digital

RP04
disk drive
installation manual

RP04
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CHAPTER 1
GENERAL INFORMATION

1.1 INTRODUCTION

The RP04 Disk Drive (Figure 1-1) is a high-performance, direct-access, single-head-per-surface drive designed to enable a data processing system to store and retrieve blocks of data at any location on a rotating disk. The RP04 (Figure 1-2) consists of a 733 DEC Disk Storage Drive (manufactured by Information Storage Systems) and a Device Control Logic (DCL) unit (Figure 1-3) (manufactured by Digital Equipment Corporation). The DCL contains the control electronics required to supervise the 733 DEC operations. The optional dual-access logic package may be accessed by either or both of two Central Processing Units (CPUs) on a time-sharing basis. A switch on the control panel of the RP04 permits the control logic to select either or both CPUs. The RP04 System Diagram (Figure 1-4) shows the way in which system elements are interconnected. The RP04 may be used in conjunction with either PDP-11s or DECsystem-10s.
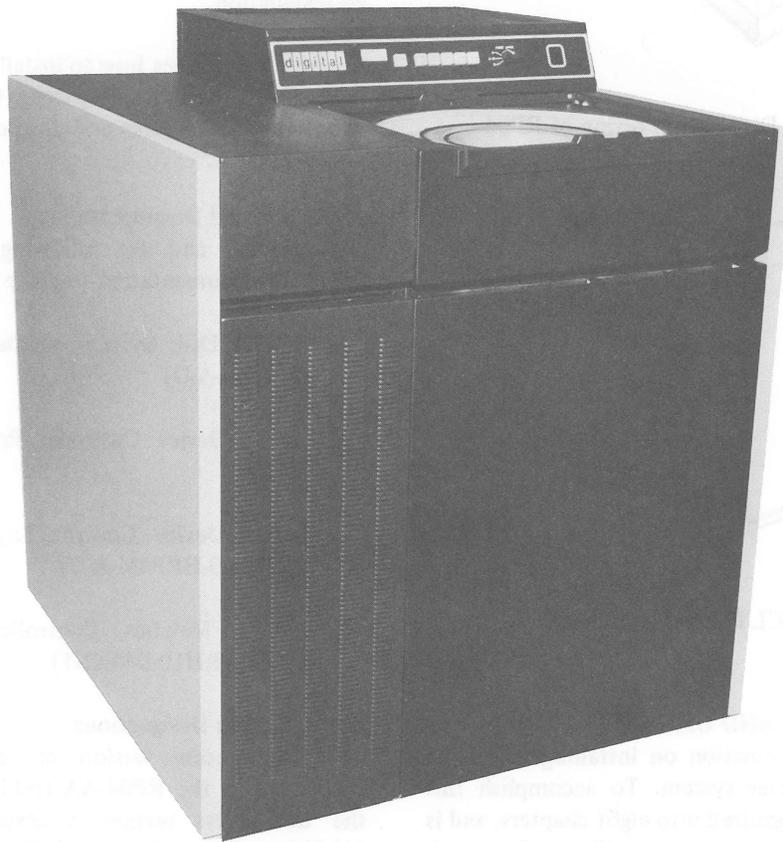
Figure 1-1   RP04 Disk Drive

1-1
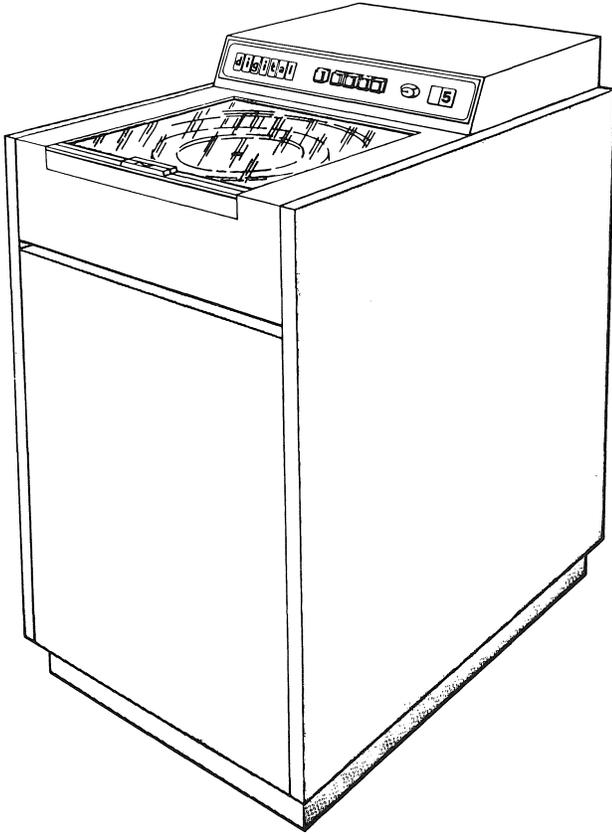
Figure 1-2 733 DEC Disk Drive Portion of RP04
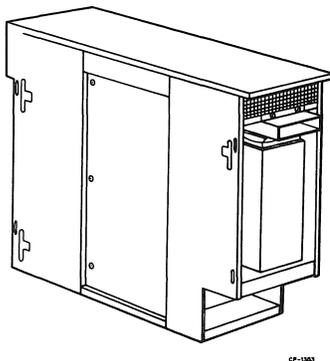
Figure 1-3 DCL Portion of RP04

1.2 MANUAL PURPOSE AND ORGANIZATION

This manual provides information on installing the RP04 Disk Drive into a computer system. To accomplish this purpose, the manual is organized into eight chapters, and is supported by the related documents identified in Paragraph 1.2.2.

1.2.1 Chapter Contents

Chapter 1 contains the general information necessary to introduce the RP04 and to present its characteristics and specifications.

Chapter 2 discusses the planning required to make the installation site compatible with operation of the RP04 Disk Drive, with particular attention to such considerations as space, cabling, power, floor loading, and fire and safety precautions.

Chapter 3 covers the specific environmental characteristics of the RP04 with respect to temperature, relative humidity, air conditioning and/or heat dissipation, acoustics, and cleanliness.

Chapter 4 describes the actual step-by-step process of installing the unit, from unpacking through the preliminary installation checks and adjustments, including power verification and conversion techniques.

Chapter 5 describes how to install the RP04 Disk Drive as a part of the RJP04 subsystem; Chapter 6 lists the field acceptance procedures and diagnostics appropriate to such an installation.

Chapter 7 describes how to install the RP04 Disk Drive as a part of the RHP04 subsystem; Chapter 8 lists the field acceptance procedures and diagnostics appropriate to such an installation.

1.2.2 Related Documentation

This manual and the following documents comprise a complete documentation package for the RP04 Disk Drive:

RJP04 Disk System Maintenance Manual (DEC-11-HRJPA-A-D)

RP04 Device Customer Print Set (RP04-0 PRINT SET)

RP04 Device Control Logic Maintenance Manual (DEC-00-HRP4M-A-D)

RH10 Massbus Controller Maintenance Manual (A-MN-RH10-0-MAN1)

1.2.3 Option Designations

The single-access version of the RP04 Disk Drive is designated as the RP04-AA (60 Hz) or RP04-AB (50 Hz); the dual-access version is designated as the RP04-BA (60 Hz) or RP04-BB (50 Hz). The data pack used with the RP04 is designated as the RP04-P.

1-3

Figure 1-4   RP04 System Diagram

1.3 SPECIFICATIONS SUMMARY

Table 1-1
RP04 Specifications Summary

Main Specifications

Storage medium	RP04-P Disk pack (3336 type)
Capacity/pack	43,980,288 16-bit or 39,982,088 18-bit words
Data transfer speed	2.48 μs/16-bit word
	2.79 μs/18-bit word
Time for 1/2 revolution	8.3 ms
Disk rotation speed	3600 RPM
Drives/control, max	8

Track Positioning Time

One cylinder seek	7 ms
Average seek	28 ms
Maximum seek	50 ms (nominal)

Data Organization

Surfaces/pack	19
Tracks/surface	411
Sectors/track	22 (16-bit format) or 20 (18-bit format)
Words/sector	256
Bits/words	16 bits or 18 bits (two formats)
Recording method	Modified frequency modulation (MFM)
Recording density	4040 bits/inch, max

Mechanical

Mounting	1 free-standing unit
Size	40" H X 31" W X 32" D
Weight	600 lbs
Cables	
Control-to-drive	25 ft standard, 40 ft optional
	(also 15 ft optional — DECsystem-10 only)
Drive-to-drive	2 ft standard
All cables, total	60 ft max

Power

Frequency	60 Hz±1%	50 Hz±1%	50 Hz±1%
Phasing	3-phase	3-phase wye	3-phase delta
Voltage	208/230±10%	380/400/415±10%	220/230/240±10%
Starting current (10 ms max)	30 A/phase	16 A/phase	26 A/phase
Running current			
Drive	8.2 A/phase @208 Vac	4.3 A/phase @400 Vac	7.1 A/phase @240 Vac
DCL	2.5 A @208 Vac (line-to-line)		
Current for control	22 A @+5 V		
	1.5 A @–15 V		
Power factor	0.7		
Power Loss (ac), duration	4 ms max.		
Heat dissipation	2100 W (7000 Btu/hr)		

CHAPTER 2
SITE PREPARATION

2.1 SPACE

Provision should be made for service clearances of 28 in. (71 cm) at the front and rear of the RP04, and 20 in. (51 cm) at either side of a drive string (Figures 2-1 and 2-2). Space should also be made available in the system environment for storage of disk packs, each of which has a diameter of approximately 15 in. (38 cm) when covered, and a height of approximately 7 in. (18 cm) to the handle of the top assembly. Disk packs should never be stacked on top of one another; a designated shelf area is recommended for each pack.

2.2 CABLING

No more than two RP04 Disk Drives should be supplied from one ac power source. (Refer to Paragraph 4.2.2, step 5.) The ac power cable used to connect the drive to the facility power source must not exceed 25 ft (7.6 m) in length.

The maximum Massbus interface cable length available (round cable) is 40 ft (12.2 m); thus, the first RP04 must be mounted no more than that distance from the controller. Multiple RP04s installed in the "string" configuration (side-by-side) will be connected by the standard 2-ft (61 cm) cable provided with each RP04. An optional 10-ft (3 m) cable can be provided for those situations where the string configuration cannot be utilized. The aggregate length of all external cables must not exceed 60 ft (18.3 m) per controller, regardless of the configuration selected.

2.3 POWER REQUIREMENTS

Those RP04 Disk Drives designed for use in the domestic market operate on 208 V, 3-phase, 60 Hz power (standard) or 230 V, 3-phase, 60 Hz power (convertible, per Paragraph 4.5). Those RP04 Disk Drives designed to be used in the international market operate on either 380 V, 3-phase, 50 Hz wye power (standard) with 400 V and 415 V optionally available or 230 V, 3-phase, 50 Hz delta power (standard) with 220 V and 240 V optionally available.
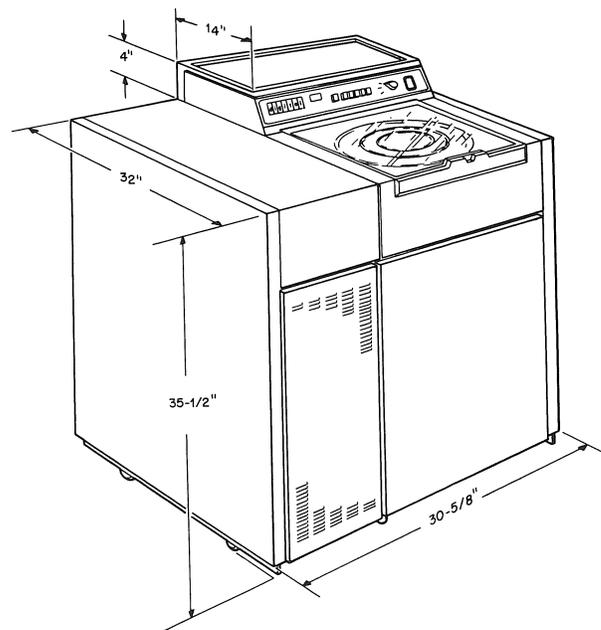
CP-1354

Figure 2-1 RP04 Service Clearances (Front)

Receptacles that will accept the 120 V/208 V 60 Hz plugs are designated variously by DEC (12-11210), NEMA (L21-20R), Hubbell (2510), and Bryant (72120-FR); receptacles that will accept 240 V/416 V 50 Hz plugs bear a DEC designation (12-11259), but no NEMA or manufacturers' numbers are presently available. 20 A circuit breakers are also necessary.

Digital Equipment Corporation should be notified *well in advance of shipment* regarding the input power requirements so that the kits necessary for conversion to available facility power can be available at the time of installation.
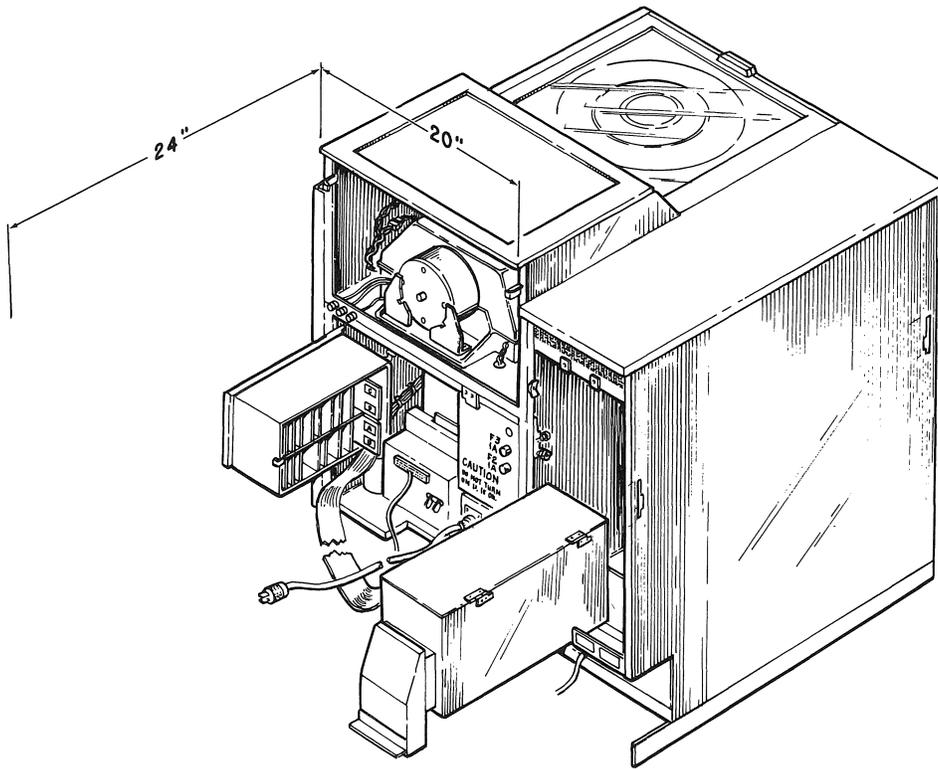
CP-1462

Figure 2-2   RP04 Service Clearances (Rear)

2.4   FLOOR LOADING

The weight of the RP04 (600 lbs/272 kg) alone is not sufficient to place unusual stress on most office building or industrial plant floors. However, the added weight should be considered in relation to the weight of the existing computer system and possible future expansion.

2.5   INSTALLATION CONSTRAINTS

The route the equipment will travel from the receiving area to the installation site should be studied in advance to ensure problem-free delivery. Among the factors to be taken into consideration are the height and location of loading doors, the size, capacity, and availability of elevators, the number and size of the aisles and doors en route, and any restrictions, such as bends or obstructions, in the hallways. Any constraints should be reported to Digital Equipment Corporation as soon as possible so that the requirements of the individual installation site may be considered when the unit is packed for shipment.

False flooring should not be necessary if the RP04s in the system are to be installed side-by-side in the string configuration, as the 2-foot cables provided with the units are just long enough to be run inside the drive cabinets to connect the units; however, if geographical or other considerations necessitate some other configuration, or if the first RP04 in the string configuration is not adjacent to the controller, false flooring may be required to avoid exposed cables.

2.6   FIRE AND SAFETY PRECAUTIONS

The RP04 Disk Drive presents no unusual additional fire or safety hazards to an existing computer system. Wiring should be carefully checked, however, to ensure that the capacity is adequate for the added load and for any contemplated expansion.

2-2

CHAPTER 3
ENVIRONMENTAL CONSIDERATIONS

3.1 GENERAL
The RP04 Disk Drive is capable of efficient operation even in marginal environments. However, the parameters of the operating environment must be determined by the most restrictive facets of the system, in this case the disk packs.

3.2 TEMPERATURE
The operating temperature range of the RP04 is from 60° to 90° F (16° to 32° C). The nonoperating temperature range is from 50° to 110° F (10° to 44° C). The operating temperature gradient is 12° F/hour, and the nonoperating temperature gradient is 15° F/hour.

3.3 RELATIVE HUMIDITY
Humidity control is important in any system as static electricity can cause errors in any CPU with memory. The RP04 is designed to operate efficiently within a relative humidity range of 20 percent to 80 percent, with a maximum wet bulb temperature of 77° F (25° C) and a minimum dewpoint of 36° F (2° C).

3.4 HEAT DISSIPATION
The heat dissipation factor for the RP04 Disk Drive is 7000 Btu/hr. By adding this figure to the total heat dissipation for the other system components, and then adjusting the result to compensate for such factors as the number of personnel, the heat radiation from adjoining areas, sun exposure through windows, system efficiency, etc., the approximate cooling requirements for the system can be determined. It is advisable to allow a safety margin of at least 25 percent above maximum estimated requirements.

3.5 AIR CIRCULATION
The air circulation system of the RP04 Disk Drive consists of a blower motor, a muffin fan motor, a prefilter, and an Absolute filter (Figure 3-1). The system is designed to supply clean air for:

Disk temperature control

Pressurization of the shroud area and the electromagnetic actuator (EMA) area

EMA temperature control

Logic cage cooling

Forced air cooling of the shroud (disk pack) area fixes the temperature of each disk in the pack with respect to all other disks in the pack, ensuring that differences in thermal expansion of the disks will not prohibit the drive from processing data to and from the pack. With the disk pack and EMA areas pressurized, foreign matter is forced out instead of being pulled in.

Room air is drawn into the RP04 by the air system blower through the prefilter, and then forced through the Absolute filter. The prefilter removes the large particles of foreign matter from the air, reducing the frequency of replacement of the Absolute filter, which is a 0.3-micron filter. The clean air output of the Absolute filter is transferred to the shroud area via an air duct; there the air is distributed into the disk pack and forced through the carriage opening (cooling the access transducer) into the EMA area to pressurize that area and force air through the EMA to cool it.

A muffin fan, mounted on the electronic gate, draws the air through the drive electronic area, cooling the drive electronic components, and then discharges the hot air to the rear of the drive. Even though the muffin fan is canted

DCL

SHROUD INLET

AIR DUCT

DCL

PREFILTER

ABSOLUTE
FILTER

NOTE:
MUFFIN FAN LOCATED
BEHIND THE ABSOLUTE FILTER

ELECTRONIC GATE
PREFILTER

ELECTRONIC GATE
MUFFIN FAN

CP-1355
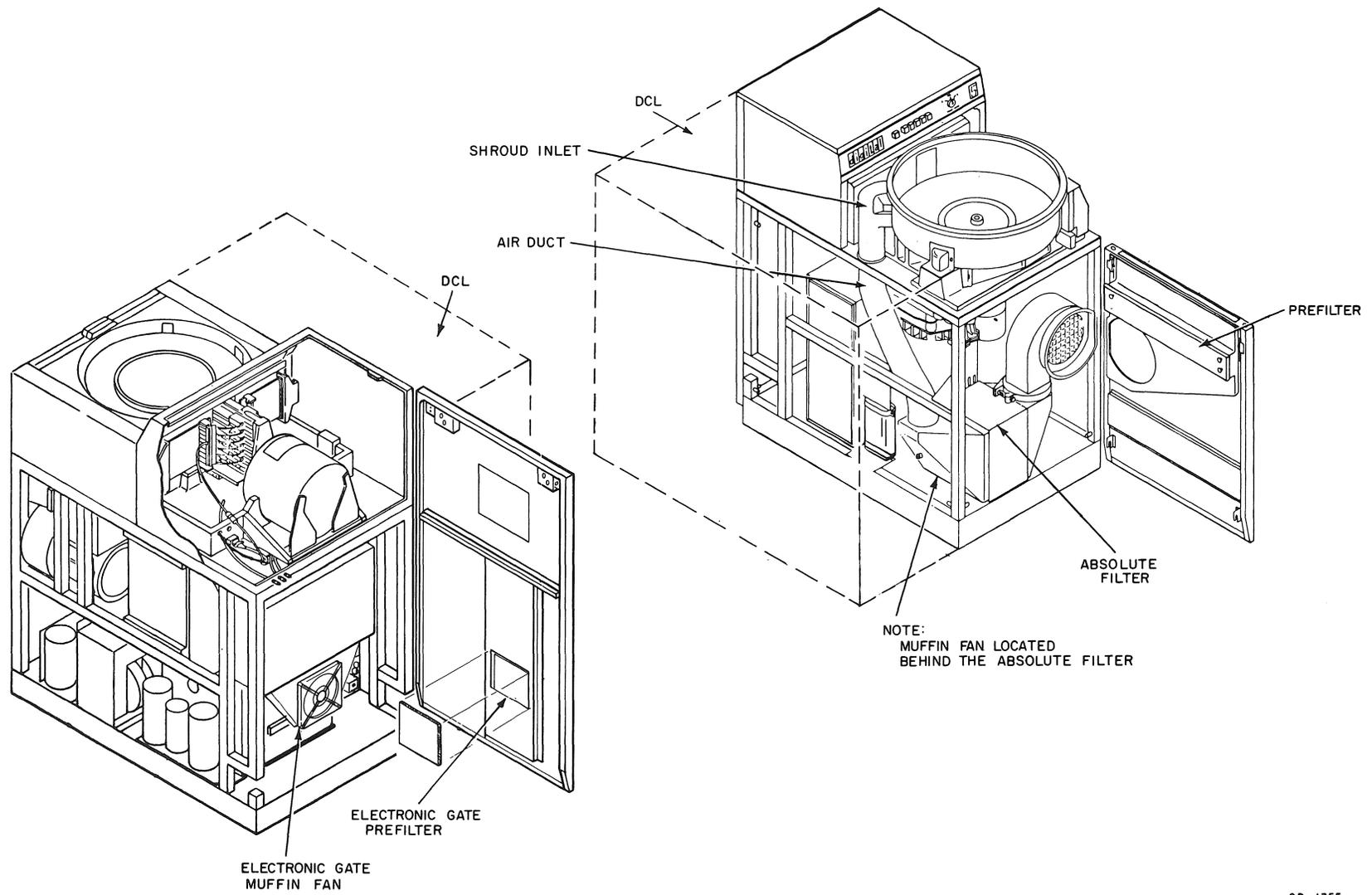
Figure 3-1 Air Circulation System

slightly to the rear, the kick plates must be installed on the front and sides of the drive so that the hot air exhausted from the electronics area will not be recirculated by the air system blower. To ensure that exhausted air moves freely away from the drive, floor air-conditioning outlets should not be placed at the rear of the drive.

3.6 ACOUSTICS
Most computer sites require at least some degree of acoustic treatment; however, the RP04 Disk Drive should not add unduly to the overall acoustic problem. Acoustic materials should neither produce nor harbor dust.

3.7 RADIATED EMISSIONS
Sources of radiation such as FM, vehicle ignitions, and radar transmitters located in close proximity to the computer system may affect the performance of the RP04 Disk Drive because of the possible adverse effect magnetic fields can have on disk packs. A magnetic field with an intensity of 50 oersteds might destroy all of the information on an individual disk pack.

