

# RM02/03 Disk Subsystem Service Manual



digital

# **RM02/03 Disk Subsystem Service Manual**

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## PREFACE

The *RM02/03 Disk Subsystem Service Manual* is designed to aid field personnel in installing, maintaining and repairing the RM02 or RM03 Disk Subsystem.

The first chapter of the book is an introduction to this manual. It contains the maintenance philosophy, as well as a list of additional resources (tools, spares, diagnostics, etc.). This chapter also contains a preventive maintenance schedule.

Chapter 2 describes the procedures to follow when installing an RM02 or an RM03 drive, and also contains a description of the TB3A2 Field Test Unit (FTU).

Chapter 3 details removal and replacement procedures for the Field Replaceable Units (FRUs) in the drive, and Chapter 4 describes several adjustment procedures that field personnel may have to perform.

Chapter 5 is designed to enable service personnel to troubleshoot the RM02 or RM03. This is done by following a step-by-step procedure known as a Fault Isolation Guide (FIG). Instructions on the use of the FIGs, as well as the Fault Isolation Procedures (FIPs) that accompany them, are included in Chapter 5.

Table 1-1 contains a list of additional documentation relevant to the RM02/03 Disk Subsystem.

# CHAPTER 1 INTRODUCTION

## 1.1 MAINTAINABILITY

### 1.1.1 Scope of Manual

This manual contains information concerning the installation, operation and servicing of the RM02/03 Disk Subsystem. It was designed for use by trained DIGITAL Field Service and customer maintenance personnel.

### 1.1.2 RM02/03 Hardware Maintenance Plan

The primary maintenance strategy calls for using on-line software (error logging, etc.) and/or DECX11 to isolate problems to the failing option level. Off-line diagnostics (XXDP) are used to isolate the problem to the adapter or drive portion of the disk. Once this is accomplished, off-line diagnostics and documentation aids are used to troubleshoot the adapter to the defective Field Replaceable Unit (FRU). These same aids, with the addition of the off-line tester, are used to troubleshoot the drive.

The preferred repair philosophy is to replace the defective FRU in accordance with the RM02/03 Service Manual instructions. The Authorized Returns List (ARL) will identify those FRUs to be returned.

#### NOTE

**Procedures requiring special training (head cleaning, carriage, and rail alignment) should not be attempted by untrained personnel.**

## 1.2 RESOURCES

### 1.2.1 Related Documentation

A list of all RM02 and RM03 related documentation that exists on hard copy or microfiche is provided in Table 1-1.

**Table 1-1 RM02/03 Documentation**

---

RM02 Disk Drive Technical Manual – Volume I	(EK-1RM02-TM)*
RM02 Disk Drive Technical Manual - Volume II (RM02 Print Set)	(EK-2RM02-TM)
RM03 Disk Drive Technical Manual - Volume I	(EK-1RM03-TM)*
RM03 Disk Drive Technical Manual - Volume II (RM03 Print Set)	(EK-2RM03-TM)
RM02/03 Disk Subsystem User's Guide	(EK-RM03-UG)
RM02/03 Adapter Technical Description Manual	(EK-RM023-TD)*
RM02 Disk Subsystem Illustrated Parts Breakdown	(EK-RM02-IP)*
RM03 Disk Subsystem Illustrated Parts Breakdown	(EK-RM03-IP)*
RM02 Field Maintenance Customer Print Set (Adapter Print Set)	(MP-00456)
RM03 Field Maintenance Customer Print Set (Adapter Print Set)	(MP-00350)

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\*These documents are also available on microfiche. Order as EP-XXXXX-XX.

### 1.2.2 Special Tools

To maintain the RM02/03 Disk Drive, the following special tools will be needed by field service personnel.

<b>Part No.</b>	<b>Part</b>
29-13212	Torque Screwdriver
29-22933	Card Extender
29-22934	Spindle Alignment Tool
29-22935	Head Adjustment Tool
29-22936	Bit Head Adjust
29-22914	Speed Sensor Tool
30-13992-02	CE Pack
RM03-P	Data Pack
RM03-FTU	Off Line Tester

It is also recommended that a 10 inch standard screwdriver and a 10 inch Phillips head screwdriver be available. The first will be needed to adjust drive belt tension. The second will be necessary to remove the front bezel bracket in order to replace the absolute filter.

### 1.2.3 Initial Spares

The following parts comprise the RM02/03 branch kit.

**RM02 DEC/CDC Cross Reference (Part Numbers)**

<b>Description</b>	<b>DEC Part No.</b>	<b>CDC Part No.</b>
Fuse, 2 A 250 V	29-22872	95647602
Fuse, 8 A 250 V	29-22873	95647606
Magnet assembly	29-22874	47200700
HRVV receiver (A2B02)	29-22875	54147709
ASGV speed detect (A2A10)	29-23117	54152505
BSHV power supply (A1A03)	29-22877	54152902
5SJV power supply (A1A01)	29-22878	54153300
5SKV power supply (A1A01)	29-22879	54153700
JTVV transmitter (A2801)	29-22880	54167710
JFRV fine servo (A2A03)	29-23112	54226114
EKFV fault register (A2A04)	29-22882	54262105
FLPV servo control (A2A09)	29-22883	54275307
JLQV D/A converter (A2A07)	29-22884	54275710
LLRV data latch (A2A05)	29-23113	54276113
BLSV write PLO (A2A01)	29-23111	54276502
NLTV A-Cont/Sect (A2B08)	29-23116	54276914
ELUV A-Cont 2 (A2A08)	29-22888	54277306
MLVV A-Cont 1 (A2B09)	29-22889	54277713
FLWV diff generator (A2B06)	29-22890	54278107
ELXV NRZ to MFM (A2B07)	29-23115	54278505
CLZV read PLO (A2A06)	29-23114	54279304
Meter, hour 60 Hz	29-22893	73120400
FZQN servo preamp (A3A05)	29-22894	73485311
Head and arm assembly (Lower)	29-23109	75010302
Head and arm assembly (Upper)	29-23107	75010303
Head and arm assembly (Servo)	29-23108	75010305
NZJN head select/read amp (A3A02)	29-23119	75061719
DZKN write drive (A3A03)	29-23118	75062106
Spindle assembly	29-22900	75074714
Blower assembly, 60 Hz	29-22901	75240304
Blower assembly, 50 Hz	29-22902	75240305
Brake assembly hysteresis	29-22903	75241500
HZYN Control panel assembly (A3A01)	29-22904	76422501
Flex lead assembly	29-22905	76426800
Transducer assembly	29-22906	76427300
Transformer, 60 Hz	29-22907	76840400
Transformer, 50 Hz	29-22908	76846800
Sensor assembly, speed	29-22909	77387101
Carriage and coil assembly	29-22910	77398303
Motor, drive 60 Hz	29-23121	77398414
Motor, drive 50 Hz	29-23122	77398412
5VTN Servo power (A3A04)	29-22913	77569100
Tool sensor height adjust	29-22914	87052600
Belt, drive 60 Hz	29-23110	92314099
Belt, drive, 50 Hz	29-23120	92314115

**RM02 DEC/CDC Cross Reference (Part Numbers) (Cont)**

<b>Description</b>	<b>DEC Part No.</b>	<b>CDC Part No.</b>
Circuit breaker, 5 A 60 Hz	29-22917	92696065
Circuit breaker, 5 A 50 Hz	29-22918	92696079
Switch interlock	29-22919	93560002
Switch, mini	29-22920	93786005
Circuit breaker, 8 A 50 Hz	29-22921	94245205
Circuit breaker, 5 A 60 Hz	29-22922	94245217
243-29MFD 60 Hz	N/A	94255112
Meter, hour 50 Hz	29-22924	94313807
Filter, air 15.77 × 11	29-22925	94364700
Filter, air	29-22926	00815481
4MFD 370 Vac 10%	29-22927	94365800
Filter, line 10 A	29-22928	94371200
Switch solid state AC	29-22929	76427404
21000MFD 50 Vdc and 10	29-22930	95578111
Card extender	29-22933	54109701
Carr/spindle adj tool	29-22934	75018400
Head adj tool	29-22935	75018804
Bit 1/4 Hex hd adj	29-22936	87016701
6MFD 660 Vac 6	29-22938	95686701
Rail, lower carr guide	29-23028	75063600
Rail, upper carr guide	29-23029	75063700

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<b>Description</b>	<b>DEC Part No.</b>	<b>CDC Part No.</b>
Fuse, 2 A 250 V	29-22872	95647602
Fuse, 8 A 250 V	29-22873	95647606
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BSHV power supply (A1A03)	29-22877	54152902
5SJV power supply (A1A01)	29-22878	54153300
5SKV power supply (A1A01)	29-22879	54153700
JTVV transmitter (A2801)	29-22880	54167710
HFRV fine servo (A2A03)	29-23881	54226113
EKFV fault register (A2A04)	29-22882	54262105
FLPV servo control (A2A09)	29-22883	54275307
JLQV D/A converter (A2A07)	29-22884	54275710
HLRV data latch (A2A05)	29-22885	54276108
CLSV write PLO (A2A01)	29-22886	54276503
ELTV A-Cont/Sect (A2B08)	29-22887	54276909
ELUV A-Cont 2 (A2A08)	29-22888	54277306
MLVV A-Cont 1 (A2B09)	29-22889	54277713
FLWV diff generator (A2B06)	29-22890	54278107

**RM03 DEC/CDC Cross Reference (Part Numbers) (Cont)**

<b>Description</b>	<b>DEC Part No.</b>	<b>CDC Part No.</b>
ELXV NRZ to MFM (A2B07)	29-22891	54278505
BLZV read PLO (A2A06)	29-22892	54279303
Meter, hour 60 Hz	29-22893	73120400
FZQN servo preamp (A3A05)	29-22894	73485311
Head and arm assembly (Lower)	29-22895	75010102
Head and arm assembly (Upper)	29-22896	75010103
Head and arm assembly (Servo)	29-22897	75010105
NZJN head select/read amp (A3A02)	29-22898	75061715
EZKN write drive (A3A03)	29-22899	75062107
Spindle assembly	29-22900	75074714
Blower assembly, 60 Hz	29-22901	75240304
Blower assembly, 50 Hz	29-22902	75240305
Brake assembly hysteresis	29-22903	75241500
HZYN Control panel assembly (A3A01)	29-22904	76422501
Flex lead assembly	29-22905	76426800
Transducer assembly	29-22906	76427300
Transformer, 60 Hz	29-22907	76840400
Transformer, 50 Hz	29-22908	76846800
Sensor assembly, speed	29-22909	77387101
Carriage and coil assembly	29-22910	77398303
Motor, drive 60 Hz	29-22911	77398410
Motor, drive 50 Hz	29-22912	77398413
5VTN Servo power (A3A04)	29-22913	77569100
Tool sensor height adjust	29-22914	87052600
Belt, drive 60 Hz	29-22915	92314113
Belt, drive, 50 Hz	29-22916	92314119
Circuit breaker, 5 A 60 Hz	29-22917	92696065
Circuit breaker, 5 A 50 Hz	29-22918	92696079
Switch interlock	29-22919	93560002
Switch, mini	29-22920	93786005
Circuit breaker, 8 A 50 Hz	29-22921	94245205
Circuit breaker, 5 A 60 Hz	29-22922	94245217
243-29MFD 60 Hz	29-22923	94255116
Meter, hour 50 Hz	29-22924	94313807
Filter, air 15.77 × 11	29-22925	94364700
Filter, air	29-22926	00815481
4MFD 370 Vac 10%	29-22927	94365800
Filter, line 10 A	29-22928	94371200
Switch solid state ac	29-22929	76427404
21000MFD 50 Vdc and 10	29-22930	95578111
Card extender	29-22933	54109701
Carr/spindle adj tool	29-22934	75018400
Head adj tool	29-22935	75018804
Bit 1/4 Hex hd adj	29-22936	87016701
6MFD 660 Vac 6	29-22938	95686701
Rail, lower carr guide	29-23028	75063600
Rail, upper carr guide	29-23029	75063700

The following parts comprise the DEC portion of the RM02/03 branch kit. These parts are to be contained in a standard universal case, 29-22390, which will be distributed with the parts. A special insert has been designed for it, 29-23001.

DEC Part No.	Description	Quantity
M5922	Transceiver	1
M5923	Transceiver	1
M7684	Control Sequencer	1
M7685	Data Sequencer	1
M7686	Control Interface	1
M7687	Drive Data Interface	1
54-11086	15 V Regulator	1
70-13784	H7440 Assembly	1

Parts which will not fit in either case, but are nevertheless part of the kit are as follows.

DEC Part No.	Description	Quantity
29-22901	Blower Assembly, 60 Hz	1
or		
29-22902	Blower Assembly, 50 Hz	1
29-22904	Control Panel Sw. Assy.	1
29-22906	Transducer Assembly	
29-22911	Drive Motor, 60 Hz	1
or		
29-22912	Drive Motor, 50 Hz	1
29-22925	Filter	1
29-22926	Filter	1
30-13992-02	CE Pack	1
RM03-P	Data Pack	1

#### 1.2.4 Cable List

The following is a list of cables and DEC part numbers.

Name	Number
Controller I/O Cables (Three in controller)	BC06R-8
25 ft Massbus Cable (Controller to drive)	BC06S-25
15 ft Massbus Cable (Drive to drive)	BC06S-15
Power Sequence Cable (Drive to drive)	7009491-02
Power Sequence Jumper (J8 on adapter backplane)	7009490
Ground Strap (Drive to drive)	7412827-3
Ground Strap (Controller to drive)	7412827-25
Terminator Assembly (On last drive)	7009938-00

### **1.2.5 Diagnostics**

The diagnostic tests that are used during installation of the disk subsystem may be used any time to demonstrate system performance or to help pinpoint problem areas. A brief functional description of these programs is provided.

#### **RM02/03 Drive Diagnostics**

**RM02/03 Formatter (MAINDEC-ZZ-CZRMA)** – This program provides the facilities to format or check the header and data fields of each data block on the disk pack.

In the format operation, the program writes the header of each data block with a cylinder number, track number, and sector number. It also writes the data field with a selected data pattern. The program then verifies the written data blocks by executing the Write Check Head and Data command.

In the check operation, the program repeats the format operation three times while the data pattern is rotated one bit at each pass.

The formatter will also flag bad sectors, and allows access to the bad sector file.

**RM02/03 Performance Exerciser (MAINDEC-ZZ-CZRMB)** – This program performs an interactive test on RM02/03 Disk Drive connected to a Massbus system. It is used to verify that the drives under test are performing to their data error rate.

The program will exercise a mixed system of dual port and single port drives and monitor the performance of each. It reports the statistics for each drive being exercised either on request from the operator or automatically at intervals determined by the operator.

**RM02/03 Functional Tests** – The functional test is a stand alone program which uses functional means to verify the operability of the RM02/03 disk subsystem. The Functional Test is comprised of three parts, which would normally be run in sequence starting with part I. Briefly, part I tests housekeeping and mechanical positional operations; part II tests write, read and write check operations using header and data; part III tests write, read and write check operations using data.

**Part I (MAINDEC-ZZ-CZRMC)** – Part I is used to establish confidence in the basic operations of the disk drive, including mechanical positioning and data transfer operations.

**Part II (MAINDEC-ZZ-CZRMD)** – Part II of the Functional Test performs write, read and write check operations using header and data.

Note that part II of the Functional Test leaves two header errors on the media and the pack must be reformatted after running this test.

**Part III (MAINDEC-ZZ-CZRME)** – Part III of the Functional Test performs write, read and write check operations using data.

Note that part III of the Functional Test leaves two header errors on the media and the pack must be reformatted after running this test.

#### **NOTE**

**Although the Functional Test, Parts II and III, leaves header errors on the pack, the Revision B or higher versions will correct the errors. REV A of the Functional Test requires reformatting after each use.**

**RM02/03 Extended Drive Test (MAINDEC-ZZ-CZRMF)** – This program contains a series of tests that will verify that the disk drive is capable of performing seeks and that the access times are within tolerance. It also verifies that the track and sector addressing circuitry operates properly and that the data storage and retrieval capabilities are functioning.

**RM02/03 Dual Port Logic Test, Part I (MAINDEC-ZZ-CZRMG)** – This program performs tests on the dual port control logic. During this test both ports of the drive are cabled to the same Massbus by a special adapter cable. This arrangement allows the dual port logic to be tested from a single RH controller.

**RM02/03 Dual Port Logic Test, Part II (MAINDEC-ZZ-CZRMH)** – Part II of the Dual Port Logic program is used to test the Port Select Switch. The special cable is also used during this test to permit operation from a single RH controller.

**RM02/03 Drive Compatibility Test (MAINDEC-ZZ-CZRMI)** – This program is used to verify the compatibility of up to 16 drives which may reside on one or more RH controllers. It tests the ability of a drive to write data that can be successfully read by all other drives, and to overwrite data written by all other drives. The diagnostic will detect the following causes of incompatibility:

1. Head misalignment
2. Positioner lateral misalignment
3. Spindle runout
4. Improper levels of write current
5. Incorrect addressing of read/write heads.

**RM02/03 Diskless Diagnostic (MAINDEC-ZZ-CZRMJ)** – This standalone program is used to verify the operability of the RM02/03 Disk Subsystem independently of the disk drive. It is used to resolve hardware failures in the RM02/03 Adapter to field replaceable modules.

### 1.3 PREVENTIVE MAINTENANCE

This section provides a general outline of the Preventive Maintenance Procedure to be used on the RM02/03 Disk Drive. For more specific information, refer to the Site Management Guide.

<b>Procedure</b>	<b>Frequency</b>
General Cleaning	Quarterly
Replace Primary Filter	Quarterly
Replace Absolute Filter	Annually
Clean Shroud and Spindle	Quarterly
Clean and Lubricate Lockshaft	Quarterly
Inspect and Clean Rails and bearings	Quarterly
Check Power Supply Output	Quarterly
Check Head Alignment	Semi-Annually

## CHAPTER 2 INSTALLATION

### 2.1 INTRODUCTION

This chapter details the information required to install an RM02 or an RM03 Disk Subsystem. There is a variety of possible combinations of drives, controllers, and processors, and Table 2-1 lists the currently acceptable configurations.

Table 2-1 Subsystem Configurations

Drive	Controller	Processor
RM02	RH11	PDP-11 (excluding PDP-11/70)
RM02/RPxx mix	RH11	PDP-11 (excluding PDP-11/70)
RM03	RH70	PDP-11/70
RM03/RPxx mix	RH70	PDP-11/70

Any special information regarding the drive or drive mix will be detailed in the paragraphs describing the specific controller's installation.

### 2.2 SITE PREPARATION AND PLANNING

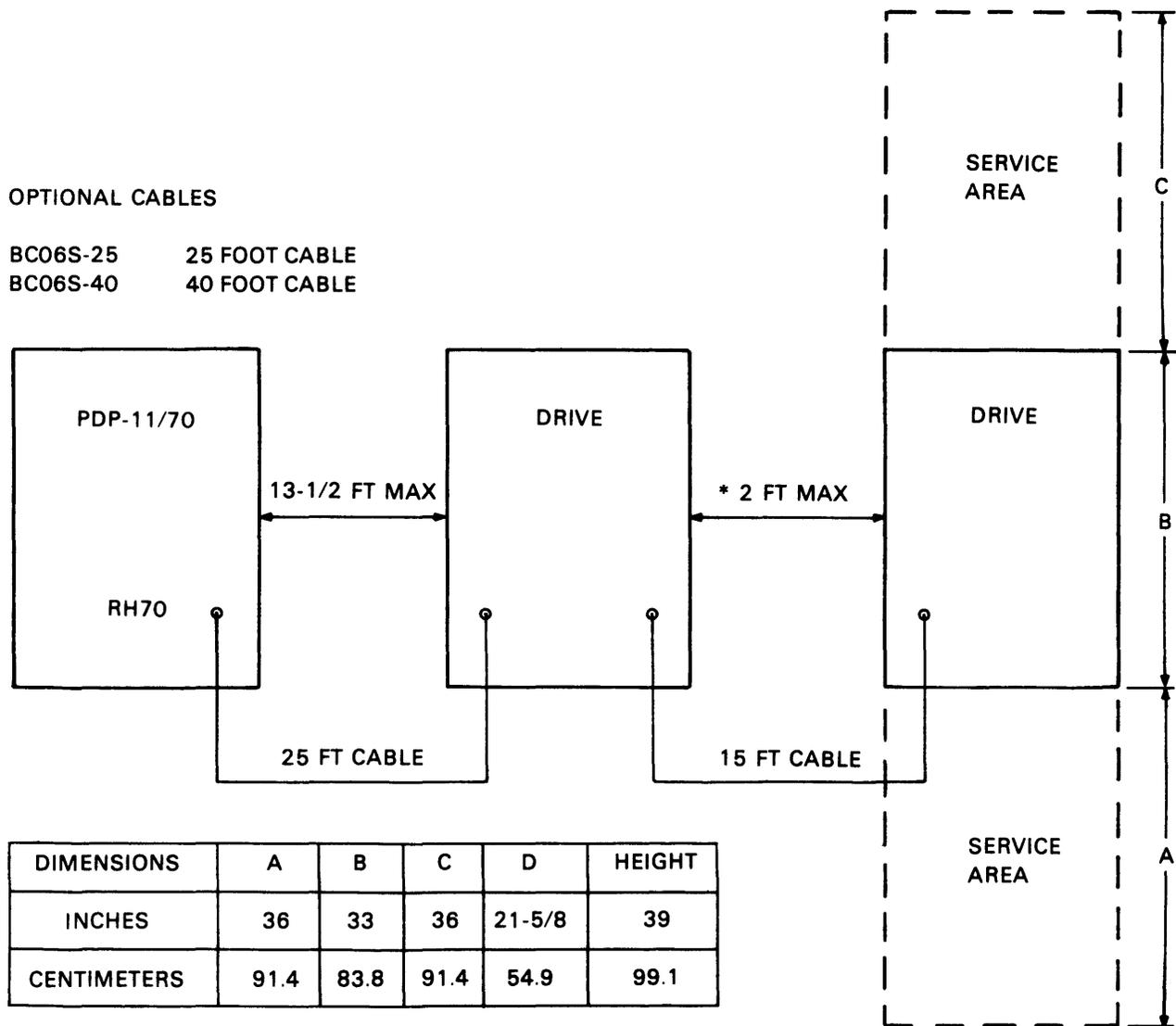
This paragraph describes power, space, environmental, cable length, and safety requirements that must be considered before installation of the RM02 or RM03 Disk Subsystem.

#### 2.2.1 Environmental Considerations

The RM02 and RM03 Disk Subsystems are designed to operate in a business or light industry environment. Although cleanliness is an important consideration in the installation of any computer system, it is particularly crucial for proper operation of a disk drive. The RM03P disk cartridge is not sealed while being loaded and is therefore vulnerable to dust or smoke particles, fingerprint smudges, hair, lint, etc. These minute obstructions can cause head crashes, resulting in catastrophic damage to the read/write heads and disk surfaces.

**2.2.1.1 Cleanliness** – The drive can operate in an ambient of less than one million particles (0.5 micron or larger in diameter) per cubic foot of air. The drive contains a filter system which, under these conditions, maintains the particle count within the cartridge below 100 particles per cubic foot.

**2.2.1.2 Space Requirements** – The space requirements for each drive is shown in Figure 2-1. The drives may be arranged so that they are either immediately adjacent to each other, or separated by a distance of up to 61 cm (2 ft) maximum. *If the drives are arranged so that they are immediately adjacent to each other, they will have to be pulled out of line to perform some types of service.*



\* WITH STANDARD CABLE LENGTH

MA-0644

Figure 2-1 Disk Subsystem Space Requirements

The maximum subsystem Massbus cable length is 48.77 m (160 ft). To calculate drive location, assume each drive uses 4 m (13 ft) of Massbus cable within the drive [2 m (6 1/2 ft) in and 2 m (6 1/2 ft) out]. Allow 1.5 m (5 ft) of cable for the connection to the RH controller inside its cabinet. Hence, the first drive may be located up to 4.1 m (13 1/2 ft) from the controller as shown in Figure 2-1.

When calculating the total cable length, add an extra 0.5 m (1-1/2 ft) for each MBA backplane.

**2.2.1.3 Floor Loading** – The weight of the disk drive alone (196 kg/430 lb) will not place undue stress on most office-building, industrial-plant, or raised-computer-room floors. However, the added weight of the number of cabinets and drives should be considered in relation to the weight of existing computer systems plus needs for possible future expansion.

**2.2.1.4 Heat Dissipation** – The heat dissipation of some RM02 or RM03 Disk Subsystems may reach 2500 Btu/hour, maximum. The approximate cooling requirements for the entire system can be calculated by multiplying this figure by the number of drives, adding the result to the total heat dissipation of the other system components, and then adjusting the total figure to compensate for personnel, cooling system efficiency, etc. It is advisable to allow a safety margin of at least 25 percent above the maximum estimated requirements.

**2.2.1.5 Acoustics** – Most computer sites require at least some degree of acoustical treatment. However, the disk subsystem should not contribute unduly to the overall system noise level. Ensure that the acoustical materials used do not produce or harbor dust.

**2.2.1.6 Temperature** – The operating temperature range of the RM02 or RM03 Disk Subsystem is from 15° C (59° F) to 32° C (90° F). The maximum temperature gradient is 7° C (12° F) per hour. The non-operating temperature range is from -40° C (-40° F) to 66° C (151° F) with a maximum gradient of 20° C (36° F) per hour.

**2.2.1.7 Relative Humidity** – Humidity control is important for proper operation of any computer system since static electricity can cause memory errors as well as permanent damage to logic components. The RM02 and RM03 Disk Subsystems are designed to operate within a relative humidity range of 20 to 80 percent with a maximum wet bulb temperature of 28° C (82° F) and a minimum dew point of 2° C (36° F). The non-operating relative humidity range is from 5 to 95 percent, with a maximum wet bulb temperature of 46° C (115° F).

**2.2.1.8 Altitude** – Computer system operation at high altitudes can result in heat dissipation problems. Altitude also affects the flying height of heads in disk drives. The maximum altitude specified for operating the RM02 or RM03 Disk Subsystem is 2000 m (6500 ft). However, the maximum allowable operating temperature is reduced by a factor of 1.8° C/1000 m (1° F/1000 ft) for high-altitude sites. Thus, the maximum allowable operating temperature at 2000 m (6500 ft) would be reduced to 28° C (83.5° F).

**2.2.1.9 Attitude/Mechanical Shock** – Performance of the RM02 or RM03 Disk Subsystem will not be affected by an attitude where maximum pitch and roll do not exceed ±5 degrees.

The subsystem is designed to operate while a half-sine shock pulse of 2 G peak and 10 ms maximum duration is applied once in either direction of three octagonal axes (3 pulses total).

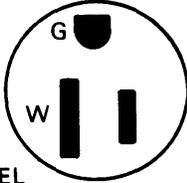
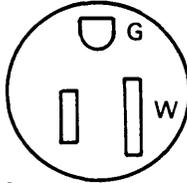
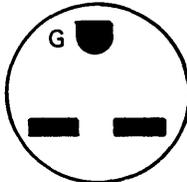
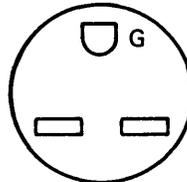
**2.2.1.10 Power and Safety Precautions** – The RM02 or RM03 Disk Subsystem presents no unusual additional fire or safety hazards to an existing computer system. AC power wiring should be carefully checked, however, to ensure that its capacity is adequate for the added load and for any contemplated expansion. The disk subsystem is UL-listed and CSA-certified.

### 2.2.2 AC Power Wiring

DEC power wiring conforms to UL, CSA, and VDE standards. This means that the wire used as equipment ground is green and yellow. It carries no load current (except in emergency), but does carry leakage current. No equipment is permitted to leave DEC that does not have a grounding connection to its frame.

The ac return line (also called the “identified” conductor, neutral, common, cold lead, etc.) is blue. It must not be used to ground equipment. Its purpose is to conduct current.

The ac input line (hot wire) is brown. Its purpose is to supply current to the system. The ac plugs and receptacles used on this subsystem are shown in Figure 2-2.

SOURCE	PLUG	RECEPTACLE	USED ON
120 V 15 A 1-PHASE	 HUBBEL #5266-C  NEMA #5-15P DEC #90-08938	 #5262 5-15R 12-05351	ALL 120 V TABLE-TOP COMPUTERS. STANDARD 120 V LOW-CURRENT DISTRIBUTION. 120 V TU10 UNITS. MOST 120 V TERMINAL DEVICES.
240 V 15 A 1-PHASE	 NEMA #6-15P DEC #90-08853	 6-15R 12-11204	ALL 240 V TABLE-TOP COMPUTERS. STANDARD LOW-CURRENT 240 V DISTRIBUTION. MOST 240 V TERMINAL DEVICES. 240 V TU10.

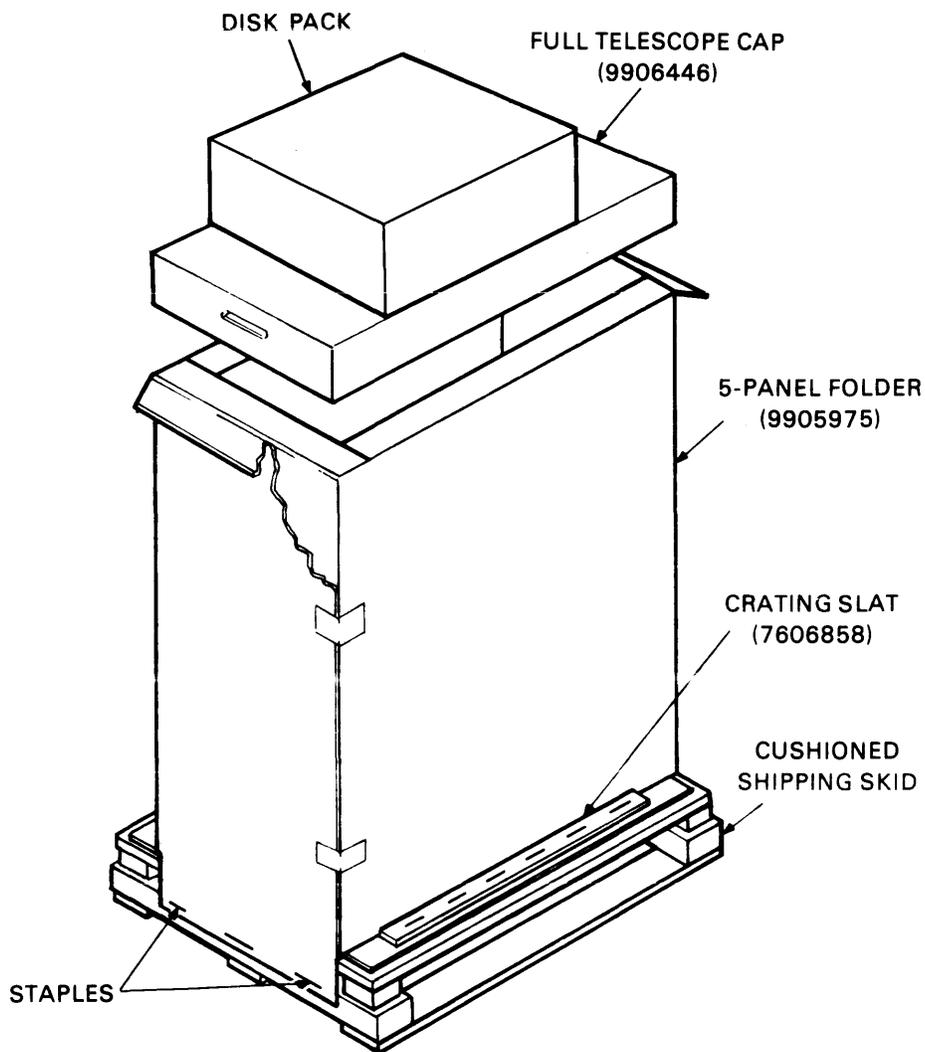
MA-0913

Figure 2-2 Approved Electrical Plugs and Receptacles

### 2.3 DRIVE UNPACKING AND INSPECTION PROCEDURE

When delivered, the drive and its associated cabinetry are enclosed by a heavy cardboard carton and are attached to a shipping skid (Figure 2-3).

1. Inspect the outside of the container for damage. Then remove the plastic straps that secure the shipping carton to the skid.
2. Remove the disk pack box.
3. Remove the lid from the top of the disk drive carton.



MA-0914A

Figure 2-3 Shipping Package

4. Remove the staples that fasten the wooden crating slats and carton flanges to the skid.
5. Remove the shipping carton.
6. Inspect the cabinet and drive for physical signs of shipping damage. Retain all packing material and receipts in the event that any claims are filed for shipping damage. All damage claims should be filed promptly with the transportation company.

Digital Equipment Corporation should be notified immediately if a damage claim is made.

7. Inventory all hardware, cables, manuals, etc. in the shipping carton against the packing slip. Notify Digital Equipment Corporation immediately if any discrepancies exist.
8. Remove front door assembly (Figure 2-4).

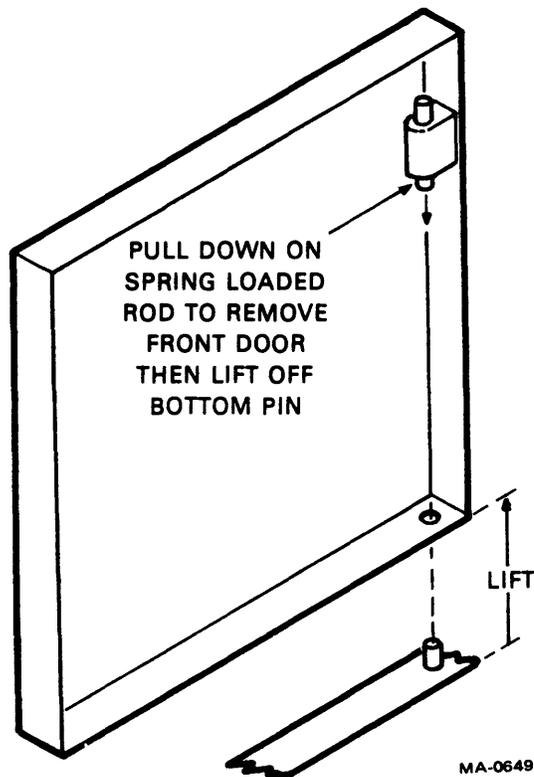


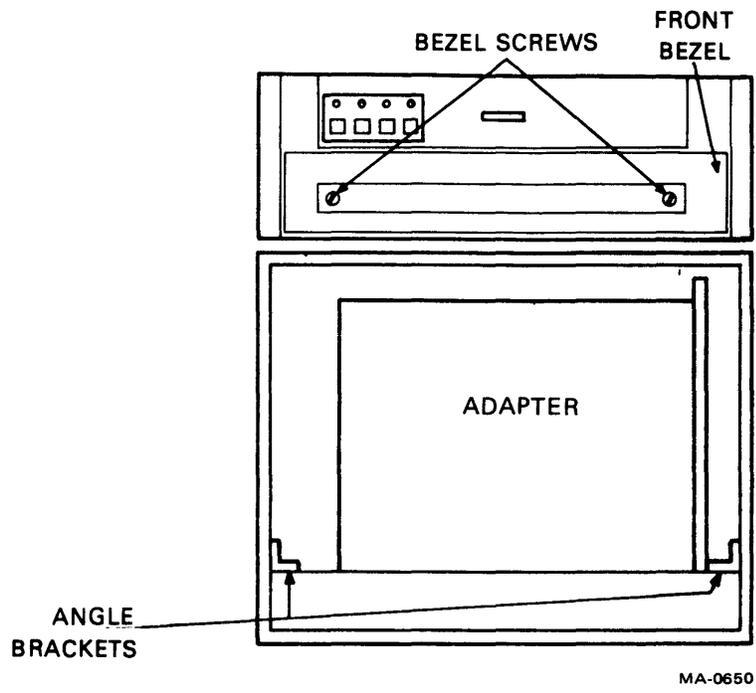
Figure 2-4 Front Door Removal

9. Remove orange angle brackets (Figure 2-5) which attach MBA drawer assembly to cabinet frame.

**CAUTION**

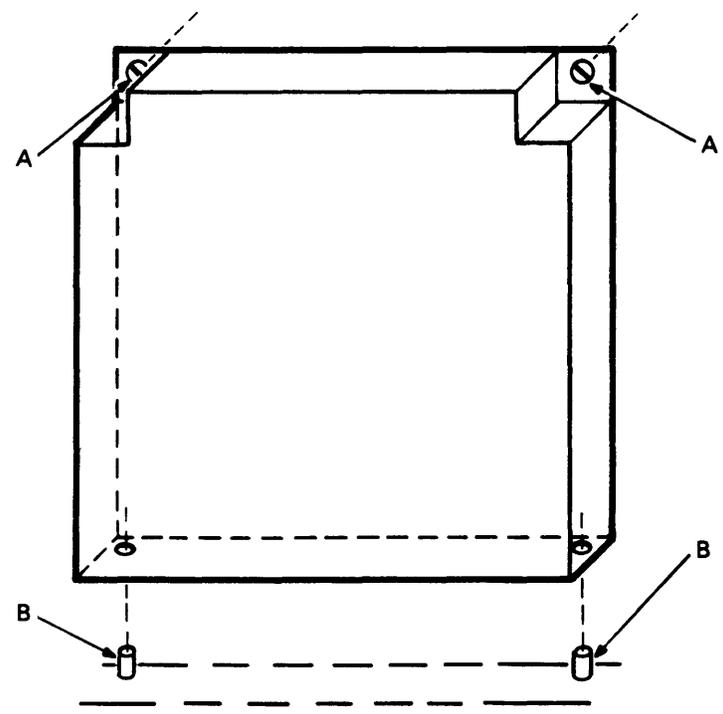
**Do not misplace these brackets. They must be replaced before the installation is completed.**

10. Remove the rear cover assembly (Figure 2-6).
11. Slide the MBA drawer forward and remove the sheet-metal screws that attach the side panels (Figure 2-7) to the cabinet frame.
12. Slide the MBA drawer back into position.
13. Lift off the side panels.
14. Remove the two bolts securing the cabinet to the shipping skid.
15. Remove all skid blocks and position the cabinet leveling feet so that the cabinet rolls freely on its casters.
16. Carefully lower the cabinet off the skid without jarring the cabinet.



MA-0650

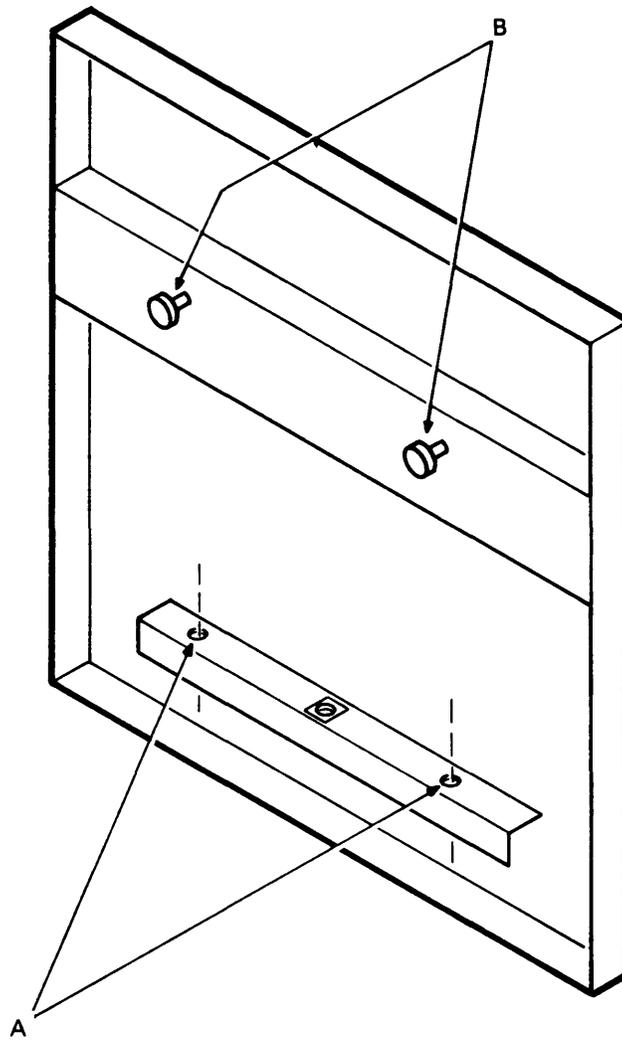
Figure 2-5 Front Bezel Location



- TO REMOVE REAR COVER:
1. LOOSEN LOCKING SCREWS (A).
  2. LIFT REAR COVER OFF PINS (B).

MA-0651

Figure 2-6 Rear Cover Removal



TO REMOVE SIDE PANELS  
REMOVE SCREWS AT LOCATIONS (A)  
AND LIFT PANEL UP. FREE PINS (B),  
THEN PULL OUTWARDS.

MA-0646

Figure 2-7 Side Panel Mounting Screws

17. Roll the cabinet to the area designated by the site preparation plan.
18. Extend the MBA slide forward. Loosen the screws on the MBA logic cage assembly and remove the cover.
19. Ensure that all MBA boards and cable connections are firmly seated.
20. Replace cage cover.

21. Loosen the two quarter-turn fasteners at the rear of the drive and then slide the rear cover back and lift it off.
22. Verify that all logic cards are firmly seated in the drive logic chassis and power supply.
23. Verify that all drive connectors are firmly seated.
24. Remove the two screws that secure the front bezel (Figure 2-5). Lift the front bezel up and off.
25. Insert a screwdriver blade into the slot under the pack access cover latch and depress the pack access cover latch release.

**NOTE**

**The pack access cover latch is not functional unless ac power is applied to the drive.**

26. Raise the pack access cover.
27. Remove the plastic cover from the spindle.
28. Remove the two deck hold-down screws (Figure 2-8).
29. Locate the drive shipping bracket which is located on the right side of the drive baseplate (Figure 2-8). Loosen the upper bolt. Remove the lower shipping bracket bolt. Swing shipping bracket 180 degrees and tighten upper bolt. Replace lower shipping bracket bolt.

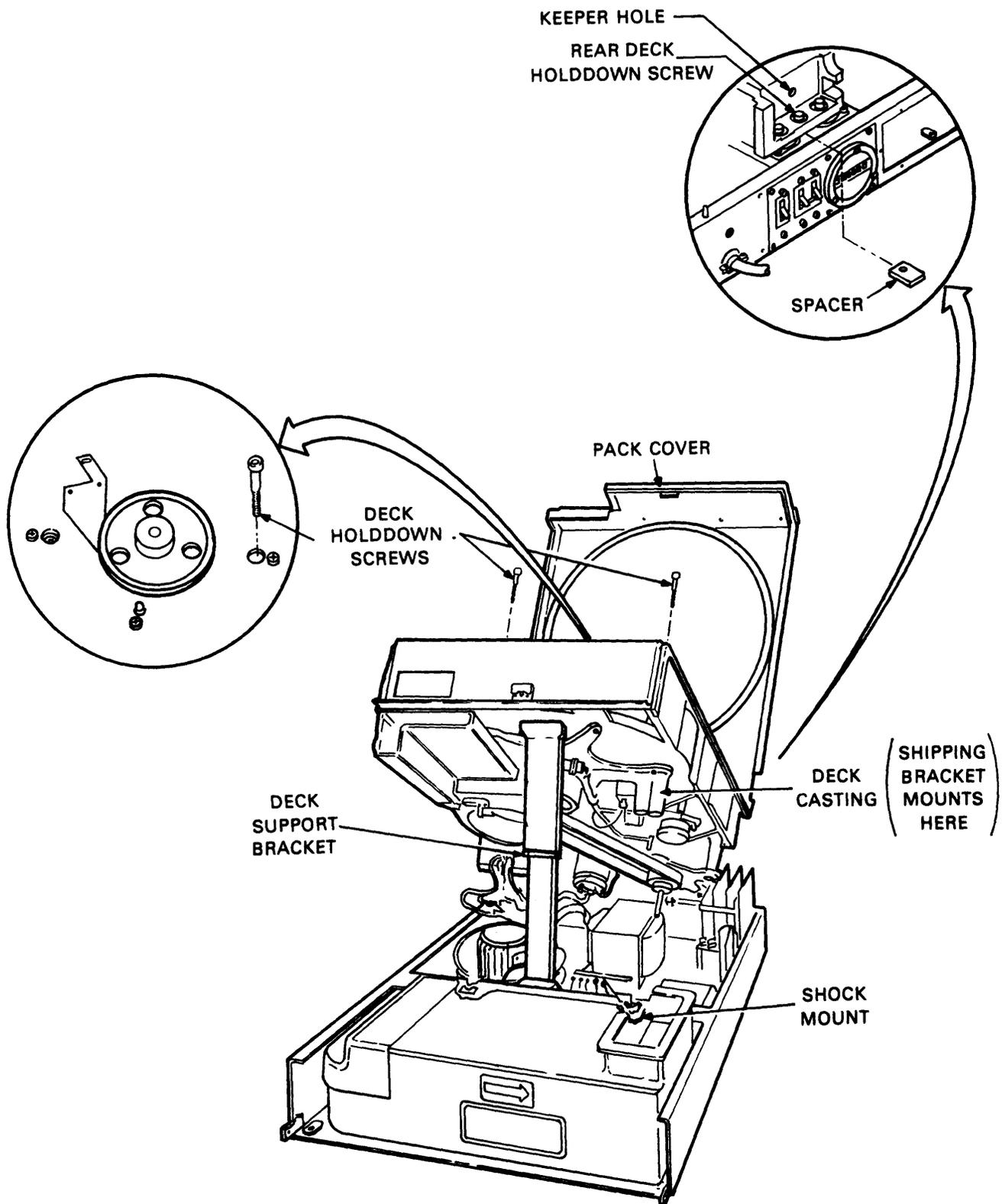
**CAUTION**

**Do not remove or misplace the shipping bracket. It must be used any time the drive is moved.**

30. Raise the drive deck and verify that all cabling is intact and that there are no broken or damaged wires.
31. Lower the drive deck and replace the two hold-down screws.
32. Remove the actuator holding pin from the hole labeled "Shipping Lock" and place it into the hole labeled "Pin Storage." The actuator holding pin is located on the rail bracket above the carriage coil assembly (Figure 2-9).
33. Remove the rear deck hold-down screw and spacer (Figure 2-10). Using the hold-down screw, fasten the spacer onto the actuator magnet housing via the keeper hole.

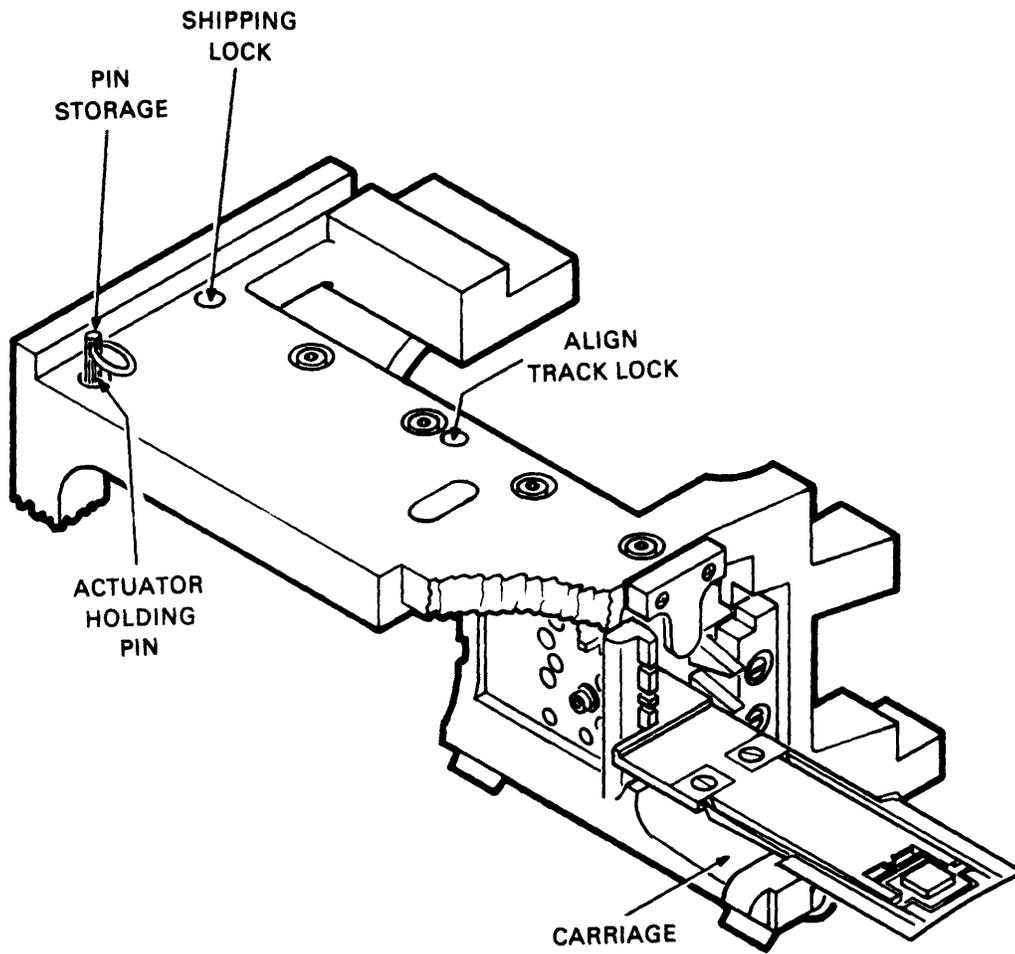
**CAUTION**

**The spacer must be placed between the magnet housing and the baseplate any time the drive deck is raised in order to prevent damage to the rubber shock mounts.**



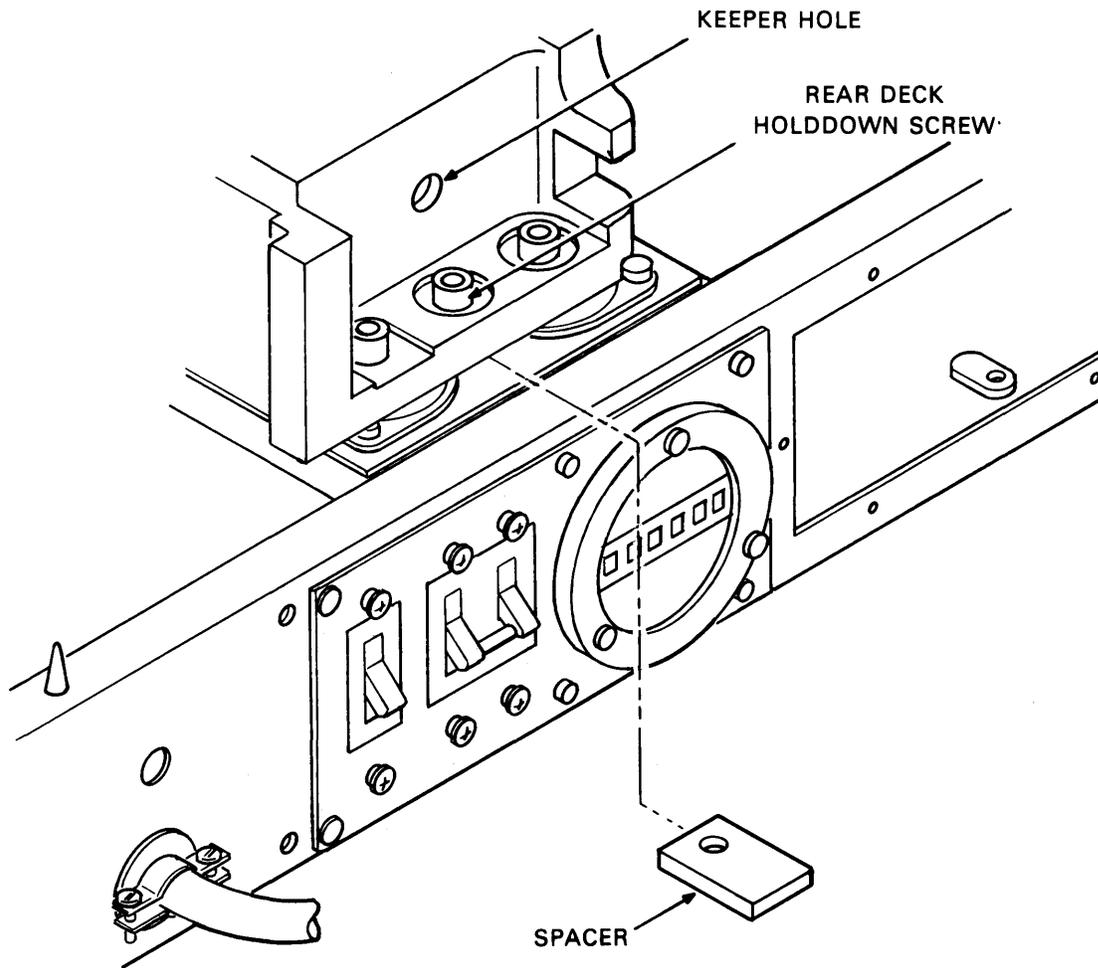
MA-0611

Figure 2-8 Deck Maintenance Position



MA-0607

Figure 2-9 Location of Actuator Holding Pin



MA-0609

Figure 2-10 Location of Rear Deck Holding Screw

## 2.4 RH11 CONTROLLER INFORMATION

The following paragraphs describe the mechanical and electrical installation, power checks, jumper configurations, and visual inspections necessary for installation of the RH11 controller. The RH11 controller will handle an RM02/RPxx drive mix. The particular details required to accommodate the mix are described in the individual paragraphs on jumper configurations.

### 2.4.1 Mechanical

The RH11 uses two hex-height modules and must be installed in a mounting box that accommodates hex-height modules. The modules are inserted in a double-system unit backplane which is installed in the mounting box with four thumbscrews. The double-system unit is oriented with the bus cable slots in line with the other options. Figure 2-11 shows a module utilization chart.

A	UNIBUS A IN (BUSA) (SEE NOTE 1)						UNIBUS B OUT (BUSB) (SEE NOTE 2)	UNIBUS B IN (BUSB) (SEE NOTE 2)	UNIBUS A OUT (BUSA) (SEE NOTE 3)
B	M7297								
C	PARITY CONTROL (PAC)	BUS CONTROL (BCT) MODULE	DATA BUFFER & CONTROL (DBC) MODULE	MASSBUS TRANS- CEIVER (MBSA)	MASSBUS TRANS- CEIVER (MBSB)	MASSBUS TRANS- CEIVER (MBSB)			
D	M7296						G727	G727	G727
E	CONTROL & STATUS REGISTERS (CSR)			UNIBUS POWER FAIL DRIVER (BUSB)	UNIBUS POWER FAIL DRIVER (BUSA)				
F									
	1	2	3	4	5	6	7	8	9

NOTES:

- MAY BE EITHER M920 (CONNECTION FROM ADJACENT DEVICE) OR BC11A CABLE (CONNECTION FROM ANOTHER BOX OR NON ADJACENT DEVICE).
- MAY BE M9300 (TERMINATION AT BEGINNING OR END OF UNIBUS B) OR BC11A CABLE (CONNECTION TO OTHER BUS B DEVICES).
- MAY BE M920 (CONNECTION TO ADJACENT DEVICE), M930 (TERMINATION AT END OF UNIBUS A) OR BC11A CABLE (CONNECTION TO NEXT BOX OR NON ADJACENT DEVICE).
- G727 GRANT CONTINUITY MODULE(S) MUST BE INSERTED IN SLOTS D

11-2384

Figure 2-11 RH11 Module Utilization

## 2.4.2 Electrical

The power cable connections, Unibus cable connections, and Massbus cable connections are described in the following paragraphs.

**2.4.2.1 Power Cable Connections** – Power is distributed to the RH11 modules via two power cables that attach to the printed circuit backplane assembly by quick-disconnect tabs. (Refer to RH11 wired assembly drawing, D-AD-7009397-0-0.) The power cables have Mate-N-Lok connectors on one end, which connect to the power distribution panel located above the backplane, and quick-disconnect tabs on the other end, which connect to the printed circuit backplane. The following chart shows the color codes associated with the power harness connections.

Red	+5 Vdc
Black	Gnd
Blue	-15 Vdc
Gray	+15 Vdc
Violet	DC LO (+3 V to +5 V)
Yellow	AC LO (+3 V to +5 V)
Brown	LTC 8 V peak-to-peak ac

### CAUTION

**When connecting the power cables to the backplane, ensure that backplane wires are not damaged. Also, do not cut AC LO and DC LO wires out of the power harness as they are used for power fail conditions on the Massbus and on both Unibus A and Unibus B ports.**

After power connections have been made, check for power shorts with an ohmmeter. Ensure that all modules are firmly seated in the proper slots (Figure 2-11). Power-up the cabinet and measure voltages in accordance with values listed in the color code chart for power connections. After this is done, turn power off.

**2.4.2.2 Unibus Cable Connections** – The RH11 is a 2-port Unibus device capable of accepting two Unibus cable systems, designated Unibus A and Unibus B.

**Unibus A Connections** – The Unibus A cable slots connect the RH11 to the processor controlling it. The Unibus A cable enters the RH11 via slot A1, B1 and connects to the next device via slot A9, B9.(Refer to module utilization drawing, D-MU-RH11-0-01.)

Connections to slot A1, B1 are made via the BC11A Unibus cable if the RH11 is the first Unibus A device in the mounting box. Otherwise, connection to A1, B1 from the preceding device is made by an M920 Unibus jumper module. Connection to the next adjacent device on the Unibus is made via the M920 Unibus jumper module; it is made by a BC11A cable if the device is not adjacent.

### NOTE

**If the RH11 is the last device on Unibus A, an M930 terminator module is installed in slot A9, B9.**

**Unibus B Connections** – Unibus B connections are generally made in systems with multiport memories. When the Unibus B port of the RH11 is not used, an M9300 terminator module (with jumper W1 cut) should be installed in slot A8, B8 to terminate Unibus B signals into the RH11. The second M9300 terminator module should *not* be used in order to conserve power. If the Unibus B port of the RH11 is used, connections are determined on the basis of whether a processor is connected to Unibus B. These connections are described below.

1. **Processor on Unibus B** – If a processor is connected to Unibus B, it is electrically connected at the beginning of the bus. In this case, the M930 terminator modules supplied with the processor are used for bus termination, and the two M9300 Unibus B terminator modules supplied with the RH11 are not used.

**NOTE**

**The M9300 terminator may be used as a substitute for the M930 terminator if the jumpers are selected correctly.**

The Unibus B cable connection to the RH11 is made via slot A8, B8 with a BC11A cable. Connection from the RH11 to the next device is made via a BC11A cable connected to slot A7, B7. If the RH11 is the last device on the bus, the M930 or M9300 terminator is installed in slot A7, B7 instead of the BC11A cable.

