

RM05 Disk Subsystem Service Manual

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1.1 INTRODUCTION

1.1.1 Scope of Manual

This manual contains information concerning the installation, operation, and servicing of the RM05 Disk Subsystem. It is intended to be used by DIGITAL Field Service and customer maintenance personnel.

1.1.2 RM05 Hardware Maintenance Plan

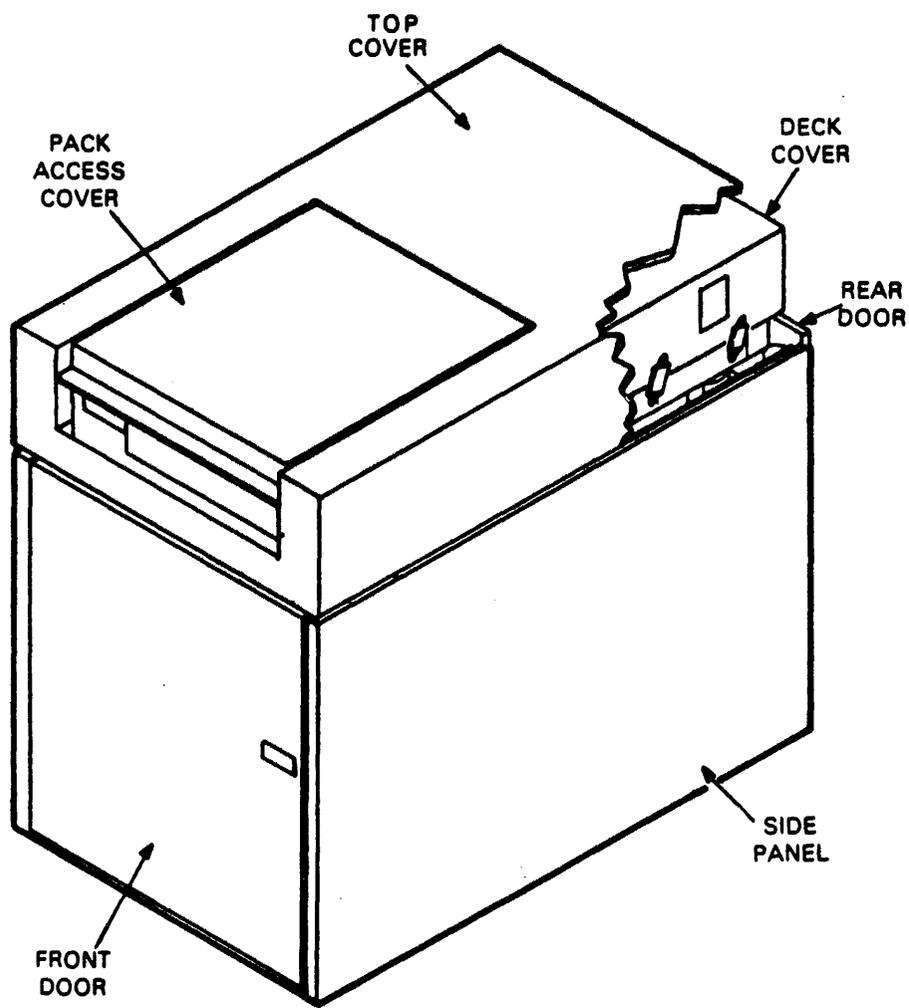
The primary strategy for maintaining the RM05 Disk Subsystem calls for using on-line software and/or the Field Test Unit to isolate problems to a field replaceable unit (FRU) on the failing option. Once the fault is isolated, the failing FRU is replaced. The Authorized Returns List identifies those FRUs to be returned.

1.2 DESCRIPTION

The RM05 is a vendor-built storage module drive (SMD) connected to a DIGITAL RM adapter. The RM05 has a formatted capacity of 256 megabytes. The RM adapter converts MASSBUS signals from the controller into compatible signals for the drive. (The major sub-assemblies of the drive are shown in Figure 1-1 and Figure 1-1A.)

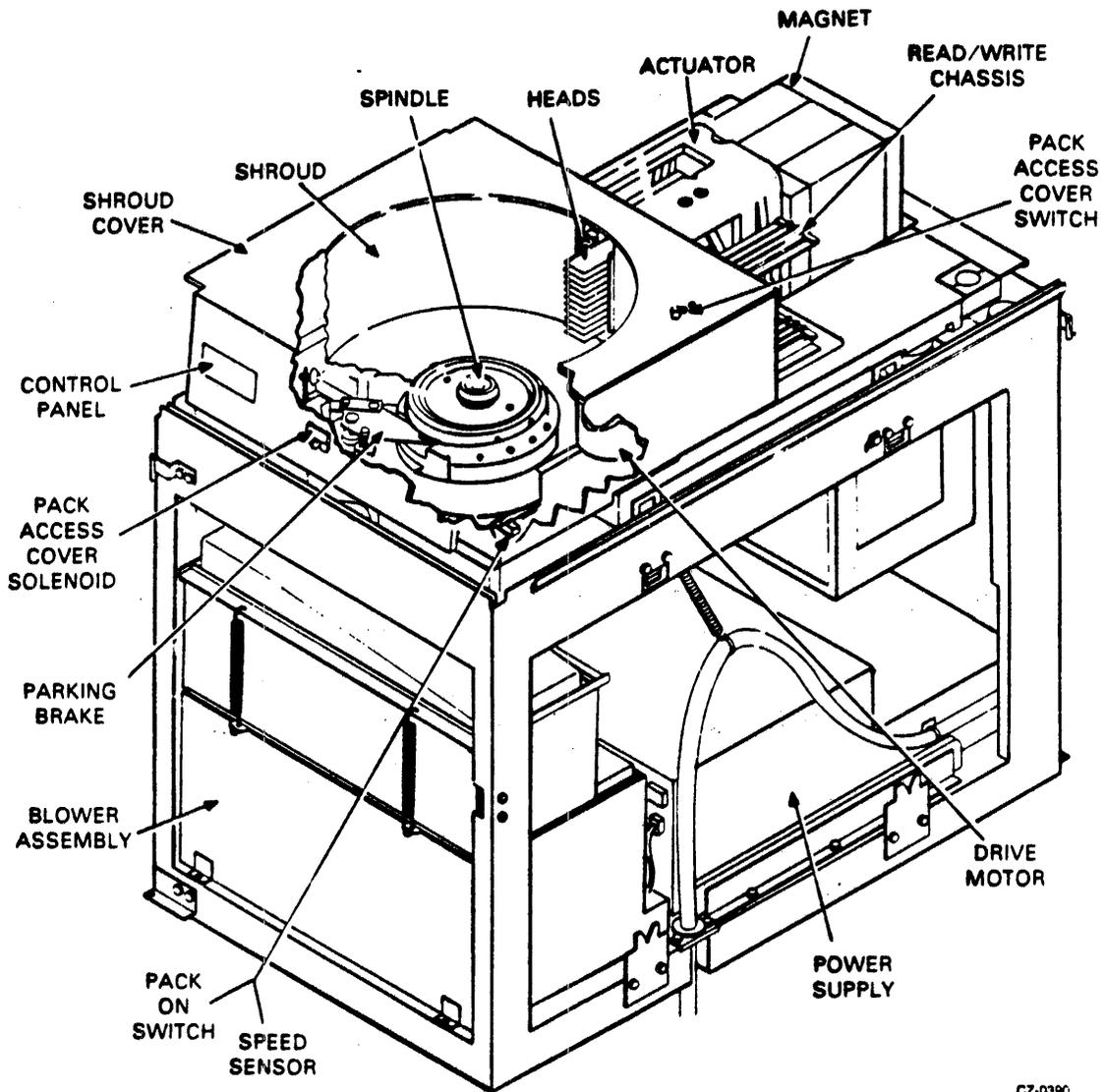
Using the appropriate MASSBUS controller, the RM05 can be used with the PDP-11/70 and VAX-11/780 computers.

The system resides in two free-standing cabinets. The adapter cabinet has provisions for a second adapter. Thus by adding a second drive, another cabinet is not required.



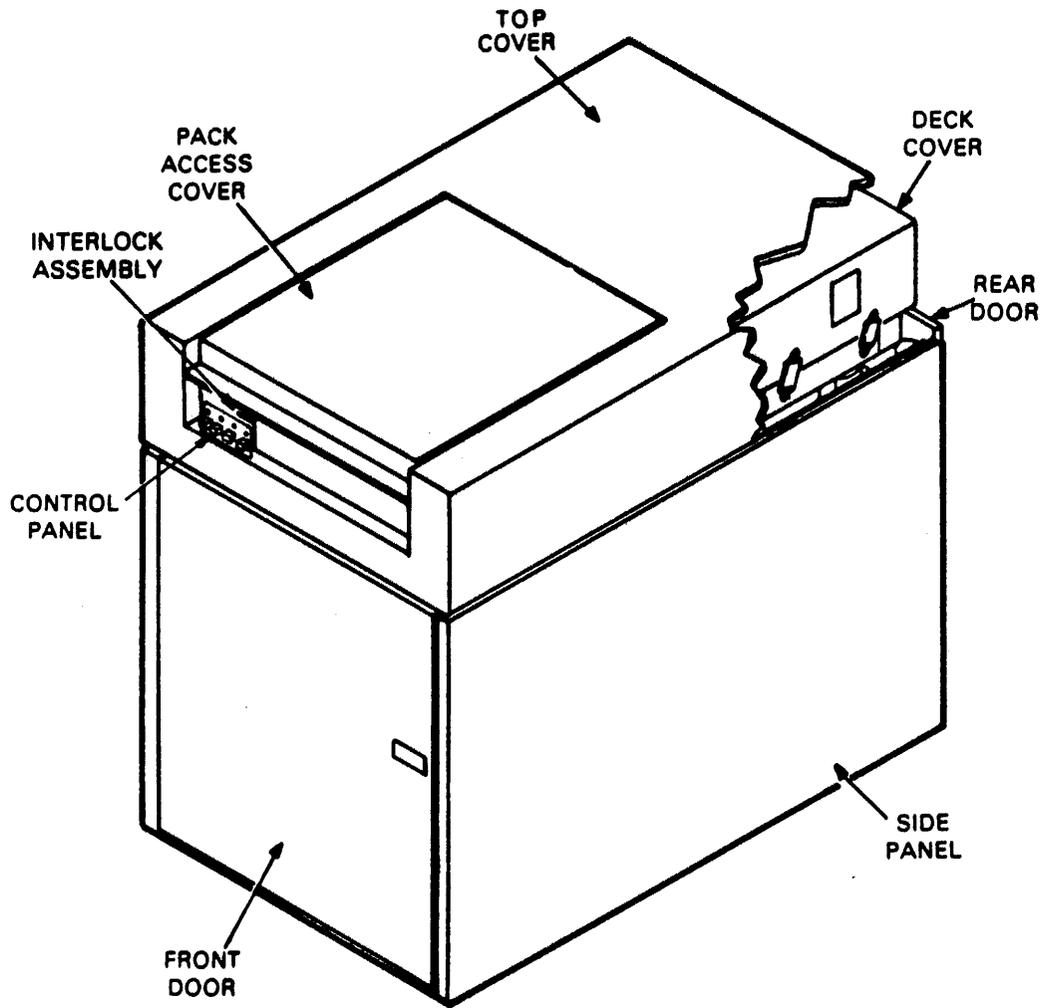
CZ-0300

Figure 1-1 NON-VDE Drive Subassemblies Sheet 1 of 2



CZ-0390

Figure 1-1 NON-VDE Drive Subassemblies Sheet 2 of 2



CZ-0635

Figure 1-1A VDE Drive Subassemblies Sheet 1 of 2

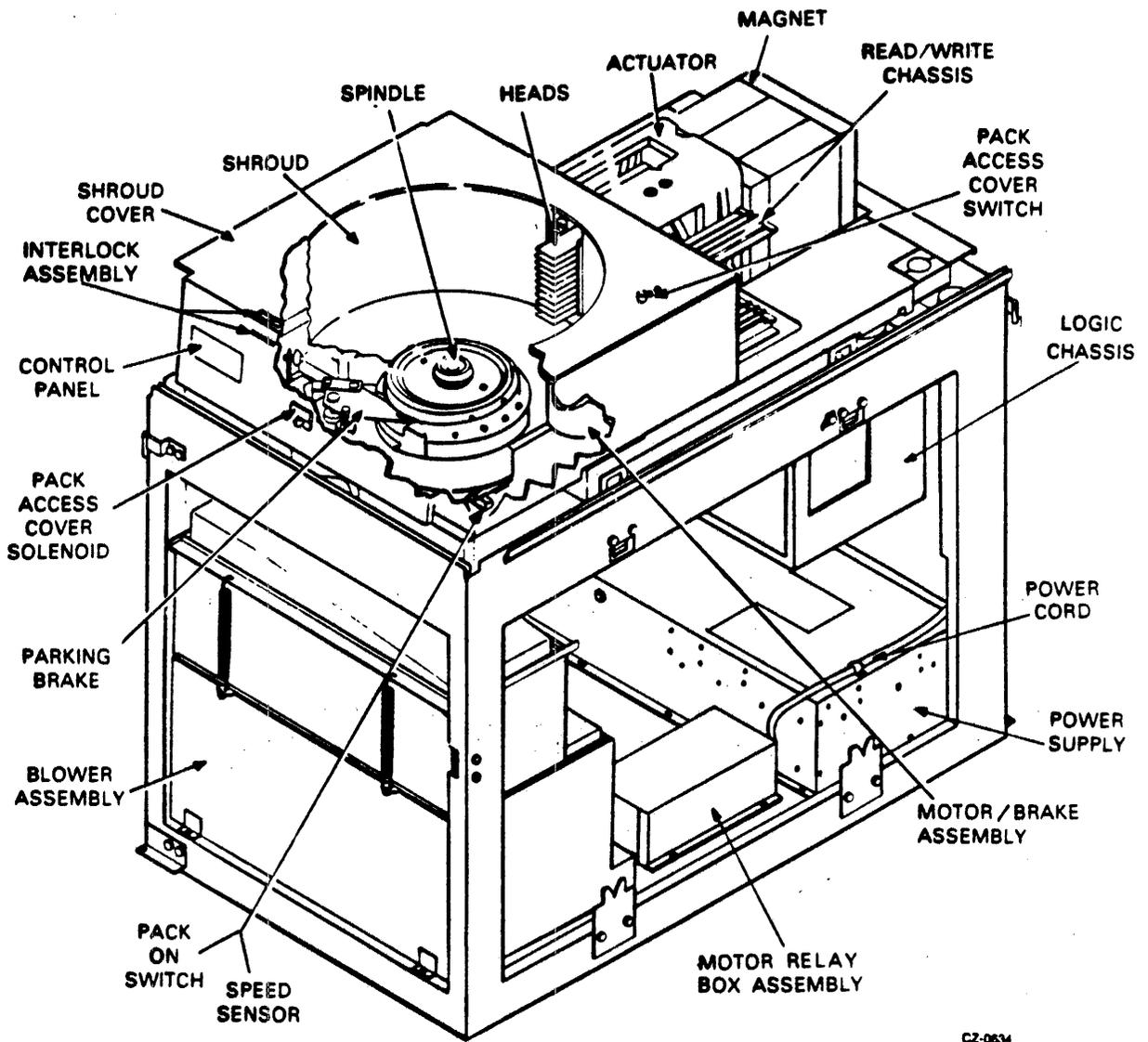


Figure 1-1A VDE Drive Subassemblies Sheet 2 of 2

The RM05 has a VDE and NON-VDE version. The difference between the two will be called out in this manual where applicable. The major VDE differences are the following.

- o Redesigned power supply
- o Motor relay box between power supply and drive motor
- o Motor assembly with direct drive brake
- o Improved pack access cover interlock
- o Logic chassis hinge is changed to provide clearance for the repositioned power supply

1.3 DISK PACK

The RM05 uses a 14 inch diameter (RM05-P type) removable disk pack which has 12 platters (see Figure 1-2). The top and bottom platters are used to protect the ten inner platters. Of the 20 surfaces on the ten inner platters, 19 are used for data storage and one is used for servo data. Table 1-1 gives RM05P Disk Pack specifications. Operator and user information and detailed specifications on both the media and the drive can be found in Chapter 1 of the RM05 User Guide.

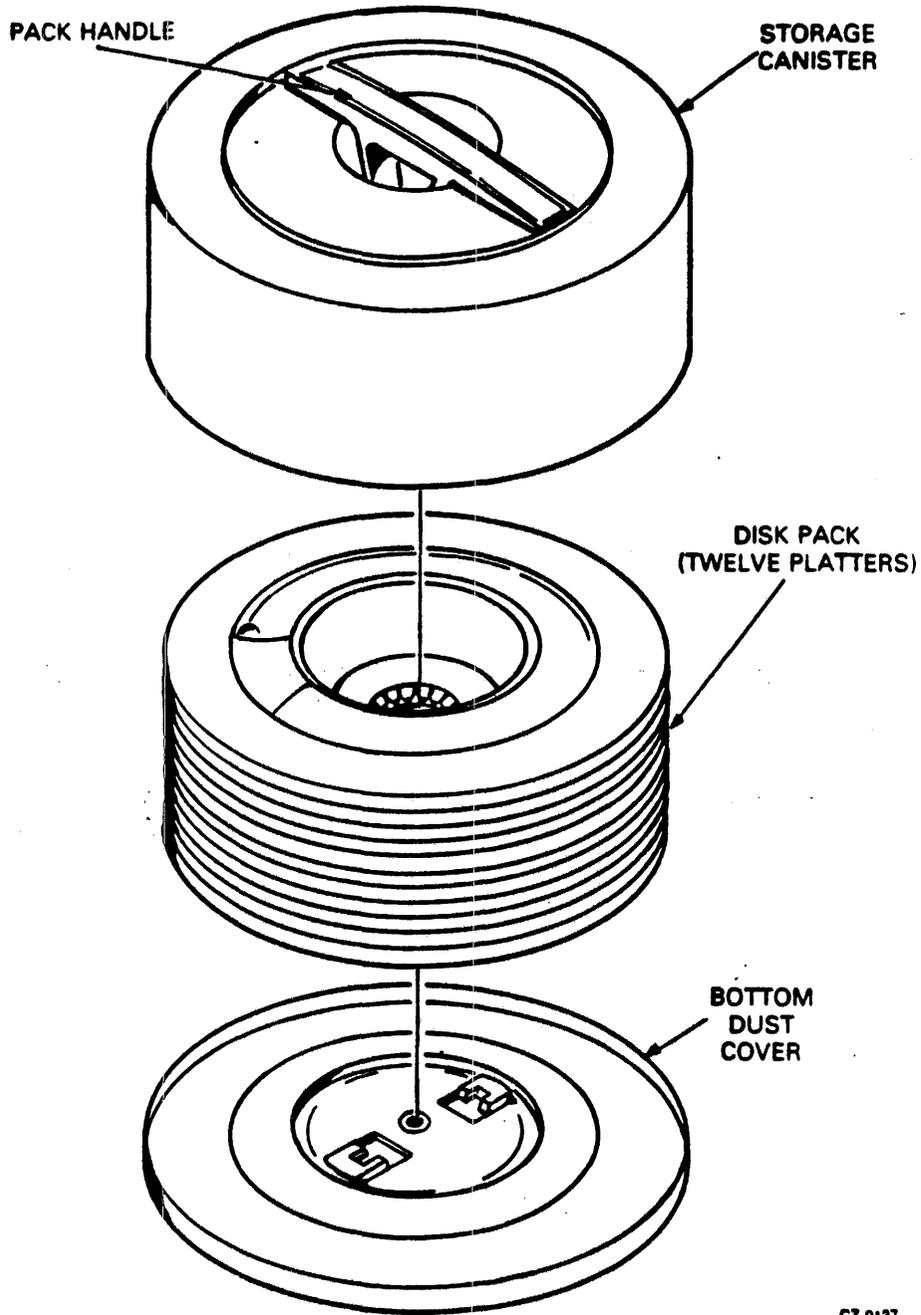
1.4 SUBSYSTEM FEATURES AND CAPABILITIES

The RM05 performs error detection and error isolation operations on all data as well as header information read from the disks. These error detection and correction operations permit the software to correct detected errors and recover data that would normally be lost.

The drive can also accept offset commands that cause the heads to move a fixed 250 microinches to either side of track centerline. These program-controlled offsets allow the recovery of data that is not normally read due to head misalignments.

Data is recorded on the disk in fixed-number sector blocks, 32 sectors for a 16-bit format. These sector blocks have headers which contain the unique cylinder, sector, and track address. They also provide for manufacturer or user-specified codes to indicate that the sector is unacceptable for data storage.

The RM05 incorporates an integrated backplane that permits dual-ported, matched-impedance MASSBUS connections to be made directly to the backplane. This feature eliminates the requirement for multiple internal cables for the interface. The integrated backplane also simplifies the interconnections of MASSBUS cables, and allows up to eight RM05s to be daisy-chained from a controller. The dual-port capability of the RM05 allows it to be accessed by two different RH controllers.



CZ-0137

Figure 1-2 RM05P Disk Pack

Extensive diagnostic programs are available for maintenance procedures. An off-line tester, used to isolate drive-associated faults, is also available. The diagnostics and tests are discussed in Chapter 2 and in Appendix A.

Table 1-1 RM05P Pack Data Capacity

Data Word Format	18-Bit Format	16-Bit Format
Sectors/data track	30	32
Data bytes/sector	512	512
Data bytes/surface	12,614,280	13,484,032
Data bytes/pack	240,184,320	256,196,608
Data bits/surface	101,130,240	109,472,256
Data bits/pack	1,921,474,560	2,049,572,864

NOTE
Data capacity is the customer-usable data area.

1.5 REFERENCE DOCUMENTATION

Hardware documentation related to the RM05 is listed in Table 1-2.

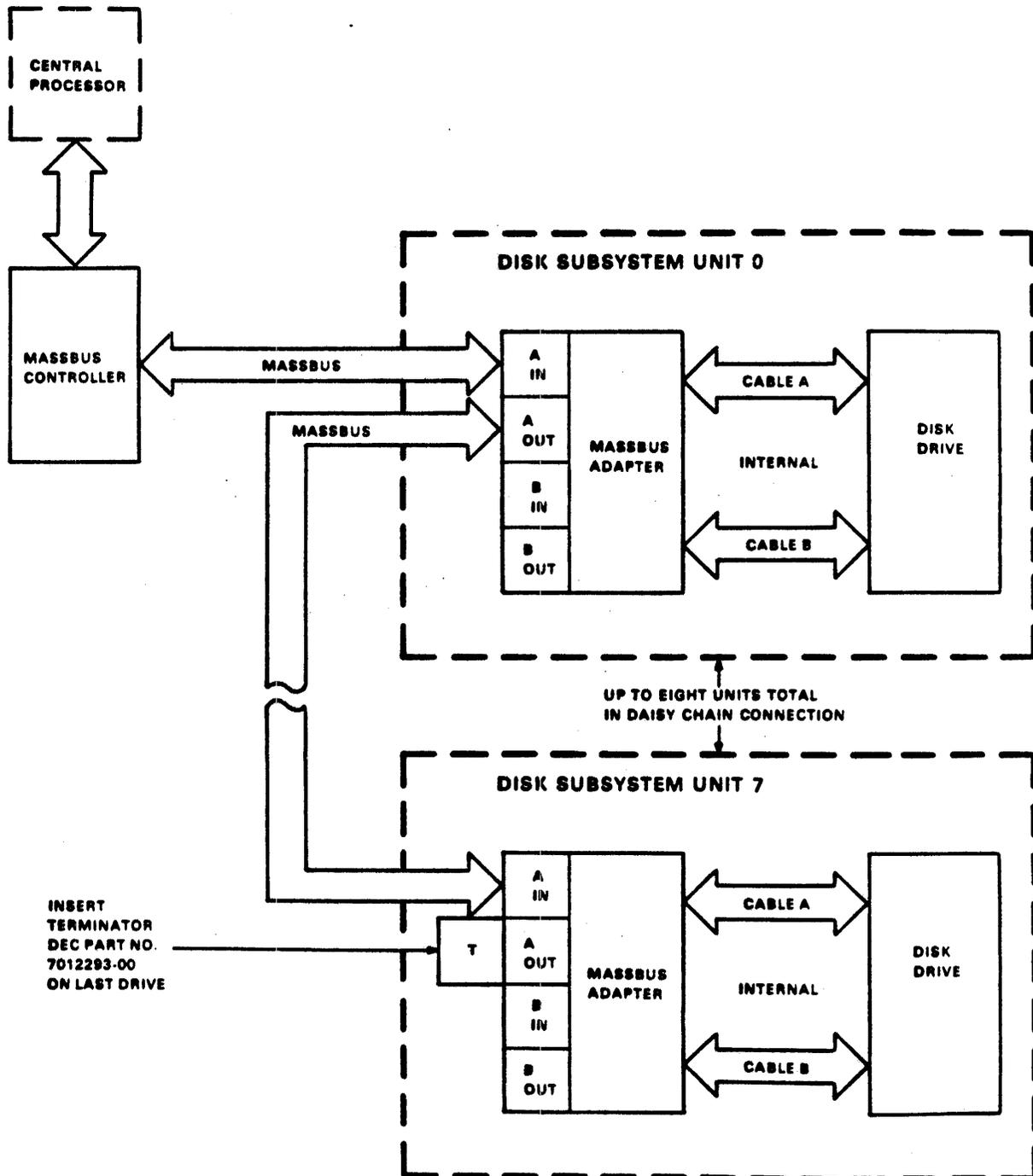
Table 1-2 Reference Documentation

Name	Microfiche Number	Hard Copy Number
<u>RM05 Disk Drive User Guide</u>	N/A	EK-ORM05-UG
<u>RM05 Disk Drive Service Manual</u>	EP-ORM05-SV	EK-ORM05-SV
<u>RM05 Disk Drive Maintenance Print Set</u>	N/A	MP-01075
<u>RM05 Disk Drive Illustrated Parts Breakdown</u>	EP-ORM05-IP	EP-0016A-IP
<u>BK7B1E/F Disk Drive Illustrated Parts Breakdown</u>	N/A	ER-BK7B1-IP
<u>BK7B1E/F Disk Drive Technical Description</u>	EP-BK7B1-TD	ER-BK7B1-TD
<u>RM MASSBUS Adapter Technical Description</u>	EP-RMADA-TD	EK-RMADA-TD

1.6 SUBSYSTEM CONFIGURATION

The RM05 disk subsystem has two hardware elements housed in two cabinets. One of the cabinets houses the disk drive, and the second cabinet houses the RM adapter.

To operate this disk system, a high-speed MASSBUS controller is needed to interface to the computer memory. The controller provides a high-speed path for direct memory transfers. Each MASSBUS controller can handle from one to eight RM05 disk subsystems as shown in Figure 1-3.

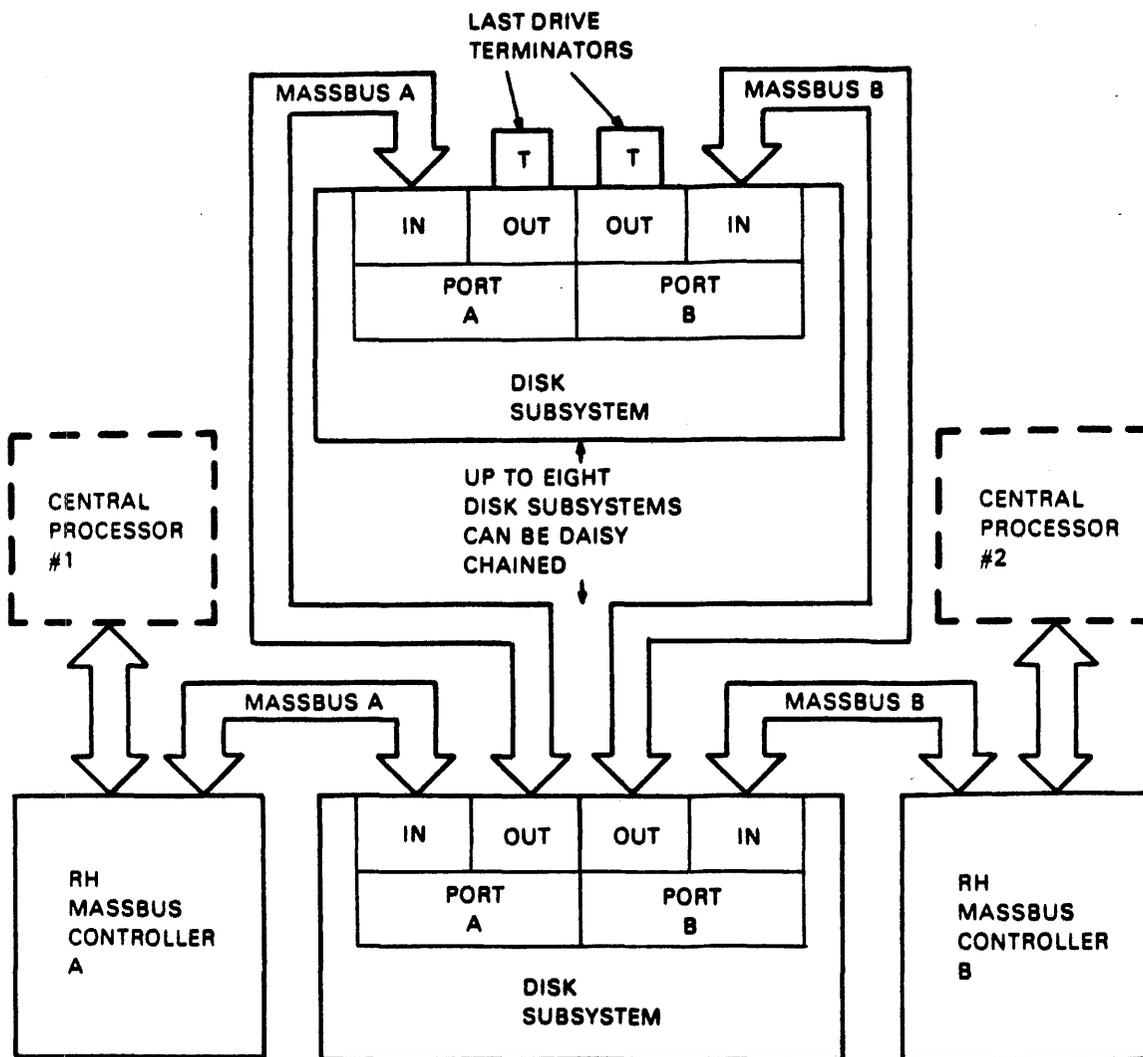


CZ-027C

Figure 1-3 Single-Port Subsystem Configuration

The RM05 uses the RH780 Controller to interface with the VAX-11/780, and the RH70 controller to interface with the PDP 11/70.

The RM05 disk subsystem also has a dual-port capability that allows each drive to be controlled in a time-shared fashion from two separate MASSBUS controllers. Figure 1-4 shows how this dual-port option is configured.



MA-0647

Figure 1-4 Dual-Port Subsystem Configuration

1.7 DUAL-PORT CONFIGURATION RESTRICTIONS

The RM05 Disk Drive can be accessed for dual-port operation using four RH MASSBUS controllers. This configuration would have a total of eight MASSBUS cables entering and leaving the RM adapter cabinet. However, due to restricted space within the RM adapter cabinet, it is not possible to have eight MASSBUS cables mounted in the cabinet. Therefore, the only configuration possible is to have the RM05 Disk Drive accessed for dual-port operation using only two RH controllers. This configuration, shown in Figure 1-4, requires only four MASSBUS cables in the RM adapter cabinet.

1.8 SUBSYSTEM SPECIFICATIONS

Performance, power, environmental, and physical specifications for the RM05 Disk Subsystem are listed in Table 1-3. The specifications for the disk pack are provided in Table 1-4.

Table 1-3 RM05 Specifications

Specification	Limit
Seek time	
Maximum seek (822 cylinder)	55 milliseconds
One cylinder seek (maximum)	6 milliseconds
Average seek	30 milliseconds
Seek to the same cylinder	4 microseconds
Latency	
Speed	3600 revolutions/minute
Maximum latency	17.3 milliseconds
Average latency	8.33 milliseconds
Start/stop time	
Start (maximum)	35 seconds
Start (typical)	25 seconds
Stop with power (maximum)	35 seconds
Stop with power (typical)	25 seconds
Stop without power	120 seconds
Heads	
Servo head	1
Read/write heads	19
Data rates	
Bit cell time	103.3 nanoseconds
Word rate	1.65 microseconds

Table 1-3 RM05 Specifications (Cont)

Specification	Limit
Number of addressable registers in RM05 adapter	16
Error detection/correction	32-bit Error Correction Code (ECC)/sector
Time for correction	4.47 milliseconds (maximum)
Temperature	
Operating:	15.0° to 32.2° C (59° to 90° F) with a maximum gradient of 6.7° C (12° F) per hour.
Non-operating:	-40° to 70.0° C (-40° to 158° F) with a maximum gradient of 20° C (36° F) per hour.
Relative humidity	
Operating	20 to 80 percent (providing there is no condensation)
Non-operating	5 to 95 percent (providing there is no condensation)
Altitude	
Operating	305 meters (1000 feet) below sea level to 2000 meters (6500 feet) above sea level
Non-operating	305 meters (1000 feet) below sea level to 4572 meters (15,000 feet) above sea level
Electrical	
Voltages available (Drive)	208 (+14.6, -29.0), 60 Hz 230 (+14.5, -32.0), 60 Hz 220 (+15.0, -25.0), 50 Hz 240 (+17.0, -27.0), 50 Hz
Voltages available (RM adapter)	120 (+8.0, -8.0), 60 Hz 220 (+15.0, -25.0), 50 Hz 240 (+17.0, -27.0), 50 Hz

Table 1-3 RM05 Specifications (Cont)

Specification	Limit
Start current	208 Vac, 60 Hz @ 39.0 A rms, maximum 230 Vac, 60 Hz @ 40.0 A rms, maximum 220 Vac, 50 Hz @ 40.0 A rms, maximum 240 Vac, 50 Hz @ 41.0 A rms, maximum
Line current	
Disk and carriage in motion	208 Vac, 60 Hz @ 8.0 A rms, max. 230 Vac, 60 Hz @ 7.2 A rms, max. 220 Vac, 50 Hz @ 9.5 A rms, max. 240 Vac, 50 Hz @ 8.7 A rms, max.
Disk not in motion	208 Vac, 60 Hz @ 2.0 A rms, max. 230 Vac, 60 Hz @ 1.8 A rms, max. 220 Vac, 50 Hz @ 2.5 A rms, max. 240 Vac, 50 Hz @ 2.3 A rms, max.
RM adapter	120 Vac, 60 Hz @ 2.1 A rms, max. 220 Vac, 50 Hz @ 1.3 A rms, max. 240 Vac, 50 Hz @ 1.4 A rms, max.
Line cord length	366 centimeters (12 ft) 14 wire gauge already installed for NON-VDE RM05 366 centimeters (12 ft) 14 wire gauge pluggable for VDE RM05
Disk cartridge type	RM05P
Weight	
RM05 drive with cabinet	550 lbs
RM adapter cabinet	120 lbs
W/1 adapter	200 lbs
W/2 adapters	280 lbs
AC plug type	
RM05 drive	
120 volts, 60 Hz	NEMA L6-20P
208 volts, 50 Hz	
RM adapter	
120 volts, 60 Hz	NEMA 5-15P
240 volts, 50 Hz	NEMA 6-15P

Table 1-4 RM05P Disk Pack Specifications

Specification	Limits
Type	RM05-P
Disk diameter	35.56 cm (14 inches)
Number of disks	12 (the upper and lower disks are not used for recording)
Number of recording surfaces	19 read/write and one read-only servo surface
Cylinders per disk pack	823
Total number of tracks	15,637 per disk pack
Tracks per cylinder	19
Tracks per inch	384
Bad sector file	Cylinder 822, track 18
Temperature range	
Operating	10° to 57° C (50° to 106° F); temperature change rate not to exceed 0.1° C (0.2° F) per minute
Non-operating	-40° to 65° C (-40° to 150° F); temperature change rate not to exceed 14° C (25° F) per hour
Relative humidity	
Operating and non-operating	8 to 80 percent
Wet bulb reading	
Operating	25° C (78° F) maximum
Non-operating	30° C (85° F) maximum
Altitude	
Operating	Sea level to 3,050 meter (10,000 ft)
Non-operating	Sea level to 12,190 meter (40,000 ft)

Table 1-4 RM05P Disk Pack Specifications (Cont)

Specification	Limits
Stray magnetic fields Operating and non-operating	Not to exceed 50 oersteds

1.9 NON-VDE/VDE RM05 SUB-ASSEMBLIES

The major sub-assemblies of the NON-VDE RM05 are shown in Figure 1-1 and are described in Table 1-5. The major sub-assemblies of the VDE RM05 are shown in Figure 1-1A and are described in Table 1-5A. The BK7B1E/F Illustrated Parts Breakdown and the RM05 Illustrated Parts Breakdown contain a complete list of RM05 parts. Chapter 4 of this service manual explains how to remove, replace, and repair the major subassemblies of the RM05.

Table 1-5 NON-VDE RM05 Subassemblies

Sub-assembly	Description
Actuator	This contains the voice coil and carriage. This assembly positions the heads over the disk surfaces.
Blower assembly	This contains a blower motor that circulates cooling air for the drive.
Deck cover	This provides an electrical interference shield for the drive and reduces the noise level output from the drive.
Drive motor	This provides rotational motion that turns the spindle and the disk pack.
Front door	This provides access to the blower assembly and the lower front part of the cabinet.
Heads	There are 20 heads, 19 of which write and read data to and from the disk pack, and one read only head which reads the servo data from the dedicated servo platter.
Logic chassis	This contains logic cards that control the operation of the drive.
Magnet	This provides a permanent magnetic field that is used in conjunction with voice coil to move the carriage and the heads.

Table 1-5 NON-VDE Drive Assemblies (Cont)

Subassembly	Description
Operator panel	This contains switches that allow the operator to control and monitor the basic drive operation.
Pack access cover	This provides access to the disk pack and pack area.
Pack access cover solenoid	This prevents the pack access cover from being opened while the pack is spinning.
Pack access cover switch	This interlock de-energizes the drive motor if the pack access cover is opened while the pack is spinning. An open cover also prevents the motor from starting.
Pack on switch	This interlock prevents the drive motor from starting when the pack is not installed.
Parking brake	This keeps the spindle from spinning while the disk pack is being installed or removed.
Power supply	This furnishes all necessary voltages for the drive operation.
Read/write chassis	This contains the modules used in drive read/write operations.
Rear door	This provides access to the power supply, logic chassis, and lower rear of cabinet.
Shroud and shroud cover	This provides protection and ventilation for the pack.
Side panels	This provides access to either side of the drive.
Spindle and lockshaft	This provides a mounting surface for the disk pack. The lockshaft secures the disk pack to the spindle. The drive motor transmits a rotational motion to the spindle via the drive belt, causing pack rotation.
Top cover	This covers the entire top of the drive, protecting drive assemblies and reducing noise level.

Table 1-5A VDE RM05 Subassemblies

Sub-assembly	Description
Actuator	This contains the voice coil and carriage. The assembly positions the heads over the disk surfaces.
Blower assembly	This contains a blower motor that circulates cooling air for the drive.
Deck cover	This provides an electrical interference shield for the drive and reduces the noise level output from the drive.
Drive motor/brake	This provides a rotational motion that turns the spindle and the disk pack as well as a (dynamic) brake used to stop spindle rotation.
Front door	This provides access to the blower assembly and the lower front part of the cabinet.
Heads	There are 20 heads, 19 of which write and read data to and from the disk pack, and one read only head which reads the servo data from the dedicated servo platter.
Logic chassis	This contains the logic cards that control the operation of the drive.
Magnet	This provides a permanent magnetic field that is used in conjunction with the voice coil to move the carriage and the heads.
Operator panel	This contains switches that allow the operator to control and monitor the basic drive operation.
Pack access cover	This provides access to the disk pack and pack area. The pack access cover cannot be opened for approximately 30 seconds after main AC power has been applied.
Interlock Assembly	This interlock combines the pack access cover solenoid and the pack access cover switch. It prevents the pack access cover from being opened while the pack is spinning. The pack access cover can now only be opened when the pack is stopped and the main AC power is applied.

Table 1-5 NON-VDE Drive Assemblies (Cont)

Subassembly	Description
Parking brake	This keeps the spindle from spinning while the disk pack is being installed or removed.
Power supply	This furnishes all necessary voltages for the drive operation.
Read/write chassis	This contains the modules used in drive read/write operations.
Rear door	This provides access to the power supply, logic chassis, and lower rear of cabinet.
Shroud and shroud cover	This provides protection and ventilation for the pack.
Side panels	This provides access to either side of the drive.
Spindle and lockshaft	This provides a mounting surface for disk the pack. The lockshaft secures the disk pack to the spindle. The drive motor transmits a rotational motion to the spindle via the drive belt, causing pack rotation.
Top cover	This covers the entire top of the drive, protecting drive assemblies and reducing noise level.

1.10 RM ADAPTER SUB-ASSEMBLIES

Refer to the RM MASSBUS Adapter Technical Description manual EK-RMADA-TD-001 for location and description of these sub-assemblies.

CHAPTER 2
INSTALLATION AND CHECKOUT PROCEDURES

2.1 INTRODUCTION

This chapter contains information concerning the installation and checkout of the RM05 Disk Drive. The person performing these procedures should be familiar with the operation of the drive and with all information in the general maintenance area of the RM05 Service Manual.

WARNING

Hazardous voltages are present inside this equipment. Installation and servicing should be performed only by qualified and trained service representatives. Bodily injury or equipment damage may result from improper servicing. Refer to the service manual for proper instructions.

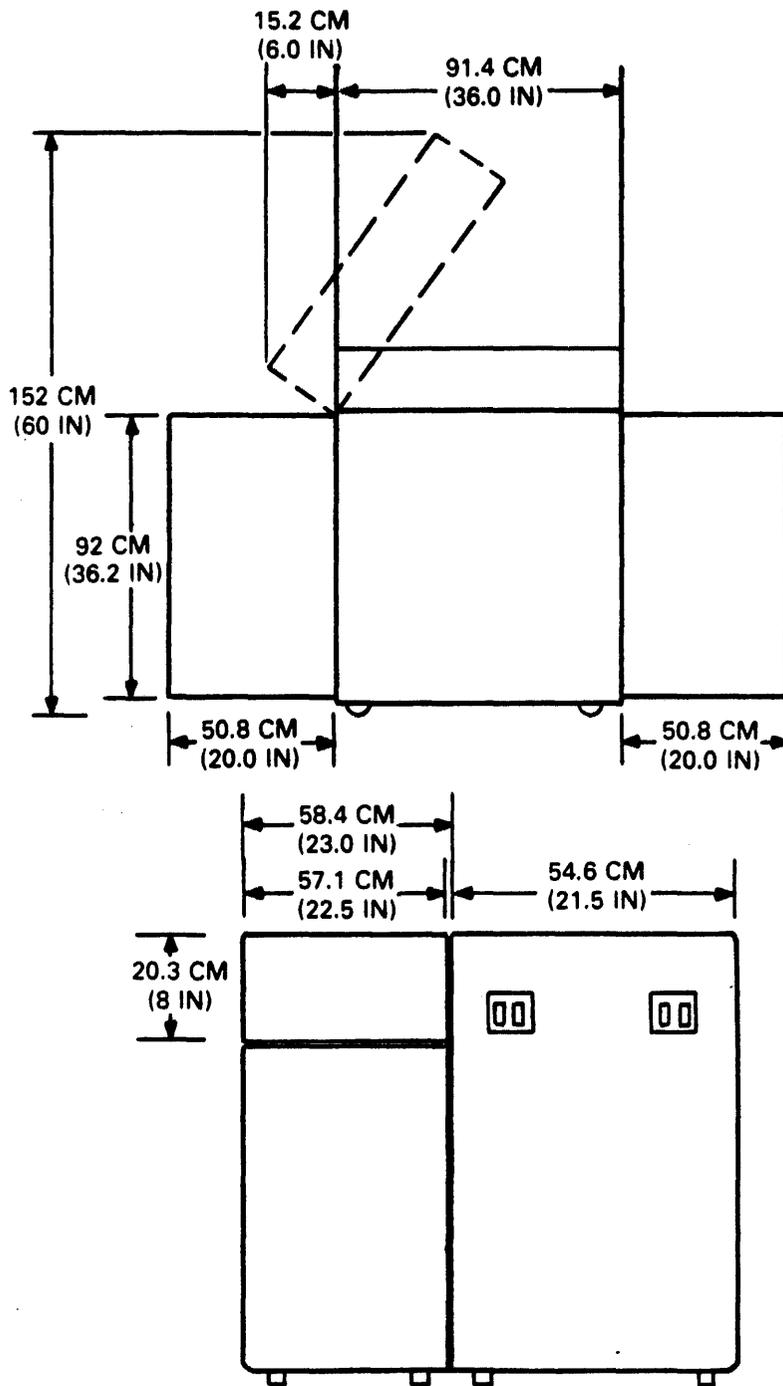
This chapter is divided into the areas listed below.

- o Site preparation and planning
- o Unpacking the drive
- o Drive installation procedures
- o Initial checkout and start-up

2.2 SITE PREPARATION AND PLANNING

Site preparation and planning enable a user to lay out a site in the most advantageous manner based upon space available and power requirements. The location of the RM05 Disk Drive must present a class A computer room environment, which includes controlled temperatures, humidity, and filtered air flow.

The RM05 Disk Drive may be located alone or in line with other drives and adapters. Whichever method is used must provide sufficient clearances around the unit to permit access for maintenance. These space requirements are shown in Figure 2-1.



CZ-0121

Figure 2-1 Space Requirements

An ac power source is required for each RM05 and adapter. Both drives and adapters connect to the power source via 3.6 m (12 ft) power cords. The 60 Hz units are shipped with a power connector attached. The 50 Hz NON-VDE units are not supplied with power connectors, and they must be obtained locally. The 50 Hz NON-VDE connector should be wired as indicated below.

- o Green or green/yellow wire to ground
- o Brown wire to phase 1
- o Blue wire to neutral or phase 2

NOTE

A 60 Hz NON-VDE drive cannot be converted to 50 Hz, or vice-versa, without making hardware changes (transformers, spindle motor, modules etc.)

The 50 Hz VDE units are shipped with a plugable power cord but not shipped with a 50 Hz power connector. The connector should be wired as indicated below:

- o Green or green/yellow to ground
- o Black wire to phase 1
- o Black wire to neutral or phase 2

NOTE

A 50 Hz Vde drive can be converted to a 60 Hz, or vice versa. The conversion procedure is found in paragraph 2.3.2.1.

Table 2-1 lists the drive input voltage tolerances and power consumption requirements.

Table 2-1 Drive Power Consumption Requirements

Input Voltage	Unit Status	Line * Current	Consumption *		Power Factor
			Kw	BTU/hr	
208 V, 60 Hz	Disks and carriage in motion	8.0 A	1.20	4200	.70
230 V, 60 Hz		7.2 A	1.20	4200	.70
220 V, 50 Hz		9.5 A	1.30	4200	.70
240 V, 50 Hz		8.7 A	1.30	4200	.70
208 V, 60 Hz	Disks not in motion	2.0 A	0.40	1400	.90
230 V, 60 Hz		1.8 A	0.40	1400	.90
220 V, 50 Hz		2.5 A	0.50	1750	.90
240 V, 50 Hz		2.3 A	0.50	1750	.90

*These are maximum values.

In addition to the requirements of space, environmental conditions and power supply, each drive and adapter must be correctly grounded to ensure safe and satisfactory operation. Each drive and adapter must have two ground connections, the site ac power system ground and a system ground.

The site ac power system ground is provided by the green (or green with yellow stripes) wire in the ac power cord. This wire connects to the drive frame and goes through the ac power cord to earth ground via the ac branch circuit supplying the drive. Also, all power receptacles in the vicinity of the drive must be at the same ground potential as the drive.

The power system safety ground does not necessarily satisfy all system grounding requirements. Therefore, additional connections to earth ground are required to ensure proper drive and system operation. This is referred to as the system ground. The system ground can connect to earth using any of the methods given below.

- o Floor Grid (grounded) - The drives and controller are connected to a floor grid consisting of horizontal and vertical members which are mechanically secured and have ground straps joining them. The ground straps ensure a constant ground potential at all points on the grid. This grid is located under a false floor and connects directly to earth ground.
- o Floor Grid (not grounded) - The drives and controller are connected to a floor grid that is isolated from earth ground. In this case, the controller is connected directly to earth ground, which grounds the entire grid.
- o Daisy-Chain - The ground terminals on the drive are connected in a daisy-chain to one another and then to the controller which connects to earth ground.

NOTE

The daisy-chain method of grounding the system is not recommended in systems containing more than ten drives.

2.3 UNPACKING THE DRIVE

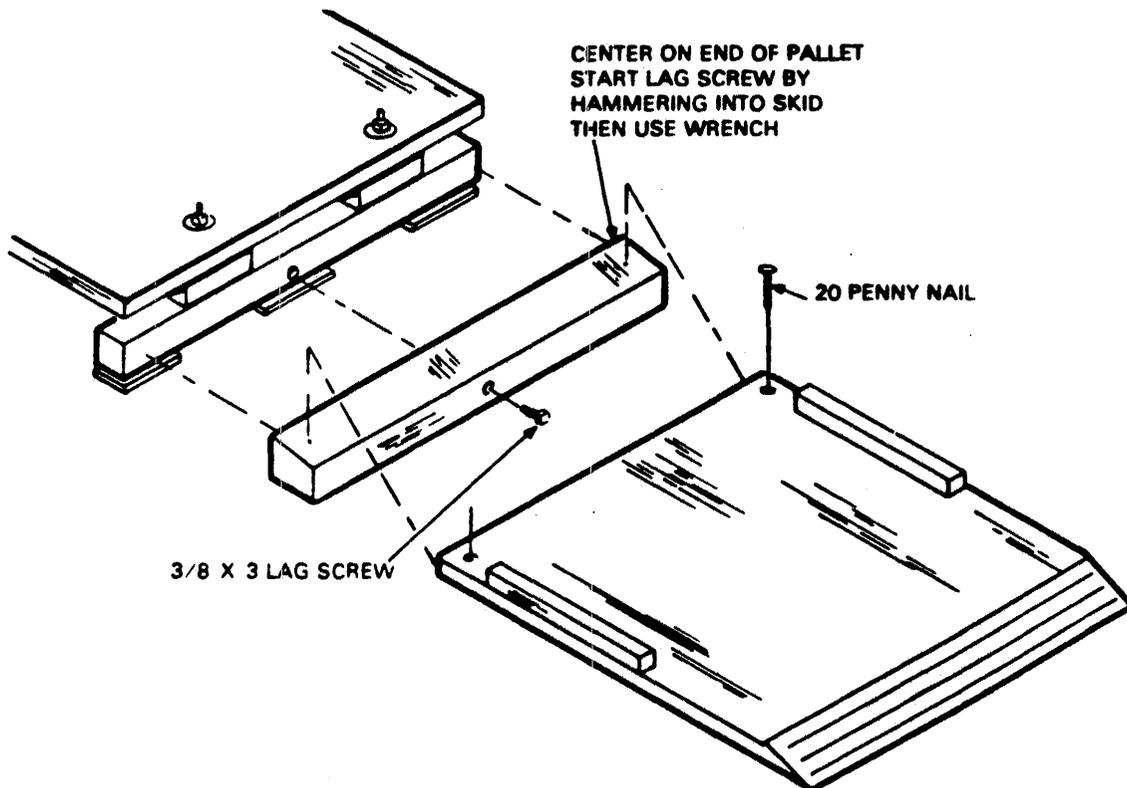
Both drive and adapter cabinets must be properly packed whenever they are shipped from one location to another. Use the procedures given below to unpack the units of the drive. Prior to unpacking the units, examine the cartons for any damage caused during shipment.

2.3.1 Unpacking the Drive Cabinet

Use the procedure below to unpack the drive cabinet.

1. Pry away four external 1 x 4s from the carton.

2. Lift off the corrugated cover from carton.
3. Remove the unloading ramp from top of carton.
4. Remove the strapping and wood framing by carefully prying the upright wood corners slightly away from the unit and lifting the carton off.
5. Remove the polyethylene dust cover from the drive.
6. Open the unit rear door and remove manuals, leveling legs, filter, and power cable. Logical address plugs are packed with the manuals. Close the rear door.
7. Install the ramp on the pallet (see Figure 2-2).
- 8a. If a lift truck or hoist is to be used, lift the cabinet clear of the pallet at this time. Remove the pallet and install the leveling legs before lowering the unit to the floor. Then proceed to step 10.
- 8b. If no lift track or hoist is available, then proceed to step 9.
9. Roll the drive cabinet down the ramp to the floor.



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Figure 2-2 Installing Ramp on Pallet

NOTE

Use the procedure given below to install leveling legs on the RM05 drive and the RM adapter cabinet.

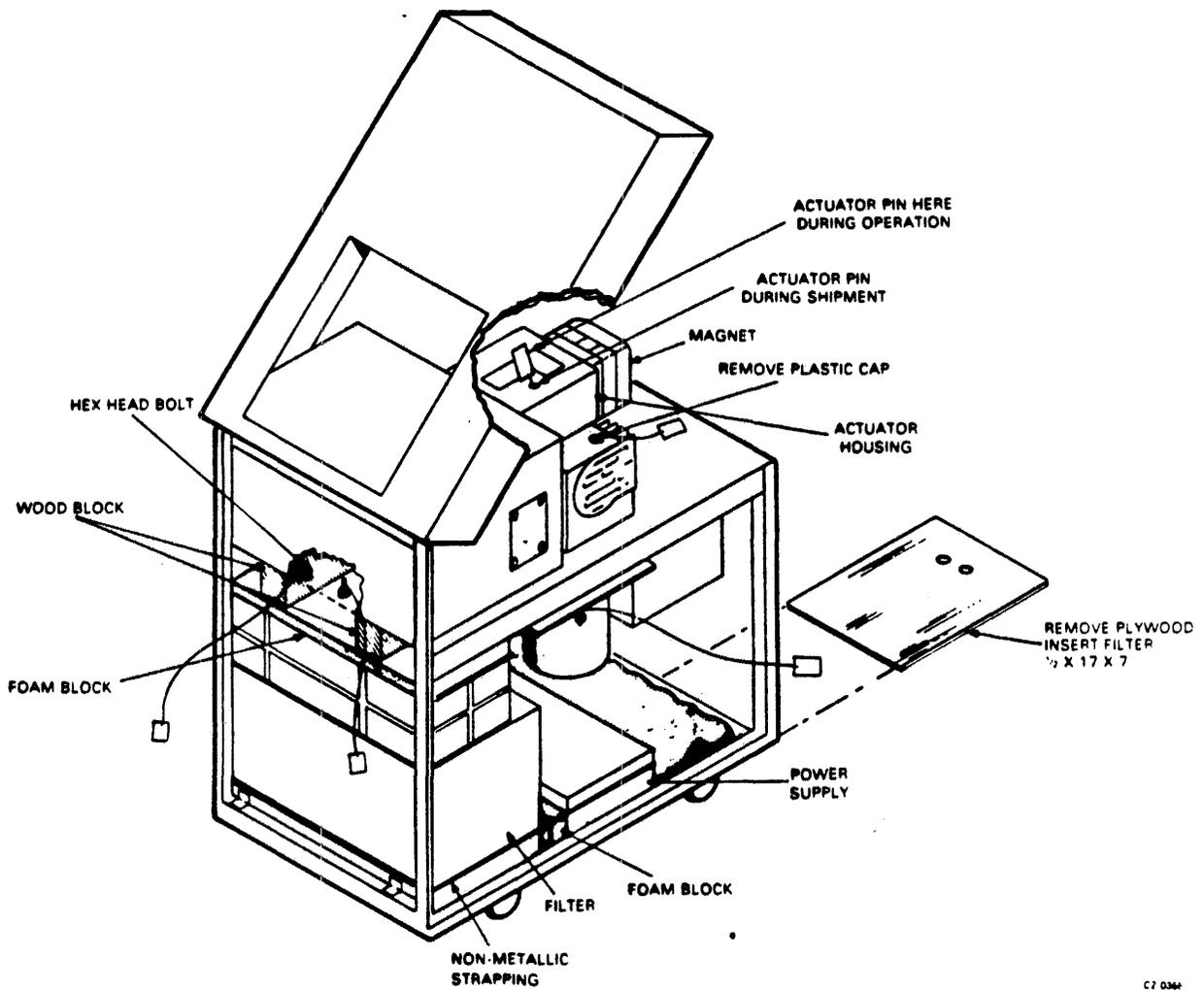
- o If the site has a raised floor, remove a panel from the raised floor and install leveling legs on the front of the cabinet. Replace the panel and repeat the procedure for the rear of the cabinet.
- o If the site does not have a raised floor, raise the cabinet off the floor and place a block of wood under the cabinet. Install legs. Remove the block of wood and repeat the procedure for the rear of the cabinet.

10. Insert the filter in the filter bracket under the front base frame. (See Figure 2-3.)
11. Open the front and rear doors, raise the top cover to the open latched position, and remove the actuator shield and the side panels. The rear door on VDE units have an additional latch. Use a 6mm Allen wrench to open this additional latch.

NOTE

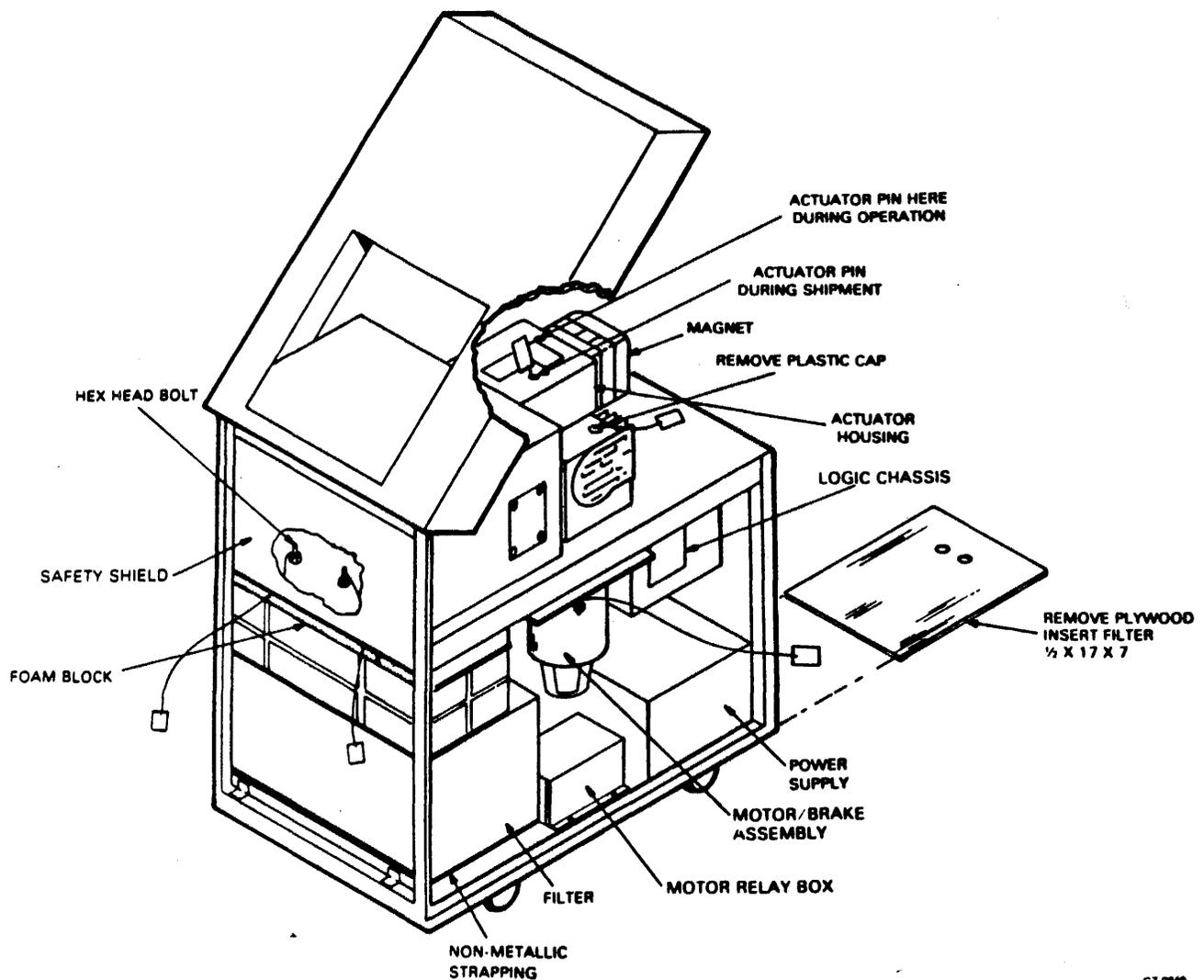
To perform Steps 12 through 20 for unpacking the RM05, refer to Figure 2-3 for NON-VDE units. Refer to Figure 2-3A for VDE units.

12. Remove the front deck hold-down screws between the upper frame and deck casting. (On units with a safety shield installed, remove the shield to remove items in steps 12 and 13.)
13. On NON-VDE UNITS, remove the two wood blocks adjacent to the screws between the deck casting and unit frame.
14. On VDE units, there are no wood blocks to remove.
15. Remove the foam block between the blower assembly and the deck casting.
16. Remove the two shipping screws in the motor plate.



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Figure 2-3 Unpacking NON-VDE RM05 Drive



CZ-0848

Figure 2-3A Unpacking RM05 VDE

17. Close the front door.
18. Remove the logic chassis latch tape.
19. Remove the plastic caps at the rear of the deck surface. Remove the rear deck hold-down screws below these caps, and then replace the caps.
20. Remove the shipping pin on the top of the actuator. Place pin in the adjacent storage hole.
21. Remove the strap and block from around and between the power supply and the blower assembly.
22. Attach the power cable. Refer to Figure 2-3.

23. Remove any remaining packing materials, then replace and close all covers and doors.

2.3.2 Unpacking RM Adapter Cabinet

Use the following procedure to unpack the RM adapter cabinet.

1. Remove two plastic straps which hold container together.
2. Remove plastic corners.
3. Remove top cover.
4. Remove four corrugated cardboard corner posts.
5. Remove the cardboard sleeve from around the cabinet by lifting it over the top of the cabinet.
6. Remove the polyethylene bag from the cabinet.
7. Remove the plastic strapping which attaches the cabinet to the pallet.
8. Remove the plastic corners which were under the plastic strapping.
9. Remove two 1/2 inch, 13 x 3 1/2 hex-head bolts which attach up through the corners of the pallet into holes in the floor of cabinet.
10. Remove the cabinet from the pallet. (The ramp provided with the drive cabinet may be used to roll the cabinet from pallet to floor.)
11. Lift the front of the cabinet several inches off the floor. Thread the leveling legs into the holes in corners of the cabinet.
12. Lower the front of the cabinet to floor.
13. Lift the rear of the cabinet several inches off the floor. Thread the leveling legs into holes in the corners of the cabinet.
14. Lower the front of the cabinet to the floor.
15. Remove any remaining packing residue.

2.3.3 Unpacking RM Adapter

Use the following procedure to unpack the RM adapters not shipped in an RM adapter cabinet.

1. Remove the straps that secure the carton to the pallet.

2. Remove the plastic corners and tape used to close the top of carton.
3. Remove the polyester foam piece from the top of the carton.
4. Remove the die-cut top from the inner carton.
5. Remove the adapter from the inner carton.
6. Unwrap the bubble wrap from the adapter.
7. Remove any remaining packing residue.
8. Set the adapter on the upper rails of the adapter cabinet.

2.4 DRIVE INSTALLATION PROCEDURES

This paragraph describes the installation of the drive. These procedures assume that the requirements discussed under site preparation have been met.

All the procedures listed below should be considered in the order presented. However, this order may have to be varied somewhat to meet requirements of specific installations.

- o Preinstallation inspection
- o Grounding
- o AC power wiring
- o Power cable routing
- o I/O cable installation
- o Logical address plug installation
- o Cabinet leveling

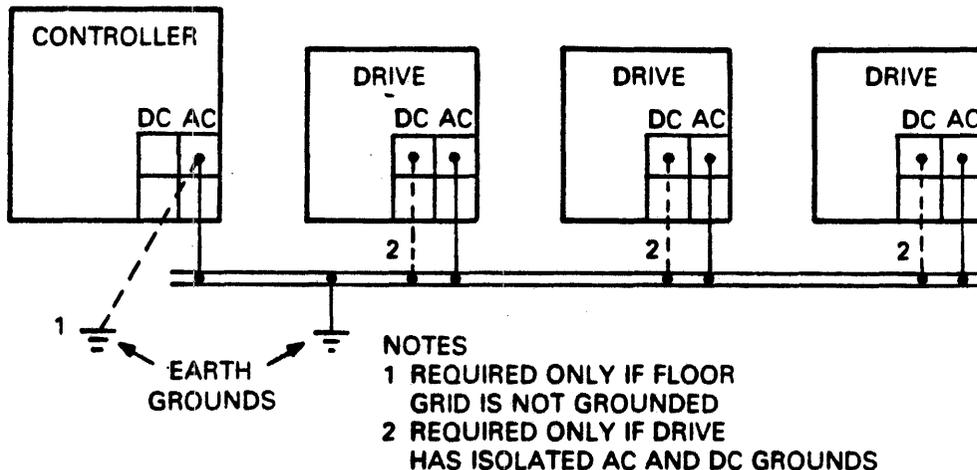
2.4.1 Preinstallation Inspection

Perform the following inspection prior to installing the RM05 Disk Drive.

1. Inspect the drive for possible shipping damage. Any claim for this type of damage should be filed promptly with the transporter involved. If a claim is filed, save the original shipping materials.
2. Verify that all logic cards are firmly seated in logic chassis.
3. Verify that all connectors are firmly seated, and tighten any loose hardware.
4. Verify that the control panel is firmly seated in front bezel.

5. Verify that all cabling is intact and that there are no broken or damaged wires.
6. Check entire drive for presence of foreign material which could cause an electrical short.
7. Check actuator and pack area for presence of material which could obstruct movement of carriage and heads.

2.4.2 Daisy-Chain Grounding - If a floor grid is not available, (refer to Figure 2-4) all drives must be connected to the controller in a daisy-chain grounding configuration (refer to Figure 2-5). The CPU cabinet must then be connected to earth ground. When connected in this configuration, the drive must have a common ac and dc ground. Therefore, the jumper on the grounding block must be connected (refer to Figure 2-5). This procedure is described below.



CZ-0122

Figure 2-4 Grounding to Floor Grid

1. Cut lengths of number four black grounding wire required to go from drive to drive, the first drive in the chain to the CPU cabinet and from the CPU cabinet to earth ground.
2. Crimp and solder terminal lugs to ends of each strap.
3. Connect the straps to the terminal of the grounding block, route straps through I/O cable guide and connect to each of the drives.
4. Connect the braided ground wire shipped with each drive between the drives and RM adapter cabinet.

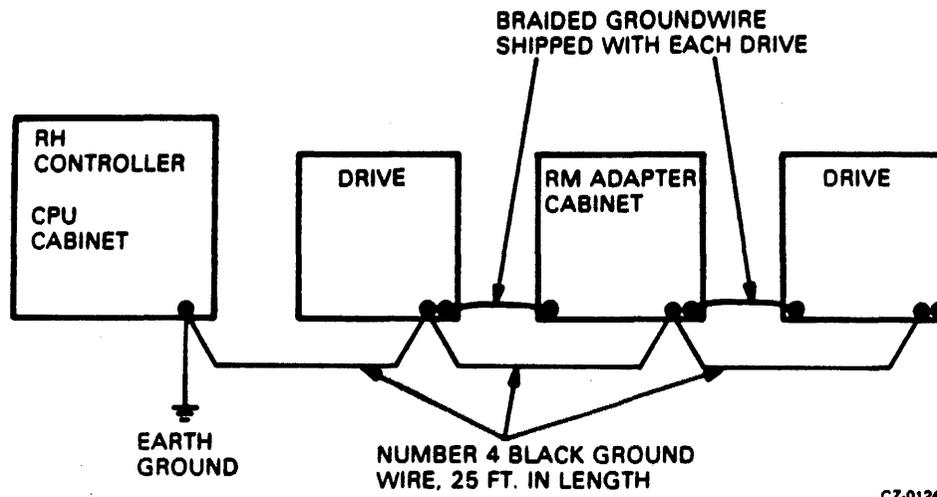


Figure 2-5 Daisy-Chain Grounding Connection

5. Ensure that the following conditions exist.
 - o All drives and RM Adapter are connected in daisy-chain.
 - o The drive closest to the CPU cabinet is connected to the CPU cabinet.
 - o The CPU cabinet is connected to earth ground.

2.4.3 AC Power Wiring

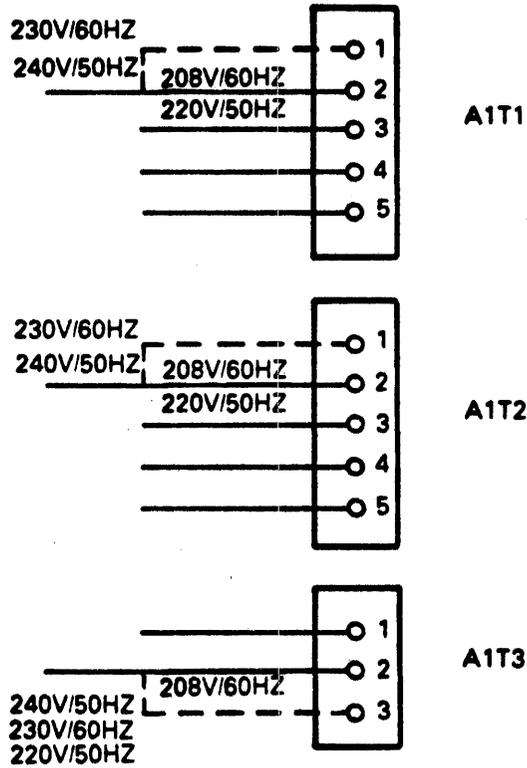
The NON-VDE drive comes from the factory wired for 208 volts, 60 Hz input power. It is possible to rewire the drive for 230 volts, 60 Hz by moving wires on transformers Alt1, Alt2, and Alt3. The required transformer wiring for each input voltage is shown on Figure 2-6. Note that a 60 Hz NON-VDE drive cannot be converted to 50 Hz without making additional changes (see paragraph 2.1).

2.4.3.1 VDE 50Hz To 60Hz Conversion - VDE units have the capability of being converted from 50 Hz to 60 Hz, or 60 Hz to 50 Hz. In some cases, converting from one power frequency to another requires that an operating voltage conversion be made. If only an operating voltage change is required (frequency remains the same), refer to Figure 2-6A for selection of the appropriate voltage taps. The following procedure details the steps required to convert a VDE unit from 50 Hz to 60 Hz, or 60 Hz to 50 Hz operation.

WARNING

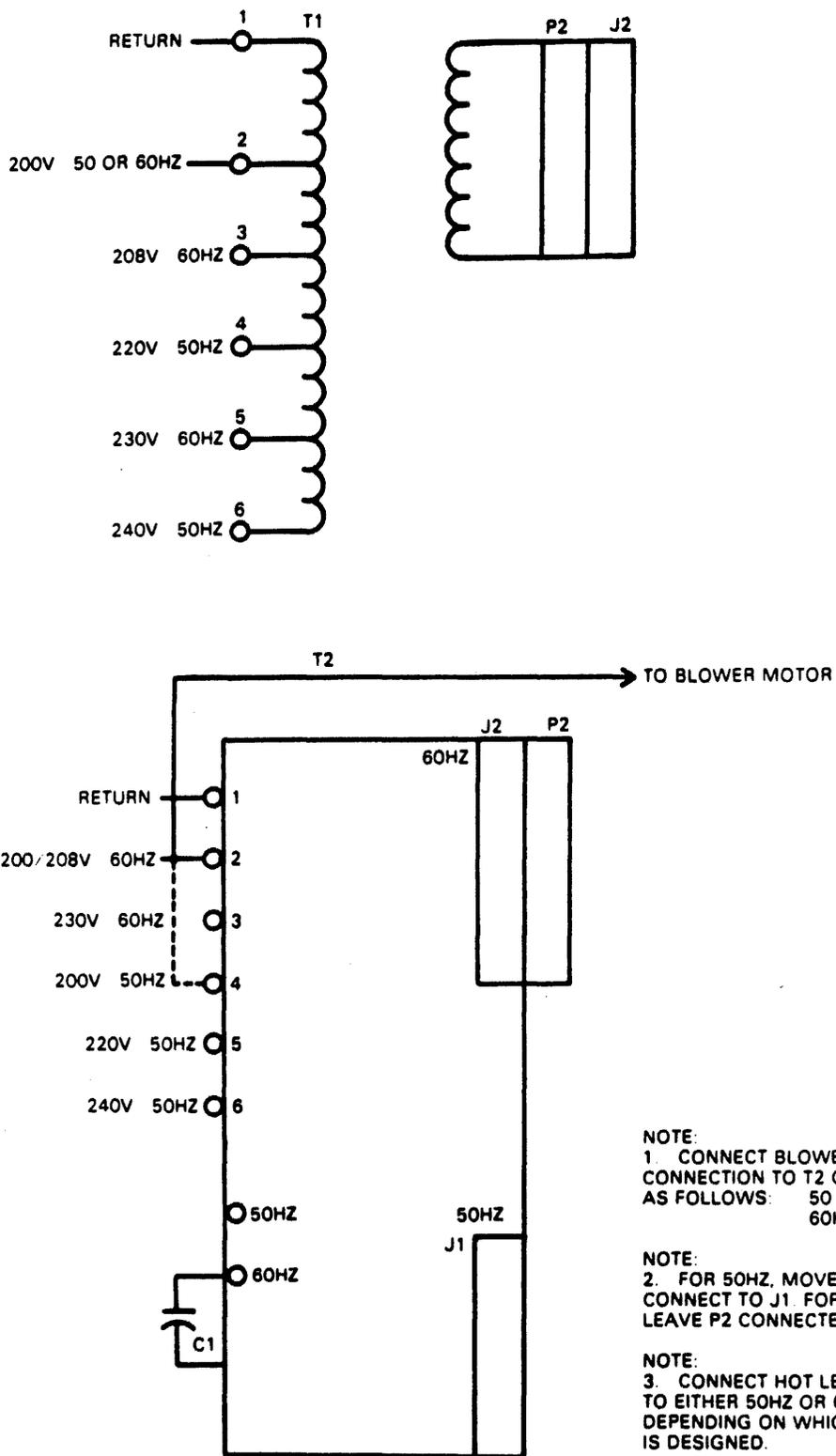
Disconnect all input power before performing any power conversions.