The effects of radiated emissions can be reduced by:

   a.   Grounding window screens and other large metal surfaces

   b.   Shielding interconnection cables with grounded shields

   c.   Providing additional grounding to the system cabinets

   d.   In extreme radiation environments, providing a grounded cage for the system.

3.8 ALTITUDE
Computer system operation at high altitudes can result in heat dissipation problems. The maximum altitude specification for the RP04 is 6500 ft (1980 m). If operation at high altitudes is anticipated, DEC should be notified when the equipment is ordered.

3.9 CLEANLINESS
Although cleanliness is important in all facets of a computer system, it is particularly crucial in the case of a device such as the RP04 Disk Drive. Disk packs are not sealed units and are extremely vulnerable to dirt. Even such minute obstructions as smoke particles, fingerprint smudges, or dust specks can cause head crashes and catastrophic destruction of heads and/or disk surfaces, as illustrated in Figure 3-2.

During site preparation, there are a number of steps that may be taken to enhance subsequent cleanliness:

   1.   Seal all windows in the vicinity of the RP04 location.

   2.   If partitions are to be installed, consider floor-to-ceiling walls, which minimize the flow of dust.

   3.   Check that the flow of air from the air-conditioning system will tend to carry lint, etc., away from the RP04 location. Provide filtration to inhibit dust and other particulate matter.

   4.   If painting is to be done in advance of installation, select paint for walls, ceilings, and floors that will not tend to flake or powder excessively. (Waterbound distemper is generally unsatisfactory in this respect.)

   5.   Select acoustical material that will neither produce nor harbor dust.

   6.   Avoid glass fiber tiles that could produce abrasive particles, and floor coverings that tend to crack or crumble.

   7.   Provide closed cabinets for disk storage.

   8.   Clean and vacuum subfloor areas and air-conditioning systems just before installation.

   9.   Place impregnated mats at each entrance to reduce the amount of dust tracked in from other areas.

HUMAN HAIR
.004" DIA

DISK HEAD

LINT
&
DUST

FINGERPRINT
SMUDGE

SMOKE PARTICLE
250µ"

FLYING
HEIGHT
APPROX 50-100µ"

OXIDE

RPO3-2400 RPM(APPROX 93 MPH)
RPO4-3600 RPM(APPROX 140MPH)
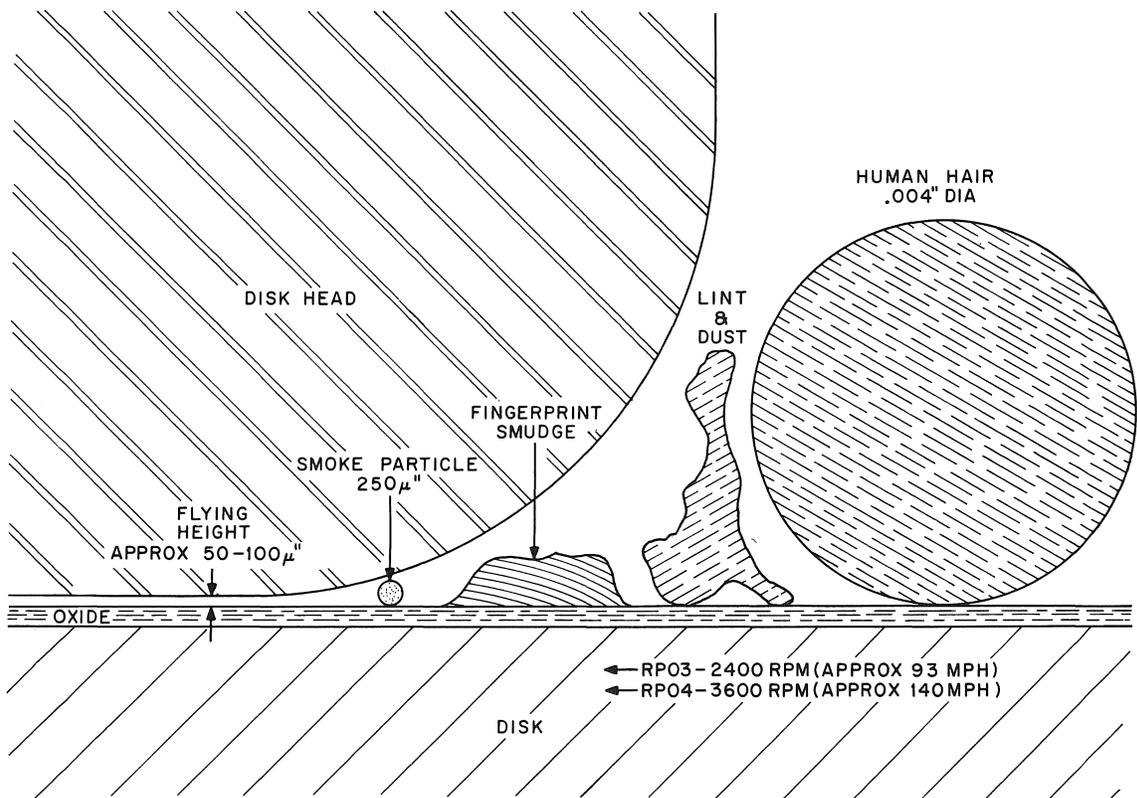
DISK

08-1097

Figure 3-2 Disk Pack-Relationship of Disk Head, Disk, Contaminants

CHAPTER 4
INSTALLATION

This chapter includes the procedures required to unpack and install the RP04 Disk Drive. The RP04 is designed to be installed as a remote device, with control logic contained in an attached Drive Control Logic (DCL) unit (Figure 1-1).

4.1 UNPACKING AND INSPECTION

The RP04 Disk Drive weighs approximately 600 lbs (272 kg); it requires a forklift or similar handling equipment to be moved or lifted. Table 4-1 lists special tools and equipment that could be required during an RP04 installation.

CAUTION
When moving or lifting the RP04 Disk Drive, always grasp the frame structure. Do NOT hold any part of the top or side covers.

Table 4-1
Tools Recommended for RP04 Installation

The following equipment is required for all RP04 installations:

Item	Part No.
Field Service Tool Kit	
Tektronix 453 oscilloscope, or equivalent	

NOTE

Oscilloscopes or meters used in the field should be calibrated frequently. Meter readings must be accurate within ±1%, oscilloscopes within ±3%.

Item	Part No.
Head fine alignment tool (Figure 4-1a)	29-21284
Head separator tool (Figure 4-1b)	29-21288

Table 4-1 (Cont)
Tools Recommended for RP04 Installation

Item	Part No.
Air measuring kit	29-21290
C.E. Pack 3336	29-21292
Data pack	RP04-P
Device Diagnostic Unit (DDU)	29-21828

The following equipment may be required if problems arise during RP04 installations:

Item	Part No.
Head installation tool (Figure 4-1c)	29-21285
Carriage alignment tool	29-21286
Head initial alignment tool (Figure 4-1d)	29-21287
Extend jump card	29-21291
Extractor tool	29-21412
Extractor pin	29-21288
Extender reverse	29-21482
Torque wrench kit	29-21487
Shim gauge (3 mil) (Green)	29-21483
Shim gauge (5 mil) (Blue)	29-21484
Shim gauge (2 mil) (Red)	29-21486
Brush	29-21481

a. Head Fine Alignment Tool   b. Head Separator Tool

c. Head Installation Tool   d. Head Initial Alignment Tool
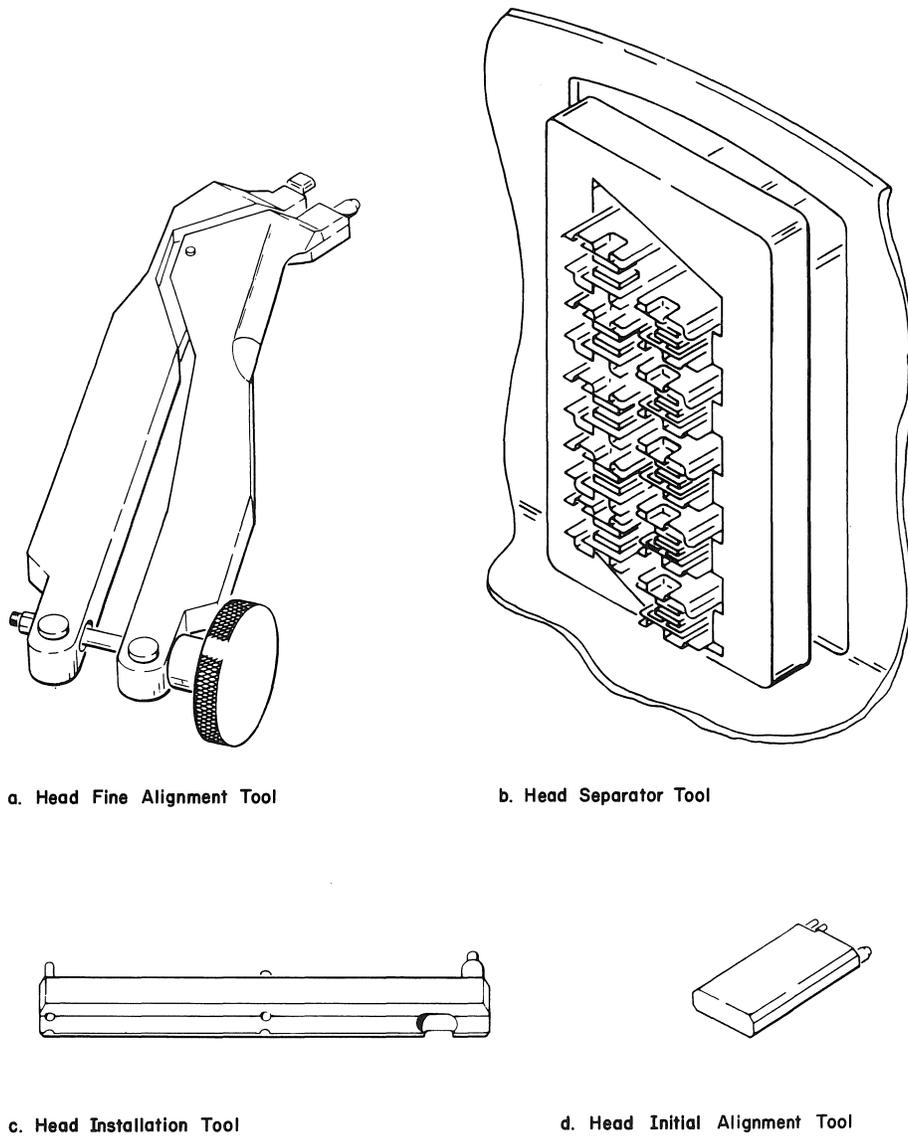
CP-1356

Figure 4-1   Special Tools for RP04 Installation

The procedure for unpacking the RP04 is as follows:

1.   The RP04 is shipped on a shipping skid, covered by a cardboard carton (Figure 4-2). Remove the two plastic straps that hold the disk pack on top of the carton, then remove the disk pack.

2.   Remove the staples that fasten the four wooden slats to the bottom flanges of the cardboard overlap carton.

3.   Remove the cardboard overlap carton.

4.   Remove the polyethylene bag that covers the RP04 (Figure 4-3).
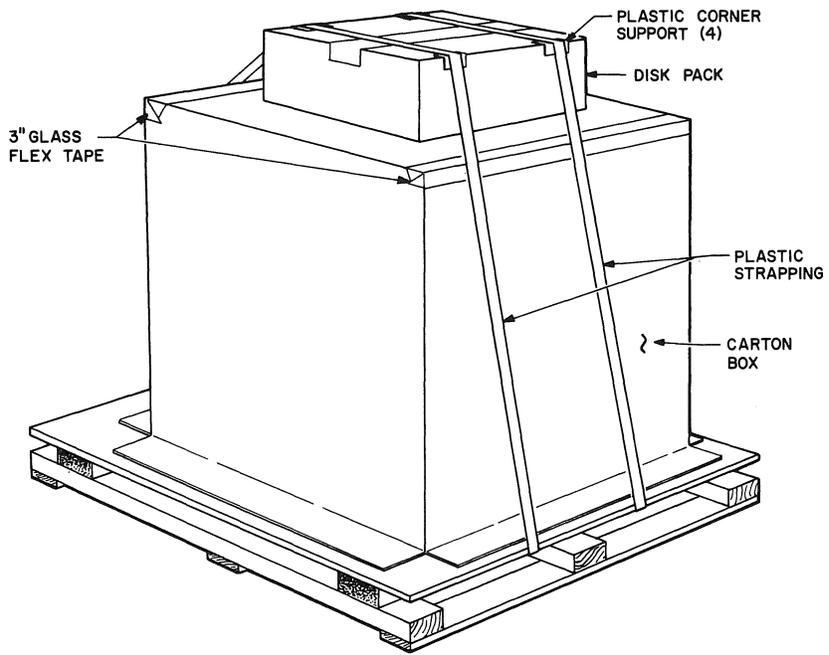
Figure 4-2 Shipping Configuration w/Box
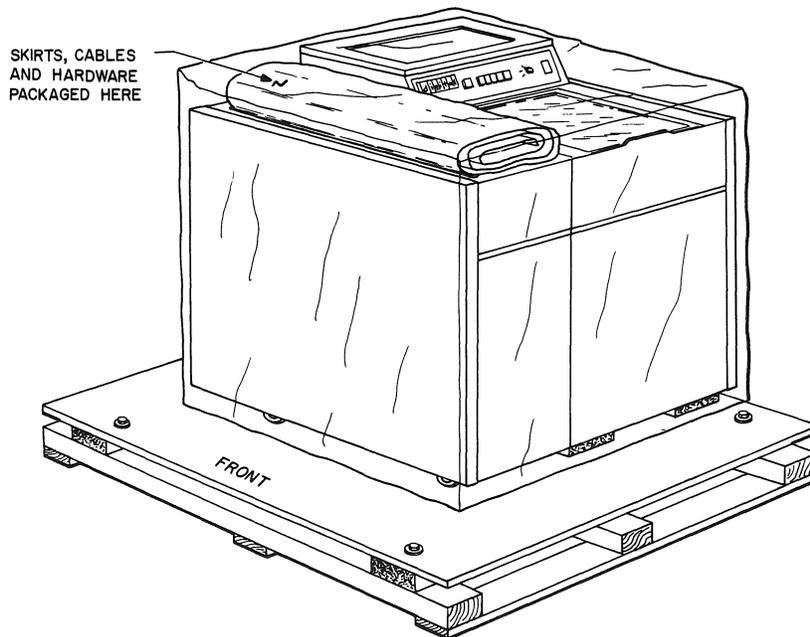
Figure 4-3 Shipping Configuration, Box Removed

5. Remove the package resting on top of the RP04; verify that it contains the following:

Item	Part No.
Skirts (7)	7411193
Screws (8)	9006418-1
Lock washers (8)	9006690
Flat washers (8)	9006661
Power sequence cable	7009491-0-1
Massbus cable*	BC06S-02
Ground wire strap	7412827-03-0

*One each for single-access unit; two each for dual-access unit.

6. Remove the tape from the door end panels.

7. Visually inspect the exterior of the RP04 for evidence of shipping damage. Retain the original packing materials and receipts in case any claims are filed for shipping damage. All damage claims should be promptly filed with the transportation company involved, and Digital Equipment Corporation should be notified immediately of any such claim.

8. Remove all service covers for inspection.

NOTE
Side covers are not used between drives that are to be installed side-by-side in the string configuration. Only exposed sides should be covered.

9. Push and release the operator cover latch, then slide the operator cover to the rear. Manually turn the spindle in a counterclockwise direction to verify that it spins freely. Depress the cone-shaped, pack-lock actuator at the left front of the spindle; manually turn the spindle in a clockwise direction. The spindle should lock to verify that it will hold the pack and permit disk pack top cover removal.

NOTE
The drive is transported with a shipping bracket installed to prevent carriage assembly motion during transit. Do NOT remove this shipping bracket yet.

10. Visually inspect the RP04; tighten all sub-assembly mounting hardware and all terminal connections. (The subassembly locations are identified in Figures 3-1 and 4-4 through 4-9.) Remove the sliding door cover assembly to inspect the brush drive and support assembly. Open the sequencer assembly to check the terminal connections and mounting hardware. Access to the sequencer is gained by releasing the gate latch and opening the electronic gate assembly. Two quick-disconnect fasteners release the sequencer cover, and a single knurled screw inside the sequencer releases the door. Access to the DCL backplane is gained by removing the front cover. To then gain access to the logic modules, loosen the two thumb-screws at the top, pivot the assembly forward and down, and loosen two screws to remove the inside cover. To gain access to the DCL power supply, remove the front cover.

11. Check the drive power requirements on the nameplate (Figure 4-10) to verify that they agree with facility power. If not, refer to Paragraph 4.5 for conversion procedures. Verify power system wiring as described in Paragraph 4.6.

12. Release the gate latches to open the electronic gate assemblies (Figures 4-4 and 4-5); check that all modules are properly seated and that all wiring harness connectors are properly connected.

13. Check that matrix modules and head plugs are properly seated (Figure 4-9).

14. Visually check the cam-follower surfaces of all head/cam assemblies to verify that arms are properly engaged with cams on tower assemblies.

15. Check the four 40-pin ribbon cables (marked A, B, C, and D) that connect the drive to the DCL unit (Figure 4-11); ensure that the connectors are securely seated in the corresponding (A, B, C, or D) receptacle on module A04 or B05 (Figure 4-12).

A1A05
DRIVE ELECTRONIC GATE A1
A1B05
STRAIN RELIEF BRACKET
SIGNAL CABLES
POWER SUPPLY A2
3Ø AC INPUT CABLE

DRIVE
RECEIVER
DCL ELECTRONIC GATE
SEQUENCER A4
DCL GROUND LEAD
MASSBUS CONNECTORS
DCL AC CONNECTOR SINGLE Ø FILTERED AC

PB000487/ 12/73
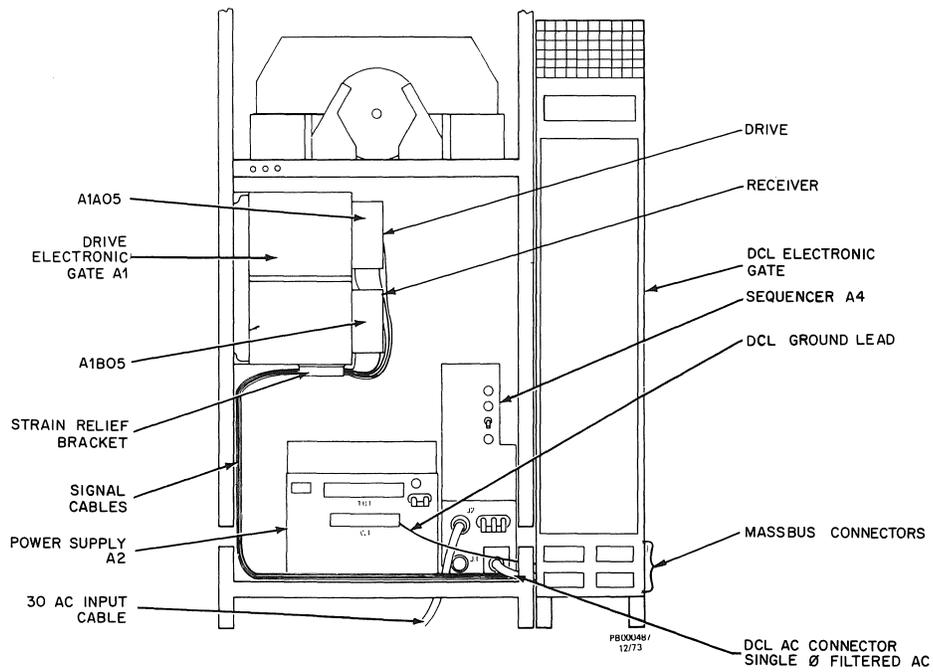
CP-1359

Figure 4-4   RP04 Drive Installation

DCL
SEQUENCER A4
RESONANT CAPACITOR
DRIVE ELECTRONIC GATE A1
DRIVE POWER SUPPLY A2
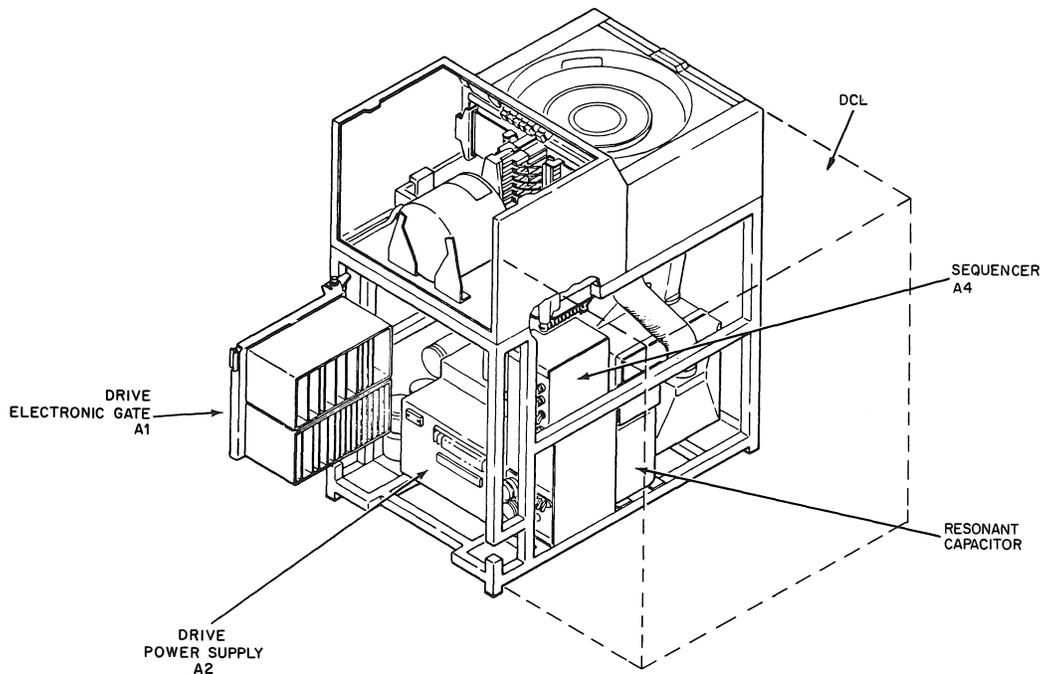
CP-1360