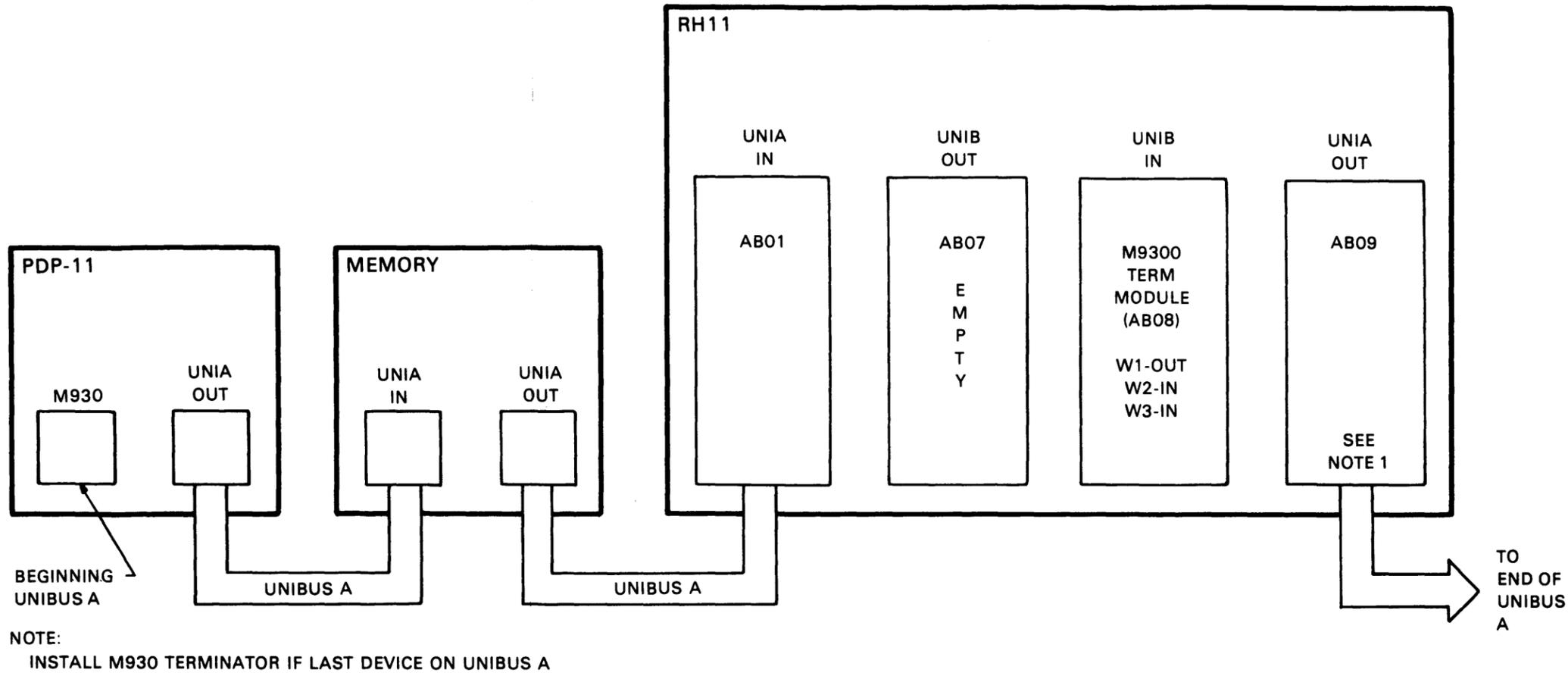
2. **No Processor on Unibus B** – If no processor is connected to Unibus B, a M9300 Unibus B terminator module must be selected as an NPR arbitrator. If one RH11 is connected to Unibus B, the RH11 is electrically connected at the beginning of the bus with the M9300 selected to act as an NPR arbitrator. One M9300 Unibus B terminator module is placed in slot A8, B8 of the RH11. Jumper W1 on this module must be cut to enable the arbitration logic. Connection to other devices on Unibus B, such as memory, is made via a BC11A cable connected to slot A7, B7. The second M9300 Unibus B terminator module is installed in the last device on Unibus B. Jumper W2 is removed for terminating the Unibus with no processor connected.

**NOTE**

**In this case, an M930 terminator module can be substituted for the M9300 Unibus B terminator in the last device slot. If more than one RH11 is installed, the user may have extra M9300 modules as a result of a particular configuration. Figures 2-12, 2-13, and 2-14 show typical Unibus configurations.**

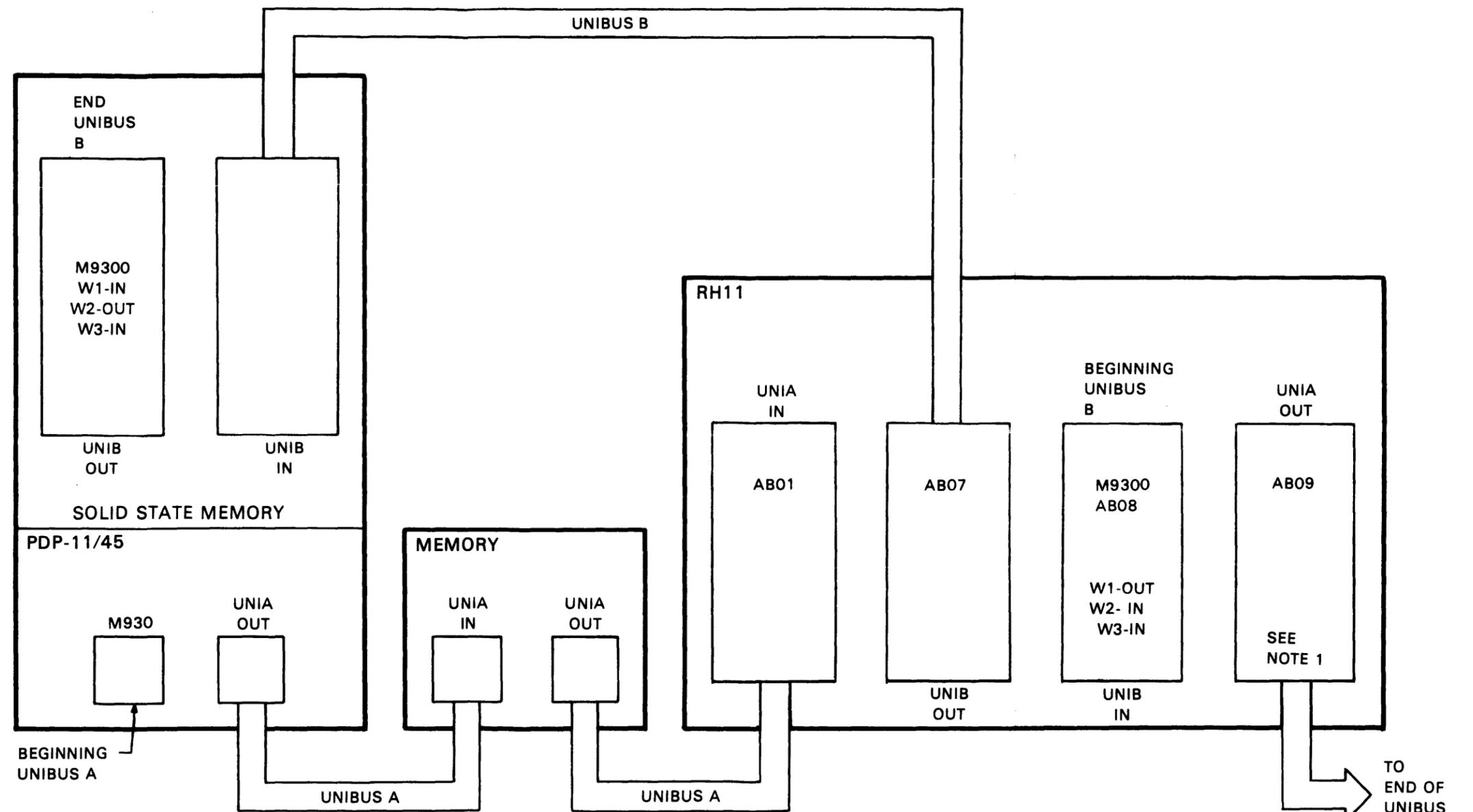
**2.4.2.3 Massbus Cables** – Massbus connections to the RH11 are made via three 40-conductor ribbon cables. These cables plug into three M5904 transceivers in the RH11 and are designated Massbus Cable A, Massbus Cable B, and Massbus Cable C. The connections are made as shown below.

Massbus Cable A	Install in M5904 module in slot C4, D4.
Massbus Cable B	Install in M5904 module in slot C5, D5.
Massbus Cable C	Install in M5904 module in slot C6, D6.



11-2220

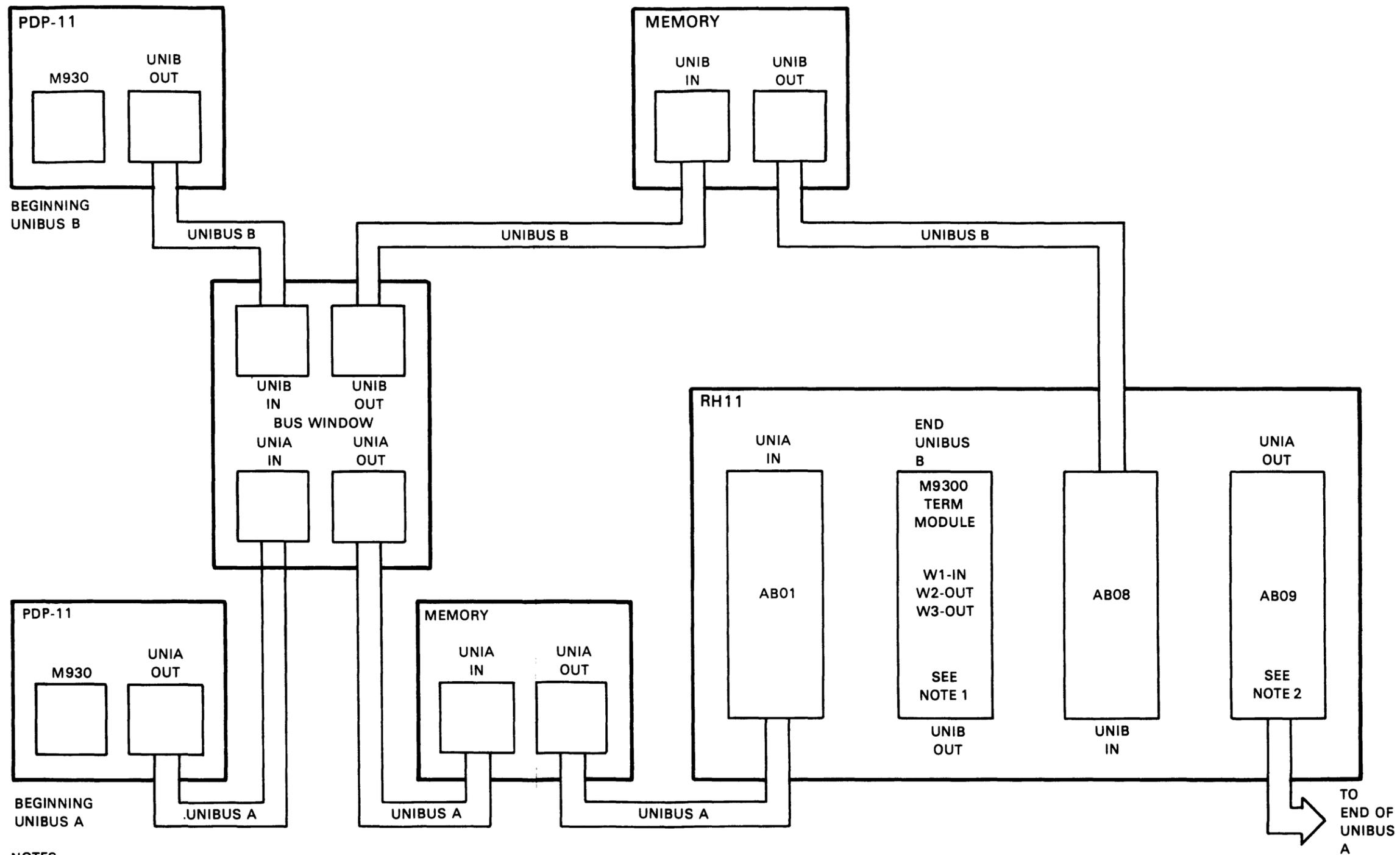
Figure 2-12 Single-Port Unibus Configuration



NOTE:  
 INSTALL M930 TERMINATOR IF LAST DEVICE ON UNIBUS A

11-2221

Figure 2-13 Dual-Port Configuration -  
 Memory on Unibus B

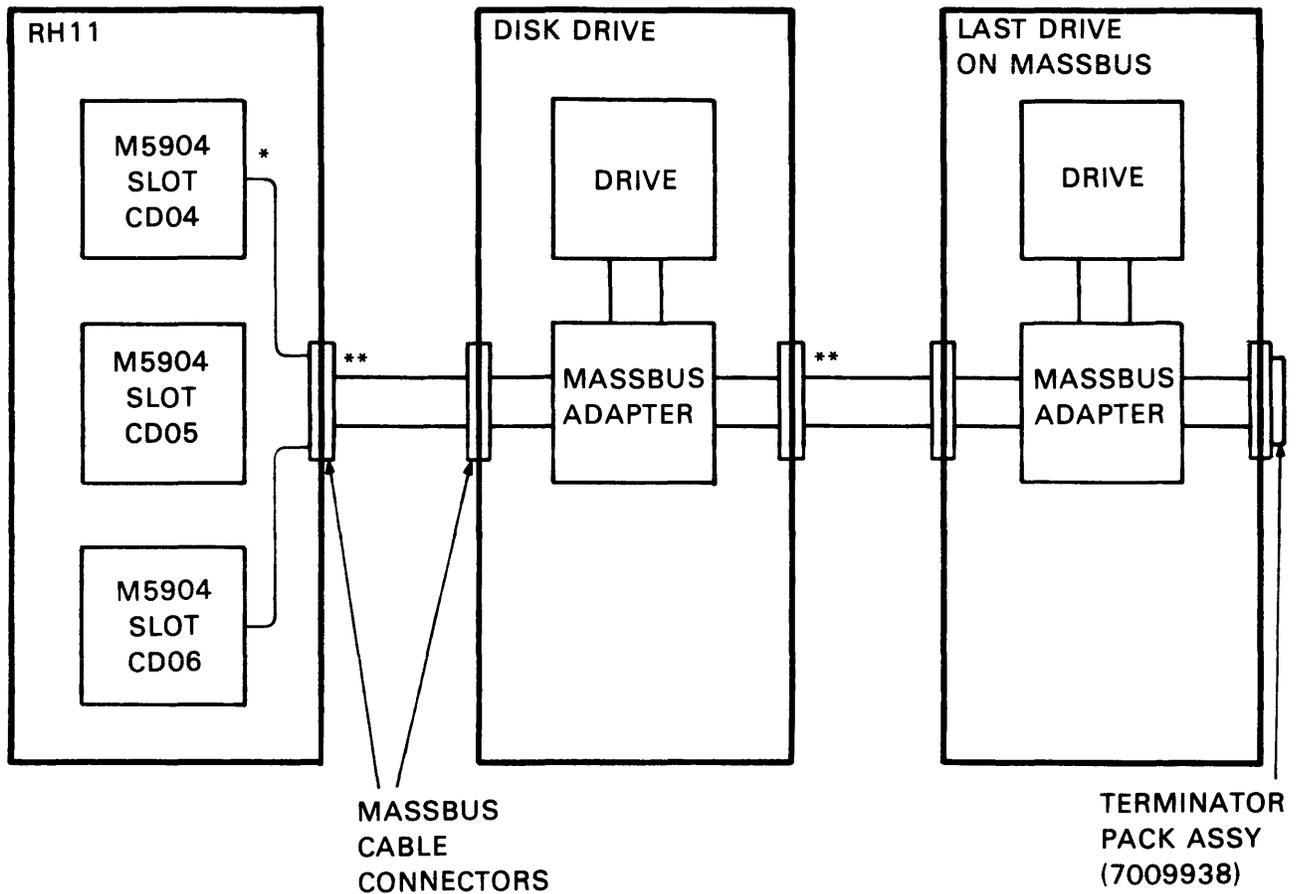


NOTES

1. IN THIS CONFIGURATION CAN BE REPLACED BY M930.
2. INSTALL M930 TERMINATOR IF LAST DEVICE ON UNIBUS A.

Figure 2-14 Dual-Port Configuration - Memory and Processor on Unibus B

The Massbus cables are marked and should be inserted per the individual cable markings. To terminate the Massbus, a 7009938 terminator pack assembly should be plugged into the output connector(s) of the last drive (Figure 2-15).



**NOTES:**

- \* FLAT MASSBUS CABLE (3) INTERNAL TO DRIVE CABINET AND TO CABINET CONTAINING RH11.
  - \*\* ROUND MASSBUS CABLE EXTERNAL TO CABINETS
1. LAST DRIVE TERMINATED WITH 7009938 TERMINATOR PACK ASSY.

11-2561

Figure 2-15 Massbus Cable System Configuration

**2.4.2.4 AC LO, DC LO** – AC LO and DC LO signals from the RH11's power supply must be connected to the RH11. The wires supplying these signals *will not be cut* from the power harness. *There will be only one AC LO and one DC LO power fail connection to each Unibus for devices mounted in the same mounting box and sharing the same power supply.* Otherwise, power fail conditions would latch up due to positive feedback to the power fail logic. If a power fail connection for AC LO and DC LO is already made to a Unibus from a device in the same mounting box, the M688 power fail module in the RH11 for that Unibus is removed. The M688 module for Unibus A is located in slot E5 and the M688 module for Unibus B is located in slot E4. The following is a summary of power fail configuration rules.

1. For each mounting box, there is only one AC LO and DC LO power fail connection to a Unibus from the power supply.
2. Power supply AC LO and DC LO must always be wired to each RH11 via the power harness.
3. Power fail signals may only be disconnected from a Unibus in an RH11 by removing the appropriate M688 power fail driver module.
4. Power supply AC LO and DC LO should be disconnected from all other options mounted in the same box as the RH11 if they do not need those signals for internal operation.

Figures 2-16, 2-17 and 2-18 show three typical power fail configurations which are configured in accordance with the above mentioned rules.

### **2.4.3 Jumper Configurations**

The following paragraphs describe the various jumper configurations on the BCT (M7295), DBC (M7294), and CSR (M7296) modules. The different configurations for RM02 only and for an RM02/RPxx mix are listed separately within each module subsection.

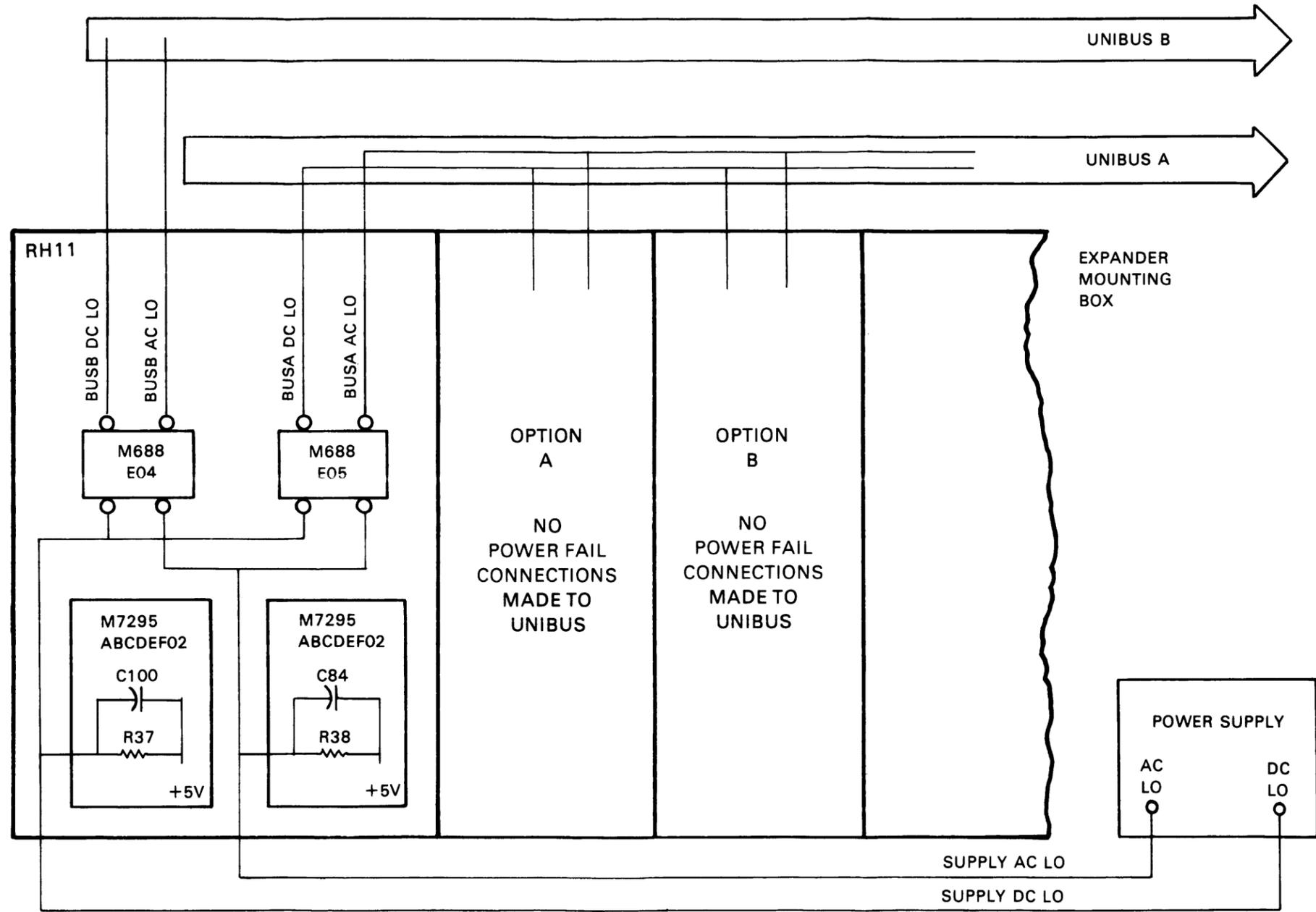
**2.4.3.1 BCT Module (M7295)** – The BCT module contains jumpers for register selection, BR level interrupt, NPR latency, vector address, and missed transfer error.

**Register Selection** – The RH11 is capable of responding to 30 possible Unibus addresses. The number of address, however, is dependent on the Massbus device. Jumpers W1–W8 select the block of Unibus addresses to which the RH11/RM02 subsystem responds. The standard block is assigned addresses 77670 through 776746. Table 2-2 shows the addressing scheme.

The jumpers in E3 (D-CS-M7295-0-1, sheet 2) are used to select the appropriate number of registers for the device. The scheme is to select two less than the appropriate number for the drive. Only the RM02 subsystems have 22 registers; therefore, select a jumper configuration of 20 (shown in Table 2-3). The RM02/RPxx mix of drives have 32 registers and require a jumper configuration of 30 (as in Table 2-4).

**BR Level Interrupt** – The priority jumper plug for the RH11 is normally set for the BR5 level. This plug is located in E57 (D-CS-M7295-0-1, sheet 7).

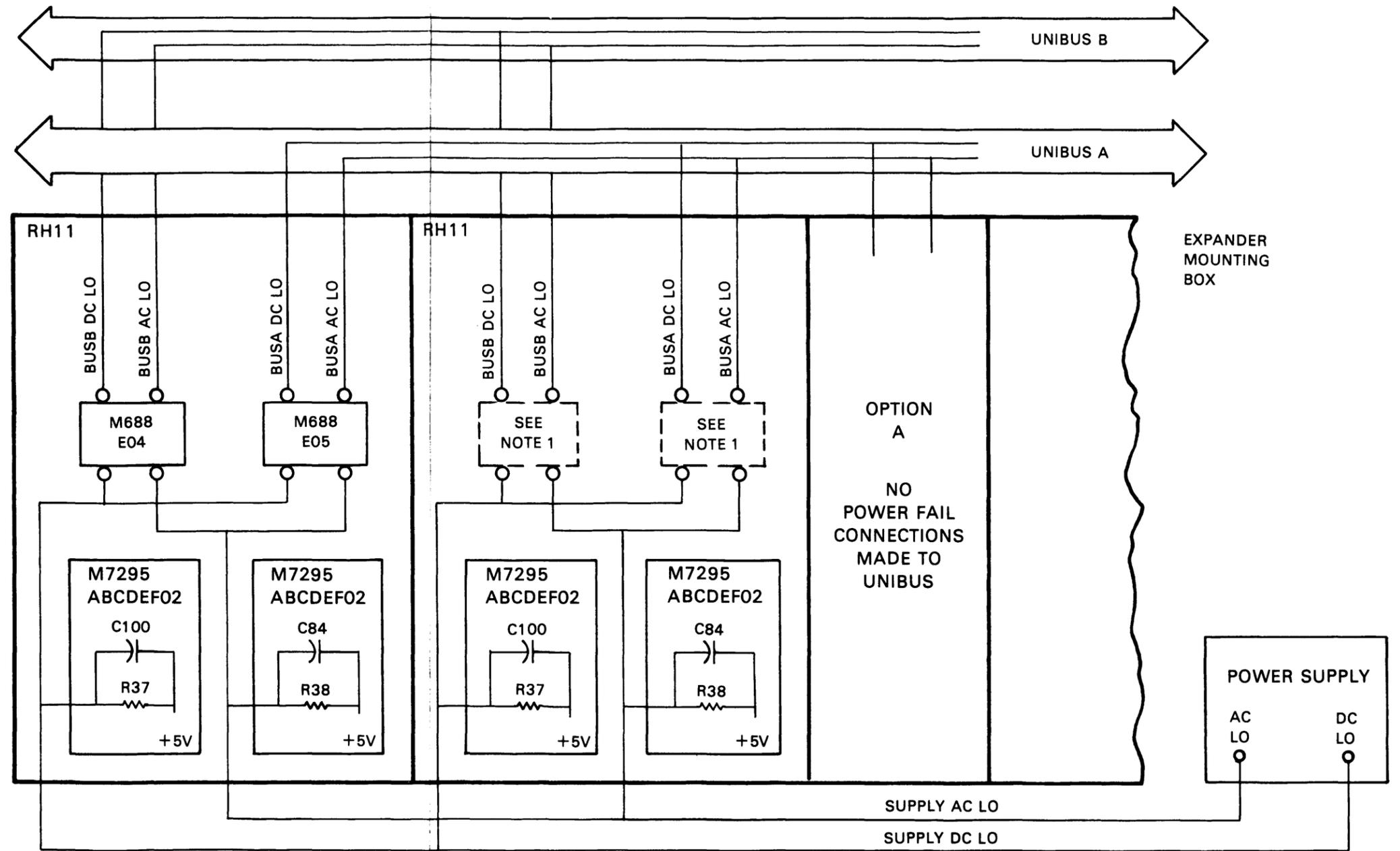
**NRP Latency** – Special circuitry is incorporated on the BCT module to improve NPR latency time for devices connected to the Unibus. This circuitry is enabled via jumper W18 (D-CS-M7295-0-1, sheet 7). When the jumper is left in, the NPR latency feature is enabled. Not all PDP-11 processors work with this special feature.



NOTE  
 ONE RH11 MOUNTED WITH OTHER OPTIONS IN  
 AN EXPANDER MOUNTING BOX.

11-2218

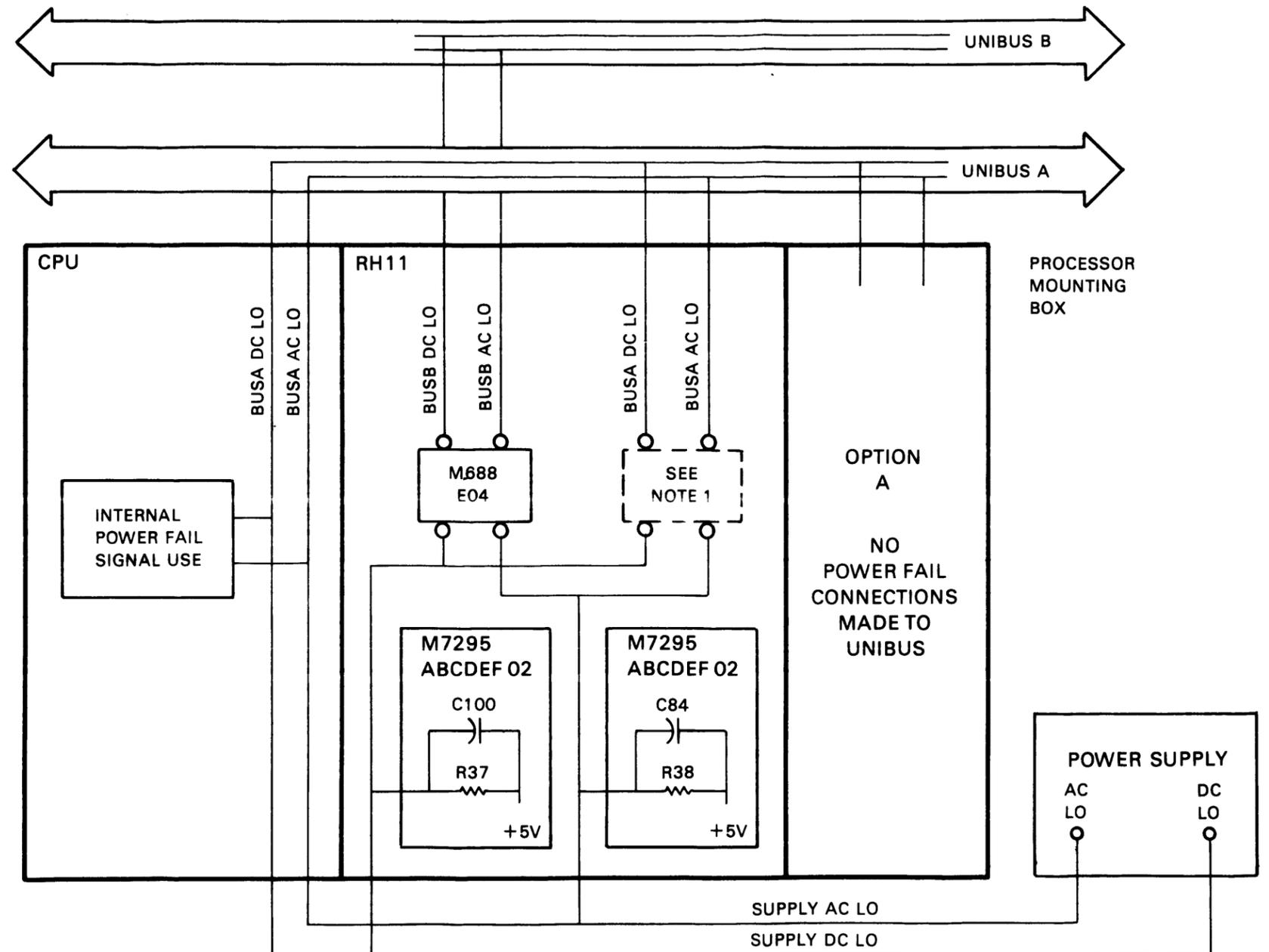
Figure 2-16 Typical Fail Configuration  
 for RH11 and Options Mounted  
 in Same Expander Box



NOTE 1:  
 DISCONNECT POWER FAIL SIGNALS FROM BUSA BY REMOVING M688 IN  
 SLOT E05 B FROM BUSB BY REMOVING M688 IN SLOT E04

11-2216

Figure 2-17 Typical Power Fail Configuration  
 for Two RH11s Mounted  
 in Same Expander Box



NOTE 1  
 DISCONNECT POWER FAIL SIGNALS FROM BUS A BY  
 REMOVING M688 IN SLOT E05.

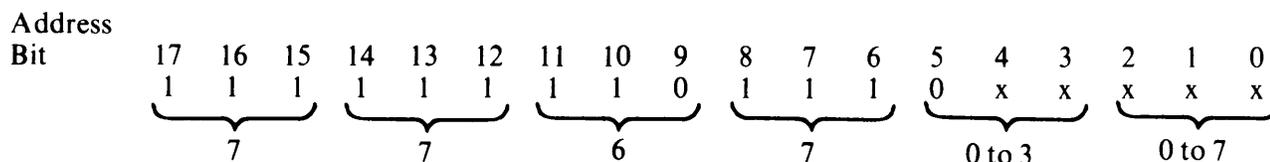
11-2217

Figure 2-18 Typical Power Fail Configuration  
 for RH11 and CPU Mounted  
 in Processor Box

**Table 2-2 RH11/RM02 Register Address Jumper Configurations**

**Jumper In = Binary 0**

Address Bit	Jumper	Jumper In/ Jumper Out
12	W1	Out
11	W2	Out
10	W3	Out
9	W4	In
8	W5	Out
7	W6	Out
6	W7	Out
5	W8	In



**Table 2-3 RH11/RM02 Jumper Configurations**

Slot	Jumper	Jumper In/ Jumper Out
E3	1-16	Out
	2-15	Out
	3-14	In
	4-13	In
	5-12 (2)	Out
	6-11 (4)	Out
	7-10 (8)	In
	8-9 (16)	Out

**Table 2-4 RH11/RM02/RPxx Mix Jumper Configurations**

Slot	Jumper	Jumper In/ Jumper Out
E3	1-16	Out
	2-15	Out
	3-14	In
	4-13	In
	5-12 (2)	Out
	6-11 (4)	Out
	7-10 (8)	Out
	8-9 (16)	Out

**Bus Grant** -If there are no small peripheral controllers installed in slots C7-F7, C8-F8, and C9-F9, then G727 grant continuity modules must be installed in slot D7, D8, or D9. These modules merely continue the Bus Grant signals to the next device on the Unibus.

**Vector Address Jumpers** - The interrupt vector transferred to the processor is jumper-selectable via jumpers W11-W17, representing vector bits 2-8, respectively. The RM02 subsystems are assigned a vector address of 000254, with the jumper configuration shown in Table 2-5.

**Table 2-5 Interrupt Vector Jumper Configurations**

<b>Jumper</b>	<b>Vector Bits</b>	<b>Jumper In/ Jumper Out*</b>
W11	V2	In
W12	V3	In
W13	V4	Out
W14	V5	In
W15	V6	Out
W16	V7	In
W17	V8	Out

\*Jumper In = Binary 1.

**MXF Jumper** – Jumper W19 (D-CD-M7295-0-1, sheet 9) is used to disable detection of MXF errors and is used during special maintenance procedures. W19 is normally left in.

**2.4.3.2 DBC Module (M7294)** – The DBC module contains jumpers for NPR cycle selection, Unibus parity, and start counter capacities.

**NPR Cycle Selection Jumpers** – Two jumpers select the type of cycle to be implemented when performing NPRs. Jumper E66 (3-4) (D-CS-M7294-0-1, sheet 2) selects the RH11 to perform one memory reference for each NPR request; this jumper is removed in the RM02 subsystem to allow back-to-back memory cycles to occur. Jumper E66 (2-15) takes advantage of dedicated Unibus B systems (those in which the RH11 is used exclusively as a Unibus B master) by allowing the RH11 to transfer complete consecutive blocks of data without giving up the Unibus; to implement this feature, both this jumper and E66 (3-14) must be cut (BUS HOG mode).

**Unibus Parity Jumpers** – The RH11 option can be selected for 16-data-bit transfers (plus 2 parity bits) or 18-data-bit transfers. Unibus A and Unibus B can each be selected individually via jumpers W1 and W2 (D-CS-M7294-0-1, sheet 8). If left in, jumper W1 allows parity error code detection on Unibus A when the RH11 is performing DATI operations; if W1 is removed, the PA and PB parity lines of Unibus B are used as data bits 16 and 17, respectively. Jumper W2 serves Unibus B in the same manner as W1 serves Unibus A. Both jumpers are normally left in.

**Start Counter Jumpers** – Various Silo capacities are jumper-selectable before a write operation onto the disk drive is started. The jumpers selections are listed below (D-CS-M7294-0-1, sheet 9).

Jumper E66, Pins 1-16	Selects full capacity of 64 words
Jumper E66, Pins 5-12	Selects 32 words
Jumper E66, Pins 7-10	Selects 16 words
No Jumper	Selects 1 word

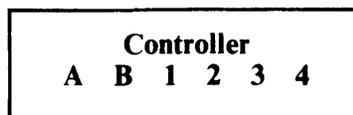
**NOTE**

**Only the jumper representing the desired Silo capacity should be connected. The other jumpers should be removed. For RM02 subsystems, the 64-word jumper E66, pins 1-16) should be connected.**

**2.4.3.3 CSR Module (M7296)** –The CSR module contains a jumper (W1 on D-CS-M7296-0-1, sheet 2) to allow for Unibus A selection only. This jumper overrides the ability of the program to select Unibus B data transfers. The jumper is normally removed.

**2.4.3.4 RH11 Installation Checklist**

1. Visually check the RH11 backplane assembly for bent pins by sighting along the rows of pins from two directions. Also check for pinched or broken wires.
2. Check the backplane for the current wire-wrap revision and remove and check all RH11 modules for current ECO revisions.
3. Mount for RH11 backplane assembly in the appropriate mounting box using four 8/32-inch × 1-inch Allen-head screws.
4. Connect the two power harnesses to the RH11. Ensure that Mate-N-Lok connectors are seated firmly in the power distribution panel located on the chassis above the backplane.
5. Check the RH11 backplane again for bent pins and shorted wires.
6. Power-up the CPU or expander box and check all voltages, then power-down.
7. Check that the wires supplying AC LO and DC LO signals from the power supply are connected to the RH11.
8. Verify and/or select the jumper configurations in the RH11.
9. Verify that all modules are placed according to the RH11 module utilization list (D-MU-RH11-0-1).
10. Verify that Unibus cable connections are made.
11. Mount an input/output connector block assembly (7009861) to a connector panel (7412379) with four 4/40-inch × 5-inch screws (9008042-8).
12. Verify that two pressure-sensitive labels are applied to the connector panel for each input/output connector block assembly (E-UA-RM02-A-0). Label 1 is applied above the input/output connector block assembly, and Label 2 is applied below it.



Label 1

The second line of Label 1 must be marked so that only one letter and one number are visible. The single controller (RH11) used in an RM02-AA or -AB subsystem, as well as the first controller used in an RM02-BA or -BB subsystem, is referred to as controller A. If it is the first subsystem using the connector panel, it is designated controller A1 (etc., up to controller A4). The second controller in an RM02-BA or -BB subsystem is designated as controller BX, where X is the same subsystem number as the associated controller A.

*Example:* Two RH11 controllers are mounted in the same cabinet, one for each of two RM02-AA subsystems. Each RH11 uses one input/output connector block on the connector panel; the first is called controller A1, the second is A2. Later, an RM02-BA subsystem is installed with its two RH11 controllers mounted in the same cabinet. The remaining two slots on the connector panel are used, with one being labeled A3 and the other B3.



Label 2

This label simply shows the relative positions of the flat Massbus cables A, B, and C.

13. Mount the connector panel at the bottom rear of the cabinet containing the RH11, using four 10/32-inch Tinnerman nuts (Part No. 9006586) and four 10/32-inch × 0.38-inch Truss-head screws (Part No. 9006071-3). (Refer to D-UA-RM02-A-0).
14. Clean the air filters at the top of the mounting cabinet, if necessary.
15. Check mounting cabinet fans for proper operation.

## **2.5 RH70 CONTROLLER INSTALLATION PROCEDURE (RWM03)**

The following paragraphs describe the mechanical and electrical installation, power checks, jumper configurations, and visual inspection for the RH70 controller for RM03 and RM03/RPxx applications.

### **2.5.1 Mechanical**

The RH70 uses one hex-height module, three quad-height modules, and three double-height modules (Massbus connectors). There is no mechanical unit to mount. The modules are merely inserted into the appropriate slots in the PDP-11/70 CPU box, as shown in the module utilization chart in Figure 2-19. The Massbus cables are plugged into the double-height slots and jumpers are configured for the proper address and interrupt vector.

### **2.5.2 Electrical**

The PDP-11/70 CPU mounting box contains a wired backplane that runs the full depth of the box. The Unibus signals are prewired on the backplane. Power to the RH70 is provided by the cabinet power supply as follows.

+5 V @ 18.5 A max  
-15 V @ 0.5 A max

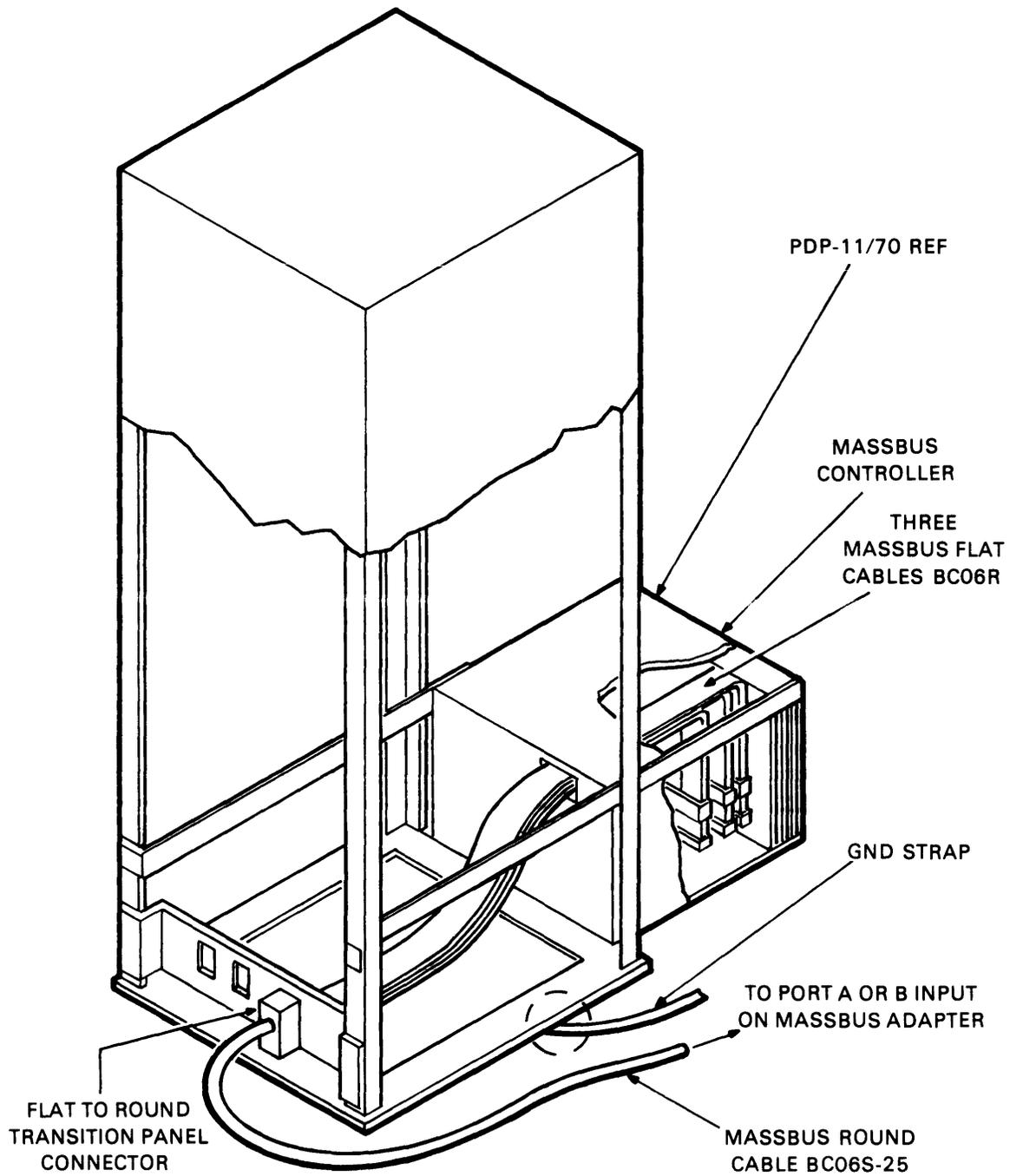
### **2.5.3 Module Locations**

The PDP-11/70 CPU mounting box houses the floating-point unit, central processor, memory management, Unibus map, cache, five small peripheral controller (SPC) slots, the KW11-L clock, and up to four RH70 controllers. The location of the respective modules is shown in Figure 2-19.

### **2.5.4 Massbus Cables**

Massbus connections to the RH70 are made via three 40-conductor ribbon cables. These cables plug into three M5904 transceivers in the RH70 and are designated Massbus cable A, Massbus cable B, and Massbus cable C. The connections are made to the RH70 as shown in Figure 2-20 and Table 2-6.





MA-0599

Figure 2-20 RH70 Massbus Cable Connections

**Table 2-6 Massbus Cable System Configurations**

	Controller A	Controller B	Controller C	Controller D
Massbus Cable A	AB 25	AB 29	AB 33	AB 37
Massbus Cable B	AB 26	AB 30	AB 34	AB 38
Massbus Cable C	AB 27	AB 31	AB 35	AB 39

The Massbus cables are marked and should be inserted with the edge-marking facing the module handles. A Massbus terminator pack assembly (7009938) should be plugged into the last drive attached to the Massbus.

**2.5.5 BCT and MDP Jumper Configurations**

The following paragraphs describe the various jumper configurations on the BCT (M8153) module and on the MDP (M8150) modules for both RM03 and RM03/RPxx applications.

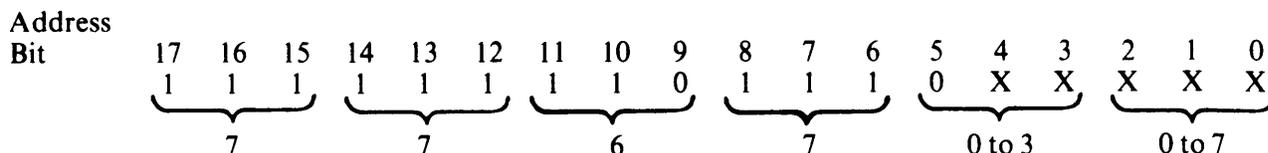
The BCT module contains jumpers for register selection, BR level interrupt, and vector address.

**2.5.5.1 Register Selection** – The RH70 is capable of responding to 32 possible Unibus addresses. The number of addresses, however, is dependent on the Massbus device. Jumpers W8–W15 select the block of Unibus addresses that both subsystems respond to. The standard addressing block assigned is 776700–776752. For both subsystems, the jumper configuration shown in Table 2-7 should be used.

**Table 2-7 RH70 Register Address Jumper Configurations**

**Jumper In = Binary 0**

Address Bit	Jumper	Jumper In/ Jumper Out
12	W14	Out
11	W10	Out
10	W9	Out
9	W8	In
8	W11	Out
7	W13	Out
6	W15	Out
5	W12	In



The jumpers in E41 (D-CS-M8153-0-1, sheet 2 of 6) are selected for the appropriate number of registers in the subsystem, minus 2. For example, there are 22 registers in the RM03 and RM03/RPxx subsystems, so the jumpers are selected for a weighted value of 22-2 or 20, as shown in Table 2-8.

**Table 2-8 RH70 Register Select Jumper Configurations**

**Jumper In = Binary 0**

Slot	Jumper Location Pins	Jumper In/ Jumper Out
E41	1-16	Out
	2-15	Out
	3-14	In
	4-13	In
	5-12 (2)	In
	6-11 (4)	Out
	7-10 (8)	In
	8-9 (16)	Out

**2.5.5.2 BR Level Interrupt** – The priority jumper plug for the RH70 is normally set for the BR5 level. This plug is located in E022 (D-CS-M8153-0-1, sheet 4 of 6).

**2.5.5.3 Vector Address Jumpers** – The interrupt vector transferred to the processor is jumper-selectable via jumpers W1–W7, representing vector bits 2–8.

The RM03 subsystem has been assigned a vector address of 000254. The jumper configuration for this vector address is shown in Table 2-9.

**2.5.5.4 Maintenance Jumpers MDP Module (M8150)** – The MDP module contains jumpers that allow maintenance personnel to disconnect wired-OR connections from the Exclusive-OR network used to detect write-check errors. These jumpers are designated W1–W4 and are shown on D-CS-M8150-0-1, sheet 6 of 9. The jumpers provide maintenance personnel with a method of isolating a faulty output (stuck low) of the wired-AR bus to one of four integrated circuit (IC) chips that perform the Exclusive-OR function during write-check operations. For example, if the output of the E21 and E23 open-collector line is stuck low, when scoping of the inputs indicate that it should be high, the faulty IC (E21 or E23) can be ascertained by removing jumpers W2 and W1. If, after removing the jumpers, the outputs of the Exclusive-OR gates in E23 are still low, it indicates that the E23 chip is defective. If E23 outputs are high, the E21 chip is defective (outputs stuck low).

**Table 2-9 RH70 Vector Address Jumper Configuration**

**Jumper In = Binary 1**

Vector Bit	Jumper	Jumper In/ Jumper Out
V2	W7	In
V3	W3	In
V4	W6	Out
V5	W2	In
V6	W5	Out
V7	W1	In
V8	W4	Out

V8	V7	V6	V5	V4	V3	V2	V1	V0
0	1	0	1	0	1	1	0	0
⏟			⏟			⏟		
2			5			4 <sub>8</sub>		

**2.5.5.5 Light-Emitting Diodes (LEDs)** – The following light-emitting diodes are incorporated into the RH70 Massbus controller logic BCT module (Figure 2-21) on the M8153.

- SSYN (Slave Sync) D-CS-M8153-0-1, sheet 3 of 6
- TRA (Transfer) D-CS-M8153-0-1, sheet 3 of 6
- BG IN (Bus Grant In) D-CS-M8153-0-1, sheet 4 of 6
- SACK (Selection Acknowledged) D-CS-M8153-0-1, sheet 4 of 6
- BBSY (Bus Busy) D-CS-M8153-0-1, sheet 4 of 6

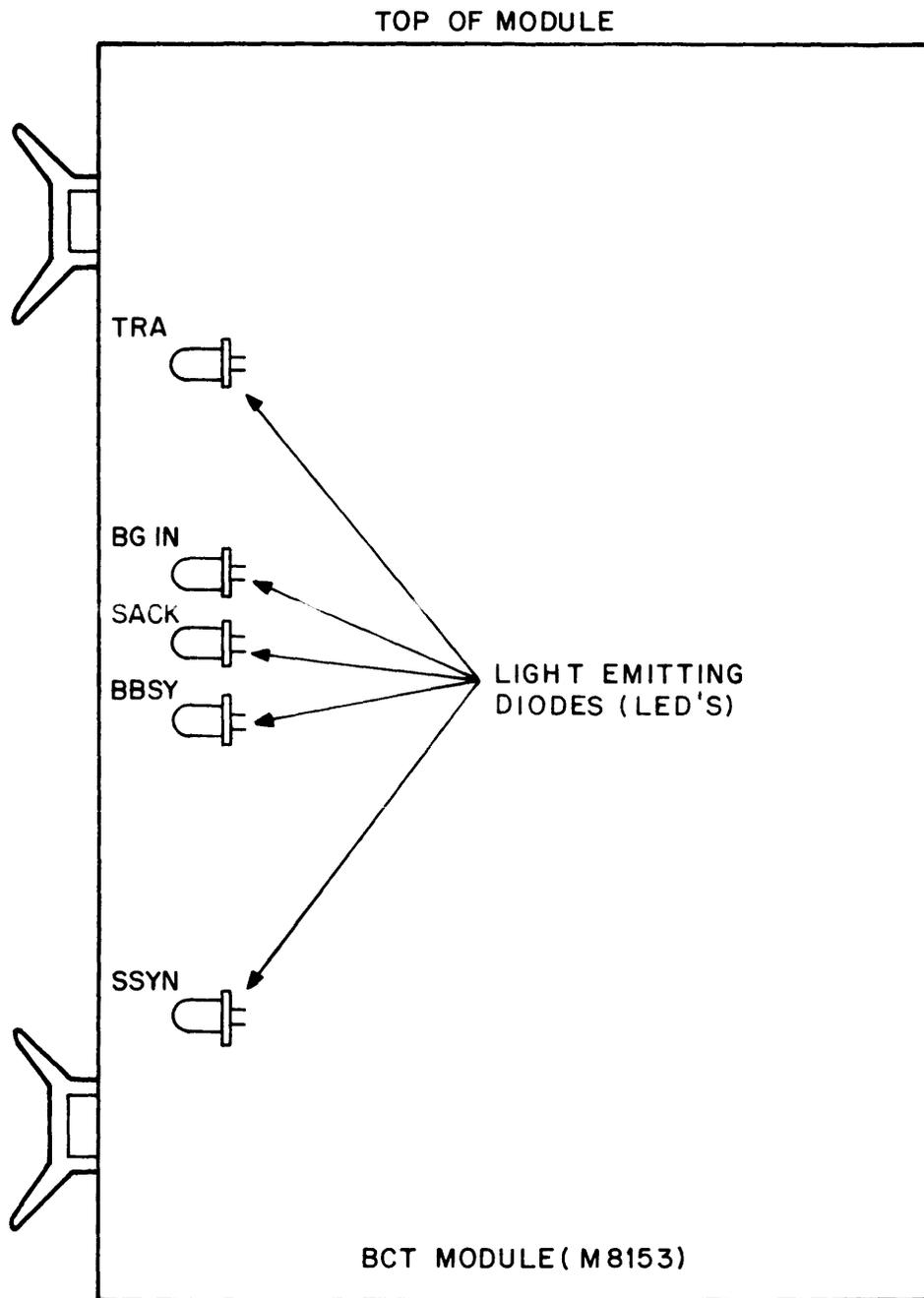
These LEDs aid maintenance personnel in isolating certain system faults, as described in the following paragraphs.

**System Fault No. 1** – The Unibus on the PDP-11/70 is in the “hung” condition (no operations can be performed on Unibus).

**Diagnosis** – This condition may be caused by:

1. Stuck SACK
2. Stuck BBSY
3. Stuck SSYN.

The LED associated with the fault condition will be illuminated continuously. (LEDs may flicker intermittently during normal operation.)



11-2940

Figure 2-21 LED Physical Locations

**System Fault No. 2** – The Unibus device interrupt sequence is not functioning properly. (The processor continuously loops in service routine and fails to execute instructions.)

**Diagnosis** – This condition is caused by discontinuity of the Bus Grant signal on the Unibus from the processor to the device interrupting, and may be caused by missing grant continuity cards or defective circuitry, which normally passes Grant signals from device to device. These will cause the BG IN LED to become illuminated, indicating that the Unibus BG IN signal coming to the device is stuck high.

**System Fault No. 3** – The processor attempts to read or write a remote register in the RM03 subsystem and receives an address error indication on the console (CPU traps to location 4).

**Diagnosis** – This condition may be caused by a stuck TRA signal on the Massbus that prevents the SSYN response from the RH70. This condition can be determined if local registers in the RH70 can be successfully accessed. If no register responds, the address jumpers may be selected improperly.

## **2.6 CABLING PROCEDURES**

### **2.6.1 Ground Cabling**

Two grounding studs are provided on each cabinet (Figure 2-22).

If this is a multiple-drive installation, connect a 0.9 m (3 ft) ground strap (DEC part number 7412827) between each drive.

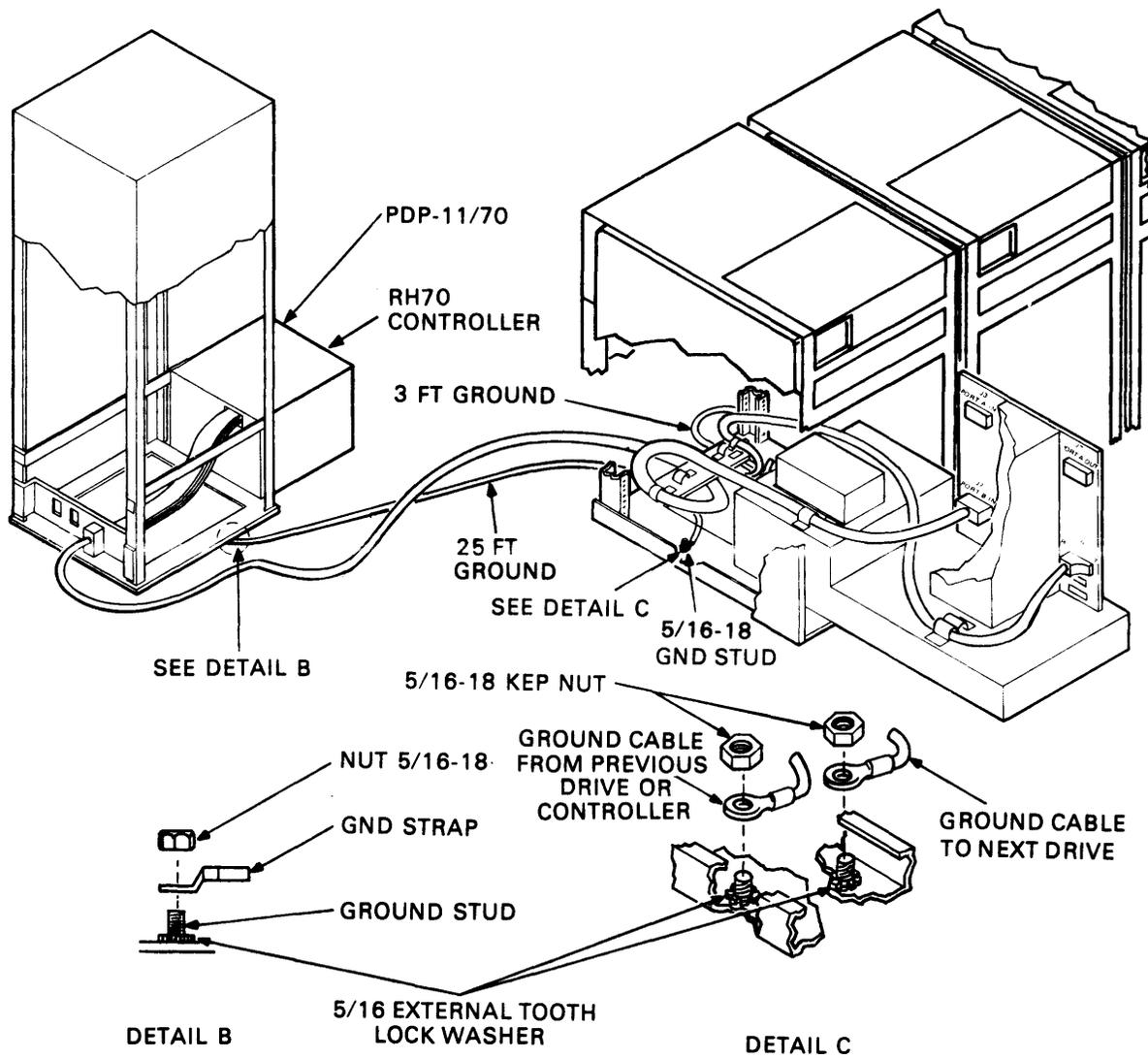
### **2.6.2 BC06S Cable Preparation**

When the BC06S Massbus cable is shipped with the disk subsystem, all necessary changes to the cable will be made at the factory. The following information is provided for those instances where a BC06S cable is used that was not shipped with a system. In such instances, some preliminary cable changes may be needed.

The RM02/03 Massbus adapter requires that the BC06S cable exit from its connector at a 90 degree angle. This implies that whenever this cable is used from drive to drive, both connectors need to be at the 90 degree angle position. For the BC06S cable that goes to the RH controller, the connector at the controller end will be at a 45 degree angle and the one at the disk drive end at a 90 degree angle.

If it becomes necessary to change the BC06S cable angle from 45 degrees to 90 degrees in the field, use the following steps.

1. Remove the four screws from the connector as shown in Figure 2-23a.
2. Examine the cable gate as shown in Figure 2-23b. Be careful not to put undue stress on the wired connections. If the cable gate is at 0.38 inch, it should be moved forward so that only 0.25 inch of the cable sleeve remains exposed.
3. With the exposed cable sleeve now at the proper 0.25 inch length, adjust the cable angle to the 90 degree position as shown in Figure 2-23c.
4. Replace the four screws that hold the connector together.



