pdp11

DZ11
user's guide

digital

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DZ11
user's guide

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CONTENTS

CONTENTS (CONT)

FIGURES

TABLES

CHAPTER 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The DZ11 is an asynchronous multiplexer that provides an interface between a PDP-11 processor and eight asynchronous serial lines. It can be used with PDP-11 systems in a variety of applications that include communications processing, time-sharing, transaction processing, and real-time processing. Local operation to terminals or computers is possible at speeds up to 9600 baud using either EIA RS232C interfaces or 20 mA current loop signaling. Remote operation using the public switched telephone network is possible with DZ11 models offering EIA RS232C interfaces. Enough data set control is provided to permit dial-up (auto answer) operation with modems capable of full-duplex* operation such as the Bell models 103 or 113 or equivalent. Remote operation over private lines for full-duplex* point to point or full-duplex* multipoint as a control (master) station is also possible. Figure 1-1 depicts several of the possible applications for the DZ11 in a PDP-11 system.

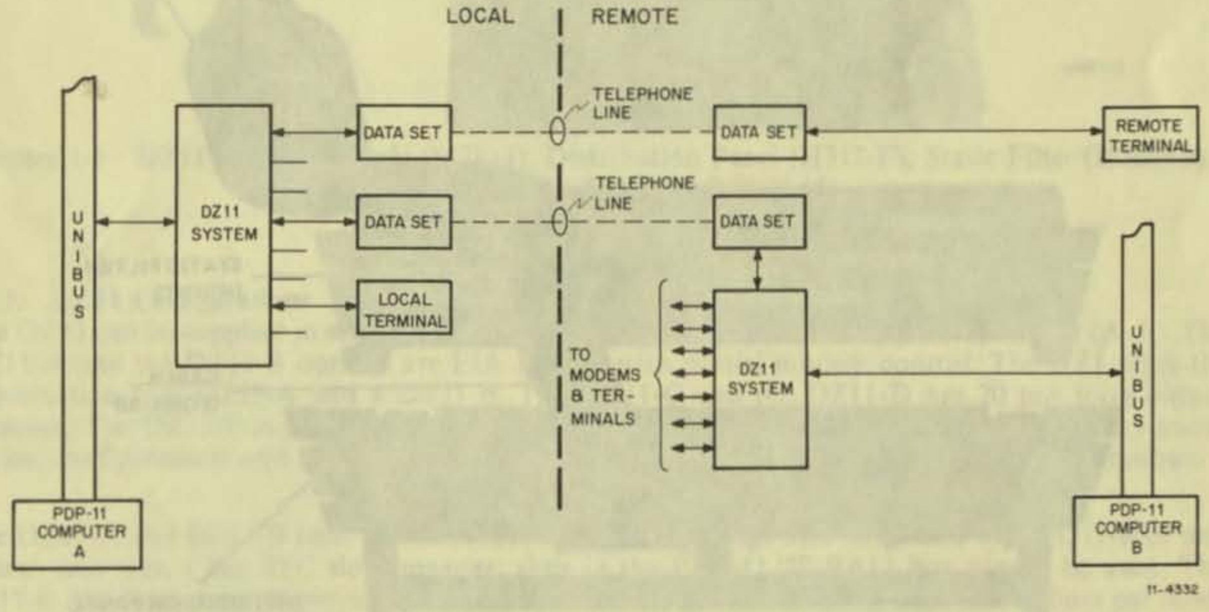

Figure 1-1 DZ11 System Applications

*The DZ11 data set control does not support half-duplex operations or the secondary transmit and receive operations available with some modems such as the Bell model 202, etc.

The DZ11 has several features that provide flexible control of parameters such as baud rate, character length, number of stop bits for each line, odd or even parity for each line, and transmitter-receiver interrupts. Additional features include limited data set control, zero receiver baud rate, break generation and detection, silo buffering of received data, module plug-in to hex SPC slots, and line turnaround.

Each DZ11 module provides for operation of eight asynchronous serial lines. Since the module interfaces to these channels with a 16-line distribution panel, 2 DZ11 modules can be used with 1 panel. Also note that the two versions of the DZ11 (EIA or 20 mA output) consist of different module and panel types. This fact allows a system to mix EIA and 20 mA by using multiple DZ11s.

1.2 PHYSICAL DESCRIPTION

The DZ11 (8-line configuration) comprises a single hex SPC module and a 13.34 cm (5.25 in), unpowered distribution panel, connected by a 4.6 m (15 ft) ribbon cable. Several types of interconnecting cables are used between the distribution panel and the modem or terminal, depending on the device. A 16-line configuration uses two modules and a single distribution panel connected by two ribbon cables. The DZ11 modules, cables, static filters,* and distribution panel are shown in Figures 1-2 and 1-3. The subsequent paragraphs present a detailed description of the physical and electrical specifications of the various DZ11 options and configurations.

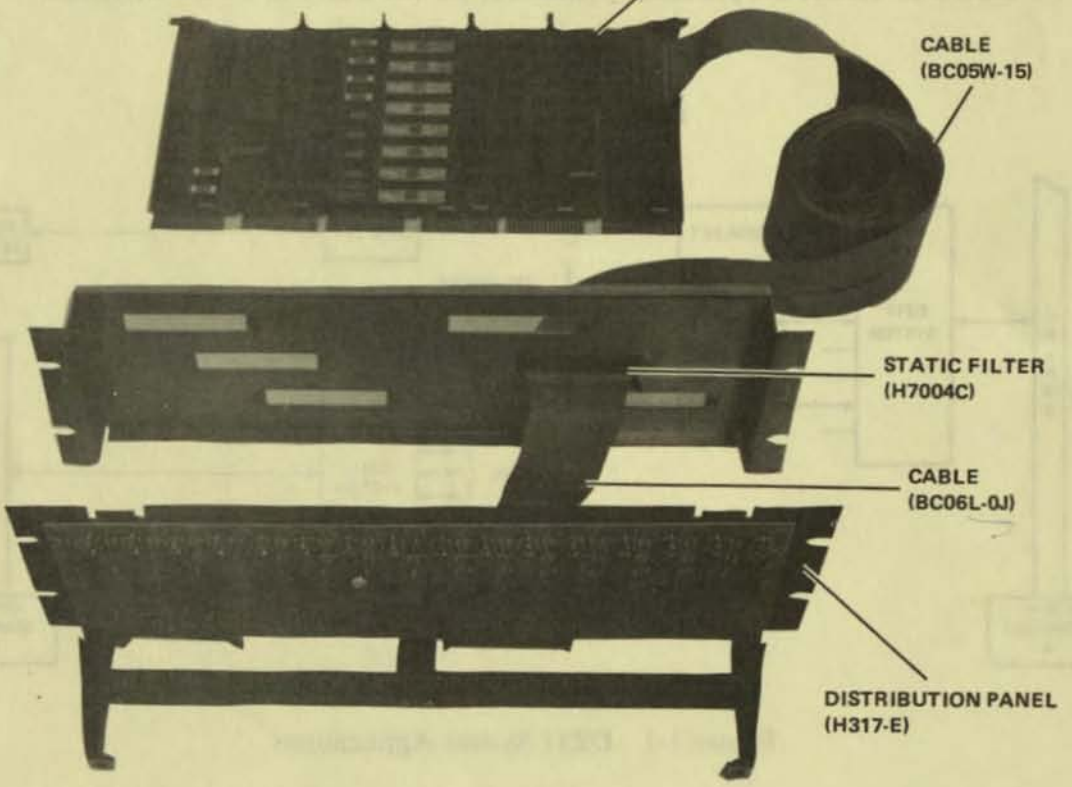

Figure 1-2 DZ11 EIA Module (M7819), Distribution Panel (H317-E), Static Filter (H7004C), and Cables (BC06L-0J and BC05W-15)

*Static filters are not supplied with earlier modules.

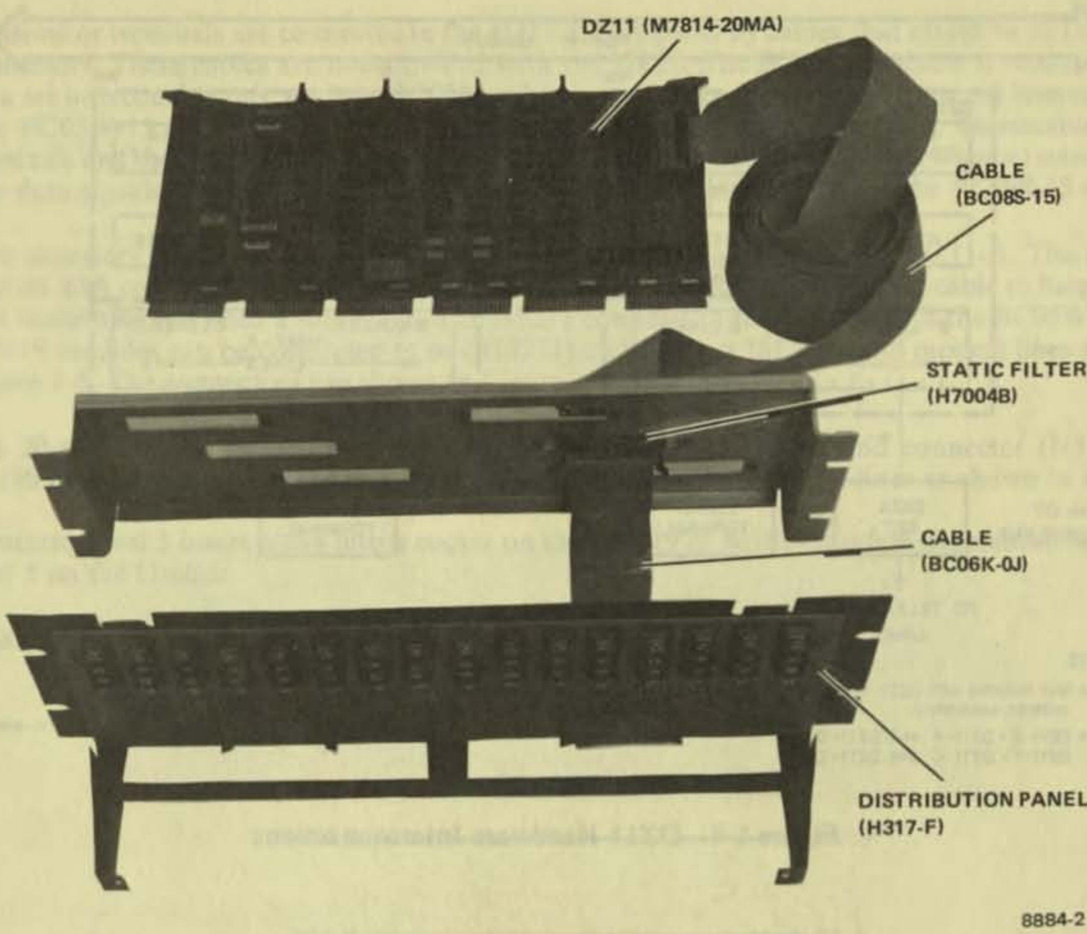

Figure 1-3 DZ11 20 mA Module (M7814), Distribution Panel (H317-F), Static Filter (H7004B), and Cables (BC06K-0J and BC08S-15)

1.2.1 DZ11 Configurations

The DZ11 can be supplied in six different configurations, each designated by a suffix letter (A–F). The DZ11-A and the DZ11-B options are EIA devices with partial modem control. The DZ11-E is the combination of a DZ11-A and a DZ11-B. The DZ11-C and the DZ11-D are 20 mA loop output versions. The DZ11-F is the combination of a DZ11-C and a DZ11-D. Table 1-1 lists the various option configurations and Figure 1-4 shows the required hardware for the various configurations.

The DZ11-A and DZ11-B each use an M7819 module that plugs into slot 2 or 3 of a DD11-B or any system unit with a hex SPC slot; however, slots in the PDP-11/20 BA11 box cannot be used. The H317-E distribution panel provides 16 communication lines from 2 M7819 modules (8 lines per module) and is included with the DZ11-A and DZ11-E configurations. The H317-F distribution panel provides 16 lines for the DZ11-C and DZ11-F configurations, which use the M7814 modules (20 mA system). The distribution panels require no power and can be mounted in an H960 48.26 cm (19 in) cabinet. Static filters (H7004C, EIA, and H7004B, 20 mA) are used to prevent problems caused by electrostatic discharge. A 50-conductor, flat, shielded cable, BC05W-15, connects from the M7819 module to the static filter. Cable BC06L-0J connects the static filter to the EIA distribution panel. A 40-conductor, flat, shielded cable, BC08S-15, connects from the M7814 module to the static filter. Cable BC06K-0J connects the static filter to the 20 mA distribution panel.

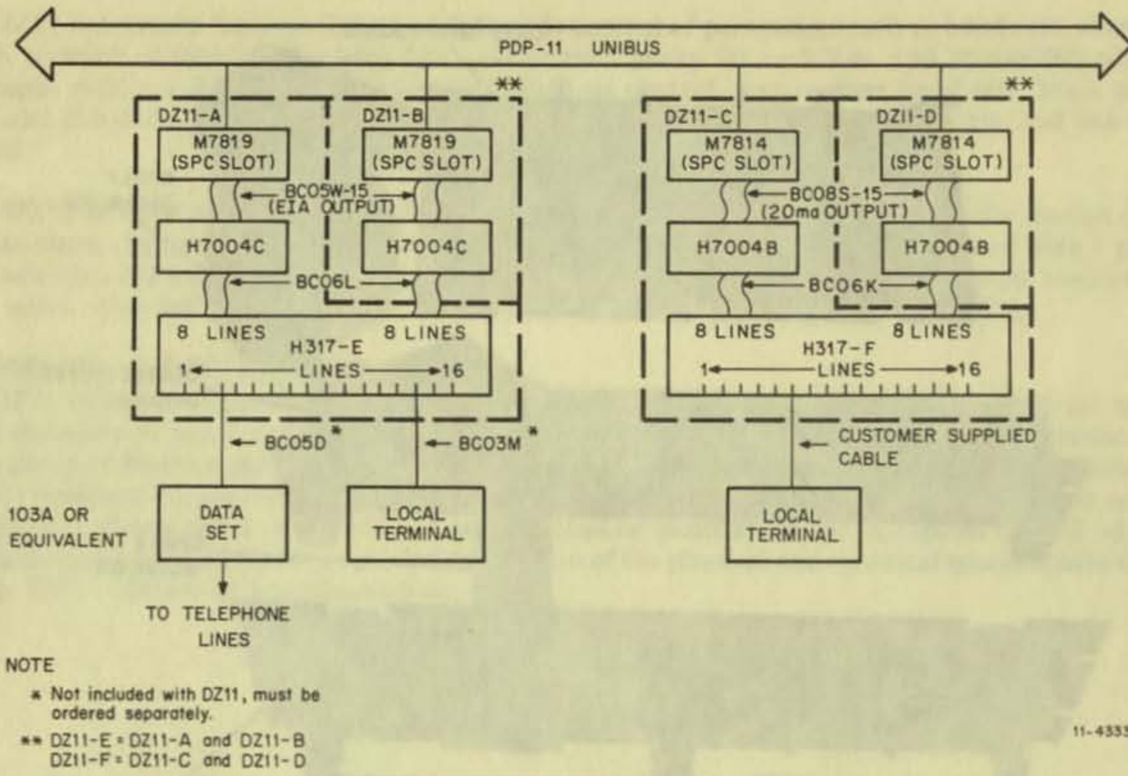

Figure 1-4 DZ11 Hardware Interconnections

Table 1-1 DZ11 Model Configurations

Model	Output	Module	Panel	Test Connector	Cables	Static Filter
DZ11-A	EIA	M7819	H317-E	H325/H327	BC05W, BC06L	H7004C
DZ11-B	EIA	M7819		H327	BC05W, BC06L	H7004C
DZ11-E	EIA	M7819 (2)	H317-E	H325/H327	BC05W (2), BC06L (2)	H7004C
DZ11-C	20 mA	M7814	H317-F	H3190	BC08S, BC06K	H7004B
DZ11-D	20 mA	M7814		H3190	BC08S, BC06K	H7004B
DZ11-F	20 mA	M7814 (2)	H317-F	H3190	BC08S (2), BC06K (2)	H7004B

NOTES

H327 will be replaced by H3271 in later units. H3190 is not supplied with early units. The shipping list will indicate which test connector, if any, is supplied.

H7004C, H7004B, BC06L, and BC06K are not supplied with early units. The shipping list will indicate which static filter and cable, if any, are supplied.

Modems or terminals are connected to the H317-E EIA panel by cables that attach to 16 DB25P cinch connectors. These cables are not provided with the DZ11. The BC05D-25 cable is recommended for data set interconnections, and the BC03M cable is recommended for local terminal interconnections. The BC05W-15 cable carries the data and control signals for all eight lines. Connections between terminals and the H317-F 20 mA panel are by customer-supplied cables to 16 (4-screw) terminal strips. The data signals for all eight lines are carried to the distribution panel by the BC08S-15 cable.

Two accessory test connectors, H325 and H3271*, are provided with each DZ11-A. The H325 plugs into an EIA connector on the distribution panel or on the end of the BC05D cable to loop back data and modem signals onto a single line. The H3271 connects to the module with the BC05W cable (two M7819 modules can be connected to one H3271) and staggers the data and modem lines as shown in Figure 1-5. The connectors are shown in Figure 1-6.

The 20 mA (M7814 module) options also have a staggered turnaround connector (H3190†). The H3190 connects to the M7814 using the BC08S cable and staggers the lines as shown in Figure 1-7.

A priority level 5 insert plugs into a socket on the M7819 or M7814 module to establish interrupts at level 5 on the Unibus.

Maximum configuration allows 16 DZ11 modules per Unibus.

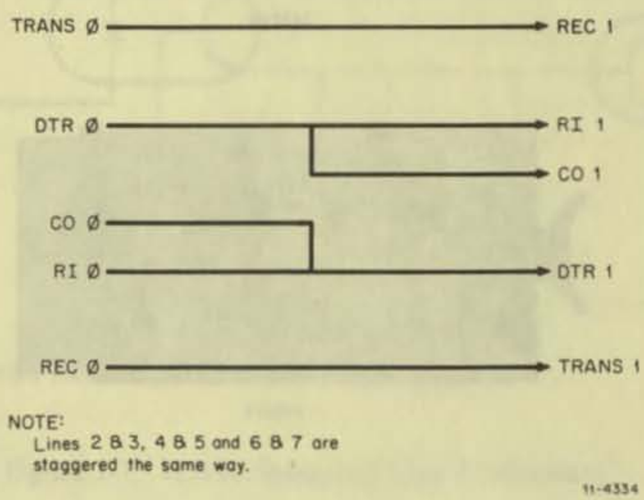

Figure 1-5 H3271 or H327 Turnaround

*This is a new item replacing the H327. The H327 may be used until the H3271 becomes available. The H327 plugs directly into J1 on the M7819 module.

†This is a new item; check the shipping list for availability.

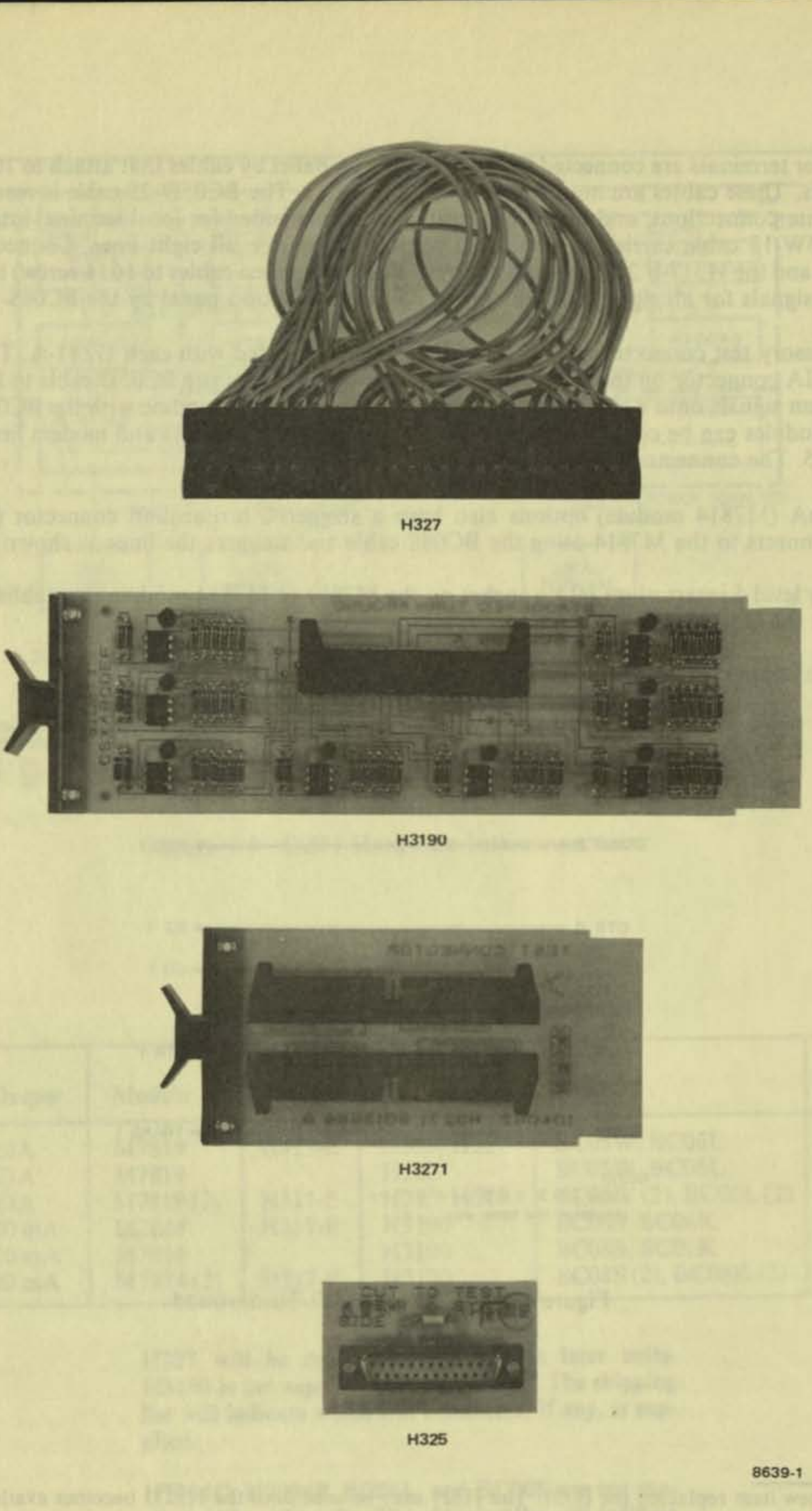

Figure 1-6 Test Connectors H327, H3190, H3271, and H325

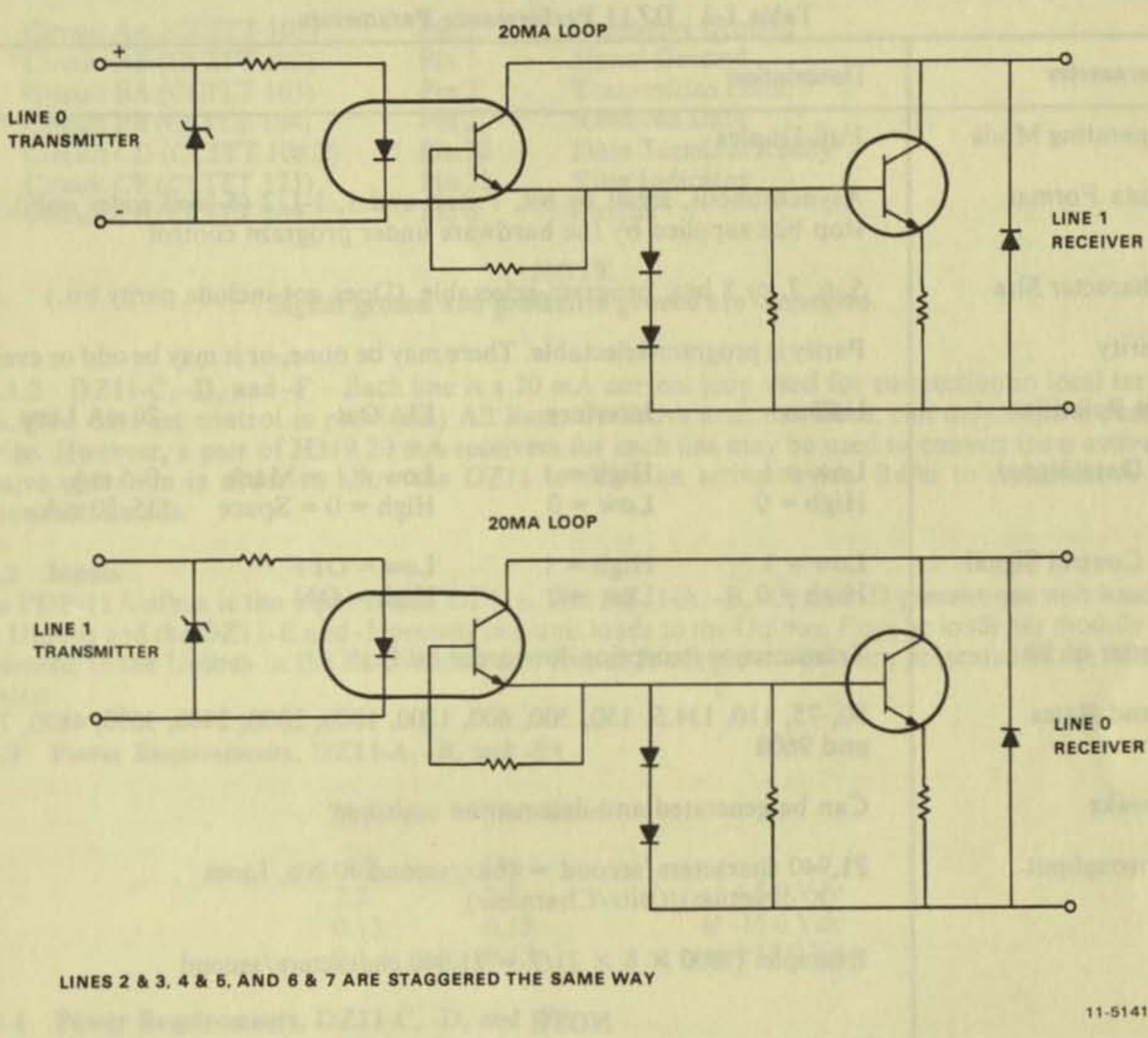

Figure 1-7 H3190 Staggered Line Turnaround

1.3 GENERAL SPECIFICATIONS

The following paragraphs contain electrical, environmental, and performance specifications for all DZ11 configurations. Table 1-2 lists the performance parameters of the DZ11.

Table 1-2 DZ11 Performance Parameters

Parameter	Description			
Operating Mode	Full-Duplex			
Data Format	Asynchronous, serial by bit, 1 start and 1, 1-1/2 (5-level codes only), or 2 stop bits supplied by the hardware under program control			
Character Size	5, 6, 7, or 8 bits; program-selectable. (Does not include parity bit.)			
Parity	Parity is program-selectable. There may be none, or it may be odd or even.			
Bit Polarities	**Unibus**	**Interface**	**EIA Out**	**20 mA Loop**
Data Signal	Low = 1 High = 0	High = 1 Low = 0	Low = 1 = Mark High = 0 = Space	0–5 mA 15–20 mA
Control Signal	Low = 1 High = 0	High = 1 Low = 0	Low = OFF High = ON	
Order of Bit	Transmission/reception low-order bit first			
Baud Rates	50, 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, and 9600			
Breaks	Can be generated and detected on each line			
Throughput	21,940 characters/second = (bits/second × No. Lines × direction)/(Bits/Character) Example: (9600 × 8 × 2)/7 = 21,940 characters/second NOTE **The theoretical maximum is 21,940. Actual throughput depends on other factors such as type of CPU, system software, etc.**			

1.3.1 Outputs

1.3.1.1 DZ11-A, -B, and -E – Each line provides voltage levels and connector pinnings that conform to Electronic Industries Association (EIA) standard RS232C and CCITT recommendation V.24. The leads supported by this option are:*

Circuit AA (CCITT 101)	Pin 1	Protective Ground
Circuit AB (CCITT 102)	Pin 7	Signal Ground
Circuit BA (CCITT 103)	Pin 2	Transmitted Data
Circuit BB (CCITT 104)	Pin 3	Received Data
Circuit CD (CCITT 108.2)	Pin 20	Data Terminal Ready
Circuit CE (CCITT 125)	Pin 22	Ring Indicator
Circuit CF (CCITT 109	Pin 8	Carrier

NOTE

Signal ground and protective ground are connected.

1.3.1.2 DZ11-C, -D, and -F – Each line is a 20 mA current loop used for connection to local terminals. (No data set control is provided.) All lines are active and, therefore, can only drive a passive device. However, a pair of H319 20 mA receivers for each line may be used to convert from active to passive operation in order to allow the DZ11 to drive an active device. Refer to Appendix A for connection details.

1.3.2 Inputs

The PDP-11 Unibus is the input for all DZ11s. The DZ11-A, -B, -C, and -D present one unit load to the Unibus and the DZ11-E and -F present two unit loads to the Unibus. Four ac loads per module are presented to the Unibus in the EIA version and five ac loads per module are presented in the 20 mA version.

1.3.3 Power Requirements, DZ11-A, -B, and -E†

Typical (A)	Maximum (A)	
2.2	2.5	at +5.0 Vdc
0.13	0.15	at -15.0 Vdc
0.1	0.13	at +15.0 Vdc

1.3.4 Power Requirements, DZ11-C, -D, and -F†

Typical (A)	Maximum (A)	
2.1	2.3	at +5.0 Vdc
0.4	0.42	at -15.0 Vdc
0.12	0.15	at +15.0 Vdc

*Circuit CA (CCITT 105 – Request to Send) is connected to circuit CD (DTR) through a jumper on the distribution panel. This allows control of the Request to Send line for full-duplex modem applications that use the RTS circuit.

†DZ11-E and DZ11-F are twice the above given values.

1.3.5 Environmental Requirements – All DZ11s

Class C Environment Operating Temperature	5° to 50° C* (41° to 122° F)
Relative Humidity	10 to 95%, with a maximum wet bulb of 32° C (90° F) and a minimum dewpoint of 2° C (36° F)
Cooling	
DZ11-A, -B, -C, and -D	Air flow 1.416 l/second (3 cu. ft/min)
DZ11-E and -F	Air flow 2.832 l/second (6 cu. ft/min)
Heat Dissipation	
DZ11-A and -B	3.99 g·cal/second (57 Btu/hr)
DZ11-E	7.98 g·cal/second (114 Btu/hr)
DZ11-C and -D	3.85 g·cal/second (55 Btu/hr)
DZ11-F	7.7 g·cal/second (110 Btu/hr)

1.3.6 Distortion – DZ11-A, -B, and -E

The maximum "space to mark" and "mark to space" distortion allowed in a received character is 40 percent.

The maximum speed distortion allowed in a received character for 2000 baud is 3.8 percent. All other baud rates allow 4 percent. The maximum speed distortion from the transmitter for 2000 baud is 2.2 percent. All other baud rates have less than 2 percent.

1.3.7 Interrupts

RDONE	Occurs each time a character appears at the silo output.
SA	Silo Alarm. Occurs after 16 characters enter the silo. Rearmed by reading the silo. This interrupt disables the RDONE interrupt.
TRDY	Occurs when the scanner finds a line ready to transmit on.

NOTE

There are no modem interrupts.

Normally, a level 5 priority plug is supplied. The interface level can be modified to level 4, 6, or 7 by using the proper priority plug.

1.3.8 Line Speed

The baud rate for a line (both transmitter and receiver) is program-selectable. Also, the receiver for each line can be individually turned on or off under program control. (See Table 1-2 for a list of available baud rates.)

*Maximum operating temperature is reduced 1.8° C per 1000 meters (1.0° F per 1000 feet) for operation at altitudes above sea level.

1.3.9 Distance (DZ11-A, -B, and -E)

The recommended distance from computer to DZ11 is 15 m (50 ft) at up to 9600 baud with a BC05D cable or equivalent. Operation beyond 15 m (50 ft) does not conform to the RS232C or CCITT V.24 specifications. However, operation will often be possible at greater distance depending on the terminal equipment, type of cable, speed of operation, and electrical environment. Reliable communication over long cables depends on the absence of excessive electrical noise. For these reasons, DIGITAL cannot guarantee error-free communication beyond 15 m (50 ft). However, the EIA versions of the DZ11 may be connected to local DIGITAL terminals and most other terminals at distances beyond 15 m (50 ft) with satisfactory results if the terminal and computer are located in the same building, in a modern office environment. Shielded twisted pair wire (Belden 8777 or equivalent) is recommended and is used in the BC03M null modem cable.

With cables made with shielded twisted pair wire, such as the Belden 8777, the following rate/distance table may be used as a guide. This chart is for informational purposes only and is not to be construed as a warranty by Digital Equipment Corporation of error-free DZ11 operation at these speeds and distances under all circumstances.

90 m (300 ft) at 9600 baud
300 m (1000 ft) at 4800 baud
300 m (1000 ft) at 2400 baud
900 m (3000 ft) at 1200 baud
1500 m (5000 ft) at 300 baud

NOTE

The ground potential difference between the DZ11 and terminal must not exceed 2 V. This requirement will generally limit operation to within a single building served by one ac power service. In other cases, or in noisy electrical environments, 20 mA operation should be used.

1.3.10 Distance (DZ11-C, -D, and -F)

The length of cable that may be used reliably is a function of electrical noise, loop resistance, cable type, and speed of operation. The following chart is given as a guide; however, there is no guarantee of error-free operation under all circumstances.

Speed (Baud)	Belden 8777, 22 AWG, shielded, twisted pairs (shields floating) (DEC P/N 9107723)	22 AWG, 4 conductor inside station wire (DEC P/N 9105856-4)
9600	150 m (500 ft)	300 m (1000 ft)
4800	300 m (1000 ft)	540 m (1800 ft)
2400	600 m (2000 ft)	900 m (3000 ft)
1200 and below	1200 m (4000 ft)	1500 m (5000 ft)

1.4 FUNCTIONAL DESCRIPTION

The following paragraphs present a general description of DZ11 operation. Figure 1-8 is a general functional block diagram that divides the DZ11 into three basic components: Unibus interface, control logic, and line interface.

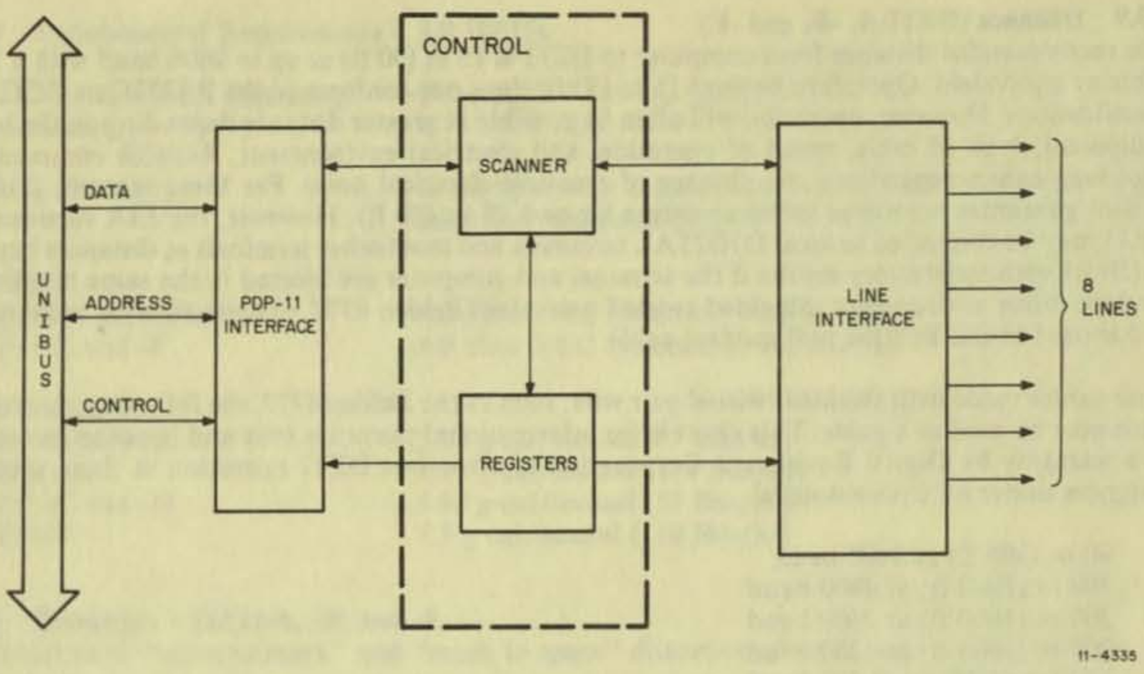

Figure 1-8 General Functional Block Diagram

1.4.1 PDP-11 Unibus Interface

The PDP-11 Unibus interface component of the DZ11 handles all transactions between the Unibus and the DZ11 control logic. The Unibus interface performs three functions: data handling, address recognition, and interrupt control. In its data handling function, the interface routes data to and from the various registers in the control logic and provides the voltage conditioning necessary to transmit and receive data to and from the PDP-11 Unibus. The address recognition and control logic activates the proper load and read signals when it recognizes its preselected address on the Unibus. These signals are used by the data handling function to route the incoming and outgoing data to the desired locations. The interrupt control function initiates and controls interrupt processing between the DZ11 and the PDP-11 processor.

1.4.2 Control Logic

The control logic provides the required timing and control signals to handle all transmitter and receiver operations. The control logic can be divided into two major sections: the scanner and the registers.

The scanner continuously examines each line in succession and, based on information from the line interface and the registers, generates signals that cause data to flow to or from the appropriate line. The scanner comprises a 5.068 MHz oscillator (clock), a 64-word FIFO receiver buffer, a 4-phase clocking network, and other control generating logic.

The DZ11 uses four device registers in a manner that yields six unique and accessible registers, each having a 16-bit word capacity. The six discrete registers temporarily store input and output data, monitor control signal conditioning, and establish DZ11 operating status. Depending on their functions, some of the registers are accessible in bytes or words; others are restricted to word-only operation. Registers can be read or loaded (written), depending on the operation. The ability to read or write a register allows the use of two of the device registers as four independent registers.

