be turned clockwise two revolutions. Then push the ENTER switch to return to the blinking "EC" prompt, and repeat Step 9.

   d. Read the LED display. If any LEDs other than the two center LEDs are on or flashing, adjust the R281 potentiometer on the servo module (Figure 3-3). The goal is to adjust the potentiometer until only the two center LEDs are flashing. Rotate R281 counterclockwise to move the LED pattern toward the ENTER switch, and clockwise to move the LED pattern away from the ENTER switch.

NOTE

Rotate the servo velocity adjustment potentiometer (R281) slowly, since there is a time delay before the LED patterns react to the adjustment.

   e. Let the servo velocity adjustment utility run for 20 minutes to thermally stabilize the positioner motor. After 20 minutes, proceed to Step f.

   f. Read the LED display. Readjust the R281 potentiometer until only the two center LEDs of the display are on or flashing.

   g. Turn the thumbwheel switches to "DD".

   h. Push the ENTER switch. The LEDs will display "AA" or blink "EC", depending on how long the ENTER switch is pushed.

   i. Push the ENTER switch again if the LEDs display an "AA". The LEDs should then display the blinking "EC" prompt.

10. Call the entire unit test by using the following procedure.

    a. Turn the thumbwheel switches to "25".

    b. Push the ENTER switch. The LEDs will momentarily display "25" and then "E7". Wait until all the tests are run and the LEDs display "AA".

    c. Push the ENTER switch and the LEDs will display the blinking "EC" prompt.

11. Return on-line using the following procedure.

    a. Turn the thumbwheel switches to "1D".

    b. Push the ENTER switch. The LEDs will momentarily display "1D" and then "E7".

    c. Turn the thumbwheel switches to "00".

    d. Push the ENTER switch. The LEDs will display "00" and the drive will be on-line. To determine if the drive is on-line, push the WRITE PROTECT switch. If the WRITE PROTECT indicator lights, then the drive is back on-line.

CHAPTER 4
DRIVE-RESIDENT DIAGNOSTICS

4.1 INTRODUCTION

This chapter describes the R80 firmware diagnostic capabilities. It begins with a description of the functional firmware fault and error codes. It shows the location of the maintenance controls and how to use them. Next, a description of each utility routine and diagnostic test is presented. The error codes are tabulated and explained at the end of the chapter.

4.2 FUNCTIONAL AND DIAGNOSTIC FIRMWARE

The functional and diagnostic firmware are two distinct software modules in the R80 Disk Drive. The functional firmware controls the spin-up cycle, seek command and recalibrate command. It also performs fault monitoring and interface handshaking operations. When the drive is operating under the control of the functional firmware, it is in functional mode (on-line). The drive is in diagnostic mode when it is operating under the control of the diagnostic firmware. The diagnostic firmware controls the drive-resident tests and utilities. These tests and utilities are invoked after the drive is placed in diagnostic mode.

4.3 FUNCTIONAL FIRMWARE FAULT CODES

Functional firmware general fault codes are reported through the operator control panel. A general fault code is obtained by entering the fault display mode when the FAULT indicator is on. To enter the fault display mode, push the FAULT switch. All of the indicators should remain on until the FAULT switch is released, providing a method of checking all the indicators. Upon releasing the FAULT switch, the indicators display the general fault code as shown in Figure 4-1. The LEDs on the microprocessor module further define the general faults with specific hexadecimal error codes. Figure 4-2 shows the location of the LED display, and Table 4-1 lists the functional LED error codes.

To exit the fault display mode, push the FAULT switch. This action stores the LED error code in the area of RAM allocated for previous faults. If the fault has been cleared, the firmware will return the operator control panel to its previous state. If the fault still exists, the FAULT indicator will light again.

The read/write unsafe and invalid interface command fault conditions can be corrected by the CPU, in which case the FAULT indicator goes off without operator intervention. If the fault cannot be corrected by the CPU, the FAULT indicator remains on and the fault must then be cleared through manual intervention.

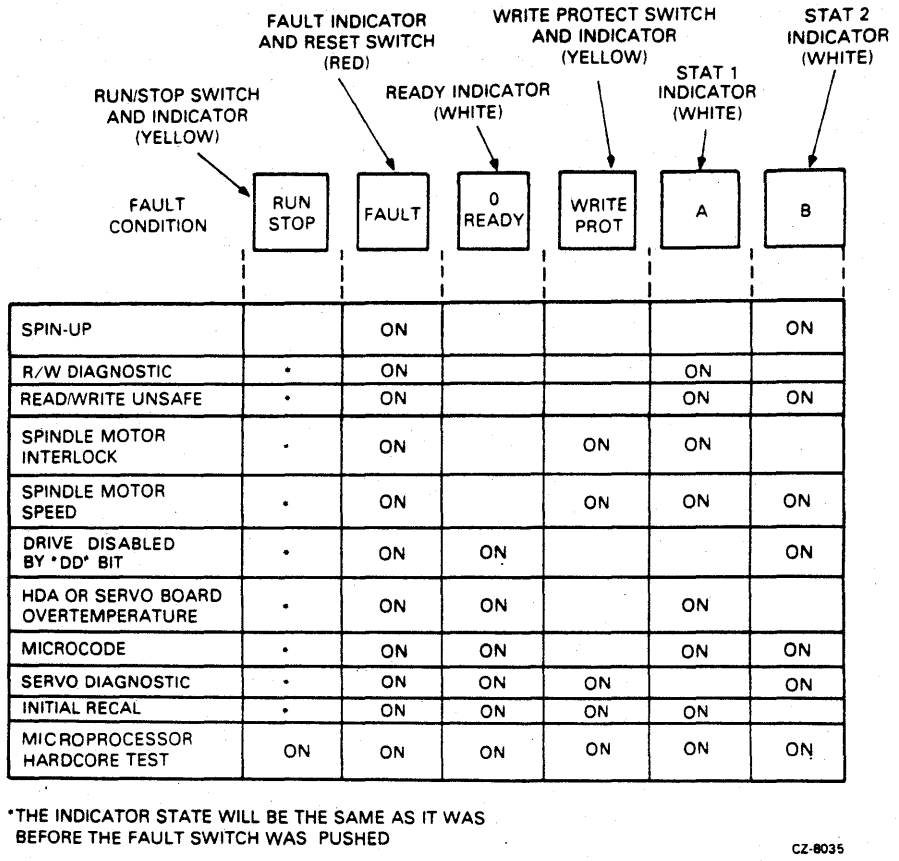

Figure 4-1 Operator Control Panel General Fault Indicators

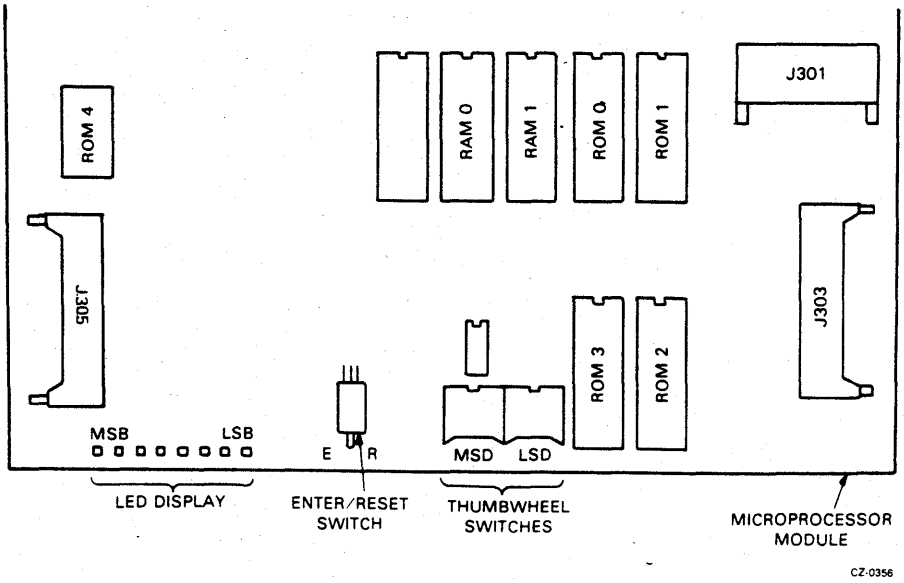

Figure 4-2 Internal Maintenance Controls and Indicators

Table 4-1 Functional LED Error Codes

Error Code	Error Condition
01	Spindle motor timeout error
02	Spin-up too slow error
03	Spindle not accelerating error
04	Spin-up too long error
05	Sequence hold/sequence pick error
06	Microcode error
0A	Invalid interface command error
11	Wrong peak entering detent error
12	Servo active PLO error
13	No fine track error
14	Servo speed or direction error
15	Seek/recal timeout error
16	Guard band error
17	Track counter underflow error
1A	Invalid cylinder address error
23	Spindle motor interlock error
24	Servo inactive PLO error
25	Servo detected off track error
26	Spindle speed error
27	HDA overtemperature error
28	Servo module overtemperature error
30	Write current and no write gate error
31	Read and write error
32	Read/write while faulted error
33	Data separator/encoder error
34	Write precompensation error
35	Write and write unsafe error
36	Head short error
37	Write gate and no write current error
38	Read and multichip select error
39	Write and off track error
3A	Write and write protected error

4.4 GENERAL FAULT CODE DESCRIPTIONS

Nine general fault codes are reported through the operator control panel indicators. These nine general fault codes are described in the paragraphs below.

4.4.1 Microprocessor Hardcore Test Fault

The microprocessor hardcore test is run when power is applied through CB1 on the back of the drive. POWER UP RESET starts the firmware at memory location "0000". The firmware then performs tests on the hardware listed below.

- Microprocessor
- ROMs
- RAMs
- Microprocessor bus
- Servo bus
- Personality bus
- Sector/byte counter
- Personality microsequencer

If the hardcore test fails, all the indicators on the operator control panel will be on. More detailed information on the hardcore failure can be obtained by examining the internal LED display. Refer to Table 4-2 for the LED error codes.

Table 4-2 LED Error Codes for Hardcore Tests

Error Code	Error Condition
00	Microprocessor self-test error
53	Personality module microsequencer error
80	ROM set error
85	RAM 0 error
86	RAM 1 error
87	ROM 0 checksum error
8A	Module interlock error
8B	Discrete port enable error
8F	ROM 1 checksum error
97	ROM 2 checksum error
9F	ROM 3 checksum error
A7	ROM 4 checksum error
B0	Three module microprocessor bus error
B1	Three module personality bus error
B2	Three module servo bus error

4.4.2 Spindle Spin-Up Fault

The spindle begins rotating when the RUN switch is pushed. During the spin-up cycle, the firmware monitors spindle acceleration and speed. If the spindle takes too long to attain its final speed, is rotating too slowly, or is not accelerating, the firmware stops the spindle and turns on the FAULT indicator. If the fault display mode is then entered, a spin-up fault will be indicated. The internal LED display indicates the specific error code. Refer to Table 4-3.

Table 4-3 LED Error Codes for Spin-Up Faults

Error Code	Error Condition
01	Spindle motor timeout error
02	Spin-up too slow error
03	Spindle not accelerating error
04	Spin-up too long error

4.4.3 Read/Write Unsafe Fault

A read/write unsafe fault is detected any time the microprocessor interrupt is enabled. Upon recognizing a read/write unsafe condition, the firmware sets drive fault in the status register on the personality module. The Disk Controller recognizes the fault and terminates the read or write command. The internal LED display indicates the specific error code. Refer to Table 4-4.

Table 4-4 LED Error Codes For Read/Write Unsafe Faults

Error Code	Error Condition
30	Write current and not write gate error
31	Read and no write gate error
32	Read/write while faulted error
33	Data separator/encoder error
34	Write precompensation error
35	Write and write unsafe error
36	Head short error
37	Write gate and no write current error
38	Read and multichip select error
39	Write and off track error
3A	Write and write protected error

4.4.4 Write Protect Fault

The write protect fault occurs if a write operation is attempted when the WRITE PROT switch is latched. A code of "3A" is also displayed on the internal LEDs.

4.4.5 Spindle Motor Interlock Fault

Before the firmware enters the spin-up routine, the belt tension microswitch is checked. If the belt tension lever is in the released position, the firmware will sense this and not spin-up the disk, lighting the FAULT indicator. If the disks are already spinning and a failure occurs in the belt tension interlock circuit, the disks will spin-down and the FAULT indicator will light. The internal LED error code is "23".

4.4.6 Spindle Motor Speed Fault

If the spindle slows to below 3420 r/min, the firmware turns on the FAULT indicator and stops the spindle motor. The internal LED error code is "26".

4.4.7 Invalid Interface Command Fault

An invalid interface command fault is generated by one of the two conditions listed below.

- The firmware receives a command other than a seek, recalibrate, or offset from the personality module.
- The firmware receives a command when the drive is not ready.

The internal LED error code for an invalid interface command fault is "0A".

4.4.8 HDA or Servo Overtemperature

There are two temperature sensors in the R80 Disk Drive, one on the bottom of the HDA and the other on the servo module heat sink. If the firmware detects an overtemperature condition, the FAULT indicator is lit. The LED error codes for these overtemperature conditions are listed in Table 4-5.

Table 4-5 LED Error Codes for HDA or Servo Module Overtemperature

Error Code	Error Condition
27	HDA overtemperature error
28	Servo module overtemperature error

4.4.9 Microcode Fault

Near the end of each ROM is an instruction to jump to a microcode fault routine. This instruction is only executed if the firmware malfunctions. When this instruction is executed, it calls the microcode fault routine. This routine turns off the spindle motor, displays an "06" in the LEDs, and lights the FAULT indicator on the operator control panel.

4.4.10 Servo Diagnostic Fault

After the spindle is up to speed, the firmware performs static servo diagnostics before doing the initial recalibration of the heads. The tests listed below are run during the static servo diagnostics.

- Track counter test
- Servo position loop test
- Servo velocity loop test

If the servo diagnostics fail, the FAULT indicator will light and the spin-up cycle can not be completed. (Refer to Figure 4-3.) Table 4-6 shows the LED error codes that appear on the microprocessor module with a servo diagnostic fault. Pushing the FAULT switch will light all the operator control panel indicators, then display the fault. If the FAULT switch is pushed again, the firmware will run the servo diagnostics again.

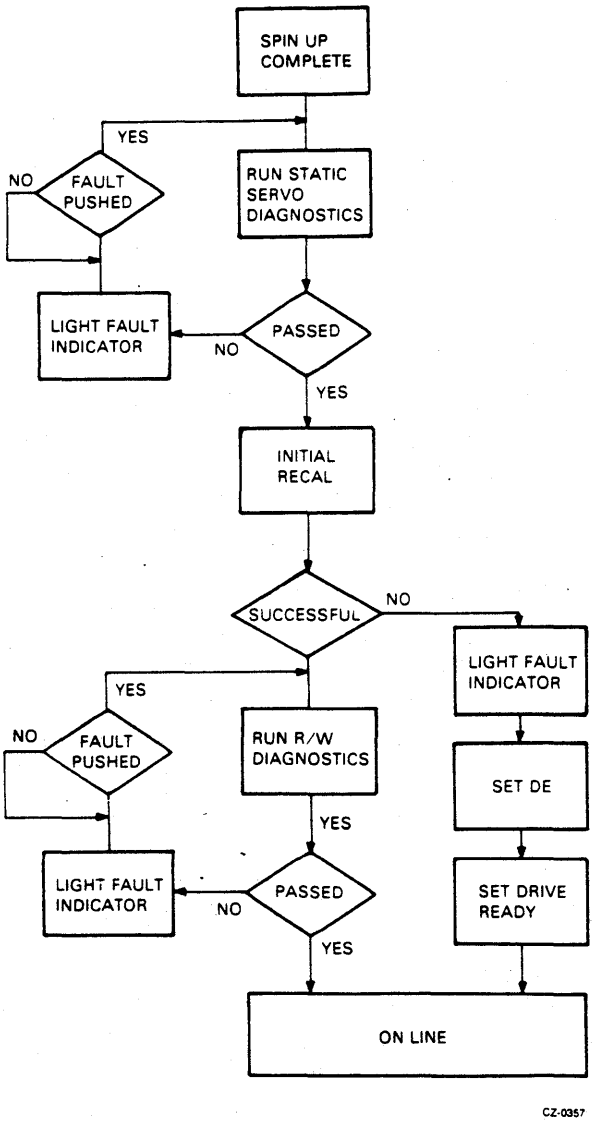

Figure 4-3 Spin-Up Diagnostic Flowchart

Table 4-6 LED Error Codes for Servo Diagnostics

Error Code	Error Condition
C2	Fine track status error
C3	Fine track over range error
C4	Fine track under range error
C5	Off track status error
C6	Off track over range error
C7	Off track under range error
CB	Acceleration status error
CD	Track counter error

4.4.11 Initial Recalibration Fault

During the spin-up cycle, the firmware does the inital recal after running the static servo diagnostics (refer to Figure 4-3). If the initial recal is successful, the firmware then runs the read/write diagnostics. If the initial recal is unsuccessful, the firmware lights the FAULT indicator, sets seek incomplete in the RM adapter and then lights the drive READY indicator. The CPU will then come back with a recalibration command which will clear the FAULT indicator and retry a recal. The CPU will retry the recalibration until successful or until the number of retries for the CPU are executed. See Table 4-7 for the LED error codes.