**TRANSFORMER
TERMINAL STRIP**



CZ-0125

**Figure 2-6 NON-VDE Transformer
Input Voltages**



CZ-0837

Figure 2-6A VDE Transformer Input Voltages

2.4.3.2 Required Parts - The following parts are required to change the drive so it will operate on a different line frequency. Conversion from 60 Hz to 50 Hz requires that the listed parts be 50 Hz. Conversion from 50 Hz to 60 Hz requires 60 Hz parts.

PARTS	DEC PART Hz # 50	DEC PART Hz # 60
1. Drive motor and pully assembly	29-23896	29-23895
2. Drive belt	29-23584	29-23575
3. Hour meter	29-23898	29-23909
4. Power cord		

NOTE

Remove power connector supplied with power cord and replace with a power connector suitable for local power receptacles.

2.4.3.3 Conversion Procedure

1. Power down the drive.
2. Open the rear door, raise the top cover, and remove the right side panel.
3. Disconnect the power cord at the power source and at the Connector on the power supply control panel.
4. Remove the power supply top cover.
5. Refer to Figure 2-6A and determine the input tap on transformer T1 that matches the required operating voltage and frequency. Reposition the T1 input (hot) lead to the appropriate tap.
6. Discharge the tuning capacitor (C1) on transformer T2.
7. Reposition the tuning capacitor (+) lead on the appropriate 50 Hz or 60 Hz terminal.
8. Reposition plug P2 on the appropriate transformer T2 output cable jack. P2 must connect to J1 for 60 Hz, or J2 for 50 Hz operation.

9. Refer to logic diagram cross reference number 804 and determine the input tap on transformer T2 that matches the required operating voltage. Reposition the input lead (hot) to the appropriate tap.
10. Remove the hour meter and replace it with the appropriate 50 Hz or 60 Hz unit.
11. Carefully check the power supply for properly routed cables, loose connections, and lead dress.
12. Install the power supply cover.
13. Remove the drive motor and brake assembly using the procedure in Chapter 4 of this manual.
14. Obtain and drive motor and pulley assembly, and a drive belt with the required voltage and frequency ratings.
15. Remove the hysteresis brake from the existing motor. Assemble it on the new motor using the procedure in Chapter 4 of this manual.
16. Install the motor and brake assembly, and drive belt, into the drive using the procedure in Chapter 4 of this manual.
17. Obtain the required power cord (60 Hz or 50 Hz) and install it.
18. Connect the power cord.
19. Power up the drive and check all voltages at the test points on the power supply control panel.
20. Close the top cover and rear door.

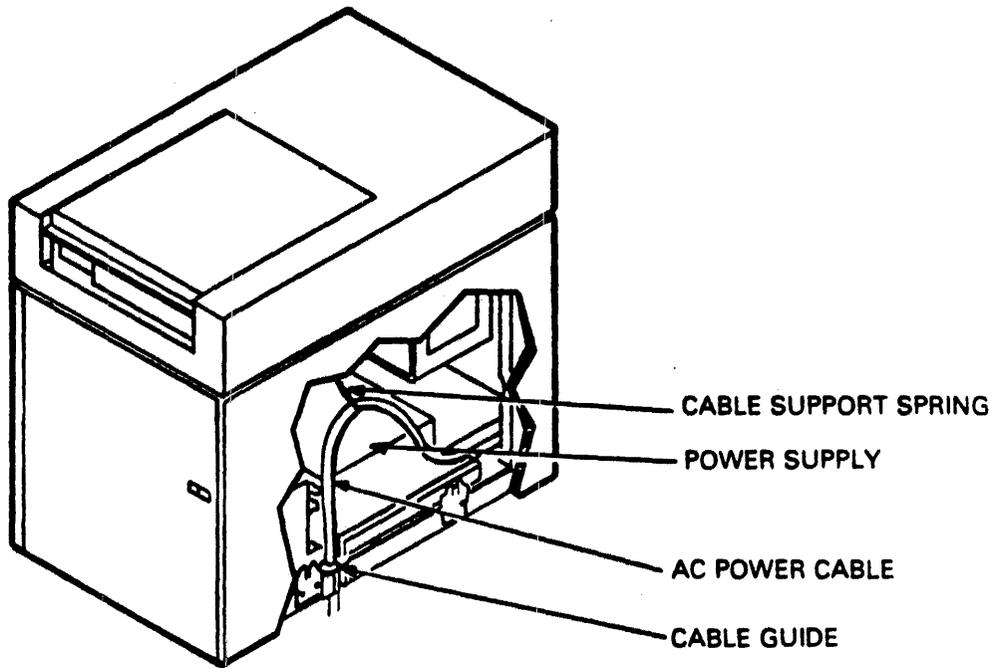
2.4.4 Drive Power Cable Routing

The drive power cable is routed and connected as shown below (refer to Figure 2-7 and 2-7A).

1. Remove screws securing cable guide to frame and remove cable guide.

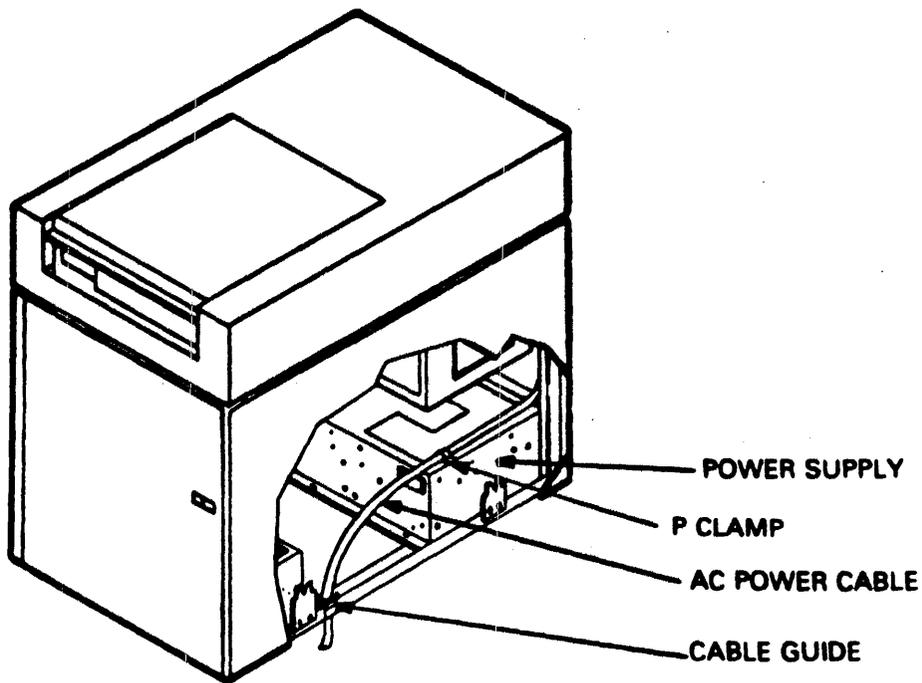
WARNING

Ensure MAIN AC circuit breaker on the wall is set to OFF when connecting power cable.



CZ-0126

Figure 2-7 NON-VDE Power Cable Routing



CZ-0842

Figure 2-7A VDE Power Cable Routing

2. Route power cable through cable guide and connect to power receptacle.
3. Position cable guide on frame and secure with screws.
4. Connect support spring to power cable.
5. Connect power cable using cable clamp. Refer to Figure 2-7A.

WARNING

Ensure ac power wiring procedure has been properly performed before connecting power cord connector to site source.

6. Connect power cord connector to site power source connection.
7. Turn all CB's off except main CB. Check power and turn all other CB's on, checking voltages.

2.4.5 I/O Cable Installations

This procedure describes the installation of drive I/O cables.

1. Remove power from drive by setting site MAIN AC circuit breaker to OFF.
2. Remove left side panel. To remove side panel you must first open rear door, then raise the top cover. This is required because of the safety latches on the side panels.
3. Remove screws securing I/O cable guide (refer to Figure 2-8) and remove guide.

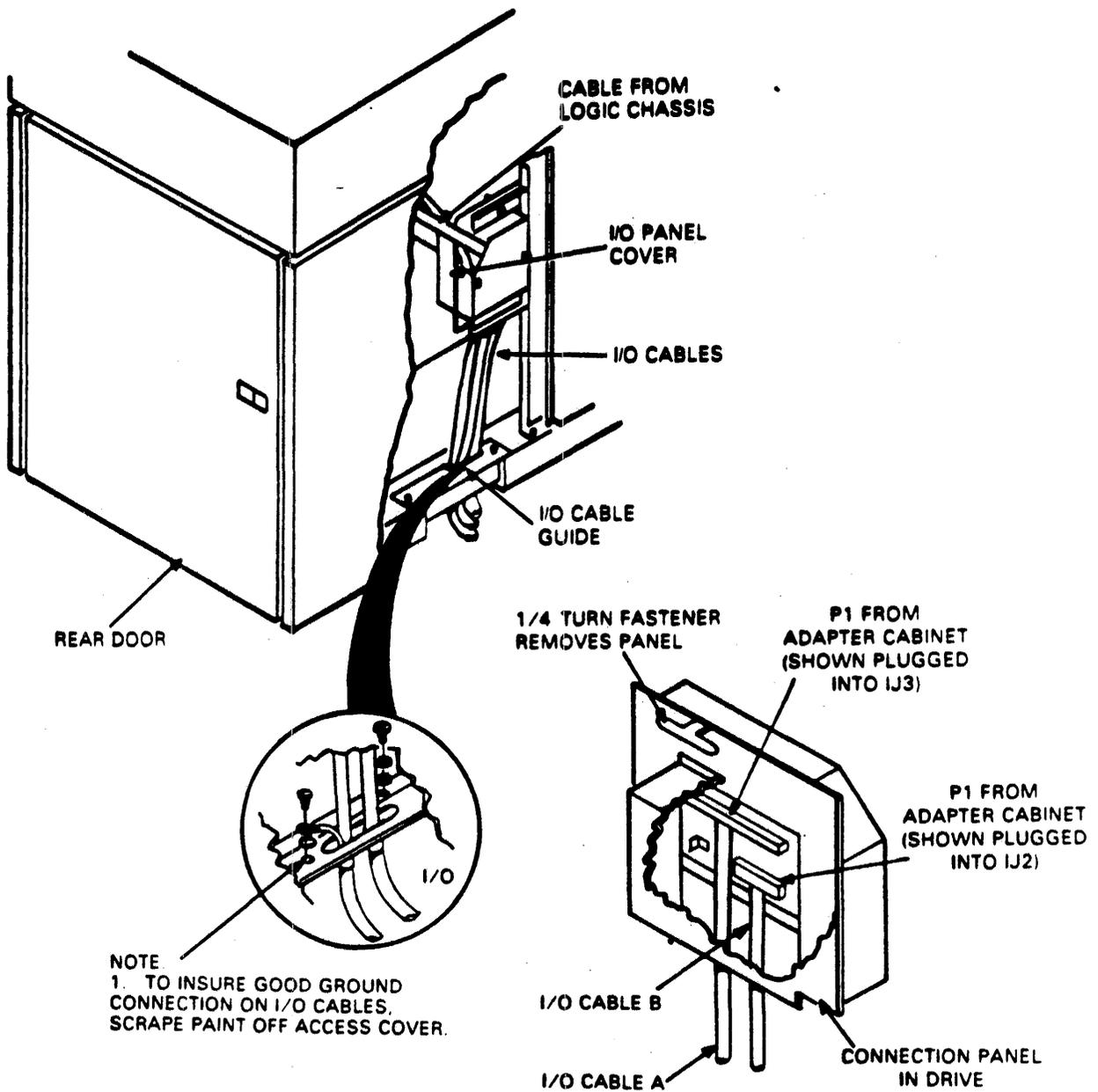
CAUTION

Use care not to damage cables between I/O panel and logic chassis when performing the following steps.

4. Turn I/O panel fastener (refer to Figure 2-8) counter-clockwise and remove I/O panel from upright support. This will allow I/O panel to be positioned so cables can be easily installed.
5. Remove hardware securing I/O panel cover to I/O panel and remove cover.

NOTE

All cables installed in the following steps are routed through the I/O cable cutoff (opening left by removal of cable guide).



CZ-0643

Figure 2-8 I/O Cable Routing

6. Connect cable B from adapter to drive I/O panel connector IJ2.
7. Connect cable A from adapter to drive I/O panel connector IJ3.
8. Replace I/O panel cover on I/O panel and secure.
9. Position I/O panel on upright support and secure.
10. Replace I/O cable guide ensuring the cables are routed as shown in Figure 2-8.
11. Replace left side panel.

2.4.6 Logical Address Plug Installation

The RM05 Disk Drive can have any logical address from 0 to 7. The address of a particular unit is determined by the logical address plug installed on the operator control panel. Determine the logical address of the drive in the system and install the proper logical address plug.

NOTE

Only one unique number is allowed on the Massbus irregardless of the port selected.

2.4.7 RM Adapter Cabling

Use the procedure given below to install the ac power cable, MASSBUS cables, cables A (60 position) and B (26 position), power sequence cable, and frame grounding cables. It is important to follow the procedures outlined to allow enough slack in cables so adapters can be pushed to front and rear ends of slides for maintenance. These procedures will also help ensure that cables do not catch or bind as the adapters are moved for access.

Prepare the adapter cabinet for cable installation by performing the tasks listed below.

Remove front door.

1. Unlock the door
2. Remove the ground braid.
3. Pull down the upper hinge pin (spring-loaded).
4. Lift the door clear of the bottom hinge pin and set the door aside.

Remove rear door.

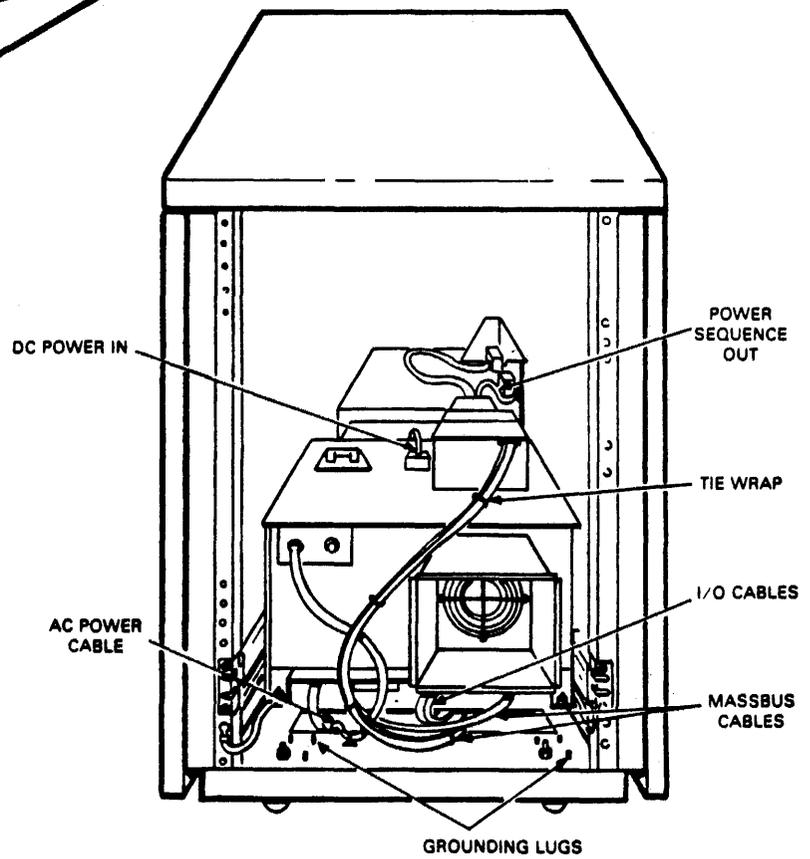
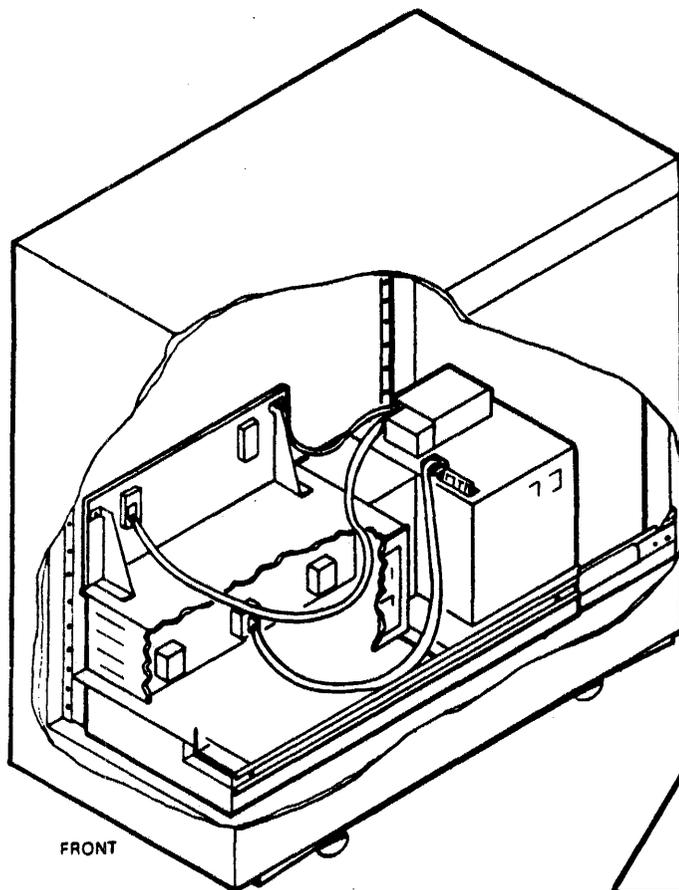
1. Unlock the door with Allen wrench (6 mm).
2. Remove the ground braid.
3. Lift the door to clear hinge pins from the hinge brackets and set the door aside.

Remove shipping bracket.

1. Remove six Phillips head screws holding the red shipping bracket in place at rear of the RM adapter cabinet.
2. Set the bracket aside. (Save the bracket in case the cabinet must be shipped at some future date.)
3. Replace and tighten the six Phillips head screws in the holes they came out of in the cabinet.

2.4.7.1 Adapter AC Power Cable Routing - Use the procedure given below to route the ac power cable (see Figure 2-9).

1. Cut ties on power cable.
2. Fasten the adhesive tie wrap mount to the side of the plenum. Place mount against the rear flange of plenum, 1-1/4 inches down from top.
3. Fasten the power cable to the tie wrap.
4. Push the adapter full forward on the slides, till it locks.
5. Remove the cable access slot cover from the bottom of the cabinet.
6. Put the power cable through the cable access slot in the bottom of cabinet.
7. Fasten the adhesive tie wrap mount to the floor of the cabinet. Place the mount 1/2 inch to the rear of the cable access slot in line with the adhesive tie wrap mount on plenum.
8. Adjust the power cable to provide some slack and tighten the tie wrap.



C2-0271

Figure 2-9 Cabling Single-Port Drive (Single Adapter)

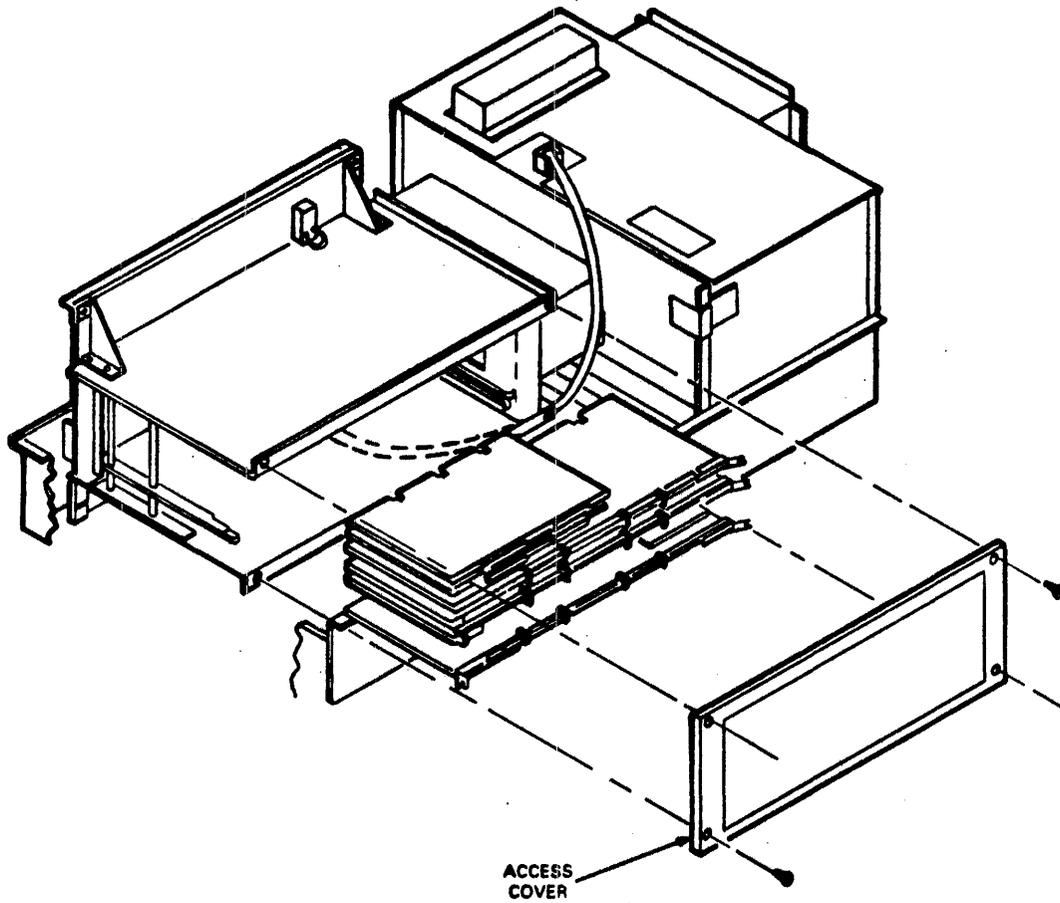
2.4.7.2 MASSBUS and Power Sequence Cable Installation - Use the procedure given below to route and install the port-A-in cable.

1. Bring the adapter end of the cable in through the cable access slot in the bottom of the cabinet. Bring in at the left side of the slot as viewed from the rear. Allow about five feet of cable inside of the cabinet.
2. Fasten the adhesive tie wrap mount on the floor of the cabinet directly below the left rear corner of the plenum. Make sure the adapter is pushed fully forward for proper positioning.
3. Tie the cable loosely with the tie wrap. It will be tightened later.
4. Make an eight inch clockwise service loop with the cable. Start the loop by passing the MASSBUS cable under the ac power cable. Finish the loop by passing the MASSBUS cable over the power cord.
5. Pass the connector end of the cable through the adapter cable access on the left side of the adapter, as seen from the rear.
6. Connect the cable to port-A-in connector J3 on the adapter backplane.
7. Remove the cable clamp from the the adapter card cage.
8. Place the cable in the clamp, reinstall clamp, and tighten.
9. Pull the excess MASSBUS cable back out of the cabinet, maintaining an eight inch service loop with the adapter fully forward.
10. Tighten the tie wrap that was loosely fastened in step 3.
11. If the adapter is the last one in a daisy-chain, install the MASSBUS terminator on connector J2, and go to step 13. Otherwise, go to step 12.
12. If this adapter is not the last in a daisy-chain, bring the power sequence cable and MASSBUS cable port-A-out into the cabinet through the cable access slot. Allow about 5-1/2 feet of cable. When viewed from the rear, bring these cables in at the right rear of the cable access slot.

13. Run cables over the top of the adapter power supply and then connect the MASSBUS cable port-A-out to connector J2 and the power sequence cable to connector J9 of the adapter backplane.
14. Remove the cable clamp from the card cage.
15. Place the cables in the clamp, reinstall clamp, and tighten down.
16. Release the locks and push the adapter to the full rear position.
17. Remove the cable clamp from the power supply cover.
18. Place the cables on right-hand side of the regulator, reinstall the clamp, and tighten down. (See Figure 2-9.)
19. With the adapter fully to the rear, pull the excess cable back through the cable access slot in bottom of the cabinet.

2.4.7.3 Cable A (60 Position) Installation - Use the procedure given below to properly install cable A from the drive cabinet to the lower RM Adapter.

1. Push the adapter fully to the front.
2. Remove the access cover from the adapter card cage (Figure 2-10).
3. Remove M7687 and M7684 modules from the card cage.
4. Pass about 4-1/2 feet of cable A through the cable access slot in bottom of the cabinet. Ground the cable to the access cover using ground attached to cable. See detail on Figure 2-11 for proper grounding.
5. Route the cable forward, under the ac power cable and through the MASSBUS service loop.
6. Bring the cable through A/B cable access hole along the bottom side of the card cage to the front of the adapter.
7. Plug the cable connector into M7684 module, with the label facing up.
8. Guide the cable through the card guide and plug M7684 into the adapter backplane slot A/F09.



CARD LOCATOR CHART

	A	B	C	D	E	F	
1	FRONT ←					M5923	1
2							2
3				M5922	M5923		3
4				M5922			4
5					M7686-YA		5
6					M7685-YA		6
7							7
8	TOP ←			M7687			8
9						M7684	9

C2-0272

Figure 2-10 Adapter Card Cage

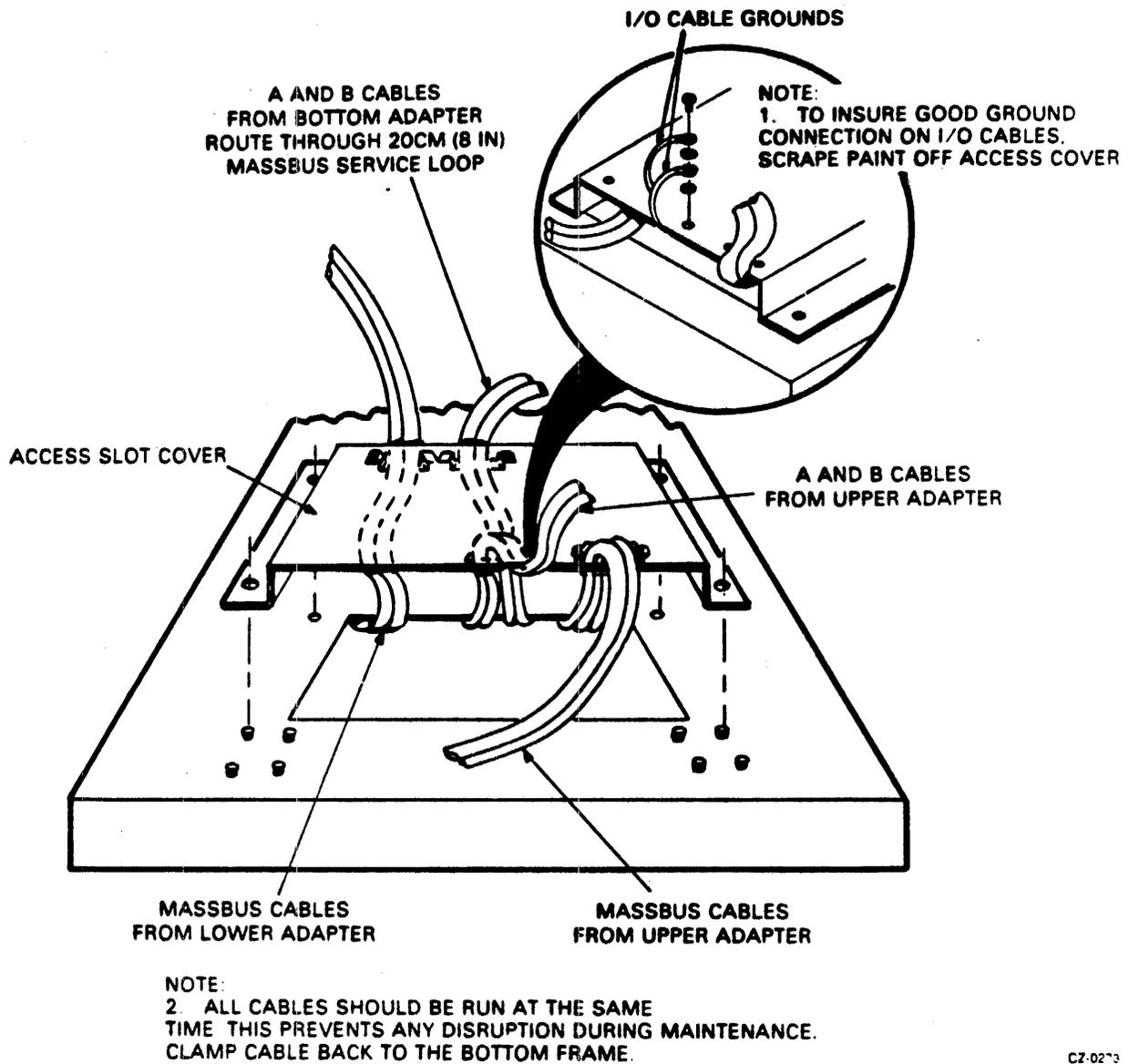
2.4.7.4 Cable B (26 Position) Installation - Use the procedure given below to properly install cable B from the drive cabinet to the lower RM Adapter.

1. Pass about 4-1/2 feet of cable B through the cable access slot in the bottom of the cabinet. Ground the cable to the access cover using the ground strap attached to the cable. See details in Figure 2-11 for proper grounding.
2. Route cable B underneath cable A to the front of the adapter.
3. Plug the cable connector into M7687 module with the label facing up.
4. Guide the cable through the card guide and plug M7687 into the adapter backplane slot E08.
5. Place the cables in the cable clamp and secure it.

2.4.7.5 Frame Grounding Procedure - There are two frame grounding studs on the floor of the adapter cabinet. One is at the left rear. The other is at the right rear (See Figure 2-11). Bring the frame ground wires from the drives and CPU or floor grounding grid into the appropriate side of the cable access slot and fasten to the grounding stud on that side of the cabinet.

2.4.7.6 Final Securing of Adapter Cabinet - Use the procedure given below to complete the cable installation and to prepare the adapter for operation. See Figure 2-11 for details.

1. Push the adapter fully forward.
2. Remove all the clamps from the cable access slot cover.
3. Place the cover loosely over the access slot.
4. Route the ac power cable and MASSBUS port-A-out cable over the cover and around the rear of the cover to exit the cabinet.
5. Route the MASSBUS port-A-in cable and cables A and B (60 and 26 position) under the front of the cover.
6. Place cables A and B in the clamp and loosely install the clamp on the underside of the access slot cover. Connect the ground straps as shown in detail in Figure 2-11 to the access cover.
7. Place the MASSBUS port-A-in cable in the clamp and loosely install the clamp on the underside of the access slot cover.



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Figure 2-11 Cable Access Slot Cover

8. Place the MASSBUS port-A-out cable and power sequence cable in the clamp and loosely install the clamp on the underside of the access slot cover.
9. Position the access slot cover over the mounting studs.
10. Adjust the cables for the proper service loops.
11. Tighten all the cable clamps.
12. Secure the cable access slot cover.

13. Tie wrap the cables as shown in Figure 2-9.
14. Slide the adapter to the center position, guiding the cables as required.
15. Install and close the front and rear doors.

2.4.8 Cabling Procedure for Second RM Adapter

Use the procedures given below for installation and cabling of the second RM adapter in the adapter cabinet.

1. Extend the top slides to forward position.
2. Set the adapter on slides.
3. Install the locking screws (see Figure 2-12).

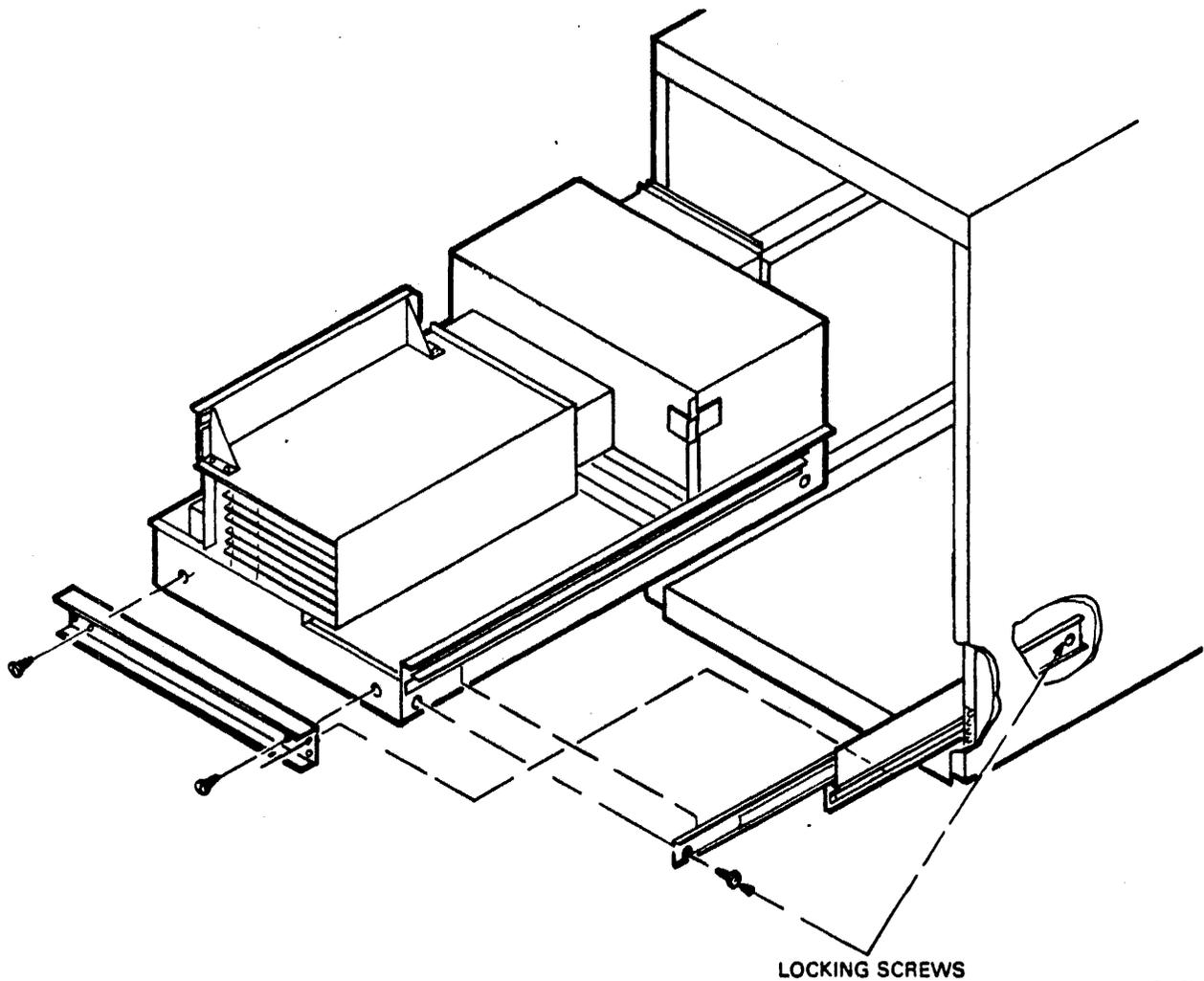


Figure 2-12 Adapter Rail Mounting

2.4.8.1 Adapter AC Power Cable Routing - Use the procedure given below to route the ac power cable from the upper RM Adapter.

1. Cut ties on the power cable.
2. Fasten the adhesive tie wrap mount to the side of the plenum. Place the mount in the center of the side of the plenum, flush with the top edge (see Figure 2-13).

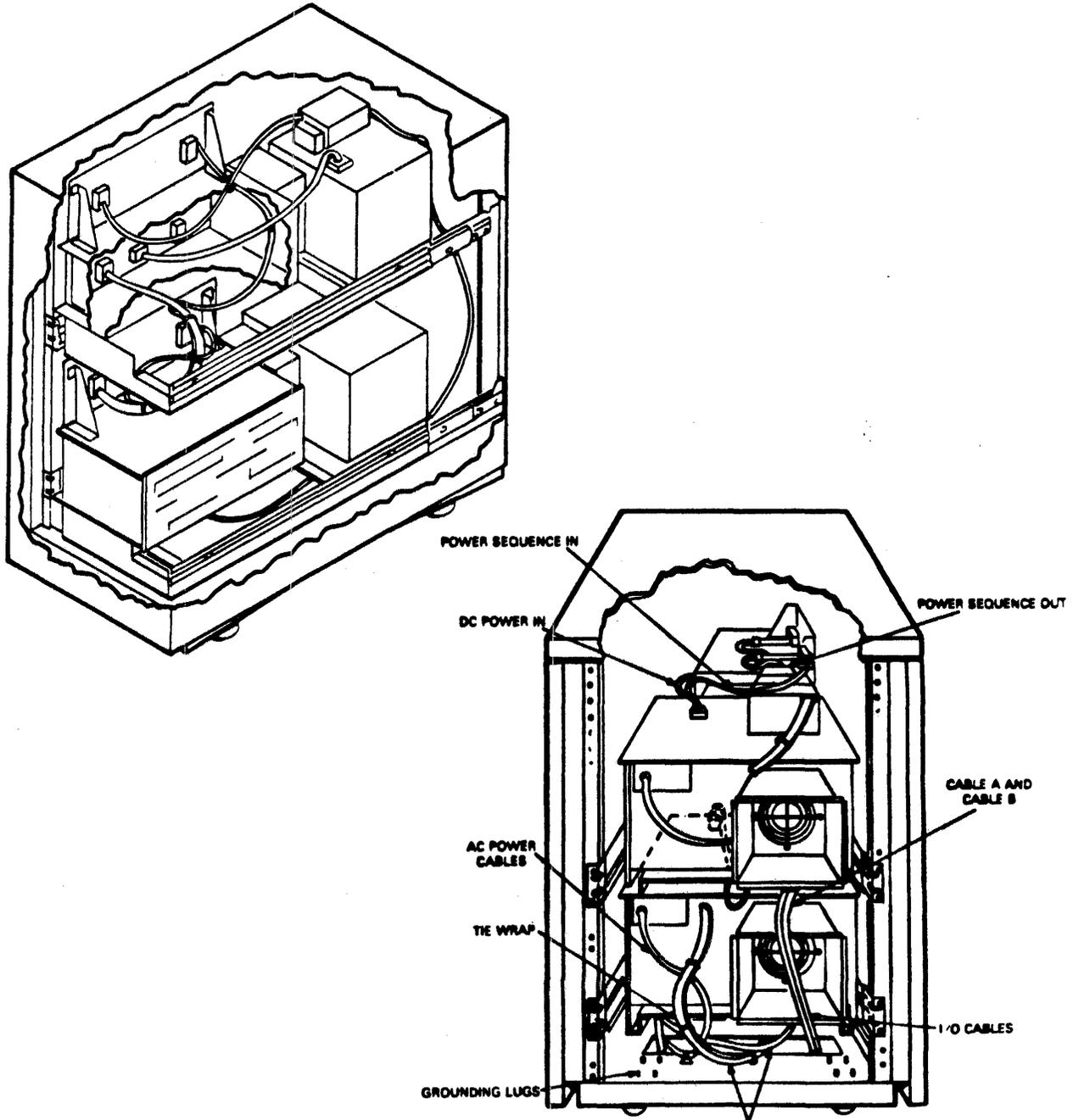


Figure 2-13 Cabling Second Adapter in Cabinet (Single-Port)

3. Plug the ac power cord into the ac power receptable (J4) in the lower adapter.
4. Push the adapter full forward on slides.
5. Coil the excess power cord and secure to tie wrap mount just installed on the side of the plenum.

2.4.8.2 MASSBUS and Power Sequence Cable Installation - Use the procedure given below to route and install the port-A-in cable to the upper RM Adapter.

1. Pull the lower adapter to the forward position.
2. Remove the terminator from the connector J2 of the lower adapter.
3. Connect the four foot MASSBUS port-A-in cable from connector J2 of the lower the adapter to connector J3 of the upper adapter (see Figure 2-13).
4. Make a clockwise service loop in the MASSBUS port-A-in cable, going from the lower to the upper adapter.
5. Secure the MASSBUS port-A-in cable to cable clamps on the lower and upper adapter.
6. Connect the five foot power sequence cable from connector J8 on the lower adapter to connector J9 on the upper adapter.
7. Make a clockwise service loop in the power sequence cable, going from the lower to the upper adapter.
8. Route the power sequence cable as shown in Figure 2-13.
9. Install the MASSBUS terminator on connector J2 of the upper adapter if this is the last adapter in a daisy-chain.
10. If it is not the last adapter in the daisy-chain, bring the MASSBUS port-A-out cable in through the cable access slot in the bottom of the cabinet.
11. Run the cables over the top of the adapter power supply and connect the MASSBUS cable port-A-out to connector J2 and the power sequence cable to connector J9 of the adapter backplane.
12. Remove the cable clamp from the card cage.
13. Place cables in the clamp, reinstall clamp, and tighten down.

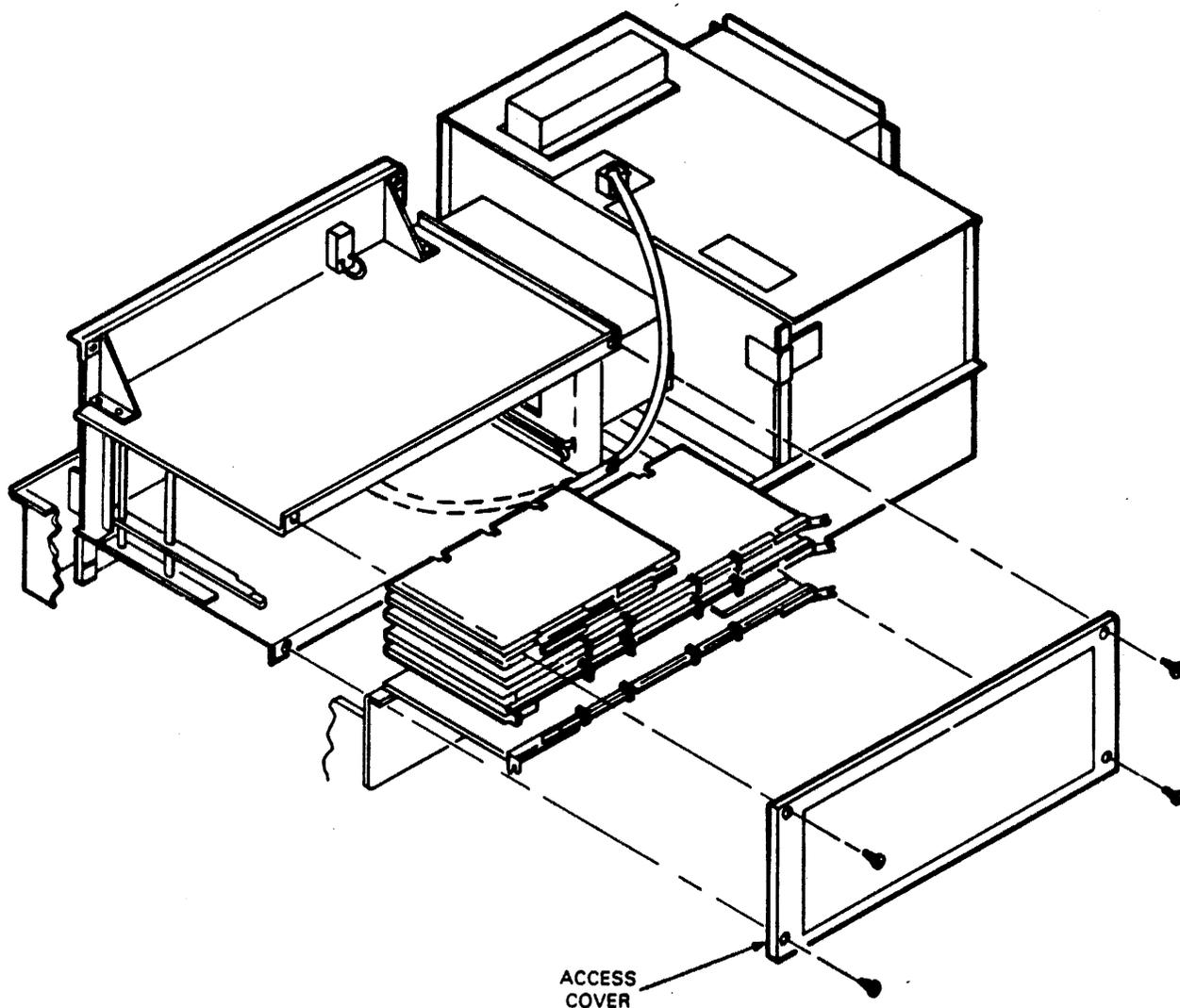
14. Release the locks and push adapter to full rear position.
15. Remove the cable clamp from power supply cover.
16. Place the cables on right-hand side of the regulator, reinstall clamp, and tighten down (see Figure 2-13).
17. With the adapter fully to the rear, pull the excess cable back through the cable access slot in the bottom of the cabinet.

2.4.8.3 Cable A (60 Position) Installation - Use the procedure given below to properly install cable A from the drive cabinet to the upper RM Adapter.

1. Push the adapter fully to the front.
2. Remove the access cover from the adapter card cage (Figure 2-14).
3. Remove M7687 and M7684 modules from the card cage.
4. Pass about 4-1/2 feet of cable A through the cable access slot in the bottom of the cabinet. It will go to the rear of the cable access slot cover. Connect the ground strap on the cable to the access cover. Refer to detail in Figure 2-15.
5. Bring the cable forward through the A/B cable access hole along the bottom side of the card cage to the front of the adapter.
6. Plug the cable connector into M7684 module with the label facing up.
7. Guide the cable through the card guide and plug M7684 into the adapter backplane slot A/F09.

2.4.8.4 Cable B (26 Position) Installation - Use the procedure given below to properly install the B cable from the drive cabinet to the upper RM Adapter.

1. Pass about 4-1/2 feet of cable B through the cable access slot in the bottom of the cabinet. It will go to the rear of the cable access slot cover. Connect the ground strap on the cable to the access cover. Refer to detail in Figure 2-15.
2. Route cable B beside cable A to the front of the adapter.
3. Plug the cable connector into M7687 module with the label facing up.

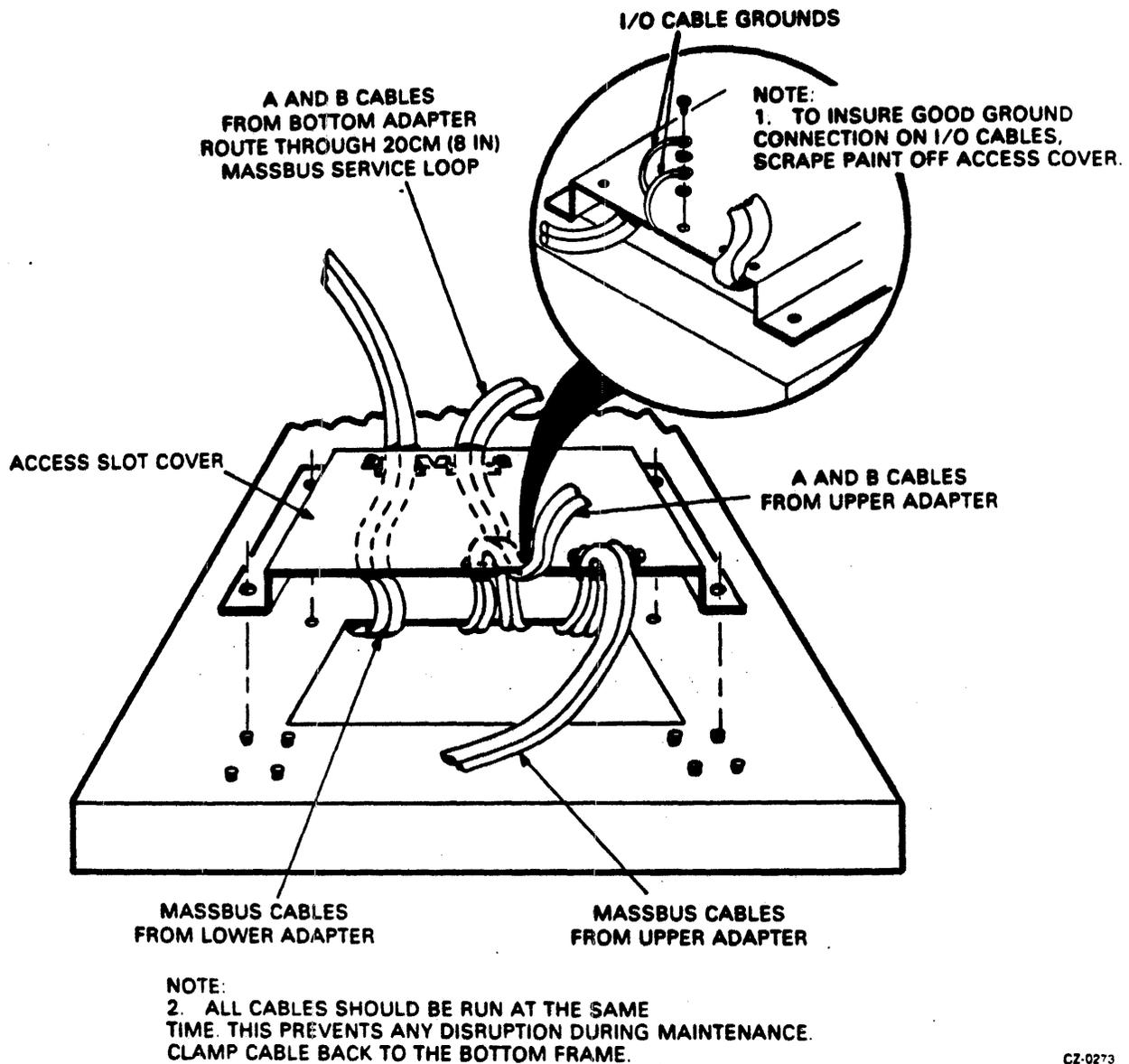


CARD LOCATOR CHART

	A	B	C	D	E	F	
1	FRONT ←		---	---	---	M5923	1
2			---				2
3					M5922	M5923	3
4					M5922		4
5						M7686-YA	5
6						M7685-YA	6
7							7
8	TOP ←			M7687	---		8
9						M7684	9

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Figure 2-14 Adapter Card Cage (Upper Adapter)



CZ-0273

Figure 2-15 Cable Access Slot Cover (Two Adapters)

4. Guide the cable through the card guide and plug M7687 into the adapter backplane slot E08.
5. Fasten the cable clamp on the bottom of the adapter about two inches from the front edge of the card cage to secure cables A and B.
6. Place the cables in the cable clamp and secure clamp.

2.4.8.5 Frame Grounding Procedure - There are two frame grounding studs on the floor of the adapter cabinet. One is at the left rear. The other is at the right rear (See Figure 2-15). Bring the frame ground wires from the drives and CPU or floor grounding grid into the appropriate side of the cable access slot and fasten to the grounding stud on that side of the cabinet.

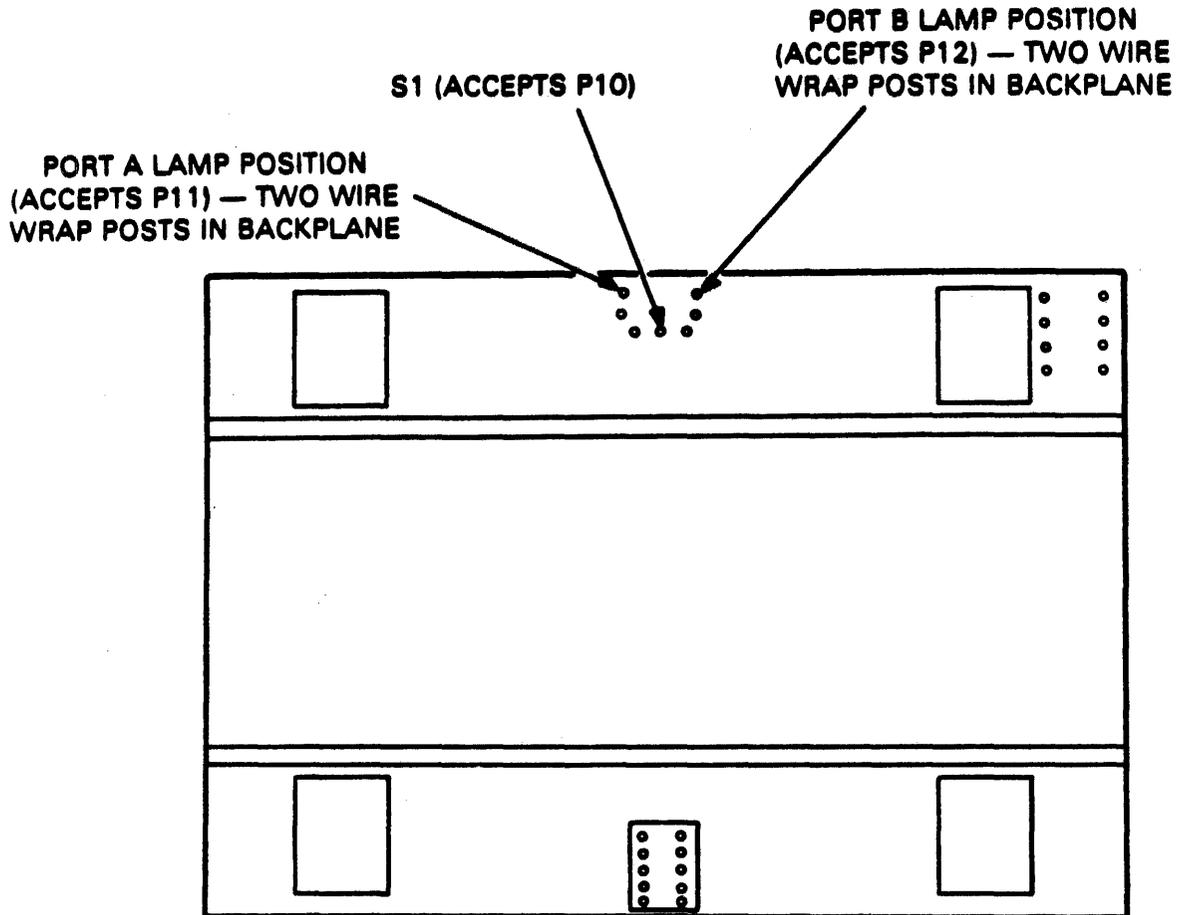
2.4.8.6 Final Securing of Adapter Cabinet - Use the procedure given below to complete the cable installation and to prepare the adapter for operation. See Figure 2-15 for details.

1. Push the adapter fully forward.
2. Remove all the clamps from the cable access slot cover.
3. Place the cover loosely over the access slot.
4. Route the ac power cable and MASSBUS port-A-out cable over the cover and around the rear of the cover to exit the cabinet.
5. Route the MASSBUS port-A-in cable and cables A and B under the front of the cover.
6. Place the A and B cables in the clamp and loosely install the clamp on the underside of the access slot cover. Connect the ground connection (as detailed in Figure 2-15) to the access cover.
7. Place the MASSBUS port-A-in cable in the clamp and loosely install the clamp on the underside of the access slot cover.
8. Place the MASSBUS port-A-out cable and power sequence cable in the clamp and loosely install the clamp on the underside of access slot cover.
9. Position the access slot cover over the mounting studs.
10. Adjust the cables for proper service loops.
11. Tighten all the cable clamps.
12. Secure the cable access slot cover.
13. Tie the wrap cables as shown on Figure 2-13.
14. Slide the adapter to the center position, guiding cables as required.
15. Install and close the front and rear doors.

2.4.9 Dual-Port Option (Lower RM Adapter)

Prepare the adapter cabinet for dual port installation as shown below.

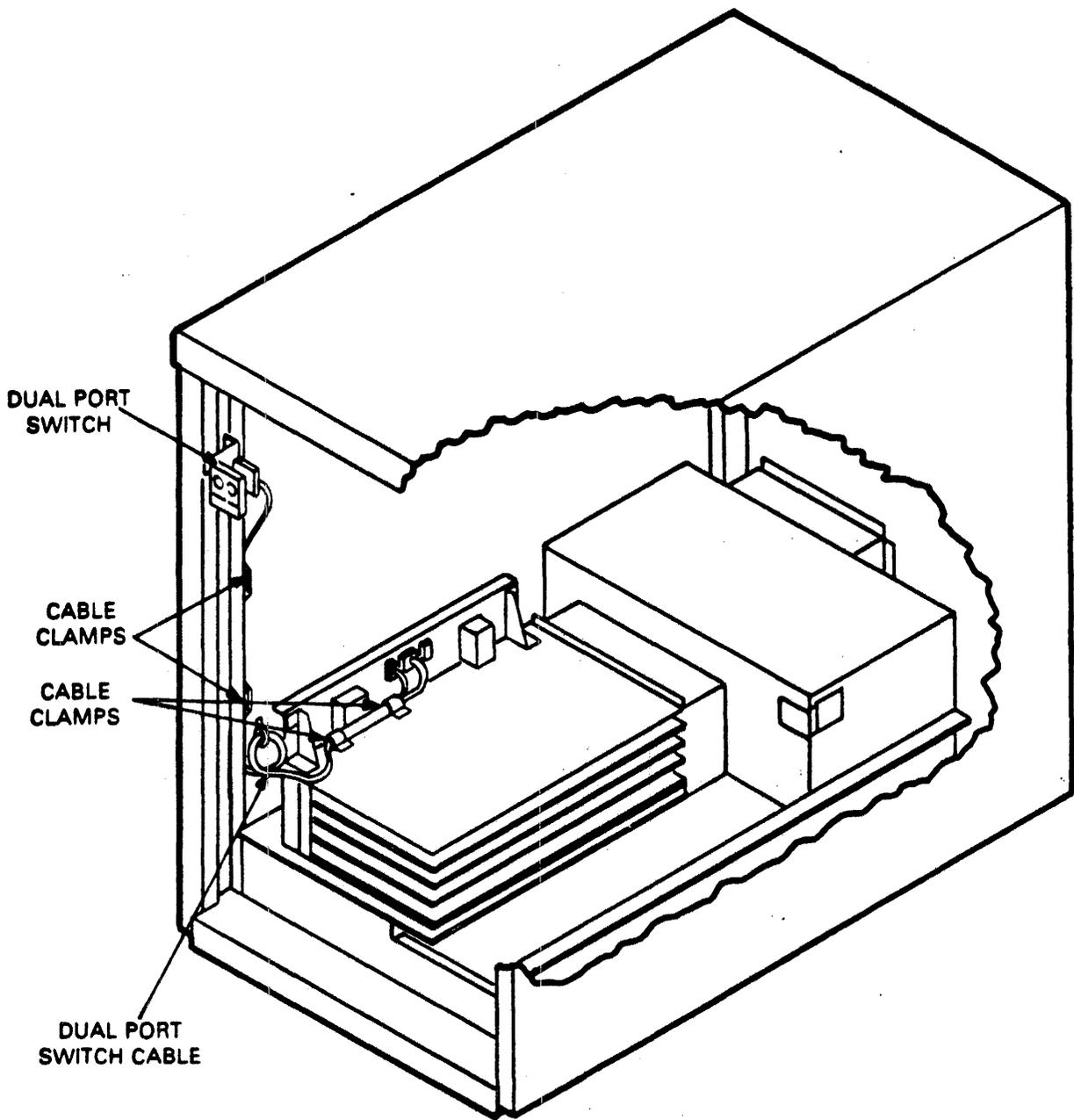
1. Cycle down the drive (if necessary) and power off the drive/adapter.
2. Remove the front door and appropriate the dual port switch cover plate
 - a. Unlock the door with an Allen wrench.
 - b. Remove the ground braid from the door.
 - c. Pull down the upper hinge pin (spring-loaded).
 - d. Lift the door clear of the bottom hinge pin and set aside.
 - e. Remove the appropriate dual-port switch cover plate from the front of the cabinet and set aside.
3. Remove the rear door.
 - a. Unlock the door with an Allen wrench.
 - b. Remove the ground braid from the door.
 - c. Lift the door to clear the hinge pins from the hinge brackets and set the door aside.
4. Push the adapter to forward stop on slides.
5. Check the adapter backplane for a dual-port toggle switch and two LEDs. If installed, proceed to the next step. If not, go to step 7. (Refer to Figure 2-16 for location of switch and LEDs).
6. Toggle switch and LED removal/replacement.
 - a. Unsolder the two LEDs and the toggle switch from the backplane using a low wattage soldering pencil.
 - b. Install one 3-pin female connector in the position where the toggle switch was located.
 - c. Install the two 2-pin connectors in the positions where the LEDs were located. The connector labeled "A" should be installed on the left side of the female connector and the connector labeled "B" on the right side.



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Figure 2-16 Adapter Backplane (Lower Adapter)

7. Remove the single-port jumper wire from connector J1 (wirewrap post) on the adapter backplane.
8. Install two M5923 modules in slots 1 and 2 (rows C-F) of the card cage.
9. Install the new dual-port switch assembly in the upper door hinge pin bracket. (Refer to Figure 2-17.)



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Figure 2-17 Dual-Port Switch (Single Adapter)

10. Route the switch assembly cable.
 - a. Install a tie wrap block on the chassis frame channel about 14 inches from the bottom of the channel (refer to Figure 2-16).

- b. Route the switch assembly cable through the chassis frame channel toward the adapter cabinet.
 - c. Place the cable through the tie wrap block installed in step 10a.
 - d. Install a tie wrap block on the backplane about two inches above the front corner of the backplane cover.
 - e. Route the switch assembly cable along the backplane, through the tie wrap block installed in step 10d and along the front of the backplane to the connectors installed in step 6.
11. Connect the 3-pin male plug to the female connector installed in step 6. Note that the plug is keyed and can only be installed one way.
12. Connect the two 2-pin plugs to the connectors installed in step 6. The plug labeled "A" goes to connector "A", and the plug labeled "B" goes to connector "B". Ensure that the orange wire installed in the plugs is on the top and the black wire is on the bottom.
13. Install MASSBUS port B cables.
 - a. Install the port B MASSBUS cable in the adapter cabinet following the same service loops as the MASSBUS port A cable.
 - b. Tie wrap the port A and port B MASSBUS cables together.
 - c. Connect MASSBUS port B cable to connector J7 (refer to Figure 2-18).
 - d. Terminate J6 (or continue to next adapter if present).
14. Check the port switches.
 - a. Power up the drive/adapter.
 - b. Install the disk pack and allow the pack to purge for 10 minutes. This is to allow the clean air system to be purged of any contaminants induced during shipment of the drive and pack.

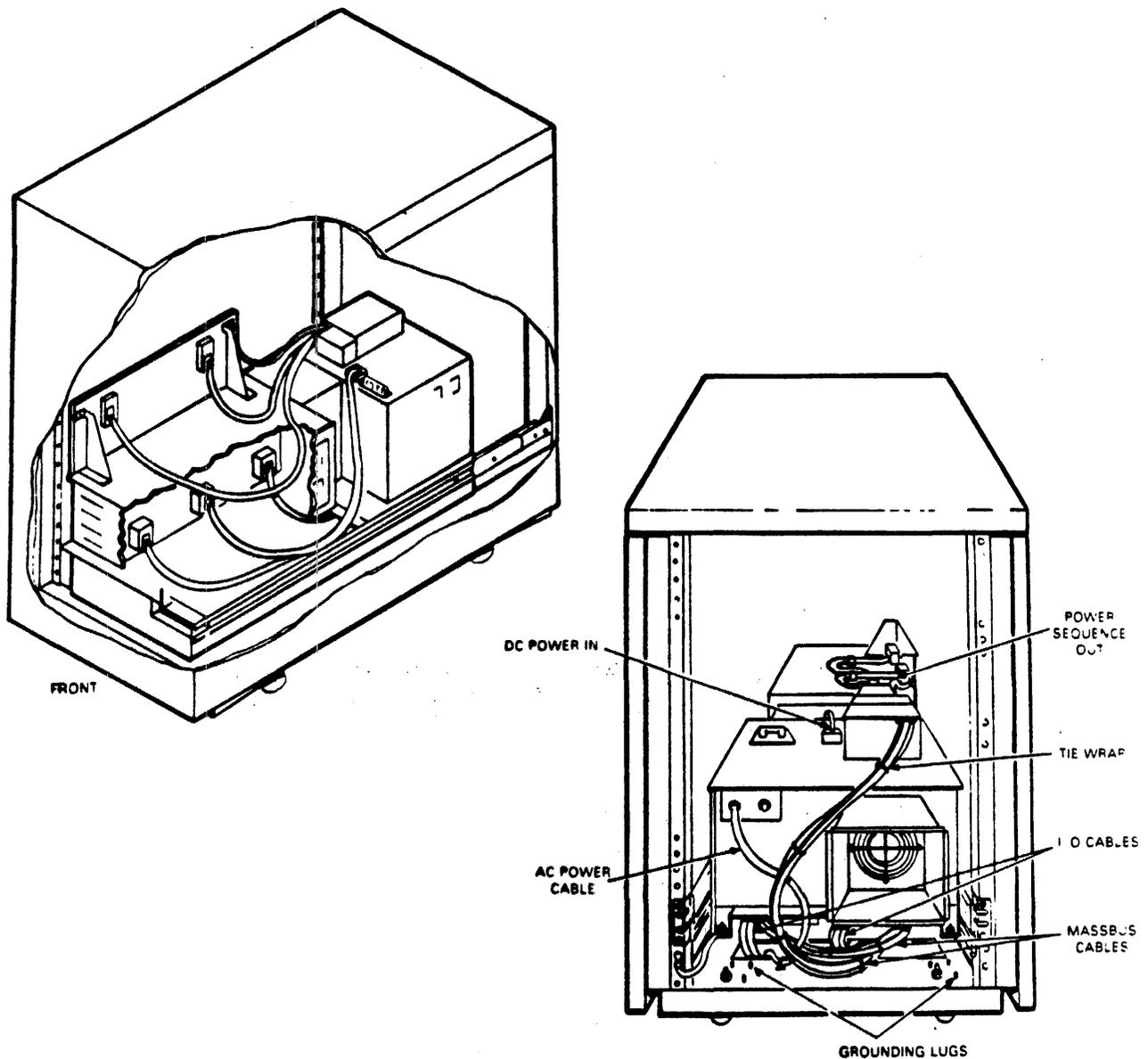


Figure 2-18 MASSBUS Cable Routing (Dual-Port, Single Adapter)

NOTE

If unused packs are properly stored in a clean environment, they should not need an extended purge prior to use.

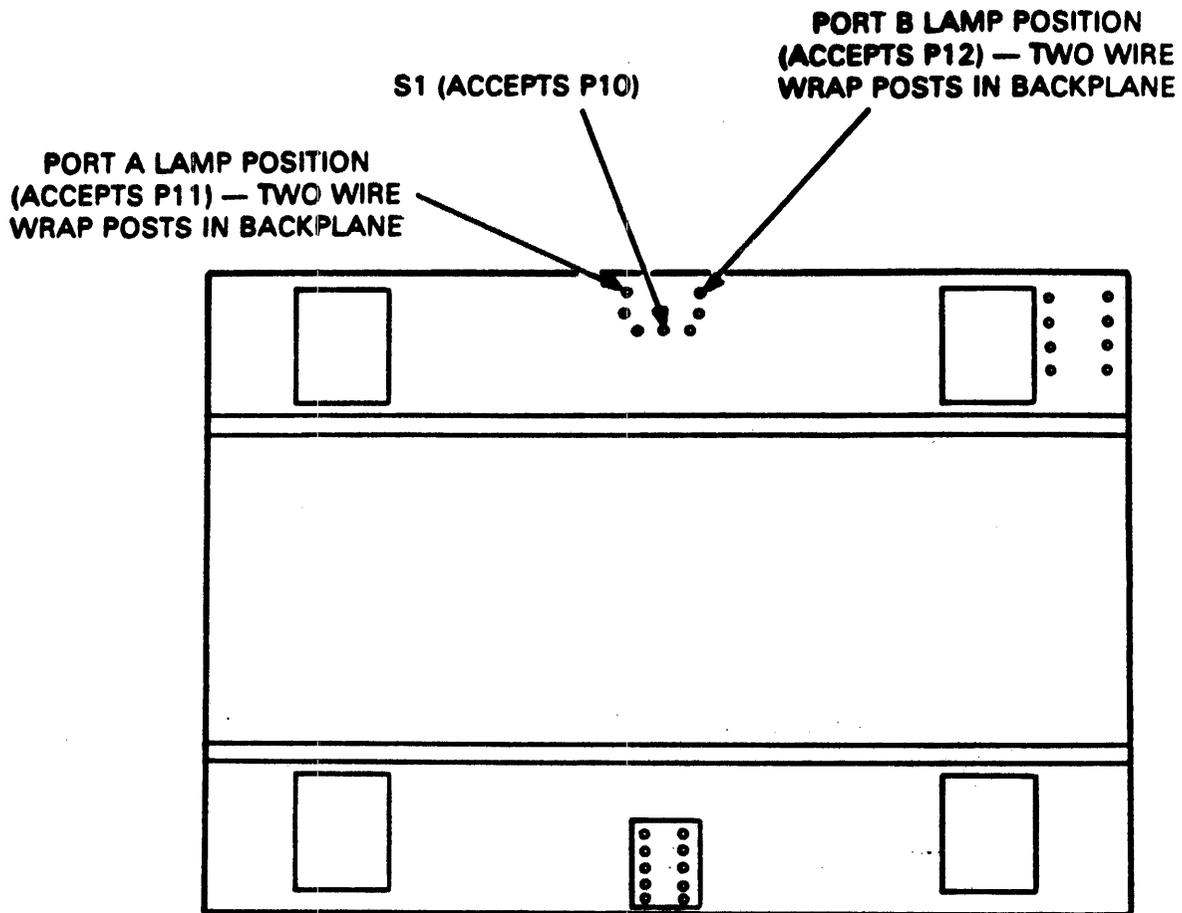
- c. Select either port A or port B by depressing the appropriate button/switch.
- d. Cycle up the drive. The button/switch will illuminate when the port is selected (heads must be loaded).

- e. Cycle down the drive.
 - f. When heads unload, select the other port switch.
 - g. Cycle up the drive. The button/switch will illuminate when the port is selected (heads must be loaded).
 - h. If either port fails to operate, check the wiring and connectors for possible malfunction.
15. Slide the adapter to center position, guiding cables as required.
 16. Install and close the front and rear doors.

2.4.10 Dual-Port Option (Upper RM Adapter)

Prepare the upper adapter cabinet for dual-port installation as shown below.

1. Cycle down the drive (if necessary) and power off drive/adapter.
2. Remove the front door and appropriate dual-port switch cover plate.
 - a. Unlock the door with an Allen wrench.
 - b. Remove the ground braid from the door.
 - c. Pull down the upper hinge pin (spring-loaded).
 - d. Lift the door clear of the bottom hinge pin and set aside.
 - e. Remove the appropriate dual-port switch cover plate from the front of the cabinet and set aside.
3. Remove the rear door.
 - a. Unlock the door with an Allen wrench (size 6mm).
 - b. Remove the ground braid from the door.
 - c. Lift the door to clear the hinge pins from the hinge brackets and set the door aside.
4. Push the adapter to forward stop on slides.
5. Check the adapter backplane for dual-port toggle switch and two LEDs. If installed, proceed to the next step. If not, go to step 7. (Refer to Figure 2-19 for location of switch and LEDs.)

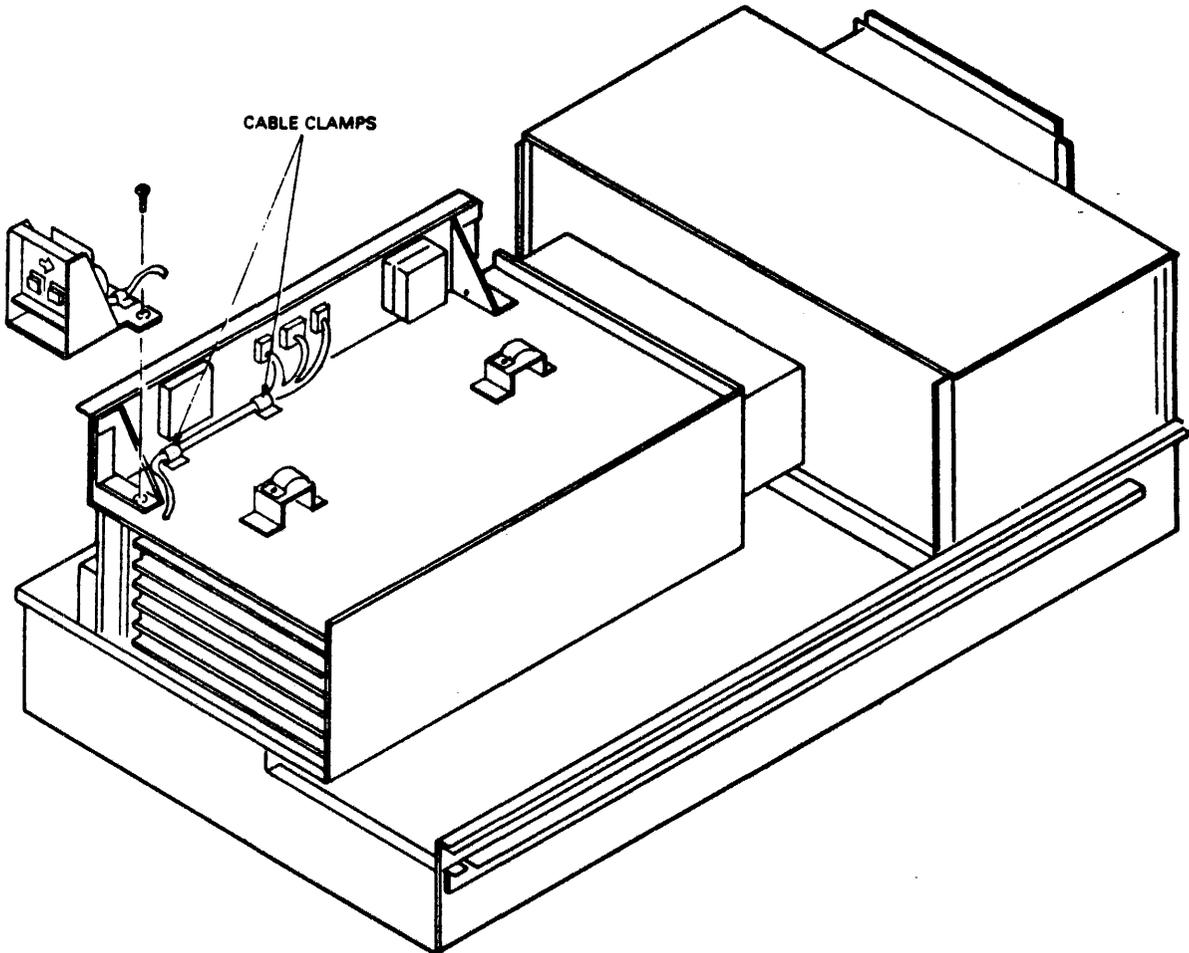


CZ-0276

Figure 2-19 Adapter Backplane (Upper Adapter)

6. Toggle Switch and LED Removal/Replacement.
 - a. Unsolder the two LEDs and the toggle switch from the backplane using a low wattage soldering pencil.
 - b. Install one 3-pin female connector in the position where the toggle switch was located.
 - c. Install the two 2-pin connectors in the positions where the LEDs were located. The connector labeled "A" should be installed on the left side of the female connector and the connector labeled "B" on the right side.
7. Remove the single-port jumper wire from connector J1 (wirewrap post) on the adapter backplane.
8. Install two M5923 modules in slots 1 and 2 (rows C-F) of the card cage.