Figure 4-5   RP04 Drive Rear View

4-5

DCL

F3-1 AMP
F2-1 AMP
CB2
F3 15 AMP
CB1
DCL AC POWER CONNECTOR

A14
A2

AC INPUT CONNECTOR

SEQUENCER

RESONANT CAPACITOR

SEQUENCER A4

DRIVE POWER SUPPLY A2

DCL

POWER TRANSISTOR HEAT SINK

POWER SUPPLY TERMINAL BOARD A2TB1

F4 6/10 AMP

CB4

GROUND BUS A2W1

POWER TRANSFORMER

DRIVE POWER SUPPLY A2

DRIVE POWER SUPPLY
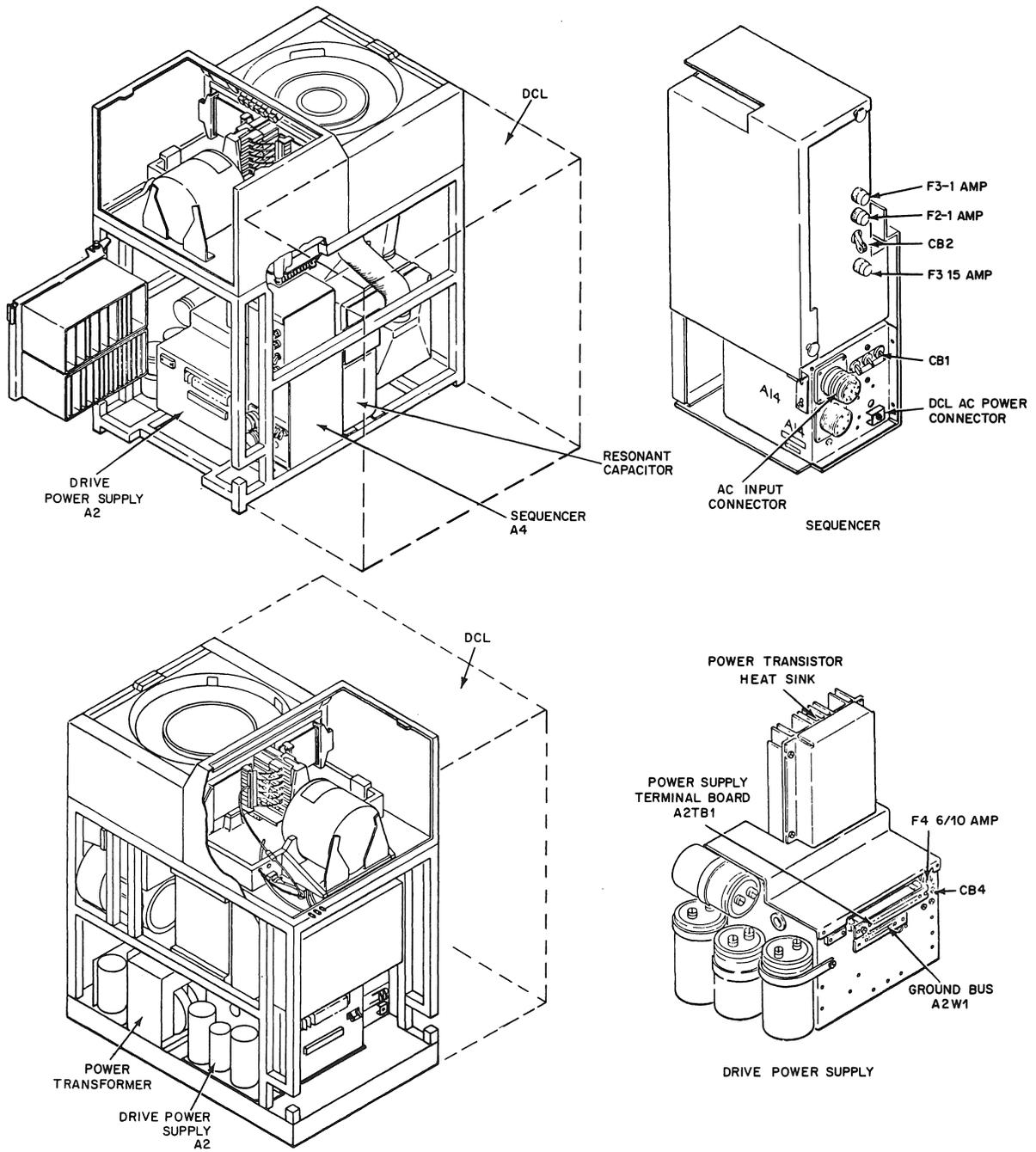
CP-1361

Figure 4-6   RP04 Power System

DCL

EXTENSION SPRING

SPINDLE ASSEMBLY

BRUSH DRIVE ASSEMBLY

PACK LOCK
ASSEMBLY

DCL

SPEED
SENSOR

PACK ON
SWITCH

DRIVE
MOTOR
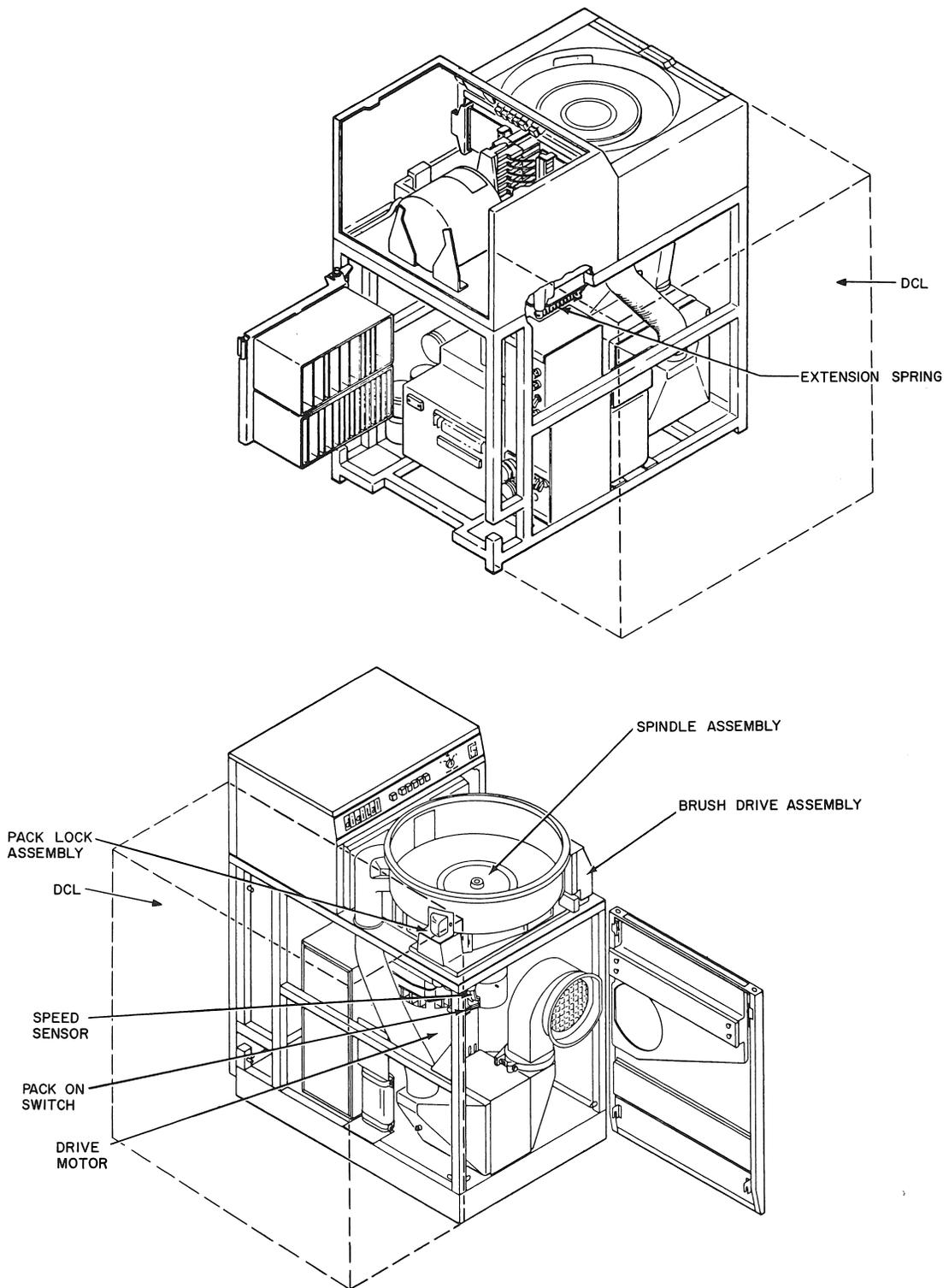
CP-1362

Figure 4-7 Disk Rotation System
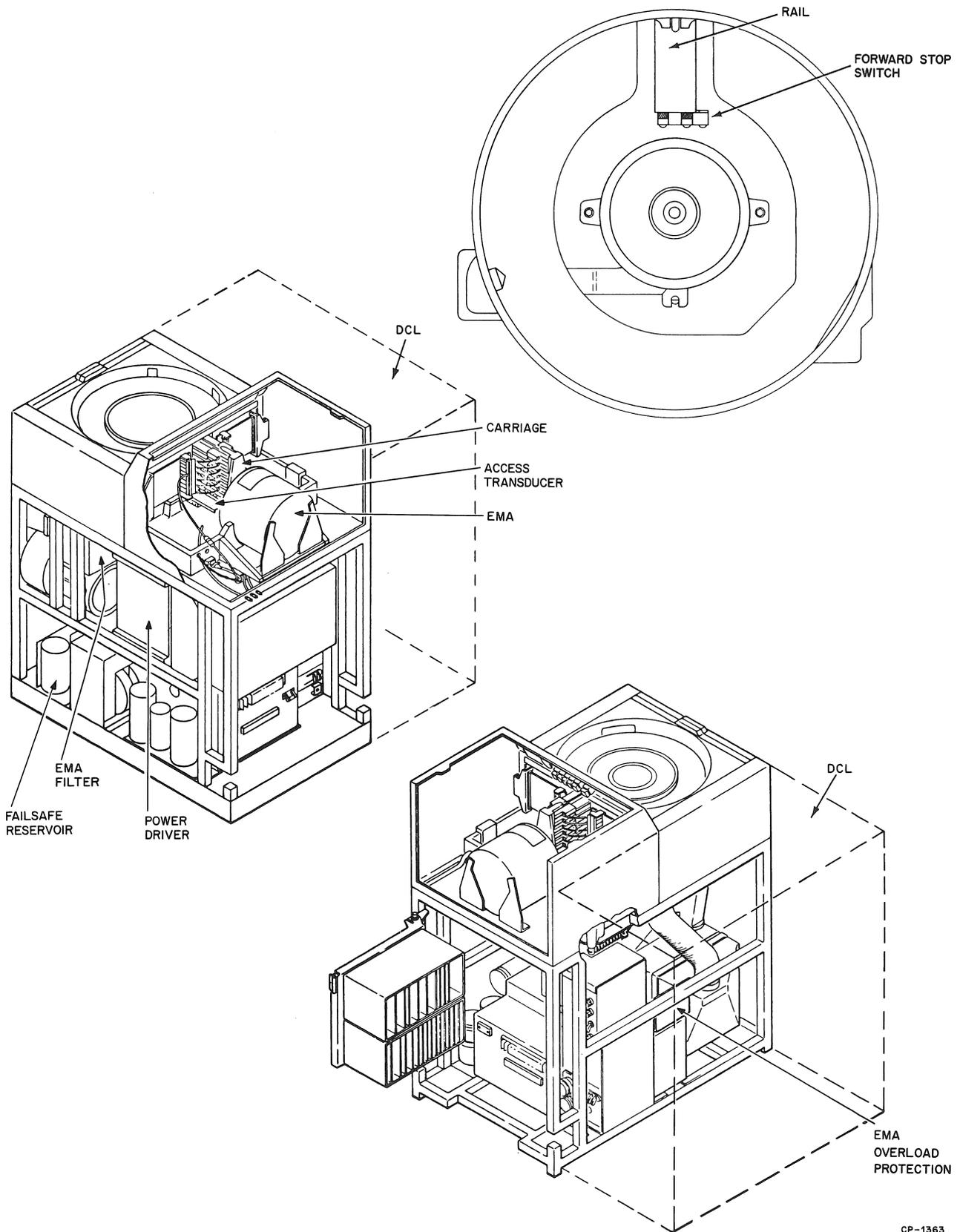
Figure 4-8 Cylinder Positioning Components

VIEW (A) 90° CCW

HEAD NUMBERS

VIEW (B) 90° CW

A DOWN HEAD (4)

A DOWN SERVO HEAD

A UP HEAD (5)

1
3
5
7
S
9
11
13
15
17

0
2
4
6
8
10
12
15
18

B DOWN HEAD (5)

B UP HEAD (5)

T-BLOCK (A SIDE)

T-BLOCK (B SIDE)

EVEN MATRIX CARD

HEAD ASSEMBLIES

DCL

ODD MATRIX CARD
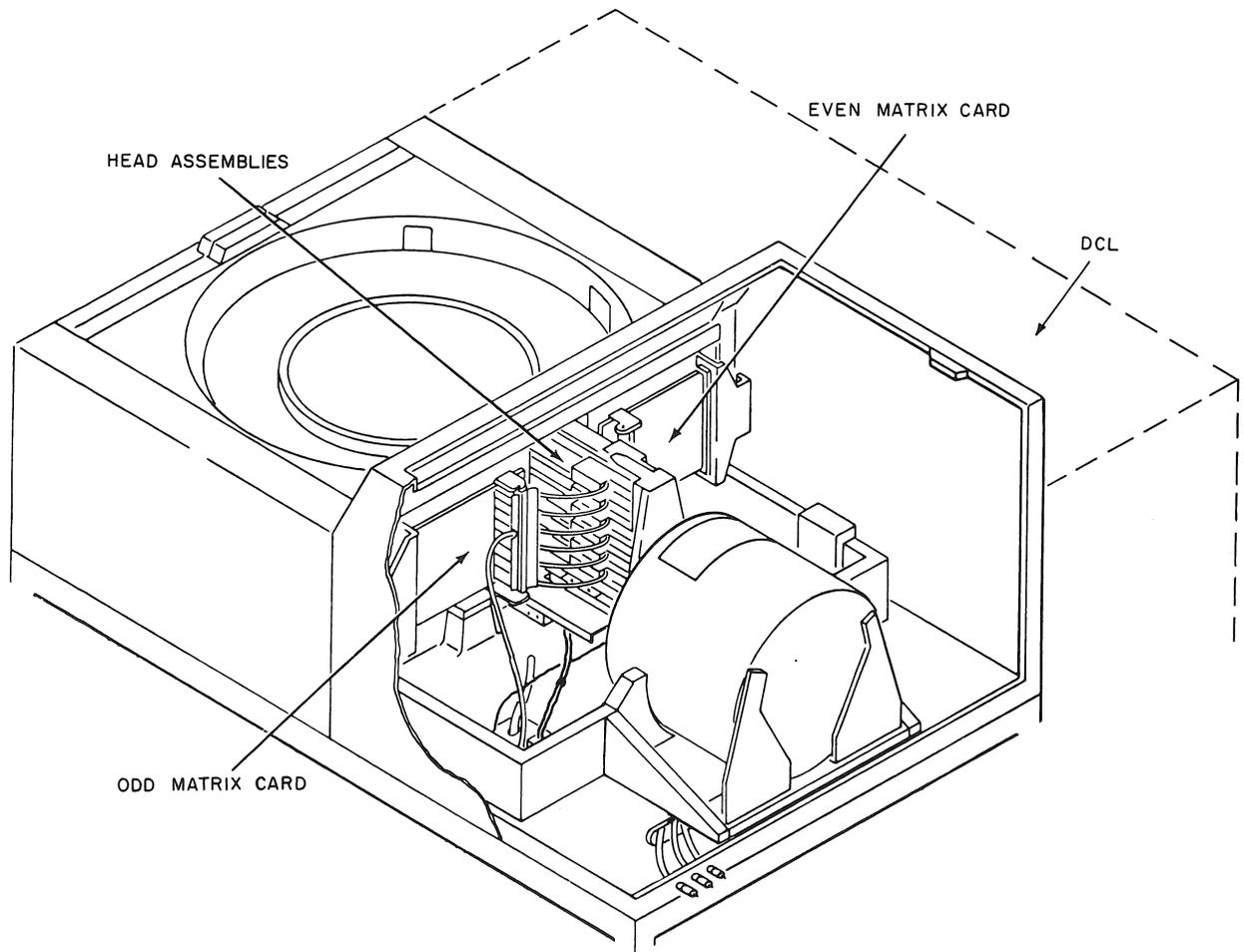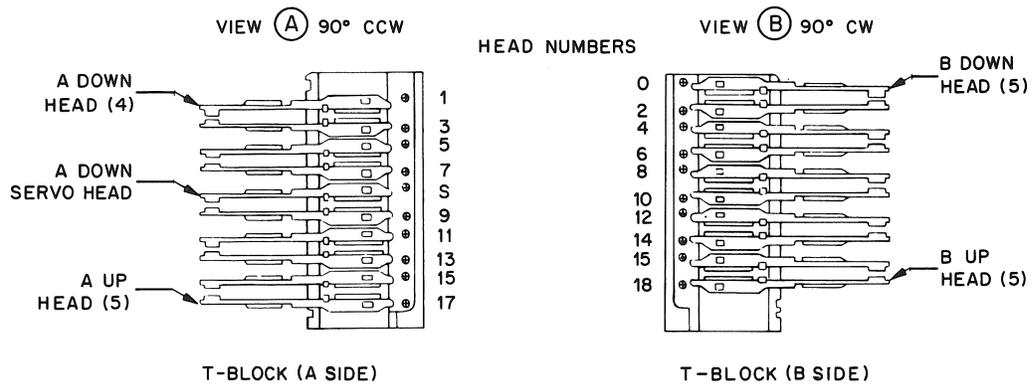
CP-1364

Figure 4-9   Head Arrangement

4-9

RP04-BB IDENT (50 HZ DUAL PORT)
RP04-BA IDENT (60 HZ DUAL PORT)
RP04-AB IDENT (50 HZ SINGLE PORT)
RP04-AA IDENT (60 HZ SINGLE PORT)

GROUND STUD

SERIAL
NUMBER TAG   CP-1465
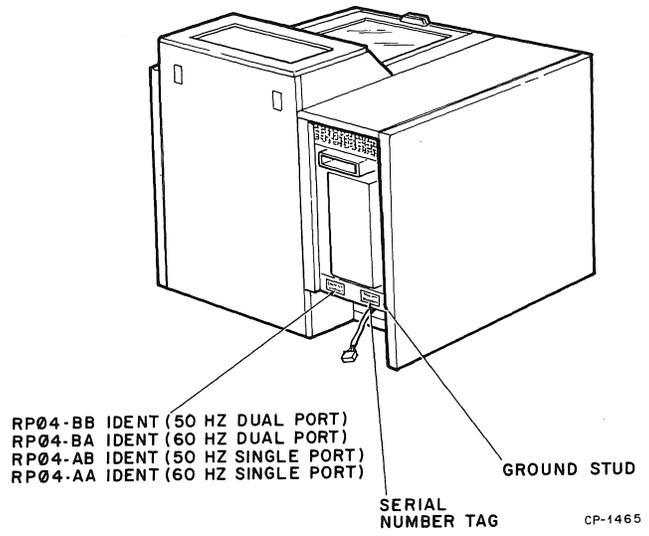
Figure 4-10   Location of Nameplate
and Serial Number Tag

POWER CABLE
(PLUGS INTO J2)

POWER LINE
(PLUGS INTO J1)

CP-1463
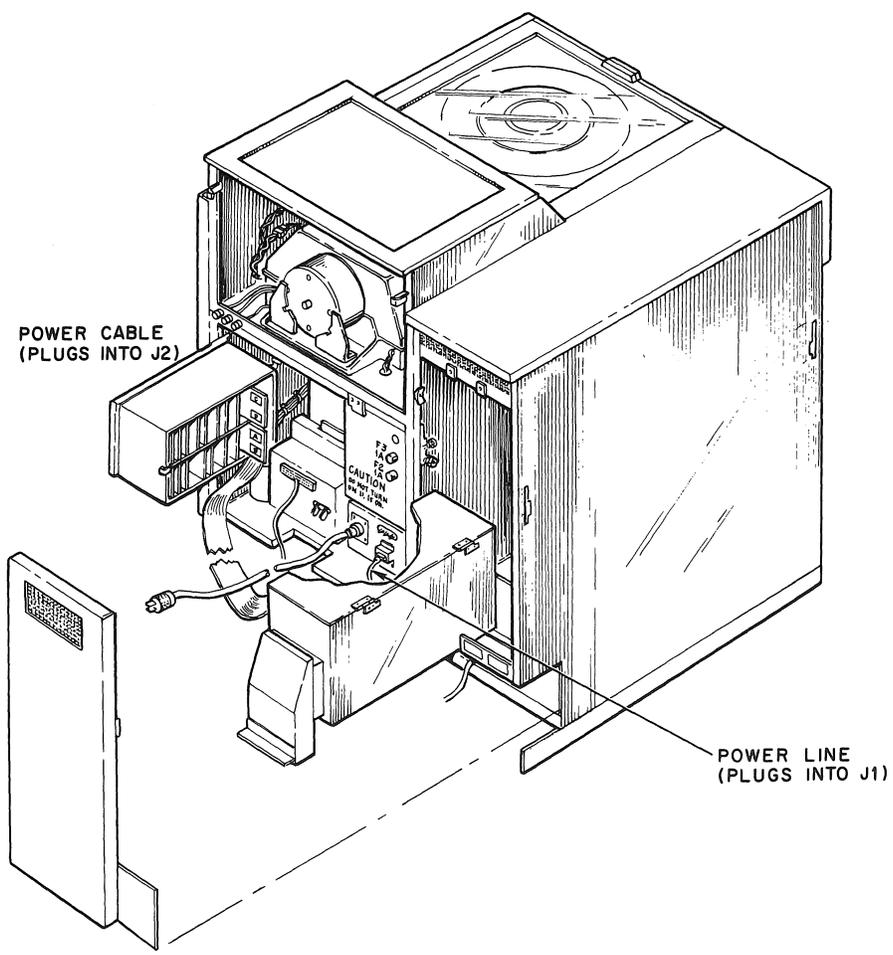
Figure 4-11   Location of Cable Connections

4-10
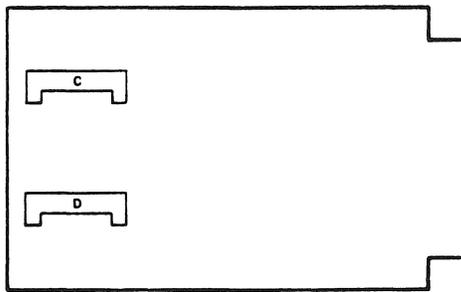
A1A05
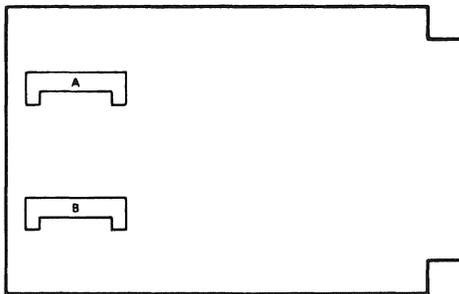
A1B05

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Figure 4-12 DCL/Drive Signal
Interface Connections

16. Measure the electromagnetic actuator coil assembly resistance across the coil leads to determine that the resistance is 1.60 ohms (typical) and that no shorts or opens exist.

17. Replace all service covers removed in step 8, unless off-line checkout is to be performed at this time.

4.2 INSTALLING THE RP04

The first RP04 Disk Drive must be mounted within 40 ft of the controller and within 15 ft of a facility ac power source. The safety precautions in Paragraph 4.2.1 should be observed while following the installation procedure in Paragraph 4.2.2.

4.2.1 Safety Precautions
Observe the following precautions to avoid injury to personnel or damage to the equipment:

1. Keep fingers and hands out of the area between the carriage and the disk pack while the drive is ON.

2. *Always* remove ac power cables when it is necessary to work inside the drive sequencer assembly or on the transformer assembly terminals when the drive is not operating; high potentials up to 230 Vac/60 Hz or 400 Vac/50 Hz are present.

3. Use only nonmagnetic tools near the EMA, which includes an extremely powerful magnet. Use care when working in the EMA area with magnetic materials, even though flux leakage is low in the pack area and outside the drive. Keep read/write heads away from the EMA.

4. Avoid touching or blowing breath on read/write heads; skin acids can etch and ruin heads and breath can cause condensation deposits that could disfigure the gliding surface.

5. *Never* manually move the carriage assembly forward without a spinning disk in place or the head separator tool installed.

6. *Never* remove or change modules without shutting down all internal drive power.