Table 4-7 LED Error Codes For Seek Incomplete Faults

Error Code	Error Condition
11	Wrong peak entering detent error
12	Servo active PLO error
13	No fine track error
14	Servo speed and direction error
15	Seek/recal timeout error
16	Guard band error
17	Track counter underflow error
1A	Invalid cylinder address error

4.4.12 Read/Write Diagnostic Fault

After the firmware has performed the initial recalibration, it then executes the read/write diagnostics before lighting the drive READY indicator. The tests listed below are performed during the read/write diagnostics.

- Read only test
- Write/read test

If the read/write diagnostics fail, the FAULT indicator will light and the spin-up cycle can not be completed. (Refer to Figure 4-3.) Table 4-8 shows the LED error codes that appear on the microprocessor module with a read/write diagnostic fault. Pushing the fault switch will light all the operator panel indicators, then display the fault. If the FAULT switch is pushed again, the firmware will run the read/write diagnostics again. If the read/write diagnostics pass, the firmware then lights the drive READY indicator.

Table 4-8 LED Error Codes for Read/Write Diagnostics

Error Code	Error Condition*
60	Read/write head select error
61	Data port preset error
62	Read-only test overall read error
63	Read-only test partial read error
64	Read/write test guard band error
65	Sector timeout error
66	Read-only test read and no enable error
67	Write test not executable error
6A	Write/read test overall read error
6B	Write/read test partial read error
6E	Write/read test read and no enable error

*Specific error codes will appear for any functional errors.

4.5 SEEK INCOMPLETE ERRORS

A seek incomplete does not light the FAULT indicator, but displays an error code on the internal LEDs. The drive flags the CPU with a seek incomplete and waits for a RECALIBRATE command. Upon recognizing the recalibrate command, the firmware stores the LED code in memory, clears the internal LED display, and then calls the recalibrate routine. Table 4-7 shows the internal LED error codes that are generated by a seek incomplete.

4.6 SEQUENCE HOLD/SEQUENCE PICK ERROR

The loss of SEQUENCE HOLD or SEQUENCE PICK causes the following indications. If SEQUENCE HOLD and SEQUENCE PICK are not asserted after the RUN switch is pushed, the spindle will not spin-up and the RUN indicator will not light. If SEQUENCE HOLD or SEQUENCE PICK is lost while the spindle is spinning, the firmware will stop the spindle and turn off the RUN indicator. The internal LED error code is "05".

4.7 DIAGNOSTIC FIRMWARE CONTROLS AND INDICATORS

The R80 internal maintenance controls and LEDs are located in the front left-hand corner of the microprocessor module. (Refer to Figure 4-2.) These maintenance controls and LEDs are divided into three functional areas: thumbwheel switches, an ENTER/RESET switch, and an 8-bit LED display.

4.7.1 Thumbwheel Switches

There are two hexadecimal thumbwheel switches (S2 and S3) next to each other. The switch on the right is the least significant hexadecimal digit. The switch on the left is the most significant hexadecimal digit. The rotary position of each thumbwheel switch is shown by a hexadecimal digit on the top surface of the switch. The test select codes and input parameters to run the utility routines and diagnostics are entered through the thumbwheel switches.

WARNING
Your fingers may hit the fans when using the thumbwheel switches.

4.7.2 ENTER/RESET Switch

The ENTER/RESET switch (S1) is a momentary-contact, dual-throw, center-off-position switch. The switch rests in its center-off-position. When the toggle switch is pushed to the right, it is in the RESET position, which is marked by an "R" on the circuit module. When the toggle switch is pushed to the left, it is in the ENTER position, which is marked by an "E" on the circuit module.

4.7.2.1 The ENTER Position – The ENTER position is periodically polled by the firmware to determine if a new action is required. The ENTER switch provides the Field Service engineer with a means of communicating with the firmware. For example, to initiate a diagnostic test, a test select code is placed in the thumbwheel switches and then the ENTER switch is pushed to start the test.

4.7.2.2 The RESET Position – The RESET position is connected to interrupt line RST 5.5 on the microprocessor chip. RST 5.5 is a maskable interrupt that is disabled by the firmware during seek operations. Pushing the RESET switch while the drive is in functional mode forces the firmware to reinitialize the drive logic. If the drive halts on a hardcore fault during power up, pushing the RESET switch places the drive in functional mode. While in diagnostic mode, pushing the RESET switch terminates the test.

4.7.3 LED Display

The LED display consists of a row of eight LEDs. The least significant LED is to the right. The codes displayed in the LEDs are read as two hexadecimal digits (four LEDs to each digit). Refer to Appendices A and B for hexadecimal conversion charts. Several kinds of codes appear in the LEDs. Appendices display error codes, prompt codes, test complete codes and test select codes for entry verification.

4.8 TEST SELECT CODES

Each utility routine and diagnostic test has a unique test select code. The test select codes are listed in Table 4-9. To call a routine or test, enter the test select code into the thumbwheel switches and push the ENTER/RESET switch to the ENTER position. When the firmware detects that the switch has been pushed to the ENTER position, it reads the contents of the thumbwheel switches. The LEDs momentarily display the test select code to verify that the firmware has received it.

Table 4-9 Test Select Codes

Test Select Codes	Tests
01	Examine diagnostic extended status area utility
02	Examine previous error utility
03	Examine drive state utility
04	Examine operational counters utility
05	Memory examine up utility
06	Memory examine down utility
07	Three module bus test
08	Microprocessor module bus test
09	Microprocessor and personality module bus test
0A	Microprocessor and servo module bus test
0B	Personality module microsequencer test
0C	Sector/byte counter test
0D	Operator control panel test
0E	Head select multiplexer test
0F	General purpose counter test
11	Track counter test
12	Read/write fault force test
13	Servo position loop test
14	Servo velocity loop test
15	Servo functional test
16	Random seek test
17	Seek–seek test with input parameters
18	Seek–seek test with fixed parameters
19	Incremental seek test with input parameters
1A	Incremental seek test with fixed parameters
1B	Read-only test
1C	Write/read test
1D	Return on-line
1E	Spindle control utility
1F	Head select and seek utility
20	Maintenance controls and indicators test
21	Read-only cylinder formatter utility
22	Logic tests
23	Servo tests
24	Read/write tests
25	Entire unit test
26	Servo velocity adjustment utility
27	Static servo test
CF	Loop mode set utility
FF	Enter diagnostic mode

A test termination code of "DD" provides the user with a way of halting diagnostic drive tests. Most tests complete so quickly that they cannot be terminated in this way. However, seek-seek and incremental seek tests are of sufficient duration that they may be terminated prematurely in this manner. Also, tests with the loop mode set can be run for long periods of time. To stop all tests safely, use the "DD" test termination code.

To use the "DD" test termination code, follow the steps listed below.

1. Turn the thumbwheel switches to "DD".

2. Hold the ENTER switch in until an "AA" appears in the LEDs. If the switch is held too long, the "AA" will change to a blinking "EC". Each of these codes is a sign that the test has halted.

If the drive is in loop mode, it will still be in loop mode when the tests are halted with a "DD" code.

4.9 PROMPT CODES

The firmware uses several prompt codes to notify the user when it is waiting for information. These prompt codes are displayed as blinking codes in the LEDs. Table 4-10 lists the prompt codes and their meaning.

Table 4-10 Prompt Codes

Blinking "EC" (1110 1100)	Indicates that the firmware is waiting for a test select code
Blinking "01, 02, 03, 04"	Indicates the number of the current input parameter required by the diagnostic utility or test
Blinking "EE" (1110 1110)	Indicates an invalid test select code was entered. To recover from this state, enter a valid test select code into the thumbwheel switches and push the ENTER switch.

4.10 STEADY STATE LED CODES

Each diagnostic test or utility has three steady state LED codes, test active, test complete and error.

4.10.1 Test Active Code

A steady state "E7" in the LEDs indicates that the firmware is actively executing a test.

4.10.2 Test Complete Code

A steady state "AA" in the LEDs indicates that the firmware has completed a utility or test successfully. Before running another test, return to the "EC" prompt by pushing the ENTER switch.

4.10.3 Error Codes

A steady state error code in the LEDs indicates where a test or utility has failed. The error codes are listed at the end of this chapter. To recover from an error code, push the ENTER switch to return to the "EC" prompt.

4.11 ENTER DIAGNOSTIC MODE

The R80 Disk Drive normally operates in an on-line functional mode; that is, under the control of the functional firmware. To perform diagnostic tests, the drive must be placed into diagnostic mode under the control of the diagnostic firmware. The steps listed below will place the drive in diagnostic mode.

1. Turn the thumbwheel switches to "FF".
2. Push the ENTER switch. The LED will blink "FF".
3. Push the ENTER switch again and the LEDs will display a steady state "FF".
4. Turn the thumbwheel switches to "00".
5. Push the ENTER switch. The LEDs will display a steady state "00".
6. Push the ENTER switch again and the LEDs will display the "EC" prompt to indicate the firmware is waiting for a test select code.

If the above sequence is not followed exactly, the test will fail and the LEDs will display a blinking "FF". Return to Step 1.

If the drive fails its hardcore diagnostic tests during the power-on cycle, push the RESET switch and then follow the above steps.

4.12 RETURN ON-LINE

After performing diagnostic tests, the drive must be returned to the control of the functional firmware. The return to the on-line functional mode is accomplished by the steps listed below.

1. Turn the thumbwheel switches to "1D".
2. Push the ENTER switch. The LEDs will momentarily display a "1D" and then display "E7".
3. Turn the thumbwheel switches to "00".
4. Push the ENTER switch. The drive is in functional on-line mode.

If the switches are not working, an alternate way to return the drive to on-line functional mode is to turn the power off and then on by means of CB1 (located in the back).

4.13 DRIVE UTILITY ROUTINES

The R80 Disk Drive has eleven utility routines available when the drive is in diagnostic mode. These utility routines let the Field Service engineer control the drive from diagnostic mode. They also supplement the diagnostic tests by providing a way for the field engineer to gain more information about the internal drive status. The general areas covered by these utility routines are listed below.

- Drive control from diagnostic mode
- Examination of drive memory contents
- Adjustments to the servo circuits
- Preparation for diagnostic loop mode tests
- Reformatting the FE read-only cylinder

4.13.1 Memory Examine Utilities

The memory examine utilities allow the Field Service engineer to examine the contents of the drive's internal ROMs and RAMs. The five memory examine modes are listed below.

- Memory examine up/down
- Examine diagnostic extended status area
- Examine drive state
- Examine seek counters
- Examine previous errors

The disk drive may have up to six ROMs and two RAMs. Each ROM has 2048 address locations, and each RAM has 256 address locations. Table 4-11 lists the hexadecimal addresses for each memory chip.

Table 4-11 Internal Memory Address Locations

Memory Chip	First Address	Last Address
ROM #0	0000	07FF
ROM #1	0800	0FFF
ROM #2	1000	17FF
ROM #3	1800	1FFF
ROM #4	2000	27FF
ROM #5	2800	2FFF
RAM #0	4000	40FF
RAM #1	4100	41FF

4.13.1.1 Memory Examine Up Utility – The memory examine up utility allows the Field Service engineer to display the contents of any memory location, by incrementing through the address locations. To use the memory examine up utility, follow the steps listed below.

1. Turn the thumbwheel switches to "05".
2. Push the ENTER switch. The LEDs will momentarily display "05" and then blink "01", calling for the first input parameter.
3. Turn the thumbwheel switches to the low byte of the memory address.
4. Push the ENTER switch. The LEDs will momentarily display the contents of the thumbwheel switches, and then blink an "02".
5. Turn the thumbwheel switches to the high byte of the memory address.
6. Push the ENTER switch. The LEDs will momentarily display the contents of the thumbwheel switches and then display the eight bits of data stored at that address location.

7. Push the ENTER switch to increment the memory address pointer. Each time the ENTER switch is pushed, the contents of the next memory address will be displayed.

To exit from this utility, turn the thumbwheel switches to "DD" and push the ENTER switch.

4.13.1.2 Memory Examine Down Utility – The memory examine down utility allows the Field Service engineer to display the contents of any memory location, by decrementing through the address locations. This utility operates similarly to the memory examine up utility described above. The difference is that the memory pointer is decremented instead of incremented. Use test select code "06" to call this utility.

4.13.1.3 Examine Diagnostic Extended Status Area Utility – The diagnostic extended status area is a segment of RAM 0 reserved for the storage of status and failure information on the test just run. The extended status area occupies 16 address locations. This utility displays these 16 bytes of information. The program starts at the first address of the extended status area. The layout of the extended status area is provided in Table 4-12. To call this utility, use test select code "01". The address pointer is incremented each time the ENTER switch is pushed. All 16 bytes must be examined before the test complete code "AA" is displayed. Push the ENTER switch again to return to the "EC" prompt.

Table 4-12 Diagnostic Extended Status Area

Byte Number	Contents
Byte 1	Test select code
Byte 2	Input parameter 1
Byte 3	Input parameter 2
Byte 4	Input parameter 3
Byte 5	Input parameter 4
Byte 6	Input parameter 5
Byte 7	Input parameter 6
Byte 8	Test result (an "AA" or error code)
Bytes 9 through 16	Starting here, the information in the last eight bytes varies with each diagnostic test. In most cases, it will consist of one or two bytes of actual test data, followed by one or two bytes of expected test data. The description of each diagnostic test will define what is contained in these last eight bytes.

4.13.1.4 Examine Previous Error Utility – The R80 Disk Drive stores the 16 latest LED functional error codes in RAM 0. The examine previous error utility allows the Field Service engineer to display these 16 previous errors in the LEDs. When a test select code of "02" is entered, the LEDs momentarily display the "02" code and then display the most recent functional error code. Each time the ENTER switch is pushed, the next most recent error code will be displayed in the LEDs. After examining all 16 locations, push the ENTER switch again and an "AA" will appear in the LEDs. Push the ENTER switch one more time to return to the "EC" prompt.

NOTE

The 16 stored error codes are lost when the drive power is turned off.

4.13.1.5 Examine Drive State Utility – The examine drive state utility allows the Field Service engineer to display the software state words maintained by the drive functional firmware. The four software state words are shown in Table 4-13. They are stored in RAM 0. To examine these four bytes of information, enter test select code "03". The LEDs will momentarily display "03" and then display the contents of the first byte. Each time the ENTER switch is pushed, the contents of the next address location will be displayed in the LEDs. After all four bytes have been examined, push the ENTER switch again and an "AA" will appear in the LEDs. Push the ENTER switch once again to return to the "EC" prompt.