9. Install the new dual-port switch assembly bracket to the front of the backplane support mount on the upper adapter (refer to Figure 2-20).

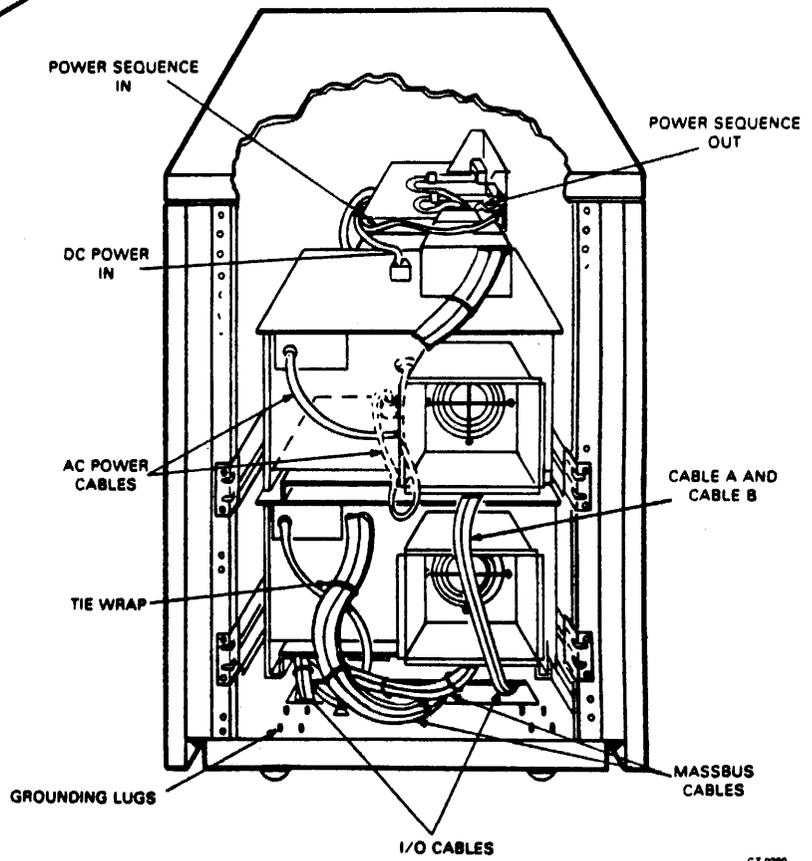
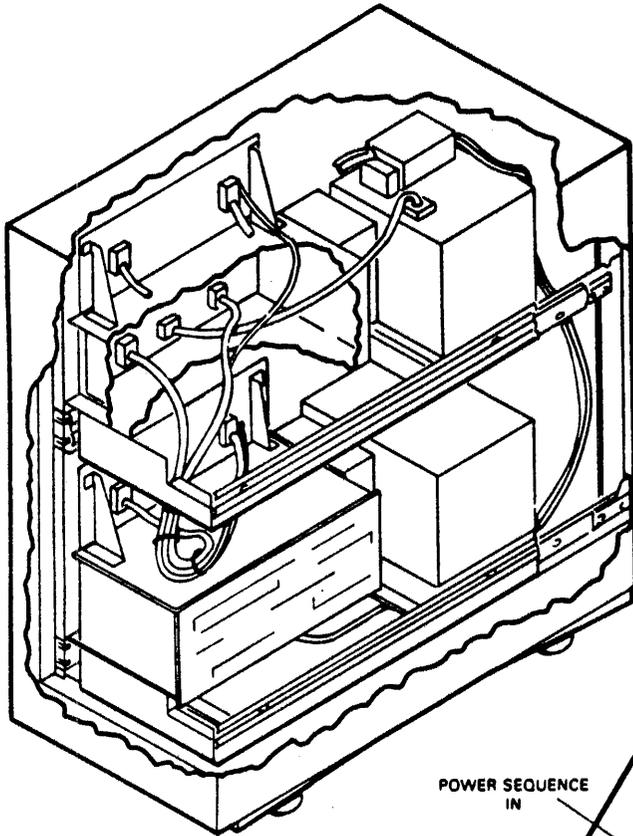


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Figure 2-20 Dual-Port Switch (Upper Adapter)

10. Install the switch assembly in the switch assembly bracket on the upper adapter.
11. Route the switch assembly cable along the front of the backplane to the connectors installed in step 6 (refer to Figure 2-20).
12. Connect the 3-pin male plug to the female connector installed in step 6. Note that the plug is keyed and can only be installed one way.

13. Connect the two 2-pin plugs to the connectors installed in step 6. The plug labeled "A" goes to connector "A" and the plug labeled "B" goes to connector "B". Ensure that the orange wire installed in the plugs is on the top and the black wire is on the bottom.
14. Install MASSBUS port B cables.
 - a. Install the port B MASSBUS cable from connector J6 of the lower adapter cabinet to connector J7 of the upper adapter cabinet following the same service loops as the MASSBUS port A cable.
 - b. Tie wrap the port A and port B MASSBUS cables together.
 - c. Connect MASSBUS port B cable to connector J6 in the lower adapter cabinet and to J7 in the upper adapter cabinet (refer to Figure 2-21).
 - d. Terminate J6 in the upper adapter if it is the last drive in the series, or route a MASSBUS cable from connector J6 to the next drive in the series (refer to RM adapter cabling procedure earlier in Chapter 2).
15. Check the port switches.
 - a. Power up the drive/adapter.
 - b. Install the disk pack.
 - c. Select either port A or port B by depressing the appropriate button/switch.
 - d. Cycle up the drive. The button/switch will illuminate when the port is selected (heads must be loaded).
 - e. Cycle down the drive.
 - f. When the heads unload, select the other port switch.
 - g. Cycle up the drive. The button/switch will illuminate when the port is selected (heads must be loaded).
 - h. If either port fails to operate, check the wiring and connectors for possible malfunction.
16. Slide the adapter to the center position, guiding cables as required.
17. Install and close the front and rear doors.



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Figure 2-21 MASSBUS Cable Routing (Dual-Port, Two Adapters)

2.4.11 Cabinet Leveling

Cabinet leveling should not be performed until the drive is in the desired location and there is no further need to move it. (Refer to paragraph 2.2.1, steps 8a and 8b).

Cabinet leveling consists of installing leveling pads, placing the drive in the desired location, screwing down the leveling pads until the drive is aligned with other cabinets, and ensuring that the weight is off the casters.

1. Install the jam nut on each leveling pad. Then install a leveling pad at each corner of the cabinet frame (see Figure 2-22) by raising the corner of the cabinet and threading the leveler into the weldnut on the frame.

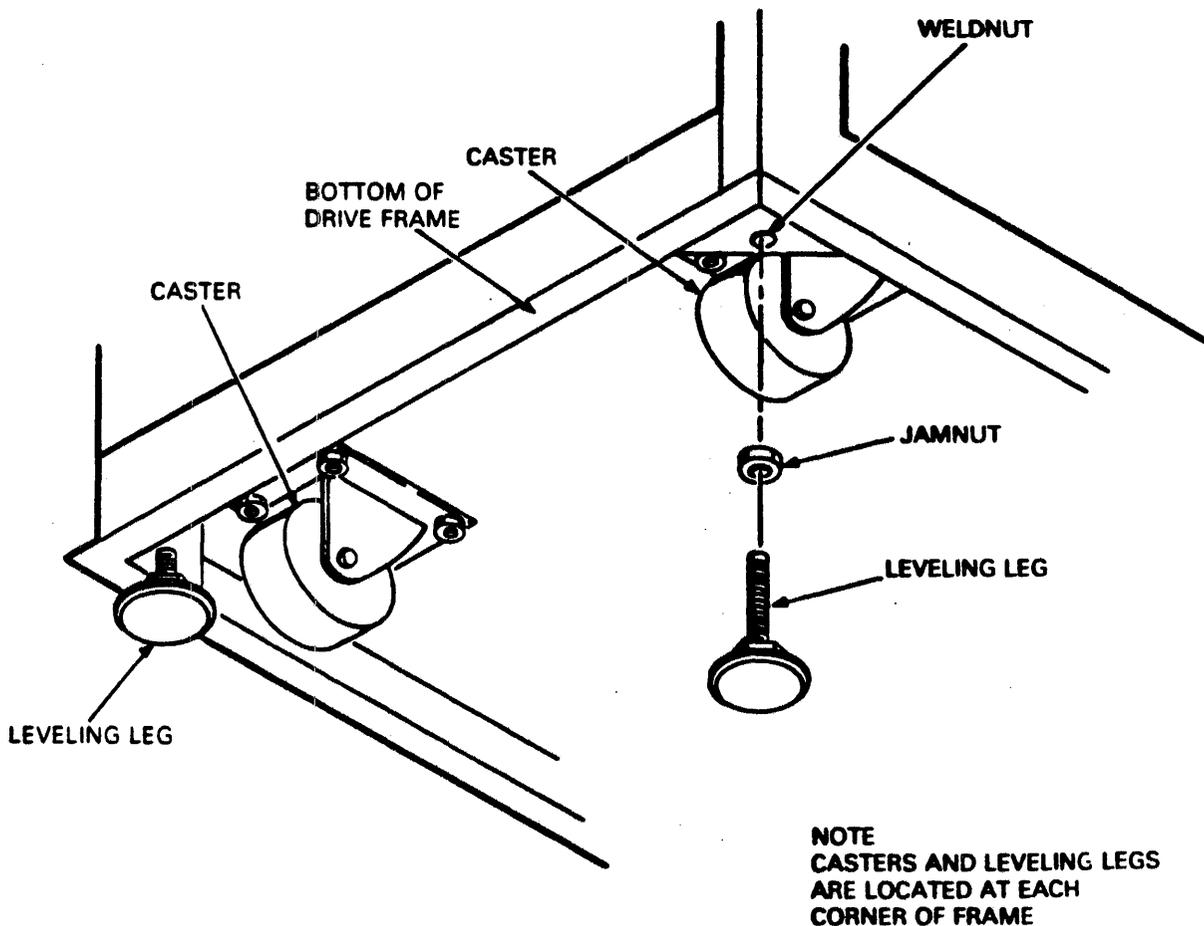


Figure 2-22 Cabinet Leveling

2. Place the drive and adapter in the desired location.

3. Turn the leveling pads down until they support the entire weight of the drive and adapter.
4. Adjust the leveling pads until the drive and adapter are aligned with adjacent equipment.
5. Place a spirit level on the cabinet top cover and adjust the leveling pads until the cabinet is level within three angular degrees both front-to-back and side-to-side.
6. When the cabinets are level in both directions, tighten the jam nut against the bottom of the frame.

2.5 INITIAL CHECKOUT AND START-UP

This procedure describes checks that should be performed on the drive prior to putting it on-line. This procedure assumes that the drive has been unpacked, installed in its normal operating position, that all grounding, power, and I/O connections have been made, and that the proper logical address plug has been installed.

2.5.1 Drive Power-Up

1. Set all circuit breakers OFF.
2. Perform the "clean shroud and spindle" procedure (refer to RM05 Disk Drive Service Manual).
3. Open the cabinet rear door, release the logic chassis catch and swing the logic chassis open.
4. Remove the logic chassis card cover and verify that all cards are firmly seated in their connectors.
5. Verify that all connectors are firmly seated on the back-panel pins, and check for loose or broken wires.
6. Open the top cover and remove the deck cover.
7. Verify that all cards in the read/write chassis are firmly seated in their connectors.
8. Set all circuit breakers to ON, verify that the blower starts and allow it to operate for at least 10 minutes before proceeding to step 9.
9. Install the scratch disk pack, and allow it to purge for 10 minutes.

NOTE

If unused scratch pack is stored in a clean environment, it should not need an extended purge prior to use.

10. Press the START switch and verify that the actions listed below occur.
 - a. The START indicator lights.
 - b. The drive motor starts, and the pack comes up to speed in approximately 30 seconds.
 - c. The heads load when the pack comes up to speed.
11. Perform the procedures listed below.
 - a. Servo system test and adjustments
 - b. Head alignment

2.5.2 Tests and Adjustments

Perform the servo system test and adjustments using either micro-diagnostic test routines (test software) or the TB3A2 field test unit (FTU).

2.5.2.1 Testing With Software - Testing with software requires the use of a controller and the appropriate software. In this type of testing, the drive communicates with the controller as during normal on-line operations and no special I/O connections are necessary.

Except for I/O connections, the procedure for preparing the drive is the same as that used when testing with the FTU. See paragraph 2.6.3 for software test routines used for initial checkout.

2.5.2.2 Preliminary Setup - Use the procedure given below to prepare the drive for initial checkout testing.

1. Press START switch to stop the drive motor and unload the heads.

NOTE

Disable I/O by deselecting the drive at the controller before performing step 2.

NOTE

All procedures other than the head alignment require installation of a scratch pack. However, head alignment requires a CE pack.

2. Raise the pack access cover, remove the customer disk pack, and replace it with either a scratch pack or CE pack for head alignment only.
3. Close the pack access cover.

4. Open the rear door and set the MAIN AC circuit breaker to OFF.
5. Release the logic chassis latch and open the chassis.

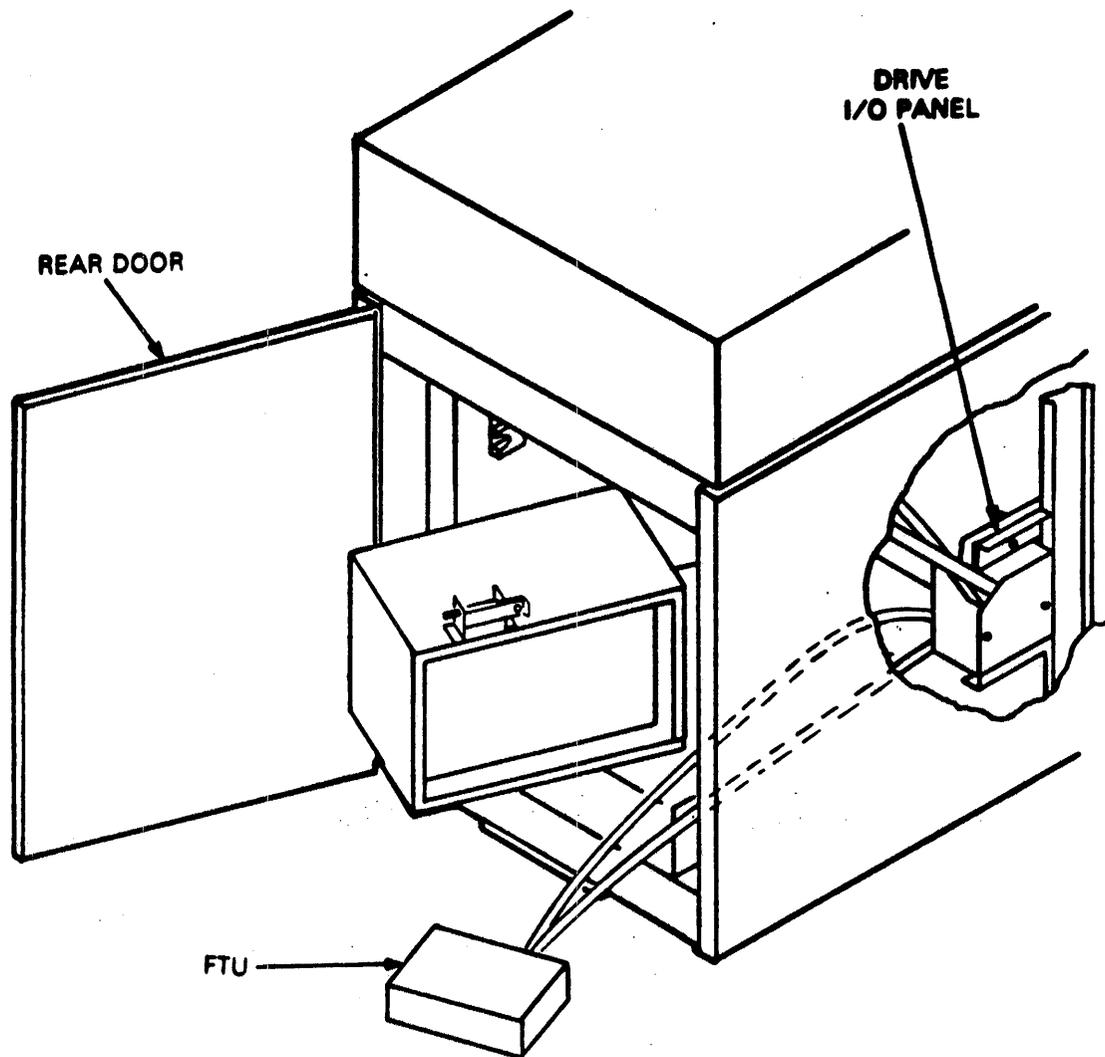
NOTE

If the test software is to be used, proceed to step 8. If the FTU is used with the standard I/O connection, proceed to step 6.

CAUTION

Do not damage the cables between the I/O panel and the logic chassis or system I/O cables when performing step 6.

6. Connect the FTU standard I/O cables to the drive as described below (see Figure 2-23).
 - a. Turn the I/O panel fastener counterclockwise and remove the panel from its upright support. This allows the panel to be positioned so the cables can easily be installed.
 - b. Remove the hardware securing the I/O panel cover to the I/O panel and remove the cover and set it aside. The cover is not replaced until the maintenance is complete.
 - c. Disconnect the I/O cables from J2 and J3 on the drive I/O panel.
 - d. Install the tester cable A to J3 and B cable to J2.
 - e. Position the I/O panel on its upright support and secure with the I/O panel fastener.
 - f. If the drive is in the daisy-chained system, make necessary connections to ensure other drives remain under system control.
7. Loosen the turn-lock fastener securing the card cage cover to the logic chassis and remove the cover.
8. Install the card extender if the test or adjustment procedure being performed requires it. This requirement will be noted in that procedure.
9. If the head alignment is being performed, proceed as described below. If not, go to step 10.
 - a. Install the head alignment card (HFSV) in location A16.



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Figure 2-23 Standard FTU to Drive I/O Connections

- b. Connect the head alignment cable from the logic backpanel location A16, pins 8 through 11, to J1 on card E03 in read/write chassis. (refer to paragraph 2.4.3 for more information.)
10. Set the MAIN AC circuit breaker to ON.
11. If using the FTU, set the SEC (sector) switch on the FTU panel to 32.

12. Set the following switches on the FTU as shown below.

Switch	Position
SEQ PWR	Up
SERVO OFFSET	Center (OFF)
DATA STROBE	Center (normal)
WRT FLAG	Down (OFF)
XTAL/SERVO	SERVO
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 (three switches)	Logical address of drive
ADDR ERROR/BYPASS (2 switches)	Both switches down (OFF)

13. Turn on the FTU.
14. Press the START switch to the start drive motor and load the heads.
15. Select the drive. When the drive is selected, it is ready for tests and/or adjustments.
16. Actuate the INITIALIZE switch.
17. Actuate the RTZ switch, then the RESET switch.

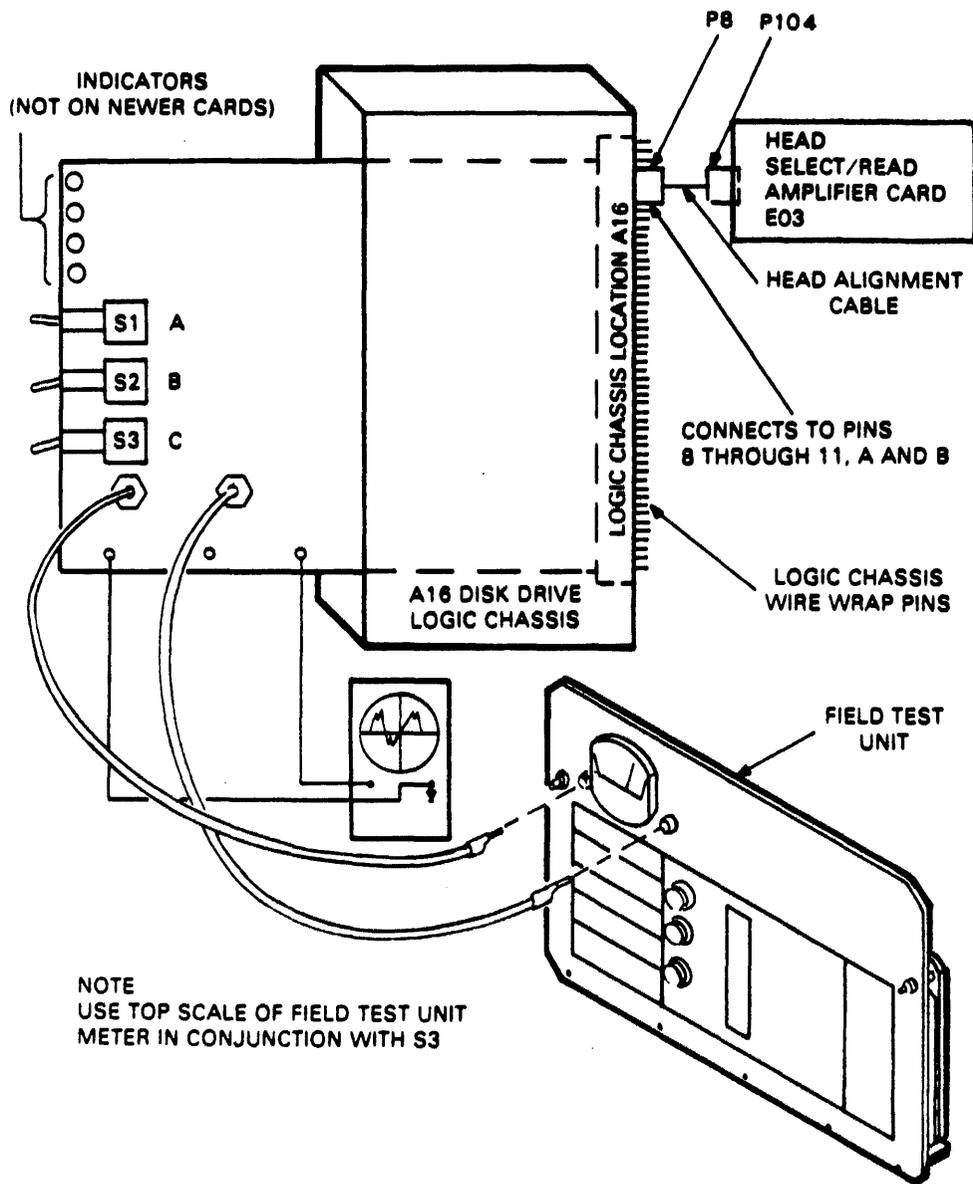
The drive is now ready for exercising. It has performed a seek to cylinder 0 and has selected head 0. If you are testing with the FTU, you may now set the switches on the FTU control panel to exercise the desired functions and operating modes. The paragraphs below describe these procedures when using the FTU.

2.5.3 Head Alignment Procedure

2.5.3.1 Installation of the Head Alignment Card - This procedure describes the use of the HFSV head alignment card and the null meter on the FTU control panel to perform read/write and servo alignment. Figure 2-24 shows the cabling involved, and Figure 2-25 gives specific connection information. Figure 2-25 shows the switches and indicators on the HFSV card.

This procedure assumes that the I/O connections between the drive and the FTU are as described in paragraph 2.5.2.2. Remove the ac power from the drive and FTU before installing and cabling the head alignment card.

1. Install the HFSV card in the logic chassis in the drive, at location A16.
2. Install the head alignment cable between the logic chassis in the drive and the jack on the card in the read/write chassis, as specified in Figure 2-24. P104 is keyed so it will fit on the read/write card only one way.
3. Connect the test leads provided with the FTU between the HFSV card and the null meter on the FTU panel. Observe the polarity.
4. Set the WRT INHIBIT/NRM switch on the FTU to WRT INHIBIT.
5. Apply ac power to the drive. The POWER lamp on the HFSV card should light up.
6. Install the proper CE pack on the drive to be tested.
7. Power up the drive.
8. Turn on the FTU. If the drive under test is in the write-protect mode, the WRT PROTECT light on the FTU 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.
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
USE TOP SCALE OF FIELD TEST UNIT
METER IN CONJUNCTION WITH S3

S3 POSITION	FULL SCALE READING
X1	-100 MV TO +100 MV
X.1	-1.0 MV TO +1.0 MV

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Figure 2-24 Head Alignment Connections

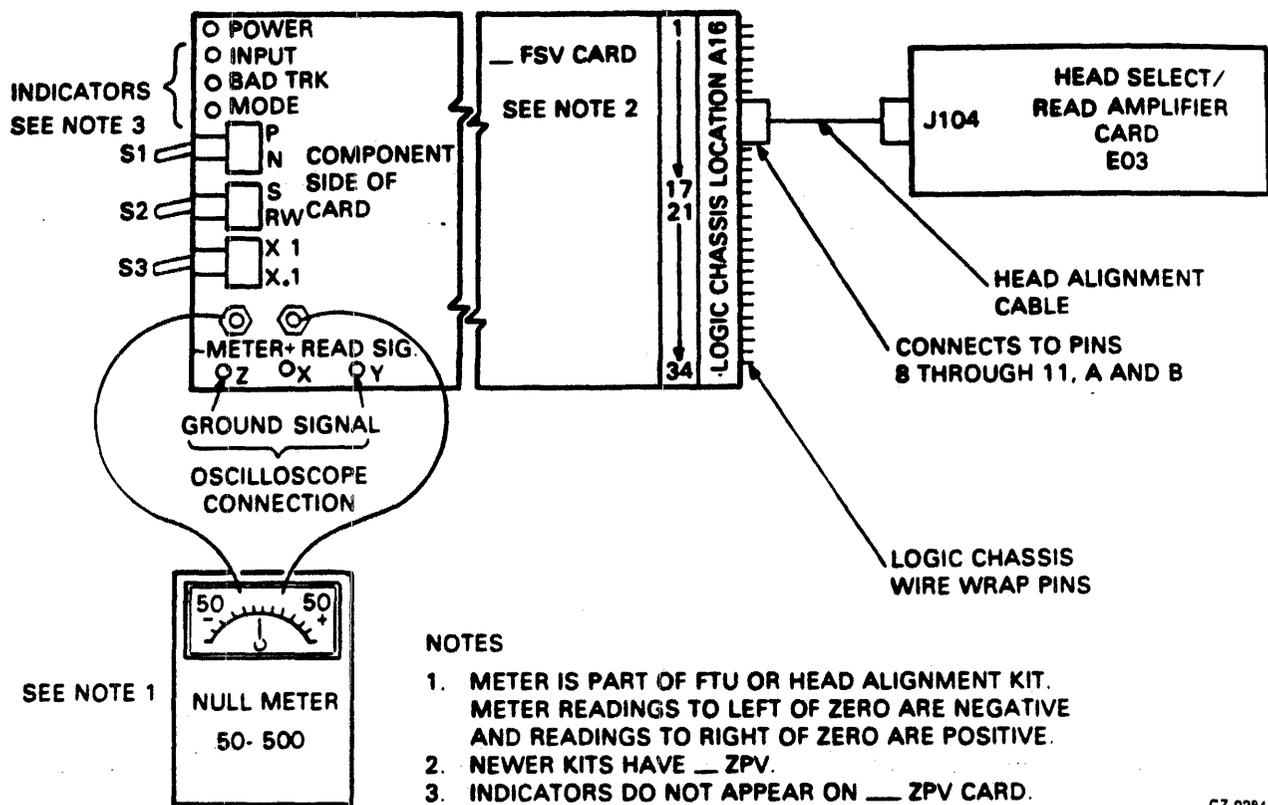


Figure 2-25 Head Alignment Card

11. Allow the drive to thermally stabilize on cylinder 0 for 60 minutes (see paragraph 2.4.3.2).

NOTE

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

Table 2-2 Head Alignment Card Switches & Indicators

Switches	Description
S1	Changes the polarity of the alignment signal to the null meter: P = positive, N = negative. Algebraically subtract N from P to determine alignment error. If P = +30 mV and N = -40 mV, the error is 70 mV.
S2	S position selects servo head as input to HFSV. RW position selects a data head as input to HFSV.

Table 2-2 Head Alignment Card Switches & Indicators (Cont)

Switches	Description
S3	Changes sensitivity of HFSV. The X.1 position attenuates the card output by a factor of 10, and alignment errors cannot be accurately measured. The X1 position does not attenuate HFSV output and alignment errors can be accurately measured.
Indicators	Description
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. 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 condition exists, read/write head alignment error cannot be measured.

2.5.3.2 Preliminaries for Head Check or Alignment - Read and understand the concepts that follow before performing the head arm alignment procedure. They are important for accurate head alignment.

Thermal Stabilization - It is important that the drive, CE pack, and FTU be at their normal operating temperature to ensure accuracy during head alignment. 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, subsequent drives need only 15 minutes for stabilization if the pack is taken immediately from a drive on which it had been operating for 60 minutes.

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 added precaution.

Alignment Tool - Use only the head alignment tool specified. Use of a different tool may cause damage to the head-arm or carriage. Always inspect the adjustment end of the 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 a crocus cloth. Any other polishing medium will damage the tool.

Do not use a defective tool. Repair or replace the tool if it is damaged. When using the tool, position it so the pin in the end of the tool engages the adjustment slot in the head arm. Ensure the tool is kept perpendicular to the hole in the carriage at all times. The tool should turn freely in the hole. If it does not, recheck the end of the tool for damage or aluminum buildup.

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. Some examples of offset calculation are given below.

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

Seek Error Prevention - 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 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 (in excess of 300 mV offset) may be discovered. When this occurs, do not realign the head until all packs written by that drive have their data transferred to other storage. Failure to dump the packs before realignment will mean that the data written by that head 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 allows the carriage to retract if an emergency retract signal is generated. If your hands are in the actuator during the head alignment procedure, the retract could be dangerous. It should also be noted that if a retract condition is generated, the carriage locking pin and ring assembly must be removed immediately 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.

2.5.3.3 Initial Setup - Use the procedures given below to check head alignment.

1. Connect the FTU to the drive using the procedures in paragraph 2.5.2.2.
2. Ensure that the CE pack is thermally stabilized.
3. Connect an oscilloscope to test points Z (ground) and Y (dibits) on the head alignment card.
4. Connect the test leads between the head alignment card and the FTU null meter as shown in Figure 2-25.

2.5.3.4 Servo Head Alignment Check - Use the following procedure to check the alignment of the servo head.

1. Set the head alignment card S/RW switch to S and X.1/X1 switch to X.1.
2. Command continuous seeks between cylinders 360_g and 365_g for a minimum of 30 seconds.
3. Command direct seek to cylinder 004.
4. Observe the dibit pattern on the oscilloscope. It should be similar to that shown in Figure 2-26.

NOTE

At X.1 switch setting, the upper scale of the FTU meter is read X100 (or + 1.0 V); at X1 switch setting, the upper scale is read X10 (or + 100 mV).

5. Move the P/N switch to both P and N positions and record the null meter readings. If both P and N readings are less than 100 mV, the X.1/X1 switch can be set to X1 position for more accurate readings.
6. Calculate the head offset by using the formula given below.

$$(P) - (N) = \text{OFFSET}$$

7. Record the offset calculated in step 6.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS/DIV

CH1 — 0.1 V

CH2 — NOT USED

TIME/DIV

A — 0.5 μ S

B — NOT USED

TRIGGERING

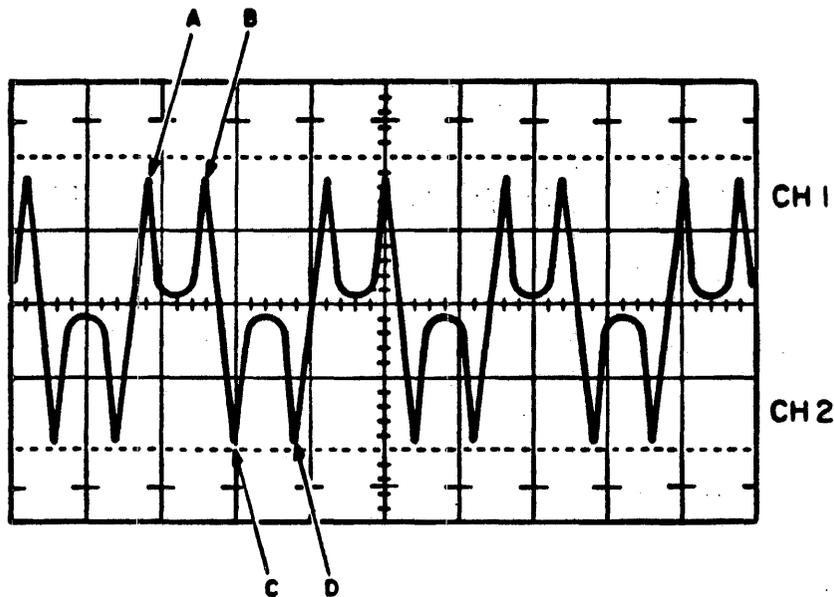
A — INTERNAL POSITIVE

B — NOT USED

PROBE CONNECTIONS (USE X10 PROBE)

CH1 TO DIBITS TEST POINT Y ON HD ALIGN CARD

CH2 — NOT USED



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Figure 2-26 Balanced Dibit Pattern

8. Evaluate the servo head offset as described below.
 - o If the offset ranges between +60 mV and -60 mV, it is acceptable; proceed with head alignment.
 - o If the offset is outside of +60 mV range, it is unacceptable. In this case, troubleshoot the servo system before proceeding with the head alignment.
9. Command the direct seek to cylinder 005 and repeat steps 4 through 8.

10. Add the offset readings from cylinders 004 and 005. This sum should be between +75 mV and -75 mV. If it is not, troubleshoot the servo system.
11. Command the direct seek to cylinder 14008 and repeat steps 4 through 8.
12. Command the direct seek to cylinder 7538.
13. Install the carriage locking pin into the alignment hole (refer to Figure 2-27 and repeat steps 4 through 8).

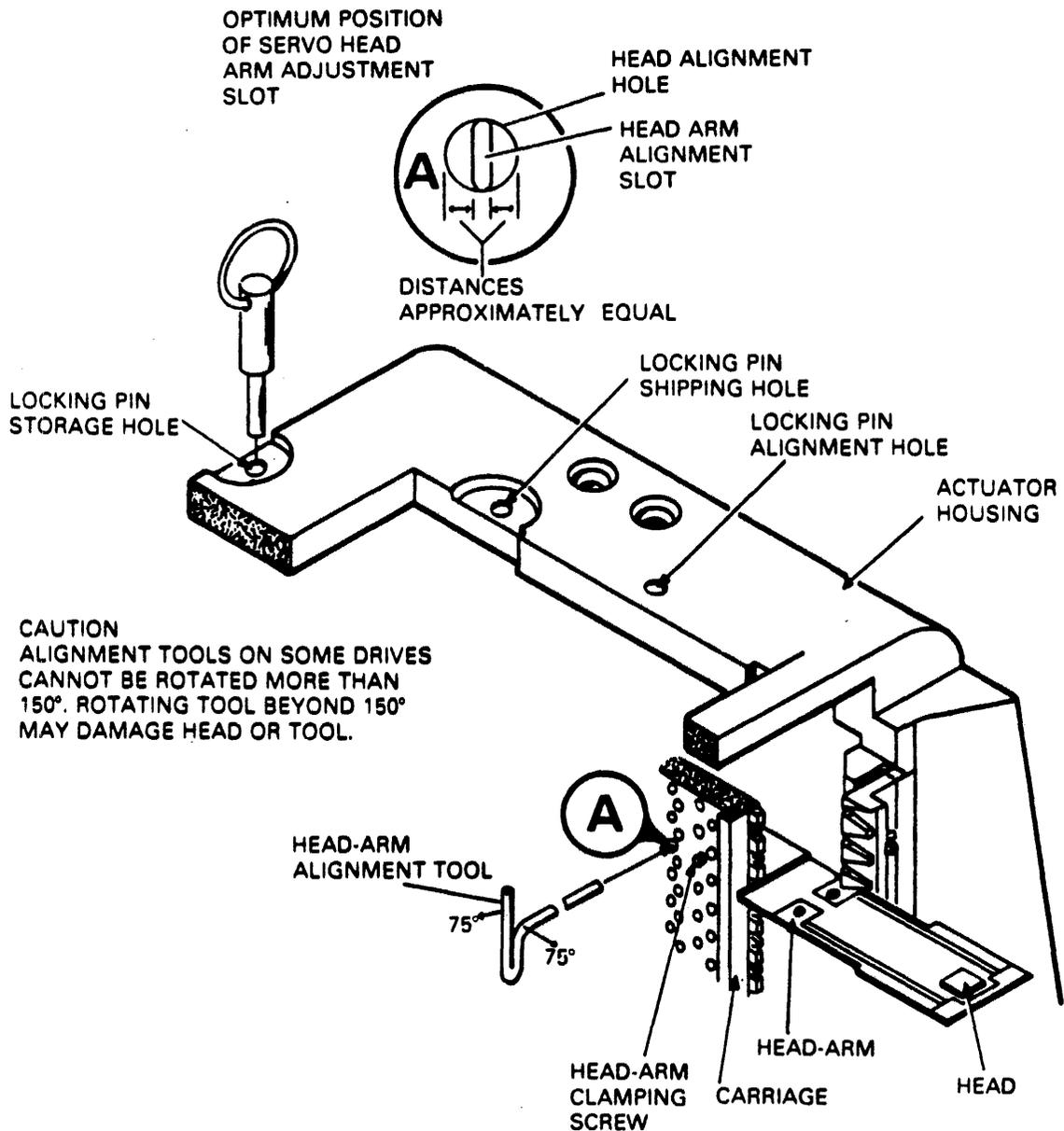


Figure 2-27 Head-Arm Alignment

CZ-0130

This completes the servo head alignment check procedure. Now proceed with the read/write heads alignment check and adjustment.

2.5.3.5 Read/Write Heads Alignment Check and Adjustment - Use the procedure given below to check the alignment of the read/write heads and adjust those out of tolerance.

1. Set the S/RW switch on the alignment card to RW. Observe that dibit pattern is similar to that shown in Figure 2-26.
2. Calculate the offset of all read/write heads using the procedure given below.
 - a. Move the P/N switch to both P and N positions and record the null meter readings. If both P and N readings are less than 100 mV, the X.1/X1 switch can be set to the X1 position for more accurate readings.
 - b. Calculate the head offset by using the formula given below.

$$(P) - (N) = \text{OFFSET}$$

3. Remove the carriage locking pin.
4. Evaluate the read/write head offset as described below.
 - o If all offsets are between +150 mV and -150 mV, head alignment is within specifications. In this case, proceed to step 15 and restore the drive to on-line operation.
 - o If any offsets are outside of the ± 150 mV range, the heads are misaligned. Proceed to step 5. However, before proceeding, ensure that no offset exceeds a +300 mV range. If any offsets exceed this range, excessive misalignment exists. Refer to the RM05 Disk Drive Service Manual for steps to take in the case of excessive misalignment.
5. Press the START switch to stop the drive motor and unload the heads.
6. Loosen the head-arm mounting screws securing the heads requiring alignment and torque these screws to 4 $\pm 1/2$ in lbs (0.5 ± 0.1 Nm).
7. Press the START switch to start the drive motor and load the heads. Before proceeding to step 8, set the MANUAL/SEQ switch of the FTU to MANUAL and set the desired head selection in the HEAD ADDR REG switch.

8. Command the direct seek to cylinder 7538.

WARNING
Power is on.

NOTE

The force exerted during adjustment can move the heads from the alignment cylinder to an adjacent cylinder, resulting in an improper alignment. Prevent this by connecting a jumper from A07-11A (seek error) to ground. Be sure to remove the jumper before commanding the drive to perform another seek.

9. Align the heads as described below.
 - a. Select the head to be aligned.

WARNING

To prevent personal injury in case of an emergency retract, install the carriage locking pin in the alignment track lock hole prior to positioning the head alignment tool. Be sure to remove the pin before the next seek is performed.

- b. Install the head alignment tool so that the tool pin engages the head-arm alignment slot (refer to Figure 2-27).
 - c. Observe the oscilloscope and adjust the head to obtain a balanced dibit pattern. The pattern is balanced when point A amplitude equals point B and point C equals point D (see Figure 2-26).
 - d. Observe the null meter and adjust the head until the offset ranges between +75 mV and -75 mV. Calculate the offset as described in step 2 above. The offset values should be in the +150 mV range. Occasionally, a head cannot be aligned because its adjustment slot is at its end of travel. If this occurs, check the position of the servo head-arm adjustment slot and, if necessary, recenter it.

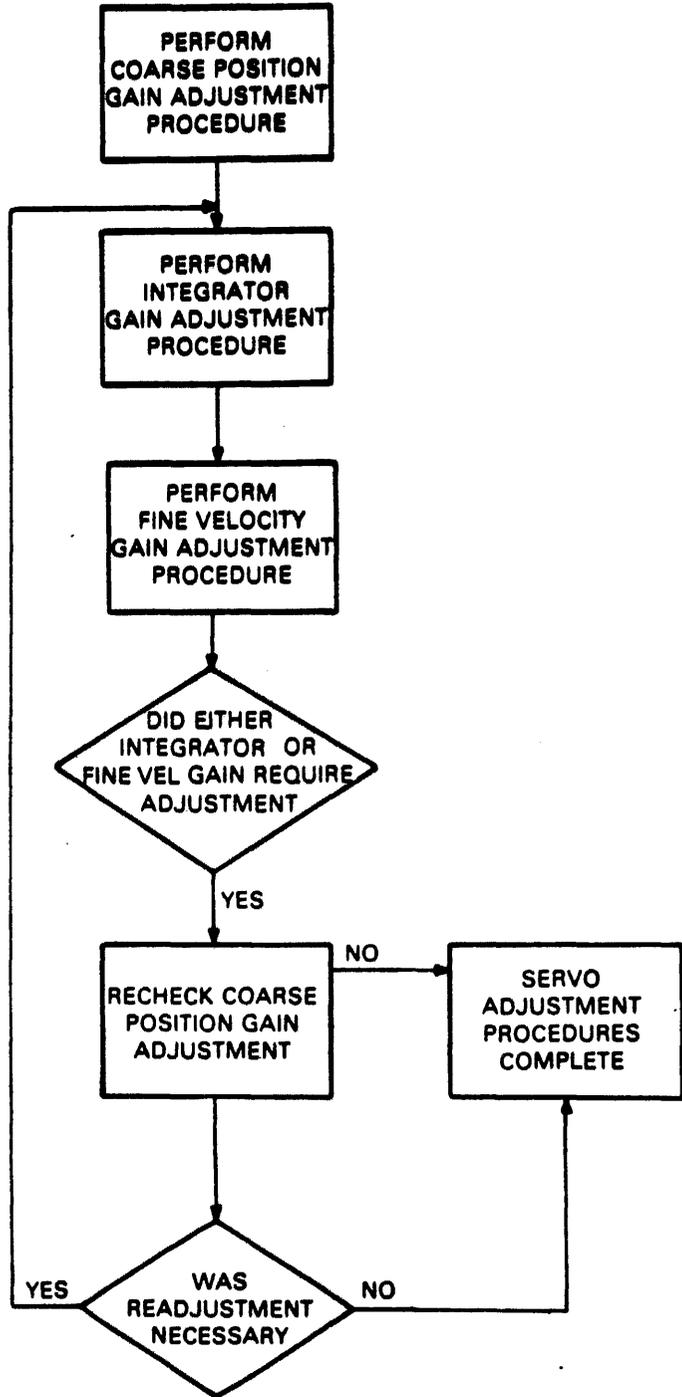
Note that any slight adjustment of the servo head requires realignment of all read/write heads. Torque the servo head to 12 \pm 1/2 in lbs (1.4 \pm 0.1 Nm). While torquing screws, use only a straight-arm Allen wrench and keep it as perfectly aligned as possible with the screws. If care is not taken during this operation, the head may be pushed out of alignment.

- e. Repeat steps a through d for each head to be aligned.
10. Remove the carriage locking pin and also remove the jumper from A07-11A if it was installed.
 11. Press the START switch to stop the drive motor and unload the heads.
 12. Torque the head-arm clamp screws of each head adjusted to $12 \pm 1/2$ in lbs (1.4 ± 0.1 Nm). While torquing screws, use only the straight-arm Allen wrench and keep it as perfectly aligned as possible with the screws.
 13. Check each head adjusted to see if torquing the screws affected the alignment. If any heads are outside the ± 150 mV range, readjust them as in steps 6 through 12.
 14. Perform the actions listed below to ensure that the heads will remain aligned under normal operating conditions.
 - a. Command continuous seeks between cylinders 3608 and 3658 for a minimum of 30 seconds.
 - b. Unload and load heads at least twice.
 - c. Command the direct seek to cylinder 7538.
 - d. Allow the drive to thermally stabilize for at least 15 minutes.
 - e. Check the alignment of each head adjusted. If any heads are outside the ± 150 mV range, repeat this procedure starting with step 9.
 15. Prepare the drive for return to on-line operation.

2.5.4 Servo System Tests and Adjustments

These procedures test and adjust the drive servo system. The servo system adjustments and their basic functions are as described below. (Refer to Figure 2-28).

- o Coarse Position Gain - Adjusts the gain of the velocity signal applied to the summing amplifier when the servo system is in coarse mode (cylinders-to-go equals more than one-half). This adjustment causes seek-time to be fast enough to meet the required specifications without causing excessive overshoot past the desired cylinder.
- o Integrator Gain - Adjusts the gain of the velocity signal applied to the integrator. The integrator output is summed with the output from the D/A converter during the last 128 cylinders of a seek.



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Figure 2-28 Servo System Test and Adjustment Flowchart

- o **Fine Velocity Gain** - Adjusts the gain of the velocity signal applied to the summing amplifier when the servo system is in fine mode (cylinders-to-go equals less than one-half). This adjustment optimizes the servo system response by minimizing overshoot without overdamping the system.

These adjustments are interactive and must be made in the sequence shown in Figure 2-29. The procedure given below describes the test and adjustment of the servo system.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS/DIV

CH 1 - 0.5 V/CM
CH 2 - NOT USED

TIME/DIV

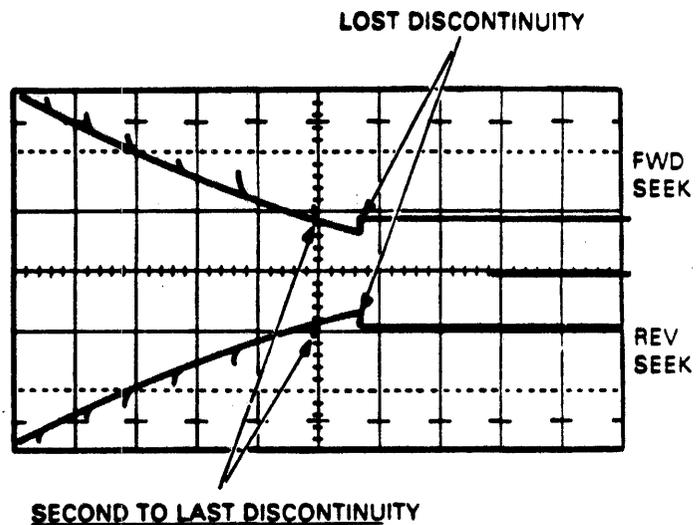
A - 0.5 MS/CM HORIZ DISPLAY
B - NOT USED SET TO MAG X 10

TRIGGERING

A - POSITIVE EXT ON A12-17B (+T≤7)
B - NOT USED

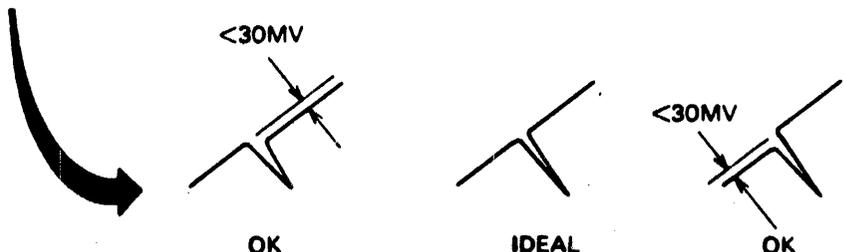
PROBE CONNECTIONS

CH1 TO A20-TPD (+ DESIRED VELOCITY)
CH2 - NOT USED



NOTE

IT IS NECESSARY TO INCREASE VERTICAL SENSITIVITY TO MAKE THIS MEASUREMENT.



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Figure 2-29 Integrator Gain Waveform

1. Prepare the drive using the preliminary setup procedures given in paragraph 2.5.2.2.

2. Test and adjust the coarse position gain as described below.
 - a. Command the continuous seeks between cylinder 000 and 14668.
 - b. Connect the oscilloscope channel 1 to A07-03A (+ON CYLINDER).
 - c. Trigger the oscilloscope negative external on A07-07A (FORWARD SEEK).
 - d. Set other oscilloscope controls as necessary to make measurements required in step e. (2 volts, 10 milliseconds).
 - e. Observe the display. If the distance between on-cylinder pulses is not within 50 to 54 milliseconds, adjust top potentiometer on card A20 until this requirement is met.

3. Test and adjust the integrator gain as described below.
 - a. Command the continuous seeks between cylinders 000 and 2008.
 - b. Set up the oscilloscope as indicated in Figure 2-29. Adjust it until the two sloped curves are displayed.

NOTE

VOLT/CM and TIME/CM settings have to be changed to make measurement required in step c.

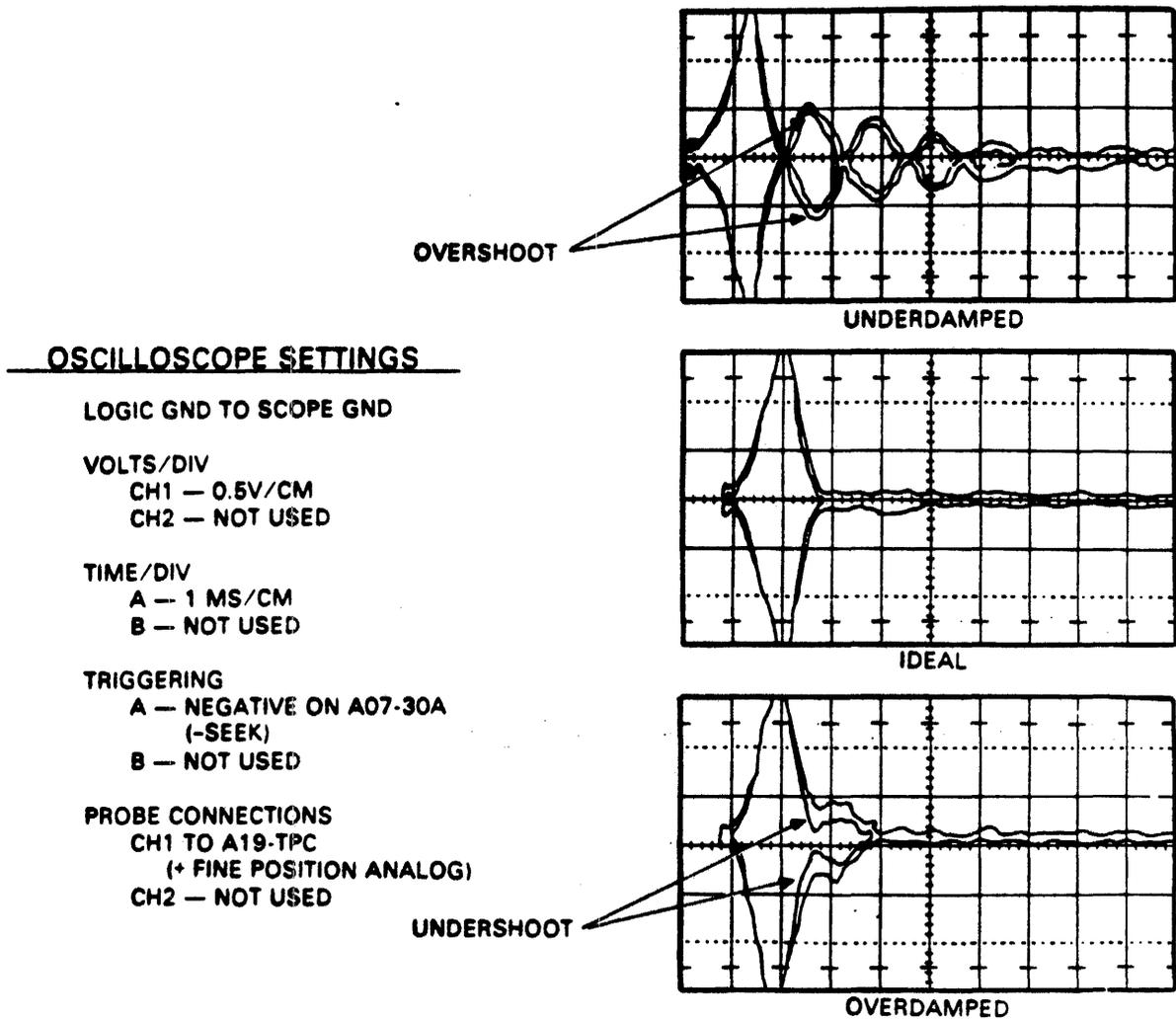
- c. Observe the second to last discontinuity (indicated in Figure 2-29) and check to see if it has a difference of ± 0.03 V. Ignore the spike. If it exceeds this value, adjust the bottom potentiometer on A20 so that it meets these requirements.

NOTE

In step 4, the read operation is performed between seeks. This causes enough delay between seeks to provide the proper display.

4. Adjust the fine velocity gain as described below.
 - a. Set MANUAL/SEQ switch on FTU to MANUAL.
 - b. Command the read operation to be performed in conjunction with continuous seeks between cylinders 000 and 001.

- c. Connect and set up the oscilloscope as indicated in Figure 2-30.



CZ-028E

Figure 2-30 Fine Velocity Initial Check Waveform

- d. Referring to Figure 2-30, note that the displayed signal settles with maximum overshoot of less than 50 mv. If the overshoot exceeds this value, adjust the middle potentiometer on card A20. When the adjustment is complete, the display should resemble the ideal waveform in Figure 2-30. A slight undershoot is desirable.
- e. Command the sequential forward seek from cylinder 000 through 14668 to be performed in conjunction with a read.

- f. Note that a displayed signal is shown in Figure 2-31 at each cylinder. If the overshoot exceeds 50 mv at any cylinder, adjust the middle potentiometer on card A20 until this requirement is met.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS/DIV

CH1 — 0.5V/CM
CH2 — NOT USED

TIME/DIV

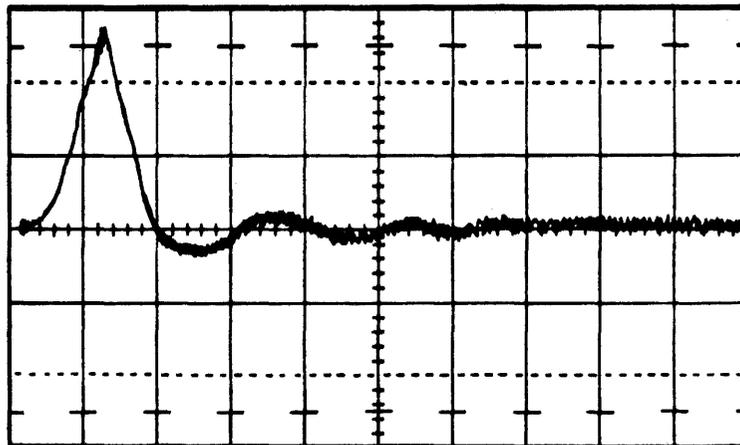
A — 0.1 MS/CM
B — NOT USED

TRIGGERING

A — EXT, A07-30A (-SEEK)
B — NOT USED

PROBE CONNECTIONS

CH1 TO A19-TPC (+ FINE POSITION ANALOG)
CH2 — NOT USED



CZ-0209

Figure 2-31 Fine Velocity Gain Overshoot

5. Prepare the drive for return to on-line operations.

2.5.5 Operating Procedures

The procedures below check all access, read/write, and head select modes. Additionally, these procedures check the data error logic circuits.

2.5.5.1 Continuous Seek, No Read/Write - This procedure performs alternate seeks between the cylinder address in the cylinder address register (CAR) and the address set in the CYLINDER ADDRESS switches.

1. Position the FTU switches as described in paragraph 2.4.2.2. Then, position the switches below as indicated.

Switch	Position
DISPLAY SELECT	CYLINDER
WRT-RD SELECT	OFF

2. Set the CYLINDER ADDRESS switches to the value of a cylinder to which the drive is to seek.
3. Set the ACCESS MODE switch to DIRECT.
4. Momentarily actuate the START switch on the FTU. When the ON CYL indicator on the FTU is lit, move the START switch momentarily to STOP. The cylinder address loaded in step 2 should now be displayed on the cylinder address display lights.
5. Set the CYLINDER ADDRESS switches to the value of some second cylinder address.
6. Set the ACCESS MODE switch to CONT.
7. Actuate START. The drive will perform alternate seeks between the two cylinder addresses loaded in steps 2 and 5. The ON CYL indicator will blink rapidly as the heads move on and off the cylinder. The cylinder address display lights will alternate between the two addresses.
8. Set the START switch to STOP.
9. Actuate RTZ.
10. Actuate START. The sound of the drive will change as it now seeks between cylinder 0 and the one loaded in step 5. Observe the ON CYL and cylinder address displays.
11. To stop the operation, actuate either STOP or RESET.

2.5.5.2 Random Seek, No Read/Write - Use the procedure given below to cause the drive to perform random seeks.

1. Maintain the preliminary setup switch positions. In addition, set the switches listed below as shown.

Switch	Position
DISPLAY SELECT	CYLINDER
WRT-RD SELECT	OFF
ACCESS MODE	RAND

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

NOTE

After an FTU write-format operation, the pack must be re-formatted using the formatter program prior to running a MAINDEC diagnostic program.

2.5.5.3 Write-Format - The procedure given below will write a prescribed format on every track of the disk pack.

1. Maintain the switch positions given in the preliminary setup procedure. In addition, set the switches listed below 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 (any non-zero number)

2. Move the RTZ/RESET switch to RESET, then 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 2-3. Data errors will not occur during WRT FORMAT. Then proceed as described below.

Table 2-3 Decision Logic Table

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.

Conditions	1	2	3	4	5	6	7	8
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
Actions								
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 2-3 Decision Logic Table (Cont)

Conditions	1	9	10
Address error	N	Y	-
Data error, OFFSET and DATA STROBE switches in center (off) position	N	-	Y
Actions			
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.			
Switch	Position		
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 2-3 Decision Logic Table (Cont)

Conditions	11	12	13	14	15	16	17	18	19	20
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
Actions										
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.

- 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 will cause the operation to begin again 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 not important.

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

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

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

2. Set the CYLINDER ADDRESS switches to the maximum cylinder address (14668).
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.

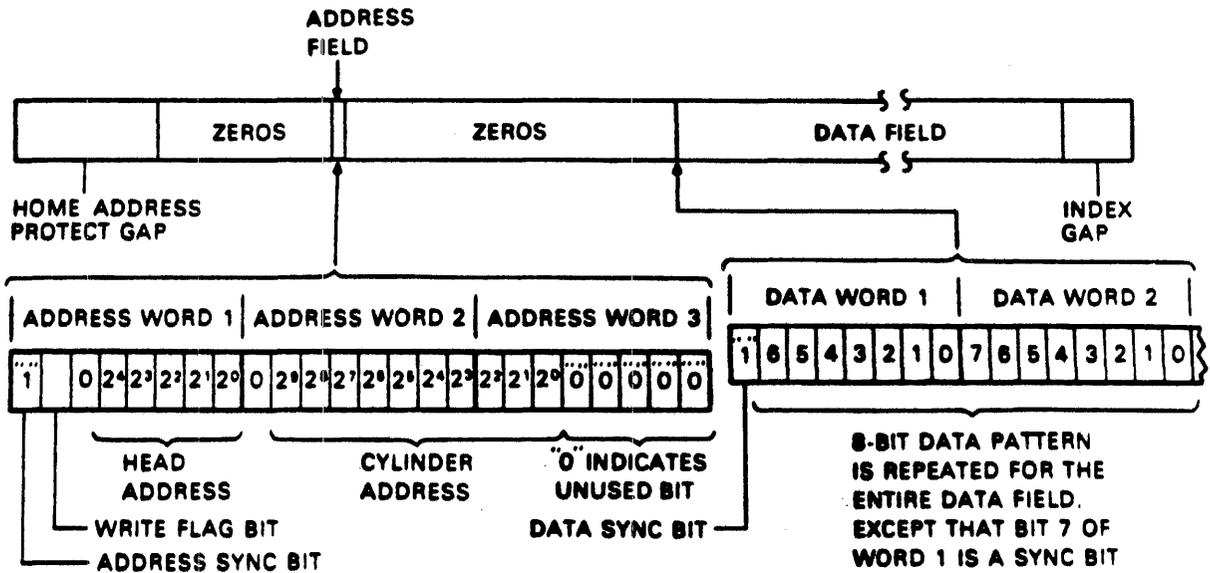
NOTE

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.

2.5.5.5 Write Flag - A single read may produce random errors that a host system error-recovery program would eliminate in an on-line environment. Before flagging a track as bad, i.e., as one that continually produces errors that are not recoverable, it is best to WRT-RD the track several times. If the error persists, execute the trouble analysis procedure below in an effort to recover the error. Flag the track only after both of these procedures have failed to correct the problem.

The procedure given below writes a "defective track" flag in bit 6 of address word 1 (Figure 2-32).



MA-0641

Figure 2-32 Track Format

NOTE

The format in Figure 2-32 is a special format used by the FTU. The pack should be reformatted before any last diagnostics are run.

1. Set the FTU switches as shown below. The other switches should remain as in the preliminary setup procedure.

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

2. Actuate RESET, then START. The drive will seek to the selected track.
3. When the ON CYL light comes on, wait about one second and then actuate STOP.
4. Set the the WRT-RD SELECT switch to RD.
5. Actuate START. The "defective track" flag will prohibit reading the track. The ADDRESS ERROR and DATA ERROR indicators 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. An address error will occur if it is not turned off.

2.5.5.6 Check Data-Error Logic - This procedure assures the operator that the FTU will recognize data errors. Use it whenever you expect data errors but none occur. It assumes the procedure in question is still running and the scratch pack, therefore, has a data field written on the tracks being tested.

1. STOP the FTU.

2. Set the FTU switches as shown below. (Note their position as you will return them at the end of this procedure.)

Switch	Position
WRT-RD SELECT	RD
DATA ERROR BYPASS	Down (OFF)
DATA PATTERN	Choose any one switch and move it to the opposite 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.

2.5.5.7 Trouble Analysis - Table 2-3 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 modes. Note that sector mark and sector count errors are not indicated if the ADDRESS ERROR BYPASS switch is active.

Basically, the DLT indicates the procedures to follow to either eliminate or recover data and address errors before writing a "defective track" flag on the track in error. These procedures involve trying various OFFSET and DATA STROBE switch combinations.

The DLT has four quadrants. The DLT reduces each test condition, shown in the upper-left quadrant, to a yes (Y) or no (N) shown in the numbered columns of the upper-right quadrant. There are two columns for each test condition. The two lower quadrants provide recommended actions.

To determine what actions, if any, to execute for a given test result, follow the selected column down to the number "1" (the first recommended action) in the lower-right quadrant. Locate the specific action to take by following across to the lower-left (actions) quadrant. After you have accomplished action 1, 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 which requires no further remedial action.

Columns 12 through 20 define the sequential tests that were al-
luded to in the second paragraph of this procedure. Use these ac-
tions to attempt to recover data errors. Note that the last ac-
tion 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. Only when the last of these sequential tests
has failed to recover the data should you carry out the write flag
procedure indicated in action 3 of column 20.

2.5.6 Preparation of the Drive for Return On-line after Testing

The procedures below prepare the drive for return to normal on-line operation after completing tests with either FTU or software.

1. Press the START switch to stop the drive motor and unload heads.
2. Open the pack access cover and remove the scratch or CE disk pack.
3. Close the pack access cover.
4. Open the rear cabinet door and set the MAIN AC circuit breaker to OFF.

NOTE

If the test software was used, proceed to step 9. If the FTU with standard I/O connection was used, proceed to step 5.

5. Disconnect the FTU standard I/O cables from J2 and J3 on the drive I/O panel.
6. Reconnect the system I/O cables to drive in the same configuration as they were prior to installation of the FTU, then replace the I/O panel cover.
7. If any card was installed on the card extender, remove the card extender and replace the card in the logic chassis.

8. If the head alignment was performed, remove the head alignment card from location A16. Also, remove the head alignment cable which is connected from E03 on the read/write chassis to A16 on the drive backpanel.
9. Replace the cover on the card cage and secure with the turnlock fastener.
10. Close the logic chassis and rear door.
11. Close the cabinet top cover, if it has been open.

2.6 FIELD ACCEPTANCE PROCEDURE

2.6.1 Introduction

The field acceptance testing demonstrates the performance of the RM05 Disk Drive to the customer prior to his acceptance of it.

2.6.2 Error Definitions and Rates

The drive contains two registers to display the error conditions possible. Error registers 1 and 2 (RMER1, RMER2) indicate the drive error conditions. One bit of RMER2 (SKI) indicates seek errors and is used to calculate the seek error rate (paragraph 2.6.2.4). 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 2-4 lists indications of the various error types and their explanations.

Table 2-4 Error Conditions

Bit	Register	Error Type	Explanation
HCE HCRC	RMER1 RMER1	Soft	The header field does not compare with the desired address. The sector compare fails due to the CRC failure.
HCRC	RMER1	Soft	The header field matches the desired address but there is a CRC error.
HCRC FER	RMER1 RMER1	Soft	The format bit in the first header is incorrect.
			NOTE
			An FER without HCRC during an operation that reads the header indicates the wrong format pack mounted.
DCK	RMER1	Soft	An error is detected during the read operation by an examination of the ECC bytes; it is correctable by retry sequence.

Table 2-4 Error Conditions (Cont)

Bit	Register	Error Type	Explanation
DCK ECH	RMER1 RMER1	Hard	An error is detected which is ECC-uncorrectable through 28 retry sequences (16 retries at nominal head position and 12 with head offset).
SKI	RMER2	Seek	<ol style="list-style-type: none"> 1. A seek operation fails to complete within 500 milliseconds of initiation. 2. A recalibration operation fails to complete within 500 milliseconds of initiation. 3. An offset or return-to-centerline operation fails to complete within 10 milliseconds.
SKI	RMER2	Seek	The positioner has drifted off the cylinder subsequent to completion of the positioning operation.
HCE	RMER1	Seek	The header field does not match the desired address, and there is not a CRC error. This error may be caused by a positioner failure or an RM adapter failure

2.6.2.1 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 twenty retries, sixteen at the nominal head position and two at each offset position.

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 one sector. The allowable error rate for hard errors is one error per 10¹² bits read.

2.6.2.2 Soft Errors - Any failure to read data correctly on the first try that is then successfully read during a recovery sequence constitutes a recoverable or soft error. (Refer to paragraph 2.5.2.1 for the definition of a complete recovery sequence.) The allowable error rate for soft errors is one error per 10¹⁰ bits read.

2.6.2.3 Pack-Attributable Errors - An error caused by imperfections in the recording surface is a pack-attributable error. If the imperfection is less than 11 bits long, it is ECC-correctable and will appear as a soft error. If it is 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 2.6.2.1 and 2.6.2.2 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.

2.6.2.4 Seek Errors - A seek error is any positioning operation that is not completed within 500 milliseconds for seek commands, 500 milliseconds for recalibrate commands, and 10 milliseconds 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 106 seek operations.

2.6.3 Field Acceptance Test Diagnostic Programs

These diagnostic programs may be used individually or in combination to demonstrate the performance of the disk drive. Use the following diagnostic programs for the RM05 Disk Drive. Refer to the applicable diagnostic operation procedures for more detailed information.

Test Programs

MAINDEC-ZZ-CZRMV	Extended drive test
MAINDEC-ZZ-CZRMR	Dual-port logic test, part 1
MAINDEC-ZZ-CZRMS	Dual-port logic test, part 2
MAINDEC-ZZ-CZRMP	RM05 diskless controller test, part 1
MAINDEC-ZZ-CZRMQ	RM05 diskless controller test, part 2
MAINDEC-ZZ-CZRMM	RM05 functional controller test, part 1
MAINDEC-ZZ-CZRMN	RM05 functional controller test, part 2
MAINDEC-ZZ-CZRMO	RM05 functional controller test, part 3. Format the pack before doing part 3

System Exerciser Programs

MAINDEC-ZZ-CZRMU

Performance exerciser, need formatted pack

MAINDEC-ZZ-CXRMC

DEC/X11 system exerciser

Utility Programs

MAINDEC-ZZ-CZRML

Formatter program, need good pack

MAINDEC-ZZ-CZRMT

Drive compatibility test

3.1 GENERAL MAINTENANCE

This chapter contains preventive and corrective maintenance information for the drive. The maintenance described here is directed toward field representatives. The information is divided into the areas described below.

- General Maintenance Information - Contains general information that a Field Service Engineer should be familiar with prior to performing maintenance on the drive.
- Preventive Maintenance Information - Gives the preventive maintenance schedule for the procedures that must be performed to maintain proper drive operation. (Refer to the RM05 Preventive Maintenance Manual for detailed information.)
- Tests and Adjustments - Contains procedures describing the electrical adjustments that may be performed on the drive in the field.
- Trouble Analysis - Describes tests that may be performed to isolate problems with the drive. (Refer to the RM05 Fault Isolation Guide for detailed information.)

This chapter also contains general information relating to maintenance of the drive. A person performing maintenance on the drive should be familiar with this information in addition to the operating principles and procedures described in the RM05 Technical Description manual.

NOTE

Be sure to include the hour meter reading on the authorized test section of the LARS form.

The information in the following is divided into the areas described below.

- Safety Precautions - Lists safety precautions that must be observed when working on the drive.
- Maintenance Tools and Materials - Lists the tools and materials required to perform maintenance on the drive. This includes descriptions of the types of disk packs used during maintenance procedures and the head alignment kit card. Drive tests and adjustments requiring test software or the field test unit (FTU) are also described.
- Accessing Drive for Maintenance - Describes the features of the drive which allow access to its subassemblies.
- Maintenance Controls and Test Points - Describes location of test points (both cards and backpanel) referred to in maintenance procedures.
- Manually Positioning the Carriage - Describes how the heads may be loaded and positioned manually.
- Special Maintenance Procedures - Describes certain procedures and practices that are important to proper maintenance of the drive.
- VDE Versus NON-VDE Differences - The RM05 has VDE and NON-VDE versions. The VDE versus NON-VDE differences will be called out in this manual where applicable. VDE differences include:
 - Redesigned power supply
 - Motor relay box between power supply and drive motor
 - Motor assembly with direct drive brake
 - Improved design pack access cover interlock
 - Hinge on logic chassis.

3.2 SAFETY PRECAUTIONS

Observe the following safety precautions at all times. Failure to do so may cause equipment damage and/or personal injury.

- Use care while working with the power supply. Line voltages are present inside the ac power assembly.

- Keep hands away from the actuator during seek operations and when reconnecting leads to the voice coil. Under certain conditions, emergency retract voltage may be present, causing sudden reverse motion and head unloading.
- Use caution while working near the head assemblies. Fingerprints may damage the heads or the disks.
- Keep pack access cover closed unless it must be opened for maintenance. This keeps dust out of the pack area.
- Keep all watches, disk packs, meters and other test equipment at least two feet away from the voice coil magnet when the deck cover is off.
- Do not use the customer's disk pack during troubleshooting.
- Do not use the CE alignment disk pack unless specifically instructed to do so. These packs contain prerecorded alignment data that can be destroyed if test procedures require the drive to perform a write operation. This alignment data cannot be recreated in the field.
- If the drive fails to power down when the START switch is depressed, disconnect the yellow leadwire to the voice coil and manually retract the heads before troubleshooting the malfunction.
- Make certain that the heads are unloaded before turning off power.
- If power to the drive motor is lost while heads are loaded and the voice coil leadwire is disconnected, immediately retract the carriage. Otherwise, the heads will crash when the disk speed is too low for the heads to fly.
- The -YFN card in the NON-VDE power supply requires special handling. Observe the safety precautions described in the discussion on Handling Electrostatic Devices.

3.3 MAINTENANCE TOOLS AND MATERIALS

Table 3-1 lists special tools, test equipment and materials required to perform preventive and corrective maintenance on the drive. The CONTROL DATA and DIGITAL part number for each of these items is also listed. Most of these items require no special instructions for their use. Special instructions, when necessary, are included in the maintenance procedures. The disk pack, the head alignment kit and the FTU all require special instructions.

Table 3-1 Maintenance Tools and Materials

DIGITAL P/N	CDC P/N	Description
29-13212-00	12218425	Torque screwdriver 2-35 in-lbs
29-20906-00	12263205	Torque wrench
29-22933-00	54109701	Card extender
29-22934-00	75018400	Carriage spindle alignment tool
29-22935-00	75018803	Head adjustment tool
29-22936-00	87016701	Screwdriver bit
NA	NA	Tool kit
NA	NA	Hex wrenches, metric
NA	NA	O'scope
NA	NA	DVM
NA	NA	Cleaning pads and cloths

3.4 DISK PACK

The maintenance procedures refer to three types of disk packs: (1) customer, (2) scratch, and (3) CE. All three are physically identical but are used for different purposes.

"Customer pack" refers to an RM05-P disk pack used for data storage during the customer's normal on-line operations.