4.2.2 Installation Procedure

1. Roll the RP04 to its designated location. Level it by lowering the six levellers, removing all weight from the casters (Figure 4-4).

2. Remove the two rear panels from the RP04.

3. Verify that the facility ac power agrees with the RP04 input power configuration (Paragraph 4.6). If a discrepancy exists, change the ac input power configuration of the RP04 to conform to available facility power (Paragraph 4.5).

4. Check that CB1 is OFF (Figure 4-13); then connect the power cable to the RP04. The cable to use is:

70-6464-4 — 60 Hz
70-6464-3 — 50 Hz

5. It is possible to daisy-chain two drives to a single ac power source by plugging the power cable of the first directly into the source and connecting the first drive to the second by means of an 8-ft power cable jumper (P/N 7006600-1).

6. Connect a 25-ft ground wire (P/N 7412827-25) from the ground stud at the bottom of the DCL to the stud at the bottom of the cabinet containing the RH11 or RH10.

7. Check that the power sequence jumper (P/N 7009490) is installed in J12 of the DCL. (Refer to drawing D-UA-RJP04-A-0.)

8. Connect the round 25-ft Massbus cable (BC06S-25) from the DCL connector marked "Controller A Input" to the connector panel in the controller cabinet.

9. If the installation is multidrive, proceed to step 10; otherwise, proceed to step 14.

10. Connect a round 2-ft Massbus cable (BC06S-02) from the DCL connector marked "Controller A Output" to the connector in the second drive marked "Controller A Input".

11. Repeat step 10 for each additional drive in the configuration.
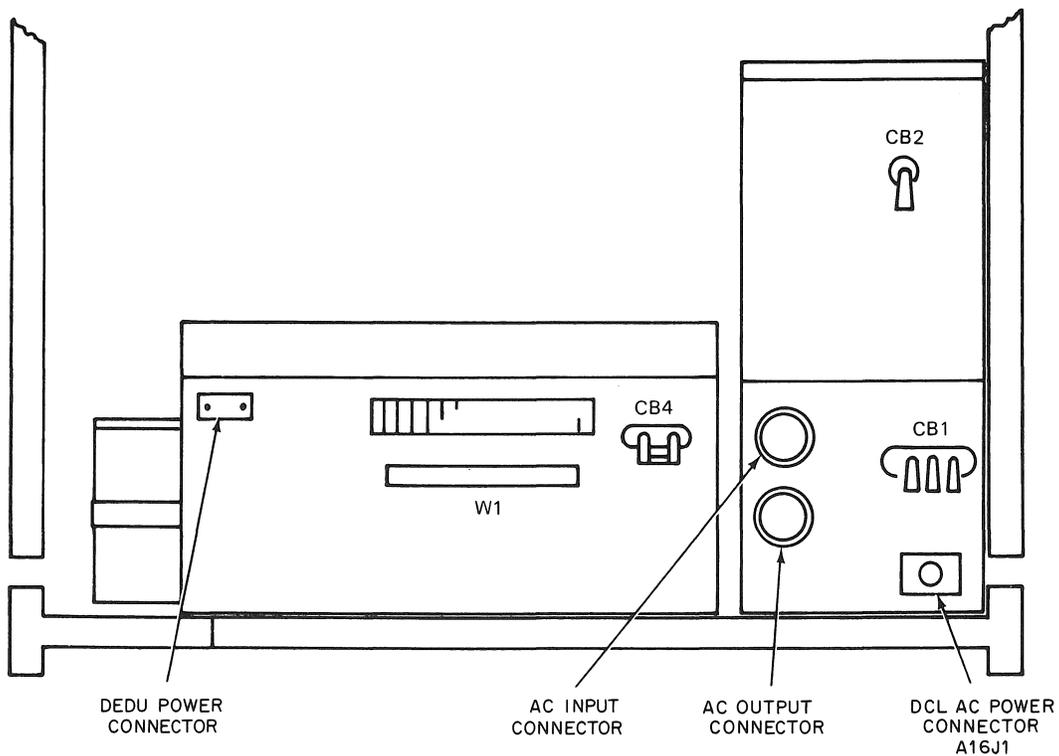
CP-1366

Figure 4-13 Drive Connectors and Circuit Breakers

12. Daisy-chain all drives by connecting 3-ft ground wires from one DCL stud to the next.

13. Daisy-chain all drives by connecting 3-ft power sequence cables (7009491-1) from J13 of the preceding drive to J12 of the next. For the first drive, the power sequence jumper should be connected to J12.

14. For the last drive, connect a Massbus terminator pack assembly (7009938) to the DCL connector marked "Controller A Output". In some cases, M5903YA transceiver cards may be used instead of the terminator pack assemblies.

NOTE
For a dual-controller configuration (refer to drawing E-UA-RJP04-B-0), the installation of the second Massbus should follow the above pattern. The DCL connectors used are those marked "Controller B Input" and "Controller B Output". A second Massbus terminator must be used in the last drive. The second controller may be mounted in the same box as the first or in a different cabinet. If the same box is used, a second receptacle housing is mounted in the connector panel to accommodate the second Massbus; if different cabinets are used for the controllers, two connector panels are necessary.

15. Lower the logic nest assembly in the DCL and remove the rear cover.

16. Set the drive unit number on the M7775 module.

4.3 INSTALLATION CHECKS AND ADJUSTMENTS
To verify performance and adjust the RP04, perform the various installation checks and adjustments described below.

4.3.1 DCL Power Supply Voltage Check
The DCL power supply develops three dc output voltages (+5 Vdc, -15 Vdc, and +15 Vdc), and is constantly monitored by a power monitor unit. The heavy dotted line in Figure 4-14 indicates the chassis outline; the lighter dotted lines indicate the two regulator board modules (A1 and A2). The DCL power supply is activated by turning ON the CB1 circuit breaker at the base of the drive.

Regulator Board A1 issues:

 a. AC LOW and DC LOW to the power monitor – If these voltages should fail, the power monitor will set error flags.

 b. +5 Vdc to the power monitor and to the DCL backplane – This voltage should be viewed on the power monitor and adjusted on the power supply.

 c. -15 Vdc to the DCL backplane – This voltage should be viewed at the backplane and adjusted on the power supply.

Regulator Board A2 issues:

 a. AC LOW and DC LOW to the power monitor – If these voltages should fail, the power monitor will set error flags.

 b. +5 Vdc to the power monitor and to the DCL backplane – This voltage should be viewed on the power monitor and adjusted on the power supply.

 c. +15 Vdc to the power monitor – This voltage should be viewed on the power monitor and adjusted on the power supply.

CAUTION
To avoid possible damage to the equipment or to the electrical system, do not adjust voltages beyond the limits shown in Figure 4-15a.

4.3.2 Drive Power Supply Voltage Check

CAUTION
Ensure that CB1 is OFF before changing the position of any other circuit breaker.

Power supply dc voltages must be within the required ranges, as shown in Figure 4-15b. Place circuit breakers to the ON position. Check dc voltage levels between the drive power supply terminal board TB1 and the ground bus W1.
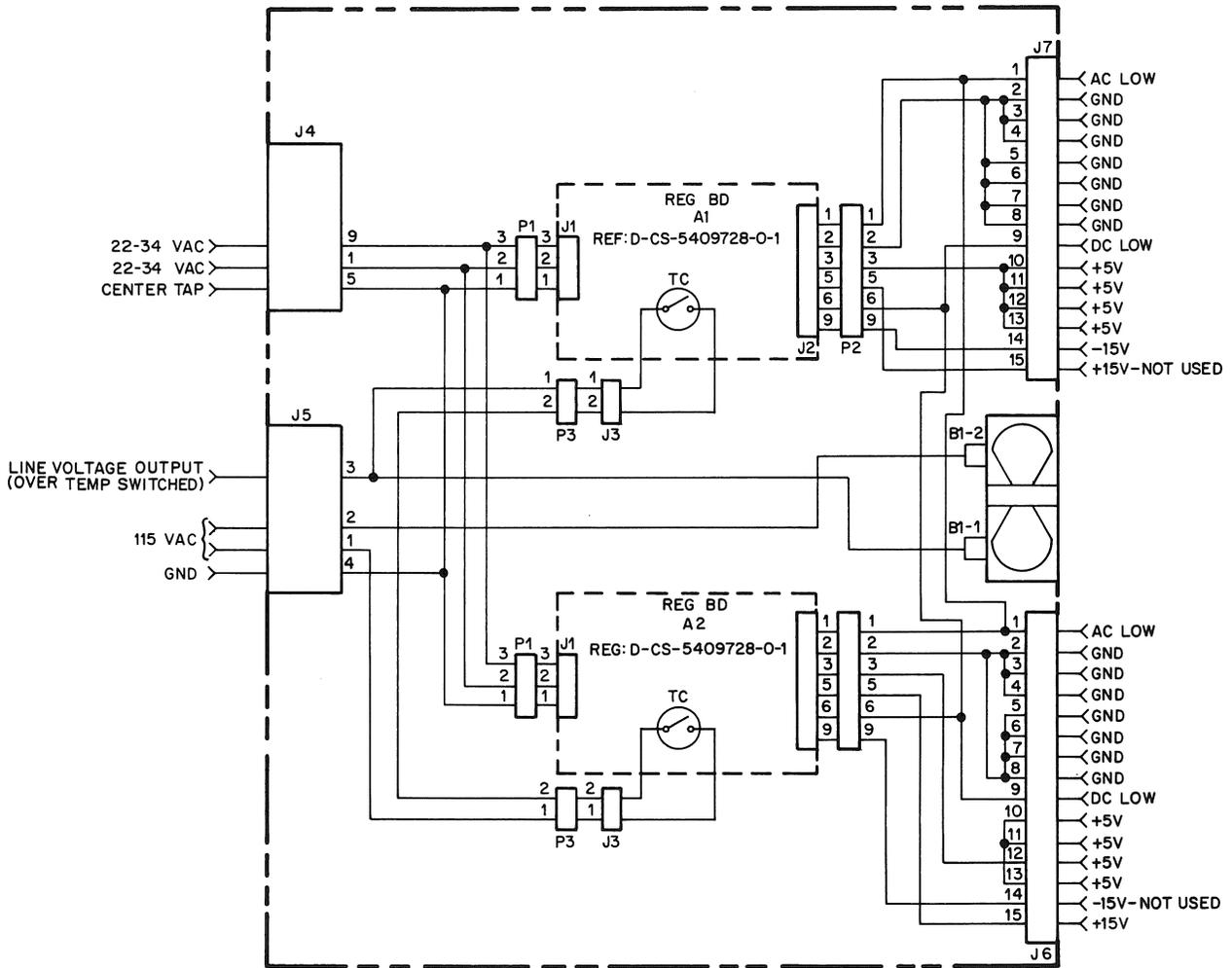
Figure 4-14   DCL Power Supply Schematic

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4-14

TB1

1 2 3 4 5 6 7 8 9 10 11 12 13

1 2 3 4 5 6 7 8

W1

W1	PIN NUMBER	NOMINAL VDC	VDC LIMITS
	1	+20.5	+19.5 TO +21.5
	2	+12.5	+11.9 TO +13.1
	3	+ 5.0	+4.75 TO +5.25
	4	− 5.0	−4.75 TO −5.25
	5	−12.5	−11.9 TO −13.1
	6	−22	−20.9 TO −23.1
	7	−40	−38.0 TO −42.0
	8	−48	−43.2 TO −52.8
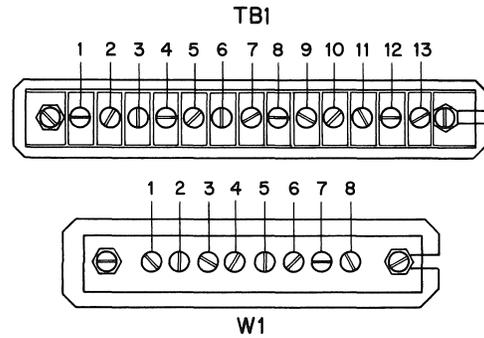
SIGNAL	LIMITS
+5 VDC	5.0 TO 5.2 VDC
+15 VDC	14.9 TO 15.3 VDC
−15 VDC	−14.9 TO −15.3 VDC
AC LOW	4.5 VDC MIN
DC LOW	4.5 VDC MIN

a. DCL

b. Drive

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Figure 4-15   DCL and Drive Power Supply Voltages

4.3.3 Hold Reverse Current Check

CAUTION
Do NOT remove the shipping bracket to perform this check.

1. Remove the rear cover assembly.

2. With CB2 ON and CB1 OFF, jumper the pack-on switch contacts below the spindle.

3. Connect a jumper between A1B1649 and B1602 (ground) on the electronic gate assembly back panel.

CAUTION
Ensure that the heads do NOT move forward off the cams when performing this step.

4. Manually move the carriage *forward* from the retracted position.

5. Turn CB1 ON. Check for the presence of hold reverse current by verifying that the carriage moves *backward* against the rear stop.

6. Turn CB1 OFF.

7. Remove ground from A1B1649 and remove the jumper from the pack-on switch.

8. Remove the shipping bracket (the L-shaped bracket inside the disk shroud) and replace the mounting screw.

4-15

4.3.4 Head Load Check

The head load check is performed during the power-on sequence to ensure that operational status can be attained. The procedure is as follows:

CAUTION
The head lock shipping bracket must be removed before this check is performed.

1. Turn CB1 OFF, install the disk pack on the drive, turn other circuit breakers ON, and then turn CB1 ON.

2. Depress the START switch to the latched-down position. As the drive cycles through the power-on sequence, observe that:

   The drive motor starts and the disk pack rotates in a counterclockwise direction.

NOTE
If the disk pack rotates in a clockwise direction, change the phase connection at the ac power connector.

   The brushes cycle into and out of the disk pack.

   The carriage moves forward to load the heads, then returns to cylinder 000.

NOTE
The heads will not load if the disk pack is rotating in the wrong direction.

   The READY indicator lights.

3. Depress the START switch again to release it from the latched-down position, and check the operation of the dynamic brake. The disk pack should stop rotating within 15 seconds. Verify that the dynamic brake is disabled by turning the pack *slowly* by hand.

4.3.5 System Offset Adjustment

Drive track-following system offset is adjusted with the carriage in the retracted position by varying the potentiometer on the Servo Select module (A1A13) while observing the meter of the Device Diagnostic Unit (DDU).

System offset must be adjusted after changing the TF Servo Amplifier module (A1A03), the TF Servo Clock module (A1A04), or the Servo Select module (A1A13). The procedure is as follows:

1. Stop the drive by depressing the START switch to release it from the latched-down position.

2. Remove the rear cover assembly and set CB1 to OFF.

3. Release the gate latch to open the electronic gate assembly and insert the DDU buffer paddle assemblies (75004226 and 75004225) into drive sockets A1A09 and A1A10, respectively.

4. Connect the 9-pin power cable plug of the DDU to the drive power supply receptacle (A2J2). *Do not start the drive at this time.*

5. Set CB2 to OFF (or the DEDU EMA switch to DISABLED), then set CB1 to ON.

6. Set the DDU FUNCTION switch to SYSTEM OFFSET.

7. Set the DDU RANGE switch to GL POS SIG.

8. Adjust the potentiometer on the drive Servo Select module (A1A13) for a zero meter indication.

9. Set the DDU FUNCTION switch to the unlabeled top position.

10. Set CB1 to OFF.

11. Set CB2 to ON and the DDU EMA switch to ENABLED.

NOTE
System offset adjustment will affect head alignment. Verify head·alignment (Paragraph 4.3.10.1) before returning the drive to service.

4.3.6 Tachometer Gain Adjustment

Tachometer gain may be adjusted in either of two ways, depending on whether or not a DDU is used.

Tachometer Gain Adjustment Using a DDU

1. Set the DDU RANGE switch to POS SIG.

2. Set the DDU FUNCTION switch to GL POS 2 ADJ.

3. Set the DDU EMA switch to DISABLE.

CAUTION
Set the DDU FAILSAFE/INHIBIT switch to INHIBIT before proceeding, to guard against crushed fingers.

4. Install a scratch pack and start the drive.

5. Manually load the heads; move the carriage assembly back and forth repeatedly. The extent of carriage motion, while not critical, should be long enough to provide stable meter indications.

6. While moving the carriage assembly, adjust the lower potentiometer on the tachometer module (A1A15) for a zero meter indication.

7. Set the DDU FUNCTION switch to GL CYL VIC ADJ.

8. Repeat the manual carriage assembly movement and adjust the upper potentiometer on the tachometer module (A1A15) for a zero meter indication.

9. Depress the DDU RECAL pushbutton and set the EMA switch to ENABLE. The drive servo will perform a Recalibrate seek to cylinder 000.

10. Set the DDU FAILSAFE/INHIBIT switch to FAILSAFE.

Tachometer Gain Adjustment Using a Dual-Trace Oscilloscope

1. Monitor the Cylinder Vicinity signal at A1A1529 and Glass Position 2 signal at A1A1532 on a dual-trace oscilloscope.

2. Switch CB1 OFF, then switch CB2 OFF. Return CB1 to the ON position.

3. Jumper pin A1B1649 to ground (A1B1602). This disables the Failsafe Unload function.

4. Install a scratch pack and start the drive.

5. Manually load the heads onto the spinning pack.

6. While manually moving the carriage assembly back and forth, adjust the upper potentiometer on the tachometer module (A1A15) for a Cylinder Vicinity signal amplitude of 8.2+0/−0.2 V peak-to-ground (Figure 4-16).

7. While continuing to move the carriage assembly back and forth manually, adjust the lower potentiometer on the tachometer module (A1A15) for a Glass Position 2 signal amplitude of 8.2+0/−0.2 V peak-to-ground (Figure 4-16). These waveforms must be within tolerance and as close to equal as possible.
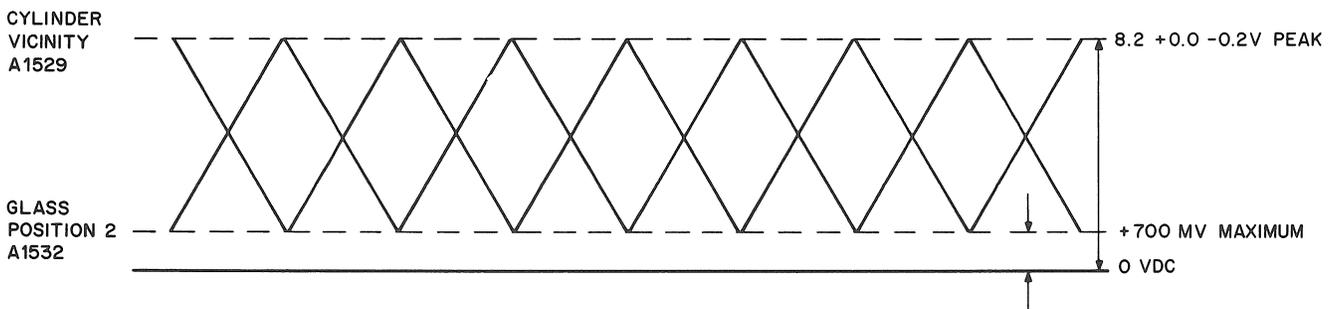
Figure 4-16 Cylinder Vicinity and Glass Position 2 Waveforms

8. Return the heads to the retracted position, then depress the START switch to release it from the latched-down position. Wait for the disk pack to stop rotating, then remove the jumper from A1B1649. Remove the oscilloscope probes from A1A1529 and A1A1532, and then remove the scratch pack. Set CB1 OFF and reset CB2. Return CB1 to the ON position.

4.3.7 Access Velocity Check

Access time is checked to determine the interval of the Seek In Process signal at B1314. The elapsed time is displayed in binary form by the LED indicators on the DDU GATE LOGIC DISPLAY. The value assigned to each LED position is indicated on the roll chart at function 12, ACCESS TIME. For example, 27.6 ms access time is indicated by illuminated LEDs above the 16.7-, 8.3-, 2.1-, and 0.5-ms positions (hex 35). An access time of approximately 28 ms should be displayed for a 136-cylinder seek. To determine access time, perform the appropriate procedure below.

4.3.7.1 Access Time Adjustment Using a DDU

1. Stop the drive by depressing the START switch to release it from the latched-down position.

2. Remove the rear cover assembly and set CB1 to OFF.

3. Release the gate latch to open the electronic gate assembly and insert the DDU buffer paddle assemblies (75004226 and 75004225) into drive sockets A1A09 and A1A10, respectively.

4. Connect the 9-pin power cable plug of the DDU to the drive power supply receptacle (A2J2).

5. Set the DDU switches as follows:

   FUNCTION – unlabeled top positions
   EMA – ENABLE
   FAILSAFE/INHIBIT – FAILSAFE

6. Set CB1 to ON.

7. Set the DDU GATE LOGIC DISPLAY thumbwheel to display function 12, ACCESS TIME, on the roll chart.

8. Perform a 136-cylinder Seek Forward operation ($136_{10} = 88_{HEX}$).

9. Halt the routine, then add the roll chart values below each illuminated LED indicator to compute access time.

10. Repeat steps 8 and 9, above, for the Reverse Seek.

11. If both indicated access times are 27.6 to 28.6 ms, no adjustment is required. If either access time is less than 27.6 or more than 28.6 ms, adjust the Curve Generator module (A1A12) potentiometer so that the access time is 28.1 ms (hex 36).

4.3.7.2 Alternate Access Time Adjustment Procedure – Access time may be verified and adjusted with the RP04 operating on-line by using a dual-trace oscilloscope, as follows:

1. Monitor the Seek Start signal at A1B0817 and the Access Ready signal at A1B1315 on a dual-trace oscilloscope.

2. Adjust the oscilloscope to trigger on negative (–) transition of the Seek Start signal.

3. Perform a 136-cylinder Seek/Seek operation ($136_{10} = 88_{HEX}$).

4. The time interval between the SEEK START and ACCESS READY signals should be between 27.6 ms and 28.6 ms for seek operations in both directions. If it is not, adjust the Curve Generator module (A1A12) potentiometer so that the access time is within the specified parameters.

4.3.8 Air Pressure Check

An Air Measuring Kit (P/N 29-21290) is used to measure the air pressure drop across the Absolute filter and the air pressure beneath the EMA cover. The procedure for this check is as follows:

1. Remove the rear cover assembly of the RP04 drive.

2. Install a pack.

3. Depress the START switch to the latched-down position. Wait for the heads to load.

4. Connect the gauge to the EMA quick-disconnect connector on the rear of the RP04 drive. The air pressure must measure more than 0.7 inches of water.

5. Connect the gauge to the FILTER INTAKE quick-disconnect connector on the rear of the RP04 drive. The air pressure must measure more than 3.5 inches of water.

6. Connect the gauge to the FILTER OUTLET quick-disconnect connector on the rear of the RP04 drive. The air pressure must measure more than 2.0 inches of water.

4.3.9 Data Separator Adjustment

The procedure used to adjust the data separator installed in the 733 DEC drives will depend on the level of the Read Write Data Control module (75007160) in (A1B06) position. Paragraph 4.3.9.1 describes a procedure that may be followed to align the Data Separator if a -1 or -2 level Read Write Data Control module is installed in the drive. The DCL or the 733 DEC DEDU must be used to control Data Separator turn-on. Paragraph 4.3.9.2 describes the procedure which may be followed if a -2 level Read Write Data Control module is installed in the drive without the use of the system (DCL) or the 733 DEC DEDU.

4.3.9.1 Data Separator Adjustment (75007160-1 or 75007160-2)

1. Depress the drive START/STOP switch to stop the drive.

2. Place the drive circuit breaker CB1 to the OFF position.

3. Install a scratch pack, formatted for use in the system (if the system is to control Data Separator turn-on), or containing data written by the DEDU (if the DEDU is to control turn-on).