MA-0604

Figure 2-22 Grounding Studs and Cables

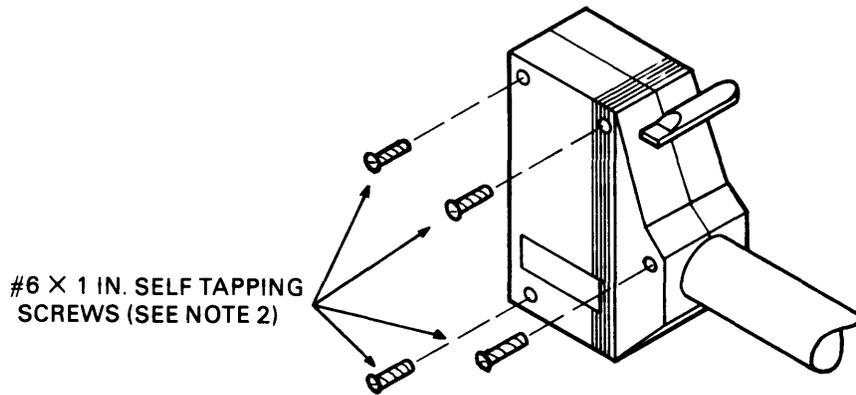


FIGURE (A)

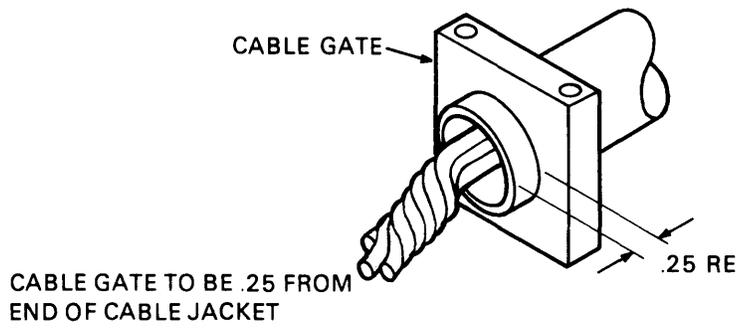


FIGURE (B)

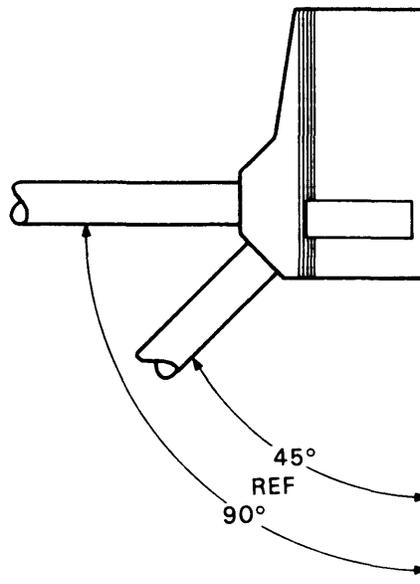


FIGURE (C)

MA-0916

Figure 2-23 BC06S Cable Preparation

### 2.6.3 Single-Port Cabling Procedure

1. Prior to installing the cables for single-port operation, the following steps should be taken (Figure 2-24).
  - a. Either port A or port B may be used. The correct port transceiver modules must be in place for each mode of operation. Two M5922 modules are needed in the position shown in Figure 2-24 for port A operation. Port B operation requires that the two M5923 modules be in their correct position. The status of both types of port transceiver modules is given in Table 2-10 for each mode of operation. Each port transceiver module may be disabled independently by a switch on each board shown in Figure 2-24.
  - b. Verify that the desired jumpers are installed on the J1 connector on the MBA backplane. Table 2-11 shows how to select the correct jumper configuration.
  - c. Verify that the MBA backplane PORT SELECT switch (S1) is in the correct position for the port used. Port A is UP. Port B is DOWN. The middle position is for dual-port programmable mode. The relationship between the PORT SELECT switch position and the SPRT JUMPER on the MBA J1 connector is shown in Table 2-12.
  - d. The serial number of the drive is wire-wrapped into the MBA backplane on 32 wire-wrap posts. There are 16 post pairs on the J4 connector shown in Figure 2-24. The last four digits of the drive serial number are used as the RM03 serial number. A jumper must be installed for each logic 0 in the BCD serial number. Table 2-13 shows how to wire a serial number of 3172.
2. Connect the BC06S-25 Massbus cable to the A-IN connector J3 on the MBA backplane (Figure 2-25), and tighten the cable clamp.

#### **CAUTION**

**Ensure that the Massbus cable is perpendicular to the connector so that no stress is applied to the backplane.**

3. If this is the last drive in the chain, install a terminator (DEC part number 7009938-00) into the A-OUT connector J2 on the MBA backplane (Figure 2-26).
4. If this is not the last drive in the chain, run a Massbus cable from the A-OUT connector J2 on the MBA backplane to the A-IN connector J3 of the next drive and tighten the appropriate cable clamp.

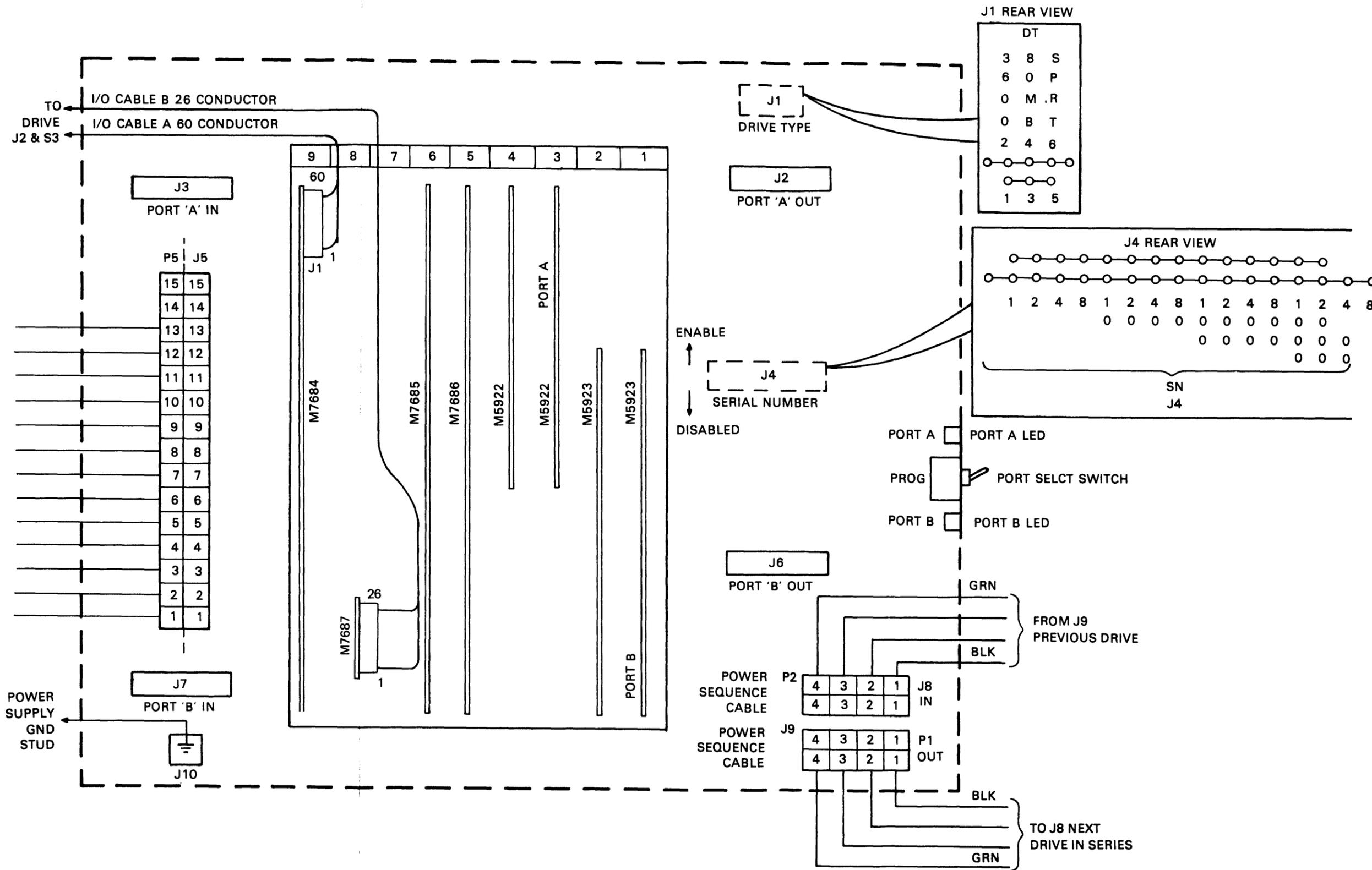


Figure 2-24 Module Shall be in Slot 8

**Table 2-10 Port Transceiver Module Status**

Mode of Operation	Port Transceiver Module Status	
	M5922s	M5923s
Single port A	In place and enabled	Removed or in place and disabled
Single port B	Removed or in place and disabled	In place and enabled
Dual port	In place and enabled	In place and enabled

**NOTE**

Each module has its own disable switch located on its board.

**Table 2-11 Backplane J1 Connector**

Jumper (J1)	In	Out
1-2	3600 rev/min	Other
3-4	80 MB	Other
5-6*	Single port A	Either port or dual port

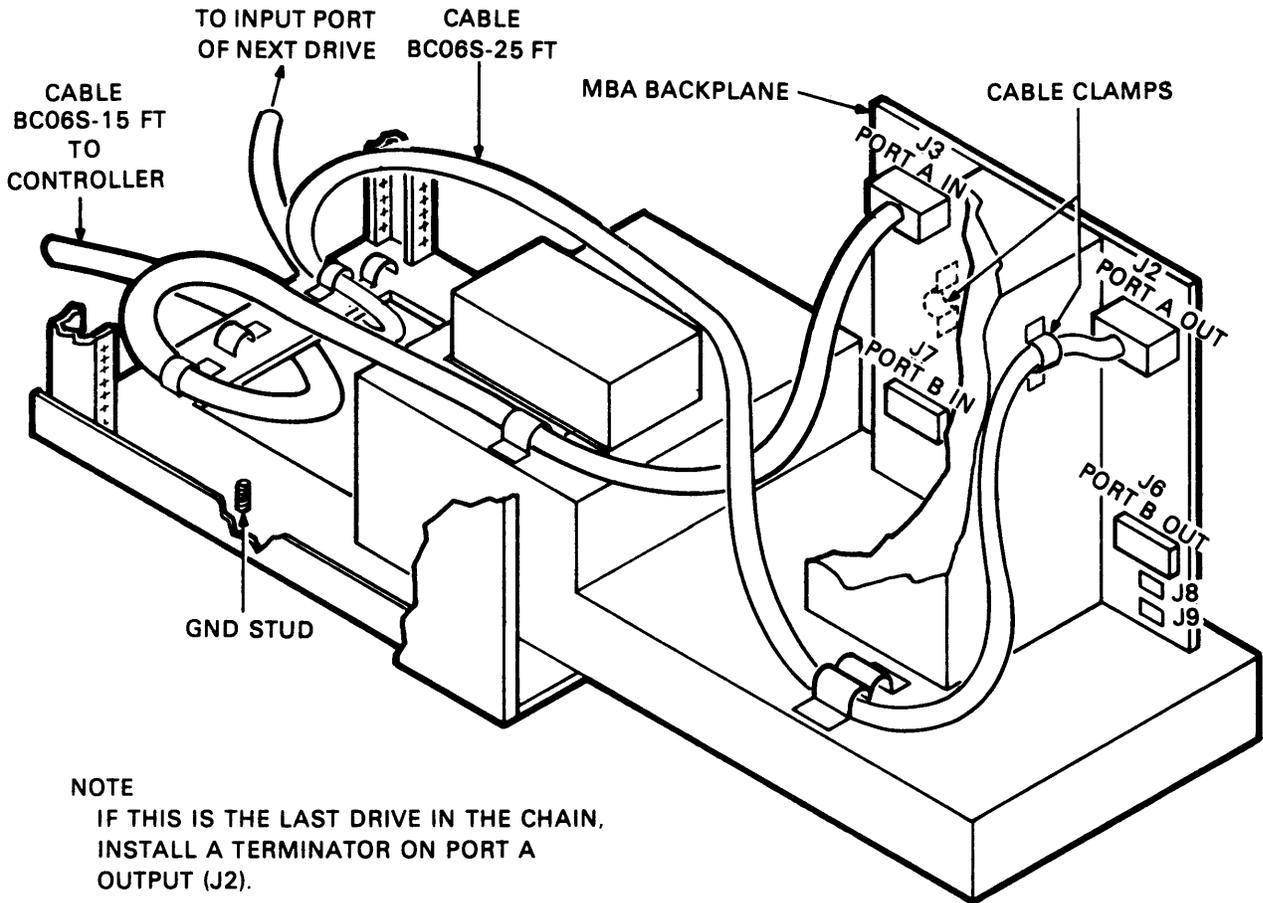
\*If jumper is in place, only port A can be used.

**Table 2-12 Port Select Switch Positions**

Port Select Switch Position	MBA Backplane J1 Connection SPRT Jumper	
	In	Out
Port A PROG (A/B) Port B	Single port A Single port A Single port A	Single port A Dual port Single port B

**Table 2-13 Backplane Serial Numbers**

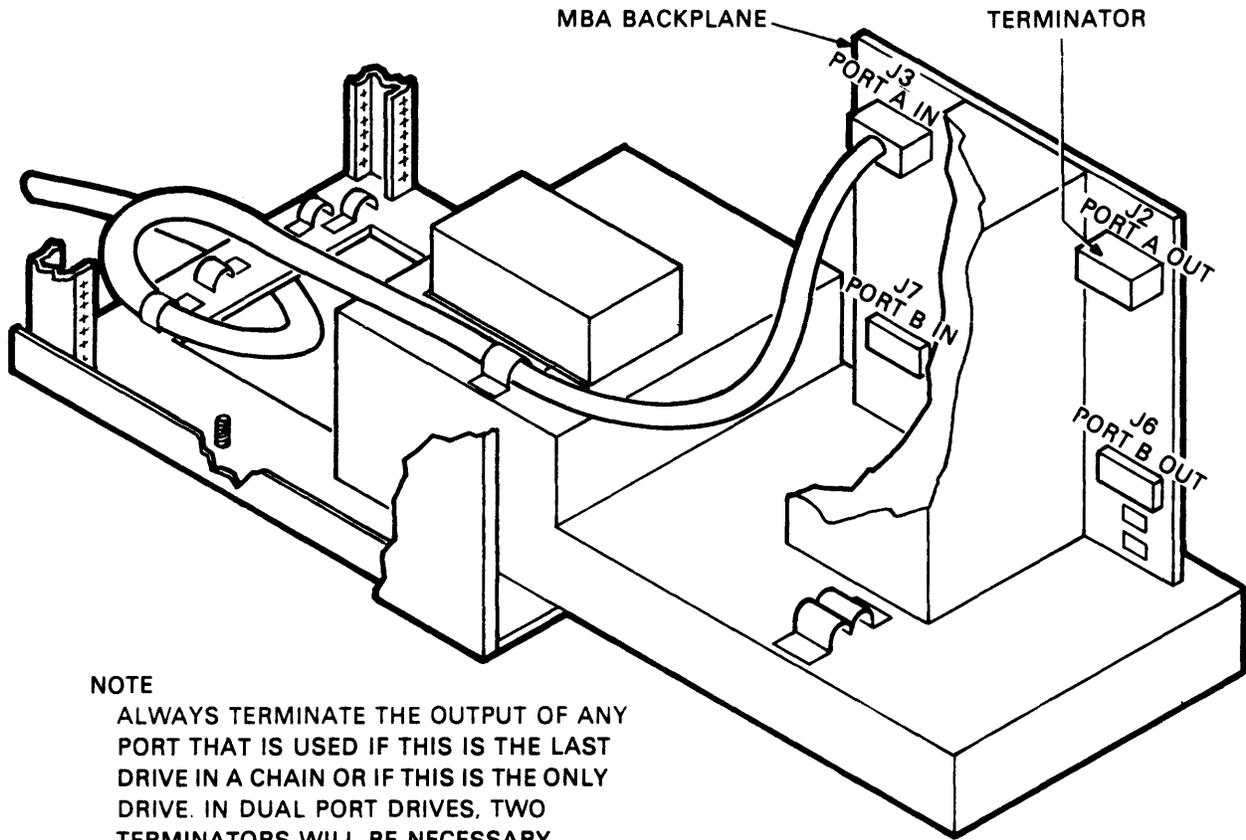
Number Bit	Serial Jumper	Resulting BCD Serial Number
1	In	
2	Out	
4	In	2
8	In	
10	Out	+
20	Out	
40	Out	70
80	In	
100	Out	+
200	In	
400	In	100
800	In	
1000	Out	+
2000	Out	
4000	In	3000
8000	In	_____
		3172



**NOTE**  
 IF THIS IS THE LAST DRIVE IN THE CHAIN,  
 INSTALL A TERMINATOR ON PORT A  
 OUTPUT (J2).

MA-0597

**Figure 2-25 BC06S Massbus Cable Connection**

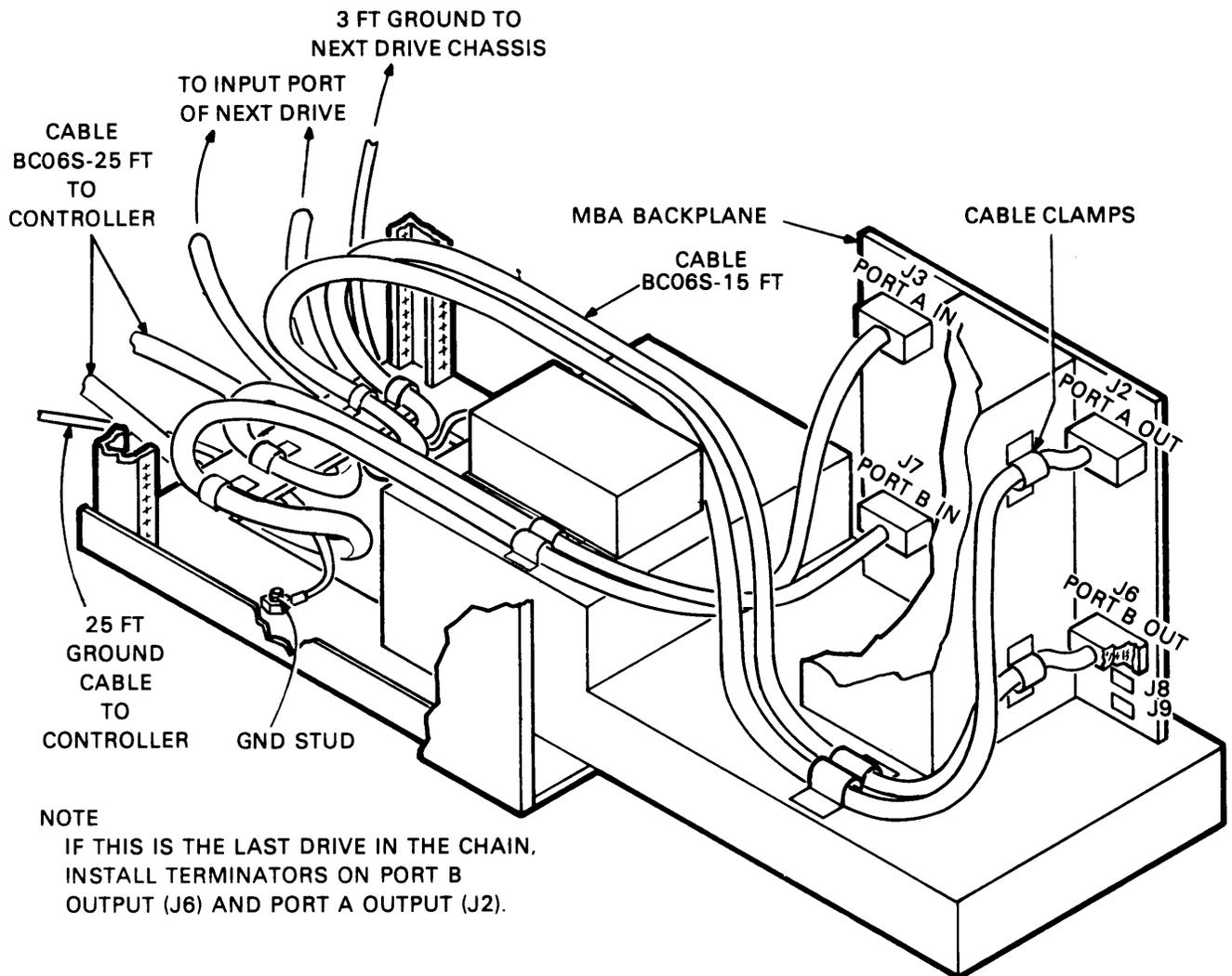


MA-0605

Figure 2-26 Terminator Installation

### 2.6.4 Dual-Port Cabling Procedure

1. Prior to installing the cables for dual-port operation, the following steps should be taken (Figure 2-24).
  - a. Verify that both port A transceivers (M5922s) and port B transceivers (M5923s) are installed into their proper locations as shown in Figure 2-24.
  - b. Verify that jumper S-6 on the J1 connector of the backplane is left out and that the other two jumpers are in place.
  - c. The PORT SELECT switch on the backplane should be in the programmable position.
  - d. Verify that the transceiver switches are in the enabled position.
2. Install the Massbus cables for dual-port operation as shown in Figure 2-27.
3. The Massbus terminators must be installed on the output connectors (J2 and J6), of ports A and B whenever it is the only drive or the last drive in a string.

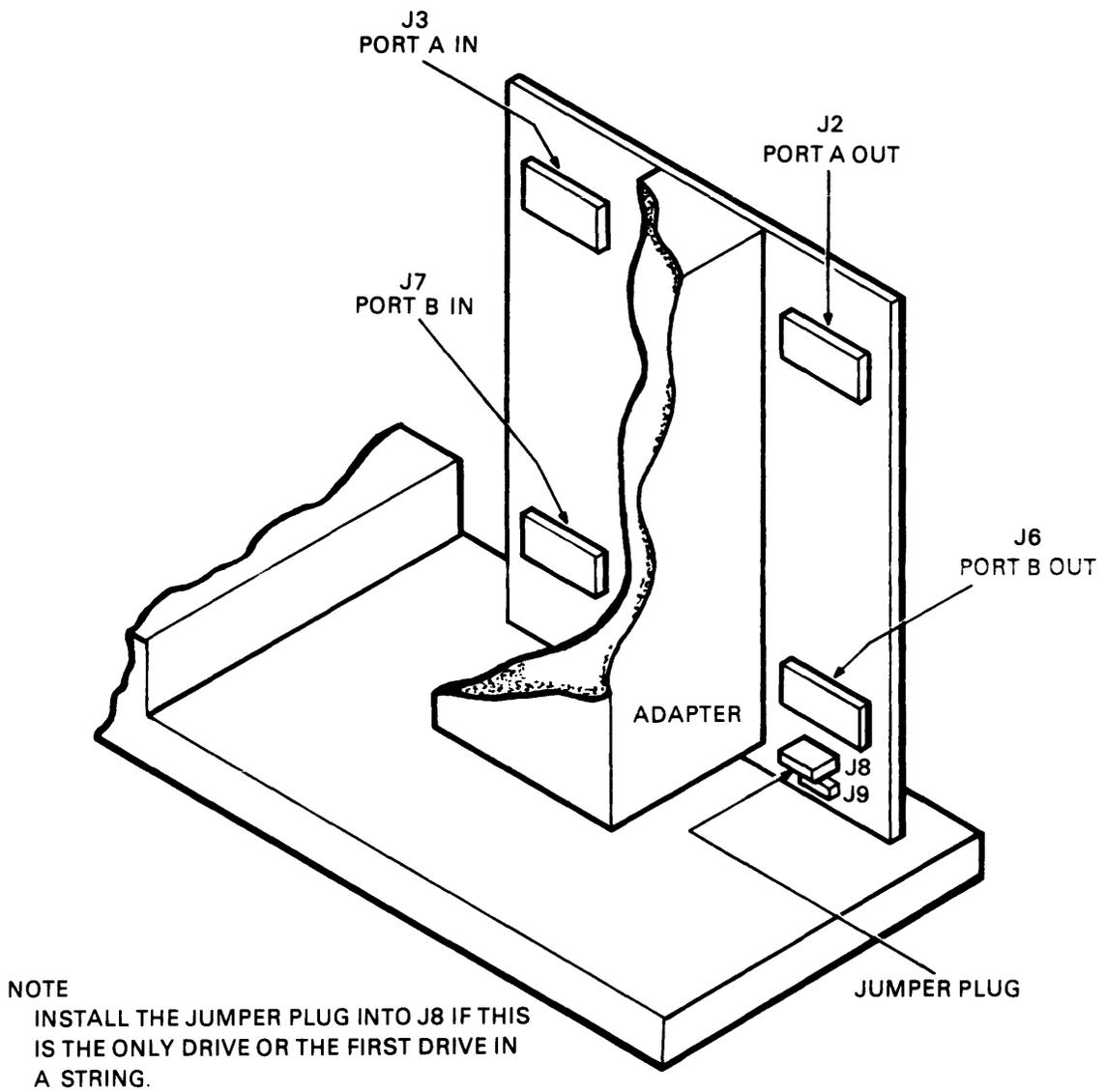


MA-0598

Figure 2-27 Dual Port Cabling

### 2.6.5 Power Sequence Cabling

1. If this is the only drive or the first drive in a string, install the power sequence jumper (DEC part number 7009490) in J8 (power sequence IN) on the MBA backplane (Figure 2-28).
2. If there is more than one drive, daisy-chain the power sequence cables (DEC part number 7009491) from J9 (power sequence OUT) on the first drive to J8 (power sequence IN) on the second drive, etc. (Refer to Figure 2-29.)
3. Verify that the ac power cord coming out of the rear panel of the disk drive is plugged into the ac receptacle on the top surface of the Massbus adapter power supply.



MA-0664

Figure 2-28 Power Sequence Jumper

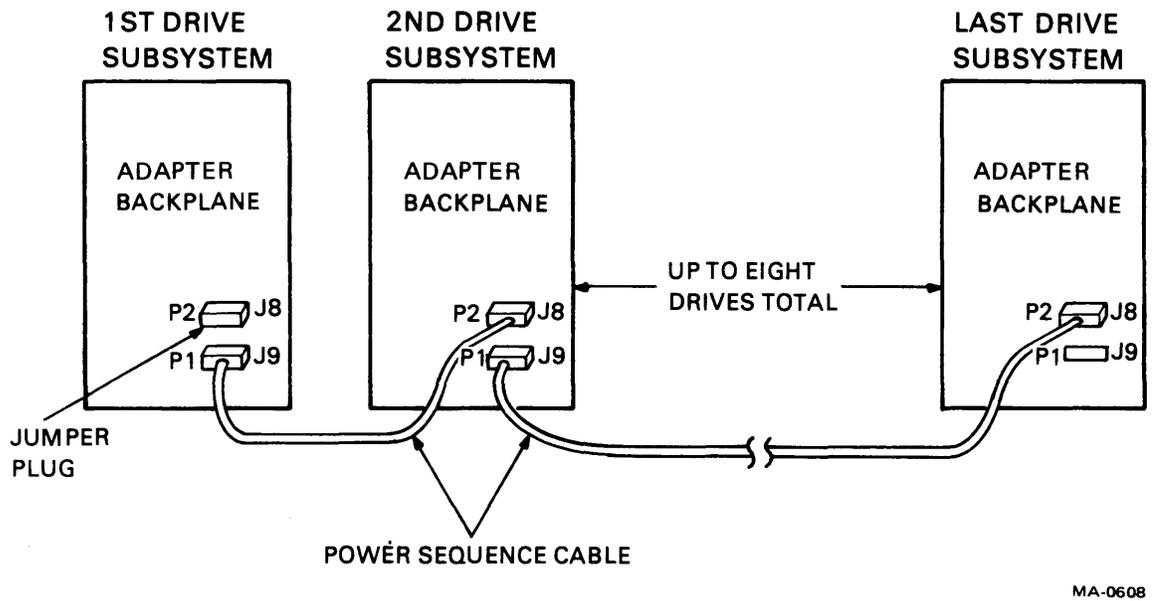


Figure 2-29 Daisy-Chain Power Sequence

## 2.7 SUBSYSTEM CHECKOUT PROCEDURE

### 2.7.1 Subsystem Power Up

1. Before plugging the main ac power cord into its power source, verify that the following steps have been performed.
  - The actuator holding pin must be inserted into its PIN STORAGE hole.
  - The rear deck hold-down screw and spacer must be screwed into its KEEPER HOLE, and the right side baseplate shipping bracket must be rotated 180 degrees.
  - All four circuit breakers (two on the drive rear panel, and two on the adapter power supply) must be in the OFF position.
  - The terminals on the large capacitors should be on tightly.
2. Plug the disk subsystem ac power cord into its appropriate power source. Once this is done, the ac indicator on the MBA power supply will come on.

3. To apply power to the subsystem, proceed as follows.
  - Switch the ac power circuit breaker on the MBA power supply to the ON position.
  - Switch the dc power supply breaker on the MBA power supply to its ON position.
  - Switch the ac circuit breaker on the drive rear panel to its ON position.
  - Turn ON the dc power supply circuit breaker on the drive rear panel.
  - Ensure that the drive's blower starts to operate and wait 2 minutes before proceeding.

#### **CAUTION**

**Failure to allow the blower to operate for 2 minutes before installing the disk pack will not allow sufficient purge time and may cause damage to the disk pack or heads.**

4. To install a disk pack and initiate a start-up sequence, follow the disk pack installation procedures described in Paragraph 3.2.2 of the Operating Instructions.

## **2.7.2 Installation of the Field Test Unit**

**2.7.2.1 General Description** – The TB3A2 Field Test Unit (FTU) is a portable, self-contained tester for exercising and/or simulating on-line operations in the DEC I/O storage module drives (SMDs), series BK5.

The FTU is housed in a suitcase-type carrying case that provides a control panel, a logic board, and an integral power supply. The case contains space for storing the power cable, all necessary I/O cables, and a head alignment card. The head alignment card plugs into the logic chassis of the SMD and permits individual head alignment, using a null meter mounted in the FTU control panel.

### **Modes of Operation**

The TB3A2 FTU provides five access (seek) modes, four read/write modes, and two modes for determining head selection.

#### **NOTE**

**Performing any write operations will destroy formatting on the pack.**

### **Access Modes**

**Direct Seek** – The drive under test will perform a single seek to the track number set in the CYLINDER ADDRESS switches on the FTU control panel.

**Continuous Seek** – The drive under test will perform repetitive seeks between any two tracks selected by the operator. Operation will continue until the START/STOP switch on the FTU control panel is moved to STOP (STOP switch actuated).

**Sequential Forward Seek** – The drive under test will perform single-track incremental seeks until the last track is reached, then seek to track 00, and continue incremental seeks in the same manner until the STOP switch is actuated.

**Sequential Reverse Seek** – The drive under test will perform single-track decremental seeks, starting with the track nominated by the CYLINDER ADDRESS switches, until track 00 is reached. The drive will then return to the nominated track and repeat the operation until the STOP switch is actuated.

**Random Seek** – The drive under test will perform seeks to random tracks as selected by a free-running counter within the FTU. Operation will continue until the STOP switch is actuated.

#### **Read/Write Modes**

The TB3A2 FTB generates serial NRZ write data at a rate determined by the servo clock signals transmitted from the unit under test. When a repeatable access mode is selected (that is, any mode except direct mode), a read/write operation will be completed at the selected cylinder, after which a seek will be initiated to the next cylinder address (as determined by the access mode) and the read/write operation repeated. This seek-read/write sequencing will continue until the STOP switch is actuated or an error occurs. For direct seeks, the read/write R/W operation will continue at the selected track or cylinder (depending upon the head select mode) until the STOP switch is actuated.

The number of tracks read or written during each read/write operation is controlled by the mode of head selection chosen. For manual head selection, only the track under the head selected by the HEAD ADDRESS switches will be read or written. For sequential head selection, the heads will be sequenced so as to read or write each track in the cylinder. When the highest-numbered head (or cylinder track) has been exercised, the drive will seek to another cylinder (except in direct seek) and the read/write operation will be repeated at that new cylinder, starting with head 00.

**Write Format** – When the FTU WRT-RD SELECT switch is set to WRT FORMAT, the FTU will write each selected track with the appropriate track address and a repetitive 8-bit data pattern that has been set in the DATA PATTERN switches on the FTU control panel. The FTU also provides a means for indicating a defective track when using the write format mode.

**Write** – When the FTU WRT-RD SELECT switch is set to WRT, the FTU will write the repetitive 8-bit data pattern on the selected track, after having first read and verified the track address.

**Read** – When the FTU WRT-RD SELECT switch is set to RD, the FTU will read the data from the selected track, after having first read and verified the track address.

**Write Then Read** – When the FTU WRT-RD SELECT switch is set to WRT.RD, the FTU will verify the track address and write the 8-bit data pattern on the selected track during one revolution of the drive, then verify the track address, and read back the data during the second revolution.

A fifth position (OFF) of the WRT-RD SELECT switch is available for access only operations. This position is also used during the head alignment procedure.

### **2.7.2.2 Tester Installation**

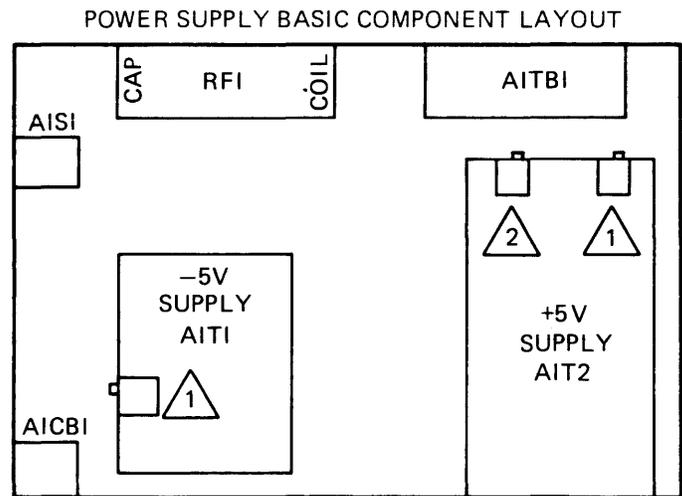
#### **Operating Voltage**

The FTU is connected at the factory for use with a 120 Vac 50/60 Hz power source. To reconnect for 240 Vac operation, proceed as follows.

1. Open the FTU cover. Unhinge the cover and set it aside if necessary.

2. Raise the control panel.
3. Remove head alignment card from its compartment on top of the power supply box.
4. Remove four screws securing the cover plate of the power supply; remove the cover plate.
5. Remove the jumper straps connecting terminals 1 and 2, and terminals 3 and 4 of AITBI (Figures 2-30 and 2-31).
6. Install both jumpers so as to connect terminals 2 and 3.
7. Replace and secure the power supply cover plate.
8. Replace the head alignment card in its compartment.
9. Procure a 120 to 240 Vac conversion plug from a local supply house and attach it to the FTU power cord plug. Alternatively, remove the molded 3-prong plug attached to the FTU line cord and install one suitable for 240 Vac receptacles.

The FTU is now ready for 240 Vac operation.



NOTES:

 VOLTAGE POT (SCREWDRIVER ADJ)

 OVERVOLTAGE POT (SCREWDRIVER ADJ)

MA-1423

Figure 2-30 FTU Power Supply Layout



### I/O Cables

Two I/O cables are provided. The A-cable has a 75-pin block-type connector on one end and a 60-pin flat-cable connector on the other end for connection to the drive. The B-cable is equipped with a 34-pin block-type connector on the tester end and a 26-pin flat-cable connector on the drive end (Figure 2-32).

### Head Alignment Cable

SMD head alignment using the TB3A2 FTU requires installing the special head alignment card in the proper position of the drive logic chassis, and connecting the 4-wire head alignment cable between the logic chassis and the appropriate jack in the drive's read/write assembly. Figure 2-33 gives the connecting information. A pair of test leads (provided) is then installed between the banana jacks on the head alignment card and the null meter on the FTU control panel.

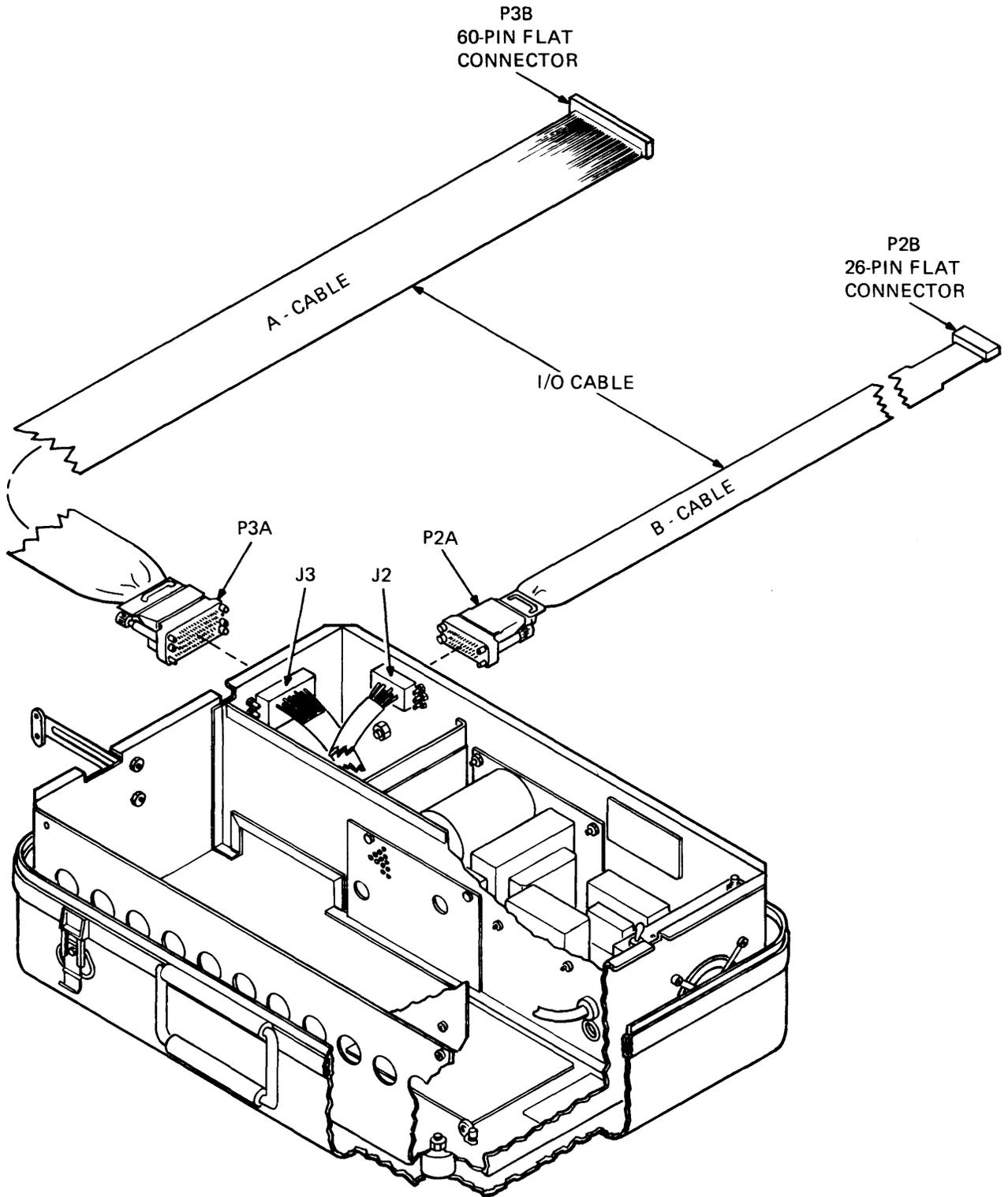
**2.7.2.3 Controls and Indicators** – Except for the power switch and circuit breaker mounted on the power supply box, all controls and indicators for operation of the TB3A2 FTU are located on the control panel (Figure 2-34). The controls and indicators are described below, moving from top left to bottom right across the panel.

+5 V, -5 V indicators	Indicate that the respective power supply voltages are present.
SERVO OFFSET switch	A 3-position switch with center "off."
+	Commands the drive to offset the carriage in the positive direction (toward the spindle).
Center	Nominal positioning (no offset).
-	Commands the drive to offset the carriage in the negative direction (away from the spindle).

#### NOTE

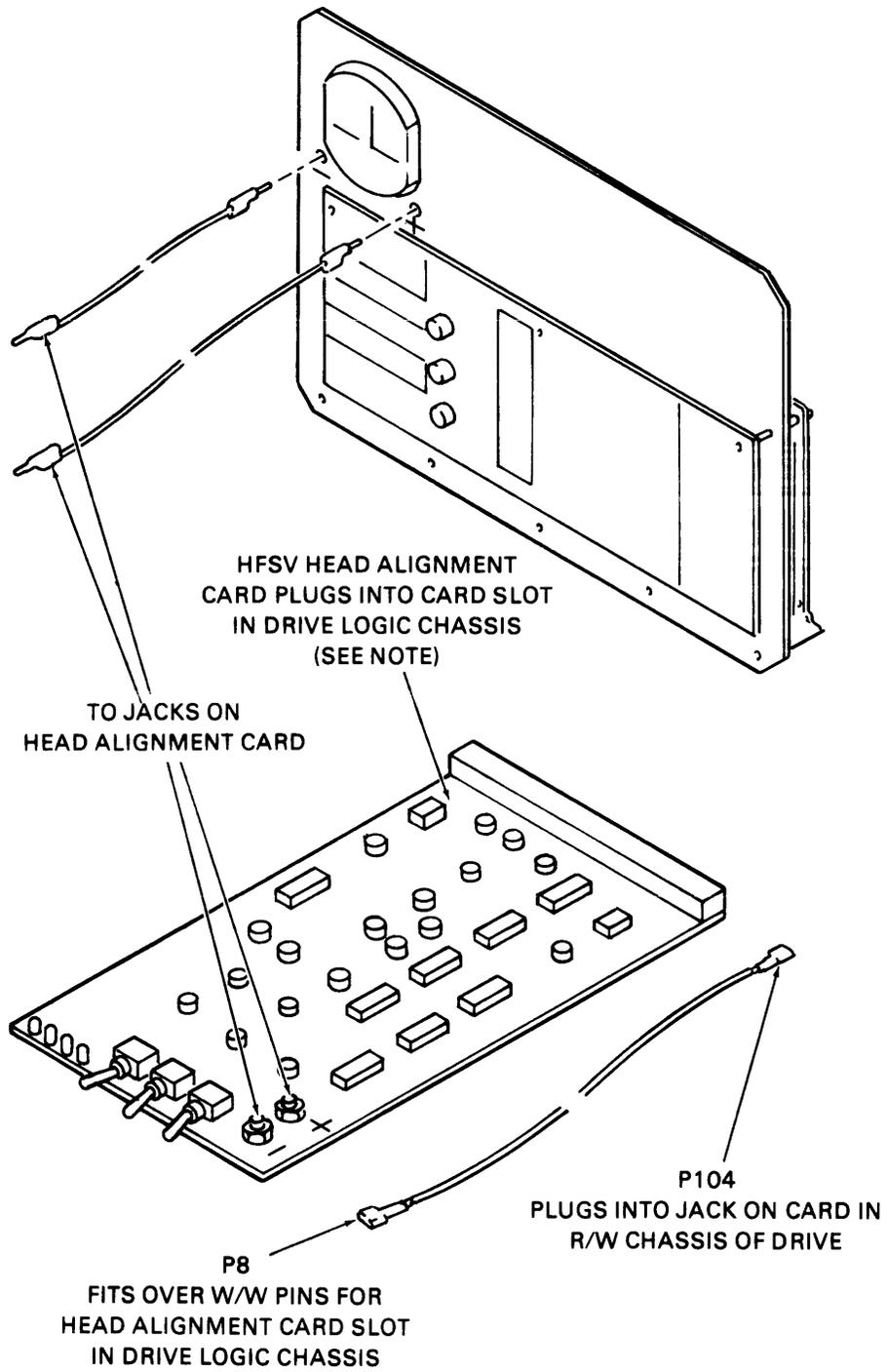
**The START/STOP switch must be actuated to effect any change in offset by the drive when in direct mode.**

DATA STROBE switch	A 3-position switch with center "off."	
EARLY	Moves the drive's read strobes from nominal to an earlier time with respect to data.	
Center	Drive strobes at nominal timing.	
DATA STROBE switch (cont)	LATE	Moves the drive's read strobes from nominal to a later time with respect to data.
WRT FLAG switch	When moved up, this switch causes a Defective Track flag bit to be inserted in Bit 6 of Address Word 1, provided that: <ul style="list-style-type: none"><li>• WRT-RD SELECT switch is set to WRT FORMAT.</li><li>• ACCESS MODE switch is set to DIRECT.</li><li>• Head-select switch (SEQ-MAN) is set to MAN.</li></ul>	



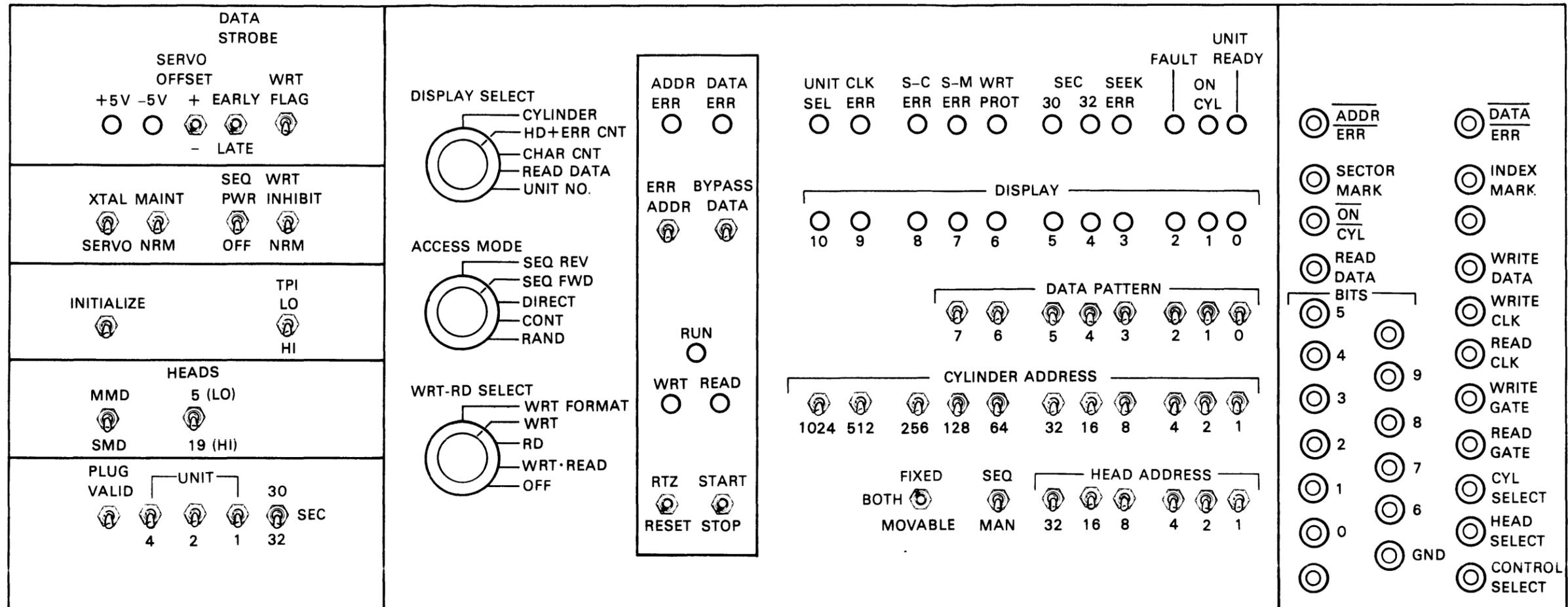
MA-0610

Figure 2-32 Tester I/O Cables



MA-0662

Figure 2-33 Head Alignment Connections



MA-0638

Figure 2-34 TB3A2 Control Panel

XTAL/SERVO switch	XTAL	A crystal oscillator within the FTU provides a nominal 9.667 MHz clock signal. Used for tester maintenance.
	SERVO	Servo Clock signals from the drive provide the basic timing for the FTU.
MAINT/NRM switch	MAINT	Used to perform maintenance on the FTU without a drive connected. Provides pseudo Ready and On Cylinder signals to simulate a drive response. It is also used during head alignments.
	NRM	Normal testing of a drive is done in this position.
SEQ PWR/OFF switch	SEQ PWR	<p>In this position, the FTU commands the drive to power-up, provided that:</p> <ul style="list-style-type: none"> <li>• The drive is in the remote mode.</li> <li>• Primary power is available at the drive.</li> <li>• The drive's START switch is ON (indicator lighted).</li> </ul>
	OFF	In this position, the FTU cannot power-up the drive.
WRT INHIBIT/NRM switch	WRT	Prevents writing by the drive.
	INHIBIT	Writing is inhibited even though all other FTU switches are set to perform a write operation.
	NRM	Allows a normal write operation in the drive, provided that other FTU switches are set to perform a write operation.
INITIALIZE		When moved to the "up" position, this momentary-contact switch provides an Initialized signal to the drive under test.
TPI switch		Not used; position irrelevant.
MMD/SMD switch		Not used; position irrelevant.
HEADS switch		Not used; position irrelevant.
PLUG VALID switch		With FTU's DISPLAY SELECT switch set to UNIT NO. so as to display the PLUG VALID indication, proceed as in Table 2-14.



ACCESS MODE  
switch (cont)

CONT

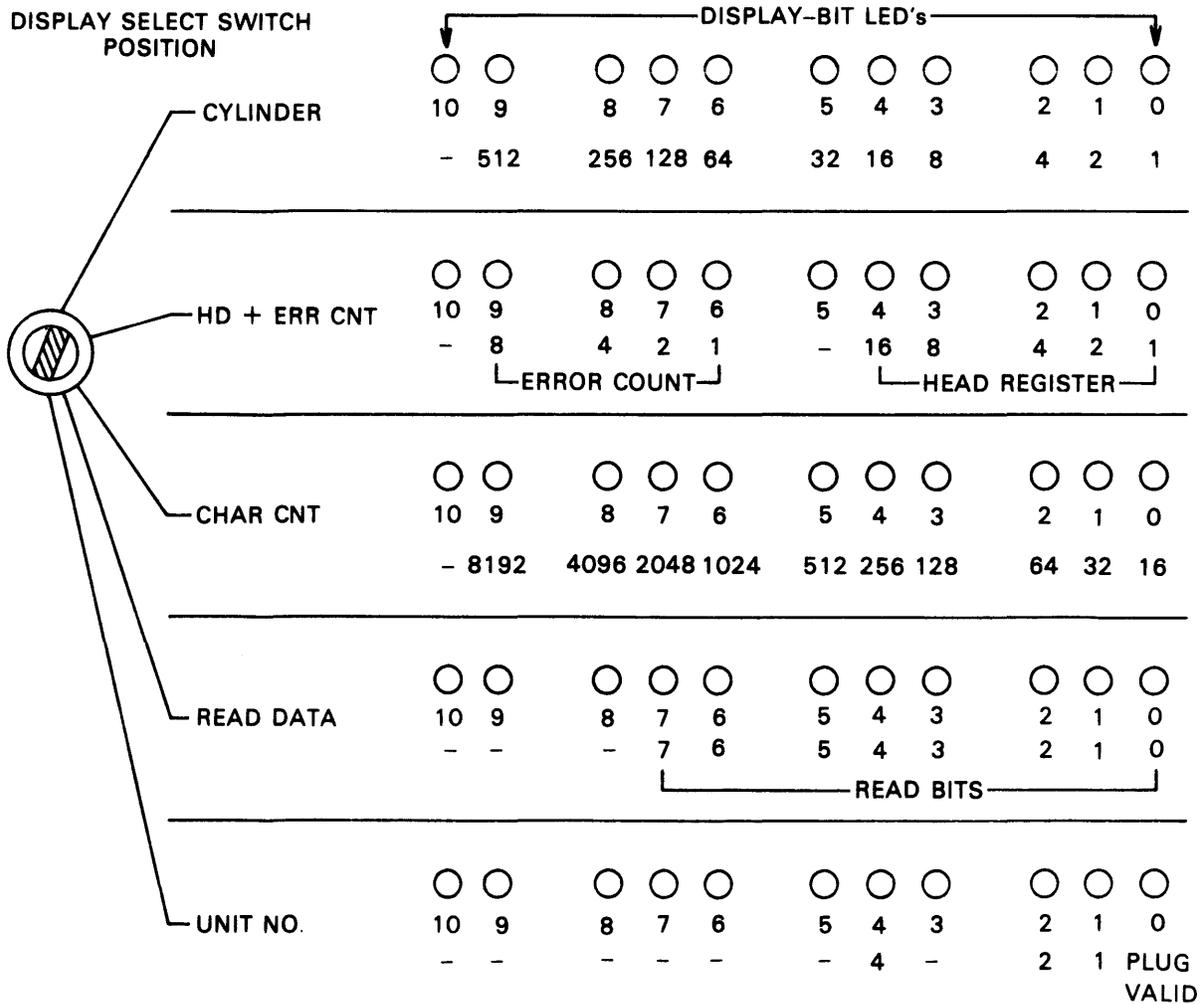
**Continuous** - The drive seeks alternately between the address in the CYLINDER ADDRESS switches and that in the cylinder address register. The contents of CAR does not change during this operation.

RAND

**Random** - The drive seeks to random addresses generated by increasing the count in the CAR during the time that the drive is not "on cylinder."

DISPLAY SELECT  
switch

A 5-position rotary switch that controls the eleven DISPLAY lamps on the FTU control panel. The interpretation of the display is shown in Figure 2-35. When the switch is set on READ DATA, the cylinder address will be displayed as long as the FTU is running. The data pattern read will be displayed if the FTU has stopped because of a data error; otherwise the display will be 0s.



MA-0639

Figure 2-35 Display Select Switch

**WRT-RD SELECT**  
switch

A 5-position rotary switch that determines the manner in which data will be exchanged between the FTU and the drive under test.

**WRT**  
**FORMAT**

**Write Format** – Writes the correct track address (HA and CA) and a preselected 8-bit data pattern field on each selected track. The format is as shown in Figure 2-36.

**NOTE**

**This format is not the same as the standard DIGITAL format.**

**WRT**

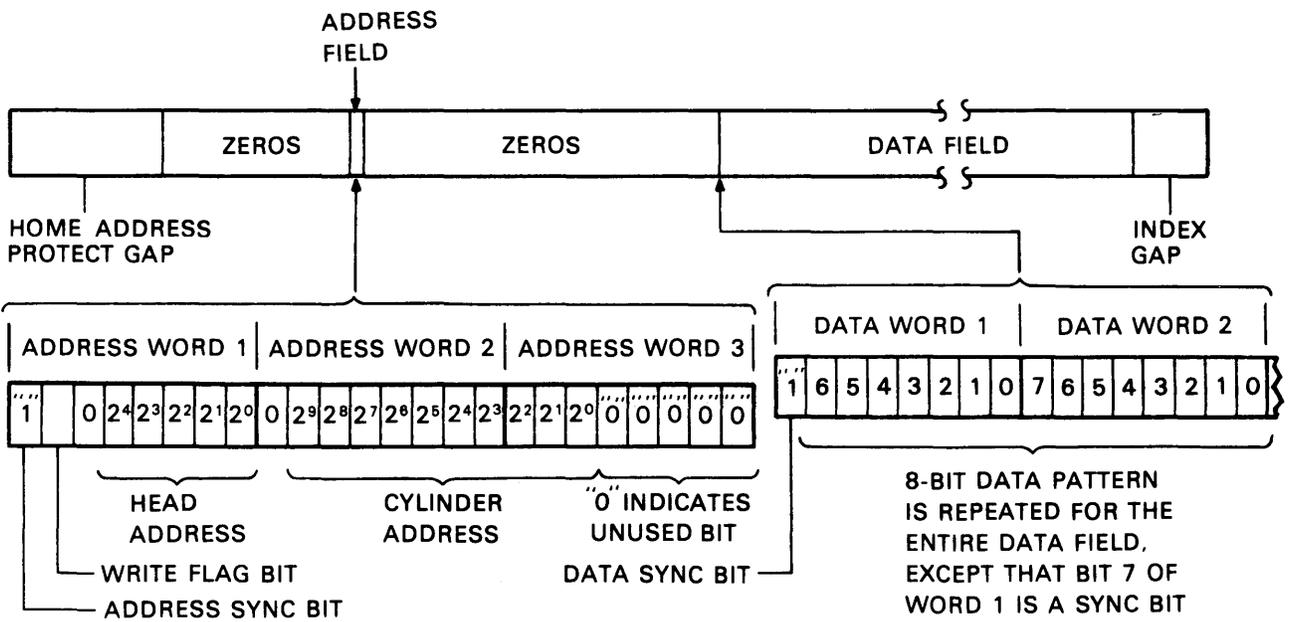
**Write** – Writes a preselected pattern in the data field of each selected track, after first verifying the track address.

**RD**

**Read** – Verifies the track address, then reads the selected track.

**WRT.READ**

**Write Then Read** – Verifies the track address, writes the data field on the selected track, then reads the track. (Operation requires two revolutions.)



MA-0641

Figure 2-36 Track Format

WRT-RD SELECT switch (cont)	OFF	Disables all read/write functions; restricts the drive under test to seek operations only.
ADDR ERROR indicator		Indicates that the address information received from the drive differs from the address requested, or that the address sync bit was not received from the drive.
DATA ERROR indicator		Indicated that the 8-bit data pattern received from the drive differs from the pattern set in the DATA PATTERN switches.
ERROR BYPASS switches	ADDR	<b>Address</b> – If this switch is in the “up” position, it allows the FTU to continue operating when an address, S-C, or S-M error occurs. In the “down” position, an address error will stop the FTU.
	DATA	If this switch is in the “up” position, it allows the FTU to continue operating when a data error occurs. In the “down” position, a data error will stop the FTU.
RUN indicator		Indicates that the FTU is running or that the RTZ switch (Return-to-Zero) is being actuated. Five conditions will turn off the indicator. <ul style="list-style-type: none"> <li>• Returning the RTZ switch to neutral (but provided that RUN was not lit before the RTZ operation)</li> <li>• A valid (unbypassed) error</li> <li>• Actuating the STOP switch</li> <li>• Actuating the RESET switch</li> <li>• If the Ready signal from the drive goes low</li> </ul>
WRT indicator		Indicates that the FTU is writing.
RD indicator		Indicates that the FTU is reading.
RTZ/RESET switch		A 3-position momentary switch with center “off.”
	RTZ	Clears HAR and CAR; clears the drive’s fault register and causes the drive to perform a return-to-zero seek. The RUN light on the FTU control panel will be lit as long as this switch is actuated to the RTZ position.
	Center	Neutral position.
	RESET	Clears the error flip-flops in the FTU and the drive. This switch must be actuated after a valid error has occurred in order to be able to restart the FTU.

**START/STOP**  
switch

A 3-position momentary switch with center "off."

**START** Generates a pulse that starts the FTU; turns on the RUN indicator. An existing error condition must be cleared by actuating the RE-SET switch before START will have any effect.

**Center** Neutral position.

**STOP** Stops the FTU; extinguishes the RUN indicator.

**UNIT SEL**  
indicator

Indicates that the unit number of the drive under test agrees with that set in the UNIT NO. switches on the FTU, and that the tester is receiving a Plug Valid signal from the drive.

**CLK ERROR**  
indicator

Indicates that a period of 200 ns has expired without a servo clock pulse from the drive under test.

**S-C ERROR**  
indicator

Indicates that the sector counter in the drive under test does not agree with the sector counter in the FTU.

**S-M ERROR**

Indicates that an incorrect number of sector marks was received from the drive under test between successive index marks.

**WRT PROTECT**  
indicator

Indicates the presence of a Write Protect signal from the drive under test.

**SEC 30/32**  
indicator

Indicates whether the drive is in 30 or 32 sector mode.

**SEEK ERROR**  
indicator

Indicates the presence of a Seek Error signal from the drive under test.

**FAULT**  
indicator

Indicates the presence of a Fault signal from the drive under test.

**ON CL**  
indicator

Indicates the presence of an On Cylinder signal from the drive under test, or a pseudo On Cylinder signal generated by the FTU if in maintenance mode.

**UNIT READY**  
indicator

Indicates the presence of a Ready signal. This signal comes from the drive if the A and B I/O cables are connected between the drive and the FTU.

**DISPLAY**  
indicators

Refer to diagram shown for the DISPLAY SELECT switch (Figure 2-35).

**DATA PATTERNS**  
switches

These switches permit setting the repetitive 8-bit data pattern that is written in the data field of the selected track during a write operation. For read operations, the data read from the track is compared with these switches to check for the presence of a read error. A 1 is indicated when a switch is in the "up" position, a 0 when the switch is "down."