A "scratch pack" is simply an RM05-P disk pack that does not contain any customer or other information that must not be destroyed. Therefore, a scratch pack can be used in maintenance procedures where the possibility exists that a pack could be damaged or its information altered or destroyed.

The "CE pack" contains special prerecorded information used during maintenance. Make sure that this data is not destroyed or altered. A CE pack cannot be reconstructed in the field.

3.4.1 Disk Pack Handling

The RM05-P cannot be cleaned. If improper operating conditions of the pack exist, the following symptoms may be observed and the pack should be removed immediately.

- A sudden increase in error rates related to one or more heads is observed.
- An unusual noise such as pinging or scratching is heard.
- A burning odor is smelled.
- Contamination of the pack from dust, smoke, oil, or similar substances is suspected.

If there is any doubt about the pack's functional condition, have it inspected. Enclose a description of the known or suspected malfunction.

CAUTION

Do not attempt to operate a pack that is suspected of being contaminated. Inspect drive heads and shroud area for contamination and/or damage. Do the above mentioned prior to operating the drive with another pack.

3.4.2 Disk Pack Inspection

In some cases, it may be possible to inspect the disk pack. This task must be performed by properly trained personnel only and is recommended every 6 months.

NOTE

Inspection of disk packs in the field can cause additional problems for the following reasons:

- Exposure of the pack to non-clean room conditions during inspection may additionally contaminate the pack.
- Disk surfaces may be scratched by using contaminated or improper inspection equipment.
- The pack may be damaged while the covers are removed.

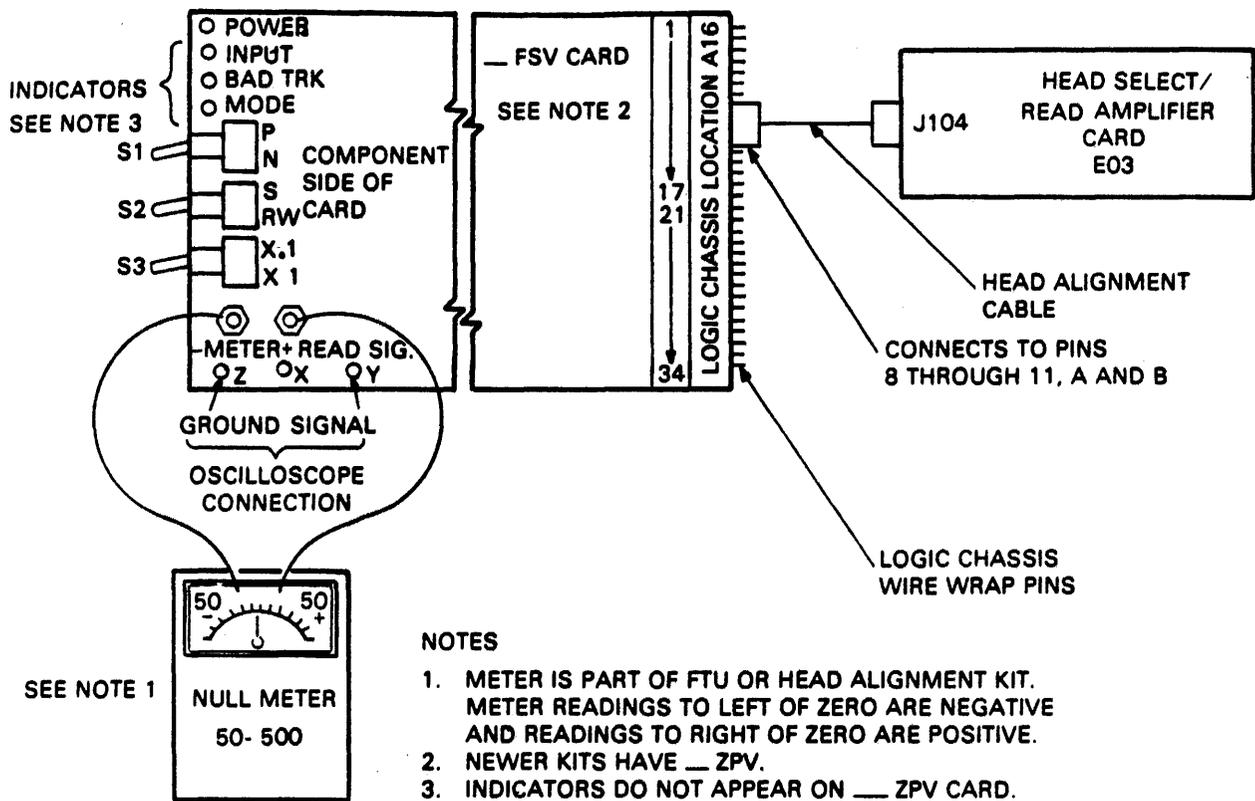
3.5 HEAD ALIGNMENT KIT

The head alignment card develops an output voltage which is derived from the output of the servo and read/write preamplifiers. When a CE disk pack is installed on the drive, this output voltage will be proportional to the distance a selected head is offset from the track centerline. The head alignment card plugs into card location A16 in the RM05 logic chassis.

The head alignment card included in the kit is either the -FSV card or the -ZPV card. The only difference between the cards is that the -ZPV card does not have the four indicators found on the -FSV card (Figure 3-1).

The following toggle switches control the operation of the cards (Figure 3-1).

- S1 Changes the polarity of the alignment signal and is used in aligning both servo and read/write heads. This is done by following the steps listed below.



CZ-0284

Figure 3-1 Head Alignment Kit

- a. Note null meter reading when switch is in P position.
- b. Note null meter reading when switch in in N position.
- c. Subtract N reading from P reading to determine the alignment error. For example:

$$\text{If } P = +30 \text{ mv and } N = -40 \text{ mv, then } P - N = (+30) - (-40) = +70 \text{ mv.}$$

- S2 When the switch is in the S position the card selects the servo head as an input. When the switch is in the R/W position, it selects a data head input to the card.
- S3 Changes the sensitivity of the card. When in X.1 position, the sensitivity is reduced by a factor of 10. When in the X1 position, the sensitivity is not reduced. This switch should be in the X1 position when making measurements for use in calculating head alignment error.

Four indicators are provided on the -FSV card as monitors to ensure the card is operating properly and is receiving the proper data. These indicators are:

- Power When lit, it indicates that power is applied to the card.
- Input When lit, it indicates that the input signals are too low for the alignment card circuits to operate.
- Bad Track When lit, it indicates a short duration loss of input. A one shot maintains the lit condition for at least four seconds. This indicator lights when the Slswitch is operated.
- Mode When lit, it indicates that either S2 is in the servo position or S3 is in the X.1 position. When either of these conditions exist, R/W head alignment errors cannot be measured.

The card receives its input via the head alignment cable which is a part of the head alignment kit. This cable connects between A16, pins 8 through 11, and J1 on the read amplifier board in R/W chassis location E03.

The output voltage of the card is measured by a null meter which connects via test leads to test points X and Z on the card (Figure 3-1). This meter is either part of the FTU or is a separate unit if the head alignment kit is being used.

The switch on the front panel of the meter changes the sensitivity of the meter. When the switch is in the 50 position, the meter reads to +50 millivolts. When the switch is in the 500 position, the meter reads to +500 millivolts. This switch should be in the +50 millivolts position when making measurements for use in calculating head alignment errors.

3.6 TESTING DRIVE WITH FTU OR SOFTWARE

The FTU and test software provide various functions necessary to perform most of the electrical tests and adjustments described in this manual. The following paragraphs describe the general use of both the FTU and software for testing the drive.

3.6.1 Testing with the FTU

The FTU is an off-line tester. This means that the drive cannot be selected or used by the controller while tests are performed with the FTU.

The FTU connects to the drive by way of standard I/O cables. This requires that the system I/O cables be disconnected and the FTU cables connected in their place. Refer to Appendix A of the RM05 Disk Subsystem Service Manual for detailed information concerning the operation, installation and use of the FTU.

3.6.2 Testing with Software

The drive can also be tested by use of software test routines. This requires use of the controller and the appropriate software or diagnostic operating systems. In this type of testing, the drive communicates with the controller during normal operations. Special I/O connections are not required.

I/O connections, except for the procedure for preparing the drive, are the same as when using the FTU. These connections are described in paragraph 3.6.3.

Refer to other documentation, such as the RM05 User Guide, applicable to the specific system or subsystem for information concerning the test software routines.

3.6.3 Preparation of Drive for Testing

This section describes the procedure that prepares the drive for testing with either the FTU or software.

1. Press START to stop the drive and unload the heads.

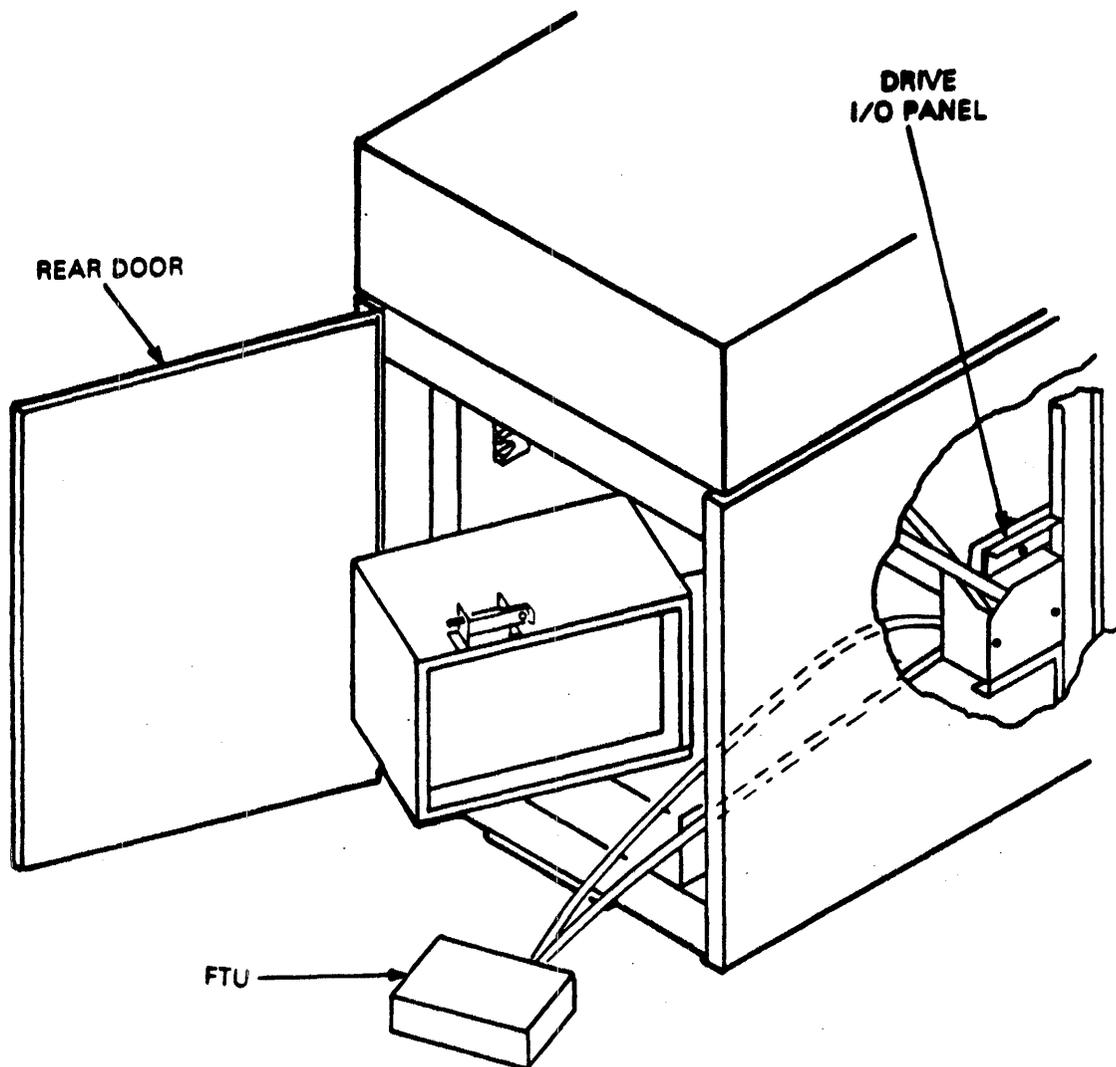
NOTE

All procedures other than head alignment require installation of a scratch pack. Head alignment requires installation of a CE pack.

2. Raise the pack access cover, remove the customer disk pack, and replace it with a scratch pack.
3. Close the pack access cover.
4. Set MAIN AC circuit breaker on the rear door to OFF.
5. Release the logic chassis latch and swing chassis open.
6. Connect the FTU standard I/O cables to the drive as follows (Figure 3-2):
 - a. Turn the I/O panel fastener counterclockwise and remove the panel from the upright support. This will allow the panel to be positioned so the cables can easily be installed.
 - b. Remove the hardware securing the I/O panel cover to the I/O panel. Remove the cover and set it aside. The cover is not replaced until maintenance is completed.

NOTE

Steps c through e refer to either a channel 1 or 2 connection, whichever is used.



CZ-0639

Figure 3-2 Standard I/O Connection

- c. Disconnect the I/O cables from J2 and J3 on the drive I/O panel.
 - d. Install tester A cable to J3 and B cables to J2.
 - e. Position the I/O panel on the upright support and secure it with the I/O panel fastener.
 - f. If the drive is in a system that is daisy-chained, make necessary connections to ensure that other drives remain under system control.
7. Loosen the turn-lock fastener securing the card cage cover to the logic chassis and remove the cover.

8. Install the card extender if the test or adjustment procedure being performed requires it. This is noted in the procedure.
9. If head alignment is being performed, proceed as follows:
 - a. Install the head alignment card (HFSV) in location A16.
 - b. Connect the head alignment cable from logic backpanel location A16, pins 8 through 11, to J1 on card E03 in the R/W chassis. Refer to head alignment procedure for detailed information.
10. Set MAIN AC circuit breaker to ON.
11. Press the START switch to start the drive motor and load the heads.
12. Select drive. When the drive is selected, it is ready for tests and/or adjustments.

3.6.4 Preparation of Drive for Return On-line After Testing

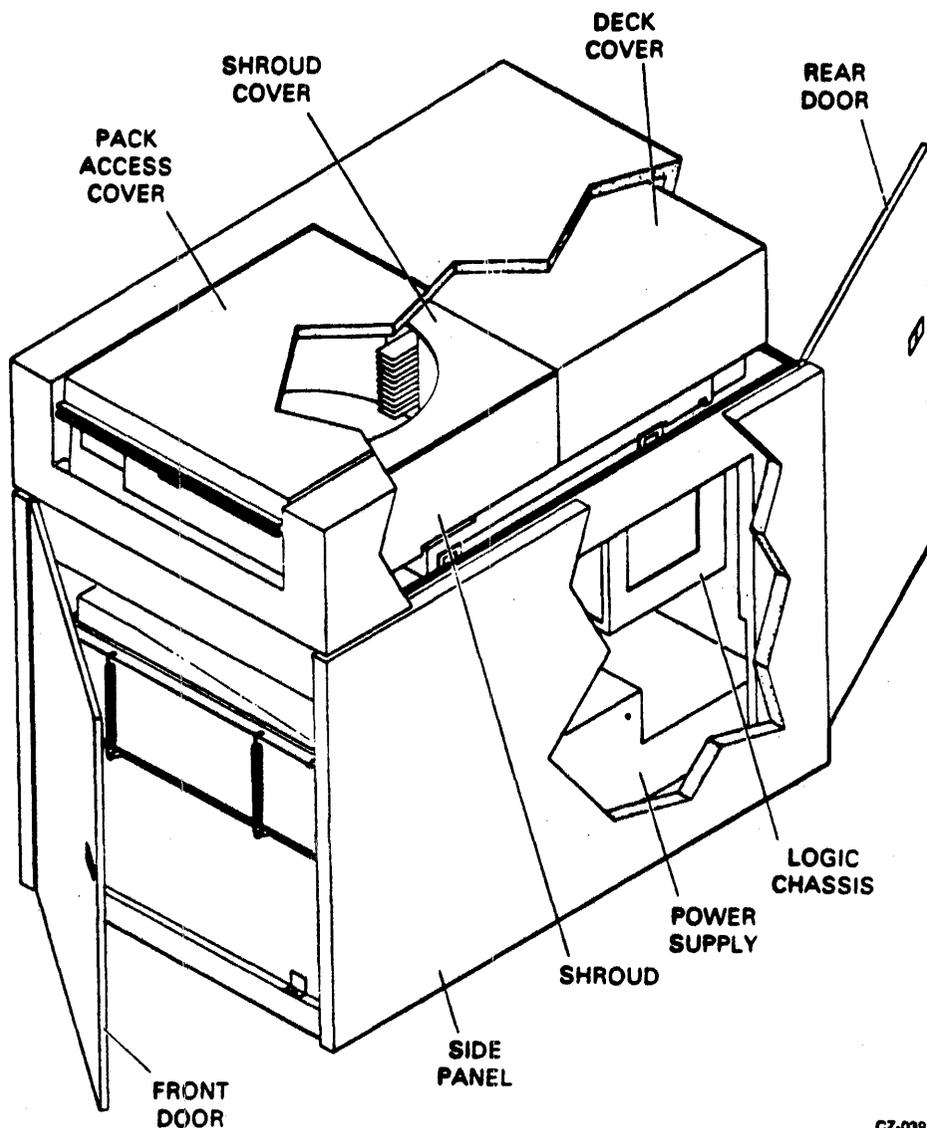
The following prepares the drive for return to on-line operation after completing tests with either FTU or software.

1. Press the START switch to stop the drive motor and unload the heads.
2. Raise the pack access cover and remove the disk pack.
3. Close pack access cover.
4. Open the rear door and set the MAIN AC circuit breaker to OFF.
5. Disconnect the FTU standard I/O cables from J2 and J3 on the drive I/O panel.
6. Disconnect the terminator, if used, from J4 on the drive I/O panel. The terminator is not required for normal on-line operation.
7. Reconnect the system I/O cables to the drive in the same configuration as they were prior to the installation of the FTU and replace the I/O panel cover.
8. If any card was installed on the card extender, remove the card extender and replace the card in the logic chassis.

9. If a head alignment was performed, remove the head alignment card from location A16. Also, remove the head alignment cable which is connected from E03 on the R/W chassis to A16 on the back of the drive.
10. Replace the cover on the card cage and secure it with the turnlock fastener.

3.7 ACCESSING THE DRIVE FOR MAINTENANCE

The doors and covers on the RM05 provide access to its major assemblies. Figure 3-3 shows all of the covers and doors and they are further described in the paragraphs below.



CZ-0092

Figure 3-3 Accessing the Drive for Maintenance

3.7.1 Cabinet Doors

The drive has doors on both the front and rear of the cabinet. The front door provides access to the blower assembly. Immediately behind the front door is a safety shield. If the safety shield and blower assembly are removed, the lower part of the spindle and its associated parts may also be accessed. The rear door allows access to the logic chassis, power supply, and drive motor. The front door is opened by pushing the latch and swinging the door outward as shown in Figure 3-3. Open the rear door by releasing the latch with a 6mm hex and swinging the door outward. The doors are removed by first removing the ground strap, then lifting out the pin securing the door to the lower hinge and slipping the door off the upper hinge. The doors are replaced by reversing the removal procedure.

3.7.2 Cabinet Top Cover

The top cover must be raised to access the deck assemblies. It must be removed prior to removing the shroud cover, shroud, pack access cover, or deck cover.

The top cover has no latch and is raised by lifting it from the rear until the support locks into place (Figure 3-4). The following section describes removal and replacement of the top cover. Note that if the drive is installed in line with other drives it must be removed from the in-line position before the cover can be removed or replaced.

3.7.2.1 Top Cover Removal

1. Raise the top cover until the support locks in the upright position. Remove ground strap.
2. Remove nuts from screws holding each side of the top cover but do not remove the screws. The cover should remain in the raised position supported by the screws and the support brackets.
3. Remove the C-clip securing the support bracket to the top cover, then lower the support bracket and the top cover to the closed position.
4. Remove the screws from the top cover hinges and lift the top cover off the drive.

3.7.2.2 Top Cover Replacement

1. Set the top cover on the drive.
2. Insert screws through the hinges and the drive frame.

NOTE

The cover should be supported by the screws when it is raised in step 3.

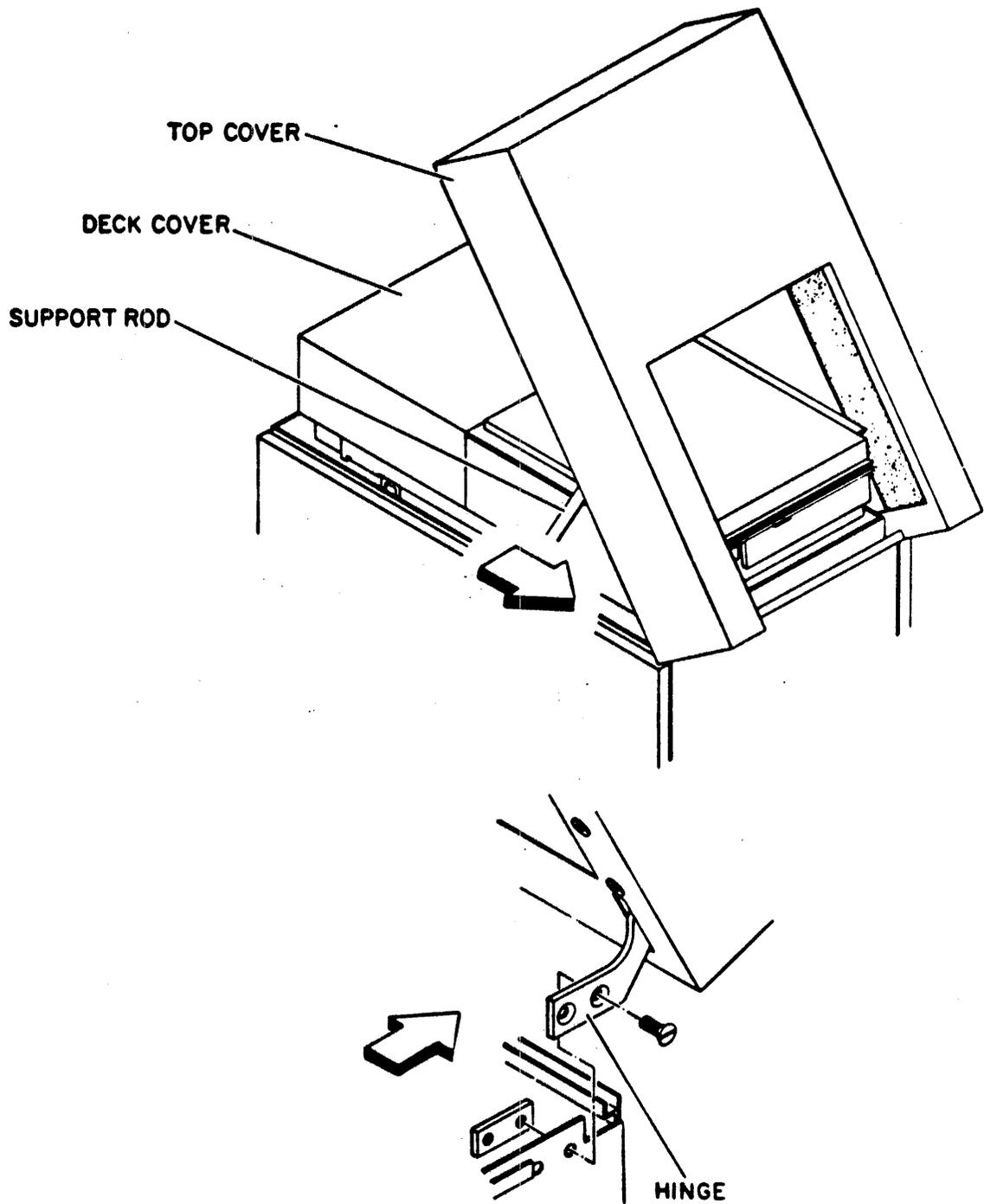


Figure 3-4 Top and Deck Covers

9W7

3. Lift the top cover to the raised position and secure the support bracket to the top cover with C-clip. Reinstall ground strap.
4. Install nuts on the screws securing the hinges to the frame.

3.7.3 Deck Cover

The deck cover (Figure 3-4) must be removed to access the rear half of the deck. This includes the actuator and the magnet assemblies. This cover provides an electromagnetic interference shield for the drive. The cover is lined with acoustical foam to reduce machine noise.

The cover is removed by releasing the latches and lifting it off the deck.

3.7.4 Logic Chassis

The logic chassis is located at the rear of the drive and is accessed by opening the rear door. Releasing the catch on the logic chassis allows it to swing outward, thus permitting access to the card cage (Figure 3-5). The card cage cover must be removed in order to reach the logic cards. Use care not to damage the cables or air hose when opening and closing the logic chassis.

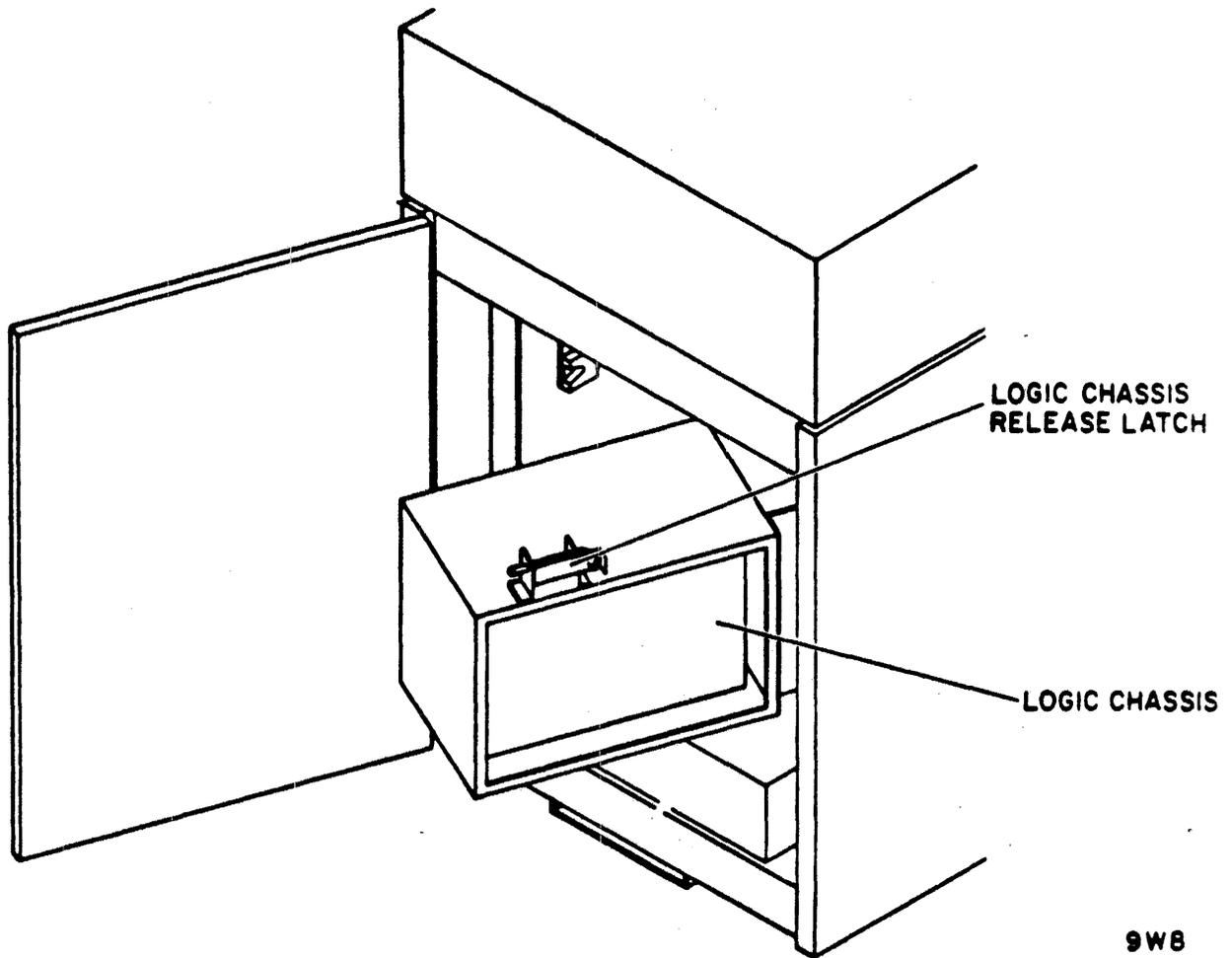
3.7.5 Pack Access Cover

Raising the pack access covers allows access to the disk pack and shroud area of the drive. Once opened, the cover is held in place by a gas spring (refer to Figure 3-6). A solenoid, located on the front of the shroud cover, prevents accidental opening of the pack access cover while the drive is in use or when the drive is completely powered down. In fact, the only time when the cover can be opened without overriding the solenoid is when the MAIN AC circuit breaker is ON, but the START switch is OFF.

The deck cover (refer to Figure 3-4) must be removed to access the rear half of the deck. This includes the actuator and magnet assemblies. The purpose of this cover is to provide an electromagnetic interference shield for the drive. The cover is lined with acoustical foam to reduce machine noise. The cover is removed by releasing the latches and lifting it off the deck.

The pack access cover solenoid can be manually actuated on NON-VDE units. Pull down on the solenoid latch while pulling up on the pack access cover latch release. On VDE units, the drive must be in the standby mode (power on, motor stopped) to open the cover. The pack access cover will remain locked for approximately 30 seconds after the MAIN AC circuit is turned on.

The pack access cover is removed and replaced as described in the following procedures.



9W8

Figure 3-5 Logic Chassis

3.7.5.1 Pack Access Cover Removal

1. Remove the cabinet top cover.
2. Remove the C-clip securing the gas spring to the pack access cover.
3. Disconnect the ground lead from the pack access cover.
4. Remove the screws and nuts securing the pack access cover hinges to the shroud cover and remove the pack access cover.

3.7.5.2 Pack Access Cover Replacement

1. Install the pack access cover on the shroud cover by securing the hinges with nuts and screws. Before tightening the screws, ensure that the cover is centered on the shroud. Also ensure that the clearance on the front of the shroud is such that the pack access cover solenoid will properly engage.
2. Secure the gas spring to the pack access cover using pin, nylon spacers, and C-clip (Figure 3-6).
3. Connect the ground lead to the pack access cover.
4. Ensure that a tight air seal exists between the pack access cover and the shroud cover. This can be checked visually and also by noting the drag on a sheet of paper as it is pulled out from between the closed pack access cover and the shroud cover. Adjust, if necessary, by moving the catch on the shroud cover up or down until the pack access cover latches tightly enough to provide an air seal.

3.8 POWER SUPPLY

The power supply is located on the floor, at the rear of the cabinet. Two types of power supplies are used. These are illustrated in Figure 3-7A. As illustrated, one power supply is mounted on slides that permits extending it out the rear of the cabinet. The other power supply is mounted on the base of the cabinet and does not incorporate the slides. Both power supplies contain replaceable cards.

3.8.1 NON-VDE Power Supply Access

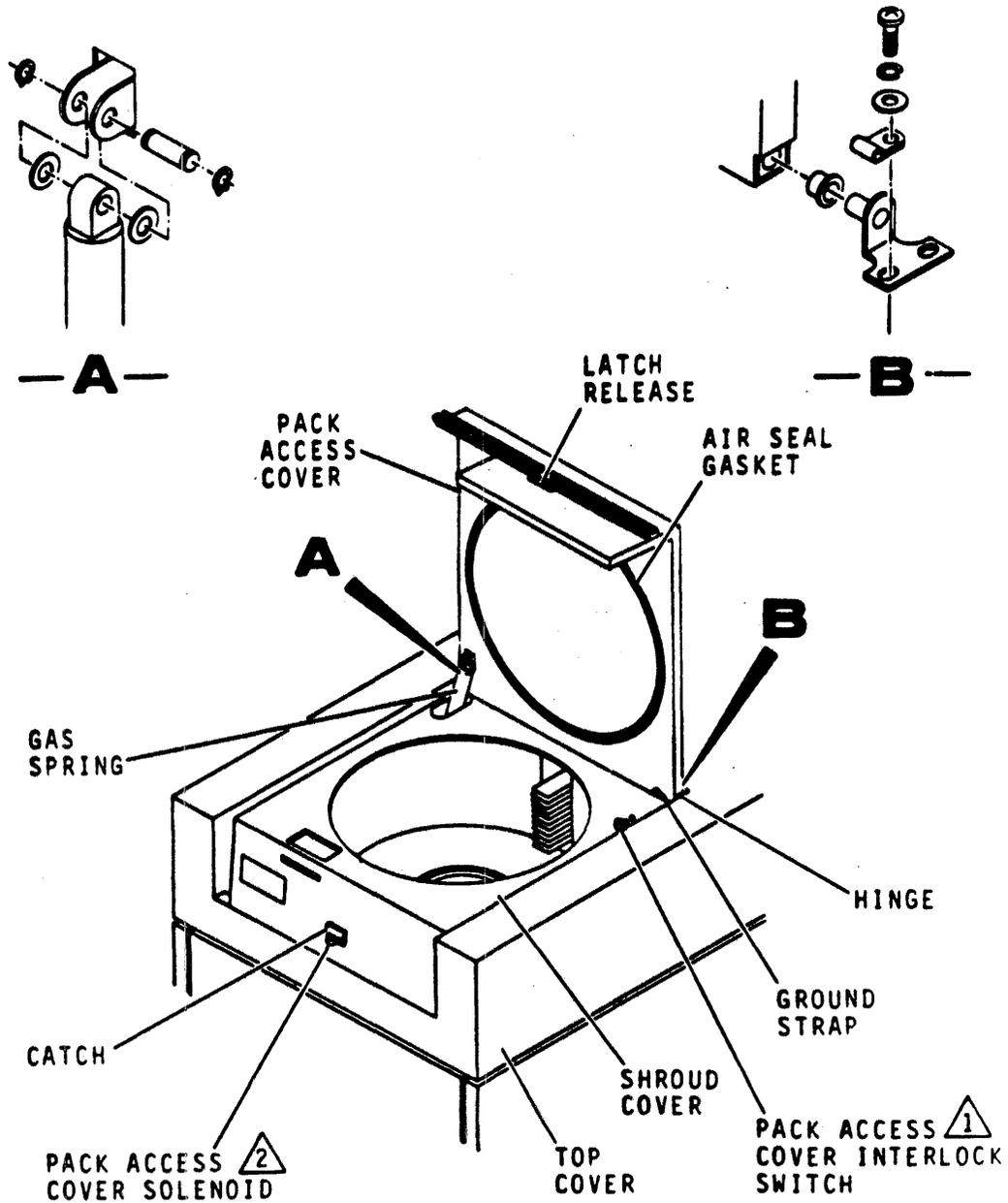
1. Swing the logic chassis outward far enough so that the chassis is not damaged when the power supply is pulled out.
2. Lift the power supply release latch and pull the power supply out to the maintenance position.

The top cover can be removed when the power supply is in the maintenance position. Remove the screws at the rear of the cover and then loosen the front screws. Slip off the cover.

The power supply control panel is hinged on its bottom edge to allow access to components on the back of the panel. To open the control panel, first remove the top cover, then remove the screws on each side of the panel and pull it open.

3.8.2 VDE Power Supply Access

The power supply shown in Figure 3-7, is mounted directly to the cabinet base. A lip at the back edge of the power supply slides under a bracket secured to the cabinet base. Two #10-24 x 3/8 self tapping screws and external tooth lockwashers secure the front edge of the power supply to the cabinet base.



① PART OF INTERLOCK ASSEMBLY ON VDE UNITS

② INTERLOCK ASSEMBLY ON VDE UNITS

10J3

Figure 3-6 Pack Access Cover

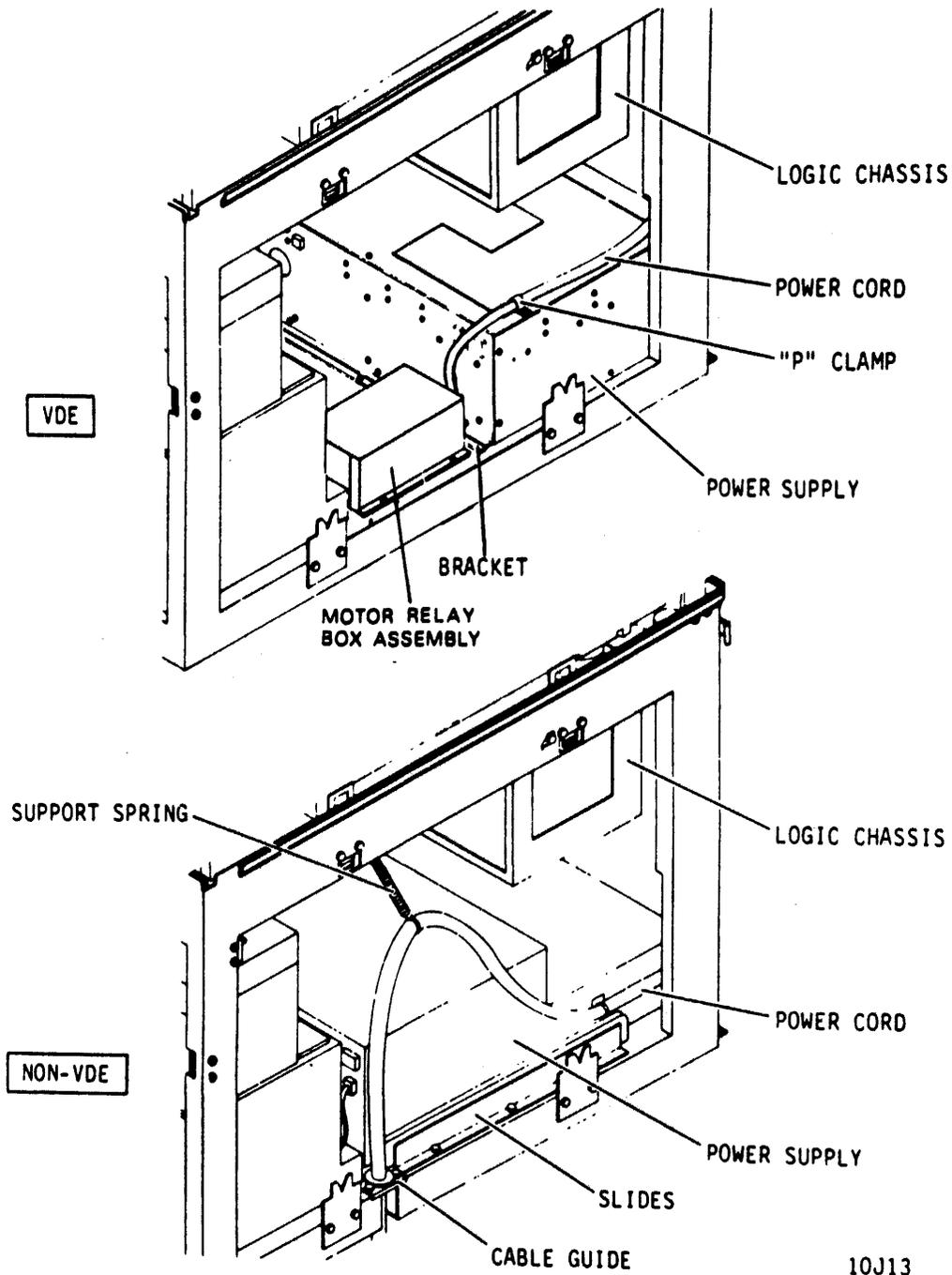


Figure 3-7 Power Supply Assembly

Removal of the two #10-24 mounting screws permits the power supply to be pulled rearward within the limits of the free length of the cables and blower hose. Servicing of the power supply will generally require its removal from the cabinet. The cover can be removed. The power supply can then be repositioned in the cabinet for power on tests.

3.8.3 Motor Relay Box Assembly

The motor relay box assembly Figure 3-7 is installed in VDE units only. It is mounted on the frame between the power supply and the air supply. The relay box contains the AWNV relay board. There are two trailing cables from the box for connections to the power supply and the drive motor. The relay box controls motor start and motor run current. To access the relay box, raise the top cover of drive. Release the latches for the right side panel and remove. Disconnect the ground strap between the side panel and drive frame.

3.9 SIDE PANELS

The drive has both left and right side panels. The panels are removed by pulling up on the release latches, swinging the panels outward far enough to disconnect the ground straps, and then removing the panels from the drive (Figure 3-8). The panels are replaced by reversing the removal procedure.

3.10 SHROUD AND SHROUD COVER

The shroud and shroud cover enclose the pack area and the front portion of the deck (see Figure 3-9). They must be removed to perform certain maintenance procedures. Their removal and replacement is described in the paragraphs below.

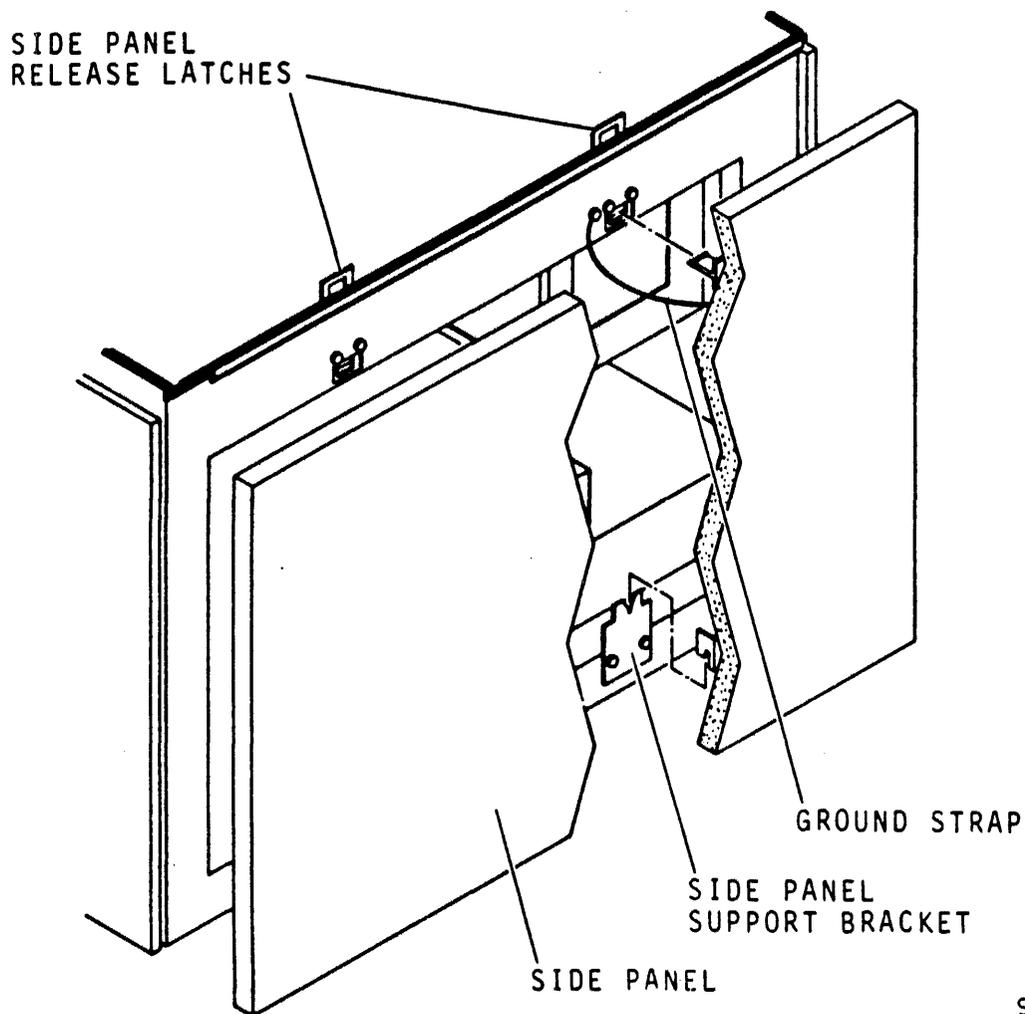
3.10.1 Shroud and Shroud Cover Removal

1. Remove the cabinet top cover.
2. Remove the pack access cover.
3. Remove the screws holding the pack access cover switch to the shroud cover. Let the switch hang by the leadwires.

NOTE

On VDE units, the pack access cover solenoid and pack access switch are integrated into one interlock assembly. Remove the interlock assembly by removing the two screws attaching it to the front of the shroud cover. Let the assembly hang by the leadwires.

4. Snap the operator control panel out of its position in the shroud cover, disconnect the control panel cable plug, then snap the control panel into place.



9W10

Figure 3-8 Side Panel

5. Move the shroud cover far enough forward to disconnect the solenoid leadwires. Disconnect A3P9 connector on VDE units.
6. Remove the screws holding the shroud cover to the shroud. Take off the shroud cover.
7. Take off the hardware securing the parking brake cover to the shroud cover and remove the parking brake cover.
8. Take off the hardware securing the shroud to the deck and remove the shroud.

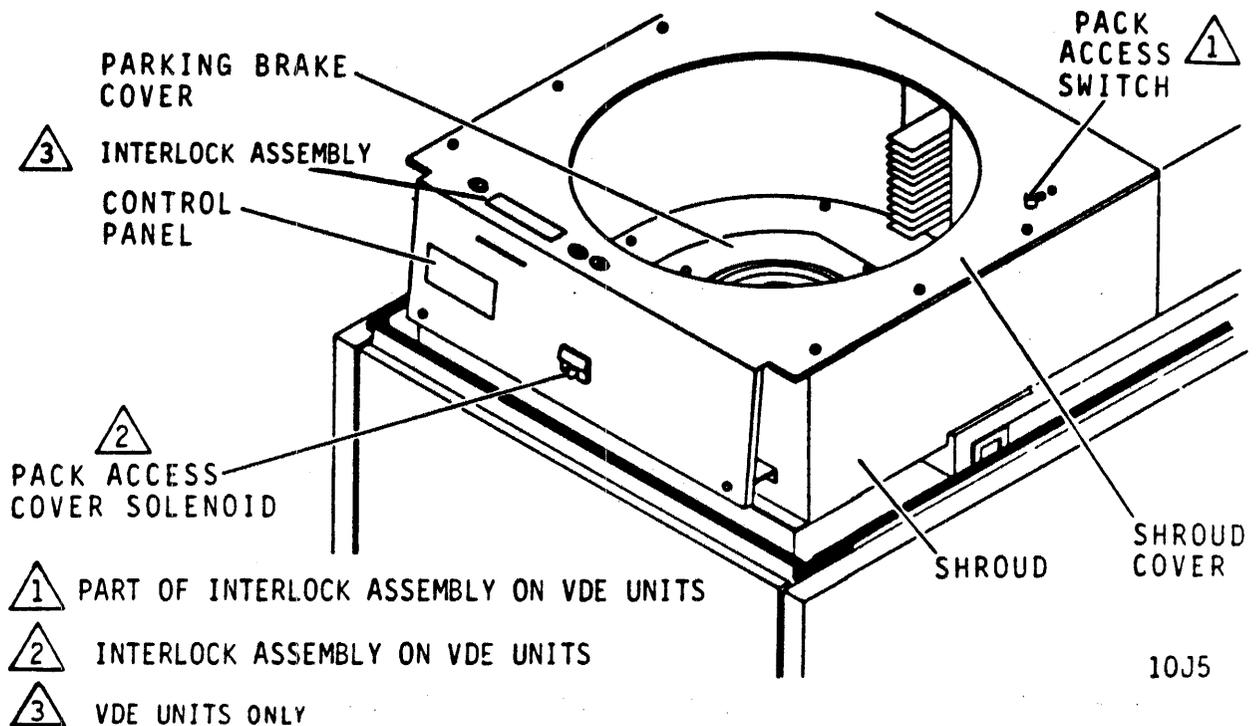


Figure 3-9 Shroud and Shroud Cover

3.10.2 Shroud and Shroud Cover Replacement

1. Position the shroud on the deck and secure it.
2. Reconnect the solenoid leadwires and connector A3P9 on VDE units before securing the shroud cover to the shroud.
3. Reattach interlock assembly to shroud cover on VDE units.
4. Position the shroud cover on the shroud and secure it.
5. Secure the parking brake cover to the shroud.
6. Snap the operator control panel out of its position in the shroud cover, connect the control panel cable plug to the operator control panel, and snap the control panel into its position in the shroud cover.
7. Position the pack access cover switch under the shroud cover and secure it.
8. Replace the pack access cover.
9. Replace the top cover.

3.11 MAINTENANCE CONTROLS AND TEST POINTS

Throughout this manual, references are made to switches, indicators, and test points. These are located and described in the following discussions.

3.11.1 Maintenance Controls

The drive has a number of controls and indicators which are used primarily for maintenance. All of these are located on the edges of the cards in the logic chassis. Figure 3-10 shows these controls and indicators, and Table 3-2 defines their functions.

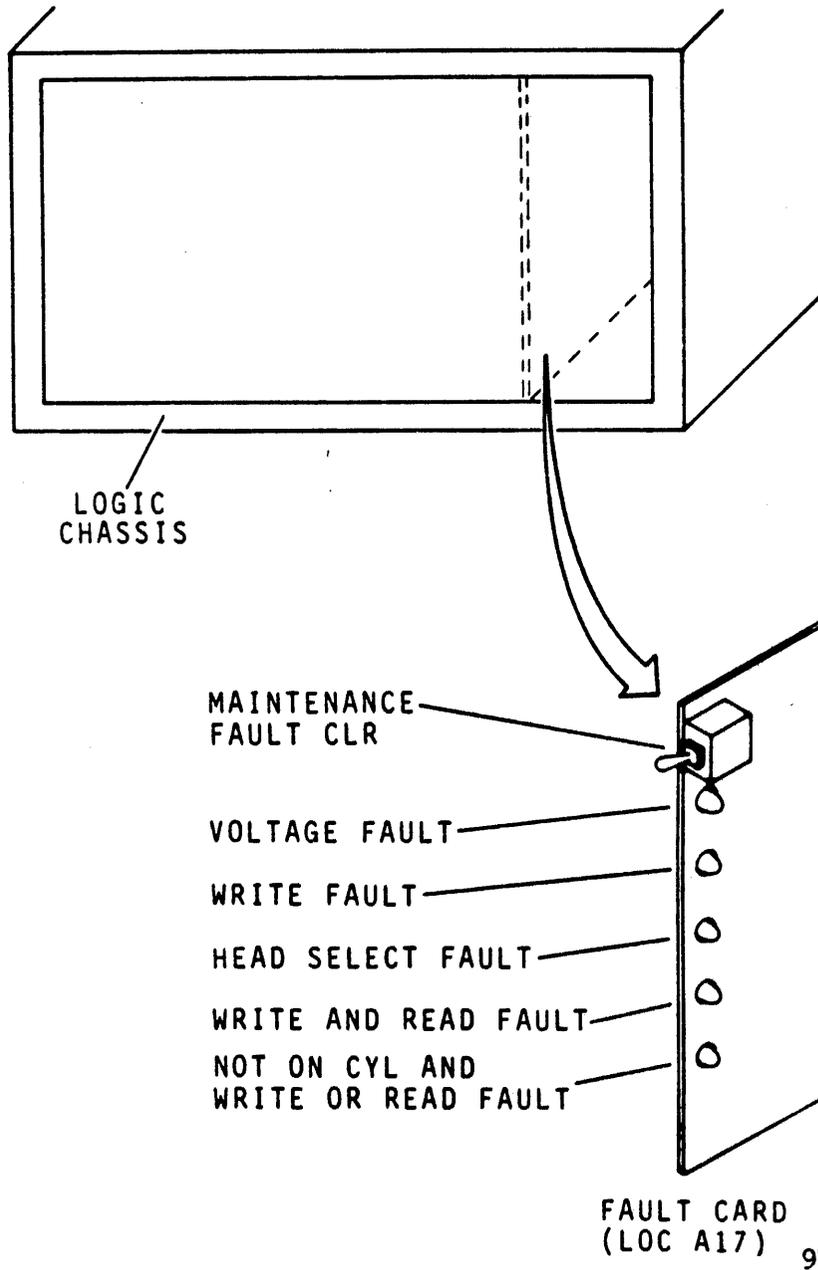


Figure 3-10 Maintenance Controls and Indicators

Table 3-2 Maintenance Controls and Indicators

Control or Indicator	Function
Maintenance fault clear switch	<p>Clear position clears the fault latch and five fault status latches. When the switch is actuated, the fault indicators on the edge of the fault card go off and remain off unless a condition causing the fault remains.</p> <p>NORM is the normal operating position for the switch and the position to which it returns when released.</p>
Voltage fault indicator	Lights to indicate a below-normal voltage exists.
Write fault indicator	Lights to indicate that a write fault exists.
Multiple head select Fault indicator	Lights to indicate a multiple head select is occurring.
Write and read fault indicator	Lights to indicate that both a write and read are commanded simultaneously.
Write or read and off cylinder indicator	Lights to indicate that a write or read is selected during a seek operation (not on cylinder).

The operator panel and the power supply control panel switches and indicators are detailed in the RM05 User Guide and the RM05 Technical Description manuals.

3.11.2 Test Points

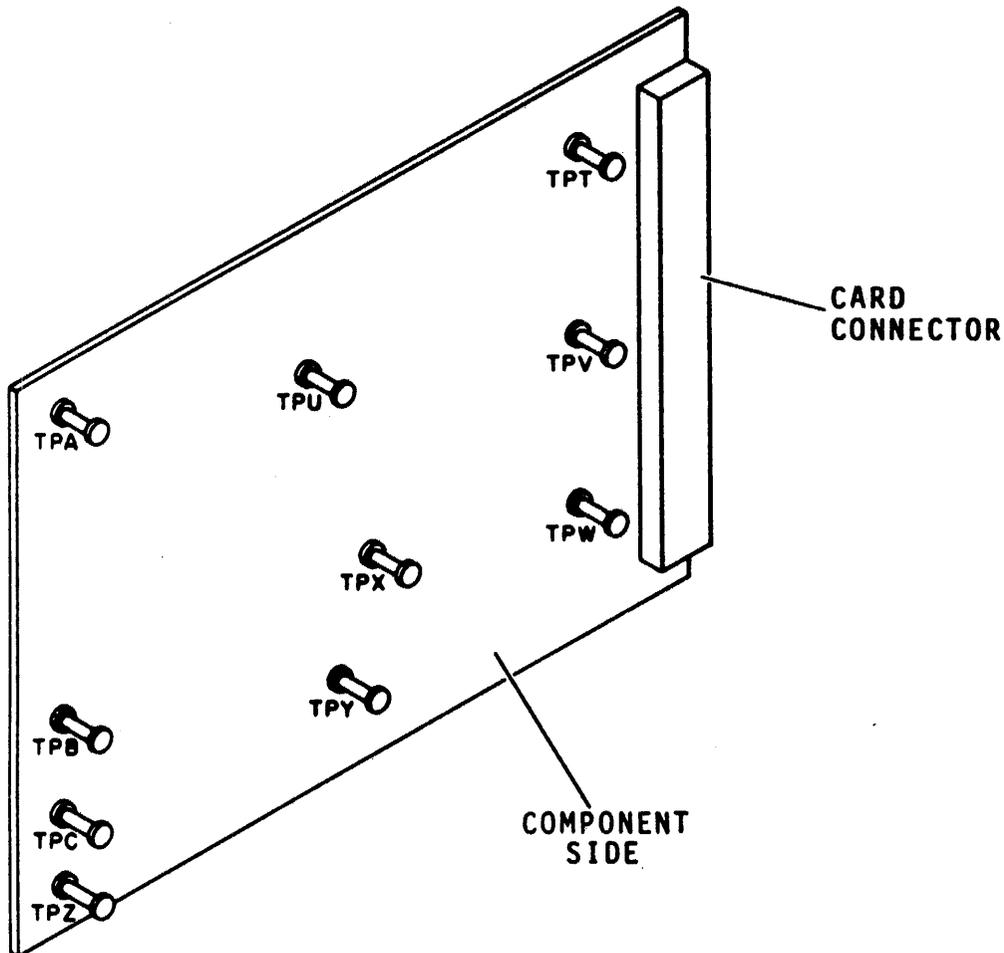
When performing the electrical checks and adjustments described in this text, it is necessary to monitor signals at various points in the drive logic or other circuitry. There are three categories of test points: (1) pins of the logic chassis wirewrap panel, (2) test points located on a card in the logic or R/W chassis, and (3) test points on the power supply control panel.

3.12 WIREWRAP PINS

The procedures refer to wirewrap pins by card location and pin number. For example, A08-05A refers to pin 05A at wirewrap panel location A08. The location and orientation of the pins of the logic chassis wirewrap panel are explained in the RM05 Print Set.

3.13 CARD TEST POINTS

The card test points (Figure 3-11) are located on logic cards in either the logic or R/W chassis. These test points are located on the component side of the card and consist of studs to which an oscilloscope probe can be attached. The test points may be located anywhere on the component side of a card and are lettered alphabetically, omitting letters I and O. When viewed from the component side with the connector at the right, the test points appear as follows (refer to Figure 3-11).



9W138

Figure 3-11 Card Test Points

- The test point in the lower left hand corner is always ground and labeled Z.
- The upper test point on the left is also ground and labeled A.

- Other test points on the card edge are labeled B, C, D, etc.
- All other test points are assigned in reverse order from the end of the alphabet (Y, X, W, etc.). Y is the nearest to the bottom right of the card and the letters progress in reverse order from right to left in successive rows from bottom to top.

The maintenance procedures refer to test points by card location and test point letter. This means that test point A on card A02 in the logic chassis is referenced as A02-TPA.

Only the test points located on the outer edge of the cards can be accessed without the use of a card extender, and only those test points are called out in the procedures.

3.14 POWER SUPPLY TEST POINTS

The power supply control panel (Figure 3-12) contains test points to measure certain voltage outputs from the power supply. These consist of jacks into which a meter probe can be inserted to make the required measurement.

3.15 PROCEDURE FOR MANUALLY POSITIONING CARRIAGE

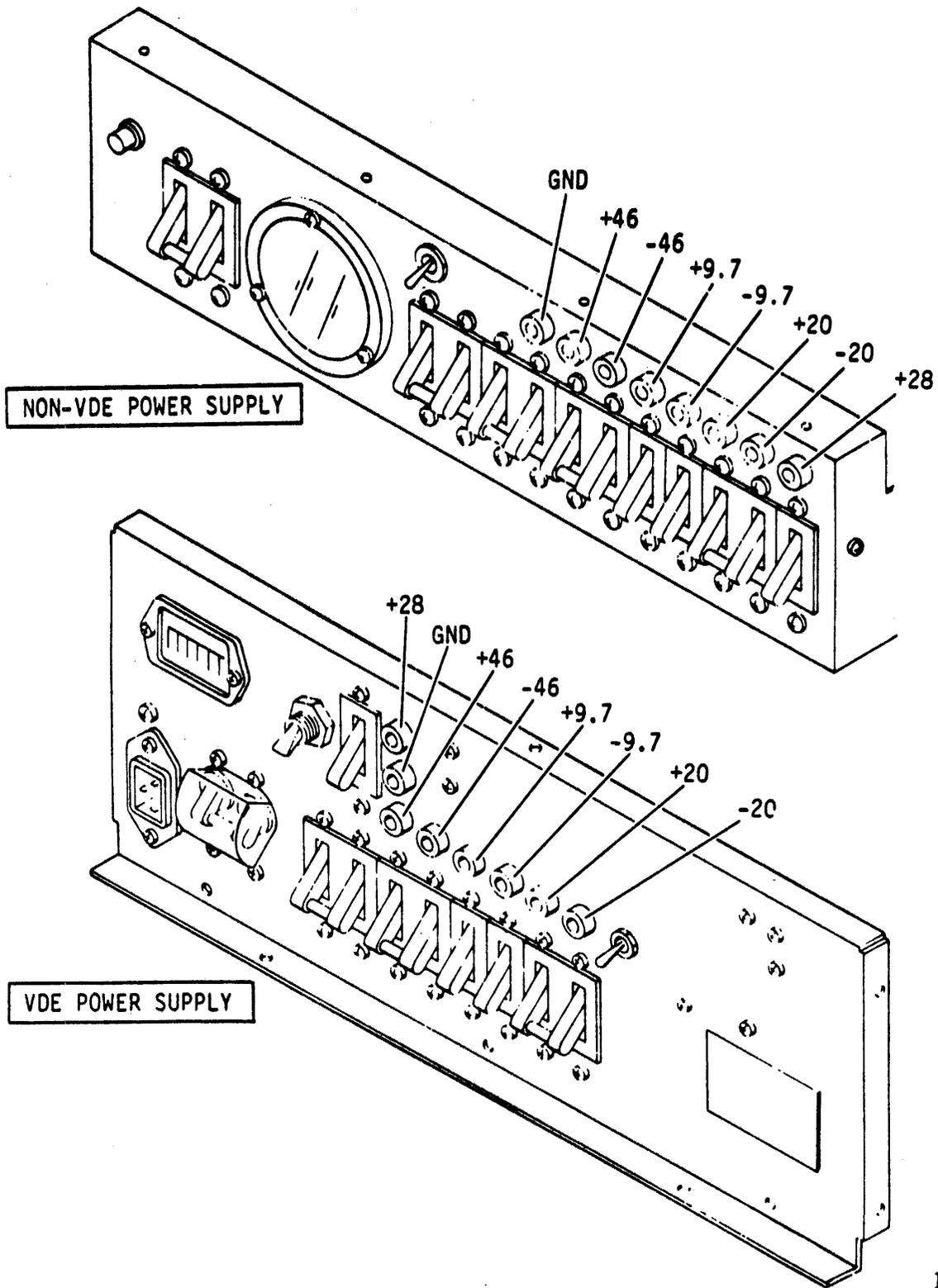
Certain tests require manual operation of the positioner. This procedure should be performed only if the drive will not respond or the desired results cannot be obtained with the servo under logic control. Improper positioning of the heads (loading too slow, hitting the forward stop or positioning heads in the loading zone) will cause a servo fault condition and a possible head crash. This could cause inaccurate results from any test that was being performed. If a servo fault occurs, unload the heads, clear the fault and repeat the operation being performed.

1. Press START to stop the drive motor and unload the heads.
2. Remove the yellow leadwire from the voice coil.
3. Press START to spin-up the drive motor.
4. Remove the plastic shield to expose the voice coil.

CAUTION

Wait for 30 seconds for the drive motor to come up to speed. Load the heads as fast as possible to avoid having them in a partially loaded position.

5. Carefully grasp the voice coil and load the heads.



10J6

Figure 3-12 Power Supply Control Panel Test Points

CAUTION

Move the coil at approximately the same speed as it moves under control of the drive positioning logic. Do not apply a downward force while moving the coil. If the spindle power is lost, immediately retract the heads.

6. Move the positioner as described by applying a lateral pressure to the coil.

CAUTION

Unload the heads as fast as possible to avoid having them in a partially loaded position.

7. When the tests are completed, manually unload the heads to the fully retracted position.
8. Press START to stop the drive motor.

WARNING

Before reconnecting the yellow leadwire, make certain that your fingers are clear of the positioner.

9. Reconnect the yellow leadwire to the voice coil.
10. Press START to begin the drive motor and load the heads.

3.16 PREVENTIVE MAINTENANCE SCHEDULE

This paragraph gives the schedule for the preventive maintenance procedures that must be performed on the drive to keep it operating properly. The schedule is shown in Table 3-3.

Table 3-3 Preventive Maintenance Schedule

Interval*	Est. Time (Minutes)	Procedure
3 months	10	Clean primary air filter
3 months	2	Check +5 volt and -5 volt output
6 months	1	Clean shroud and spindle
6 months	2	Clean and lubricate lockshaft
6 months	5	Clean carriage rails and bearings
6 months	20	Absolute air filter replacement
6 months	90	Head alignment check
12 Months	30	Servo adjustment check

* Intervals are maximum times. Preventive maintenance may be required more frequently depending on the level of dust contamination in the operating area.

3.17 TESTS AND ADJUSTMENTS

This paragraph contains procedures describing all electrical adjustments that may be performed in the field. Each of these procedures describes both the tests and adjustments of a particular aspect of drive performance.

The person performing these procedures should be thoroughly familiar with operation of the drive and with all information in Paragraph 3.1 of this manual.

3.17.1 +5 Volt and -5 Volt Test and Adjustment

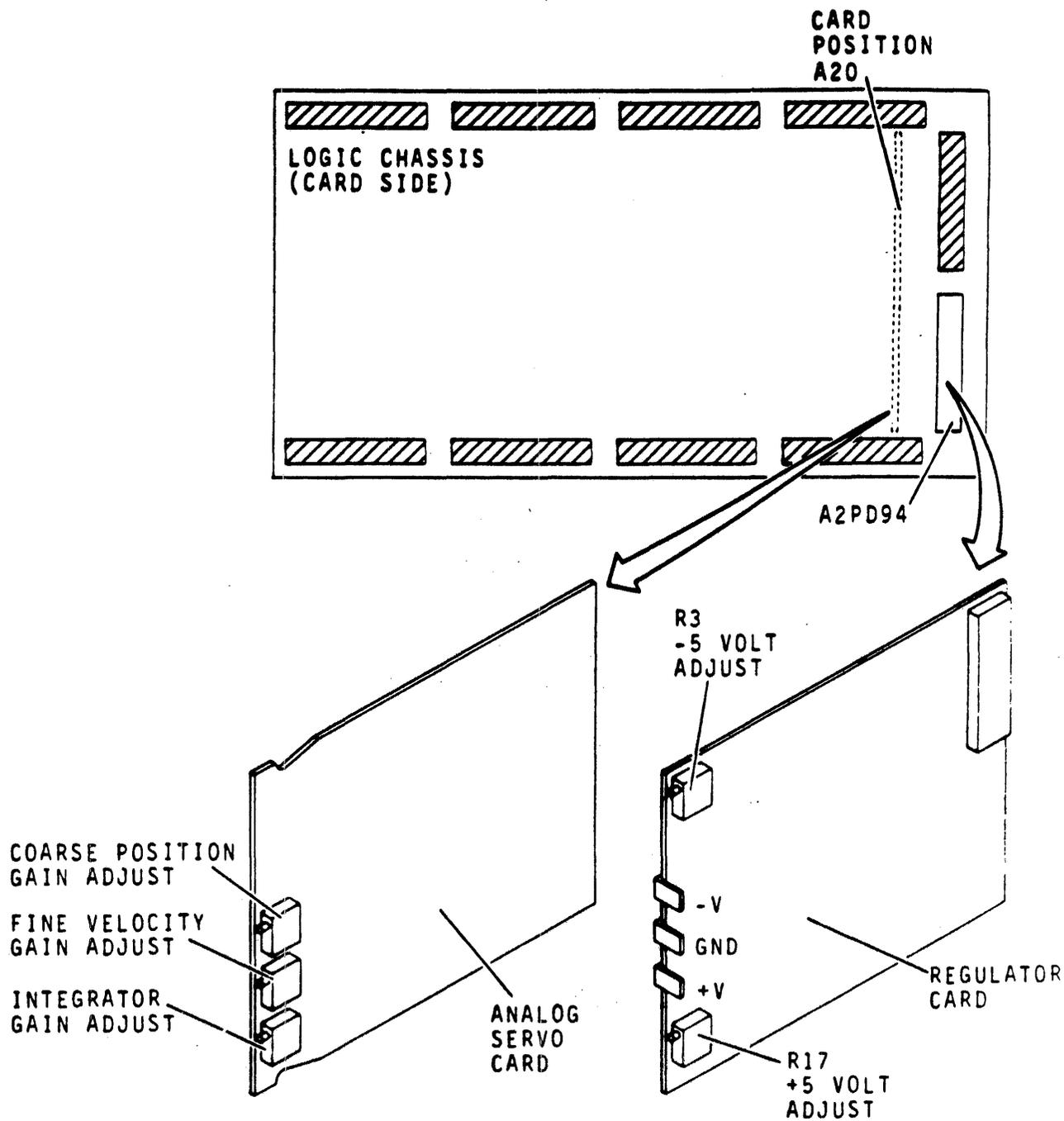
This procedure describes test and adjustment of the +5 and -5 volt outputs from the regulator board (refer to Figure 3-13).

1. Prepare drive for use with test software or FTU.
2. Command continuous seeks between cylinders 000 and 128.
3. Check and adjust +5 volts as follows:
 - a. Connect positive meter lead to A2JD94-04A on logic backpanel.
 - b. Connect negative meter lead to terminal marked ground on front edge of regulator card.
 - c. Measured voltage should be +5.1 (+0.05 volts). If this requirement is not met, adjust the bottom potentiometer on the regulator card until voltage is within specified limits.
4. Check and adjust -5 volts as follows:
 - a. Connect positive meter lead to terminal marked ground on front edge of regulator board.
 - b. Connect negative meter lead to wirewrap pin A2JD94-01A on logic backpanel.
 - c. Measured voltage should be -5.1 (+ 0.05) volts. If this adjustment is not met, adjust top potentiometer on regulator board until voltage is within specific limits.
5. Prepare drive for return to on-line operation.

3.17.2 Head Alignment

Alignment of the heads is checked under the conditions listed below.

- During initial installation of the drive
- After replacing one or more head arm assemblies



9W16

Figure 3-13 Voltage Regulator and Servo Adjustments

- When misalignment of one or more heads is suspected (for example, inability to read a pack written on another drive).

If it is determined that a head is misaligned, the head-arm is adjusted to bring the alignment of the head within specifications. Figure 3-14 is a flowchart summarizing the basic functions of the head alignment check and adjustment procedure.

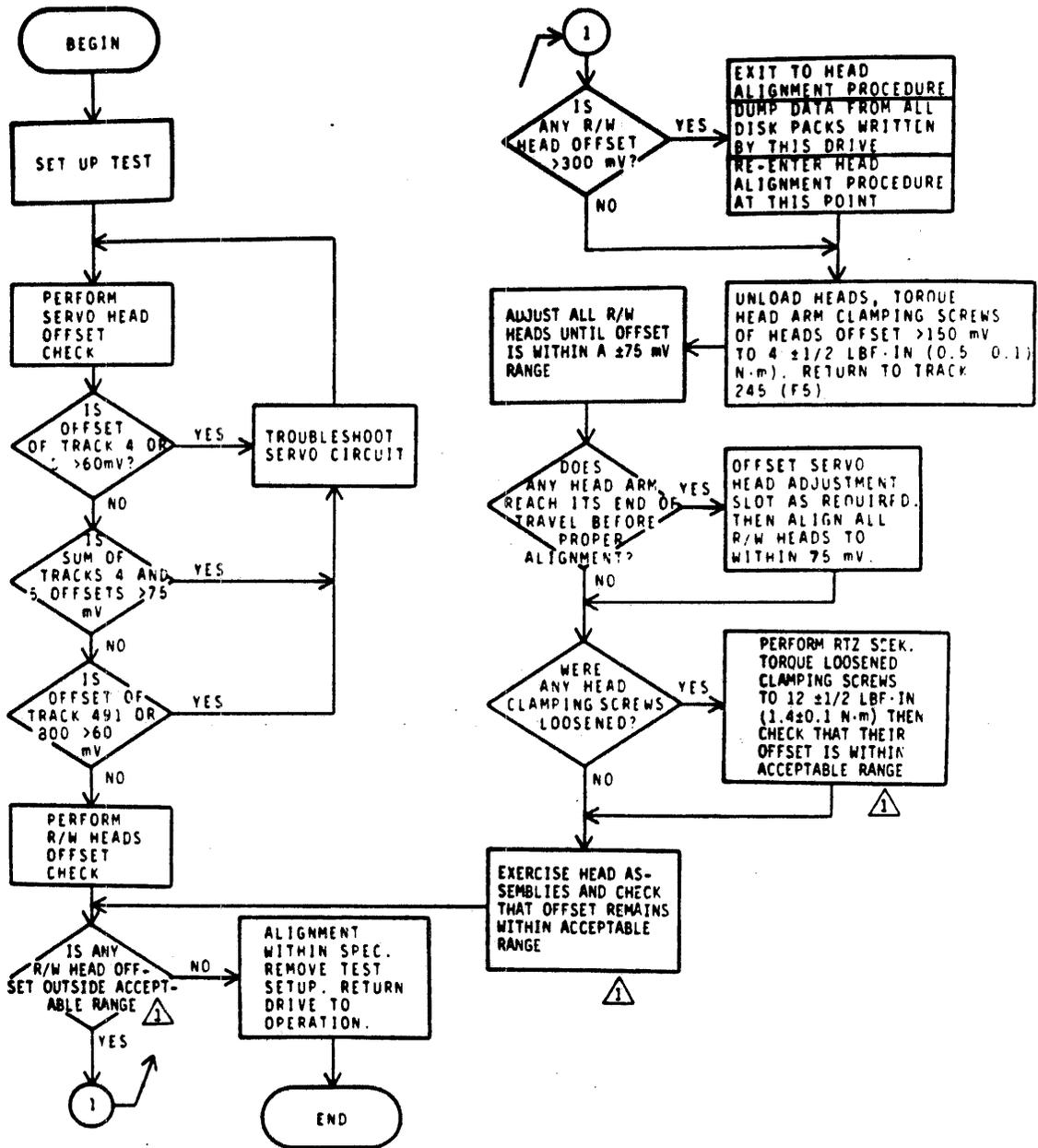
When performing head alignment, give special consideration to the items listed in the following paragraphs.

3.17.2.1 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 zero) for a minimum of 60 minutes. The CE pack requires only a 15 minute stabilization time when all of the following conditions have been met.

- Head alignment is being performed on more than one drive
- The pack is taken immediately from another drive
- The drive being tested has been operating with heads loaded for a minimum of 60 minutes before the tests.

3.17.2.2 Alignment Tool - Use only the head alignment tool specified in Table 3-1. Use of a different tool may cause damage to head-arm or carriage. Always inspect the adjustment end of the tool prior to use. The tool must be free of nicks and scratches and must have a polished surface where it enters the carriage alignment hole. If any aluminum deposits are present, polish the tool surface with a 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 it so that the pin in the end of the tool engages the alignment slot in the head arm. If anything more than a small amount of force is required to adjust the head, the tool is probably binding in the hole of the carriage. Ensure that the alignment tool is kept perpendicular to the hole in the carriage at all times.

3.17.2.3 Carriage Locking - During the alignment procedure when the heads are over the alignment track, the carriage locking pin and ring assembly must be installed in the ALIGN TRACK LOCK hole in the rail bracket assembly. This locks the carriage in the head alignment position. Failure to install the pin and ring assembly allows the carriage to retract if any emergency retract signal is generated. Since your hands are in the actuator area during the head alignment procedure, the retract could be dangerous.