4. Ground (A1B0602) the Coarse Alignment to the Read/Write Data Control board (A1B0637).

5. Place the RP04 circuit breaker CB1 in the ON position.

6. Depress the drive START/STOP switch to start the drive.

7. Connect an oscilloscope to the Data Separator +OSC 1 output (A1A0737).

8. Adjust the upper Data Separator potentiometer (frequency) (A1A07) to establish a waveform period of 155 ns (Figure 4-17).

9. Adjust the lower Data Separator potentiometer (window) (A1A07) to establish equal half-cycles of 77.5 ns each (Figure 4-17) with scope set at 1 ms/div.

10. Remove the ground installed on pin A1B0637.

11. The fine alignment of the Data Separator requires the Data Separator to be turned on (DS ENABLE) and the DATA SEPARATOR ERROR signal to be adjusted for optimum response in an all zeros area.

    If the DCL is used as the control source, execute a routine to read at least one record per revolution.

    If the 733 DEC DEDU is used as the control source:

    > Place the DEDU PROGRAM switch in the READ position.

    > Place the DEDU ROUTINE switch to WRITE/READ.

    > Initiate the DEDU READ routine.

12. Connect the oscilloscope A channel to the +DS ENABLE signal (A1B0655). Adjust the oscilloscope to trigger on the leading edge of the +DS ENABLE signal.

13. Connect the oscilloscope B channel to the DATA SEPARATOR ERROR signal (A1A0715).

14. Observe the waveform on channel B and adjust the upper potentiometer on the Data Separator module (A1A07) for minimum distortion and optimum DATA SEPARATOR ERROR (A1A0715) response. Optimum response is defined as recovery to the normal null level in the minimum time without overshoot or oscillation. Oscillations may occur at both limits of the Data Separator upper potentiometer (Figure 4-18).

+ OSC 1
A1A0737

77.5 NSEC

155 NSEC
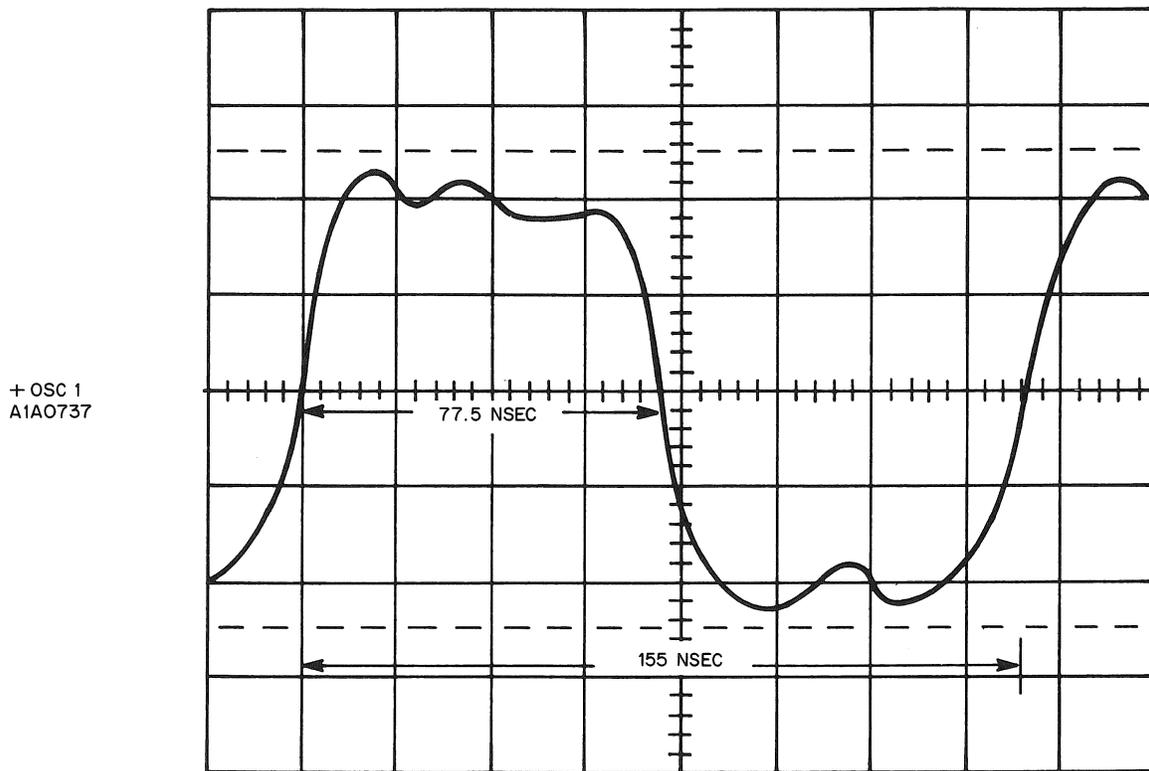
CP-1370

Figure 4-17   Data Separator Coarse Adjustment

+ DS ENABLE
A1B0655

OVERSHOOT

DATA
SEPARATOR
ERROR
A1A0715

UNDERSHOOT

OPTIMUM
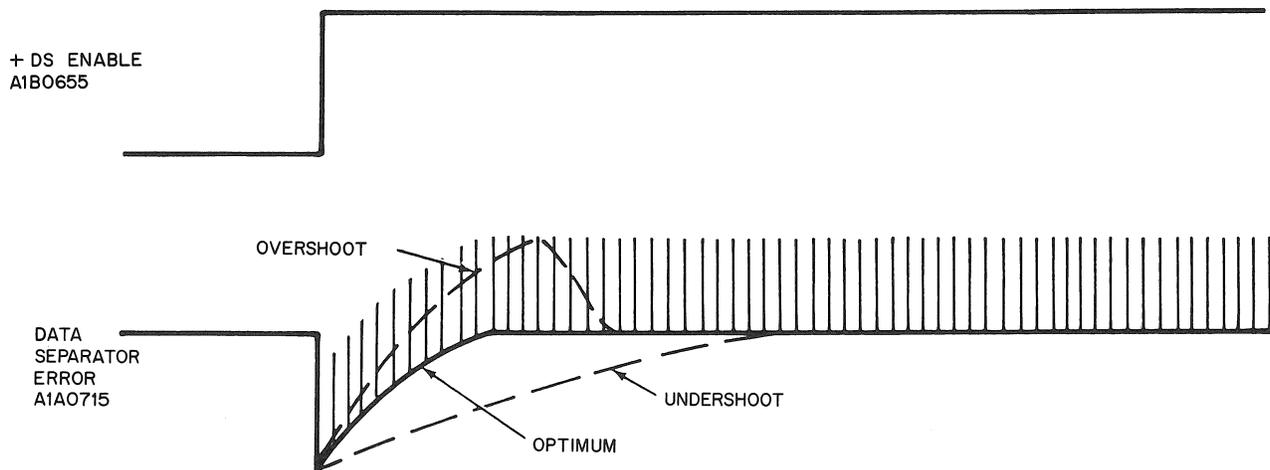
CP-1371

Figure 4-18   Data Separator Fine Adjustment

4.3.9.2 Data Separator Adjustment (75007160-2)

1. Depress the drive START/STOP switch to stop the drive.

2. Place the RP04 circuit breaker CB1 in the OFF position.

3. Install a scratch disk pack.

NOTE
Alignment of the Data Separator by this method does not depend on pack format.

4. Ground (A1B0602) Coarse Align input to the Read/Write Data Control board (A1B0637).

5. Place the RP04 circuit breaker CB1 to the ON position.

6. Depress the drive START/STOP switch to start the drive.

7. Connect the oscilloscope to the Data Separator +OSC 1 output (A1A0737).

8. Adjust the upper Data Separator potentiometer (frequency) (A1A07) to establish a waveform period of 155 ns (Figure 4-17).

9. Adjust the lower Data Separator potentiometer (window) (A1A07) to establish equal half-cycles of 77.5 ns each (Figure 4-17).

10. Remove the ground installed on pin A1B0637.

11. The fine alignment of the Data Separator requires the Data Separator to be turned on (DS ENABLE) in a known zeros area and the DATA SEPARATOR ERROR signal to be adjusted for optimum response. Connect a jumper between the +SECTOR 0 (A1B0826) signal and the Read/Write Data Control board (A1B0633). This causes the leading edge of the +SECTOR 0 pulse to deactivate the DS ENABLE signal and the trailing edge to activate the DS ENABLE signal in a known zeros area.

12. Connect the oscilloscope A channel to the +DS ENABLE signal (A1B0655). Adjust the oscilloscope to trigger on the leading edge of the +DS ENABLE signal. Connect the oscilloscope B channel to the DATA SEPARATOR ERROR voltage at (A1A0715).

13. Observe the waveform on channel B and adjust the upper potentiometer on the Data Separator module (A1A07) for minimum distortion and optimum DATA SEPARATOR ERROR response. Optimum response is defined as recovery to the normal null level in the minimum time without overshoot or oscillation. Oscillation may occur at both limits of the Data Separator upper potentiometer (Figure 4-18).

14. Remove the jumper between the +SECTOR 0 signal (A1B0826) and the Read/Write Data Control board (A1B0633).

4.3.10 Read/Write Head Alignment

The read/write heads must be aligned with the servo head to form a vertical cylinder of 19 data tracks for each servo location of the carriage. This ensures that disk packs will be interchangeable and that heads can be replaced without losing recorded data.

Head alignment is checked by varying the offset required to center the heads on a data track, detecting when the heads cross the data track as the offset is decremented in 25-microinch increments from both positive and negative sides, and averaging the two values to determine the offset error (within ±12.5 microinches). After an adjustment has been completed, the verification procedure should be repeated.

4.3.10.1 Head Alignment Verification

1. Depress the START switch to release it from the latched-down position.

2. Place CB1 in the OFF position.

3. Install an alignment pack on the drive.

4. Connect an oscilloscope to the Head Align Signal 1 output (A1B0145). Use an X10 probe.

5. Release the gate latch to open the drive electronic gate assembly, and insert the DDU buffer paddle assemblies (75004226 and 75004225) into drive sockets A1A09 and A1A10, respectively.

6. Connect the 9-pin power cable plug to the drive power supply receptacle (A2J2).

7. Set the DDU switches as follows:

   FUNCTION — unlabeled top positions
   EMA — ENABLE
   FAILSAFE/INHIBIT — FAILSAFE

8. Set CB1 to ON.

9. Depress the drive START switch to the latched-down position.

10. Allow the RP04 drive to warm up for one hour.

11. Set the DDU FUNCTION switch to HEAD ALIGN and the DDU RANGE switch to 2000 microinches.

12. Execute the Head Alignment Verification Program (MAINDEC-11-DZRPM), which is supplied with the RP04 drive. Figure 4-19 depicts a flowchart of a typical Head Alignment Verification Program.

13. Observe the DDU meter; it should deflect to the right for *positive* offset and to the left for *negative* offset. Aligning the heads in a positive offset of +1200 microinches causes the meter to offset approximately 6/10 of the 2000-microinch positive scale; aligning the heads in a negative offset of −1200 microinches causes the meter to offset approximately 6/10 of the 2000-microinch negative scale.

14. List or display the head alignment error values to determine the heads that need to be aligned. A head displaying a Head Alignment Error greater than ±150 microinches must be aligned. Aligned heads must display a Head Alignment Error less than ±50 microinches to allow for the pack-to-pack differences of 100 microinches.

15. During head alignment verification, the head alignment signal waveform should be observed to ensure that the heads are positioned over the head alignment tracks. When the head is correctly positioned over the data track cylinder, the waveform should resemble View C of Figure 4-20.

NOTE
Head alignment errors greater than 1200 microinches may cause invalid sign change indications.

4.3.10.2 Head Alignment Procedure

1. Depress the START switch to release it from the latched-down position.

2. Remove the top cover, the EMA cover, and the rear cover from the RP04 drive.

3. Place CB1 in the OFF position.

4. Install an alignment pack on the drive.

5. Connect an oscilloscope to the Head Alignment Signal 1 (A1B0145), using an X10 probe.

6. Release the drive gate latch to open the electronic gate assembly, and insert the DDU buffer paddle assemblies (75004226 and 75004225) into drive sockets A1A09 and A1A10, respectively.

7. Set the DDU switches as follows:

   FUNCTION — unlabeled top position
   EMA — ENABLE
   FAILSAFE/INHIBIT — FAILSAFE

8. Place CB1 to the ON position.

9. Depress the drive START switch to the latched-down position.

10. Set the DDU FUNCTION switch to HEAD ALIGN and the DDU RANGE switch to 2000 microinches. Set the DDU PROGRAM INTERRUPT/RUN switch to RUN.

11. Allow the drive to warm up for one hour.

Column 1:

DEVICE INITIALIZE

↓

ON LINE — NO
↓ YES

WRITE PROTECT — NO → PRESS THE DRIVE WRITE PROTECT SWITCH
↓ YES

WRITE PROTECT — NO
↓ YES (from PRESS THE DRIVE WRITE PROTECT SWITCH)

UNSAFE — YES
↓ NO

RECALIBRATE

↓

FILE READY — NO
↓ YES

SEEK TO CYLINDER 245

↓

FILE READY — NO
↓ YES

A

Column 2:

A

↓

ROUTINE — ALIGNMENT → PROGRAM STOP WITH OPERATOR CONTROL OF HEAD SELECT LEVELS

VERIFICATION
↓

HEAD 0

↓

OBSERVE DDU METER AND RECORD INITIAL HEAD ALIGNMENT ERROR

USE AN OSCILLOSCOPE TO MONITOR HEAD ALIGNMENT SIGNALS ON DRIVE PWA A1B0145 & A1B0147 D1 BITS SHOULD BE AS SHOWN IN VIEW C OF FIGURE 4.20 WHEN THE HEADS ARE ALIGNED

↓

HEAD ALIGNED — >±25 µINCHES → LOG HEAD & HEAD ALIGNMENT ERROR
↓ <±25 µINCHES

NO (loop)

HEAD 18 — YES → TEST HEAD ALIGNMENT USING DRIVE OFFSET ON AT LEAST ONE HEAD OR ALL LOGGED HEADS
↓ NO

INCREMENT HEAD ADDRESS

SELECT 1ST HEAD LOGGED

C →

SET OFFSET + 1200 µ IN

↓

B

Column 3:

B

↓

PASS 1

↓

EXECUTE OFFSET

↓

OFFSET READY — NO
↓ YES

STORE SIGN CHANGE STATUS

↓

DECREMENT OFFSET 25 µIN

↓

EXECUTE OFFSET

↓

OFFSET READY — NO
↓ YES

COMPARE STORED SIGN CHANGE TO DRIVE SIGN CHANGE STATUS

↓

CHANGE OF STATE — YES
↓ NO

D →

Column 4:

STORE OFFSET REQUIRED TO CAUSE DRIVE SIGN CHANGE TO CHANGE STATES

↓

PASS COMPLETED — 2 → AVERAGE PASS 1 & PASS 2 OFFSET REQ TO CAUSE DRIVE SIGN CHANGE TO CHANGE STATES
↓ 1

SET OFFSET 1200 µIN

↓

PASS 2

↓

D

LOG HEAD ALIGNMENT ERROR HEAD NUMBER AND CYLINDER

↓

CYLINDER — 004 OR 400 → G
↓ 245

HEAD 18 — YES → RESET OFFSET → SEEK TO CYLINDER 004 → SELECT HEAD 0 → C
↓ NO

SELECT NEXT HEAD TO BE TESTED

↓

C

ON CYLINDER 245 HEADS THAT ARE MISALIGNED MORE THAN + 150 µINCHES MUST BE ALIGNED TO WITHIN +50 µINCHES ON CYLINDERS 4 & 400 HEAD ALIGNMENT ERROR SHOULD BE +350 µINCHES (NOMINAL)

Column 5:

G

↓

004 OR 400 HEAD ALIGNMENT ERROR LOGGED — HEAD 18 → CYLINDER — 400 → RESET OFFSET → END OF SEQUENCE
↓ HEAD 0   ↓ 004

SELECT HEAD 18   SEEK TO CYL 400
↓   ↓
C   SELECT HEAD 0
                                  ↓
                                  C

Figure 4-19 Head Alignment & Verification Flowchart

CP-1372

VIEW A.   HEAD POSITIONED OVER EVEN SERVO TRACK
              (INNER GUARD BAND)

VERTICAL GAIN = 5V/CM   TIME BASE = 1 μSEC/CM

Notes
  1. The Servo Data Signal (A0321) is ac coupled
  2. Position Signal-P1-(A0323) is dc coupled
  3. Position Signal-P2-(A0327) is dc coupled and inverted
  4. When P1 P2 The head is correctly positioned over
     a cylinder

VIEW B.   HEAD POSITIONED WITH 1200 MICROINCHES
              FORWARD OFFSET FROM THE CYLINDER POSITION

VERTICAL GAIN = 2 V/CM   TIME BASE = 1μSEC/CM
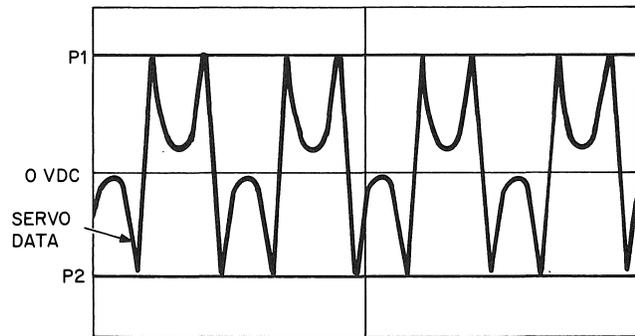
VIEW C.   HEAD CORRECTLY POSITIONED OVER CYLINDER

VERTICAL GAIN = 2V/CM   TIME BASE = 1μSEC/CM
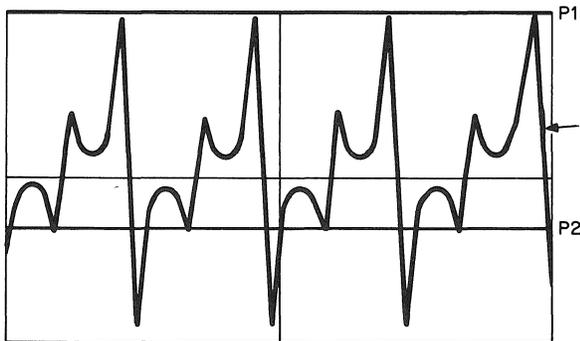
VIEW D.   HEAD POSITIONED WITH 1200 MICROINCHES
              REVERSE OFFSET FROM THE CYLINDER POSITION

VERTICAL GAIN = 2V/CM   TIME BASE = 1μSEC/CM
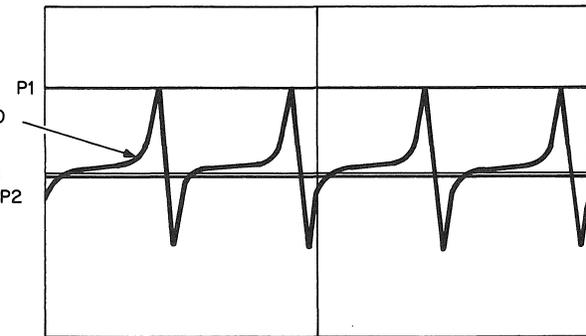
VIEW E.   HEAD POSITIONED OVER AN ODD SERVO TRACK
              (OUTER GUARD BAND)

VERTICAL GAIN = 5 V/CM   TIME BASE = 1μ SEC/CM

CP-1373

Figure 4-20   Track Following Servo Waveforms

4-24

12. Set the DDU FAILSAFE/INHIBIT switch to INHIBIT. The DDU HEAD ALIGNMENT SAFE indicator will illuminate.

13. Test the drive failsafe circuits to verify that the DDU INHIBIT signal has disabled the drive failsafe function by depressing the DDU RECAL pushbutton. This should cause the heads to move off track, and the EMA to deactivate, leaving the heads in the pack.

WARNING
If the carriage assembly performs a recalibrate when the RECAL pushbutton is depressed or resists manual movement, a problem exists in the FAILSAFE/ INHIBIT circuit. Correct this problem before proceeding with head alignment. Failure to do so may result in personal injuries and component damage.

14. Retract the carriage by placing the DDU FAILSAFE/INHIBIT switch to the FAILSAFE position to generate a safety unload.

15. Stop the drive by pressing the drive START switch. When the disk pack has stopped, press the START switch to restart the drive and load the heads.

16. Execute the Head Alignment Verification Program, which is supplied with every RP04 drive (Figure 4-19). This should cause the drive to seek to cylinder 245 and stop with Operator Control of Head Selection enabled.

17. Set the DDU FAILSAFE/INHIBIT switch to INHIBIT after the heads are positioned on cylinder 245.

18. Using the Head Alignment Error Log, loosen the head clamp screws of the heads to be adjusted and retighten to 3 in/lb, using the torque-indicating screwdriver.

19. Select the first head to be aligned. Install the Head Fine Alignment Tool (P/N 29-21284) in the first head (Figure 4-21) and adjust the head position until the DDU meter pointer is at zero.
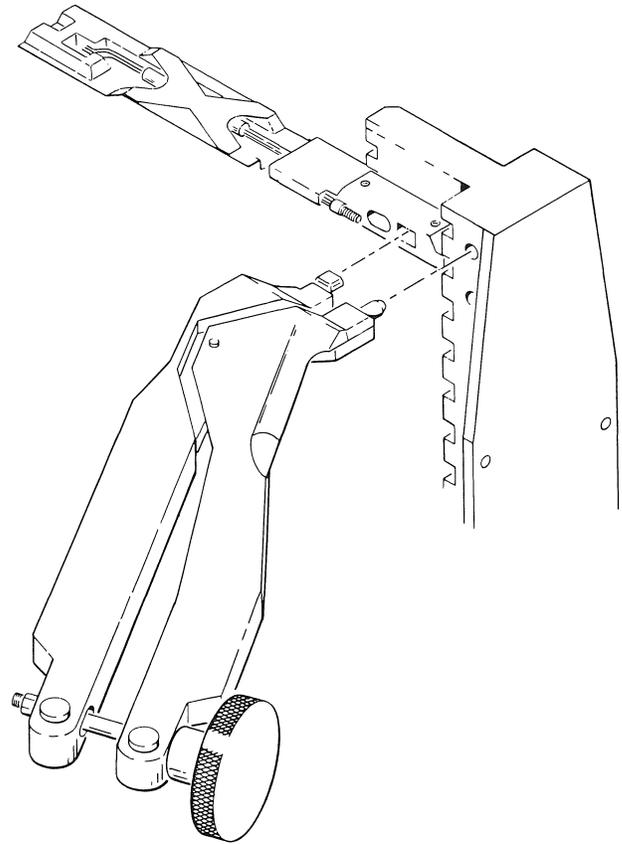
CP-1374

Figure 4-21 Head Alignment Tool Installed

Observe the waveform on the oscilloscope to ensure that the head is positioned over the head alignment track. When the head is correctly positioned over the data track cylinder, the waveform should resemble View C of Figure 4-20.

20. Set the DDU RANGE to 200 microinches and readjust the head position for a meter indication of less than +25 microinches on the meter scale. Remove the head alignment tool, checking that the meter deflection does not exceed ±25 microinches.

21. Secure the aligned head to 7 in/lb, using the torque-indicating screwdriver and checking that meter deflection does not exceed ±25 microinches.

22. Select the next head to be aligned and repeat steps 18 through 21.

23. When all heads are aligned and secured, perform Head Alignment Verification as described in Paragraph 4.3.10.1. Heads must be aligned within ±50 microinches.