1.4.3 Line Interface

Two of the most important operations in the DZ11 are the conversions from serial-to-parallel and parallel-to-serial data formats. These conversions are required since the DZ11 is located between the PDP-11 Unibus (a parallel data path) and either local terminals or telephone lines (serial data paths). Conversions for each line in the DZ11 are performed by independent universal asynchronous receiver-transmitter (UART) integrated circuits. Another component of the line interface, the line receiver or driver, converts the TTL voltage levels in the DZ11 so that they correspond to those in the external device input lines (modem or terminal).

CHAPTER 2
INSTALLATION

2.1 SCOPE
This chapter contains the procedures for the unpacking, installation, and initial checkout of the DZ11 Asynchronous Multiplexer.

2.2 CONFIGURATION DIFFERENCES
The DZ11 can be supplied with or without a distribution panel. The DZ11-B and -D do not have distribution panels. The following list describes the variations.

DZ11-A	EIA level conversion with distribution panel (8 lines)
DZ11-B	EIA level conversion without distribution panel (8 lines)
DZ11-C	20 mA loop conversion with distribution panel (8 lines)
DZ11-D	20 mA loop conversion without distribution panel (8 lines)
DZ11-E	DZ11-A and DZ11-B (16 lines)
DZ11-F	DZ11-C and DZ11-D (16 lines)

2.3 UNPACKING AND INSPECTION
The DZ11 is packaged in accordance with commercial packaging practices. First, remove all packing material and check the equipment against the shipping list. (Table 2-1 contains a list of supplied items per configuration.) Report damage or shortages to the shipper immediately and notify the DIGITAL representative. Inspect all parts and carefully inspect the module for cracks, loose components, and separations in the etched paths.

2.4 INSTALLATION PROCEDURE
The following paragraphs should be followed to install the DZ11 option in a PDP-11 system.

2.4.1 H317 Distribution Panel and Static Filter Installation
Install the H317 distribution panel and static filters according to unit assembly drawing D-UA-DZ11-0-0.

2.4.1.1 EIA Option – For the DZ11-A or DZ11-E option, check to ensure that all of the machine-insertable jumpers on the distribution panel are in place. (See Drawing E-UA-5411928-0-0 for jumper locations.) These jumpers are in anticipation of future use of the DZ11 with modems other than the 103; however, two of the jumpers are now functional. The jumper labeled DTR (refer to D-CS-5911928-0-1) connects DTR to pin 4 or Request to Send. This allows the DZ11 to assert both DTR and RTS if using a modem which requires control of RTS. The jumper labeled BUSY is also connected to the DTR lead for use in modems that implement the Force Busy function. This jumper should normally be cut out unless the modem has the Force Busy feature and the system software is implemented to control it.

Table 2-1 Items Supplied Per Configuration

Quantity	Description	A	B	E	C	D	F
1	M7819 module	X	X	*			
1	H7004C static filter (EIA)	X	X	*			
1	H3271 test connector†	X		X			
1	BC06L-0J filter cable (EIA)	X	X	*			
1	H317-E distribution panel assembly	X		X			
1	H325 test connector	X		X			
1	BC05W-15 cable	X	X	*			
1	Print set (B-TC-DZ11-0-6) DZ11, A, B, and C order number MP00132	X	X	X			
1	Software kit	X		X	X		X
1	Panel and static filter mounting hardware set	X		X	X		X
1	Priority insert (5)	X	X	*	X	X	*
1	DZ11 User's Manual (EK-DZ110-OP-01)	X		X	X		X
1	M7814 module				X	X	*
1	H7004B static filter (20 mA)				X	X	*
1	BC08S cable				X	X	*
1	BC06K-0J filter cable (20 mA)				X	X	*
1	H317-F distribution panel assembly				X		X
1	Print set (B-TC-DZ11-0-11) DZ11, C, D, and F order number MP00253				X	X	X
1	H3190 test connector‡				X	X	*

*Shipment contains two of the items listed.

†*New item:* An H327 will be shipped with each M7819 unit until the H3271 becomes available. The shipping list will indicate which test connector is supplied.

‡*New item:* The shipping list will include the H3190 test connector when supplied.

2.4.1.2 20 mA Option – For the DZ11-C or DZ11-F option, refer to D-UA-5411974-0-0. Each line has a jumper on the distribution panel (W1 through W16) which should be in if the terminal operates at 300 baud or less. The jumper should be removed for higher baud rates.

2.4.2 M7819 Module Installation

To install the M7819 module, perform the following procedure.

1. Ensure that the priority insert (level 5) is properly seated in socket E52 on the M7819 module(s). (Refer to drawing D-UA-M7819-0-0.)

2. Refer to Paragraph 3.1.1 for descriptions of the address assignments. Set the switches at E81 so that the module will respond to its assigned address. When a switch is closed (on), a binary 1 is decoded. When a switch is open (off), a binary 0 is decoded. Note that the switch labeled 1 corresponds to bit 3, 2 corresponds to bit 4, etc. (See Figure 2-1.)

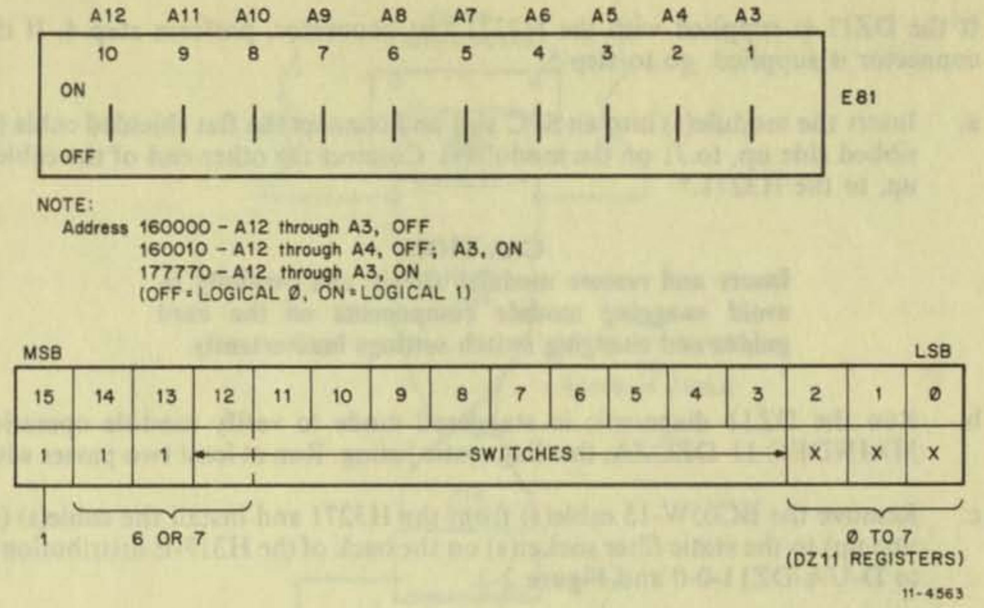

Figure 2-1 M7819 Address Selection

3. Vector selection is accomplished by the 8-position switch at E11. Switch positions 1 and 8 are not used. Switch position 2 corresponds to vector bit 3, 3 corresponds to vector bit 4, etc. When a switch is closed (on), a binary 0 is decoded. When a switch is open (off), a binary 1 is decoded. Note that this is opposite of the address switch decoding. (See Figure 2-2.)

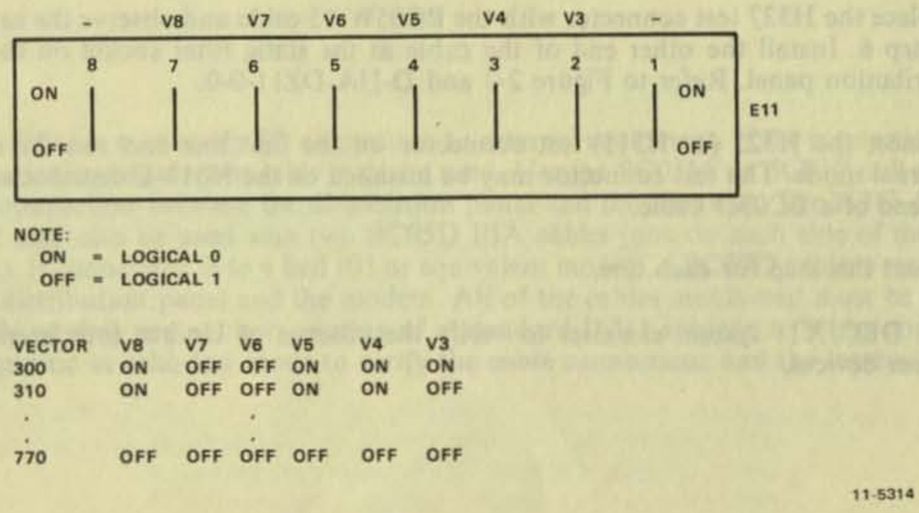

Figure 2-2 M7819 Vector Selection

4. If the DZ11 is supplied with the H3271 test connector, perform step 4. If the H327 test connector is supplied, go to step 5.

   a. Insert the module(s) into an SPC slot and connect the flat shielded cable (BC05W-15), ribbed side up, to J1 on the module(s). Connect the other end of the cable, ribbed side up, to the H3271.*

      CAUTION
      Insert and remove modules slowly and carefully to avoid snagging module components on the card guides and changing switch settings inadvertently.

   b. Run the DZ11 diagnostic in staggered mode to verify module operation. Refer to MAINDEC-11-DZDZA, the diagnostic listing. Run at least two passes without error.

   c. Remove the BC05W-15 cable(s) from the H3271 and install the cable(s) (with smooth side up) to the static filter socket(s) on the back of the H317-E distribution panel. Refer to D-UA-DZ11-0-0 and Figure 2-3.

   d. Proceed to step 8.

5. Install the H327 test connector in J1 (the cable connector at the top of the M7819) and align arrows for proper connection.

6. Insert the M7819 in its SPC slot and run the DZ11 diagnostic in the staggered mode to verify module operation. Refer to MAINDEC-11-DZDZA, the diagnostic listing for the correct procedure. Run at least two passes without error.

   CAUTION
   Insert and remove modules slowly and carefully to avoid snagging module components on the card guides and changing switch settings inadvertently.

7. Replace the H327 test connector with the BC05W-15 cable and observe the same caution as in step 6. Install the other end of the cable at the static filter socket on the back of the distribution panel. Refer to Figure 2-3 and D-UA-DZ11-0-0.

8. Connect the H325 (or H315) test connector on the first line and run the diagnostics in external mode. The test connector may be installed on the H317-E distribution panel or on the end of a BC05D cable.

   Repeat this step for each line.

9. Run DEC/X11 system exerciser to verify the absence of Unibus interference with other system devices.

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*The H3271 has connections for two H7819 cables.

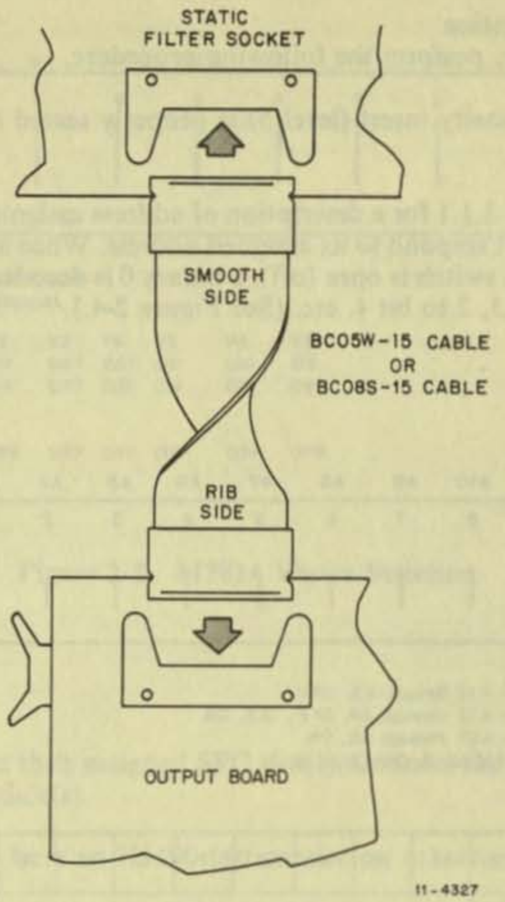


Figure 2-3 BC05W-15 and BC08S-15 Interconnection

10. The DZ11 is now ready for connection to external equipment. If the connection is to a local terminal, a null modem cable must be used. Use the BC03M or BC03P null modem cables for connection between the distribution panel and the terminal. The H312-A null modem unit may also be used with two BC05D EIA cables (one on each side of the null modem unit). If connection is to a Bell 103 or equivalent modem, a BC05D cable is required between the distribution panel and the modem. All of the cables mentioned must be ordered separately as they are *not* components of a standard DZ11 shipment. When possible, run the diagnostic in echo test mode to verify the cable connections and the terminal equipment.

2.4.3 M7814 Module Installation

To install the M7814 module, perform the following procedure.

1. Ensure that the priority insert (level 5) is properly seated in socket E41. Refer to D-UA-M7814-0-0.

2. Refer to Paragraph 3.1.1 for a description of address assignments. Set the switches at E72 so that the module will respond to its assigned address. When a switch is closed (on), a binary 1 is decoded. When a switch is open (off), a binary 0 is decoded. Note that the switch labeled 1 corresponds to bit 3, 2 to bit 4, etc. (See Figure 2-4.)

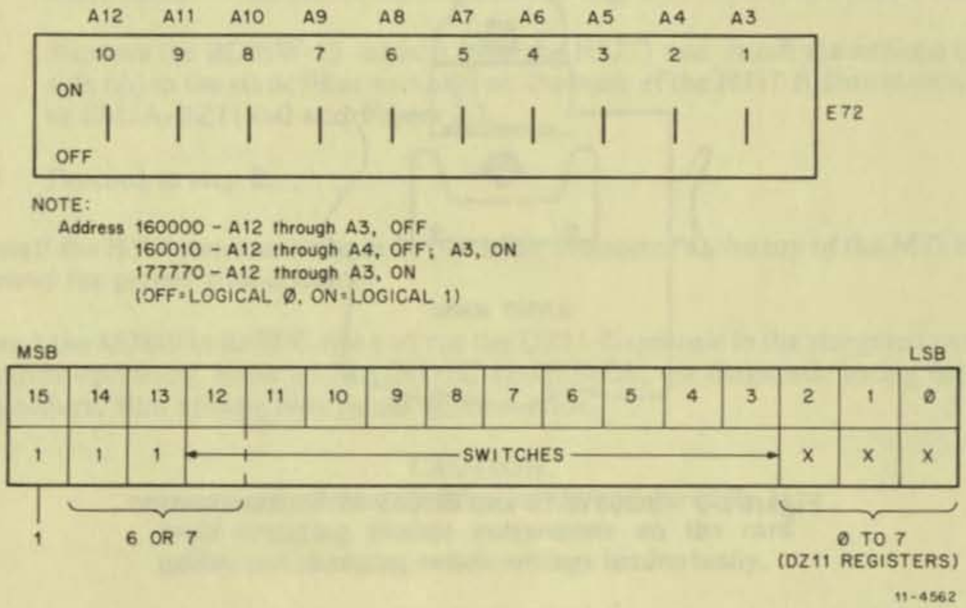
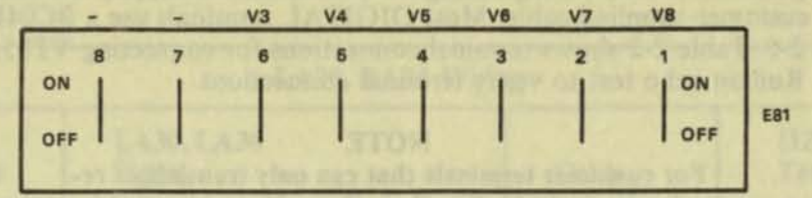


Figure 2-4 M7814 Address Selection

3. Vector selection is accomplished by an 8-position switch at E81 on the module(s). When a switch is closed (on), a binary 0 is decoded. When a switch is open (off), a binary 1 is decoded. Note that this is the opposite of the address switch decoding. Also, note that switch positions 7 and 8 are not used and switch 6 corresponds to bit 3, 5 to bit 4, etc. (Refer to Figure 2-5.)

CAUTION

Insert and remove modules slowly and carefully to avoid snagging module components on the card guides and changing switch settings inadvertently.



NOTE:
ON = LOGICAL 0
OFF = LOGICAL 1

VECTOR	V8	V7	V6	V5	V4	V3
300	ON	OFF	OFF	ON	ON	ON
310	ON	OFF	OFF	ON	ON	OFF
.			.			
.			.			
770	OFF	OFF	OFF	OFF	OFF	OFF

11-5140

Figure 2-5 M7814 Vector Selection

4. Insert module(s) into their assigned SPC slot(s). Connect the BC08S cable, with ribbed side up, to J1 on the module(s).

5. Skip this step if you have an H3190 test connector; otherwise perform the following.

   a. Connect the other end of the BC08S cable to the static filter on the back of the distribution panel (H317-F) with smooth side up. Refer to Figure 2-3 and D-UA-DZ11-0-0.

   b. Run the DZ11 diagnostic in internal (maintenance) mode for two error-free passes. Refer to MAINDEC-11-DZDZA, the diagnostic listing, for the proper procedure.

   c. Proceed to step 9.

6. Connect the other end of the BC08S cable, with smooth side up, to the H3190 test connector.

7. Run the DZ11 diagnostic in staggered mode for two error-free passes. Refer to MAINDEC-11-DZDZA, the diagnostic listing, for the correct procedure.

8. Remove the BC08S cable from the H3190 test connector and plug it into the static filter socket on the back of the distribution panel (H317-F) with smooth side up. Refer to Figure 2-3 and D-UA-DZ11-0-0.

9. Run the DEC/X11 system exerciser to verify the absence of Unibus interference with other system devices.

10. The DZ11 is now ready for connection to passive external equipment. This is accomplished with a customer-supplied cable. Most DIGITAL terminals use a BC04R cable as shown in Figure 2-6. Table 2-2 shows terminal connections for connecting VT05, LA30, or LA36 to DZ11. Run an echo test to verify terminal connections.

NOTE

For customer terminals that can only transmit or receive in a single direction, the echo test cannot be run.

If the DZ11 is to be connected to an active device, a pair of H319s are required. Refer to Appendix A for details on this connection.

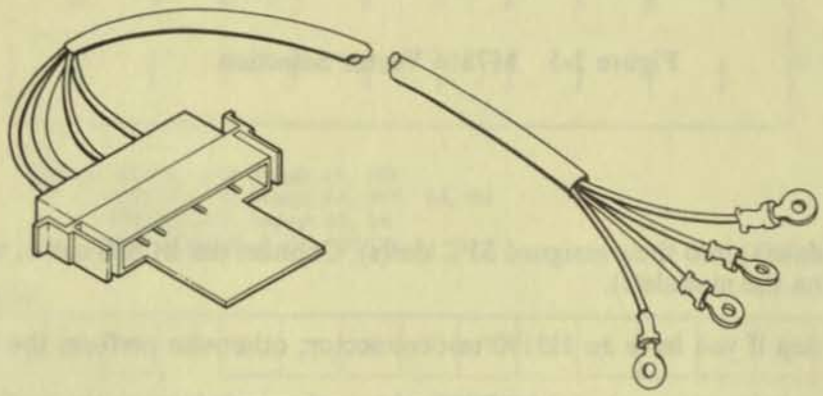


Figure 2-6 BC04R Cable

Table 2-2 DZ11 to Terminal Wiring (Using BC04R Cable)

VT05 Wiring

Mate-N-Lok	VT05 Signal	Color	DZ11 Terminal No.
5	Terminal +RCV	Black	4 (XMIT+)
2	Terminal −RCV	White	3 (XMIT−)
3	Terminal −XMIT	Green	2 (REC−)
7	Terminal +XMIT	Red	1 (REC+)

Table 2-2 DZ11 to Terminal Wiring (Using BC04R Cable) (Cont)

LA30, LA36 Wiring			
Mate-N-Lok	**LA30, LA36 Signal**	**Color**	**DZ11 Terminal No.**
5	Terminal +XMIT	Black	1 (REC+)
2	Terminal −XMIT	White	2 (REC−)
3	Terminal −REC	Green	3 (XMIT−)
7	Terminal +REC	Red	4 (XMIT+)

NOTE

Terminal RCV is connected to DZ11 XMIT. Terminal XMIT is connected to DZ11 RCV. Polarity should always be + to + and − to − for both XMIT and RCV.

In addition, post 1 is located at the top of the terminal block on the distribution panel and goes in sequence to post 4 at the bottom of the terminal block.

CHAPTER 3
PROGRAMMING

3.1 INTRODUCTION

This chapter provides basic information for programming the DZ11. A description of each DZ11 register, its format, programming constraints, and bit functions are presented to aid programming and maintenance efforts. Special programming features are also presented in this chapter.

3.1.1. Device and Vector Address Assignments

The DZ11's device and vector addresses are selected from the floating vector and device address space.

NOTE

The device floating address space is 160010_8 to 163776_8. The vector floating address space is 300_8 to 776_8.

Its floating address space follows the DJ11, DH11, DQ11, DU11, DUP11, LK11, and DMC11.

Its floating vector space follows the DC11; KL11/DL11-A, -B; DP11, DM11-A; DN11; DM11-BB and other modem control vectors; DR11-A; DR11-C; PA611 reader, PA611 punch; DT11; DX11; DL11-C, -D, -E; DJ11; DH11; GT40; LPS11; DQ11; KW11-W; DU11; DUP11; DV11; LK11-A; DWUN; and DMC11. If a DZ11 is installed in a system with any of the above listed options, then its assigned vector and device address should follow the vector and device address of the other options.

Two examples follow. First, the simplest case where there is only one DZ11.

Option	Address	Vector	Comment
GAP	160010		No DJ11s
GAP	160020		No DH11s
GAP	160030		No DQ11s
GAP	160040		No DU11s
GAP	160050		No DUP11s
GAP	160060		No LK11s
GAP	160070		No DMC11s
DZ11	160100	300	
GAP	160110		No more DZ11s

Next, a system with one DJ11, one DH11, one GT40, one KW11-W, and two DZ11s.

Option	Address	Vector	Comment
DJ11	160010	300	
GAP	160020		No more DJ11s
GAP	160030		DH11 must start on an address boundary that is a multiple of 20.
DH11	160040	310	
	160050		
GAP	160060		No more DH11s
GT40		320	GT40 address is not in the floating address space.
KW11-W		330	KW11-W address is not in the floating address space.
GAP	160070		No DQ11s
GAP	160100		No DU11s
GAP	160110		No DUP11s
GAP	160120		No LK11s
GAP	160130		No DMC11s
DZ11	160140	340	
DZ11	160150	350	
GAP	160160		No more DZ11s

3.2 REGISTER BIT ASSIGNMENTS

A comprehensive pictorial of all register bit assignments is shown in Figure 3-1. The four device registers (DR0, DR2, DR4, and DR6) are subdivided to form six unique registers. This subdivision is accomplished in DR2 and DR6 by assigning read-only (RO) or write-only (WO) status to each register. Since the reading and writing of DR2 and DR6 accesses two registers, PDP-11 processor instructions that perform a read-modify-write (DATIP) bus cycle cannot be used with DR2 or DR6. Also, DR2 permits only word instructions, but either byte or word instructions may be used with DR6. DR0 and DR4 have no programming constraints. In all register operations, the following applies: read-only bits are not affected by an attempt to write, and write-only and "not-used" bits appear as a binary 0 if a read operation is performed. Specific programming constraints for each register are discussed in the following paragraphs. A description of each bit function is presented in Tables 3-1 through 3-3.

3.2.1 Control and Status Register (CSR)

The control and status register (CSR) contains the states of flags and enable bits for scanning, processor interrupts, clearing, and maintenance. The 16-bit CSR has no programming constraints. The format is depicted in Figure 3-1, and bit functions are described in Table 3-1. Write-only and "not-used" bits are read as zeros by the Unibus, and read-only bits are not affected by write attempts.

	BYTES HIGH	LOW							LSB
	08	07	06	05	04	03	02	01	00
	RO	RO	RW	RW	RW	RW			
IE	TLINE A	RDONE	RIE	MSE	CLR	MAINT	NOT USED	NOT USED	NOT USED
	RO	RO	RO	RO	RO	RO	RO	RO	RO
E	RX LINE A	RBUF D7	RBUF D6	RBUF D5	RBUF D4	RBUF D3	RBUF D2	RBUF D1	RBUF D0
	WO	WO	WO	WO	WO	WO	WO	WO	WO
Q	FREQ A	ODD PAR	PAR ENAB	STOP CODE	CHAR LGTH B	CHAR LGTH A	LINE C	LINE B	LINE A
	RW	RW	RW	RW	RW	RW	RW	RW	RW
R	DTR 0	LINE ENAB 7	LINE ENAB 6	LINE ENAB 5	LINE ENAB 4	LINE ENAB 3	LINE ENAB 2	LINE ENAB 1	LINE ENAB 0
	RO	RO	RO	RO	RO	RO	RO	RO	RO
	CO 0	RI 7	RI 6	RI 5	RI 4	RI 3	RI 2	RI 1	RI 0
	WO	WO	WO	WO	WO	WO	WO	WO	WO
.	BRK 0	TBUF 7	TBUF 6	TBUF 5	TBUF 4	TBUF 3	TBUF 2	TBUF 1	TBUF 0

h the 20 mA options.

11-5313

Figure 3-1 Register Bit Assignments

		BYTES HIGH 15 (MSB)	14	13	12	11	10	09	08	BYTES LOW 07	06	05	04	03	02	01	00 (LSB)
DR0	CONTROL & STATUS (CSR)	RO TRDY	RW TIE	RO SA	RW SAE	NOT USED	RO TLINE C	RO TLINE B	RO TLINE A	RO RDONE	RW RIE	RW MSE	RW CLR	RW MAINT	NOT USED	NOT USED	NOT USED
DR2	RECEIVER BUFFER (RBUF)	RO DATA VALID	RO OVRN	RO FRAM ERR	RO PAR ERR	NOT USED	RO RX LINE C	RO RX LINE B	RO RX LINE A	RO RBUF D7	RO RBUF D6	RO RBUF D5	RO RBUF D4	RO RBUF D3	RO RBUF D2	RO RBUF D1	RO RBUF D0
DR2	LINE PARAMETER (LPR)	NOT USED	NOT USED	NOT USED	WO RX ON	WO FREQ D	WO FREQ C	WO FREQ B	WO FREQ A	WO ODD PAR	WO PAR ENAB	WO STOP CODE	WO CHAR LGTH B	WO CHAR LGTH A	WO LINE C	WO LINE B	WO LINE A
DR4	TRANSMIT * CONTROL (TCR)	RW DTR 7	RW DTR 6	RW DTR 5	RW DTR 4	RW DTR 3	RW DTR 2	RW DTR 1	RW DTR 0	RW LINE ENAB 7	RW LINE ENAB 6	RW LINE ENAB 5	RW LINE ENAB 4	RW LINE ENAB 3	RW LINE ENAB 2	RW LINE ENAB 1	RW LINE ENAB 0
DR6	MODEM * STATUS (MSR)	RO CO 7	RO CO 6	RO CO 5	RO CO 4	RO CO 3	RO CO 2	RO CO 1	RO CO 0	RO RI 7	RO RI 6	RO RI 5	RO RI 4	RO RI 3	RO RI 2	RO RI 1	RO RI 0
DR6	TRANSMIT DATA (TDR)	WO BRK 7	WO BRK 6	WO BRK 5	WO BRK 4	WO BRK 3	WO BRK 2	WO BRK 1	WO BRK 0	WO TBUF 7	WO TBUF 6	WO TBUF 5	WO TBUF 4	WO TBUF 3	WO TBUF 2	WO TBUF 1	WO TBUF 0

*The high byte of the TCR (Data Terminal Ready) and the MSR are not used with the 20 mA options.

11-5313

Figure 3-1 Register Bit Assignments

Table 3-1 CSR Bit Functions

Bit	Title	Function
00–02	Not used	
03	Maintenance (MAINT)	A read/write bit that, when set, causes the serial output data from the transmitter to be fed back as serial input data to the receiver. All lines are turned around. Cleared by BUS INIT and CLR.
04	Clear (CLR)	A read/write bit that fires a one-shot to generate a 15 μs reset which clears the receiver silo, all UARTs, and the CSR. After a CLR is issued, the CSR and line parameters must be set again. CLR in progress is indicated by CLR = 1. Modem control registers are not affected, nor are bits 00 through 14 of RBUF.
05	Master Scan Enable	A read/write bit that activates the scanner to enable the receiver transmitter and silo. Cleared by CLR and BUS INIT.
06	Receiver Interrupt Enable	A read/write bit that enables the receiver interrupt. Cleared by CLR and BUS INIT.
07	Receiver Done (RDONE)	A read-only bit (hardware set) that generates RCV INT if bit 06 = 1 and bit 12 = 0. The bit clears when the RBUF is read and resets when another word reaches the output of the silo (RBUF). If bit 06 = 0, RDONE can be used as a flag to indicate that the silo contains a character. If bit 12 = 1, RDONE does not cause interrupts but otherwise acts the same.
08–10	Transmit Line A–C (TLINE)	When bit 15 = 1, these three read-only bits indicate the line that is ready to transmit a character. Bit 15 clears when the character is loaded into the transmit buffer, but sets again if another line is ready. A new line number could appear within a minimum of 1.9 μs. Bits 08–10 return to line 0 after a CLR or BUS INIT. These bits are meaningful only when bit 15 (TRDY) is true.
11	Not used	
12	Silo Alarm Enable (SAE)	A read/write bit that enables the silo alarm and prevents RDONE from causing interrupts. If bit 06 = 1, the SAE allows the SA (bit 13) to cause an interrupt after 16 entries in the silo. If bit 06 = 0, the SA can be used as a flag. The bit is cleared by CLR and BUS INIT.

Table 3-1 CSR Bit Functions (Cont)

Bit	Title	Function
13	Silo Alarm (SA)	A read-only bit set by the hardware after 16 characters enter the silo. It causes an interrupt if bit 06 = 1 and is cleared by CLR, BUS INIT, and reading the RBUF. When the silo flag occurs (SA = 1), the silo must be emptied because the flag will not be set again until 16 additional characters enter the silo.
14	Transmitter Interrupt Enable (TIE)	A read/write bit that allows an interrupt if bit 15 (TRDY) = 1.
15	Transmitter Ready (TRDY)	A read-only bit that is set by hardware when a line number is found that has its transmit buffer empty and its LINE ENAB bit set. It is cleared by CLR, BUS INIT, and by loading the TBUF register.

3.2.2 Receiver Buffer (RBUF)

The receiver buffer (RBUF) register contains the received character bits, with line identification, error status, and data validity flag. As one of two registers in DR2 (RBUF and LPR), RBUF is accessed when a read operation is performed (write operation accesses the LPR). The programming constraints for the RBUF register are as follows.

1. Byte instructions cannot be used.

2. It is a read-only register.

3. TST or BIT instructions cannot be used because they cause the loss of a character.

4. The register requires master scan enable (CSR, bit 05) to be set in order to be functional. When this bit is off, bits 00 to 14 of the RBUF become invalid regardless of the state of bit 15 (data valid) and the silo is held empty. The register format of RBUF is depicted in Figure 3-1 and bit functions are described in Table 3-2. Each reading of the RBUF register advances the silo and presents the next character to the program. Bits 00 through 14 do not go to zero after a CLR or BUS INIT; however, they become invalid and the silo is emptied. Bit 15 (data valid) does clear to zero. (See Table 3-2.)

Table 3-2 RBUF Bit Functions

Bit	Title	Function
00–07	Received Character	These bits contain the received character. If the selected code level is less than eight bits wide, the high-order bits are forced to zero.
08–10	Line Number	These bits present the line number on which the character was received.
11	Not used	
12	Parity Error	This bit indicates whether the received bit had a parity error. The parity bit is generated by hardware and does not appear in the RBUF word.
13	Framing Error	This bit indicates improper framing (stop bit not a mark) of the received character and can be used for break detection.
14	Overrun	This bit indicates receiver buffer overflow. The result is a received character which is replaced by another received character before storage in the silo. A character is lost but the received character put in the silo is valid.
15	Data Valid	This bit indicates that the character read from the silo (RBUF) is valid. The RBUF is read until the data valid bit = 0, indicating an invalid character and empty silo. Cleared by CLR and BUS INIT.

3.2.3 Line Parameter Register (LPR)

The line parameter register (LPR) is a 16-bit register that sets the parameters (character and stop code lengths, parity, speed, and receiver clock) for each line (Table 3-3). Bits 00–02 select the line for parameter loading. Line parameters for each line must be reloaded after a CLR (bit 04 of CSR) or BUS INIT operation. The programming constraints for the LPR are as follows.

1. It is a write-only register.

2. BIS or BIC instructions are not allowed.

3. Byte operations cannot be used.

Table 3-3 LPR Bit Functions

Bit	Title	Function
00–02	Line Number	These bits select the line for parameter loading
03–04	Character Length	These bits set the character length for the selected line. The parity bit is not part of the character length. **04** **03** 0 0 5 bits 0 1 6 bits 1 0 7 bits 1 1 8 bits
05	Stop Code	This bit sets the stop code length (0 = 1-unit stop, 1 = 2-unit stop or 1.5-unit stop if a 5-level code is employed).
06	Parity	This bit selects the parity option (0 = no parity check, 1 = parity enabled on TRAN and RCV).
07	Odd Parity	This bit selects the kind of parity (0 = even parity select, 1 = odd parity select). Bit 06 must be set for this bit to have effect.
08–11	Speed Select	These bits select the TRAN and RCV speed for the line selected by bits 00–02. Refer to Table 3-4 for a list of available baud rates.
12	Receiver On	This bit must be set when loading parameters to activate the receiver clock. (Transmitter clock is always on.) A CLR or BUS INIT turns the receiver clock off.

3.2.4 Transmit Control Register (TCR)

The transmit control register contains 16 bits for the EIA options (M7819 module) and 8 bits for the 20 mA option (7814 module). The difference is that the data terminal ready (DTR) lines that make up the high byte (bits 08 through 15) of the TCR are not used by the 20 mA options because they do not have modem control capabilities.

The high byte (M7819 only) contains a read/write DTR bit for each line. This byte is cleared by BUS INIT only, not by CLR. When the high byte is not used (M7814 only), it reads back to the Unibus as all zeros. Attempts to write into it will have no effect. The low byte contains a read/write line enable bit for each line. A set bit allows transmission on the corresponding line. Paragraph 3.3.7 explains how to properly use this bit. This byte is cleared by CLR and BUS INIT.

3.2.5 Modem Status Register (MSR)

This is a 16-bit register used only with the EIA options (M7819 module). The 20 mA options (M7814 module) do not have modem control capabilities. When not used, this register reads all zeros to the Unibus.

The MSR consists of two bytes: the low byte (bits 00–07) and the high byte (bits 08–15). The low byte monitors the state of each line's ring indicator (RI) lead; the high byte monitors the state of each line's carrier (CO) lead. The MSR is the read-only portion of DR6 and has the following programming characteristics.

1. It is a read-only register.
2. CLR and BUS INIT have no effect.
3. Bit format is shown in Figure 3-1.

3.2.6 Transmit Data Register (TDR)

The TDR consists of two 8-bit bytes. The low byte is the transmit buffer (TBUF) and holds the character that is to be transmitted. The high byte is the break register with each line controlled by an individual bit. When a break bit is set, the line associated with that bit starts sending zeros immediately and continuously. The TDR is the write-only portion of DR6 and has the following programming characteristics.

1. It is a write-only register.
2. BIS or BIC instructions cannot be used.
3. For character lengths less than 8 bits, the character loaded into the TBUF must be right justified because the hardware forces the most significant bits to zero.
4. The break register has no effect when running in the maintenance mode (i.e., CSR bit 03 = 1).
5. It is cleared by CLR and BUS INIT.
6. Bit format is shown in Figure 3-1.

3.3 PROGRAMMING FEATURES

The DZ11 has several programming features that allow control of baud rate, character length, stop bits, parity, and interrupts. This section discusses the application of these controls to achieve the desired operating parameters.

3.3.1 Baud Rate

The selection of the desired transmission and reception speed is controlled by the conditions of bits 08 through 11 of the LPR. Table 3-4 depicts the required bit configuration for each operating speed. The baud rate for each line is the same for both the transmitter and receiver. The receiver clock is turned on and off by setting and clearing bit 12 in the LPR for the selected line.

Table 3-4 Baud Rate Selection Chart

Bits 11	10	09	08	Baud Rate
0	0	0	0	50
0	0	0	1	75
0	0	1	0	110
0	0	1	1	134.5
0	1	0	0	150
0	1	0	1	300
0	1	1	0	600
0	1	1	1	1200
1	0	0	0	1800
1	0	0	1	2000
1	0	1	0	2400
1	0	1	1	3600
1	1	0	0	4800
1	1	0	1	7200
1	1	1	0	9600
1	1	1	1	Not used

3.3.2 Character Length
The selection of one of the four available character lengths is controlled by bits 03 and 04 of the LPR. The bit conditions for bits 04 and 03, respectively, are as follows: 00 (5-level), 01 (6-level), 10 (7-level), and 11 (8-level). For character lengths of 5, 6, and 7, the high-order bits are forced to zero.

3.3.3 Stop Bits
The length of the stop bits in a serial character string is determined by bit 05 of the LPR. If bit 05 is a zero, the stop length is one unit; bit 05 set to a one selects a 2-unit stop unless the 5-level character length (bits 03 and 04 at zero) is selected, in which case the stop bit length is 1.5 units.

3.3.4 Parity
The parity option is selected by bit 06 of the LPR. Parity is enabled on transmission and reception by setting bit 06 to a one. Bit 07 of the LPR allows selection of even or odd parity, and bit 06 must be set for bit 07 to be significant. The parity bit is generated and checked by hardware, and does not appear in the RBUF or TBUF. The parity error (bit 12, RBUF) flag is set when the received character has a parity error.

3.3.5 Interrupts
The receiver interrupt enable (RIE) and silo alarm enable (SAE) bits in the CSR control the circumstances upon which the DZ11 receiver interrupts the PDP-11 processor.

If RIE and SAE are both clear, the DZ11 never interrupts the PDP-11 processor. In this case, the program must periodically check for the availability of data in the silo and empty the silo when data is present. If the program operates off a clock, it should check for characters in the silo at least as often as the time it takes for the silo to fill, allowing a safety factor to cover processor response delays and time to empty the silo. The RDONE bit in the CSR will set when a character is available in the silo. The program can periodically check this bit with a TSTB or BIT instruction. When RDONE is set, the program should empty the silo.