NOTE
When the drive-state bytes are examined, a true bit condition is indicated when the LED is on.

Table 4-13 Drive State Bytes

Bit	Definition	Bit	Definition
	Byte 1 Drive-State Byte		**Byte 3 Interface-Status Byte**
0	Off-line	0	Fault
1	Not used	1	Seek error
2	Not used	2	On cylinder
3	Diagnostic non-manual request	3	Unit ready
4	Diagnostic quick verify flag	4	Hard fault
5	Servo diagnostics need to be run	5	Start enable
6	Servo/read/write diagnostics failed	6	Not used
7	Initial recal complete	7	Not used
	Byte 2 Command-Status Byte		**Byte 4 Drive-Status Byte**
0	Fault display in progress	0	Spindle stopped
1	Sector size 0 = 30 sectors 1 = 32 sectors	1-7	Not used
2	Seek performed		
3	Recalibration performed		
4	Hard fault		
5	Not used		
6	Diagnostic mode		
7	Velocity check mode		

4.13.1.6 Examine Operational Counters Utility – The R80 functional firmware maintains three counters in RAM to monitor the items listed below.

- Seek/recalibration errors
- Number of seeks
- Number of read and no enable errors

The contents of these counters may be displayed in diagnostic mode with the examine seek counter utility. These counters are reset during drive power up, or whenever the RESET switch is pushed while the drive is in the functional mode of operation.

The byte order in which the counter information is retrieved is shown in Table 4-14. Note that each counter has an overflow indicator byte that is retrieved first. Whenever a counter overflows, its indicator byte will contain an "FF" code.

Table 4-14 Recovery Sequence of Seek Counter Bytes

Byte	Definition	
1	Overflow Indicator	
2	Low Byte	Seek/Recal Error Counter
3	High Byte	
4	Overflow Indicator	
5	Low Byte	Seek Counter
6	Middle Byte	
7	High Byte	
8	Overflow Indicator	
9	Low Byte	Read and No Enable Counter
10	High Byte	

To call the examine seek counters utility, enter a test select code of "04". The LEDs will momentarily display "04" and then display the first byte of seek counter information. Each time the ENTER switch is pushed, the next byte in the sequence will be displayed in the LEDs. After the tenth byte has been examined, and the ENTER switch is pushed again, the LEDs will display an "AA". Push the ENTER switch one more time to return to the "EC" prompt.

4.13.2 Spindle Control Utility

The spindle control utility allows the Field Service engineer to cycle the spindle either up or down from the drive diagnostic mode. While the drive is under the control of this utility, the firmware ignores whether SEQUENCE PICK and SEQUENCE HOLD signals are present. When the drive returns to functional mode, the spindle will spin-down if these two signals are not present, which results in a LED error code of "05".

To call the spindle control utility, enter a test select code of "1E". The LEDs will momentarily display "1E" and then a steady state "E7". The drive will spin-up when the RUN switch is pushed. The LEDs will display an "AA" when the spin-up is complete.

To spin-down in the diagnostic mode, enter test select code "1E" to call up the spindle control utility. The LEDs will momentarily display "1E" and then a steady state "E7". Then push the RUN switch, releasing it from the latched position. After the spindle stops, an "AA" will appear in the LEDs and the RUN indicator will go out.

NOTE
The READY light will not be lit when the disks are spinning in the diagnostic mode.

4.13.3 Head Select and Seek Utility

The head select and seek utility allows the field engineer to seek to a specific head and cylinder address (0 to 566). The firmware forces the drive into a read-only state before head selection, to prevent possible data damage. Use the information listed below to run and interpret the results of this utility.

- Test select code is "1F"
- Parameter #1 – Head number
- Parameter #2 – Cylinder low byte
- Parameter #3 – Cylinder high byte

After the third parameter is entered, the drive will seek to the desired cylinder and display an "E7" in the LEDs. Enter a "DD" to terminate this test. If a malfunction occurs, one of the error codes listed below appears in the LEDs.

- 70 – Read/write control select error
- 71 – Utility head select error
- 7F – Spindle not spinning error
- E1 – Seek check error
- EA – Can't run test, drive faulted error
- EF – FE entered invalid cylinder address error
- Any functional error (refer to Table 4-1)

If this utility fails with a "70", "71" or "E1" error code in the LEDs, an examination of the diagnostic extended status area will reveal the information given below.

- Extended status area for error code "70"
    - Bytes 1 through 8 contain the same type of information for all tests. (See Table 4-12.)
    - Byte 9 – Actual contents of bit 4 and 5 of RAM input port "EB". Bit 4 is read gate and bit 5 is write gate. A one indicates a nonasserted state.
    - Byte 10 – Expected contents of bit 4 and 5 of RAM input port "EB". The hexadecimal code of "20" in byte 10 indicates read gate and no write gate.
- Extended status area for error code "71"
    - Bytes 1 through 8 contain the same type of information for all tests. (See Table 4-12.)
    - Byte 9 – Actual head address
    - Byte 10 – Expected head address
- Extended status area for error code "E1"
    - Bytes 1 through 8 contain the same type of information for all tests. (See Table 4-12.)
    - Byte 9 – Functional error code

4.13.4 Set Loop Mode Utility

The set loop mode utility allows the Field Service engineer to set up the diagnostic firmware to either loop on a test or not loop on a test. Once the diagnostic firmware has been set to run in a particular loop mode, it will remain in this state until the utility is recalled and an alternate mode is selected. To run the set loop mode utility, use the following information.

- Test select code is "CF"
- Input parameter #1
    - 0F – Loop forever on the test
    - 4F – Loop forever on the test but halt on error
    - FF – Halt on error or at the end of the test

NOTE

After drive power-up, the loop mode is always set to halt on error or at the end of the test.

After entering the input parameter, the LEDs will display "AA". Push the ENTER switch once t restore the "EC" prompt. The drive is now prepared to run the next test selected in the manner chose in the set loop mode utility. For example, if the random seek test is called, and the loop forever on te parameter was chosen, the random seek test will be performed until the "DD" test termination code entered. Hold the ENTER switch long enough (about one second) for the diagnostic firmware to com plete its current test, and examine the contents of the switches. Remember that the next test entere will also loop forever, unless the set loop mode utility is recalled and a different parameter is chosen

4.13.5 Read-Only Cylinder Formatter Utility

The read-only cylinder formatter utility allows the Field Service engineer to reformat the prerecorde read-only cylinder in the guard band. As a safety precaution against the indiscriminate use of this uti ity, pin 13 of E11 on the microprocessor module must first be grounded. Figure 4-4 shows the locatio of E11. Use the information given below to run this utility.

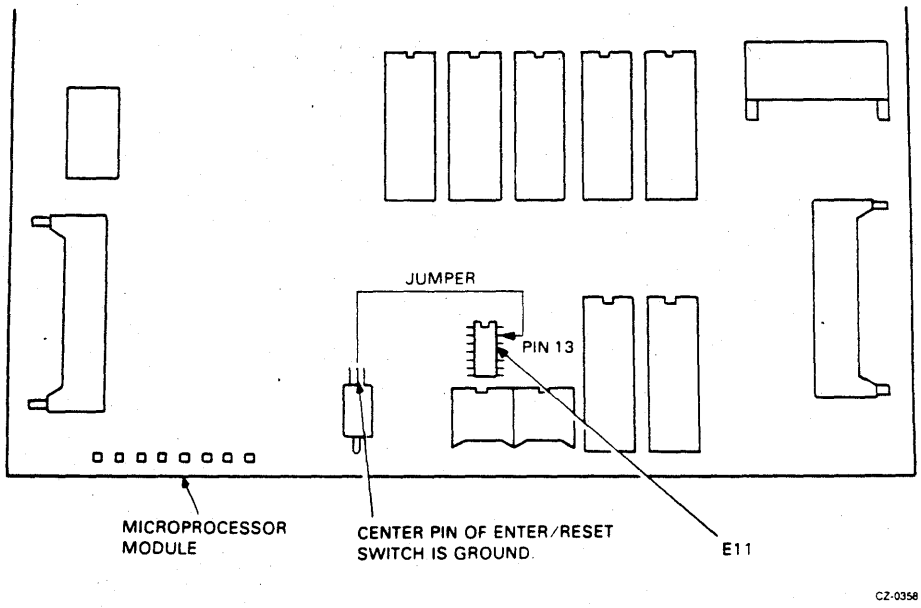

Figure 4-4 Ground Jumper for Read-Only Cylinder Formatter

- Install jumper from pin 13 of E11 to ground (center pin of ENTER/RESET switch)
- Test select code is "21"
- Error Codes
  - 60 – Read/write test head select error
  - 61 – Data port preset error
  - 62 – Read-only test overall read error
  - 63 – Read-only test partial read error
  - 64 – Read/write test guard band error
  - 65 – Sector timeout error
  - 66 – Read-only test read and no enable error
  - 6A – Write/read test overall read error
  - 6B – Write/read test partial read error
  - 6E – Write/read test read and no enable error
  - 7F – Spindle not spinning error
  - EE – Entry error
  - Any functional error code (refer to Table 4-1)

- Extended status area for error codes "62", "63", "66", "6A", "6B" and "6E"

    - Byte 9 – Number of bad heads
    - Byte 10 – Low byte of read and no enable counter
    - Byte 11 – High byte of read and no enable counter

4.13.6 Servo Velocity Adjustment Utility

This utility allows the Field Service engineer to adjust the servo velocity potentiometer on the servo module. The velocity adjustment should be performed after replacing the servo module or the HDA. Before doing this adjustment, the random seek test must be run for 20 minutes to stabilize the temperature of the HDA and servo system. The servo seek velocity adjustment utility uses the LED display to indicate the direction to adjust the velocity potentiometer. When the adjustment is correct, the two LEDs in the middle will alternate between steady state and flashing. Use the following information to run and interpret the results of this utility.

- Test select code is "26"
- Error codes

    - 7D – Bad seek count overflow error
    - 7E – Too fast seek error
    - 7F – Spindle not spinning error
    - E1 – Seek check error
    - Any functional error code (refer to Table 4-1)

- Extended status area for error code "E1"

    - Bytes 1 through 8 contain the same type of information for all tests. (See Table 4-12.)
    - Byte 9 – Functional error code

Refer to the adjustment chapter to perform the servo velocity adjustment.

4.14 DRIVE DIAGNOSTIC TESTS

The R80 Disk Drive diagnostics allow the Field Service engineer to test the drive in the diagnostic mode. The tests are run by entering a test select code when the LED display is blinking "EC". The test select code is then momentarily displayed. When the test is running, an "E7" is displayed in the LEDs. If an error is detected, the test will halt with an error code displayed in the LEDs. If the test is successful, an "AA" will be displayed in the LEDs. To return to the "EC" prompt from an "AA" or error code display, push the ENTER switch.

The tests listed below require input parameters or operator action.

- Operator control panel test
- Seek–seek test
- Incremental seek test
- Maintenance controls and indicators test

The paragraphs below describe each test, with the test select codes, parameters, error codes and the extended status area.

NOTE

The first eight bytes of the extended status area are the same for all diagnostic tests. The contents of these eight bytes are shown in Table 4-12, and are not repeated in the description of each diagnostic test.

4.14.1 Three Module Bus Test

This test checks the internal data bus on the microprocessor module, the servo bus (TSB SERVO), ar personality bus (TSB NATIVE). The sector counter write I/O port is used to check the microprocess internal data bus. The track counter on the servo module is used to test the servo bus. The diagnost write data register and the diagnostic read buffer are used to test the personality bus. All cables mu be connected to run this test because the module interlock signal is checked. Use the information giv below to run and interpret the results of this test.

- Test select code is "07"
- Error codes
    - B0 – Three module microprocessor bus error
    - B1 – Three module personality bus error
    - B2 – Three module servo bus error
    - 8A – Module interlock error
    - 8B – Discrete port enable error
- Extended status area for error code "B0", "B1" and "B2"
    - Byte 9 – Actual bus contents
    - Byte 10 – Expected bus contents

4.14.2 Microprocessor Module Bus Test

This test uses the sector counter write I/O port to check the microprocessor internal data bus in th same way as the three module bus test. The test is run with the servo and personality modules di connected. The module interlock signal is not checked. If the three module bus test indicated a micr processor bus error, this test is run to determine whether the servo module or personality module cause the failure. Use the information listed below to run and interpret the results of this test.

- Test select code is "08"
- B3 – Microprocessor module bus error
- Extended status area
    - Byte 9 – Actual contents of bus
    - Byte 10 – Expected contents of bus

4.14.3 Microprocessor and Personality Module Bus Test

This test checks the data bus between the personality and microprocessor modules. The diagnostic firm ware writes into the diagnostic write data register and then reads the data through the diagnostic rea buffer. The test is run with the servo module disconnected. The module interlock signal is not checked This test checks the personality bus in the same way as the three module bus test. The microprocesso module bus test should be successfully completed before running this test. Use the information give below to run and interpret the results of this test.

- Test select code is "09"
- B4 – Personality module bus error
- Extended status area
    - Byte 9 – Actual contents of bus
    - Byte 10 – Expected contents of bus

4.14.4 Microprocessor and Servo Module Bus Test

This test checks the data bus between the servo and the microprocessor modules. The diagnostic firmware writes into the track counter and then reads the data. The test is run with the personality module disconnected. The module interlock signal is not checked. This test checks the servo bus in the same way as the three module bus test. The microprocessor module bus test should be successfully run before this test. Use the information given below to run and interpret the results of this test.

- Test select code is "0A"
- B5 – Servo module bus error
- Extended status area
    - Byte 9 – Actual contents of bus
    - Byte 10 – Expected contents of bus

4.14.5 Personality Module Microsequencer Test

This test checks the microsequencer logic on the personality module using the ECHO BIT signal. The diagnostic firmware sets the ECHO BIT in the drive status register. When the microsequencer receives the ECHO BIT signal, it returns the signal to the control buffer. When the diagnostic firmware recognizes that the bit is set, it clears the ECHO BIT using the same path.

After successfully running the microsequencer test, the diagnostic firmware checks the personality bus by calling the microprocessor and personality module bus test. Use the information given below to run and interpret the results of this test.

- Test select code is "0B"
- Error codes
    - 53 – Personality module microsequencer error
    - B4 – Personality module bus error
- Extended status area for error code "53"
    - Byte 9 – Actual ECHO BIT (bit 2). A zero indicates that the ECHO BIT did not set. A one indicates that the ECHO BIT did not clear.
- Extended status code for error code "B4"
    - Byte 9 – Actual contents of bus
    - Byte 10 – Expected contents of bus

4.14.6 Sector/Byte Counter Test

This test checks the sector/byte counters by using diagnostic controls that perform the functions listed below.

- Reset the sector/byte counters
- Load the sector/byte counters
- Clock the sector/byte counters

Use the information given below to run and interpret the results of this test.

- Test select code is "0C"
- 51 – Sector/byte counter error
- Extended status area
    - Byte 9 – Expected low byte of byte counter
    - Byte 10 – Expected high byte of byte counter
    - Byte 11 – Actual contents of sector counter
    - Byte 12 – Expected contents of sector counter

4.14.7 Operator Control Panel Test

This test checks the operator control panel switches and indicators for proper operation. As each switch is pushed, the operator control panel indicator and an internal LED will light. The one exception is the FAULT switch which only lights the FAULT indicator. The internal LEDs also display the presence of the plug valid signal and the plug address lines. The internal LEDs display the operator control panel switches as shown in Table 4-15.

Table 4-15 LED Display for Operator Control Panel Test

LEDs	Operator Control Panel Function
MSB 7	PLUG VALID
6	PLUG ADDRESS 4
5	PLUG ADDRESS 2
4	PLUG ADDRESS 1
3	STAT 2
2	STAT 1
1	WRITE PROTECT
LSB 0	RUN

Use test select code "0D" to start the operator control panel test. As each switch is pushed, the corresponding indicator and LED will light. There are no error codes, only visual indications. To exit this test, enter "DD" in the thumbwheel switches and push the ENTER switch. The LEDs then display "AA". Push the ENTER switch to return to the "EC" prompt.