9W145A

Figure 3-14 Basic Head Alignment Check and Adjustment Flowchart

CAUTION

Should an emergency retract condition be generated when the locking pin is in the ALIGN TRACK LOCK hole, the results listed below may occur.

- Blown fuse
- Tripped dc circuit breaker
- Blown power amplifier transistors
- Unretracted heads on a stationary CE pack

3.17.2.4 Initial Set-Up

1. Prepare drive for use with FTU (refer to paragraph 3.6.3).
2. Ensure that CE pack is thermally stabilized.
3. Connect oscilloscope to test points Z (ground) and Y (dibits) on head alignment card.
4. Connect test leads between head alignment card and FTU null meter.

3.17.2.5 Servo Head Offset Check

1. Set head alignment card S/RW switch to S and X.1/X1 switch to S1. Refer to Figure 3-1 for entire check.
2. Command continuous seeks between cylinders 240_{10} (360_8) and 245_{10} (365_8) for a minimum of 30 seconds.
3. Command direct seek to cylinder 004.
4. Observe dibit pattern on oscilloscope. It should be similar to that shown in Figure 3-15.
5. Toggle P/N switch to both P and N positions and record null meter readings. If both P and N readings are less than 100 mV, the X.1/X1 switch can be set to the X1 position for more accurate readings.
6. Calculate head offset by using the following formula:

$$(P) - (N) = \text{OFFSET}$$

Where P the is meter reading with P/N switch in P position and N is the meter reading with switch in N position. Meter readings to the right of zero are positive and meter readings to the left of zero are negative.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS/DIV

CH 1 - 1 V

CH 2 - NOT USED

TIME/DIV

A - 1 μ SEC

B - NOT USED

TRIGGERING

A - INTERNAL POSITIVE

B - NOT USED

PROBE CONNECTIONS (USE x10 PROBE)

CH 1 TO DIBITS TEST POINT Y ON HD ALIGN CARD

CH 2 NOT USED

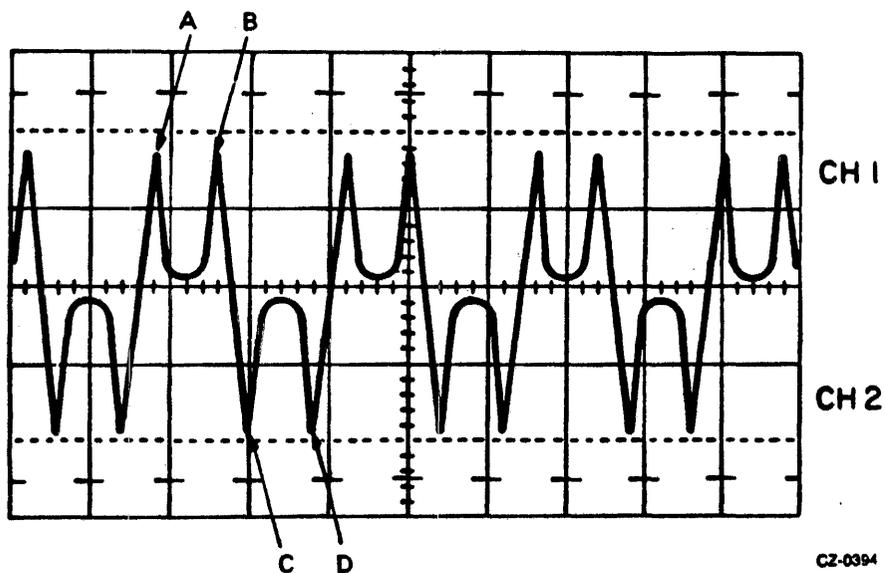


Figure 3-15 Balanced Dibit Pattern

- Example 1: $P = +20$; $N = +15$
 $(P) - (N) = (+20) - (+15) = +5$
- Example 2: $P = +20$; $N = -15$
 $(P) - (N) = (+20) - (-15) = +35$
- Example 3: $P = -20$; $N = +15$
 $(P) - (N) = (-20) - (+15) = -35$

7. Record offset calculated in step 6.

8. Evaluate servo head offset as follows:
 - If offset ranges between +60 mV and -60 mV, it is acceptable. Proceed with head alignment.
 - If offset is outside +60 mV range, it is unacceptable. In this case, troubleshoot servo system before proceeding with head alignment.
9. Command direct seek to cylinder 005 and repeat steps 4 through 8.
10. Add the offset readings from cylinders 004 and 005. This sum should range between +75 mV and -75 mV. If it does not, troubleshoot servo system.

Example 1:

IF

$$P_4 = -25; N_4 = -15$$

$$(P) - (N) = (-25) - (-15) = -10 \text{ mV}$$

AND

$$P_5 = +10; N_5 = -10$$

$$(P) - (N) = (+10) - (-10) = +20 \text{ mV}$$

THEN

$$(-10) + (+20) = +10 \text{ mV}$$

Sum is within +75 mV range and is therefore acceptable.

EXAMPLE 2:

IF

$$P_4 = +30; N_4 = -10$$

$$(P) - (N) = (+30) - (-10) = +40 \text{ mV}$$

AND

$$P_5 = +15; N_5 = -30$$

$$(P) - (N) = (+15) - (-30) = +45 \text{ mV}$$

THEN

$$(+40) + (+45) = +85 \text{ mV}$$

Sum is outside +75 mV range and is therefore unacceptable. Servo system troubleshooting is required.

11. Command direct seek to cylinder 800 and repeat steps 4 through 8.
12. Command direct seek to cylinder 491.
13. Install carriage locking pin into alignment hold (refer to Figure 3-16) and repeat steps 4 through 8.

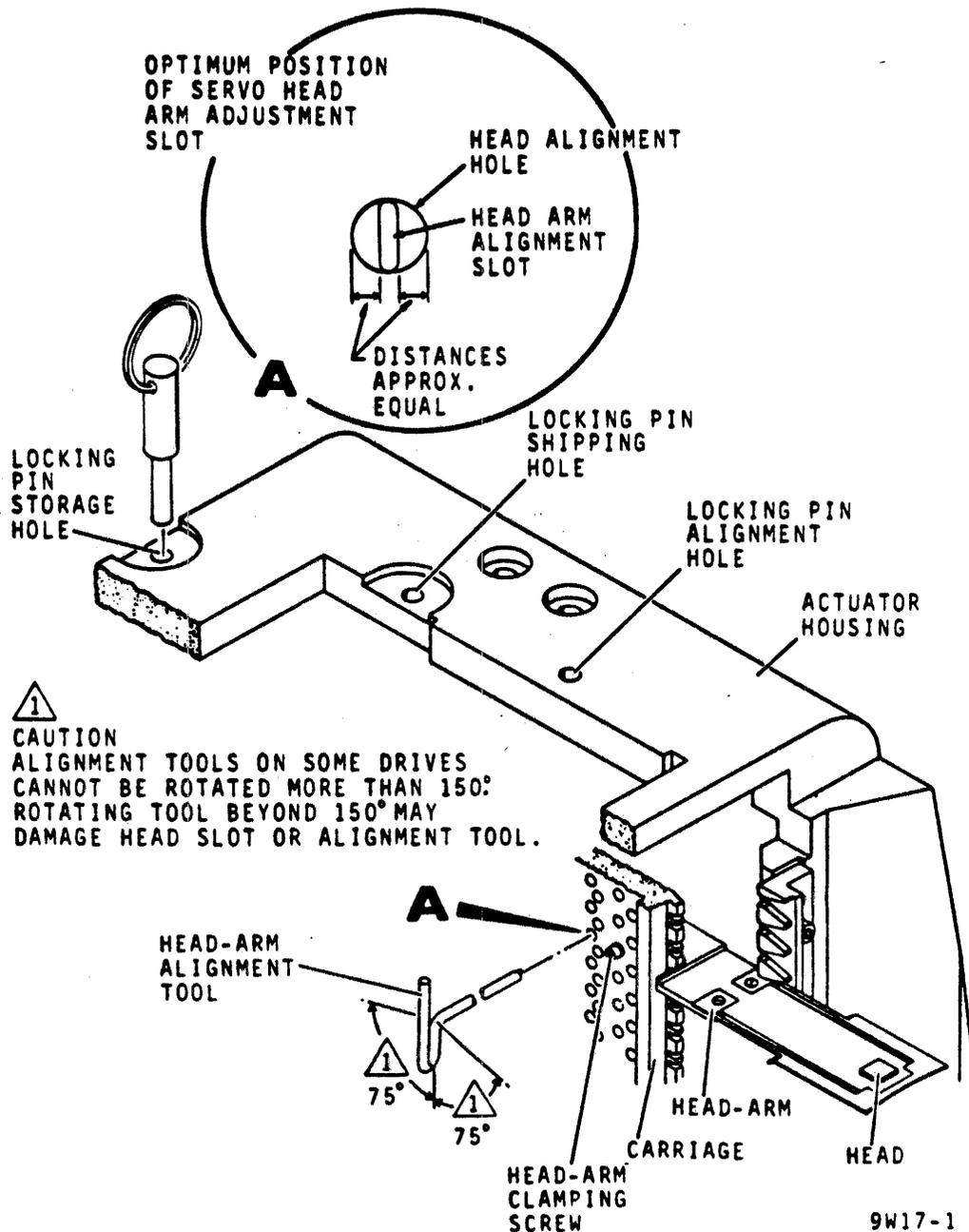


Figure 3-16 Head-Arm Alignment

3.17.2.6 Read/Write Heads Check and Adjustment

1. Set R/RW switch to RW. Observe that dibit pattern is similar to that shown in Figure 3-15.
2. Calculate offset of all read/write heads by using same method given in Steps 5 and 6 of Paragraph 3.17.2.5.
3. Remove carriage locking pin.
4. Evaluate read/write head offset as follows:
 - o If all offsets range between +150 mV and -150 mV, head alignment is within specifications. Therefore, proceed to Step 15 and restore drive to on-line operation.
 - o If any offsets are outside of the +150 mV range, these heads are misaligned. Proceed to Step 5. However, before proceeding, ensure that no offset exceeds a +300 mV range. If any offsets exceed this range, excessive misalignment exists. Transfer data from all packs written with these heads to other storage before proceeding with alignment.
5. Press START switch to stop drive motor and unload heads.
6. Loosen head-arm mounting screw securing heads that require alignment and torque these screws to $0.5 \pm 0.1 \text{ N}\cdot\text{m}$ ($4 \pm 1/2 \text{ lbf}\cdot\text{in}$).
7. Press start switch to start drive motor and load heads.
8. Command direct seek to cylinder 491.

NOTE

Force exerted during adjustment can move the heads from the alignment cylinder to an adjacent cylinder, resulting in an improper alignment. Prevent this by connecting a jumper from A07-11A (Seek Error) to ground. Be sure to remove the jumper before commanding the drive to perform another seek.

9. Align heads as follows:
 - a. Select head to be aligned.

WARNING

To prevent personal injury in case of an emergency retract, install carriage locking pin in head alignment hole prior to positioning head alignment tool. Be sure to remove pin before next seek is performed.

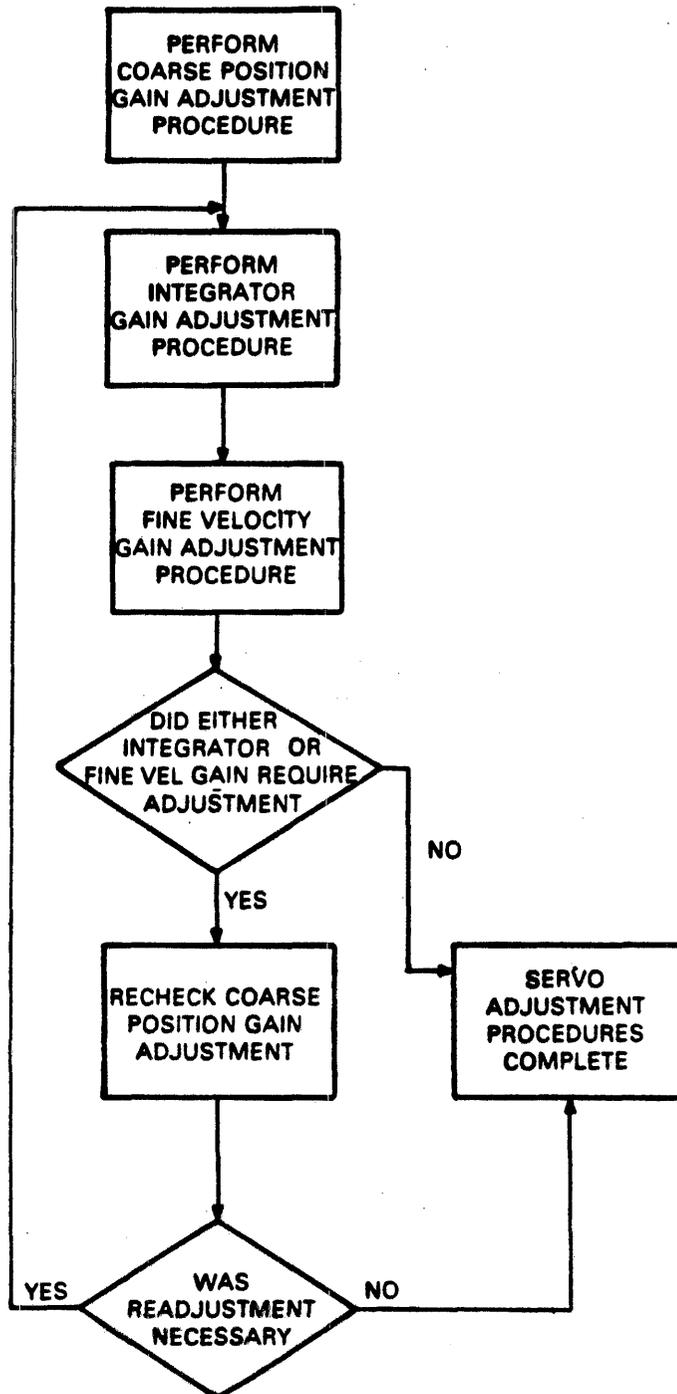
12. Torque head-arm clamp screws of each head adjusted to 1.4 +0.1 N·m (12 +1/2 lbf·in). While torquing screws, use only straight-arm Allen wrench and keep it as perfectly aligned as possible with screws.
13. Check each head adjusted to see if torquing screws affected alignment. If any heads are outside +150 mV range, re-adjust them as directed in Steps 6 through 12.
14. Perform the following to ensure that heads will remain aligned under normal operating conditions.
 - a. Command continuous seeks between cylinders 240 and 245 for a minimum of 30 seconds.
 - b. Unload and load heads at least twice.
 - c. Command direct seek to cylinder 291.
 - d. Check alignment of each head adjusted. If any heads are outside +150 mV range, repeat this procedure starting with Step 9.
15. Prepare drive for return to on-line operation.
 - b. Install head alignment tool so that tool pin engages head-arm alignment slot (refer to Figure 3-16).
 - c. Observe oscilloscope and adjust head to obtain balanced dibit pattern. Pattern is balanced when point A amplitude equals point B and point C equals point D (see Figure 3-15).
 - d. Observe null meter and adjust head until the offset reaches a range between +75 mV and -75 mV. Calculate offset as described in Steps 5 and 6 in Paragraph 3.17.2.5. Occasionally, a head cannot be aligned because its adjustment slot is at the end of travel. If this occurs, check position of servo head-arm adjustment slot and, if necessary, recenter it. It should be noted that any slight adjustment of the servo head requires realignment of all read/write heads. Torque servo head to 1.4 +0.1 N·m (12 +1/2 lbf·in). While torquing screws, use only straight-arm Allen wrench and keep it as perfectly aligned as possible with screws. If care is not taken during this operation, head may be pushed out of alignment.
 - e. Repeat Steps a through d for all heads to be aligned.
10. Remove carriage locking pin and also remove jumper from A07-11A (if it was installed).
11. Press START switch to stop drive motor and unload heads.

3.17.2.7 Servo System Test and Adjustment - The procedure tests and adjusts the servo system. The servo system adjustments and their basic functions are listed below.

- **Coarse Position Gain** - Adjusts the gain of the velocity signal applied to the summing amplifier when the servo system is in the coarse mode (cylinders-to-go equals more than one half). This adjustment causes seek time to be fast enough to meet the required specifications without causing excessive overshoot past the desired cylinder.
- **Integrator Gain** - Adjusts the gain of the velocity signal applied to the integrator. The integrator output is summed with the output from the D/A converter during the last 128 cylinders of a seek.
- **Fine Velocity Gain** - Adjusts the gain of the velocity signal applied to the summing amplifier when the servo system is in fine mode (cylinders-to-go equals less than one half). This adjustment optimizes servo system response by minimizing overshoot without overdamping the system.

These adjustments are interactive and therefore must be made in the proper sequence. The proper sequence is shown in Figure 3-17. The following describes test and adjustments of the servo system.

1. Prepare the drive for use with test software or FTU.
2. Test and adjust coarse position gain as follows:
 - a. Command continuous seeks between cylinder 000 and 822_{10} (1466_8).
 - b. Connect oscilloscope channel 1 to A07-03A (+On Cylinder).
 - c. Trigger oscilloscope negative external on A07-07A (-Forward Seek).
 - d. Set other oscilloscope controls as necessary to make measurements required in Step e.
 - e. Observe display. If distance between on-cylinder pulses is not within 50 to 54 ms, adjust top potentiometer on card A20 until this requirement is met.
3. Test and adjust integrator gain as follows:
 - a. Command continuous seeks between cylinders 000 and 128_{10} (200_8).



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Figure 3-17 Servo System Adjustments Flowchart

- b. Set up oscilloscope as indicated in Figure 3-18 and adjust it until the two sloped curves shown are displayed.

OSCILLOSCOPE SETTINGS

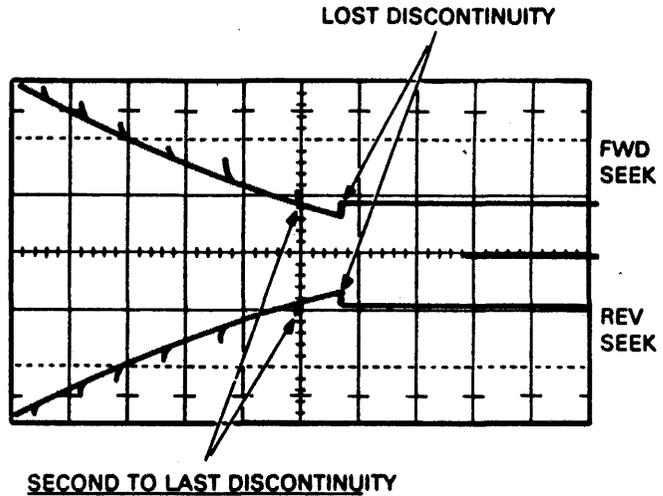
LOGIC GND TO SCOPE GND

VOLTS/DIV
 CH 1 - 0.5 V/CM
 CH 2 - NOT USED

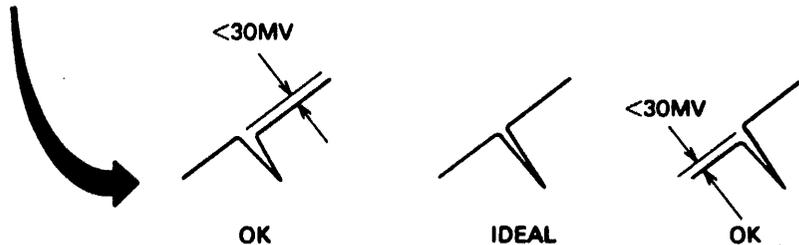
TIME/DIV
 A - 0.5 MS/CM HORIZ DISPLAY
 B - NOT USED SET TO MAG X 10

TRIGGERING
 A - POSITIVE EXT ON A12-17B (+T≤7)
 B - NOT USED

PROBE CONNECTIONS
 CH1 TO A20-TPD (+ DESIRED VELOCITY)
 CH2 - NOT USED



NOTE
 IT IS NECESSARY TO INCREASE
 VERTICAL SENSITIVITY TO MAKE
 THIS MEASUREMENT.



CZ-0287

Figure 3-18 Integrator Gain Waveform

NOTE

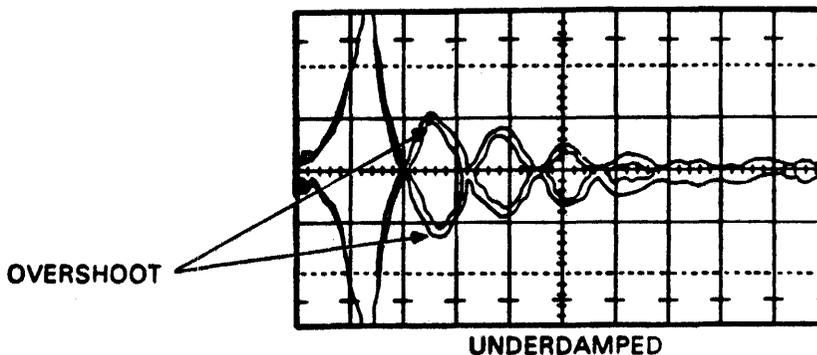
VOLT/CM and TIME/CM settings have to be changed to make measurement required in step c.

- c. Observe the second to last discontinuity indicated in Figure 3-18 and note that it has a difference of ± 0.03 V (ignore the spike). If it exceeds this value, adjust bottom potentiometer on A20 so that it meets these requirements.

NOTE

In step 4, the read operation is performed between seeks. This causes enough delay between seeks to provide the proper display.

4. Adjust fine velocity gain as follows:
 - a. Set manual/sequential switch to manual and command read operation to be performed in conjunction with continuous seeks between cylinders 000 and 001.
 - b. Connect and set up oscilloscope as indicated in Figure 3-19.



OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS/DIV

CH1 — 0.5V/CM
CH2 — NOT USED

TIME/DIV

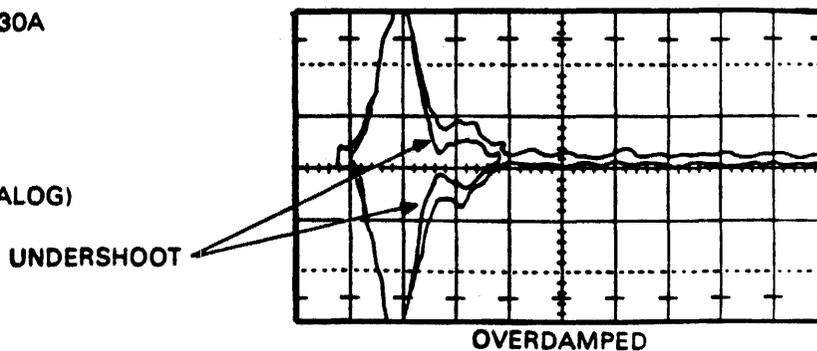
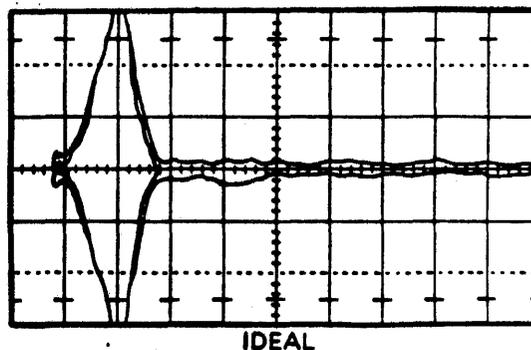
A — 1 MS/CM
B — NOT USED

TRIGGERING

A — NEGATIVE ON A07-30A
(-SEEK)
B — NOT USED

PROBE CONNECTIONS

CH1 TO A19-TPC
(+ FINE POSITION ANALOG)
CH2 — NOT USED



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Figure 3-19 Fine Velocity Initial Check Waveform

- c. Referring to Figure 3-19, note that the displayed signal settles out with maximum overshoot of less than 50 mv. If overshoot exceeds this value, adjust middle potentiometer on card in A20. When adjustment is complete, the display should resemble the ideal waveform in Figure 3-19.
- d. Command sequential forward seek from cylinder 000 through 822₁₀ (1466₈) to be performed in conjunction with a read₁₀.
- e. Note that the displayed signal is as shown in Figure 3-20 at each cylinder. If overshoot exceeds 50 mv at any cylinder, adjust middle potentiometer on card in A20 until this requirement is met.

5. Prepare drive for return to on-line operations.

3.18 TROUBLE ANALYSIS

This section describes procedures for checking various portions of drive circuitry which are critical to proper drive operation. For complete trouble analysis information, refer to the RM05 Fault Isolation Guide.

The purpose of the procedures is to assist maintenance personnel in isolating problems causing improper drive operation. However, if the drive appears to be operating properly, failure to meet a specification given in this section does not in itself indicate improper drive operation.

The procedure is divided into the following major areas:

- Power Supply DC Voltage Output Checks
- Servo System Checks
- Read/Write System Checks
- Miscellaneous Logic Checks

The person performing the maintenance procedures in this section should be thoroughly familiar with operating the drive and with all information in the General Maintenance section of this manual.

3.18.1 Power Supply DC Voltage Output Check

This procedure checks the dc power supply output voltages (refer to Figure 3-12.) This includes all voltages except +5 volts and -5 volts which are checked in the +5 volt and -5 volt test and adjustment procedure.

1. Prepare drive for use with test software or FTU.
2. Command continuous seeks between cylinders 000 and 128₁₀ (200₈).

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS/DIV

CH1 — 0.5V/CM

CH2 — NOT USED

TIME/DIV

A - 0.1 MS/CM

B — NOT USED

TRIGGERING

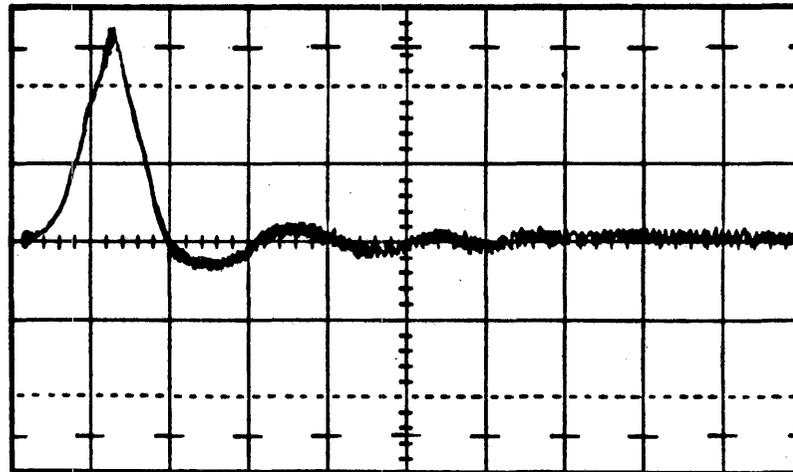
A — EXT, A07-30A (-SEEK)

B — NOT USED

PROBE CONNECTIONS

CH1 TO A19-TPC (+ FINE POSITION ANALOG)

CH2 — NOT USED



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Figure 3-20 Fine Velocity Gain Final Check

3. Connect voltmeter ground lead to ground test jack on power supply panel.
4. Measure between ground jack and test jacks on power supply control panel to check following DC voltages as listed in Table 3-4.
5. Disconnect voltmeter, then set up and connect oscilloscope as appropriate to measure ripple.

Table 3-4 Power Supply Output Checks

DC Volts	Tolerance in Volts	Maximum Ripple in Volts
+46	-2,+5	4.5
-46	+2,-5	4.5
+9.7	+1	NA
-9.7	+1	NA
+20	+2	1.0
+28	+2	1.0

6. Measure between ground jack and the following test jacks on power supply control panel. Ensure that peak to peak voltage ripple is within the specified limits of Table 3-4.

3.18.2 Servo System Checks

The servo system checks consist of procedures that test various points in the drive servo logic. These procedures are divided into two categories: (1) logic controlled checks (paragraph 3.18.2.1) and (2) manually controlled checks (paragraph 3.18.2.2).

The logic controlled checks use the FTU or test software to command the carriage movement required for testing the servo system.

The manually controlled checks provide various tests that can be performed by manually positioning the carriage. These tests may be necessary if problems exist such that satisfactory results cannot be made through the use of the FTU or test software.

3.18.2.1 Logic Controlled Servo Checks - The following procedures describe various tests that can be performed by using the FTU or test software.

1. **D/A Converter Output Check** - This procedure checkoutput of the D/A converter. The D/A converter produces an output that begins at some maximum value and steps down as each track is crossed until the drive is on cylinder. When on cylinder, the D/A output should be zero.
 - a. Prepare drive for use with test software or FTU.
 - b. Connect and set up oscilloscope as shown in Figure 3-21.
 - c. Command continuous seeks between cylinder 000 and 128.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 5V/CM
CH 2 - NOT USED

TIME / DIV

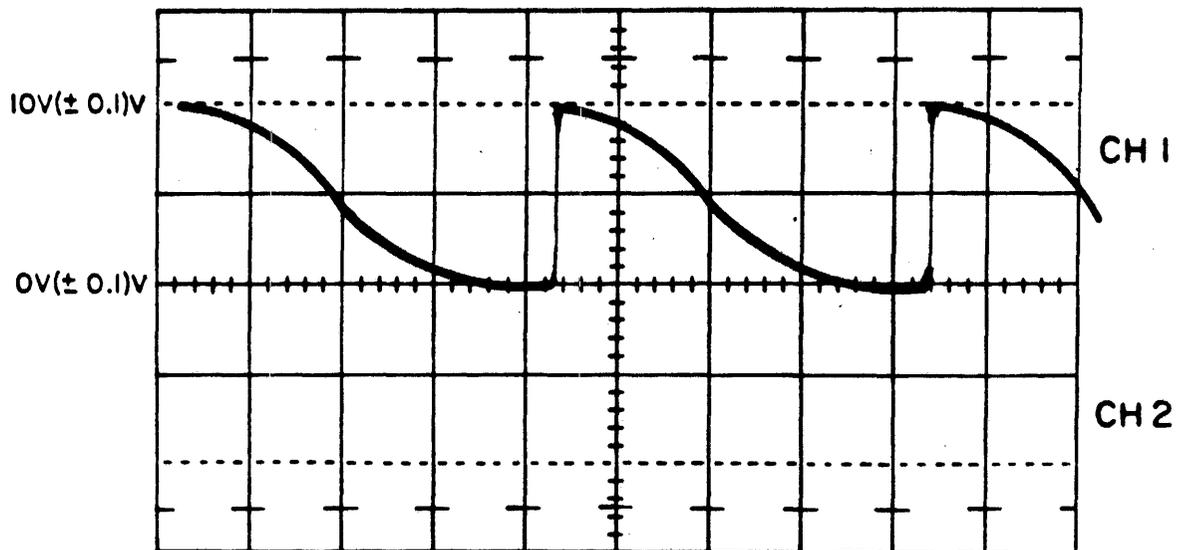
A - 5MS/CM
B - NOT USED

TRIGGERING

A - NEG EXT, A07-07A (-FWD SEEK)
B - NOT USED

PROBE CONNECTIONS

CH 1 TO A20-TPB
CH 2 - NOT USED



9W21

Figure 3-21 D/A Converter Output Waveform

- d. Check that the observed waveforms are as shown in Figure 3-22. Note that by further expanding this waveform it is possible to see the individual steps produced as each track is crossed. The steps should be approximately equal and about 0.07 V in amplitude (refer to Figure 3-22).

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 0.1V/CM
CH 2 - NOT USED

TIME / DIV

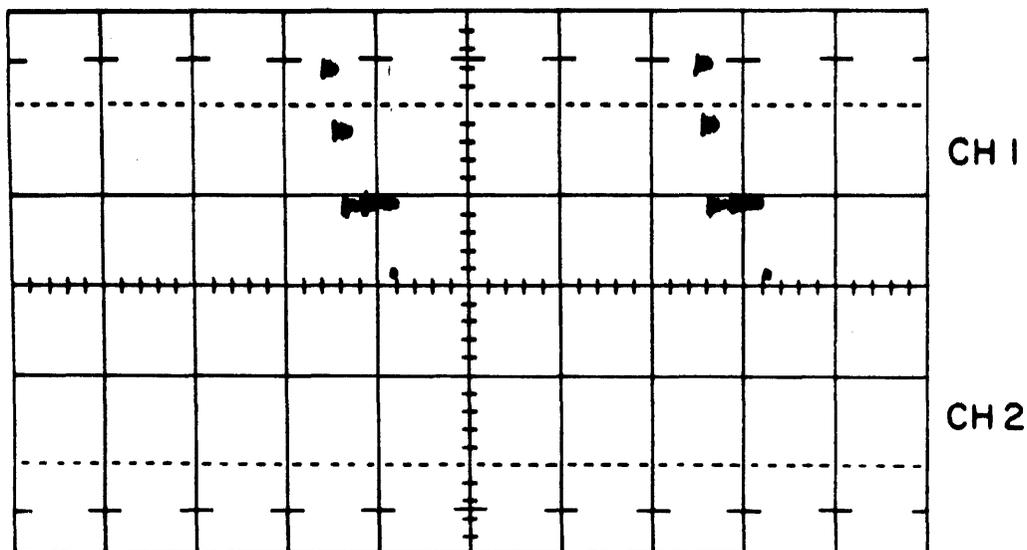
A - 5MS/CM
B - NOT USED

TRIGGERING

A - NEG EXT, A07-07A (-FWD SEEK)
B - NOT USED

PROBE CONNECTIONS

CH 1 TO A20-TPB
CH 2 - NOT USED



9W22

Figure 3-22 D/A Converter Output Waveform Expanded

- e. Prepare drive for return to on-line operation.
2. Cylinder Pulse Blanking Delay Check - This procedure checks the delay preventing a cylinder pulse from being generated as the drive moves off cylinder.
 - a. Prepare drive for use with test software or FTU.

- b. Command continuous seeks between cylinders 000 and 003.
 - c. Connect and set up oscilloscope as follows:
 - Connect channel 1 to A07-30B (+Cylinder Pulse Blanking).
 - Trigger positive internal.
 - Set other controls as appropriate to make measurements required in step 4.
 - d. Observe that the Cylinder Pulse Blanking delay is a logic 1 for 950 (+50) microseconds.
 - e. Prepare drive for return to on-line operation.
3. Cylinder Pulse One Shot Check - This procedure checks the duration of the cylinder pulses.
- a. Prepare drive for use with test software or FTU.
 - b. Command continuous seeks between cylinders 000 and 003.
 - c. Connect and set up oscilloscope as follows:
 - Connect channel 1 to A07-22A (+Cylinder Pulses).
 - Trigger positive internal.
 - Set other controls as appropriate to make measurements required in step 4.
 - d. Observe that the Cylinder Pulse one shot is a 1 for 10 (+2.5) microseconds.
 - e. Prepare drive for return to on-line operation.
4. Cylinder Pulse Switching Level Check - This checks the levels at which the track-crossing detectors switch to cause generation of a cylinder pulse.
- a. Prepare drive for use with either test software or FTU.
 - b. Command continuous seeks between cylinders 000 and 822.

- c. Connect and set up oscilloscope as indicated in Figure 3-23. Note that this figure actually shows four different checks, each having a separate resulting waveform.
- d. Evaluate results as shown in Figure 3-23.
- e. Prepare drive for return to on-line operation.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

NOTE:

TIME/DIV AND PROBE CONNECTIONS ARE COMMON TO ALL THE FOLLOWING WAVEFORMS.

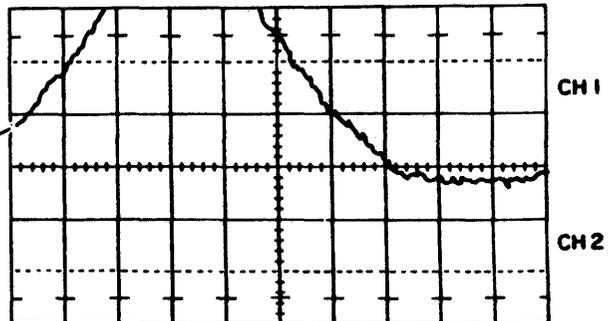
TIME / DIV

- A - .2 MS/CM
- B - NOT USED

PROBE CONNECTIONS

- CH 1 TO A18-09 B (+TRACK SERVO SIGNAL)
- CH 2 - NOT USED

+0.4(±.1)V



VOLTS / DIV

- CH 1 - .5V/CM
- CH 2 - NOT USED

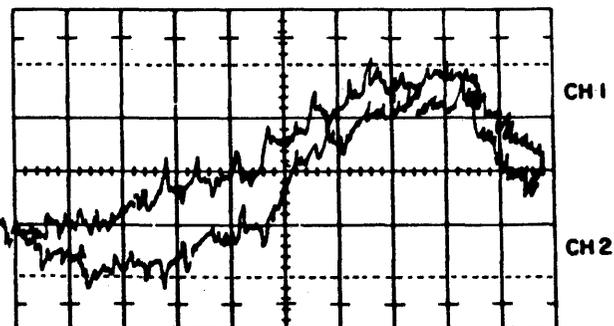
TRIGGERING

- A - NEG EXT. A18-08B (+CYL DET B)
- B - NOT USED

VOLTS / DIV

- CH 1 - .1V/CM
- CH 2 - NOT USED

0(±.1)V



TRIGGERING

- A - POS EXT. A18-08B (+CYL DET B)
- B - NOT USED

9W23-1

Figure 3-23 Cylinder Pulse Switching Level Waveform (Sheet 1 of 2)

5. **Fine Enable Switching Level Check** - This procedure verifies that the Fine Enable signal switches at the proper time. The Fine Enable signal is turned on when tracks-to-go are less than one and integrated velocity reaches a certain point.

- a. Prepare drive for use with test software or FTU.

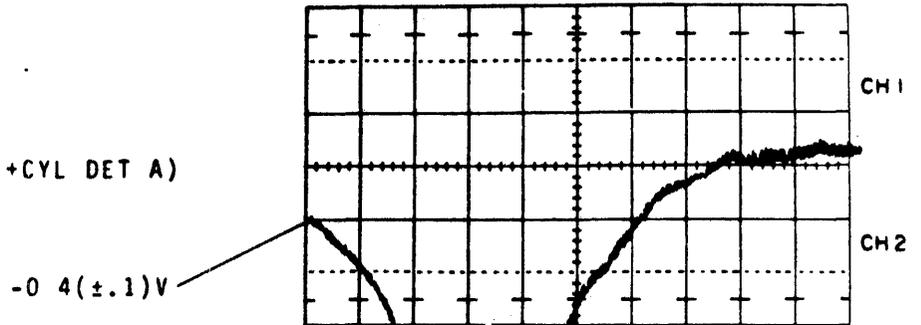
OSCILLOSCOPE SETTINGS

VOLTS / DIV

CH 1 - .5V/CM
CH 2 - NOT USED

TRIGGERING

A- NEG EXT. A18-07B (+CYL DET A)
B- NOT USED



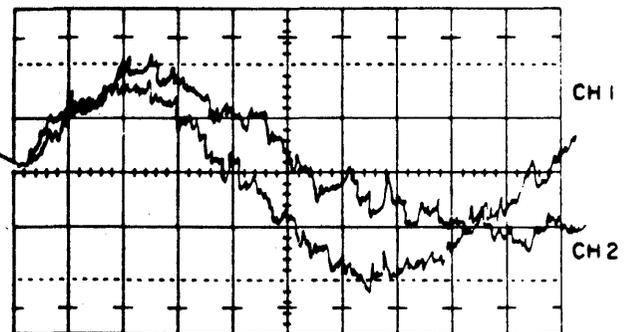
VOLTS / DIV

CH 1 - .1V/CM
CH 2 - NOT USED

TRIGGERING

A- POS EXT. A18-07B (+CYL DET A)
B- NOT USED

0(±.1)V



9W23-2

**Figure 3-23 Cylinder Pulse Switching Level Waveform
(Sheet 2 of 2)**

- b. Connect and set up oscilloscope as indicated in Figure 3-24.
- c. Command continuous seeks between cylinders 000 and 001.
- d. Observe that the waveforms are as indicated in Figure 3-24. Note that Fine Enable switches to a zero level when integrated velocity is between +0.82 and +0.98 V for forward seeks and -0.82 and -0.98 V for reverse seeks.
- e. Prepare drive for return to on-line operation.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 5V/CM

CH 2 - 0.5V/CM

TIME / DIV

A - 0.5MS/CM

B - NOT USED

TRIGGERING

A - EXT NEG, A20-12A (-FWD SEEK)

B - NOT USED

PROBE CONNECTIONS

CH 1 TO A20-10A (-FINE ENABLE)

CH 2 TO A20-TPG (+INTEGRATED VEL)

NOTE: SET DISPLAY MODE TO CHOP.

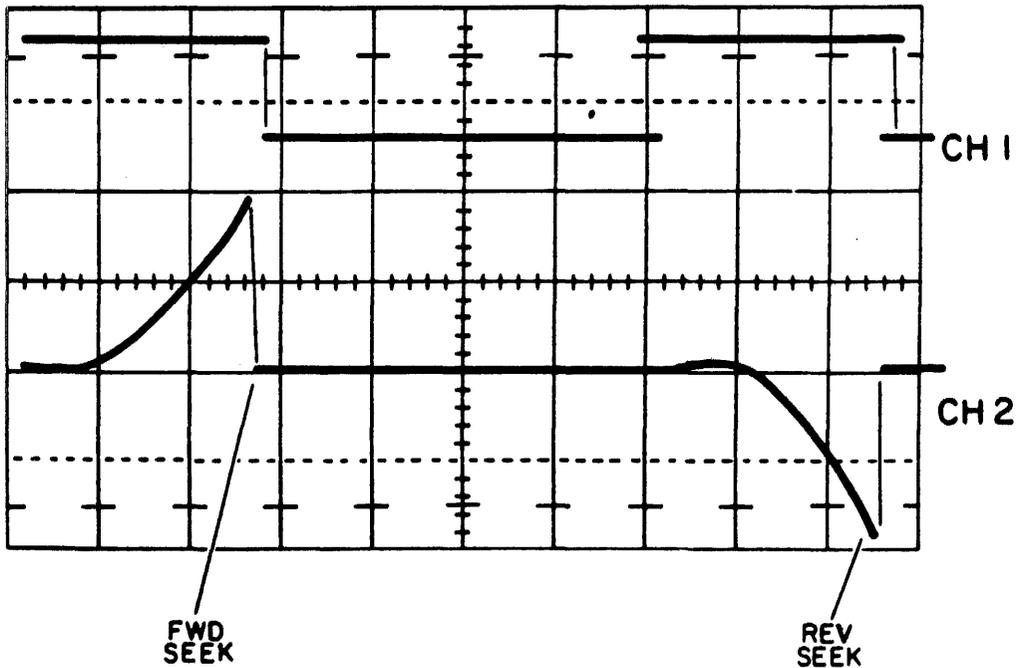


Figure 3-24 Fine Enable Switching Level Waveform

6. **Cylinder Delay Check** - This procedure checks the delay between the time the drive is on cylinder and the On Cylinder pulse is generated.
 - a. Prepare drive for use with test software or FTU.
 - b. Command continuous seeks between cylinders 000 and 003.
 - c. Connect and set up oscilloscope as follows:
 - Connect channel 1 to A07-03B (-On Cylinder).
 - Trigger positive on A07-15A (+On Cylinder Sense).
 - Set other controls as appropriate to make measurements required in step 4.
 - d. Observe that Not On Cylinder is a logic 1 for 1.75 (+0.35) milliseconds.
 - e. Prepare drive for return to on-line operation.
7. **On Cylinder Dropout Delay Check** - This procedure checks the delay between the time the drive goes off cylinder and when the On Cylinder signal drops.

NOTE

Place card A07 on card extender during drive preparation procedure. Also place chip clip on IC in position A3.

- a. Prepare drive for use with test software or FTU.
- b. Command continuous seeks between cylinders 000 and 003.
- c. Connect and set up oscilloscope as follows:
 - Connect channel 1 to pin 3 of chip in position A3.
 - Trigger negative internal.
 - Set other controls as appropriate to make measurements required in step 4 of this procedure.

- d. Observe that Not On Cylinder is a logic 1 for 1.75 (+0.35) milliseconds.
 - e. Prepare drive for return to on-line operation.
 8. On Cylinder Pulse Check - This procedure measures duration of On Cylinder pulse.
 - a. Prepare drive for use with test software or FTU.
 - b. Command continuous seeks between cylinders 000 and 001.
 - c. Connect and set up oscilloscope as follows:
 - Connect channel 1 to A07-22A (+Cylinder Pulses).
 - Trigger positive internal.
 - Set other controls as appropriate to make measurements required in step 4 of this procedure.
 - d. Observe that On Cylinder is a logic 1 for 0.3 (+0.05) milliseconds.
 - e. Prepare drive for return to on-line operation.
 9. On Cylinder Switching Level Check - This procedure checks the level at which the On Cylinder Sense signal goes true. This should occur at each zero (track) crossing.
 - a. Prepare drive for use with either test software or FTU.
 - b. Set up and connect oscilloscope as shown in Figure 3-25.
 - c. Command continuous seeks between cylinders 000 and 002.
 - d. Check that resulting waveforms agree with those shown in Figure 3-25.
 - e. Set up and connect oscilloscope as shown in Figure 3-26.

CAUTION

While performing step 6, refer to paragraph 3.15 and perform that entire procedure before proceeding to step 7.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 0.2V/CM

CH 2 - NOT USED

TIME / DIV

A - 0.1MS/CM

B - NOT USED

TRIGGERING

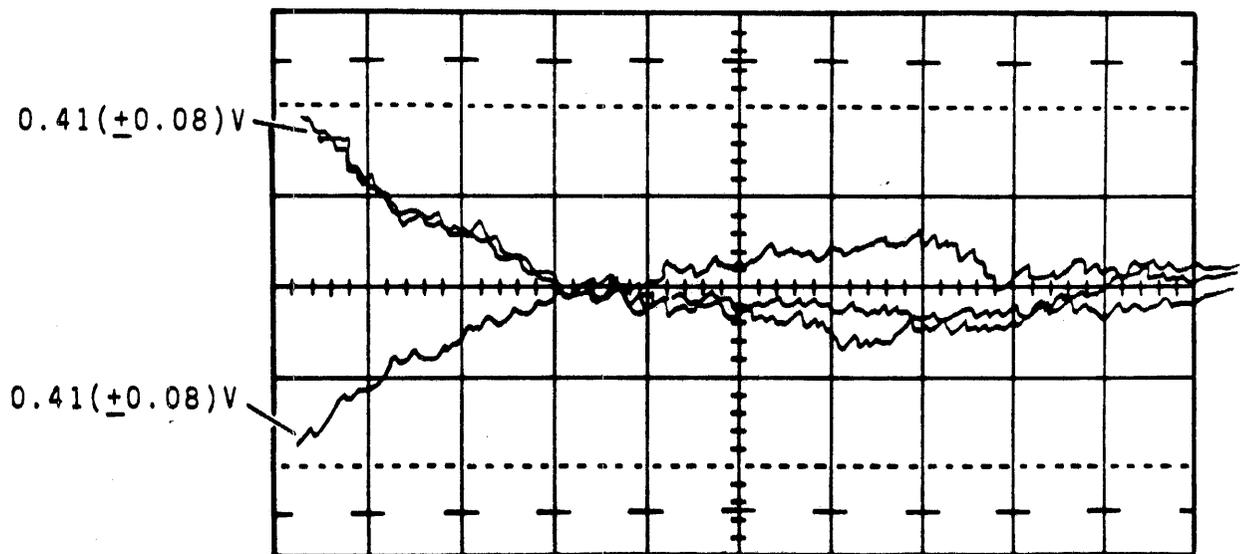
A - POS EXT, A08-31B (+ON CYL SENSE)

B - NOT USED

PROBE CONNECTIONS

CH 1 TO A18-09B (+TRACK SERVO SIGNAL)

CH 2 TO NOT USED



9W25

Figure 3-25 On Cylinder Switching Level - Waveform I

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 0.5V/CM

CH 2 - NOT USED

TIME / DIV

A - 0.2MS/CM

B - NOT USED

TRIGGERING

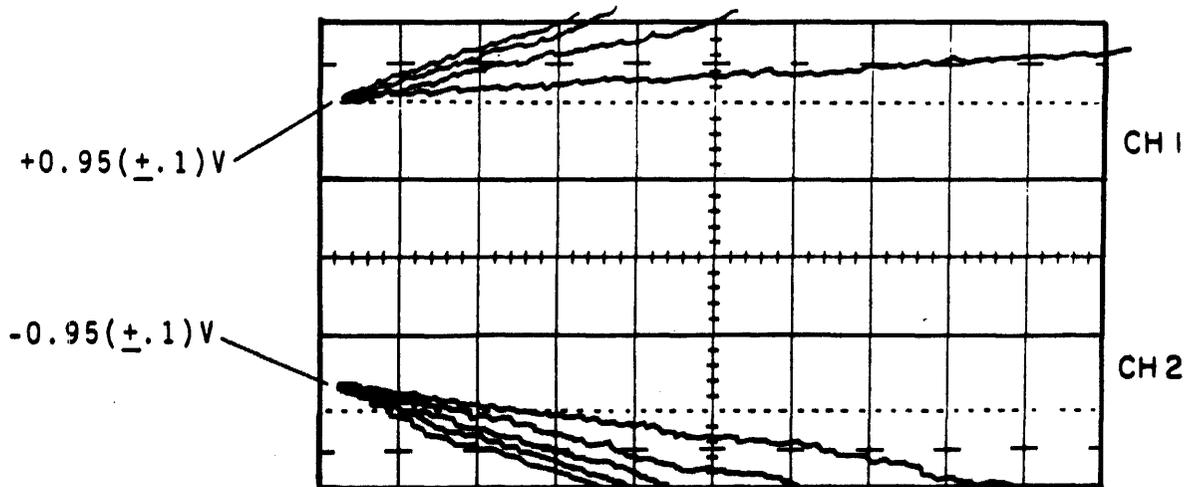
A - NEG EXT, A08-31B (+ ON CYL SENSE)

B - NOT USED

PROBE CONNECTIONS

CH 1 TO A18-09B (+ TRACK SERVO SIGNAL)

CH 2 TO NOT USED



9W26

Figure 3-26 On Cylinder Switching Level - Waveform II

- f. Observe display while manually moving carriage in forward and reverse directions. Check that resulting waveforms agree with those in Figure 3-27.
- e. Prepare drive for return to on-line operation.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 0.1V/CM (READ SCALE AS 100MV)
CH 2 - NOT USED

TIME / DIV

A - 2MS/CM
B - NOT USED

TRIGGERING (POSITIVE/EXTERNAL)

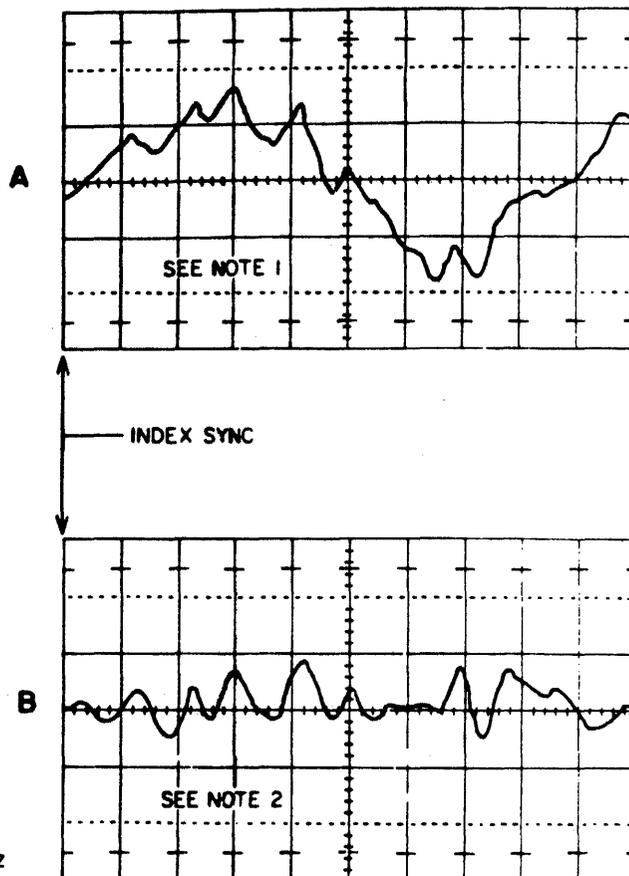
A - INDEX
B - NOT USED

PROBE CONNECTIONS

CH 1 TO A19-TPC (FINE POS ANALOG)
CH 2 - NOT USED

NOTES:

1. MORE THAN NORMAL RUNOUT RESULTS IN THE WAVEFORM HAVING A 60 Hz SINUSOIDAL COMPONENT AS SHOWN ON WAVEFORM A. AS AMOUNT OF RUNOUT INCREASES, THE PEAK TO PEAK AMPLITUDE OF THE 60 Hz COMPONENT INCREASES.
2. NORMAL RUNOUT IS SHOWN ON WAVEFORM B. IN THIS CASE, THE AMPLITUDE OF THE 60 Hz SINUSOIDAL COMPONENT IS LESS THAN 400MV PEAK TO PEAK.



9W27

Figure 3-27 Track Following Check Waveform

10. **One Track Seek Time Check** - This procedure checks the time it takes for the positioner to move from one track to another.
 - a. Prepare drive for use with test software or FTU.
 - b. Command drive to perform one cylinder sequential forward seek, starting at cylinder 000 and ending at 822. Perform a read operation between each seek.
 - c. Connect and set up oscilloscope as follows:
 - Connect channel 1 to A07-03A (+On Cylinder).
 - Trigger negative internal on A07-07A (-Forward Seek).
 - Set other oscilloscope controls as appropriate for making measurements required in step 4.

- d. Observe that signal is low for 8 milliseconds or less.
 - e. Prepare drive for return to on-line operation.
11. **Positioner Offset Voltage Check** - This checks the offset level produced by a servo offset command. The measurement is made on the Track Servo signal which normally has an average dc level of zero when the drive is on cylinder.
- a. Prepare drive for use with either test software or FTU.
 - b. Command direct seek to cylinder 400.
 - c. Connect and set up oscilloscope as follows:
 - Connect channel 1 to A18-09B (+Track Servo Signal).
 - Set channel A sweep trigger mode to AUTO.
 - Set other controls as appropriate for making measurements required in step 4.

NOTE

Measure average dc level in steps 4 and 5.

- d. Command carriage offset plus (forward offset) and observe that the scope indicates $+0.6$ (± 0.1) V.
 - e. Command carriage offset minus (reverse offset) and observe that the scope indicates -0.6 (± 0.1) V.
 - f. Prepare drive for return to on-line operation.
12. **Track Following Check** - This procedure checks the ability of the heads to accurately follow the track. Inability to stay on track may be caused by excessive runout of the disk pack or spindle assembly. Runout is the degree to which a rotating disk pack wobbles off its center of rotation.

Inability to stay on track is also caused by the servo logic being unable to respond to allowable runout.

If the heads do not accurately follow the track, read errors may occur and the drive may also intermittently drop the On Cylinder signal.

- a. Prepare drive for use with test software or FTU.
- b. Command direct seek to cylinder 400.
- c. Connect and set up oscilloscope as follows:
 - Connect channel 1 to A19-TPC (Fine Position Analog).
 - Trigger positive external on A06-TPC (Index).
 - Set other controls as appropriate to make observations required in remainder of this procedure.
- d. Observe display and refer to Figure 3-27. As runout increases, waveform sinusoidal amplitude increases.
- e. Interpret display as follows:
 - If amplitude of 60 Hz sinusoidal component of waveform exceeds 400 mV peak to peak, it is excessive and a problem exists with either drive or disk pack. In this case, note point at which waveform syncs with Index, and proceed to step 6.
 - If waveform sinusoidal amplitude does not exceed 400 mV the drive or disk pack does not have excessive runout. In this case, proceed to step 11.
- f. Press START switch to stop drive motor and unload heads.
- g. Note position of disk pack on spindle, remove disk pack, rotate it 90 degrees (1/4 turn) in either direction and reinstall it on the spindle.
- h. Press START switch to spin-up drive motor and load heads.
- i. Command direct seek to cylinder 400.

NOTE

Index and Fine Position signals are derived from servo dibit tracks on the disk pack. Zero phase shift between these signals indicates a no spindle runout condition. This is a dynamic check performed while the disk pack is rotating with respect to the spindle.

- j. Compare the phase position of waveform displayed with phase position of waveform observed in step. Interpret results as follows:
 - If phase relationship of both waveforms coincide, disk pack or servo system is cause of excessive runout.
 - If phase relationship of both waveforms do not coincide, spindle or servo system is causing excessing runout.
 - k. Prepare drive for return to on-line operations.
13. **Track Servo Amplitude Check** - This procedure checks the amplitude of the track servo dibits signal that inputs to the track servo circuit.
- a. Prepare the drive for use with test software or FTU.
 - b. Connect and set up oscilloscope as indicated in Figure 3-28.
 - c. Command direct seek to cylinder 000 and observe peak to peak amplitude of the waveform.
 - d. Command direct seek to cylinder 822 and observe peak to peak amplitude of the waveform.
 - e. Check that the waveform observed in steps 3 and 4 is between 0.3 and 1.5 V peak to peak. Also note that the waveform of step 3 has the largest amplitude.
 - f. Prepare drive for return to on-line operation.
14. **Velocity Transducer Gain Uniformity Check** - This checks the output of the velocity transducer by monitoring the sawtooth output of the velocity integrator. Note that the positive sawtooth waveforms are produced during forward seeks and the negative waveforms during reverse seeks.
- a. Prepare drive for use with test software or FTU.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 0.5V/CM

CH 2 - 0.5V/CM

TIME / DIV

A - 1 μ S CM

B - NOT USED

TRIGGERING

A - INTERNAL NEGATIVE

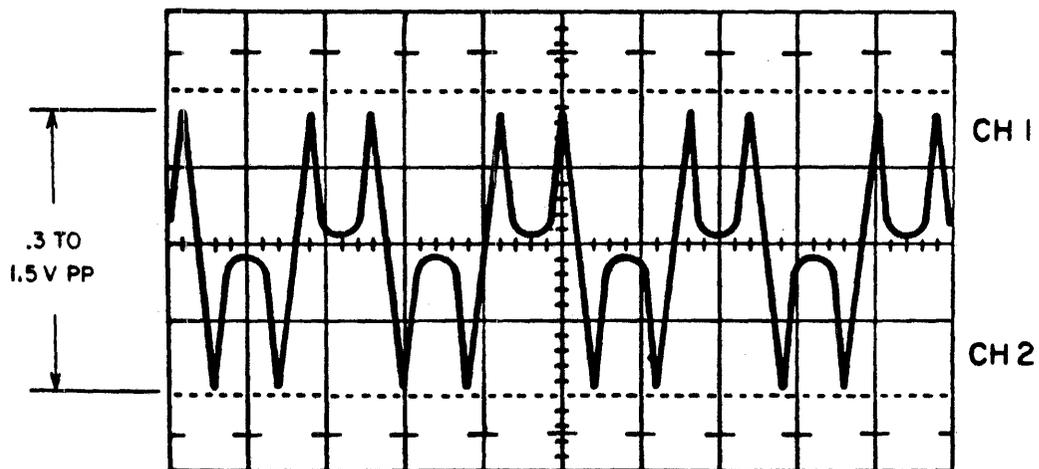
B - NOT USED

PROBE CONNECTIONS

CH 1 TO A18-25B (-DIBITS)

CH 2 TO A18-23B (+DIBITS)

NOTE: SET DISPLAY MODE TO ADD AND INVERT ONE CHANNEL



9W28

Figure 3-28 Track Servo Amplitude Waveform

- b. Connect and set up oscilloscope as indicated in Figure 3-29.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 1V/CM

CH 2 - NOT USED

TIME / DIV

A - 0.5MS/CM

B - NOT USED

TRIGGERING

A - EXT POS, A12-17B (T 7)

B - NOT USED

PROBE CONNECTIONS

CH 1 TO A20-TPG (+INTEGRATED VELOCITY)

CH 2 - NOT USED

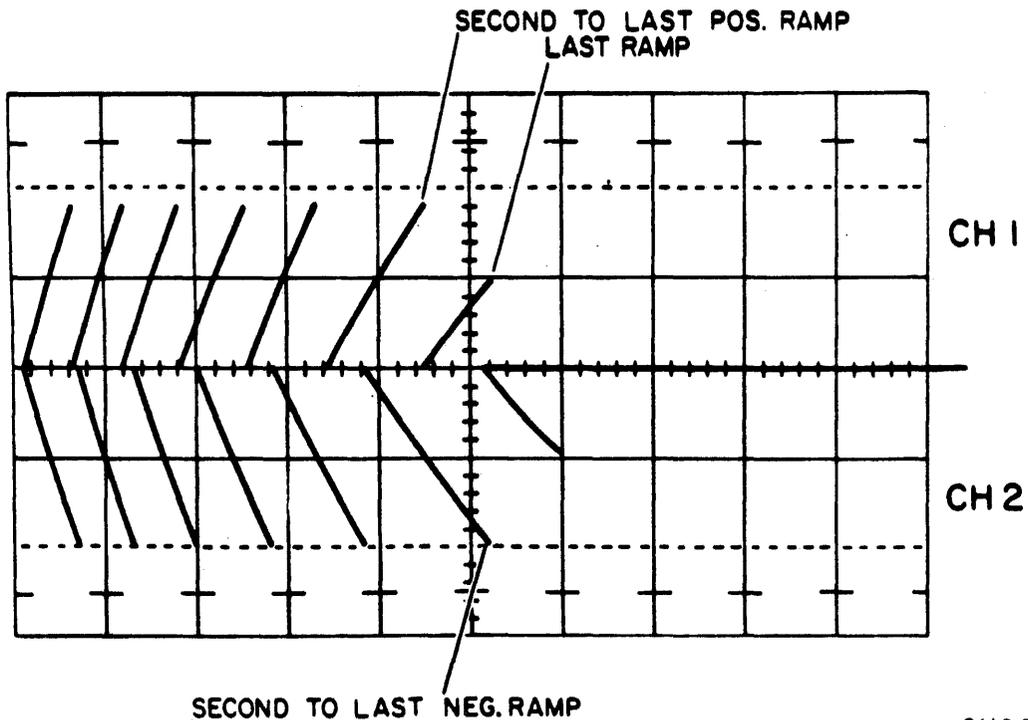


Figure 3-29 Velocity Gain Uniformity Waveform

- c. Command continuous seeks between cylinders 000 and 822.
- d. Observe waveforms as shown in Figure 3-29 and evaluate the second-to-last positive and negative ramps as follows:
 - The amplitude of each ramp must range, in its respective direction between 1.8 V and 2.2 V.
 - The difference in amplitude between the two ramps must range between +0.3 V and -0.3 V.

3.18.2.2 Manually Controlled Servo Checks - This procedure describes testing the servo system while manually positioning the carriage.

1. Prepare drive as follows:
 - a. Press START switch to stop drive motor.
 - b. Set MAIN AC circuit breaker to OFF.
 - c. Raise top cover.
 - d. Put logic chassis in maintenance position.
 - e. Remove logic control of voice coil by disconnecting yellow lead wire at voice coil.

CAUTION

Make sure the carriage is fully retracted. Refer to the procedure for manually positioning the carriage.

2. Check that the output of the summing amplifier is at 0 volts before drive motor is energized by performing the following procedure:
 - a. Set oscilloscope vertical sensitivity control to 5 V/CM.
 - b. Set oscilloscope horizontal sweep control to 0.1 MS/CM.
 - c. Set oscilloscope trigger control to AUTO (free running).
 - d. Connect oscilloscope channel A to A20-25A (+Summing Amp Output).
 - e. Set MAIN AC circuit breaker to ON and observe that voltage remains at 0 V.

3. Check that the output of the summing amplifier goes to -10 V when drive motor gets up to speed by performing the following procedure.
 - a. Connect and set up oscilloscope as in step 2.
 - b. Press START switch to start drive motor and observe that the summing amplifier output drops to -10 V when drive motor gets up to speed (approximately 30 seconds).

CAUTION

Refer to paragraph 3.15 before loading and positioning heads as described in the following steps.

4. Manually load heads. Refer to discussion on manually positioning carriage.
5. Check velocity transducer and amplifier as described in the following:
 - a. Set up oscilloscope as follows:
 - Vertical sensitivity to 0.5 V/M
 - Horizontal sweep to 10 MS/CM
 - Trigger control to AUTO (free running)
 - Connect channel A to A20-TPE (+Velocity).
 - b. Manually move carriage toward cylinder 822 (forward direction). Signal should go negative and amplitude should increase as speed of carriage increases.
 - c. Manually move carriage toward cylinder 000 (reverse direction). Signal should go positive and amplitude should increase as speed of carriage increases.
6. Check Fine Position Analog signal. If signals observed are as specified in the following, it indicates that the track servo and servo head are functioning properly.
 - a. Set up and connect oscilloscope as follows:
 - Set vertical sensitivity control to 1V/CM
 - Set horizontal sweep control to 10MS/CM
 - Set trigger control to AUTO (free running)
 - Connect channel A to A19 TPC (Fine Position Analog).

9. Check the power amplifier output. If signals observed are as specified in following, power amplifier is functioning properly.

a. Connect and set up oscilloscope as follows:

- Set vertical sensitivity control to 2 V/CM (use 10X probe)
- Set horizontal sweep control to 10MS/CM
- Set trigger control to AUTO (free running)
- Connect channel A to yellow leadwire which was disconnected from voice coil.

b. Move carriage in forward, and then reverse direction and observe signal switching from +46 to -46 V.

CAUTION

Refer to paragraph 3.15 before manually unloading heads.

10. Manually unload heads.
11. Press START switch to stop drive motor.
12. Set MAIN AC circuit breaker to OFF.
13. Reconnect yellow lead wire to voice coil.
14. Prepare drive for on-line operation.

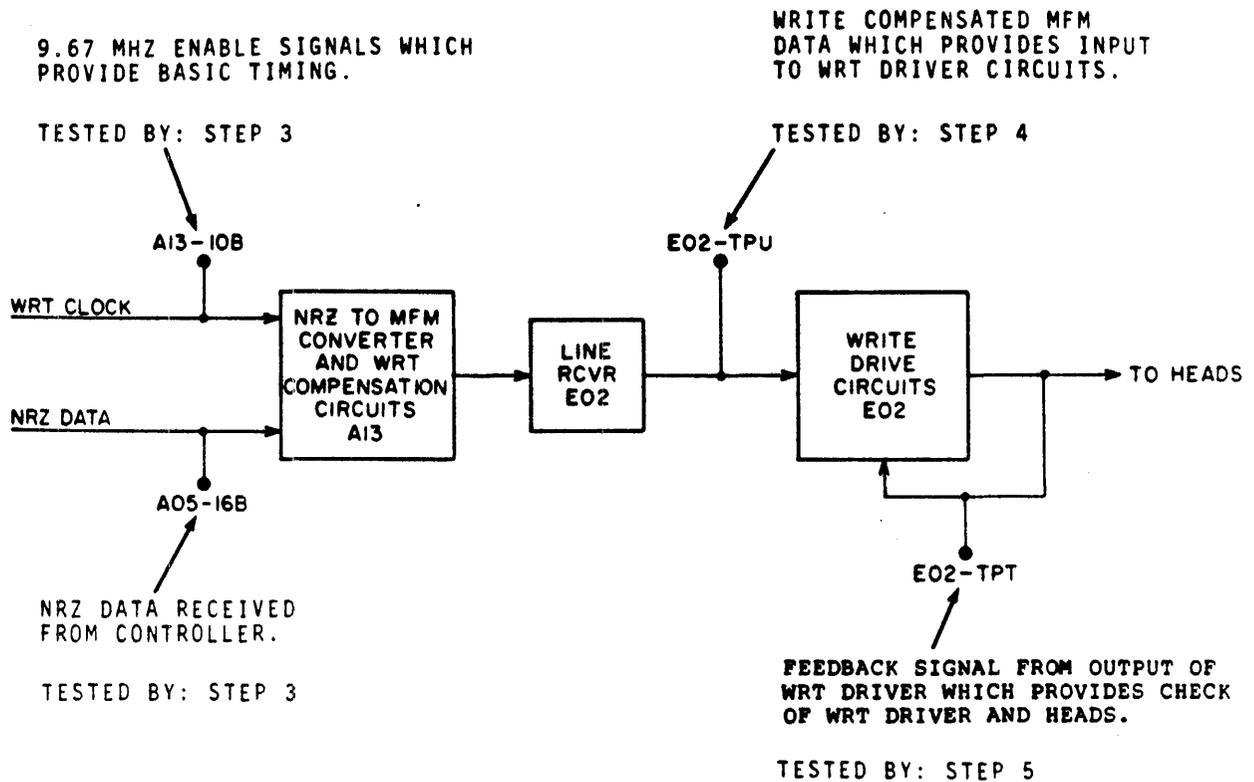
3.19 READ/WRITE SYSTEM CHECKS

The read/write system checks consist of procedures checking the basic read/write capability of the drive.

3.19.1 Write Circuit Checks

This procedure checks three points in the write circuits (refer to Figure 3-30). If the signals at these points are correct, it indicates the circuits are performing their basic function.

1. Prepare the drive for use with test software or FTU.
2. Command drive to write a 1010 bit pattern on the disk.
3. Check the inputs to the NRZ to MFM converter and write compensation circuits. Timing relationships between these signals (NRZ data and 9.67 MHz enable signal) must be correct before proper NRZ to MFM conversion and write compensation can be performed.