If RIE is set and SAE is clear, the DZ11 will interrupt the PDP-11 processor to the DZ11 receiver vector address when RDONE is set, indicating the presence of a character at the bottom of the silo. The interrupt service routine can obtain the character by performing a MOV instruction from the RBUF. If the program then dismisses the interrupt, the DZ11 will interrupt when another character is available (which may be immediately if additional characters were placed in the silo while the interrupt was being serviced). Alternatively, the interrupt service routine may respond to the interrupt by emptying the silo before dismissing the interrupt.

If RIE and SAE are both set, the DZ11 will interrupt the PDP-11 processor to the DZ11 receiver vector when the silo alarm (SA) bit in the CSR is set. The SA bit will be set when 16 characters have been placed in the silo since the last time the program has accessed the RBUF. Accessing the RBUF will clear the SA bit and the associated counter. The program should follow the procedure described in Paragraph 3.3.6 to empty the silo completely in response to a silo alarm interrupt. This will ensure that any characters placed in the silo while it is being emptied are processed by the program.

NOTE

If the program processes only 16 entries in response to each silo alarm interrupt, characters coming in while interrupts are being processed will build up without being counted by the silo alarm circuit and the silo may eventually overflow without the alarm being issued.

If the silo alarm interrupt is used, the program will not be interrupted if fewer than 16 characters are received. In order to respond to short messages during periods of moderate activity, the PDP-11 program should periodically empty the silo. The scanning period will depend on the required responsiveness to received characters. While the program is emptying the silo, it should ensure that DZ11 receiver interrupts are inhibited. This should be done by raising the PDP-11 processor priority. The silo alarm interrupt feature can significantly reduce the PDP-11 processor overhead required by the DZ11 receiver by eliminating the need to enter and exit an interrupt service routine each time a character is received.

The transmitter interrupt enable bit (TIE) controls transmitter interrupts to the PDP-11 processor. If enabled, the DZ11 will interrupt the PDP-11 processor to the DZ11 transmitter interrupt vector when the transmitter ready (TRDY) bit in the CSR is set, indicating that the DZ11 is ready to accept a character to be transmitted.

3.3.6 Emptying the Silo

The program can empty the silo by repeatedly performing MOV instructions from the RBUF to temporary storage. Each MOV instruction will copy the bottom character in the silo so it will not be lost and will clear out the bottom of the silo, allowing the next character to move down for access by a subsequent MOV instruction. The program can determine when it has emptied the silo by testing the data valid bit in each word moved out of the RBUF. A zero value indicates that the silo has been emptied. The test can be performed conveniently by branching on the condition code following each MOV instruction. A TST or BIT instruction must not access the RBUF because these instructions will cause the next entry in the silo to move down without saving the current bottom character. Furthermore, following a MOV from the RBUF, the next character in the silo will not be available for at least 1 μs. Therefore, on fast CPUs, the program must use sufficient instructions or NOPs to ensure that successive MOVs from the RBUF are separated by a minimum of 1 μs. This will prevent a false indication of an empty silo.

3.3.7 Transmitting a Character

The program controls the DZ11 transmitter through five registers on the Unibus: the control and status register (CSR), the line parameter register (LPR), the line enable register, the transmitter buffer (TBUF), and the break register (BRK).

Following DZ11 initialization, the program must use the LPR to specify the speed and character format for each line to be used and must set the master scan enable (MSE) bit in the CSR. The program should set the transmitter interrupt enable (TIE) bit in the CSR if it wants the DZ11 transmitter to operate on a program interrupt basis.

The line enable register is used to enable and disable transmission on each line. One bit in this 8-bit register is associated with each line. The program can set and clear bits by using MOV, MOVB, BIS, BISB, BIC, and BICB instructions. (If word instructions are used, the line enable register and the DTR registers on M7819 modules are simultaneously accessed.)

The DZ11 transmitter is controlled by a scanner which is constantly looking for an enabled line (line enable bit set) which has an empty UART transmitter buffer. When the scanner finds such a line, it loads the number of the line into the 3-bit transmit line number (TLINE) field of the CSR and sets the TRDY bit, interrupting the PDP-11 processor if the TIE bit is set. The program can clear the TRDY bit by moving a character for the indicated line into the TBUF or by clearing the line enable bit. Clearing the TRDY bit frees the scanner to resume its search for lines needing service.

To initiate transmission on an idle line, the program should set the TCR bit for that line and wait for the scanner to request service on the line, as indicated by the scanner loading the number of the line into TLINE and setting TRDY. The program should then load the character to be transmitted into the TBUF by using a MOVB instruction. If interrupts are to be used, a convenient way of starting up a line is to set the TCR bit in the main program and let the normal transmitter interrupt routine load the character into the TBUF.

NOTE

The scanner may find a different line needing service before it finds the line being started up. This will occur if other lines request service before the scanner can find the line being started. The program must always check the TLINE field of the CSR when responding to TRDY to ensure it loads characters for the correct line. Assuming the program services lines as requested by the scanner, the scanner will eventually find the line being started. If several lines require service, the scanner will request service in priority order as determined by line number. Line 7 has the highest priority and line 0 the lowest.

To continue transmission on a line, the program should load the next character to be transmitted into the TBUF each time the scanner requests service for the line as indicated by TLINE and TRDY.

To terminate transmission on a line, the program loads the last character normally and waits for the scanner to request an additional character for the line. The program clears the line enable bit at this time instead of loading the TBUF.

The normal rest condition of the transmitted data lead for any line is the 1 state. The break register (BRK) is used to apply a continuous zero signal to the line. One bit in this 8-bit register is associated with each line. The line will remain in this condition as long as the bit remains set. The program should use a MOVB instruction to access the BRK register. If the program continues to load characters for a line after setting the break bit, transmitter operation will appear normal to the program despite the fact that no characters can be transmitted while the line is in the continuous zero sending state. The program may use this facility for sending precisely timed zero signals by setting the break bit and using transmit ready interrupts as a timer.

It should be remembered that each line in the DZ11 is double buffered. The program must not set the BRK bit too soon or the two data characters preceding the break may not be transmitted. The program must also ensure that the line returns to the 1 state at the end of the zero sending period before transmitting any additional data characters. The following procedure will accomplish this. When the scanner requests service the first time after the program has loaded the last data character, the program should load an all-zero character. When the scanner requests service the second time, the program should set the BRK bit for the line. At the end of the zero sending period, the program should load an all-zero character to be transmitted. When the scanner requests service, indicating this character has begun transmission, the program should clear the BRK bit and load the next data character.

3.3.8 Data Set Control

DZ11 models with EIA interfaces include data set control as a standard feature. The program may sense the state of the carrier and ring indicator signals from each data set and may control the state of the data terminal ready signal to each data set. The program uses three 8-bit registers to access the DZ11 data set control logic. One bit in each register is associated with each of the eight lines. There are no hardware interlocks between the data set control logic and the receiver and transmitter logic. Any required coordination should be done under program control.

The data terminal ready (DTR) register is a read/write register. Setting or clearing a bit in this register will turn the appropriate DTR signal on or off. The program may access this register with word or byte instructions. (If word instructions are used, the DTR and line enable registers will be simultaneously accessed.) The DTR register is cleared by the INIT signal on the Unibus but is not cleared if the program clears the DZ11 by setting the CLR bit of the CSR.

The carrier register (CAR) and ring register (RING) are read-only registers. The program can determine the current state of the carrier signal for a line by examining the appropriate bit of the CAR register. It can determine the current state of the ring signal by examining the appropriate bit of the ring register. The program can examine these registers separately by using MOVB or BITB instructions or can examine them as a single 16-bit register by using MOV or BIT instructions. The DZ11 data set control logic does not interrupt the PDP-11 processor when a carrier or ring signal changes state. The program should periodically sample these registers to determine the current status. Sampling at a high rate is not necessary.

3.4 PROGRAMMING EXAMPLES

The following six examples are sample programs for the DZ11 option. These examples are presented only to indicate how the DZ11 can be used.

Example 1 – Initializing the DZ11

The DZ11 is initialized by a power-up sequence, a reset instruction, or a device clear instruction.

Device Clearing the DZ11

```
001000   012737   START:   MOV #20, DZCSR      ;Set bit 4 in the
001002   000020                                ;DZ11 control and
001004   160100                                ;status register.
001006   032737   1$:      BIT #20, DZCSR      ;Test bit 4.
001010   000020
001012   160100
001014   001374            BNE 1$              ;If bit 4 is still
                                               ;set, the branch
                                               ;condition is true
                                               ;and the device clear
                                               ;function is still in
                                               ;progress.
001016   000000            HALT                ;The device clear
                                               ;function is complete
                                               ;and the DZ11 has been
                                               ;cleared.
```

DZCSR = Control and Status Register Address = 160100.

Example 2 – Transmit Binary Count Pattern on One Line

```
001000   012737   START:   MOV #20, DZCSR      ;Set bit 4 in the DZ11
001002   000020                                ;control and status
                                               ;register.
001004   160100
001006   032737   1$:      BIT #20, DZCSR      ;Test bit 4.
001010   000020
001012   160100
001014   001374            BNE 1$              ;If bit 4 is still set,
                                               ;the branch condition
                                               ;is true and the device
                                               ;clear function is still
                                               ;in progress.
001016   012737            MOV #n, DZLPR       ;Load the parameters
001020   001070                                ;for line 0: 8-bit
001022   160102                                ;character; 2 stop bits;
                                               ;110 baud
001024   012737            MOV #1, DZTCR       ;Enable line 0
                                               ;transmitter.
```

```
001026   000001
001030   160104
001032   012737              MOV #m, DZCSR        ;Set scanner enable bit
001034   000040                                   ;5 in the control and
001036   160100                                   ;status register.
001040   005000              CLR R0               ;Set binary count
                                                  ;pattern to zero.
001042   005737     2$:      TST DZCSR            ;Test the transmitter
001044   160100                                   ;ready flag (bit 15).
001046   100375              BPL 2$               ;If branch condition
                                                  ;is false, continue;
                                                  ;otherwise test again.
001050   110037              MOVB R0, DZTDR       ;Load character to be
001052   160106                                   ;transmitted.
001054   105200              INCB R0              ;Increment binary count.
001056   100371              BPL 2$               ;If branch condition is
                                                  ;false, the binary count
                                                  ;pattern is complete.
001060   000000              HALT
```

R0 = Register 0 = Binary Count Pattern
DZCSR = DZ11 Control and Status Register Address = 160100
DZLPR = DZ11 Line Parameter Register Address = 160102
DZTCR = DZ11 Transmit Control Register Address = 160104
DZTDR = DZ11 Transmit Data Register Address = 160106

Example 3 – Transmit a Binary Count in Maintenance Loopback Mode, with the Receiver "On" in the Interrupt Mode

Output Received Data to Console

```
001200   005000              CLR R0               ;Set binary count
                                                  ;to zero.
001202   012701              MOV 1400, R1         ;Set R1 to first
001204   001400                                   ;address of data
                                                  ;buffer.
001206   012706              MOV #SP, R6          ;Initialize stack
001210   001100                                   ;pointer.
001212   012737              MOV #INT, RVEC       ;Set DZ11 vector
001214   001304                                   ;address to start of
001216   000300                                   ;receiver interrupt
                                                  ;routine.
001220   005037              CLR (RVEC+2)         ;Set up processor
001222   000302                                   ;status word for DZ11
                                                  ;receiver interrupt.
001224   012737              MOV #20, DZCSR       ;Set bit 4 in the
001226   000020                                   ;DZ11 control and
                                                  ;status register.
```

```
001230   160100
001232   032737   1$:   BIT #20 DZCSR       ;Test bit 4.
001234   000020
001236   160100
001240   001374         BNE 1$              ;If bit 4 is still
                                            ;set, the branch
                                            ;condition is true
                                            ;and the device clear
                                            ;function is still in
                                            ;progress.
001242   012737         MOV #PAR, DZLPR     ;Load the parameters
001244   011070                             ;for line 0: 8-bit
001246   160102                             ;character; 2 stop bits;
                                            ;110 baud; no
                                            ;parity; receiver on.
001250   012737         MOV #1, DZTCR       ;Enable line 0
                                            ;transmitter.
001252   000001
001254   160104
001256   012737         MOV #150, DZCSR     ;Turn scanner on,
001260   000150                             ;enable receiver
001262   160100                             ;interrupts, and loop
                                            ;lines back on themselves.
001264   005737   2$:   TST DZCSR           ;Test the transmitter
001266   160100                             ;ready flag.
001270   100375         BPL 2$              ;If branch condition is
                                            ;false, continue;
                                            ;otherwise test again.
001272   110037         MOVB R0, DZTBUF     ;Load character to be
001274   160106                             ;transmitted.
001276   105200         INCB R0             ;Increment binary count.
001300   001371         BNE 2$              ;If branch condition is
                                            ;false, the binary count
                                            ;pattern is complete.
001302   000777         BR.                 ;Wait for last character
                                            ;transmitted to be
                                            ;received.
```

Receiver Interrupt Service Routine

```
001304   013711          MOV DZRBUF, (R1)     ;Store received
001306   160102                               ;character in memory
                                              ;table.
001310   022721          CMP #100377,         ;Check for last
001312   100377          (R1)+                ;character.
001314   001401          BEQ .+2              ;Branch condition is
                                              ;true when last
                                              ;transmitted character
                                              ;is received.
001316   000002          RTI                  ;Exit routine.
001320   012701          MOV #1400, R1        ;Initialize pointer
001322   001400                               ;to start of received
                                              ;data buffer in memory.
001324   105737   3$:    TSTB TPS             ;Test to see if console
001326   177564                               ;is ready.
001330   100375          BPL 3$               ;Wait, and test again.
                                              ;If condition is met,
001332   111137          MOVB (R1), TPB       ;transfer character
001334   177566                               ;to console.
001336   022721          CMP #100377,         ;Check for last
001340   100377          (R1)+                ;character.
001342   001370          BNE 3$               ;Not finished if
                                              ;condition is true.
001344   000000          HALT                 ;finished.
```

RVEC = DZ11 Receiver Interrupt Vector Address
DZCSR = DZ11 Control and Status Word Address
DZLPR = DZ11 Line Parameter Register (Write-Only) Address
DZTCR = DZ11 Transmit Control Register Address
DZTBUF = DZ11 Transmit Buffer Address
DZRBUF = DZ11 Receiver Buffer Address (Read-Only Register)
TPS = Teletype® Punch Status Register Address
TPB = Teletype Punch Data Register Address

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Example 4 – Transmit and receive in Maintenance Mode on a Single Line
The switch register bits (SWR00–SWR07) hold the desired data pattern (character).

```
001000   012737   START:   MOV #LINE, DZTCR     ;Select the line for
001002   000002                                 ;transmitting on.
                                                ;Choose one of eight.
001004   160104                                 ;Line #1 selected.
001006   012737            MOV #PAR, DZLPR      ;Select desired line
001010   017471                                 ;parameters for
                                                ;transmitting line
001012   160102                                 ;and turn on receiver
                                                ;for that line.
                                                ;8-level code, 2 stop
                                                ;bits, and no parity
                                                ;selected.
                                                ;19.2K baud selected
                                                ;Note: 19.2K baud is
                                                ;not used by the
                                                ;customer but can be
                                                ;used for diagnostic
                                                ;purposes to speed up
                                                ;the transmit-receive
                                                ;loop to make it easier
                                                ;to scope.
001014   012737            MOV #N, DZCSR        ;Start scanner and set
001016   000050                                 ;maintenance bit 3.
001020   160100
001022   005737   Test 1:  TST DZCSR            ;Test for bit 15
001024   160100                                 ;(transmitter ready).
001026   100375            BPL Test 2           ;If the branch condition
                                                ;is false, the transmitter
                                                ;is ready; if true, go
                                                ;back and test again.
001030   113737            MOVB SWR,            ;Load the transmit
001032   177570            DZTBUFF              ;character from the
001034   160106                                 ;switch register.
001036   000240            NOP                  ;No operation. This
                                                ;location can be changed
                                                ;to a branch instruction
                                                ;if only test 1 is
                                                ;desired (replace 000240
                                                ;with 000771).
001040   012701            MOV #DEL, R1         ;Delay equals a
         177670                                 ;constant that will
                                                ;allow enough time for
                                                ;the receiver done
                                                ;flag to set before
                                                ;recycling the test.
                                                ;The value will change
                                                ;with baud rate and
                                                ;processor. The
                                                ;constant given is
                                                ;good for 19.2K baud
                                                ;on a PDP-11/05.
```

```
001042   105737   Test 2:   TSTB DZCSR          ;Test bit 2 (receiver
001044   160100                                 ;done flag).
001046   100402             BMI 1$              ;When the branch
                                                ;condition is true,
                                                ;the receiver done
                                                ;flag is set.
001050   005201             INC R1              ;Increment delay.
001052   001373             BNE TEST 2          ;If the branch
                                                ;condition is true, the
                                                ;delay is not finished.
001054   013700   1$:       MOV DZRBUF, R0      ;Read the DZ11
001056   160102                                 ;receiver buffer to
                                                ;register 0.
001060   000760             BR TEST 1           ;Loop back and
                                                ;test again.
```

Example 5 – Transmit and Receive on a Single Line Using Silo Alarm in Maintenance Mode

```
001200   012706             MOV #1100, R6       ;Initialize stack
001202   001100                                 ;pointer.
001204   012737             MOV #3$, TVEC       ;Initialize transmitter
001206   001274                                 ;vector address.
001210   000304
001212   005037             CLR TVEC+2          ;Initialize transmitter
001214   000306                                 ;vector processor status
                                                ;word.
001216   012700             MOV #DBUF, R0       ;Set first address of
001220   001304                                 ;input data table
                                                ;into R0.
001222   012737             MOV #1, DZTCR       ;Enable line 0
                                                ;transmitter.
001224   000001
001226   160104
001230   012737             MOV #17470,         ;Set up line parameters
001232   017470             DZLPR               ;and turn on the receiver
001234   160102                                 ;clock for line 0.
001236   012737             MOV #50050,         ;Enable transmitter
001240   050050             DZCSR               ;interrupt and silo
001242   160100                                 ;alarm. Turn on
                                                ;scanner and maintenance
                                                ;mode.
001244   032737   1$:       BIT #20000,         ;Test for silo alarm
001246   020000             DZCSR
001250   160100
001252   001774             BEQ 1$              ;Loop until silo alarm
                                                ;flag sets.
001254   013720   2$:       MOV DZRBUF,         ;Read DZ11 silo
001256   160102             (R0)+               ;receiver buffer output.
001260   000240             NOP                 ;Delay to allow next
001262   000240             NOP                 ;word in silo to filter
                                                ;down to the silo
                                                ;output.
```

```
001264    100773         BMI 2$              ;Data valid set says
                                             ;that word is good,
                                             ;go back for more.
001266    012700         MOV #DBUF, R0       ;Silo has been emptied.
001270    001304                             ;Reinitialize data
                                             ;table address pointer.
001272    000764         BR 1$               ;Do it again.
```

Transmitter Interrupt Service Routine

```
001274    112737    3$   MOVB DAT, DZTBUF    ;Transmit
001276    000252                             ;character 252
001300    160106
001302    000002         RTI
```

Data Table

```
1304    100252    ;Word 1
1306    100252    .
  .       .       .
  .       .       .
  .       .       .
  .       .       .
  .       .       .
  .       .       .
1340    100252    ;Word 16
1342    000252    ;Data valid
                  ;not set
                  ;character is
                  ;invalid
```

NOTE

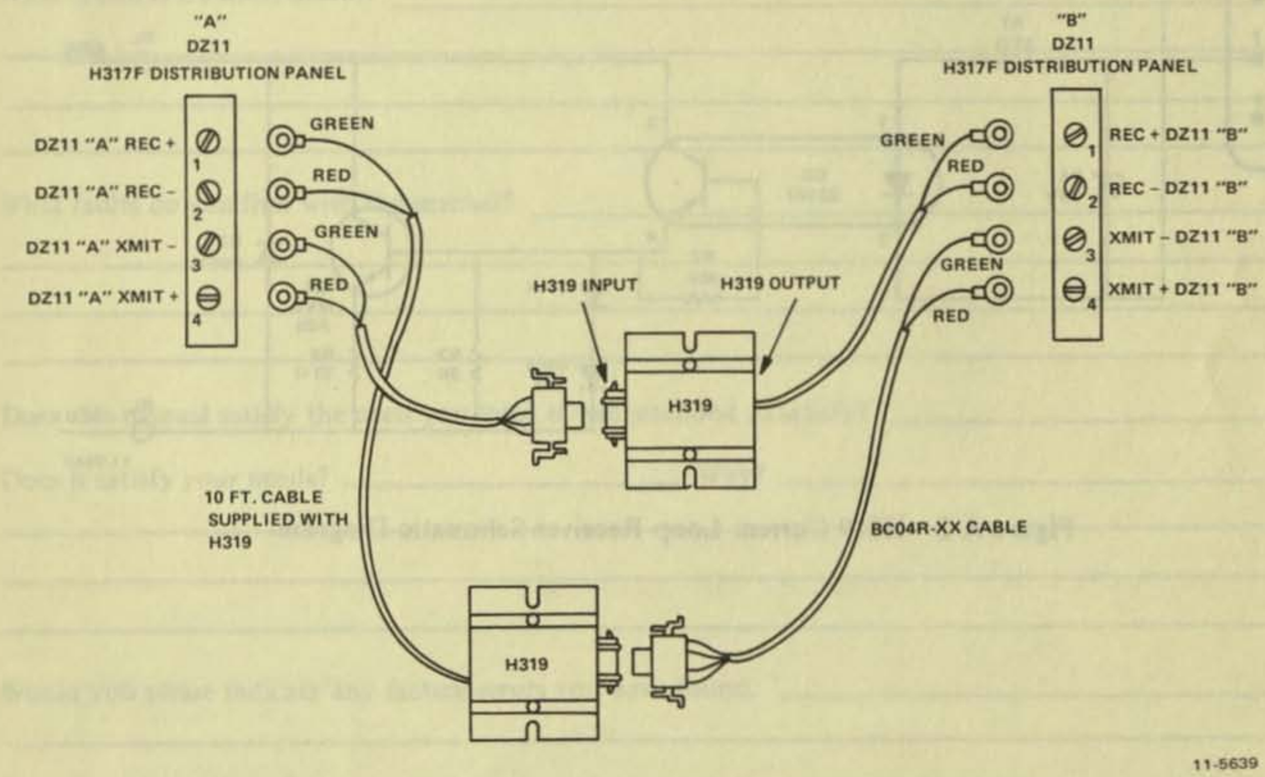
It is possible to get more than 16 words because they are being put into the silo simultaneously with the reading of the silo.

Example 6 – Echo Test on a Single Line (Transmit Received Data)

```
001000   012737   START   MOV #PAR, DZLPR      ;Load line parameters
                                               ;for line being used.
001002   011073                                ;Line 3, 8-bit
001004   160102                                ;character, 2 stop
                                               ;bits, no parity,
                                               ;110 baud, and receiver
                                               ;clock on.
001006   012737           MOV #LINE, DZTCR     ;Turn line 3
001010   000010                                ;transmitter on.
001012   160104
001014   012737           MOV #n, DZCSR        ;Turn scanner on
001016   000040                                ;(set CSR-5)
001020   160100
001022   105737   1$:     TSTB DZCSR           ;Test (bit 7) for
001024   160100                                ;RDONE
001026   100375           BPL 1$               ;If bit 7 is not set,
                                               ;go back and test again.
001030   005737   2$:     TST DZCSR            ;Test (bit 15) for
001032   160100                                ;TRDY
001034   100375           BPL 2$               ;If bit 15 is not set
                                               ;go back and test again.
001036   013700           MOV RBUF, R0         ;Read received data
001040   160102                                ;word into R0
001042   110037           MOVB R0, DZTDR       ;Load character
001044   160106                                ;into DZ11 TBUF
                                               ;register for
                                               ;transmitting.
001046   000765           BR 1$                ;Repeat.
```

APPENDIX A
DZ11 (M7814) TO AN ACTIVE DEVICE INSTALLATION

When a 20 mA DZ11 is used with another active device, two H319 current loop receivers must be used. Figure A-1 provides an example of the connections involved when the DZ11 is used with another active device, in this case another DZ11. A schematic of the H319 is shown in Figure A-2.



NOTE: THE CABLE ATTACHED TO THE H319 SHOULD HAVE THE CONNECTOR REMOVED AND RING LUGS ATTACHED TO THE RED AND GREEN LEADS AS SHOWN.
THE BLACK AND WHITE LEADS IN THE H319 CABLE AND BC04R CABLE ARE NOT USED.

Figure A-1 DZ11 (M7814) to Active Device Connection

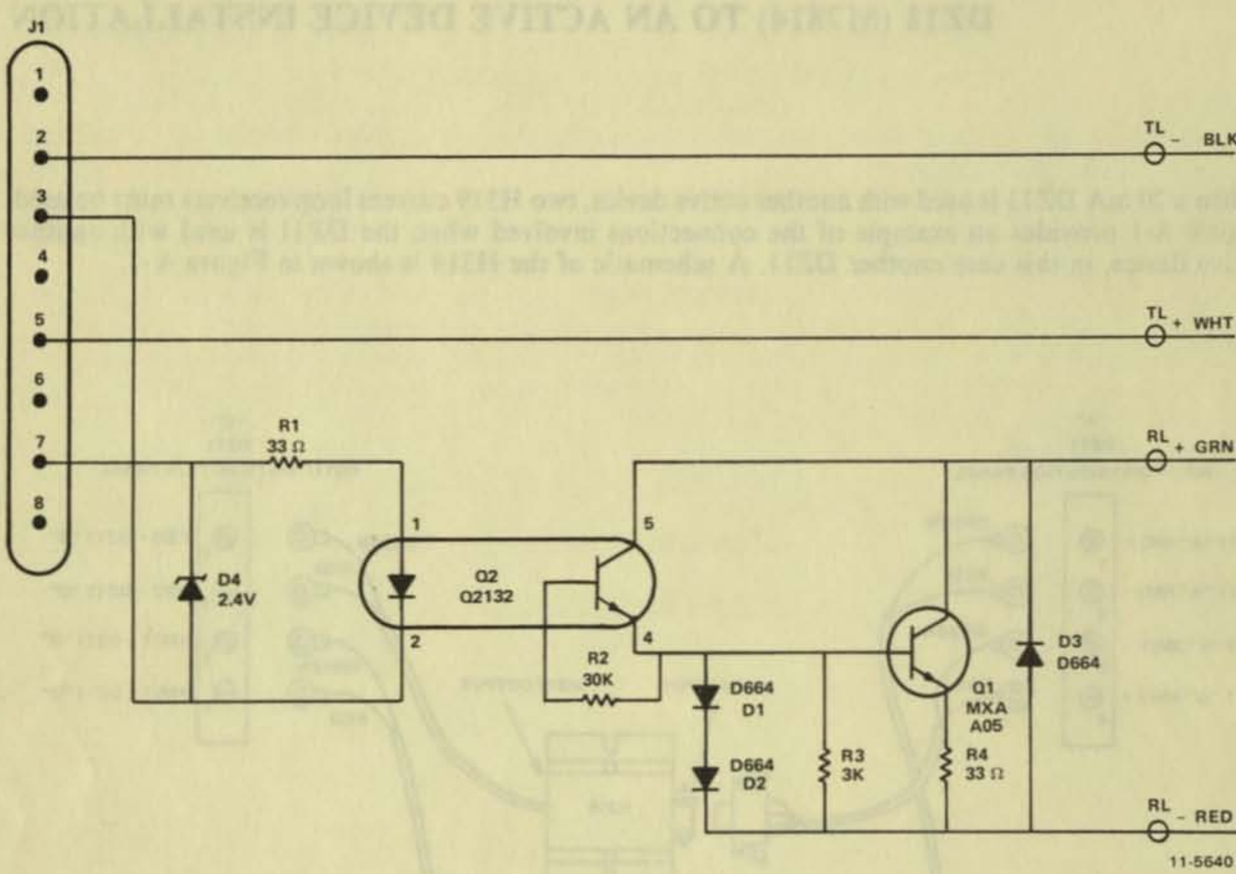


Figure A-2 H319 Current Loop Receiver Schematic Diagram

Reader's Comments

DZ11 USER'S GUIDE
EK-DZ110-UG-002

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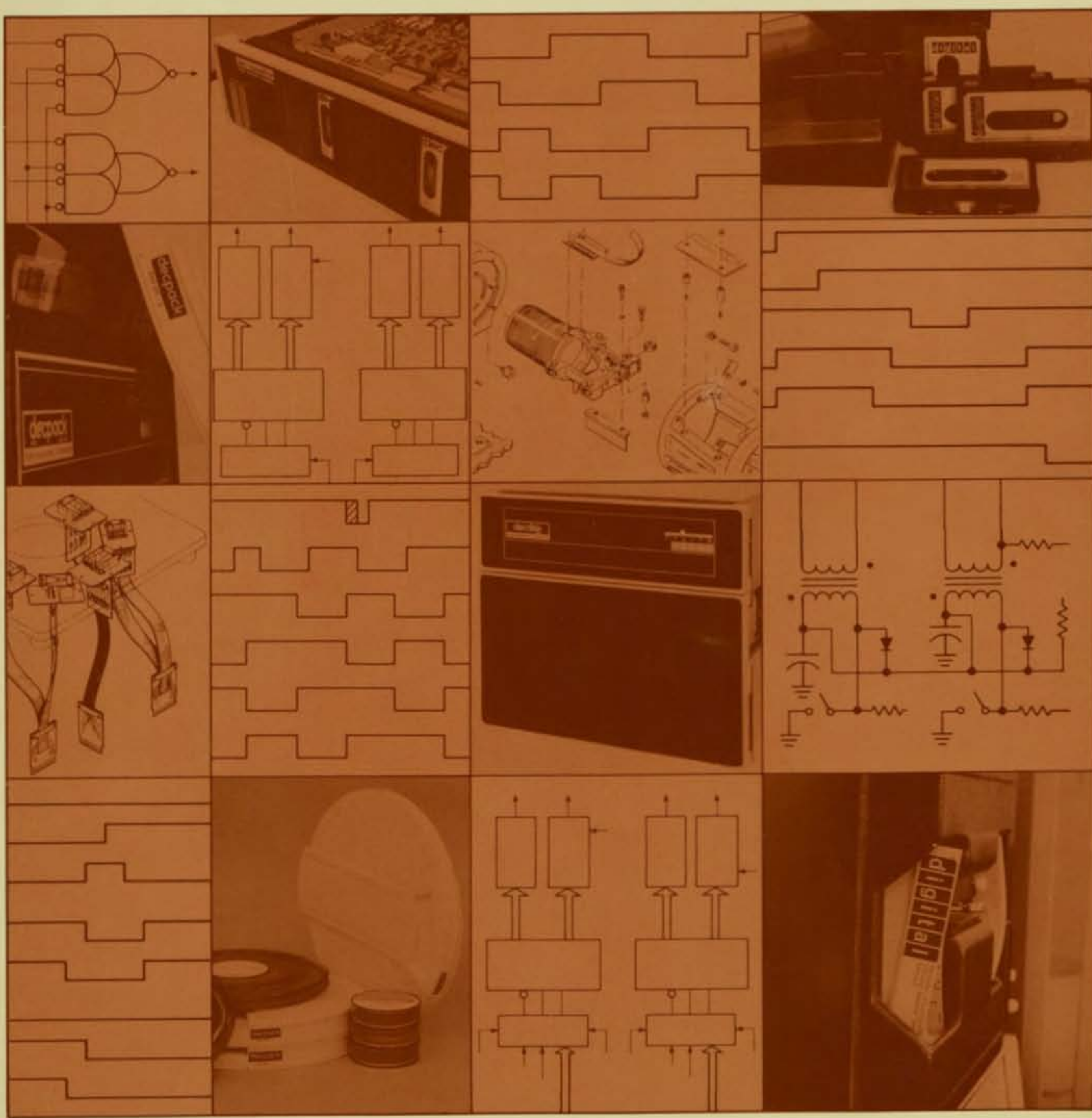
RP05/RP06 disk drive installation manual



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CONTENTS

CONTENTS (CONT)

CONTENTS (CONT)

CONTENTS (CONT)

CONTENTS (CONT)

FIGURES

FIGURES (CONT)

TABLES

CHAPTER 1
GENERAL INFORMATION

1.1 INTRODUCTION

The RP05/RP06 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 RP05/RP06 consists of a 677-51 (RP05) or 677-01 (RP06) disk drive, which is manufactured by Memorex, and a device control logic (DCL) unit, which is manufactured by Digital Equipment Corporation. The DCL unit contains the control electronics required to supervise the RP05/RP06 operations.

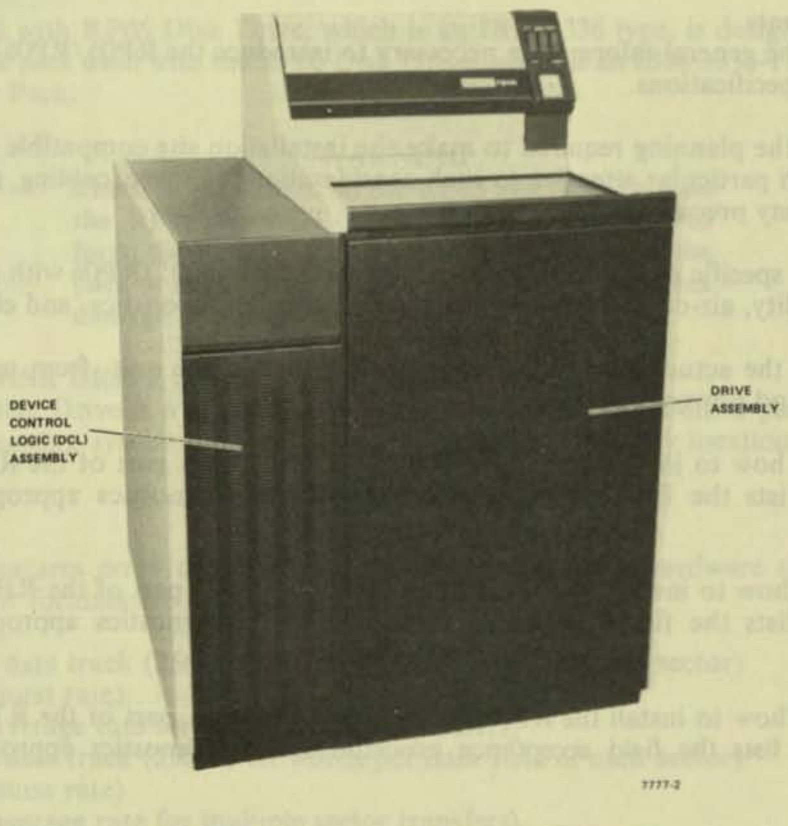


Figure 1-1 Drive and DCL Assemblies

The optional dual-access logic package may be accessed by either or both of the central processing units (CPUs) on a time-sharing basis. A switch on the control panel of the drive permits the control logic to select either or both CPUs.

NOTE

The primary functional difference between an RP05 and an RP06 Disk Drive is in their storage capacities. An RP05 can address up to 411 cylinders; an RP06 can address up to 815 cylinders. Except for this difference, the RP05 and RP06 are quite similar in their functions and interfaces. In this manual, when descriptions are applicable to both the RP05 and the RP06, they will be referred to either as the RP05/RP06 Disk Drive, or simply as disk drives. Where descriptions differ for the two drives, those differences will be noted and the individual drives will be referred to as the RP05 or RP06 Disk Drive.

1.2 MANUAL PURPOSE AND ORGANIZATION

This manual provides information on installing the RP05/RP06 Disk Drive into a computer system. To accomplish this purpose, the manual is organized in 13 chapters and is supported by the related documents listed in Paragraph 1.2.2.

1.2.1 Chapter Contents

Chapter 1 contains the general information necessary to introduce the RP05/RP06 and to present its characteristics and specifications.

Chapter 2 discusses the planning required to make the installation site compatible with operation of the RP05/RP06, 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 RP05/RP06 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 preliminary checks and power verification.

Chapter 5 describes how to install the RP05/RP06 Disk Drive as a part of the RJP05/RJP06 subsystem. Chapter 6 lists the field acceptance procedures and diagnostics appropriate to such an installation.

Chapter 7 describes how to install the RP05/RP06 Disk Drive as a part of the RHP05/RHP06 subsystem. Chapter 8 lists the field acceptance procedures and diagnostics appropriate to such an installation.

Chapter 9 describes how to install the RP05/RP06 Disk Drive as a part of the RTP05/RTP06 subsystem. Chapter 10 lists the field acceptance procedures and diagnostics appropriate to such an installation.

Chapter 11 describes how to install the RP05/RP06 Disk Drive as a part of the RWP05/RWP06 subsystem. Chapter 12 lists the field acceptance procedures and diagnostics appropriate to such an installation.

Chapter 13 deals with the optional dual-port configuration and discusses the potential upgrading of RP05/RP06 operation.

1.2.2 Related Documentation

This manual and the following documents comprise a complete documentation package for the RP05/RP06 Disk Drive. When the drive is used with the PDP-11, applicable documents include:

RJP05/RJP06 Moving Head Disk Subsystem Maintenance Manual (EK-RJP05-MM-001)
RWP05/RWP06 Moving Head Disk Subsystem Maintenance Manual (EK-RWP56-MM-001)
RP05/RP06 Device Control Logic Maintenance Manual (EK-RP056-MM-001)
RP05/RP06 DCL Print Set (MP0086).

Manuals related to the disk drive include:

Memorex RP05/RP06 677-01/51 DEC Disk Storage Drives Technical Manual (ER-00012)
Memorex RP05/RP06 677-01/677-51 Disk Storage Drive Illustrated Parts Catalog (ER-00011)
Memorex RP05/RP06 677-01 Logic Manual (EK-RP05M-TM-V02).

1.2.3 Option Designations

The single-access version of the RP05/RP06 Disk Drive is designated as the RP05/RP06-AA (60 Hz) or RP05/RP06-AB (50 Hz); the dual-access version is designated as the RP05/RP06-BA (60 Hz) or RP05/RP06-BB (50 Hz).

The disk pack used with RP05 Disk Drive, which is an IBM 3336 type, is designated as the RP04P Disk Pack. The disk pack used with the RP06 Disk Drive, which is an IBM 3336-11 type, is designated as the RP06P Disk Pack.