4.14.8 Head Select Multiplexer Test

This test checks the head select multiplexer on the microprocessor module. The diagnostic firmware sets up the head select multiplexer for diagnostic use. Then the diagnostic firmware loads the multiplexer and reads it back. Use the information given below to run and interpret the results of this test.

- Test select code is "0E"
- 54 – Multiplexer head-select error
- Extended status area
    - Byte 9 – Actual contents of head select multiplexer
    - Byte 10 – Expected contents of head select multiplexer

4.14.9 General Purpose Counter Test

This test checks the ability of the two RAM chip general purpose counters to count, overflow, and interrupt the microprocessor correctly. Use the information given below to run and interpret the results of this test.

- Test select code is "0F"
- Error codes
    - 57 – RAM 1 general purpose counter error
    - 58 – RAM 0 general purpose counter error

4.14.10 Track Counter Test

This test checks the ability of the track difference counter to count. The diagnostic firmware connects the off/fine track compare logic to the output of the DAC. The DAC is then set to values which cause the off/fine track compare logic to generate DIFF CNTR CLK. If this test is run with the spindle spinning, the servo motor is disabled. Use the information given below to run and interpret the results of this test.

- Test select code is "11"
- CD – Track counter error
- Extended status area
    - Byte 9 – Actual contents of the track counter
    - Byte 10 – Expected contents of the track counter

4.14.11 Read/Write Fault Force Test

This test checks the read/write safety sense circuits. A combination of diagnostic firmware and fault force hardware checks the read/write faults listed below.

- Read and write error
- Write current and no write gate error
- Write gate and no write current error
- Separator/encoder error

This test checks logic on the microprocessor and read/write modules. Since the test is done while detented in the outer guard band, the spindle must be spinning. Use the information given below to run and interpret the results of this test.

- Test select code is "12"
- Error codes
    - A0 – Read and write safety error
    - A3 – Forced read and write error
    - A4 – Forced write current and no write gate error
    - A5 – Forced write gate and no write current error
    - A6 – Forced separator/encoder error
    - AB – Outer guard band seek error
    - 7F – Spindle not spinning error
    - EA – Can't run test, drive faulted error
    - Any functional error code (refer to Table 4-1)
- Extended status area for a forced read/write error
    - Byte 9 – Read/write error word 1
    - Byte 10 – Read/write error word 2

4.14.12 Servo Position Loop Test

This test checks the servo position loop circuitry in a static mode. The diagnostic firmware uses the DAC to generate analog ramp voltages to the OFF/FINE track compare logic. The FINE TRK, POS PEAK and NEG PEAK signals are monitored by firmware to measure circuit tolerances. Use the information given below to run and interpret the results of this test.

- Test select code is "13"
- Error codes
    - C2 – Fine track status error
    - C3 – Fine track over range error
    - C4 – Fine track under range error
    - C5 – Off track status error
    - C6 – Off track over range error
    - C7 – Off track under range error
- Extended status area for error code "C2"
    - Byte 9 – Actual servo status
    - Byte 10 – DAC value
- Extended status area for error code "C5"
    - Byte 9 – Actual servo status
    - Byte 10 – Expected servo status

4.14.13 Velocity Loop Test

This test checks the servo velocity loop with a sawtooth waveform that forces the acceleration thresholds. The test performs the actions listed below.

- Sets DIAG 1 mode
- Generates a sawtooth excitation for the servo by stepping the DAC up and down
- Determines the range when forward and reverse acceleration are true

Use the information given below to run and interpret the results of this test.

- Test select code is "14"
- CB – Acceleration status error
- Extended status area
    - Byte 9 – Actual servo status
    - Byte 10 – Expected servo status
    - Byte 11 – Direction flag
    - Forward = "00"
    - Reverse = "FF"
    - Byte 12 – Frequency flag
    - High frequency = "00"
    - Low frequency = "08"
    - Byte 13 – Iteration count

4.14.14 Servo Functional Test

The servo functional test checks the functional operation of the servo system by performing the actions listed below.

- Does a recalibration and then checks that the heads are not in the guard bands
- Seeks to the outer guard band and checks that the heads arrive there
- Does a recalibration from the outer guard band
- Seeks to cylinder 560 in 2 cylinder increments
- Seeks to the inner guard band and then checks that the heads are there
- Does a recalibration from the inner guard band

Use the information given below to run and interpret the results of this test.

- Test select code is "15"
- Error codes
  - 7F – Spindle not spinning error
  - D0 – Recalibration error
  - D1 – Outer guard band status error
  - D2 – Inner guard band status error
  - D3 – Seek into outer guard band error
  - D4 – Outer guard band status not true error
  - D5 – Recal from outer guard band error
  - D6 – Two track seek to track 560 error
  - D7 – Seek into inner guard band error
  - D8 – Inner guard band status not true error
  - D9 – Recal from inner guard band error
  - EA – Can't run test, drive faulted error
- Extended status area for error codes "D0", "D5", "D7" and "D9"
  - Byte 9 – Functional error code (refer to Table 4-1)
- Extended status area for error code "D6"
  - Byte 9 – Functional error code
  - Byte 10 – Destination cylinder

4.14.15 Random Seek Test

This test does 32 repetitions of a random sequence of 32 seeks. The last seek of each random sequence should encounter the inner guard band. The heads entering the inner guard band on the last seek indicates the sequence has completed correctly. Use the information given below to run and interpret the results of this test.

- Test select code is "16"
- Error codes
    - 7F – Spindle not spinning error
    - E0 – Random seek error
    - E1 – Seek check error
    - EA – Can't run test, drive faulted error
    - Any functional error code (refer to Table 4-1)
- Extended status area for error code "E1"
    - Byte 9 – Functional error code
- Extended status area for functional error codes
    - Byte 9 – Low byte of the destination cylinder
    - Byte 10 – High byte of the destination cylinder
    - Byte 11 – Low byte of old cylinder
    - Byte 12 – High byte of old cylinder

4.14.16 Seek–Seek Test With Input Parameters

This test does 32 repetitive seeks between cylinders that are entered at the beginning of the test. After calling the seek–seek test with a test select code of "17", the LEDs will momentarily display a "17". Then the LEDs will blink "01", indicating the first parameter must be inserted. Place the low byte of the starting cylinder address in the thumbwheel switches, then push the ENTER switch. The LEDs will momentarily display what was in the thumbwheel switches and then blink "02" for the second parameter, etc. A blinking "EE" prompt code in the LEDs indicates the starting and ending addresses are the same. The test starts after the last parameter is entered. Use the information given below to run and interpret the results of this test.

- Test select code is "17"
- Parameter 1 – Low byte of the starting cylinder
- Parameter 2 – High byte of the starting cylinder
- Parameter 3 – Low byte of ending cylinder
- Parameter 4 – High byte of ending cylinder
- Error codes
    - 7F – Spindle not spinning error
    - EF – FE entered invalid cylinder address error
    - E1 – Seek check error
    - EA – Can't run test, drive faulted error
    - Any functional error code (refer to Table 4-1)

- Extended status area for error code "EF"
    - Byte 9 – Low byte of starting cylinder
    - Byte 10 – High byte of starting cylinder
    - Byte 11 – Low byte of ending cylinder
    - Byte 12 – High byte of ending cylinder
    - Byte 13 – Low byte of maximum cylinder (30)
    - Byte 14 – High byte of maximum cylinder (02)
- Extended status area for error code "E1"
    - Byte 9 – Functional error code
- Extended status area for functional error codes
    - Byte 9 – Low byte of destination cylinder
    - Byte 10 – High byte of destination cylinder
    - Byte 11 – Low byte of starting cylinder
    - Byte 12 – High byte of starting cylinder
    - Byte 13 – Low byte of ending cylinder
    - Byte 14 – High byte of ending cylinder

4.14.17 Seek-Seek Test With Fixed Parameters

This test does 32 repetitive seeks between cylinders 0 and 560. Use the information given below to run and interpret the results of this test.

- Test select code is "18"
- Error codes
    - 7F – Spindle not spinning error
    - E1 – Seek check error
    - EA – Can't run test, drive faulted error
    - Any functional error code (refer to Table 4-1)
- Extended status area for functional error codes
    - Byte 9 – Low byte of destination cylinder
    - Byte 10 – High byte of destination cylinder
    - Byte 11 – Low byte of starting cylinder
    - Byte 12 – High byte of starting cylinder
    - Byte 13 – Low byte of ending cylinder
    - Byte 14 – High byte of ending cylinder
- Extended status area for error code "E1"
    - Byte 9 – Functional error code

4.14.18 Incremental Seek Test With Input Parameters

This test does an incrementing seek between cylinders entered at the beginning of the test. After each incremental seek step, the heads return to the starting cylinder. Call the incremental seek test with a test select code of "19". The LEDs momentarily display "19", and then blink "01", indicating the first parameter must be input through the thumbwheel switches. Place the low byte of the starting cylinder address in the thumbwheel switches and push the ENTER switch. The LEDs will momentarily display what was in the thumbwheel switches and then blink "02" for the second parameter, etc. A blinking "EE" prompt code in the LEDs indicates that the starting and ending addresses are the same. The test starts after the last parameter is entered. Use the information given below to run and interpret the results of this test.

- Test select code is "19"
- Parameter 1 – Low byte of starting cylinder
- Parameter 2 – High byte of starting cylinder
- Parameter 3 – Low byte of ending cylinder
- Parameter 4 – High byte of ending cylinder
- Error codes
    - 7F – Spindle not spinning error
    - EF – FE entered invalid cylinder address error
    - E1 – Seek check error
    - EA – Can't run test, drive faulted error
    - Any functional error code (refer to Table 4-1)
- Extended status area for error code "EF"
    - Byte 9 – Low byte of starting cylinder
    - Byte 10 – High byte of starting cylinder
    - Byte 11 – Low byte of ending cylinder
    - Byte 12 – High byte of ending cylinder
    - Byte 13 – Low byte of maximum cylinder (30)
    - Byte 14 – High byte of maximum cylinder (02)
- Extended status area for error code "E1"
    - Byte 9 – Functional error code
- Extended status area for functional error codes
    - Byte 9 – Low byte of current cylinder
    - Byte 10 – High byte of current cylinder

4.14.19 Incremental Seek Test With Fixed Parameters

This test does an incrementing seek between cylinder 0 and 560. After each incremental seek step, the heads return to the starting cylinder. Use the information given below to run and interpret the results of this test.

- Test select code is "1A"
- Error codes
    - 7F – Spindle not spinning error
    - E1 – Seek check error
    - EA – Can't run test, drive faulted error
    - Any functional error code (refer to Table 4-1)
- Extended status area for functional error codes
    - Byte 9 – Low byte of current cylinder
    - Byte 10 – High byte of current cylinder
- Extended status area for error code "E1"
    - Byte 9 – Functional error code

4.14.20 Read-Only Test

This test reads with each read/write head using the prerecorded read-only cylinder. The diagnostic read/write hardware on the personality module monitors the data and does a data compare. The head selection is accomplished through the head-select multiplexer. Use the information given below to run and interpret the results of this test.

- Test select code is "1B"
- Error codes
    - 60 – Read/write head select error
    - 61 – Data port preset error
    - 62 – Read-only test overall read error
    - 63 – Read-only test partial read error
    - 64 – Read/write test guard band error
    - 65 – Sector timeout error
    - 66 – Read-only test read and no enable error
    - 7F – Spindle not spinning error
    - EA – Can't run test, drive faulted error
    - Any functional error code (refer to Table 4-1)
- Extended status area for error code "62", "63" and "66"
    - Byte 9 – Number of bad heads
    - Byte 10 – Low byte of read and no enable counter
    - Byte 11 – High byte of read and no enable counter

4.14.21 Write/Read Test

This test does a write followed by a read with each read/write head on the two write/read cylinders in the guard band. The firmware uses the diagnostic read/write hardware on the personality module tc write and verify the data. The head selection is accomplished through the head select multiplexer.

A prerequisite of this test is that the read-only test has run successfully. Use the information given below to run and interpret the results of this test.

- Test select code is "1C"
- Error codes
    - 60 – Read/write head select error
    - 61 – Data port preset error
    - 62 – Read-only test overall read error
    - 63 – Read-only test partial read error
    - 64 – Read/write test guard band error
    - 65 – Sector timeout error
    - 66 – Read-only test and no enable error
    - 67 – Write test not executable error
    - 6A – Write/read test overall read error
    - 6B – Write/read test partial read error
    - 6E – Write/read test read and no enable error
    - 7F – Spindle not spinning error
    - EA – Can't run test, drive faulted error
    - Any functional error code (refer to Table 4-1)
- Extended status area for error code "62", "63", "66", "6A", "6B" and "6E"
    - Byte 9 – Number of bad heads
    - Byte 10 – Low byte of read and no enable counter
    - Byte 11 – High byte of read and no enable counter

4.14.22 Maintenance Controls and Indicators Test

This test checks the ability of the firmware to read the thumbwheel switches and control the internal LEDs. The operator must interact with the test to place values in the thumbwheel switches and read the LEDs for proper operation. If the LEDs do not display the proper value, the microprocessor module should be replaced before attempting to run any internal diagnostics. Perform the steps listed below to run this test.

1. Turn the thumbwheel switches to "20".
2. Push the ENTER switch.
3. Check that the LED display blinks "FF".
4. Turn the thumbwheel switch to "FF".
5. Push the ENTER switch.
6. Check that the LEDs display a steady state "FF".
7. Turn the thumbwheel switches to "00".
8. Push the ENTER switch.
9. Check that the LEDs display a steady state "00".
10. Push the enter switch.
11. Check that the LEDs display a steady state "AA".
12. Push the ENTER to return to the "EC" prompt.

If the diagnostic firmware does not read "FF" or "00" when it expects to, an error code of "FE" is displayed.

4.14.23 Logic Tests

This test runs the logic tests listed below.

- Three module bus test
- Personality module microsequencer test
- Sector/byte counter test
- Head select multiplexer test
- General purpose counter test

The test select code is "22". The error codes obtained from this logic test are the same as the error codes for each individual test.

4.14.24 Servo Tests

This test runs the servo tests listed below.

- Servo position loop test
- Servo velocity loop test
- Track counter test
- Servo functional test
- Random seek test

The test select code is "23". The error codes obtained from this servo test are the same as the error codes for each individual test.

4.14.25 Read/Write Tests

This test runs the read/write tests listed below.

- Read-only test
- Write/read test

The test select code is "24". The error codes obtained from this read/write test are the same as the error codes for each individual test.

4.14.26 Entire Unit Test

This test runs the tests listed below.

- Three module bus test
- Personality module microsequencer test
- Sector/byte counter test
- Head-select multiplexer test
- General purpose counter test
- Servo position loop test
- Servo velocity loop test
- Track counter test
- Servo functional test
- Random seek test
- Read-only test
- Write/read test
- Read/write force fault test

The test select code is "25". The error codes obtained from this test are the same as the error codes from each individual test.

4.14.27 Static Servo Test

This test runs the static servo tests listed below.

- Servo position loop test
- Servo velocity loop test
- Track counter test

The test select code is "27". The LED error codes obtained from this servo test are the same as the error codes for each individual test.

4.15 ERROR CODE DEFINITIONS

A list of all the error codes and their definitions is presented in Table 4-16 in numerical order. This is a complete listing of all functional and diagnostic error codes that are encountered in the internal LED display.