CYLINDER ADDRESS switches	These switches enter the binary value of the cylinder address to which a seek is desired. Used in conjunction with the ACCESS MODE switch. A 1 is indicated when a switch is in the “up” position, a 0 when the switch is “down.”
FIXED/BOTH MOVABLE switch	Not used. Reserved for future use with MMDs.
SEQ/MAN	This switch determines the manner in which the head address is selected.
SEQ	<b>Sequential</b> – After performing a write or read operation, the FTU increases the count in the head address register by 1 for each index mark or, when in random, for each access. When the count is maximum (5 or 19), head zero is the next head selected, and the incrementing continues.
MAN	<b>Manual</b> – The FTU will select the head address set in the HEAD ADDRESS switches.
ADDR ERROR test point	This test point goes to a logical 0 when an address error occurs.
DATA ERROR test point	This test point goes to a logical 0 when a data error occurs.
SECTOR MARK test point	This test point goes to a logical 1 when the FTU receives a Sector Mark signal from the drive under test.
INDEX MARK test point	This test point goes to a logical 1 when the FTU receives an Index Mark signal from the drive under test.
ON CYL test point	This test point will be a logical 0 when the drive under test is On Cylinder.
READ DATA test point	This test point reflects the binary value of the serial data bits being received from the drive under test during a read operation. The test point is inoperative during maintenance mode.
WRITE DATA test point	This test point reflects the binary value of the serial data bits being processed by the FTU during a write operation (“0” = 0, “1” = 1). The indication is valid for any write operation, even though the FTU is in the maintenance mode. The test point remains a logical 0 during read operations.
BITS 0–9 test points	These ten test points reflect the logical value of the bus-out bits (BOB) delivered to the drive under test via the A-cable. Logically, these bits are present in the FTU’s bus-out multiplexer, and are available at the test point panel regardless of the operating mode (including maintenance mode) of the TB3A2. For an interpretation of the specific bus-out bits, see Table 2-15.

**Table 2-15 FTU Test Points**

<b>Signal Name</b>	<b>Function – A-Cable (To Drive)</b>		
Tag Bus Lines	Three lines that define the operation to be performed by the drive. Tag 1 gates the cylinder address and initiates the seek. Tag 2 gates the head address. Tag 3 is the control select that gates the function to be performed.		
<b>Bus-Out Lines</b>	<b>Tag 1</b>	<b>Tag 2</b>	<b>Tag 3</b>
Bit 0	1	1	Write Gate – Enables write circuits in drive unless drive is write protected.
Bit 1	2	2	Read Gate – Enables read circuits in drive.
Bit 2	4	4	Servo Offset Plus – Offsets the actuator from the nominal On Cylinder position toward the spindle.
Bit 3	8	8	Servo Offset Minus – Offsets the actuator from the nominal On Cylinder position away from the spindle.
Bit 4	16	16	Fault Clear – Pulse to clear the fault summary flip-flop in the drive.
Bit 6	64	–	RTZ – Pulse that causes the drive actuator to seek to track 0.
Bit 7	128	–	Data Strobe Early – Enables the drive’s PLO data separator to strobe the data at a time earlier than optimum.
Bit 8	256	–	Data Strobe Late – Enables the drive’s PLO data separator to strobe the data at a time later than optimum.
Bit 9	–	–	

**GND**  
test point

This test point is a common ground point between the FTU logic board and the control panel.

**WRITE CLK**  
test point

This test point reflects the logic level of the 9.667 MHz Write Clock signal that the FTU sends to the drive under test during any write operation.

**READ CLK**  
test point

This test point reflects the logic level of the 9.667 MHz Read Clock signal received from the drive under test during any read operation. A read error forces the test point to logical 0.

**WRITE GATE**  
test point

A logical 1 at this point indicates the presence of a Write Gate signal generated by the FTU during any write operation.

**READ GATE**  
test point

A logical 1 at this test point indicates the presence of a Read Gate signal generated by the FTU during any read operation.

CYL SELECT test point	This test point goes to a logical 1 when the FTU sends a Cylinder Select signal (Tag 1) to the drive.
HEAD SELECT test point	This test point goes to a logical 1 when the FTU sends a Head Select signal (Tag 2) to the drive.
CONTROL SELECT test point	This test point goes to a logical 1 when the FTU sends a Control Select signal (Tag 3) to the drive.

### 2.7.3 Operation of the Field Test Unit (FTU)

**2.7.3.1 General Description** – The TB3A2 FTU is used to pin-point a problem in the drive, once the nature of that problem has been defined. Suppose, for example, that a drive is suspected of intermittent read errors. The TB3A2 can be set up to repeatedly write and read back any chosen data pattern on a given track, on the entire pack, on any portion of the pack between two selected cylinders, stopping when an error occurs.

By making several such error-stop passes, and by using the DISPLAY SELECT switch to identify the cylinder, head, character count, and the data pattern read for each error stop, the FE can create a record of error parameters that will provide a failure pattern for pin-pointing the problem.

The character-count display provides an indication of how far from index the error occurred. If you suspect a bad spot on the disk because errors consistently occur for the same head (track) and cylinder, the character count can confirm it. If the character count is random for that situation, suspect intermittent data failures on the selected head rather than a bad spot on the disk.

That is to say, the degree of flexing to which the head lead is subject at a particular head/arm location, plus machine vibration, might cause read/write errors; but they would most logically be random errors, not occurring at the same spot for every revolution of the disk. Discriminations between random errors and bad spots are important when writing the track format on a new scratch pack, as described in the operating procedures (Paragraph 2.7.3.3).

Data and address errors are the most prevalent causes for failure. The TB3A2 FTU provides bypass switches for each of these errors. This allows the FTU to alternately write and read a suspected track (or cylinder or pack area) for an extended period without stopping when an error of this type appears. After the test, the error count display will show the number of errors that occurred during the test period, up to a maximum of 15.

#### 2.7.3.2 Preliminary Setup

1. At the drive, disconnect the A and B I/O cables running to the drive controller; connect the A and B adapter cables, provided with the FTU, between the drive and the tester.
2. Take steps to ensure that the system will not attempt to select the drive while that drive is being exercised by the FTU.
3. Remove ac power from the drive and make the I/O cable connections as determined in step 1. Do not reapply ac power to the drive.
4. Set the SEC (sector) switch on the FTU panel to 30 or 32, as desired for the drive under test.

- Set the following switches as shown for normal testing.

Switch	Position
SEQ PWR	Up
SERVO OFFSET	Center (off)
DATA STROBE	Center (normal)
WRT FLAG	Down (off)
XTAL/SERVO	SERVO
MAINT/NRM	NRM
WRT INHIBIT/NRM	NRM
PLUG VALID	Up
UNIT (3 switches)	To logical address of the drive
ADDR ERROR/BYPASS	Both down (off)
DATA ERROR/BYPASS (2 switches)	

- Turn on the FTU.
- Apply ac power to the drive. The UNIT SEL indicator should light up, as will the WRT PROT indicator if the drive under test is in the write protect mode.
- Install a scratch pack on the drive to be tested.
- Power up the drive. The WRT PROT lamp, if on, will go out when the drive is up to speed. The UNIT READY lamp will light up when the heads are loaded.
- Actuate the INITIALIZE switch.
- Actuate the RTZ switch, then the RESET switch on the FTU panel.

The drive is now ready for exercising. It has performed a seek to cylinder 0 and has selected head 0. The remaining switches on the FTU panel may now be set for the desired function and operating modes, as illustrated in the operating procedures (Paragraph 2.7.3.3).

**2.7.3.3 Operating Procedures** – The first five of the procedures described below embody every access, read/write, and head-select mode provided by the TB3A2. Paragraph 2.7.3.3.6 checks the data error logic and Paragraph 2.7.4.1 describes the use of the head alignment card.

**Continuous Seek, No Read/Write** – This procedure performs alternate seeks between the cylinder address in the CAR and the address set in the CYLINDER ADDRESS switches.

- Ensure that the FTU switches are positioned as described in the preliminary setup procedure (Paragraph 2.7.3.2). In addition, position the following switches as shown.

Switch	Position
DISPLAY SELECT	CYLINDER
WRT-RD SELECT	OFF

2. Set the CYLINDER ADDRESS switches to the value of one of the cylinder address to which the drive will seek. (For illustration, choose CA8.)
3. Set the ACCESS MODE switch to DIRECT.
4. Momentarily actuate the START switch. When the ON CYL indicator is lit, move the switch momentarily to STOP. Address 8 is now in the CAR, and will be displayed on the panel.
5. Set the CYLINDER ADDRESS switches to the value of the second cylinder address. (For illustration, choose CA16.)
6. Set the ACCESS MODE switch to CONT.
7. Actuate START. The drive will perform alternate seeks between addresses 8 and 16. The ON CYL indicator will blink rapidly as the heads move on and off cylinder. The cylinder address display lights will alternate between 8 and 16.
8. Stop the FTU.
9. Actuate RTZ.
10. Start the FTU. The tone of the drive will change as it now seeks between cylinders 0 and 16. Observe the display.
11. To stop the operation, actuate either STOP or RESET.

**Random Seek, No Read/Write**

1. Maintain the preliminary setup switch positions (Paragraph 2.7.3.2, step 5). In addition, set the following switches as shown.

<b>Switch</b>	<b>Position</b>
DISPLAY SELECT	CYLINDER
WRT-RD SELECT	OFF
ACCESS MODE	RAND

2. Actuate START.
3. Ensure that cylinders are being selected randomly by observing the changing pattern on the display lamps.
4. Stop the FTU by actuating STOP or RESET.

**Write Format** – This procedure is used to write a prescribed format on every track of the disk pack. The next procedure, read, determines whether any of the tracks so written contain errors. The final procedure, write flag, shows how to select a single track, write a “defective track” flag bit on that track, and check to ensure that the flag bit was indeed written. The track format is shown in Figure 2-36.

1. Maintain the switch positions as given in the preliminary setup procedure (Paragraph 2.7.3.2, step 5). In addition, set the following switches as shown.

Switch	Position
DISPLAY SELECT	READ DATA
ACCESS MODE	SEQ FWD
WRT-RD SELECT	WRT FORMAT
CYLINDER ADDRESS	All down (off)
SEQ/MAN	SEQ
HEAD ADDRESS	All down (off)
DATA PATTERN	70 octal

2. Move RTZ/RESET switch to RESET, then to RTZ.
3. Actuate START. Observe the progression of the display lights as the drive moves away from cylinder 0. (With the DISPLAY SELECT switch set to READ DATA, the cylinder address is displayed while the FTU is running.)
4. If an error stop occurs, remove the cause of the error by proceeding as indicated in the trouble analysis chart in Table 2-16. (Data errors will not occur during WRT FORMAT.) Then proceed as follows.
  - a. Actuate RESET to clear the error indication in the FTU.
  - b. Actuate START. This rewrites the track that was selected when the error occurred, then continues the write format operation.
  - c. Do not actuate RTZ. To do so would cause the operation to begin anew at cylinder 0, head 0.
5. After all tracks have been written, stop the FTU. (Writing will begin again at cylinder 0, so the actual stopping point is immaterial.)

**Read** – This operation tests the entire data pack for errors, using the sequential reverse access mode.

1. Set the following switches as shown. All others should remain as given for the write format procedure.

Switch	Position
DISPLAY SELECT	CYLINDER
ACCESS MODE	SEQ REV
WRT-RD SELECT	RD

2. Set the CYLINDER ADDRESS switches to the maximum cylinder address (822 decimal) The switch settings are as follows.

ON	OFF
512	1024
256	128
32	64
16	8
4	1
2	

**Table 2-16 Trouble Analysis (Sheet 1 of 3)**

**Assume:**

1. A & B I/O cables connected between drive and FTU.
2. Power applied to FTU and drive.
3. +5 V indicators on FTU panel are lit.
4. DATA/ADDRESS BYPASS switches OFF.
5. FTU set to READ track format.
6. READ indicator comes on when START switch (on FTU panel) is actuated.

<b>Conditions</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>
Seek error	N	Y	-	-	-	-	-	-
Clock error in SERVO position	N	-	Y	-	-	-	-	-
Clock error in XTAL position	-	-	-	N	Y	-	-	-
Sector Mark Error	N	-	-	-	-	Y	-	-
Sector Count Error	N	-	-	-	-	-	Y	-
Drive Fault	N	-	-	-	-	-	-	Y
<b>Actions</b>								
Go to sheet 2, "Conditions."	1	-	-	-	-	-	-	-
Actuate RESET, RTZ, START.	-	1	-	-	-	-	-	-
Refer to drive service manual.	-	2	-	-	-	4	4	1
Set XTAL-SERVO switch to XTAL; Actuate RESET, START.	-	-	1	-	-	-	-	-
Check TP5 (WRITE CLK) on FTU panel.	-	-	-	-	1	-	-	-
Refer to FTU diagrams.	-	-	-	-	2	5	5	-
Check B-cable for SERVO CLK signal. Troubleshoot discontinuity in drive, cable, FTU.	-	-	-	1	-	-	-	-
Check that sector switch (SEC) in FTU is set correctly.	-	-	-	-	-	1	1	-
Check TP1 (SECTOR MK) on FTU panel.	-	-	-	-	-	2	2	-
Check TP0 (INDEX MK) on FTU panel.	-	-	-	-	-	3	3	-

Upper-Left Quadrant: Assumptions needed for tests, as well as the test conditions.

Upper-Right Quadrant: Results of the test: N = No; Y = Yes; - = Don't care.

Lower-Left Quadrant: Actions to be taken for each test result.

Lower-Right Quadrant: Numbers show sequence of actions for the test results in a given column. After each action, the test is repeated and, if X = a "no error" or "problem solved" situation.

**Table 2-16 Trouble Analysis (Sheet 2 of 3)**

<b>Conditions</b>	<b>1</b>	<b>9</b>	<b>10</b>												
Address error	N	Y	-												
Data error, OFFSET and DATA STROBE switches in center (off) position	N	-	Y												
<b>Actions</b>															
Track was read without error.	X	-	-												
Perform WRT FORMAT for track in error; READ rewritten track.	-	1	-												
Perform WRT.RD retry as follows.	-	-	1												
Set FTU switches as indicated below.															
<table border="0" style="width: 100%;"> <thead> <tr> <th style="text-align: left;"><b>Switch</b></th> <th style="text-align: left;"><b>Position</b></th> </tr> </thead> <tbody> <tr> <td>WRT-RD SELECT</td> <td>WRT.RD</td> </tr> <tr> <td>ACCESS MODE</td> <td>DIRECT</td> </tr> <tr> <td>SEQ/MAN</td> <td>MAN</td> </tr> <tr> <td>HD ADRS</td> <td>Select</td> </tr> <tr> <td>CYL ADRS</td> <td>Failing track</td> </tr> </tbody> </table>	<b>Switch</b>	<b>Position</b>	WRT-RD SELECT	WRT.RD	ACCESS MODE	DIRECT	SEQ/MAN	MAN	HD ADRS	Select	CYL ADRS	Failing track			
<b>Switch</b>	<b>Position</b>														
WRT-RD SELECT	WRT.RD														
ACCESS MODE	DIRECT														
SEQ/MAN	MAN														
HD ADRS	Select														
CYL ADRS	Failing track														
Actuate START; check for conditions 11 or 12 on following page of table.															
Unrecoverable error. Perform WRT FLAG procedure for track in error.	-	2	-												

**Table 2-16 Trouble Analysis (Sheet 3 of 3)**

<b>Conditions</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>	<b>17</b>	<b>18</b>	<b>19</b>	<b>20</b>
Data error on WRT.RD retry	N	Y	-	-	-	-	-	-	-	-
Data error, OFFSET switch in + (FWD) position	-	-	N	Y	-	-	-	-	-	-
Data error, OFFSET switch in - (REV) position	-	-	-	-	N	Y	-	-	-	-
Data error, DATA STROBE switch set EARLY	-	-	-	-	-	-	N	Y	-	-
Data error, DATA STROBE switch set LATE	-	-	-	-	-	-	-	-	N	Y
<b>Actions</b>										
Set OFFSET switch to + (FWD) position; READ track in error.	-	1	-	-	-	-	-	-	-	-
Check Bit 2 TP on FTU panel; if missing, refer to FTU diagrams.*	-	-	-	1	-	-	-	-	-	-
Check BOB2 in drive; if missing, check I/O cable and FWD offset logic in drive.*	-	-	-	2	-	-	-	-	-	-
Set OFFSET switch to - (REV) position; READ track in error.	-	-	-	3	-	-	-	-	-	-
Check Bit 3 TP on FTU panel; if missing, refer to FTU diagrams.*	-	-	-	-	-	1	-	-	-	-
Check BOB3 in drive; if missing, check I/O cable and REV offset logic in drive.*	-	-	-	-	-	2	-	-	-	-
Return OFFSET switch to center (off); set DATA STROBE switch to EARLY. Read track in error.	-	-	-	-	-	3	-	-	-	-
Check Bit 7 TP on FTU panel; if missing, refer to FTU diagrams.*	-	-	-	-	-	-	-	1	-	-
Check BOB7 in drive; if missing, check I/O cable and Early Strobe logic in drive.*	-	-	-	-	-	-	-	2	-	-
Set DATA STROBE switch to LATE; Read track in error.	-	-	-	-	-	-	-	3	-	-
Check Bit 8 TP on FTU panel; if missing, refer to FTU diagrams.*	-	-	-	-	-	-	-	-	-	1
Check BOB8 in drive; if missing, check I/O cable and Late Strobe logic in drive.*	-	-	-	-	-	-	-	-	-	2
Drive has demonstrated its ability to recover data.	X	-	X	-	X	-	X	-	X	-
Unrecoverable error. Perform WRT FLAG procedure for track in error.	-	-	-	-	-	-	-	-	-	3

\*When checking for the presence of these bits, the DATA ERROR BYPASS switch must be on ("up" position). This allows reading to continue in the event of an error. The switch should be off ("down" position) when checking for the conditions.

3. Actuate START. Reading will begin at maximum cylinder, head 0. Should an error occur, the RUN light will go out and the panel lamps will display the type of error, as well as the cylinder that was being read when the error occurred. Follow steps 4 and 5 for each separate error stop. If no errors, skip to step 6.
4. Record the error parameters, moving the DISPLAY SELECT switch as needed.

**NOTE**

**It is not necessary to record the ERROR COUNT. This will remain at count 1 for any stop-on-error operation.**

5. After the error parameters have been recorded, actuate RESET to clear the error indication in the FTU, then actuate START to continue reading.
6. When the FTU begins reading again at the maximum cylinder address, actuate STOP to halt the FTU.

**Write Flag** – A single read may produce random errors that in an on-line environment would be eliminated by the system's error-recovery program.

Before flagging a track as bad – that is, as one that continually produces errors that are not recoverable – it is best to WRT.RD the track several times. If the error persists, the trouble analysis procedure (below) should be executed in an effort to recover the error. Only after both of these attempts have failed, should the track be flagged.

This procedure writes a “defective track” flag bit in Bit 6 of Address Word 1 (Figure 2-36).

1. Set the following FTU switches as indicated. Other switches should remain as shown for the preliminary setup procedure (Paragraph 2.7.3.2, step 5).

<b>Switch</b>	<b>Position</b>
WRT FLAG	Up (on)
DISPLAY SELECT	READ DATA
ACCESS MODE	DIRECT
WRT-RD SELECT	WRT FORMAT
DATA PATTERN (8)	As set when the track was most recently written
CYLINDER ADDRESS (11)	To select the track
HEAD ADDRESS (6)	To be flagged
SEQ-MAN	MAN

2. Actuate RESET, then START. Drive will seek to the selected track.
3. When ON CYL light comes on, wait about 1/2 second and then actuate STOP.
4. Set WRT-RD SELECT switch to RD.
5. Actuate START. The “defective track” flag bit will prohibit reading the track. The ADDRESS ERROR and DATA ERROR lights should not light up.
6. Actuate STOP.

Repeat steps 1 through 6 for each track to be flagged as defective.

**NOTE**

**The WRT FLAG switch must be turned off before reading a track that has not been written as defective; otherwise an address error will occur.**

**Check Data-Error Logic** – This procedure assures the operator that data errors will be recognized by the FTU. It is used when the FTU is exercising a drive in any situation where data errors are expected but none occur – an intermittent read failure, for example. It assumes that the procedure in question is still running and that the scratch pack therefore has a data field written on the tracks being tested.

1. Stop the FTU.
2. Set the following FTU switches as indicated.

<b>Switch</b>	<b>Position</b>
WRT-RD SELECT	RD
DATA ERROR BYPASS	Down (off)
DATA PATTERN	Choose any one switch and move it to the opposition position. (Move just one!)

All other switches must remain as they were at the start of the procedure being questioned.

3. Start the FTU. The FTU should stop with the DATA ERROR indicator lit.
4. Actuate RESET to clear the error indication.
5. Set the DATA ERROR BYPASS switch up (on).
6. Actuate START. The FTU should run without stopping on an error, but the RD/WRT ERROR counter will count the errors (up to 15).
7. Stop the FTU. Return all switches used during this procedure to the state they were in at the start of the procedure being questioned.

**Trouble Analysis** – Table 2-16 is a decision logic table (DLT). It shows the procedures the operator should take to eliminate any error that might occur when using the FTU to exercise a drive. Address and data errors will, of course, occur only during one of the read or write modes. Other errors may occur for either read/write or access only (no read/write) modes. It should be noted that sector mark and sector count errors are not indicated if the ADDRESS ERROR BYPASS switch is active.

Basically, the DLT deals with attempts to either eliminate or recover data and address errors before writing a “defective track” flag on the track in error. This involves trying various OFFSET and DATA STROBE switch combinations.

The DLT is divided into four quadrants. Each test condition (shown in the upper-left quadrant) is reduced to a yes (Y) or no (N) result, as indicated in numbered columns of the upper-right quadrant, two columns being allotted for each test condition. The two lower quadrants deal with recommended actions.

To determine what actions (if any) should be executed for a given test result, follow the selected column down to the number "1" (first recommended action) in the lower-right quadrant. The specific action to be taken is then located by following across to the lower-left (actions) quadrant. After action 1 has been taken, repeat the test that gave rise to the error condition. If the error persists, perform action 2, test again, and so on. An "X" in the lower-right quadrant indicates a "no error" or a "problem solved" situation, and requires no further remedial action.

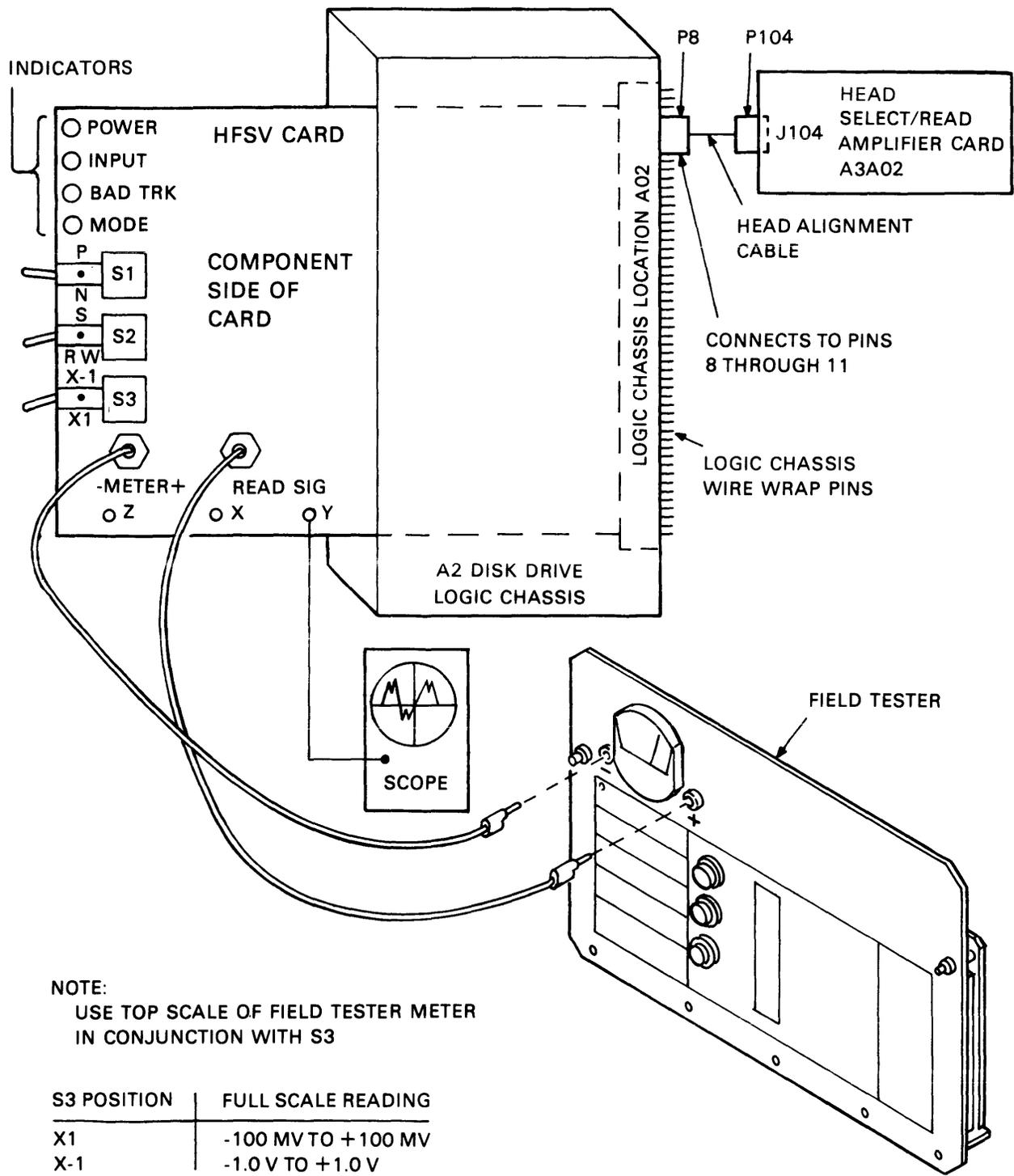
Columns 12 through 20 (Table 2-16) define the sequential test that were alluded to in the second paragraph of this procedure, and which should be made in an attempt to recover any data error. Note that the last action item in any of these "yes" (even-numbered) columns instructs the operator to set up the next condition, or test, for rereading the track in error. When the last of these sequential tests has failed to recover the data, then and only then should the write flag procedure be carried out as indicated by action 3 of column 20.

## **2.7.4 Head Alignment Procedure**

**2.7.4.1 Installation of Head Alignment Card** – This procedure describes the use of the type HFSV head alignment card and the null meter on the FTU control panel to perform read/write and/or servo-head alignment on the SMD under test. The cabling involved is seen in Figures 2-37 and 2-38 gives specific connection information. The switches and indicators on the HFSV card are shown in Figure 2-37.

This procedure assumes that the I/O connections between the drive and the FTU have already been made as described in the installation portion of this manual. The installation and cabling of the head alignment card, must be made with ac power removed from the drive and the FTU.

1. Install the proper CE pack on the drive to be tested.
2. Install the HFSV card in the drive's logic chassis at location A02.
3. Install the head alignment cable between the drive's logic chassis and the jack on the card in the read/write (R/W) chassis, as specified in Figure 2-38. Note that P104 is keyed so that it will fit on the R/W card only one way.
4. Connect the test leads, provided with the FTU, between the HFSV card and the null meter on the FTU panel. Observe polarity.
5. Set the WRT INHIBIT/NRM switch on the FTU to WRT INHIBIT.
6. Apply ac power to the drive. The POWER lamp on the HFSV card should light up.
7. Power-up the drive.
8. Turn on the FTU. If the drive under test is in the write protect mode, the WRT PROT light on the FTU panel will be lit.
9. When the drive is up to speed and the READY light on the FTU panel is lit, actuate RESET, then RTZ.



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Figure 2-37 Head Alignment Connections

SMD SERIES	HEAD ALIGNMENT CARD LOCATION	HEAD ALIGNMENT CABLE	
		P104 	P8 
CDC BK5xx  DEC RMO2 RMO3	A02	PLUGS INTO J104 ON HEAD SELECT/READ AMPLIFIER CARD IN R/W CHASSIS.	SLIPS OVER W/W PINS 8A,B THROUGH 11A,B AT LOCATION RESERVED FOR HEAD ALIGNMENT CARD. A02

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Figure 2-38 Head Alignment Card

10. Set the MAINT/NRM switch to MAINT. This provides a pseudo-index mark that enables the FTU to generate a head select. (The CE pack does not have an index mark.)

**NOTE**

**Installing the head alignment card (Table 2-17) automatically “write protects” the drive (even though it will not of itself cause the WRT PROT light to come on). Therefore, if write, write-then-read, or write-format operations are to be conducted, the HFSV card must first be removed from the drive.**

**2.7.4.2 Preliminaries for Head Check or Alignment** – Before performing the head arm alignment procedure, read and understand the concepts that follow. These are important for accurate head alignment, and they are only referenced in the procedure.

**Thermal Stabilization** – In order to ensure accuracy during head alignment, it is important that the drive, CE pack, and FTU be at their normal operating temperature. This requires that all three be connected and allowed to operate (pack turning and heads loaded to cylinder 0) for a minimum of 60 minutes. If head alignment is being performed on more than one drive, provided that the pack was taken immediately from a previous drive and the drive under test has been operating with heads loaded for a minimum of 60 minutes preceding test, the CE pack only requires 15-minute stabilization.

**Write Protect** – Although the presence of the head alignment card in the appropriate slot will write protect the drive, the WRITE PROTECT switch on the front of the drive should be pushed in, as an extra precaution.

**Alignment Tool** – Use only the head alignment tool specified in the maintenance tools and materials table. Use of a different tool may cause damage to head-arm or carriage. Always inspect the adjustment end of tool prior to use. The tool must be free of nicks and scratches, and must have a polished surface. If any aluminum deposits are present, polish the tool surface with crocus cloth. Any other polishing medium will damage the tool. Do not use a defective tool; repair or replace the tool if damage exists. When using the tool, position alignment tool so that pin in the end of the tool engages the adjustment slot in the head arm. Ensure that the alignment tool is kept perpendicular to the hole in the carriage at all times. The tool should turn freely in hole. If it doesn't, recheck the end of the tool for damage or aluminum buildup.

**Table 2-17 Head Alignment Card Switches and Indicators**

<b>Switches</b>	
S1	Changes the polarity of the alignment signal to the null meter; P = positive; N = negative. Algebraically subtract P from N to determine alignment error: P = +30 mV; N = -40 mV; Error = 70 mV.
S2	S position selects servo head as input to HFSV. RW position selects a data head as input to HFSV.
S3	Changes sensitivity of HFSV. The X.1 position attenuates card output by a factor of 10, and alignment error cannot be accurately measured. The X1 position does not attenuate HFSV output; alignment error can be accurately measured.
<b>Indicators</b>	
POWER	Lit when power is applied to the card.
INPUT	When lit, indicates that input signals are too low for HFSV to operate.
BAD TRK	When lit, indicates a short duration loss of input. <i>A one-shot keeps the LED lit for at least 4 seconds.</i> The lamp will light when S1 is toggled.
MODE	Lit when S2 is in the S (servo) position or when S3 is set to X.1. When either of these conditions exists, read/write head alignment error cannot be measured.

**Calculating Offset** – The formula for calculating head offset is  $(P) - (N) = \text{Offset}$ , where P is equal to the meter reading with the head alignment card P/N switch in the P position, and N is equal to the reading with the switch in the N position. All meter readings to the left of 0 are negative. The following are examples of offset calculation.

1. P = +20 mV, N = +15 mV:  
 $(P) - (N) = (+20) - (+15) = +5 \text{ mV}$
2. P = +20 mV, N = -15 mV:  
 $(P) - (N) = (+20) - (-15) = +35 \text{ mV}$
3. P = -20 mV, N = +15 mV:  
 $(P) - (N) = (-20) - (+15) = -35 \text{ mV}$

**Seek Error Preventing** – When the alignment tool is used to position the heads, a small amount of sideways pressure on the tool can cause the carriage to move. This relatively minor amount of movement generates an error voltage which is sensed by the logic as a seek error. The end result is that the logic clears the slope flip-flop and causes the drive to seek to the next even cylinder.

**Excessive Misalignment** – Occasionally, during the alignment check, a badly misaligned head(s) (in excess of 200 mV offset) may be discovered. If this is so, the head(s) should not be realigned until all packs written by that drive have been dumped (data transferred from pack to other storage). Failure to dump the packs before realignment of the heads will mean that the data is not recoverable.

**Carriage Locking** – During the alignment procedure (when the heads are over the alignment track), the carriage locking pin and ring assembly is installed in the ALIGN TRACK LOCK hole in the rail bracket assembly. This locks the carriage in place. Failure to install the pin and ring assembly would allow the carriage to retract if any emergency retract signal were generated. If the FE's hands are in the actuator during the head alignment procedure, the retract could be dangerous. It should also be noted that should a retract condition be generated, the carriage locking pin and ring assembly must be immediately removed to allow the heads to retract before a head crash occurs. Carefully observe the instructions regarding the installation and removal of the carriage locking pin and ring assembly.

**NOTE**

**Do not do an RTZ on the FTU with the carriage locking pin in the ALIGN TRACK LOCK hole.**

**CE Pack** – The CE pack has odd-even dibits written on tracks 000 through 330 only, on the servo surface. Do not attempt to access beyond track 330.

**2.7.4.3 Head Alignment Check** – The following procedure first checks the alignment of the servo head and then checks the alignment of the read-write heads (which are aligned in relation to the servo head).

**NOTE**

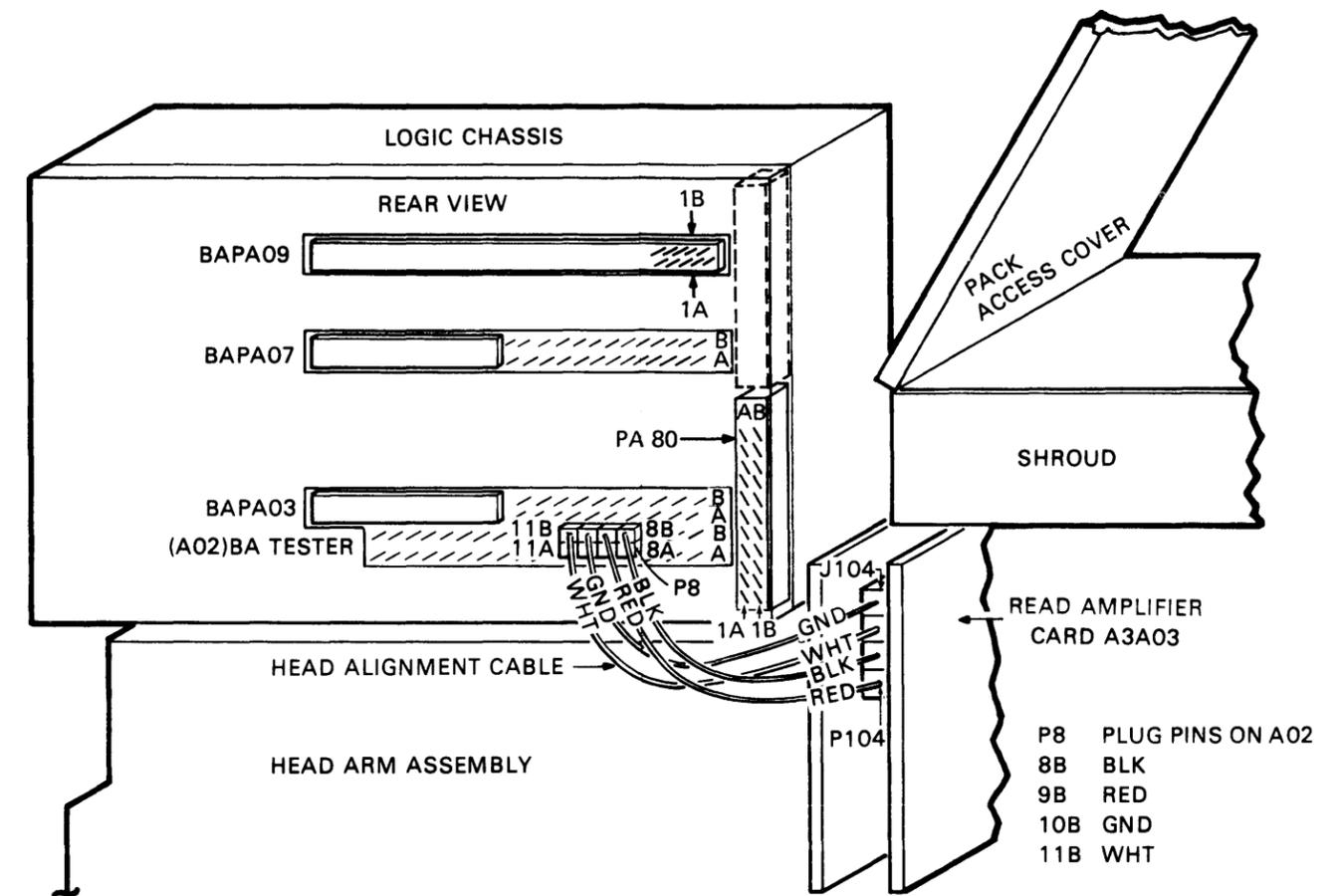
**Check that the rear shipping bracket is removed before attempting alignment and place the LOCAL/REMOTE switch in the LOCAL position.**

Alignment instructions are provided if any head exceeds the allowable offset. The numbers specified are decimal values for the cylinder address.

1. With heads fully retracted, raise logic chassis to maintenance position and note position of servo head adjustment slot in relation to hole in carriage. The adjustment slot should be approximately centered in carriage alignment hole (Figure 2-39).

**NOTE**

**If drive has been used to write data packs, servo head should not be realigned until all read-write heads have been checked and it is known that excessive misalignment does not exist on any of them. Refer to step 1.**



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Figure 2-39 Head Alignment Cable

2. If servo head is misaligned, loosen mounting screw and (using alignment tool) position adjustment slot as shown in Figure 2-40. When servo head is properly positioned, tighten head-mounting screw to a torque of  $12 \pm 1/2$  inch-pounds. Lower logic chassis to normal operating position.

**NOTE**

**If servo head is adjusted, all read-write heads must be adjusted.**

3. With CE pack installed and oscilloscope connected to head alignment card test point Y, load heads to cylinder 000 and perform thermal stabilization.

**CAUTION**

**Do not attempt to access beyond cylinder 330.**

4. When thermal stabilization is completed, command continuous seeks between cylinders 240 and 245 for 30 seconds, minimum. This allows head-gimbal springs to settle to a normal operating position, and also settles any binding between head arm and head-mounting screw. Track 4 is a spare alignment servo track. The switch settings for cylinder 240 are 16, 32, and 128. For cylinder 245, they are 1, 4, 16, 32, 64, and 128.
5. Stop continuous seeks and command a direct seek to cylinder 245.
6. On head alignment card, set S/RW (servo/read write) switch to S position; set X.1/X1 switch to X.1 position.
7. Balanced dibit pattern, similar to Figure 2-41, should be observable on oscilloscope. If pattern is not balanced, terminate head arm alignment and perform trouble analysis.

**NOTE**

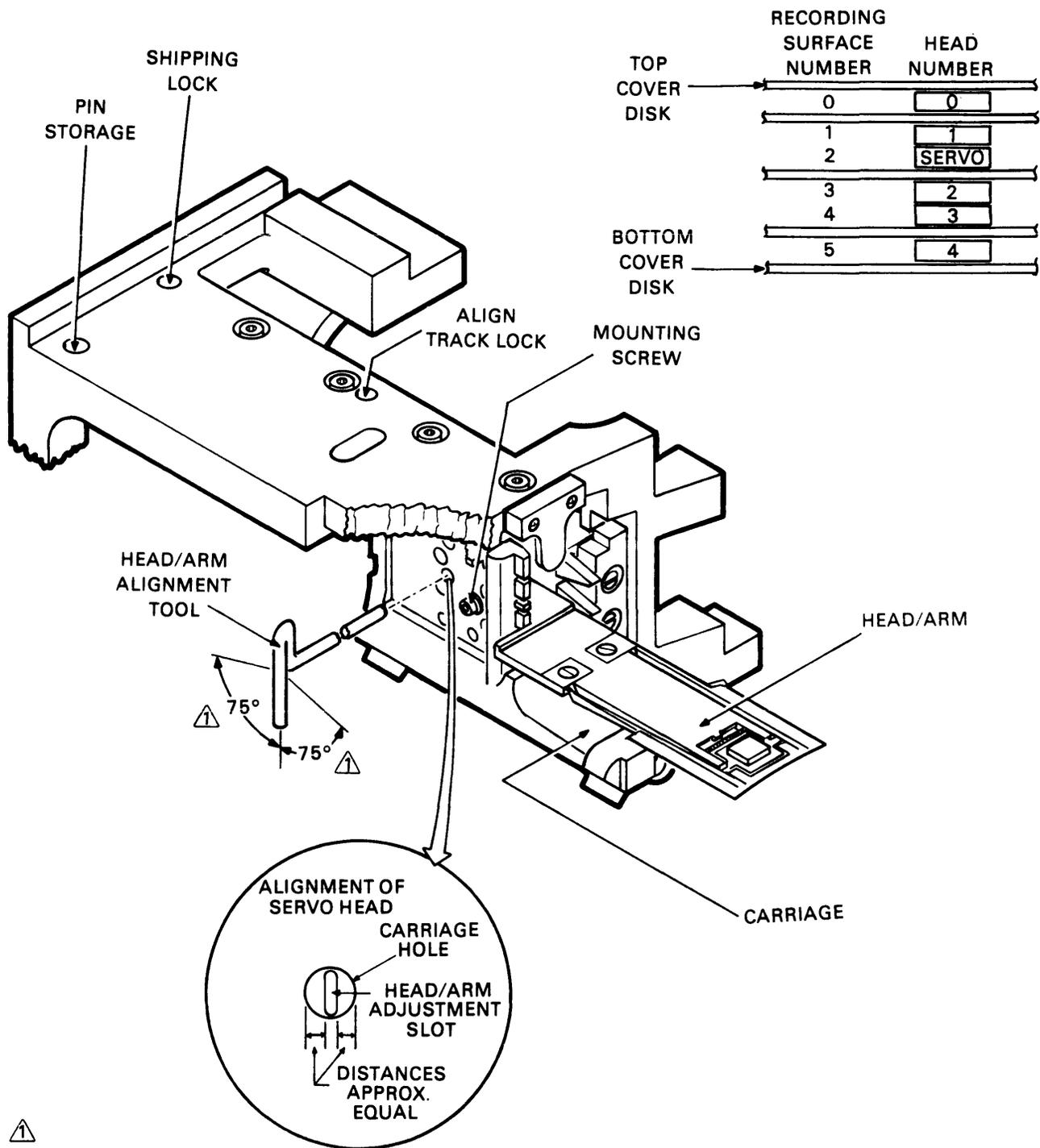
**When calculating head offset, if both P and N readings are less than 100 mV, set X.1/X1 switch on head alignment card to X1 position. Return switch to X.1 position before proceeding to next head.**

8. If balanced dibit pattern was observed in previous step, calculate head offset for servo head. Servo head offset must be  $0 \pm 30$  mV. If offset is greater than 30 mV, terminate procedure and troubleshoot servo system.
9. On head alignment card, set S/RW switch to RW position. Select head 0.
10. Calculate and record offset for head 0.
11. Repeat previous step for all remaining heads.

**CAUTION**

**If any read-write head exceeded 200 mV offset, excessive misalignment exists. Refer to Step 1 and realign.**

12. If calculated offset for any read-write head exceeded 100 mV, proceed to align heads. If all heads were within the offset requirements, restore drive to normal operation.



**CAUTION**  
 ALIGNMENT TOOLS ON SOME DRIVES CANNOT BE ROTATED MORE THAN 150°. ROTATING TOOL BEYOND 150° MAY DAMAGE HEAD SLOT OR ALIGNMENT TOOL.

MA-0593

Figure 2-40 Head Arm Alignment

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS/DIV

CH 1 - 2 V

CH 2 - NOT USED

TIME/DIV

A - 2  $\mu$ sec

B - NOT USED

TRIGGERING

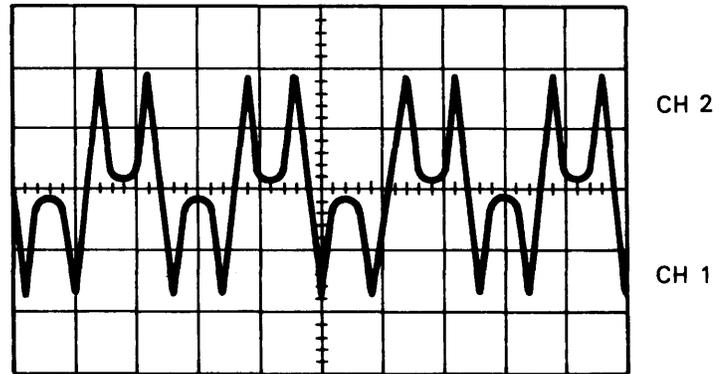
A - INTERNAL POSITIVE

B - NOT USED

PROBE CONNECTIONS (USE X10 PROBE)

CH 1 TO ON HFSV CARD READ SIGNAL Y

CH 2 - NOT USED



MA-0606

Figure 2-41 Balanced Dibit Pattern

#### 2.7.4.4 Performing Head Alignment

1. Ensure that the locking pin has been removed.
2. Command a return-to-zero seek. Press START switch to stop drive motor and unload heads.
3. Raise logic chassis to maintenance position and loosen head-mounting screw for any head that exceeded the offset specification. Then retighten each loosened screw to a torque of 6 inch-pounds. *Remove the connector support bracket from the head-arm connectors.* This prevents possible electrical contact between the alignment tool and bracket. Contact could cause a short circuit that would damage power amplifier.
4. Press START switch to start drive motor and load heads. Command continuous seeks between cylinders 240 and 245 for 30 seconds, minimum. Note that the MAINT/NRM switch must be in the NRM position to do oscillating seeks.
5. Stop continuous seeks and command a direct seek to cylinder 245.

#### WARNING

**Use care not to cause any short circuits when moving logic chassis to install locking pin. Failure to install locking pin could cause personal injury.**

6. Swing down logic chassis and install carriage locking pin and ring assembly in ALIGN TRACK LOCK hole. Return logic chassis to maintenance position.

7. Ground back panel pin A2B09, 03B (Not On Cylinder) to prevent nuisance errors. Ensure that head alignment card X.1/X1 switch is set to X.1 position and select head to be aligned.

**NOTE**

**The MAINT/NRM switch must be in the MAINT position to select a different head. Place the RD/WRT select switch to RD.**

8. Using recommended head alignment tool, (with the sleeving on it) perform coarse adjustment as follows.
  - a. Adjust head until balanced dibit pattern is visible on oscilloscope.
  - b. Continue to adjust head for minimum deflection of null meter with respect to 0.
  - c. While changing position of P/N switch, continue to adjust head until calculated offset is less than 100 mV.

**NOTE**

**If head cannot be aligned to less than 100 mV, it is possible read-write head is at its end of travel. Re-check servo head alignment.**

9. Repeat previous step for all heads to be aligned.
10. On head alignment card, set X.1/X1 switch to X1 position.
11. Perform fine adjustment same as coarse adjustment except adjust until calculated offset is less than 50 mV. Perform fine head adjustment for all heads to be aligned.
12. Remove ground from backpanel pin A2B09 03B.
13. Move carriage locking pin and ring assembly to PIN STORAGE hole.
14. Perform a return-to-zero seek.
15. For each head adjusted, tighten head-mounting screw to a torque of  $12 \pm 1/2$  inch-pounds.
16. Command continuous seeks between cylinders 240 and 245 for 30 seconds, minimum.
17. Stop continuous seeks and command a direct seek to cylinder 245.

**WARNING**

**Use care not to cause any short circuits when moving logic chassis to install locking pin. Failure to install locking pin could cause personal injury.**

18. Swing down logic chassis and install carriage locking pin and ring assembly in ALIGN TRACK LOCK hole. Return logic chassis to maintenance position.
19. Ensure that head alignment card X.1/X1 switch is in X1 position.

20. Check alignment of each head that was adjusted to ensure that tightening screws did not change alignment.

#### **CAUTION**

**Use care when using alignment tool on heads that have been tightened to torque of  $12 \pm 1/2$  inch-pounds. Misuse of tool will damage head arm or carriage.**

21. If calculated offset for any head exceeds 75 mV, repeat fine adjustment procedure until offset is less than 50 mV.
22. Move carriage locking pin and ring assembly to PIN STORAGE hole.
23. Restore drive to normal operation.

## **2.8 FIELD ACCEPTANCE PROCEDURE**

### **2.8.1 Introduction**

Field acceptance testing is intended to demonstrate the performance of the RM02 or RM03 disk drive subsystem to the customer prior to his acceptance.

### **2.8.2 Error Definitions/Rates**

The drive contains two registers to display the various error conditions possible. Error registers 1 and 2 (RMER1, RMER2) indicate drive error conditions. One bit of RMER2 (SKI) indicates seek errors and is used to calculate the seek error rate (Paragraph 2.8.2.4). Four bits of RMER1 (HCRC, HCE, ECH, and DCK, which may include DTE and FER) indicate data errors; the remaining bits of RMER1 indicate command and control errors. Table 2-18 lists indications of the various error types and their explanations.

**2.8.2.1 Hard Errors** – Any failure to read data correctly after a complete recovery sequence with ECC enabled constitutes an irrecoverable, or hard, error. (A complete recovery sequence consists of 20 retries, 16 at the nominal head position and 2 at each offset.)

Errors that are not ECC-correctable include bursts greater than 11 bits in length and isolated dropped bits (separated by more than 11 bits) within a sector. The allowable error rate for hard errors is one error per  $10^{12}$  bits read.

**2.8.2.2 Soft Errors** – Any failure to read data correctly on the first try that is then read successfully during a recovery sequence constitutes a recoverable, or soft, error. (Refer to the Paragraph 2.8.2.1 definition of a complete recovery sequence.) The allowable error rate for soft errors is one error per  $10^{10}$  bits read.

**2.8.2.3 Pack-Attributable Errors** – An error caused by imperfections in the recording surface is regarded as pack-attributable, or media-dependent. If the imperfection is less than 11 bits long, it is ECC-correctable and will appear as a soft error; if more than 11 bits long, it will appear as a hard error. On a given pack, pack-attributable errors will always appear at the same cylinder, sector, and track addresses, with an ECC POS REG value within 11 bits. The definitions of hard and soft errors in Paragraphs 2.8.2.1 and 2.8.2.2 apply only to randomly distributed errors, and do not take into account errors that are pack-attributable. Imperfections in the pack surface may be found by mapping the pack using the formatter program but there is no guarantee that they will all be found.

**Table 2-18 Error Conditions**

<b>Bit</b>	<b>Bit Set Register</b>	<b>Error Type</b>	<b>Explanation</b>
HCE HCRC	RMER1 RMER1	Soft	Sector count field/desired. Sector compare fails due to CRC failure.
HCRC	RMER1	Soft	Sector count field matches desired sector field but there is CRC error.
HCRC FER	RMER1 RMER1	Soft	Format bit in first header word incorrect.  <b>NOTE</b> <b>FER without HCRC during an operation that reads the header indicates wrong format pack mounted.</b>
DCK	RMER1	Soft	Error detected during read operation by examination of ECC bytes; correctable by retry sequence.
DCK ECH	RMER1 RMER1	Hard	Error detected which is ECC uncorrectable through 28 retry sequence (16 retries at nominal head position and 12 with head offset).
SKI	RMER2	Seek	1. Seek operation fails to complete within 500 ms of initiation.  2. Recalibration operation fails to complete within 500 ms of initiation.  3. Offset or return-to-centerline operation fail.
SKI	RMER2	Seek	Positioner has drifted off cylinder subsequent to completion of positioning operation.
HCE	RMER1	Seek	Sector count field (RHLA) does not match desired sector field (RHDST) and there is not a CRC error. This error is not caused by a positioner failure: It is due to a DCL failure. Therefore, HCE alone indicates a drive seek error.

**2.8.2.4 Seek Errors** – A seek error is any positioning operation that is not completed within 500 ms for seek commands, 500 ms for recalibrate commands, and 10 ms for offset and return-to-centerline commands, or that terminates with the positioner in an incorrect location. The allowable error rate for seek errors is one error per 10<sup>6</sup> seek operations.

**2.8.3 Field Acceptance Test**

The tests described in Paragraph 2.8.4 may be used, individually or in combination, to demonstrate the performance of the disk drive when used with an RH70 controller.

#### **2.8.4 Diagnostic Programs**

The diagnostic programs described herein are employed with the RM02 and RM03 subsystems. Refer to the applicable diagnostic operation procedures for more detailed information.

##### **Test Programs**

MAINDEC-ZZ-CZRMF	Extended Drive Test
MAINDEC-ZZ-CZRMG	Dual-Port Logic Test, Part 1
MAINDEC-ZZ-CZRMH	Dual-Port Logic Test, Part 2
MAINDEC-ZZ-CZR MJ	RM02/03 Diskless Controller Test (only MBA test)
MAINDEC-ZZ-CZRMC	RM02/03 Functional Controller Test, Part I
MAINDEC-ZZ-CZRMD	RM02/03 Functional Controller Test, Part II
MAINDEC-ZZ-CZRME	RM02/03 Functional Controller Test, Part III (format the pack before doing Part III)

##### **System Exerciser Program**

MAINDEC-ZZ-CZRMB	Performance Exerciser (need formatted pack)
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##### **Utility Programs**

MAINDEC-ZZ-CZRMA	Formatter Program (need good pack)
MAINDEC-ZZ-CZRMI	Drive Compatibility Test

## CHAPTER 3

# PARTS REMOVAL AND REPLACEMENT

### NOTE

**The following parts on the Recommended Spares List (RSL) do not require any special removal and replacement procedure.**

Name	DEC Part No.	
Circuit Breaker	12-13754	
Circuit Breaker	12-14167	
Thermostat	12-14168	
Varistor	13-11996	
Transformer (50 Hz)	29-22908	(60 Hz) 29-22907
Circuit Breaker (50 Hz)	29-22918	(60 Hz) 29-22917
Switch-mini	29-22920	
Circuit Breaker (50 Hz)	29-22921	(60 Hz) 29-22922
Hr Meter (50 Hz)	29-22924	(60 Hz) 29-22893
4 Mfd Capacitor	29-22927	
Line filter	29-22928	
Drm Capacitor (50 Hz)	29-22937	(60 Hz) 29-22923
6 Mfd Capacitor	29-22938	
Rail-lower	29-23028	
Rail-upper	29-23029	
Transformer	70-13785	
Line Filter	70-13791	
Lamp Assy (50 Hz)	12-02556	(60 Hz) 12-01280
21K Mfd Capacitor	29-22930	

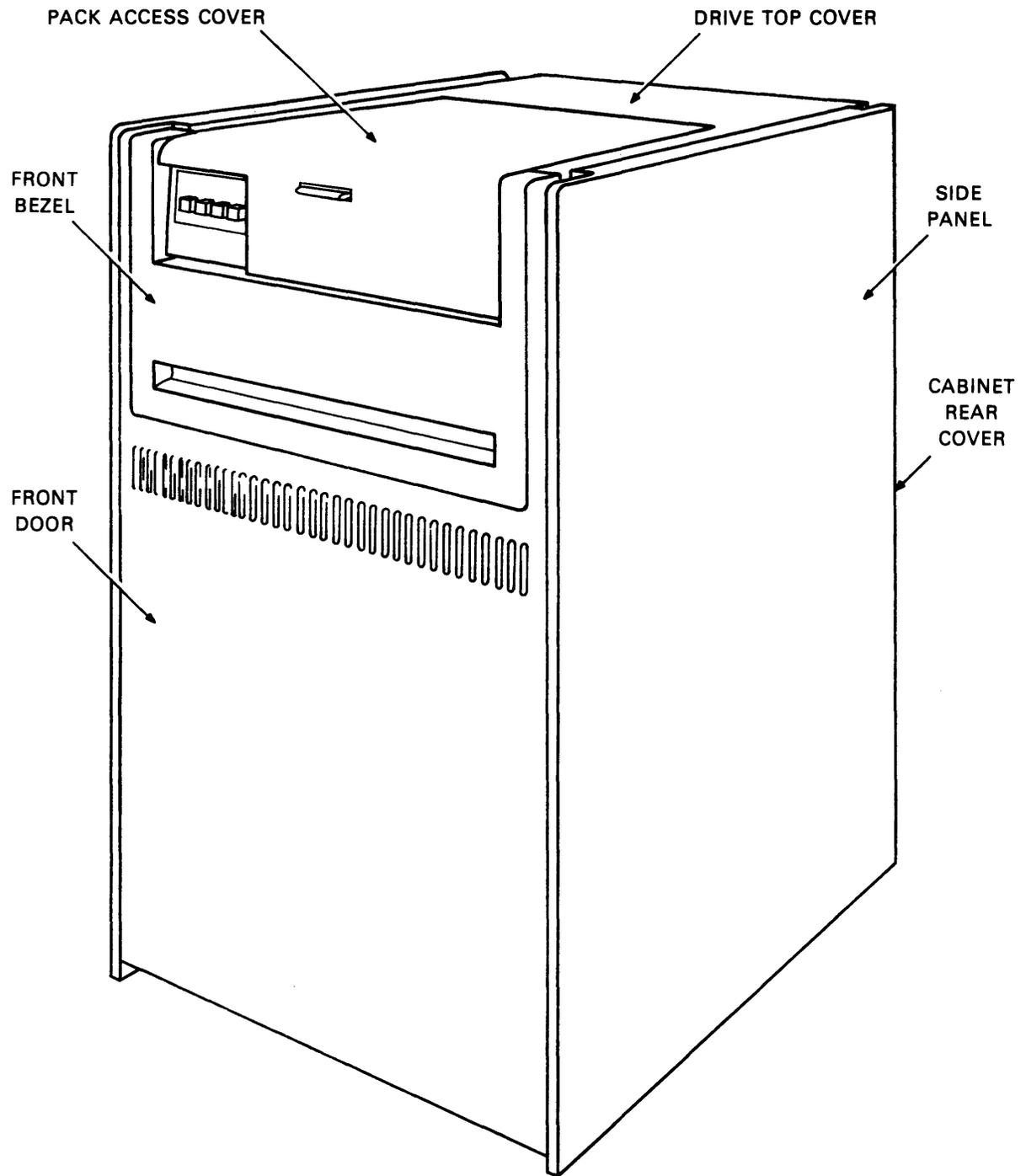
### 3.1 LOCATION OF OUTER SKINS

To gain access to the interior parts of the RM02 and RM03 Disk Subsystem, many of the outer skin surfaces will have to be removed. These outer skins are shown in Figure 3-1. They are as follows:

- Front door
- Front bezel
- Pack access cover
- Drive top cover
- Cabinet rear cover
- Side panels.

### NOTE

**These removal procedures assume that the drive power is off, the pack has been removed and the pack access cover is open.**



MA-1300

Figure 3-1 Location of Outer Skins

### 3.2 FRONT DOOR

Removal Procedure: (Figure 3-2)

1. Open the door.
2. Pull down on the spring loaded rod that hinges the top of the door.
3. Lift the door off its bottom pin.

Replacement Procedure:

1. Mount the door on its bottom pivot pin.
2. Pull down the spring loaded rod on the top of the door hinge and lock the door in place.
3. Close the door.

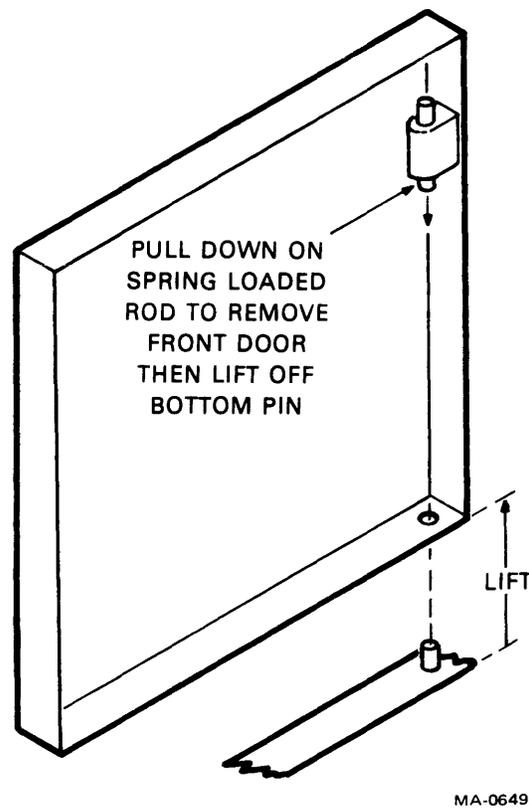


Figure 3-2 Front Door Removal

### 3.3 FRONT BEZEL

Removal Procedure:

#### NOTE

**Power must be applied to the drive in order to raise the pack access cover.**

1. Raise the pack access cover, then remove power.
2. Remove the two screws that secure the front bezel (Figure 3-3).
3. Lift the front bezel up and off its mounting brackets.