WARNING

The disk packs used on the RP05 and those used on the RP06 are NOT interchangeable. Attempts to force the wrong pack onto a drive can damage the pack or the drive, or both, and can lead to subsequent damage to other packs or drives.

1.3 RP05/RP06 DISK DRIVE SPECIFICATIONS

The RP05/RP06 Disk Drive is a high-performance, direct-access, single-head-per-surface drive that enables a data processing system to store or retrieve information at any location on a rotating disk pack.

1.3.1 Features

The RP05/RP06 features error detection and correction capability hardware that is permanently installed. Two sector formats are available:

20 sectors per data track (256 18-bit words per data field of each sector)
  2.79 μs (burst rate)
  3.25 μs (average rate for multiple sector transfers)
22 sectors per data track (256 16-bit words per data field of each sector)
  2.48 μs (burst rate)
  2.96 μs (average rate for multiple sector transfers).

The RP05/RP06 also offers remote standby operation and optional dual-controller capability.

1.3.2 Mechanical Specifications

Mounting	Mounted in a free-standing cabinet, approximately 119 cm h × 84 cm w × 81 cm d (47 in h × 33 in w × 32 in d). The width includes a 25.4-cm (10-in) chassis attached to the side of the basic cabinet.
Weight	273 kg (600 lb)

1.3.3 Electrical Specifications

Standard Power Requirements	
DC	None
AC	208 Vac ± 10%, DELTA, 60 Hz ± 1%, 3-phase 380 Vac ± 10%, Star W/Neutral, 50 Hz ± 1%, 3-phase
Other Power Options	230 Vac ± 10%, DELTA, 60 Hz ± 1%, 3-phase 240 Vac ± 10%, DELTA, 50 Hz ± 1%, 3-phase 408 Vac ± 10%, Star W/Neutral, 50 Hz ± 1%, 3-phase 420 Vac ± 10%, Star W/Neutral, 50 Hz ± 1%, 3-phase 220 Vac ± 10%, DELTA, 50 Hz ± 1%, 3-phase 230 Vac ± 10%, DELTA, 50 Hz ± 1%, 3-phase
	Surge (starting) current does not exceed five times running current which shall not exceed 6 A per phase (excluding DCL). Maximum phase current unbalance on two drives (excluding DCL) shall not exceed 70 percent. A maximum of two 60 Hz drives may be connected on any one 60 Hz ac cable string. Only one 50 Hz drive may be connected on any one 50 Hz cable string.
Non-Operating Temperature Range	10° C minimum, 43° C maximum (50° F minimum, 110° F maximum)
Drive Cooling (Internal)	Forced air
Maximum Wet Bulb Temperature	26° C (78° F)
Heat Dissipation	2100 W (7000 Btu/hr) maximum 1650 W (5500 Btu/hr) nominal
Relative Humidity	20% minimum, 80% maximum (no condensation)
Vibration	1.3 g from 2 to 5 Hz

Shock	
Operating	3 g for 10 ms, 3 pulses in vertical direction only
Shipping	6 g for 30 ms, 3 pulses in vertical direction only
Read/Write	
Number of Read/Write Heads	19 (plus 1 read head for the servo)
Cylinders Per Disk Pack	411 on an RP05 pack 815 on an RP06 pack
Tracks Per Cylinder	19
Total Number of Tracks	7,809 per RP05 disk pack 15,485 per RP06 disk pack
Data Bits Per Track, Maximum	107,520 (unformatted)
Data Bits Per Cylinder, Maximum	2,042,880 (unformatted)
Data Bits Per Disk Pack, Maximum	840,000,000 (unformatted) on an RP05 pack 1,665,000,000 (unformatted) on an RP06 pack
Data Rate (Nominal)	6,448,000 bits/second
Data Words Per Disk Pack (Formatted Capacity)	43,980,288 (22-sector pack, 16-bit words) on an RP05 pack 39,982,080 (20-sector pack, 18-bit words) on an RP05 pack 87,211,520 (22-sector pack, 16-bit words) on an RP06 pack 79,283,200 (20-sector pack, 18-bit words) on an RP06 pack
Data Compatibility	The drive allows for disk pack interchangeability between PDP-10/PDP-11/PDP-15 system through software-controlled format and data word width settings.

NOTE
RP05 and RP06 disk packs are not interchangeable.

1.3.4 Access Times

One Cylinder Seek	6 ms
Average Seek	28.5 ms
Maximum Seek	53 ms
Average Rotational Latency Time	8.33 ms

1.3.5 Operation

Start-Up Time (Head Load and First Seek)	15 seconds
Disk Rotational Speed	3600 rev/min ± 2.5% (counterclockwise)
Stop Time (Retract Heads and Stop Disk Rotation)	15 seconds
Disk Drive Motor	1 hp induction, 208/230 Vac, single-phase
Bit-Cell Time	155 ns

1.3.6 Disk Pack

Type	RP04P pack (IBM 3336 type) for an RP05 RP06P pack (IBM 3336-11 type) for an RP06
Disk Diameter	35.56 cm (14 in)
Number of Disks	10 magnetic disks (not including upper and lower protective disks)
Magnetic Recording Surfaces	19 (uppermost surface is numbered zero)

CHAPTER 2
SITE PREPARATION

2.1 SPACE

Provision should be made for service clearances of 71 cm (28 in) at the front and rear of the RP05/RP06 Disk Drive, and 51 cm (20 in) 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 36 cm (14 in) when covered, and a height of approximately 18 cm (7 in) 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.

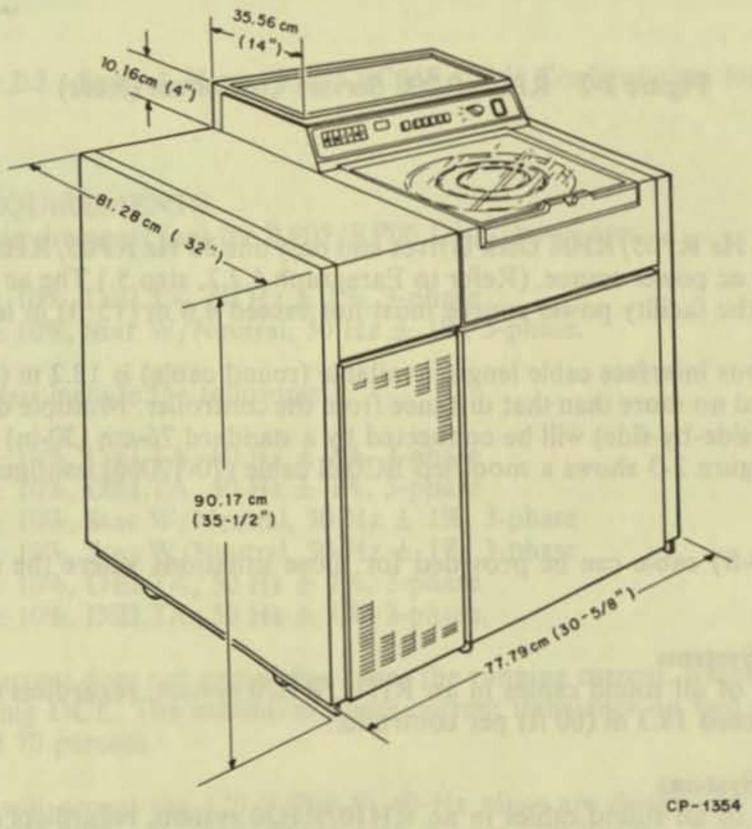


Figure 2-1 RP05/RP06 Service Clearances (Front)

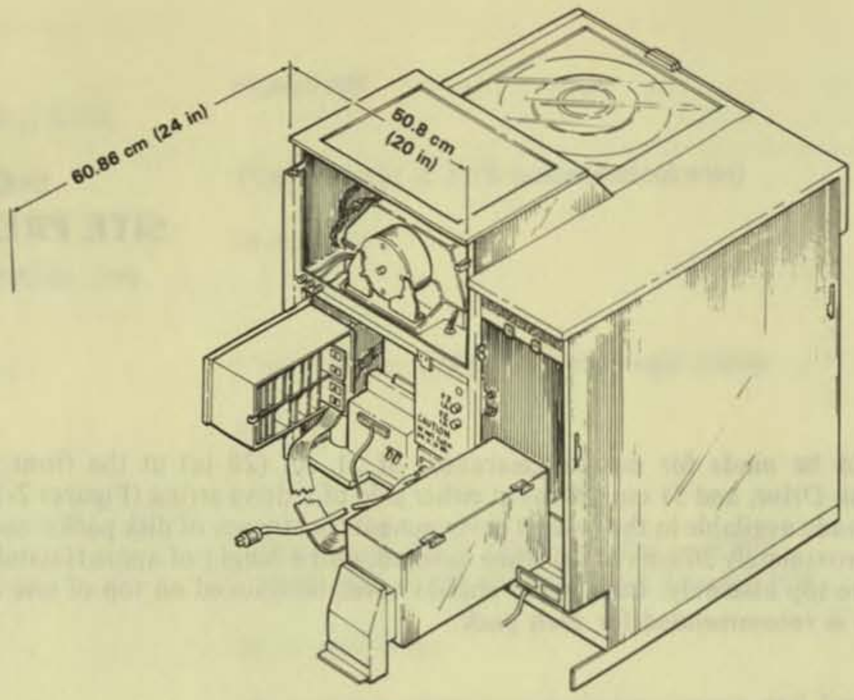


Figure 2-2 RP05/RP06 Service Clearances (Rear)

2.2 CABLING

No more than two 60 Hz RP05/RP06 Disk Drives and only one 50 Hz RP05/RP06 Disk Drive 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 4.6 m (15 ft) in length.

The maximum Massbus interface cable length available (round cable) is 12.2 m (40 ft); thus, the first drive must be mounted no more than that distance from the controller. Multiple drives installed in the *string* configuration (side-by-side) will be connected by a standard 76-cm (30-in) cable provided with each RP05/RP06. Figure 2-3 shows a modified BC06S cable (70-12066) configuration for drive-end RP05/RP06 use.

An optional 3-m (10-ft) cable can be provided for those situations where the string configuration cannot be utilized.

2.2.1 RH11/RH70 Systems

The aggregate length of all round cables in an RH11/RH70 system, regardless of the configuration selected, must not exceed 18.3 m (60 ft) per controller.

2.2.2 RH10/RH20 Systems

The aggregate length of all round cables in an RH10/RH20 system, regardless of the configuration selected, must not exceed 48.8 m (160 ft) minus 3.8 m (12.5 ft) for each RP05/RP06 on the system.

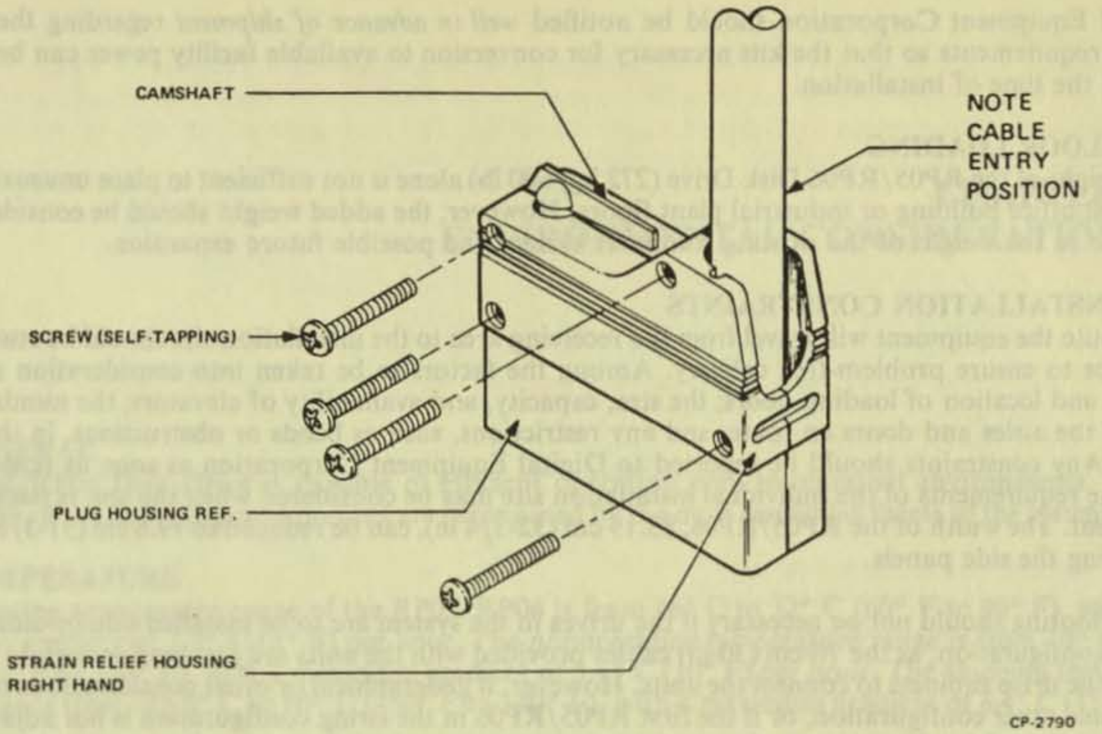


Figure 2-3 Special 76-cm (30-in) BC06S Cable Configuration for Drive End

2.3 POWER REQUIREMENTS

Standard power requirements (ac) for RP05/RP06 Disk Drives are:

- 208 Vac ± 10%, DELTA, 60 Hz ± 1%, 3-phase
- 380 Vac ± 10%, Star W/Neutral, 50 Hz ± 1%, 3-phase.

Other power options include the following:

- 230 Vac ± 10%, DELTA, 60 Hz ± 1%, 3-phase
- 240 Vac ± 10%, DELTA, 50 Hz ± 1%, 3-phase
- 408 Vac ± 10%, Star W/Neutral, 50 Hz ± 1%, 3-phase
- 420 Vac ± 10%, Star W/Neutral, 50 Hz ± 1%, 3-phase
- 220 Vac ± 10%, DELTA, 50 Hz ± 1%, 3-phase
- 230 Vac ± 10%, DELTA, 50 Hz ± 1%, 3-phase.

Surge (starting) current does not exceed five times the running current, which should not exceed 6 A per phase, excluding DCL. The maximum phase current unbalance on two drives (excluding DCL) should not exceed 70 percent.

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 240/416 V. 50-Hz plugs bear a DEC designation (12-11259) but no NEMA or manufacturers' numbers are presently available.

It is also necessary to have 20 A circuit breakers.

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.

2.4 FLOOR LOADING

The weight of the RP05/RP06 Disk Drive (272 kg/600 lb) 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. The width of the RP05/RP06, 83.19 cm (32-3/4 in), can be reduced to 79.8 cm (31-3/8 in) by removing the side panels.

False flooring should not be necessary if the drives in the system are to be installed side-by-side in the string configuration, as the 76-cm (30-in) 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 RP05/RP06 in the string configuration is not adjacent to the controller, false flooring may be required to avoid exposed cables. It may be necessary to remove end panels.

2.6 FIRE AND SAFETY PRECAUTIONS

The RP05/RP06 Disk Drive presents no unusual additional fire of 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.

CHAPTER 3
ENVIRONMENTAL CONSIDERATIONS

3.1 GENERAL
The RP05/RP06 Disk Drive is capable of efficient operation even in marginal environments. The parameters of the operating environment are determined by the most restrictive facets of the system.

3.2 TEMPERATURE
The operating temperature range of the RP05/RP06 is from 16° C to 32° C (60° F to 90° F), with a maximum gradient of 2.8° C (5° F) per hour. The nonoperating temperature range is from 10° C to 44° C (50° F to 110° F), with a maximum gradient of 5.6° C (10° F) per hour. The shipping temperature range is from -45.6° C to 60° C (-50° F to 140° F), with a maximum gradient of 8.4° C (15° F) per hour.

3.3 RELATIVE HUMIDITY
Humidity control is important in any system, as static electricity can cause errors in any CPU with memory. The RP05/RP06 is designed to operate efficiently within a relative humidity range of 20 percent to 80 percent, with a maximum wet bulb temperature of 26° C (78° F) and a minimum dew point of 2° C (36° F). The nonoperating relative humidity range is from 8 percent to 85 percent, with no condensation. The shipping relative humidity range is from 5 percent to 90 percent, with no condensation.

3.4 HEAT DISSIPATION
Heat dissipation for the RP05/RP06 Disk Drive is 5500 Btu/hour, nominal and 7000 Btu/hour, maximum. 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, 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 the maximum estimated requirements.

3.5 ACOUSTICS
Most computer sites require at least some degree of acoustic treatment; however, the RP05/RP06 Disk Drive should not contribute unduly to the overall acoustic problem. Acoustic materials should neither produce nor harbor dust.

3.6 ALTITUDE
Computer system operation at high altitudes can result in heat dissipation problems. The maximum altitude specified for the RP05/RP06 is 1980 m (6500 ft). If operation at high altitudes is anticipated, DEC should be notified when the equipment is ordered.

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 RP05/RP06 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:

1. Grounding window screens and other large metal surfaces
2. Shielding interconnection cables with grounded shields
3. Verifying existing grounds for common-mode currents
4. In extreme radiation environments, providing a grounded cage for the system.

3.8 AIR CIRCULATION

The air circulation system of the RP05/RP06 Disk Drive (Figure 3-1) is designed to supply clean air for:

- Disk temperature control
- Pressurization of the shroud area
- Logic cage cooling.

To ensure that intake air moves freely into the drive, floor access must not be restricted by cables, etc.

3.9 CLEANLINESS

Although cleanliness is important in all facets of a computer system, it is particularly crucial to the RP05/RP06 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 cleanliness.

- Seal all windows in the vicinity of the RP05/RP06 locations.

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

- Check that the flow of air from the air-conditioning system will tend to carry lint, etc., away from the RP05/RP06 location. Provide filtration to inhibit dust and other particulate matter.

- 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.)

- Select acoustic material that will neither produce nor harbor dust.

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

- Provide closed cabinets for disk storage.

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

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

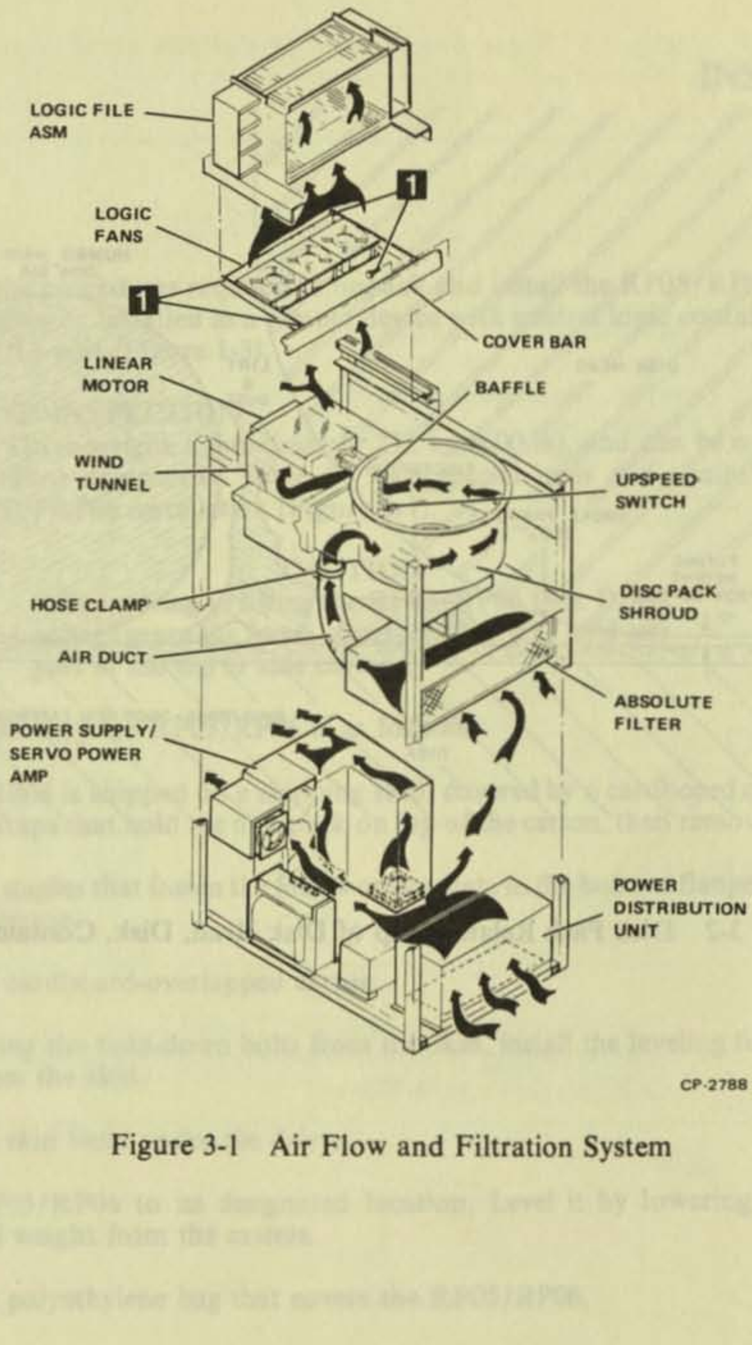


Figure 3-1 Air Flow and Filtration System

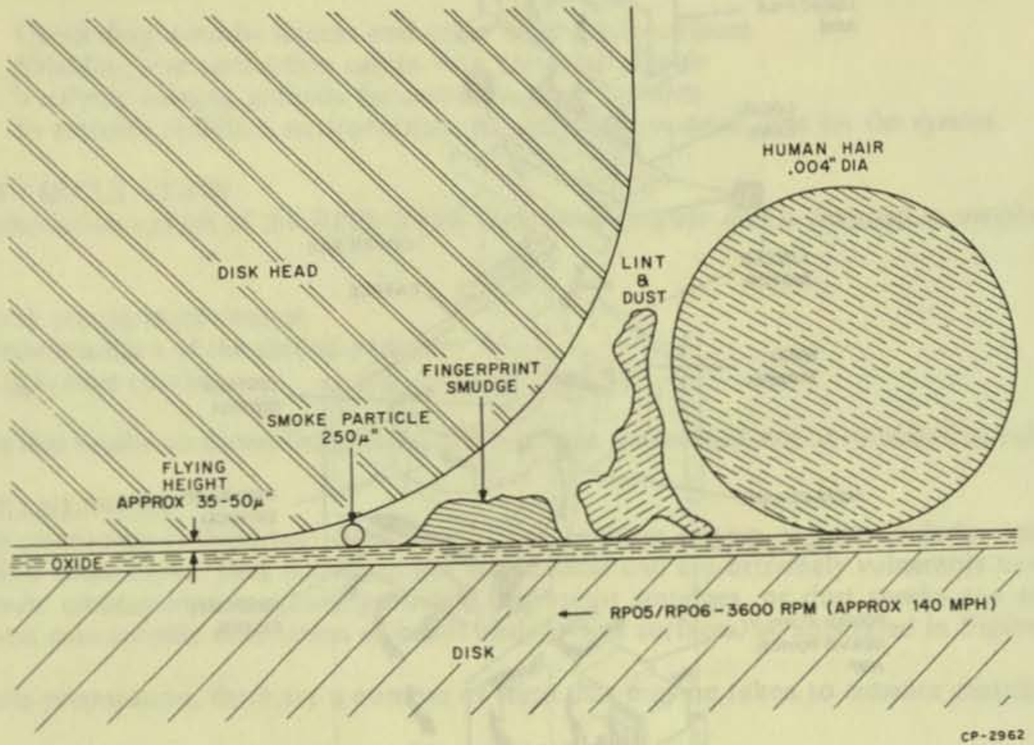


Figure 3-2 Disk Pack Relationship of Disk Head, Disk, Contaminants

CHAPTER 4
INSTALLATION

This chapter includes the procedures required to unpack and install the RP05/RP06 Disk Drive. The RP05/RP06 is designed to be installed as a remote device with control logic contained in an attached drive control logic (DCL) unit (Figure 1-3).

4.1 UNPACKING AND INSPECTION

The RP05/RP06 Disk Drive weighs approximately 272 kg (600 lb), and can be moved or lifted by a forklift or similar handling equipment. Table 4-1 lists special tools and equipment that could be required during an RP05/RP06 installation (Figure 4-1).

CAUTION

When moving or lifting the RP05/RP06 Disk Drive, always grasp the frame structure. Do NOT hold any part of the top or side covers.

The procedure for unpacking the RP05/RP06 is as follows.

1. The RP05/RP06 is shipped on a shipping skid, covered by a cardboard carton. 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-overlapped carton.

3. Remove the cardboard-overlapped carton.

4. After removing the hold-down bolts from the skid, install the leveling feet *before* removing the drive from the skid.

5. Remove the skid from under the drive.

6. Roll the RP05/RP06 to its designated location. Level it by lowering the eight levelers, removing all weight from the casters.

7. Remove the polyethylene bag that covers the RP05/RP06.

Table 4-1 Tools Required for RP05/RP06 Installation

Item	Part No.
Field Service Tool Kit	
Tektronix 453 oscillscope, or equivalent	
NOTE **Oscilloscopes or meters used in the field should be calibrated frequently. Meter readings must be accurate within ±1 percent, oscilloscope within ±3 percent.**	
RP05/RP06 Disk Storage Subsystem Tester	
Absolute filter gauge	29-21290
C.E. Pack 3336 For RP05 For RP06	 29-21292 29-22193
Data pack For RP05 For RP06	 RP04-P RP06-P

NOTE

The Mechanical Alignment Kit (Capital Equipment) may be required if problems arise during installation of RP05/RP06 Disk Drives.

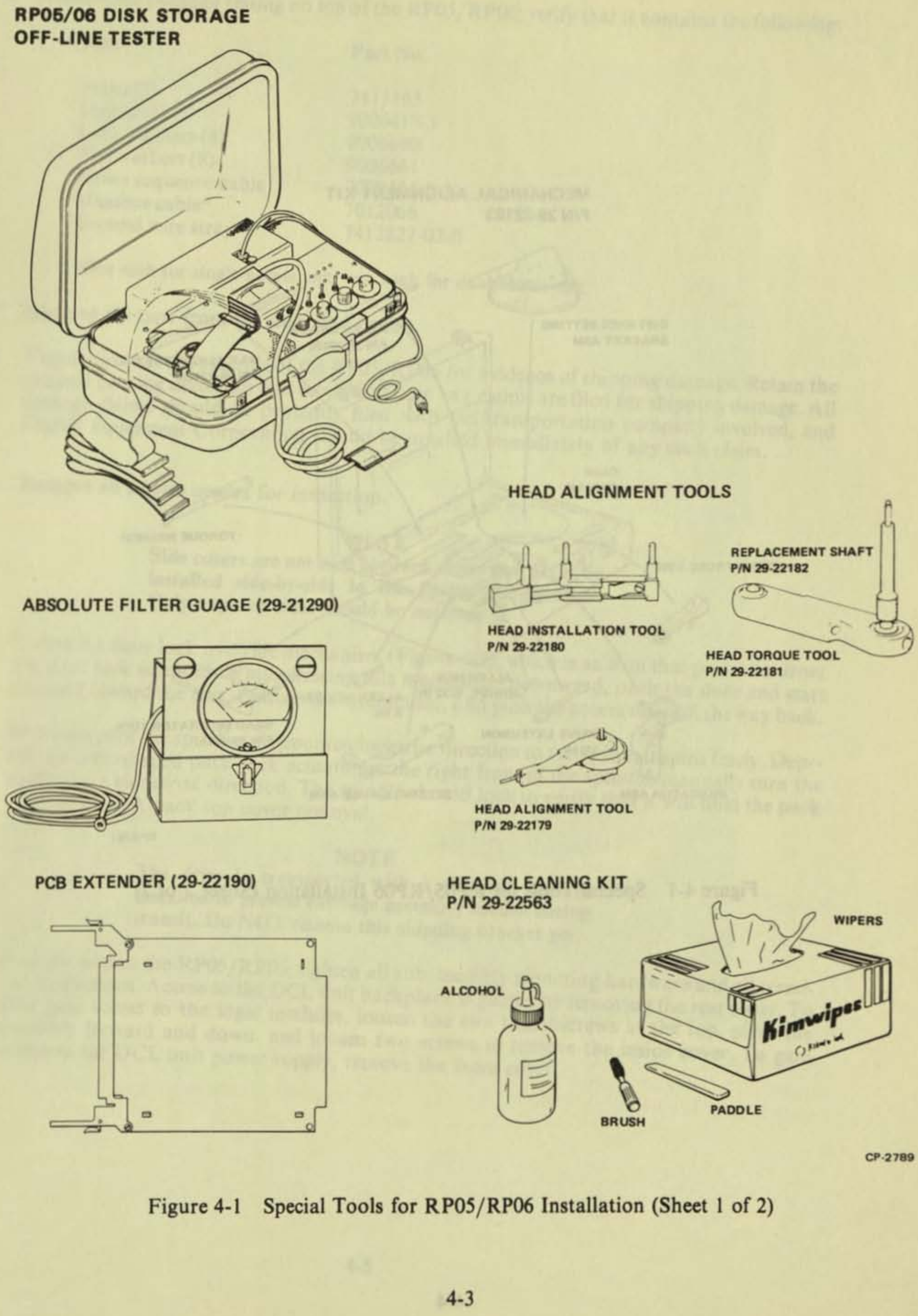


Figure 4-1 Special Tools for RP05/RP06 Installation (Sheet 1 of 2)

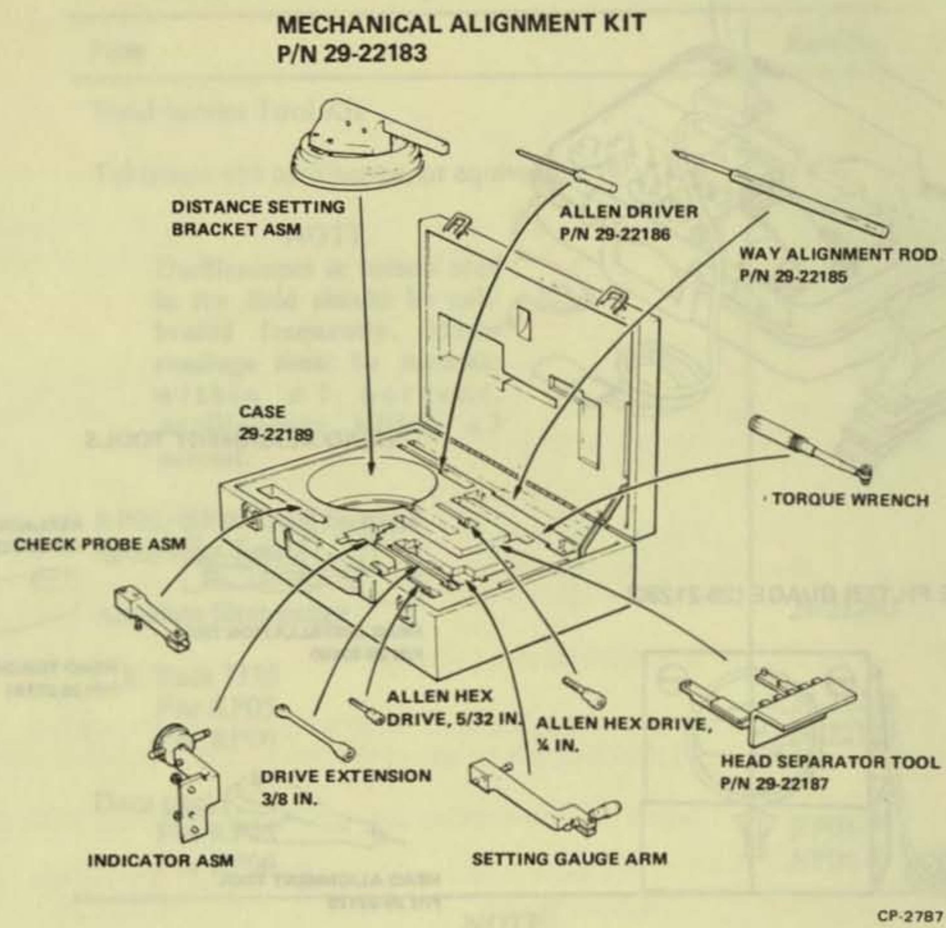


Figure 4-1 Special Tools for RP05/RP06 Installation (Sheet 2 of 2)

8. Remove the package resting on top of the RP05/RP06; 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*	7012066
Ground wire strap	7412827-03-0

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

9. Remove the tape from the door end panels.

10. Visually inspect the exterior of the RP05/RP06 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.

11. 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.

12. Locate the door lock override mechanism (Figure 4-2), which is an arm that protrudes from the door lock solenoid. While pressing this mechanism downward, push the door and start sliding it toward the rear. Release the mechanism, and push the access door all the way back.

13. Manually turn the spindle in a counterclockwise direction to verify that it spins freely. Depress the cone-shaped pack-lock actuator at the right 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.

14. Visually inspect the RP05/RP06; tighten all subassembly mounting hardware and all terminal connections. Access to the DCL unit backplane is gained by removing the rear cover. To then gain access to the logic modules, loosen the two thumbscrews at the top, pivot the assembly forward and down, and loosen two screws to remove the inside cover. To gain access to the DCL unit power supply, remove the front cover.

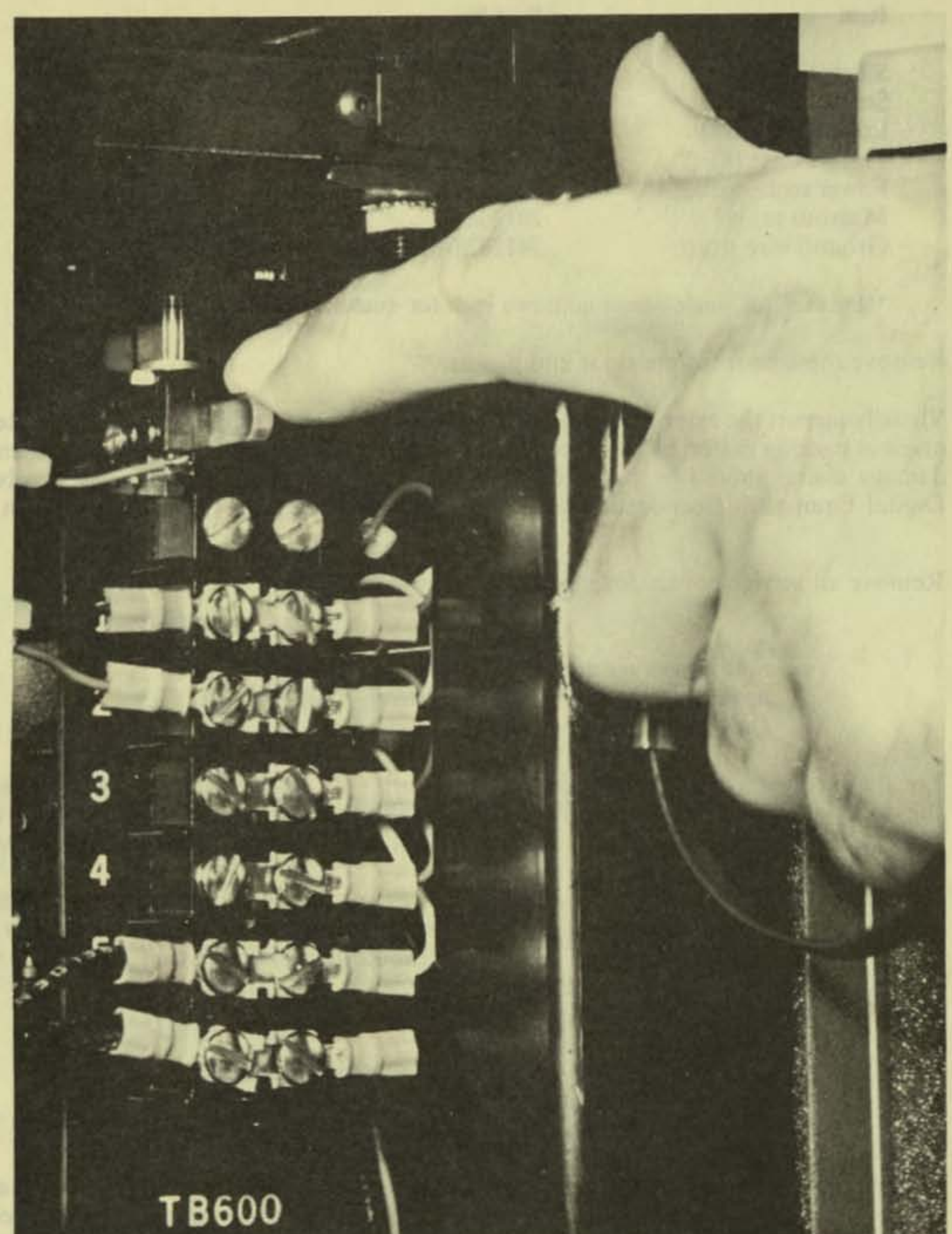


Figure 4-2 Door Lock Override Mechanism

15. Check the drive power requirements on the nameplate (Figure 4-3) to verify that they agree with facility power. If a discrepancy exists, change the ac input power configuration of the RP05/RP06 to conform to available facility power (Paragraph 4.6). Verify that the power conversion plug is properly configured (Paragraph 4.6).

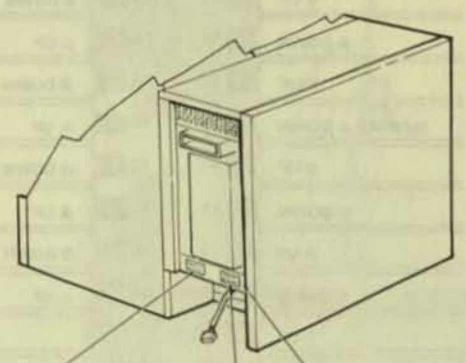


Figure 4-3 Location of Nameplate and Serial Number Tag

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

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

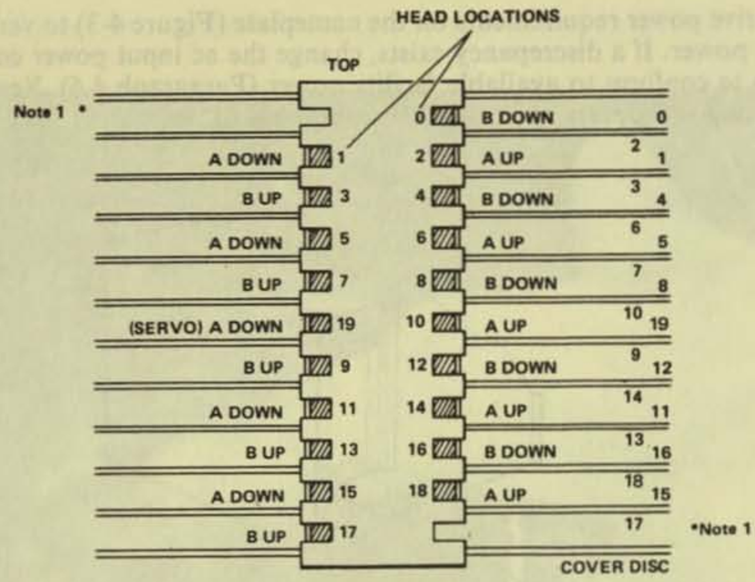
CAUTION

Never push the carriage forward so that the cam followers leave the cam unless the head separator tool is installed.