Table 4-16 Error Code Definitions

Error Code	Definition
00	**Microprocessor Self-Test Error** – The microprocessor fails its self-diagnostic test.
01	**Spindle Motor Timeout Error** – The spindle did not spin after the RUN switch was pushed. The firmware did not detect a change of state of the spindle speed transducer during spin-up.
02	**Spin-Up Too Slow Error** – The spindle did not reach 1000 r/min in six seconds.
03	**Spindle Not Accelerating Error** – The motor did not accelerate during the spin-up cycle.
04	**Spin-Up Too Long Error** – The spindle did not reach 3420 r/min in 40 seconds.
05	**SEQUENCE HOLD/SEQUENCE PICK Error** – The signals, SEQUENCE PICK or SEQUENCE HOLD, are not present on the interface between the disk controller and the R80 Disk Drive.
06	**Microcode Error** – Near the end of each ROM is an instruction to jump to a microcode fault routine. This instruction is only executed if the firmware malfunctions. When it is executed, the microcode fault routine is called. This routine turns off the spindle motor, displays "06" in the LEDs, and lights the FAULT indicator on the operator control panel.
0A	**Invalid Interface Command Error** – This error is caused by one of the two conditions listed below. • The firmware receives a byte command from the personality module that is not a seek, recalibration, or offset command. • The firmware receives a command when the drive is not ready.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
11	**Wrong Peak Entering Detent Error** – The wrong peak polarity of the TRACK POSITION signal is detected by the firmware before detenting. The servo TRACK POSITION signal generates negative and positive peaks as the servo head crosses odd and even cylinders. The firmware monitors the polarity of the peaks at 3/4 track away from detent. The polarity of the peak, at this time, depends on the direction of head travel and whether the destination cylinder is odd or even. The firmware looks for the servo patterns shown in Figure 4-5 as the head approaches the destination cylinder.
12	**Servo Active PLO Error** – This error occurs during seek mode, indicating one of the conditions listed below. • Two pulses are detected outside the servo sync window that has the same timing characteristics as the SEGMENT CODE and SYNC pulses. • Four successive servo segments pass without the PLO fault circuit detecting the SEGMENT CODE and SYNC pulse combination.
13	**No Fine Track Error** – The firmware does not detect "FINE TRACK" at the end of a seek operation.
14	**Servo Speed or Direction Error** – This error occurs during seek mode, indicating one of the conditions listed below. • Positioner going too fast • Positioner going in the wrong direction

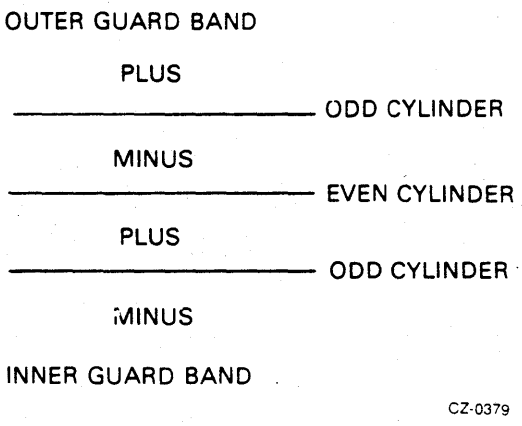

Figure 4-5 Servo Patterns

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
15	**Seek/Recal Timeout Error** – The seek or recalibration operation takes too long.
16	**Guard Band Error** – The heads enters the guard band during a seek.
17	**Track Counter Underflow Error** – The track counter decrements past zero before the firmware expects it.
1A	**Invalid Cylinder Address Error** – The firmware receives an invalid cylinder address. Valid cylinder addresses are between 0 and 560 decimal.
23	**Spindle Motor Interlock Error** – The belt tension interlock microswitch indicates that the belt tension lever is released.
24	**Servo Inactive PLO Error** – This error occurs during detent mode, indicating one of the conditions listed below. • Two pulses are detected outside the servo sync window that have the same timing characteristics as the SEGMENT CODE and SYNC pulses. • Four successive servo segments pass without the PLO fault circuit detecting the SEGMENT CODE and SYNC pulse combination.
25	**Servo Detected Off Track Error** – The servo is detected off track during detent mode.
26	**Spindle Speed Error** – The spindle slows down to less than 3420 r/min (3600 minus 5%).
27	**HDA Overtemperature Error** – The temperature of the HDA is too high.
28	**Servo Module Overtemperature Error** – The temperature of the heat sink on the servo module is too high.
30	**Write Current and No Write Gate Error** – Write current is detected without WRITE GATE asserted.
31	**Read and Write Error** – READ GATE and WRITE GATE are asserted at the same time.
32	**Read/Write While Faulted Error** – WRITE GATE or READ GATE is asserted while the drive is in a fault condition.
33	**Data Separator/Encoder Error** – During a write operation, the write precompensation data does not match the data out of the read decoder.
34	**Write Precompensation Error** – During a write operation, the early and late data strobes in the write precompensation logic occur at the same time.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
35	**Write and Write Unsafe Error** – A write unsafe from the preamplifier IC is asserted during a write operation.
36	**Head Short Error** – A shorted head winding is detected during a write operation.
37	**Write Gate and No Write Current Error** – No write current is sensed when WRITE GATE is asserted.
38	**Read and Multichip Select Error** – More than one preamplifier IC is selected during a read operation.
39	**Write and Off Track Error** – The head is off track during a write operation.
3A	**Write and Write Protected Error** – A write command is attempted while the drive is write protected.
51	**Sector/Byte Counter Error** – The sector or byte counter fails to count correctly.
53	**Personality Module Microsequencer Error** – The echo bit test of the microsequencer fails on the personality module.
54	**Multiplexer Head Select Error** – The head select multiplexer does not select the correct head during the head select multiplexer test.
57	**RAM 1 General Purpose Counter Error** – The general purpose counter in RAM 1 fails.
58	**RAM 0 General Purpose Counter Error** – The general purpose counter in RAM 0 fails.
60	**Read/Write Head Select Error** – The wrong head is selected through the head select multiplexer during the read/write tests.
61	**Data Port Preset Error** – The data byte written into the diagnostic write register cannot be read back correctly through the diagnostic read register on the personality module.
62	**Read-Only Test Overall Read Error** – The data read from three or more heads is bad during the read-only test.
63	**Read-Only Test Partial Read Error** – The data read from one or two heads is bad during the read-only test.
64	**Read/Write Test Guard Band Error** – The head is not in the inner guard band after seeking to cylinder 563.
65	**Sector Timeout Error** – The diagnostic cannot find the proper sector to read or write on.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
66	**Read-Only Test Read and No Enable Error** – The firmware detects that a head went off track more than 15 times during the read-only test.
67	**Write Test Not Executable Error** – The write test cannot be executed because the prerequisite read-only test failed.
6A	**Write/Read Test Overall Read Error** – The data read from three or more heads is bad during the write/read test.
6B	**Write/Read Test Partial Read Error** – The data read from one or two heads is bad during the write/read test.
6E	**Write/Read Test Read and No Enable Error** – The firmware detects that a head went off track more than 15 times during the write/read test.
70	**R/W Control Select Error** – WRITE GATE is present during the head select and seek utility.
71	**Utility Head Select Error** – The wrong head is selected through the head select multiplexer during the head select and seek utility.
7C	**Too Slow Seek Error** – The heads are moving too fast during the servo velocity adjustment utility. Turn the velocity potentiometer counterclockwise a turn or two, and then restart the utility.
7D	**Bad Seek Count Overflow Error** – There are too many seek errors during the servo velocity adjustment utility.
7E	**Too Fast Seek Error** – The heads are moving too fast during the servo velocity adjustment utility. Turn the velocity potentiometer clockwise a turn or two, and then restart the utility.
7F	**Spindle Not Spinning Error** – The spindle is not spinning at the beginning of the read/write or servo tests.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
80	**ROM Set Error** – The ROMs are not of the same set.

NOTE

Each ROM in the set should have an identical ROM set word, indicating that the firmware in the ROMs is compatible. The ROM set word consists of two bytes. The contents of these bytes can be displayed in the LEDs using the examine memory up utility with the addresses listed below.

ROM Number	High Byte	Low Byte
ROM 0	07FA	07FB
ROM 1	0FFA	0FFB
ROM 2	17FA	17FB
ROM 3	1FFA	1FFB
ROM 4	27FA	27FB

85	**RAM 0 Error** – RAM 0 does not pass the RAM test.
86	**RAM 1 Error** – RAM 1 does not pass the RAM test.
87	**ROM 0 Checksum Error** – The checksum of ROM 0 does not agree with the calculated checksum.
8A	**Module Interlock Error** – Not all of the module interconnecting cables are connected.
8B	**Discrete Port Enable Error** – The discrete port enable latch fails to set, therefore, the microprocessor cannot communicate with the servo module or personality module.
8F	**ROM 1 Checksum Error** – The checksum of ROM 1 does not agree with the calculated checksum.
97	**ROM 2 Checksum Error** – The checksum of ROM 2 does not agree with the calculated checksum.
9F	**ROM 3 Checksum Error** – The checksum of ROM 3 does not agree with the calculated checksum.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
A0	**Read and Write Safety Error** – An R/W fault cannot be cleared.
A3	**Forced Read and Write Error** – The diagnostic firmware cannot force READ GATE and WRITE GATE at the same time.
A4	**Forced Write Current and No Write Gate Error** – The diagnostic firmware cannot force write current without WRITE GATE.
A5	**Forced Write Gate and No Write Current Error** – The diagnostic firmware cannot force WRITE GATE without write current.
A6	**Forced Separator/Encoder Error** – The diagnostic firmware cannot force a miscompare of the data from the write precompensation logic and the read decoder logic during a write operation.
A7	**ROM 4 Checksum Error** – The checksum of ROM 4 does not agree with the calculated checksum.
AB	**Outer Guard Band Seek Error** – The diagnostic firmware cannot seek into the outer guard band during the R/W force fault test.
B0	**Three Module Microprocessor Bus Error** – The microprocessor module internal data bus fails during the three module bus test.
B1	**Three Module Personality Bus Error** – The bus between the microprocessor module and the personality module fails during the three module bus test.
B2	**Three Module Servo Bus Error** – The bus between the microprocessor module and the servo module fails during the three module bus test.
B3	**Microprocessor Module Bus Error** – The microprocessor module internal data bus test fails during the microprocessor module bus test.
B4	**Personality Module Bus Error** – The bus between the microprocessor and the personality module fails during the microprocessor module and personality module bus test.
B5	**Servo Module Bus Error** – The bus between the microprocessor and the servo modules fails during the microprocessor module and servo module bus test.
C2	**Fine Track Status Error** – Something other than the FINE TRACK bit is set in the servo status register when the firmware is expecting only FINE TRACK.
C3	**Fine Track Over Range Error** – The DAC value needed to make FINE TRACK go false is too high.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
C4	**Fine Track Under Range Error** – The DAC value needed to make FINE TRACK go false is too low.
C5	**Off Track Status Error** – Additional bits of the servo status register are set when firmware expects only the POS PEAK and NEG PEAK bits to be set.
C6	**Off Track Over Range Error** – The DAC value needed to make off track (NEG PEAK or POS PEAK) go true is too high.
C7	**Off Track Under Range Error** – The DAC value needed to make off track (NEG PEAK or POS PEAK) go true is too low.
CB	**Acceleration Status Error** – The FWD ACC or REV ACC signals are either present when they should be absent, or absent when they should be present.
CD	**Track Counter Error** – The track difference counter did not count properly.
D0	**Recalibration Error** – The first recalibration in the servo functional test fails.
D1	**Outer Guard Band Status Error** – The servo status indicates the heads are in the outer guard band when they should be over cylinder 0.
D2	**Inner Guard Band Status Error** – The servo status indicates that heads are in the inner guard band when they should be over cylinder 0.
D3	**Seek Into Outer Guard Band Error** – The seek to the outer guard band from cylinder 0 fails.
D4	**Outer Guard Band Status Not True** – The servo status indicates that the heads are not in the outer guard band when they should be.
D5	**Recal From Outer Guard Band Error** – The drive fails to perform a recalibration when the heads are in the outer guard band.
D6	**Two Track Seek to Track 560 Error** – The drive fails to successfully complete a seek from cylinder 0 to cylinder 560 in increments of two cylinders.
D7	**Seek Into Inner Guard Band Error** – The drive fails to seek into the inner guard band from cylinder 560.
D8	**Inner Guard Band Status Not True Error** – The servo status indicates that the heads are not in the inner guard band when they should be.
D9	**Recal From Inner Guard Band Error** – The drive fails to perform a recalibration when the heads are in the inner guard band.

Table 4-16 Error Code Definitions (Cont)

Error Code	Definition
E0	**Random Seek Error** – The heads do not enter the inner guard band on the last seek of the random seek test.
E1	**Seek Check Error** – The drive fails to meet one of the seek preconditions listed below. • Spindle not at proper speed • Drive unsafe condition occurs • Drive fails recalibration test
EA	**Can't Run Test, Drive Faulted Error** – This test cannot be run because the drive has a non-clearable fault.
EE	**Entry Error** – The same starting and ending addresses are entered during a diagnostic seek test.
EF	**FE Entered Invalid Cylinder Address Error** – An invalid cylinder address is entered during a diagnostic seek test.
FE	**Thumbwheel Switch Error** – The diagnostic firmware does not read the expected value from the thumbwheel switches during the maintenance controls and indicators test.

CHAPTER 5
DRIVE FAULT ISOLATION

5.1 INTRODUCTION

This chapter describes the fault isolation procedures for the R80 Disk Drive. Although these procedures are greatly dependent on the internal LED error codes, the drive has several other features that help in fault isolation. This chapter begins with a description of the fault isolation features that are available. Fault isolation tables are then presented, enabling the Field Service engineer to look up the most likely failing FRU for each LED error code. A section on power supply problems is presented next. The chapter ends with a series of troubleshooting tips.

5.2 FAULT ISOLATION FEATURES

The R80 Disk Drive has many features that are helpful in fault isolation. These features are listed below.

- Operator control panel fault codes
- LED error codes
- Storage of previous error codes

5.2.1 Operator Control Panel Fault Codes

Functional firmware general fault codes are reported through the operator control panel. A general fault code is obtained by entering the fault display mode when the FAULT indicator is on. To enter the fault display mode, push the FAULT switch. All of the indicators should remain on until the FAULT switch is released, providing a method of checking all the indicators. Upon releasing the FAULT switch, the indicators display the general fault code as illustrated in Figure 5-1. (The causes of these fault codes are described in Chapter 4.)

To exit the fault display mode, push the FAULT switch. This action stores the LED error code in the area of RAM allocated for previous errors. If the fault has been cleared, the firmware will return the operator control panel to its previous state. If the fault still exists, the fault indicator will light again.

The seek incomplete, read/write unsafe, and invalid interface command fault conditions can be corrected by the CPU, in which case the FAULT indicator goes off without operator intervention. If the fault cannot be corrected by the CPU, the FAULT indicator remains on and the fault must then be cleared through manual intervention.

5.2.2 Internal LED Error Codes

The R80 Disk Drive indicates error codes through an internal LED display on the microprocessor module. The location of the LED display is shown in Figure 5-2. The LED display has eight LEDs in a row. The least significant LED is to the right. The codes displayed in the LEDs are read as two hexadecimal digits (four LEDs to each digit). Table 5-1 lists all the LED error codes.