24. Execute 100 Recalibrate cycles.

25. Perform Head Alignment Verification.

26. Realign all heads that exhibit a Head Alignment Error greater then ±150 microinches.

27. When all heads are aligned and verified, press the RP04 START/STOP switch to stop the drive.

28. When the disk pack has stopped, place CB1 to OFF.

29. Remove the DDU and oscilloscope from the drive.

30. Install the EMA cover, top cover, and rear cover.

31. Install a scratch or user pack.

32. Start the RP04 by pressing the drive START/STOP switch.

4.4 EQUIPMENT CLEANUP

When the installation procedures, checks, and adjustments detailed earlier in this chapter have been completed, all exterior service covers should be wiped off using lint-free wipes or cloths and soap and water. When this cleanup is complete, the RP04 Disk Drive is ready for use.

4.5 POWER CONVERSION

The basic RP04 Disk Drive power system includes a line filter, a sequencer, a power transformer, two power supplies (one in the DCL unit), a power control module (29-21243), a drive motor, a brush motor, and a fan motor. The normal power configuration of 60 Hz drives shipped from Digital Equipment Corporation is for 208 V, 3-phase ac power. There are two standard configurations for 50 Hz drives: 380 V, 3-phase wye ac power and 220 V, 3-phase delta ac power. The factory configuration is indicated on the drive nameplate, located near the rear corner of the

baseplate. If drive power and facility power do not agree, convert the RP04 wiring as described below. Figure 4-22 shows the conversion points.

4.5.1 60 Hz/208 V to 60 Hz/230 V Conversion

1. Remove the brown wire from the drive sequencer terminal board TB4 pin 7 and pin 6; insulate and tie these wires back.

2. Locate the black wires on sequencer transformers T1 and T2. Connect the T1 black wire to the drive sequencer terminal board TB4 pin 7. Connect the T2 black wire to the drive sequencer terminal board TB4 pin 6.

3. Move the wire connecting the sequencer to the drive power transformer terminal board pin 2 so that it connects the sequencer to pin 3 of that board.

4. Use tape or stick-on labels to mark both the sequencer and the drive nameplates with the voltage to which the drive has been converted.

4.5.2 60 Hz/230 V to 60 Hz/208 V Conversion

1. Remove the black wires from the drive sequencer terminal board TB4, pins 7 and 6; insulate and tie these wires back.

2. Locate the brown wires on sequencer transformers T1 and T2. Connect the T1 brown wire to the drive sequencer terminal board TB4, pin 7. Connect the T2 brown wire to pin 6 of that board.

3. Move the wire connecting the sequencer to the drive power transformer terminal board pin 2.

4. Use tape or stick-on labels to mark both the sequencer and the drive nameplates with the voltage to which the drive has been converted.

4.5.3 50 Hz/400 V Wye to 50 Hz/230 V Delta Conversion

1. Remove the sequencer transformer wires (T1 and T2) on (drive) TB4—7 and TB4—6 (violet, yellow, or orange), insulate, and tie back into the sequencer cable.
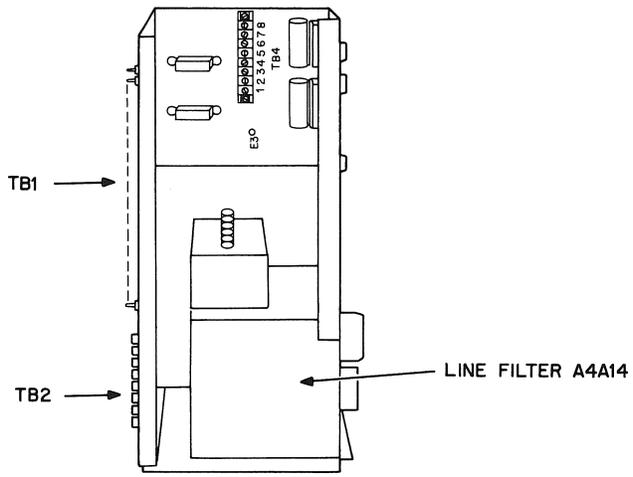
SEQUENCER
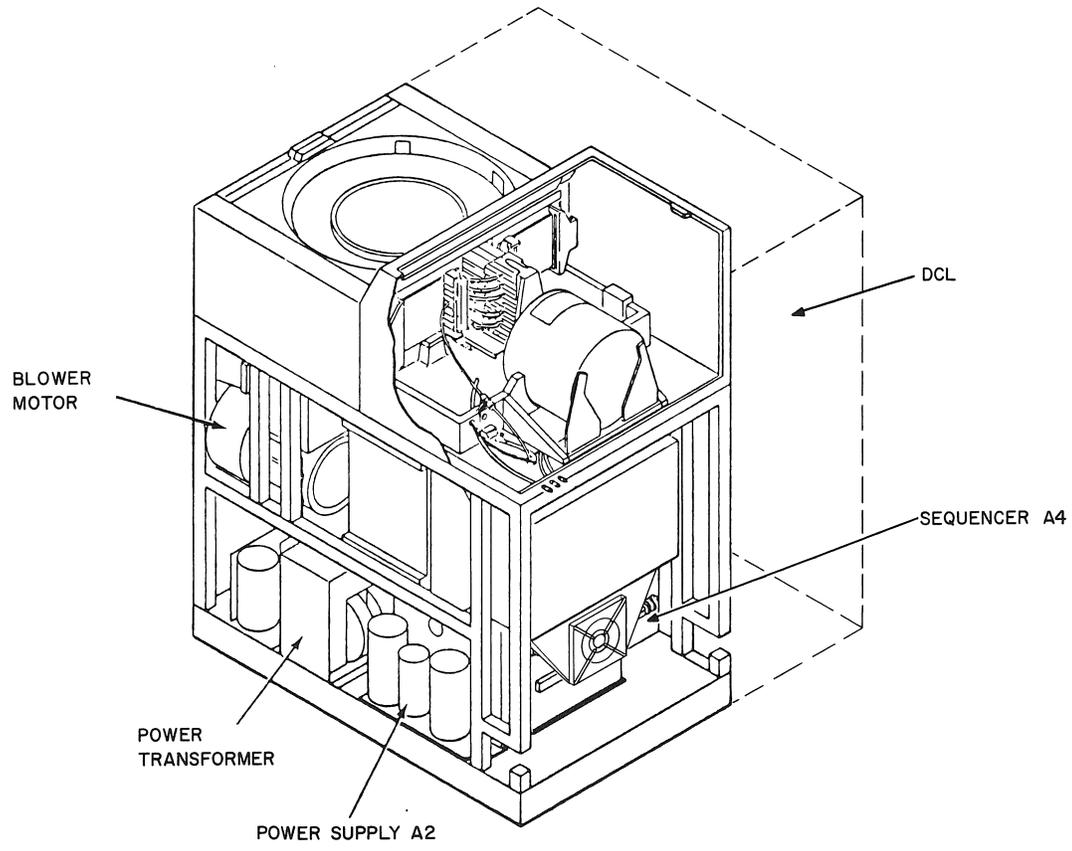
CP–1375

Figure 4-22   RP04 Power System Conversion Points

2. Locate and select the sequencer transformer T1 lead that corresponds to the input voltage (brown − 220 V, red − 230 V, or black − 240 V) and connect it to sequencer TB4−6 in the drive.

3. Locate and select the sequencer transformer T2 lead that corresponds to the input voltage (brown − 220 V, red − 230 V, or black − 240 V) and connect it to sequencer TB4−7 in the drive.

4. Remove the wires between A14-D (line filter assembly) and sequencer TB2−4, and the ac connector (A4J4) at the line filter (A14-D). Connect these two wires to A14-B (line filter).

5. Remove the jumper between sequencer TB1−17 and TB1−14 in the drive.

6. Install resistor assembly 76007863-1 between TB1−17 and TB1−14 in the drive.

7. Remove the voltage adapter plug (400 V, 50 Hz) from the RP04 drive motor and install a 230 V, 50 Hz voltage adapter plug (76007662-1).

8. Replace SSRA and SSRB with SSR 29-21236. Use the existing capacitor and resistor.

9. Remove the air filter motor wires from the filter motor terminal board and rewire according to Figure 4-23. *Do not remove the interconnecting wires from the sequencer.*

10. Ensure that the reference phase wire on the drive power transformer terminal board is connected to the tap that corresponds to the input voltage (TB-3 for 240 V and 230 V input, or TB-2 for 220 V input).

11. Use tape or stick-on labels to mark both the sequencer and the drive nameplates with the voltage to which the drive has been converted.

4.5.4 50 Hz/230 V Delta to 50 Hz/400 V Wye Conversion

1. Remove the drive sequencer transformer (T1 and T2) wires on TB4−7 and TB4−6 (brown, red, or black), insulate, and tie back into the sequencer cable.
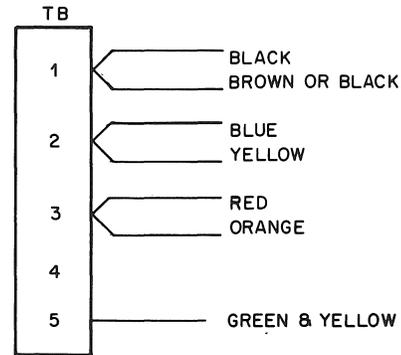
Figure 4-23 Filter Motor Terminal Board Wiring (50 Hz/230 V Delta Conversion)

2. Locate and select the sequencer transformer T1 lead that corresponds to the input voltage (violet − 415 V, yellow − 400 V, or orange − 380 V) and connect it to sequencer TB4−6.

3. Locate and select the sequencer transformer T2 lead that corresponds to the input voltage (violet − 415 V, yellow − 400 V, or orange − 380 V) and connect it to sequencer TB4−7.

4. Remove the wires between A14-B (line filter assembly) and sequencer TB2−4 and the DCL ac connector at the line filter end (A14-B). Connect these two wires to A14-D (line filter).

5. Remove the resistor assembly (76007863-1) between sequencer TB1−17 and TB1−14.

6. Install a jumper (84001467-54) between sequencer TB1−17 and TB1−14.

7. Remove the voltage adapter plug (230 V, 50 Hz) from the drive motor and install a 400 V/50 Hz voltage adapter plug (76007662-2).

8. Replace SSRA and SSRB with SSR 29-21235. Use the existing capacitor and resistor.

9. Remove the air filter motor wires from the filter motor terminal board and rewire it according to Figure 4-24. *Do not remove the interconnecting wires from the sequencer.*

TB

1	BLACK
2	BLUE
3	RED
4	ORANGE / YELLOW / BROWN OR VIOLET
5	GND
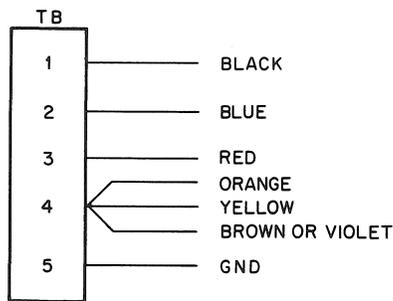
CP–1377

Figure 4-24   Filter Motor Terminal Board Wiring
(50 Hz/400 V Wye Conversion)

10. Ensure that the reference phase wire on the power transformer terminal board is connected to the tap corresponding to the input voltage (TB-3 for 415 V and 400 V input power, or TB-2 for 380 V).

11. Use tape or stick-on labels to mark both the sequencer and the drive nameplates with the voltage to which the drive has been converted.

4.6 POWER VERIFICATION

4.6.1   60 Hz/208 V Input Power Configuration

1. Verify that the sequencer and drive nameplates are marked 208 V, 60 Hz.

2. Verify that the drive sequencer T1 and T2 brown wires are wired to sequencer TB4 pin 6 and pin 7.

3. Verify that sequencer TB2-2 is wired to the power transformer terminal board pin 2.

4.6.2   60 Hz/230 V Input Power Configuration

1. Verify that the sequencer and drive nameplates are marked 230 V, 60 Hz.

2. Verify that the drive sequencer T1 and T2 black wires are wired to sequencer TB4 pin 6 and pin 7.

3. Verify that sequencer TB2-2 is wired to the power transformer terminal board pin 3.

4.6.3   50 Hz/400 V Wye Input Power Configuration

1. Verify that the sequencer and drive nameplates are marked 380 V, 400 V, or 415 V, 50 Hz.

2. Verify that the drive sequencer T1 and T2 wires corresponding to the input voltage (380 V – orange,   400 V – yellow,   or 415 V – violet) are wired to sequencer TB4 pins 6 and 7.

3. Verify that the line filter A14-D is wired to the sequencer TB2–4 and the sequencer DCL ac power connector.

4. Verify that the resistor assembly (76007863-1) on sequencer TB1–14 and TB1–17 is removed and a jumper (84001467-54) is installed between TB1–14 and TB1–17.

5. Verify that the wire from sequencer A4TB2–4 is wired to the power transformer terminal board pin 3 for 400 V or 415 V input voltages, and to pin 2 for 380 V input voltage.

6. Verify that the blower motor is wired according to Figure 4-24.

7. Verify that the voltage adapter plug (76007662-2, 400 V, 50 Hz) is installed on the drive motor.

4.6.4   50 Hz/230 V Delta Input Power Configuration

1. Verify that the sequencer and drive nameplates are marked 220 V, 230 V, or 240 V, 50 Hz.

2. Verify that the drive sequencer T1 and T2 wires corresponding to the input voltage (220 V – brown,   230 V – red,   or 240 V – black) are wired to sequencer TB4 pins 6 and 7.

3. Verify that the line filter A14-B is wired to the sequencer TB2–4 and the sequencer DCL ac power connector.

4. Verify that the resistor assembly (76007863-1) is installed between sequencer TB1–14 and TB1–17.

5. Verify that the wire from sequencer A4TB2–4 is wired to the power transformer terminal board pin 3 for 230 V or 240 V input voltage, and to pin 2 for 220 V input voltage.

6. Verify that the blower motor is wired as shown in Figure 4-23.

7. Verify that a 230 V/50 Hz voltage adapter plug (76007662-1) is installed on the drive motor.

CHAPTER 5
INSTALLING THE RPO4
INTO AN RJP04 SUBSYSTEM

5.1 INTRODUCTION
When one or more RP04s are combined with one or more
RH11 controllers, the combination is designated as an
RJP04 subsystem. System Diagram E-SD-RP04-0-1 shows
system interconnection, module locations, power wiring,
and single-port and dual-port option data. More complete
details regarding this type of installation can be found in
the *RJP04 Moving Head Disk Subsystem Maintenance
Manual* (DEC-11-HRJPA-A-D) and the *RP04 Device Con-
trol Logic Maintenance Manual* (DEC-00-HRP4M-A-D).

5.2 ELECTRICAL
Power cable connections, Unibus cable connections, and
Massbus cable connections are described in the following
paragraphs.

5.2.1 Power Cable Connections
Power is distributed to the two hex-height RH11 modules
via two power cables that attach to the printed circuit
backplane assembly by quick-disconnect tabs. (Refer to
RH11 Wired Assembly Drawing D-AD-7009397-0-0.) The
power cables have Mate-N-Lok connectors on one end to
connect to the power distribution panel located above the
backplane, and quick-disconnect tabs on the other end to
connect to the RH11 backplane assembly. The color codes
associated with the power harness connections are as
follows:

Harness #1		Harness #2	
Rows 1–4		Rows 5–9	
+5 V	Red	AC LO (+3 V to +5 V)	Yellow
+5 V	Red	DC LO (+3 V to +5 V)	Violet
Gnd	Black	LTC (8 V peak-to-peak ac)	Brown
Gnd	Black	+15 V	Gray
		–15 V	Blue
		+5 V	Red
		+5 V	Red
		Gnd	Black
		Gnd	Black

CAUTION
**Ensure that backplane wires are not damaged
when power cables are connected to the back-
plane. Do *not* cut AC LO and DC LO wires out
of the power harness, as they are used for
power fail conditions on the Massbus and on
both Unibus A and Unibus B ports.**

After power connections have been made, check for power
shorts with an ohmmeter. Ensure that all modules are
firmly seated in the proper slots (Figure 5-1). Power up the
CPU or expander box and measure voltages in accordance
with values listed for the preceding color codes. After this is
done, turn the power OFF.

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

5.2.2.1 Unibus A Connections – The Unibus A cable slots
connect the RH11 to the processor controlling it. The
Unibus A cable enters the RH11 via slot A1B1 and
connects to the next device via slot A9B9. (Refer to
Module Utilization Drawing D-MU-RH11-0-01.) Connec-
tions to slot A1B1 are made via the BC11A Unibus cable if
the RH11 is the first Unibus A device in the mounting box.
Otherwise, connection to A1B1 from the preceding device
is made by an M920 Unibus Jumper module. If the next
device on the Unibus is adjacent, connection is also made
by an M920 module; if it is not adjacent, connection is
made by a BC11A cable.

NOTE
**If the RH11 is the last device on Unibus A, an
M930 Terminator module is installed in slot
A9B9.**

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

NOTES:

1. MAY BE EITHER M920 (CONNECTION FROM ADJACENT DEVICE) OR BC11A CABLE (CONNECTION FROM ANOTHER BOX OR NON-ADJACENT DEVICE).

2. MAY BE M9300 (TERMINATION AT BEGINNING OR END OF UNIBUS B) OR BC11A CABLE (CONNECTION TO OTHER BUS B DEVICES).

3. MAY BE M920 (CONNECTION TO ADJACENT DEVICE), M930 (TERMINATION AT END OF UNIBUS A), OR BC11A CABLE (CONNECTION TO NEXT BOX OR NON-ADJACENT DEVICE).

4. G727 GRANT CONTINUITY MODULE(S) MUST BE INSERTED IN SLOTS D.

11-2384

Figure 5-1   RH11 Module Utilization

5.2.2.2 Unibus B Connections – Unibus B connections are generally made in systems with multiport memories. When the Unibus B port of the RH11 is not used, an M9300 Terminator module (with jumper W1 cut) should be installed in slot A8B8 to terminate Unibus B signals into the RH11. The second M9300 Terminator module should *not* be used in A7B7 in order to conserve power. If the Unibus B port of the RH11 is used, connections are determined on the basis of whether a processor is connected to Unibus B. These connections are described below.

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

NOTE
The M9300 Terminator module may be used as a substitute for the M930 Terminator module if the jumpers are selected correctly.

The Unibus B cable connection to the RH11 is made via slot A8B8 with a BC11A cable. Connection from the RH11 to the next device is made via a BC11A cable connected to

slot A7B7. If the RH11 is the last device on the bus, the M930 or M9300 module is installed in slot A7B7 instead of the BC11A cable.

No Processor on Unibus B – If no processor is connected to Unibus B, an M9300 Unibus B Terminator module must be selected as an NPR arbitrator. If one RH11 is connected to Unibus B, the RH11 is electrically connected at the beginning of the bus with the M9300 selected to act as an NPR arbitrator. One M9300 Unibus B Terminator module is placed in slot A8B8 of the RH11. Jumper W1 of that module must be cut to enable the arbitration logic. Connection to other devices on Unibus B, such as memory, is made via a BC11A cable connected to slot A7B7. The second M9300 is installed in the last device on Unibus B. Jumper W2 is removed to terminate the Unibus with no processor connected.

NOTE
In this case, an M930 Terminator module can be substituted for the M9300 Unibus B Terminator in the last device slot. If more than one RH11 is installed, the user may have extra M9300 modules as a result of a particular configuration. Figures 5-2, 5-3, and 5-4 show typical Unibus configurations.
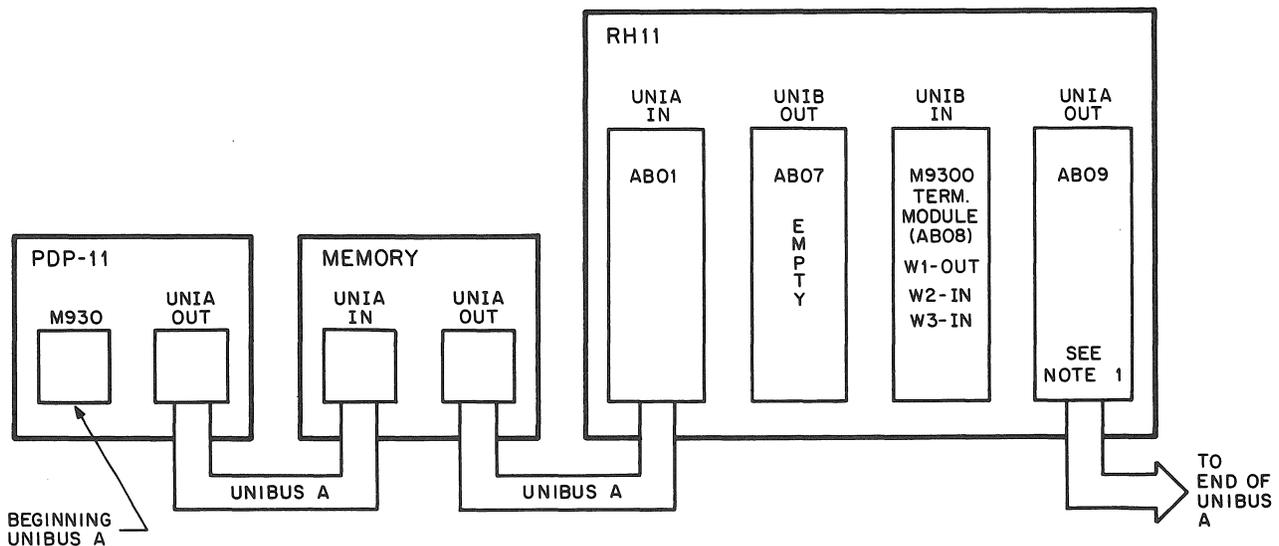
NOTE 1:
  Install M930 terminator if last device on UNIBUS A.

II-2220

Figure 5-2 Single-Port Unibus Configuration

5-3
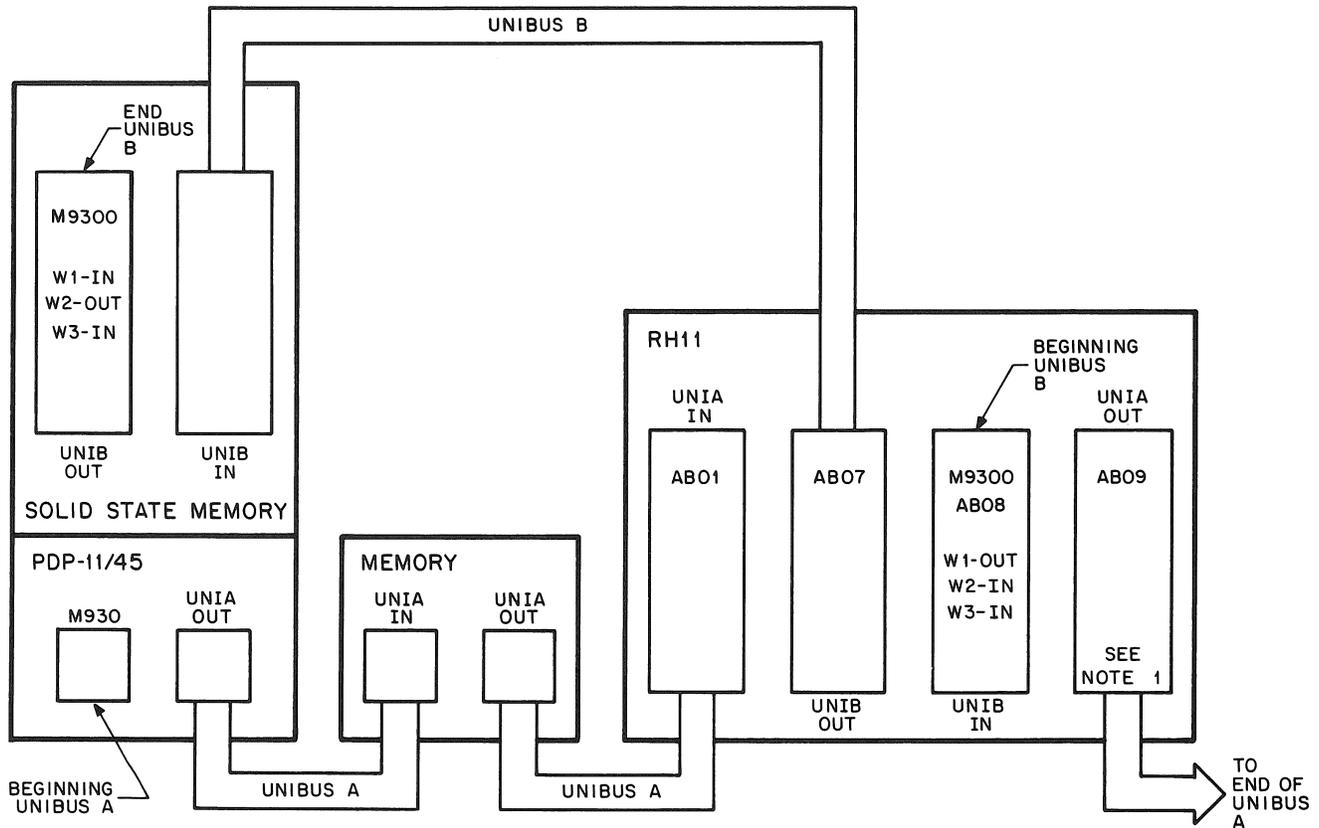
Figure 5-3 Dual-Port Configuration — Memory on Unibus B

5.2.3 Massbus Cable Connections

Massbus connections to the RH11 are made via three 8-foot, 40-conductor ribbon cables (BC06R-08). These cables plug into three M5904 Transceivers in the RH11, and are designated Massbus Cables A, B, and C. These cables should be inserted into the modules with the edge-marking facing the module handles. The other ends of these cables mate to the input/output connector block assembly on the connector panel with the edge-marking facing up (per D-UA-RJP04-A-0). The connections are made as follows:

Massbus Cable A – From slot C4D4 of the RH11 to the righthand side of the connector block (viewed from the male side, springs at top). The edge-marking should face up.