18. Check the four 40-pin ribbon cables (marked A, B, C, and D) that connect the drive to the DCL unit; ensure that the connectors are securely seated in the corresponding (A, B, C, or D) receptacle on module D01 or D02 (Figure 4-5).

19. Measure the electromagnetic actuator coil assembly (bobbin) resistance across the coil leads to determine that the resistance is 1.6 Ω (typical) and that no shorts or opens exist.

20. Remove shipping brackets from rear of deck plate and frame (Figure 4-6); provide room for accessing other shipping hardware by removing the absolute filter (Figure 4-7). (To remove the filter, reach through the left side of the drive with a screwdriver and remove the hose clamp at the rear of the filter, then slide the filter out.)



NOTES:
1. Do not attempt to install a head in these two locations; these slots are used only for the head separator tool.
2. Before installing a head, be sure that the etching (A-Up/Down, B-Up/Down) agrees with the chart on the linear motor and the head position on the T-block.

CP-2785

Figure 4-4 T-Block Viewed from Linear Motor

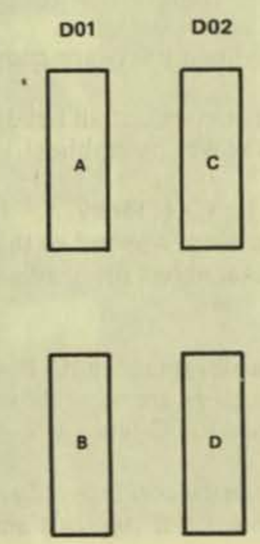


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Figure 4-5 DCL/Drive Signal Interface Connections

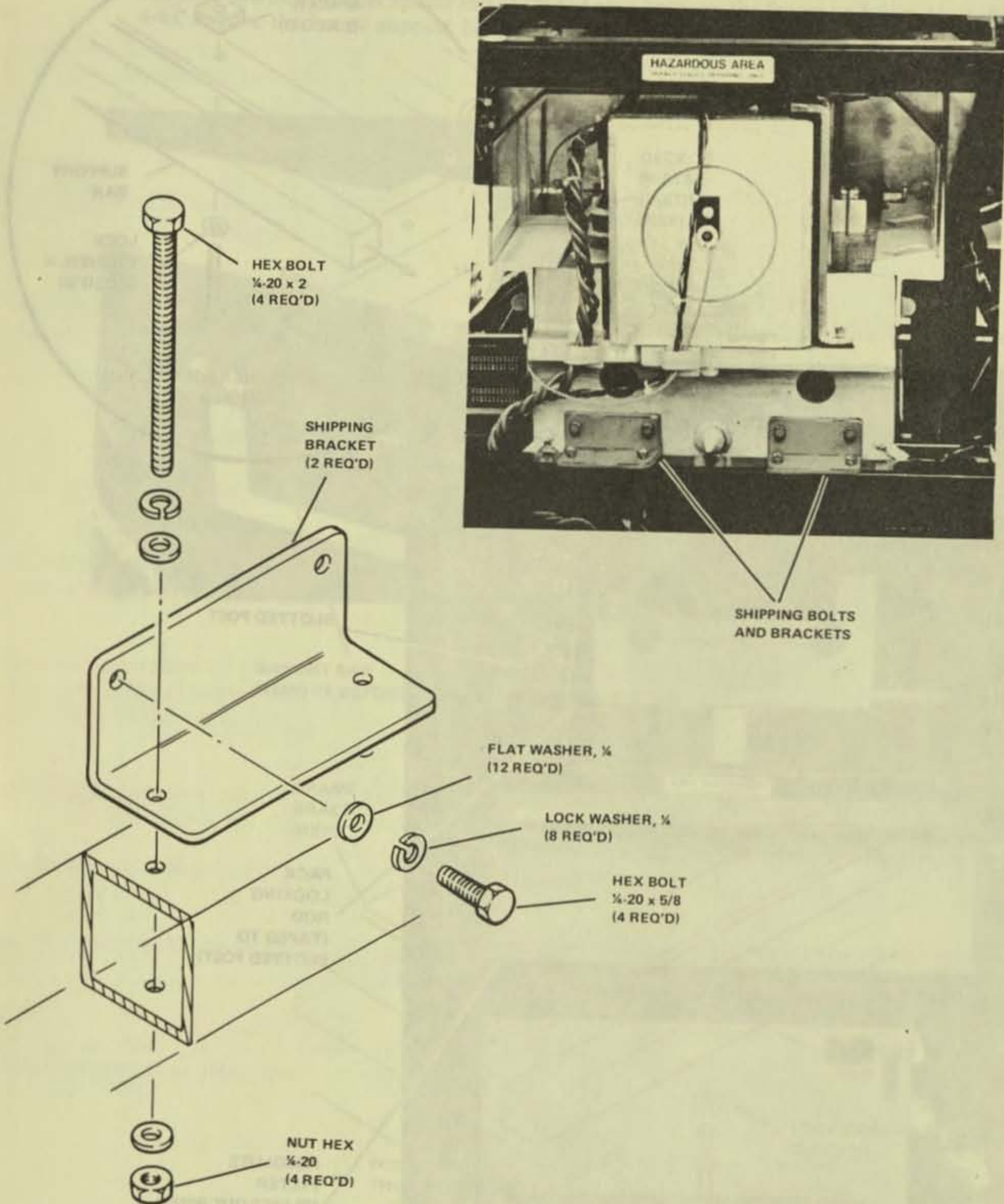


Figure 4-6 Shipping Brackets

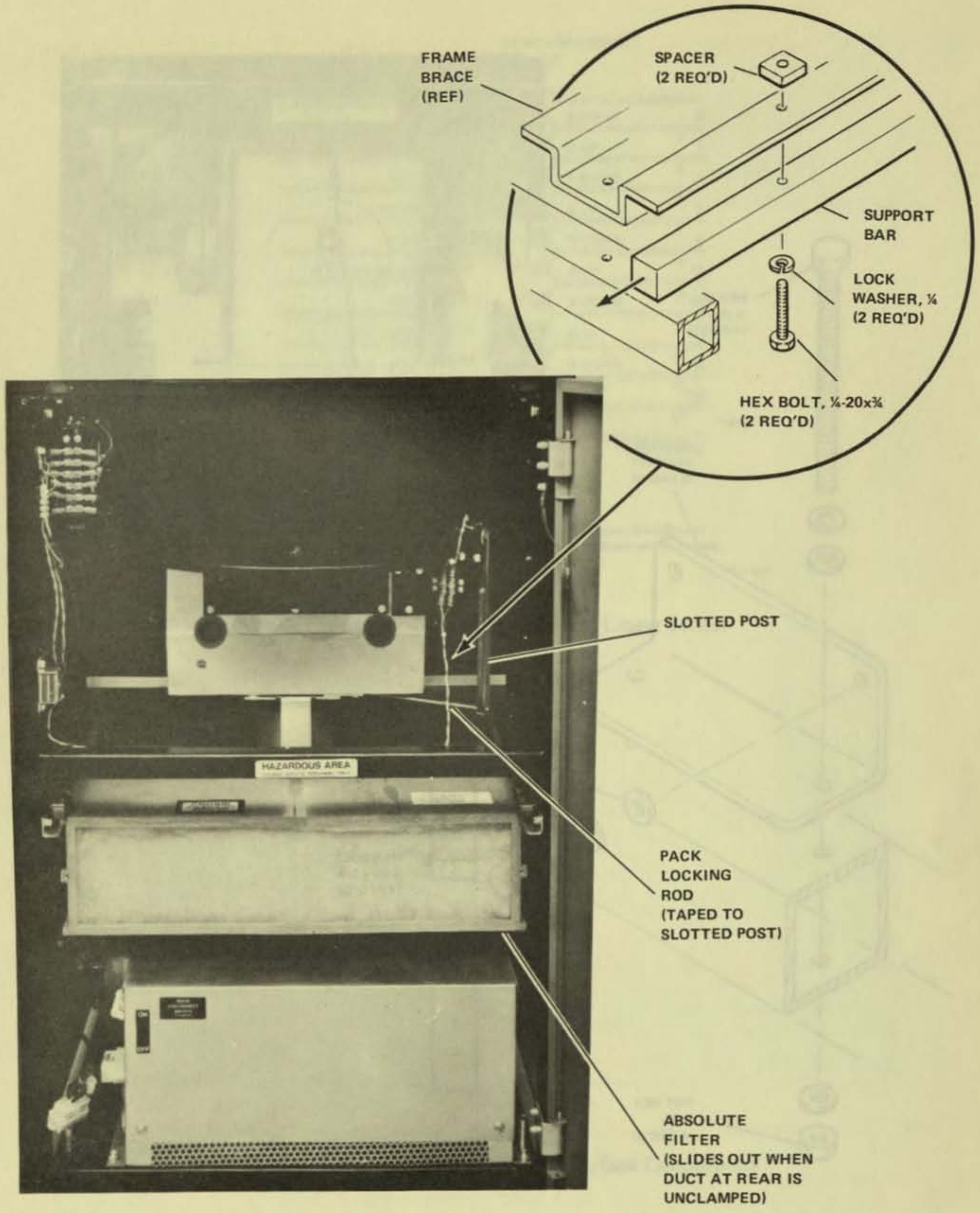


Figure 4-7 Absolute Filter and Pack Loading Rod

21. Remove two bolt washer spacer sets from the area between the frame and deck plate (Figure 4-8); remove the heavy support bar by pushing out from the side.

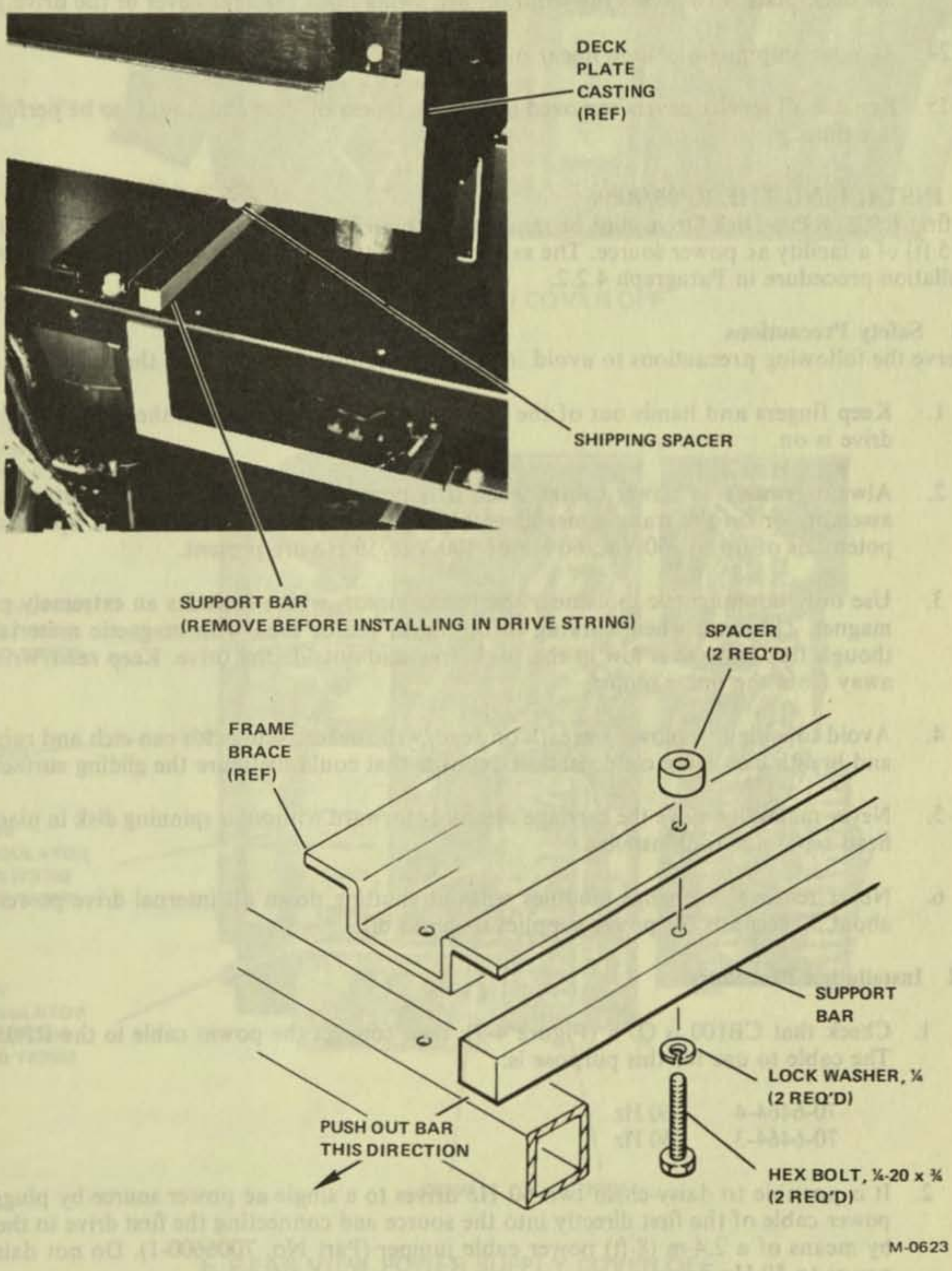


Figure 4-8 . Shipping Spacers and Support Bar

22. Replace the absolute filter and clamp the hose to the rear of the filter.

23. Remove the tape (if any) wrapped around the disk pack locking rod and the slotted post (Figure 4-7); remove two strips of tape (if any) securing the wind tunnel (plastic deflector) to the deck plate. (To access the wind tunnel, swing open the rear cover of the drive.)

24. Remove shipping block on linear motor.

25. Replace all service covers removed in step 11, unless off-line checkout is to be performed at this time.

4.2 INSTALLING THE RP05/RP06

The first RP05/RP06 Disk Drive must be mounted within 12 m (40 ft) of the controller and within 4.4 m (15 ft) of a facility ac power source. The safety precautions 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 of up to 230 Vac/60 Hz or 400 Vac/50 Hz are present.

3. Use only nonmagnetic tools near the linear motor, which includes an extremely powerful magnet. Use care when working in the linear motor 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 linear motor.

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.

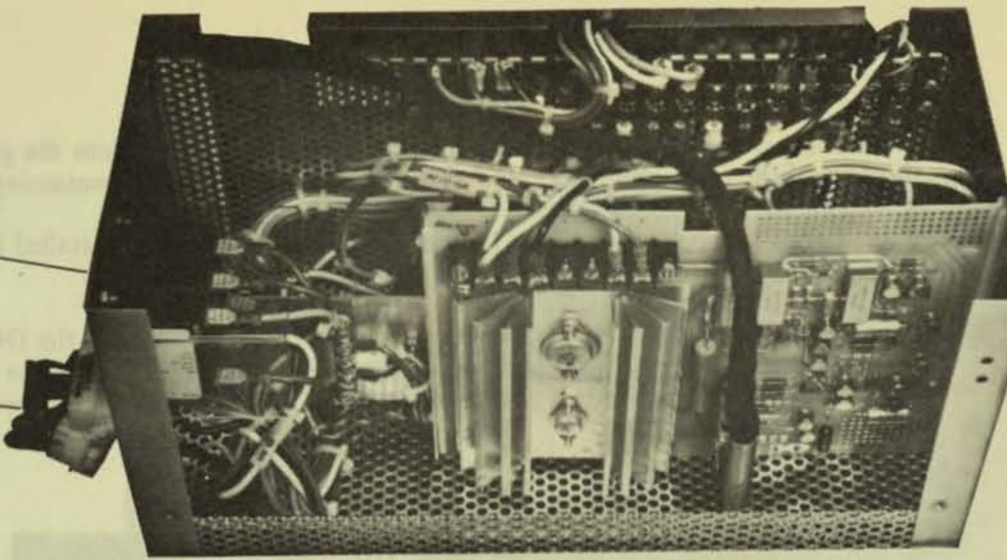
6. Never remove or change modules without shutting down all internal drive power. Allow about 30 seconds for power supplies to bleed off.

4.2.2 Installation Procedure

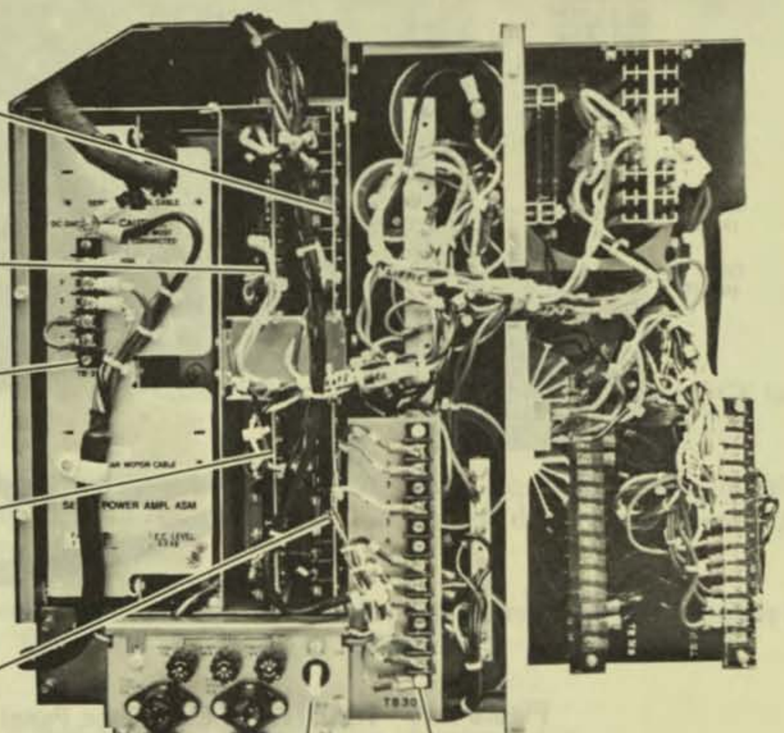
1. Check that CB100 is OFF (Figure 4-9); then connect the power cable to the RP05/RP06. The cable to use for this purpose is:

70-6464-4	60 Hz
70-6464-3	50 Hz

2. It is possible to daisy-chain two 60 Hz 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 a 2.4-m (8-ft) power cable jumper (Part No. 7006600-1). Do not daisy-chain power to 50 Hz drives.



a. FRONT VIEW, PDU COVER OFF



b. REAR VIEW, POWER SUPPLY COVER OFF

M-0625

Figure 4-9 RP05/RP06 Installation

3. Connect a 7.6-m (25-ft) ground wire (Part No. 741827-25) from the ground stud at the bottom of the DCL unit to the stud at the bottom of the cabinet containing the controller.

4. Check that the power sequence jumper (Part No. 7009490) is installed in J12 of the DCL unit. (Refer to drawing D-UA-RJP05-A-0 or D-UA-RJP06-A-0.)

5. Connect the round 7.6-m (25-ft) Massbus cable (BC06S-25) from the DCL unit connector marked "Controller A Input" (Figure 4-10) to the connector panel in the controller cabinet. Ensure that the drive end of this cable is bent at an angle of 90 degrees to the cable gate (Figure 2-3).

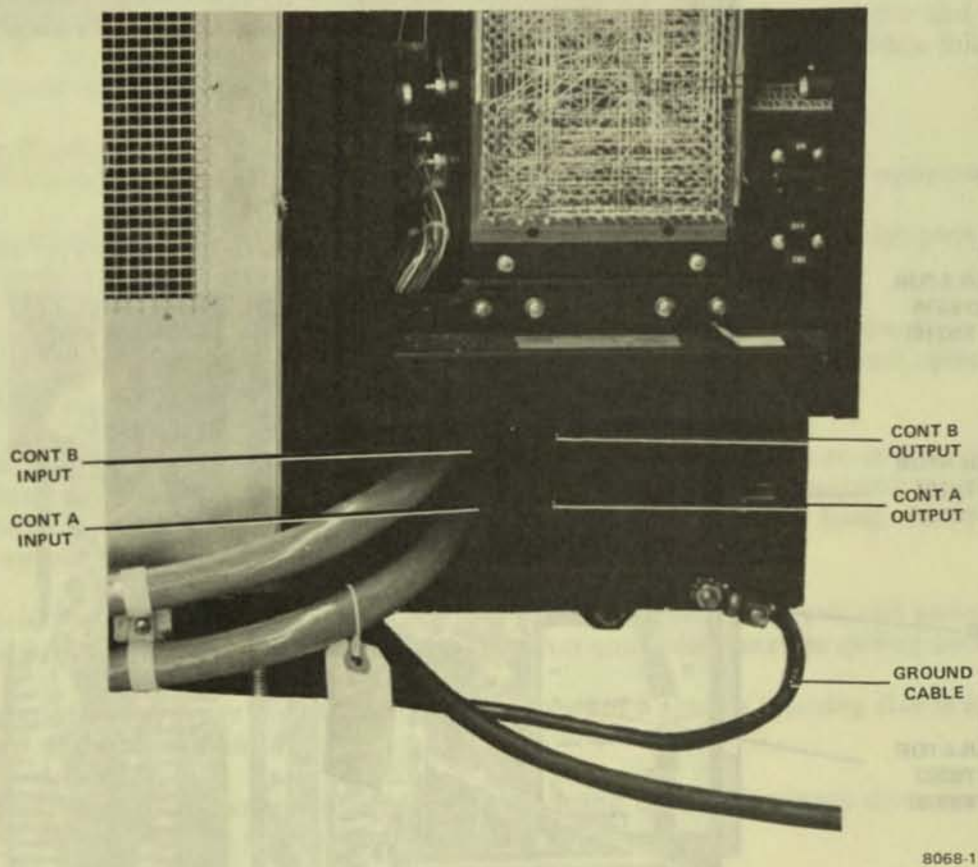


Figure 4-10 RP05/RP06 Connector Panel

6. If the installation is multidrive, proceed to step 7; otherwise, proceed to step 11.

7. Connect a round 76-cm (30-in) Massbus cable (7012066) from the DCL unit connector marked "Controller A Output" to the connector in the second drive marked "Controller A Input." Install cable clamps as shown in Figure 4-11.

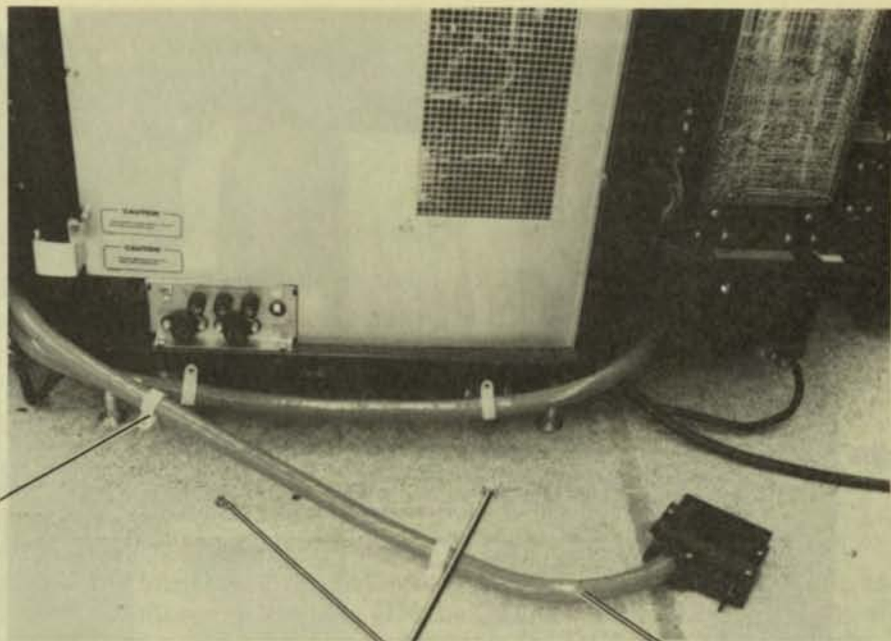


Figure 4-11 Massbus Connector Prior to Mounting

8. Repeat step 7 for each additional drive in the configuration.

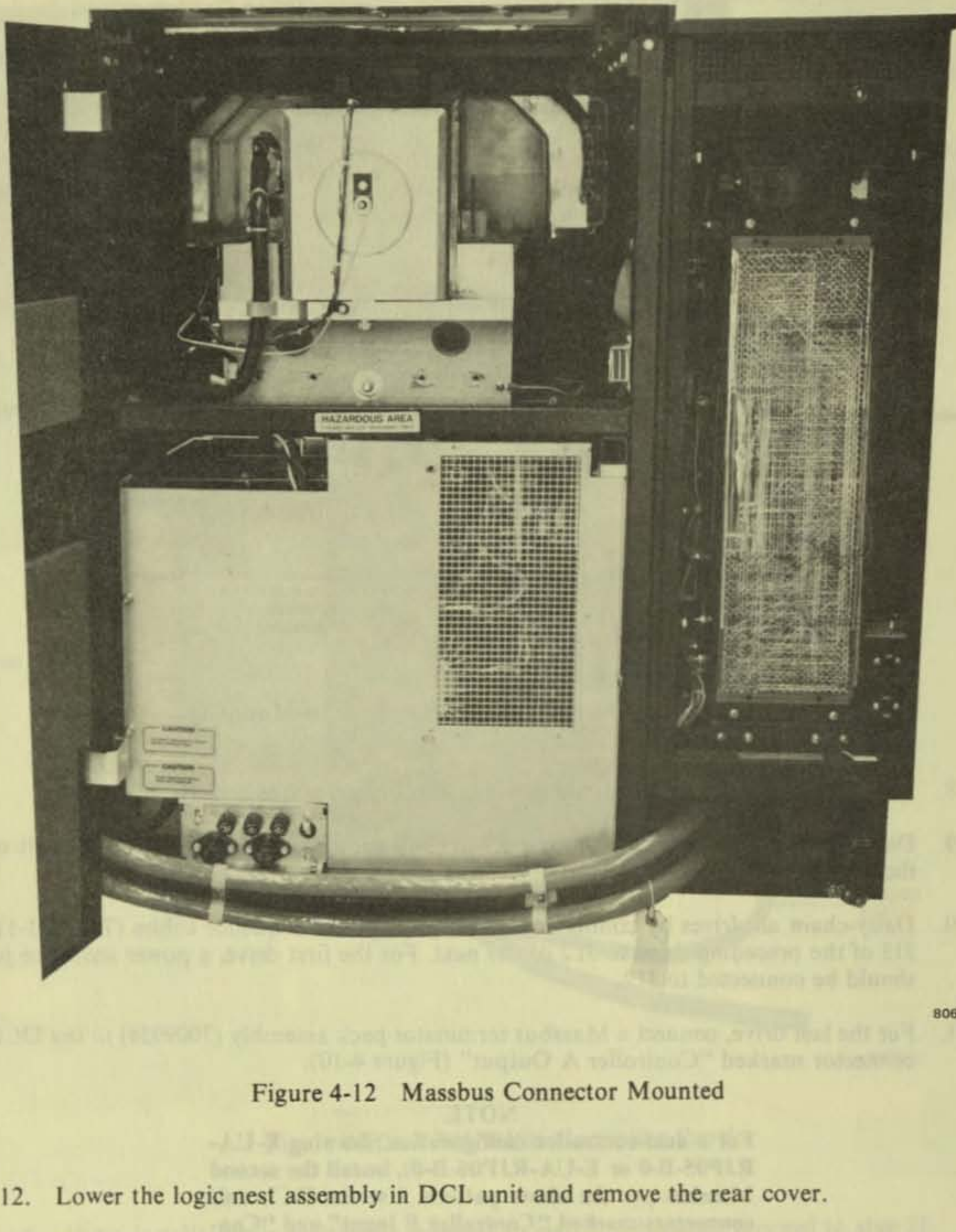
9. Daisy-chain all drives by connecting 0.9-m (3-ft) ground wires from one DCL unit stud to the next.

10. Daisy-chain all drives by connecting 0.9-m (3-ft) power sequence cables (7009491-1) from J13 of the preceding drive to J12 of the next. For the first drive, a power sequence jumper should be connected to J12.

11. For the last drive, connect a Massbus terminator pack assembly (7009938) to the DCL unit connector marked "Controller A Output" (Figure 4-10).

NOTE

For a dual-controller configuration (drawing E-UA-RJP05-B-0 or E-UA-RJP06-B-0), install the second Massbus per the above pattern. Use the DCL unit connectors 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 cabinet as the first, or in a different one. 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.



8068-1

Figure 4-12 Massbus Connector Mounted

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

13. Verify that the drive unit number switches on the M7787 module are all in the OFF position.

NOTE
Any switch left in the ON position will force the corresponding bit position in the unit number to zero.

14. Verify that the drive-type jumpers on the M7776 module are configured to reflect the proper type of drive, as follows:

Drive	W1	W2
RP05	IN	OUT
RP06	OUT	IN

If the serial number option is required, check board M7776 and configure jumpers according to the drive serial number.

4.3 INSTALLATION CHECKS AND ADJUSTMENTS

To verify performance and adjust the RP05/RP06, perform the various installation checks and adjustments described in the following paragraphs.

4.3.1 DCL Unit Power Supply Voltage Checks

The DCL unit power supply develops three dc output voltages (+5 Vdc, -15 Vdc, and +15 Vdc), and is constantly monitored by a power monitor unit. Turning ON the CB1 circuit breaker at the base of the drive and the circuit breaker at the rear of the DCL unit activates the DCL unit power supply. The heavy dotted line in Figure 4-13a indicates the chassis outline; the lighter dotted lines indicate the two regulator board modules, A1 and A2. A1 is accessible from the front of the DCL unit; A2 is accessible from the rear. Figure 4-13b and the following paragraphs describe the functions of the two regulator board modules.

4.3.1.1 Regulator Board Module A1 – Regulator board A1 issues the following.

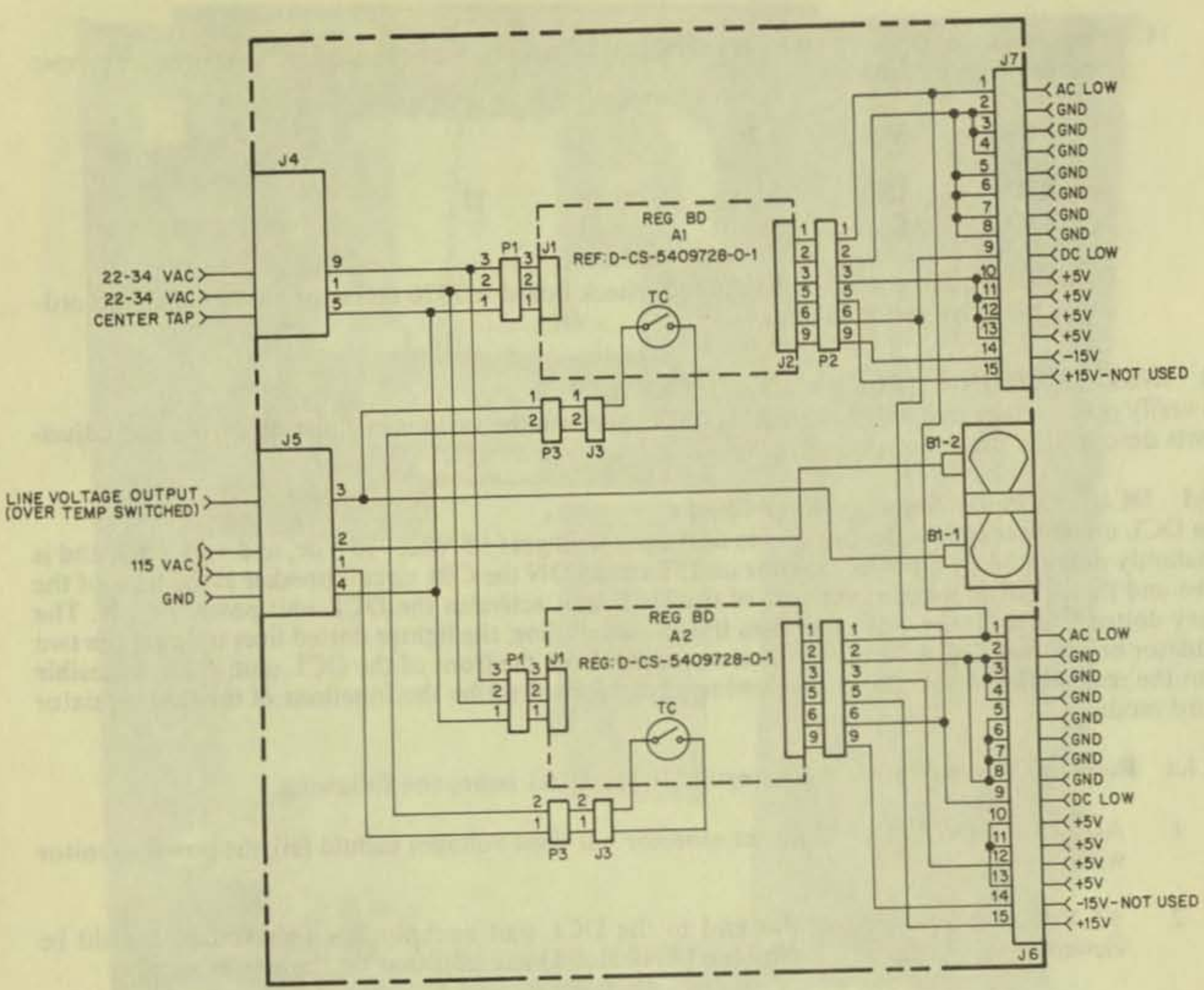
1. AC LO and DC LO to the power monitor – If these voltages should fail, the power monitor will set error flags.
2. +5 Vdc to the power monitor and to the DCL unit backplane – This voltage should be viewed on the DCL unit backplane (AA2 slot 1) and adjusted on the power supply.
3. -15 Vdc to the DCL unit backplane – This voltage should be viewed at the backplane (AB2 slot 1) and adjusted on the power supply.
4. +15 Vdc is not used and not monitored.

4.3.1.2 Regulator Board Module A2 – Regulator board A2 issues the following.

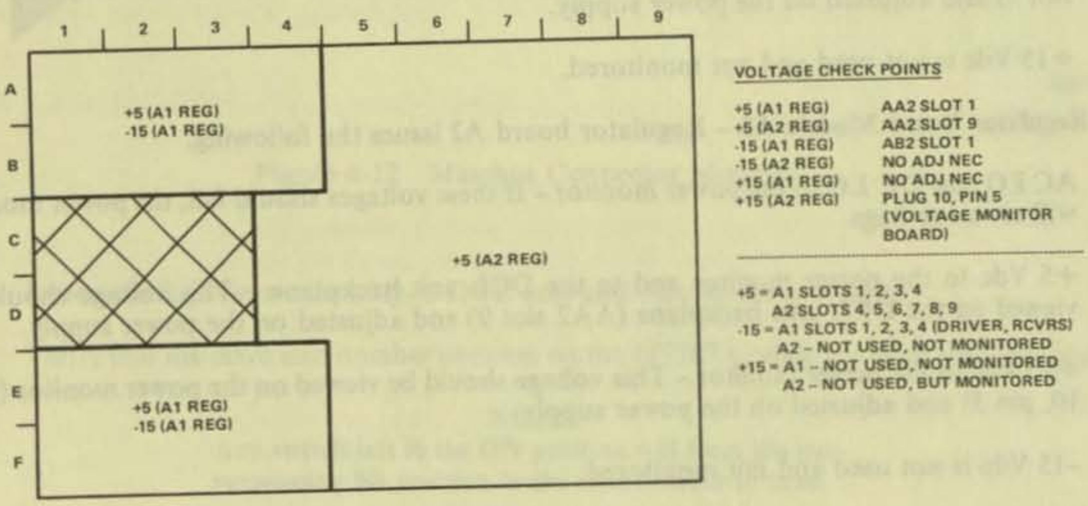
1. AC LO and DC LO to the power monitor – If these voltages should fail, the power monitor will set error flags.
2. +5 Vdc to the power monitor and to the DCL unit backplane – This voltage should be viewed on the DCL unit backplane (AA2 slot 9) and adjusted on the power supply.
3. +15 Vdc to the power monitor – This voltage should be viewed on the power monitor (plug 10, pin 5) and adjusted on the power supply.
4. -15 Vdc is not used and not monitored.

CAUTION

To avoid possible damage to the equipment or to the electrical system, do not adjust voltages beyond on the limits shown in Table 4-2.



a. DCL Unit Power Supply Schematic



b. DCL Unit Voltage Checks

CP-2797

Figure 4-13 Power Distribution (DCL Unit)

Table 4-2 DC Voltages

Minimum	Nominal	Maximum	
+4.9	+5	+5.2	
-5.3	-5.2*	-5.1	
+14.7	+15	+15.3	
-15.3	-15	-14.7	
+19.0	+24	+29.0	Not Adjustable
+45.0	+50	+55.0	Not Adjustable

*At TB500A terminal No. 3, not marked as -5.2.

4.3.2 Drive Power Supply Voltage Check

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

Perform ac and dc power checks for the drive(s) as described in the following paragraphs.

4.3.2.1 AC Power Checks – Perform ac power checks as follows.

1. Set CB100 on the RP05/RP06 power distribution unit (PDU) to ON. (See Figure 4-9a.)
2. Verify that three fans located under the logic gate and two fans in power supply are operating (Figure 4-9b).
3. Verify that door interlock latch is released by sliding open the glass door.
4. Repeat steps 1, 2, and 3, above, for each drive in the installation.

4.3.2.2 DC Power Checks – Perform dc power checks as follows.

1. Momentarily press LAMP TEST on the operator panel; verify that all indicators are illuminated.
2. Set CB300 on the power supply to ON. (See Figure 4-9b).
3. Using a digital voltmeter, measure voltages at the back panel and compare them to the specifications in Table 4-2. With the one exception noted in the table, the measurement locations are etched onto the back panel itself, using their nominal voltage values. If adjustment is necessary, adjust these voltages as near the nominal values as possible.
4. Repeat steps 1 through 3, above, for each drive in the installation.