9W149

Figure 3-30 Write Circuits Test Points

- a. Connect and set up oscilloscope as shown in Figure 3-31.
- b. Observe that signals have timing relationships as shown in Figure 3-31.
4. Check input to write driver circuits. This checks compensated MFM data input to write toggle flip-flop.
 - a. Move oscilloscope channel 2 probe to E02-TPU.
 - b. Observe that signals have approximately the relationship shown in Figure 3-32, and that channel 2 signal has proper polarity.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 0.2V/CM

CH 2 - 0.2V/CM

TIME / DIV

A - 2MS/CM

B - 0.05 S/CM

TRIGGERING

A - +EXT, A06-TPC (INDEX)

B - -INT

PROBE CONNECTIONS (10X PROBES)

CH 1 TO A13-TPE (NRZ DATA)

CH 2 TO A13-TPB (WRT STROBE)

NOTE: SET TO DISPLAY MODE TO ALT AND TRIGGER MODE TO CH 1 ONLY.
ALSO SET HORIZONTAL DISPLAY TO B (DELAYED SWEEP)

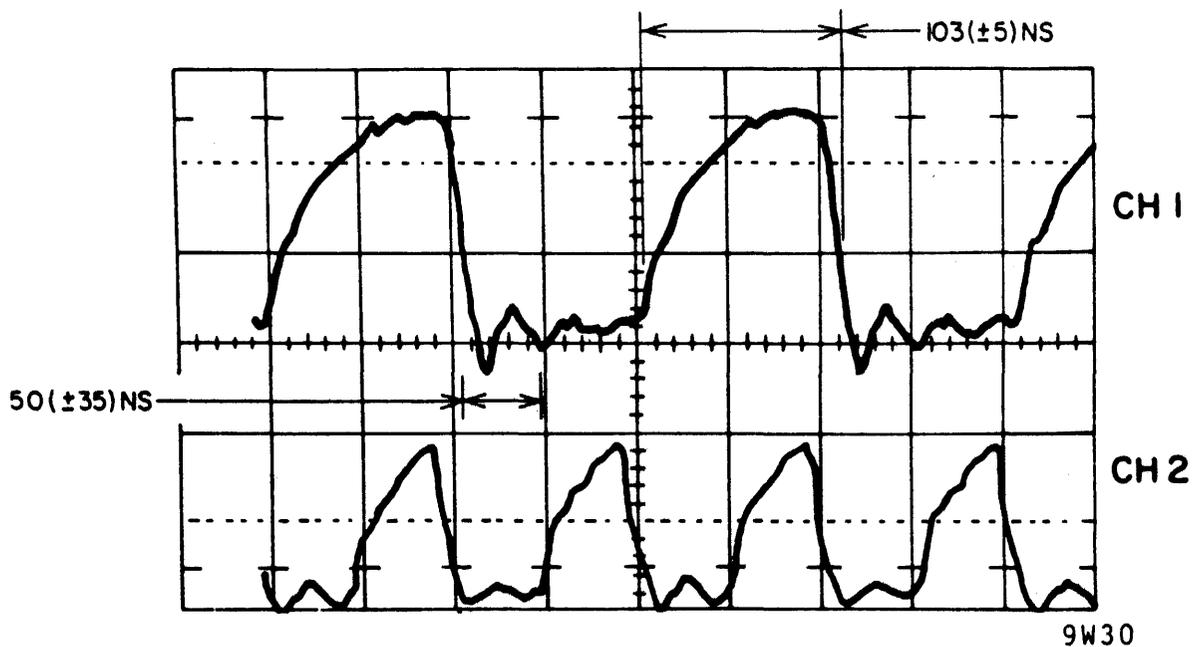


Figure 3-31 NRZ Write Data Input Waveform

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 0.2V/CM

CH 2 - 0.2V/CM

TIME / DIV

A - 2MS/CM

B - 0.05 μ S/CM

TRIGGERING

A - +EXT, A06-TPC (+INDEX)

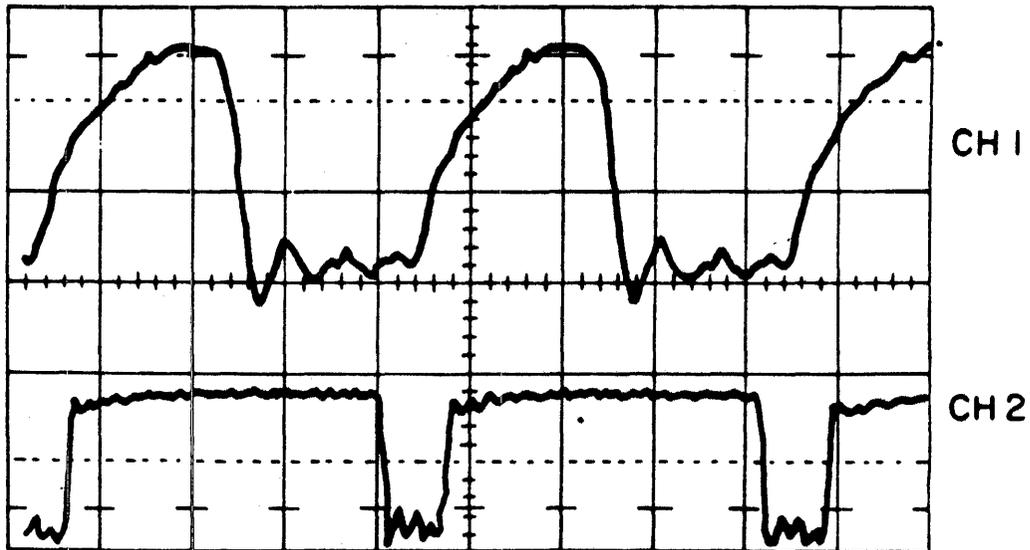
B - -INT

PROBE CONNECTIONS (10X PROBES)

CH 1 TO A13-TPE (NRZ DATA)

CH 2 TO E02-TPU

NOTE: SET DISPLAY MODE TO ALT AND TRIGGER MODE TO CH 1 ONLY.
ALSO SET HORIZONTAL DISPLAY TO B (DELAYED SWEEP)



9W31

Figure 3-32 Write Driver Input Waveform

5. Check output of write driver circuits. This ensures that write driver is sending data and that the head is functioning.
 - a. Move oscilloscope channel 2 probe to E02-TPT.
 - b. Observe that signals are approximately as shown in Figure 3-33.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 0.2V/CM

CH 2 - 0.2V/CM

TIME / DIV

A - 2MS/CM

B - 0.05 μ S/CM

TRIGGERING

A - +EXT, A06-TPC (+INDEX)

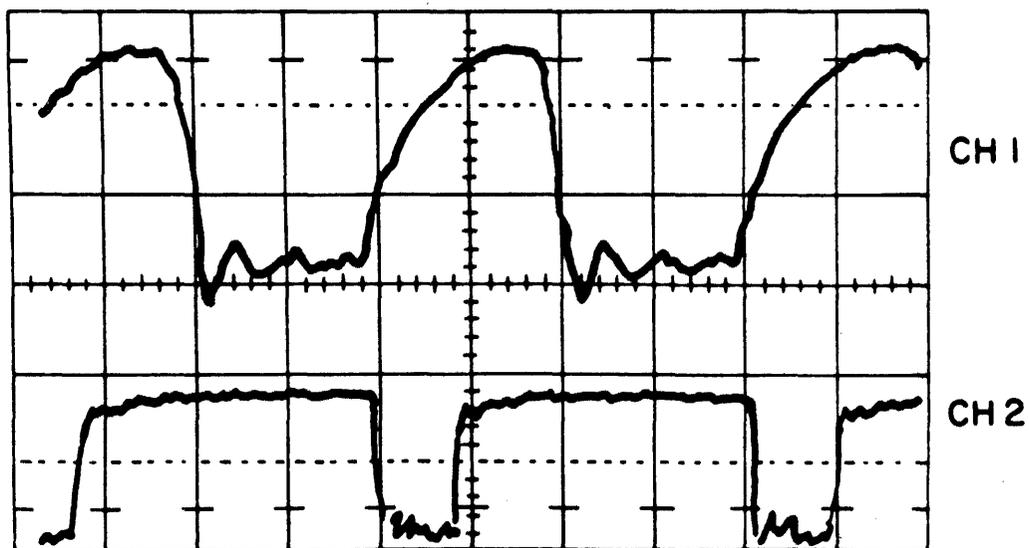
B - -INT

PROBE CONNECTIONS (10X PROBES)

CH 1 TO A13-TPE (NRZ DATA)

CH 2 TO E02-TPT

NOTE: SET DISPLAY MODE TO ALT AND TRIGGER MODE TO CH 1 ONLY.
ALSO SET HORIZONTAL DISPLAY TO B (DELAYED SWEEP)



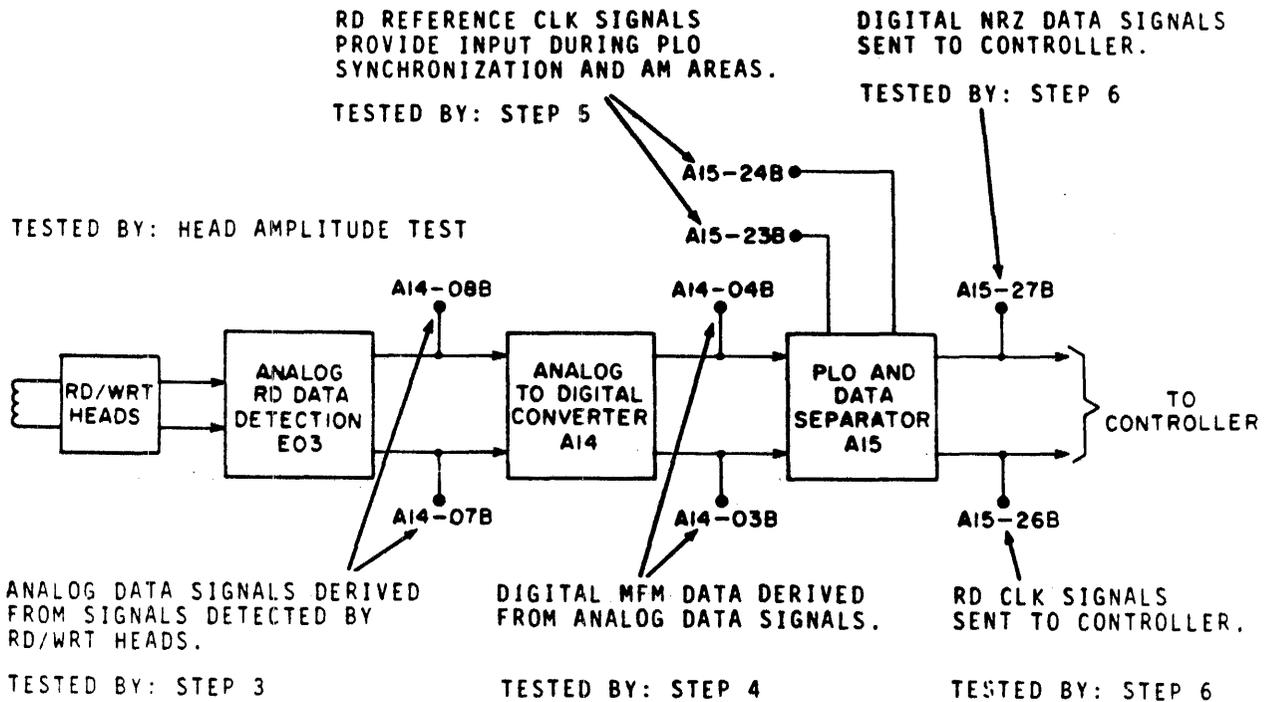
9W32

Figure 3-33 Write Driver Output Waveform

6. Prepare drive for return to on-line operation.

3.19.2 Read Circuit Checks

This procedure checks the basic operation of the read circuits. Refer to Figure 3-34. If the observed signals are correct, it indicates these circuits are performing their basic functions.



9W150

Figure 3-34 Read Circuits Test Points

1. Prepare drive for use with test software or FTU.
2. Command drive to write 1010 bit pattern on disk.
3. Command drive to read 1010 bit pattern.
4. Check analog data input to the analog to digital converter circuits. If signals are correct, it indicates that the analog data detection circuits are functioning.
 - a. Connect and set up oscilloscope as indicated in Figure 3-35.
 - b. Observe that signal is approximately as shown in Figure 3-35 with approximately 200 ns between zero crossings.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 0.1V/CM

CH 2 - 0.1V/CM

TIME / DIV

A - 2MS/CM

B - 0.05 S/CM

TRIGGERING

A - +EXT, A06-TPC (+INDEX)

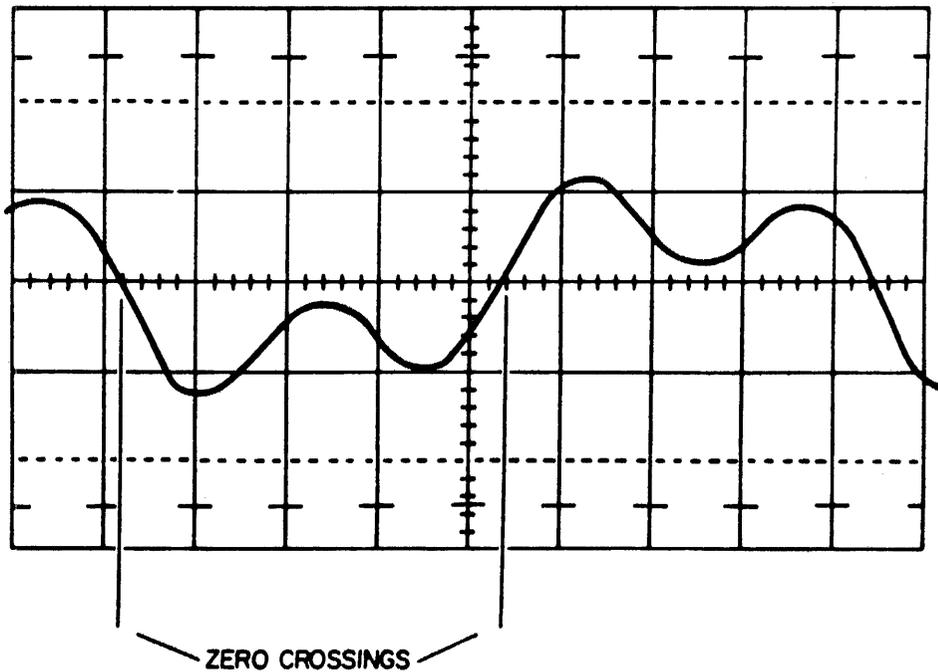
B - -INT

PROBE CONNECTIONS (10X PROBES)

CH 1 TO A14-08B (-ANALOG DATA)

CH 2 TO A14-07B (+ANALOG DATA)

NOTE: SET DISPLAY MODE TO ADD AND INVERT ONE CHANNEL.
ALSO SET HORIZONTAL DISPLAY TO B (DELAYED SWEEP)



9W33

Figure 3-35 Analog Read Data Waveform

5. Check output of data latch flip-flop. If observed signals are correct it indicates high and low resolution channels and data latch flip-flop are functioning.
- a. Connect and set up oscilloscope as shown in Figure 3-36.

OSCILLOSCOPE SETTINGS

LOGIC GND TO SCOPE GND

VOLTS / DIV

CH 1 - 0.1V/CM

CH 2 - 0.1V/CM

TIME / DIV

A - 2MS/CM

B - 0.05S/CM

TRIGGERING

A - +EXT, A06-TPC (+INDEX)

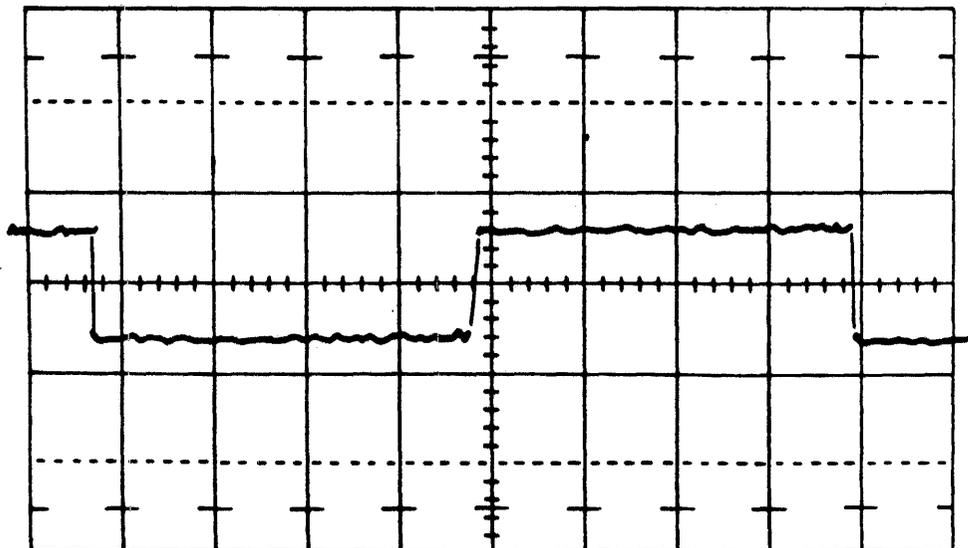
B - -INT

PROBE CONNECTIONS (10X PROBES)

CH 1 TO A14-03B (+RD DATA)

CH 2 TO A14-04B (-RD DATA)

NOTE: SET DISPLAY MODE TO ADD AND INVERT ON CHANNEL.
ALSO SET HORIZONTAL DISPLAY TO B (DELAYED SWEEP)



9W34

Figure 3-36 Data Latch Output Waveform

6. Check frequency of Read Reference Clock signals.
 - a. Connect and set up oscilloscope as shown in Figure 3-35 except move channel 1 probe to A15-24B (+Read Reference Clock) and channel 2 probe to A15-23B (-Read Reference Clock).
 - b. Observe that the displayed signal has a frequency of approximately 4.84 MHz.
7. Check the read data to read clock timing relationship. If signals are correct, it indicates read circuits are generating the proper Read Data and Read Clock signals.
 - a. Connect and set up oscilloscope as shown in Figure 3-37.
8. Prepare drive for return to on-line operation.

3.20 HEAD AMPLITUDE CHECK

This procedure verifies that the read signal has sufficient amplitude to be reliably processed by the read logic. Since amplitude decreases as recording frequency increases, the minimum amplitude, in MFM recording, is obtained when an all "0" or all "1" patterns are being read. The minimum amplitude is tested first. Minimum recording frequency and the greatest amplitude is obtained by an alternate "1010..." pattern. This amplitude is also tested.

1. Prepare the drive for use with test software or FTU.
2. Command direct seek to cylinder 822 and write an all "1s" pattern.
3. Connect and set up oscilloscope as follows:
 - a. Trigger negative external on A06-TPC (Index)
 - b. Connect channel 1 to E03-TPB
 - c. Connect channel 2 to E03-TPC
 - d. Set DISPLAY MODE to ADD and invert one channel
 - e. Set VOLTS/CM and TIME/CM controls to values appropriate for making measurements required in remainder of this procedure.
4. Command drive to read, select each head in turn and measure amplitude of read signal for each head. This amplitude should be a minimum of 130 mV peak to peak.

5. Command direct seek to cylinder 001 and write a "101010..." pattern with all heads.
6. Command drive to read, select each head in turn, and measure amplitude of read signal for each head. This amplitude should be a maximum of 1100 mV peak to peak.
7. Prepare drive for return to on-line operation.

3.21 MISCELLANEOUS LOGIC CHECKS

3.21.1 Index Timing Check

This procedure ensures that Index is present and has the proper pulse width. It also checks the time between successive Index pulses which is an indication of disk pack rotational speed.

1. Prepare drive for use with test software or FTU.
2. Connect and set up oscilloscope as follows:
 - a. Connect channel 1 to A06-TPC (+Index).
 - b. Trigger internal positive.
 - c. Set other controls as appropriate to make measurements required in steps 3 and 4.
3. Observe that Index is a logic 1 for 2.5 (± 0.3) us.
4. Observe that time between indexes is approximately 16.7 ms.
5. Prepare drive for return to on-line operation.

3.21.2 Speed Sensor Output Check

This procedure checks the output of the speed sensor to ensure that it has the proper polarity and is of sufficient amplitude.

1. Prepare drive for use with test software or FTU.
2. Connect and set up oscilloscope as follows:
 - a. Connect channel 1 to A17-71A (speed sensor output).
 - b. Trigger positive internal.
 - c. Set other controls as necessary to make measurement in step 3.

3. Check oscilloscope waveform for the following:
 - a. Scope trace should first go positive and then negative with respect to ground.

If not, wiring to speed sensor is reversed. Correct the wiring to speed sensor and recheck polarity of signal. If waveform is correct, go to step 3B.
 - b. Observe amplitude of waveform on oscilloscope. Signal should have positive and negative amplitudes of at least 0.6 V. If not, recheck speed sensor gap.
4. Prepare drive for return to on-line operation.

CHAPTER 4
REPAIR AND REPLACEMENT

4.1 INTRODUCTION

This chapter contains information pertinent to the mechanical repair and replacement of the RM05 subsystem field replaceable units (FRU). It also describes the associated adjustments required to maintain proper operation of the RM05 subsystem.

The procedures in this chapter are arranged alphabetically according to the assembly or component associated with the procedure. All procedures assume that the drive and adapter are installed in line with other drives and adapters, permitting access only from front or rear. If the cabinets are not installed in this position, certain procedures may be performed more easily by removing side panels and accessing the FRUs from the side.

Figure 4-1 locates the FRUs in the RM05 which require a replacement and/or adjustment procedure. Additional parts data, including illustrations and part numbers, may be obtained from the RM05 Illustrated Parts Breakdown.

4.2 ACTUATOR ASSEMBLY REPLACEMENT

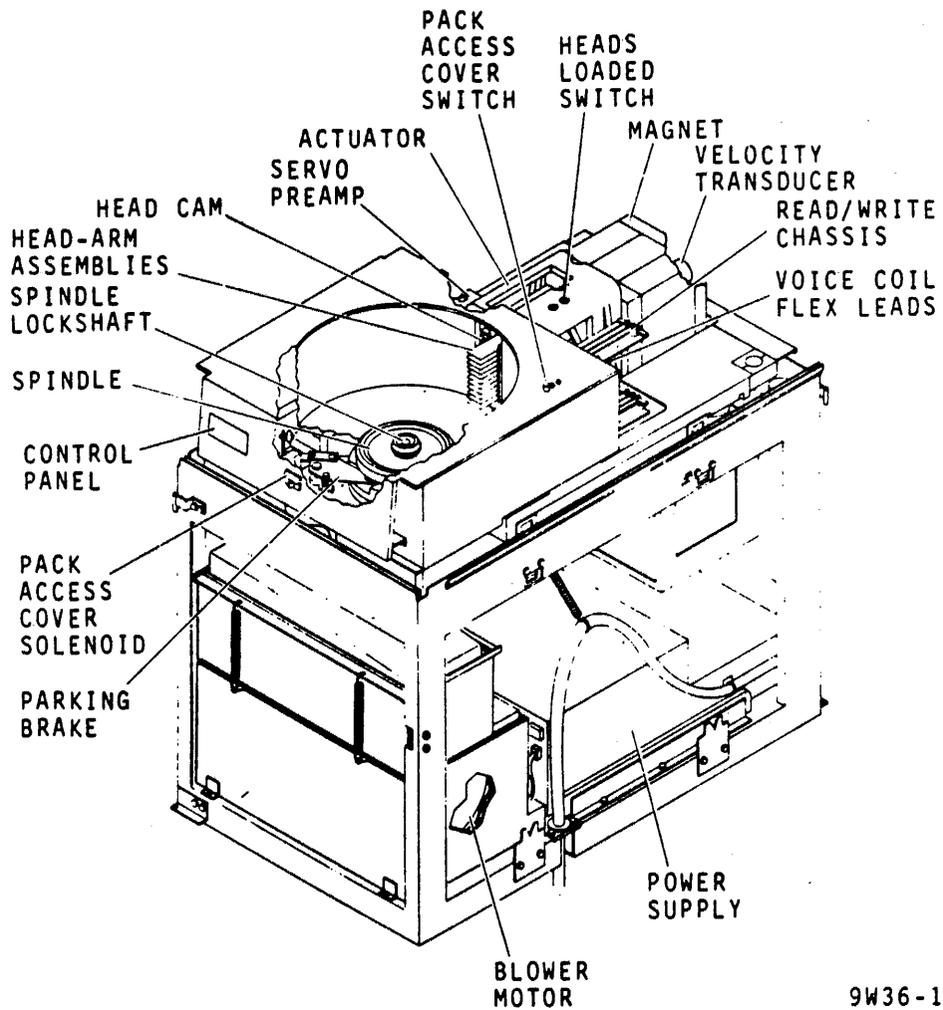
The actuator is located on the deck assembly. Refer to Figure 4-1 VDE and NON-VDE versions.

The following describes the entire procedure for replacing the actuator assembly. Figure 4-2 is an exploded view of the deck assemblies involved in actuator replacement.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.

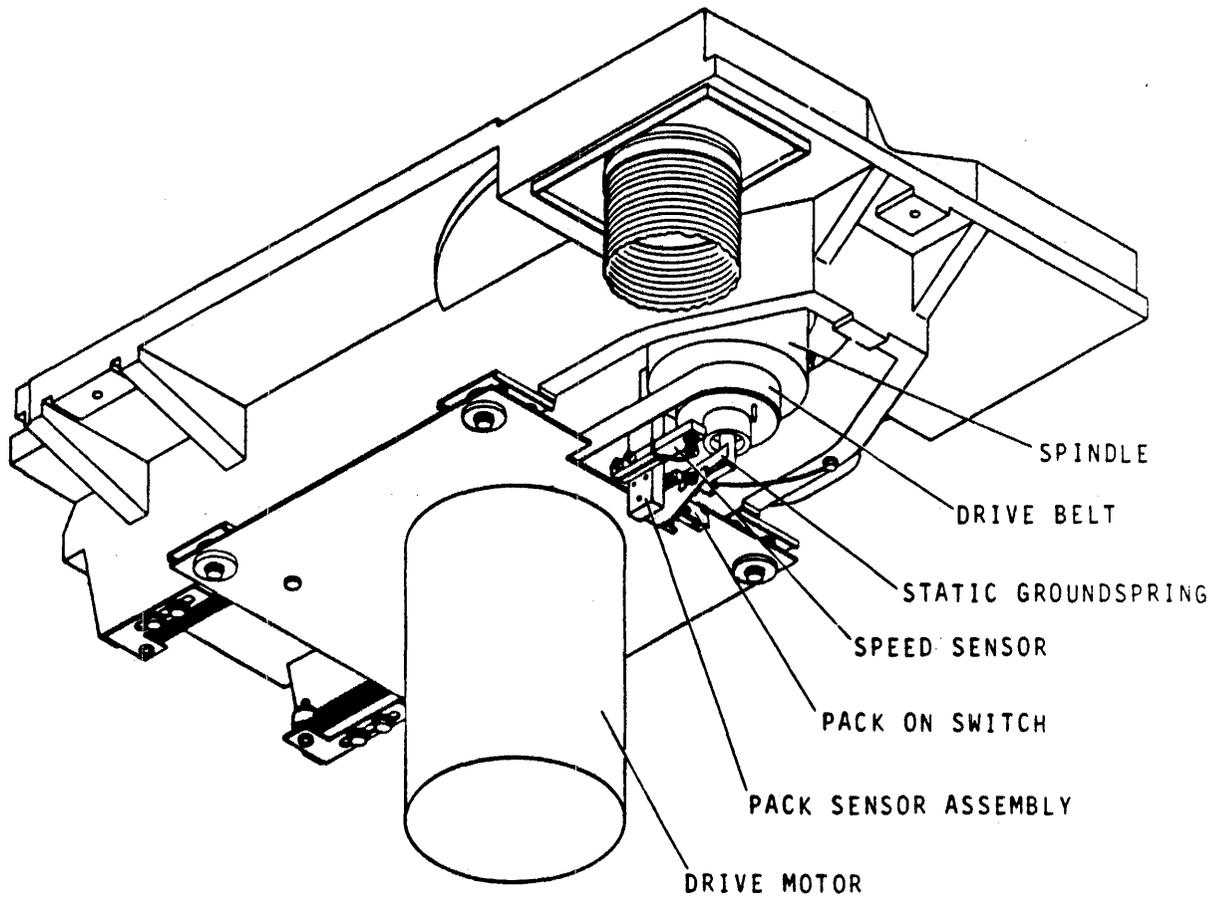
NOTE

If the drive is installed in line with other drives, it may be necessary to move the drive out of line to remove the top cover.



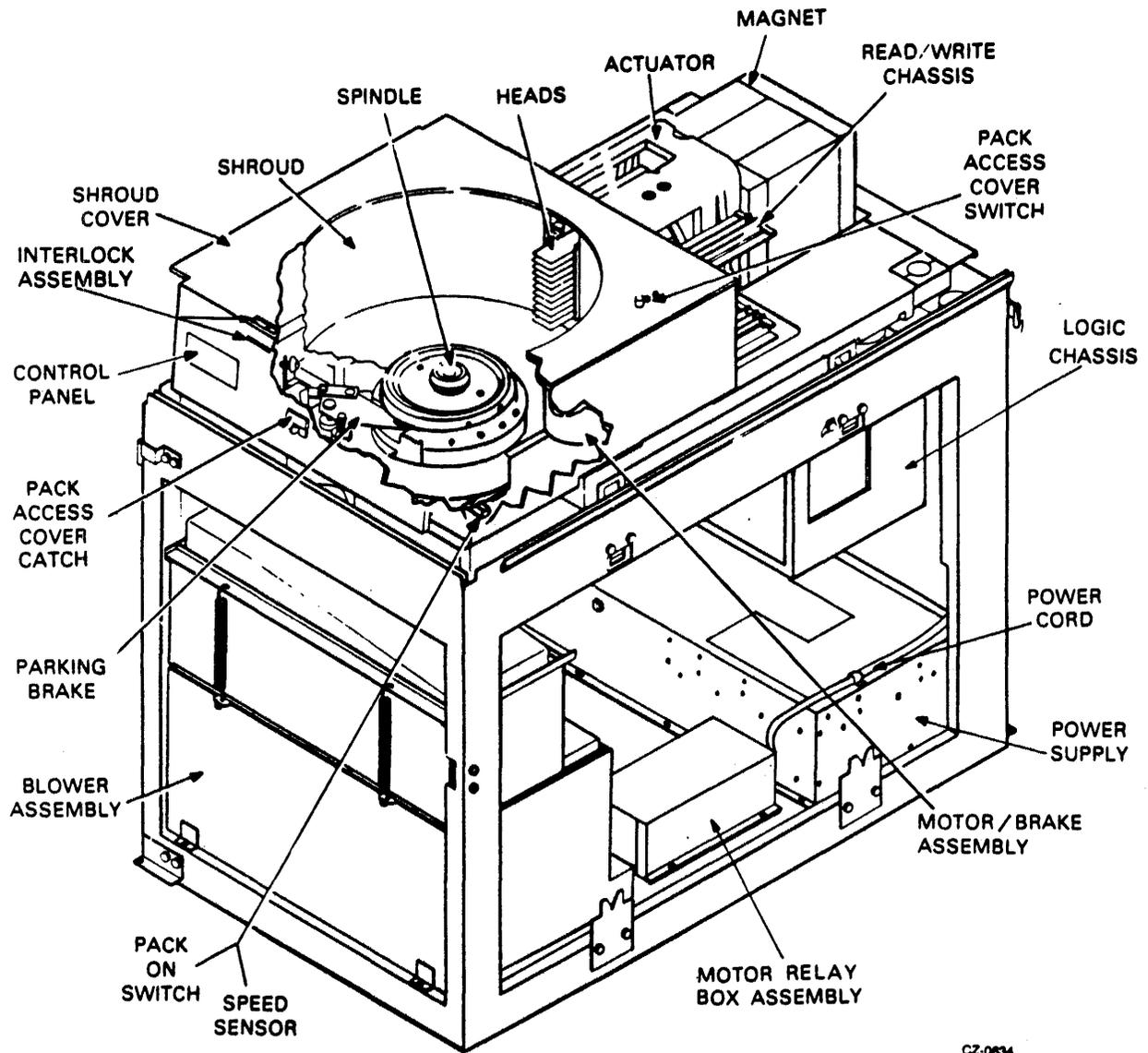
9W36-1

Figure 4-1 Assembly Locator NON-VDE (Sheet 1 of 2)



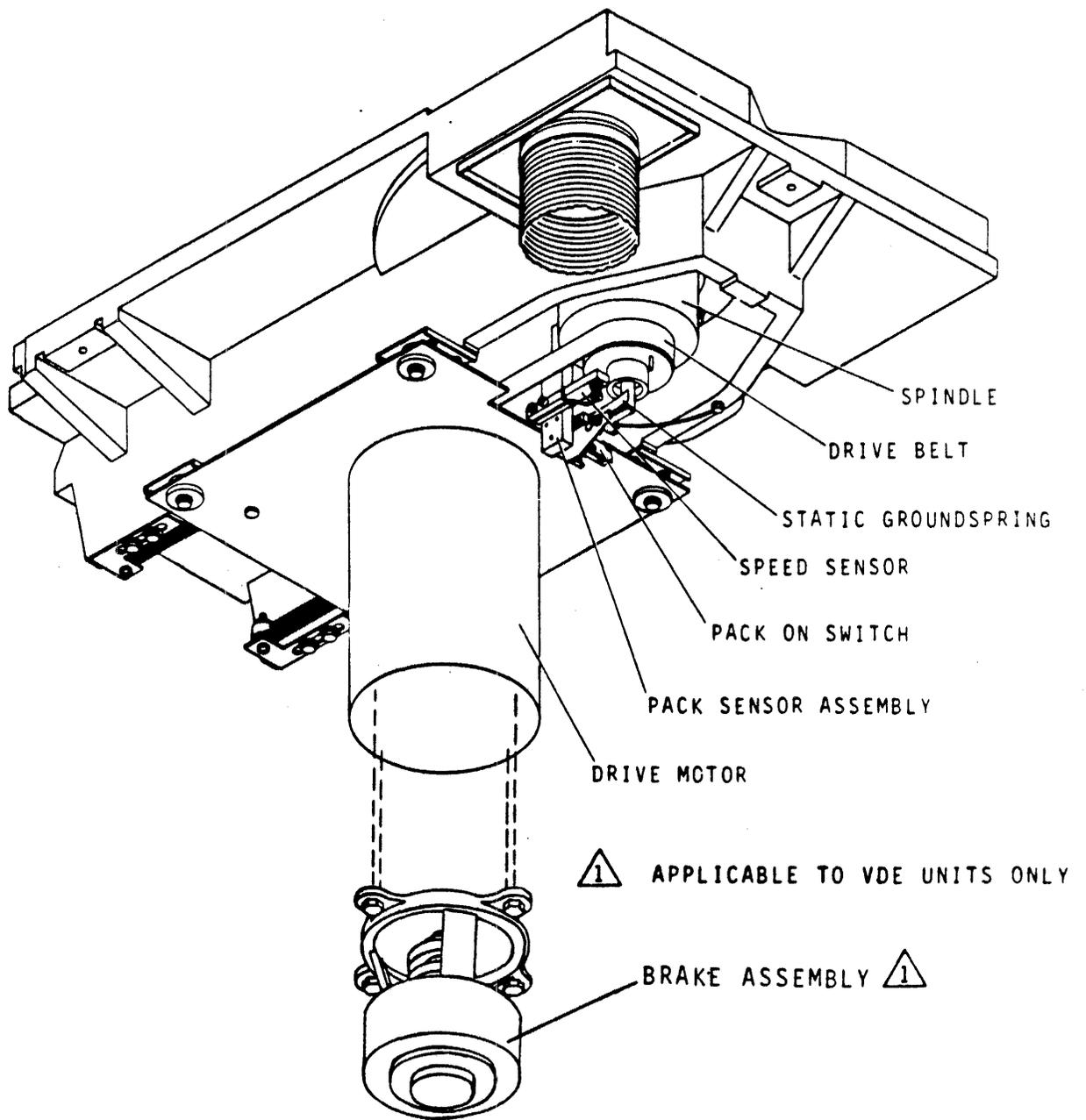
9W36-2

Figure 4-1 Assembly Locator NON-VDE (Sheet 2 of 2)



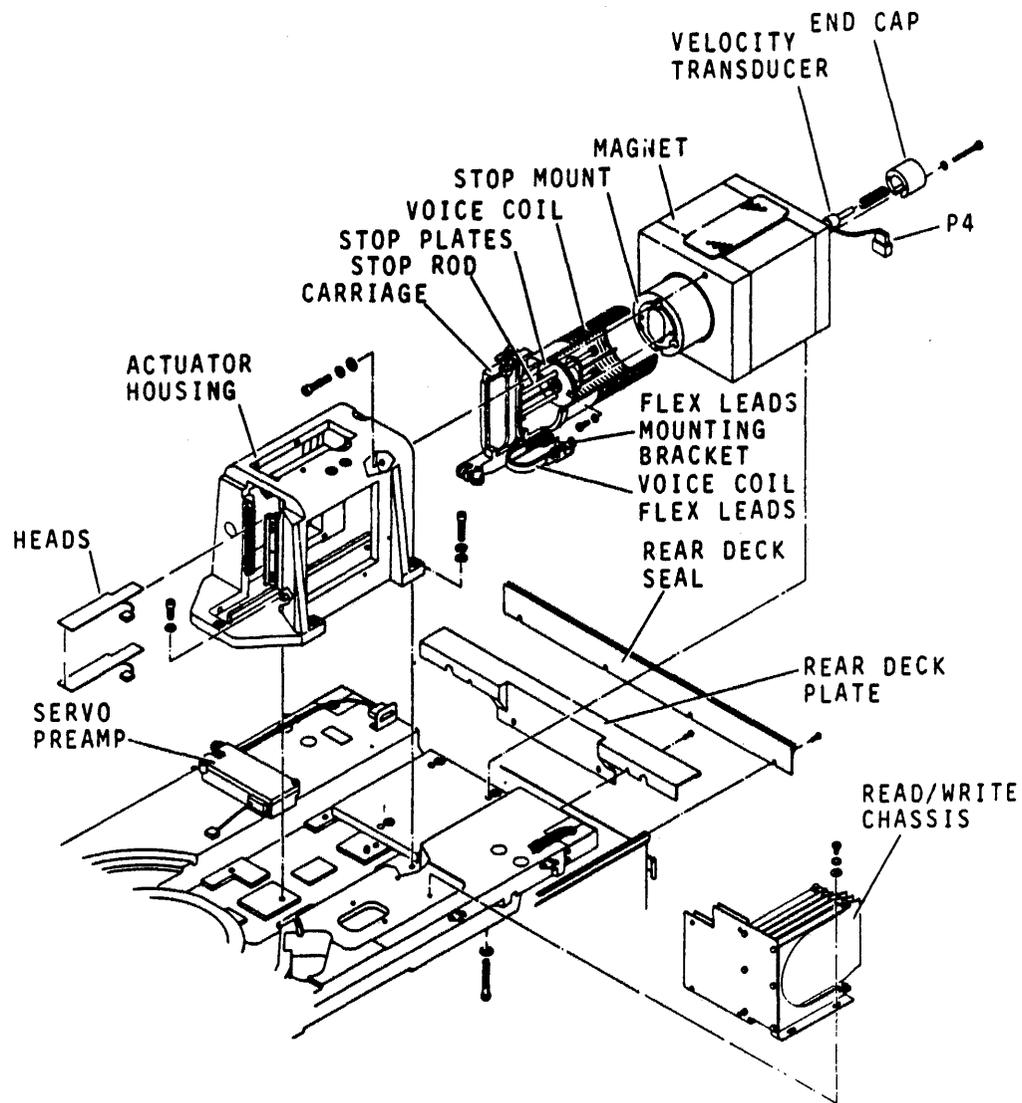
CZ-0834

Figure 4-1A Assembly Locator VDE (Sheet 1 of 2)



CZ-0645

Figure 4-1A Assembly Locator VDE (Sheet 2 of 2)



9W37

Figure 4-2 Actuator Replacement

3. Remove cabinet top cover.
4. Remove deck cover.
5. Remove pack access cover.
6. Remove shroud and shroud cover.

CAUTION

The magnetic field generated by the magnet is very strong. Permanent damage will occur to any watch brought near the magnet.

7. Make note of voice coil leadwire connections and disconnect leadwires.
8. Disconnect velocity transducer cable plug P4.
9. Cut cable ties securing voice coil and heads-loaded switch leadwires to side of actuator housing.
10. Remove two screws and washers securing heads-loaded switch to actuator housing, then remove switch and set it aside leaving leadwires connected.
11. Move servo preamp housing as follows:
 - a. Remove two screws securing cover to preamp housing and remove cover,
 - b. Disconnect servo head cable plug from servo preamp board,
 - c. Remove two screws securing servo preamp housing to deck,
 - d. Move housing to one side leaving leadwires connected.

NOTE

Remove only one head-arm assembly at a time. As each head-arm assembly is removed, observe order in which they are removed and lay out in order of removal. Lay each head (face up) on a clean surface. Each head-arm assembly must be installed in the same slot from which it was removed.

12. Remove head-arm assemblies starting with head 00. Refer to head-arm assembly replacement procedure (paragraph 4.8, step 8).
13. Remove read/write logic chassis as follows:
 - a. Remove connectors from cards,
 - b. Remove four screws and washers securing read/write logic chassis to deck and remove chassis.

14. Refer to velocity transducer assembly replacement (paragraph 4.35, step 5), and remove velocity transducer from magnet assembly.
15. Remove magnet assembly as follows (refer to Figure 4-2):
 - a. Loosen four screws securing rear deck seal to frame and remove rear deck seal,
 - b. Loosen four screws securing deck rear plate to deck and remove rear deck plate. Reposition rear top cover and hold down latch to either side,
 - c. Remove plastic magnet cover by prying cover from magnet assembly.

CAUTION

The screws removed in the next step go through the actuator housing. Thread this into the magnet assembly. The magnet will have a strong pull on the wrench used to remove this screw so use care not to damage actuator components.

- d. Remove screw securing actuator housing to magnet assembly. This screw is located at the top inside surface of the actuator housing next to the magnet.
- e. Remove two screws securing stop rod plate to stop mount on magnet.
- f. Move carriage as far forward as possible.
- g. Remove three screws and washers (under deck) securing magnet assembly to deck.

CAUTION

When removing magnet assembly, use care not to damage voice coil. Also be sure to place magnet away from metallic objects.

- h. Remove magnet from deck by sliding it straight back from the voice coil.
16. Remove carriage and voice coil from actuator housing as follows (refer to Figure 4-2):
 - a. Remove nut and screw securing flex lead mounting bracket and voice coil flex leads to actuator housing,

- b. Back carriage out of actuator housing, being careful not to damage voice coil flex leads.
17. Remove seven screws and washers securing actuator housing to deck. Then lift actuator housing straight up off pin and deck.

NOTE

The defective actuator assembly has now been completely removed. The following steps describe installation of the replacement actuator assembly.

18. Prepare replacement actuator for installation as follows:
- a. Remove nut and screw securing the flex lead adjustment bracket to actuator housing. This frees the flex leads and bracket from the housing.
 - b. Back carriage out of actuator housing, using care not to damage voice coil flex leads.
 - c. Check to see that there are no burrs or foreign particles on mounting surfaces of deck or actuator housing. If necessary clean these surfaces.

NOTE

When installing actuator housing, leave screws loose enough to perform carriage to spindle alignment.

19. Install actuator housing on deck using seven screws and washers.
20. Slide carriage into actuator housing taking care not to damage voice coil flex leads.
21. Align carriage to spindle as follows:
- a. Install and position carriage alignment arm as instructed in step 5 (a, b and c) of carriage to spindle alignment procedure (paragraph 4.32).
 - b. Check to see that clearance between carriage alignment arm and spindle post is between 0.002 and 0.004 inches (paragraph 4.32).
 - c. If requirements of step c (paragraph 4.32) are not met, gently tap actuator on one side or the other to move it in the proper direction.

NOTE

Do not disturb actuator position when removing carriage alignment arm and carriage.

- d. Remove carriage alignment arm from carriage.
- e. Remove carriage from actuator housing.

NOTE

Start with center screws when securing actuator housing to deck and use care not to disturb actuator position.

- f. Torque the seven screws securing actuator housing to deck to 60 (+5) inch-pounds.
 - g. Slide carriage into actuator housing.
 - h. Check to ensure alignment was not disturbed while torquing actuator housing screws by repeating steps a and b. If requirements of step b are not met, continue from step i. Otherwise proceed to step m.
 - i. Remove carriage alignment arm.
 - j. Back carriage out of actuator housing.
 - l. Realign as instructed in steps a through h.
 - m. Remove carriage alignment arm.
22. Apply Loctite, grade C, to threads of screw and attach voice coil flex lead mounting bracket to actuator housing.
23. Move carriage and check to see that voice coil flex leads do not bind and ride approximately parallel to deck.

If necessary, adjust flex lead mounting bracket until these conditions are met.

CAUTION

While performing next step, use care not to damage voice coil windings.

24. Install magnet assembly as follows:
- a. Move carriage forward as far as possible without unloading bearings from rails,
 - b. Carefully slide magnet into position and loosely secure it to deck using three screws and washers.

CAUTION

While performing the following step, use caution not to damage voice coil.

25. Align magnet and voice coil as follows.
 - a. Loosely install screw and washer through top of actuator into magnet assembly.
 - b. Move voice coil in and out of magnet assembly slowly. Ensure that voice coil does not touch magnet assembly. Move magnet assembly, if necessary, to avoid contact with the voice coil.
 - c. While moving coil in and out of magnet, insert a 0.005 inch non-metallic feeler gauge between the coil and magnet. This ensures that an 0.005 inch gap exists all around the coil.
 - d. Torque the screw through the top of the actuator to 60 (+2) inch-pounds.
 - e. Recheck gap (step c) and, if required, loosen screw and repeat steps b through d until proper gap is obtained.
 - f. Torque three screws securing magnet to deck to 30 (+1) inch-pounds.
 - g. Recheck gap (step c) and, if required, loosen all magnet screws and repeat steps b through f until proper gap is obtained.
26. Secure stop rod plates to magnet assembly with two screws and washers. Ensure that stop rods do not rub on stop plates during carriage movement.
27. Replace plastic magnet shield.
28. Replace velocity transducer assembly (refer to paragraph 4.35) as follows:
 - a. Insert coil housing containing transducer core and extension rod into rear of magnet.
 - b. Position end cap and spring on magnet and then secure with two screws and washers.
 - c. Apply one drop of Loctite, grade C, to extension rod threads. Then thread extension rod into carriage and tighten.
 - d. Connect velocity transducer cable plug P4.

29. Replace heads-loaded switch on actuator housing, using two screws and washers.
30. Perform heads-loaded switch adjustment procedure (paragraph 4.11, steps 6 through 15).
31. Position read/write chassis on deck and secure using four screws and washers.
32. Replace cable connectors on read/write chassis cards.

NOTE

Inspect heads before installing them.
Refer to head inspection and cleaning
procedure, paragraph 4.7.1.

33. Replace head-arm assemblies (starting at bottom) as follows.

CAUTION

Ensure that head cable and plug do not
contact head pad on adjacent heads or
they may be damaged.

- a. Install head-arm, plug and cable carefully between existing heads until head-arm is in proper position.
 - b. Install head-arm clamp screw and torque to 4 inch-pounds.
 - c. If installing read/write head-arm, connect head cable plug to SGN card in read/write chassis location E05. If installing servo head, connect servo cable jumper plug to connector card on actuator housing.
 - d. Repeat steps a through c for all heads to be installed.
34. Replace voice coil leadwire.
 35. Secure heads-loaded switch and voice coil lead wires to side of actuator housing with cable ties.
 36. Replace servo preamp assembly as follows:
 - a. Position servo preamp housing on deck and secure using two screws,
 - b. Connect servo head plug to servo preamp board,
 - c. Secure cover to servo preamp housing using two screws and washers.

37. Position deck rear plate on deck and securely tighten four screws (refer to Figure 4-2).
38. Position rear deck seal on frame and secure by tightening four screws (refer to Figure 4-2).
39. Replace shroud and shroud cover.
40. Replace pack access cover.

NOTE

If the drive was moved from in-line position to remove top cover, reinstall drive in-line after replacing top cover.

41. Replace cabinet top cover.

CAUTION

Before installing a disk pack, allow blower to operate for at least two minutes. This is necessary to purge shroud area of foreign particles that may have accumulated during actuator replacement.

42. Perform the procedures listed below.
 - a. Head alignment (paragraph 3.17.2)
 - b. Servo system adjustment (paragraph 3.17.2.7)

4.3 BLOWER MOTOR REPLACEMENT

The blower motor is located within the blower assembly as shown in Figure 4-3. Replacing the motor requires removing the entire blower assembly from the drive. The following describes removal and replacement of the blower motor.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set main AC circuit breaker to OFF.
2. Remove disk pack.
3. Open cabinet front door.
4. Remove blower assembly (containing blower motor) from drive as indicated below.
 - a. Remove protective plate from drive frame,

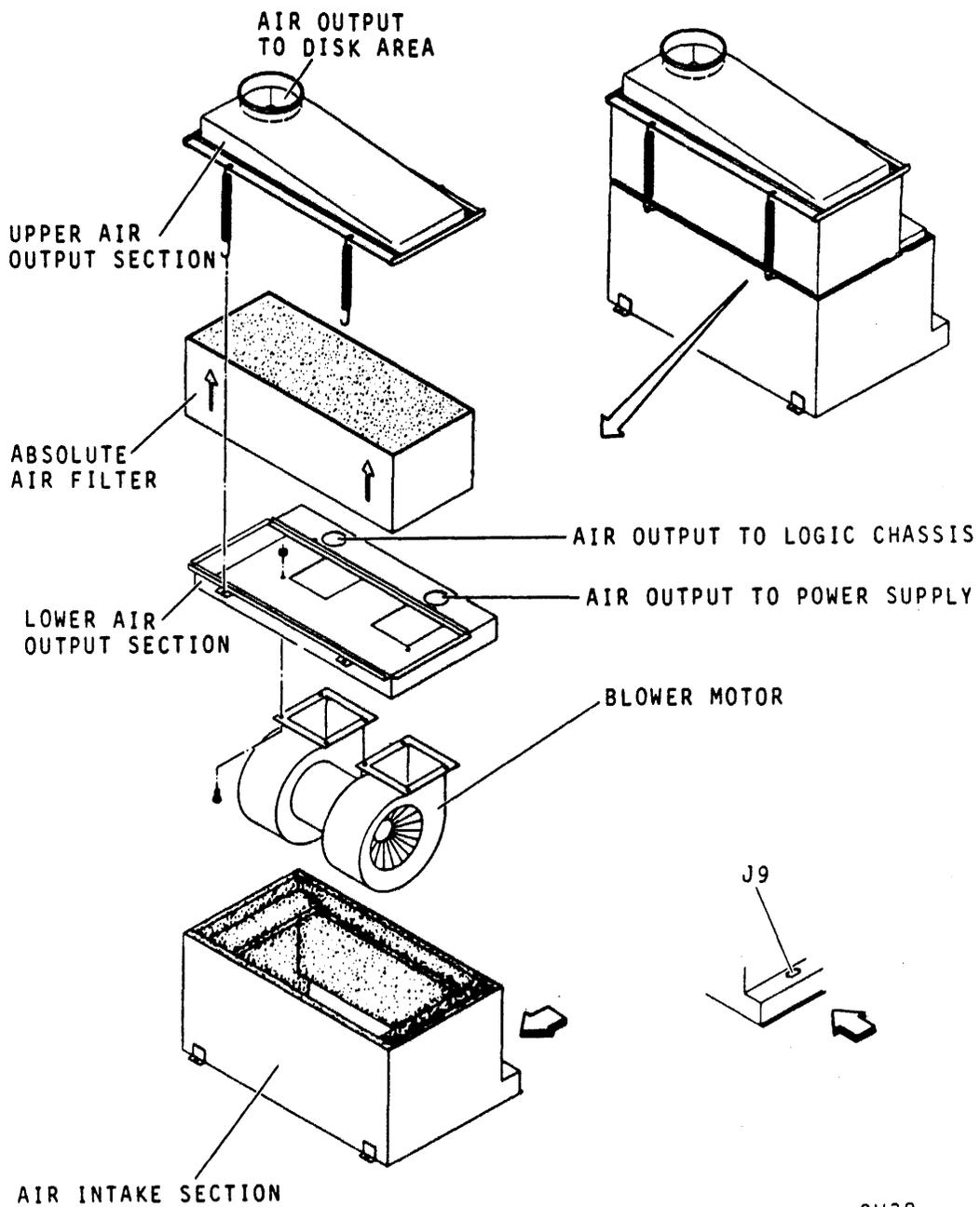


Figure 4-3 Blower Assembly

- b. Loosen clamp on large hose located on top of blower enclosure, then slide clamp up on hose and remove hose from blower enclosure,
- c. Remove two screws securing bottom front of blower enclosure to deck,

- d. From the rear of the drive, remove the two smaller hoses from the blower enclosure. Turn hoses in a clockwise direction until they come free,

CAUTION

Hoses actually unscrew from their position in blower enclosure but use care not to exert too much upward force or hoses will tear.

- e. Disconnect blower motor cable plug P9 from its connector on blower enclosure,
 - f. Slide blower enclosure out of front of drive and set on floor.
5. Snap J9 out of its position on air intake section of blower enclosure and allow it to hang from its leadwire.
 6. Disconnect ground strap from terminal on air intake section of blower enclosure.
 7. Remove four posts securing upper air output section and absolute air filter and set aside.
 8. Lift lower air output section containing blower motor off the air intake section.
 9. Remove six screws and nuts securing blower motor to lower air input section and remove motor.
 10. Position replacement blower motor on lower air input section and secure with six screws and nuts.
 11. Set lower air output section (with motor mounted) on air intake section.
 12. Reconnect ground strap and install J9 in its position on air intake section.
 13. Observing arrows indicating air flow, set absolute air filter on lower air output section.
 14. Secure upper air output section with four springs.

CAUTION

Following replacement of blower assembly, the blower should be allowed to purge system for at least two minutes before installing a disk pack.

15. Replace blower enclosure in drive as follows:

- a. Connect blower motor cable plug P9 to J9 on rear of air intake section,
- b. Connect small air hoses to rear of lower air output section by screwing them counterclockwise into holes. Refer to Figure 4-3 for proper orientation,

CAUTION

Ensure that air hoses or blower motor cable are not pinched.

- c. Slide blower into drive until flange on rear lower edge of blower enclosure slips into channel on cabinet frame,
- d. Secure front of blower enclosure to cabinet using two screws,
- e. Slip large air hose over output hole on top of blower enclosure and secure with clamp,
- f. Replace protective plate on drive frame.

16. Close cabinet front door.

4.4 DRIVE BELT REPLACEMENT

The drive belt (refer to Figure 4-1) transfers drive motor power to the spindle. It is removed by first removing the two idler springs, which keep tension on the belt, then slipping it off the pulleys. When the belt is replaced, the drive belt tension may need adjustment (refer to drive belt adjustment procedure, paragraph 4.5). The following describes removal and replacement of the drive belt.

CAUTION

A drive belt should only be removed by first removing the two tension springs as directed in the replacement procedure. Never remove a drive belt by rolling the belt off the pulleys or damage to the drive motor shaft or belt will result.

1. Remove power to drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.

3. Open cabinet rear door and swing logic chassis open.
4. Remove blower enclosure from drive cabinet. Refer to blower motor replacement procedure, paragraph 4.3, steps 3 and 4.
5. Remove static groundspring leadwire from static ground-spring.
6. Disconnect speed sensor cable plug A3P3.
7. Note lead wire connections and disconnect pack on leadwires at pack on switch.

CAUTION

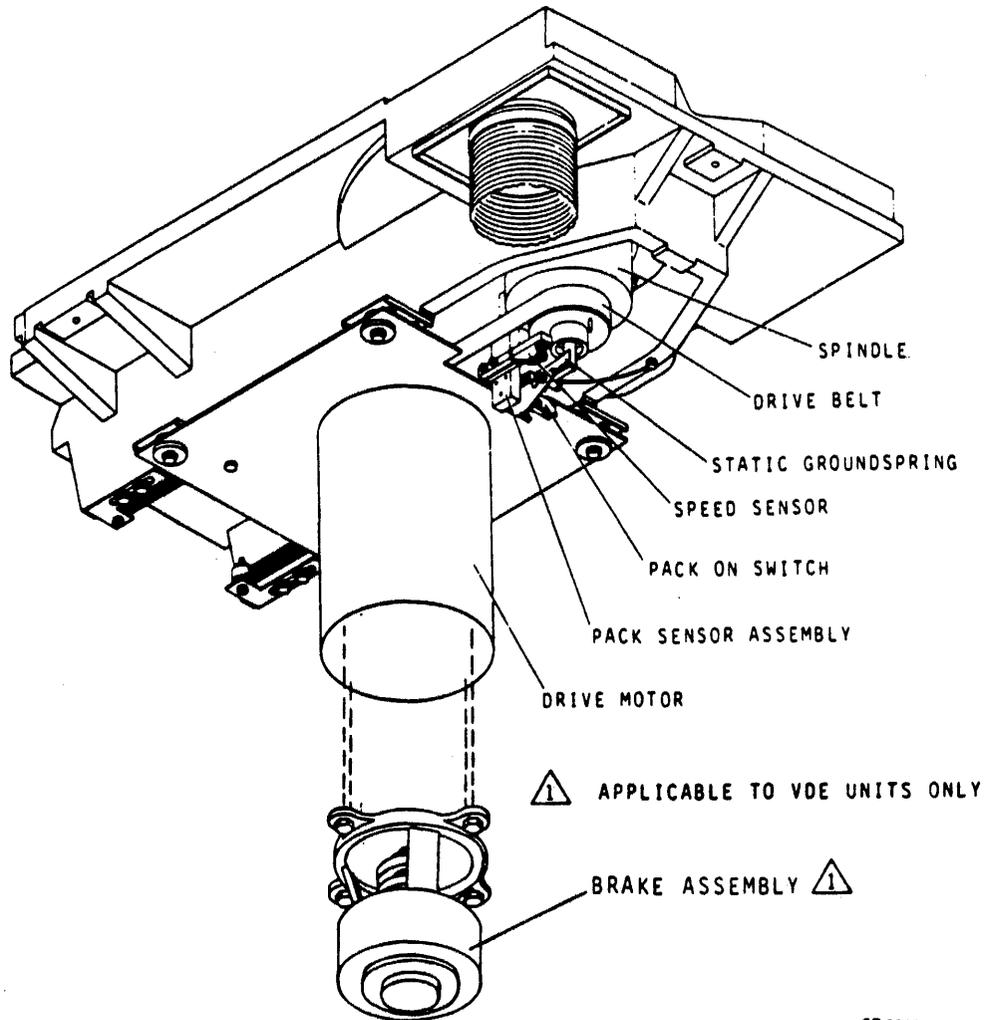
Use care not to damage the pack sensor assembly when removing drive belt.

8. Remove drive belt as follows (refer to Figure 4-4):
 - a. Remove two idler springs.
 - b. Push drive motor toward spindle assembly to relieve tension on drive belt and then slip belt off pulleys and set aside.

NOTE

Smooth surface of belt goes against pulleys.

9. Install replacement belt as follows:
 - a. Position belt around drive motor pulley,
 - b. Push drive motor toward spindle and slip belt around spindle pulley,
 - c. Install idler springs,
 - d. Move drive motor and mounting plate back and forth several times to ensure the mounting plate is properly seated,
 - e. Manually rotate spindle to align drive belt on pulleys.
10. Connect speed sensor plug A3P3 and static groundspring leadwire.
11. Connect pack on switch leadwires to switch terminals.



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Figure 4-4 Drive Belt Replacement/Adjustment

12. Replace blower assembly. Refer to blower motor replacement procedure, paragraph 4.3, step 15.
13. Close cabinet rear door.
14. Perform drive belt adjustment procedure (paragraph 4.5) starting with step 3.

4.5 DRIVE BELT ADJUSTMENT

The drive belt adjustment consists of changing the belt tension which is maintained by the two idler springs. These springs are attached between posts mounted on adjustable brackets on the deck casting and fixed posts mounted on the motor mounting plate (refer to Figure 4-4). The drive motor mounting plate is moved by the springs to exert tension on the belt. The springs are adjusted by removing them from the brackets, repositioning the adjustable brackets and then replacing the springs.

1. Remove power to drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.
3. Open rear door of cabinet and swing logic chassis open.
4. Inspect drive belt for cracks or worn spots. If required, replace belt by performing drive belt replacement procedure (paragraph 4.4) starting with step 4.
5. Check drive belt adjustment by measuring distance between idler spring posts. Refer to Figure 4-4.

This distance should be from 5.25 to 5.50 inches (135.35-139.50 millimeters). If distance is not within these limits, adjustment is required. Refer to step 6. If distance is within these limits, no adjustment is required. Refer to step 7.

6. Adjust idler spring tension, which is also drive belt tension as follows:
 - a. Remove idler spring from its post connected to adjustment bracket,
 - b. Loosen two screws securing adjustment bracket and reposition the bracket to 5.25 to 5.50 inches (135.35 - 139.50 millimeters).
 - c. Tighten screws securing adjustment bracket,
 - d. Replace idler spring on its posts,

NOTE

Tension between idler springs is interacting; therefore when adjusting one spring always recheck both springs.

- e. Recheck spring distance requirements by repeating procedure starting with step 5.
7. Close logic chassis and rear door of cabinet.

4.6 DRIVE MOTOR AND BRAKE REPLACEMENT

The replacement motor assembly includes the motor, pulley, and cable with attached plug. Replacing the drive motor assembly involves removing the motor mounting plate with motor attached. The old motor is then removed from the mounting plate and the replacement motor is mounted in its place. This assembly is then replaced in the drive cabinet.

If the drive motor includes an externally mounted brake assembly, it must be removed from the old motor and installed on the replacement motor.

4.6.1 Drive Motor Replacement

1. Remove power from the drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.

NOTE

If drive is installed in-line with other drives, it must be taken out of line to remove side panels.

2. Remove cabinet side panels.
3. Open cabinet rear door and swing logic chassis open.

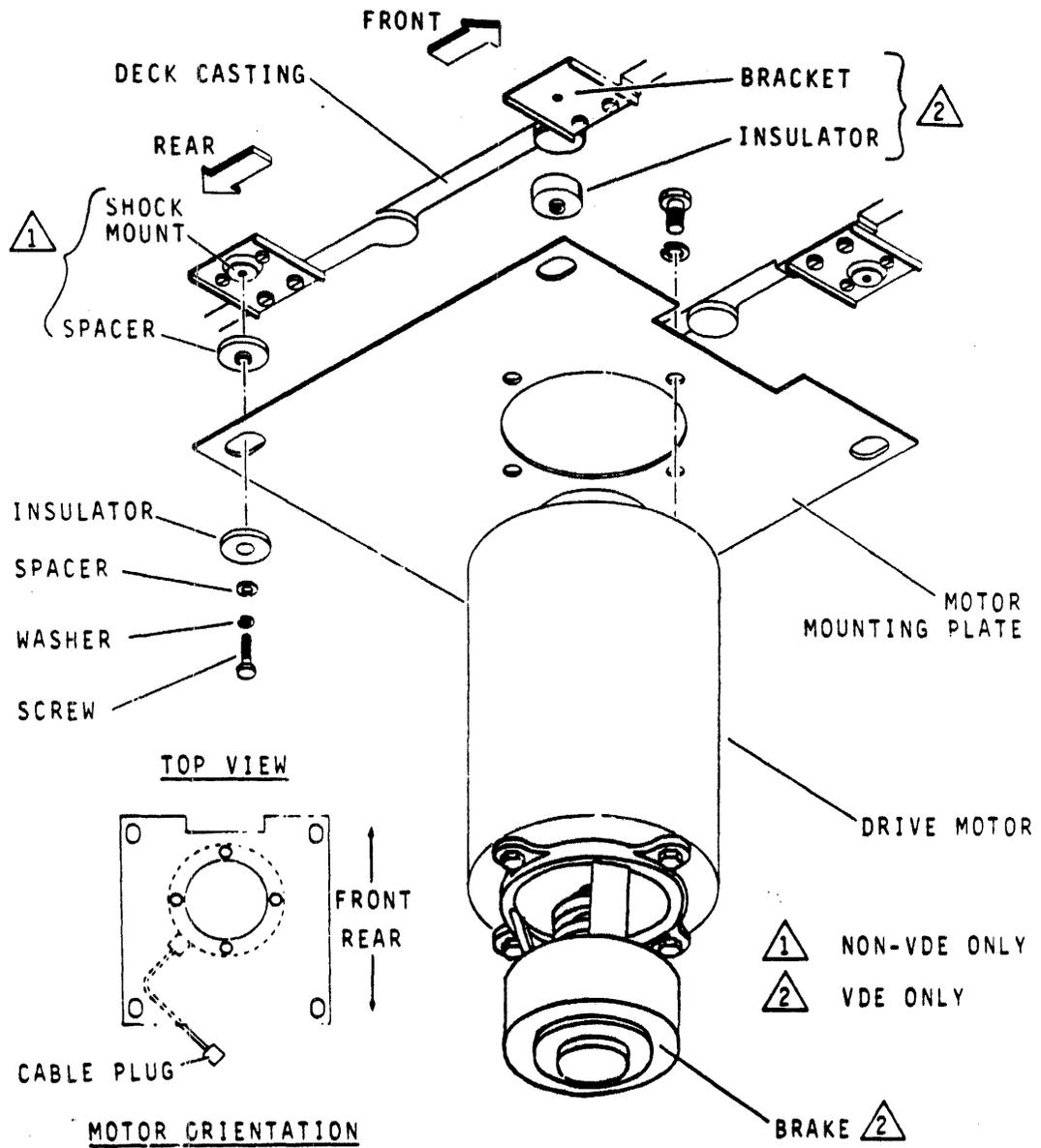
CAUTION

Use care not to damage pack sensor assembly when removing drive belt.

4. Remove drive belt by performing drive belt replacement procedure, (paragraph 4.4) steps 5 through 8.
5. Remove drive motor and motor mounting plate as follows (refer to Figure 4-5):
 - a. Disconnect drive motor cable plug AIP7 from rear of power supply. If the motor includes an externally mounted brake, disconnect AIP9 and brake cable plug A3P2 on the power supply,
 - b. Remove motor relay box.

CAUTION

Drive motor and mounting plate require support from beneath (such as block of wood on floor of cabinet) to prevent them from being dropped during installation.



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Figure 4-5 Drive Motor and Brake Replacement

6. Remove hardware securing drive motor to mounting plate and remove the drive motor and pulley from plate and set aside. Remove the externally mounted brake (if so equipped) using the brake replacement procedure, and install it on the replacement motor.
7. Replace drive motor and motor mounting plate as follows:
 - a. Orient replacement drive motor and pulley as shown in Figure 4-5 and secure it to mounting plate,

CAUTION

Drive motor and mounting plate require support from beneath (such as block of wood on floor of cabinet) to prevent them from being dropped during installation.

NOTE

Apply one drop of Loctite, grade C, to threads of each screw installed in step b. Do not overtighten screws or motor mounting plate will not be free to move between spacers.

- b. Position motor mounting plate and drive motor as shown in Figure 4-5 and secure with hardware removed in step 5,
 - c. Check that the motor mounting plate is free to move forward and backwards between motor spaces. If not, loosen screws and retighten so that mounting plate is free to move.
8. Replace drive belt as follows:
 - a. Push drive motor toward spindle and slip drive belt around drive motor pulley,
 - b. Install idler springs,
 - c. Move drive motor and mounting plate back and forth several times to ensure the mounting plate is properly seated,
 - d. Manually rotate spindle to align drive belt on pulleys,
 - e. Connect speed sensor plug A3P3 and static ground spring leadwire,
 - f. Connect pack-on switch leadwires to switch terminals.

9. Connect drive motor cable plug A1P7 to J7 and brake cable A3P2 on rear of power supply.
10. Replace motor relay box and connect A1P9 to J8 on rear of power supply.
11. Close logic chassis and then close cabinet rear door.

NOTE

If drive was moved from in-line position prior to removing side panels, reinstall drive in-line after replacing side panels.

12. Replace side panels.

4.6.2 Brake Replacement

The brake assembly, on units so equipped, is mounted on a bracket attached to the bottom of the drive motor. The brake applies its braking force to the motor through a flexible coupling connecting the motor and brake shafts.

When replacing a drive motor, the brake assembly must be transferred to the replacement motor. Use the following procedure to transfer the assembly, or to replace the brake.

1. Remove the drive motor using the drive motor replacement procedure. It is not necessary to remove the motor from the mounting plate if the motor is not being replaced.
2. Remove the hardware securing the brake mounting bracket to the bottom of the motor. See Figure 4-5.
3. Separate the brake and bracket assembly from the motor.

NOTE

If the brake is being transferred to a replacement motor, go to step 4. If the brake is being replaced, go to step 9.

4. Loosen the setscrews in the flexible coupling on the motor shaft and slip the coupling off the motor shaft.
5. Install the coupling on the replacement motor, lightly tighten the setscrews.
6. Assemble the brake and bracket to the motor using the hardware removed in step 2. Ensure that the flexible coupling components engage properly.

7. Slide the flexible coupling on the motor shaft downward. Ensure that all coupling components engage properly and tighten all setscrews.
8. Skip steps 9-15 and install the drive motor using the drive motor replacement procedure, beginning with step 8.
9. Loosen the setscrew that secures the flexible coupling to the brake shaft.
10. Slip the coupling off the brake shaft.
11. Remove the screws that secure the brake to the mounting bracket.
12. Assemble the replacement brake to the mounting bracket using the hardware removed in step 11.
13. Slip the flexible coupling onto the brake shaft. Leave the setscrews in the coupling loose.
14. Position the brake and bracket assembly on the motor and secure it with the hardware removed in step 2.
15. Raise the flexible coupling on the brake shaft so it engages the coupling components. Tighten all setscrews securely.
16. Connect brake cable A3P2 to J8 on power supply.
17. Install the drive motor using the drive motor replacement procedure beginning with step 8.

4.7 HEAD-ARM ASSEMBLIES

The following describes head inspection and gives criteria for determining if a head-arm assembly should be replaced. A procedure for replacing one or more of the head-arm assemblies is also included.

The heads should be inspected only for the reasons given below.

1. A problem is traced to a specific head or heads; for example, excessive data errors. Replace head or multiple head-select.
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. Replace all heads in the event of a head crash where there is a large amount of particle contamination. Examples of this are problems 2 and 3 of 4.7.

4.7.1 Head Inspection

CAUTION

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

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

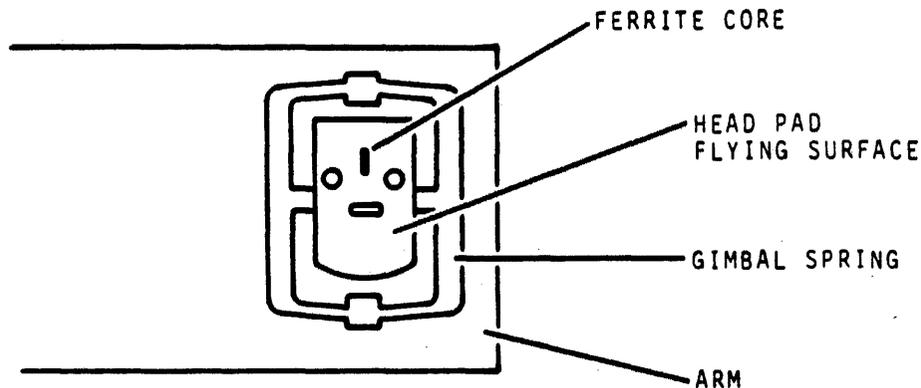
If head must be laid down, do not allow the head pad or gimbal spring to touch anything. If possible, use a magnifying device to inspect the heads.

Remove suspect head as described in Paragraph 4.8. Refer to Figure 4-6, observe the head-arm assembly, and perform the remedy given below.

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

CAUTION

Do not reuse any packs that were used on these types of heads.



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Figure 4-6 Typical Head-Arm Components

4.7.2 Head-Arm Replacement Criteria

A head-arm assembly requires replacement if any of the following conditions listed below exist.

1. Consistent oxide buildup on the same head, indicating repeated head to disk contact
2. Appreciable oxide build-up
3. Scratches on the head flying surface
4. Imbedded particles in the head pad flying surface
5. Bent or damaged gimbal spring
6. Any apparent physical damage to head-arm assembly

4.8 HEAD-ARM ASSEMBLY REPLACEMENT

The following describes replacement of read/write and/or the servo head-arm assemblies. Head alignment must be performed on any head-arm assembly replaced. Replacing the servo head-arm assembly requires alignment of all heads. Head alignment is covered in a separate procedure (paragraph 3.17.2).

NOTE

In the event of suspected contamination of the shroud, the shroud should be removed, cleaned and replaced in conjunction with this procedure. The actuator assembly and deckplate must also be cleaned.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Open pack access cover, remove disk pack and then close pack access cover.
3. Open cabinet top cover and remove deck cover.
4. Open pack access cover as far as possible.

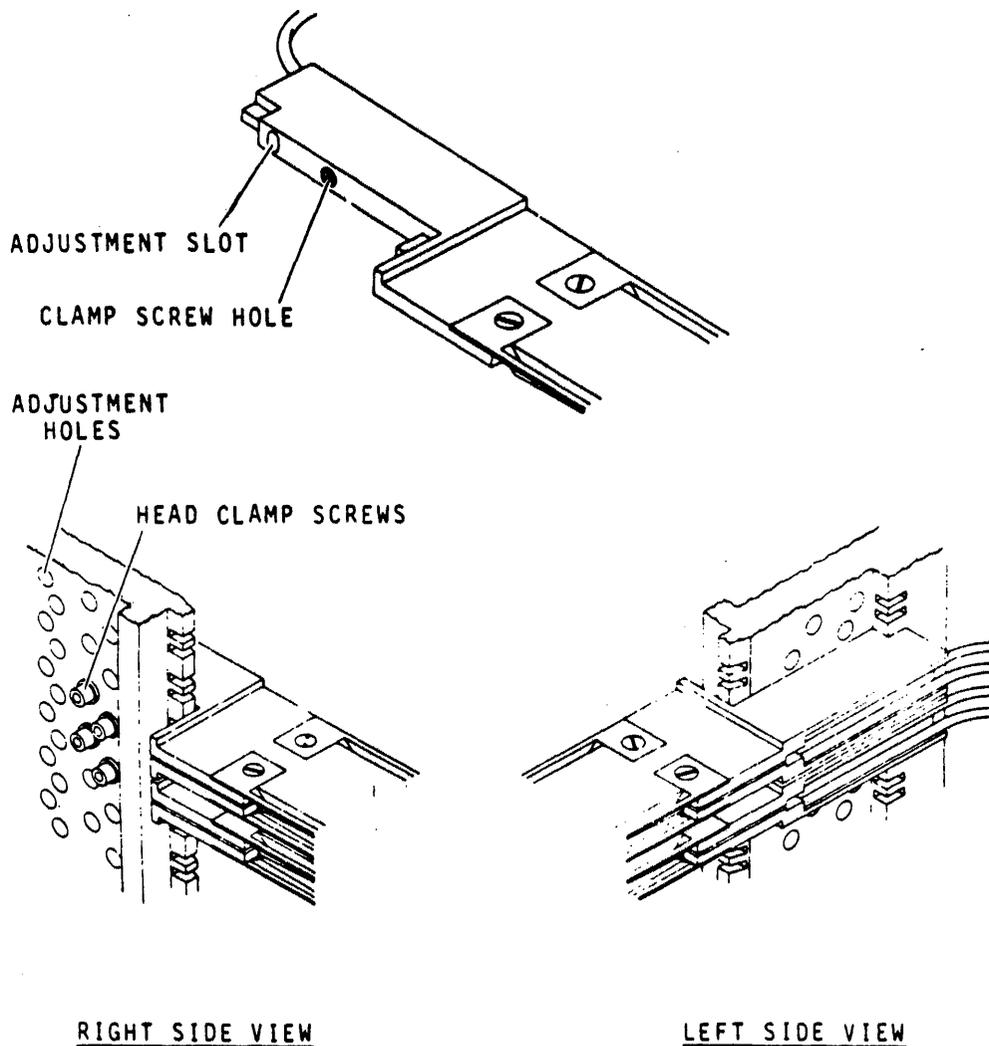
NOTE

Perform step 5 if any of the items below apply.

- If removing all heads
- If removing any of the heads in surface positions 15 through 19
- If removing the servo head. In this case, perform only a and b under step 5.

If none of these apply, proceed to step 6.

5. Move servo preamp housing as follows:
 - a. Remove two screws securing cover to housing and remove cover,
 - b. Disconnect servo head cable plug from servo preamp board,
 - c. Remove two screws securing preamp housing to deck, then move preamp housing to provide access to head clamp screws for head surface positions 15 through 19.
6. Determine surface location of head (or heads to be replaced) by referring to head identification label on actuator housing or to Figure 4-7.
7. Lock carriage in place by inserting carriage locking pin into shipping hole.
8. Remove heads as follows:



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Figure 4-7 Head-Arm Assembly Replacement

NOTE

If more than one head is to be removed, disconnect head cables one at a time as the heads are removed.

- a. If removing read/write head, disconnect corresponding head cable plug from XGN card in read/write chassis location E05. If removing servo head, disconnect servo cable jumper plug from connector card on actuator housing.

CAUTION

When head-arm clamping screw is removed, use care not to dislodge head from its position in carriage. This may allow head to contact an adjacent head thus causing damage to itself or other head. If more than one head is to be removed, undo clamping screws one at a time.

- b. Remove clamping screw securing head-arm to be removed.
 - c. Slide head-arm assembly forward from its position in carriage until it can be grasped from front, then carefully remove head-arm, cable and plug from carriage assembly.
 - d. Repeat steps a through c for all heads to be removed.
9. Install heads as follows:

CAUTION

Ensure that head plug and cable do not contact head pad on adjacent heads or these heads may be damaged.

- a. Slide head-arm, plug and cable carefully between existing heads until head-arm is in proper position.
 - b. Install head-arm clamp screw and torque to 4 inch-pounds,
 - c. If installing read/write head, connect head cable plug to XGN card in read/write chassis location E05. If installing servo head, connect servo cable jumper plug to connector card on actuator housing,
 - d. Repeat steps a through c for all heads to be installed.
10. Remove carriage locking pin from shipping hole.

NOTE

Step 11 is applicable only if step 5 was performed.

11. Reinstall servo preamp housing as follows:
- a. Place it in its proper position on deck and secure with two screws,
 - b. Reconnect servo head cable plug to preamp board,

- c. Replace servo preamp housing cover using two screws.

NOTE

Do not adjust servo head-arm if it was not replaced because all read/write heads must be realigned whenever this adjustment is changed.

12. If servo head-arm was replaced, adjust it as follows. Otherwise, proceed to step 14.
 - a. Using head-arm adjustment tool, center servo head-arm adjustment slot in the head adjustment hole,
 - b. Torque head-arm clamp screw to 12 (\pm 1/2) inch-pounds.
13. Check alignment of all heads and adjust as necessary (refer to head alignment procedure, paragraph 3.17.2).

4.9 HEAD CAM REPLACEMENT

This procedure describes removal and replacement of the head cams. The top cover, pack access cover, shroud, and shroud cover must be removed to gain access to the head cams. The cams fit onto pins in the actuator housing and require no adjustment after installation.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.