Massbus Cable B – From slot C5D5 to the next connector slot, with the edge-marking facing up.

Massbus Cable C – From slot C6D6 to the next connector slot, with the edge-marking facing up.

To terminate the Massbus, a 7009938 Terminator Pack assembly should be plugged into the output connector(s) of the last drive (Figure 5-5). The Massbus cable connections to the RH11 are shown in Figure 5-2 and 5-3 for single-port and dual-port systems, respectively.

NOTE
In some cases, M5903YA transceiver cards may be used instead of the terminator pack assemblies; however, all units ultimately will be shipped with terminator pack assemblies.
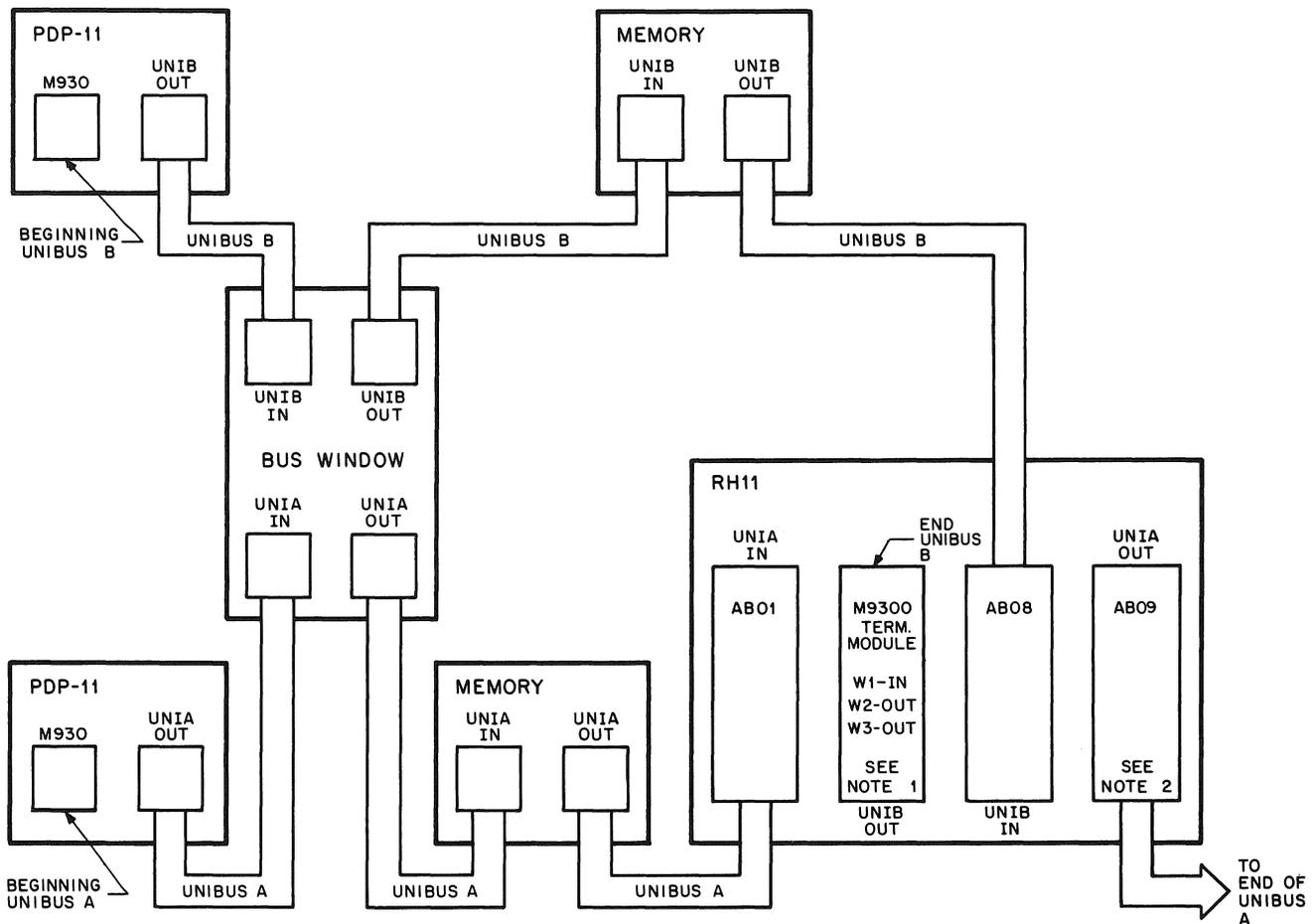
NOTES:
1. In this configuration can be replaced by M930.

2. Install M930 terminator if last device on UNIBUS A.

11-2222

Figure 5-4   Dual-Port Configuration — Memory & Processor on Unibus B

5.2.4 AC LO, DC LO

AC LO and DC LO signals from the RH11 power supply must be connected to the RH11. There should be only one AC LO and one DC LO power fail connection to each Unibus from the power supply of each mounting box. (Otherwise, power fail conditions would latch up due to positive feedback to the power fail logic.) If a device already mounted in the mounting box to be used for the RH11 has AC LO and DC LO connections to a Unibus, remove the M688 Power Fail Driver module for that Unibus from the RH11. The M688 for Unibus A is located in slot E5; the M688 for Unibus B is located in slot E4.

If the configuration is such that Unibus A and Unibus B are jumpered together and AC LO and DC LO connections are already made to either Unibus from a device in the mounting box to be used for the RH11, remove the M688 for the RH11 Unibus connection, whether it is A or B. Power supply AC LO and DC LO should be disconnected from all other options mounted in the same box as the RH11 if they do not need those signals for internal operation.

5.3 JUMPER CONFIGURATIONS

The following paragraphs describe the various jumper configurations on the BCT, DBC, and CSR modules.

5-5

Figure 5-5 Massbus Cable System Configuration

5.3.1 BCT Module (M7295)

The BCT module contains jumpers for register selection, BR level interrupt, NPR latency, vector address, and missed transfer error.

5.3.1.1 Register Selection – The RH11 is capable of responding to 30 possible Unibus addresses, with the exact number dependent on the Massbus device. For the RP04 Disk Drive, the following jumper configuration should be used (D-CS-M7295, sheet 2).

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

*Jumper In = Binary 0

Jumpers W1–W8 select the block of Unibus addresses to which the RH11/RP04 responds. The standard addressing block assigned is 776700–776746.

The jumpers in E3 (D-CS-M7295-0-1, sheet 2) are selected for the appropriate number of registers (20) in the RJP04 subsystem.

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

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

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

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

5.3.1.5 Vector Address Jumpers – The interrupt vector transferred to the processor is jumper-selectable via jumpers W11–W17, representing vector bits 2–8, respectively. The RJP04 subsystems are assigned a vector address of 000254, with the following jumper configuration:

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

*Jumper In = Binary 1

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

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

5.3.2.1 NPR Cycle Selection Jumpers – Two jumpers select the type of cycle to be implemented when performing NPRs. Jumper E66 (3–14) (D-CS-M7294-0-1, sheet 2) selects the RH11 to perform one memory reference for each NPR request; this jumper is removed in the RJP04 subsystem to allow back-to-back memory cycles to occur. Jumper E66 (2–15) takes advantage of dedicated Unibus B systems (those in which the RH11 is used exclusively as a Unibus B master) by allowing the RH11 to transfer complete consecutive blocks of data without giving up the Unibus; to implement this feature, both this jumper and E66 (3–14) must be cut.

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

5.3.2.3 Start Counter Jumpers – Various Silo capacities are jumper-selectable before a write operation onto the disk drive is started. For RJP04 operation, jumper E66, pins 1–16, which selects the full 64-word capacity, should be connected (D-CD-M7294-0-1, sheet 9).

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

5.4 RH11 INSTALLATION PROCEDURE
This procedure should be performed twice when installing RJP04-BA or RJP04-BB subsystems.

1. Visually check the RH11 backplane assembly for bent pins by sighting along the rows of pins from two directions. Also check for pinched or broken wires.

2. Check the backplane for the current wire-wrap revision and remove and check all RH11 modules for current ECO revisions.

3. Mount the RH11 backplane assembly in the appropriate mounting box using four 8/32" X 1" Allen-head screws.

4. Connect the two power harnesses to the RH11 as described in Paragraph 5.2.1. Ensure that Mate-N-Lok connectors are seated firmly in the power distribution panel located on the chassis above the backplane.

5. Check the RH11 backplane again for bent pins and shorted wires.

6. Power-up the CPU or expander box and check all voltages, then power-down.

7. Check that the wires supplying AC LO and DC LO signals from the power supply are connected to the RH11, as described in Paragraph 5.2.4.

8. Verify and/or select the jumper configurations in the RH11 according to Paragraph 5.3 and drawing D-CS-M7295-0-1.

9. Verify that all modules are placed according to the RH11 Module Utilization List (D-MU-RH11-0-1).

10. Verify that Unibus cable connections are made according to Paragraph 5.2.2.

11. Mount an input/output connector block assembly (7009861) to an RJP04 connector panel (7412379) with four 4/40" X 5" screws (9008042-8).

12. Verify that two pressure-sensitive labels are applied to the connector panel for each input/output connector block assembly (E-UA-RJP04-A-0). Label 1 is applied above the input/output connector block assembly, and Label 2 is applied below it.

```
┌─────────────────┐
│   Controller    │
│   A B 1 2 3 4   │
└─────────────────┘
```
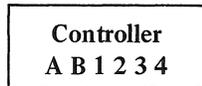
Label 1 (3612116-00)

The second line of Label 1 must be marked so that only one letter and one number are visible. The single controller (RH11) used in an RJP04-AA or -BB subsystem, as well as the first controller used in an RJP04-BA or -BB subsystem, is referred to as controller A. If it is the first subsystem using the connector panel, it is designated controller A1 (etc., up to controller A4). The second controller in an RJP04-BA or -BB subsystem is designated as controller BX, where X is the same subsystem number as the associated controller A.

Example: Two RH11 controllers are mounted in the same cabinet, one for each of two RJP04-AA subsystems. Each RH11 uses one input/output connector block on the connector panel; the first is called controller A1, the second is A2. Later, an RJP04-BA subsystem is installed with its two RH11 controllers mounted in the same cabinet. The remaining two slots on the connector panel are used, with one being labeled A3 and the other B3.

```
┌─────────────────┐
│     C B A       │
└─────────────────┘
```
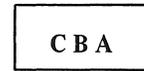
Label 2 (3612116-01)

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

13. Mount the connector panel at the bottom rear of the cabinet containing the RH11, using four 10/32" Tinnerman nuts (9006586) and four 10/32" X 0.38" Truss-head screws (9006071-3). (Refer to D-UA-RJP04-A-0.)

14. Verify that Massbus cable connections are according to Paragraph 5.2.3.

15. Clean the air filters at the top of the mounting cabinet, if necessary.

16. Check mounting cabinet fans for proper operation.

CHAPTER 6
RJP04 FIELD ACCEPTANCE
PROCEDURES AND DIAGNOSTICS

6.1 INTRODUCTION

Field acceptance testing is intended to demonstrate performance of the RP04 Disk Drive and/or the RJP04 subsystem to the customer prior to his acceptance.

6.2 ERROR DEFINITIONS/RATES

The RP04 contains three registers to display the various error conditions possible. Error register #1 (RHER 1) indicates the operational error related to command and control; error registers #2 and #3 (RHER 2, RHER 3) indicate drive error conditions. Two bits of RHER 3 (SKI and OCYL) indicate seek errors and are used to calculate the seek error rate (Paragraph 6.2.4). Four bits of RHER 1 (DCK, HCRC, HCE, and ECH) indicate data errors; the remaining bits of RHER 1 indicate command and control errors. Table 6-1 lists indications of the various error types and their explanations.

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. Errors that are not ECC-correctable include bursts greater than 11 bits in length and isolated dropped bits (separated by more than 11 bits) within a sector. The allowable error rate for hard errors is 1 error per 10^{12} bits read.

6.2.2 Soft Errors

Any failure to read correctly on the first try, data that is then read successfully during a recovery sequence, constitutes a recoverable, or soft error. The allowable error rate for soft errors is 1 error per 10^9 bits read.

*A complete recovery sequence consists of 28 retries, 16 of them at the nominal head position, and 2 each at offsets of ±400, ±800, and ±1200 microinches. The first release of the DEC PDP-11 operating system does not include offset capability.

6.2.3 Pack-Attributable Errors

An error caused by imperfections in the recording surface is regarded as pack-attributable, or media dependent. If the imperfection is less than 11 bits long, it is ECC-correctable and will appear as a soft error. If it is longer than 11 bits, 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. The definitions of hard and soft errors in Paragraphs 6.2.1 and 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.

6.2.4 Seek Errors

Any positioning operation that is not completed within a specified time (85 ms for SEEK commands, 500 ms for RECALIBRATE commands, and 10 ms for OFFSET and RETURN TO CENTERLINE commands) or that terminates with the positioner in an incorrect location, constitutes a seek error. The allowable error rate for seek errors is 1 error per 10^6 seek operations.

6.3 RJP04 FIELD ACCEPTANCE TEST

The RJP04 Field Acceptance Test is designed to demonstrate the performance of the RP04 Disk Drive when used with an RH11 controller.

6.3.1 Operational Checks, Single Controller

When all installation procedures have been completed, the tests described in the following paragraphs should be performed. The total time required to run these tests, in the absence of failures, is 3.7 hours per drive. Diagnostics are described in Paragraph 6.4.

Table 6-1

Bit	BIT SET Register	Error Type	Explanation
HCE HCRC	RHER 1 RHER 1	Soft	Sector Count Field/Desired. Sector Compare fails due to CRC failure.
HCRC	RHER 1	Soft	Sector Count Field matches desired sector field but there is CRC error.
HCRC FER	RHER 1 RHER 1	Soft	Format bit in first header word incorrect. NOTE: FER without HCRC indicates wrong format pack mounted.
DCK	RHER 1	Soft	Error detected during Read operation by examination of ECC bytes; correctable by retry sequence.
DCK ECH	RHER 1 RHER 1	Hard	Error detected which is ECC uncorrectable through 28 retry sequence (16 retries at nominal head position and 12 with head offset).
SKI	RHER 3	Seek	1. SEEK operation fails to complete within 85 ms of initiation. 2. RECALIBRATION operation fails to complete within 500 ms of initiation. 3. OFFSET or RETURN to CENTERLINE operations fail to complete within 10 ms of initiation.
SKI OCYL	RHER 3 RHER 3	Seek	Positioner has drifted off cylinder subsequent to completion of positioning operation.
HCE	RHER 1	Seek	Sector Count Field (RHLA) does not match Desired Sector Field (RHDST) and there is not a CRC error. This error is not caused by a positioner failure: It is due to a DCL failure. Therefore, HCE alone indicates an RP04 Seek Error and not a DEC 733 Drive Seek failure.

Diskless Controller Test, Part I (Static 1A) (MAINDEC-11-DZRPS)
Run Procedure: Run two passes, using default parameters.

Errors Allowed: None

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 5 minutes/drive

Diskless Controller Test, Part II (Static 1B) (MAINDEC-11-DZRPT)
Run Procedure: Run two passes, using default parameters.

Errors Allowed: None

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 10 minutes/drive

Functional Controller Test, Part I (Static 2A) (MAINDEC-11-DZRPU)
Run Procedure: Run two passes, using default parameters.

Errors Allowed: Only pack-attributable errors.

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 5 minutes/drive

Functional Controller Test, Part II (Static 2B) (MAINDEC-11-DZRPV)
Run Procedure: Run two passes, using default parameters.

Errors Allowed: Only pack-attributable errors.

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 5 minutes/drive

Formatter Program (MAINDEC-11-DZRPL)
Run Procedure: Run according to Table 6-2.

Errors Allowed: Pack-attributable errors only.

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 15 minutes/drive

Mechanical Read/Write Test (MAINDEC-11-DZRPK)
Run Procedure:

   1.   One pass of all tests, using default parameters.

   2.   Ten passes of tests 0–6.

Errors Allowed: Only pack-attributable errors. (The same pack should be used for this test that was used for the test in the preceding paragraph.)

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: One hour, 15 minutes/drive

Multidrive Exerciser (MAINDEC-11-DZRPN)
Run Procedure: Run all drives, using default parameters, until 6.25×10^7 words have been transferred on all drives.

Errors Allowed: One soft error that is not pack-attributable. (Use the same pack that was used for preceding test.)

Error Recovery Procedure: Drop failing drive from test. Continue test on remaining drives. Correct problem and restart acceptance on failing drive.

Approximate Run Time: 45 minutes/drive

DEC-X-11
Run Procedure: Run configured for system with default parameters for one hour.

Errors Allowed: Two system soft errors that are not pack-attributable. (Use the same pack that was used in the preceding tests.) Data Late errors (DLT) are to be expected on heavily loaded systems and, as such, should not be considered as errors.

Error Recovery Procedure: Drop failing drive and continue test on remaining drives. Correct problem and restart acceptance on failing drive.

6.3.2 Operational Checks, Dual Controller
When all installation procedures have been completed for a dual-controller system, the tests described in the following paragraphs should be performed. The total time required to run these tests, in the absence of errors, is 4.0 hours per drive.

Table 6-2
Format (MAINDEC-11-DZRPL) Run Procedure

DRV 0	DRV 1	DRV 2	DRV 3	DRV 4	DRV 5	DRV 6	DRV 7
Default Option (1)	Write Check (1)	Write Check (1)	Write Check (1)	Write Check (1)	Write Check (1)	Write Check (1)	Write Check (1)
Write Check (1)	Default Option (2)	Write Check (2)	Write Check (2)	Write Check (2)	Write Check (2)	Write Check (2)	Write Check (2)
	Write Check (2)	Default Option (3)	Write Check (3)	Write Check (3)	Write Check (3)	Write Check (3)	Write Check (3)
		Write Check (3)	Default Option (4)	Write Check (4)	Write Check (4)	Write Check (4)	Write Check (4)
			Write Check (4)	Default Option (5)	Write Check (5)	Write Check (5)	Write Check (5)
				Write Check (5)	Default Option (6)	Write Check (6)	Write Check (6)
					Write Check (6)	Default Option (7)	Write Check (7)
						Write Check (7)	Default Option (8)
							Write Check (8)

Diskless Controller Test, Part I (Static 1A) (MAINDEC-11-DZRPS)
Run Procedure: Run two passes, using default parameters (both ports).

Errors Allowed: None

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 10 minutes/drive

Diskless Controller Test, Part II (Static 1B) (MAINDEC-11-DZRPT)
Run Procedure: Run two passes, using default parameters (both ports).

Errors Allowed: None

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 20 minutes/drive

Functional Controller Test, Part I (Static 2A) (MAINDEC-11-DZRPU)
Run Procedure: Run two passes, using default parameters (both ports).

Errors Allowed: Only pack-attributable errors.

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 10 minutes/drive

Functional Controller Test, Part II (Static 2B) (MAINDEC-11-DZRPV)
Run Procedure: Run two passes, using default parameters (both ports).

Errors Allowed; Only pack-attributable errors.

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 10 minutes/drive

Dual Controller Logic Test, Part I (MAINDEC-11-DZRPP)
Run Procedure:

1. Install dual controller option test cable (7010507-02).

2. Run two passes, using default parameters.

Errors Allowed: Pack-attributable errors only.

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 5 minutes/drive

Dual Controller Logic Test, Part II (MAINDEC-11-DZRPQ)
Run Procedure:

1. Install dual controller option test cable (7010507-02).

2. Run one pass, using default parameters.

Errors Allowed: None

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 5 minutes/drive

Formatter Program (MAINDEC-11-DZRPL)
Run Procedure: Run according to Table 6-2 (one port only).

Errors Allowed: Pack-attributable errors only.

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: 15 minutes/drive

Mechanical Read/Write Test (MAINDEC-11-DZRPK)
Run Procedure:

1. One pass of all tests, using default parameters (one port only).

2. Ten passes of tests 0–6 (one port only).

Errors Allowed: Pack-attributable errors only. (Use the same pack for this test that was used for the preceding test.)

Error Recovery Procedure: Correct problem and restart acceptance on failing drive.

Approximate Run Time: One hour, 15 minutes/drive

Multidrive Exerciser (MAINDEC-11-DZRPN)
Run Procedure: Run all drives, using default parameters, until 6.25×10^7 words have been transferred on all drives. (Run both ports simultaneously.)

Errors Allowed: One soft error, not pack-attributable. (Use the same pack for this test that was used for the preceding tests.)

Error Recovery Procedure: Drop failing drive from test. Continue test on remaining drives. Correct problem and restart acceptance on failing drive.

Approximate Run Time: 45 minutes/drive

DEC-X-11
Run Procedure: Run configured for system, using default procedures, for one hour (both ports).

Errors Allowed: Two system soft errors that are not pack-attributable. (Use the same pack that was used for the preceding tests.) Data Late errors (DLT) are to be expected on heavily loaded systems and, as such, should not be considered as errors. Engineering guidelines will be available at a later date.

Error Recovery Procedure: Drop failing drive and continue test on remaining drives. Correct problem and restart acceptance on failing drive.

6.4 DIAGNOSTICS
The diagnostic programs employed with the RJP04 subsystem are described briefly below. Refer to the applicable diagnostic operating procedures for detailed information.

6.4.1 Test Programs

MAINDEC-11-DZRPS and MAINDEC-11-DZRPT RP04 Diskless Controller Test, Parts I and II (Static 1A and 1B) – This program tests the RH11 and the DCL portion of the RP04 Disk Drive. The DCL must be plugged into the mass device level interface (MDLI) connecting to the drive assembly. This program does not use the disk surface or any signals from the MDLI. If the disk is powered up, it must be in the Heads Unloaded position. A successful run (no errors) of this diagnostic indicates that the DCL logic is working properly; the logic controlling mechanical commands is not tested by this diagnostic. All data commands use the Maintenance register in the wraparound mode.