4.3.3 Readiness Tests

Test the drive(s) for readiness as follows.

1. Inspect and clean (as required) all heads in the drive, as described in Paragraphs 4.5.1 and 4.5.2.

2. Mount a scratch pack on the drive. Remove the logical address plug from the operator panel.

NOTE
The logical address plugs on the RP05 and RP06 can be removed simply by pulling them out.

3. Press the START/STOP switch to START. START and DOOR LOCKED should light, and the spindle should start spinning. Allow the drive to come up to speed and purge for 5 minutes. With the logical address plug removed and without a first launch, hand load heads very carefully. Check for binding or unusual noise that might indicate head-to-disk interference (HDI). (For clues on HDI detection, refer to Paragraph 4.3.5.8.) If HDI is observed, retract the heads, turn the drive OFF, and investigate the problem.

4. Install the any-numbered logical address plug; this will allow the heads to launch to track 000. Remove and reinstall the logical address plug; the drive should do a re-zero.

5. Verify the capability of the drive to execute a seek operation by using the off-line tester and running routines 01 through 03.

6. Perform the head alignment procedure described in Paragraph 4.5.5, using the off-line tester. Before starting head alignment, be sure that the drive is in the Write Protect mode and allow 30 minutes for thermal stabilization of drive and CE pack.

Repeat steps 1 through 6, above, for each drive in the installation.

NOTE
At this stage in the installation procedure, the following activities should be performed.

1. Verify correct system cabling and signal termination in the DCL unit.

2. Use system diagnostics to verify the presence of an operational condition in each drive.

3. Use system diagnostics to perform the system head alignment verification procedure.

4.3.4 Drive Cycle Up/Down Checks

To check the starting and stopping of the spindle motor, ensure that a logical address plug is installed, a disk pack is installed, and the glass access door is closed, then proceed as follows.

1. Verify that all lamps light by pushing the Lamp Test switch. This also indicates that main power is applied to the drive. If UNSAFE lights, indicating an unsafe condition, proceed to Paragraph 4.3.5.1 to clear this condition. When it is cleared, proceed to step 2, below.

2. Press the START/STOP switch to the START position, triggering the following series of events: START illuminates, DOOR LOCKED illuminates, and the pack begins to rotate. If DOOR LOCKED does not illuminate, close the door fully.

3. Wait approximately 20 seconds until the word READY illuminates, indicating that the drive is started and ready to execute commands. START and DOOR LOCKED should remain illuminated.

4. Stop the drive spindle motor by pressing the START/STOP switch to STOP. This extinguishes the READY and START lights, and causes the drive to retract heads. The DOOR LOCKED light is extinguished approximately 20 seconds later, when the motor-down sequence has been completed.

NOTE

The system can stop the drive motor by issuing a command to place the drive in Standby mode. Whether stopped by the system or the operator, the resulting status of indicators is the same, except that a stop by the system causes STANDBY to illuminate.

4.3.5 Response to Abnormal Conditions

4.3.5.1 Clearing an Unsafe Condition – A sequence malfunction during a start operation causes UNSAFE to illuminate and initiates an abnormal stop sequence in the drive. At the end of that sequence, the spindle should come to a complete stop. Pressing the START/STOP switch to START clears the unsafe condition and restarts the drive; if UNSAFE does not disappear or if it reoccurs during the normal starting sequence, corrective maintenance is necessary.

CAUTION

Any malfunction of the stop sequence (e.g., failure of the spindle to stop at the end of the sequence) requires corrective maintenance; do NOT attempt other operations. If it is necessary to remove ac power from the drive, first unload the heads manually.

4.3.5.2 Removing a Pack With No Drive Power – To remove a pack from a drive with no ac power applied, proceed as follows.

1. Verify that the spindle is stopped and the heads are retracted.

2. Pull open the drive's front cover. Referring to Figure 4-2, locate the door lock override mechanism; it is an arm protruding from the door lock solenoid. Press the mechanism downward, and while holding down, push the door and start sliding it toward the rear. Release the mechanism and push the access door all the way back.

3. Lower the top cover straight down over the pack, carefully avoiding contact with the edges of the disks. Turn the handle on the top cover two full turns counterclockwise.

4. Using the handle, remove the pack from the drive.

5. Immediately attach the bottom cover to the pack, and store.

4.3.5.3 Detecting Head-to-Disk Interference – Head-to-disk interference (HDI) results from head contact with a disk surface, usually the result of a foreign particle in the air stream or a protrusion from the disk surface causing the head to break through the air bearing and abrade the disk surface. This problem, if not corrected, can be propagated from pack to pack and, ultimately, from drive to drive. HDI symptoms include:

1. Sudden hard read errors
2. Black contamination on flying surface of any head
3. UNSAFE illuminating during a write operation
4. Uncommon noise from the disk, such as audible tinkling, zinging, or scratching, which become gradually louder toward a screech.

If any of the above symptoms are detected, stop the drive immediately.

CAUTION

1. If the suspected pack is replaced with another pack and the drive is operated, or if the suspected pack is used in another drive, damage to either the second drive or the substituted pack may well occur.

2. All packs and drives in use when HDI symptoms are detected must be checked for HDI by service personnel.

4.4 TESTER HOOKUP, ROUTINES, AND RUN OPTIONS

4.4.1 Tester Hookup

Hook up the RP05/RP06 Disk Storage Subsystem Tester (Figure 4-14) as follows.

1. Connect the tester to 115 Vac, 50/60 Hz wall power, and run Wrap Test for tester checkout. If no error occurs, proceed to step 2.

2. Turn off ac power to the drive and DCL and place the START/STOP switch in the STOP position.

3. Disconnect the drive from DCL I/O cables A, B, C, and D.

4. Connect tester I/O cables A, B, C, and D to the drive. Cables should be installed so that the "rib" sides of cables A and C face each other and B and D face each other.

5. Connect the tester's head alignment cable to the drive in slot B04 (Figure 4-15).

6. Connect the drive to ac wall power and set all ac/dc circuit breakers to on. STANDBY, READY, DOOR CLOSED, CTRL A, B, and UNSAFE should *not* be lit.

7. Press RESET in tester; all tester LED (light-emitting diode) displays should illuminate. Release RESET; all LED displays should extinguish.

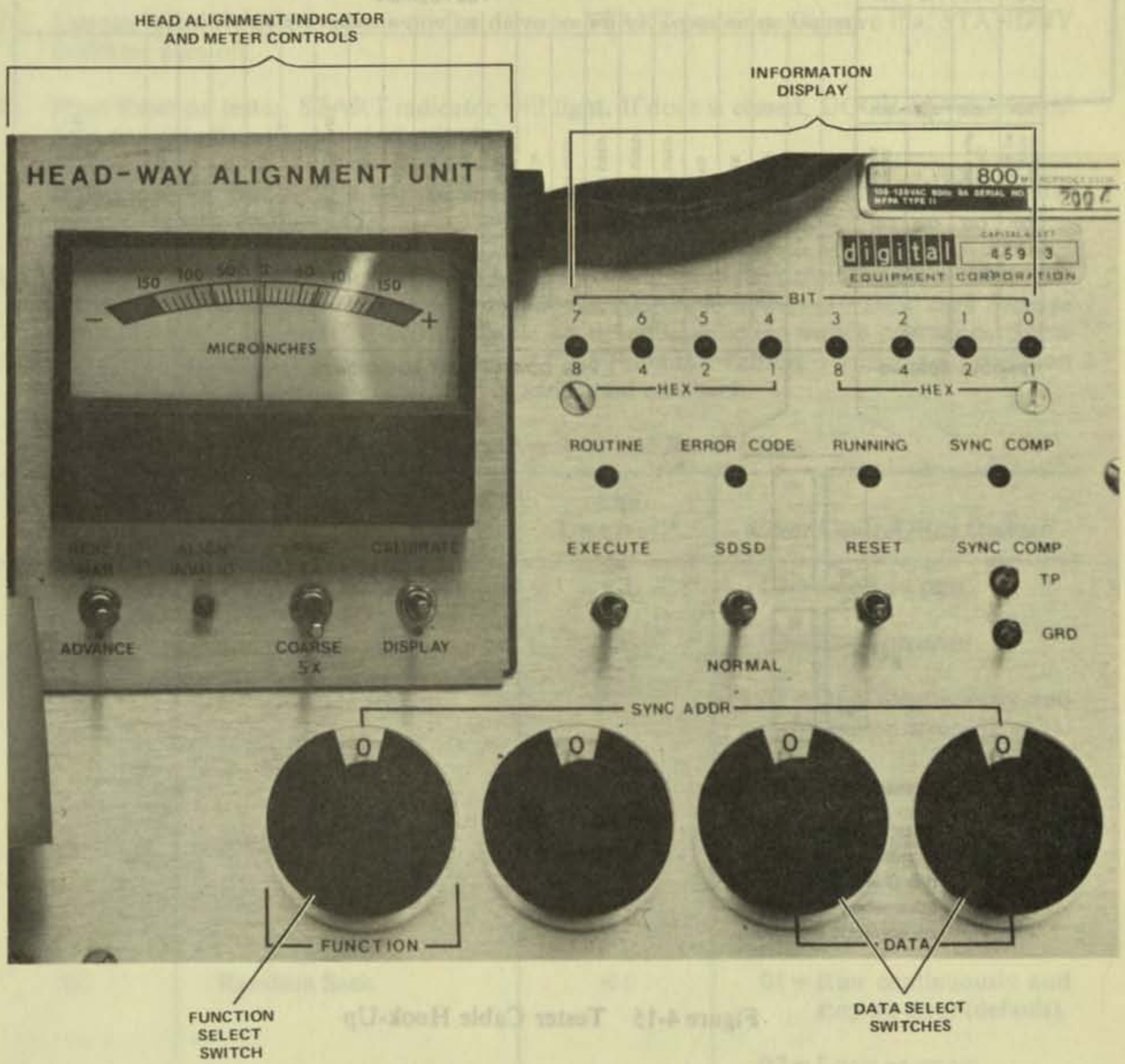


Figure 4-14 RP05/RP06 800 Disk Storage Subsystem Tester

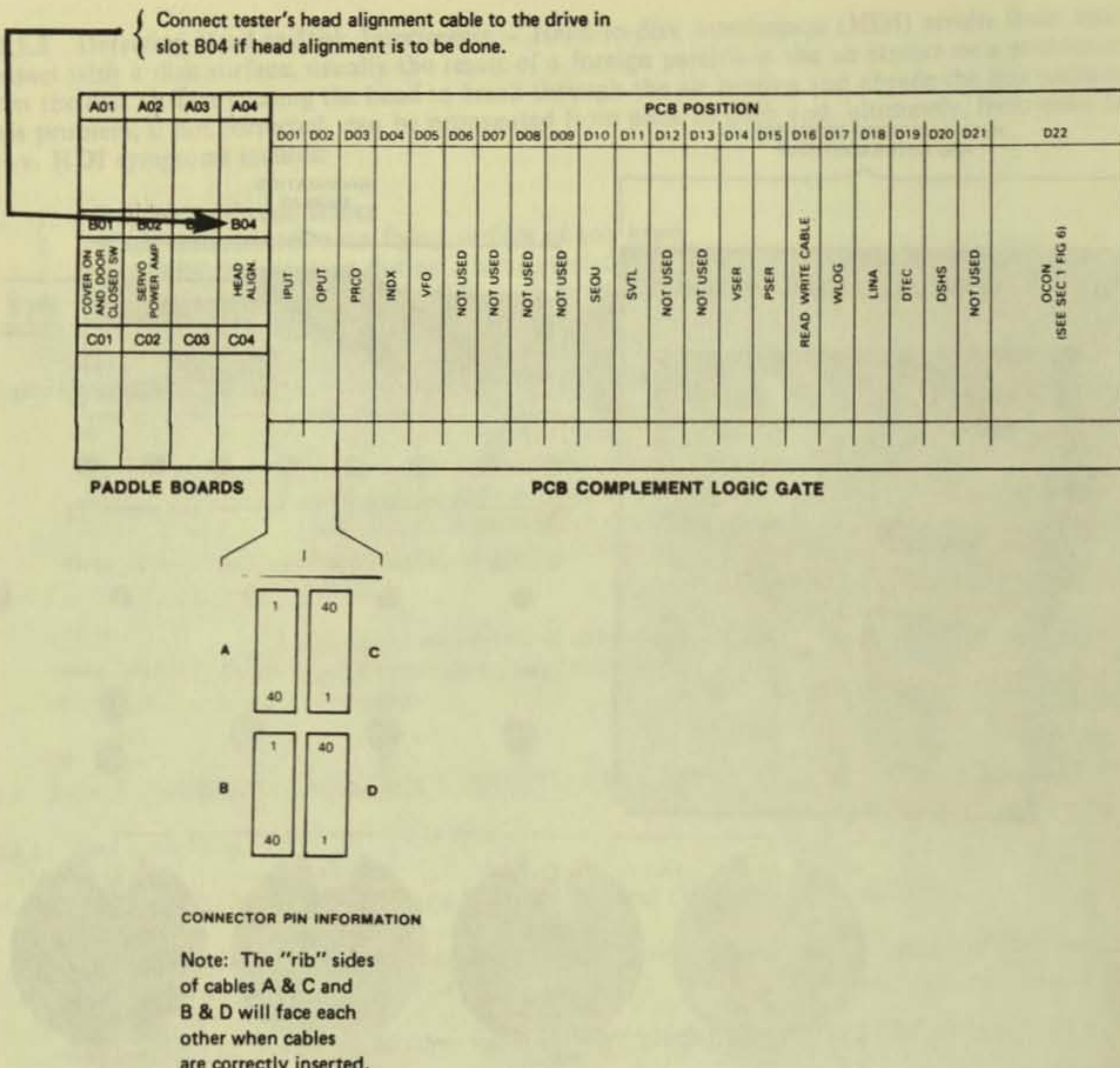


Figure 4-15 Tester Cable Hook-Up

8. Turn drive ac power OFF, then ON. Observe that the following indicators are lit.

Tester	Drive
Display = FF	CTRL A, B
Error Code	UNSAFE
	STANDBY

This step demonstrates the expected results when the drive is powered down and up with the tester connected.

9. Toggle Reset on tester and observe that all indicators go off except STANDBY.

10. Depress START/STOP switch on the drive to START position. Observe that STANDBY indicator goes off.

11. Press Reset on tester. START indicator will light. If door is closed, DOOR LOCKED will light and spindle will now start spinning.

12. Heads will not load until a test routine is executed. Pressing reset on the tester will cause heads to retract and unload.

13. Perform the routines listed in Table 4-3 to verify operation of the drive. Details of these tests are contained in Appendix B of the *Memorex RP05/RP06 677-01/51 DEC Disk Storage Drives Technical Manual* (ER-00012). Table 4-4 describes function switch operations. Some of the routines are expressed in hexadecimal form (base 16); Table 4-5 contains a conversion procedure between decimal, octal, and hexadecimal numbers.

Table 4-3 Tester Routine Numbers and Run Options

Routine	Test	Run Time (sec)*	Error Control/Run Options
00	Wrap	<1	01 = Loop on pass. 02 = Loop on error.
01	Incremental Seek	<1	01 = Run continuously and stop on error (default). 02 = Loop on error
02	Alternate Seek	<1	01 = Alternate seek stop on error. 02 = Loop on error.
03	Random Seek	<1	01 = Run continuously and stop on error (default). 02 = Loop on error.
04	Tachometer Gain Adjustment	<1	00 = Verify tachometer gain (no link). 01 = Adjustment mode 02 = Loop on error. 80 = Verify tachometer gain and link (default).

*Time required for one loop through the routine.

Table 4-3 Tester Routine Numbers and Run Options (Cont)

Routine	Test	Run Time (sec)*	Error Control/Run Options
05	Head Alignment	<1	01 = Run continuously and stop on error (default). 02 = Loop on error.
06	Head Alignment Verification	≈10	00 = Verify mode (default). 02 = Loop on error.
07	Head Alignment Track Seek	<1	00 = Run once and stop (default). 02 = Loop on error.
08	Write Read Verification	<2	00 = Write all heads of cylinder and stop (default). 02 = Loop on error.
09	Incremental Offset Read	<2	00 = Read once and stop (default). 01 = Read continuously and stop on error. 02 = Loop on error.
0A	Read Continuously (Errors Monitored)	≈20 min	01 = Read 65,535 times and stop (default). 02 = Loop on error.
0B	Read Write Safety	<1	00 = Check latches once (no link). 02 = Loop on error. 80 = Check latches once and link (default).

*Time required for one loop through the routine.

Table 4-3 Tester Routine Numbers and Run Options (Cont)

Routine	Test	Run Time (sec)*	Error Control/Run Options
0D	Offset	<1	00 = Run once and stop (no link). 01 = Run continuously and stop on error. 02 = Loop on error. 80 = Run once and link (default).
10	Index	<1	00 = Run once (no link). 01 = Run continuously and stop on error. 02 = Loop on error. 80 = Run once and link (default).
11	Display Drive Output Byte	<1	00 = Display one drive output byte. Byte number 00 (default).
12	Recalibrate	<1	00 = Run once (default). 02 = Loop on error.
13	Write	<1	00 = Write all heads of cylinder and stop. 01 = Write continuously and stop on error. 02 = Loop on error.

NOTE

Error code dictionaries and flowcharts for tester routines are contained in Appendix B. An error code of "FF" indicates successful completion of the test.

*Time required for one loop through the routine.

Link Options: Routines 0D, 10, 04, 0B, and 08 can be linked together to provide automatic consecutive execution of these routines. To run, load Routine 0D into function 1. Switch to function 0 and execute. An error code of "FF" indicates successful completion. Executing function F will display the last routine run if successful completion did not occur.

Table 4-4 Function Switch Operations

Function Position	Function Operation	Data Switch Entry	Comments
0	Execute routine	N/A	Executes the routine defined by function 1.
1	Enter routine to be run	XX	XX = the number of the routine to be run.
2	Enter parameter data	XX	Enters parameter data XX in the byte defined by function 3. Automatically increments to the next byte number at execution of this function.
3	Enter parameter byte	XX	XX = Parameter byte number to be operated on.
4	Display parameter byte	N/A	Displays parameter data of byte defined by function 3. Automatically increments the next byte number after execution of this function.
5	Error control/run options	XX	XX = Option code for routine to be run.
6	Advance head	N/A	May be selected only where head alignment feature is installed in the tester and the head alignment routine is running.
F	Display routine number	N/A	Displays the number of the routine just executed.

Table 4-5 Hexadecimal-Octal Conversion

Decimal	Binary	Octal	Hexadecimal
0	0000	0	0
1	0001	1	1
2	0010	2	2
3	0011	3	3
4	0100	4	4
5	0101	5	5
6	0110	6	6
7	0111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F

4.5 HEAD CLEANING

4.5.1 Head Inspection Procedure

Remove the disk pack and inspect the heads for evidence of brown streaks or residue on the white-colored sliders. Use of the dental inspection mirror permits an unobstructed view of each head surface. If a head faces upward, a better view of the head surface may be obtained by pushing the cam surface of the head arm down slightly with one finger. The downward-facing head directly above can also be inspected at this time via a dental mirror, which will also provide an unobstructed view of the upper head slider.

CAUTION

Do not touch the face of read/write heads with fingers or dental mirror. Oil from the skin can cause deposits of foreign materials to build up. Do not leave any residue or lint on the head. Do not blow on the head, as moisture from breath causes contamination.

4.5.2 Possible Head Conditions

Head inspection should categorize the head slider in one of the three conditions described in the following paragraphs.

4.5.2.1 Clean Head – If the head slider is clean and white, with no visible indications of lint or foreign material, no cleaning is required.

4.5.2.2 Dirty Head – If there is brown residue on the trailing edges of the slider, the head is dirty and needs cleaning.

4.5.2.3 Head/Disk Interference – If there are light brown or dark brown streaks across the face of the slider, head/disk interference (HDI), or *head crash* is indicated. In this case the head(s) should be removed and replaced.

CAUTION

If evidence of HDI is detected, all packs that have run on the affected drive should be isolated. These packs will require surface cleaning and inspection, or possibly a refurbishing by the vendor, before they can be run again on ANY drive. Failure to observe these precautions could result in further head crashes and damage to additional packs. Do NOT attempt to clean pack surfaces yourself!

4.5.3 Head Cleaning (Figure 4-16)

The need for cleaning heads should be determined by inspection and drive usage. Cleaning a clean head serves no useful purpose and exposes the head to possible contamination; therefore, frequency of cleaning must be based on the observed condition of the heads.

1. Clean and polish the heads, using a clean Kimwipe wrapped tightly and smoothly around the plastic paddle. Hold the paddle firmly against the head surface, keeping the paddle flat against the head at all times, and clean with a side-to-side motion.

   NOTE

   A clean Kimwipe should be used for each head. The top of the wrapped paddle may be used for the upper head and the bottom for the lower head. However, the wipe should then be replaced with a clean one before beginning on the next head.

2. One to three drops of alcohol may be used; however, this *must* be followed by a polishing or buffing with a clean, dry Kimwipe-wrapped paddle. Use of a greater amount is permissible if the heads are extremely dirty, but must be followed by a cleaning with one to three drops of alcohol and then a dry buffing.

3. Reinspect the heads after cleaning to ensure that the residue has been completely removed, and no lint or paper fragments were left.

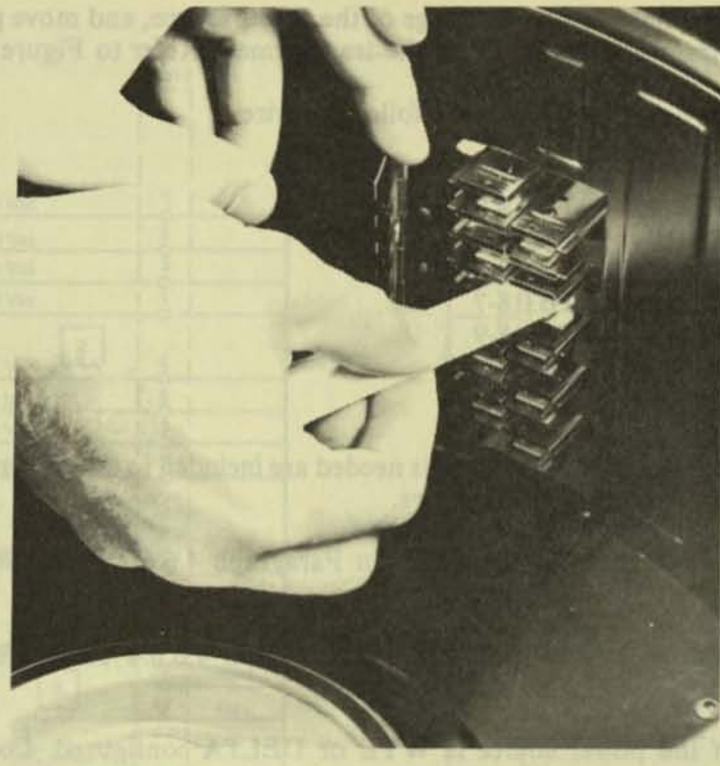


Figure 4-16 Cleaning Heads in Drive

4.6 POWER

4.6.1 Power Conversion

NOTE
Following any frequency conversion, be sure to check power supply voltages both at the transformer primary and secondary windings and at regulator outputs.

4.6.1.1 50-Hz to 60-Hz Conversion – Materials needed are included in the 60-Hz Drive Motor Assembly Kit. The conversion procedure is as follows.

1. Replace the drive motor as described in Paragraph 4.6.6.2 of the *RP05/RP06 Technical Manual*.

2. Replace the drive belt as described in Paragraph 4.6.6.4 of the *RP05/RP06 Technical Manual*.

3. Verify that the Power Conversion Plug Assembly (Figure 4-6) has the phase-to-phase connector installed.

4. Determine the phase-to-phase voltage of the power source, and move power supply leads to appropriate terminals of TB319 on the transformer. (Refer to Figure 4-17.)

5. Refer to Figure 4-17 and move the following wires:

   From TB317-1 to TB318-1
   From TB317-3 to TB318-3
   From TB317-4 to TB318-4
   From TB317-6 to TB318-6
   From TB317-7 to TB318-7
   From TB317-9 to TB318-9
   From TB317-10 to TB318-10
   From TB317-12 to TB318-12.

4.6.1.2 60-Hz to 50-Hz Conversion – Materials needed are included in the 50-Hz Drive Motor Assembly Kit. The conversion procedure is as follows.

1. Replace the drive motor as described in Paragraph 4.6.6.2 of the *RP05/RP06 Technical Manual.*

2. Replace the drive belt as described in Paragraph 4.6.6.4 of the *RP05/RP06 Technical Manual.*

3. Determine if the power source is WYE or DELTA configured. Locate the Power Conversion Plug. If the source is DELTA, install the phase-to-phase plug. If the source is WYE, install the phase-to-neutral plug.

4. Determine the phase-to-phase voltage of power source if DELTA configured, or the phase-to-neutral voltage if WYE configured, and move power supply leads to appropriate terminals of TB319 on the transformer. (Refer to Figure 4-17.)

5. Refer to Figure 4-17 and move the following wires:

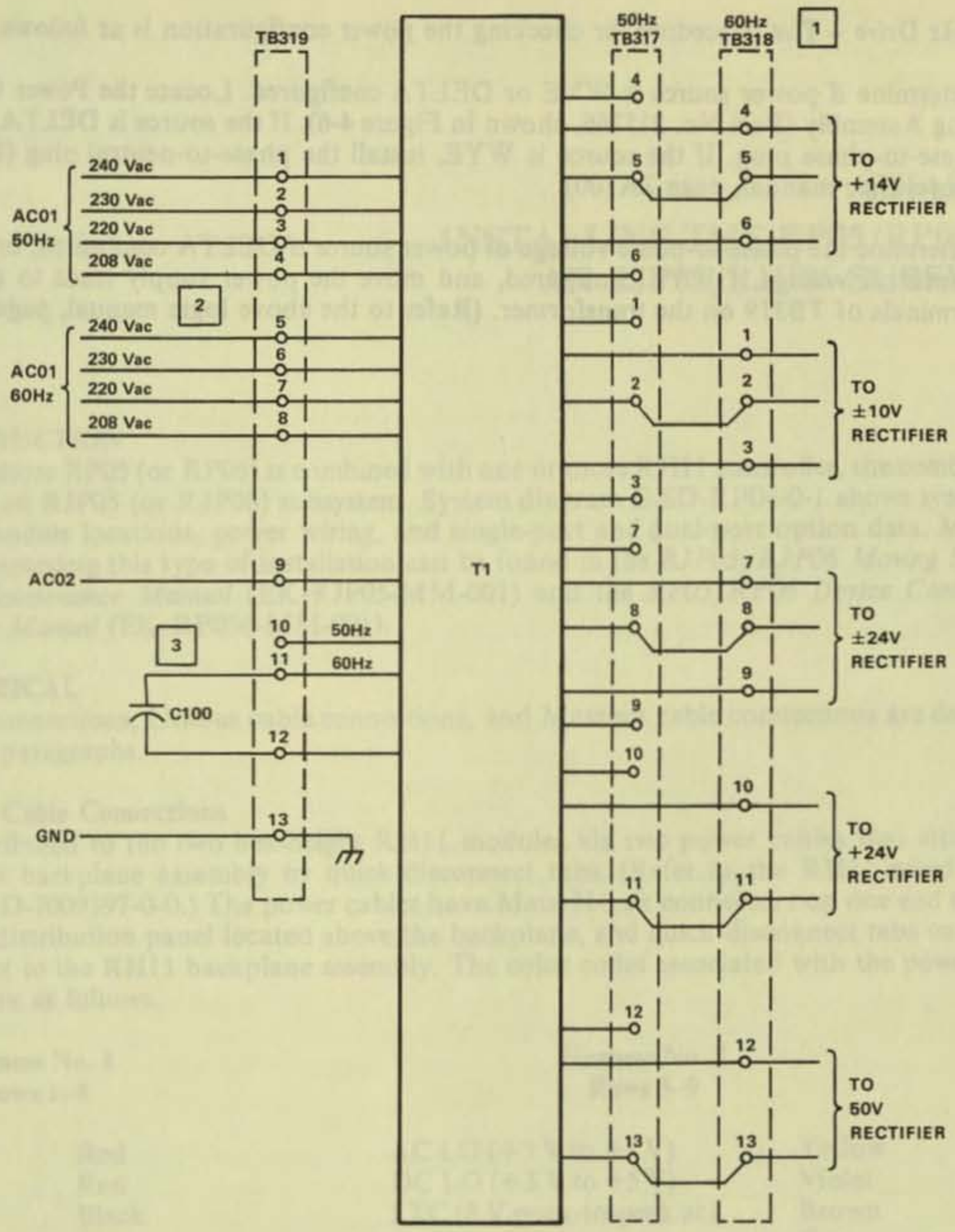
   From TB318-1 to TB317-1
   From TB318-3 to TB317-3
   From TB318-4 to TB317-4
   From TB318-6 to TB317-6
   From TB318-7 to TB317-7
   From TB318-9 to TB317-9
   From TB318-10 to TB317-10
   From TB318-12 to TB317-12.

4.6.2 Power Configuration Check

4.6.2.1 60-Hz Drive – The procedure for checking the power configuration is as follows.

1. Verify that the Power Conversion Plug Assembly (Part No. 215766, shown in Figure 4-6) has the phase-to-phase connector installed (P110 in the Memorex *RP05/RP06 677-01 Logic Manual,* EK-RP05M-TM-V01, page ZA100).

2. Determine the phase-to-phase voltage of the power source, and move power supply leads to appropriate terminals of TB319 on the transformer. (Refer to the above logic manual, page ZD100.)



NOTES: Unless otherwise specified:

1. Wiring shown for 60Hz. For 50Hz wire connections to corresponding points on TB317.

2. Connect lead to voltage tap closest to local supply voltage and at proper frequency.

3. Connect lead to appropriate tap (50Hz or 60Hz).

Refer to RP05/06 Logic Manual for more detail [EK-RP05M-TM-V02].

CP-2959

Figure 4-17 Transformer Primary and Secondary Connections

4.6.2.2 50-Hz Drive – The procedure for checking the power configuration is as follows.

1. Determine if power source is WYE or DELTA configured. Locate the Power Conversion Plug Assembly (Part No. 215766, shown in Figure 4-6). If the source is DELTA, install the phase-to-phase plug. If the source is WYE, install the phase-to-neutral plug (P110 in the above logic manual, page ZA100).

2. Determine the phase-to-phase voltage of power source if DELTA configured, or the phase-to-neutral voltage if WYE configured, and move the power supply leads to appropriate terminals of TB319 on the transformer. (Refer to the above logic manual, page ZD100).

CHAPTER 5
INSTALLING THE RP05/RP06 INTO AN RJP05/RJP06 SUBSYSTEM

5.1 INTRODUCTION
When one or more RP05 (or RP06) is combined with one or more RH11 controller, the combination is designated as an RJP05 (or RJP06) 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 *RJP05/RJP06 Moving Head Disk Subsystem Maintenance Manual* (EK-RJP05-MM-001) and the *RP05/RP06 Device Control Logic Manintenance Manual* (EK-RP056-MM-001).

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

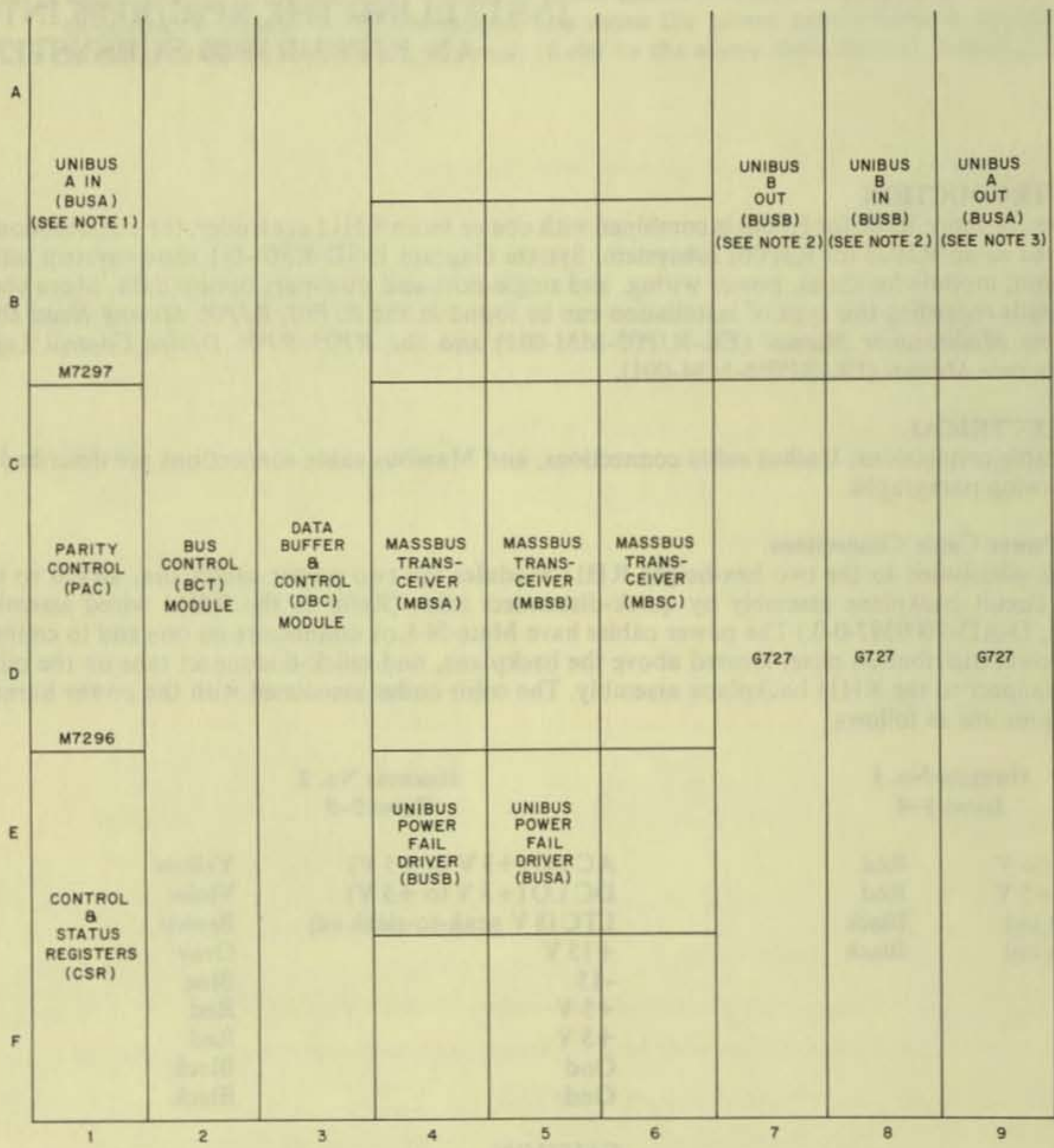
5.2.1 Power Cable Connections
Power is distributed to the two hex-height RH11 modules via two power cables that attach to the printed circuit backplane assembly by quick-disconnect tabs. (Refer to the RH11 wired assembly drawing, D-AD-7009397-0-0.) The power cables have Mate-N-Lok connectors on one end 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 No. 1 Rows 1–4		Harness No. 2 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	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 backplane. 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.



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 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 the module utilization drawing, D-MU-RH11-0-01.) Connections 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.

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.