NOTE

If drive is installed in line with other drives, it may be necessary to move the drive out of line to remove the top cover.

3. Remove cabinet top cover.
4. Remove pack access cover.
5. Remove shroud and shroud cover.
6. Manually load heads.
7. Remove two screws securing each head cam to actuator housing and then remove cams by pulling straight off from pins on actuator housing. (Refer to Figure 4-8.)

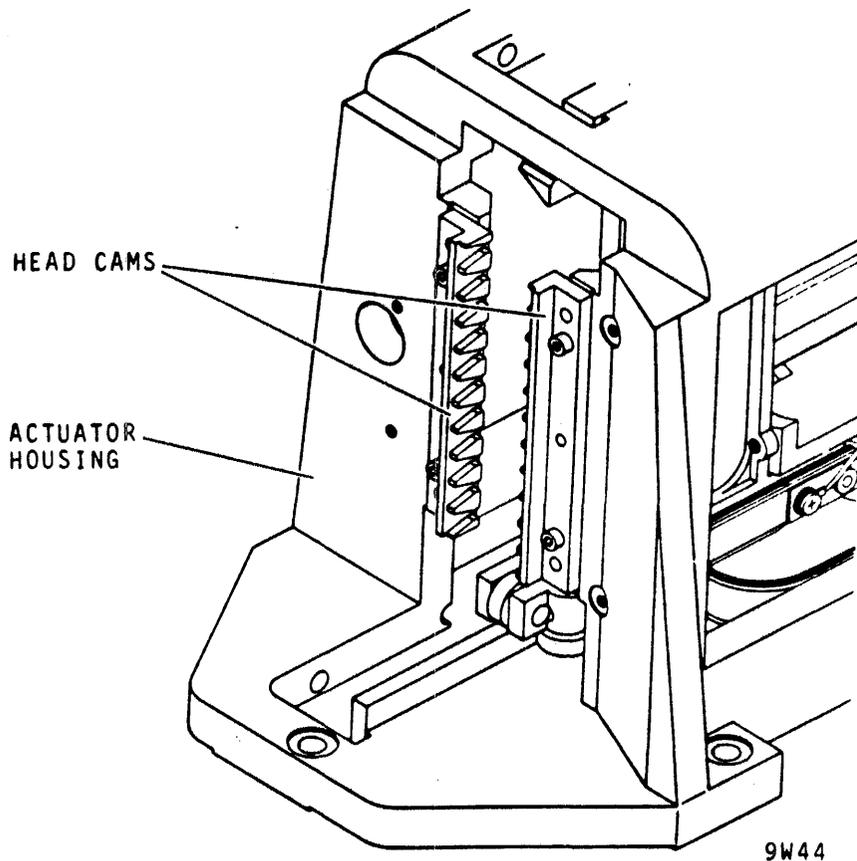


Figure 4-8 Head Cams

CAUTION

Before replacing head cams, ensure that mating surfaces of actuator housing and cams are clean.

8. Install replacement head cams as follows (refer to Figure 4-8):
 - a. Fit replacement head cams over dowel pins on actuator housing so they are flush against housing,
 - b. Install screws and torque to 4 (+.5) inch-pounds.
9. Manually unload heads.
10. Replace shroud and shroud cover with nine screws and washers.
11. Replace pack access cover.

NOTE

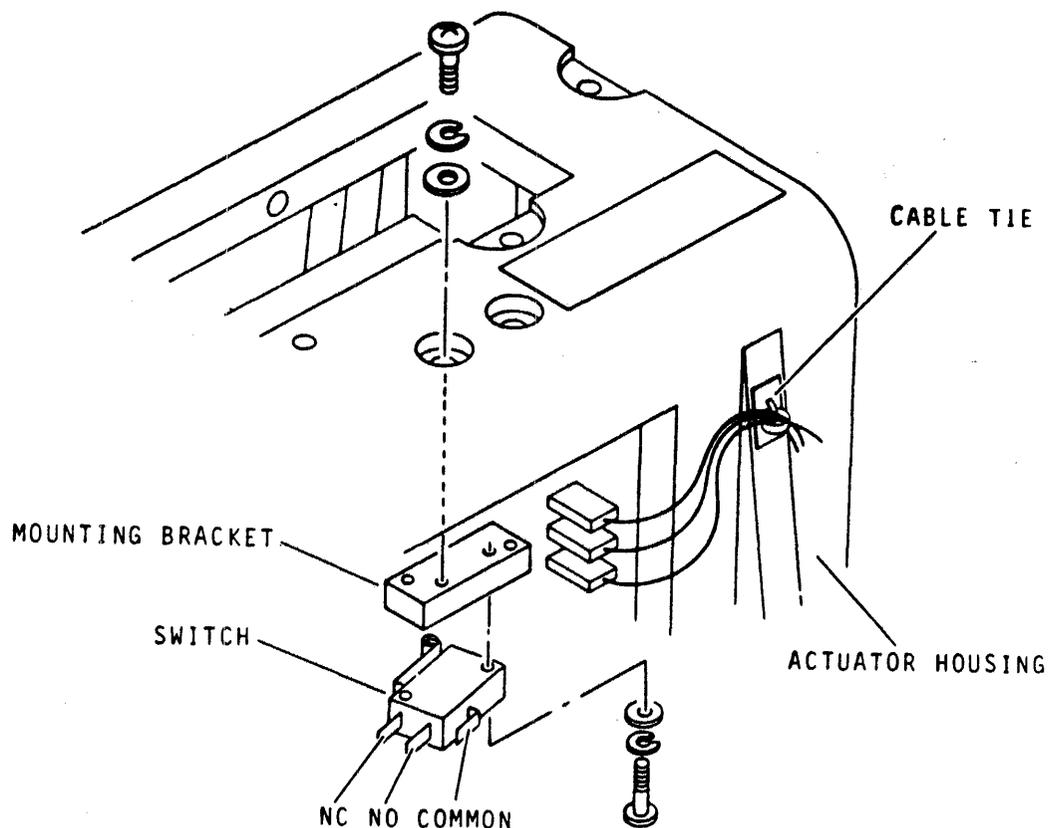
If it had been necessary to move drive from in-line position to remove top cover, reinstall drive in-line after replacing top cover.

12. Replace cabinet top cover.

4.10 HEADS-LOADED SWITCH REPLACEMENT

This switch is mounted on the actuator housing (refer to Figure 4-9) and indicates to the drive logic whether or not the heads are loaded. The following describes the removal and replacement of this switch. This switch also requires adjustment which is explained in the heads-loaded switch adjustment procedure (paragraph 4.11).

1. Remove power to drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.
3. Open cabinet top cover and remove deck cover.
4. Move carriage back to retracted stop.
5. Remove heads-loaded switch from actuator housing as follows (refer to Figure 4-9):
 - a. Cut cable tie securing heads-loaded switch leadwires to actuator housing,
 - b. Remove two screws and washers securing the heads-loaded switch mounting block to actuator housing, then remove mounting block and switch from actuator housing,
 - c. Note leadwire connections and remove leadwire from switch,
 - d. Remove two screws and washers securing switch to block and remove switch.
6. Install replacement switch on mounting block.
7. Install replacement switch and mounting block on actuator housing, leaving screws loose enough to perform adjustments in step 8 of adjustment procedure.
8. Secure leadwires to side of actuator housing with cable tie.



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Figure 4-9 Heads-Loaded Switch Replacement

9. Perform heads-loaded switch adjustment procedure (paragraph 4.11) starting with step 6.

4.11 HEADS-LOADED SWITCH ADJUSTMENT

The heads-loaded switch should actuate when the carriage is forward enough for the heads to be loaded. To ensure this condition, adjust the heads-loaded switch using the following procedure.

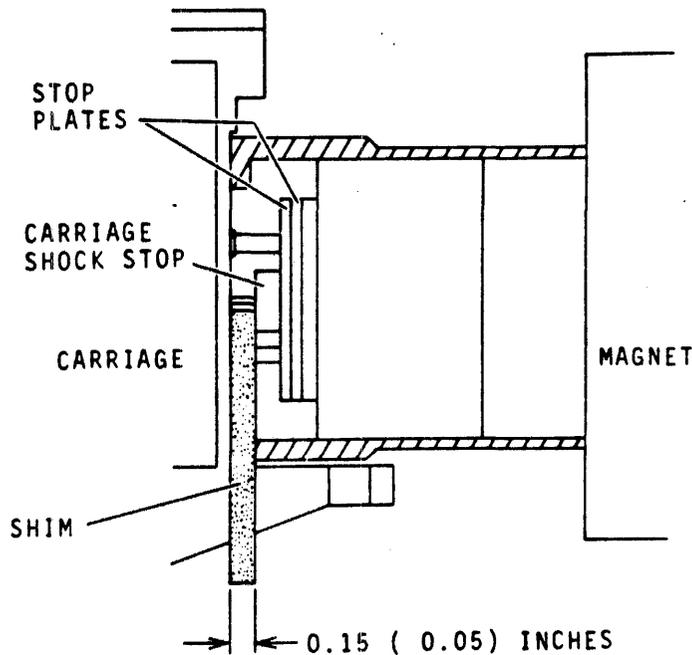
1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.
3. Open cabinet top cover and remove deck cover.

4. Move carriage back to retracted stop.
5. Note heads-loaded switch leadwire connection and disconnect leadwires.
6. Connect an ohmmeter (set to Rx1 scale) across common and normally closed (NC) terminals of the switch. Refer to Figure 4-9.
7. Check heads-loaded switch operation.
 - a. With carriage at retracted stop, meter should read zero. If it does not, proceed to step 8. If it does, proceed to b.
 - b. Move carriage forward until switch transfers (meter indicates infinity) and measure distance traveled. If distance is between 0.1 and 0.2 inches, proceed to step 17. If distance is not between these limits, proceed to step 8.
8. Loosen screws securing switch mounting block to actuator housing and then move block to actuator housing. Move block and switch as far back as possible toward magnet. Meter should now indicate infinity.
9. Disconnect one of the meter leads at meter.

NOTE

In next step, a suitable shim is constructed by taping a number of feeler gauges together until their combined thickness is from 0.1 to 0.18 inches. Check their thickness with a steel rule.

10. Insert 0.15 (0.05) inch shim between stop on magnet and shock stop on carriage assembly. Refer to Figure 4-10.
11. Reconnect meter lead and note that meter still indicates infinity when carriage is moved back against shim.
12. Hold carriage against shim and then move heads-loaded switch towards spindle until switch transfer occurs (meter indicates zero). Tighten screws securing switch and mounting block to actuator housing, taking care not to disturb their position.
13. Remove shim and move carriage back to retracted stop.
14. Move carriage forward and check with shim or steel rule to ensure switch transfer occurs between 0.1 and 0.2 inches of retracted stop.



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Figure 4-10 Heads-Loaded Switch Adjustment

15. If requirements of step 14 are not met, repeat steps 7 through 14 until the adjustment is correct and then proceed to step 16.
16. Disconnect meter from switch terminals and reconnect heads-loaded switch leadwires.
17. Replace deck cover and close top cover.

4.12 LOGIC CHASSIS BACKPANEL REPAIR

Backpanel repair is limited to replacing damaged wires and bent or broken pins. Both procedures are described below.

4.12.1 Wirewrap Pin Replacement

This procedure describes removing a damaged pin from the backpanel and replacing it with a new one.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.

NOTE

Use care not to damage wires when removing them from pin. Also note level of wires so they are replaced in the same position as they were removed.

2. Open cabinet rear door and remove cover from logic chassis card cage.
3. Remove all wires from pin. Refer to wirewrap replacement procedure, paragraph 4.12.2, step 3.
4. Remove card associated with pin to be replaced.
5. Slide post removal tool over pin and apply pressure toward backpanel until bond breaks between pin and collar (refer to Figure 4-11).
6. Grasp shank of pin (with long nose pliers or similar tool) and pull it out of backpanel. If collar comes out with pin, proceed to step 7. If collar remains secure in backpanel, proceed to step 8.
7. Coat collar of replacement pin (not hole) with epoxy and insert it into backpanel from wirewrap side. Proceed to step 9.
8. Insert replacement pin with collar removed from wirewrap side of backpanel. Push it into collar in backpanel hole until it is same length as adjacent pins.

CAUTION

Any cement on shaft of pin will prevent an electrical connection.

9. Apply fast cure epoxy cement around pin on wirewrap side of backpanel to ensure tightness of pin. Refer to Figure 4-11.
10. Replace wires removed in step 3. Refer to wirewrap replacement procedure, paragraph 4.12, steps 5 through 9.
11. Replace cover on logic chassis card cage and close cabinet rear door.

4.12.2 Wirewrap Replacement

This procedure describes removal and replacement of backpanel wirewrap connections.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,

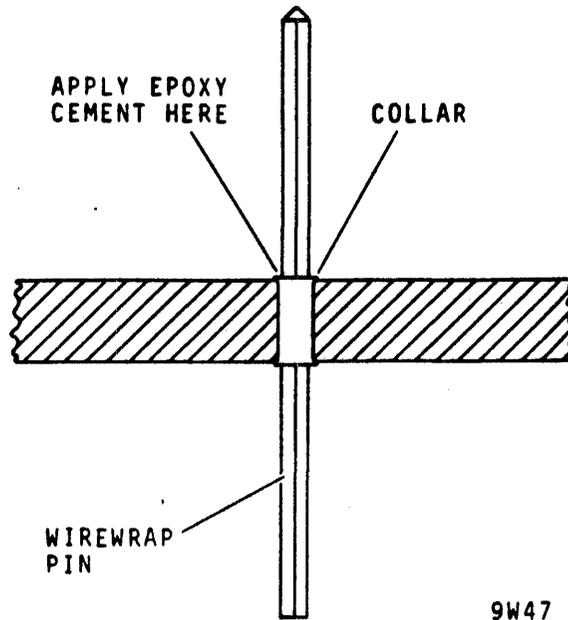


Figure 4-11 Wirewrap Pin Replacement

- b. Set MAIN AC circuit breaker to OFF.
2. Open cabinet rear door.

NOTE

If pin has two wires and the wire to be replaced is closest to backpanel, it is necessary to remove the other wire. In this case, use care not to damage the other wire.

3. To unwrap each end of wire, use end of wirewrap tool with notch opposing direction of wrap and slide tool over pin. Carefully turn tool to unwrap wire.
4. Cut replacement wire to proper length and strip approximately 1 1/8 inch of insulation from each end of wire.
5. Insert one end of wire into wirewrap tool until insulation rests against stop.
6. Slide tool over backpanel pin leaving a small gap between bottom of post or lower wrap level and new wire.
7. Hold wire securely (allow a small amount of slack to assure one turn of insulation) and twist tool to wrap wire around pin. As tool is twisted, wire wrapping around pin forces tool up and off wire.

8. When wire is completely wrapped, remove tool and proceed to wrap other end of wire to its pin.
9. Ensure that each connection has one turn of insulation and six to seven turns of bare wire around pin.
10. Close cabinet rear door.

4.13 OPERATOR CONTROL PANEL REPLACEMENT

The operator control panel is replaced by snapping it out of the shroud cover, removing it from the connector and replacing it with a new control panel assembly.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Open pack access cover and remove disk pack.
3. Open cabinet top cover.
4. Remove plastic plug from access hole in shroud cover. Refer to Figure 4-12.

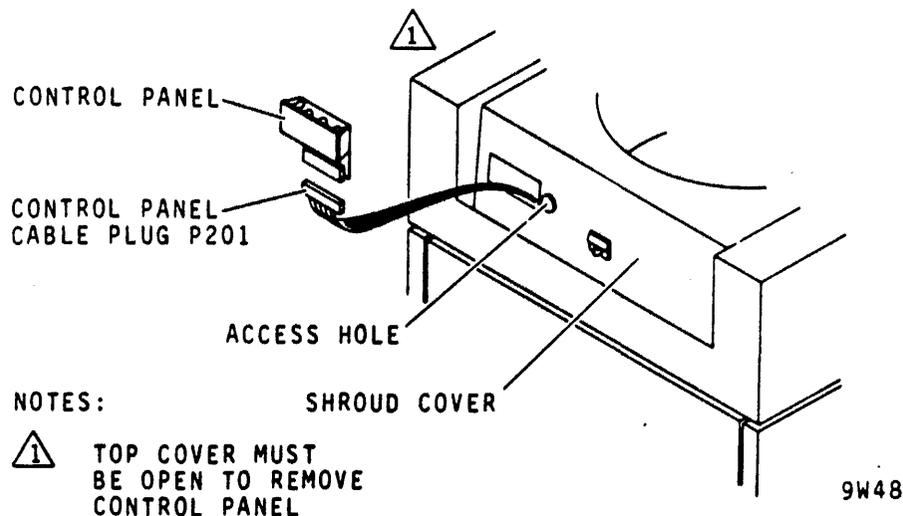


Figure 4-12 Operator Control Panel Replacement

5. Snap operator control panel out of its position in shroud cover. Refer to Figure 4-12.
6. Remove control panel cable plug P201 from control assembly card and set assembly aside.

7. Install control panel connector plug P201 on replacement operator control panel and then snap replacement control panel into its position in shroud cover.
8. Close pack access cover.

4.14 PACK ACCESS COVER SOLENOID REPLACEMENT (NON-VDE)

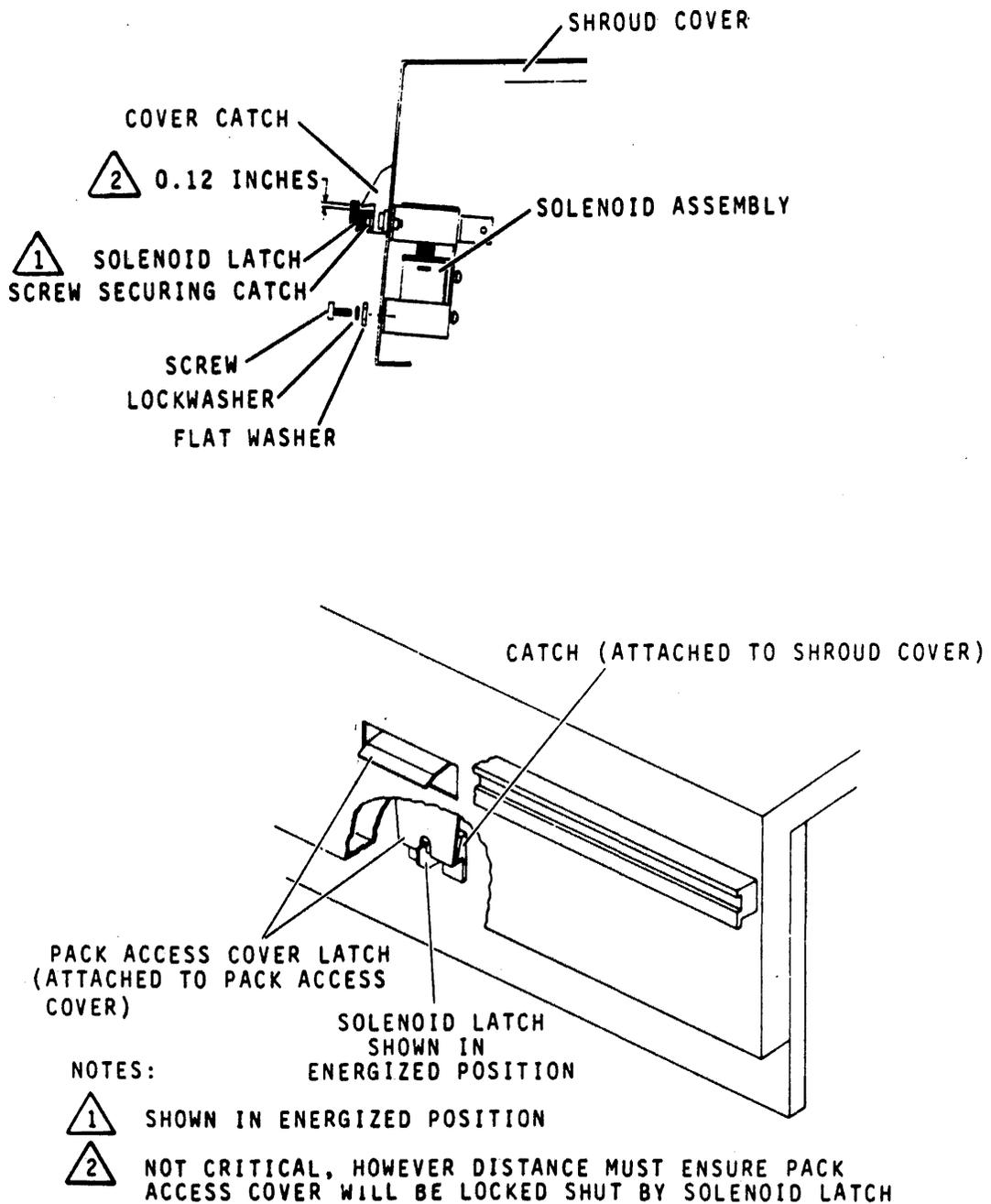
This solenoid is mounted on the front of the shroud cover and prevents the pack access cover from being opened while the spindle is turning. Refer to Figure 4-13. The following describes replacement. Adjustment is covered in the pack access cover solenoid adjustment procedure (paragraph 4.15).

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.

NOTE

If drive is installed in-line with other drives, it will be necessary to pull drive out of line to remove top cover.

3. Remove cabinet top cover.
4. Remove pack access cover.
5. Snap operator control panel out of its position in shroud cover and let it hang by control panel cable wires.
6. Remove 12 screws securing shroud cover to shroud and move shroud cover forward far enough to allow access to pack access cover solenoid assembly.
7. Remove two screws and washers securing solenoid assembly and slip it out from beneath shroud cover.
8. Note solenoid leadwire connections, disconnect leadwires and set solenoid aside.
9. Install replacement solenoid to shroud cover using two screws and washers.
10. Connect leadwires to solenoid.
11. Move shroud cover back into position and secure using 12 screws.



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Figure 4-13 Pack Access Cover Solenoid Replacement/Adjustment (NON-VDE)

12. Replace pack access cover.
13. Replace operator control panel in shroud cover.

NOTE

If it was necessary to move drive from in-line position to remove top cover, reinstall drive in-line after replacing top cover.

14. Replace cabinet top cover.
15. Perform pack access cover solenoid adjustment procedure (paragraph 4.15).

4.15 PACK ACCESS COVER SOLENOID ADJUSTMENT (NON-VDE)

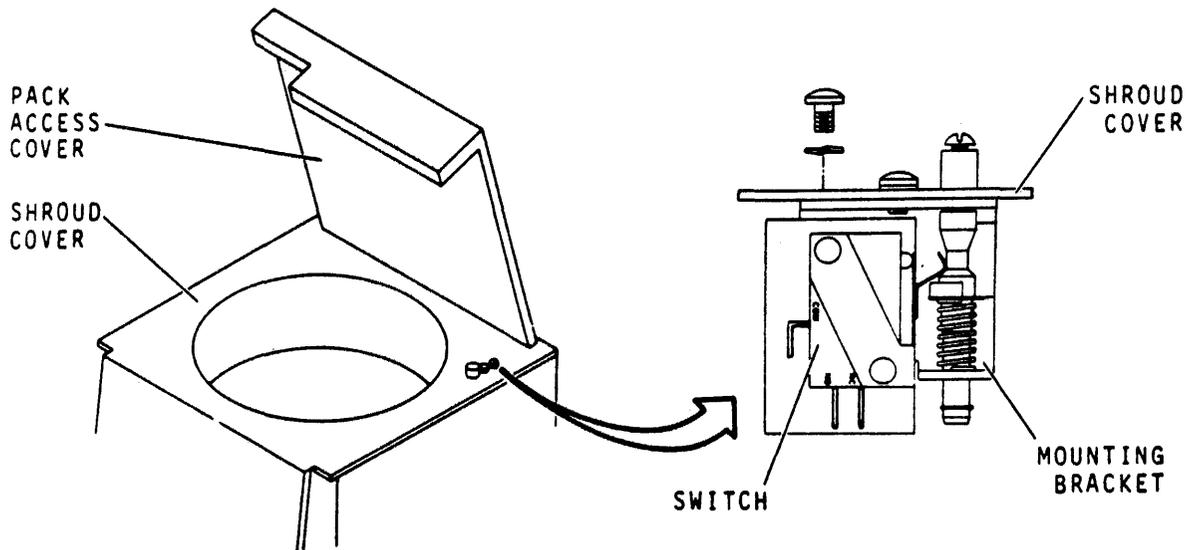
This adjustment consists of moving the solenoid assembly (installed on the shroud cover) up or down until the clearance between it and the cover catch is correct. When this is accomplished, the solenoid should prevent the cover from opening when the spindle is turning.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.
3. Raise cabinet top cover.
4. Raise pack access cover as far as possible.
5. Check adjustment by pushing solenoid latch up to simulate energized condition and then measure distance between it and catch on shroud cover. Refer to Figure 4-13.
6. If distance measured in step 5 is as indicated on Figure 4-13, proceed to step 7. Otherwise, adjust as follows:
 - a. Loosen screws securing solenoid assembly to shroud cover,
 - b. Hold solenoid latch in energized position and adjust solenoid assembly until proper clearance is obtained,
 - c. Tighten screws securing solenoid assembly to shroud cover.
7. Perform final check as follows:
 - a. Close top cover allowing pack access cover to fully open,
 - b. Install scratch disk pack and close pack access cover,

- c. Set MAIN AC circuit breaker to ON,
 - d. Press START switch to start drive motor and load heads,
 - e. Solenoid should energize and prevent pack access cover from being opened. If it operates properly, proceed to step 8. However if cover can be opened, repeat steps 1 through 6. Also check catch, latch, and solenoid for proper operation.
8. Remove disk pack.
 9. Press START switch to stop drive motor and unload heads.
 10. Set MAIN AC circuit breaker to OFF.
 11. Close pack access cover.

4.16 PACK ACCESS COVER SWITCH REPLACEMENT (NON-VDE)

This switch prevents the drive motor from starting when the pack access cover is open. It is located under the shroud cover as shown in Figure 4-14. The following describes its removal and replacement. This switch cannot be adjusted.



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Figure 4-14 Pack Access Cover Switch Replacement (NON-VDE)

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.

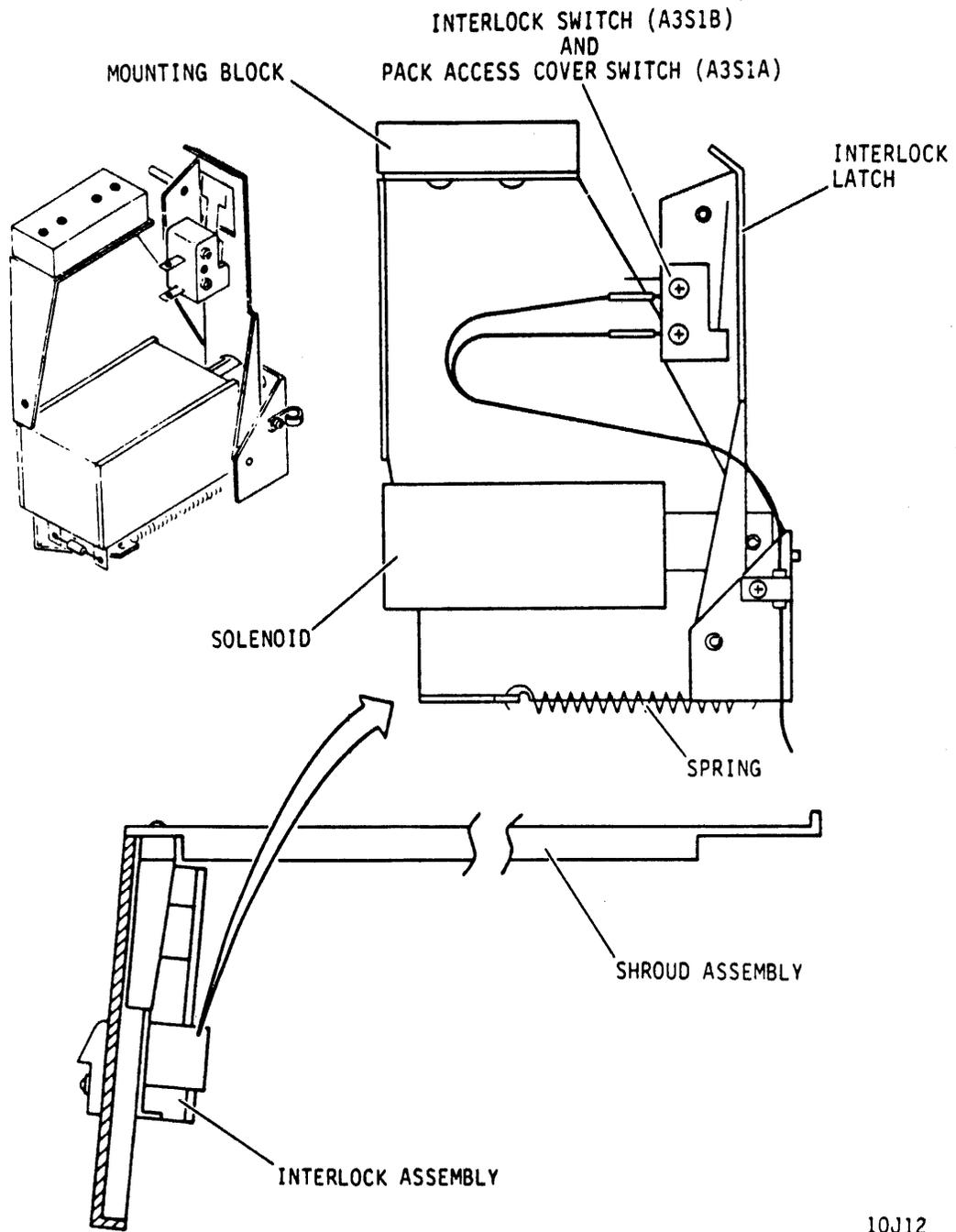
2. Remove disk pack.
3. Open cabinet top cover and remove deck cover.
4. Open pack access cover as far as possible.
5. Open pack access cover switch assembly as shown below. Refer to Figure 4-14.
 - a. Remove two screws and washers securing pack access cover switch assembly to shroud cover and remove switch assembly from beneath shroud cover.
 - b. Note leadwire connections and remove leadwires from switch.
 - c. Remove two screws and washers securing switch to its mounting bracket and then remove switch from bracket and set aside.
6. Replace pack access cover switch assembly as follows:
 - a. Position replacement switch on mounting bracket and secure using two screws and washers,
 - b. Connect leadwires to switch terminals,
 - c. Position switch under shroud cover and secure with two screws and washers.
7. Close pack access cover.
8. Replace deck cover and close cabinet top cover.

4.17 INTERLOCK SOLENOID AND SWITCH REPLACEMENT (VDE)

The interlock assembly shown in Figure 4-15 is used on VDE units. Its purpose is to lock the pack access cover so it can only be opened when the drive is in the standby mode (MAIN AC breaker on and drive motor stopped). It also prevents the drive motor from starting if the pack access cover is open.

The following procedure details removal and replacement of the interlock assembly.

1. Press the START switch to stop the drive.
2. Open the pack access, turn off the MAIN AC breaker and remove the disk pack.
3. Remove the cabinet top cover.
4. Remove the pack access cover.



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Figure 4-15 Interlock Assembly (VDE)

5. Remove the shroud cover attaching hardware and slide the cover forward far enough to allow access to the interlock assembly.
6. Disconnect interlock connector A3P9.

7. Note the lead position on the solenoid and disconnect them.
8. Remove the hardware securing the interlock assembly to the shroud. Slip the assembly out of the drive.
 - If the solenoid is being replaced, proceed with step 9.
 - If the interlock switch is being replaced, go to step 14.
 - If the entire interlock assembly is being replaced, reverse steps 1-8 to install the new assembly.
9. Remove the hardware that secures the solenoid to the bracket.
10. Remove the solenoid and plunger.
11. Install the solenoid plunger and solenoid on the bracket and secure it with the hardware removed in step 9.
12. Manually operate the solenoid and check for freedom of movement. The solenoid body can be repositioned within limits of the attaching hardware to eliminate slight binding.
13. Reverse steps 1-8 to install the interlock assembly.
14. Note lead position on the interlock switch and disconnect them.
15. Remove the hardware that secures the switch to the latch.
16. Install the new switch with the hardware removed in step 15.
17. Attach the leads to the switch.
18. Reverse steps 1-8 to install the interlock assembly.

With the interlock assembly installed, the pack access cover should lock when the drive motor is running, or when the MAIN AC breaker is off.

NOTE

The interlock solenoid will not release the latch (energize) for 30 seconds after the MAIN AC breaker is turned on.

4.18 PACK-ON SWITCH REPLACEMENT

This switch is located on the pack sensor assembly. The following describes replacement of the pack-on switch. The switch must be adjusted following replacement, and this is covered in the pack-on switch adjustment procedure (paragraph 4.19).

1. Press START switch to stop drive motor and unload heads.
2. Open pack access cover and remove pack, close cover, and set MAIN AC circuit breaker to OFF.
3. Remove blower assembly. Refer to blower motor replacement procedure, paragraph 4.3, steps 3 and 4.
4. Note leadwire connections and disconnect leadwires at pack-on switch terminals.
5. Remove hardware securing switch to switch base.
6. Install replacement switch to switch base using hardware removed in step 5. Do not tighten screws.
7. Perform pack-on switch adjustment procedure (paragraph 4.19).

4.19 PACK-ON SWITCH ADJUSTMENT

The pack-on switch must be adjusted to close when a pack is installed and open when the pack is removed.

Refer to Figure 4-16 and proceed with the following steps.

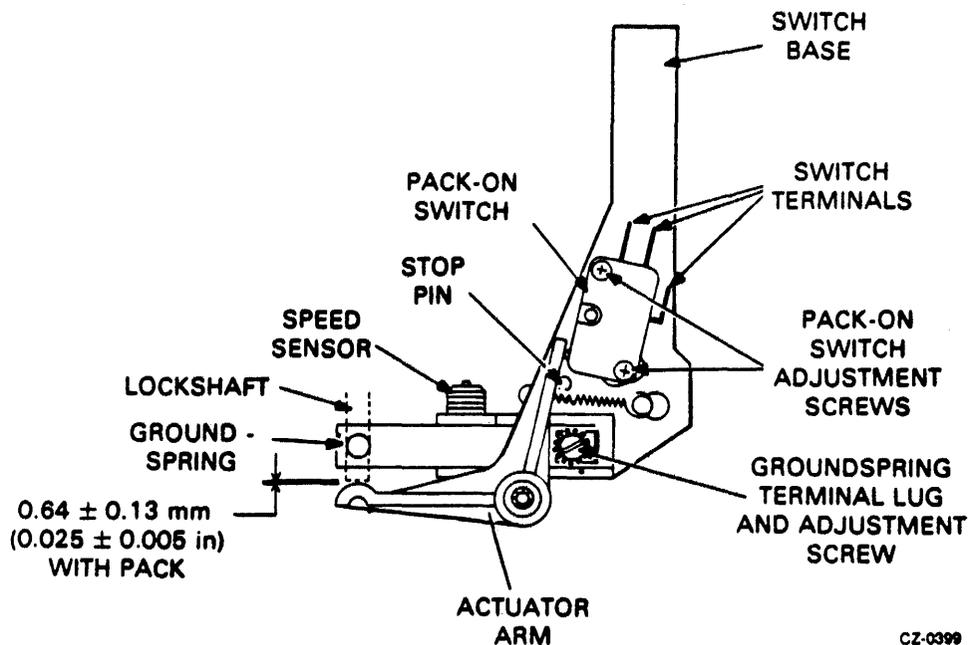
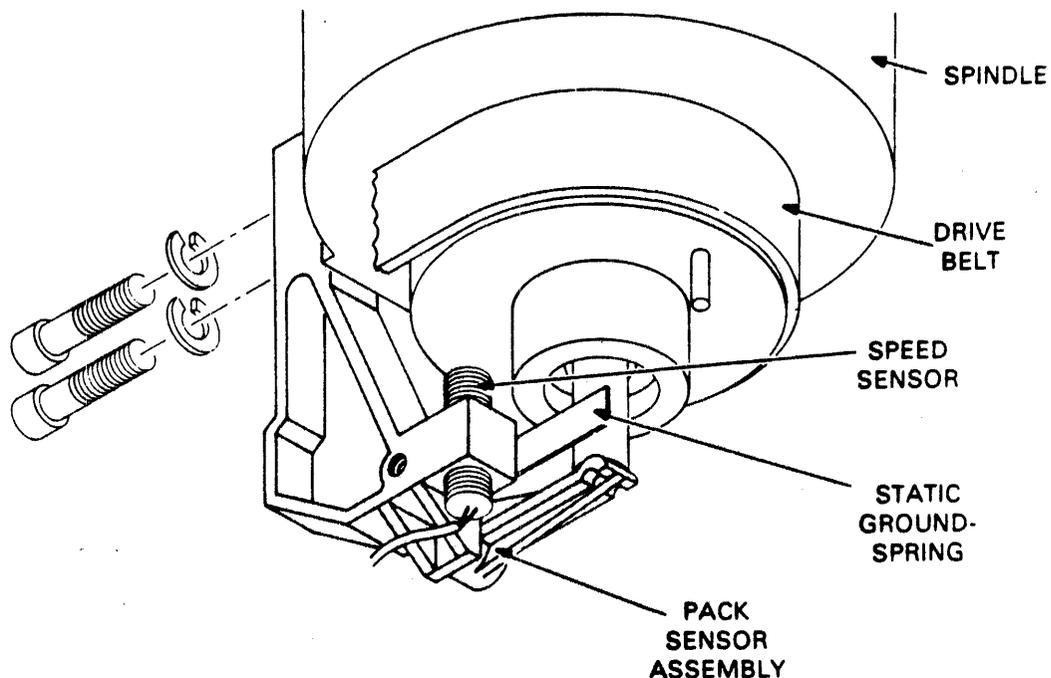


Figure 4-16 Pack-On Switch Replacement/Adjustment

1. Press START switch to stop drive motor and unload heads.
2. Open pack access cover.
 - a. Remove disk pack.
 - b. Install scratch pack.
 - c. Close cover.
 - d. Set MAIN AC circuit breaker to OFF.
3. Remove blower assembly. Refer to blower motor replacement procedure, paragraph 4.3, steps 3 and 4).
4. Note leadwire connections and disconnect leadwires at pack-on switch terminals.
5. Using feeler gauge, measure distance between lockshaft and actuator arm. If dimension is as specified in Figure 4-17, proceed to step 7.



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Figure 4-17 Pack Sensor Assembly Replacement

6. Loosen switch base adjustment screws and reposition switch base so that dimension between actuator arm and lockshaft is as specified in Figure 4-16.

7. Check, and if necessary, adjust pack-on switch.
 - a. Place test leads of multimeter (set at Rx1) on terminals of switch.
 - b. If meter indicates zero ohms, proceed to step 7e. If meter does not indicate zero, proceed to step 7c.
 - c. Loosen switch adjustment screws until meter just indicates zero.
 - d. Tighten switch adjustment screws.
 - e. Insert 0.011 inch thick feeler gauge between actuator arm and stop pin.
 - f. Multimeter must indicate infinity. If not, go to step 7g. If correct, remove feeler gauge and go to step 8.
 - g. Loosen pack sensor switch adjustment screws and position switch until multimeter just indicates infinity. Tighten screws.
 - h. Remove feeler gauge. Multimeter must indicate zero ohms. If correct, go to step 8. If not, repeat procedure starting at step 7c.
8. Disconnect multimeter from switch terminals.
9. Connect pack sensor switch leadwires to switch terminals.
10. Perform static groundspring adjustment procedure (paragraph 4.34) if mounting plate screws were loosened.
11. Install blower assembly. Refer to blower motor replacement procedure, paragraph 4.3, step 15.

4.20 PACK SENSOR ASSEMBLY REPLACEMENT

This assembly is mounted beneath the deck on the rear of the spindle. The two main elements of the pack sensor assembly are the static groundspring and pack-on switch. The procedure for individually replacing each of these are contained elsewhere in this section. The following describes replacement of the entire pack sensor assembly. Refer to Figure 4-17.

1. Press START to stop drive motor and unload heads.
2. Open pack access cover and remove pack. Leaving cover open, set MAIN AC circuit breaker to OFF.
3. Remove blower assembly. Refer to blower motor replacement procedure, paragraph 4.2, steps 3 and 4.

4. Remove pack sensor assembly as follows:
 - a. Disconnect static groundspring leadwire from terminal on groundspring,
 - b. Cut tie wrap on leadwires,
 - c. Note leadwire connections and disconnect leadwires from pack-on switch,
 - d. Disconnect speed sensor cable plug (A3P3),
 - e. Remove drive belt. Refer to drive belt replacement procedure, paragraph 4.4,
 - f. Remove hardware securing pack sensor assembly to spindle assembly, then remove pack sensor assembly and set aside.
5. Install replacement pack sensor assembly as follows:
 - a. Position replacement pack sensor assembly on rear of spindle assembly and secure,
 - b. Replace drive belt. Refer to drive belt replacement procedure, paragraph 4.4,
 - c. Connect speed sensor cable plug (A3P3),
 - d. Connect leadwire to pack-on switch and static groundspring leadwire.
6. Perform the procedures listed below (paragraph 4.17).
 - a. Pack-on switch adjustment (paragraph 4.19)
 - b. Static groundspring adjustment (paragraph 4.34)
 - c. Speed sensor adjustment (paragraph 4.29)
7. Install blower assembly. Refer to blower motor replacement procedure, paragraph 4.3, step 15.
8. Perform speed sensor output check procedure, paragraph 3.21.2.

4.21 PARKING BRAKE REPLACEMENT

The parking brake is located on the deck near the spindle. Refer to Figure 4-18). It is necessary to remove only the brake cover plate to access the parking brake for removal and replacement. Adjustment is covered in the parking brake adjustment procedure, paragraph 4.21.

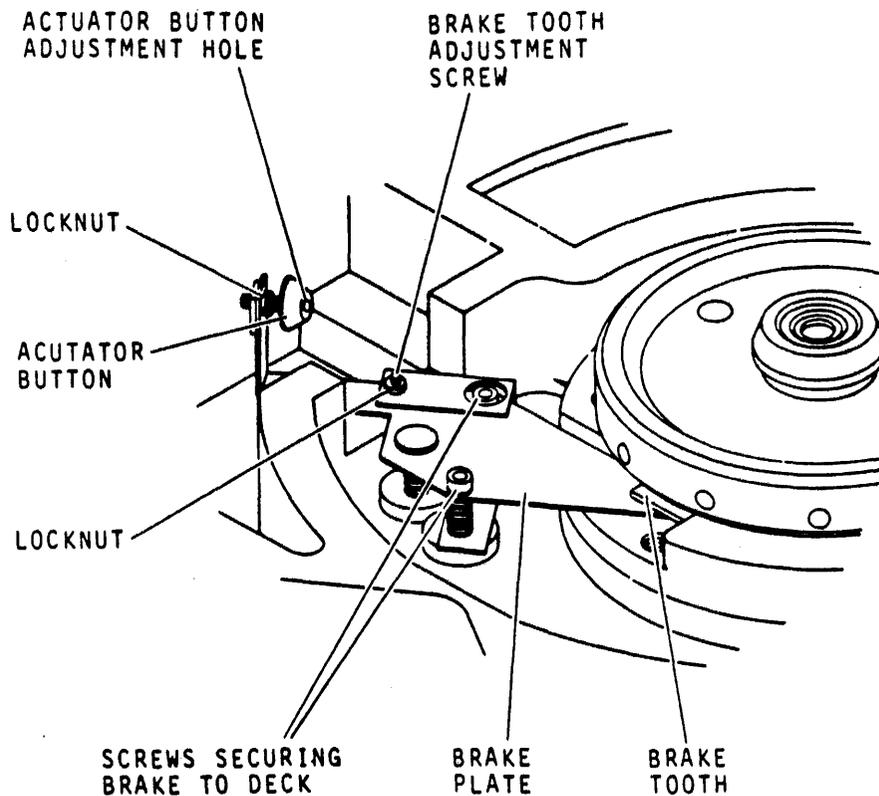


Figure 4-18 Parking Brake Replacement/Adjustment

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Open pack access cover and remove disk pack.
3. Remove six screws and washers securing brake plate cover to deck and then remove cover.
4. Remove two screws securing parking brake assembly to deck. Refer to Figure 4-18 and then remove assembly and set aside.

NOTE

Apply Loctite primer grade N and Loctite grade C to screws used in step 5.

5. Install parking brake assembly to deck using two screws.
6. Perform parking brake adjustment procedure (paragraph 4.22) starting with step 4.

4.22 PARKING BRAKE ADJUSTMENT

The parking brake has two adjustments. Refer to Figure 4-18. These are the actuator button to pack clearance and the brake tooth to bottom of spindle clearance.

The distance between the actuator button and the disk pack bottom disk surface is adjusted by turning the actuator button in or out. The brake tooth to bottom of spindle clearance is adjusted by the brake tooth adjustment screw.

Adjustment of brake tooth to bottom of spindle clearance requires removing only the brake cover plate. However, the entire shroud must also be removed to adjust brake button to disk pack clearance.

1. Remove power to drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Open pack access cover and remove disk pack.
3. Remove six screws and washers securing brake cover plate.
4. Check clearance between brake tooth and underside of spindle as follows:
 - a. Rotate spindle until brake tooth is not engaged or under a notch in spindle,
 - b. Check to see if clearance between tooth and underside of spindle is between 0.005 and 0.020 inches. If this requirement is not met, proceed to step 5. If it is met proceed, to step 6.
5. Adjust brake tooth to underside of spindle clearance as follows:
 - a. Loosen locknut brake tooth adjustment screw.
 - b. Adjust screw until clearance between tooth and underside of spindle is from 0.005 to 0.020 inch. Turning setscrew clockwise narrows gap and counter-clockwise widens gap.
 - c. When gap is correct, tighten setscrew.
6. Install a scratch disk pack.

NOTE

In step 7, it is impossible to check the clearance with a conventional feeler gauge. However, a suitable tool can be constructed by taping the proper feeler gauge to the end of a long object such as a screwdriver.

7. Check that clearance between actuator button and bottom disk surface on disk pack is between 0.01 and 0.02 inches. If the requirement is not met, remove disk pack and proceed to step 8. If it is met, remove disk pack, replace brake cover plate and proceed to step 19.
8. Remove disk pack.

NOTE

If drive is installed in-line with other drives, it may be necessary to move the drive out of line to remove the top cover.

9. Remove cabinet top cover.
10. Remove deck cover.
11. Remove pack access cover.
12. Remove shroud and shroud cover.
13. Adjust actuator button to disk pack clearance as follows:
 - a. Install scratch disk pack,
 - b. Loosen locknut on actuator button adjustment screw,
 - c. Turn actuator button until clearance between button is between 0.10 and 0.02 inches. Turning button clockwise increases clearance and turning it counter-clockwise decreases clearance,
 - d. When gap is correct, tighten locknut,

CAUTION

Remove and install disk pack and then rotate spindle to ensure there is no interference between brake tooth and spindle.

- e. Remove scratch disk pack.
14. Replace shroud, shroud cover and brake cover plate.

15. Install pack access cover.
16. Replace deck cover.

NOTE

If drive was moved from in-line position to remove top cover, reinstall drive in-line after replacing top cover.

17. Install cabinet top cover.
18. Open pack access cover and clean shroud.
19. Close pack access cover.

4.23 POWER SUPPLY ASSEMBLY REPLACEMENT AND MAINTENANCE

The power supply is located on the floor at the rear of the cabinet. Two types of power supplies are used. These are illustrated in Figure 4-19. One power supply is mounted on slides that permits extending it out the rear of the cabinet. The other power supply is mounted on the base of the rear cabinet and does not incorporate the slides. Both power supplies contain replaceable cards. Table 4-1 shows card usage.

Table 4-1 Power Supply Card Usage

Card Type VDE	Card Type NON-VDE	Description
_ZCN _FNN	_ZCN _YFN _YEN	Power amplifier Relay board Capacitor board
_CBN		Recitifier/filter board
_CFN		Control board

The following procedure describes replacement of the entire power supply as well as each of the cards. It also describes triac and power transistor replacement.

4.23.1 Power Supply Assembly Replacement (NON-VDE)

The following procedure describes removal and replacement of the entire power supply assembly.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF,
 - c. Disconnect power cable from site power receptacle.

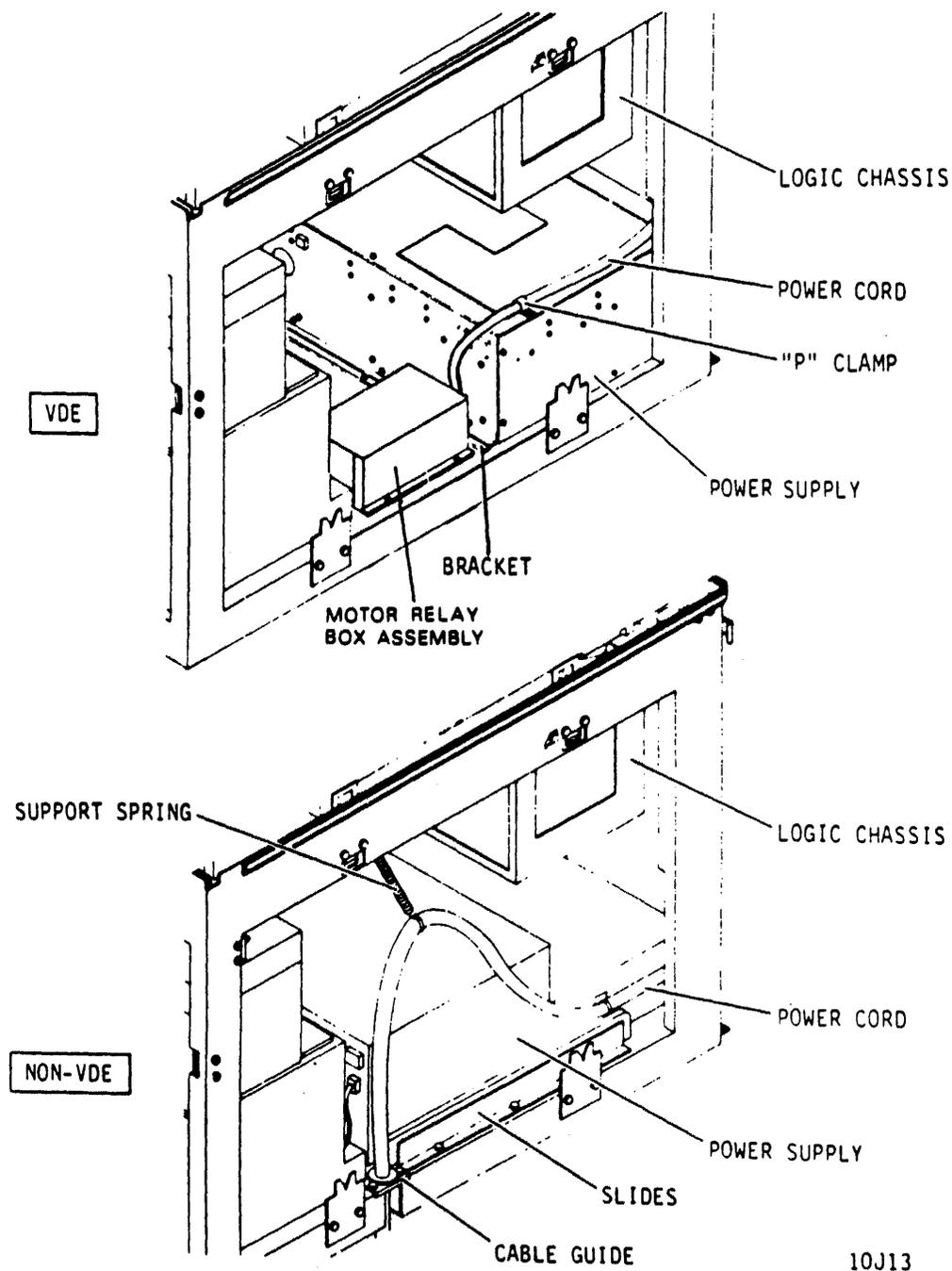


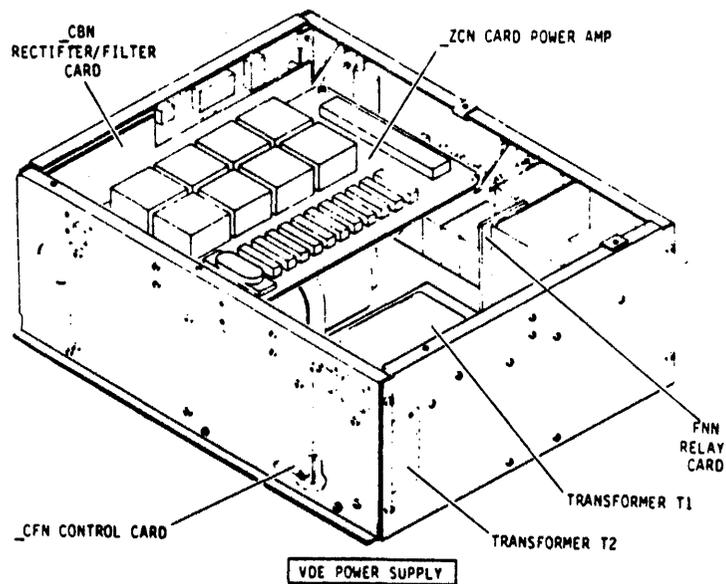
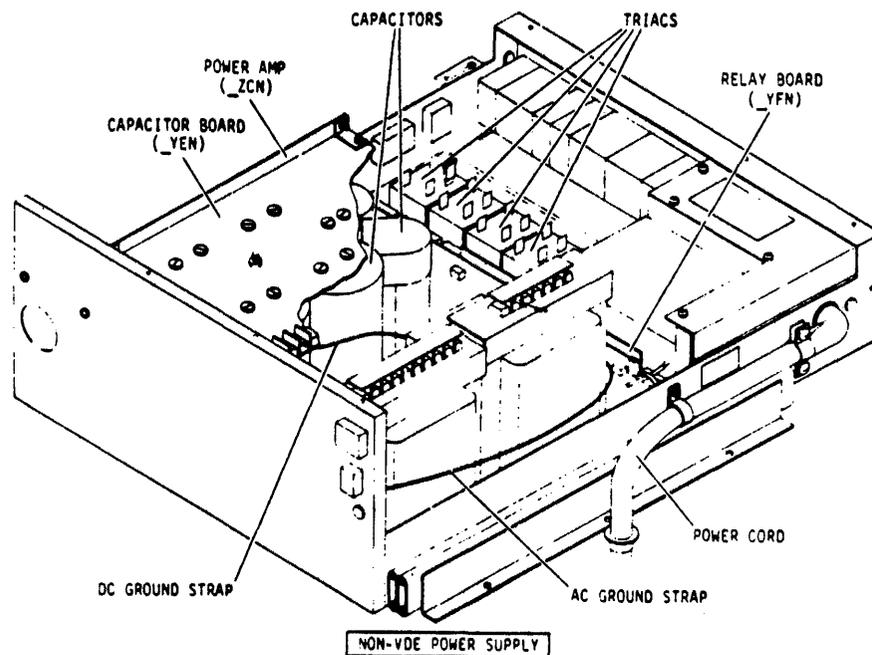
Figure 4-19 Power Supply Assembly Location

NOTE

If drive is installed in-line with other drives it will have to be pulled out of line to remove side panels.

2. Remove cabinet side panels.

3. Remove two screws securing cable guide to frame and remove cable guide.
4. Disconnect support spring from power cable.
5. Disconnect five plug connectors to power supply. Also disconnect air hose by turning it in a counterclockwise direction until it comes free.
6. Open cabinet rear door and swing logic chassis open.
7. Remove power supply top cover.
8. Disconnect ac and dc ground straps and remove them from power supply. Refer to Figure 4-20. Replace top cover on power supply.
9. Remove six screws securing power supply slides to floor of drive cabinet and slide supply out rear of cabinet.
10. Slide replacement power supply into cabinet and secure slides to floor of cabinet with six screws.
11. Remove top cover from replacement power supply and connect ground straps (removed in step 8) as shown in Figure 4-20.
12. Connect power wiring as described in Chapter 2.
13. Replace top cover on power supply.
14. Reconnect five plugs to power supply. Also reconnect air hose by screwing it clockwise into hole.
15. Position power cable in cable guide and secure cable guide to floor of cabinet.
16. Replace cabinet side panels.
17. Connect power cord to site power receptacle.
18. If drive was moved out of line to perform step 2, reinstall it in-line.
19. Perform the procedures listed below.
 - a. +5 volt and -5 volt test and adjustment (paragraph 3.17.1)
 - b. DC voltage output check (paragraph 3.18.1)



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Figure 4-20 Power Supply Card Replacement

4.23.2 -ZCN (Power Amplifier) Card Replacement (NON-VDE)

The following procedure describes removal and replacement of only the -ZCN card. Refer to Figure 4-19.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF,
 - c. Disconnect power cable from site main power receptacle.
2. Slide power supply out and remove power supply top cover.
3. Note connections, then disconnect all wires from -ZCN card.
4. Remove two screws and washers securing card in power supply, remove insulated spring clip, then remove card.
5. Position replacement card in power supply, attach insulated spring clip removed from old card (step 4), and secure with two screws and washers.
6. Connect wires to replacement -ZCN card.
7. Replace top cover on power supply and perform steps 1, 4 and 9 of manually controlled servo checks procedure (paragraph 3.18.2.2).

4.23.3 -YEN (Capacitor Board) Replacement (NON-VDE)

The following procedure describes removal and replacement of the -YEN card. Refer to Figure 4-20.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF,
 - c. Disconnect power cable from site main power receptacle.
2. Slide power supply out and remove power supply top cover.
3. Remove two screws and washers securing -ZCN card, remove insulated spring clip, then move -ZCN card away from -YEN.

4. Note connections, then disconnect all wires from -YEN card.
5. Remove ten screws securing card to capacitors.
6. Remove nut and washers from stud securing card to power supply, then remove card.
7. Ensure that all lockwashers are positioned on capacitors, then position -YEN card on capacitors and install ten screws. Reconnect all wires to -YEN card.
8. Install nut and washers on stud and tighten nut.
9. Reposition -ZCN card and secure with two screws and washers. Replace insulated spring clip and all wires to -ZCN card.
10. Replace top cover on power supply and perform following procedures:
 - a. +5 volt and -5 volt Test and Adjustment (paragraph 3.17.1).
 - b. Power Supply DC Output Voltage Check (paragraph 3.18.1).

4.23.4 -YFN (Relay Board) Replacement (NON-VDE)

The following procedure describes removal and replacement of the -YFN card. Refer to Figure 4-20.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF,
 - c. Disconnect power cable from site main power receptacle.
2. Slide power supply out and remove power supply top cover.
3. Remove two connectors from -YFN card.
4. Carefully pry card off three fasteners and remove from power supply.
5. Install replacement -YFN card in power supply by pushing it carefully onto fasteners.
6. Install two connectors on replacement card.

7. Replace top cover on power supply, return power supply to normal position, and perform the procedures listed below.
 - a. Reconnect power cable to site main power receptacle.
 - b. Set MAIN AC circuit breaker to ON and set LOCAL/REMOTE switch to LOCAL. Install a scratch pack.
 - c. Press START switch and observe that drive motor starts and heads load.
 - d. Press START switch and observe that heads unload and pack stops rotating in approximately 30 seconds.
 - e. Set LOCAL/REMOTE switch to REMOTE (ensure sequence power is available).
 - f. Press START switch and observe that drive motor starts and heads load.
 - g. Press START switch and observe that heads unload and pack stops rotating in approximately 30 seconds. Remove scratch pack.
 - h. Set MAIN AC circuit breaker to OFF.

4.23.5 Triac and Power Transistor Replacement

When replacing triacs or power transistors, the following procedure should be performed:

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF,
 - c. Disconnect power cable from site power receptacle.
2. Swing logic chassis open, slide power supply out, and remove power supply top cover.
3. Remove defective triac or power transistor.
4. Apply a coating of silicone grease to mating surfaces of replacement triac or power transistor and power supply (or heat sink in case of power transistor).
5. Install replacement triac or power transistor.
6. Replace cover on power supply and slide power supply into normal position.

7. Close logic chassis and cabinet rear door.

4.23.6 Power Supply Replacement (VDE)

The following procedure describes removal and replacement of the entire power supply assembly used on VDE units.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF,
 - c. Disconnect power cable from site power receptacle.

NOTE

If drive is installed in-line with other drives it will have to be pulled out of line to remove side panels.

2. Remove cabinet side panels and open the rear door.
3. Remove the screw securing the power cord clamp to the top of the power supply.
4. Disconnect the power cord from the power supply control panel.
5. Disconnect plugs P3, P4, P6 on the side and P2, P8, P9 on the rear of the power supply.
6. Disconnect the air hose at the rear of the power supply by turning it counter clockwise.
7. Remove the hardware that secures the control panel end of the power supply to the cabinet base.
8. Pull the power supply out the rear of the cabinet.

NOTE

The power supply may be reinstalled in the cabinet and all cables are connected to operate the drive with or without the cover removed. Ensure the blower hose is connected.

9. To install the power supply, rest it on the cabinet base and push it toward the front of the drive until the lip at the rear of the power supply slips under the mounting bracket.
10. Secure the control panel end of the power supply to the chassis with the hardware removed in step 9.

11. Connect plugs P2, P8, P9 on the rear and P3, P4, P6 on the side of the power-supply. Attach the air hose by turning it clockwise into the power supply.
12. Connect the power cord to the receptacle on the power supply control panel.
13. Attach the power cord cord clamp to the top of the power supply.
14. Connect the power cord to the site power receptacle.
15. Place the MAIN AC circuit breaker in the ON position.
16. Perform DC voltage checks and +5 V test and adjustment.
17. Replace the cabinet panels and position the drive in line with the other drives.

4.23.7 -ZCN (Power Amplifier) Card Replacement (VDE)

The following procedure details removal and replacement of the ZCN card used in VDE units (refer to Figure 4-20).

1. Press the START switch to stop the drive motor and unload the heads.
2. Remove the power supply using the Power Supply Replacement procedure.
3. Remove the power supply cover.
4. Note all lead connections on the -ZCN card to the mounting brackets, and remove the card.
6. Position the replacement card on the mounting brackets and secure it with the hardware removed in step 5.
7. Connect all leads to the -ZCN card.
8. Install the power supply top cover.
9. Install the power supply in the cabinet.
10. Perform steps 1 and 9 of the manual controlled servo checks procedure.

4.23.8 -FNN (Relay) Card Replacement (VDE)

The following procedure details removal and replacement of the -FNN card used in VDE units (refer to Figure 4-20).

1. Press the START switch to stop the drive motor and unload the heads.

2. Remove the power supply using the power supply replacement procedure.
3. Remove the power supply cover.
4. Disconnect P1 at the -FNN card.
5. Remove the hardware that secures the card to the power supply chassis and then remove the card.
6. Reverse steps 1-5 to install the replacement -FNN card.

4.23.9 -CFN (Control) Card Replacement (VDE)

The following procedure describes removal and replacement of the -CFN card used in VDE units (refer to Figure 4-20).

1. Press the START switch to stop the drive motor and unload the heads.
2. Remove the power supply using the power supply replacement procedure.
3. Remove the power supply cover.
4. Remove the -ZCN (Control) card.
5. Disconnect connectors P1, P2, P3, and P4 on the -CFN card.
6. Remove the hardware that secures the CFN card to the rear panel of the power supply. Remove the card.
7. Position the replacement -CFN card on the rear panel of the power supply and secure it with the hardware removed in step 6.
8. Reverse steps 1-5 to complete the installation.

4.23.10 -CBN (Rectifier/Filter) Card Replacement (VDE)

The following procedure describes removal and replacement of the -CBN card used in VDE units (refer to Figure 4-20).

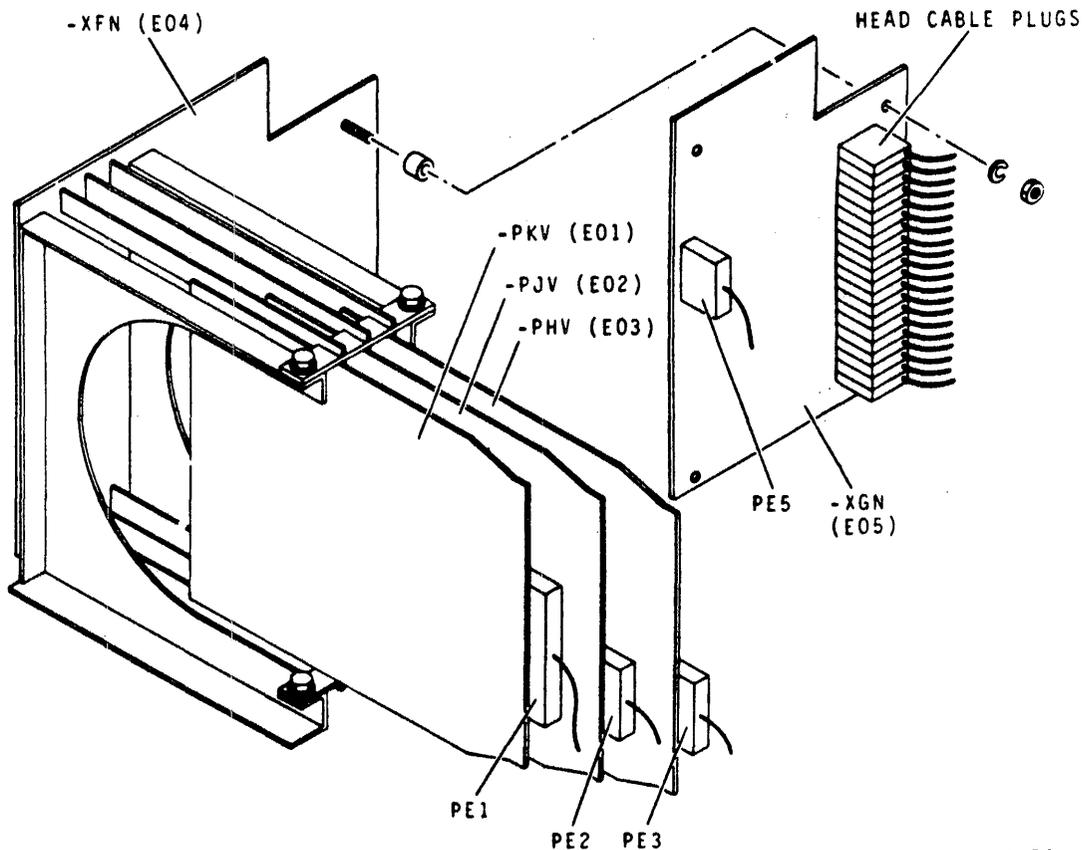
1. Press the START switch to stop the drive motor and unload the heads.
2. Remove the power supply using the power supply replacement procedure.
3. Remove the power supply cover.
4. -ZCN (Power Amplifier) card.
5. Disconnect connectors P1, P2, and P3 and the -CBN card.

4.24 MOTOR RELAY BOX ASSEMBLY REPLACEMENT (VDE)

Turn off MAIN AC breaker located on the rear door. Access the motor relay box according to the procedure outlined in paragraph 3.8.3. Refer to Figure 4-14. Remove the two mounting screws closest to the side panel. Loosen the two mounting screws on the motor side of the relay box. Carefully slide the relay box out the right side. Disconnect P9 on the power supply. Disconnect motor drive cable at P7. Remove the three screws securing top cover. Circuit card may now be accessed. Replace the relay box assembly by reversing the above procedure.

4.25 READ/WRITE CHASSIS -XGN CARD REPLACEMENT

The -XGN card is located in read/write chassis location E05. It is mounted on the -XFN card in location E04 (the -XFN card is also referred to as the "mother" board). Replacing the XGN card involves removing the read/write chassis from the deck and then removing the -XGN card from its position on the mother board (refer to Figure 4-21).



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Figure 4-21 Read/Write Chassis Card Replacement

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.
3. Open cabinet top cover and remove deck cover.
4. Remove read/write chassis from deck as follows:
 - a. Note connections and remove cable plugs PE1, PE2, PE3 and PE5 from read/write cards,
 - b. Remove cards E01, E02 and E03 from read/write chassis,
 - c. Note connections and remove head cable plugs from -XGN card starting with top plug,
 - d. Remove four screws and washers securing read/write chassis to deck and remove chassis from deck.
5. Remove -XGN card from mother board as follows. Refer to Figure 4-21:
 - a. Remove four nuts and washers securing -XGN card to mother board,

CAUTION
Use care not to damage pins.
 - b. Pry -XGN card from mother board.
6. Install replacement -XGN card to mother board as follows:

CAUTION
Ensure that all pins go through the proper holes and all pins are straight.

 - a. Position -XGN card over pins on mother board, then press cards together,
 - b. Secure -XGN card to mother board using four lockwashers and nuts.

7. Install read/write chassis on deck as follows:
 - a. Position read/write chassis on deck ensuring that mother board engages the clip on actuator housing,
 - b. Secure read/write chassis to deck using four screws and washers,

NOTE

Head cable connectors are keyed and plug to mother board only one way. Ensure that cable between head-arm and plug is not twisted or kinked.

- c. Connect head cable plugs, starting with top plug (0),
 - d. Replace cards E01, E02 and E03 in read/write chassis,
 - e. Connect cable plugs PE1, PE2, PE3 and PE5.
8. Install deck cover and close cabinet top cover.

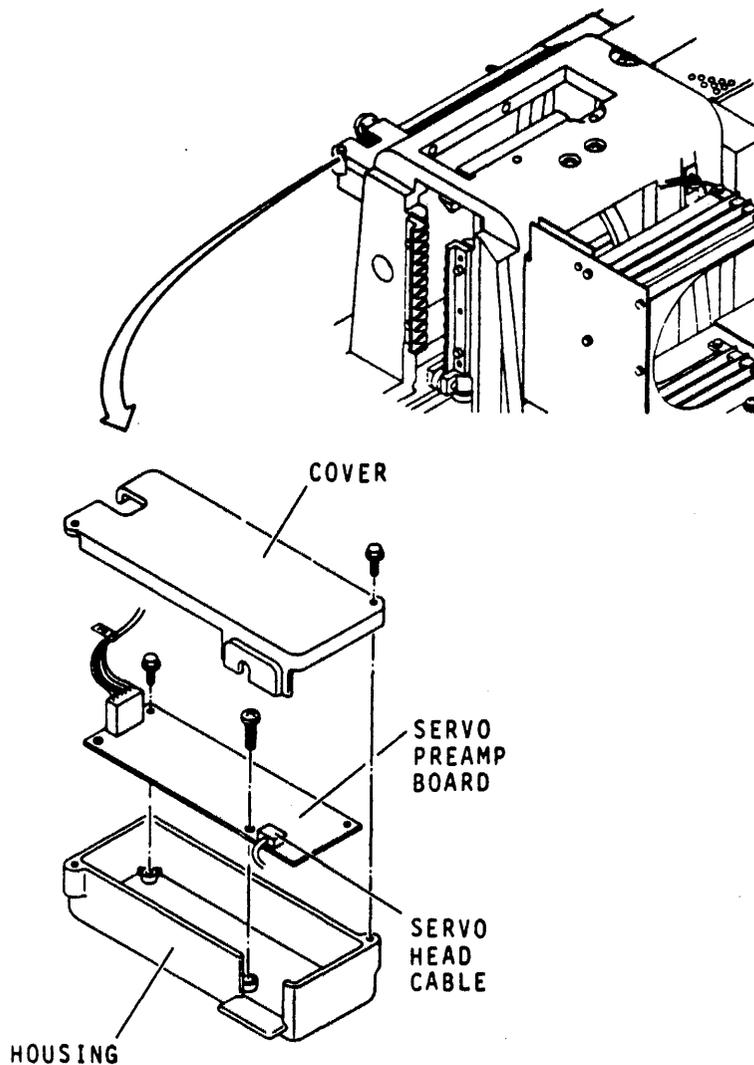
4.26 READ/WRITE CHASSIS -XFN (MOTHER BOARD) REPLACEMENT

The -XFN card is also referred to as the "mother" board. All the other cards in the read/write chassis plug onto pins on the mother board. Replacing the mother board involves removing the read/write chassis from the deck, disconnecting the other cards from the mother board, then removing the mother board from the read/write chassis.

1. Remove read/write chassis from deck and -XGN card from mother board by performing steps 1 through 5 of read/write chassis -XGN card replacement procedure (paragraph 4.25).
2. Separate mother board from read/write chassis by removing six screws and washers, and then set mother board aside. Refer to Figure 4-21.
3. Position replacement mother board on read/write chassis and secure with six screws and washers.
4. Replace -XGN card on replacement mother board as instructed in step 6 of read/write chassis -XGN card replacement procedure (paragraph 4.25). Although step 6 refers to a replacement -XGN card, in this case the old card is reinstalled.
5. Perform steps 7 and 8 of read/write chassis -XGN card replacement procedure (paragraph 4.25).

4.27 SERVO PREAMP BOARD REPLACEMENT

This board is located in the servo preamp housing which is mounted on the deck (refer to Figure 4-22). Replacing the board involves removing the board from the preamp housing.



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Figure 4-22 Servo Preamp Board Replacement

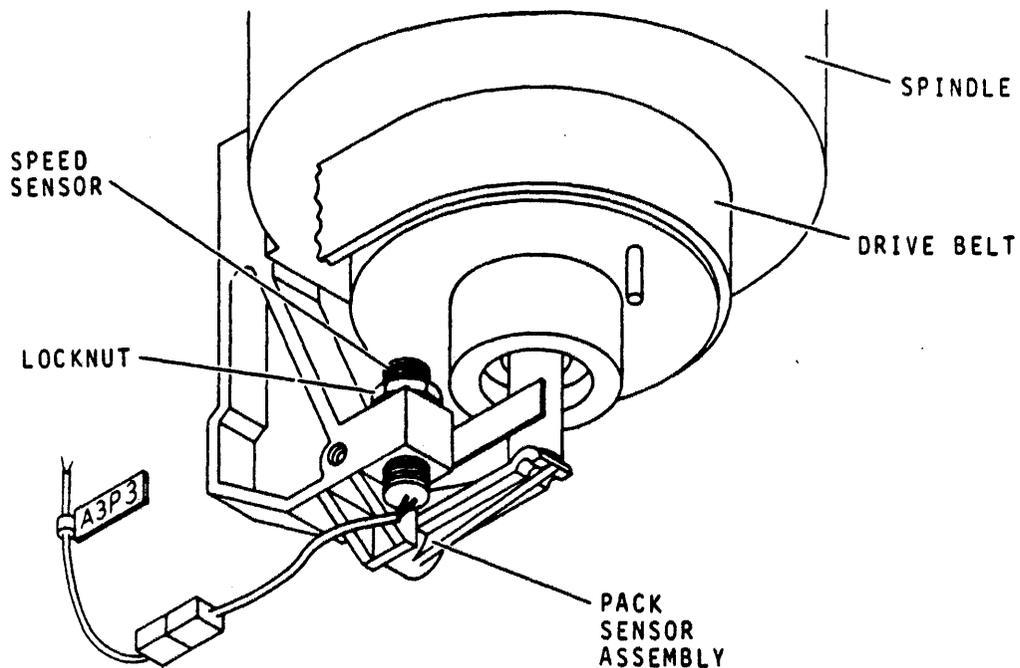
1. Remove power to drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.