Replacement Procedure:

1. With the pack access cover raised, place the front bezel onto its mounting brackets.
2. Secure the front bezel in place with the two screws.

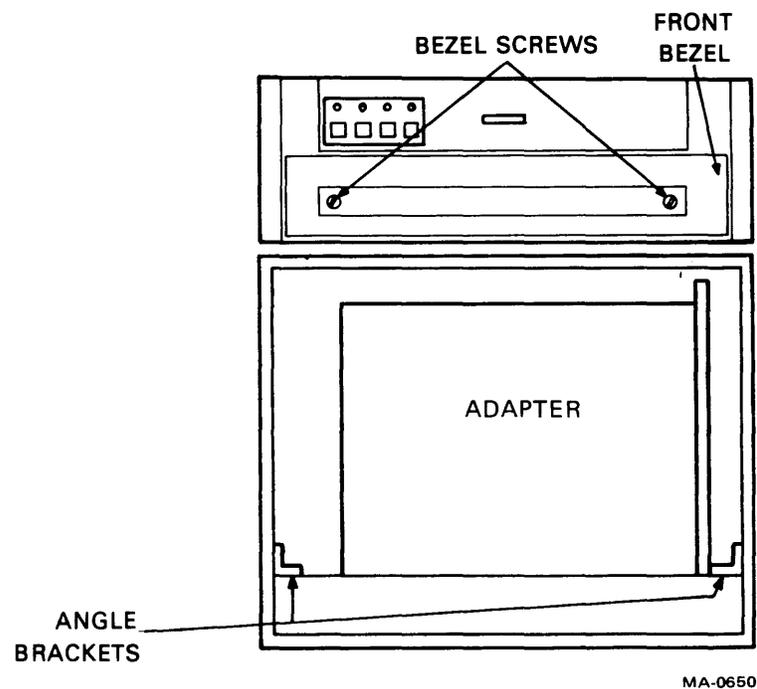


Figure 3-3 Front Bezel Location

### 3.4 DRIVE TOP COVER

#### Removal Procedure:

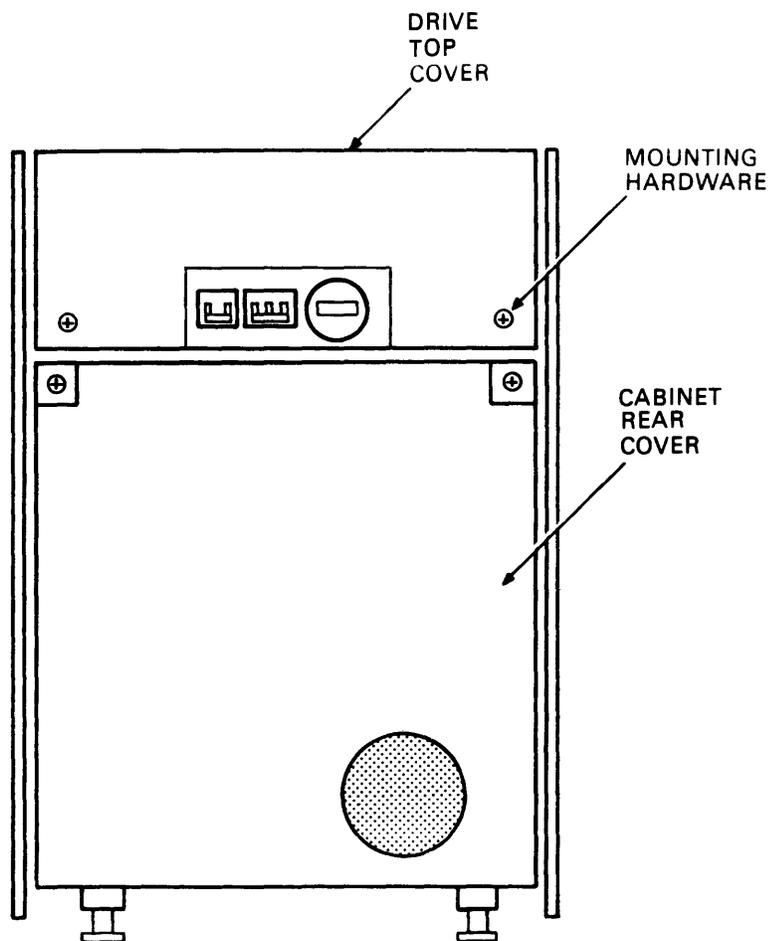
1. Loosen the two locking screws on the back of the top cover (Figure 3-4).
2. Slide the drive top cover back and then lift it off the rear of the drive.

#### CAUTION

**Do not lift the cover until the guide pins are totally disengaged.**

#### Replacement Procedure:

1. Place the top cover part way onto the drive.
2. Slide it forward into place.
3. Secure the drive top cover with the two locking screws.



MA-1299

Figure 3-4 Drive Top Cover

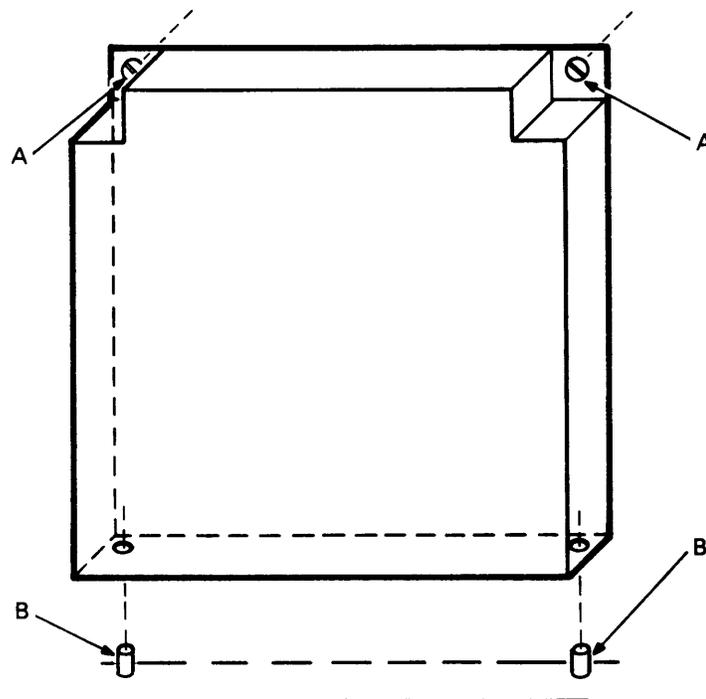
### 3.5 CABINET REAR COVER

#### Removal Procedure:

1. Loosen the two locking screws that hold the rear cover in place (Figure 3-5).
2. Lift the rear cover off its two holding pins.

#### Replacement Procedure:

1. Mount the rear cover onto its two holding pins.
2. Secure the two locking screws that hold it in place.



TO REMOVE REAR COVER:  
1. LOOSEN LOCKING SCREWS (A).  
2. LIFT REAR COVER OFF PINS (B).

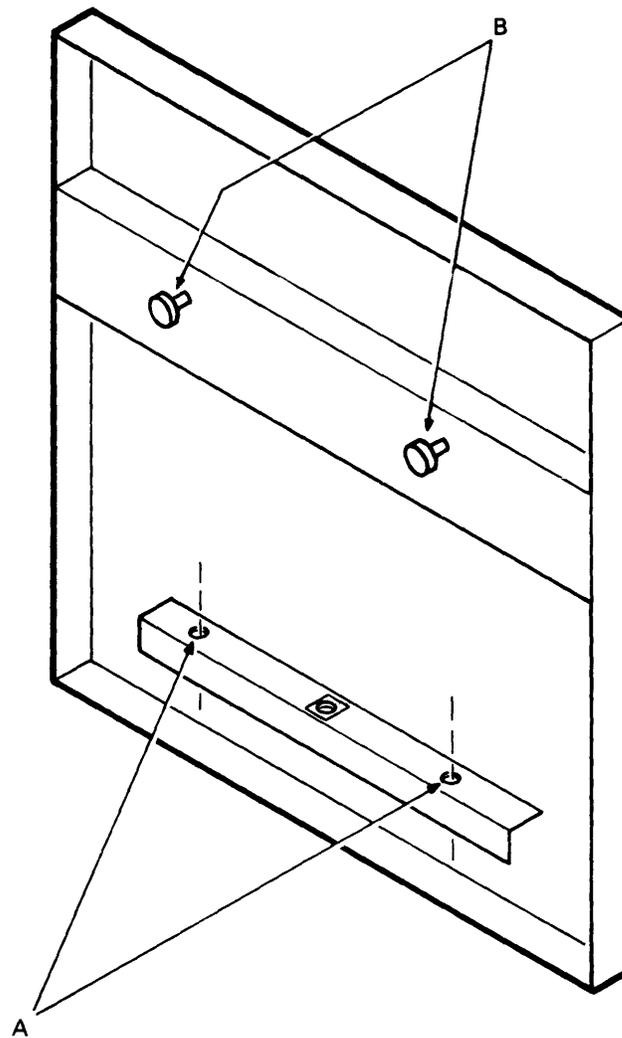
MA-0651

Figure 3-5 Rear Cover Removal

### 3.6 SIDE PANELS

#### Removal Procedure:

1. Remove rear cover for easier access to the side panels.
2. Remove the two mounting screws from the inside bracket shown in Figure 3-6.
3. Lift up the side panel to free the holding pins shown in Figure 3-6.
4. Pull the side panel outward and lift off.



TO REMOVE SIDE PANELS  
REMOVE SCREWS AT LOATIONS (A)  
AND LIFT PANEL UP. FREE PINS (B),  
THEN PULL OUTWARDS.

MA-0646

Figure 3-6 Side Panel Mounting Screws

#### Replacement Procedure:

1. Hold the side panel up to the side of the drive cabinet.
2. Line up the (B) mounting pins above their slots on the cabinet frame.
3. Lower the side panel so the holding pins lock into place.
4. Replace the two mounting screws on the inside bracket.
5. Replace rear cover.

#### **3.7 PACK ACCESS COVER**

The pack access cover is designed to lock when power is not applied to the drive. This makes it necessary to apply power to up the drive before the pack access cover can be raised.

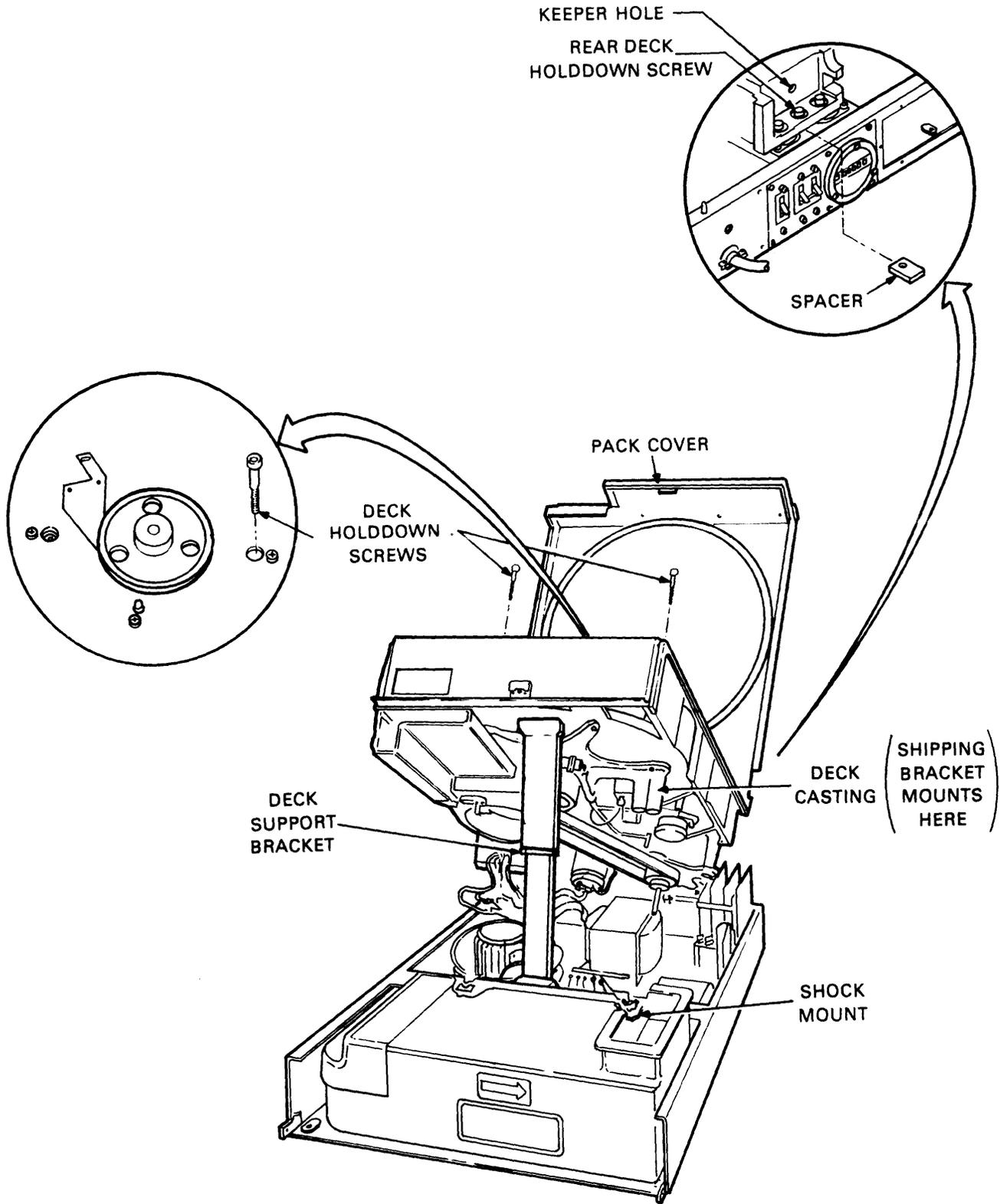
#### **3.8 DECK MAINTENANCE POSITION**

Many of the parts replacement procedures require raising the drive deck to its maintenance position. This position is illustrated in Figure 3-7. To raise the deck to the maintenance position, perform the following steps.

1. With power applied to the drive, raise the pack access cover up.
2. With the pack access cover in the open position, remove drive power.
3. Loosen the locking screws that hold the drive top cover in place, and slide it backwards off the drive.
4. Install the rear deck hold-down spacer.
5. Remove the two top deck hold-down screws from inside the pack shroud area.
6. Raise the deck upwards until its support bracket locks into place.

#### Restoring the deck to the operating position:

1. Hold the deck and unlock the support bracket.
2. Lower the deck carefully to its normal position.
3. Install the two deck hold-down screws inside the shroud.
4. Remove the rear hold-down spacer and install it in the keeper hole.
5. Slide the drive top cover into place and secure the two locking screws.



MA-0611

Figure 3-7 Deck Maintenance Position

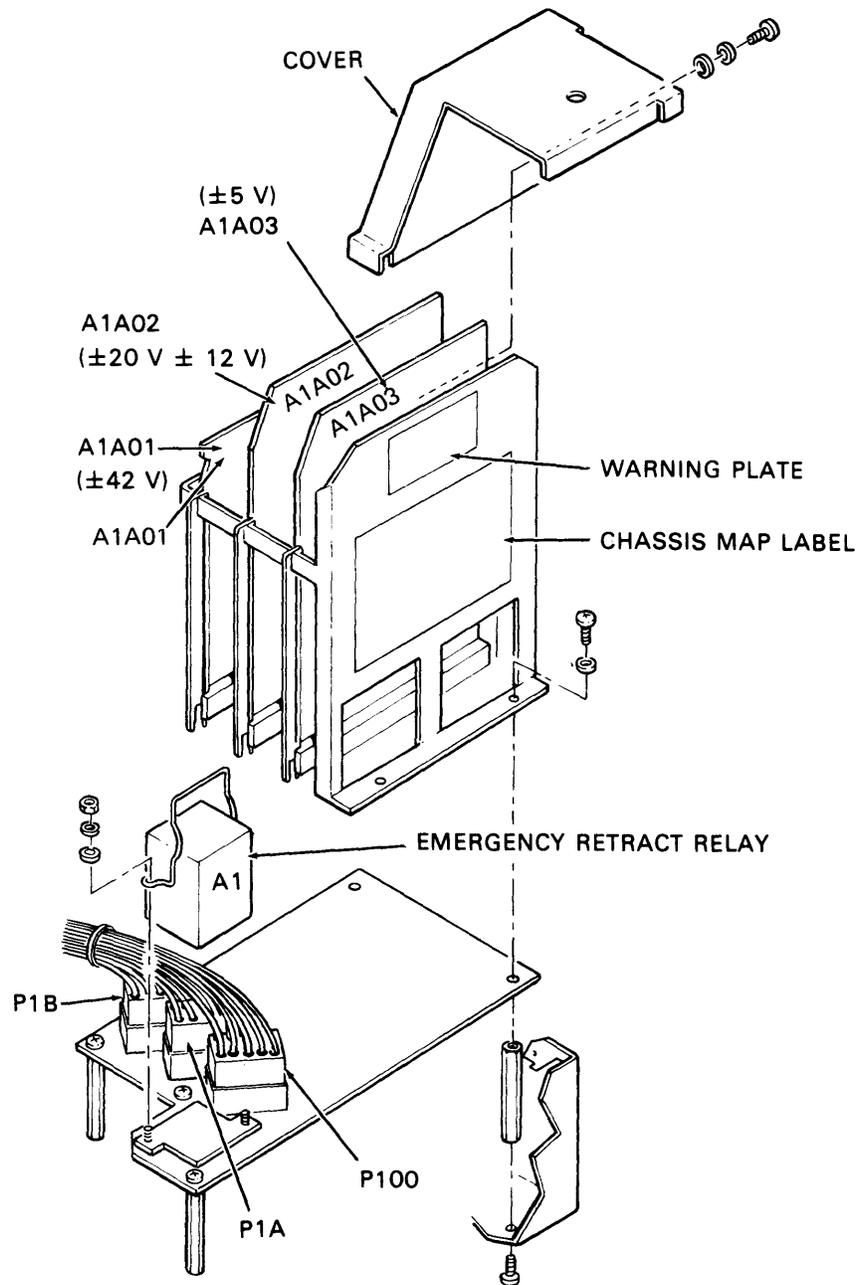
### 3.9 POWER SUPPLY MODULES

There are three separate power supply modules in the power supply assembly shown in Figure 3-8.

A1A01 ( $\pm 42$  V and emergency retract) (DEC Part No. 29-22878)

A1A02 ( $\pm 20$  V and  $\pm 12$  V) (DEC Part No. 29-22879)

A1A03 ( $\pm 5$  V) (DEC Part No. 29-22877)



MA-1522

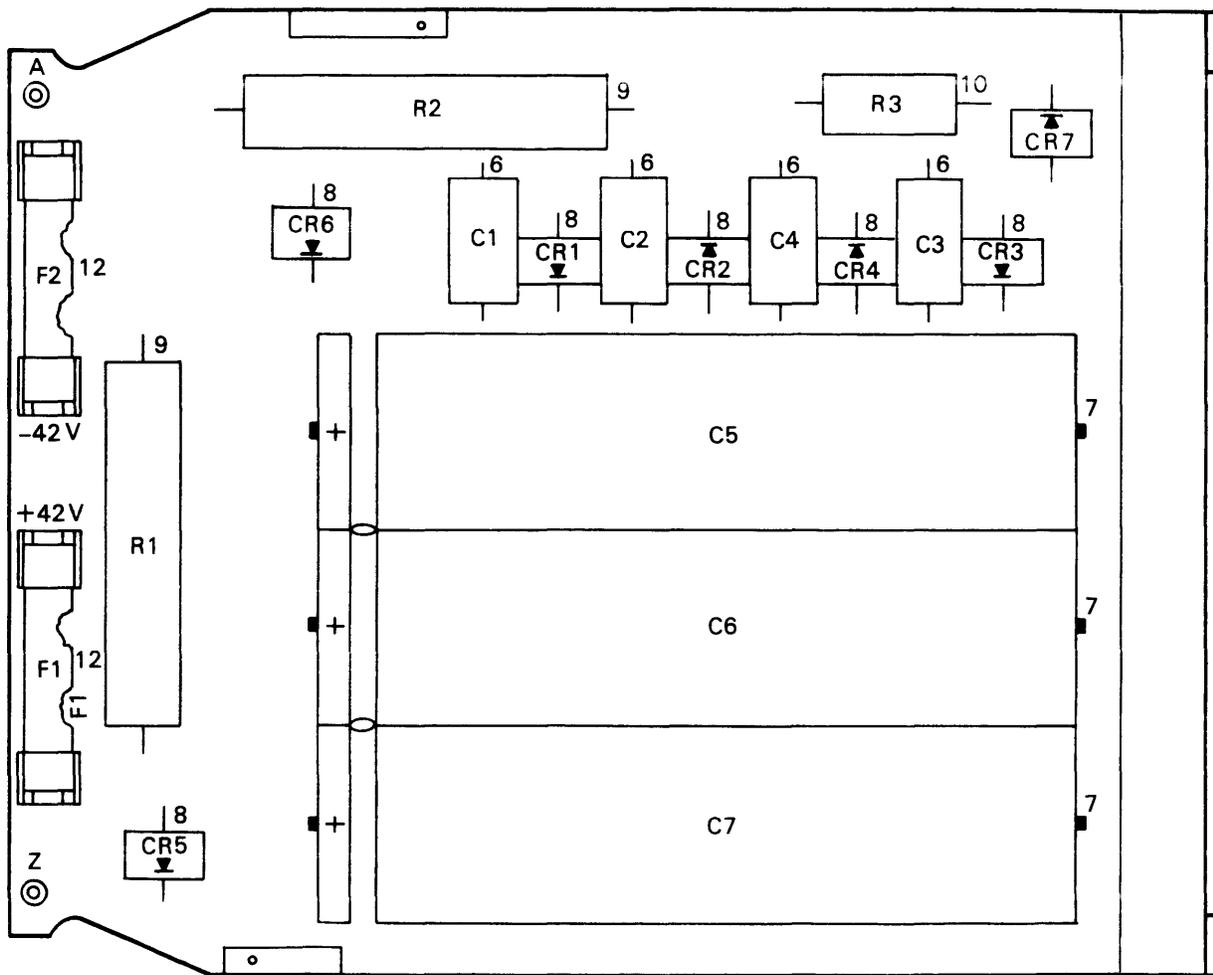
Figure 3-8 Power Supply Assembly

Module Removal Procedure:

1. Turn off power to the drive.
2. Remove the disk drive rear cover.
3. Remove the power supply cover.
4. Extract the desired module by lifting it straight up out of the chassis.

**3.9.1 42 V Supply and Emergency Retract (A1A01)**

There are no adjustments to be made on this board (DEC Part No. 29-22878) (Figure 3-9). Fuses F1 and F2 are quick acting 8 A. R1 and R2 are fixed 510 ohm, 15 W, 10 percent resistors.

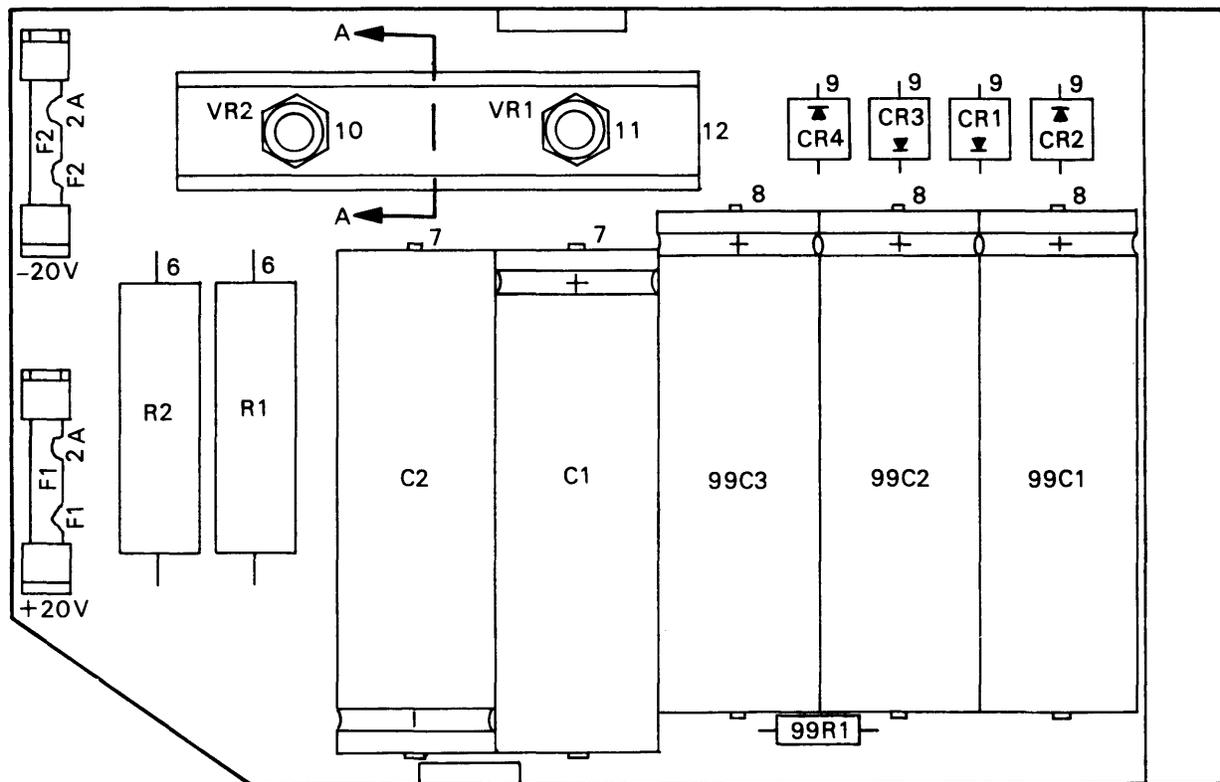


MA-1298

Figure 3-9 ±42 Volt Supply

### 3.9.2 12 and 20 V Supply (A1A02)

There are no adjustments to be made on this board (DEC Part No. 29-22879). A board layout is shown in Figure 3-10. Fuses F1 and F2 are quick acting 2 A.



MA-1297

Figure 3-10 12 and 20 Volt Supply

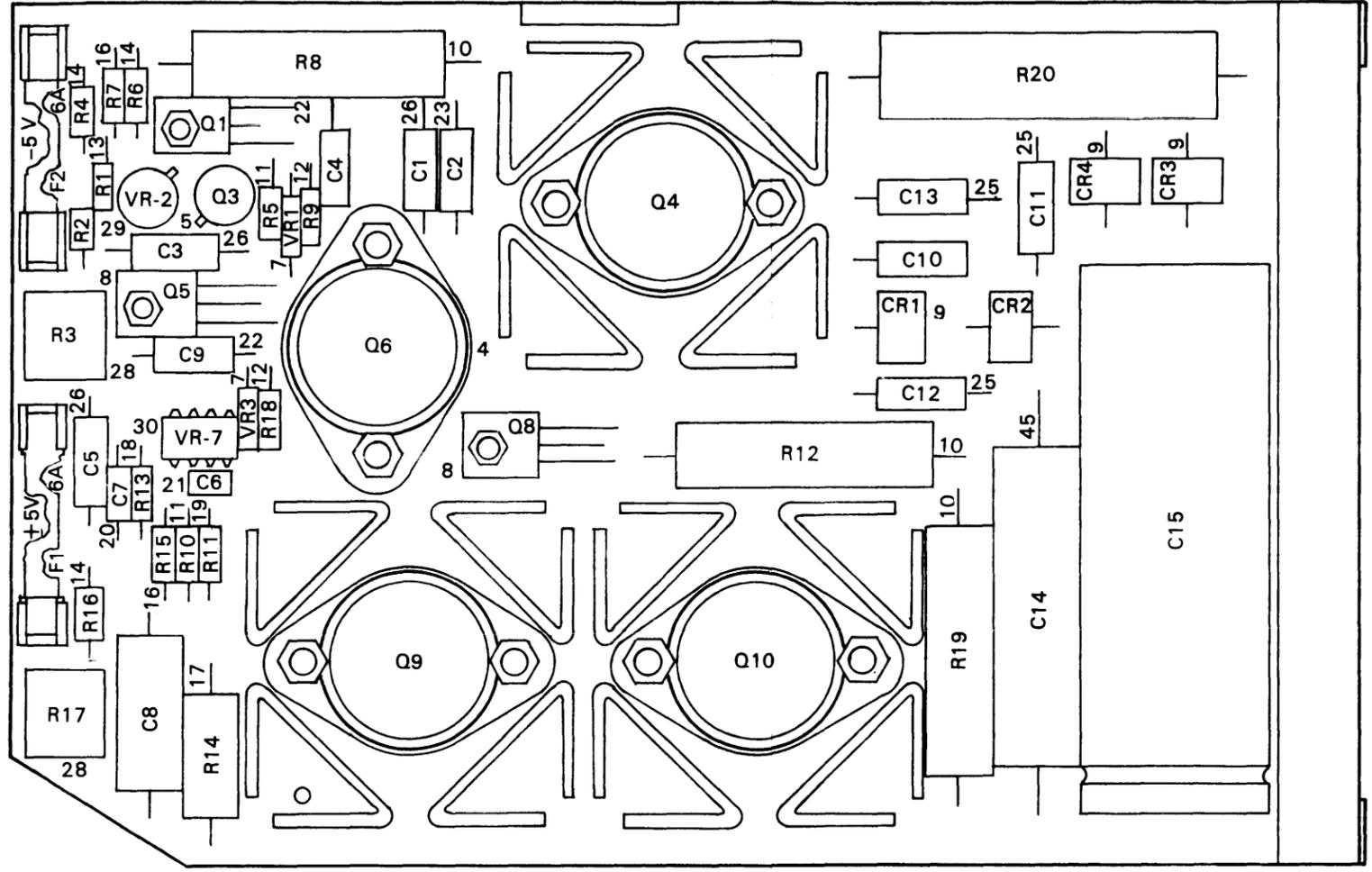
### 3.9.3 5 V Supply (A1A03)

The adjustment procedure for the 5 V power supply (DEC Part No. 29-22877) is covered in Paragraph 4.2. Fuses F1 and F2 are quick acting 8 A (Figure 3-11).

### 3.10 BLOWER MOTOR ASSEMBLY (A1BM1)

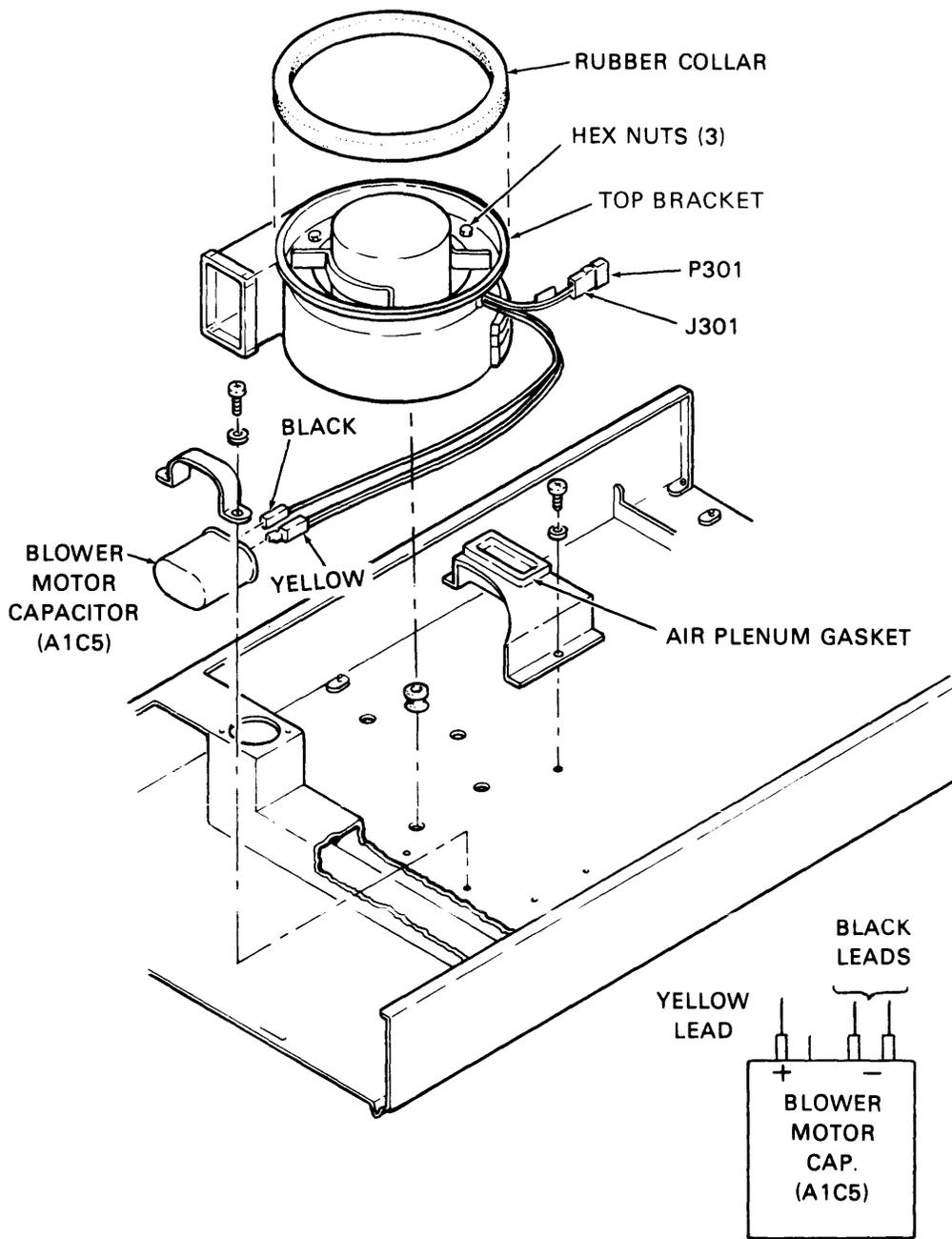
Removal Procedure (DEC Part No. 29-22901, 60 Hz, or Part No. 29-22902, 50 Hz) (Figure 3-12):

1. Install the rear hold-down bracket.
2. Raise the deck to the maintenance position.
3. Remove the rubber collar from the blower assembly.
4. Remove J301 and 2 ground wires (black) and hot (yellow) wire from C5 (A1C5).



MA-1532

Figure 3-11 5 Volt Supply



MA-1525

Figure 3-12 Blower Motor Replacement

5. Remove the three hex nuts.
6. Remove blower, spacer, top bracket and squirrel cage.

**Replacement Procedure:**

1. Install new blower, spacer, top bracket and squirrel cage.
2. Install the three hex nuts.
3. Reconnect J301 and the three faston connectors. The yellow wire connects to the (-) side and the black wires connect to the (-) side of capacitor C5. The positive side of C5 is indicated by a red mark.
4. Install the rubber collar.
5. Lower the deck to its normal position.
6. Install the hold-down screws inside the shroud.
7. Remove the rear hold-down bracket and install it into the keeper hole.

### **3.11 PRIMARY FILTER**

The primary filter (DEC Part No. 29-22926) must be kept clean in order to allow sufficient passage of air to keep the drive cool.

**Removal Procedure:**

1. Turn off power to the drive.
2. Remove front bezel.
3. Remove primary filter.

**Replacement Procedure:**

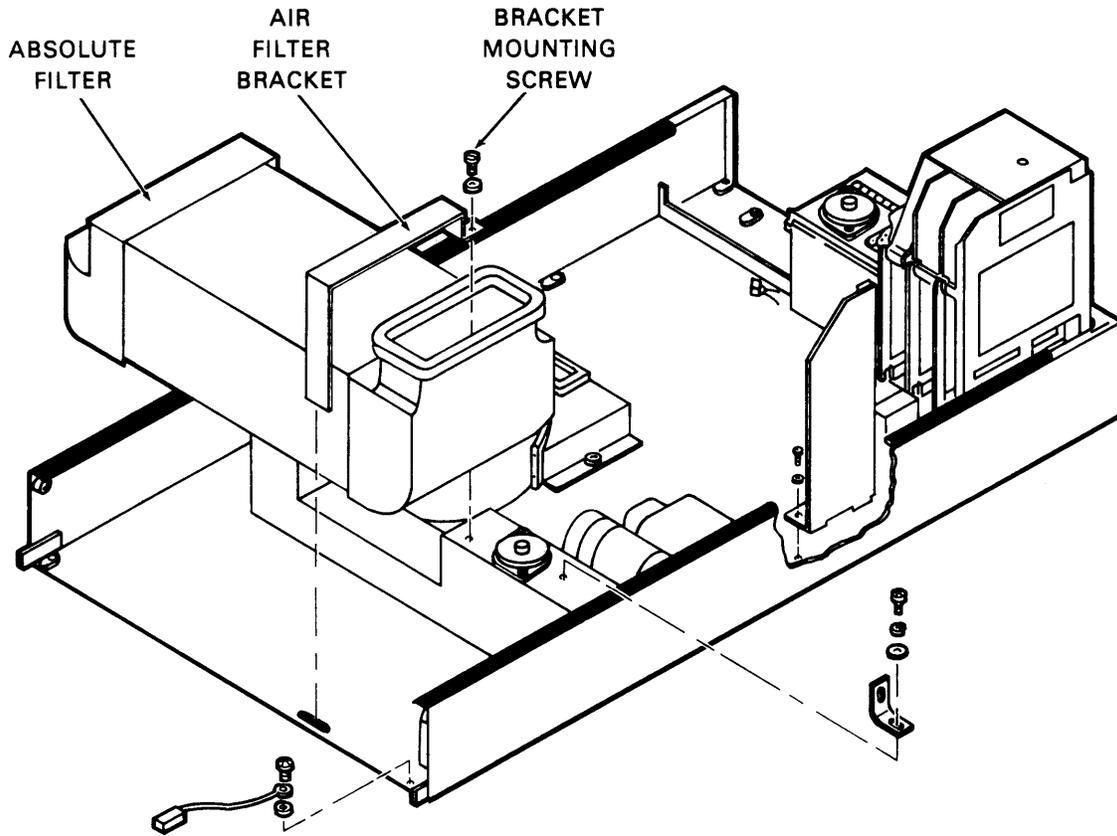
1. Install primary filter.
2. Replace front bezel.
3. Restore power to the drive.

### **3.12 ABSOLUTE FILTER**

An adequate supply of clean air to the pack area is essential to proper operation of the drive. Replacement of the absolute filter (DEC Part No. 29-22925) is required once every year.

**Removal Procedure (Figure 3-13):**

1. Turn off power to the drive.
2. Install the rear hold-down spacer.
3. Raise the deck to the maintenance position.



MA-1529

Figure 3-13 Absolute Filter Removal

4. Remove the front bezel from the brackets.
5. Remove the screw and lockwasher securing the absolute filter retaining bracket.
6. Remove the four screws holding the front bezel support brackets.
7. Remove the absolute filter bracket by pivoting it towards the front of the drive and lifting the flange on the bracket from the slot in the base.
8. Remove the absolute filter by pulling it toward the front of the drive. It may be necessary to jiggle the filter to disengage it from the blower motor outlet.
9. Wipe the base pan clean in the area under the absolute filter and around the blower motor outlet.

**Replacement Procedure:**

1. Install the new absolute filter by sliding it in from the front of the drive and engaging it in the blower motor outlet.
2. Install the filter retaining bracket and secure it with a screw and lockwasher.
3. Install the front bezel support bracket with the four screws. Adjust the bracket for proper mounting of the front bezel.
4. Lower the deck to its normal operating position and install the hold screws.
5. Install the front bezel.
6. Remove the rear hold-down spacer and install it in the keeper hole.

**3.13 START TRIAC (A1K5)**

The start triac (DEC Part No. 29-22929) cannot be repaired. If it fails, it must be replaced. The location of the start triac is shown in Figure 3-14.

**Removal Procedure:**

1. Turn off power to the drive.
2. Install the rear hold-down spacer.
3. Install the shipping lock on the heads.
4. Raise the deck to the maintenance position.
5. Remove all connectors from the start triac terminals.
6. Remove the two screws that hold the triac in place.

**Replacement Procedure:**

1. Apply a light coat of dielectric grease to the base of the new triac.
2. Mount the new triac in place with the two screws, with the green wire attached to one of the screws.
3. Reconnect all wires to its terminals according to Figure 3-14.
4. Return the deck to its operating position and install the mounting bolts in the shroud.
5. Remove the rear hold-down spacer and install it in the keeper hole.
6. Replace all skins.

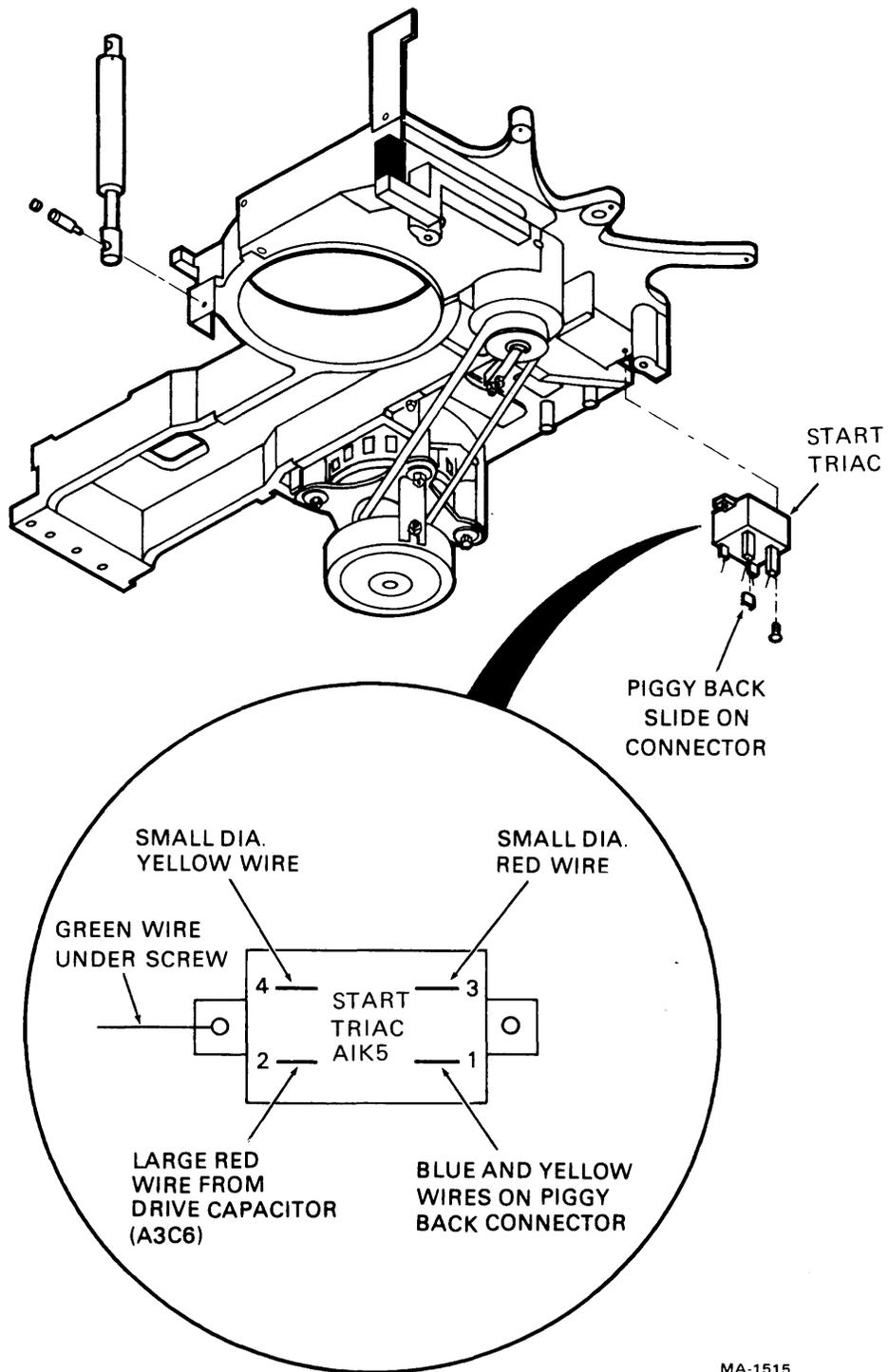


Figure 3-14 Start Triac

### **3.14 RUN TRIAC (A1K1)**

This procedure requires two people.

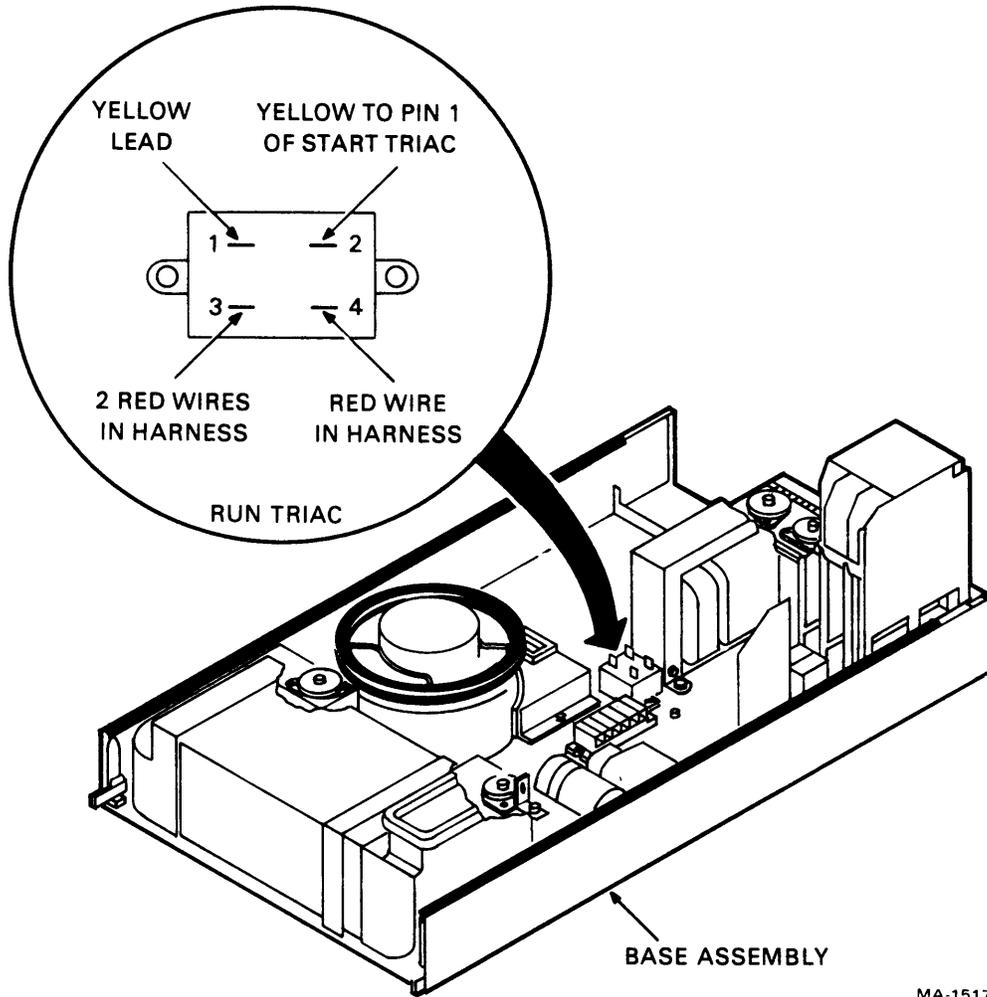
Removal Procedure (DEC Part No. 29-22929) (Figure 3-15):

1. Remove the cabinet back cover.
2. Remove the two side panels.
3. Remove four drive hold-down screws from the inside of the adapter enclosure.
4. Raise the deck to its maintenance position with rear hold-down spacer in place.
5. Remove the leads from the RUN TRIAC.
6. Apply a light coat of dielectric grease to the bottom of the new triac to be installed.
7. One person then pulls the drive backwards until the two Phillips head screws securing the triac are visible.
8. The second person removes the screws from the old triac and installs the new one.
9. Push the drive back into position.
10. Install the four drive hold-down screws that secure the drive to the cabinet.
11. Connect the leads to the new RUN TRIAC as in Figure 3-15.
12. Restore the deck to its operating position and replace the hold-down screws.
13. Remove the hold-down spacer and store it in the keeper hole.
14. Replace all skins.

### **3.15 LOGIC CHASSIS ASSEMBLY (A2)**

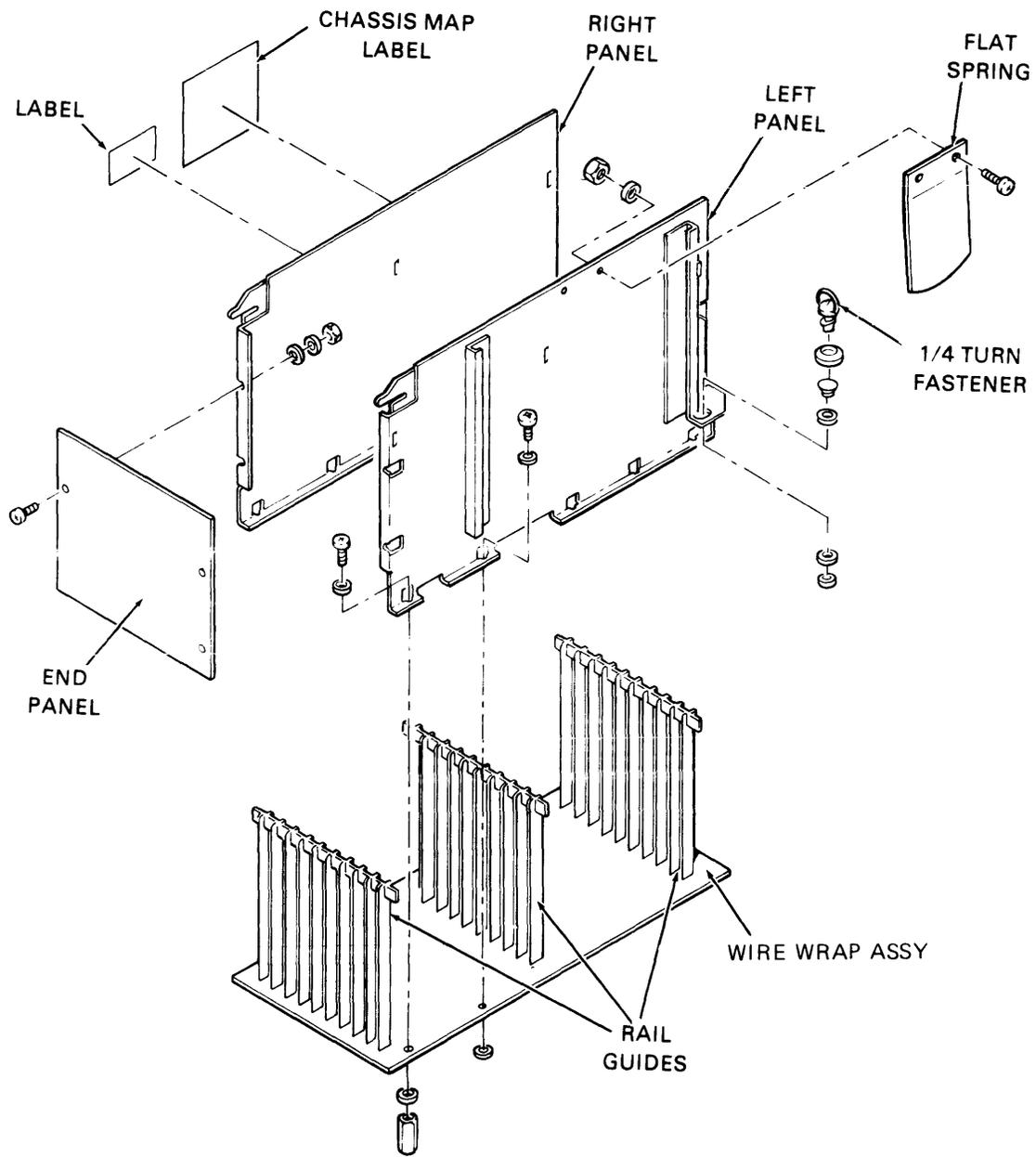
The most common repairs of the logic chassis are the changing of wires and the straightening of pins on the wirewrap panel. For these procedures it is not necessary to remove the entire logic chassis. Access to the wirewrap panel on the bottom of the logic chassis can be gained by raising the logic chassis to its maintenance position and removing the bottom cover. If there is a broken pin, the logic chassis must be replaced.

There is an old and a new version logic chassis assembly. The old style (series code 15) is illustrated in Figure 3-16. The new style (series code 17) is illustrated in Figure 3-17.



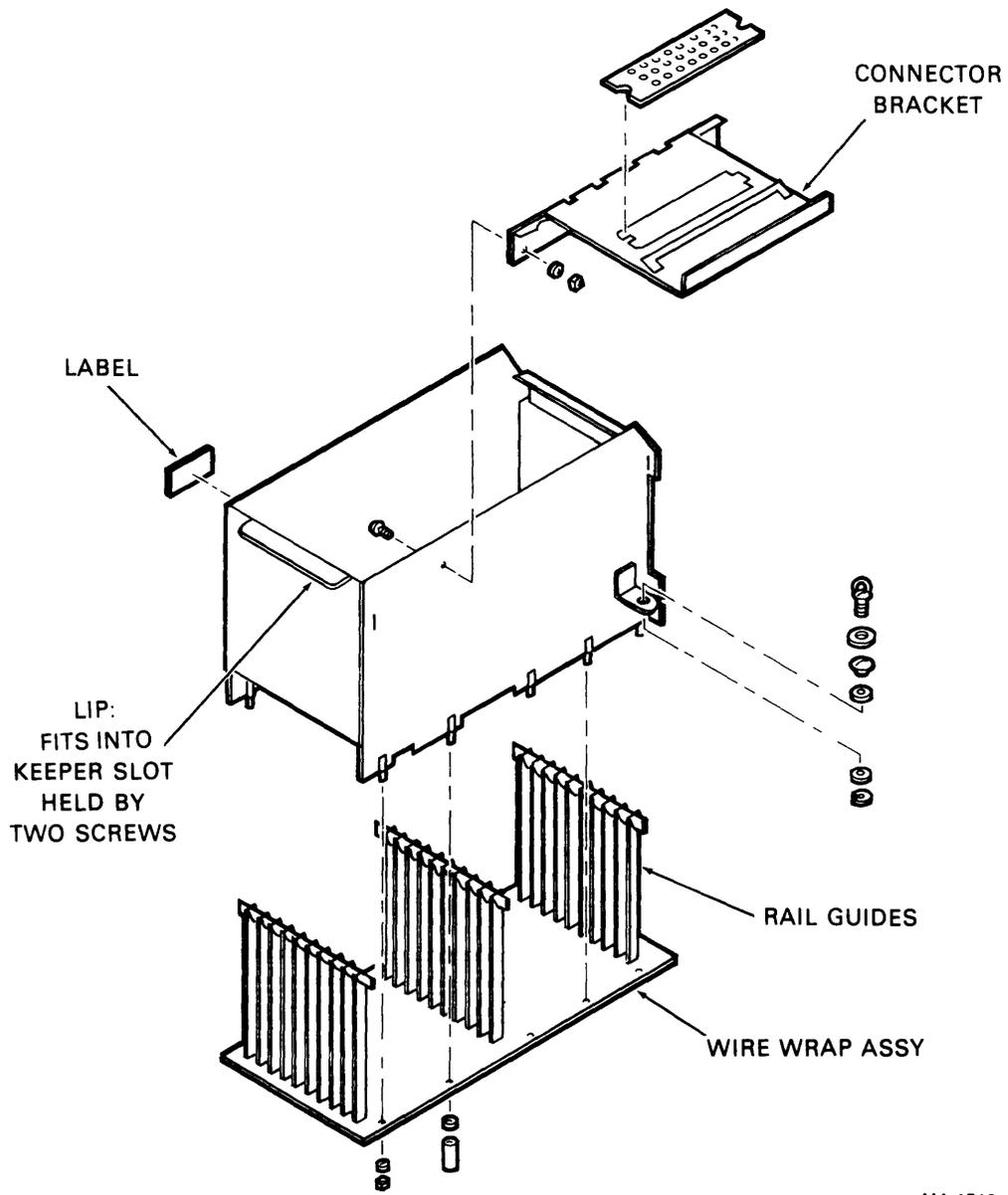
MA-1517

Figure 3-15 Run Triac



MA-1526

Figure 3-16 Logic Chassis (Old)



MA-1519

Figure 3-17 Logic Chassis (New)

#### Removal Procedure:

1. Remove the drive top cover.
2. Disconnect the drive I/O cables from the logic chassis connectors.
3. Remove all cards from the logic chassis.
4. Raise the logic chassis to the maintenance position.
5. Remove the cover over the logic chassis wirewrap panel.
6. Remove all connectors and leads that would prevent the logic chassis from being lifted out.

#### **NOTE**

**On the new style logic chassis, loosen (but do not remove) the two screws holding the logic chassis lip (Figure 3-17).**

7. If this is a new style (code 17 and above) logic chassis, then perform steps 8 through 10. If this is the old style (code 15) logic chassis then go to step 11.
8. Lower the logic chassis to its normal position.
9. Remove the two screws that hold it to the top of the magnetic housing.
10. Remove the logic chassis from the drive.
11. With the logic chassis in the maintenance position, press in on the flat spring and slide the logic chassis off its hinge.

#### Replacement Procedure:

1. Install the logic chassis into the drive and secure it in place.
2. With the logic chassis raised to the maintenance position, reconnect all connectors and lead to the bottom wirewrap panel.
3. Replace the cover over the wirewrap panel.
4. Lower the logic chassis to its operating position.
5. Return all cards to their proper location in the logic chassis.
6. Reconnect the drive I/O cables and tighten their cable clamp.
7. Make sure the logic chassis is returned to its operating position and then replace the drive top cover.

### 3.16 CONTROL PANEL ASSEMBLY

Removal Procedure (DEC Part No. 29-22904):

1. Remove the front bezel.
2. Raise the pack access cover.
3. Pop the control panel bezel off the deck assembly by pressing the metal tabs on the side of the bezel (Figure 3-18).

#### CAUTION

**Cable clearance going to P201 is minimal.**

4. Pull the control panel bezel forward a short distance using caution to avoid damaging the cable.
5. Once the control panel bezel is extended just beyond the edge of the cabinet side panel, use a screw driver in the opening next to the bezel ears to press the ears on the plastic control panel inside (Figure 3-18).
6. Gently slide the control panel out of its bezel enclosure.
7. Unplug the cable and remove the control panel.