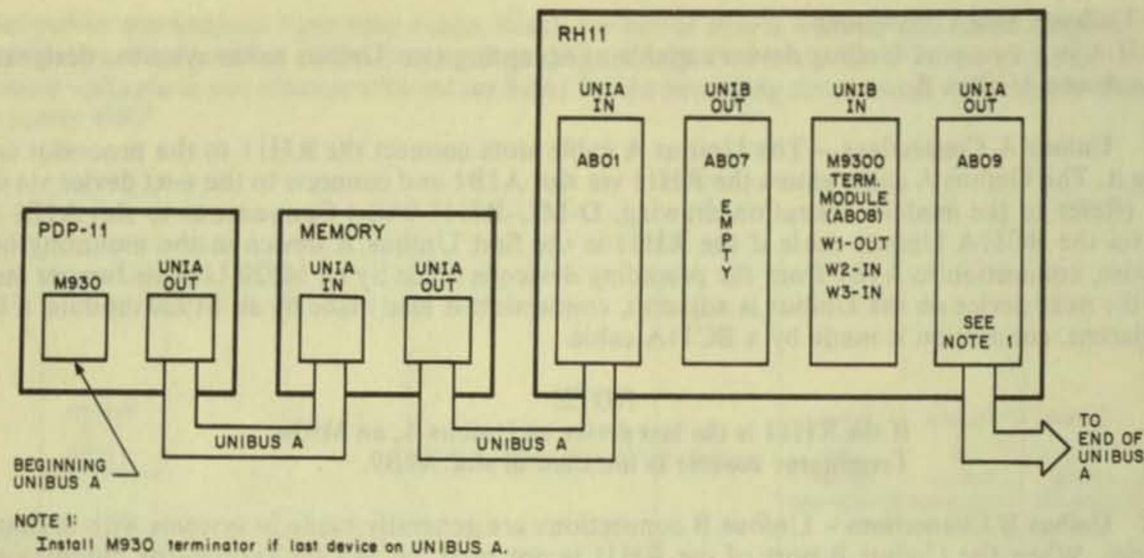


Figure 5-2 Single-Port Unibus Configuration

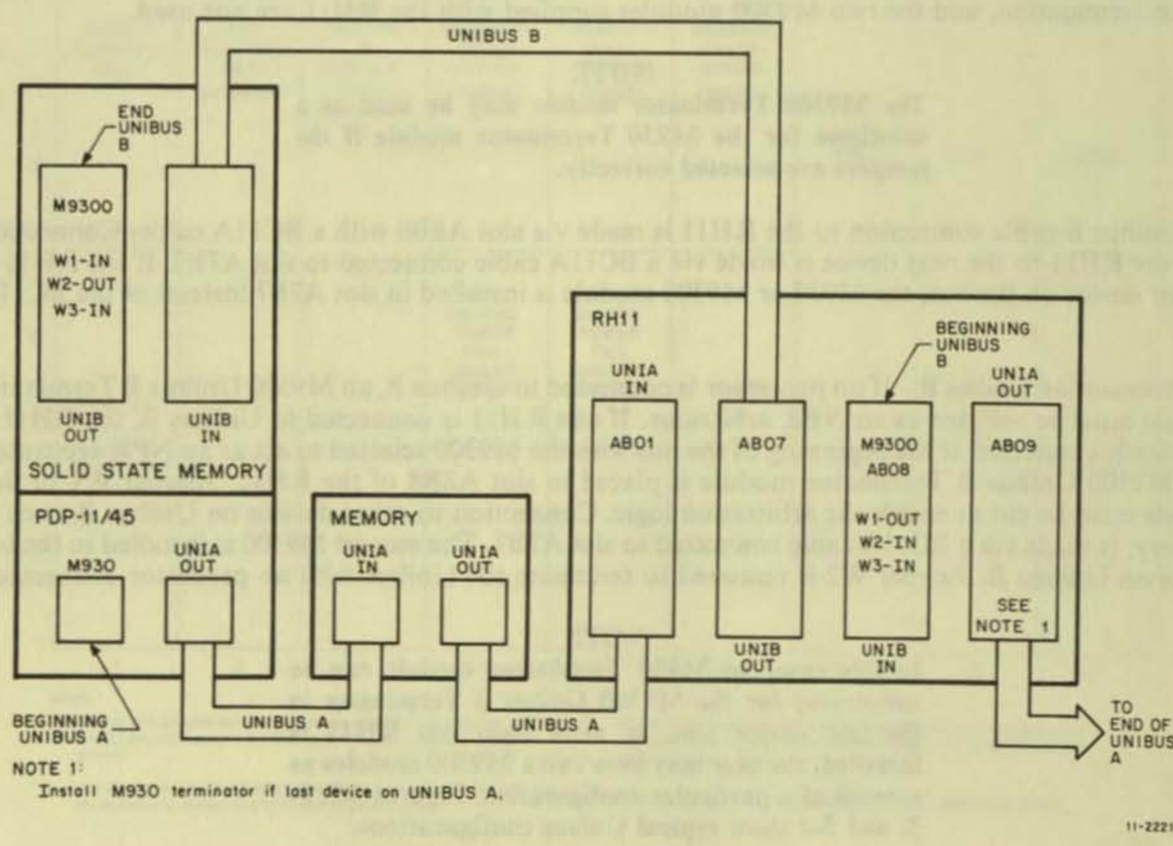


Figure 5-3 Dual-Port Configuration – Memory on Unibus B

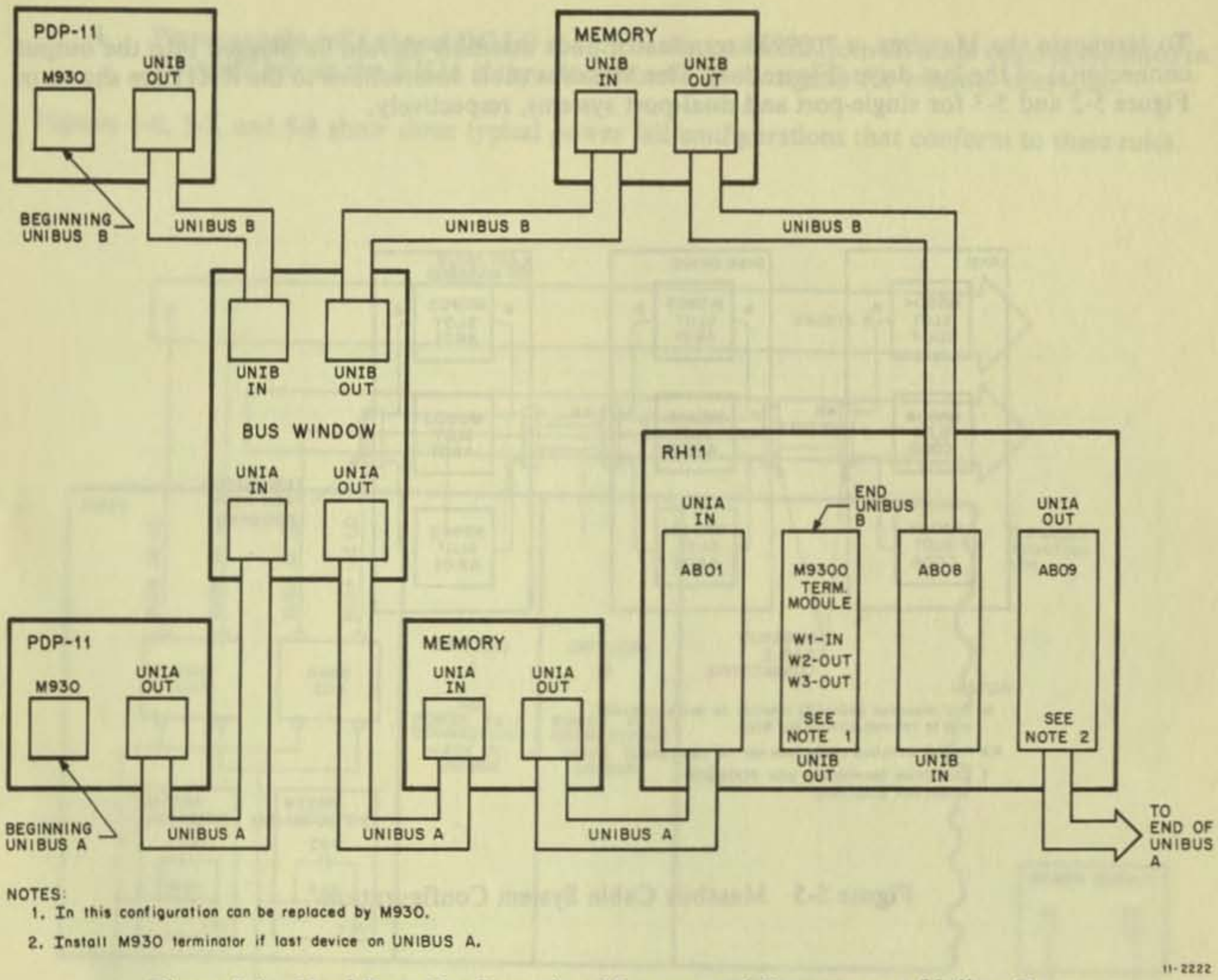


Figure 5-4 Dual-Port Configuration Memory and Processor on Unibus B

5.2.3 Massbus Cable Connections

Massbus connections to the RH11 are made via three 2.45-m (8-ft), 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.

1. *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.

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

3. *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.

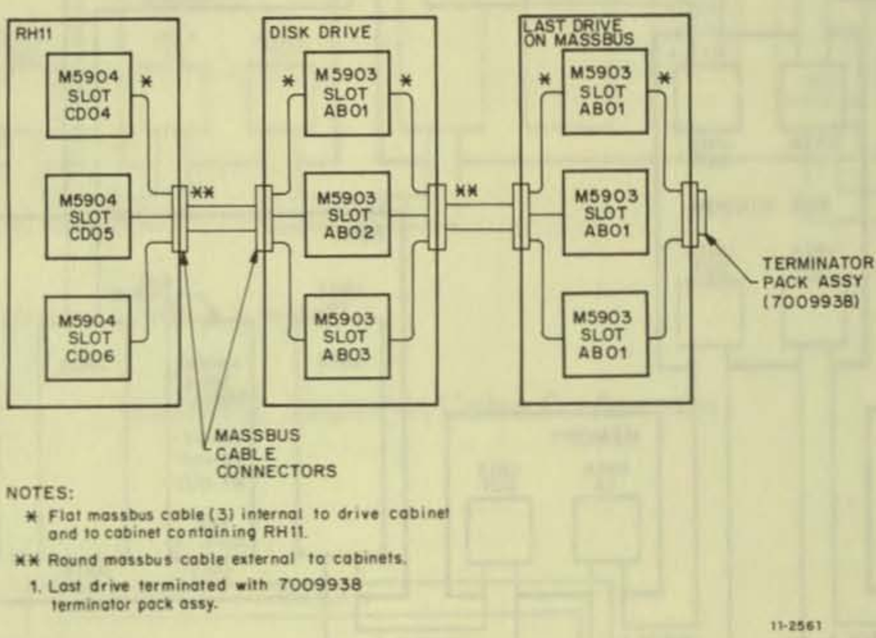


Figure 5-5 Massbus Cable System Configuration

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 Drive 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.

The following is a summary of power fail configuration rules.

1. For each mounting box, there is only one AC LO and DC LO power fail connection to a Unibus from the power supply.

2. Power supply AC LO and DC LO must always be wired to each RH11 via the power harness.

3. Power fail signals may only be disconnected from a Unibus in an RH11 by removing the appropriate M688 Power Fail Driver module.

4. Power supply AC LO and DC LO should be disconnected from all other options mounted in the same box as the RH11 if they do not need those signals for internal operation.

Figures 5-6, 5-7, and 5-8 show three typical power fail configurations that conform to these rules.

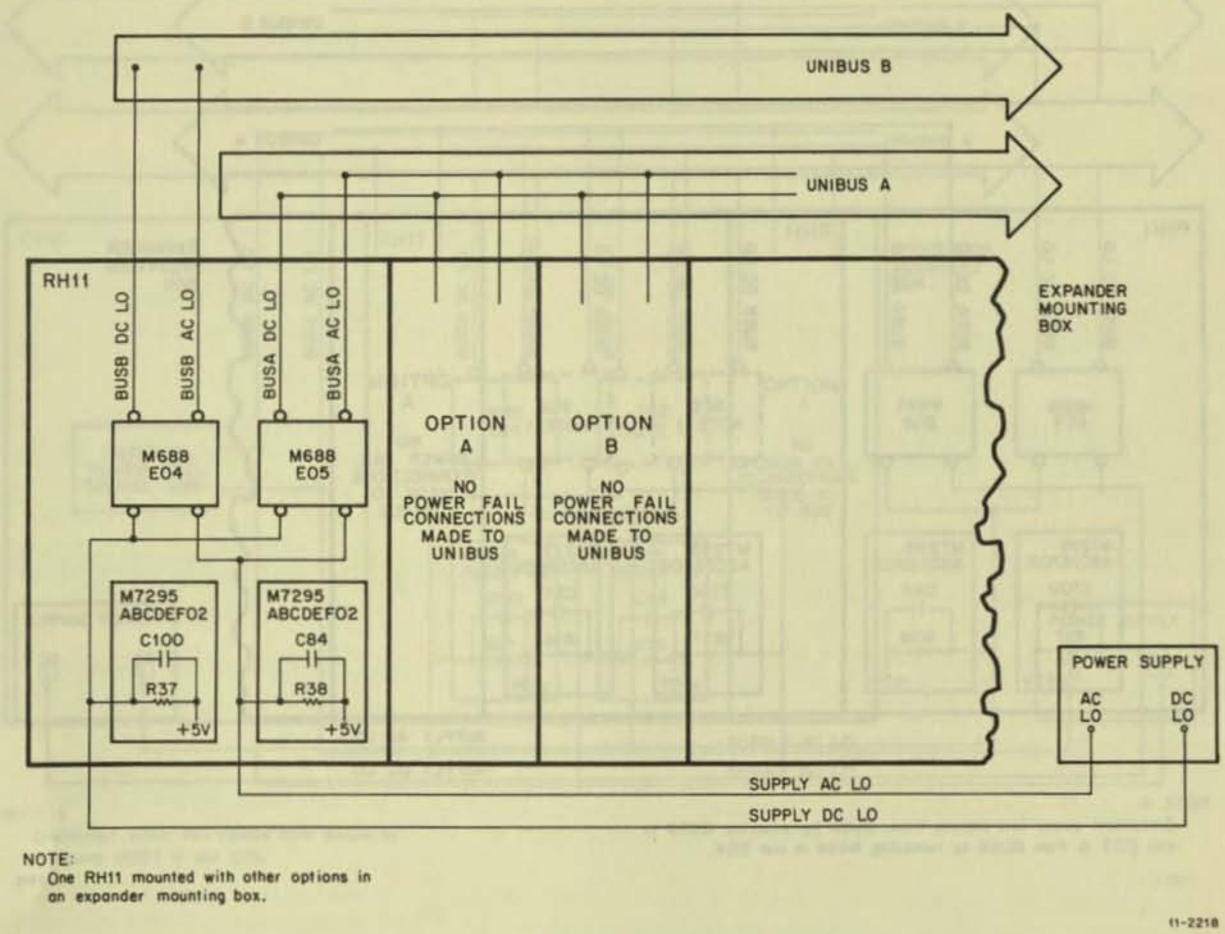


Figure 5-6 Typical Power Fail Configuration for RH11 and Options Mounted in Same Expander Box

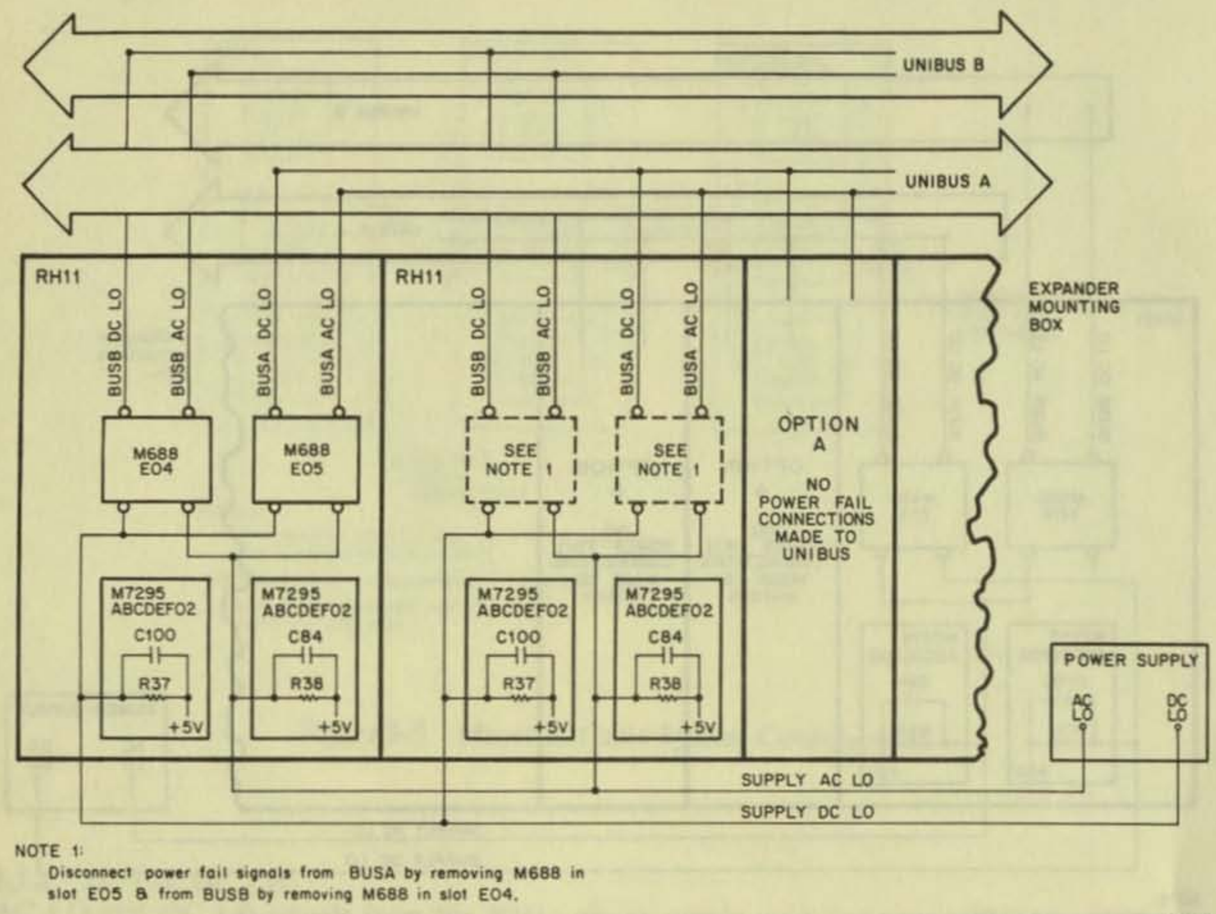


Figure 5-7 Typical Power Fail Configuration for Two RH11s Mounted in Same Expander Box

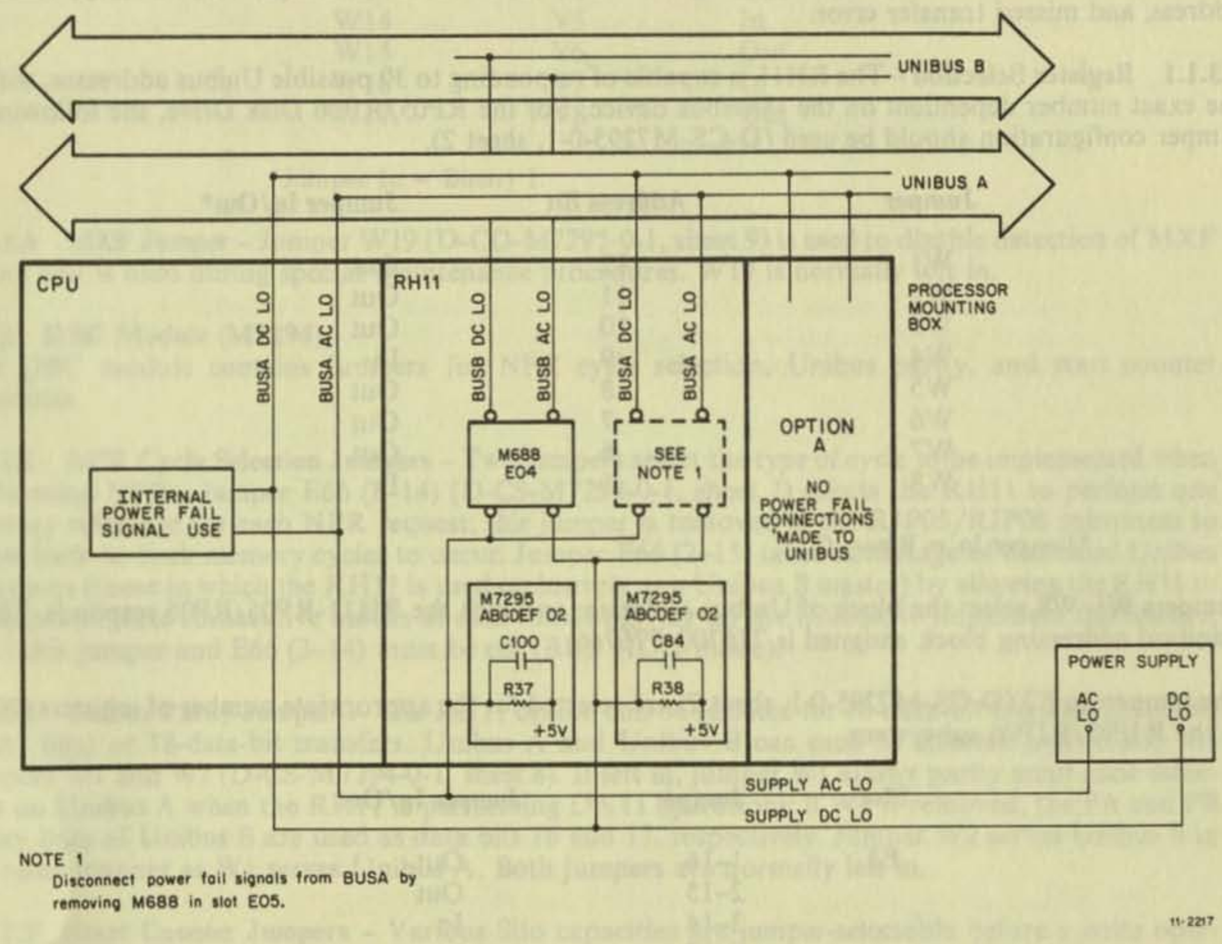


Figure 5-8 Typical Power Fail Configuration for RH11 and CPU Mounted in Processor Box

5.3 JUMPER CONFIGURATIONS

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

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 RP05/RP06 Disk Drive, the following jumper configuration should be used (D-CS-M7295-0-1, 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-RP05/RP06 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 RJP05/RJP06 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-CS-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 RJP05/06 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 RJP05/RJP06 subsystem to allow back-to-back memory cycles to occur. Jumper E66 (2–15) takes advantage of dedicated Unibus B systems (those in which the RH11 is used exclusively as a Unibus B master) by allowing the RH11 to transfer complete consecutive blocks of data without giving up the Unibus; to implement this feature, both this jumper and E66 (3–14) must be cut (BUS HOG mode).

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. The jumper selections are listed below (D-CS-M7294-0-1, sheet 9).

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

NOTE

Only the jumper representing the desired Silo capacity should be connected. The other jumpers should be removed. For RJP05/RJP06 subsystems, the 64-word jumper (E66, pins 1–16) should be connected.

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 RJP05/RJP06-BA or -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 for RH11 backplane assembly in the appropriate mounting box using four 8/32-inch × 1-inch Allen-head screws.
4. Connect the two power harnesses to the RH11 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 a connector panel (7412379) with four 4/40-inch × 5-inch screws (9008042-8).
12. Verify that two pressure-sensitive labels are applied to the connector panel for each input/output connector block assembly (E-UA-RJP05-A-0 or E-UA-RJP06-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

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 RJP05/06-AA or -AB subystem, as well as the first controller used in an RJP05/06-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 RJP05/06-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 RJP05/06-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 RJP05/06-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.

CBA

Label 2

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

13. Mount the connector panel at the bottom rear of the cabinet containing the RH11, using four 10/32-inch Tinnerman nuts (Part No. 9006586) and four 10/32-inch × 0.38-inch Truss-head screws (Part No. 9006071-3). (Refer to D-UA-RJP05-A-0 or D-UA-RJP06-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
RJP05/RJP06 FIELD ACCEPTANCE PROCEDURES AND DIAGNOSTICS

6.1 INTRODUCTION
Field acceptance testing is intended to demonstrate performance of the RP05/RP06 Disk Drive and/or the RJP05/RJP06 subsystem to the customer prior to his acceptance.

6.2 ERROR DEFINITIONS/RATES
The RP05/RP06 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 (HCRC, HCE, ECH, and DCK, which may include DTE and FER) 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 sequency with ECC enabled constitutes an irrecoverable, or hard, error. (A complete recovery sequence consists of 28 retries, 16 at the nominal head position, and 2 each at selected offsets; 10 μm, 20.3 μm, and 30.4 μm (400, 800, and 1200 microinches) for the RP05, and 5 μm, 10 μm, and 15.2 μm (200, 400, and 600 microinches) for the RP06. Errors that are not ECC-correctable include bursts greater than 11 bits in length and isolated dropped bits (separated by more than 11 bits) within a sector. The allowable error rate for hard errors is one error per 10^{12} bits read.

Table 6-1 RP05/RP06 Error Conditions

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 during an operation that reads the header 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 2	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 RP05/RP06 seek error and not a 677-51 or 677-01 drive seek failure.

6.2.2 Soft Errors
Any failure to read data correctly on the first try that is then read successfully during a recovery sequence constitutes a recoverable, or soft, error. (Refer to Paragraph 6.2.1 for definition of a complete recovery sequence.) The allowable error rate for soft errors is one error per 10^9 bits read.

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 more than 11 bits long, it will appear as a hard error. On a given pack, pack-attributable errors will always appear at the same cylinder, sector, and track addresses, with an ECC POS REG value within 11 bits. The definitions of hard and soft errors in Paragraphs 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 one error per 10^6 seek operations.

6.3 RJP05/RJP06 FIELD ACCEPTANCE TEST
The RJP05/RP06 Field Acceptance Test is designed to demonstate the performance of the RP05/RP06 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 3.5 hours per RP04 or RP05, and 4.7 hours per RP06. The diagnostics are defined in Paragraph 6.4).

RP04/05/06 Diskless Controller Test, Part 1 (Static 1A) - MAINDEC-11-DZRJG

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

RP04/05/06 Diskless Controller Test, Part 2 (Static 1B) - MAINDEC-11-DZRJH

Run Procedure	Run two passes, using default parameters.
Error Allowed	None
Error Recover Procedure	Correct problem and restart acceptance on failing drive.
Approximate Run Time	10 minutes/drive

RP04/05/06 Functional Controller Test, Part 1 (Static 2A) - MAINDEC-11-DZRJI

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

RP04/05/06 Functional Controller Test, Part 2 (Static 2B) - MAINDEC-11-DZRJJ

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

Format Program - MAINDEC-11-DZRJB

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	8 minutes/RP05; 16 minutes/RP06.

RP04/05/06 Mechanical and Read/Write Test - MAINDEC-11-DZRJA

Run Procedure	One pass of all tests, using default parameters. Ten passes of tests 0 through 6.
Errors Allowed	Pack-attributable errors only. (Use same pack as Format Program.)
Error Recovery Procedure	Correct problem and restart acceptance on failing drive.
Approximate Run Time	1 hour, 15 minutes/RP05; 2 hours, 30 minutes/RP06

RP04/05/06 Multidrive Exerciser - MAINDEC-11-DZRJD

Run Procedure	Runs 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 same pack as Format Program.)
Error Recovery Procedure	Drop failing drive from test. Continue test on remaining drives. Correct problem and restart acceptance on failing drive.
Approximate Run Time	1 hour, 30 minutes/drive

DEC/X11

Run Procedure	Run configured for system with default parameters for one hour.
Errors Allowed	Two system soft errors that are not pack-attributable. (Use same pack as Format Program.) 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.

Table 6-2 Format (MAINDEC-11-DZRJB) 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)

To avoid compatibility problems:

1. Use the same CE pack for all drives that will have packs.
2. Format all scratch packs on the same drive.
3. Isolate compatibility problems using Table 6-2.

6.3.2 Operational Checks, Dual 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 4.5 hours per RP05 and 5.5 hours per RP06. The diagnostics are defined in Paragraph 6.4.

RP04/05/06 Diskless Controller Test, Part 1 (Static 1A) – MAINDEC-11-DZRJG

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	5 minutes/drive/port

RP04/05/06 Diskless Controller Test, Part 2 (Static 1B) – MAINDEC-11-DZRJH

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/port

RP04/RP05/RP06 Functional Controller Test, Part 1 (Static 2A) – MAINDEC-11-DZRJI

Run Procedure	Run two passes, using default parameters (both ports).
Error Allowed	Only pack-attributable errors
Error Recovery Procedure	Correct problem and restart acceptance on failing drive.
Approximate Run Time	5 minutes/drive/port

RP04/05/06 Functional Controller Test, Part 2 (Static 2B) – MAINDEC-11-DZRJJ

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	5 minutes/drive/port

Dual Controller Logic Test, Part 1 – MAINDEC-11-DZRJE

Run Procedure	Install dual controller option test cable (Part No. 7010507-02). Run two passes, using default parameters.
Errors Allowed	Pack-attributable errors only
Error Recovery Procedures	Correct problem and restart acceptance on failing drive.
Approximate Run Time	5 minutes/drive

Dual Controller Logic Test, Part 2 MAINDEC-11-DZRJF

Run Procedure	Install dual controller option test cable (Part No. 7010507-02). 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

Format Program – MAINDEC-11-DZRJB

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 R/W Test – MAINDEC-11-DZRJA

Run Procedure	One pass of all tests, using default parameters (one port only). Ten passes of tests 0 through 6 (one port only).
Errors Allowed	Pack-attributable errors only. (Use same pack as Format Program.)
Error Recovery Procedure	Correct problem and restart acceptance on failing drive.
Approximate Run Time	1 hour, 15 minutes/drive/port/RP05; 2 hours, 30 minutes/drive/port/RP06.

RP04/05/06 Multidrive Exerciser – MAINDEC-11-DZRJD

Run Procedure	Runs 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 that is not pack-attributable. (Use same pack as Format Program.)
Error Recovery Procedure	Drop failing drive from test. Continue test on remaining drives. Correct problem and restart acceptance on failing drive.
Approximate Run Time	2 hours/drive

DEC/X11

Run Procedure	Run configured for system with default paramters for one (both ports).
Errors Allowed	Two system soft errors that are not pack-attributable. (Use same pack as Format Program.) 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.

6.4 DIAGNOSTIC MAINTENANCE

The diagnostic programs described herein are employed with the RJP05/06 subsystems. The following diagnostics are briefly described. Refer to the applicable diagnostic operating procedures for detailed information.

Test Programs

MAINDEC-11-DZRJG MAINDEC-11-DZRJH	RP04/05/06 Diskless Controller Test (Parts 1 and 2)
MAINDEC-11-DZRJI MAINDEC-11-DZRJJ	RP04/05/06 Functional Controller Test (Parts 1 and 2)
MAINDEC-11-DZRJE MAINDEC-11-DZRJF	RP04/05/06 Dual-Controller Logic Test (Parts 1 and 2)
MAINDEC-11-DZRJA	RP04/05/06 Mechanical and Read/Write Test

System Exerciser Program

MAINDEC-11-DZRJD	RP04/05/06 Multidrive Exerciser

Utility Programs

MAINDEC-11-DZEJB	RP04/05/06 Formatter Program
MAINDEC-11-DZRJC	RP04/05/06 Head Alignment Verification Program

6.4.1 MAINDEC-11-DZRJG and MAINDEC-11-DZRJH – RP04/05/06 Diskless Controller Test

This program tests the RH11 and the DCL portion of the drive. The DCL is the device control logic used to make the RP05/06 Massbus compatible and must be plugged into the MDLI, or appropriately terminated. The program does not use the disk surface or any signals from the MDLI. The MDLI is the mass device level interface which connects the DCL to the drive assembly.

If the disk is powered up, it must be in the Heads Unloaded position. After a successful run (with no errors) of this diagnostic, it can be ascertained that the DCL logic that processes the data is working properly. The logic that handles the mechanical commands is not tested in this diagnostic. All data commands use the Maintenance register in the Wraparound mode.

6.4.2 MAINDEC-11-DZRJI and MAINDEC-11-DZRJJ – RP04/05/06 Functional Controller Test

The diagnostic tests the DCL portion of the drive. It exercises the disk surface and the mechanical of the drive to prove proper operation of the subsystem. To run the diagnostic, a disk pack with no vital information written on it is essential. The disk pack need not be formatted.

After a successful run of this diagnostic (with no errors), it can be concluded that the RP05/06 subsystem is functional. Extended drive testing, timing and subsystem interaction is left to other diagnostics. The RP04/05/06 Diskless Controller Test (MAINDEC-11-DZRJG and MAINDEC-11-DZRJH) must have been run successfully before the Functional Controller Test diagnostics can be run.

6.4.3 MAINDEC-11-DZRJE and MAINDEC-11-DZRJF–RP04/05/06 Dual-Controller Logic Test (Parts 1 and 2)

This program checks the dual-controller logic in the DCL portion of the RP05/06 and requires a special adapter cable.

6.4.4 MAINDEC-11-DZRJA – RP04/05/06 Mechanical and Read/Write Test

This program contains 19 tests numbered 0 through 22_8.* Tests 0 through 6 use a Read Header and Data command to read the cylinder, track, and sector information from the header; the tests then check the information for validity, ensuring that the seek operation functions properly. Tests 7 through 12 measure the rotational speed, the one-cyclinder 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. Test 17 performs all possible seek combinations and verifies that the cylinder difference calculation is correct for all possible combinations of cylinders. Test 20 verifies that the drive's positioner is not drifting off cylinder after the on cylinder indication has been set. Test 21 performs a series of random seeks with the position verified immediately after the seek has completed.

The program starts by identifying itself and determining that all drives are available for testing. All drives are then tested beginning with the lowest numerical drive and proceding in sequential order. One pass (tests 0 through 15, 20, and 21) is performed on each drive before moving to the next drive in sequence. The drive to be tested will be typed at the beginning of each pass. At the completion of each pass, an end-of-pass message will be typed. After testing all drives, an end-of-test message will be typed.

6.4.5 MAINDEC-11-DZRJD – RP04/05/06 Multidrive Exerciser

The Multidrive Exerciser Program exercises one to eight disk drives attached to the same RH11. If two or more disk drives are being exercised, operations on the drives are overlapped. (Other drives are performing seek/search operations while one drive is performing a data transfer or write-check operation.) Operations among the drives are optimized so that a high subsystem data transfer rate or a high positioning operation rate is maintained.

The performance of each drive is monitored by the program. If a drive exceeds a reset number of errors in any of several categories, that drive is automatically deassigned. (The operator may override the automatic deassignment feature.) The program reports performance statistics for each drive being exercised on request from the operator or automatically at an interval determined by the operator.

All data transfer commands are used (i.e., Write Data, Write Header and Data, Read Data, and Read Header and Data) 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.

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*Test 22_8 is an RJP04 Subsystem Test and is not applicable to the RJP05/06 subsystems.

Program/operator communications are through the Teletype®; program options are selected by Switch register settings and errors are normally reported on the Teletype. However, if a line printer is available, the program will use the printer for error message display.

All commands, data patterns, and data buffer sizes are selected randomly by the program. The addresses (e.g., cylinder, track, and sector) for each operation are also selected randomly.

At the completion of each operation, the program checks the RH11. The program requires data packs created by the Formatter Program (MAINDEC-11-DZRJB), by the Read/Write and Mechanical Test (MAINDEC-11-DZRJA), or by the Data Pack Generation command of the Exerciser Program.

6.4.6 MAINDEC-11-DZRJB – RP04/05/06 Formatter Program

The Formatter Program is designed to write and verify header and data information on all possible disk pack addresses with the intention of testing the retention of the recording surfaces. The format is maintained on a basis of 411 cylinders (for an RP05; 815 cylinders for an RP06), 19 tracks per cylinder, and 22 sectors per track.

This 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 portion of the pack to be formatted is determined by the first and last cylinder and track addresses, inclusively. A single track is the smallest element that may be formatted.

Write-check errors are reported when they are detected. If an error is detected, the sector must be rewritten and verified correctly two successive times to be considered usable. Sectors that cannot be written correctly twice after an error will be declared unacceptable by the program.

After the last track has been formatted and verified, an additional check is performed. The header of track 0 and sector 0 of each cylinder is read and compared by the software. This check is performed to isolate a possible positioner error that may have occurred during the format operation. Two such cases of positioner malfunction are: failure of the positioner to advance to the next cylinder, and advancement of the positioner past the cylinder desired.

6.4.7 MAINDEC-11-DZRJC – RP04/05/06 Head Alignment Verification Program

This program checks head alignment of the RP05/06 disk drives. For the RP05 drive, the program checks alignment of heads 0 through 18 at cylinder 245 and heads 0 and 18 at cylinders 4 and 400. For the RP06 drive, the program checks alignment of heads 0 through 18 at cylinder 496 and heads 0, 1, 10, 17, and 18 at cylinders 8 and 800. Alignment is then reverified at the basic alignment cylinder (245 for the RP05; 496 for the RP06). The operator will be notified if any head is out of alignment by more than the specified value.

The program requires that the head alignment test box (Perch) be connected to the drive under test and that the alignment disk pack to be mounted. The program provides options which allow the operator to use the head alignment test box to perform head alignment and to exercise the positioner to verify that the heads were tightened properly after alignment.

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CHAPTER 7
INSTALLING THE RP05/RP06 INTO AN RHP05/RHP06 SUBSYSTEM

7.1 INTRODUCTION

When one or more RP05 is combined with one or more RH10 controller, the combination is designated as an RHP05 subsystem. When one or more RP06 is combined with one or more RH10 controller, the combination is designated as an RHP06 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 RP05/RP06. The drives have 16 Masssbus registers; Figure 7-1 shows the formats for all RP05/RP06 Massbus registers in an RHP05/RHP06 subsystem. Refer to drawing D-FD-RH10-0-INST for DATAO and CONO/CONI formats.

RP05/RP06 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 RHP05/RHP06 subsystem cable types and connections.

7.2 ELECTRICAL

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

Register	20 15	21 14	22 13	23 12	24 11	25 10	26 9	27 8	28 7	29 6	30 5	31 4	32 3	33 2	34 1	35 0	RH10 BIT POSITION CONTROL BUS POSITION
CTRL 0					DVA						← FUNCTION →						RG2 RG6
STATUS 1	RTA	ERR	PIP	MOL	WRL	LST	DGM	DPR	DPY	VV	0	0	0	0	0	0	RG6
ER-1 2	DCK	UNS	OPI	DTE	WLE	IAE	AOE	HC RC	HCE	ECH	WCF	FER	PAR	RMR	ILR	ILF	RG0 RG2
MAINT 3						H1 CNT	SYN DET	0 DET	DTA ENV	ECC ENV	WET DAT	RD DAT	DTA CLK	M IND	SEC CLK	MAIN	EC RG3
ATA 4								A 8	A 7	A 6	A 5	A 4	A 3	A 2	A 1	A 0	DP
DA 5	0	0	0	← TRACK → 16	8	4	2	1	0	0	0	← SECTOR → 16	8	4	2	1	SS3 SS6
TYPE 6	0	0	1	0	X	0	0	0	0	0	0	1	0	0	0	1	05 EC8
								0	0	0	0	1	0	0	1	0	06 EC8
LA 7	0	0	0	0	0	← SECT → 16	8	4	2	1	← EXT → 5	4	3	2	1	0	DP6
S/N 10	1000	1000	1000	1000	100	100	100	BCD 100	10	10	10	10	1	1	1	1	EC8
OFFSET 11	SGN	0	0	FMT	ECI	HCI	0	0	OF 7	OF 6	OF 5	OF 4	OF 3	OF 2	OF 1	OF 0	RG1
DCY 12	0	0	0	0	0	0	← DESIRED CYL →										SS1 SS6
CCY 13	0	0	0	0	0	0	← CURRENT CYL →										SS1
ECC POS 16	0	0	0	← POSITION → 4096	2048	1024	512	256	128	64	32	16	8	4	2	1	EC2 EC4
ECC PAT 17	0	0	0	0	0	← PATTERN → 10	9	8	7	6	5	4	3	2	1	0	EC1
ER2 14			PLU		IXE	NHS	MHS	WRU	ABS	TUF	TDF	RAW	CSV	WSU	CSF	WCU	EC6 EC8
ER3 15	OCYL	SKI	OPE							ACL	DCL	35 VF			WAO	DCU	EC7

CP-2791

Figure 7-1 RP05/RP06 Register Format (RH10)

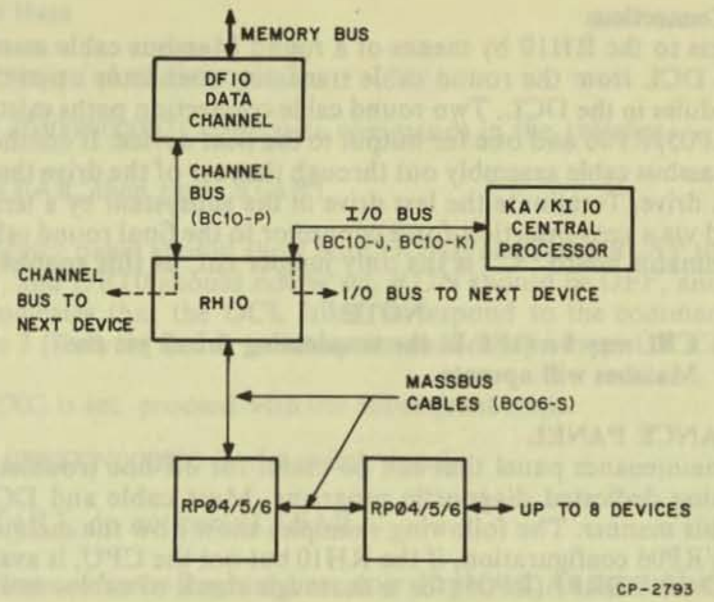


Figure 7-2 RH10/DF10/RP04/RP05/RP06 Interconnection Diagram

7.2.1 Power Cable Connections

Power is distributed within an RHP05/06 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 drive power plug into the unswitched 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.