2. Remove disk pack.
3. Open cabinet top cover and remove deck cover.
4. Remove servo preamp board as follows:
 - a. Remove two hex head screws securing servo preamp cover and remove cover,
 - b. Disconnect servo head cable plug and output plug P8 from servo preamp board,
 - c. Remove two pan head screws inside preamp housing that secure housing to deck,
 - d. Remove two hex head screws securing preamp circuit board to housing and then remove circuit board and set aside.
5. Install replacement servo preamp board as follows:
 - a. Secure preamp circuit board to housing with two hex head screws,
 - b. Secure housing to deck with two pan head screws,
 - c. Connect servo head cable plug and output plug P8 to preamp circuit board,
 - d. Secure housing cover to housing using two hex head screws.
6. Install deck cover and close cabinet top cover.

4.28 SPEED SENSOR ASSEMBLY REPLACEMENT

The speed sensor assembly consists of the speed sensor and its mounting bracket and is located on the pack sensor assembly. The following procedure (Figure 4-23) describes speed sensor assembly replacement. Speed sensor adjustment is covered in the speed sensor assembly adjustment procedure (paragraph 4.29).

1. Remove power to the drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.
3. Open cabinet front door.



NOTES:

1. SHADED AREAS INDICATE SPEED SENSOR ASSEMBLY.

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Figure 4-23 Speed Sensor Assembly Replacement

4. Remove blower assembly. Refer to blower motor replacement procedure, paragraph 4.3, steps 3 and 4.
5. Remove speed sensor assembly as follows:
 - a. Disconnect speed sensor cable plug A3P3 and cut tie wrap from speed sensor lead,
 - b. Remove locknut from speed sensor,
 - c. Remove speed sensor from switch base.
6. Replace speed sensor assembly as follows:
 - a. Install new speed sensor in switch base,
 - b. Reinstall locknut on speed sensor, torque to 5 inch pound maximum (15 inch pound maximum on the steel sensors),
 - c. Connect speed sensor cable plug A3P3,
 - d. Secure speed sensor leadwire to speed sensor switch base with a tie wrap,

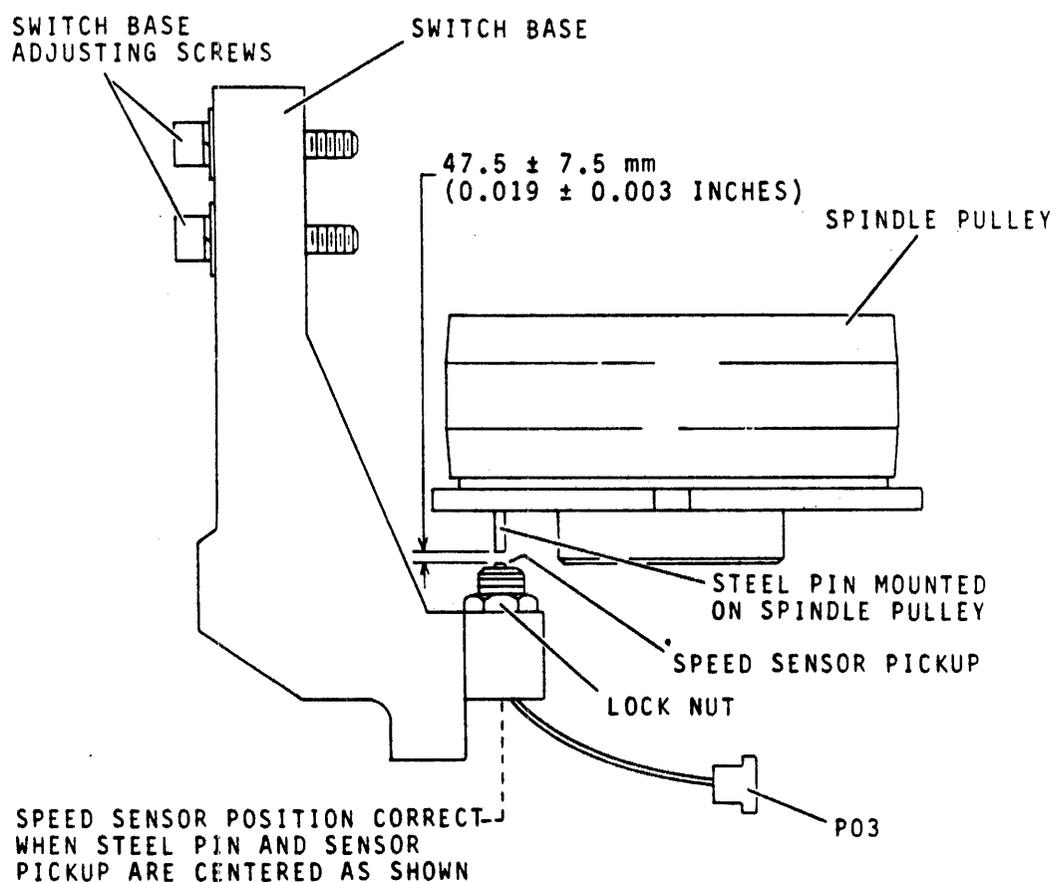
e. Perform speed sensor adjustment.

4.29 SPEED SENSOR ASSEMBLY ADJUSTMENT

The speed sensor assembly must be adjusted whenever the spindle assembly, pack sensor assembly or speed sensor assembly are replaced. The speed sensor assembly has a lateral and a gap adjustment.

The lateral adjustment is accomplished by moving the speed sensor mounting bracket sideways until the sensor tip is in line with the steel pin on the spindle pulley.

The gap adjustment is accomplished by turning the speed sensor to achieve a specific distance between the sensor tip and the steel pin in the spindle pulley (Figure 4-24).



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Figure 4-24 Speed Sensor Assembly Adjustment

1. Stop spindle motor.
2. Remove disk pack.
3. Set UNIT POWER circuit breaker to OFF.
4. Use feeler gauge to check that gap between sensor tip and pin which is 0.019 (+0.003) inch (Figure 4-24).

CAUTION

Ensure that steel pin in pulley does not contact speed sensor. This could happen if speed sensor was significantly out of adjustment as, for example, following replacement.

5. If requirement of step 4 is not met, adjust speed sensor as follows:
 - a. Loosen locknut on speed sensor assembly.
 - b. Adjust sensor assembly (clockwise rotation closes gap and counterclockwise rotation widens gap) to meet the requirements of step 3.

CAUTION

To avoid damage to the plastic threads, do not over-tighten locknut in next step.

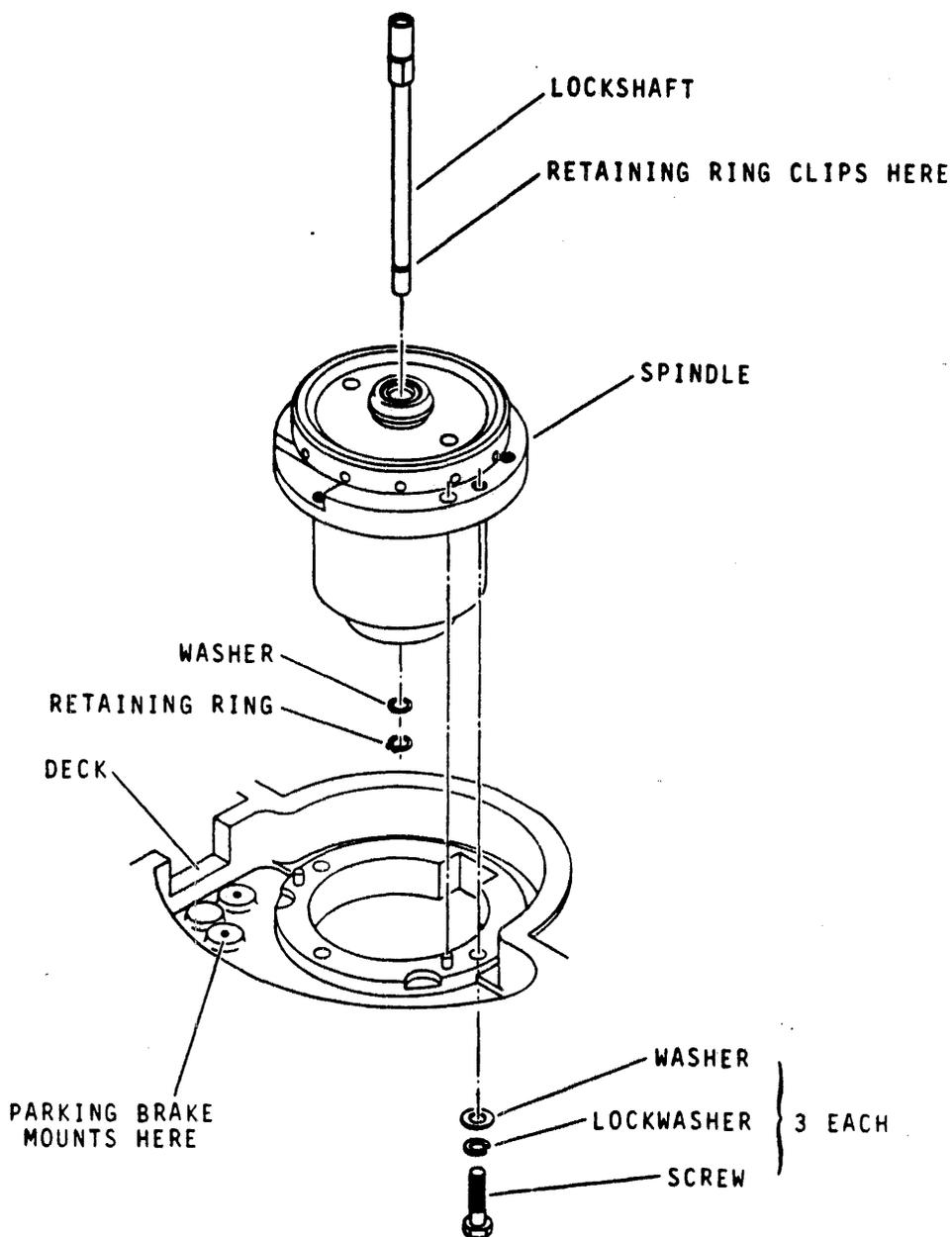
- c. Torque locknut to 5 (+1) inch-pounds.
 - d. Recheck dimension of gap.
6. Perform speed sensor output check (paragraph 3.21.2).

4.30 SPINDLE LOCKSHAFT REPLACEMENT

The lockshaft is located within the spindle assembly. Refer to Figure 4-25. However, the lockshaft is removed without removing the spindle. There is no adjustment for the lockshaft replacement.

CAUTION

When spindle assembly is removed from drive or shipping container, do not allow it to rest on pulley end of assembly. When it must be set down, lay it on its side or on spindle faceplate. Improper handling of spindle assembly may cause damage to spindle bearings which could result in premature failure of spindle or even damage to disks and heads.



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Figure 4-25 Spindle and Lockshaft Replacement

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Open pack access cover, remove disk pack, leave pack access cover open.

3. Open cabinet front door.
4. Remove blower assembly. Refer to blower motor replacement procedure, paragraph 4.3, step 4.
5. Refer to the following procedures for the removal of the speed sensor assembly.

Remove pack sensor assembly. Refer to pack sensor assembly replacement, paragraph 4.20.

NOTE

In the following step, do not remove retaining ring securing springs in spindle assembly. This retaining ring is located behind the flat washer removed in next step.

6. Remove retaining ring and flat washer from lower end of lockshaft. Refer to Figure 4-25.
7. Carefully raise lockshaft out of top of spindle assembly.
8. Lower replacement lockshaft until washer and retaining ring can be snapped into place, thus securing lockshaft in spindle assembly.

CAUTION

Push downward on lockshaft making certain that it is free to move downward against internal spring force. Lockshaft must be free and not binding.

9. To reinstall pack sensor assembly, refer to pack sensor assembly replacement, paragraph 4.19.
10. Perform pack-on switch adjustment procedure, paragraph 4.19, steps 4 through 14.
11. Reconnect leadwire to static groundspring.
12. Perform static groundspring adjustment procedure, paragraph 4.34, steps 4 and 5.
13. Reinstall blower assembly. Refer to blower motor replacement procedure, paragraph 4.3, step 15.
14. Close cabinet front door.

CAUTION

When spindle assembly is removed from drive or shipping container, do not allow it to rest on pulley end of assembly. When it must be set down, lay it on its side or on spindle faceplate. Improper handling of spindle assembly may cause damage to spindle bearings which could result in premature failure of spindle or even damage to disks and heads.

4.31 SPINDLE ASSEMBLY REPLACEMENT

The spindle assembly (refer to Figure 4-25) includes the spindle and lockshaft. It is removed from the top of the deck with the pack sensor assembly still attached. The pack sensor assembly is then transferred to the replacement spindle and they are both replaced in the drive. The spindle must be realigned to the carriage following a spindle replacement and this is covered in the spindle to carriage alignment procedure, paragraph 4.32.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.
3. Open drive cabinet front door.
4. Remove blower assembly (refer to blower motor replacement procedure, paragraph 4.3, step 4).
5. Identify leadwires to pack-on switch and static groundspring and then disconnect leadwires.
6. Disconnect speed sensor plug A3P3.
7. Open cabinet rear door.
8. Remove drive belt as follows (refer to Figure 4-4):
 - a. Remove idler springs,
 - b. Move motor mounting plate towards spindle to relieve tension from drive belt off pulleys and set aside.
9. Remove parking brake assembly as follows (refer to Figure 4-18):
 - a. Open pack access cover,

- b. Remove six screws and washers securing brake cover to shroud and then remove cover and set aside,
 - c. Remove two screws securing parking brake assembly to deck casting and then remove and set assembly aside.
10. Remove spindle assembly as follows (refer to Figure 4-25):
- a. Remove three screws and washers (located under deck) securing spindle assembly to deck.

CAUTION

When removing spindle, use care not to damage pack sensor assembly.

- b. Lift spindle assembly straight up and off from dowel pins and remove from drive.

NOTE

In step c, position pack sensor assembly so pack-on switch is as close as possible to dimensions shown in Figure 4-16. This minimizes final adjustment when spindle is replaced in drive.

- c. Remove pack sensor assembly from old spindle assembly and install on replacement spindle assembly.

NOTE

Ensure mating surfaces of spindle and deck are clean.

11. Lower replacement spindle into position on deck orienting pack sensor assembly toward drive motor and fit spindle over pins in deck. Refer to Figure 4-25.

NOTE

Tighten spindle down evenly, keeping its bottom surface parallel to deck surface.

12. Secure spindle assembly to deck using three screws and washers. Leave screws loose enough to allow lateral movement of spindle to carriage alignment.
13. Perform spindle to carriage alignment procedure (paragraph 4.32, steps 4 through 22).

NOTE

Apply Loctite primer, grade N, and Loctite grade C to screws used in step 14.

14. Secure parking brake to deck using two screws (paragraph 4.22).
15. Perform parking brake adjustment procedure, steps 4 through 14.
16. Replace drive belt as follows:
 - a. Position drive belt on drive motor pulley and then move drive motor mounting plate towards spindle and slip drive belt around spindle pulley,
 - b. Install idler springs,
 - c. Manually rotate spindle to seat drive belt,
 - d. Close rear door.
17. Perform pack-on switch adjustment procedure (paragraph 4.19, steps 4 through 11).
18. Replace ground lead on static groundspring and perform static groundspring adjustment procedure (paragraph 4.34, steps 4 and 5).
19. Reconnect speed sensor cable plug P3.
20. Perform speed sensor adjustment procedure (paragraph 4.29, steps 4 through 7).
21. Reinstall blower assembly. Refer to blower motor replacement procedure, paragraph 4.3, step 15.
22. Close cabinet front door.
23. Perform speed sensor output check procedure (paragraph 3.21.2).

4.32 SPINDLE TO CARRIAGE ALIGNMENT

This adjustment is required whenever the spindle is loosened from the deck casting. A similar adjustment must be made when the actuator is loosened from the deck. However, this is described in the actuator assembly replacement procedure (paragraph 4.2).

The spindle and carriage are properly aligned when carriage motion is along a radial line from the axis of rotation of the spindle assembly. The following describes spindle to carriage alignment.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,

- b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.
3. Raise top cover, then open pack access cover as far as possible. Refer to Figure 4-26.

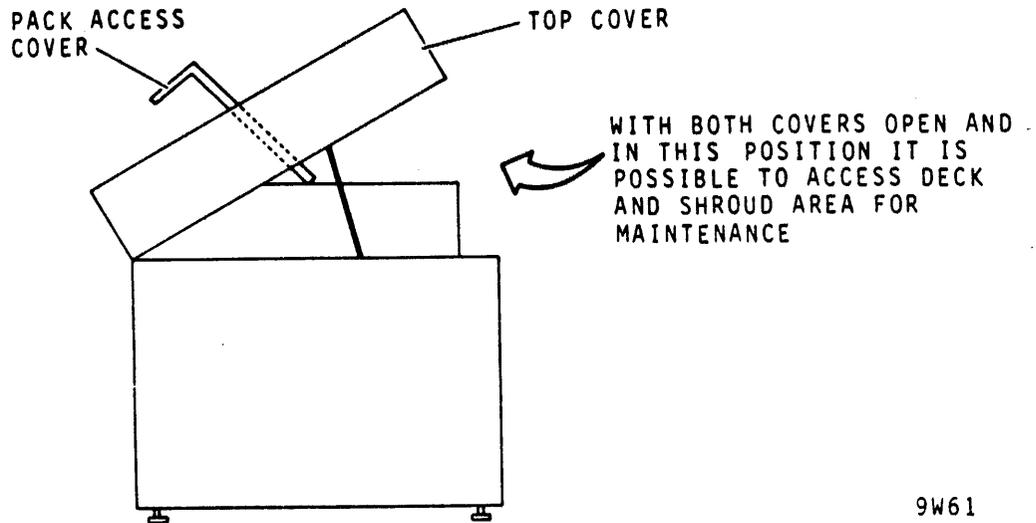
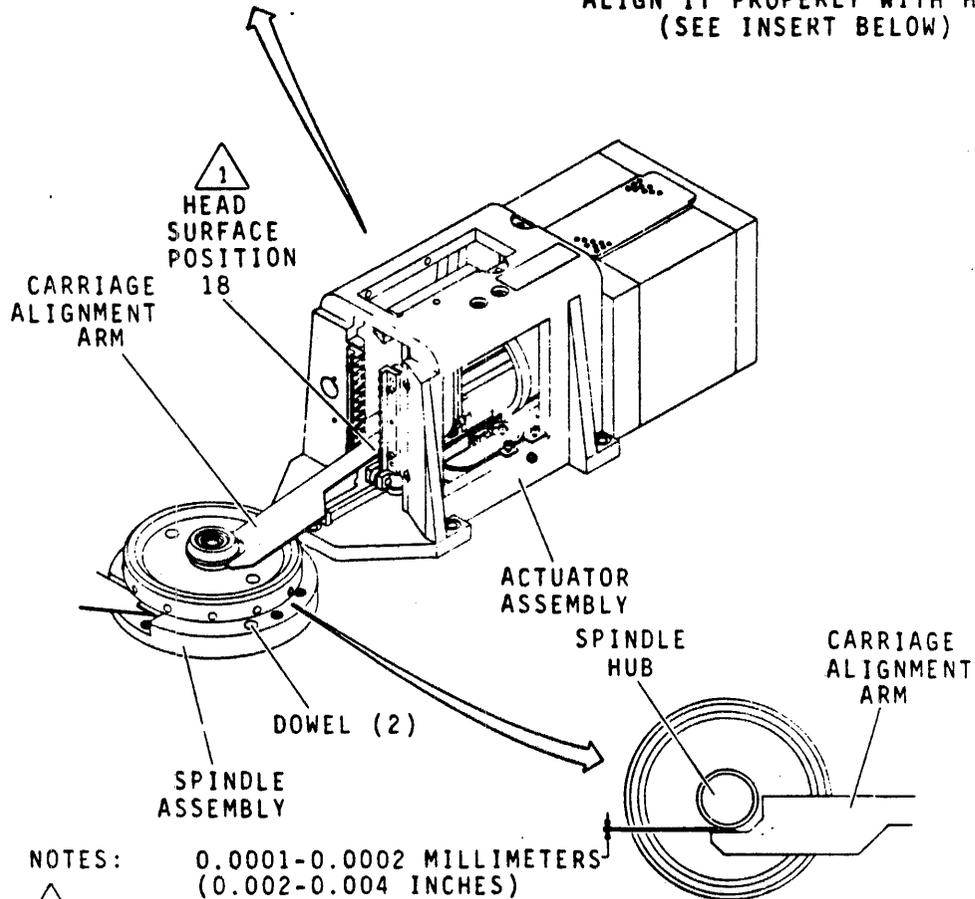
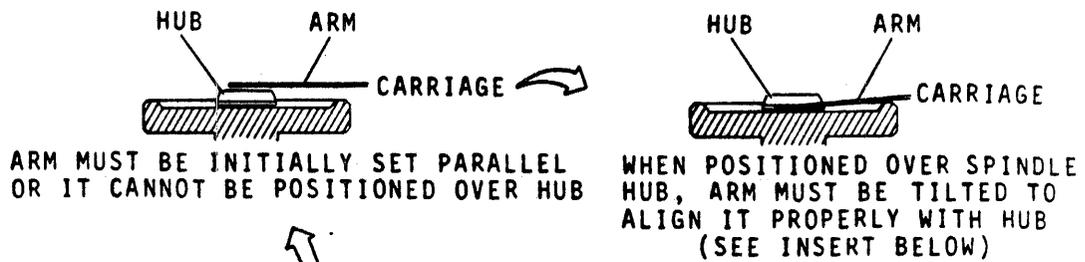


Figure 4-26 Cabinet with Pack Access and Top Covers Open

4. Remove heads from surface positions 17 and 18 as instructed in head-arm assembly replacement procedure (paragraph 4.8, steps 5, 6 and 7).
5. Install and position carriage alignment arm as follows (refer to Figure 4-27):
 - a. Install carriage alignment arm in surface position 18 and parallel to the deck. Torque clamp screw to 4 (\pm 1/2) inch-pounds,
 - b. Slowly extend carriage until heads load, then forward until carriage alignment arm clears edge of spindle and is positioned approximately over spindle hub,
 - c. Loosen head-arm clamp screw, and tilt carriage alignment arm downward until it aligns with spindle hub as shown in Figure 4-27, then torque clamp screw to 4 (\pm 1/2) inch-pounds,
 - d. Close top cover, thus allowing pack access cover to open fully.



HEADS 17 AND 18 ARE REMOVED, ALL OTHER HEADS WILL REMAIN IN POSITION ALTHOUGH NOT SHOWN IN THIS ILLUSTRATION

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Figure 4-27 Spindle to Carriage Alignment

6. Check to see if clearance between carriage alignment arm and spindle post is as specified in Figure 4-27. If clearance is not as specified, proceed to step 7. If clearance is as specified, proceed to step 20.
7. Raise top cover so that covers are as shown in Figure 4-26.
8. Unload heads and remove carriage alignment arm.

9. Close top cover allowing pack access cover to fully open.
10. Remove six screws and washers securing parking brake cover to shroud and remove cover.
11. Raise top cover so that covers are as shown in Figure 4-26.
12. Install and position carriage alignment arm as instructed in step 5.
13. Close top cover allowing pack access cover to fully open.
14. Loosen three screws securing spindle to deck, thus allowing lateral movement of spindle assembly.

NOTE

If specified clearance is obtained in step 15, proceed to step 17. If it is too far out of alignment to be adjusted in this manner, it will be necessary to move the actuator housing to obtain the proper clearance. In this case proceed to step 16.

15. Using spindle adjustment tool, move spindle to obtain clearance specified in Figure 4-27.
16. Align spindle to carriage by moving actuator housing as follows:
 - a. Move spindle until dowel pins are centered in spindle slots (refer to Figure 4-27), and then tighten three screws securing spindle to deck,
 - b. Raise top cover so that covers are as shown in Figure 4-26,
 - c. Unload heads and remove carriage alignment arm,
 - d. Close pack access and top covers,

NOTE

Upon completion of step e, spindle to carriage alignment will have been performed. Therefore, do not complete steps 17 through 24 of this procedure.

- e. Perform actuator assembly replacement procedure (paragraph 4.2). However, instead of replacing the actuator housing in steps 17, 18 and 19, only loosen the screws securing it to the deck.

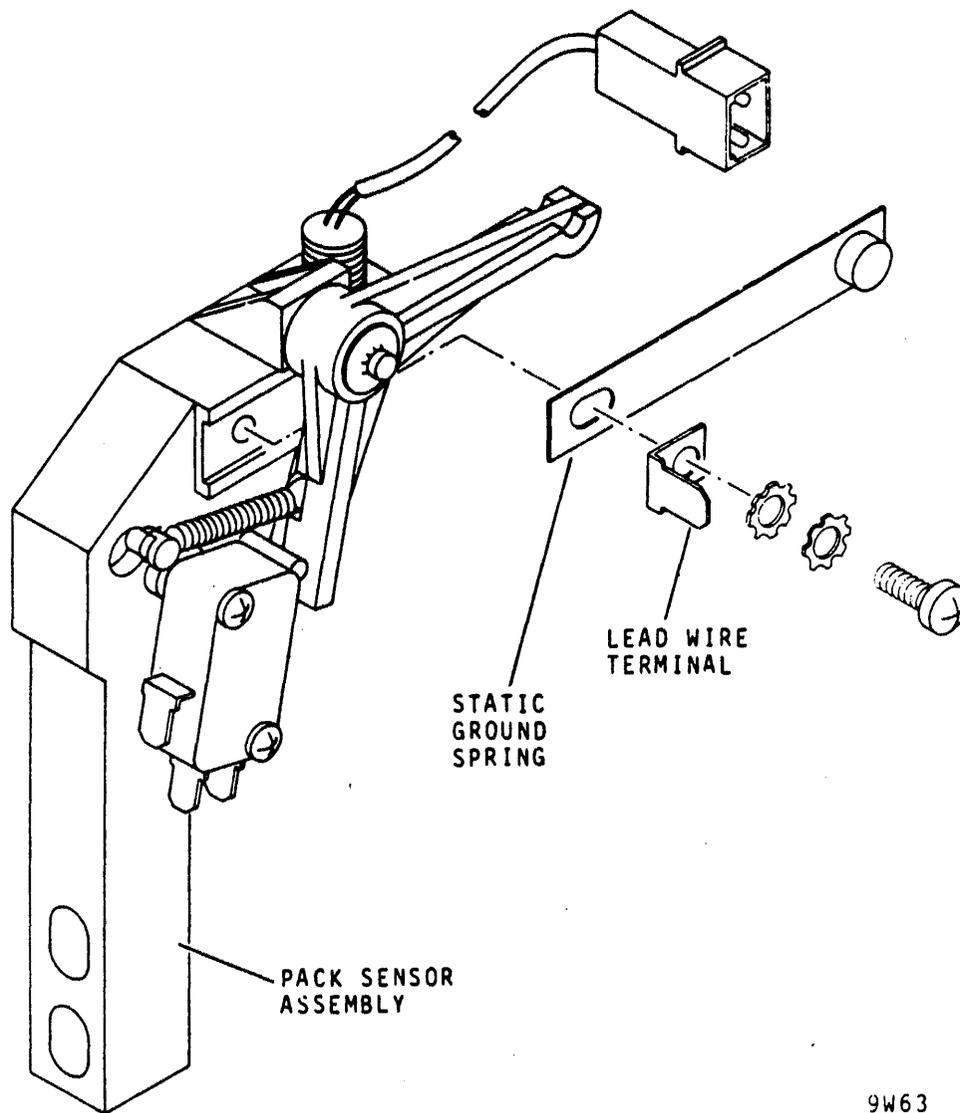
17. Secure spindle by tightening three spindle screws.
18. Recheck clearance and if it is incorrect, repeat steps 14 and 15 until proper clearance is obtained.
19. Raise top cover as shown in Figure 4-26.
20. Unload heads and remove carriage alignment arm.
21. Replace heads (removed in step 4) as instructed in head-arm assembly replacement procedure (paragraph 4.8, step 9).
22. Close top cover allowing pack access cover to fully open.
23. Replace parking brake cover using six screws and washers.
24. Perform head alignment procedure (paragraph 3.17.2) for heads in surface positions 17 and 18.

4.33 STATIC GROUNDSRING REPLACEMENT

The static groundspring is mounted on the static groundspring mounting bracket which, in turn, is mounted on the pack sensor assembly.

This procedure describes removal and replacement of the groundspring from its mounting bracket. Adjustment is required following replacement and this is described in the static groundspring adjustment procedure (paragraph 4.34).

1. Stop spindle motor.
2. Remove disk pack.
3. Set UNIT POWER circuit breaker to OFF.
4. Remove left side panel (as viewed from front).
5. Refer to Figure 4-28 and remove static groundspring leadwire.
6. Remove self-threaded screw, lockwasher, terminal lug, and groundspring from switch base bracket.
7. Install replacement groundspring on switch base bracket using screw, lockwasher, and terminal lug.
8. Perform static groundspring adjustment procedure (paragraph 4.34).
9. Connect groundspring leadwire.
10. Replace side panel.



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Figure 4-28 Static Groundspring Adjustment

4.34 STATIC GROUNDSRING ADJUSTMENT

This adjustment properly positions the static groundspring in relation to the lockshaft. A check is also made to ensure the groundspring has the correct tension.

1. Stop spindle motor.
2. Remove disk pack.
3. Set UNIT POWER circuit breaker to OFF.
4. Remove left side panel (as viewed from front).

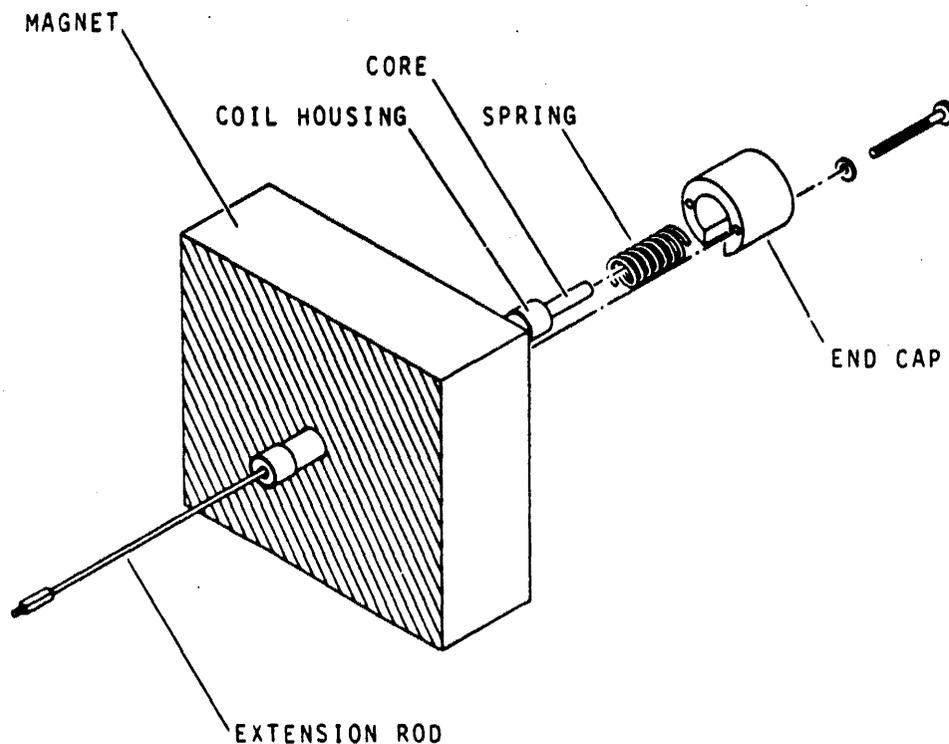
5. Refer to Figure 4-28 and visually check that groundspring is approximately centered on lockshaft.
6. If required, loosen screw securing groundspring to mounting bracket and center spring as required. Tighten screw.
7. Place an 0.019 (+ 0.003) inch non-metallic feeler gauge between groundspring and lockshaft.
8. Hook a push-pull gauge to outer end of groundspring.
9. The force required to allow feeler gauge to fall free should be 125 (+ 25) grams. It should be applied perpendicular to the spring.
10. If required, adjust set screw in switch base bracket for proper spring tension.
11. Replace side panel.

4.35 VELOCITY TRANSDUCER ASSEMBLY REPLACEMENT

The velocity transducer assembly consists of the coil housing, transducer core and the extension rod. Refer to Figure 4-28.

The coil housing is secured to the magnet assembly while the transducer core (located inside the coil housing) is connected to the carriage by the extension rod. As the carriage is moved to position the head-arm assemblies, the transducer core and extension rod move with it. The following describes replacement of the transducer coil housing and core.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.
3. Open cabinet top door and remove deck cover.
4. Disconnect yellow voice coil leadwire.
5. Remove transducer coil and core assembly as follows:
 - a. Manually move carriage forward until end of extension rod can be unthreaded from carriage. Refer to Figure 4-29. However, do not remove transducer core and rod until instructed to do so,



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Figure 4-29 Velocity Transducer Replacement

- b. Remove velocity transducer cable plug P4,
- c. Remove two screws and washers securing velocity transducer end cap to magnet and remove end cap,
- d. Carefully remove coil housing and transducer core (connected to extension rod) from magnet and set aside.

CAUTION

Transducer core can be ruined if it comes in contact with a ferromagnetic object.

6. Carefully remove replacement coil and core from shipping container and set on a non-ferrous surface.
7. Determine which end of replacement transducer core is to be connected to extension rod as follows.

NOTE

Replacement transducer core should have a red dot or stripe at one end indicating that end is the north pole of the core. Therefore, the unmarked end is the core's south pole. The unmarked end (south pole) always connects to the extension rod. Whether or not core has a marked end, always check replacement core to determine polarity.

- a. Identify end of defective transducer core that connects to extension rod. Place unmarked end (no red mark) next to extension rod end of defective transducer. If cores repel each other then you have identified the extension rod end. If cores attract each other, opposite end connects to extension rod.
- b. After determining which end of replacement transducer core to connect to extension rod, place replacement transducer core on a non-ferrous surface.

CAUTION

Extension rod must be grasped at end nearest transducer core when separating or connecting the two.

8. Carefully unthread extension rod from defective transducer core assembly and set defective transducer core aside.
9. Thread extension rod into end of transducer core observing that polarity of replacement core is same as old transducer core. Wipe off excess Loctite.
10. Insert replacement transducer core and extension rod into replacement coil housing until core is completely contained in housing.
11. Install replacement transducer core and coil housing in magnet as follows:
 - a. Insert replacement coil housing, containing transducer core and extension rod, into magnet,
 - b. Position velocity transducer end cap and spring on magnet and then secure end cap to magnet with two screws and washers,
 - c. Apply one drop of Loctite, Grade C, to extension rod threads and then thread extension rod into carriage,
 - d. Connect velocity transducer cable plug P4.

12. Manually move carriage back to retracted stop.
13. Install scratch disk pack.
14. Set MAIN AC circuit breaker to ON.
15. Ensure velocity transducer output has proper polarity by performing following check:
 - a. Open cabinet rear door,
 - b. Open logic chassis and remove card cover,
 - c. Connect oscilloscope channel 1 (using 10X probe) to A20 - TPE,
 - d. Trigger oscilloscope positive internal,
 - e. Press START switch to start drive motor,

CAUTION

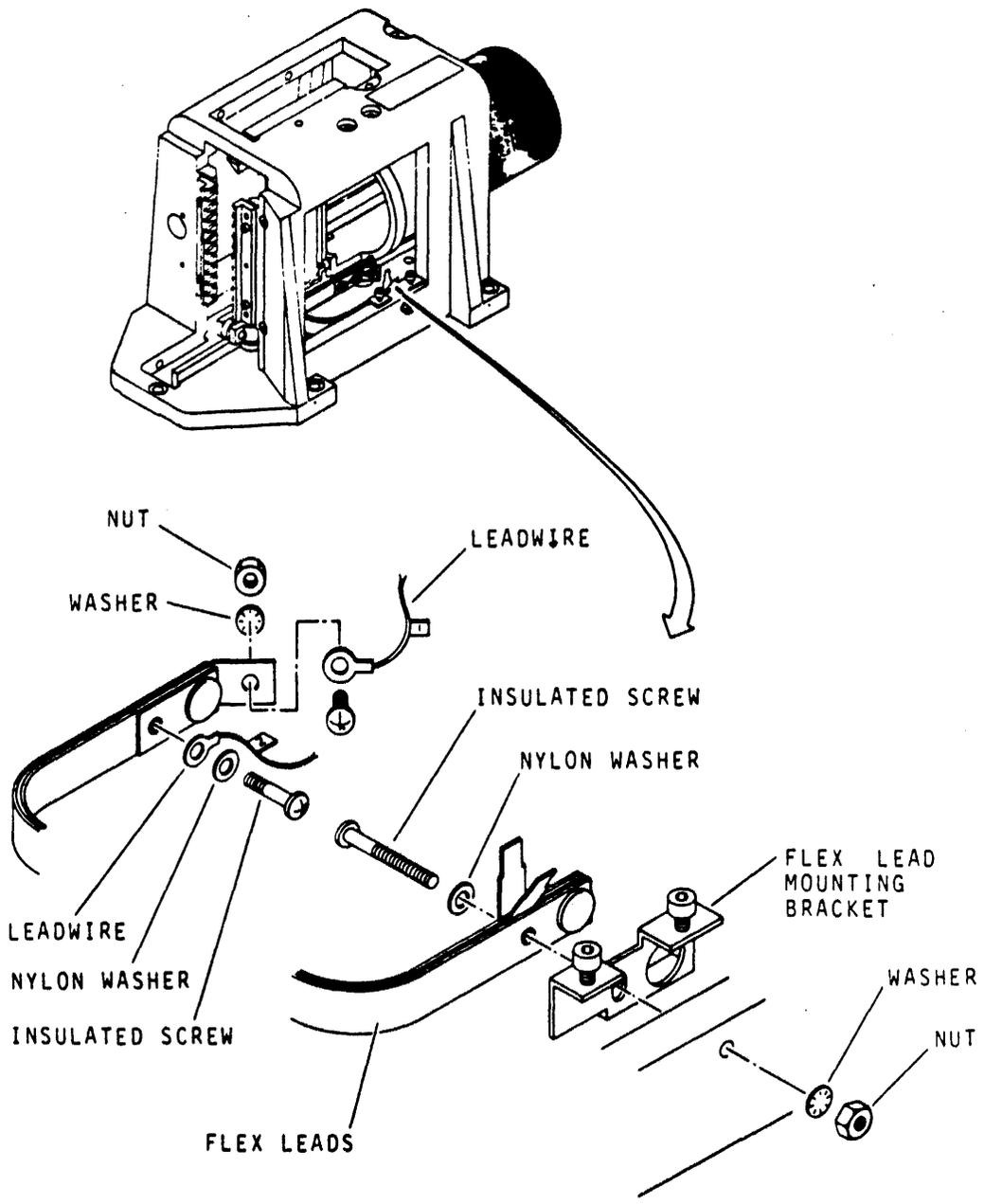
Refer to paragraph 3.15 (steps 4 and 5)
when performing steps f and g.

- f. Manually load heads,
 - g. Manually move carriage in a forward direction and observe that oscilloscope waveform goes in a negative direction. If signal goes positive, transducer core is in backwards. In this case, remove core, turn it end for end and repeat this check,
 - h. Manually retract heads as instructed in step 7 of manually positioning carriage procedure (paragraph 3.15),
 - i. Press START switch to stop drive motor and unload heads.
16. Set MAIN AC circuit breaker to OFF.
 17. Reconnect yellow leadwire to voice coil.
 18. Replace deck cover and close top cover.
 19. Perform procedures listed below.
 - a. Servo system test and adjustment (paragraph 3.17.2.7).
 - b. Velocity transducer gain uniformity check (paragraph 3.18.2.15).

4.36 VOICE COIL FLEX LEAD REPLACEMENT

The voice coil flex leads are attached between the carriage and actuator housing. They consist of flexible copper strips separated by flexible insulators. The following describes replacement and adjustment of the flex leads. Adjustment is required so they do not bind, kink, or restrict carriage travel.

1. Remove power from drive as follows:
 - a. Press START switch to stop drive motor and unload heads,
 - b. Set MAIN AC circuit breaker to OFF.
2. Remove disk pack.
3. Open drive top cover and remove deck cover.
4. Remove connectors from cards E01, E02, and E03 in read/write chassis, then remove these cards and set them aside.
5. Disconnect voice coil leadwire plug from voice coil connector (refer to Figure 4-30).
6. Remove voice coil flex lead as follows:
 - a. Remove nut, insulated screws and washers securing voice coil leads and flex lead mounting bracket to actuator housing,
 - b. Separate flex leads from mounting bracket and attaching hardware, then set bracket and attaching hardware aside,
 - c. Position free end of flex leads out of actuator housing,
 - d. Manually extend carriage until end of flex leads attached to carriage is easily accessed,
 - e. Disconnect number one leadwire by removing screw nut and washer securing it to flex lead,
 - f. Remove insulated screw and nylon washer securing number two leadwire, flex leads and backing plate to carriage,
 - g. Remove voice coil flex heads and backing plate from actuator housing and set aside.



9W66

Figure 4-30 Voice Coil Flex Lead Replacement

CAUTION
 Handle replacement flex leads carefully. Do not bend or twist them. Also ensure that flex lead copper strips are parallel when installation is complete.

7. Install replacement voice coil flex leads as follows:
 - a. Position flex leads inside actuator housing as shown in Figure 4-30. Note, however, that the mounting bracket is not in place,

NOTE

Apply one drop of Loctite, grade C, to screws used in steps b, c and d.

- b. Secure number two leadwire, flex lead and backing plate to carriage using insulated screw and nylon washer,
 - c. Secure number two leadwire to flex conductor using screw, nut and lockwasher,
 - d. Secure flex lead mounting bracket and flex leads to actuator housing as shown in Figure 4-30.
8. Inspect and adjust voice coil flex leads as follows:
 - a. Ensure that number one flex lead does not touch carriage casting. If necessary, carefully bend lead until this requirement is met,
 - b. Ensure that copper strips are parallel. If necessary, loosen all screws and adjust copper strips until they are parallel,
 - c. Check that flex leads travel freely through the entire range of travel without linking or interfering with carriage movement.
9. Grasp coil through opening in top of magnet assembly. Carefully and slowly push coil forward to extend heads.
10. Once head arms have cleared the cams, gently slide carriage and coil assembly back and forth along the full length of rails. While moving coil, be aware of any possible irregularity (bumps or jerks) in movement. A sudden irregularity indicates dirt on the rails and bearings. Do not confuse pressure of flex leads with a sudden irregularity in motion. Pressure from leads is a smooth change.
11. Reconnect voice coil leadwires.
12. Replace voice coil leadwires.
13. Manually move heads back to fully retracted position.
14. Replace plastic magnet shield on magnet.
15. Replace deck cover and close top cover.

APPENDIX A
TB3A2 FIELD TEST UNIT

A.1 INTRODUCTION

The TB3A2 Field Test Unit (FTU) is a portable, self-contained tester for exercising and simulating on-line operations in the RM05 Disk Subsystem.

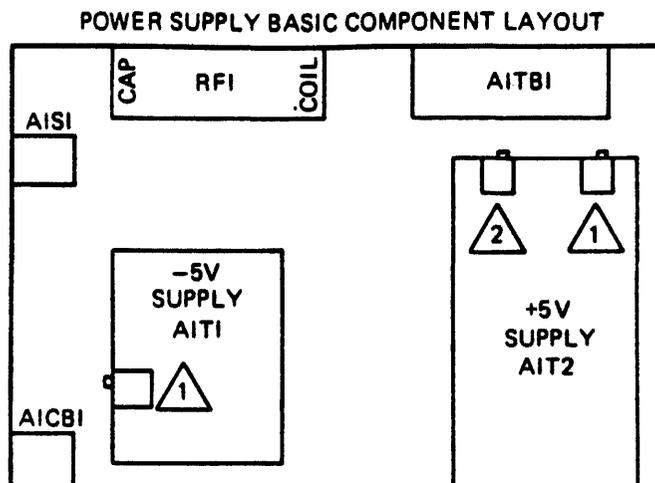
The FTU is housed in a suitcase-type carrying case that provides a control panel, a logic board, and an integral power supply. The case contains space for storing the power cable, all necessary I/O cables, and a head alignment card. The head alignment card plugs into the logic chassis of the drive and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

A.1.1 Operating Voltage

The FTU normally uses a 120 Vac, 50 or 60 Hz power source. To configure the FTU for 240 Vac operation, proceed as follows:

1. Open the FTU cover. Unhinge the cover and set it aside,
2. Raise the control panel,
3. Remove the head alignment card from its compartment on top of the power supply box,
4. Remove the four screws securing the cover plate of the power supply. Remove the cover plate,
5. Remove the jumper straps connecting terminals 1 and 2, then terminals 3 and 4 of AlTB1 (Figures A-1 and A-2),
6. Install both jumpers 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. Attach a 120 to 240 Vac conversion plug to the FTU power cord.

The FTU is now ready for 240 Vac operation.



NOTES:

- VOLTAGE POT (SCREWDRIVER ADJ)
- OVERVOLTAGE POT (SCREWDRIVER ADJ)

MA-1423

Figure A-1 FTU Power Supply Layout

A.1.2 I/O Cables

The FTU comes equipped with two I/O cables. 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 has a 34-pin block-type connector on the tester end and a 26-pin flat-cable connector on the drive end (Figure A-3).

A.1.3 Head Alignment Cable

In addition to the head alignment card described earlier, the FTU comes equipped with a 4-wire head alignment cable. This cable connects between the logic chassis of the drive and the appropriate jack in the drive's read/write assembly (see Figure A-4). A pair of test leads, which also comes with the FTU, then connects between the banana jacks on the head alignment card and the null meter on the FTU control panel.

A.2 MODES OF OPERATION

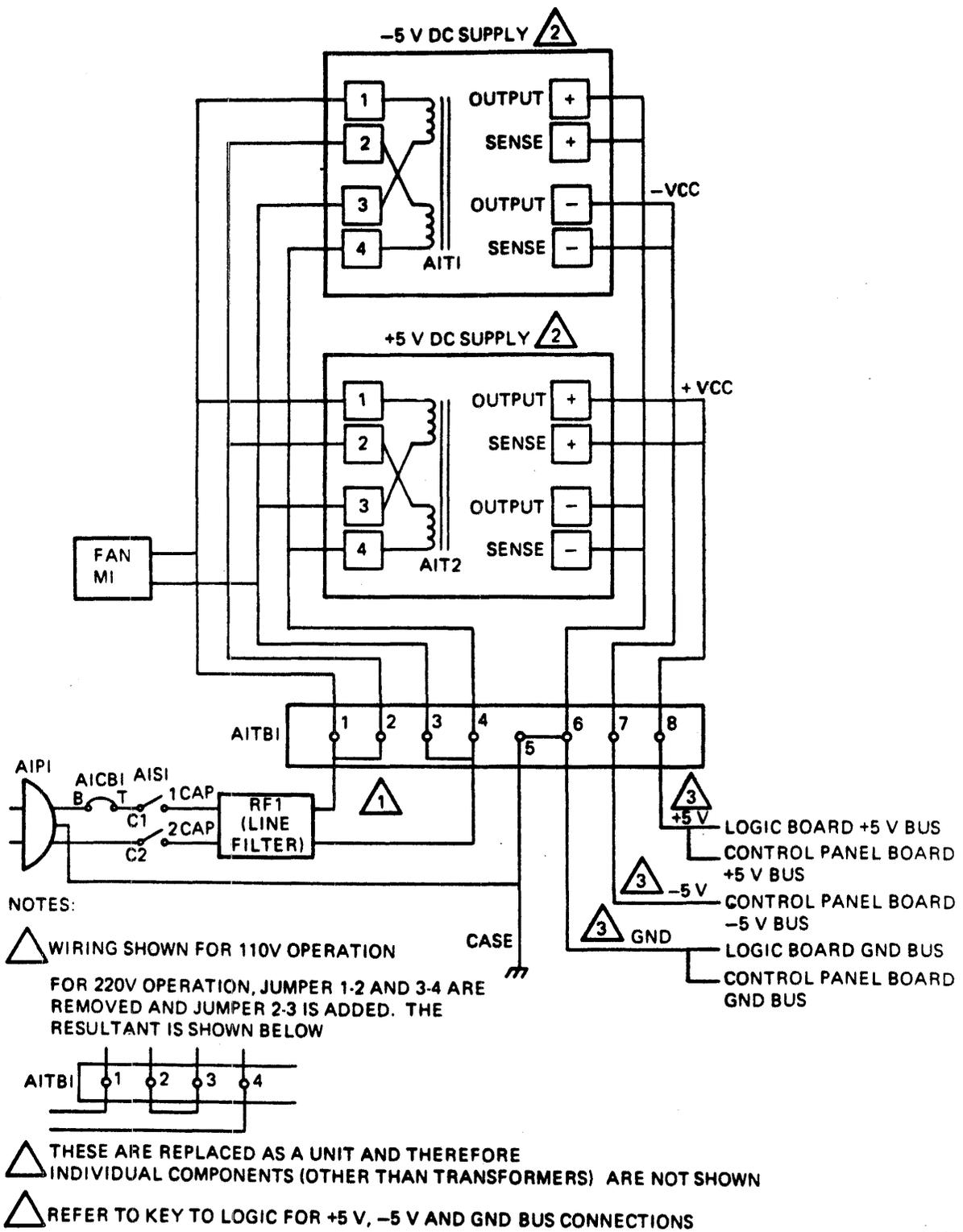
The TB3A2 FTU provides five access (seek) modes, four read/write modes, and two modes for selecting heads.

NOTE

Performing any write operations will destroy formatting on the pack.

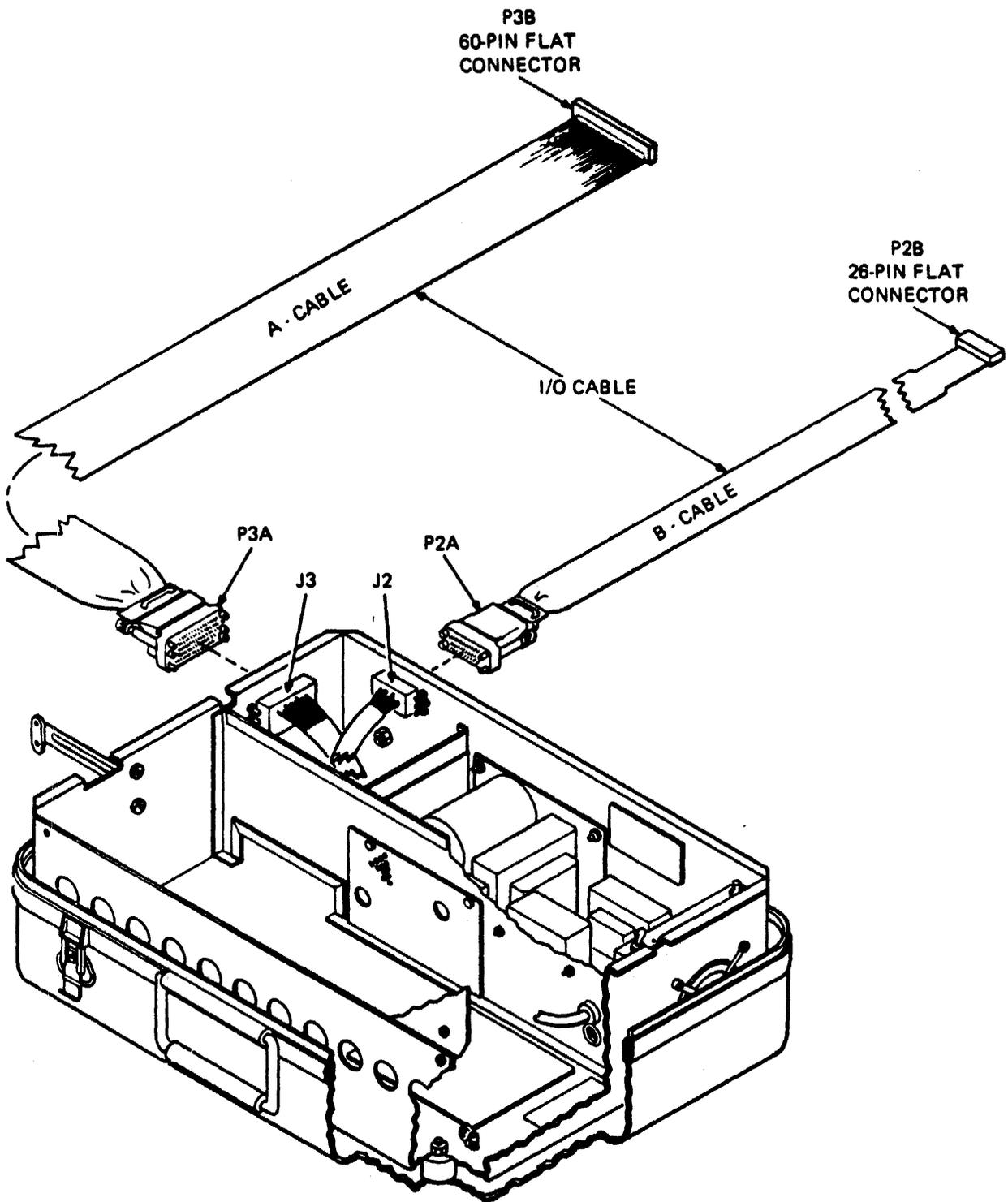
A.2.1 Direct Seek

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



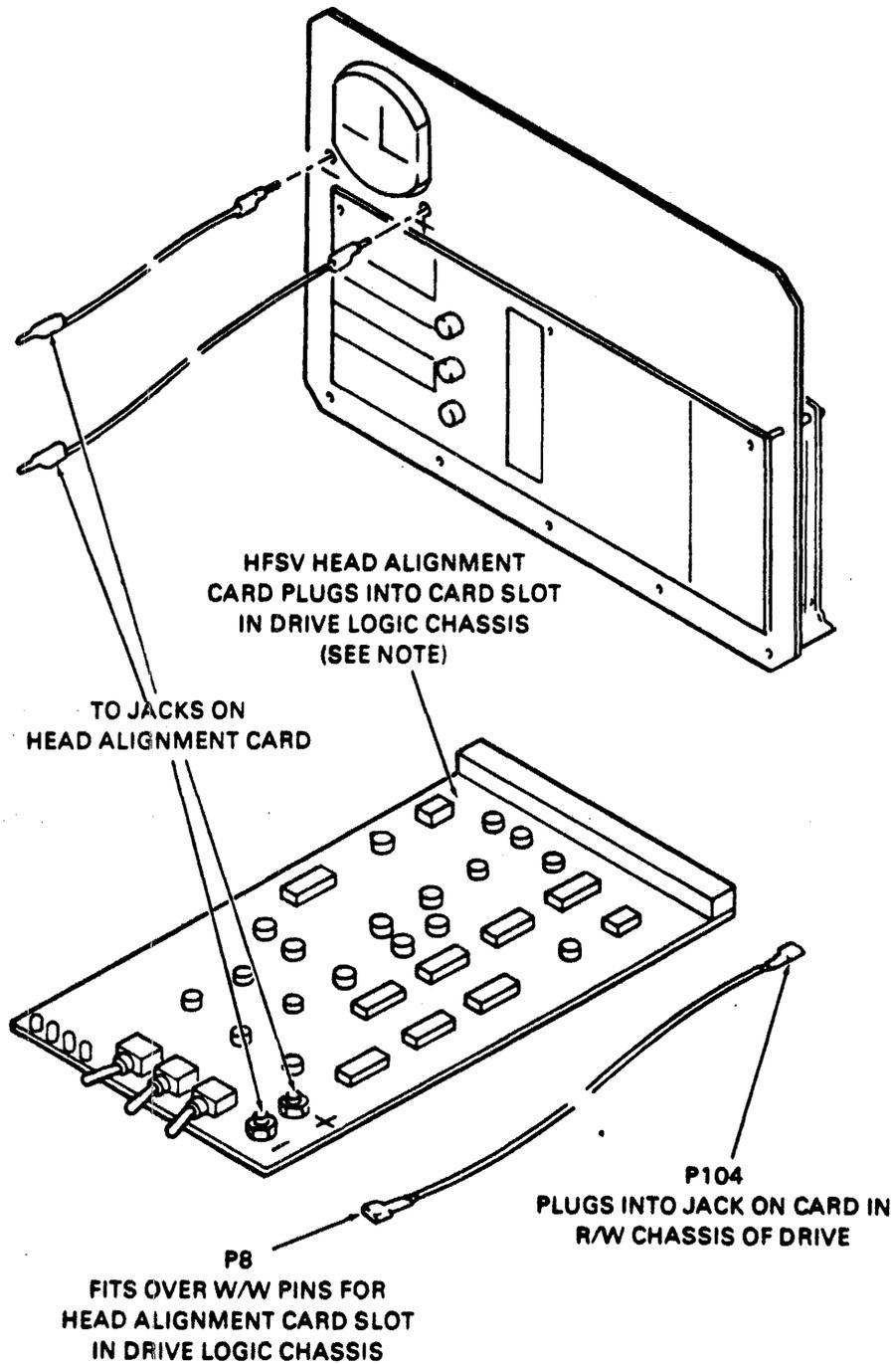
MA-1422

Figure A-2 FTU Power Supply Wiring Diagram



MA-061

Figure A-3 Tester I/O Cables



MA-0662

Figure A-4 Head Alignment Connections

A.2.2 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).

A.2.3 Sequential Forward Seek

The drive under test will perform single-track incremental seeks until the last track is reached, then seek to track 000, and continue incremental seeks in the same manner until the STOP switch is actuated.

A.2.4 Sequential Reverse Seek

The drive under test will perform single-track decremental seeks, starting with the track set in the CYLINDER ADDRESS switches, until track 000 is reached. The drive will then return to the set track and repeat the operation until the STOP switch is actuated.

A.2.5 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.

A.3 READ/WRITE MODES

The TB3A2 FTU 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. Then the FTU will initiate a seek to the next cylinder address determined by the access mode and the read/write operation will be repeated. This seek-read/write sequencing will continue until the STOP switch is actuated or an error occurs. For direct seeks, the read/write operation will continue at the selected track or cylinder until the STOP switch is actuated, depending on the head-select mode.

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.

A.3.1 Write Format

With the FTU WRT-RD SELECT switch 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.

A.3.2 Write

With the FTU WRT-RD SELECT switch set to WRT, the FTU will write the repetitive 8-bit data pattern on the selected track. The FTU will, however, first read and verify the track address.

A.3.3 Read

With the FTU WRT-RD SELECT switch set to RD, the FTU will read the data from the selected track. It will first read and verify the track address.

A.3.4 Write Then Read

With the FTU WRT-RD SELECT switch 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. It will then again verify the track address and read back the data during the second revolution.

A.3.5 Off

The OFF position of the WRT-RD SELECT switch is used for access operations and head alignment procedures.

A.4 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 on the control panel (Figure A-5). The controls and indicators are described below, moving from top left to bottom right across the panel.

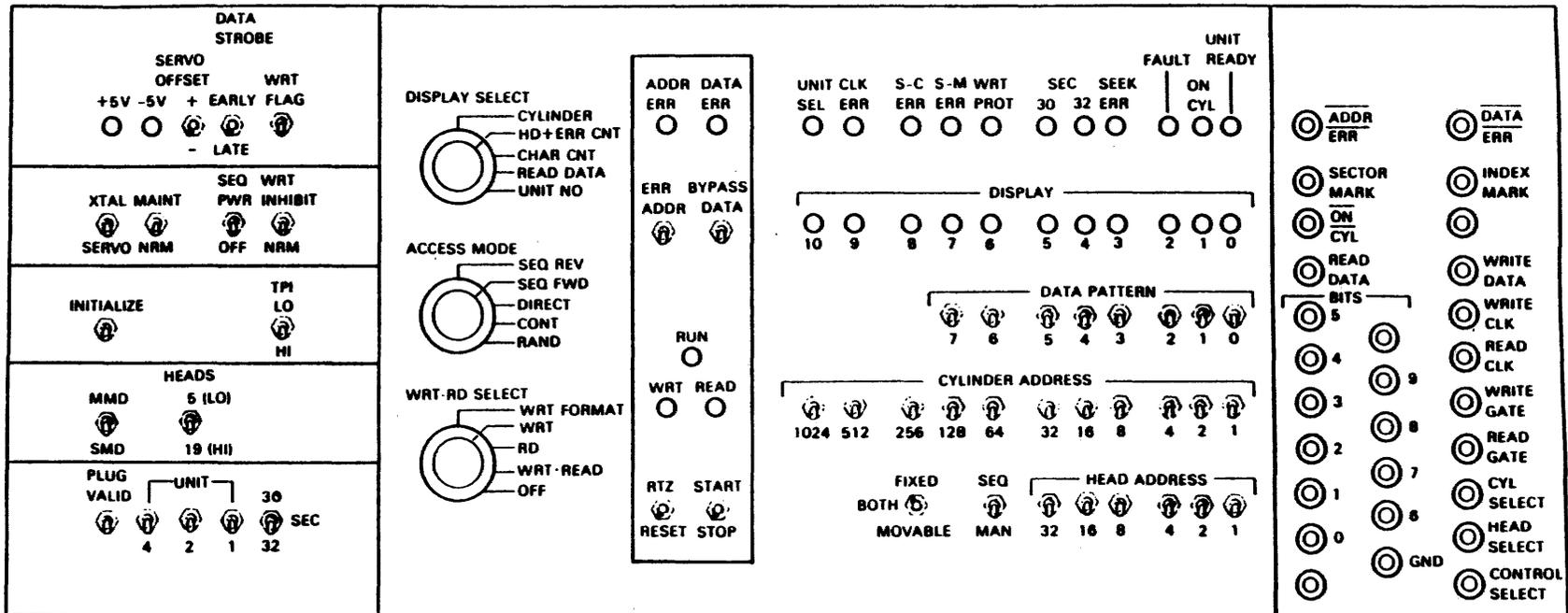


Figure A-5 TB3A2 Control Panel

+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.

LATE Moves the drive's read strobes from nominal to a later time with respect to data.

WRT FLAG

When moved up, this switch causes a defective track flag bit to be inserted in bit 6 of address word 1, provided that:

- o WRT-RD SELECT switch is set to WRT FORMAT.
- o ACCESS MODE switch is set to DIRECT.
- o Head-select switch (SEQ-MAN) is set to MAN.

XTAL/SERVO
switch

XTAL

A crystal oscillator within the FTU provides a nominal 9.667 MHz clock signal. Used for tester maintenance.

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"> o The drive is in the remote mode. o Primary power is available at the drive. o The drive's START switch is ON (indicator lit).
	OFF	In this position, the FTU cannot power-up the drive.
WRT INHIBIT/NRM switch	WRT INHIBIT	Prevents writing by the drive even though all other FTU switches are set to perform a write operation.
	NRM	Allows a normal write operation in the drive, provided all other FTU switches are set to perform a write operation.
INITIALIZE		When moved to the up position, this momentary contact switch provides an Initialize signal to the drive.
TPI switch		Not used.
MMD/SMD switch		Not used.
HEADS switch		Place in the down position to select a drive which has 19 disk surfaces.
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 A-1.

Table A-1 Plug Valid Indication

"0" Display Light (Plug Valid Indicator)	Meaning	To Select Drive
ON	Logical address plug is installed in drive.	<ol style="list-style-type: none"> 1. Set PLUG VALID switch up. 2. Set the three UNIT switches to desired drive number (0-7).
OFF	Logical address plug is not installed in drive.	<ol style="list-style-type: none"> 1. Set PLUG VALID switch down. 2. Set all three UNIT switches down to pseudo-select unit 0.
UNIT switches	421	Used to indicate the binary value of the three select address lines to the drive. This code must match that of the logical address plug in the drive under test.
SEC 30/32 switch		Selects the drive under test for either 30- or 32-sector operation.

ACCESS MODE
switch

A five-position rotary switch that controls the seek (access) mode of the drive under test.

SEQ REV Sequential Reverse - The drive seeks to the address in the FTU CYLINDER ADDRESS switches, sequences down to 0 and then repeats.

SEQ FWD Sequential Forward - The drive performs a series of incremental seeks, starting with the address that is in the cylinder address register (CAR) at the start of the operation. When the maximum cylinder is reached, the cycle begins again at address 0.

DIRECT Direct - The drive seeks to the address in the CYLINDER ADDRESS switches. Seeking to another address requires changing the address in the switches and manually initiating another seek operation by actuating the START switch.

CONT Continuous - The drive seeks alternately between the address in the CYLINDER ADDRESS switches and that in the CAR. The contents of the CAR do 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

A five-position rotary switch that controls the eleven DISPLAY lamps on the FTU control panel. The interpretation of the display is shown in Figure A-6. 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.

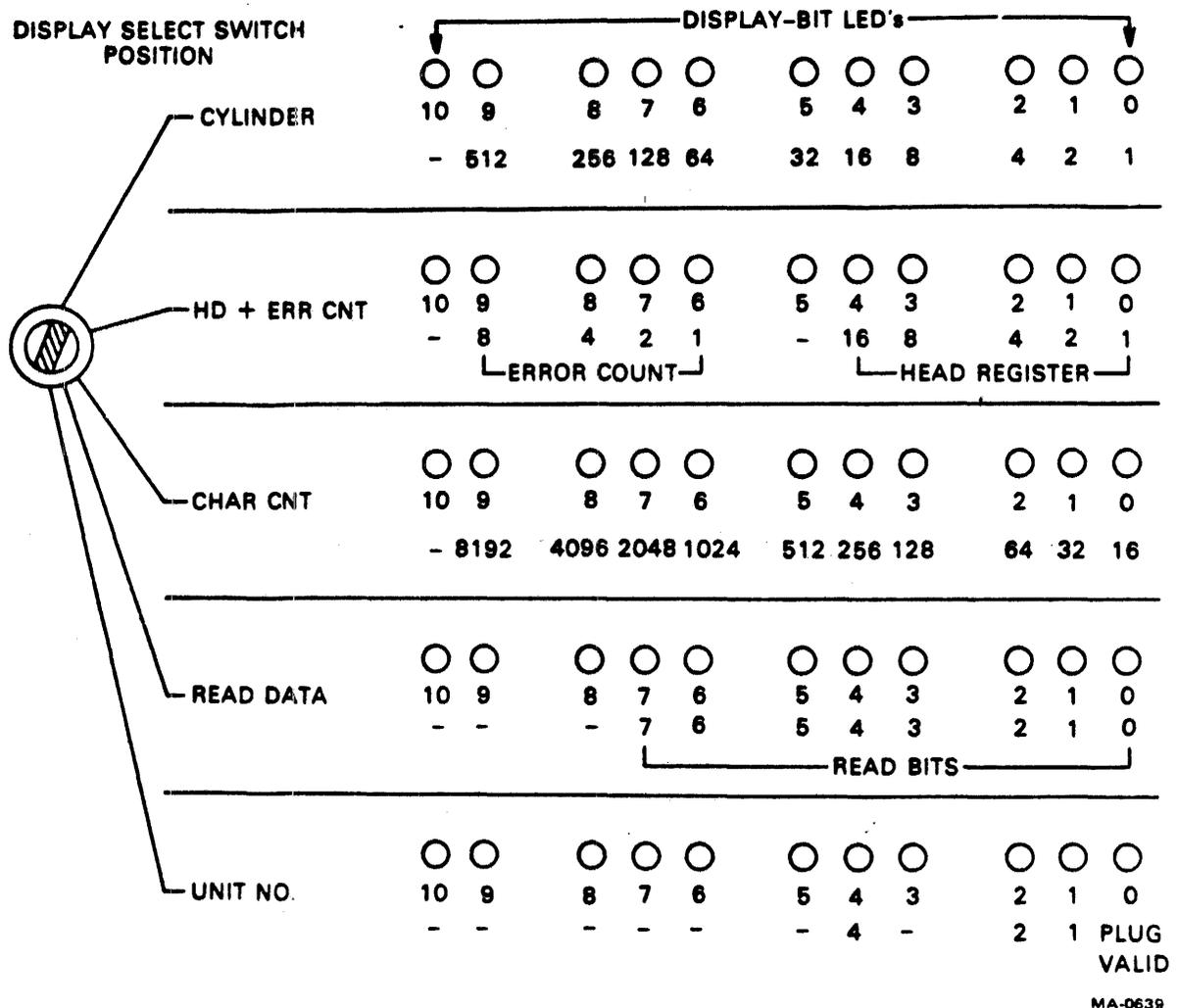


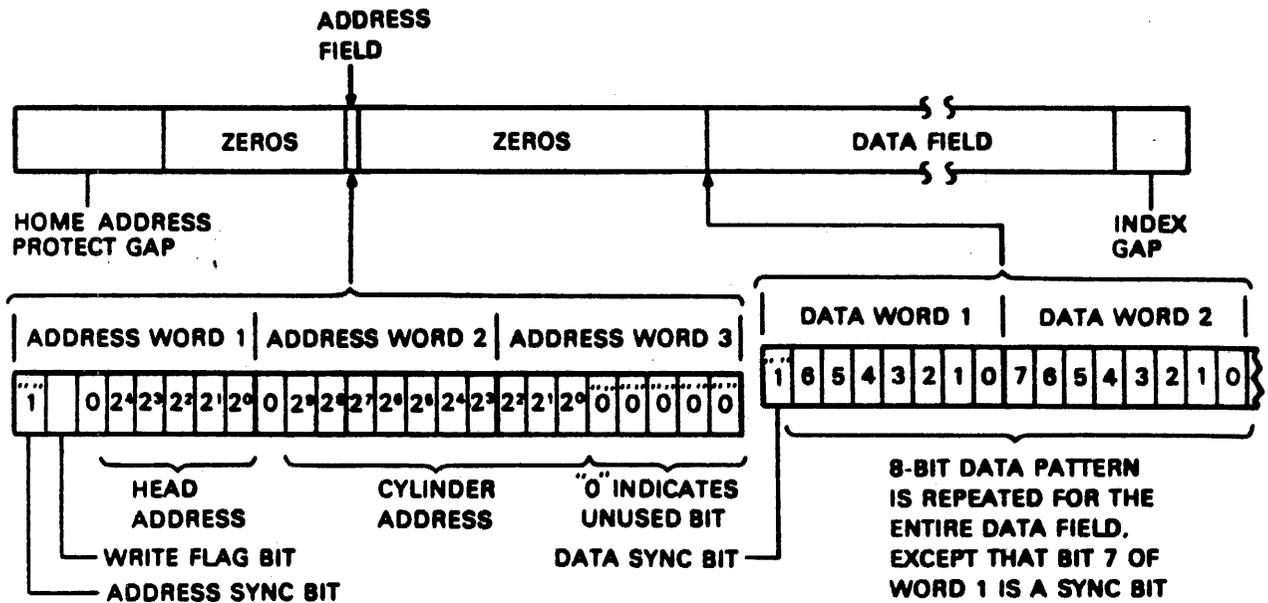
Figure A-6 Display Select Switch

WRT-RD SELECT switch

A five-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 and a prescribed 8-bit data pattern field on each selected track. The format is as shown in Figure A-7.



MA-0841

NOTE

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

Figure A-7 Track 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 pattern.

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.)

	OFF	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		Indicates that the 8-bit data pattern received from the drive differs from the pattern set in the DATA PATTERN switches.
ERROR BYPASS switches	ADDR	Address - 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	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"> o Returning the RTZ switch to neutral, provided RUN was not lit before the RTZ operation o A valid (unbypassed) error o Actuating the STOP switch o Actuating the RESET switch o If the ready signal from the drive goes low

RTZ/RESET switch	A three-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 three-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 RESET 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 nanoseconds 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 indicator	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 A-6).
DATA PATTERNS switches	These switches permit setting the repetitive 8-bit 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 one is indicated when a switch is in the up position, a zero when in the down position.
CYLINDER ADDRESS switches	These switches enter the binary value of the cylinder address to which a seek is desired and are used in conjunction with the ACCESS MODE switch. A one is indicated when a switch is in the up position; a zero when in the down position.
FIXED/BOTH MOVABLE switch	Not used.

SEQ/MAN
switch

This switch determines the manner in which the head address is selected.

SEQ

Sequential - After performing a write or read operation, the FTU increases the count in the head address register by one for each index mark. When in a random operation, each access increases the count by one. When the count is maximum (19), head zero is the next head selected and the incrementing continues.

MAN

Manual - The FTU will select the head address set in the HEAD ADDRESS switches.

ADDR ERROR
test point

This test point goes to a logical zero when an address error occurs.

DATA ERROR
test point

This test point goes to a logical zero when a data error occurs.

SECTOR MARK
test point

This test point goes to a logical one when the FTU receives a sector mark signal from the drive under test.

ON CYL
test point

This test point will be a logical zero 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 serial data bits being processed by the FTU during a write operation. 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 of the TB3A2. For an interpretation of the specific bus-out bits, see Table A-2.

Table A-2 FTU Test Points

Bus-Out-Lines	Tag 1	Tag 2	Tag 3
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 5	32	-	Not used.
Bit 6	64	-	RTZ - Pulse that causes the drive actuator to seek to track zero.
Bit 7	128	-	Data Strobe Early - Enables the drive's PLO 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	512	-	-

The three tag bus lines 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.

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 zero.
WRITE GATE test point	A logical one 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 one 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 one when the FTU sends a cylinder select signal (tag 1) to the drive.
HEAD SELECT test point	This test point goes to a logical one when the FTU sends a head select signal (tag 2) to the drive.
CONTROL SELECT test point	This test point goes to a logical one when the FTU sends a control select signal (tag 3) to the drive.

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