Replacement Procedure:

1. Assemble in reverse order.

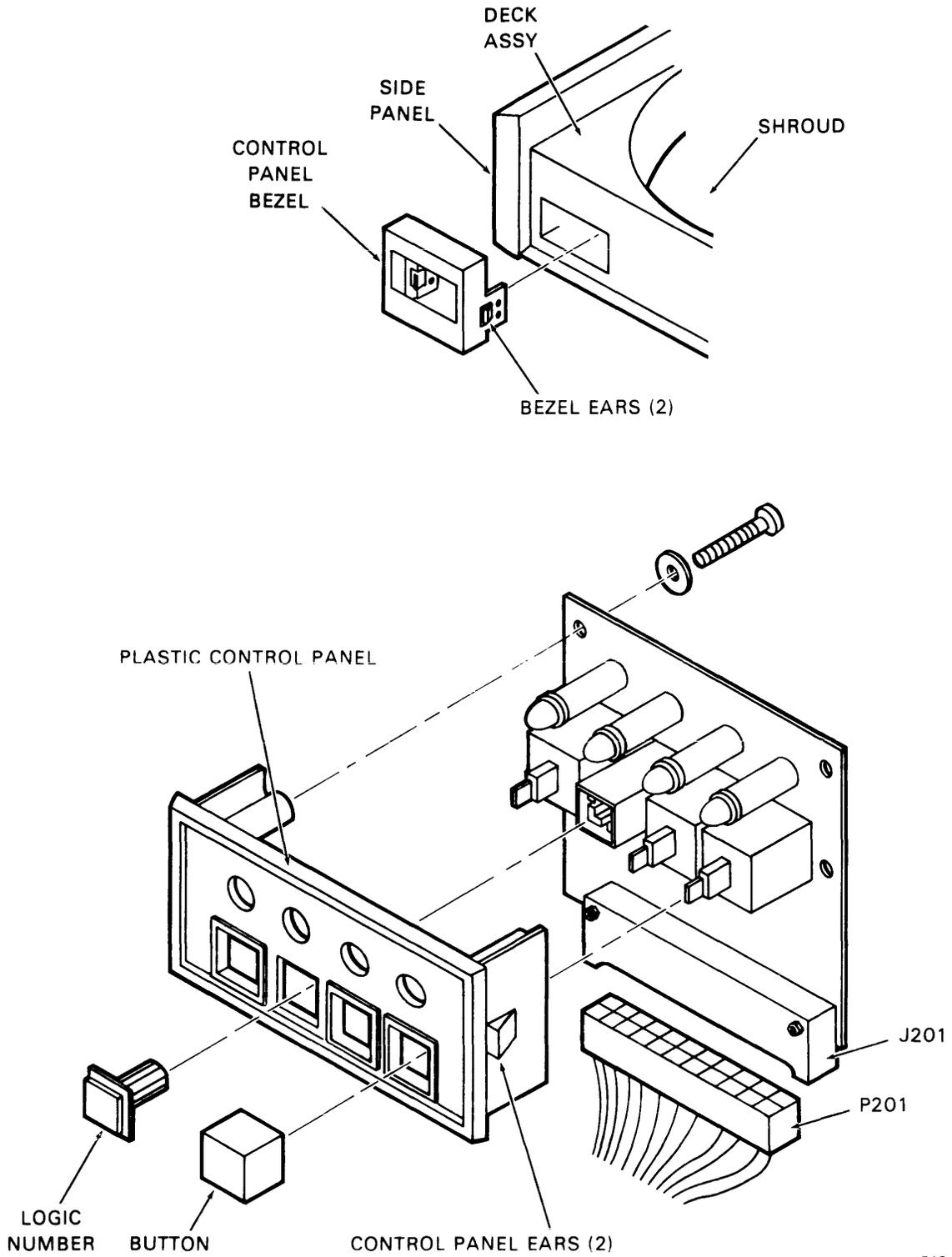
### 3.17 POWER AMPLIFIER ASSEMBLY (A3A04)

Removal Procedure (DEC Part No. 29-22913) (Figure 3-19):

1. Remove the quick connect terminal (yellow leadwire) from faston on upper left hand corner of assembly (Figure 3-19).
2. Loosen the hardware that secures the upper left hand corner of the power amplifier assembly, but do not remove it yet.
3. Remove connector J200.
4. Cut the tie wrap from the bottom right hand corner.
5. Remove the two sets of hardware that secure the assembly to the deck casting. An offset Phillips screwdriver will be needed.
6. Carefully lift assembly off.

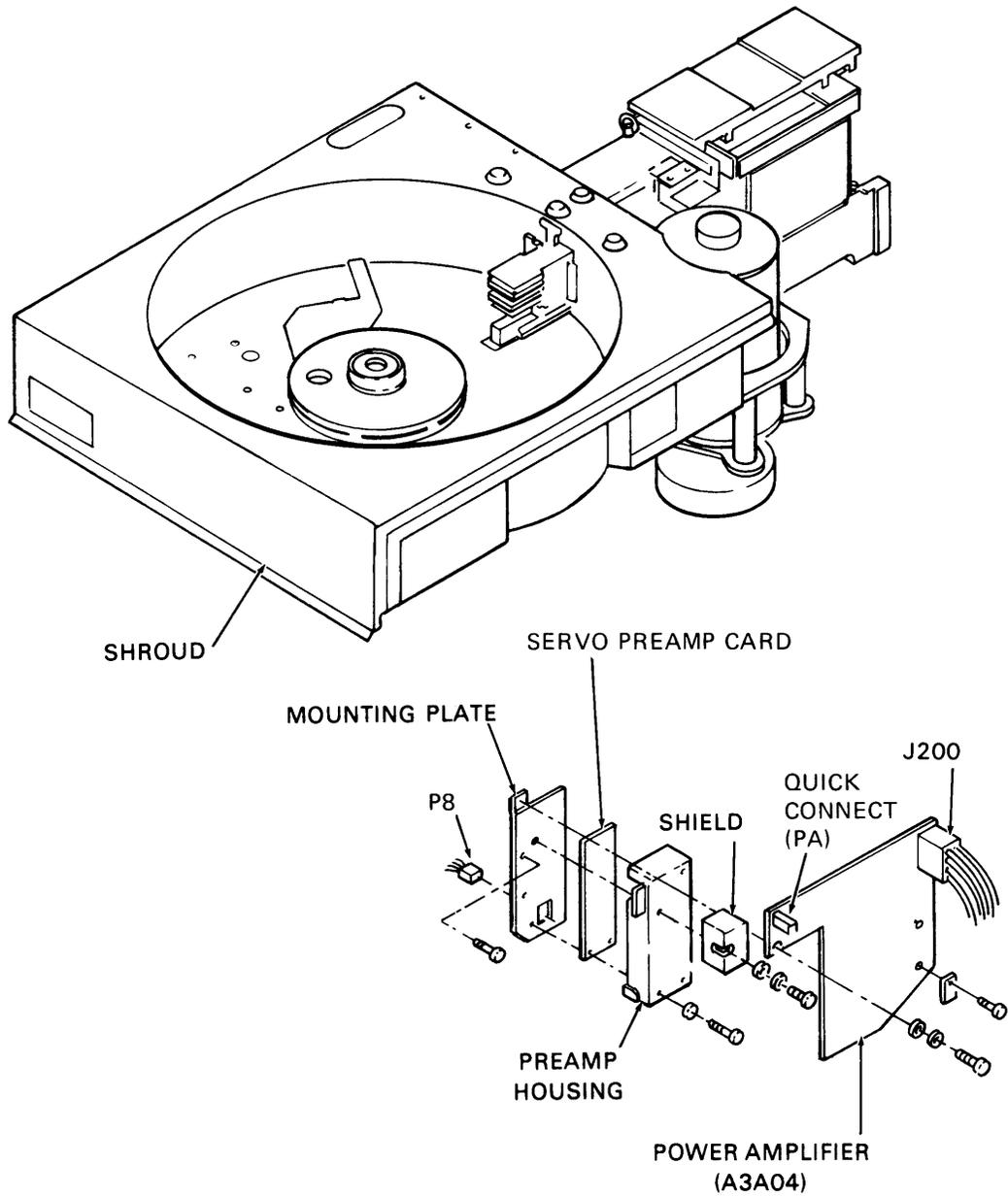
Replacement Procedure:

1. Assemble in reverse order.



MA-1512

Figure 3-18 Control Panel Assembly



MA-1528

Figure 3-19 Power Amplifier

**3.18 TRACK SERVO PREAMPLIFIER (A3A05)**

Removal Procedure (DEC Part No. 29-22894) (Figure 3-19):

1. Remove the attaching hardware on the upper left hand corner of the assembly. Carefully slide the servo preamplifier shield out and let it hang on the servo head cable.
2. Unplug the servo head connector from the servo preamp board.
3. Raise the deck to the maintenance position.

4. Reach behind the servo preamplifier from under the deck and disconnect connector J8. It may be necessary to cut and remove the cable tie wrap.
5. Remove the screw in the bottom left hand corner that secures the servo preamplifier housing to its mounting plate.
6. Lower the deck.
7. Remove the hardware securing the servo preamp board to its housing.

Replacement Procedure:

1. Assemble in reverse order. Note that the servo head connector is keyed.

### 3.19 DRIVE BELT

#### 3.19.1 Adjustment

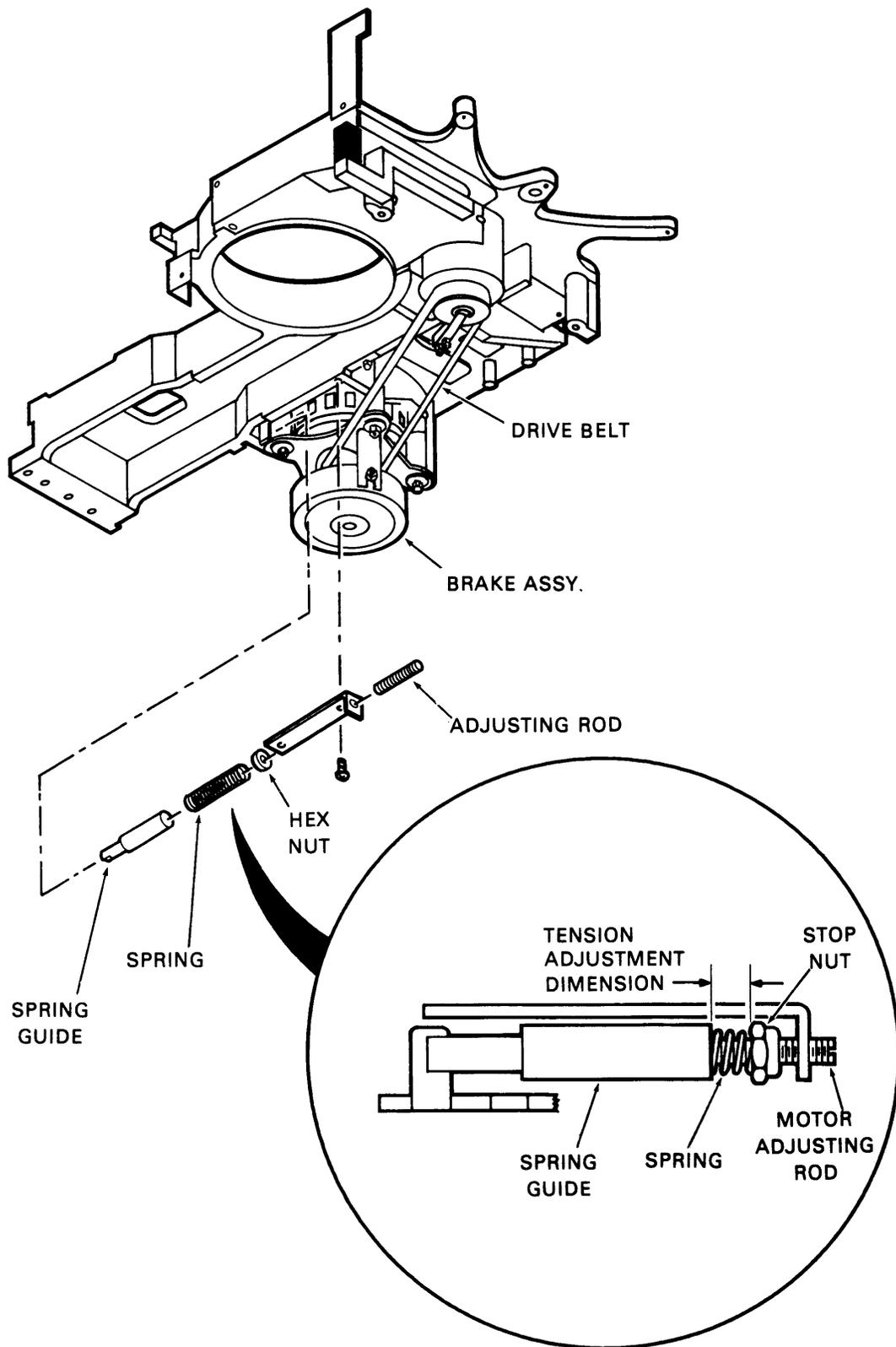
The drive belt (DEC Part No. 29-23110, 60 Hz; Part No. 9-23120, 50 Hz) adjustment may be performed any time there is suspicion that the belt may be slipping or as required by other procedures in this manual. Before performing the adjustment, check the belt for any signs of damage: fraying, cracking, or checking of belt surface. If any of these signs exist, replace the belt before performing adjustment.

1. Raise the deck to the maintenance position.
2. Referring to Figure 3-20, measure the distance between the spring guide and stop nut. Distance must be:
  - Between 0.96 to 1.12 cm (3/8 and 7/16 inch) for 50 Hz drives.
  - Between 0.48 to 0.8 cm (3/16 and 5/16 inch) for 60 Hz drives.
3. If the dimension is not correct, turn the motor adjusting rod until it meets specifications. A ten inch screwdriver will be necessary to make this adjustment. It may also be necessary to remove a cable clamp located in front of the adjusting rod.

#### CAUTION

**If the adjusting rod is turned too far, the spring may fall out of the spring guide.**

4. Rotate the spindle while checking drive belt tracking. The belt must run true on both the motor pulley and the spindle pulley. A failure to do so indicates a pulley misalignment.
5. When the belt is tracking properly, reinstall the cable clamp (if it was removed).
6. Return the deck to its normal operating position.
7. Apply power to the drive and press the START switch to start the drive motor. Remove the side panel (Paragraph 3.6) and watch the drive belt to make sure it is tracking properly and also that it does not slip.



MA-1521

Figure 3-20 Drive Belt Adjustments

### 3.19.2 Removal Procedure

1. Raise the deck (Figure 3-20) to the maintenance position.

#### CAUTION

**Failure to relieve pressure on the compression spring while removing the drive belt may cause the motor shaft to bend.**

2. Remove the cable clamp located in front of the adjustment rod to gain access to the belt adjustment fixture.
3. Relieve the pressure on the compression spring by turning the adjustment out until pressure is relieved. A long screwdriver will ease this process.
4. Remove the drive belt from the motor pulley by rolling the belt off while rotating the pulley. Disengage the belt from the spindle pulley and slip it out from around the brake.

### 3.19.3 Replacement Procedure

1. Slide the drive belt up over the brake (but not onto the pulley) and then engage the other end of the belt on the spindle pulley.

#### NOTE

**The smooth side of the belt goes in.**

2. Apply tension to the belt and guide it onto the motor pulley while manually rotating drive belt and drive motor pulley.
3. Manually rotate drive motor pulley several times to make certain that the drive belt is tracking properly.
4. Perform the drive belt adjustment procedure.
5. Reinstall the cable clamp if it was removed.

### 3.20 DRIVE MOTOR AND BRAKE ASSEMBLY ADJUSTMENT (A3DM1, A3HB1)

There are two adjustments pertaining to the drive motor (DEC Part No. 29-231, 60 Hz, RM02; Part No. 29-23122, 50 Hz, RM02; Part No. 29-22911, 60 Hz, RM03; Part No. 29-22912, 50 Hz, RM03) and brake assemblies (DEC Part No. 29-22903): drive belt adjustment and brake adjustment. The drive belt adjustment procedure is provided in the Paragraph 3.19. The brake adjustment is performed during the replacement and is provided in the Removal-Replacement paragraph under brake replacement.

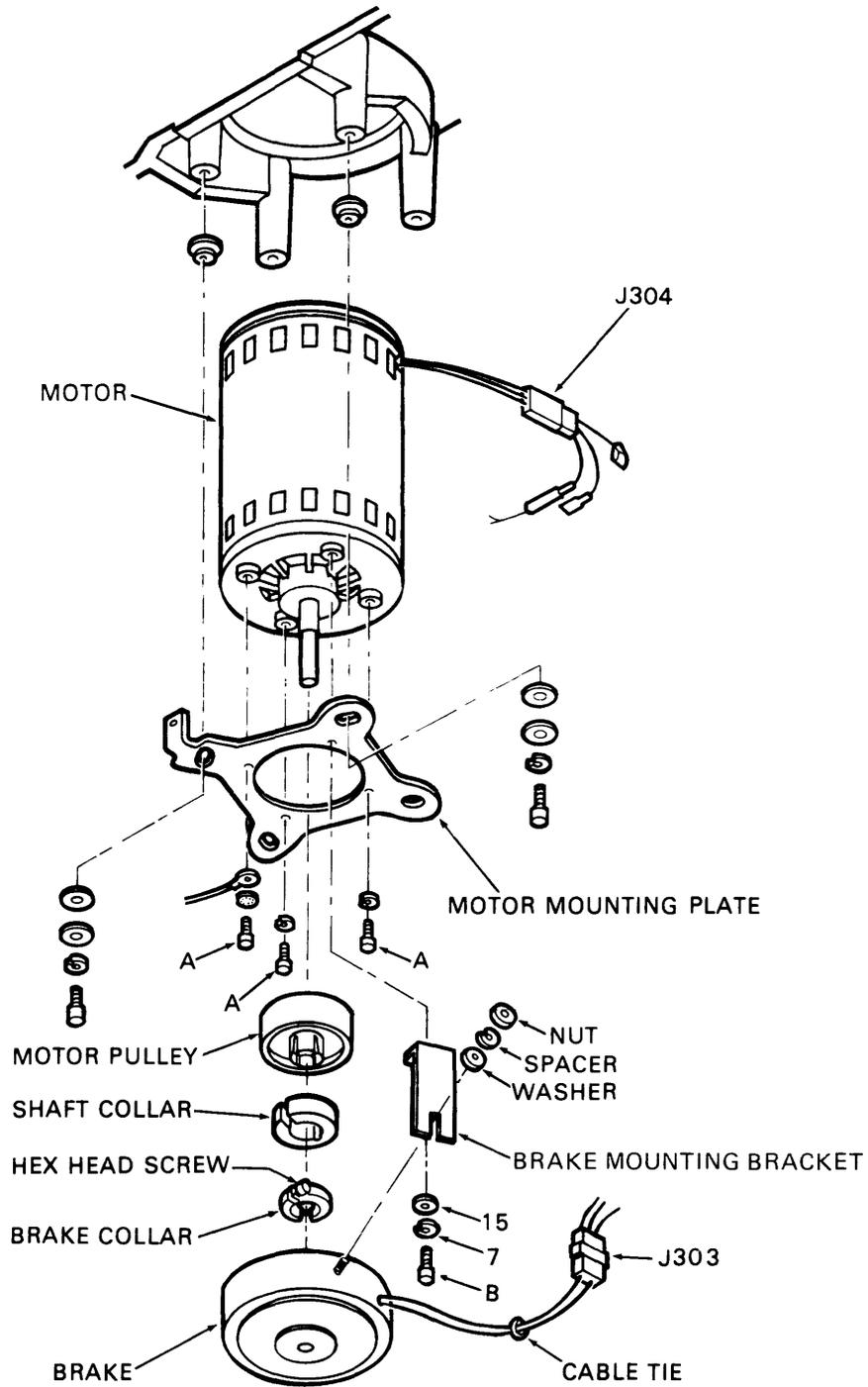
The brake assembly may be removed and replaced separately, or the drive motor and brake assemblies may be removed and replaced as a unit. When removing the drive motor, the brake must also be removed.

## Removal Procedure

1. Remove drive belt tension either by adjusting the motor adjusting rod or by applying counter pressure to the drive motor brake assembly and pivoting it.
2. Remove the drive belt.
3. Remove tie wraps.
4. Disconnect the P303 drive brake plug.
5. Remove nut, spacer, and washer from the brake mounting bracket. Refer to Figure 3-21.
6. Loosen brake collar shaft Allen screw and remove the disk brake. Refer to Figure 3-21.
7. Remove four screws (three labeled "A", one labeled "B" in Figure 3-21) holding the motor to the motor mounting plate. Note which screw has the grounding strap under it.
8. Disconnect P304.
9. Remove the drive motor and motor pulley assembly. Applying counter pressure to the drive motor bracket against the tension spring may be necessary to obtain clearance for the top of the motor.
10. If the drive motor is replaced, also replace the drive motor capacitor A366.

## Replacement Procedure

1. Install the motor and pulley assembly using a slight rotation to clear the power cables. Apply counter pressure on the drive motor bracket against the belt tension spring to clear the top of the motor.
2. Connect P304.
3. Install three screws (labeled "A" in Figure 3-21) to hold the motor in place. Make sure ground strap is under the correct screw.
4. Loosely install the brake mounting bracket with the fourth screw (labeled "B" in Figure 3-21). Note the position of the bracket in Figure 3-21.
5. Install the brake assembly onto the drive motor shaft in such a manner that its stud strikes the end of the bracket slot.
6. Secure the Allen screw on its collar but do not snug up yet. *This is the only adjustment to the drive motor brake.*
7. Install the nut, spacer, and washer on the drive break mounting assembly and tighten.
8. Tighten the brake mounting bracket and motor with an offset Allen wrench.
9. Tighten the Allen screw from step number 6 on the brake collar to  $30 \pm 2$  in-lb.
10. Reconnect P303 drive brake plug.



MA-1513

Figure 3-21 Drive Motor and Brake Assembly

11. Replace cable ties.
12. Make sure motor and brake assembly are free to pivot so belt tension will be maintained when the disk drive is operating.
13. Reinstall the drive belt and proceed to belt tension procedure.

### **3.21 SPINDLE ASSEMBLY**

#### **3.21.1 Adjustment**

Spindle adjustment (DEC Part No. 29-22900) must be performed any time the attaching hardware securing the spindle to the deck has been loosened.

1. Open the pack cover.
2. Remove head arm assembly numbers 3 and 4. Refer to head assembly removal procedures in Paragraph 3.32.
3. Install carriage alignment arm in the slot on carriage just vacated by head arm assembly number 3. Secure the alignment arm to the carriage and tighten its attaching screw to a torque of 4 in-lb.
4. Extend the carriage until the alignment arm is aligned as shown in Figure 3-22.
5. Using the attached nonmetallic feeler gauge, check that the distance between the alignment arm and the spindle is  $0.0077 \pm 0.0025$  cm ( $0.003 \pm 0.001$  inches) as shown in Figure 3-22. If adjustment is required, go to step 6. If the specification is met, go to step 15.
6. Raise the deck to its maintenance position after installing rear holding bracket.
7. Remove the drive belt.
8. Lower the deck to its normal position.
9. Retract the carriage and rotate the spindle until the holes in the top of the spindle line-up with the spindle mounting screws.
10. Loosen the screws and washers that secure the spindle to the deck.
11. Extend the carriage until the alignment arm is positioned as shown in Figure 3-22.
12. Using a plastic faced hammer, gently tap the spindle until the dimensions between the alignment arm and the spindle are as specified.
13. Tighten one screw at a time and check the dimension after each one.
14. When the spindle alignment specifications are met, raise the deck and replace the drive belt. Then return the deck to its operating position and secure it. Remove the rear hold-down bracket.
15. Remove the alignment arm and install head arm assemblies 3 and 4 back into the carriage. A slight upward force on the heads as the head arm reaches the ramp area allows for easy insertion.

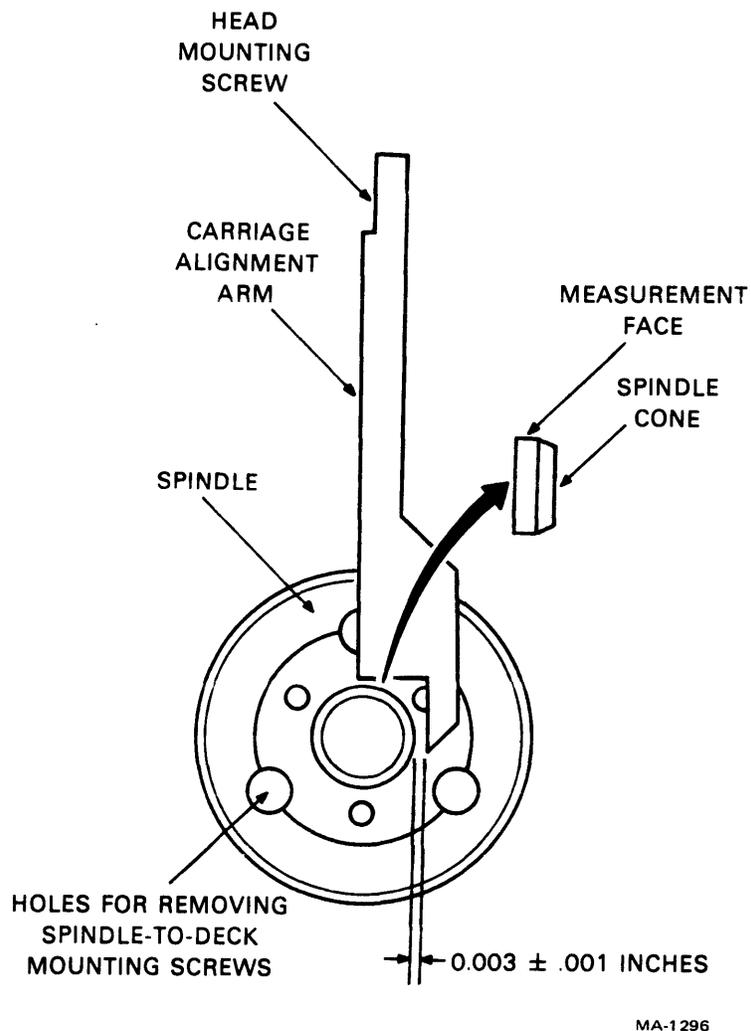


Figure 3-22 Spindle to Carriage Alignment

### 3.21.2 Removal Procedure

This procedure covers removing the spindle assembly. Note that it is not necessary to remove the spindle to perform lockshaft replacement.

1. Insert the rear hold-down bracket.
2. Raise the deck to its maintenance position.
3. Remove the hardware that secures the ground cable to the static ground spring block (Figure 3-24). Be careful not to lose the two star washers.
4. Remove the drive belt.
5. Lower the deck to its normal operating position.

6. Rotate the spindle until the holes in the top of the spindle line up with the mounting hardware.
7. Remove the three Allen head screws that secure the spindle assembly to the deck.

**CAUTION**

**Never rest the spindle assembly down on its pulley end. Lay it either on its side or on the face plate.**

8. Lift the spindle assembly from the deck being very careful not to damage the static ground spring.
9. Remove the ground spring mounting block and assembly from the spindle assembly.

### **3.21.3 Replacement Procedure**

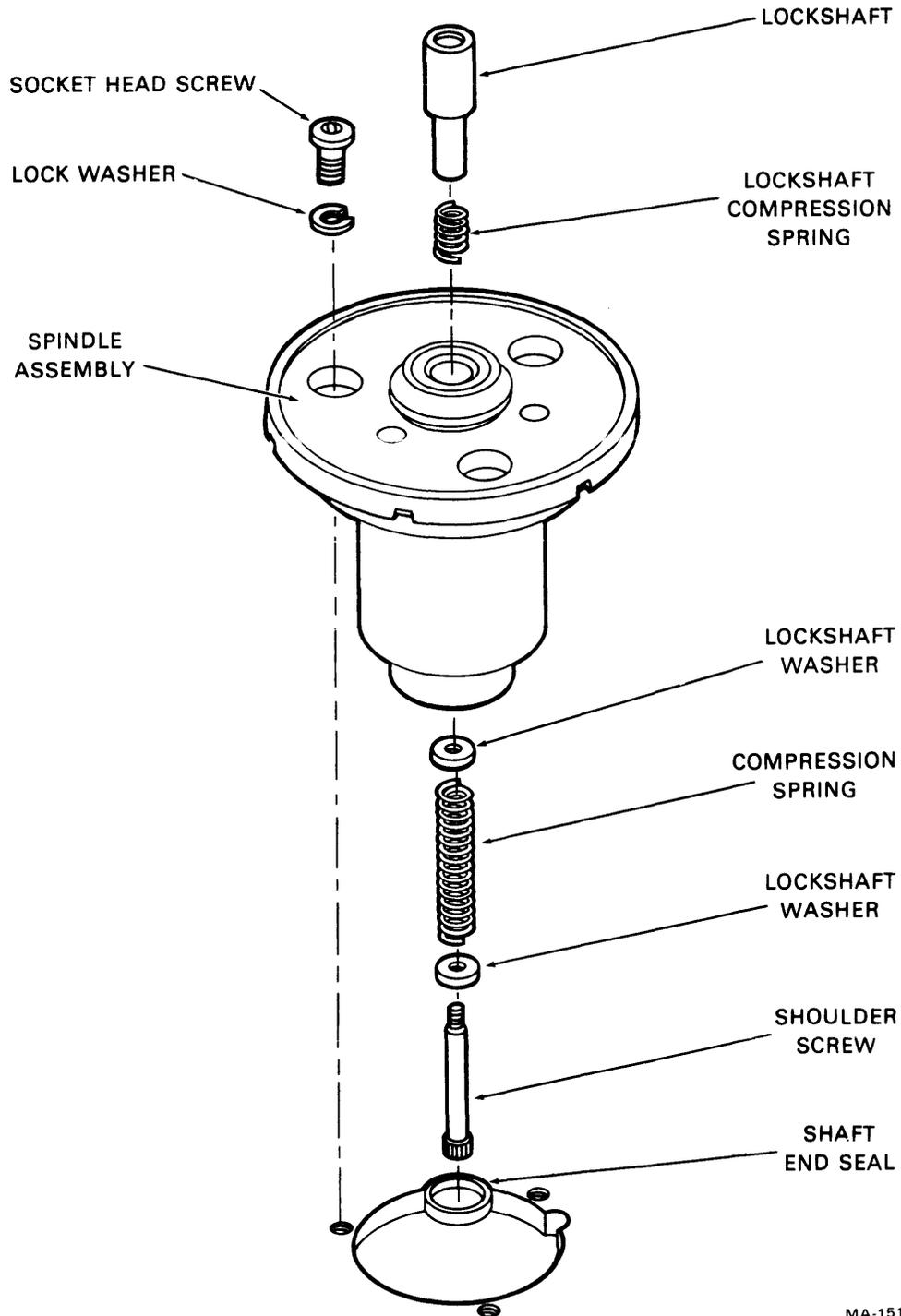
1. Install the static ground spring assembly onto the new spindle assembly.
2. Carefully lower the replacement spindle assembly through the deck opening in the shroud. Orient the spindle assembly so that the ground spring mounting block faces the drive motor.
3. Secure the spindle assembly to the deck with the mounting screws.
4. Perform the spindle adjustment procedure.
5. When spindle adjustment is complete, install the ground cable to the static ground spring.
6. Install the drive belt and perform the belt adjustment procedure.
7. Check the speed sensor adjustment.
8. Remember to install the rear hold-down spacer into its keeper hole after the deck is secured back into its operating position.

### **3.22 SPINDLE LOCKSHAFT REPAIR**

Repair of the spindle assembly is limited to removal and replacement of the lockshaft and associated hardware as indicated in the parts data section. The following procedure covers removal and replacement of the lockshaft.

1. Raise the deck to maintenance position after the rear hold-down bracket is installed.
2. Referring to Figure 3-24, remove attaching hardware securing ground cable to static ground spring block.
3. Remove static ground spring from mounting block.
4. Remove shaft end seal by prying down with a pair of opposing screwdrivers.
5. Reaching in from bottom of spindle, remove shoulder screw and associated washers and spring. Spindle may be locked in position during shoulder screw removal, by pressing down on end of brake plate.
6. Lift lockshaft out from top of spindle.

7. Install replacement lockshaft, sliding it in from top of spindle. If smaller compression spring came out with old lockshaft, assemble it on new lockshaft before assembly.
8. Assemble two washers and compression spring on shoulder screw as shown in Figure 3-23. Apply a thin coat of Loctite primer, grade T, to last four threads of shoulder screw; being careful not to get any primer on spring or washers.



MA-1511

Figure 3-23 Spindle Assembly

9. Allow Loctite primer to air dry for approximately five minutes.
10. When Loctite primer is dry apply a thin coat of Loctite, grade C, to last four threads of shoulder screw. Parts must be assembled within three minutes of Loctite application.
11. Assemble shoulder screw and hardware into bottom of lockshaft. Tighten shoulder screw to a torque of  $40 \pm 5$  in-lb.
12. Press shaft end seal into position on bottom of spindle assembly. Lower deck to normal operating position and allow Loctite to air dry for approximately three hours.
13. Following Loctite cure, raise deck to maintenance position and assemble static ground spring and associated ground cable.
14. Perform clean and lubricate lockshaft procedure.
15. Perform static ground spring adjustment procedure.

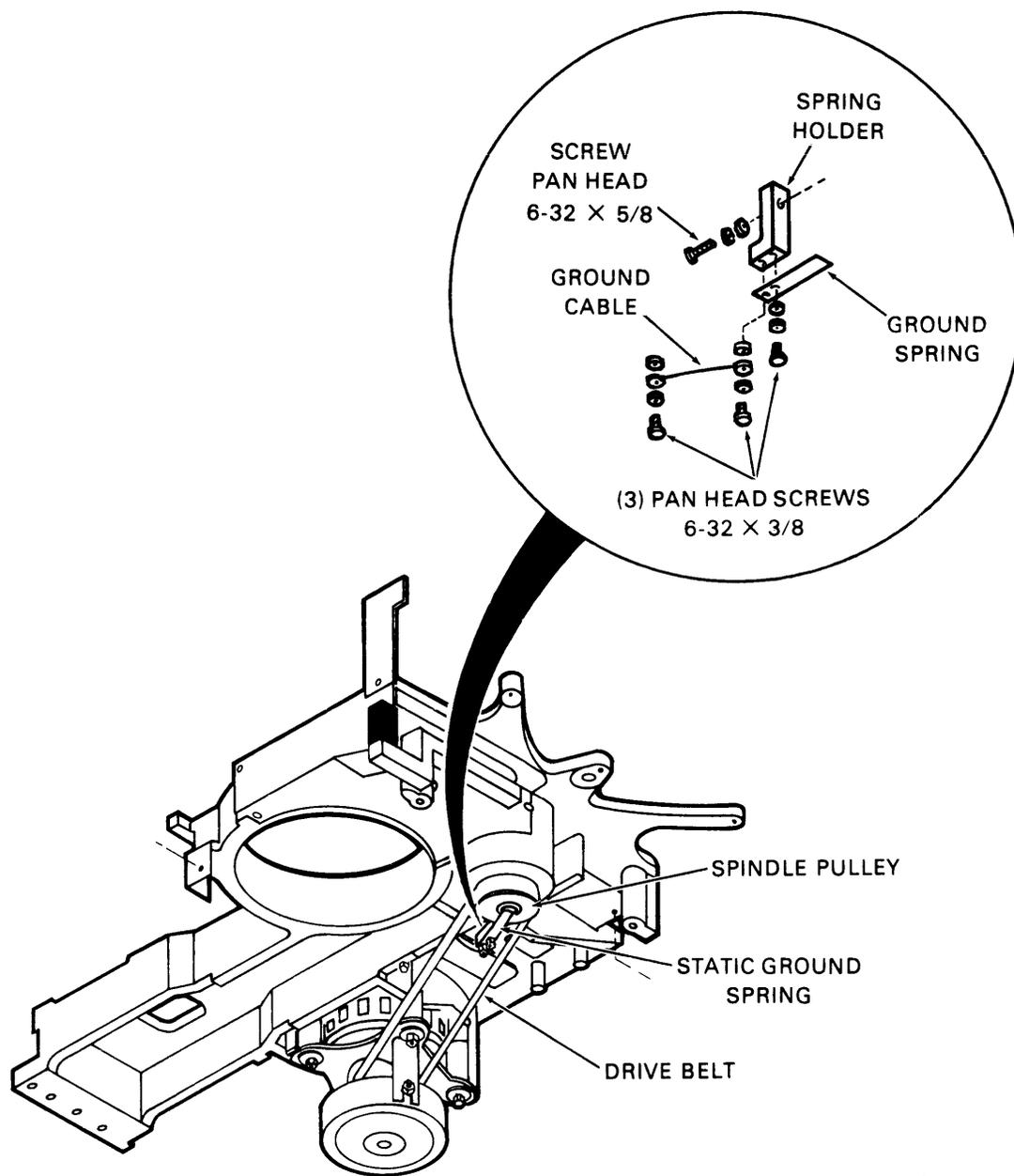
#### **CAUTION**

**Replace the rear hold-down spacer into its keeper hole after the deck is restored to its operating position.**

### **3.23 STATIC GROUND SPRING ADJUSTMENT**

The ground spring adjustment procedure (Figure 3-24) must be performed any time the screws securing the spring or mounting block have been loosened.

1. Install the rear hold-down bracket.
2. Raise the deck to its maintenance position.
3. Remove the hardware that secures the ground cable to the ground spring mounting block and disconnect the ground cable.
4. Connect a multimeter (set to RX1) between the ground cable and the ground spring. The meter should read zero ohms. If not, go to step 5. Otherwise, proceed to step 6.
5. Clean the bottom of the shaft end seal (on the bottom of spindle) using a piece of gauze slightly dampened with media cleaning solution. Repeat step 4.
6. Disconnect the multimeter and connect the ground cable to the ground spring mounting block.
7. Ensure the ground spring is tight enough to eliminate any bounce.
8. Secure the deck in its normal operating position.
9. Replace the rear hold-down bracket in its keeper hole.



MA-1510

Figure 3-24 Static Ground Spring

## **3.24 SPEED TRANSDUCER (A3L1)**

### **3.24.1 Adjustment**

Speed transducer (DEC Part No. 29-22909) adjustment is required whenever the relative position of the spindle and the speed transducer has changed, or as required by other procedures in this manual.

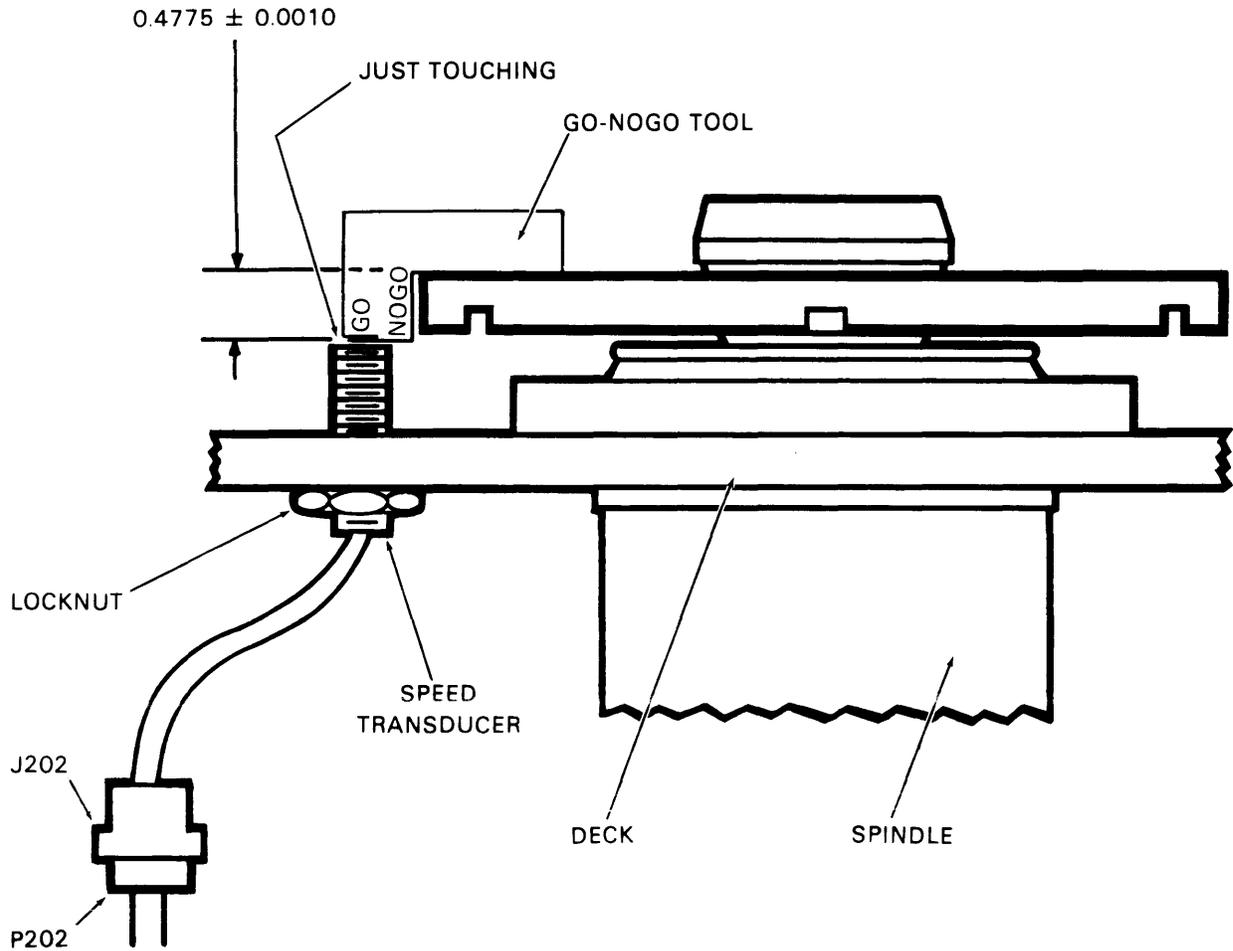
1. Place the Go-NoGo tool across the top of the spindle face plate so that the gauge extends out over the top of the speed transducer. Refer to Figure 3-25.
2. Check the dimension from the top of the speed transducer to the top of the spindle face plate as shown in Figure 3-25. This dimension should be  $1.2224 \pm 0.0026$  cm ( $0.4775 \pm 0.0010$  in). If adjustment is required, proceed to step 3. If no adjustment is required, go to next adjustment.
3. Install the rear hold-down bracket and then raise the deck to the maintenance position.
4. Loosen the locknut on the bottom of the speed transducer. Disconnect connector J202 so that the transducer leads are free to turn during adjustment.
5. Rotate the speed transducer until its top makes contact with the Go surface of the Go-NoGo tool. Tighten the locknut with caution since the housing is made of plastic.
6. Recheck the dimension with the Go-NoGo tool.
7. When the dimension is correct and the locknut is tightened, install connector J202.
8. Return the deck to the normal operating position and install the rear hold-down bracket back into its keeper hole.

### **3.24.2 Removal Procedure**

1. Install the rear hold-down bracket and raise the deck to the maintenance position.
2. Disconnect connector J202.
3. Remove the locknut on the bottom of the speed transducer and remove the transducer from the deck opening.

### **3.24.3 Replacement Procedure**

1. Install the new speed transducer into the deck opening.
2. Secure the transducer loosely in place with its locknut using caution not to damage the plastic housing.
3. Perform the speed transducer adjustment procedure.
4. Secure the deck in its operating position and make sure that the rear hold-down spacer is installed back into its keeper hole.



MA-1509

Figure 3-25 Speed Transducer Adjustment

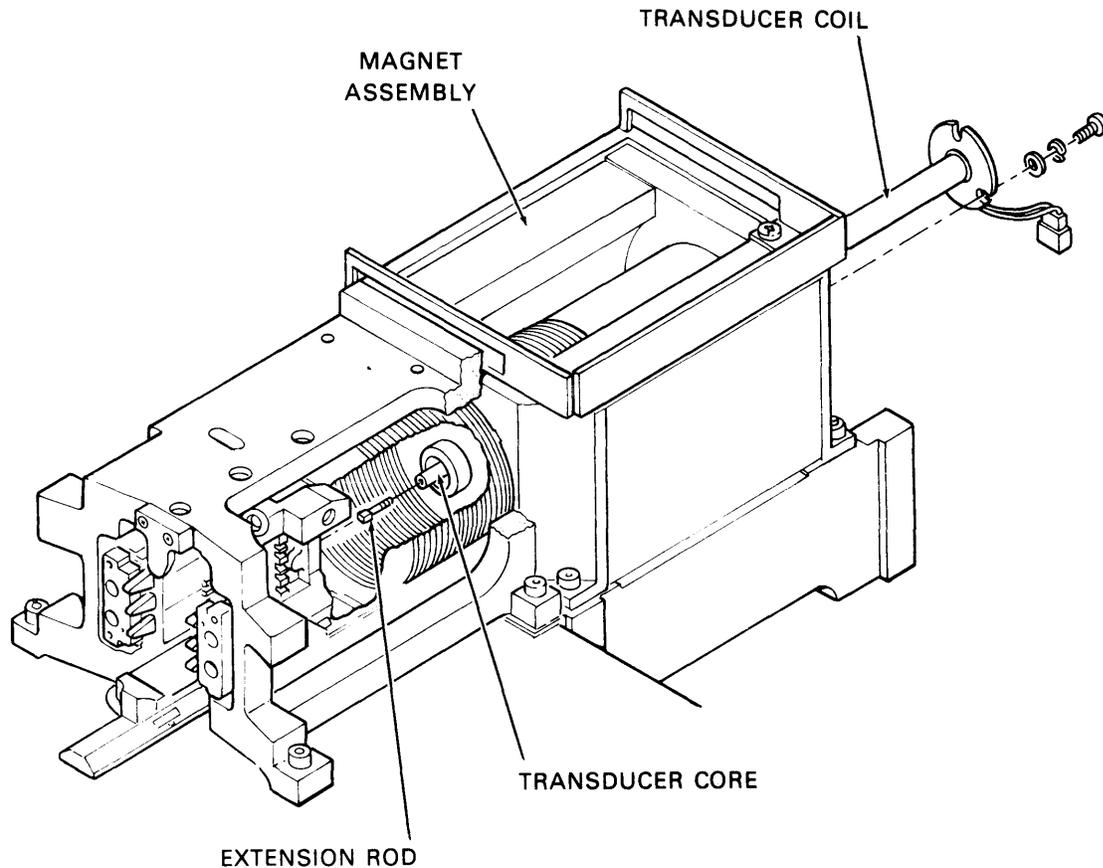
### 3.25 VELOCITY TRANSDUCER (A3L2) REMOVAL AND REPLACEMENT PROCEDURE

The velocity transducer assembly (DEC Part No. 29-22906) consists of a transducer coil (complete with housing and connector).

#### NOTE

**The coil and rod come together as a single item, and must be replaced as such.**

1. Remove the hardware securing the transducer coil to the rear of the magnet assembly. Unplug connector P22 (Figure 3-26).
2. Carefully remove the transducer coil, sliding it straight out of the rear of the magnet assembly.
3. Slowly and carefully slide the replacement transducer coil into the rear of the magnet assembly.



MA-1523

Figure 3-26 Velocity Transducer Replacement

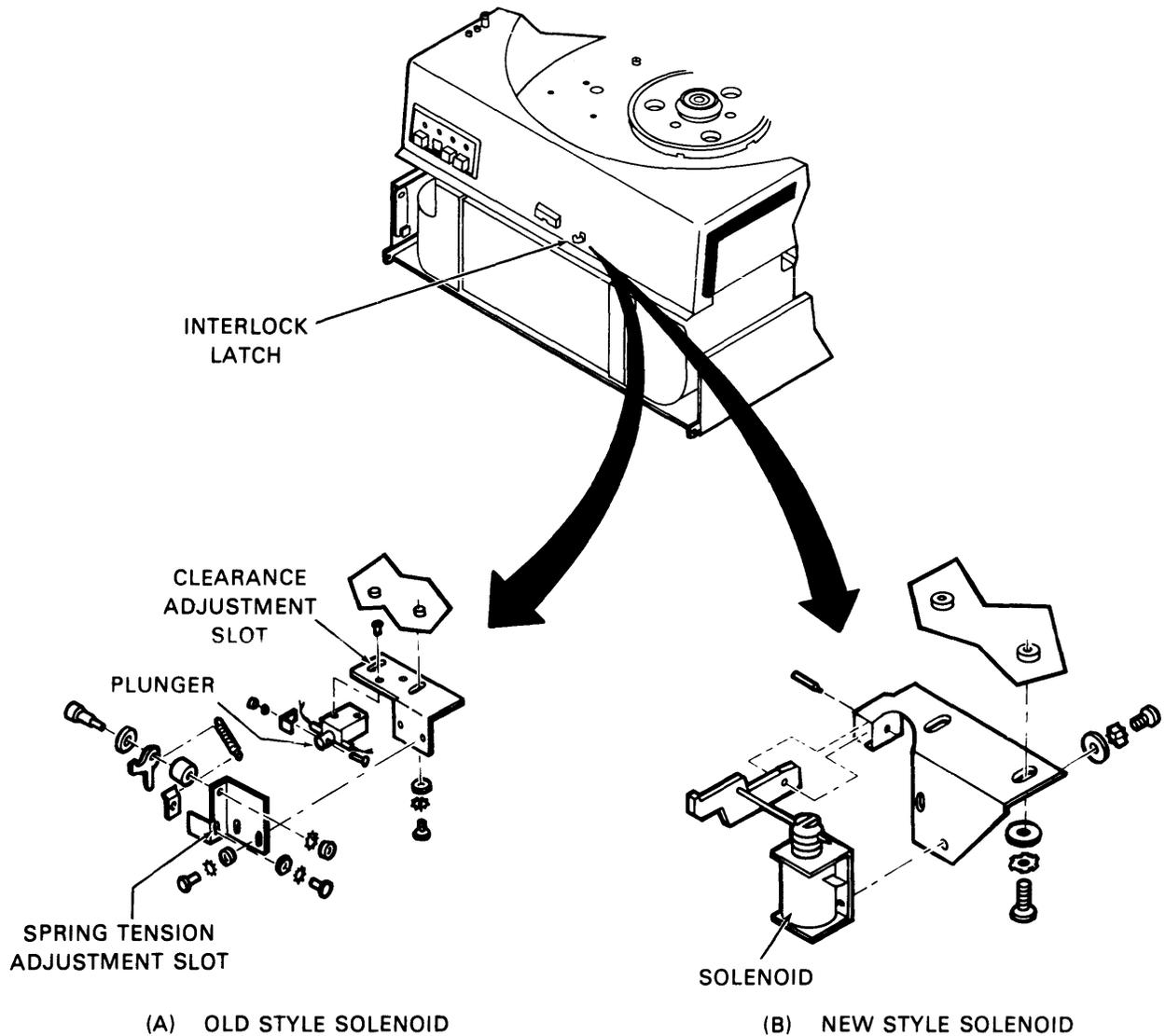
4. Align one of the three slots on the back of the transducer coil with the mounting hole in the magnet. Manually extend the heads and slide the carriage back and forth. Be aware of any drag or rubbing sound. Rotate the coil and move the carriage again for each of the remaining two slots on the back of the transducer coil.
5. Select the mounting slot which produced the least drag or rubbing. Orient this slot toward the mounting hole and install and tighten the attaching hardware.
6. Connect connector P22. Extend the heads and move the carriage back and forth to verify the alignment of the transducer coil.

### 3.26 PACK COVER SOLENOID (A3L3) ADJUSTMENT

There are two versions of the pack cover solenoid assembly (Figure 3-27). There is an old style that exists on the early drives, and a new style that is used on the DEC customized drives.

#### 3.26.1 Old Style Solenoid Adjustment

The pack cover solenoid adjustment is required whenever the solenoid is changed or if the pack cover does not lock when power is removed from the drive. There are two adjustments pertaining to the solenoid: clearance, and spring tension.



MA-1527

Figure 3-27 Pack Cover Solenoid Adjustment

The clearance adjustment is made to obtain minimum clearance between the interlock latch (refer to Figure 3-27) and the interlock keeper on the pack access cover. When the pack access cover is latched (solenoid deenergized, and latch in up position) the keeper must strike the latch and not allow the pack cover catch to be released. Loosen the attaching hardware securing the solenoid assembly to the shroud, and slide the assembly backwards or forwards to achieve this adjustment.

The spring tension adjustment is made to fully extend the solenoid plunger when the solenoid is deenergized. The tension should not be so great as to prevent the plunger from fully retracting when the solenoid is energized. Perform the adjustment by loosening the spring mounting hardware and sliding it up or down in the mounting slot.

### 3.26.2 New Style Solenoid Adjustment

1. Raise the deck to the maintenance position after the rear hold-down bracket is installed.
2. Loosen the mounting screws securing the solenoid assembly to the shroud.
3. Close the pack cover.
4. Slide the solenoid assembly backwards until the latch engages the strike plate.
5. Hold the solenoid in this position and tighten the mounting screws.
6. Lower the deck and return rear hold-down bracket to its keeper hole.

### 3.27 RAIL BRACKET ASSEMBLY

Only specially trained and qualified field service personnel should make adjustments to the rail bracket assembly (Figure 3-28), or attempt to replace it. These procedures require special tools and great precision and should not be attempted by untrained personnel.

Under no circumstances should the screws securing the rails or the rail bracket to the deck be loosened. If either the rails or the rail bracket assembly are damaged or misaligned, contact the nearest Regional Support Center.

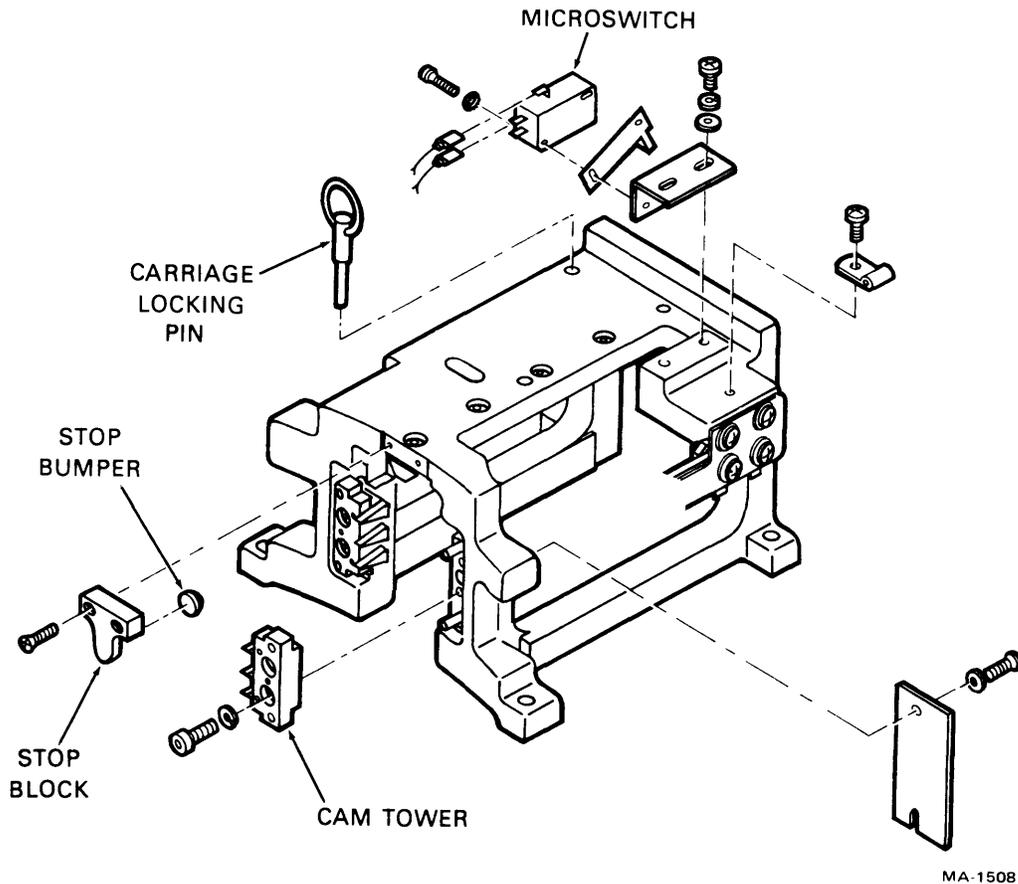


Figure 3-28 Rail Bracket Assembly

### 3.28 CARRIAGE AND COIL ASSEMBLY

Only properly trained personnel with the special tools needed, should attempt the alignment procedure for the carriage and coil assembly (DEC Part No. 29-22910). The precision alignment of the carriage bearings makes this process difficult. The carriage and coil assembly is illustrated in Figure 3-29.

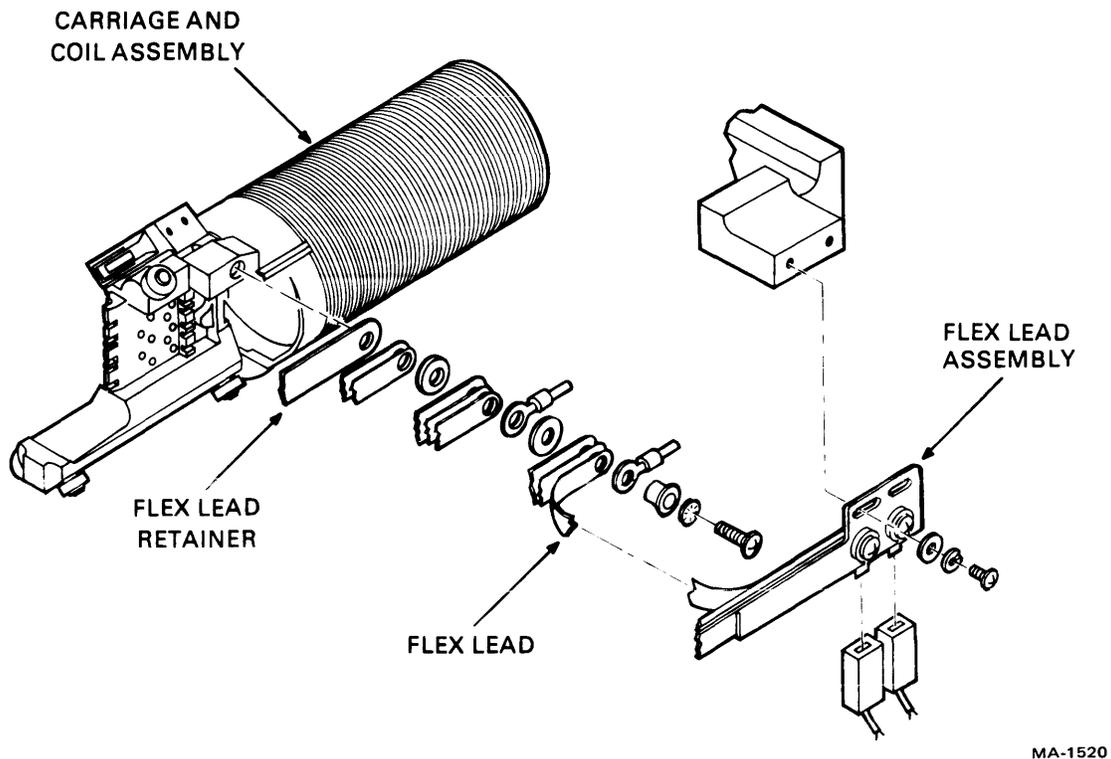


Figure 3-29 Carriage and Coil Assembly

### 3.29 FLEX LEAD ASSEMBLY ADJUSTMENT

Adjust the flex lead assembly (DEC Part No. 29-22905) (Figure 3-29) any time the assembly is changed. Adjustment of the flex lead assembly is a matter of positioning the assembly so that it is parallel with the travel of the carriage and coil assembly. When the flex lead assembly is properly aligned, there is no buckling of the leads during extension and retraction of the carriage and coil assembly.

### 3.30 HEADS LOAD SWITCH (A352) ADJUSTMENT

Perform the heads loaded switch adjustment (Figure 3-30) under any of the following conditions

- Heads do not fully retract when drive is powered down.
- Unknown cause of a power amplifier or power amplifier fuse failure.
- Heads loaded switch is changed or in any way moved.
- Instructed to do so by another procedure.

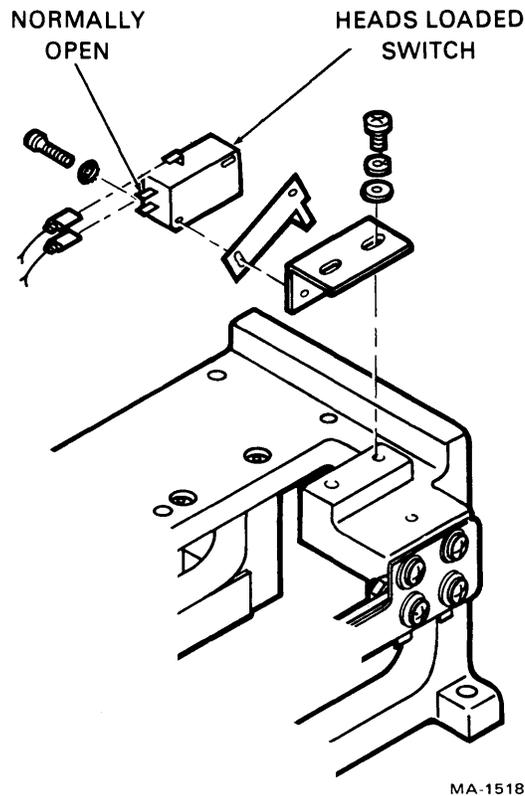


Figure 3-30 Head Loaded Switch Replacement

To adjust the heads load switch, complete the following steps.