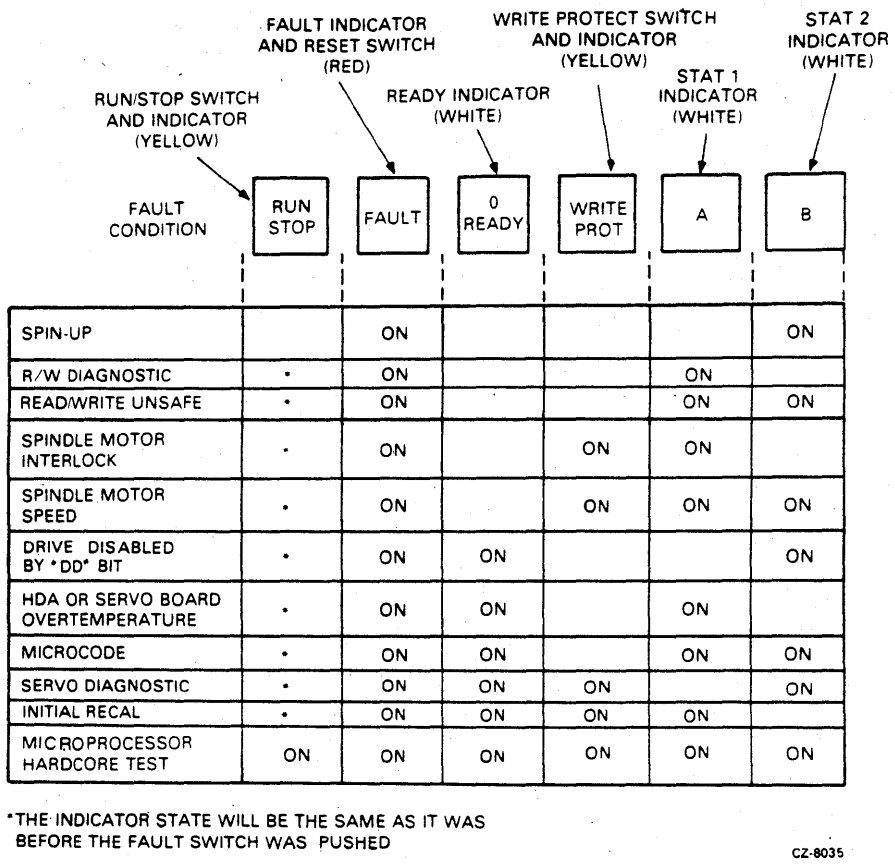

Figure 5-1 Operator Control Panel General Fault Indicators

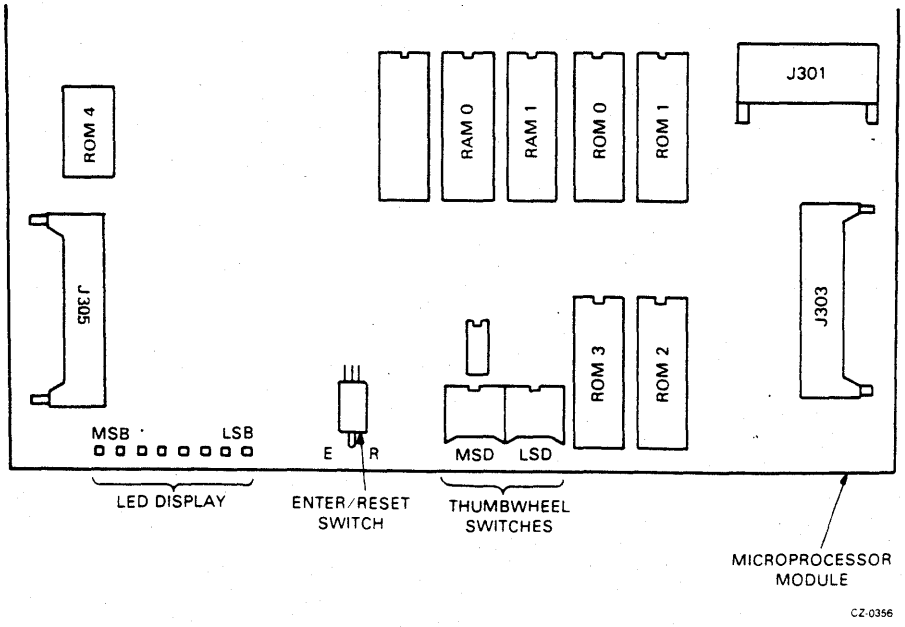

Figure 5-2 Internal LED Display

Table 5-1 Internal LED Error Codes

Error Code	Error
00	Microprocessor self-test error
01	Spindle motor timeout error
02	Spin-up too slow error
03	Spindle not accelerating error
04	Spin-up too long error
05	SEQUENCE HOLD/SEQUENCE PICK error
06	Microcode error
0A	Invalid interface command error
11	Wrong peak entering detent error
12	Servo active PLO error
13	No fine track error
14	Servo speed or direction error
15	Seek/recal timeout error
16	Guard band error
17	Track counter underflow error
1A	Invalid cylinder address error
23	Spindle motor interlock error
24	Servo inactive PLO error
25	Servo detected off track error
26	Spindle speed error
27	HDA overtemperature error
28	Servo module overtemperature error
30	Write current and no write gate error
31	Read and write error
32	Read/write while faulted error
33	Data separator/encoder error
34	Write precompensation error
35	Write and write unsafe error
36	Head short error
37	Write gate and no write current error
38	Read and multichip select error
39	Write and off track error
3A	Write and write protected error
51	Sector/byte counter error
53	Personality module microsequencer error
54	Multiplexer head select error
57	RAM 1 general purpose counter error
58	RAM 0 general purpose counter error
60	Read/write head select error
61	Data port preset error
62	Read-only test overall read error
63	Read-only test partial read error
64	Read/write test guard band error
65	Sector timeout error
66	Read-only test read and no enable error
67	Write test not executable error

Table 5-1 Internal LED Error Codes (Cont)

Error Code	Error
6A	Write/read test overall read error
6B	Write/read test partial read error
6E	Write/read test read and no enable error
70	Read/write control select error
71	Utility head select error
7C	Too slow seek error
7D	Bad seek count overflow error
7E	Too fast seek error
7F	Spindle not spinning error
80	ROM set error
85	RAM 0 error
86	RAM 1 error
87	ROM 0 checksum error
8A	Module interlock error
8B	Discrete port enable error
8F	ROM 1 checksum error
97	ROM 2 checksum error
9F	ROM 3 checksum error
A0	Read and write safety error
A3	Forced read and write error
A4	Forced write current and no write gate error
A5	Forced write gate and no write current error
A6	Forced separator/encoder error
A7	ROM 4 checksum error
AB	Outer guard band seek error
B0	Three module microprocessor bus error
B1	Three module personality bus error
B2	Three module servo bus error
B3	Microprocessor module bus error
B4	Personality module bus error
B5	Servo module bus error
C2	Fine track status error
C3	Fine track over range error
C4	Fine track under range error
C5	Off track status error
C6	Off track over range error
C7	Off track under range error
CB	Acceleration status error
CD	Track counter error
D0	Recalibration error
D1	Outer guard band status error
D2	Inner guard band status error
D3	Seek into outer guard band error
D4	Outer guard band status not true error
D5	Recal from outer guard band error
D6	Two track seek to track 560 error
D7	Seek into inner guard band error

Table 5-1 Internal LED Error Codes (Cont)

Error Code	Error
D8	Inner guard band status not true error
D9	Recal from inner guard band error
E0	Random seek error
E1	Seek check error
EA	Can't run test, drive faulted error
EE	Entry error
EF	F.E. entered invalid cylinder address error
FE	Thumbwheel switch error

5.2.3 Storage of Previous Error Codes

The R80 Disk Drive can store up to 16 previous error codes in RAM memory. Most error codes are stored when the operator control panel FAULT switch is pushed to clear a fault condition. Other error codes, like seek incompletes, are stored as they occur. These error codes may be retrieved through the internal LED error display on a last in, first out basis. The most recent error code will be displayed first. These errors may be examined by invoking the examine previous error utility with a test select code of 02. Refer to Chapter 4.

NOTE

Always examine the previous errors before switching off power. Once the power has been removed, all stored previous errors are lost.

5.3 FAULT ISOLATION TABLES

The R80 fault isolation tables are based on the use of the internal LED error codes to perform trouble-shooting. Table 5-1 lists the LED error codes which directly indicate the one or several FRUs may be at fault. A priority of FRU replacement is assigned, based on the failure rate of each FRU, as well as other considerations. Table 5-2 provides an explanation of FRU replacement codes. Table 5-3 shows the FRU replacement sequence.

The second table concerns the LED error codes that indirectly indicate what the failing FRUs are. These error codes require further action by the Field Service person to determine what FRUs may be responsible for the error. No attempt is made to prioritize FRU replacement here, since any of the FRUs in the error path could be at fault. A meter or oscilloscope may be required to isolate the actual failing FRU. Table 5-4 describes the fault isolation procedures for these indirect FRU indications.

The FRUs listed below are assigned a letter designation so they may be referred to in Table 5-3.

NOTE

Cables are not contained in the controlled distribution (CD) kit. Before replacing a cable, check for proper seating and continuity.

Table 5-2 FRU Replacement Codes

FRU Code	Description
A	Microprocessor module
B	Servo module
C	Personality module
D	Read/write module
E	Operator control panel module
F	40 conductor data cable (personality module)
G	40 conductor data cable (servo module)
H	20 conductor data cable (personality module)
I	50 conductor read/write cable (read/write module)
J	20 conductor data cable (read/write module)
K	Operator control panel cable
L	Servo preamp cable
M	Power supply
N	HDA

Table 5-3 FRU Replacement Sequence

Error Code	FRU Codes A	B	C	D	E	F	G	H	I	J	K	L	M	N
00	1		2			3								
01	See Table 5-4													
02	See Table 5-4													
03	See Table 5-4													
04	See Table 5-4													
05	See Table 5-4													
06	1													
0A	2		1			3								
11*	2	1					3							4
12	2	1					3					4	6	5
13	2	1					3						5	4
14*	2	1					3						5	4
15*	See Table 5-4													
16*	2	1					3						5	4
17*	2	1					3						5	4
1A	See Table 5-4													
23	See Table 5-4													
24	2	1					3					4	6	5
25*	2	1					3						5	4

*Perform the servo adjustments before replacing the modules.

Table 5-3 FRU Replacement Sequence (Cont)

Error Code	FRU Codes A	B	C	D	E	F	G	H	I	J	K	L	M	N
26	See Table 5-4													
27	See Table 5-4													
28	See Table 5-4													
30	2			1					3					4
31	See Table 5-4													
32	1		2	3				4	5	6				7
33	1		3	2				5	4					
34	1		2			3								
35	5			1					2	3				4
36	5			1					2	3				4
37	5			1					2	3				4
38	5			1					2	3				4
39*	2	1					3					4		5
3A	1				2						3			
51	1	2					3							
53	2		1			3								
54	1		2	3				4	5					
57	1													
58	1													
60	1		2	3				4	5					
61	2		1			3								
62	1		2	3				4	5	6				7
63	5		7	3				6	4	1				2
64	2	1					3							4
65	2	1					3							
66	See Table 5-4													
67	See Table 5-4													
6A	1		2	3				4	5	6				7
6B	5		7	3				6	4	1				2
6E	See Table 5-4													
70	1		2			3								
71	1													
7C	See Table 5-4													
7D	2	1					3						5	4
7E	See Table 5-4													
7F	See Table 5-4													
80	1													
85	1													
86	1													
87	1													
8A	See Table 5-4													
8B	1													
8F	1													
97	1													
9F	1													

Table 5-3 FRU Replacement Sequence (Cont)

Error Code	A	B	C	D	E	F	G	H	I	J	K	L	M	N
A0	1		2	3		4		5	6	7				8
A3	1		2			3								
A4	1		2			3								
A5	1		2			3								
A6	1													
A7	1													
AB*	2	1					3						5	4
B0	1													
B1	2		1			3								
B2	2	1					3							
B3	1													
B4	2		1			3								
B5	2	1					3							
C2	2	1					3							
C3	2	1					3							
C4	2	1					3							
C5	2	1					3							
C6	2	1					3							
C7	2	1					3							
CB	2	1					3							
CD	2	1					3							
D0*	2	1					3						5	4
D1*	2	1					3						5	4
D2*	2	1					3						5	4
D3*	2	1					3						5	4
D4*	2	1					3						5	4
D5*	2	1					3						5	4
D6*	2	1					3						5	4
D7*	2	1					3						5	4
D8*	2	1					3						5	4
D9*	2	1					3						5	4
E0*	2	1					3						5	4
E1	See Table 5-4													
EA	See Table 5-4													
EE	See Table 5-4													
EF	See Table 5-4													
FE	See Table 5-4													

*Perform the servo adjustments before replacing the modules.

Table 5-4 Indirect FRU Failure

Error Code	Actions	Possible Causes
01	Attempt to spin-up the disk while watching the top of the spindle motor for rotation.	
	• If the spindle motor rotated, check that the belt is on properly.	Belt
	If the belt is on properly, isolate the fault to the failing unit.	HDA speed sensor Microprocessor module Read/write module 50 conductor read/write cable
	• If the spindle motor did not rotate, isolate the fault to the failing unit.	Motor/brake Motor too hot Motor start capacitor Power supply Logic dc power harness Logic ac power harness Microprocessor module
02 03 04	Isolate the fault to the failing unit.	Fan behind spindle motor Motor/brake Belt HDA speed sensor Microprocessor module HDA
05	Check drive I/O cables.	Drive I/O cables are not connected properly.
	Replace personality module.	Personality module
	If the problem still exists, trace START ENABLE, SEQUENCE PICK, and SEQUENCE HOLD from the personality module back through the disk controller.	Disk controller

Table 5-4 Indirect FRU Failure (Cont)

Error Code	Actions	Possible Causes
15	Check that the HDA positioner is in the UNLOCK position.	HDA positioner lock is in LOCK position.
	If the HDA positioner lock was not locked, replace the following FRUs.	Servo module Microprocessor module 40 conductor data cable from servo module HDA positioner cable in the belt tension switch harness assembly HDA Power supply
1A	Replace the items in the list of possible causes.	Personality module Microprocessor module 40 conductor data cable from personality module
	If the problem still exists, check that the correct address is being received from the disk controller.	Disk controller Drive I/O cable assembly between the disk controller and the R80 personality module.
23	Check that belt tension lever is in the locked position.	Belt tension lever is in the release position.
	Check BELT TENSION signal on the microprocessor module.	
	• If the signal is asserted, replace the microprocessor module.	Microprocessor module
	• If the signal is not asserted, isolate the failing unit.	Belt tension microswitch Belt tension switch harness assembly
26	Check the fans.	Fan behind motor is not working.
	Attempt to spin-up the disk again.	
	• If the spin-up fails, use corrective action for the new error code, or let the motor cool for 10 to 15 minutes.	Motor may be overheated.

Table 5-4 Indirect FRU Failure (Cont)

Error Code	Actions	Possible Causes
	• If the spin-up attempt succeeds, ignore this error and proceed.	Motor may have overheated previously.
27	Check the items on the list of possible causes.	Fans not working Ambient temperature of the room too high Speed transducer cable not connected
	If the problem still exists, trace the TEMP HDA signal through the following FRUs.	HDA terminal switch Read/write module 50 conductor read/write cable Microprocessor module
28	Check the items on the list of possible causes.	Fans not working Ambient temperature of the room too high
	If the problem still exists, trace the TEMP SERVO signal through the following FRUs	Servo module 40 conductor data cable from the servo module Microprocessor module
31	Replace the items listed in possible causes.	Personality module Microprocessor module 20 conductor data cable from the personality module
	If the problem still exists, the cause may be in the disk controller.	Disk controller Drive I/O cable assembly from disk controller R80 personality module
66	Perform the servo adjustments and then run the test again. If the error code of "66" occurs again, replace the servo module.	Servo adjustments Servo module HDA
67	Perform the read–only test, "1B".	Read–only test failed
6E	Perform the servo adjustments and then run the test again. If error the code of "6E" occurs again, replace the servo module.	Servo adjustments Servo module HDA

Table 5-4 Indirect FRU Failure (Cont)

Error Code	Actions	Possible Causes
7C	Turn the servo velocity potentiometer (R281) two revolutions counterclockwise, then restart the test.	The positioner motor was going too slow.
7E	Turn the servo velocity potentiometer (R281) two revolutions clockwise, then restart the test.	The positioner motor going too fast.
7F	Spin-up the spindle with the spindle control utility before running tests using the positioner motor.	Spindle is not spinning.
A	Check that all of the cables are properly connected. If all the cables are connected, check the I LOCK signal path.	Cables are not connected properly.
B	Examine byte 9 of the extended status area for the functional error code. Use corrective action for that functional error code.	Drive unsafe condition Recalibration failure
A	Troubleshoot the previous LED error code.	Previous error code caused a drive faulted condition that inhibited this test.
E	Enter the correct information for seek tests.	Starting and ending address were the same for the seek tests.
	Install jumper for the read-only test.	The jumper for the read-only cylinder formatter utility is not present.
F	Enter a valid cylinder address.	The entered cylinder address was greater than 560 (0230 hexadecimal).
E	Perform the test again following the correct procedure.	Either the wrong procedure was used or the wrong value was entered.
	If the problem still exists, replace the microprocessor module.	Microprocessor module

5.4 POWER SUPPLY PROBLEMS

Some power supply problems will exhibit themselves visually while others may not. Table 5-5 supplies a list of power supply failure symptoms to look for. For the power supply problems with no visual failure symptoms, refer to the power distribution diagram in Figure 5-3. If the dc voltages need to be measured, use Table 5-6 to find the voltage tolerances and Table 5-7 to find the locations of each voltage checkpoint. Table 5-7 includes a list of reference references for Figures 5-4 through 5-8 showing the location of each voltage checkpoint.