MAINDEC-11-DZRPU and MAINDEC-11-DZRPV RP04 Functional Controller Test, Parts I and II (Static 2A and 2B) – This diagnostic tests the DCL portion of the RP04 by exercising the disk surface and the mechanics of the drive to prove proper operation of the subsystem. A disk pack (which need not be formatted) with no vital information written on it is necessary to run this diagnostic. A successful run (no errors) indicates that the DCL circuitry works properly while not connected to the rest of the subsystem. This test should be run after the Diskless Controller Test has been run successfully.

MAINDEC-11-DZRPK Mechanical Read/Write Test – This program contains 15 tests numbered from $0-16_8$. Tests 0–6 use a Read Header and Data command to read the cylinder, track, and sector information from the header; the tests then check for validity, ensuring that the seek operation functions properly. Tests 7–12 measure the rotational speed, the one-cylinder seek, the average seek, and the maximum seek times to ensure that they are all within the specified tolerances. Tests 13 and 14 ensure that the sector and track addressing circuitry is working properly. Test 15 ensures that the data storage and retrieval capabilities are operative. Test 16 is used to stress and check the read/write and servo systems. The program starts by identifying itself and determining that all drives are available for testing; it then tests them in numerical order, beginning with the lowest numbered. One pass (tests 0–15) is performed on each drive, with the number of the tested drive typed at the beginning of the pass. An End of Pass message is typed at the completion of each pass; after all drives have been tested, an End of Test message is typed.

MAINDEC-11-DZRPP and MAINDEC-11-DZRPQ Dual-Port Logic Test (Parts I and II) – This program, which requires a special adapter cable, checks the dual-port logic in the DCL portion of the RP04.

6.4.2 System Exerciser Programs

MAINDEC-11-DZRPN Multidrive Exerciser – This program exercises one to eight RP04 Disk Drives attached to the same RH11. If two or more RP04s are being exercised, operations may be overlapped so that one drive performs a data transfer or write-check operation while others perform seek/search operations. Performance of each drive is monitored by the program, so that a drive which exceeds a preset number of errors in any of several categories is automatically deassigned, unless the operator chooses to override that feature. Performance statistics for each drive being exercised are reported on request from the operator or automatically at intervals determined by the operator. All data transfer commands (Write Data, Write Header and Data, Read Data, and Read Header and Data) are used, as well as Write-Check Data and Write-Check Header and Data commands. Recalibrate and Read-In Preset commands are used at startup and drive initialization; Recalibrate, Offset, and Return to Centerline commands are used during error processing. Program/operator communication is via the teletypewriter, which also normally reports errors, unless a line printer is available. Program options are selected by switch register settings. All commands, data patterns, and data buffer sizes are selected randomly by the program, as are the addresses (cylinder, track, and sector) for each operation. At completion of each operation, the program checks the RH11. This program requires data packs created by the Formatter Program (below), by the Mechanical Read/Write Test (above), or by the Data Pack Generation command of the Exerciser Program.

6.4.3 Utility Programs

MAINDEC-11-DZRPL Formatter Program – This program is designed to write and verify header and data information on all possible disk pack addresses in order to test the retention of the recording surfaces. The format is maintained on a basis of 411 cylinders, 19 tracks per cylinder, and 22 sectors per track. The program formats the disk pack on the assigned drive one track at a time. The data fields are written with the selected pattern; key words are written with 0s. Each track is verified with a Write-Check command immediately after it is written. The first and last cylinder and track addresses, inclusively, determine the portion of the pack to be formatted (no smaller than a single track). Write-check errors are reported when they are detected. If an error is detected, the sector must be

rewritten and verified by two consecutive successful tests before being considered usable again. Sectors that cannot be written correctly twice, after an error, are declared by the program to be unacceptable. After the last track has been formatted and verified, the header of track 0 and sector 0 of each cylinder is read and compared by the software to isolate possible positioner errors that might have occurred during formatting (e.g., failure of the positioner to advance to the next cylinder, or advancement of the positioner past the desired cylinder).

MAINDEC-11-DZRPM Head Alignment Verification Program – This program checks head alignment at cylinder 245, heads 0–18, and at cylinders 400 and 4, heads 0 and 18; it also reverifies alignment of cylinder 245, heads 0–18. Head alignment is checked as follows:

1. Offset the positioner to +1200 microinches.

2. Store the sign change bit.

3. Move the positioner in the opposite direction in increments of 25 microinches until the sign change bit changes value; store the offset value.

4. Offset the positioner to –1200 microinches and repeat steps 2 and 3.

5. Average the two sign change offset values and report if the selected head is misaligned by more than ±150 microinches for cylinder 245 or ±35 microinches for cylinders 4 and 400.

6. Repeat steps 1 through 5 for all heads at cylinder 245 and for heads 0 and 18 at cylinders 4 and 400.

The program will notify the operator if any head is out of alignment by more than the specified amount.

MAINDEC-11-DZRPO Peripheral Test Generator Program – This program is a modified form of FOCAL-11, and allows the user to write RP04 programs in the FOCAL-11 language.

CHAPTER 7
INSTALLING THE RP04
INTO AN RHP04 SUBSYSTEM

7.1 INTRODUCTION

When one or more RP04s are combined with one or more RH10 controllers, the combination is designated as an RHP04 subsystem. The Massbus interface and all channel bus, I/O bus, and Massbus operations that apply to the RH10/RS04 are described in detail in the *RH10 Massbus Controller Maintenance Manual* and also apply to the RP04. The RP04 has 16 Massbus registers; Figure 7-1 shows the formats for all RP04 Massbus registers in an RHP04 subsystem.

RP04 Massbus commands are as follows:

Octal Code	Command
01	NO OP
03	UNLOAD
05	SEEK
07	RECALIBRATE
11	DRIVE CLEAR
13	RELEASE
15	OFFSET
17	RETURN TO CENTERLINE
21	READ IN PRESET
23	PACK ACKNOWLEDGE
31	SEARCH
61	WRITE DATA
63	WRITE HEADER AND DATA
71	READ DATA
73	READ HEADER AND DATA

These command codes may be set in the last two octal digits of the switch panel, and are displayed in the CR FUNCTION CODE lights. Figure 7-2 represents a simplified block diagram showing typical cable types and connections for an RHP04 subsystem.

7.2 ELECTRICAL

Power cable connections and Massbus cable connections are described in the following paragraphs.

7.2.1 Power Cable Connections

Power is distributed within an RHP04 subsystem by means of the self-contained RH10 power supply and a DEC Type 857 Power Control. The +5 Vdc and −15 Vdc requirements of the system are provided by DEC Type 742 Power Supplies; the +15 Vdc requirement is provided by a DEC Type 783 Power Supply. Power is applied to the subsystem as follows:

1. Insert the RP04 power plug into the un-switched side of the 861 Power Control.

2. Connect the incoming remote power cable (3-wire) into J1 of the drive, and the output remote power cable into J2, if applicable.

3. Connect the power sequence into J3 if this is the first drive; otherwise, connect the incoming 4-wire power sequence cable to J3.

4. If this is the last drive, or the only drive, no connection need be made to J4; otherwise, a 4-wire sequence cable is output from J4 to J3 of the next drive. Part numbers are:

70-08288	J1, J2 Cable, 3-wire
70-09490	J3 Jumper Plug, 1st device
70-09491	J3, J4 Cable, 4-wire

5. Turn SW1 to REMOTE and turn the circuit breaker ON. When the CPU is turned ON, all drives (if multidrive) will power sequence up, one at a time.

Figure 7-1 RP04 Massbus Registers — register bit map

Register	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	
DRCR 00					DVA						F5	F4	F3	F2	F1	(GO) FO	R/W
DIB REG BIT #	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	
DCL BIT #	C15	C14	C13	C12	C11	C10	CO9	CO8	CO7	CO6	CO5	CO4	CO3	CO2	CO1	COO	
DRSR 01	ATA	ERR	PIP	MOL	WRL	LST	PGM	DPR	DRY	VV	DE1	DL64	GRV	DIGB	DF20	DF5	R
DRER1 02	DCK	UNI	OPI	DTE	WLE	IAE	AOE	HCRC	HCE	ECH	WCF	FER	PAR	RMR	ILR	ILF	R/W
DRMR 03						HI CNT DETET	SYNC BYTE DETET	ZERO DETET	DATA EV	ECC EV	MAINT WRT	MAINT RD *	MAINT SCLK *	MAINT IDX *	MAINT CLK *	DMD *	R/W
DRAS 04									ATTN 7	ATTN 6	ATTN 5	ATTN 4	ATTN 3	ATTN 2	ATTN 1	ATTN 0	R/W
DRDA 05				TA 16	TA 8	TA 4	TA 2	TA 1				SA 16	SA 8	SA 4	SA 2	SA 1	R/W
DRTR 06	NBA 0	TAP 0	MOH 1		DRQ 0 **			DT 08	DT 07	DT 06	DT 05	DT 04	DT 03	DT 02	DT 01	DT 00	R
DRLA 07						SC 4	SC 3	SC 2	SC 1	SC 0	EXT 5	EXT 4	EXT 3	EXT 2	EXT 1	EXT 0	R
DRSN 10	SN 38	SN 34	SN 32	SN 31	SN 28	SN 24	SN 22	SN 21	SN 18	SN 14	SN 12	SN 11	SN 08	SN 04	SN 02	SN 01	R
DROF 11	SIGN CNG			FMT 22	ECI	HCI			OF 7 *	OF 6 *	OF 5 *	OF 4 *	OF 3 *	OF 2 *	OF 1 *	OF 0 *	R/W
DRDC 12							DC 9	DC 8	DC 7	DC 6	DC 5	DC 4	DC 3	DC 2	DC 1	DC 0	R/W
DRCC 13							CC 9	CC 8	CC 7	CC 6	CC 5	CC 4	CC 3	CC 2	CC 1	CC 0	R
DRER2 14	AC UNS		PLU	30V	IXE	NHS	MHS	WRU	FEN	TUF	TDF	MSE	CSU	WSU	CSF	WCU	R/W
DRER3 15	OCYL	SKI							ACL	DCL	DIS ERR	UNS EX RW		VUF	PSU		R/W
DREC1 16 (POS)																	R
DREC2 17 (PAT)																	R

DRSR 01 note: THESE BITS SHOULD BE ZERO IF HD LD OK

DRSN 10 grouping: HIGH ORDER (4th) DEC. | 3rd DEC. | SECOND LOWEST DEC. | LOW ORDER DIGIT

DREC1 16 / DREC2 17 note: GUARANTEED ZEROS

* INDICATES CLEARED BY MSB INT OR DR CLR
** HARDWIRED FOR SINGLE PORT

10-1369

Figure 7-1 RP04 Massbus Registers

7-2

```
              MEMORY BUS
                 │
          ┌──────┴──────┐
          │    DF10     │
          │    DATA     │
          │   CHANNEL   │
          └──────┬──────┘
                 │
            CHANNEL
              BUS
            (BC10-P)      I/O BUS        ┌──────────────┐
                       (BC10-J,BC10-K)   │  KA/KI 10    │
                       ┌────────────────│  CENTRAL     │
CHANNEL          ┌─────┴───┐            │  PROCESSOR   │
BUS TO  ◄── ──── │  RH10   │ ──►I/O BUS TO NEXT DEVICE
NEXT DEVICE      └────┬────┘
                      │       MASSBUS
                      │       CABLES (BC 06-S)
          ┌───────────┴──┐
    ┌─────┴───┐    ┌──────┴──┐
    │  RP04   │◄──►│  RP04   │◄──► UP TO 8 DEVICES
    └────┬────┘    └────┬────┘
         │              │
         └──────┬───────┘
          ┌─────┴──────┐
          │   RP04     │
          └────────────┘
```

CP-1464

Figure 7-2 RH10/DF10/RP04 Cable
Interconnection Diagram

6. Ensure that phasing is correct by noting that the pack spins in a *counterclockwise* direction. If not, reverse the phases in the power box.

7. When preceding steps have been completed, the RP04 is physically mounted. Refer to the acceptance procedures in Chapter 8.

7.2.2 Massbus Cable Connections

The RP04 connects to the RH10 by means of a round Massbus cable assembly (BC06S). Flat cable is used within the DCL from the round cable transition connector up to the M5903 standard Massbus transceiver modules in the DCL. Two round cable connection paths exist; one for input from the previous RH10 or RP04, and one for output to the next device. If another drive is to follow, route a BC06S round Massbus cable assembly out through the rear of the drive through the left cable clamp and into the next drive. Terminate the last drive in the subsystem by a termination block (70-09938), which is installed via a zero-insertion-force connector to the final round cable connector block.

NOTE
CB1 may be OFF in the terminating drive, yet the Massbus will operate.

7.3 RH10 MAINTENANCE PANEL

The RH10 contains a maintenance panel that can be useful for off-line troubleshooting of an initial installation before running dedicated diagnostic programs. Most cable and DCL problems can be found and repaired in this manner. (MAINDEC-10-DCRPF, discussed in Chapter 8, can also be used to resolve these problems.) The following examples show how the maintenance panel can be used to check the RP04 configuration.

Example 1 — Initial Hookup

1. Place the LOCAL/REMOTE switch to LOCAL, with all other switches OFF.

2. Start drive(s) and ascertain that the CON-TROLLER SELECT switch points to the correct port. Wait for READY to come ON.

3. Deposit 01000N000000 in the switches (with N the number of the drive to be tested). Read Register 1 (DRSR), which is the drive status register.

4. Press CLEAR, then press START.

5. The DIB register data should be 010600 [starting with bit 0 as the first and total octal digit (Figure 7-1)]. If the DIB register data is not correct, check the DIB CBT0 light. If this is ON, the drive did not recognize the command. In any case, the cables and drives in the chain are suspect. If problems exist, power down the drives (by setting CB1 to OFF) to eliminate DCL faults and investigate cable/transceiver problems using one drive.

NOTE
The terminators do not require power to operate.

6. If the response was correct, deposit 00400N000021 in the switches. This is a read-in preset command.

7. Press CLEAR, then press START.

8. Repeat steps 3 and 4.

9. The DIB Register Data should be 010700. The VOLUME VALID bit is now set.

10. If the data is not correct, set the RECYCLE switch to ON and repeat steps 6 and 7. (Dynamic logic cannot be observed with the oscilloscope.)

Example 2 — Read Data

1. Execute steps 1–4 of Example 1.

2. Deposit 40400N000071 (read data command) in the switches.

3. Press CLEAR, then press START.

4. The indicator panel should show both DONE and NOT BUSY to be ON. DR EXC should be OFF, and DBT0 should not be set. RUN should be OFF, and FIN EN should be ON. DBT0 indicates that the DCL failed to respond to the command. If DBT0 is set, go to Example 3 (Recycle Read) to set up an oscilloscope loop. CR CBT0 should be OFF.

5. If DR EXC is set, proceed with the subsequent steps.

6. Deposit 020000N000000 in the switch panel.

7. Press START; do *not* press CLEAR.

8. The contents of Error Register 1 are now displayed. Analyze this data, referring to Figure 7-1.

9. Repeat steps 6–8, using 14 and then 15 as the first two digits, to read Error Registers 2 and 3.

Example 3 — Recycle Read

1. Place the LOCAL/REMOTE switch in LOCAL, with all other switches OFF.

2. Deposit 00400N000021 in the switches.

3. Press CLEAR, then press START.

4. Deposit 01000N000000 in the switches.

5. Press START.

6. Check the DIB Register Data for 010700. (Steps 4, 5, and 6 are for continuity only.)

7. Deposit 05400N000000 in the switches. This is a set to zero of the track and sector address. When recycling, this DIB command is re-executed following every Read.

8. Press START; do *not* press CLEAR.

9. Deposit 40400N000071 in the switches.

10. Set RECYCLE to ON, and press START. The drive will now continually read cylinder, track, sector 0, and can be examined with an oscilloscope. If the entire disk is to be read, omit steps 7 and 8, and the RH10 will automatically move through the entire disk.

Example 4 — Write Data

1. Place the LOCAL/REMOTE switch in LOCAL, with all other switches OFF.

2. Deposit 00400N000021 in the switches.

3. Press CLEAR, then press START.

4. Deposit 40400N000061 in the switches.

5. Press START.

6. The indicator panel should show both DONE and NOT BUSY as being ON. DR EXC should be OFF, and DBT0 should not be set. Debug in accordance with Examples 2 and 3, but use the Write Function code (61) where applicable. RUN should be OFF, and FIN EN should be ON.

7. The data in the Data Buffer lights was written onto the drive (zeros, in this case).

8. To set a data pattern into the Data Buffer for writing, set the switches to 50400NPPPPPP (where P is the pattern).

9. Press START, and repeat steps 4 and 5.

NOTE
Do *not* press CLEAR; this will erase the error.

7.4 VISUAL INSPECTION

Before the acceptance testing is performed, the following visual inspections should be made:

1. Verify that all modules are configured according to the *RH10/RP04 Module Utilization List*.

2. Ensure that all modules are firmly seated in the system backplane assembly.

3. Inspect the backplane wiring for broken wires or damaged pins; repair or replace as needed.

4. Ensure that the power cable is firmly attached to the system backplane assembly (RP04).

5. Clean the air filters at the top of the cabinet, if necessary.

6. Ensure that all Massbus cables are properly terminated and firmly seated.

7. Check the cabinet fans for proper operation.

CHAPTER 8
RHP04 FIELD ACCEPTANCE
PROCEDURES AND DIAGNOSTICS

8.1 INTRODUCTION

Field acceptance testing is intended to demonstrate performance of the RP04 Disk Drive and/or the RHP04 subsystem to the customer prior to his acceptance.

8.2 ERROR DEFINITIONS/RATES

The RP04 contains three registers to display the various error conditions possible. Error register #1 (RHER 1) indicates the operational error related to command and control; error registers #2 and #3 (RHER 2, RHER 3) indicate drive error conditions. Two bits of RHER 3 (SKI and OCYL) indicate seek errors and are used to calculate the seek error rate (Paragraph 8.2.4). Four bits of RHER 1 (DCK, HCRC, HCE, and ECH) indicate data errors; the remaining bits of RHER 1 indicate command and control errors. Table 6-1 lists indications of the various error types and their explanations.

8.2.1 Hard Errors

Any failure to read data correctly after a complete recovery sequence* with ECC enabled constitutes an irrecoverable, or hard error. Errors that are not ECC-correctable include bursts greater than 11 bits in length and isolated dropped bits (separated by more than 11 bits) within a sector. The allowable error rate for hard errors is 1 error per 10^{12} bits read.

8.2.2 Soft Errors

Any failure to read correctly on the first try, data that is then read successfully during a recovery sequence, constitutes a recoverable, or soft error. The allowable error rate for soft errors is 1 error per 10^9 bits read.

8.2.3 Pack-Attributable Errors

An error caused by imperfections in the recording surface is regarded as pack-attributable, or media dependent. If the imperfection is less than 11 bits long, it is ECC-correctable and will appear as a soft error. If it is longer than 11 bits, 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. The definitions of hard and soft errors in Paragraphs 8.2.1 and 8.2.2 apply *only* to randomly distributed errors, and do *not* take into account errors that are pack-attributable. Imperfections in the pack surface may be found by mapping the pack using the formatter program.

8.2.4 Seek Errors

Any positioning operation that is not completed within a specified time (85 ms for SEEK commands, 500 ms for RECALIBRATE commands, and 10 ms for OFFSET and RETURN TO CENTERLINE commands) or that terminates with the positioner in an incorrect location constitutes a seek error. The allowable error rate for seek errors is 1 error per 10^6 seek operations.

8.3 RHP04 ACCEPTANCE TESTING

The actual configuration of customer acceptance testing for the RP04 Disk Drive used with an RH10 controller depends upon the individual contractual arrangements between the customer and Digital Equipment Corporation. A diagnostic distribution list, contained on the magtape distributed with the RP04 Disk Drive, contains the most recent field procedures for determining whether or not the RP04 meets the error specification established by DEC for minimum

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*A complete recovery sequence consists of 28 retries, 16 of them at the nominal head position, and 2 each at offsets of ±400, ±800, and ±1200 microinches. The first release of the DEC PDP-11 operating systems does not include offset capability.

acceptable performance at installation. One version of such acceptability testing might be as shown below, based on subtests contained in the *RP04 Disk Transfer and Reliability Diagnostic* (MAINDEC-10-DCRPG).

8.3.1 Diagnostic and Reliability Testing

1. Run MAPWRT to identify potential error areas of a given pack, so the computer can avoid pack-attributable errors.

2. Run ITEST for one pass, then rotate packs and run it again. Continue in this manner until each pack has been read by every drive to ensure compatibility between drives and packs. One soft error per pack, per pass is permitted (one pass = at least 10^9 bits).

3. Run ACCEPT Script until a minimum of 1×10^{10} bits/drive has been read. (Nominal run time = approximately 3 hours/drive.) Summary printout every hour indicates, among other things, the number of bits transferred. Multiple drives can be tested; refer to DCRPG for details.

8.3.2 User Mode

In User Mode no unrecoverable or hard errors are permitted within a 24-hour period. (Disregard pack-attributable errors.) No more than five soft errors that are not pack-attributable are permitted per drive within a 24-hour period.

8.4 DIAGNOSTIC DESCRIPTIONS

For complete descriptions of specific diagnostics, refer to the diagnostics themselves. For the latest list of applicable diagnostics, refer to the diagnostic distribution list on the magtape distributed with the RP04 Disk Drive. Among the diagnostics likely to be contained on that list are the following.

MAINDEC-10-DCRHA Deviceless Diagnostic

This program exercises the major portion of RH10 logic; no Massbus device necessarily has to be connected to the system. The I/O bus and DF10/DF10C channel bus paths are thoroughly exercised.

MAINDEC-10-DCRPF Disk Exerciser

This program exercises all RP04 Massbus registers, and checks Massbus error conditions. Simple data transfers to and from the disk are executed and basic mechanical movements are tested. The program can be caused to loop on errors.

This diagnostic is useful in isolating Massbus cable and transceiver problems during installation. It should also be run after replacement of any DCL board, before attempting more complicated programs. To verify Massbus operation, run DRSTAT, which uses the control bus only and checks the read/write capabilities of all DCL registers. If problems occur, isolate to the drive, and then to the module. Figure 8-1 is a block diagram of the RP04 DCL, and is useful in identifying defective modules flagged by DRSTAT. For example, an inability to write DRER3 (15) would map to replacement of the EC board. If data showed parity errors while writing, the Massbus transceiver, the EC board MUX, or the SN board buffer and parity network would be suspect. If more than one drive is affected, power down (CB1 OFF) all drives, except one, and isolate the Massbus problem. After running DRSTAT, run DATA to verify the data bus portion of the Massbus. Successful operation of these programs ensures correct cabling and transceiver operation.

RP04 Disk Transfer and Reliability Diagnostic (MAINDEC-10-DCRPG)

This is a reliability diagnostic program for RHP04 subsystems consisting of up to 8 drives and an RH10 with an associated DF10/DF10C Data Channel. Basic and complex data transfers and mechanical movements are executed, depending upon the tests selected.

Figure 8-1   DCL Block Diagram

RP04 DISK DRIVE
INSTALLATION MANUAL
EK-RP04-IN-001

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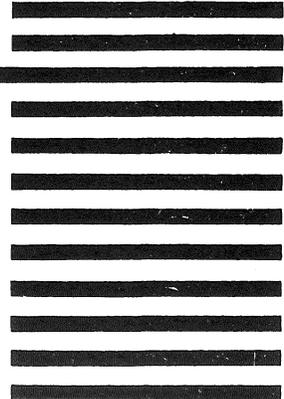
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