1. Disconnect leadwires from heads lo aded switch, taking note of leadwire placement.
2. Connect multimeter (set to RX1 scale) between ground contact and normally open contact as shown in Figure 3-30. With carriage fully retracted, multimeter should indicate zero ohms.

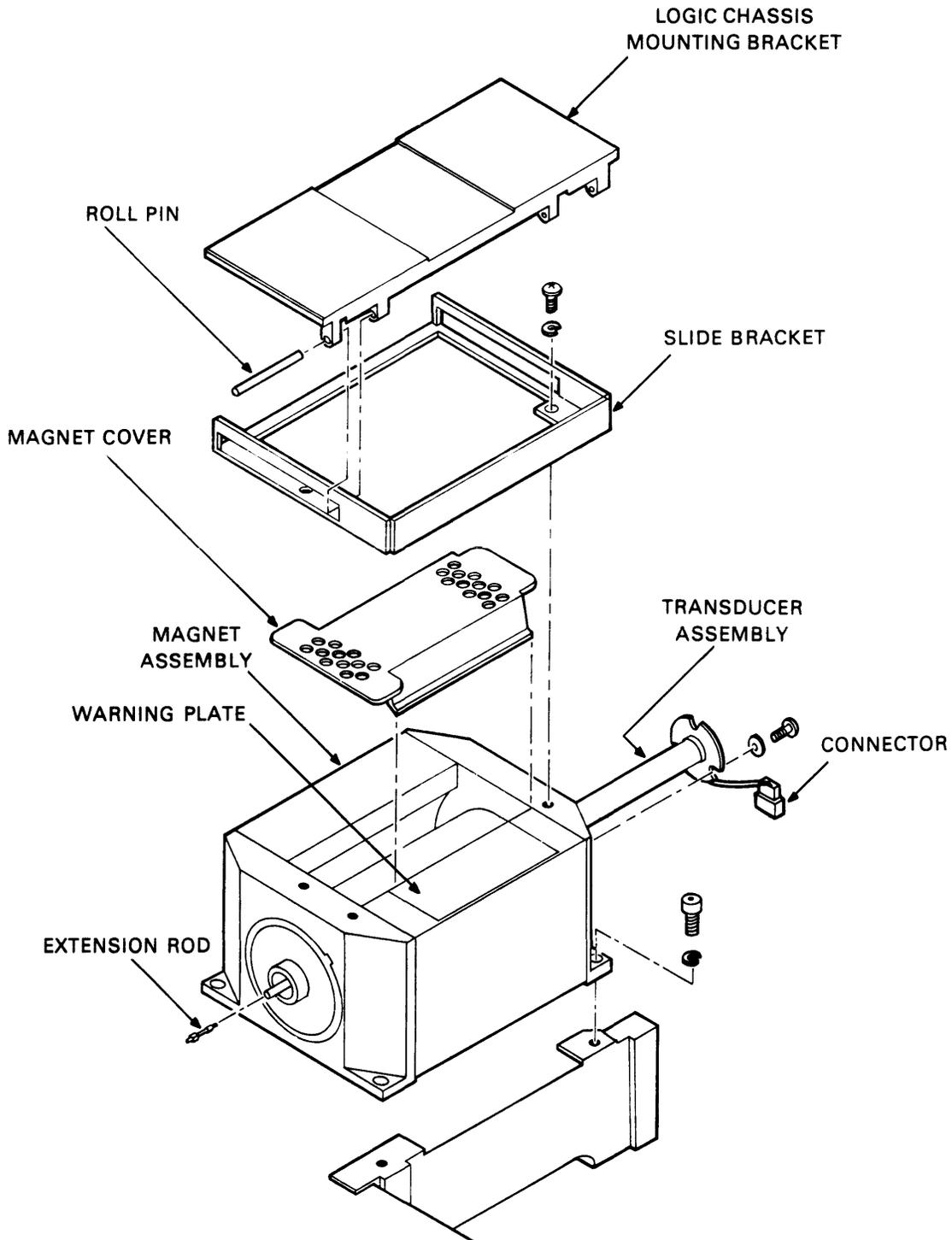
**NOTE**

**Measure carriage travel between rear edge of voice coil and inside back edge of magnet assembly.**

3. Note measurement from rear of voice coil to inside back edge of magnet assembly with carriage retracted. Manually extend heads very slowly, while observing multimeter. Measure carriage travel at point that multimeter switches from zero ohms to infinity. Difference between fully retracted measurement and heads extended measurement should be 0.125 to 0.1875 inch.
4. If switch does not transfer within specified measurement, loosen hardware securing switch mounting bracket to rail bracket assembly and adjust switch position.
5. When adjustment is complete recheck carriage travel per step 3. Assuming adjustment is correct, reconnect leadwire to heads loaded switch.

### 3.31 MAGNET ASSEMBLY ADJUSTMENT

The magnet assembly (DEC Part No. 29-22874) (Figure 3-31) must be adjusted any time the mounting hardware securing the magnet to the deck is loosened.



MA-1530

Figure 3-31 Magnet Assembly

The magnet assembly is properly adjusted when the coil slides through its complete travel without contacting the magnet assembly. Ensure that when the magnet assembly is secured to the deck, a 0.005 inch nonmetallic feeler gauge passes between the coil and the magnet. The 0.005 inch clearance must be maintained at all points around the coil in the front opening of the magnet assembly. After securing the magnet to the deck, and before installing the velocity transducer, manually extend the heads and move the carriage and coil assembly back and forth through its full travel. There should be no rubbing or scraping sound and there should be no drag felt during this movement.

### **3.31.1 Removal/Replacement Procedure**

When removing the magnet assembly the hinge for the logic card cage assembly will have to be removed from the magnet housing.

#### **CAUTION**

**Be sure that when the assembly is removed and replaced, the housing does not hit or damage the carriage and coil assembly.**

## **3.32 HEAD ARM ASSEMBLY**

Refer to Chapter 1, Paragraph 1.2.3 for part numbers.

### **3.32.1 Repair**

The drive has a positive pressure filtration system that eliminates the need for periodic inspection and cleaning of heads. The heads should be inspected for the following reasons only:

1. A problem is traced to a specific head or heads; for example, excessive data errors.
2. Head to disk contact is suspected. This may be indicated by an audible ping, scratching noise, or a burning odor when the heads are over the disk area.
3. Concentric scratches are observed on the disk surfaces.
4. Contamination of pack is suspected (possibly due to improper storage of the pack).
5. The pack has been physically damaged (possibly due to dropping or bumping).

#### **CAUTION**

**Do not attempt to operate the media on another drive until full assurance is made that no damage or contamination has occurred to the media.**

**Do not attempt to operate the drive with another media until full assurance is made that no damage or contamination has occurred to the drive heads or to the shroud area.**

### 3.32.2 Head Inspection

#### CAUTION

**Do not smoke when inspecting or cleaning heads. Use extreme care not to damage the head.**

**Do not touch the head pad or gimbal spring with fingers or tools.**

**If head must be laid down, do not allow the head pad or gimbal spring to touch anything.**

Remove suspected head as described in the Read/Write Servo Head/Arm Replacement procedure. Observe the head/arm, and perform the suggested remedy as follows:

1. If reddish-brown oxide deposits exist on the head, replace or clean the head/arm assembly.
2. If head appears scratched, replace or clean the head/arm assembly.
3. If head appears damaged, replace the head/arm assembly.
4. If the gimbal spring (holding the head pad to the arm) is bent or damaged, replace the head/arm assembly.

#### Head Cleaning

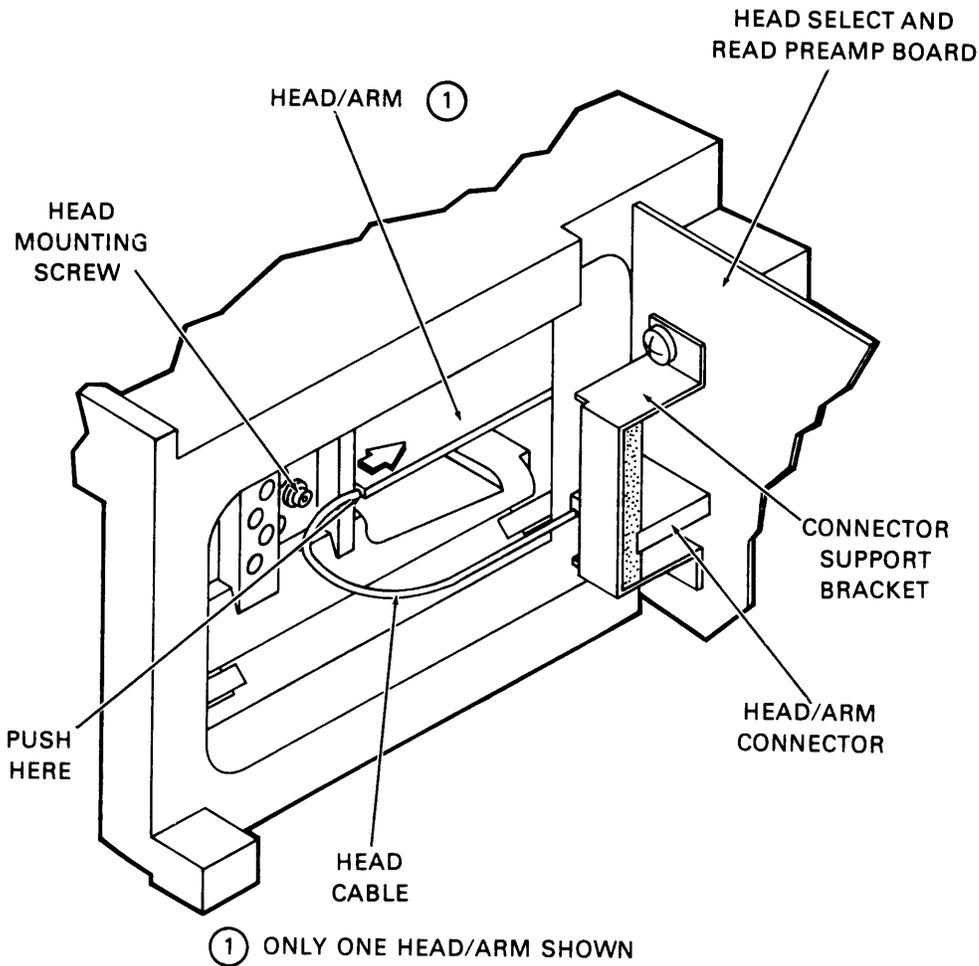
#### CAUTION

**Head cleaning is a delicate procedure which is not recommended. It should not be undertaken unless it is absolutely necessary and then it should be performed by properly trained personnel only.**

#### Head Replacement Procedure

The following procedure covers removal and replacement of either the servo head or the read/write heads. Remove heads from the carriage only to perform head inspection and cleaning, or as directed by other procedures in this manual. When removing the servo head also remove read/write head number two. This allows room for the head cable and connectors to pass between the adjacent head arms with a lessened chance of doing damage.

1. Remove connector support bracket or servo pre-amplifier shield and disconnect head arm connector for subject head (for servo head, also remove head cable from cable clip and disconnect tie point connector). Refer to Figure 3-32.
2. Remove head mounting screw and associated hardware.



MA-1516

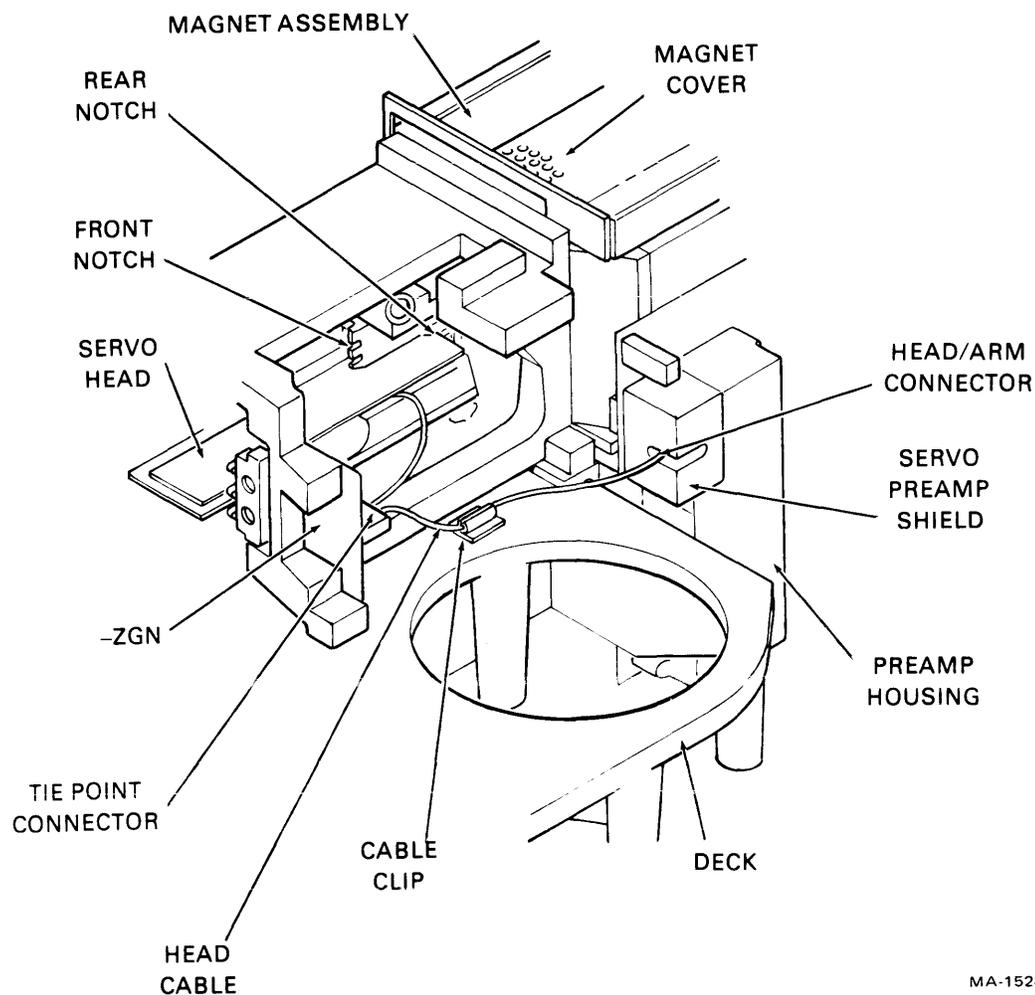
Figure 3-32 Head Replacement - Left Side View

3. Manually extend heads far enough to be able to grasp front of head arm from inside pack area.

**CAUTION**

**Head pads and gimbal springs are extremely delicate and easily damaged. Grasp head arms carefully and only by edges of head arm if head pad is touched, perform head cleaning procedure.**

4. Grasp entire stack of heads such that they are all held in alignment to one another. Carefully extend heads all the way into pack area.
5. Carefully grasp subject head arm at front and also push gently on rear of head arm as shown in Figure 3-33. Guide head arm and connector(s) through adjacent head arms and into pack area.
6. Perform required maintenance procedure.



MA-1524

Figure 3-33 Head Replacement – Right Side View

7. Install head arm assembly by fully extending heads into pack area, and guiding head arm connector between adjacent head arms. Use care not to damage adjacent heads.
8. Seat head arm in both front and rear notches on carriage.
9. Grasp entire stack of heads such that they are all held in alignment to one another. Carefully retract heads. Do not push on front of head arm assemblies while retracting heads.
10. Carefully position head arm as required in order to insert head mounting screw. Support head arm from opposite side when inserting head mounting screw or forward pressure of wrench may dislodge head arm.
11. Ensure that head arm assembly is aligned in relation to remainder of heads where they protrude into pack area.
12. Tighten screw, securing head arm assembly to carriage, until torque is  $12 \pm 1/2$  in-lb.
13. Carefully reconnect head arm connector and replace related hardware removed in step 1.
14. Perform Head Arm Adjustment procedure, described in Chapter 2.

## **CHAPTER 4**

### **ADJUSTMENT PROCEDURES**

#### **4.1 VELOCITY GAIN ADJUSTMENT WITH FTU**

This procedure provides information on the checking and, if necessary, adjusting of the servo system velocity signal. If the adjustment cannot be completed satisfactorily, the procedure must be terminated. If this happens, perform trouble analysis. The following procedure assumes that the FTU is connected, and that a scratch pack is installed on the drive.

1. With the drive case closed, command random seeks for 10 minutes minimum in order to thermally stabilize drive.
2. Stop random seeks and set up oscilloscope per Figure 4-1. Oscilloscope ground references must be as shown.
3. Command 822 cylinder continuous seeks and adjust oscilloscope trigger level to obtain waveform shown in Figure 4-1.
4. Measure full length seek time. Time between On Cylinder pulses should be 52 to 54 milliseconds.
5. If full length seek time is not as specified, perform velocity gain adjustment. On card A2A07, adjust velocity gain potentiometer E2R6 (Figure 4-2) until time between leading edges of On Cylinder pulses is 52 to 54 milliseconds. Use a No. 50 Allen wrench (0.127 cm or 0.050 in).
6. Return drive to normal operation.

#### **NOTE**

**Head alignment is detailed in Chapter 2.**

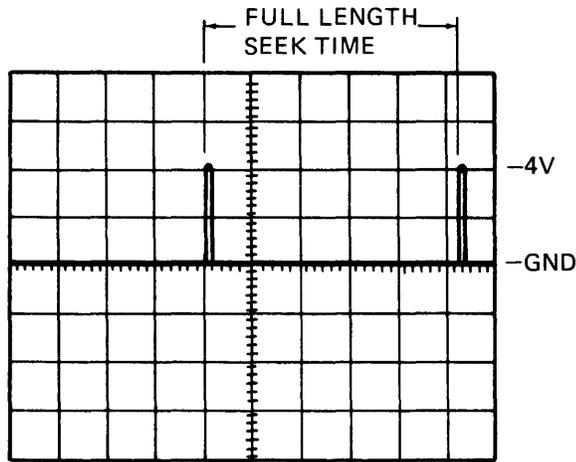
#### **4.2 GENERAL VOLTAGE ADJUSTMENTS**

This procedure checks the output of the plus and minus dc power supplies while the drive is doing repetitive seeks. Either the Field Tester Unit or the extended drive diagnostic may be used to perform the repetitive seek operation.

#### **CAUTION**

**Drive should not be operated for extended period with logic chassis in maintenance position. Loss of cooling air (when logic chassis is raised) could cause drive to overheat.**

1. Remove the rear cover from the drive.
2. Loosen (but do not remove) the two screws on top of the front card cage area.

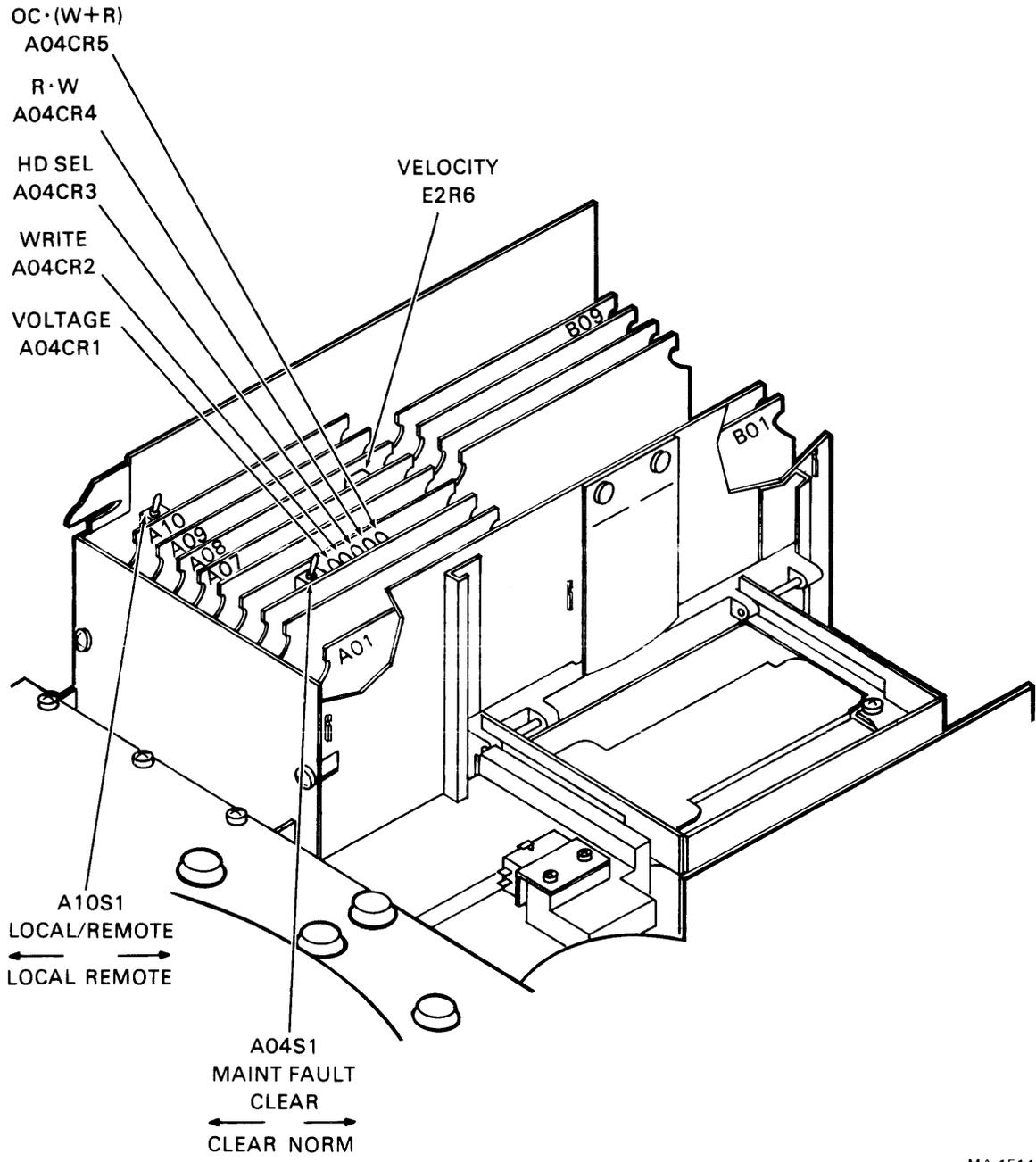


OSCILLOSCOPE SETUP

	VOLTS/DIV	TEST POINT	SIGNAL NAME
CH 1- (USE X10 PROBE)	0.2 V	A2B09 03A	+ ON CYLINDER
CH 2- (USE X PROBE)	NOT USED		
	SLOPE/SOURCE	TEST POINT	SIGNAL NAME
TRIGGER A - (USE X10 PROBE)	+ /EXT	A2B09 07A	- FORWARD SEEK
TRIGGER B- (USE X PROBE)	NOT USED		
TIME/DIV: 10 ms		MODE TRIGGER: CH 1	
ADDITIONAL SETTINGS:	NONE		

MA-1294

Figure 4-1 Velocity Gain Waveform



MA-1514

Figure 4-2 Velocity Gain Adjustment

3. Loosen the rear hold-down screw on the bottom of the card cage.
4. Raise the card cage to its service position by sliding it back and lifting it up and over on its side.
5. Using a digital volt/ohmmeter, the following dc voltage levels can be measured (Figure 4-3).
  - a.  $\pm 5$  V ( $\pm 0.05$  V) on faston connectors
  - b.  $\pm 20$  V ( $\pm 1.0$  V) on faston connectors
  - c.  $\pm 42$  V ( $\pm 2.0$  V) at Pin 32B,  $-42$  V ( $\pm 2.0$  V) at Pin 3B, on connector PA09
  - d.  $\pm 12$  V ( $\pm 0.3$  V) at Pin 8B,  $-12$  Volts ( $\pm 0.3$  V) at Pin 8A, on connector PA80

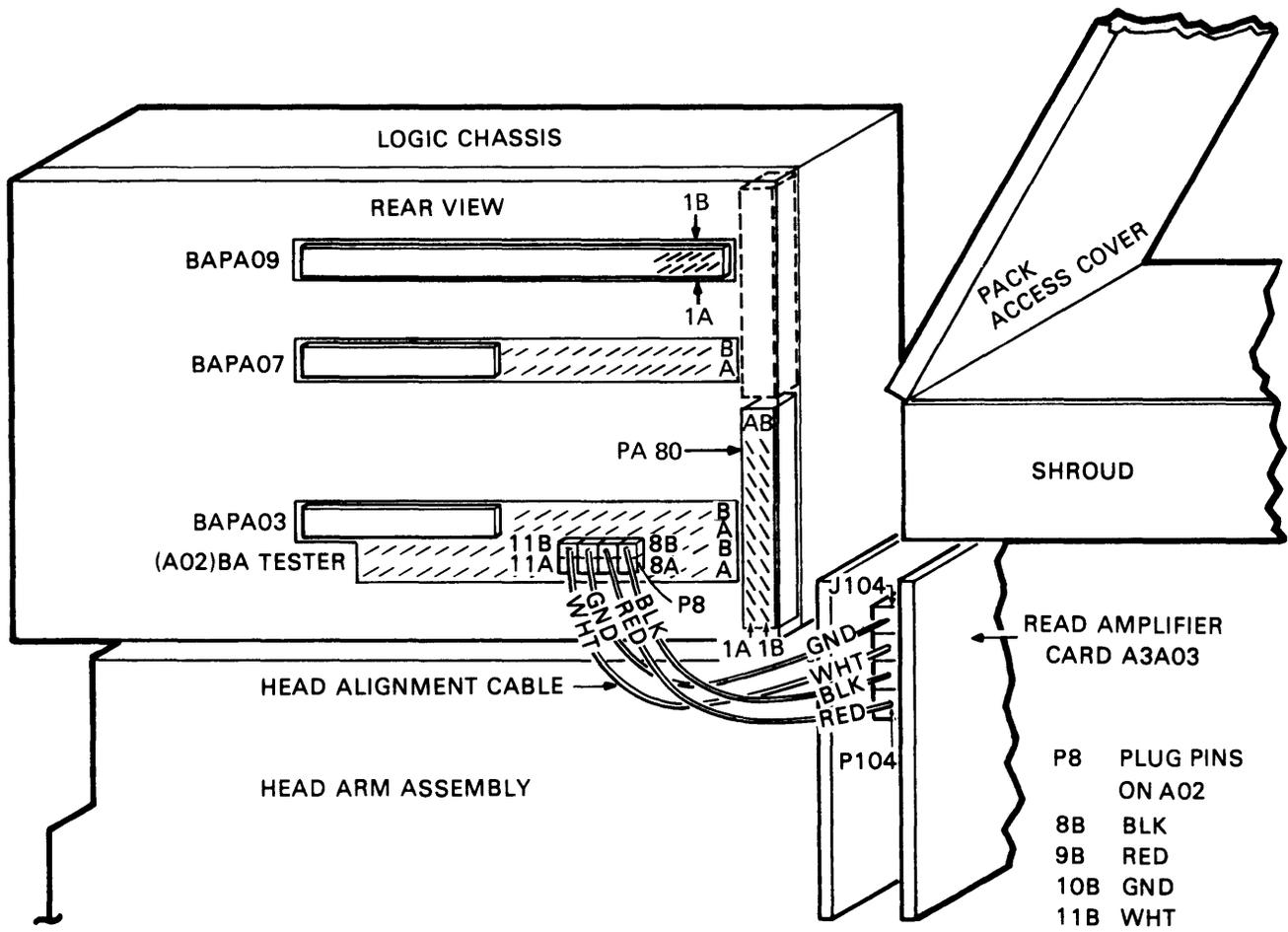
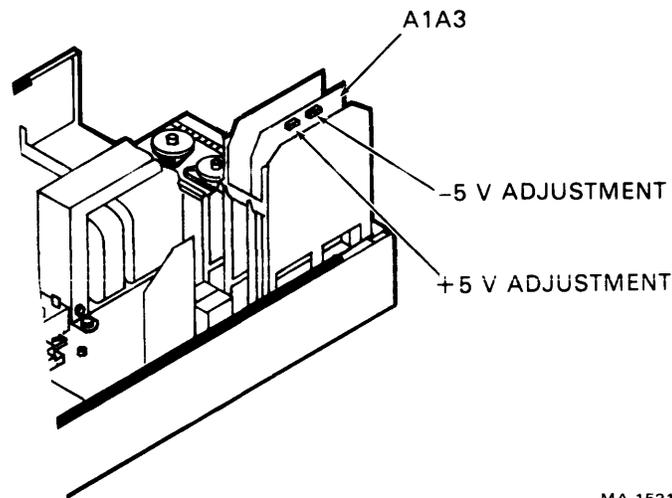


Figure 4-3 Power Supply Test Pins

MA-0640

6. Command the drive to do repetitive seeks between cylinders 0 and 32.
7. The +5 V output should read  $+5.10 \pm 0.05$  V. If not, adjust the +5 V potentiometer on card A1A3 (Figure 4-4) until it is within specification. Use a No. 50 Allen wrench.
8. Move the volt/ohmmeter leads to -5 V faston.
9. -5 V output should read  $-5.10 \pm .05$  V. If not, adjust the -5 V potentiometer on card A1A3 (Figure 4-4) until it is within specification. Use a No. 50 Allen wrench.
10. If any adjustment was necessary in the preceding steps, recheck both outputs.
11. When both power supply outputs are within specification, restore the drive to normal operation.



MA-1531

Figure 4-4 5 Volt Adjustments

## CHAPTER 5 FAULT ISOLATION

### 5.1 USING THE FAULT ISOLATION GUIDES

#### 5.1.1 Introduction

This chapter contains the Fault Isolation Guides (FIGs) that are designed to enable service personnel to troubleshoot the RM02 or RM03 Disk Drive to the Field Replaceable Unit (FRU). The maintenance philosophy for this drive is for the service personnel to replace a defective FRU without attempting to repair it.

The first portion of this chapter, Paragraph 5.1, “Using the Fault Isolation Guides”, describes how to use the FIGs as a troubleshooting tool. Paragraph 5.1.2 contains some general safety tips and other important information. Paragraph 5.1.3 describes how to determine which portion of the subsystem (either drive, adapter or RH controller) is defective. Paragraph 5.1.4 describes the use of the FIGs in more detail, including a list of test points and a flow diagram to point the service personnel to the correct FIG for a specific condition. Paragraphs 5.2, 5.3, 5.4, and 5.5 contain the actual Fault Isolation Guides, and Paragraph 5.6 contains some information on advanced troubleshooting techniques for the RM02 or RM03 Disk Drive.

#### 5.1.2 General Information

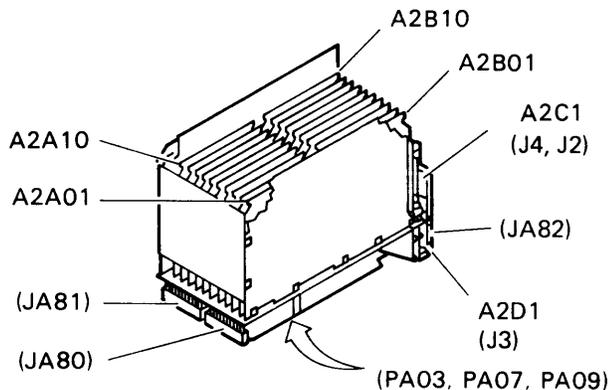
The following paragraphs contain information needed to correctly employ the Fault Isolation Guides.

**5.1.2.1 Safety** – The following is a list of safety-related hints and tips to be aware of while troubleshooting and servicing the RM02/03 Disk Drive.

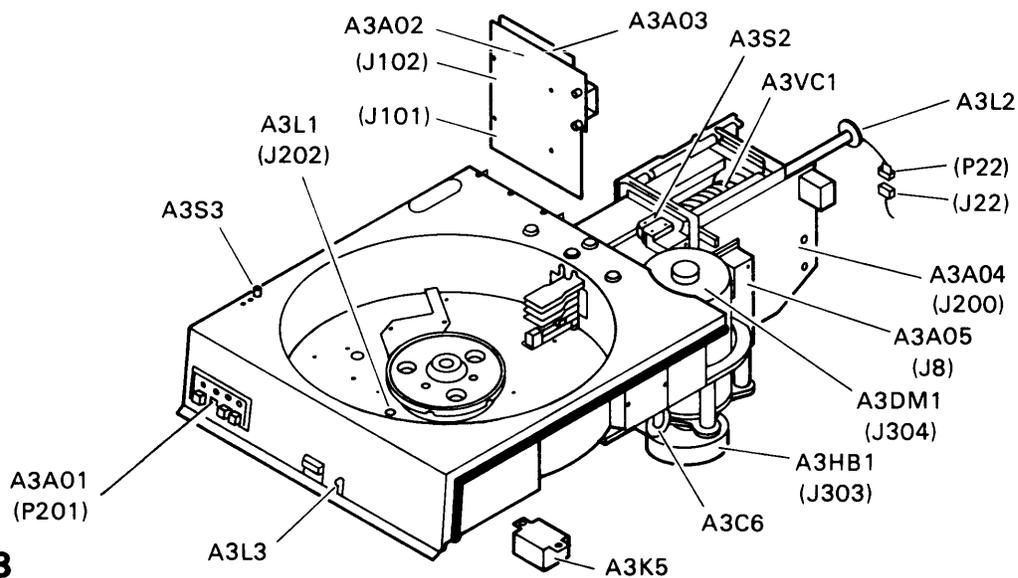
1. Turning capacitor A1C8 to 440 V. Treat it with respect (Figure 5-1). After shutting off the circuit breaker it is advisable to short out the capacitor several times with the side of a screwdriver blade.
2. If the fault LEDs on A2A04 do not momentarily flicker when CB2 is turned off there may not be any +5 V. The voice coil can burn out if the power supplies are left on with +5 V being present. Therefore, turn off CB2 and verify the +5 V supply before burning out the voice coil.
3. Keep all watches, disk packs, meters, and other test equipment at least 2 feet away from voice coil magnet.
4. Power supply fuse ratings are as follows:

±5 V	8 A fuse
±20 V	2 A fuse
±42 V	6 A fuse
±12 V	current limiting resistors (51 Ω at 10 W).

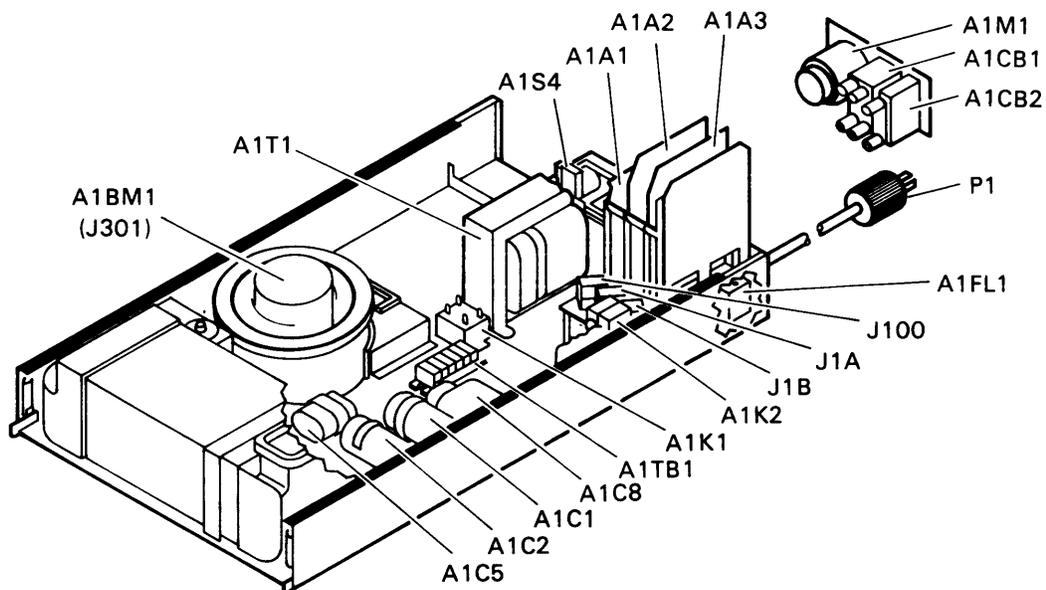
**A2**



**A3**



**A1**



MA-1901

Figure 5-1 Physical Location Codes

5. Line voltages are present inside the base (A1) in the area of the ac power supply (Figure 5-1).
6. Do not remove or install circuit cards while power is on. They can be damaged by the transient voltages that occur.
7. If the drive fails to power down when the start switch is pressed (to turn off indicator), disconnect the voice coil leadwire and manually retract the heads before troubleshooting the malfunction.
8. When manually loading heads, move the carriage swiftly (7 inches/second) into the pack until the heads come off the cam towers and the heads are in the guard band zone. Once loaded in the guard band, slow changes to carriage position are advisable. This procedure will prevent head and disk pack damage.
9. When manually unloading heads move the carriage off the guard band area to the rear crash stop swiftly (7 inches/second.) This procedure will prevent head and disk pack damage.
10. If power to drive motor is lost while heads are loaded and not under servo control (during manual carriage positioning), immediately retract carriage. Otherwise heads will crash when disk speed is insufficient to enable heads to fly.
11. Do not use CE alignment disk pack unless specifically directed to do so. These packs contain prerecorded alignment data that can be destroyed if test procedure requires drive to write. This alignment data cannot be generated in the field.
12. Do not use customer disk pack for testing purposes.
13. Keep hands away from actuator during seek operations and when reconnecting leads to voice coil. Under certain conditions, emergency retract voltage may be present, causing sudden reverse motion and head unloading.
14. A 1.5 inch brace is attached to the positioner along with the flex leads and held with one screw. It can be very easily pushed out of position where it will interfere with servo head cable. This may result in head crashes.
15. The solder connections on the flex leads to the linear motor can be easily shorted out by torquing down on the screw. The symptom is "popped DC breaker upon attempting heads load sequence".
16. The alignment pack track density is 1/2 the track density on a data pack. Cylinder 245 on the alignment pack is physically 490 on a data pack. A seek to 490 on the data pack can be visually checked using the alignment pin.
17. Intermittent, clearable read/write faults tend to be generated on the read/write card (location A3A02). If a fault is indicated, and it clears by hitting CLEAR, watch to see if it appears some time later. If so, swap this card.

**5.1.2.2 FRU Locations** – The physical arrangement of the drive is described in Figures 5-1 and Table 5-1. Figure 5-1 separates the drive into three sections. Each section and its assemblies and components have been assigned a physical location code. All physical location codes shown on Figure 5-1 are listed in Table 5-1. Table 5-1 identifies the physical location code by title, and refers to the reference page of the RM02 Disk Drive Technical Manual, Vol. II (EK-2RM02-TM) or RM03 Disk Drive Technical Manual, Vol II, (EK-2RM03-TM) where the location code is shown.

**Table 5-1 Physical Location Codes**

<b>Physical Location Code</b>	<b>Name</b>	<b>Reference Numbers</b>
A1	Base Assembly (AC Power System)	302
A1A1	±42 V Supply and Emergency Retract	31X
A1A2	±12 and ±20 V Supplies	32X
A1A3	±5 V Supply	33X
A1BM1	Blower Motor	302
A1C1	Servo Capacitor (+)	312
A1C2	Servo Capacitor (-)	312
A1C5	Blower Motor Start Capacitor	302
A1C8	Transformer Tuning Capacitor	302
A1CB1	AC Power Circuit Breaker	302
A1CB2	Power Supply Circuit Breaker	302
A1FL1	Line Filter	302
A1K1	Start Triac	302
A1K2	Emergency Retract Relay	312
A1M1	Elapsed Time Meter	302
A1S4	Deck Interlock Switch	302
A1T1	AC Power Transformer	302
A1TB1	Terminal Board	302
A1J1A	Power Supply Connector	31X-33X
A1J1B	Power Supply Connector	31X-33X
A1J100	Power Supply Connector	31X-33X
A1P1	AC Power Connector	302
A2	Logic Chassis	-
A2A01	Write Clock (806 kHz)	01X
A2A02	FTU/Head Alignment Card Slot	02X
A2A03	Fine Servo Decoder	03X
A2A04	Fault Card	04X
A2A05	Data Latch	05X
A2A06	Read PLO	06X
A2A07	D/A Function Generator	07X
A2A08	Access Control No. 2	08X
A2A09	Switching Mode Control	09X
A2A10	Interlocks and Speed Detector	10X
A2B01	Transmitters and Receivers head Address Register	11X
A2B02	Receivers	12X
A2B06	Difference Generator Controls	16X
A2B07	NRZ to Compensated MFM	17X
A2B08	Access Control and Index/Sector Decode	18X
A2B09	Access Control No. 1	19X
A2D1	I/O	23X
A3	Deck Assembly	-
A3A01	Control Panel	25X
A3A02	Head Select and Read Amplifier	26X
A3A03	Writer	27X
A3A04	Power Amplifier	28X
A3A05	Track Servo Preamplifier	29X
A3C6	Drive Motor Capacitor	302

**Table 5-1 Physical Location Codes (Cont)**

<b>Physical Location Code</b>	<b>Name</b>	<b>Reference Numbers</b>
A3DM1	Drive Motor	302
A3HB1	Hysteresis Brake	302
A3K5	Start Triac	302
A3L1	Speed Transducer	103
A3L2	Velocity Transducer	072
A3L3	Pack Cover Solenoid (Optional)	102
A3S2	Heads Loaded Switch	302
A3S3	Peak Cover Switch	252
A3VC1	Voice Coil	312

**5.1.2.3 Power Distribution** – AC power distribution problems are covered in the troubleshooting pathfinder. However, a more traditional approach to power distribution problems is detailed in the following paragraphs. The power system can be divided into two sections; ac power and dc power. The ac power section will cover everything up to the A1CB2 circuit breaker and the dc power section everything after A1CB2. Refer to Figure 5-2.

**AC Power Distribution** – Figure 5-2 shows a simplified line drawing of the ac power distribution system. A complete diagram of the ac power system is found on reference page 302 of the RM02 Disk Drive Technical Manual, Vol. II or page 302 of the RM03 Disk Drive Technical Description Manual, Vol. II. Fault isolation should be performed by dropping loads off the A1CB1 one at a time.

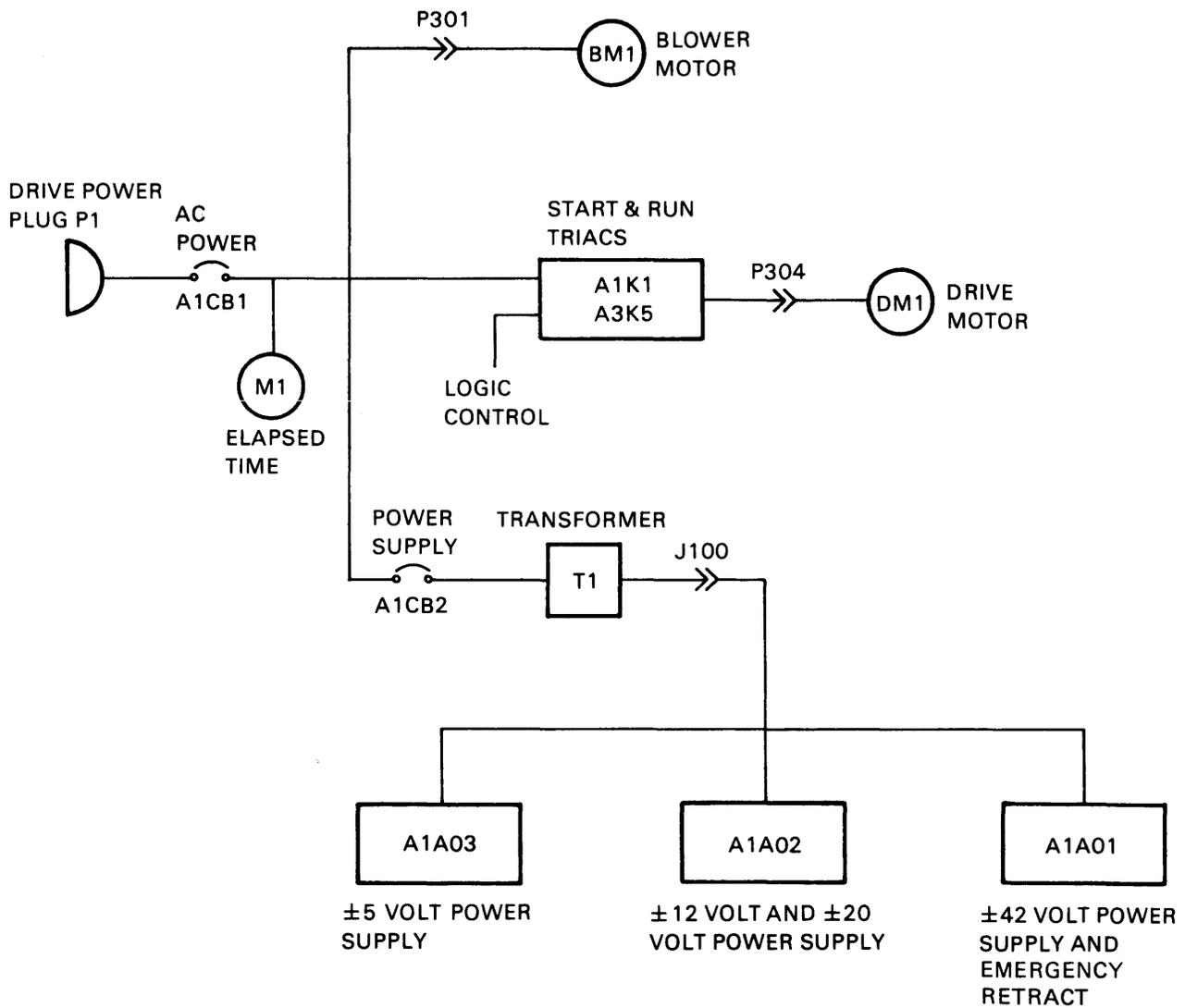
**NOTE**

**The drive A1CB2 circuit breaker should not be on when troubleshooting. Drive motor and blower motor are easily disconnected by P304 and P301 respectively.**

Isolating the elapsed time meter and start and run triacs will require a judgement decision as to which one to disconnect first; any one may be suspect. Once the fault is isolated, replace the FRU using the steps outlined in the parts removal and replacement procedures in Chapter 3 of this manual and verify the repair. Reconnect all dropped loads and retest.

**DC Power Distribution** – The dc power system starts at A1CB2 which supplies the ac input power to transformer T1. The transformer secondary outputs supply ac power to the dc power supply modules. The following reference pages of the two Disk Drive Technical Manuals detail the distribution system.

A1CB2, Transformer T1	
and secondary output connections	302
±42 V Power Supply	311, 312
±12 V and ±20 V Power Supply	321, 322
±5 V Power Supply	331–333



MA-1902

Figure 5-2 Power Distribution System

If A1CB2 trips when powered on, either excessive power is being drawn through it or A1CB2 is defective. Excessive power being drawn is more likely the case. This condition indicates a defective power supply module, transformer, or wiring error or fault. Fault isolation may best be performed by replacement of power supply modules one at a time. If modules are removed, remember that the transformer will oscillate with no load on it. Table 5-2 shows the ac input voltages for each power supply module. Test points are included.

**Table 5-2 Checking AC Inputs to Power Supplies\***

Supply to be checked for AC Input	Scope Connections		AC Input Voltages ( $\pm 5\%$ )
	+ Probe (AC Input)	GND Probe (Center Tap)	
$\pm 5$ V	A1A03 - 17A A1A03 - 15A	A1A03 - 28A	11 Vac
$\pm 20$ V	A1A02 - 23A A1A02 - 21A	A1A02 - 01A	22 Vac
$\pm 42$ V	A1A01 - 14A A1A01 - 12A	A1A01 - 01A	44 Vac

\*Use card extender for easy access to motherboard pins listed in table.

Table 5-3 shows dc voltage test points and readings under load and no-load conditions. Table 5-4 shows typical power supply failure symptoms. Using both these tables should isolate a defective power supply.

**Table 5-3 Check DC Voltages\***

Volt-Ohmmeter Connections					
Voltage to be Checked	Normal Load P/J1A Mated P/J1B Mated		No Load P/J1A Separated P/J1B Separated		Voltage Readings
	+ PROBE	- PROBE	+ PROBE	- PROBE	
+5	+5 Faston	GND Faston	Cannot be checked		+5.0 ( $\pm 0.05$ )
-5	GND Faston	-5 Faston	Cannot be checked		-5.0 ( $\pm 0.05$ )
+12	A1A02 - 27A	A1A02 - 01A	A1A02 - 27A	A1A02 - 01A	+12.0 ( $\pm 0.3$ )
-12	A1A02 - 01A	A1A02 - 08A	A1A02 - 01A	A1A02 - 08A	-12.0 ( $\pm 0.3$ )
+20	+20 Faston	GND Faston	A1A02 - 29A	A1A02 - 01A	+20.0 ( $\pm 1.0$ )
-20	GND Faston	-20 Faston	A1A02 - 01A	A1A02 - 05A	-20.0 ( $\pm 1.0$ )
+42	A2A04 - 32B	A2A09 - 17B	A1A01 - 33A	A1A01 - 01A	+42.0 ( $\pm 2.0$ )
-42	A2A09 - 17B	A2A04 - 03B	A1A01 - 01A	A1A01 - 02A	-42.0 ( $\pm 2.0$ )

\*Power supply boards A1A01 ( $\pm 42$  V) and A1A02 ( $\pm 12$ ,  $\pm 20$  V) must be fitted to two card extenders to permit access to the pins. Other connections are available when the logic chassis (A2) is raised to the maintenance position.

**Table 5-4 Typical Power Supply Failure Symptoms**

Symptom	Probable Cause
Noticeable ripple at output (checked with oscilloscope)	Open diode or open filter capacitor.
Less than specified output (ac input ok)	Shorted diode or shorted filter capacitor.
Output decreases significantly when load is connected	Open bleeder resistor.

If the dc power problem is a frequently blown fuse the indication is towards a module or sub-assembly that is drawing excessive power rather than a defective power supply module. A systematic replacement of modules is indicated for fault isolation. Table 5-5 shows module and subassembly dc voltage utilization. This table should limit the number of replacements necessary to isolate a fault.

**NOTE**

**Do not remove or insert modules with power on the drive.**

Using the reference pages to isolate loads by separating plugs may also be of some help.

**5.1.2.4 Miscellaneous – Card cage backplane voltage pins are as follows:**

+5 volts	pin 34B	
-5 volts	pin 1B	All slots
+20 volts	pin 33B	
-20 volts	pin 2B	Slots A01-A10
GND	pin 1A and 34A	All slots

Pins are numbered 01 to 17 and 21 to 34. Pin numbers 18, 19 and 20 do not exist.

Test Points "A" and "Z" on all cards are always ground.

Never remove all three power supply boards at the same time. This causes the transformer to go into oscillation when power is reapplied (NO-LOAD situation).

The  $\pm 5$  V power supply cannot be checked without a load on it.

Power supply fuse ratings are as follows:

$\pm 5$ V	8 A fuse
$\pm 20$ V	2 A fuse
$\pm 42$ V	6 A fuse
$\pm 12$ V	Uses current limiting resistors (51 $\Omega$ at 10 W)

**Table 5-5 Module and Subassembly DC Voltage Utilization**

Location	Name	+5	-5	+12	-12	+20	-20	+42	-42
A1	Base								
A1C1	Servo Cap.							X	
A1C2	Servo Cap.								X
A1K1	Run Triac	X							
A1K2	Emergency Retract Relay						X		
A2	Logic Chassis								
A2A01	Write Clock	X	X			X	X		
A2A02	FTU-HD Align.	X	N/C			X	X		
A2A03	Fine Servo Decode	X	X			X	X		
A2A04	Fault Card	X	X			X	X	X	X
A2A05	Data Latch	X	X			X	X		
A2A06	Read PLO	X	X			X	X		
A2A07	D/A Func. Gen.	X	N/C			X	X		
A2A08	Access Cont. #2	X	X			X	X		
A2A09	Switching Mode Controls	X	X			X	X	X	X
A2A10	Interlocks & Speed Detect	X	X			X	N/C	X	X
A2B01	TX RX Head Address Reg.	X	X						
A2B02	RX	X	X						
A2B03		N/C	N/C						
A2B04		N/C	N/C						
A2B05		N/C	N/C						
A2B06	Difference Generator Cont.	X	N/C						
A2B07	NRZ to Comp MFM	X	X						
A2B08	Access Control Index/Sector	X	N/C						
A2B09	Access Control #1	X	N/C						
A2B10		N/C	N/C						
A3	Deck								
A3A01	Control Panel	X							
A3A02	HD Select Read Amp.	X	X	X	X	X			
A3A03	Writer	X	X					X	
A3A04	Power Amp.							X	X
A3A05	Track Servo Pre Amp.			X	X				
A3HB1	Hysteresis Brake					X			
A3K5	Start Triac	X							
A3L3	Pack Cover Solenoid					X			
A3VC1	Voice Coil							X	X

### 5.1.3 Initial Fault Analysis

**5.1.3.1 Introduction** – The scope of this section is to provide a means of determining which major functional block within the disk subsystem is faulty. The three major functional subsystem blocks are the RH controller, adapter, and drive. Techniques to diagnose each of these areas will be discussed separately but should be linked logically to round out a troubleshooting strategy.

Typically, the first step accomplished on any trouble call is to verify the problem as reported or to ascertain the correct symptoms and begin a logical deductive reasoning process to isolate one of the three major blocks. Unless there is an obvious reason to go directly to a major block it is usually better to start cold and begin troubleshooting using the MAINDEC diagnostics. The following subsections will utilize this process and will cover the major subsystem blocks.

**5.1.3.2 Initial Fault Analysis – RH Controller** – The drive will be running on RH11 or an RH70 controller (in most cases) depending on the particular system. To test the RH70 controller, the *MAINDEC RH70 Controller Test Diagnostic* (MAINDEC-11-DERHA) can be run. It requires a drive to run, however. As for the RH11 controller, there is no diagnostic currently available to specifically test it. However, a special tester called a Massbus Simulator can be used, if available. Additionally, cable swapping should serve to illustrate if a problem is in the controller or the drive. This, however, requires a second controller.

**5.1.3.3 Initial Fault Analysis – Adapter** – Before continuing with troubleshooting the adapter, consider that the cable from RH to adapter may be swapped completely with another cable set to ensure cable integrity. It also provides a means to identify a defective adapter.

The most powerful tool to fault isolation is the Diskless Diagnostic (MAINDEC-ZZ-CZRMJ). If the diagnostic fails to isolate the problem, utilize the following technique before module swap-out of the adapter. The cables interconnecting the drive to the adapter, in most cases, are long enough to attach the drive to another adapter. (This requires a 2-drive system.) Once this configuration is complete any battery of tests can be performed to isolate the fault. In multiple RH controller installations, the defective adapter could be reconfigured to verify the fault, or to indicate the problem may be compatibility between RH and adapter.

**5.1.3.4 Initial Fault Analysis – Drive** – The first step to isolating the drive as a fault source is to verify the RH and adapter portions (Paragraphs 5.1.3.2 and 5.1.3.3) utilizing the associated analysis procedure. Whenever the diagnostics indicate positioning or major drive fault errors the drive is immediately suspect. A difficult problem to isolate is read/write data problems since the paths cannot be isolated and verified. Unless the drive can be configured to another adapter by swapping cables and diagnostics rerun, then pronounce the drive at fault and proceed to the Functional Analysis section for the drive.

### 5.1.4 Using The Guides

**5.1.4.1 Introduction** – This section explains the use of each Fault Isolation Guide (FIG) and how it can be utilized most efficiently. Paragraphs 5.1.4.3 and 5.1.4.4 detail the resources used by each FIG. Emphasis is placed on each FIG to isolate only in its respective area. The level of detail goes beyond the Field Replaceable Unit (FRU) level and points the troubleshooter to print set references if more in-depth treatment is necessary.

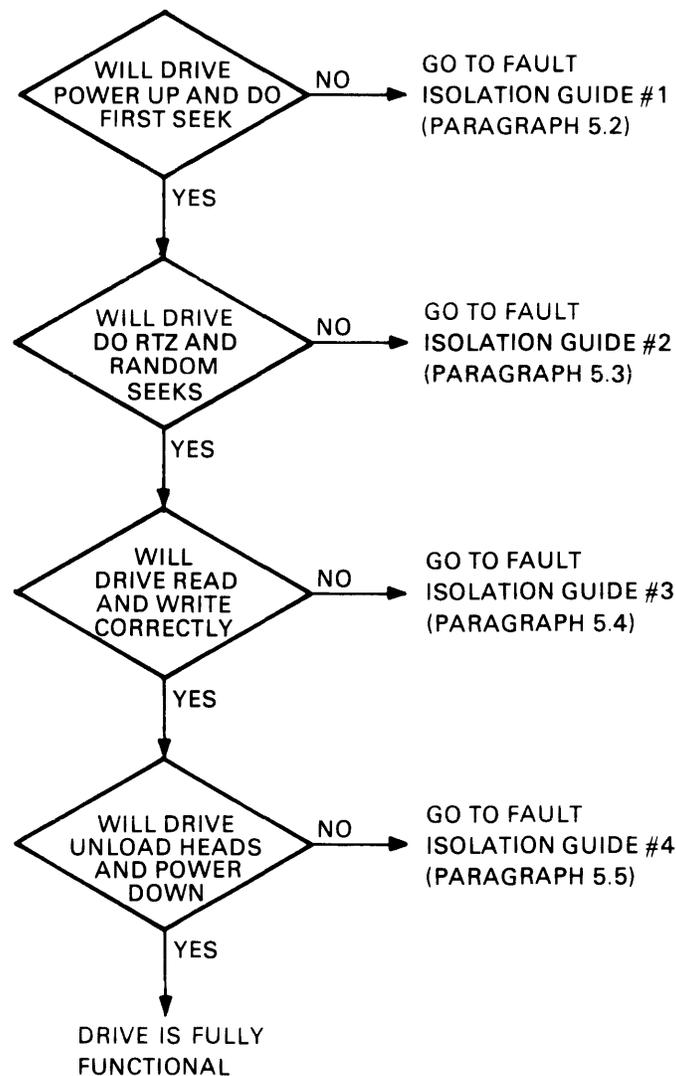
**5.1.4.2 FIG Usage Guide** – This paragraph will present an overview of the FIG layout and explain the manner in which the FIG should be utilized. The use of the Fault Isolation Procedures (FIPs) associated with each FIG will also be described.

The Fault Isolation Guides are designed to isolate a problem to a defective FRU. To cover the complete functionality of the drive, there are four FIGs, one for each of the following areas:

- FIG No. 1     Power Up and First Seek
- FIG No. 2     RTZ and Random Seeks
- FIG No. 3     Read/Write Data Path
- FIG No. 4     Head Unload and Power Down.

Each FIG starts with a question. If the answer to the question is no, that is the correct FIG to use to correct the problem. When the answer is yes, the problem with the drive lies in a functional area covered by another FIG.

Figure 5-3 is a flow diagram to point to the correct FIG to use. When a FIG has been completely utilized, and the answer to its appropriate question is “yes”, the flow diagram will point to the next FIG to be used.



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Figure 5-3 FIG Determination Flow Diagram

Each FIG states the starting conditions necessary for that guide's particular procedure. Always ensure all the starting conditions are met before proceeding into the FIG.

The FIG itself consists of three columns. The first column, Step, is self-explanatory. The items in the second column, labeled Procedure/Questions are either instructions to the service personnel or questions to be answered by the service personnel. If the answer to a question is "yes", the next place to go is to the very next step. If, however, the answer to the question is "no", the place to go is to the FIP indicated in the third column of the FIG, entitled Action. The FIPs for a given FIG follow immediately after the particular FIG.