Table 5-5 Power Supply Failure Symptoms

Symptom Check	Action
Fans	Check that all four fans are spinning.
+5 Volt Indicators	Check that the operator control panel indicators and the internal LED display flash on momentarily when power is applied to the drive. The flash will indicate that +5 volts is present.
WRITE PROTECT Switch	Check that +5 volts is present at the operator control panel WRITE PROTECT switch. The WRITE PROTECT switch should light when pushed if +5 volts is present and the drive is on-line.
12 Volt LEDs	Check that the two 12 volt LEDs on the servo module next to the heat sink are on. When lit, they indicate that both +12 and −12 volts are present.
FAULT indicator off. All other operator control panel indicators on.	Check if only the FAULT indicator on the operator control panel is not lit. This condition occurs only when the DC LOW signal is asserted. Possible causes could be the power supply, microprocessor module or servo module.

Table 5-6 DC Voltage Tolerances

DC Voltages	Acceptable Tolerances
+5 volts	±.2 volts
−5.2 volts	±.2 volts
+12 volts	±.6 volts
−12 volts	±.6 volts
+6 volts	±.3 volts
−4 volts	±.2 volts
−8.2 volts	±.65 volts
+24 volts	+3, −1 volts
−24 volts	+1, −3 volts

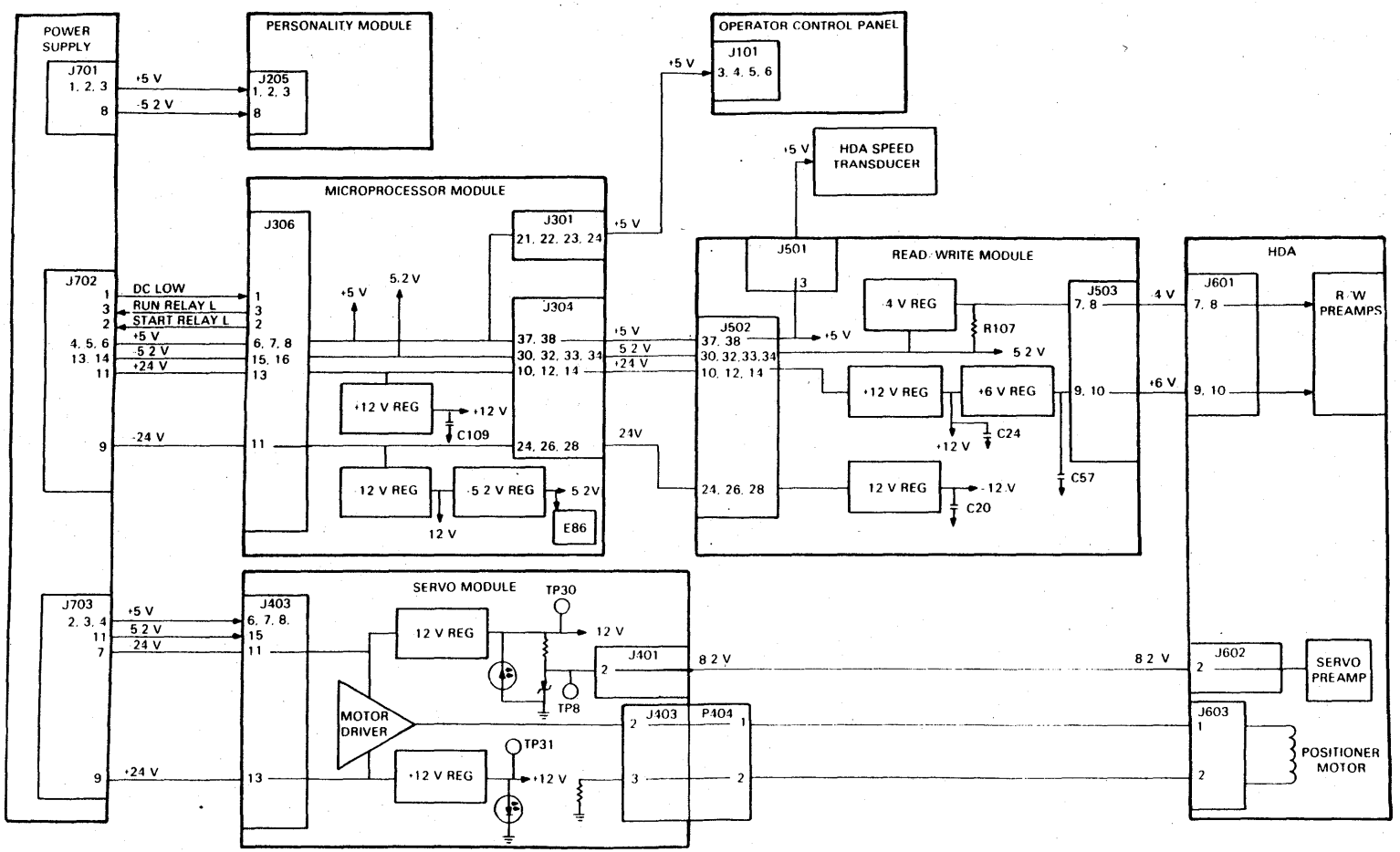

Figure 5-3 Power Distribution Diagram

Table 5-7 Voltage Checkpoints

Module	Voltage	Checkpoint	Reference Figure
Microprocessor	+5	J306 pins 6, 7, 8	5-4
	−5.2	J306 pins 15, 16	5-4
	−5.2	E86 pin 8 (This −5.2 volts comes from a regulator on this module.)	5-4
	+12	Positive side of C109	5-4
	+24	J306 pin 13	5-4
	−24	J306 pin 11	5-4
Servo	+5	J403 pins 6, 7, 8	5-5
	−5.2	J403 pin 15	5-5
	+12	TP31	5-5
	−12	TP30	5-5
	−8.2	TP8	5-5
	+24	J403 pin 13	5-5
	−24	J403 pin 11	5-5
Personality	+5	J205 pins 1, 2, 3	5-6
	−5.2	J205 pin 8	5-6
Read/Write	+5	J501 pin 3	5-7
	−5.2	End of R107 toward rear of drive	5-7
	+12	Positive side of C24	5-7
	−12	Negative side of C20	5-7
	+6	Positive side of C57	5-7
	−4	End of R107 toward front of drive	5-7
HDA Preamplifier	+6	J601 pins 9, 10	5-8
	−4	J601 pins 7, 8	5-8
	−8.2	J608 pin 8	5-8

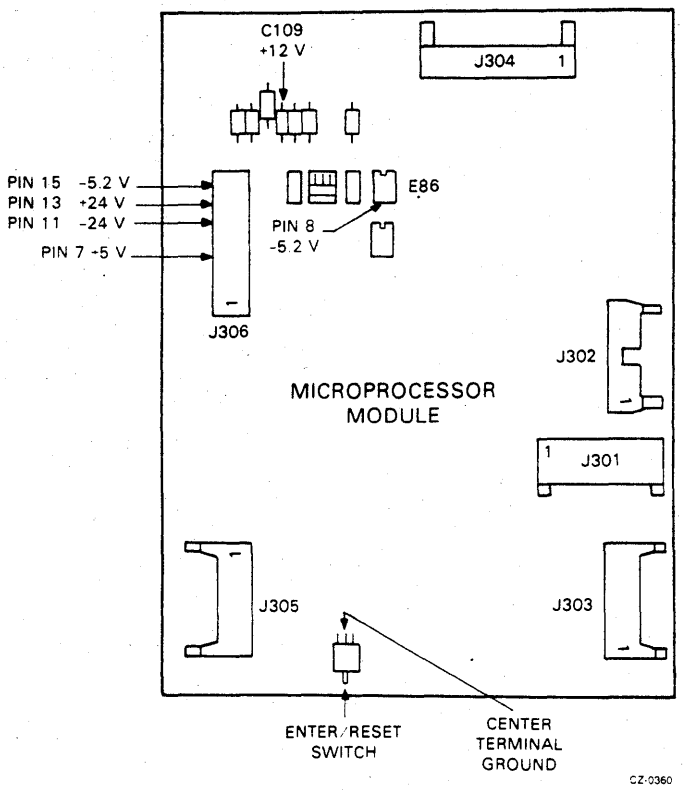

Figure 5-4 Microprocessor Module Voltage Checkpoints

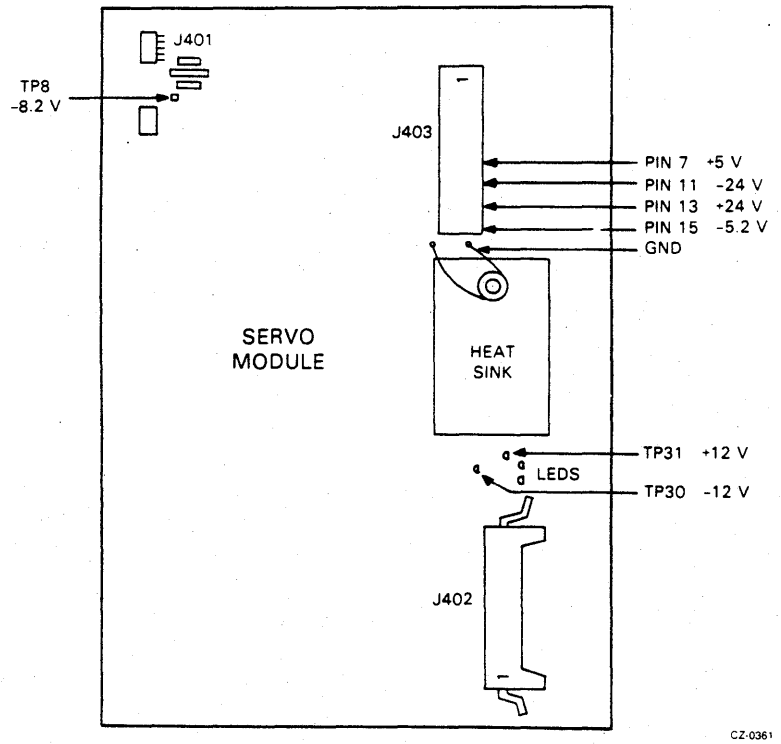

Figure 5-5 Servo Module Voltage Checkpoints

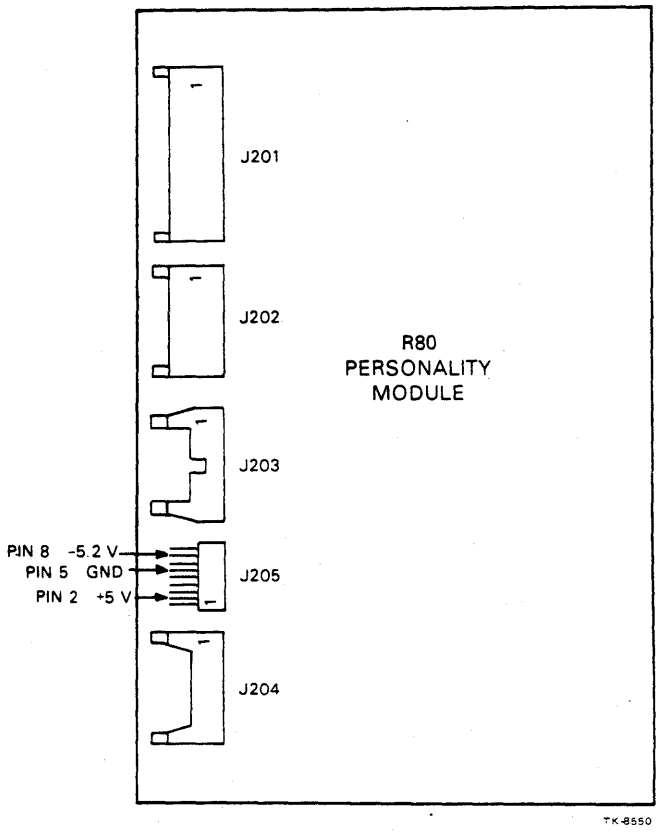

Figure 5-6 Personality Module Voltage Checkpoints

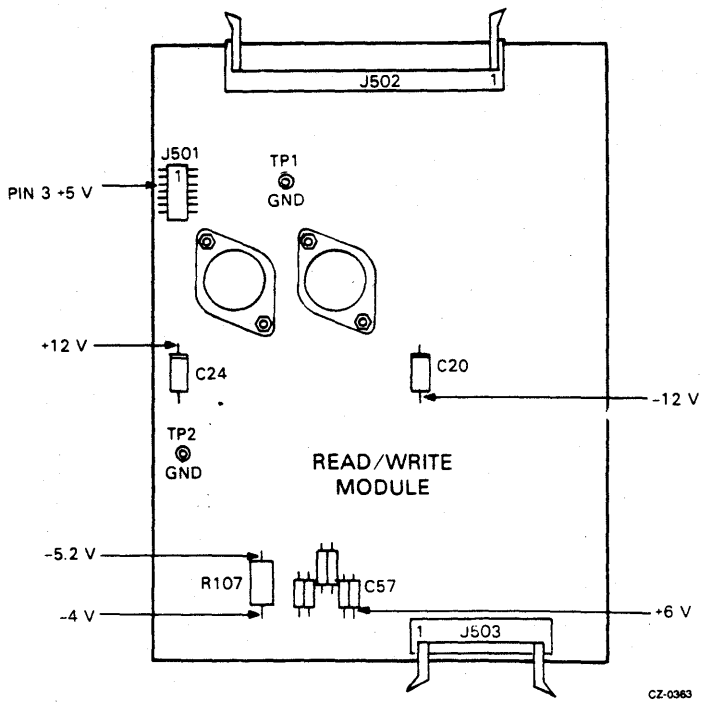

Figure 5-7 Read/Write Module Voltage Checkpoints

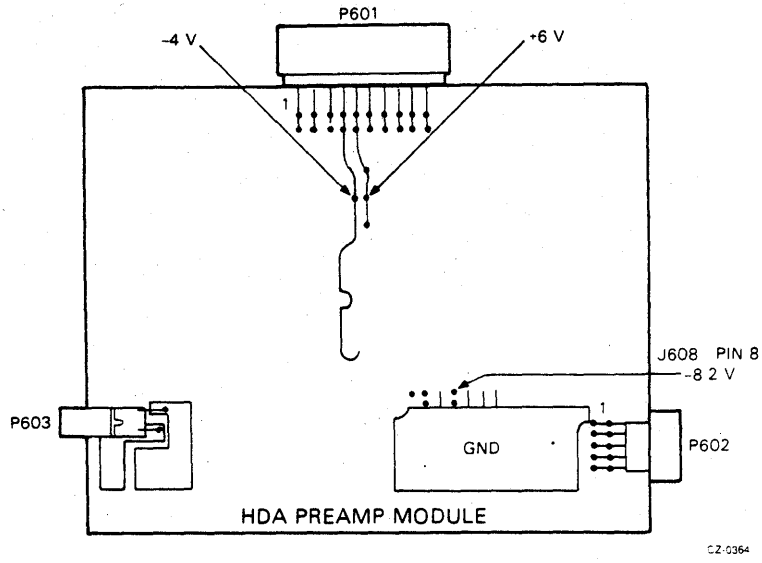

Figure 5-8 HDA Preamplifier Voltage Checkpoints

5.5 TROUBLESHOOTING TIPS

The following text describes some general troubleshooting tips that may be useful when performing R80 drive fault isolation.