Each FIP begins with a statement that describes the problem encountered. There are then a series of possible solutions to the problem, arranged so that the most likely solution is first, the second most likely solution next, and so on. The solutions usually make reference to specific FRUs which should be replaced. After some of the possible solutions are page numbers, representing references to the print sets contained within the *RM02 Disk Drive Technical Description Manual, Volume II*, or the *RM03 Disk Drive Technical Description Manual, Volume II*.

Occasionally, a step in a FIP will be a "jump" to another step in that FIP or to another Fault Isolation Guide. These statements are self-explanatory. Also there are some references to test points or other procedures located in Paragraphs 5.1.4.3 and 5.1.4.4, respectively. These steps should be done sequentially, or as specifically described.

If none of the possible solutions given in a FIP will solve the problem stated at the beginning of that FIP, the recommended procedure is to call for regional support.

**5.1.4.3 FIG Test Point Locator** – The following table is a list of test points referenced in the Fault Isolation Guide. The test points are listed by signal name, location, and reference pages found in the disk drive technical manuals.

**Table 5-6 Test Point Locator**

Signal	Test Point	Page
+ Remote Start	"C" A2A10	102
Speed Analog	"E" A2A10	103
- Speed Pulses	"D" A2A10	104
+ Up to Speed Enable	"D" A2A10	104
+ Up to Speed	"B" A2A04	43
+ Up to Speed Delayed Enable	"F" A2A10	104
- Servo Dibits	A2A03 extended pin 25B	32
+ Servo Dibits	A2A03 extended pin 23B	32
+ Track Servo	"H" A2A03	35
+ Cyl. Detect A	"F" A2A03	35
+ Cyl. Detect B	"G" A2A03	35
Summing Amp Output	"E" A2A07	72
Velocity	"F" A2A07	72
Fine Positioning Analog	"F" A2A08	84

**5.1.4.4 FIG Test Point Procedures** – The following test point procedures are referenced by the Fault Isolation Guide. Each procedure details the manual intervention, if any, as well as scope settings and desired waveform results. Several procedures are added at the end to make in-depth troubleshooting of the servo system easier. Those extra procedures are not referred to by the FIG since test point references are kept to a minimum.

1. Manual Head Loading

- a. The power amplifier must be disconnected before manual head loading.
- b. Never load heads onto a stopped disk pack.
- c. Never load or unload heads slower than 7 inches/second.
- d. Heads should be unloaded immediately if unusual noise occurs when heads are manually loaded.

2. + Remote Start

Test Point: C A2A10  
Reference Page: 102  
Scope: 2 V/Div – Drive Not Loaded  
5 ms/Div – Spindle At Rest  
Drive: Not loaded, spindle at rest.  
Observe: +4 V if Local/Remote switch is in Local or if in Remote the drive is sensing a remote start command.

3. Speed Analog

Test Point: B A2A10  
Reference Page: 103  
Scope: 2 V/Div  
5  $\mu$ s/Div  
Drive: From dead stop with pack loaded hit start and observe the pulses.  
Observe: 5 V p-p waveforms indicating spindle rotation.

4. – Speed Pulses

Test Point: D A2A10  
Reference Page: 104  
Scope: 2 V/Div  
20  $\mu$ s/Div  
Drive: Pack is spinning up or is at speed.  
Observe: 5 V p-p waveforms approximately 40  $\mu$ s in duration.

5. + Up To Speed Enable

Test Point: E A2A10

Reference Page: 104

Scope: 2 V/Div  
5 ms/Div

Drive: Pack is loaded; hit start. Approximately 6–9 seconds later observe signal change

Observe: Initially 0 V; after 6–9 seconds, +4 V.

6. Up To Speed

Test Point: B A2A04

Reference Page: 43

Scope: 2 V/Div  
1 ms/Div

Drive: Pack is loaded; hit start; signal changes after approximately 6–9 seconds

Observe: Initially 0 V, 6–9 seconds after hitting start, +4 V indicates pack is Up To Speed.

7. + Up To Speed Delayed Enable

Test Point: F A2A10

Reference Page: 104

Scope: 2 V/Div  
1 ms/Div

Drive: Pack loaded; hit start; signal changes approximately 10 seconds after Up To Speed true.

Observe: 0 V initially; 10 seconds after Up To Speed is true; signal changes to +4 V.

8. + Servo Dibits

Test Point: 23B A2A03

Reference Page: 32

9. - Servo Dibits

Test Point: 25B A2A03

Reference Page: 32

Scope: Mount the A2A03 card on an extender. This allows easy access to pins 23B and 25B

0.2 V/Div  
0.5  $\mu$ s/Div

Drive: With pack spinning and heads loaded. The heads may be manually loaded with similar results.

Observe: Figure 5-4 on both pins.

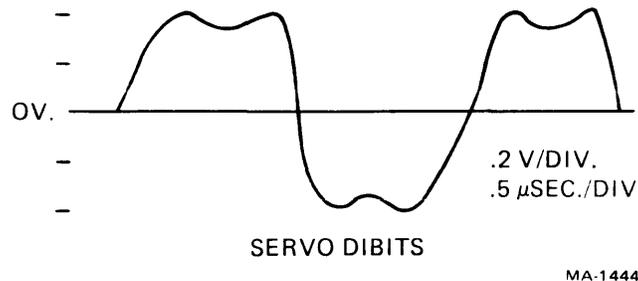


Figure 5-4 Servo Dibits

10. + Track Servo

Test Point: H A2A03

Reference Page: 35

Scope: 2 V/Div  
5 ms/Div

Drive: With voice coil power amplifier disconnected, load heads and manually move carriage back and forth over disk surface.

Observe: 5 V p-p waveforms with varying cycle time due to different track crossing speeds as in Figure 5-5.

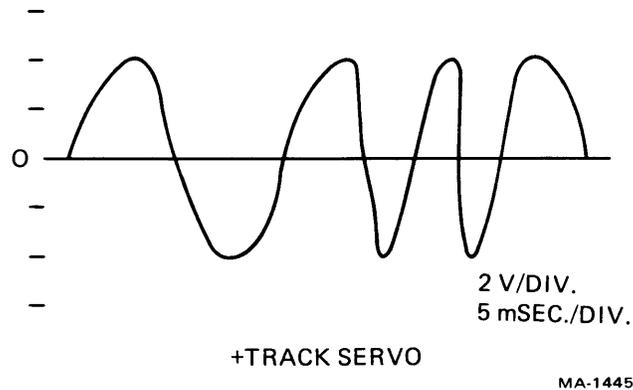


Figure 5-5 +Track Servo Signal

11. + Cycle Detect A

Test Point: F A2A03

Reference Page: 35

12. + Cycle Detect B

Test Point: G A2A03

Reference Page: 35

Scope: 2 V/Div  
5 ms/Div

Drive: With voice coil power amplifier disconnected, load heads, and manually move carriage back and forth over disk surface.

Observe: 0 to +4 V pulses varying in time due to differences in carriage speed as shown in Figure 5-6.

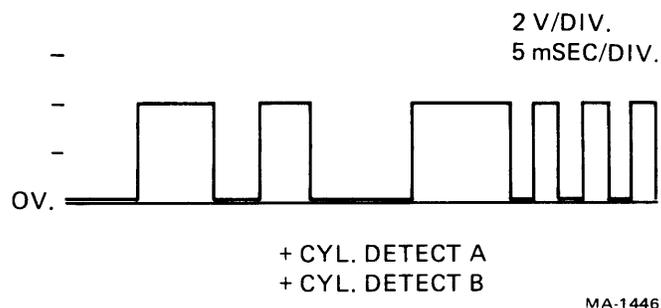


Figure 5-6 CYL Detect Signals

13. Summing Amp. Output

Test Point: E A2A07

Reference Page: 72

Scope: 5 V/Div  
1 ms/Div

Drive: With voice coil power amplifier disconnected, hit start, wait for up to speed, manually load heads and move carriage back and forth over disk surface.

Observe: Initially (before start) 0 V, after 20–30 seconds – 10 V. When heads are moved observe 20 V p-p varying waveforms.

**NOTE**

**Fault will illuminate if servo heads fail to sense di-bits. Only way to clear is to unload heads, stop disk, hit Fault button. Also, ready light will come on when over dibit pattern.**

14. Velocity

Test Point: F A2A07

Reference Page: 72

Scope: 1 V/Div  
0.1 ms/Div

Drive: With voice coil power amplifier disconnected, hit start, wait for up to speed, manually load heads and move carriage back and forth over disk surface.

Observe: On forward travel: 1 V p-p waveform; swings negative then falls to zero.

On reverse travel: 1 V p-p waveform; swings positive then falls to zero.

15. Fine Positioning Analog

Test Point: F A2A08

Reference Page: 84

Scope: 2 V/Div  
1 ms/Div

Drive: With voice coil power amplifier disconnected, hit start, wait for up to speed, manually load heads and move carriage back and forth over disk surface.

Observe: Approximately 10 V p-p waveforms as carriage is moved back and forth.

## **5.2. FAULT ISOLATION GUIDE NO. 1**

Will the drive come ready from power on? If yes, refer to Figure 5-3 in Paragraph 5.1.4.2 to determine which guide should be used next. If the drive will *not* come ready from power on, continue with this guide.

The following starting conditions are assumed by this guide:

- Start switch is not pressed
- Write Protect switch is not pressed
- Local/Remote switch to Remote position
- No pack in drive
- Pack cover is closed
- Cables A and B are connected to the adapters
- Drive is in normal operating position with top case cover removed
- Power Sequence cable is installed
- CB1 is off
- CB2 is off
- AC power at the outlet is correct for the drive (i.e., 110/50 Hz, 220/60 Hz, etc.)

If all of the above conditions are met, refer to step 1-1 in FIG 1 and proceed from there.

**FIG 1**

<b>Step</b>	<b>Procedure/Questions</b>	<b>Action (if answer is NO)</b>
1-1	Plug drive power cord into ac outlet	-
1-2	Turn drive on. Does CB1 stay on?	FIP 1-1
1-3	Does blower motor start?	FIP 1-2
1-4	Ensure Start switch is not pressed and that CB2 is off. Does drive motor stay off?	FIP 1-3
1-5	Turn CB2 on. Does it stay on?	FIP 1-4
1-6	Ensure Start switch is not pressed. Turn CB1 and CB2 on. Does drive motor stay off?	FIP 1-5
1-7	Is Start light off?	FIP 1-6
1-8	Is Ready light off?	FIP 1-7
1-9	Ensure Write Protect switch is not pressed. Is the Write Protect light off?	FIP 1-8
1-10	Examine the front panel and fault card A2A04. Are all the fault lights out?	FIP 1-9
1-11	Press Write Protect switch. Does the Write Protect indicator come on?	FIP 1-10
1-12	Attempt to raise the pack access cover. Does it open?	FIP 1-11
1-13	Is air flowing in shroud area?	FIP 1-12
1-14	Mount a scratch pack and close cover.	-
1-15	Set Local/Remote switch on A2A10 card to Local.	
1-16	Ensure Start switch is not pressed. Does the drive motor stay off?	FIP 1-5
1-17	Press the Start switch. Does the Start light come on?	FIP 1-13
1-18	Ensure the Start switch is pressed. Does the drive motor come on?	FIP 1-14
1-19	Does the drive motor continue to run, even after several seconds?	FIP 1-15

1-20	Do both the thermo protect circuit breaker and the main breaker CB1 stay on after the drive motor has started to run?	FIP 1-16
1-21	Ensure the drive motor is running and the Start indicator is lit. Is the Ready light flashing?	FIP 1-17
1-22	Ensure the Start light is on and that the Ready light is flashing. After the Ready has been flashing for approximately one minute, have the heads loaded?	FIP 1-18
1-23	Do the heads stay loaded?	FIP 1-19
1-24	Ensure the heads have loaded. Do they not seek to the full mechanical stop?	FIP 1-20
1-25	Ensure the heads have loaded. Do they not creep forward to the full mechanical stop?	FIP 1-21
1-26	Ensure the heads are loaded. Does the Ready light come on?	FIP 1-22
1-27	The drive is now powered up; the heads have successfully loaded at the home position and the drive is ready to accept commands.	-

**FIP 1-1**

CB1 does not stay on when drive is turned on.

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective motor. Disconnect P301. Turn on CB1. If CB1 stays on, replace blower motor. (Refer to Paragraph 3.10.)	302
2	Possible defective elapsed time meter	302
3	Possible short or poor connection in wiring harness	302
4	Possible defective CB1	

**FIP 1-2**

Blower motor does not start.

<b>Step</b>		<b>Print Set Page</b>
	Possible disconnected blower motor plug P301	302
2	Possible jammed impeller	302
3	Possible defective blower motor	302

4	Possible defective start winding or starting capacitor A1C5	302
5	Possible defective or poor wiring connections	302
6	Possible loose wiring connections on A1CB1 circuit breaker or line filter A1FL1	302
7	Possible defective circuit breaker A1CB1 or line filter A1FL1	302
8	Excessively low ac input voltage	302

**FIP 1-3**

With Start switch not pressed and CB2 off, the drive motor starts.

Step		Print Set Page
1	Possible defective run triac A1K1. (Refer to Paragraph 3.14 for removal and replacement procedure.)	302
2	Possible defective A2A10 cord (ASGU)	102-103
3	Possible defective start switch and wiring harness	252

**FIP 1-4**

CB2 does not stay on when it is turned on.

Step		Print Set Page
1	Voltage selection block (TB1) is miswired	302
2	Possible short on transformer T1 or tuning capacitor A1C8	302

**WARNING**

**Turning capacitor is changed to 440 volts**

3	Possible defective power supply module(s) – A1A01 (5SJV), A1A02 (5SKV), A1A03 (ASHV) (refer to Paragraph 3.9 for removal and replacement procedure)	312, 322, 333
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**CAUTION**

**Do not power up drive with all three power supply modules removed. Do not remove any of the modules with the drive powered up.**

4	Possible defective circuit breaker CB2	302
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**FIP 1-5**

With the Start switch not pressed, and CB1 and CB2 on, the drive motor starts.

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective run triac A1K1. Refer to Paragraph 3.14 for removal and replacement procedure.	302
2	Possible defective A2A10 cord (ASGV)	102-103
3	Possible defective Start switch or wiring harness	252
4	Possibly receiving a remote start condition via Sequence Pick and Hold. Check test point C (TPC) on the A2A10 (ASGV) cord. Signal name is Remote Start. +4 V indicates Start, 0 V indicates No Start	102-103
5	Possible defective Cable A or adapter problem	232

**FIP 1-6**

Start light is on, even though Start switch is not pressed.

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective Start switch. Refer to Paragraph 3.16 for removal and replacement procedure.	252
2	Possible short on control panel or wiring harness	252

**FIP 1-7**

Ready light is on, even though drive has not been started.

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective A2A04 card (EKFV)	102
2	Possible defective A2A10 card (ASGV)	44
3	Possible short in wiring harness on control panel	252

**FIP 1-8**

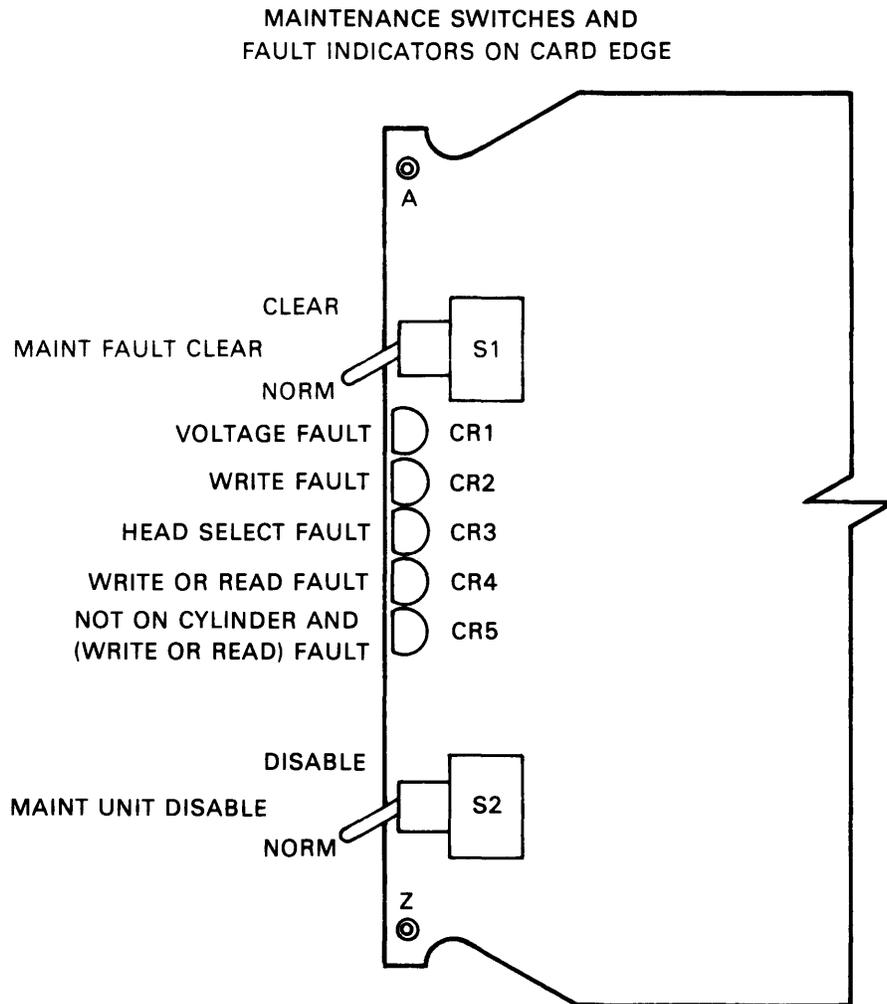
Write Protect light is on, even though Write Protect switch is not pressed.

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective receivers card – A3B01	113
2	Possible short in wiring harness or defective WRITE Protect switch or defective control panel	252

**FIP 1-9**

At least one of the fault lights on either the front panel or the fault card A2A04 is on.

Step		Print Set Page
1	Attempt to clear fault(s) by flipping S1 on the A2A04 card or hitting the Fault switch on the front panel.	252, 41-45
2	Determine which fault lights are on (refer to Figure 5-7). If the voltage fault LED is on, go to step 8 of this FIP. Otherwise, continue with step 3.	41-45



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Figure 5-7 Fault Indicators on Edge of A2A04 Card

3	Check for $\pm 5$ V on card cage and check the $\pm 5$ V fuses. Refer to Paragraph 5.1.2.3 for dc power distribution problems.	331-333
4	Check for $\pm 12$ V and $\pm 20$ V on card cage and check the appropriate fuses. Refer to Paragraph 5.1.2.3 for dc power distribution problems.	321-322
5	Check the $\pm 42$ V plug (PA09) on the bottom of the card cage and check the $\pm 42$ V fuses.	311-312
6	Possible defective fault card A2A04 (EK FV)	41-44
7	If Voltage Fault LED is still on, call for regional support. If any other fault indicators are still on, continue. Otherwise, return to step 1-11 of Fault Isolation Guide No. 1.	-
8	Possible defective fault card A2A04 (EK FV)	41-44
9	Reexamine the fault indicators and proceed as directed. CR2 - Write Fault - if ON, go to step 10 CR3 - Head Select Fault - if ON, go to step 16 CR4 - Read or Write Fault - if ON, go to step 22 CR5 - Not On Cylinder and (Write or Read) - if ON, go to step 28 Front Panel - Servo Track Fault - if ON, go to step 35	-
10	Possible defective Writer card - A2A03	271-274
11	Possible defective NRZ to MFM card - A2B07	171-173
12	Possible defective Write Clock and Write Data card - A2B01	111-113
13	Possible defective Receivers card - A2B02	121-124
14	Possible defective Interlocks and Speed Detector card - A2A10	101-104
15	If the Write Fault LED is still on, call for regional support. If any fault indicators are still on, return to step 9. Otherwise, return to step 1-11 of Fault Isolation Guide No. 1.	-
16	Possible defective Head Select and Read Pre-amp card - A3A02	261-263
17	Possible defective Transmit and Receive Head Address Register card - A2B01	111-113

18	Possible defective Receiver card – A2B02	121–124
19	Possible defective “A” cable	–
20	Possible adapter problem	–
21	If the Head Select LED is still on, call for regional support. If any fault indicators are still on, return to step 9. Otherwise, return to step 1-11 of Fault Isolation Guide No. 1.	–
22	Possible Receiver card – A2B02	121–124
23	Possible defective Interlocks and Speed Receiver card – A2A10	101–104
24	Possible defective ‘A” cable	–
25	Possible defective Writer card – A3A03	271–274
26	Possible adapter problem	–
27	If the Read or Write Fault LED is still on, call for regional support. If any fault indicators are still on, return to step 9. Otherwise, go to step 1-11 of Fault Isolation Guide No. 1.	–
28	Possible defective Access Control card – A2B09	191–193
29	Possible defective Receiver card – A2B02	121–124
30	Possible defective Write card – A3A03	271–274
31	Possible defective Interlocks and Speed Detector card – A2A10	101–104
32	Possible defective “A” cable	–
33	Possible adapter problem	–
34	If the Not on Cylinder and (Write or Read) Fault LED is still on, call for regional support. If any fault indicators are still on, return to step 9. Otherwise, go to step 1-11 of Fault Isolation Guide No. 1.	–
35	Possible defective Access Control No. 1 card – A2B09	191–194
36	Possible defective A/O Function Generator card – A2A07	71–73
37	Possible defective Access Control and Index/Sector card – A2B08	181–184

38	Possible defective Track Servo Pre-amp – A3A05	291
39	If Servo Track Fault is still on, call for regional support. If any other fault indicators are still on, continue. Otherwise, return to step 1-11 of Fault Isolation Guide No. 1.	–

**FIP 1-10**

Write Protect indicator does not come on when Write Protect is pressed.

Step		Print Set Page
1	Loose cable connection going to control panel	252
2	Possible defective switch (S4) on control panel.	252
3	Possible defective LED (1CR6) on control panel.	252

**FIP 1-11**

The pack access cover will not open.

Step		Print Set Page
1	Ensure Start switch is not pressed	102
2	Possible defective Interlocks and Speed Detector card – A2A10	102
3	Possible defective pack cover solenoid, or solenoid out of adjustment. Refer to Paragraph 3.26 for adjustment procedure	102
4	Possible defective cabling from card cage to pack cover solenoid	102

**FIP 1-12**

Air is not flowing in shroud area.

Step		Print Set Page
1	Absolute filter clogged. Refer to Paragraphs 3.11 and 3.12 for removal and replacement procedure.	–
2	Squirrel cage fan on blower motor loose. Refer to Paragraph 3.10 for removal and replacement procedure.	–
3	Possible physical obstruction or leaky or damaged air flowpath	–

**FIP 1-13**

With the Start switch pressed, the Start light does not come on.

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective Start switch on control panel.	252
2	Possible defective Start light (1CR2) on control panel.	252
3	Possible loose or defective wiring or connections on control panel.	252

**FIP 1-14**

With the Start switch pressed, the drive motor does not come on.

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective pack covers interlock – A353	252
2	Possible defective deck interlock – A1S4	302
3	Possible defective start triac – A3K5. Refer to Paragraph 3.13 for removal and replacement procedures.	302
4	Possible defective run triac – A1K1. Refer to Paragraph 3.14 for removal and replacement procedures.	302
5	Possible defective Interlocks and Speed Detector card – A2A10	101–104
6	Possible defective drive motor or wiring connection (P304).	302
7	Thermo protect tripped or defective	302

**FIP 1-15**

Drive motor stops after running for several seconds.

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective Interlocks and Speed Detector card – A2A10	101–104
2	Possible defective Start switch on control panel	252
3	Possible defective run triac – A1K1. Refer to Paragraph 3.14 for removal and replacement procedures.	302
4	Possible defective drive motor brake (A1HB1) or heads unloaded switch (A3S2). Refer to Paragraphs 3.20 or 3.30, respectively, for removal and replacement procedures.	302

- 5 Possible defective speed transducer (A2L1) or lack of speed pulses. Table 5-7 lists the test points that can be used to trace the path of the speed pulses. -

**Table 5-7 Speed Pulse Path Test Points**

Test Point	Card	Signal	Print Set Page
B	A2A10	Speed Analog	102-104
D	A2A10	- Speed Pulses	102-104
E	A2A10	+ Up To Speed Enabled	102-104
F	A2A10	+ Delayed Up To Speed Enabled	102-104

- 6 Possible defective run winding of drive motor or thermo protection circuit breaker. Refer to Paragraph 3.20 for removal and replacement procedure. 302
- 7 Possible voltage problem or blown fuses or defective circuit breaker A1CB1 302

**FIP 1-16**

Either the thermo protect circuit breaker or the main circuit breaker CB1 or both trip after the drive motor has started.

Step		Print Set Page
1	If the thermo circuit breaker trips:	
	a. Possible defective start triac - A3K5. Refer to Paragraph 3.13 for removal and replacement procedure.	302
	b. Possible defective drive motor starting capacitor A3C6 or defective drive motor start winding. Refer to Paragraph 3.20 for removal and replacement procedure.	302
2	If the main circuit breaker CB1 trips:	
	a. Possible defective drive motor. Refer to Paragraph 3.20 for removal and replacement procedure.	302
	b. Possible defective circuit breaker CB1.	302
	c. Possible loose wiring connections in ac power wiring.	302

**FIP 1-17**

With the drive motor running, and the Start indicator lit, the Ready light does not flash.

Step		Print Set Page
1	Possible defective Interlocks and Speed Detect card – A2A10	102
2	Possible defective Fault card – A2A04	44
3	Possible defective wiring between A2A10 and control panel.	252
4	Possible defective LED 1CR3 on control panel	252

**FIP 1-18**

After the Ready light has been flashing for approximately one minute, the heads have not loaded.

Step		Print Set Page
1	a. Verify the + Up To Speed signal by checking test point B on the A2A04 card. Refer to part F of Paragraph 5.1.4.4 to do this. The signal should be +4 V. If it is, skip to step 2. If it is not +4 V, proceed with b.	103–104
	b. Possible defective Interlocks and Speed Detector card – A2A10	101–104
	c. Possible defective wiring speed transducer (J201, PA80)	103–104
	d. Possible defective speed transducer – A3L1. Refer to Paragraph 3.24 for removal and replacement procedure.	103–104
	e. If the heads still will not load, call for regional support. If they do load, return to step 1-23 of Fault Isolation Guide No. 1.	–
	The drive may be in constant “emergency retract” mode.	
	a. Possible defective relay A1K2 on the ±42 V supply card (A1A01).	312
	b. Possibly incorrectly picking relay (A1K2) due to defective Interlocks and Speed Detect card (A2A10) or defective Fault card (A2A04) or maladjusted head load switch (A35S). Refer to Paragraph 3.30 for adjustment procedure.	443
	c. Possible voltage fault. Check all voltages for fault conditions.	043

3	The positioner may not be able to be driven.	
	a. Possible defective Servo Fault Card – A2B09	194
	b. Possible defective Summing Amp card – A2A07	072
	c. Possible defective Power Amp card – A2A09	092
	d. Possible mechanical obstruction of positioner or power amplifier cable (J200) not connected.	282

**FIP 1-19**

The heads retract after loading.

Step		Print Set Page
1	a. Use the special test procedures in part H and J of Paragraph 5.1.4.4 to check for servo dibits on A2A03 pins 23B and 25B.	32
	b. Possible defective Track Servo Preamp A3A05	292
	c. Possible defective servo head.	292
	d. Possible defective or damaged wiring harness (J1, J8, etc.)	292
2	Possible defective Servo Tracking Logic card – A2A03	31–35
3	Possible defective logic in servo loop. The following cards make up most of the logic:  A2A07, Reference pages 71–73 A2A08, Reference pages 81–85 A2A09, Reference pages 91–93 A2B06, Reference pages 161–165 A2B08, Reference pages 181–184 A2B09, Reference pages 191–194	–

**FIP 1-20**

The heads load and then seek to the full mechanical stop.

Step		Print Set Page
1	Heads stay at full mechanical stop.	
	a. Possible defective power amplifier – A3A04	281–282

- b. Possible defective D/A function generator – A2A07 71–73
- c. Possible defective Access Control No. 2 card – A2A08 81–85
- d. Possible defective Access Control No. 1 card – A2B09 191–194
- e. Check velocity transducer connection. -

2 Heads retract from full mechanical stop.

- a. Possible defective Power Amplifier – A3A04. 281–282
- b. Possible defective D/A Function Generator – A2A07. 71–73
- c. Possible defective Fine Servo Decoder card – A2A03 31–35
- d. Possible defective Switching Mode Control card – A2A09. 91–93
- e. Check velocity transducer connections. -

**FIP 1-21**

The heads load and then creep forward to the full mechanical stop.

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective Access Control No. 2 card – A2A08	81–83
2	Possible defective Access Control No. 1 card – A2B09	192
3	Possible defective Fine Servo Decoder card – A2A03	31–35
4	Possible defective D/A Function Generator card – A2A07	71–73
5	Possible defective Switching Mode Control card – A2A09	93

**NOTE**

If  $\pm 12$  V differs by more than 1.6 V, the dibits will not be evenly amplified and a permanent offset condition will occur.

**FIP 1-22**

With the heads loaded, the Ready light does not come on

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective Interlocks and Speed Detect card – A2A10	101–104
2	Possible defective Fault card – A2A04	41–45
3	Possible defective Servo Fault card – A2B09	191–194
4	Possible defective wiring harness to control panel	341–343

### **5.3 FAULT ISOLATION GUIDE NO. 2**

Will the drive do Return To Track Zero (RTZ) and random seeks? If yes, refer to Figure 5-3 in Paragraph 5.1.4.2 to determine which guide should be used next. If the drive will *not* do RTZ and random seeks, continue with this guide.

To correctly utilize this Fault Isolation Guide a Field Test Unit (FTU) is required. Paragraph 2.7.2 details the FTU installation procedure and explains the controls and indicators. A working knowledge of this information is a prerequisite for attempting to use FIG No. 2. This guide assumes the drive in question can come up to a drive ready state.

## FIG 2

Step	Procedure/Questions	Action  (if answer is NO)
2-1	Install the FTU as described in Paragraph 2.7.2. Set the FTU switches as indicated in Paragraph 2.7.3.2. Ensure the WRT-RO SELECT is off.	-
2-2	Turn on the FTU and then the drive power. Mount a scratch pack and then make the drive ready.	-
2-3	Actuate RTZ on the FTU. Did the drive do an RTZ?	FIP 2-1
2-4	Set the FTU for Continuous Seeks and set all cylinder switches down. One by one, select/deselect each cylinder address switch (1-512). Does each switch have an appropriate effect on the motion of the carriage?	FIP 2-2
2-5	Set FTU to make the drive seek to track 822 decimal (1466 octal). This is the Last Track. Does the drive seek to Last Track?	FIP 2-3
2-6	Set the FTU to make the drive seek to track 823 decimal (1467 octal). Does an error indication appear?	FIP 2-4
2-7	Reset the drive error generated in step 2-6. Set the FTU to perform continuous, random seeks. Does the drive do random seeks for five minutes without errors?	FIP 2-5
2-8	The drive is now reasonably capable of performing random seeks without errors.	-

### FIP 2-1

The drive did not do an RTZ when RTZ on the FTU was actuated

Step		Print Set Page
1	Possible defective Access Control and Index/Sector Decode card - A2B08	183
2	Possible defective Access Control No. 1 card - A2B09	194
3	Possible defective Access Control No. 2 card - A2A08	82
4	Possible defective D/A Function Generator card - A2A07	72-73

5	Possible defective Receivers card – A2B02	123
6	Possible defective Switching Mode Control card – A2A09	232
7	Possible defective FTU or cable A	–

**FIP 2-2**

Changing the cylinder address switches does not correctly affect the carriage motion.

1	Ensure the FTU is set for CONT (continuous seeks)	–
2	Possible defective Access Control and Index/Sector Decode Card – A2B08	183
3	Possible defective Difference Generator and Control card – A2B06	162–165
4	Possible defective D/A Function Generator card – A2A07	72–73
5	Possible defective Receivers card – A2B02	122–123
6	Possible defective Switching Mode Control card – A2A09	92–93
7	Possible defective Access Control No. 1 card – A2B09	191–194
8	Possible defective FTU or cable A	–

**FIP 2-3**

Drive does not seek to Last Track.

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective Access Control and Index/Sector Decode card – A2B08	183
2	Possible defective Difference Generator Control card – A2B06	162–164
3	Possible defective D/A Function Generator card – A2A07	73
4	Possible defective Receivers card – A2B02	122–123
5	Possible defective Switching Mode Control card – A2A09	92–93
6	Possible defective FTU or cable A	–

**FIP 2-4**

No error is indicated when the drive attempts to seek to track 823 decimal (an illegal address).

<b>Step</b>		<b>Print Set Page</b>
1	Possible defective Access Control and Index/Sector Decode card – A2B08	184
2	Possible defective Difference Generator Control card – A2B06	162–164
3	Possible defective D/A Function Generator card – A2A07	73
4	Possible defective Receivers card – A2B02	122–123
5	Possible defective Switching Mode Control card – A2A09	92–93
6	Possible defective FTU or cable A	–

**FIP 2-5**

Drive will not do continuous random seeks for five minutes, error free.

<b>Step</b>		<b>Print Set Page</b>
1	Check the velocity gain adjustment. Refer to Paragraph 4.1 for the adjustment procedure.	–
2	Possible defective Access Control and Index/Sector Decode card – A2B08	184
3	Possible defective Difference Generator Control card – A2B06	–
4	Possible defective D/A Function Generator card – A2A07	73
5	Possible defective Receivers card – A2B02	122–123
6	Possible defective Switching Mode Control card – A2A09	92–93
7	Possible defective FTU or cable A	–

#### 5.4 FAULT ISOLATION GUIDE NO. 3

Will the drive read and write correctly? If yes, refer to Figure 5-3 in Paragraph 5.1.4.2 to determine which guide should be next. If the drive will *not* read and write correctly, continue with this guide.

To correctly utilize this Fault Isolation Guide a Field Test Unit (FTU) is required. Paragraph 2.7.2 details the FTU installation procedure and explains the controls and indicators. A working knowledge of this information is a prerequisite for attempting to use FIG No. 3. This guide assumes the drive in question can come ready and can perform all the seek operations described in Fault Isolation Guide No. 2.

The starting conditions for FIG No. 3 are:

1. The Local/Remote switch is in the Local position.
2. A scratch pack is mounted in the drive.
3. The FTU is installed as per Paragraph 2.7.2.
4. The FTU switches are set for continuous write/formats using sequential heads and sequence forward as outlined in Paragraph 2.7.3.3.

#### NOTE

When using the FTU to isolate Read/Write problems, Table 5-8 may be valuable. The routines are listed from lesser to greater complexity.

Table 5-8 FTU Read/Write Sequence

Cylinder	Mode	Heads
1 Direct	Write/Format	Manual Heads
2 Direct	Write/Read	Manual Heads
3 Direct	Write-Format	Sequential Heads
4 Direct	Write/Read	Sequential Heads
5 Sequential Mode	Write-Format	Sequential Heads
6 Sequential Mode	Write/Read	Sequential Heads

FIG 3

Step	Procedure/Questions	Action (if the answer is NO)
3-1	Set the FTU and the drive to perform a continuous Write/Format using sequential heads and sequence forward. Does this happen without any <i>drive</i> faults?	FIP 3-1
3-2	Set the FTU and the drive to perform a continuous Write/Format using sequential heads and sequence forward (as in step 3-1). Does this happen without any <i>FTU</i> faults?	FIP 3-2
3-3	Set the FTU to perform a continuous, Write/Format using sequential heads and sequence forward (as in step 3-1). Does this happen without an indication of FAULT on only <i>some</i> addresses?	FIP 3-3
3-4	If no faults have occurred while using the FTU, but faults <i>did</i> occur while running some diagnostics, check for M7684 ECO No. 7 – “Consecutive Reads While In Offset Mode.”	–
3-5	Set the FTU to perform continuous reads using sequential heads and sequence forward as detailed in Paragraph 2.7.2.2. Does this happen without any <i>address</i> errors?	FIP 3-4
3-6	Set the FTU to perform continuous reads using sequential heads and sequence forward (as in step 3-5). Does this happen without any <i>data</i> errors?	FIP 3-5
3-7	Set the FTU to perform random WRT.RD functions with sequential heads, as described in Paragraph 2.7.2.2. Run for five minutes. Does this happen without any errors?	FIP 3-6
3-8	The drive is now reasonably sure of being able to read, write and seek without errors.	–

**FIP 3-1**

There is a fault on the drive when performing a continuous write/format using sequential heads and sequence forward.

Step		Print Set Page
1	Attempt to clear the fault by flipping S1 on the fault card – A2A04 or by hitting the Fault switch indicator on the front panel of the drive.	252, 41–45

2	Determine which fault lights are on (refer to Figure 5-7). If the voltage fault LED (CR1) is not on, go to step 7. Otherwise, continue with step 3 of this FIP.	-
3	Check the $\pm 5$ V on the card cage and check the $\pm$ V fuses. Refer to Paragraph 5.1.2.3 for dc power distribution problems.	331-333
4	Check $\pm 12$ V and $\pm 20$ V on the card cage, and check the fuses. Refer to Paragraph 5.1.2.3 for dc power distribution problems.	321-322
5	Check the $\pm 42$ V plug PA09 on the bottom of the card cage. Check the $\pm 42$ V fuses.	311-312
6	Possible defective Fault card - A2A04. If the voltage fault LED is still on after this card is replaced, call for regional support . If no faults are indicated, return to step 3-1 of Fault Isolation Guide No. 3. Otherwise, continue with this FIP.	41-44
7	Reverify which faults are indicated and proceed as specified.  CR2 - Write Fault - if ON, go to step 8 CR3 - Head Select Fault - if ON, go to step 14 CR4 - Read or Write Fault - if ON, go to step 20 CR5 - Not On Cylinder and (Write or Read) - ON, go to step 26 Front Panel - Servo Track Fault - if ON, go to step 33	
8	Possible defective Write card - A3A03	271-274
9	Possible defective NRZ to MFM card - A2B07	171-173
10	Possible defective Transmitters and Receivers/Head Address Register card - A2B01	111-113
11	Possible defective Receivers card - A2B02	121-124
12	Possible defective Interlocks and Speed Detector card - A2A10	101-104
13	If the Write Fault LED is still on, call for regional support. If any fault indicators are still on, return to step 7. Otherwise, return to step 3-2 of Fault Isolation Guide No. 3.	-
14	Possible defective Head Select and Read Preamp card - A3A02	261-263

15	Possible defective Transmitters and Receiver/Head Addresss Register card – A2B01	111–113
16	Possible defective Receivers card – A2B02	121–124
17	Possible defective cable A	–
18	Possible adapter problem	–
19	If the Head Select Fault LED is still on, call for regional support. If any other fault indicators are still on, return to step 7. Otherwise, return to step 3-2 of Fault Isolation Guide No. 3.	–
20	Possible defective Receivers card – A2B02	121–124
21	Possible defective Interlocks and Speed Detector card – A2A10	101–104
22	Possible defective cable A	–
23	Possible defective Writer – A3A03	271–274
24	Possible adapter problem	–
25	If the Read or Write Fault LED is still on, call for regional support. If any other fault indicators are still on, return to step 7. Otherwise, return to step 3-2 of Fault Isolation Guide No. 3.	–
26	Possible defective Access Control No. 1 card – A2B09	191–193
27	Possible defective Receivers card – A2B02	121–124
28	Possible defective Writer card – A3A03	271–274
29	Possible defective Interlocks and Speed Detector card – A2A10	101–104
30	Possible defective cable A	–
31	Possible adapter problem	–
32	If the Not On Cylinder and (Write or Read) LED is still on, call for regional support. If any other fault indicators are still on, return to step 7. Otherwise, return to step 3-2 of Fault Isolation Guide No. 3	–
33	Possible defective Access Control No. 1 card – A2B09	191–194
34	Possible defective A/D Function Generator card – A2A07	71–73

35	Possible defective Access Control and Index/Sector Decode card – A2B08	181–184
36	Possible defective Track Servo Preamp – A3A05	291–295
37	If the Servo Track Fault indicator is still on, call for regional support. If any other fault indicators are still on, return to step 7. Otherwise, return to step 3-2 of Fault Isolation Guide No. 3.	–

**FIP 3-2**

There is a fault on the FTU when performing a continuous write format using sequential heads and sequence forward.

<b>Step</b>		<b>Print Set Page</b>
1	Determine what type of fault has occurred and proceed as indicated.  If the FTU shows a Clock Error (no servo clock from drive), go to step 2 If the FTU shows an S-C Error (counters do not agree), go to step 6 If the FTU shows an S-M Error (error count does not agree), go to step 12 If the FTU shows an Address Error, go to step 17 If the FTU shows a Data Error, go to step 27 If the FTU shows a Seek Error or a Fault (both turned on by the drive), go to step 37.	
2	Possible defective Write Clock card – A2A01.	11–12
3	Possible defective Transmitter and Receivers/Head Address Register card – A2B01.	111–113
4	Possible defective FTU or cable on FTU	–
5	If the FTU still shows Clock Error, call for regional support. Otherwise repeat step 3-2 of Fault Isolation Guide No. 3 and continue from there.	–
6	Possible defective Fault card – A2A04	41–45
7	Possible defective Access Control and Index/Sector Decode card – A2B08	181–184
8	Possible defective Transmitters and Receivers/Head Address Register – A2B01	111–113
9	Possible defective Receivers card – A2B02	121–124

10	Possible defective FTU or FTU cables	-
11	If the FTU still indicates an S-C errors, call for regional support. Otherwise, repeat step 3-2 of Fault Isolation Guide No. 3 and continue from there	-
12	Possible defective Write clock - A2A01	11-13
13	Possible defective Access Control and Index/Sector Decode card - A2B08	181-184
14	Possible defective Transmitters and Receivers/Head Address Register card - A2B01	111-113
15	Possible defective FTU or FTU cables	-
16	If the FTU still indicates an S-M error, call for regional support. Otherwise, return to step 3-2 of Fault Isolation Guide No. 3 and continue from there	-
17	Possible defective Read PLO card - A2A06	61-65

**NOTE**

**The data switches on the FTU must be the same as when the procedure was started.**

18	Possible defective NRZ to MFM card - A2B07.	171-173
19	Possible defective Data Latch card - A2A05.	51-53
20	Possible defective Access Control No. 2 card - A2A08.	81-85
21	Possible defective Receivers card - A2B02.	121-124
22	Possible defective Transmitters and Receivers/Head Address Register card - A2B01.	111-113
23	Possible defective Head Select and Read Amplifier - A3A02.	261-263
24	Possible defective Read/Write head. Refer to Paragraph 3.32 for removal and replacement procedures.	-
25	Possible defective FTU or FTU cables.	-
26	If the FTU still indicates an Address Error, call for regional support. Otherwise, repeat step 3-2 of Fault Isolation Guide No. 3 and continue from there.	-
27	Possible defective Read PLO card - A2A06.	61-65
28	Possible defective NRZ to MFM card - A2B07.	171-173
29	Possible defective Data Latch card - A2A05.	51-53

30	Possible defective Access Control No. 2 card – A2A08.	81–85
31	Possible defective Receivers card – A2B02.	121–124
32	Possible defective Transmitters and Receivers/Head Address card – A2B01.	111–113
33	Possible defective Head Select and Read Amplifier – A3A02.	261–263
34	Possible defective Read/Write head. Refer to Paragraph 3.32 for removal and replacement procedures.	–
35	Possible defective FTU or FTU cables.	–
36	If the FTU still indicates a Data Error, call for Regional Support. Otherwise, repeat step 3-2 of Fault Isolation Guide No. 3 and proceed from there.	–
37	Attempt to clear the fault by flipping S1 on the Fault card – A2A04 or by hitting the Fault Switch indicator on the front panel of the drive.	252, 41–45
38	Determine which fault lights are on (Figure 5-7). If the voltage fault LED (CR1) is not on, go to step 43. Otherwise, continue with step 39 of this FIP.	–
39	Check the $\pm 5$ V on the card cage and check the $\pm 5$ V fuses. Refer to Paragraph 5.1.2.3 for dc power distribution problems.	331–333
40	Check $\pm 12$ V and $\pm 20$ V on the card cage, and check the fuses. Refer to Paragraph 5.1.2.3 for dc power distribution problems.	321–322
41	Check the $\pm 42$ V plug PA09 the bottom of the card cage. Check the $\pm 42$ V fuses.	311–312
42	Possible defective Fault card – A2A04. If the voltage fault LED is still on after this card is replaced, call for regional support. If no faults are indicated, return to step 3-2 of Fault Isolation Guide No. 3. Otherwise, continue with this FIP.	41–44
43	Reverify which faults are indicated and proceed as specified.  CR2 – Write Fault – if ON, go to step 44 CR3 – Head Select Fault – if ON, go to step 50 CR4 – Read or Write Fault – if ON, go to step 56 CR5 – Not on Cylinder and (Write or Read) – if ON, go to step 62 Front Panel – Servo Track Fault – if ON, go to step 69	

44	Possible defective Write card – A3A03.	271–274
45	Possible defective NRZ to MFM card – A2B07.	171–173
46	Possible defective Transmitters and Receivers/Head Address Register card – A2B01.	111–113
47	Possible defective Receivers card – A2B02.	121–124
48	Possible defective Interlocks and Speed Detector card – A2A10.	101–104
49	If the Write Fault LED is still on, call for regional support. If any fault indicators are still on, return to step 43. Otherwise, return to step 3-2 of Fault Isolation Guide No. 3.	–
50	Possible defective Head Select and Read Preamp card – A2A02.	261–263
51	Possible defective Transmitters and Receivers/Head Address Register card – A2B01.	111–113
52	Possible defective Receivers card – A2B02.	121–124
53	Possible defective cable A.	–
54	Possible adapter problem.	–
55	If the Head Select Fault LED is still on, call for regional support. If any other fault indicators are still on, return to step 43. Otherwise, return to step 3-2 of Fault Isolation Guide No. 3.	–
56	Possible defective Receivers card – A2B02.	121–124
57	Possible defective Interlocks and Speed Detector card – A2A10.	101–104
58	Possible defective cable A	–
59	Possible defective Writer – A3A03.	271–274
60	Possible adapter problem.	–
61	If the Read or Write Fault LED is still on, call for regional support. If any other fault indicators are still on, return to step 43. Otherwise, return to step 3-2 of Fault Isolation Guide No. 3.	–

62	Possible defective Access Control No. 1 card – A2B09.	191–193
63	Possible defective Receivers card – A2B02.	121–124
64	Possible defective Writer card – A3A03.	271–274
65	Possible defective Interlocks and Speed Detector card – A2A10.	101–104
66	Possible defective cable A.	–
67	Possible adapter problem.	–
68	If the Not On Cylinder And (Write or Read) LED is still on, call for regional support. If any other fault indicators are still on, return to step 43. Otherwise, return to step 3-2 of Fault Isolation Guide No. 3.	–
69	Possible defective Access Control No. 1 card – A2B09.	191–194
70	Possible defective A/D Function Generator card – A2A07.	71–73
71	Possible defective Access Control and Index/Sector Decode card – A2B08.	181–184
72	Possible defective Track Servo Preamp – A3A05.	291–295
73	If the Servo Track Fault indicator is still on, call for regional support. If any other fault indicators are still on, return to step 43. Otherwise, return to step 3-2 of Fault Isolation Guide No. 3.	

### FIP 3-3

There is a fault on the FTU for only *some* (not all) addresses while the drive is doing a continuous write format using sequential heads and sequence forward.

Step		Print Set Page
1	Possible defective Difference Generator Controls card – A2B06	161–165
2	Possible defective D/A Function Generator card – A2A07	71–73
3	Possible defective or worn bearings and/or carriage rails. Call for support if bad.	–

**FIP 3-4**

Address errors occur while the drive is performing continuous read, using sequential heads and sequence forward.

<b>Step</b>		<b>Print Set Page</b>
1	If the address errors were not head-related, go to step 6. Otherwise, continue with this FIP.	-
<p><b>NOTE</b>  <b>Th data switches on the FTU must be the same as when the procedure was started.</b></p>		
2	Possible defective Transmitters and Receivers/Head Address Register card – A2B01.	111–113
3	Possible defective Head Select and Read Amplifier – A2A02.	261–263
4	Possible defective read/write head. Refer to Paragraph 3.32 for removal and replacement procedures.	-
5	If the FTU still indicates address errors that appear to be head-related, call for regional support. Otherwise, return to step 3-5 of Fault Isolation Guide No. 3 and continue from there.	-
6	Possible defective Read PLO card – A2A06.	61–65
7	Possible defective NRZ to MFM card – A2B07.	171–173
8	Possible defective Data Latch card – A2A05.	51–53
9	Possible defective Access Control No. 2 card – A2A08.	81–85
10	Possible defective Receivers card – A2B02.	121–124
11	Possible defective Transmitters and Receivers/Head Address card – A2B01.	111–113
12	Possible defective Head Select and Read Amplifier – A3A02.	261–263
13	Possible defective read/write head. Refer to Paragraph 3.32 for removal and replacement procedures.	-
14	Possible defective FTU or FTU cables.	-

**FIP 3-5**

Data errors occur while the drive is performing continuous reads using sequential heads and sequence forward.

<b>Step</b>		<b>Print Set Page</b>
1	If the data errors were not head-related, go to step 7. Otherwise, continue with step 2.	-
2	Ensure that the data errors are not caused by bad spots on the disk by checking the cylinder address and character count, along with head selected.	-
3	Possible defective Transmitters and Receivers/Head Address card - A2B01.	111-113
4	Possible defective Head Select and Read Amplifier - A3A02.	261-264
5	Possible defective read/write head. Refer to Paragraph 3.32 for removal and replacement procedures.	-
6	If the FTU still indicates data errors that appear to be head related, call for regional support. Otherwise return to step 3-6 of Fault Isolation Guide No. 3 and continue from there.	-
7	Possible defective Read PLO card - A2A06.	61-65
8	Possible defective NRZ to MFM card - A2B07.	171-173
9	Possible defective Data Latch card - A2A05.	51-53
10	Possible defective Access Control No. 2 card - A2A08.	81-85
11	Possible defective Receivers card - A2B02.	121-124
12	Possible defective Transmitters and Receivers/Head Address Register card - A2B01.	111-113
13	Possible Head Select and Read Amplifier - A3A02.	261-263
14	Possible worn or defective carriage rails or bearings. Call for support if bad.	-

**FIP 3-6**

The FTU indicates an error while the drive is performing random WRT.RD functions with sequential heads.

**Step**

- |   |   |   |
|---|---|---|
| 1 | Determine the nature of the error and proceed as indicated:   |   |
|   | a. For motion failures, go to step 2  |   |
|   | b. For Write failures, go to step 3   |   |
|   | c. For read failures, go to step 4  |   |
|   | d. For head select faults or write or read faults, go to step 5.  | - |
| 2 | If the symptom of the failure is Read or Write and (Not On Cylinder) return to the beginning of Fault Isolation Guide No. 3 and continue from there. If the symptom is seek errors, return to the beginning of Fault Isolation Guide No. 2. | - |
| 3 | If the symptom of the failure is a Write Fault, return to the beginning of Fault Isolation Procedure 3-1 and continue from there. Otherwise, return to the beginning of Fault Isolation Guide No. 3.  | - |
| 4 | For either head select or read or write faults, go to the beginning of Fault Isolation Procedure 3-1 and continue from there.   | - |

#### **5.5 FAULT ISOLATION GUIDE NO. 4**

Will the drive power down correctly and are there no irregularities in the Power Down sequence? If yes, refer to Figure 5-3 in Paragraph 5.1.4.2 to determine which guide should be next. If the drive will not power down correctly, continue with this drive.

This Fault Isolation Guide assumes that the drive is powered up, and is ready with the heads loaded and the pack spinning.

### FIG 4

Step	Procedure/Question	Action (if answer is NO)
1	Press the Start button. Does the Start light go out?	FIP 4-1
2	Do the heads unload?	FIP 4-2
3	Does the drive motor brake to a stop?	FIP 4-3
4	Attempt to open the pack access cover. Does it open?	FIP 4-4
5	The drive is able to power down.	-

#### FIP 4-1

The Start light does not go out when the Start button is pushed.

Step	Action	Print Set Page
1	Possible defective Start switch or control panel. Refer to Paragraph 3.16 for removal and replacement procedures.	252

#### FIP 4-2

The heads do not unload while the drive is attempting to power down.

Step	Action	Print Set Page
1	Possible defective Access Control No. 1 card - A2B09.	194
2	Possible defective D/A Function Generator card - A2A07.	72
3	Possible defective Switching Mode Control card - A2A09.	93
4	Possible defective Power Amplifier - A3A04.	282

### FIP 4-3

The drive motor does not brake to a stop while the drive is attempting to power-down.

Step		Print Set Page
1	Check the heads loaded switch (A3S2). Refer to Paragraph 3.30 for the adjustment procedure.	-
2	Possible defective Interlocks and Speed Detect card – A2A10.	103
3	Possible defective brake – A1HB1.	302
4	Possible defective wiring harnesses.	-

### FIP 4-4

The pack access cover will not open after the drive is powered down.

Step		Print Set Page
1	Ensure the Start switch is not pressed.	102
2	Possible defective Interlocks and Speed Detect card – A2A10.	102
3	Possible defective or maladjusted pack cover solenoid. Refer to Paragraph 3.26 for solenoid adjustment procedure.	102
4	Possible defective cabling from card cage to pack cover solenoid.	102

## 5.6 ADVANCED TROUBLESHOOTING

### 5.6.1 Introduction

The section is provided for the advanced troubleshooter. Information being presented here is in outline form with less emphasis placed on procedural or FRU data. Explanations are given when applicable and outlines of procedural listings are provided.

### 5.6.2 DCK and ECH Error Descriptions

A data check error is a read error; the 32-bit ECC word calculated and written when the 256 data words were written on the disk does not agree with the 32-bit ECC word calculated when the 256 data words are read from the disk. A DCK can only occur during the following commands.

1. Read Head and Data
2. Read Data
3. Write Check Header and Data essentially disk read operations
4. Write Check Data.

The Error Correction Code (ECC) is a hardware/software feature that may be used (if bit 11 of the RMOF is reset) to attempt to correct bad data read from the disk without actually performing another read operation. The sequence is as follows. After reading a sector and the DCK bit is set and the ECI bit is reset, the ECC circuits in the MBA will automatically perform a cycling operation to determine which bits in the sector data area were picked up or dropped, and where those bits are located in the sector. This feature is limited to 11 consecutive bits. At the completion of the ECC cycle either of two things happen.

1. If the bits picked up or dropped are within 11 consecutive bits of each other, the ECC pattern register is equal to the 11-bit burst of bad data bits (a one in the register corresponds to a bad bit, a zero is a good bit) and the ECC position register is equal to the number of bits into the 256-word data area that the bad 11-bit burst begins. It is now up to the software to read these registers and to go into the memory location(s) determined from the original RMBA register value and the value in the ECC position register and perform a Bit Complement instruction using the value in the ECC pattern register.
2. If the bits picked up or dropped in the 256-word data area are not within 11 consecutive bits of each other, ECH is set (bit 6 of RMER1). At this point the software must attempt to execute another read command in order to recover the data in that particular sector.

**NOTE**

**It is particularly advantageous to use the ECC feature because an ECC cycle (not including the software calculation time) takes approximately 7 ms as opposed to waiting 16.6 ms per full disk revolution in order to reread the sector.**

**5.6.3 Data Check Fault Isolation Guide**

This Fault Isolation Guide is designed like Guide No. 1 through No. 4, with the referenced Fault Isolation Procedures (FIPs) appearing after the Guide itself.

<b>Step</b>	<b>Procedure/Question</b>	<b>Action (if answer is NO)</b>
DC-1	Check to see if Data Check is true. If it is true, have the heads <i>not</i> crushed	DC-7
DC-2	The heads have crashed. Determine the history of the packs on that site that have been used on the drive in question.	-
DC-3	Set aside all suspect packs for inspection.	-
DC-4	Clean the shroud area of each disk and inspect all heads on other drives for contamination. Clean as needed.	-
DC-5	On drive in question, replace and align heads as necessary. Refer to Paragraph 3.32 for these procedures.	-
DC-6	Check the drive for compatibility and run the appropriate diagnostics.	-

DC-7	Is DCK true for more than one head?	FIP-DC1
DC-8	Is DCK occurring on a large number of cylinders?	FIP-DC2
DC-9	Are there no intermittent LBCs, SKIs or HCEs with the DCK?	FIP-DC3
DC-10	End.	

**FIP DC1**

DCK is true on only one head.

Step		Print Set Page
1	Replace or align head. Refer to Paragraph 3.32 for procedures.	-
2	Reformat the pack. (This is not necessary if the head alignment is done correctly.)	-
3	Possible defective Head Select and Read Amplifier - A3A02.	261-263
4	Possible defective Writer - A3A03.	271-274
5	Possible defective pack.	-

**FIP DC2**

DCK occurs on a small number of cylinders.

Step		Print Set Page
1	Possible defective Writer - A3A03.	271-274
2	Possible defective NRZ to MFM card - A2B07.	171-173

**FIP DC3**

DCK occurs with intermittent LBCs, SKIs or HCEs.

Step		Print Set Page
1	Possible defective Track Servo Preamplifier - A3A05.	291-292
2	Possible defective Fine Servo Decode - A2A03.	31-35
3	Possible defective Write Clock - A2A01.	11-13
4	Replace and realign servo head. Refer to Paragraph 3.32 for these procedures. Note that realignment of the servo head requires realignment of all the other heads as well.	-

#### 5.6.4 Error Tests

The following routine may be used to RUN LOOP on error or HALT on error tests.

DZQUD-E 25-FEB-76 RKDP-XXDP RK11 MONITOR 24K

RESTART ADDR: 132522

BOOTED VIA U

R UPD2

DZQUB-I 25-FEB-76-XXDP UPDATE PROGRAM #2

DATE: 8-JAN-78

8-JAN-78

PROGRAM RELOCATED TO: 100764

RESTART: 105116

\*LOAD DK0:RMULTI.BIN

XFR:000001 CORE:000050,007501

\*

:LOC	1004	;LOAD UNIT NO. INTO LOC 1004
MOD200		
000200	013727	
000202	177570	MOV CONTENTS OF S.R. INTO LOC 204
(GET COMM)		
000204	000000	
000206	000000	;HALT
000210	000240	;NO OP
000212	012737	
000214	177400	MOV 177400 INTO W.C.
000216	176702	
000220	012737	
000222	002000	MOV 2000 INTO B.A.
000224	176704	
000226	013737	
000230	001004	MOV CONTENTS OF 1004 INTO CS2
000232	176710	
000234	012737	
000236*	000000	LOAD CONTENTS OF LOC 236 INTO D.A.
000240	176706	
000242	012737	
000244*	000000	LOAD CONTENTS OF LOC 244 IN D.C.
000246	176734	
000250	013737	
000252	000204	LOAD CONTENTS OF LOC 264 INTO CS1
000254	176700	
000256	000137	
000260	000100	JUMP TO LOC 100
000262	000240	
000264	032737	
000266	040000	
000270	176700	
000272	001001	
000274	000411	
000276	005737	
000300	177570	
000302	100331	
000304	000000	

000306	012737	IF NO ERRORS AND S.R.(7) = 1 = HALT
000310	000040	IF NO ERRORS AND S.R.(7) = 0 = LOOP
000312	176710	
000314	000137	
000316	000212	
000320	132737	
000322	000200	IF AN ERROR AND S.R.(15) = 1 = HALT
000324	177570	IF AN ERROR AND S.R.(15) = 0 = LOOP
000326	001002	
000330	000137	
000332	000212	
000334	000000	
000336	000137	
000340	000212	
000342	000000	
000344	000000	
000346	000000	
*MOD100		
000100	105737	
000102	176700	TEST CS1 RDY BIT
000104	100375	
000106	105737	READY? IF YES ;IF NO
000110	176712	
000112	100375	TEST DS READY BIT
000114	000137	
000116	000264	JUMP TO 264
000120	000000	
000122	000000	

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What features are most useful? \_\_\_\_\_

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