5.5.1 Check Firmware Revision and ROM Set Numbers

The firmware revision and ROM set numbers are in the last few bytes of each ROM. The easiest way to examine these numbers is by using the memory examine down utility, test select code "06". Enter the address of the last byte of the ROM to be examined; then push the ENTER switch to examine each byte location, starting with the last byte in the ROM. Refer to Table 5-8 for the last address of each ROM. Figure 5-9 shows what is contained in the last eight bytes of each ROM.

Table 5-8 Last Byte Address of Each ROM

ROM	Address of Last Byte
0	07FF
1	0FFF
2	17FF
3	1FFF
4	27FF
5	2FFF

REV HIGH BYTE	REV LOW BYTE	ROM SET HIGH BYTE	ROM SET LOW BYTE	ZEROS (UNUSED)	ONES COLUMN CHECK	ZEROS COLUMN CHECK	CHECK SUM
XXX8	XXX9	XXXA	XXXB	XXXC	XXXD	XXXE	XXXF

CZ-0366

Figure 5-9 Last Eight Bytes of a ROM

5.5.2 Testing the Write Protect Function

The write protect function in the R80 Disk Drive may be tested with the following procedure while the drive is in the functional mode.

1. Spin-down the disk by releasing the RUN/STOP switch.
2. Push in the WRITE PROTECT switch.
3. Spin-up the disk by pushing in the RUN/STOP switch. If the write protect function is working, the FAULT indicator will light. The internal LEDs on the microprocessor module will display an error code of "6A".
4. Push the FAULT switch to enter the fault display mode. The operator control panel will display an R/W diagnostic fault code. Both the FAULT and STAT 1 indicators should be on.
5. Push the FAULT switch again to clear this fault condition.
6. Release the WRITE PROTECT switch.

5.5.3 Spin-Up Delay After Power On

When spinning up the disk drive after a power loss, a 40 second delay will occur before the drive begins a spin-up cycle if one of the conditions listed below are met.

- The RUN/STOP switch is already depressed at power on.
- The RUN/STOP switch is pushed in within three seconds after power on.

This 40 second delay will occur regardless of whether the power loss is due to power failure or a normal circuit breaker power down.

5.5.4 Spindle Motor Thermal Timeouts

The R80 engineering specification calls for a three minute wait period between successive start-up cycles of the spindle motor. This wait period is required to prevent the spindle motor from overheating and setting an internal thermal switch in the motor. A spindle motor thermal timeout may be caused by one of the problems listed below.

- Frequent spindle motor start-up
- Loss of cooling due to a fan failure

If the spindle motor thermal switch was set, it would result in the symptoms listed below.

- LED error codes of 01, 02, 03, 04, or 26
- Spin-up fault on the operator control panel

To recover from a spindle motor thermal timeout, check the fans first. If the fans are operating, let the motor cool off for 10 to 15 minutes while power is applied to the drive.

APPENDIX A
HEXADECIMAL TO BINARY CONVERSION

The LED display on the microprocessor module consists of eight LEDs in a row which are read as two hexadecimal digits. Use Table A-1 to convert the binary LED code into hexadecimal. Figure A-1 provides a sample LED conversion for an error code of EA.

Table A-1 Hexadecimal/Binary Conversion Chart

Hexadecimal	Binary
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
A	1010
B	1011
C	1100
D	1101
E	1110
F	1111

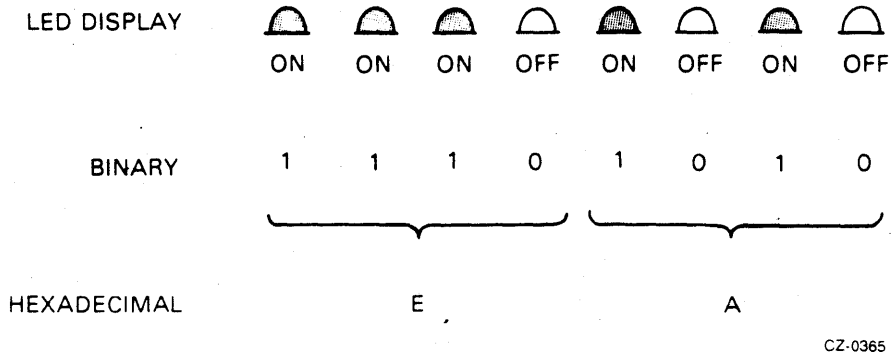

Figure A-1 Sample LED Conversion of EA

APPENDIX B
DECIMAL TO HEXADECIMAL CONVERSION

Some of the seek diagnostic tests in the R80 Disk Drive call for the user to enter the cylinder addresses in hexadecimal format. Since there are 560 (decimal) cylinders available, the hexadecimal code must be entered into the two thumbwheel switches in two bytes consisting of two hexadecimal digits each.

The first byte entered is always the low byte of the cylinder address. The second byte is the high byte of the cylinder address. Use Table B-1 to convert the cylinder addresses between hexadecimal and decimal.

Table B-1 Hexadecimal/Decimal Cylinder Conversion Chart

Decimal Value	Hexadecimal Value		Decimal Value	Hexadecimal Value		Decimal Value	Hexadecimal Value	
	High Byte	Low Byte		High Byte	Low Byte		High Byte	Low Byte
1	00	01	24	00	18	47	00	2F
2	00	02	25	00	19	48	00	30
3	00	03	26	00	1A	49	00	31
4	00	04	27	00	1B	50	00	32
5	00	05	28	00	1C	51	00	33
6	00	06	29	00	1D	52	00	34
7	00	07	30	00	1E	53	00	35
8	00	08	31	00	1F	54	00	36
9	00	09	32	00	20	55	00	37
10	00	0A	33	00	21	56	00	38
11	00	0B	34	00	22	57	00	39
12	00	0C	35	00	23	58	00	3A
13	00	0D	36	00	24	59	00	3B
14	00	0E	37	00	25	60	00	3C
15	00	0F	38	00	26	61	00	3D
16	00	10	39	00	27	62	00	3E
17	00	11	40	00	28	63	00	3F
18	00	12	41	00	29	64	00	40
19	00	13	42	00	2A	65	00	41
20	00	14	43	00	2B	66	00	42
21	00	15	44	00	2C	67	00	43
22	00	16	45	00	2D	68	00	44
23	00	17	46	00	2E	69	00	45

Table B-1 Hexadecimal/Decimal Cylinder Conversion Chart (Cont)

Decimal Value	Hexadecimal Value		Decimal Value	Hexadecimal Value		Decimal Value	Hexadecimal Value	
	High Byte	Low Byte		High Byte	Low Byte		High Byte	Low Byte
70	00	46	112	00	70	154	00	9A
71	00	47	113	00	71	155	00	9B
72	00	48	114	00	72	156	00	9C
73	00	49	115	00	73	157	00	9D
74	00	4A	116	00	74	158	00	9E
75	00	4B	117	00	75	159	00	9F
76	00	4C	118	00	76	160	00	A0
77	00	4D	119	00	77	161	00	A1
78	00	4E	120	00	78	162	00	A2
79	00	4F	121	00	79	163	00	A3
80	00	50	122	00	7A	164	00	A4
81	00	51	123	00	7B	165	00	A5
82	00	52	124	00	7C	166	00	A6
83	00	53	125	00	7D	167	00	A7
84	00	54	126	00	7E	168	00	A8
85	00	55	127	00	7F	169	00	A9
86	00	56	128	00	80	170	00	AA
87	00	57	129	00	81	171	00	AB
88	00	58	130	00	82	172	00	AC
89	00	59	131	00	83	173	00	AD
90	00	5A	132	00	84	174	00	AE
91	00	5B	133	00	85	175	00	AF
92	00	5C	134	00	86	176	00	B0
93	00	5D	135	00	87	177	00	B1
94	00	5E	136	00	88	178	00	B2
95	00	5F	137	00	89	179	00	B3
96	00	60	138	00	8A	180	00	B4
97	00	61	139	00	8B	181	00	B5
98	00	62	140	00	8C	182	00	B6
99	00	63	141	00	8D	183	00	B7
100	00	64	142	00	8E	184	00	B8
101	00	65	143	00	8F	185	00	B9
102	00	66	144	00	90	186	00	BA
103	00	67	145	00	91	187	00	BB
104	00	68	146	00	92	188	00	BC
105	00	69	147	00	93	189	00	BD
106	00	6A	148	00	94	190	00	BE
107	00	6B	149	00	95	191	00	BF
108	00	6C	150	00	96	192	00	C0
109	00	6D	151	00	97	193	00	C1
110	00	6E	152	00	98	194	00	C2
111	00	6F	153	00	99	195	00	C3

Table B-1 Hexadecimal/Decimal Cylinder Conversion Chart (Cont)

Decimal Value	Hexadecimal Value		Decimal Value	Hexadecimal Value		Decimal Value	Hexadecimal Value	
	High Byte	Low Byte		High Byte	Low Byte		High Byte	Low Byte
196	00	C4	239	00	EF	281	01	19
197	00	C5	240	00	F0	282	01	1A
198	00	C6	241	00	F1	283	01	1B
199	00	C7	242	00	F2	284	01	1C
200	00	C8	243	00	F3	285	01	1D
201	00	C9	244	00	F4	286	01	1E
202	00	CA	245	00	F5	287	01	1F
203	00	CB	246	00	F6	288	01	20
204	00	CC	247	00	F7	289	01	21
205	00	CD	248	00	F8	290	01	22
206	00	CE	249	00	F9	291	01	23
207	00	CF	250	00	FA	292	01	24
208	00	D0	251	00	FB	293	01	25
209	00	D1	252	00	FC	294	01	26
210	00	D2	253	00	FD	295	01	27
211	00	D3	254	00	FE	296	01	28
212	00	D4	255	00	FF	297	01	29
213	00	D5	256	01	00	298	01	2A
214	00	D6	257	01	01	299	01	2B
215	00	D7	258	01	02	300	01	2C
216	00	D8	259	01	03	301	01	2D
217	00	D9	260	01	04	302	01	2E
218	00	DA	261	01	05	303	01	2F
219	00	DB	262	01	06	304	01	30
220	00	DC	263	01	07	305	01	31
221	00	DD	264	01	08	306	01	32
222	00	DE	265	01	09	307	01	33
223	00	DF	266	01	0A	308	01	34
224	00	E0	267	01	0B	309	01	35
225	00	E1	268	01	0C	310	01	36
226	00	E2	269	01	0D	311	01	37
227	00	E3	270	01	0E	312	01	38
228	00	E4	271	01	0F	313	01	39
229	00	E5	272	01	10	314	01	3A
230	00	E6	273	01	11	315	01	3B
231	00	E7	274	01	12	316	01	3C
232	00	E8	275	01	13	317	01	3D
233	00	E9	276	01	14	318	01	3E
234	00	EA	277	01	15	319	01	3F
235	00	EB	278	01	16	320	01	40
236	00	EC	279	01	17	321	01	41
237	00	ED	280	01	18			
238	00	EE						

Table B-1 Hexadecimal/Decimal Cylinder Conversion Chart (Cont)

Decimal Value	Hexadecimal Value		Decimal Value	Hexadecimal Value		Decimal Value	Hexadecimal Value	
	High Byte	Low Byte		High Byte	Low Byte		High Byte	Low Byte
322	01	42	362	01	6A	402	01	92
323	01	43	363	01	6B	403	01	93
324	01	44	364	01	6C	404	01	94
325	01	45	365	01	6D	405	01	95
326	01	46	366	01	6E	406	01	96
327	01	47	367	01	6F	407	01	97
328	01	48	368	01	70	408	01	98
329	01	49	369	01	71	409	01	99
330	01	4A	370	01	72	410	01	9A
331	01	4B	371	01	73	411	01	9B
332	01	4C	372	01	74	412	01	9C
333	01	4D	373	01	75	413	01	9D
334	01	4E	374	01	76	414	01	9E
335	01	4F	375	01	77	415	01	9F
336	01	50	376	01	78	416	01	A0
337	01	51	377	01	79	417	01	A1
338	01	52	378	01	7A	418	01	A2
339	01	53	379	01	7B	419	01	A3
340	01	54	380	01	7C	420	01	A4
341	01	55	381	01	7D	421	01	A5
342	01	56	382	01	7E	422	01	A6
343	01	57	383	01	7F	423	01	A7
344	01	58	384	01	80	424	01	A8
345	01	59	385	01	81	425	01	A9
346	01	5A	386	01	82	426	01	AA
347	01	5B	387	01	83	427	01	AB
348	01	5C	388	01	84	428	01	AC
349	01	5D	389	01	85	429	01	AD
350	01	5E	390	01	86	430	01	AE
351	01	5F	391	01	87	431	01	AF
352	01	60	392	01	88	432	01	B0
353	01	61	393	01	89	433	01	B1
354	01	62	394	01	8A	434	01	B2
355	01	63	395	01	8B	435	01	B3
356	01	64	396	01	8C	436	01	B4
357	01	65	397	01	8D	437	01	B5
358	01	66	398	01	8E	438	01	B6
359	01	67	399	01	8F	439	01	B7
360	01	68	400	01	90	440	01	B8
361	01	69	401	01	91	441	01	B9

Table B-1 Hexadecimal/Decimal Cylinder Conversion Chart (Cont)

Decimal Value	Hexadecimal Value		Decimal Value	Hexadecimal Value		Decimal Value	Hexadecimal Value	
	High Byte	Low Byte		High Byte	Low Byte		High Byte	Low Byte
442	01	BA	484	01	E4	527	02	0F
443	01	BB	485	01	E5	528	02	10
444	01	BC	486	01	E6	529	02	11
445	01	BD	487	01	E7	530	02	12
446	01	BE	488	01	E8	531	02	13
447	01	BF	489	01	E9	532	02	14
448	01	C0	490	01	EA	533	02	15
449	01	C1	491	01	EB	534	02	16
450	01	C2	492	01	EC	535	02	17
451	01	C3	493	01	ED	536	02	18
452	01	C4	494	01	EE	537	02	19
453	01	C5	495	01	EF	538	02	1A
454	01	C6	496	01	F0	539	02	1B
455	01	C7	497	01	F1	540	02	1C
456	01	C8	498	01	F2	541	02	1D
457	01	C9	499	01	F3	542	02	1E
458	01	CA	500	01	F4	543	02	1F
459	01	CB	501	01	F5	544	02	20
460	01	CC	502	01	F6	545	02	21
461	01	CD	503	01	F7	546	02	22
462	01	CE	504	01	F8	547	02	23
463	01	CF	505	01	F9	548	02	24
464	01	D0	506	01	FA	549	02	25
465	01	D1	507	01	FB	550	02	26
466	01	D2	508	01	FC	551	02	27
467	01	D3	509	01	FD	552	02	28
468	01	D4	510	01	FE	553	02	29
469	01	D5	511	01	FF	554	02	2A
470	01	D6	512	02	00	555	02	2B
471	01	D7	513	02	01	556	02	2C
472	01	D8	514	02	02	557	02	2D
473	01	D9	515	02	03	558	02	2E
474	01	DA	516	02	04	559	02	2F
475	01	DB	517	02	05	560	02	30
476	01	DC	518	02	06	561	02	31
477	01	DD	519	02	07	562	02	32
478	01	DE	520	02	08	563	02	33
479	01	DF	521	02	09	564	02	34
480	01	E0	522	02	0A	565	02	35
481	01	E1	523	02	0B	566	02	36
482	01	E2	524	02	0C			
483	01	E3	525	02	0D			
			526	02	0E			

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