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 drive is physically mounted. Refer to the acceptance procedures in Chapter 8.

7.2.2 Massbus Cable Connections

The RP05/RP06 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 RP05/RP06 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 right 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. Be sure that W2 of terminator board "C" is the only jumper cut, as this enables Massfail.

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 inital installation before running dedicated diagnostic programs. Most cable and DCL problems can be found and repaired in this manner. The following examples show how the maintenance panel can be used to check the RP05/RP06 configuration, if the RH10 but not the CPU, is available. Run MD-10-DDRPK (RP06) or MD-10-DDRPJ (RP05) for a thorough check of cables and drive system, if the CPU is available.

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 CONTROLLER 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 reexecuted 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 RP05/RP06 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 (RP05/RP06).

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

6. Ensure that all round Massbus cables are properly terminated and firmly seated, and that the bus is terminated. Inspect the DCL to verify that all flat cables are firmly seated.

7. Check the cabinet fans for proper operation.

CHAPTER 8
RHP05/RHP06 FIELD ACCEPTANCE PROCEDURES AND DIAGNOSTICS

8.1 INTRODUCTION
Field acceptance testing is intended to demonstrate performance of the RP05/RP06 Disk Drive and/or the RHP05/RHP06 subsystem to the customer prior to his acceptance.

8.2 ERROR DEFINITIONS/RATES
The RP05/RP06 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 register 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 8.2.3). Six bits of RHER 1 (OPS, DTE, 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.

If all ECOs are installed, MAINDEC-10-DDRPJ and MAINDEC-10-DDRPK should run with no errors detected. Error definitions for MAINDEC-10-DDRPI are listed in the following paragraphs.

8.2.1 Soft Errors
Any error recoverable by the retry sequence (including retry, offset, and ECC) constitutes a soft error.

8.2.2 Hard Errors
Any error not recoverable the retry sequence constitutes a hard error. No hard errors are permitted.

8.2.3 Seek Errors
Seek errors include SKI, OCYL, or HCE (header compare errors) where the printout shows that the drive is on the wrong cylinder. HCE logic faults and miscompares of sector and track are not seek errors. The allowable error rate for seek errors is 1 error per 10^6 seeks.

8.2.4 Pack-Attributable Errors
Pack-attributable errors include any errors (DCK, ECH, OPI, DTE, etc.) that occur on the same cylinder and head (track) more than once, even through they may not occur every time. A record of the pack location of every error should be kept so that pack errors can be identified, as they may occur on a certain area as rarely as one time in ten. The pack specification allows a total of 20 pack errors maximum, no more that 5 of which may be hard pack errors.

8.2.5 Read Errors
Errors such as DCK, DCK/ECH, DTE, HCRC, or HCE where one or more bits are picked or dropped in the header field on the correct cylinder constitute read errors. The allowable error rate for read errors in 1 per 10^9 bits read, not counting pack errors.

8.3 RHP05/RHP06 ACCEPTANCE TESTING

The RHP05/RHP06 Field Acceptance Test is designed to demonstrate the performance of the RP05/RP06 Disk Drive when used with an RH10 controller.

1. Run MAINDEC-10-DDRHA for one pass (controller diagnostic).

2. Run one pass of:

   MAINDEC-10-DDRPJ for RP05 on each port
   MAINDEC-10-DDRPK for RP06 on each port.

3. Run one pass of MAINDEC-10-DDRPI, selecting "ACCEPT." (All drives may be selected at once.)

4. For dual-port systems, also run the special dual-port tests in MAINDEC-11-DDRPJ and -DDRPK according to the instructions in the diagnostic. A special test cable (7010507-02) is required.

8.4 DIAGNOSTIC DESCRIPTIONS

For complete descriptions of specific diagnostics, refer to the diagnostics themselves.

MAINDEC-10-DDRHA 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-DDRPJ (RP05); MAINDEC-10-DDRPK (RP06)

This program is a gate-by-gate check of the DCL, and attempts to exercise all of the disk logic functionally. It provides module callout capability upon error. When run, this diagnostic verifies the Massbus cables, drive, and DCL subsystems.

It starts with simple control bus transfers, moves on to seek exercising, and finally checks the data path. A loop-on-error capability is provided. A separate switch-selectable feature allows testing of dual-port systems. The head-alignment program is also included.

MAINDEC-10-DDRPI Reliability Diagnostic

This is a reliability diagnostic for an RHP05/RHP06 system consisting of any number of controllers with up to eight drives of either type, mixed. Basic and complex seek patterns and data transfers are executed. This program can be used to format or read packs, check the mechanical timing, establish the read error reliability, etc. It may also be run under time-sharing.

CHAPTER 9
INSTALLING THE RP05/RP06 INTO AN RTP05/RTP06 SUBSYSTEM

9.1 INTRODUCTION

When one or more RP05/RP06 Disk Drive is combined with an RH20 controller, the combination is designated as an RTP05/RTP06 subsystem. Refer to the *RH20 Unit Description* (EK-RH20-UD-001) for details on the controller and a description of the Massbus. Refer to drawing D-FD-RH20-0-INST for DATAO and CONO/CONI formats in the RH20.

RP05/RP06 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

Figure 9-1 is an interconnection diagram for the RTP05/RTP06 subsystem.

9.2 ELECTRICAL

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

9.2.1 Power Cable Connections

9.2.1.1 RH20 – Power in the RH20 comes from H744 power supplies mounted in the KL10 I/O bay. Drawing D-UA-KL10-0-0 describes in detail the dc wiring from the power supplies to the RH20.

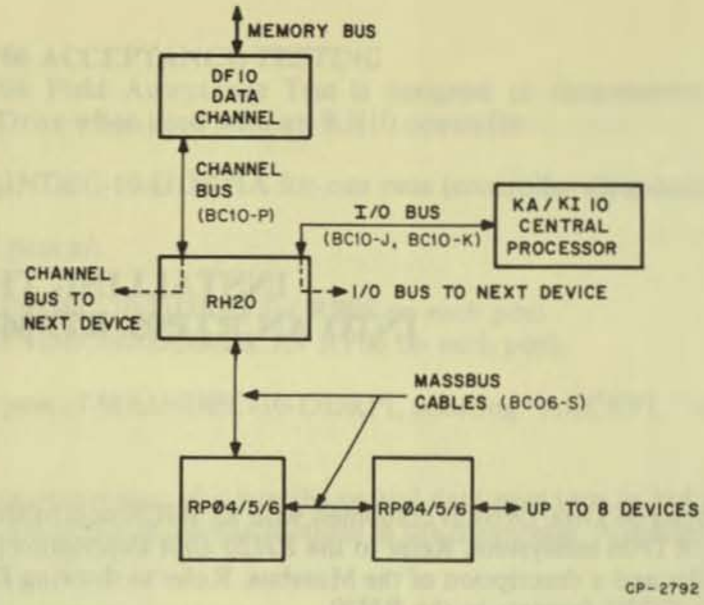


Figure 9-1 RH20/DF10/RP04/RP05/RP06 Interconnection Diagram

9.2.1.2 RP05/RP06 – Drives are plugged into a 3-phase power outlet through 4.6 m (15 ft) or less of ac cable supplied with the drive. One drive may be power-daisy-chained to another, but a third drive may not be added.

NOTE

When the drive is started, the pack should spin in a counterclockwise direction. If it does not, the phases must be reversed, or else the drive will not perform properly.

9.2.2 Massbus Cable Connections

Round Massbus cable (BC06S) is used to connect the RH20 to the drive, and to connect the drives to each other. Short cables (70-12066-00) 81.28 cm (32 in) long are used to connect the RP05/RP06 drives together. Skins must be removed from the drives before these cables can be used.

The last drive in the system must be terminated by a termination block (7009938) for the Massbus to operate correctly. Jumper W2 of the C terminator board must be the only jumper cut, as this enables Massfail.

NOTE

The terminator does not require power to work; thus, the last drive on the chain may be powered down.

Any mixture of RP04, RP05, and RP06 drives may be supported on the system provided that the proper software is run. Also, any drive may be dual-ported to the RH11 front end. This is accomplished via the same BC06 cables and another termination block. For software purposes, this drive should be logical zero.

NOTE

Unused ports do not require terminators.

If there are RH20s present without any drives connected to them, a terminator should be put on the RH20 plug to avoid spurious problems.

CHAPTER 10
RTP05/RTP06 FIELD ACCEPTANCE PROCEDURES AND DIAGNOSTICS

10.1 INTRODUCTION
Field acceptance testing is intended to demonstrate performance of the RP05/RP06 Disk Drive and/or the RTP05/RTP06 subsystem to the customer prior to his acceptance.

10.2 ERROR DEFINITIONS/RATES
The RP05/RP06 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 10.2.3). Six bits of RHER 1 (OPS, DTE, 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.

If all ECOs are installed, MAINDEC-10-DFRPJ and MAINDEC-10-DFRPK should run with no errors detected. Error definitions for MAINDEC-10-DDRPI are listed in the following paragraphs.

10.2.1 Soft Errors
Any error recoverable by the retry sequence (including retry, offset, and ECC) constitutes a soft error.

10.2.2 Hard Errors
Any error not recoverable by the retry sequence constitutes a hard error. No hard errors are permitted.

10.2.3 Seek Errors
Seek errors include SKI, OCYL, or HCE (head compare errors) where the printout shows that the drive is on the wrong cylinder. HCE logic faults and miscompares of sector and track are not seek errors. The allowable error rate for seek errors is 1 error per 10^6 seeks.

10.2.4 Pack-Attributable Errors
Pack-attributable errors include any errors (DCK, ECH, OPI, DTE, etc.) that occur on the same cylinder and head (track) more than once, even though they may not occur every time. A record of the pack location of every error should be kept so that pack errors can be identified, as they may occur on a certain area as rarely as one time in ten. The pack specification allows a total of 20 pack errors maximum, no more than five of which may be hard pack errors.

10.2.5 Read Errors
Errors such as DCK, DCK/ECH, DTE, HCRC, or HCE where one or more bits are picked up or dropped in the header field on the correct cylinder constitute read errors. The allowable error rate for read errors in 1 per 10^9 bits read, not counting pack errors.

10.3 RTP05/RTP06 ACCEPTANCE TESTING

The RTP05/RTP06 Field Acceptance Test is designed to demonstrate the performance of the RP05/RP06 Disk Drive when used with an RH20 controller.

1. Run any applicable CPU and/or memory diagnostics.

2. Run one pass of MAINDEC-10-DFSXA, System Exerciser, to verify interaction between disk drive, controller, channel, and memory.

3. Run MAINDEC-10-DFRHB for one pass with no errors (controller diagnostic).

4. Run one pass of:

   MAINDEC-10-DFRPJ for RP05 on each port
   MAINDEC-10-DFRPK for RP06 on each port.

5. Run one pass of MAINDEC-10-DDRPI, selecting "ACCEPT." (All drives may be selected at once.)

6. For dual-port systems, also run the special dual-port tests in MAINDEC-11-DFRPJ and -DFRPK according to the instructions in the diagnostic. A special test cable (7010507-02) is required.

10.4 DIAGNOSTIC DESCRIPTIONS

For complete descriptions of specific diagnostics, refer to the diagnostics themselves.

MAINDEC-10-DFRHB

This is an RH20 controller diagnostic that checks the 3-board RH20 option as it interacts with the channel. It allows for testing of the Massbus data and control buses through a hardware wrap feature. A terminator must be used either on the end drive or on the RH20 plug itself if no drives are cabled to it. If drives are on the system, select a drive number not on the system, so that only the RH20 is tested.

MAINDEC-10-DFRPJ (RP05); MAINDEC-10-DFRPK (RP06)

This program is a gate-by-gate check of the DCL, and attempts to exercise all of the disk logic functionally. It provides module callout capability upon error. When run, this diagnostic verifies the Massbus cables, drive, and DCL subsystem.

It starts with simple control bus transfers, moves on to seek exercising, and finally checks the data path. A loop-on-error capability is provided. A separate switch-selectable feature allows testing of dual-port systems. The head alignment program is also included.

MAINDEC-10-DDRPI

This is a reliability diagnostic for an RTP05/RTP06 system consisting of any number of controllers with up to eight drives of either type, mixed. Basic and complex seek patterns and data transfers are executed. This program can be used to format or read packs, check the mechanical timing, establish the read error reliability, etc. It may also be run under time-sharing.

CHAPTER 11
INSTALLING THE RP05/RP06 INTO AN RWP05/RWP06 SUBSYSTEM

11.1 INTRODUCTION
When one or more RP05 is combined with one or more RH70 controller, the combination is designated as an RWP05 subsystem. When one or more RP06 is combined with one or more RH70 controller, the combination is designated as an RWP06 subsystem. More complete details regarding this type of installation can be found in the *RWP05/RWP06 Moving Head Disk Subsystem Maintenance Manual* (EK-RWP05-MM-001) and the *RP05/RP06 Device Control Logic Maintenance Manual* (EK-RP056-MM-001).

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

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

+5 V ± 18.5 A max –15 V ± 0.5 A max

11.2.2 Module Locations
The PDP-11/70 CPU mounting box contains the floating point unit, central processor, memory management, Unibus map, cache, five small peripheral controller (SPC) slots, the KW11-L line frequency clock, and up to four RH70 controllers. Figure 11-1 shows the location of the respective modules. Ensure that all modules are firmly seated in the proper slots when installing the device.

11.2.3 Massbus Cable Connections
Massbus connections to the RH70 are made via three 40-conductor ribbon cables. These cables plug into three M5904 transceivers in the RH70, and are designated Massbus Cable A, Massbus Cable B, and Massbus Cable C. 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. The connections are made as indicated in Figure 11-2.

To terminate the Massbus, a 7009938 terminator pack assembly should be plugged into the output connector(s) of the last RP05/RP06 drive attached to the Massbus.

11.3 JUMPER CONFIGURATIONS
The following paragraphs describe the various jumper configurations on the BCT and MDP modules.

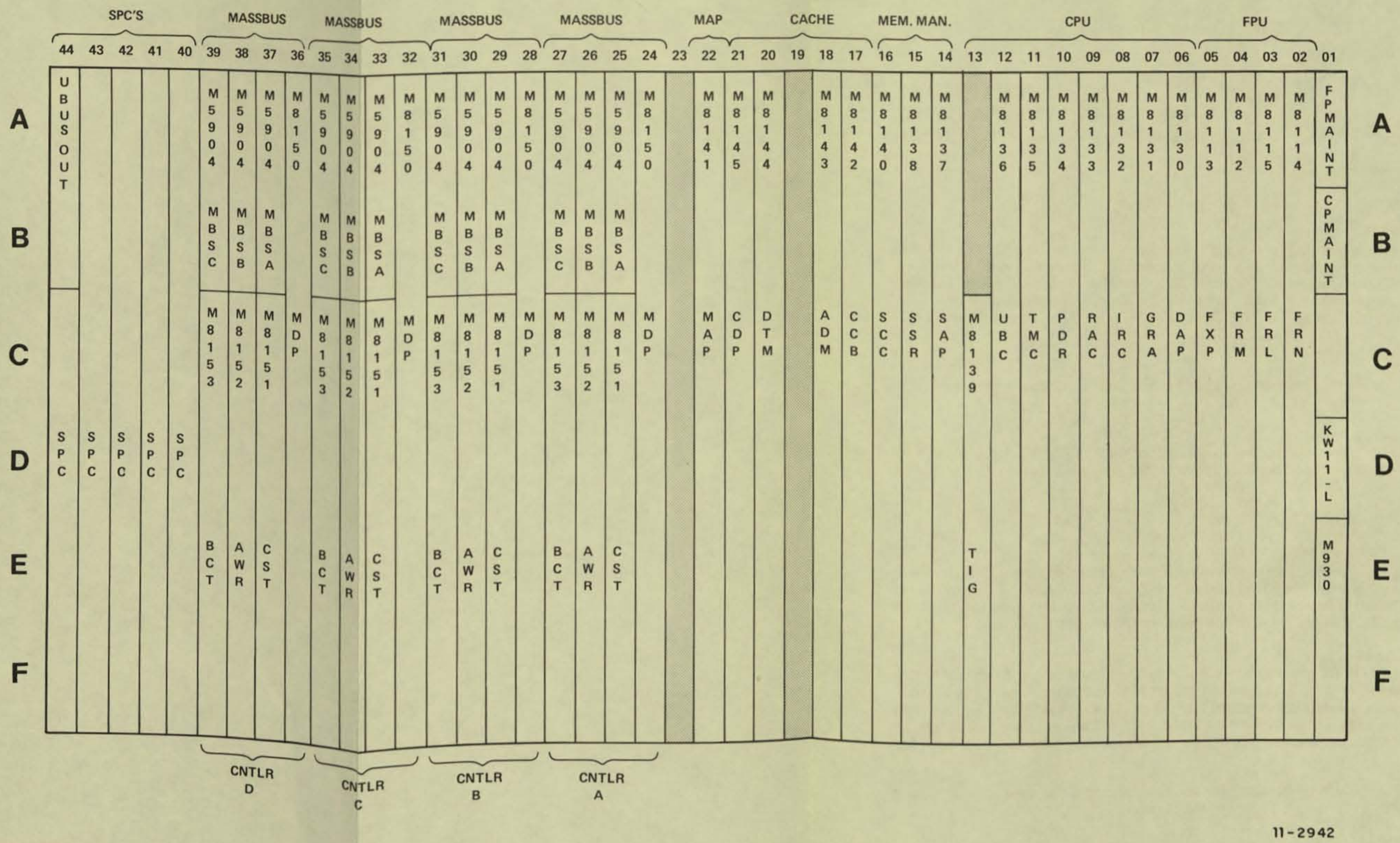
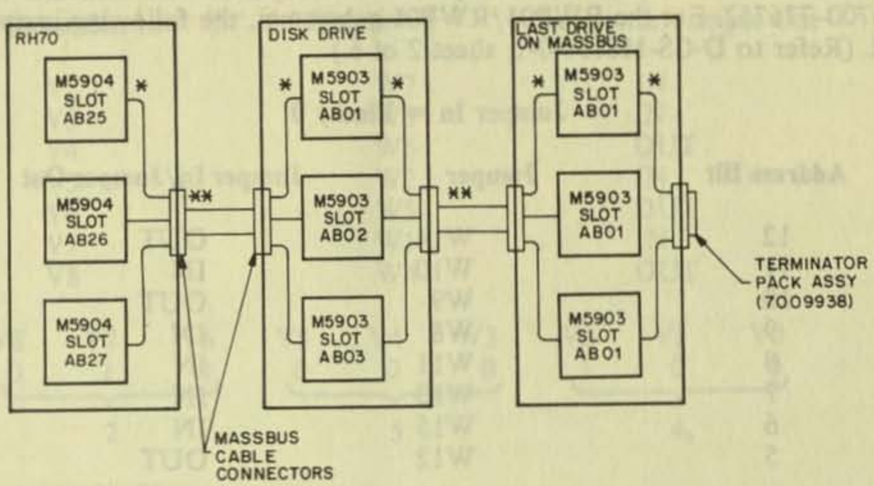


Figure 11-1 Module Utilization Chart

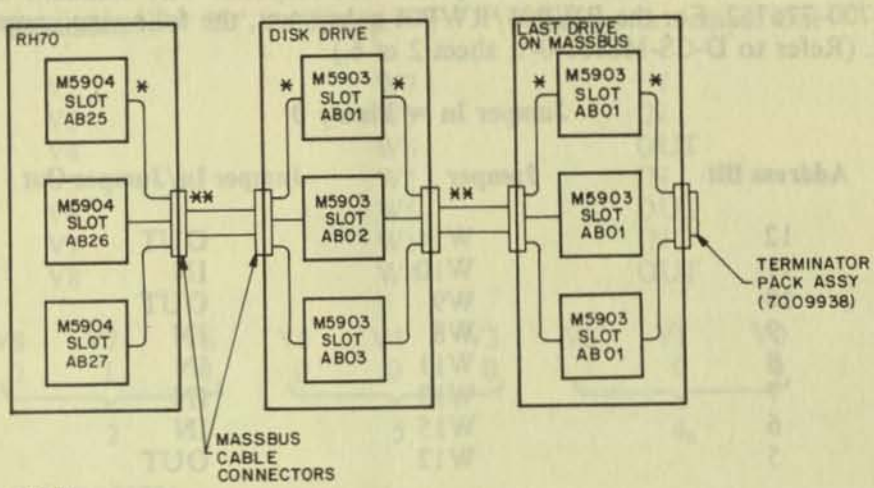


NOTES:
* Flat massbus cable (3) internal to RP05/06 cabinet and to cabinet containing RH70
** Round massbus cable external to cabinets.
1. Last drive terminated with 7009938 terminator pack assy.

*	CONTROLLER A	CONTROLLER B	CONTROLLER C	CONTROLLER D
MASSBUS CABLE A	AB 25	AB 29	AB 33	AB 37
MASSBUS CABLE B	AB 26	AB 30	AB 34	AB 38
MASSBUS CABLE C	AB 27	AB 31	AB 35	AB 39

11-3824

Figure 11-2 Massbus Cable System Configuration



*	CONTROLLER A	CONTROLLER B	CONTROLLER C	CONTROLLER D
MASSBUS CABLE A	AB 25	AB 29	AB 33	AB 37
MASSBUS CABLE B	AB 26	AB 30	AB 34	AB 38
MASSBUS CABLE C	AB 27	AB 31	AB 35	AB 39

11-3824

Figure 11-2 Massbus Cable System Configuration

11.3.1 BCT Module (M8153)

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

11.3.1.1 Register Selection – The RH70 is capable of responding to 32 possible Unibus addresses, with the exact number dependent of the Massbus device. Jumpers W8–W15 select the block of Unibus addresses to which the RWP05/RWP06 subsystem will respond. The standard addressing block assigned is 776700–776752. For the RWP05/RWP06 subsystem, the following jumper configuration should be used. (Refer to D-CS-M8153-0-1, sheet 2 of 6.)

Jumper In = Binary 0

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

ADDR BIT	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	1	1	1	1	1	1	0	1	0	0	0	0	1	X	X	X	X	X
		7			7			2			0			4 to 7			0 to 7	

The jumpers in E41 (D-CS-M8153-0-1, sheet 2 of 6) are selected for the appropriate number of registers in the subsystem minus 2. For example, there are 22 registers in the RWP05/RWP06 subsystem, so the jumpers are selected for a weighted value of 22 – 2, or 20, as shown below.

Jumper In = Binary 0

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

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

11.3.1.3 Vector Address Jumpers – The interrupt vector transferred to the processor is jumper-selectable via jumpers W1–W7, representing vector bits 2–8. The RWP05/RWP06 subsystem has been assigned a vector address of 000254. The jumper configuration for this address is shown below.

Jumper In = Binary 1

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

$$\underbrace{\overset{V8}{0}\quad\overset{V7}{1}\quad\overset{V6}{0}}_{2}\qquad\underbrace{\overset{V5}{0}\quad\overset{V4}{0}\quad\overset{V3}{0}}_{5}\qquad\underbrace{\overset{V2}{1}\quad\overset{V1}{0}\quad\overset{V0}{0}}_{4_8}$$

11.3.2 MDP Module (M8150)

The MDP module contains jumpers that allow maintenance personnel to disconnect wired-OR corrections from the Exclusive-OR network used to detect write-check errors.

These jumpers are designated W1–W4, and are shown on D-CS-M8150-0-1, sheet 6 of 9. The jumpers provide maintenance personnel with a method of isolating a faulty output (stuck low) of the wired-OR bus to one of four integrated circuit (IC) chips, which perform the exclusive-OR function during write-check operations. For example, if the output of the E21 and E23 open-collector line is stuck low when scoping of inputs indicates that it should be high, the faulty IC (E21 or E23) can be ascertained by removing jumpers W2 and W1. If, after the jumpers are removed, the outputs of the exclusive-OR gates in E23 are still low, the E2 3 chip is probably defective. If E23 outputs are high, the E21 chip is probably defective (outputs stuck low).

11.4 LIGHT-EMITTING DIODES (LEDs)

The following light-emitting diodes are incorporated into the RH70 Massbus controller logic BCT module (Figure 11-3) on the M8153.

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

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

System Fault No. 1 – Unibus on PDP-11/70 is in "hung" condition. (No operations can be performed on Unibus.)

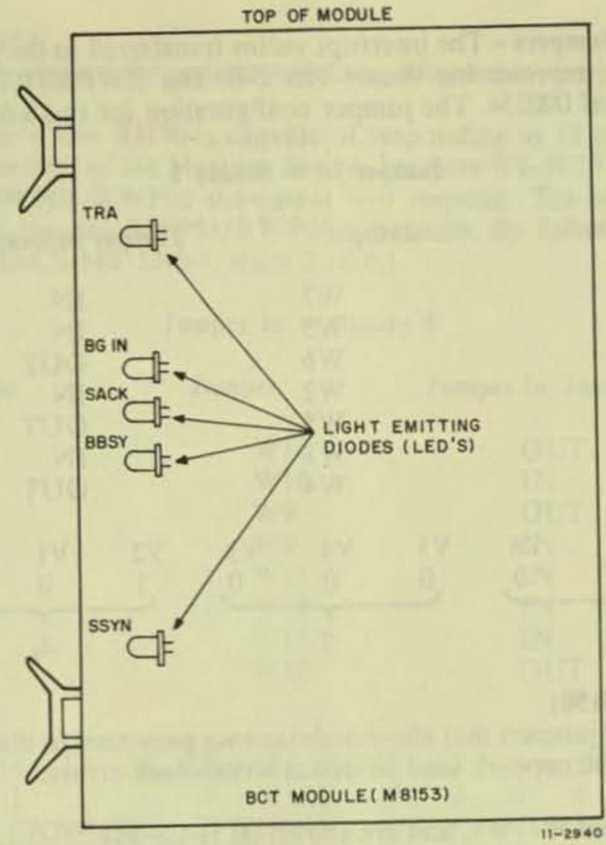


Figure 11-3 LED Physical Locations

Diagnosis – This condition may be caused by:

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

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

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

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

System Fault No. 3 – Processor attempts to read or write a remote register in the RWP05/RWP06 subsystem and receives an address error indication on the console (CPU traps to location 4).

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

CHAPTER 12
RWP05/RWP06 FIELD ACCEPTANCE PROCEDURES AND DIAGNOSTICS

12.1 INTRODUCTION
Field acceptance testing is intended to demonstrate performance of the RP05/RP06 Disk Drive and/or the RWP05/RWP06 subsystem to the customer prior to his acceptance.

12.2 ERROR DEFINITIONS/RATES
The RP05/RP06 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 12.2.4). Four bits of RHER 1 (HCRC, HCE, ECH, and DCK, which may include DTE and FER) indicate data errors; the remaining bits of RHER 1 indicate command and control errors. Table 12-1 lists indications of the various error types and their explanations.

12.2.1 Hard Errors
Any failure to read data correctly after a complete recovery sequence with ECC enabled constitutes an irrecoverable, or hard, error. (A complete recovery sequence consists of 28 retries, 16 at the nominal head position, and 2 each at selected offsets; 10.1 μm, 20.3 μm, and 34.8 μm (400, 800, and 1200 microinches) for the RP05, and 5 μm, 10.2 μm, and 15.2 μm (200, 400, and 600 microinches) for the RP06. (The first release of the DIGITAL PDP-11 operating system does not include offset capability.) Errors that are not ECC-correctable include bursts greater than 11 bits in length and isolated dropped bits (separated by more than 11 bits) within a sector. The allowable error rate for hard errors is one error per 10^{12} bits read.

12.2.2 Soft Errors
Any failure to read data correctly on the first try that is then read successfully during a recovery sequence constitutes a recoverable, or soft, error. (Refer to Paragraph 12.2.1 for definition of a complete recovery sequence.) The allowable error rate for soft errors in one error per 10^9 bits read.

12.2.3 Pack-Attributable Errors
An error caused by imperfections in the recording surface is regarded as pack-attributable, or media-dependent. If the imperfection is less than 11 bits long, it is ECC-correctable and will appear as a soft error; if more than 11 bits long, it will appear as a hard error. On a given pack, pack-attributable errors will always appear at the same cylinder, sector, and track addresses, with an ECC POS REG value within 11 bits. The definitions of hard and soft errors in Paragraphs 12.2.1 and 12.2.2 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.

Table 12-1 RP05/RP06 Error Conditions

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 during an operation that reads the header 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 operation 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 RP05/RP06 seek error and not a 677-51 or 677-01 drive seek failure.

12.2.4 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 one error per 10^6 seek operations.

12.3 RWP05/RWP06 FIELD ACCEPTANCE TEST
The tests described in Paragraph 12.4 may be used, individually or in combination, to demonstrate the performance of the RP05/RP06 Disk Drive when used with an RH70 controller.

12.4 DIAGNOSTIC MAINTENANCE
The diagnostic programs described herein are employed with the RWP04/RWP05/RWP06 subsystem. Refer to the applicable diagnostic operating procedures for more detailed information.

Test Programs

MAINDEC-11-DERHA	RH70 Controller Test
MAINDEC-11-DZRJA	Mechanical Read/Write Test
MAINDEC-11-DZRJE	Dual-Port Logic Test, Part 1
MAINDEC-11-DZRJF	Dual-Port Logic Test, Part 2
MAINDEC-11-DZRJG	RP04/RP05/RP06 Diskless Controller Test (Static I, Part I)
MAINDEC-11-DZRJH	RP04/RP05/RP06 Diskless Controller Test (Static I, Part II)
MAINDEC-11-DZRJI	RP04/RP05/RP06 Functional Controller Test (Static II, Part I)
MAINDEC-11-DZRJJ	RP04/RP05/RP06 Functional Controller Test (Static II, Part II)

System Exerciser Program

MAINDEC-11-DZRJD	Multidrive Exerciser

Utility Programs

MAINDEC-11-DZRJB	Formatter Program
MAINDEC-11-DZRJC	Head Alignment Verification Program

12.4.1 MAINDEC-11-DERHA – RH70 Controller Test

This diagnostic verifies that the RH70 controller is operating correctly. The diagnostic can test up to four RH70 controllers simultaneously; however, an operating Massbus peripheral must be connected to each RH70 controller. The major tests in the diagnostic are:

1. Determining whether all registers in the controller can be read from or written into
2. Checking error conditions in the controller by causing an error and observing the results on the associated error bit in the CS1, CS2, or CS3 registers
3. Checking that the data buffer can accurately store and transfer data.

12.4.2 MAINDEC-11-DZRJG, MAINDEC-11-DZRJH – RP04/RP05/RP06 Diskless Controller Test

This program tests the RH70 and the DCL portion of the RP04/RP05/RP06 Disk Drive. The DCL makes the drive compatible with the Massbus, and must be plugged into the MDLI or appropriately terminated. (The MDLI is the mass device level interface that connects the DCL to the drive assembly.) The 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. After a successful run (with no errors) of this diagnostic, it can be ascertained that the DCL logic that processes the data is working properly. The logic that handles the mechanical commands is not tested in this diagnostic. All data commands use the Maintenance register in the Wraparound mode.

12.4.3 MAINDEC-11-DZRJI, MAINDEC-11-DZRJJ – RP04/RP05/RP06 Functional Controller Test

This diagnostic tests the DCL portion of the drive. It exercises the disk surface and the mechanics of the drive to prove proper operation of the subsystem. To run the diagnostic, a disk pack *with no vital information written on it* is essential. The disk pack need not be formatted.

After a successful run of this diagnostic (with no errors), it can be concluded that the DCL circuitry in the RP04/RP05/RP06 works successfully while not connected to the rest of the subsystem. System interaction and drive timing are left to other diagnostics. (This diagnostic presupposes that MAINDEC-11-DZRJG and MAINDEC-11-DZRJH have been run successfully.)

12.4.4 MAINDEC-11-DZRJA – Mechanical Read/Write Test

This program contains 15 tests, numbered $0–16_8$. 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 the information 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. All drives are then tested, beginning with the lowest numerical drive and proceeding in sequential order. One pass (tests 0–15) is performed on each drive before moving to the next drive in seequence. The number of the drive to be tested is typed at the beginning of each pass. At the completion of each pass, an end-of-pass message is typed. After all drives have been tested, an end-of-test message is typed.

12.4.5 MAINDEC-11-DZRJE, MAINDEC-11-DZRJF – Dual-Port Logic Test (Parts 1 and 2)

This program checks the dual-port logic in the DCL portion of the drive; it requires a special adapter cable.

12.4.6 MAINDEC-11-DZRJD – Multidrive Exerciser

The RP04/RP05/RP06 Multidrive Exerciser program exercises from one to eight drives attached to the same RH70. If two or more of the drives are being exercised, operations on the drives are overlapped. (One drive performs a data transfer or write-check operation while others are performing seek/search operations.) Optimization makes it possible to maintain a high subsystem data transfer rate or a high positioning operation rate.

The performance of each drive is monitored by the program. If a drive exceeds a preset number of errors in any of several categories, that drive is automatically deassigned. (The operator may override the automatic deassignment feature.) The program reports performance statistics for each drive being exercised on request from the operator, or automatically at an interval determined by the operator.

All data transfer commands are used (i.e., Write Data, Write Header and Data, Read Data, and Read Header and Data), 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 communications are through the console device; program options are selected by Switch register settings and errors are normally reported on the teletypewriter. However, if a lineprinter is available, the program will use the printer for error message display.

All commands, data patterns, and data buffer sizes are selected randomly by the program. The addresses (e.g., cylinder, track, and sector) for each operation are also selected randomly.

At the completion of each operation, the program checks the RH70. The program requires data packs created by the Formatter program (MAINDEC-11-DERPL), the Read/Write Mechanical Test (MAINDEC-11-DERPK), or the Data Pack Generation command of the Exerciser program.

12.4.7 MAINDEC-11-DZRJB – Formatter Program

The RP05/RP06 Formatter program is designed to write and verify header and data information on all possible disk pack addresses with the intention of testing 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.

This 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 portion of the pack to be formatted is determined by the first and last cylinder and track addresses, inclusively. A single track is the smallest element that may be formatted.

Write-check errors are reported when they are detected. If an error is detected, the sector must be rewritten and verified correctly *two successive times* to be considered usable. Sectors that cannot be written correctly twice after an error will be declared unacceptable by the program.

After the last track has been formatted and verified, an additional check is performed. The header of track 0 and sector 0 of each cylinder is read and compared by the software. This check is performed to isolate a possible positioner error that may have occurred during the format operation. Two such cases of positioner malfunction are: failure of the positioner to advance to the next cylinder, and advancement of the positioner past the desired cylinder.

12.4.8 MAINDEC-11-DZRJC – 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, and also reverifies alignment of cylinder 245, heads 0–18. The operator is notified if any head is out of alignment by more than the specified amount.

The procedure for checking head alignment is as follows.

1. Offset the positioner to +30 μm (+1200 microinches).
2. Store the sign change bit.
3. Move the positioner in the opposite direction in 0.64-μm (25-microinch) increments until the sign change bit changes value. Store the offset value.
4. Offset the positioner to –30 μm (–1200 microniches) 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 ±3.9 μm (±150 microinches) for cylinder 245 or by more than ±9 μm (±350 microinches) for cylinders 4 and 400.

Repeat the above sequence for all heads at cylinder 245, and for heads 0 and 18 at cylinders 4 and 400.

CHAPTER 13
OPTIONS

13.1 INTRODUCTION
The following paragraphs describe some of the ways in which the RP05/RP06 Disk Drive can be optionally configured.

13.2 DUAL-PORT OPERATION
The RP05/RP06 interface logic is designed to permit access by two different controllers, with the setting of the CONTROL switch on the drive front panel determining which controller is to be granted access. When the switch is set to the center position (A/B), the drive may be accessed by either controller, and will be controlled by that controller until its operation is completed.

13.2.1 Converting to Dual-Port
Converting an RP05/RP06 Disk Drive to dual-port operation takes approximately 2.5 manhours and requires only an 8.7 mm (11/32-inch) open or box wrench and a 2.4-mm (3/32-inch) hex (Allen) wrench. In order for the dual-port option to be operable, the M7775 (dual-port) board must be at Etch Rev. C or higher and CS Rev. D or higher.

13.2.2 Conversion Procedure
To convert the RP05/RP06 Disk Drive from single-port to dual-port operation, proceed as follows.

1. With power OFF, move the drive (if necessary) so that the side cover of the DCL is accessible.
2. Remove the side cover, revealing a metal plate.
3. Remove the six screws holding the metal plate, and remove the plate.
4. Remove the rear cover of the DCL.
5. Loosen the two fastener screws at the top of the DCL assembly (Figure 13-1). Pivot the card nest down to the horizontal position (Figure 13-2).
6. Loosen the two fastener screws (Figure 13-3) that are holding the air flow cover closed. Lift the air cover to the vertical position (Figure 13-4).
7. Remove the three cable clamps (two on the left-hand side, one at the bottom inside the frame).
8. Lay the new harness (Port B) in position over the existing harness (Port A), with the red-lined edge of the cabling up along the side of the card nest. Pull the new harness until the top cable connector is flush with the front of the card nest (Figure 13-2).

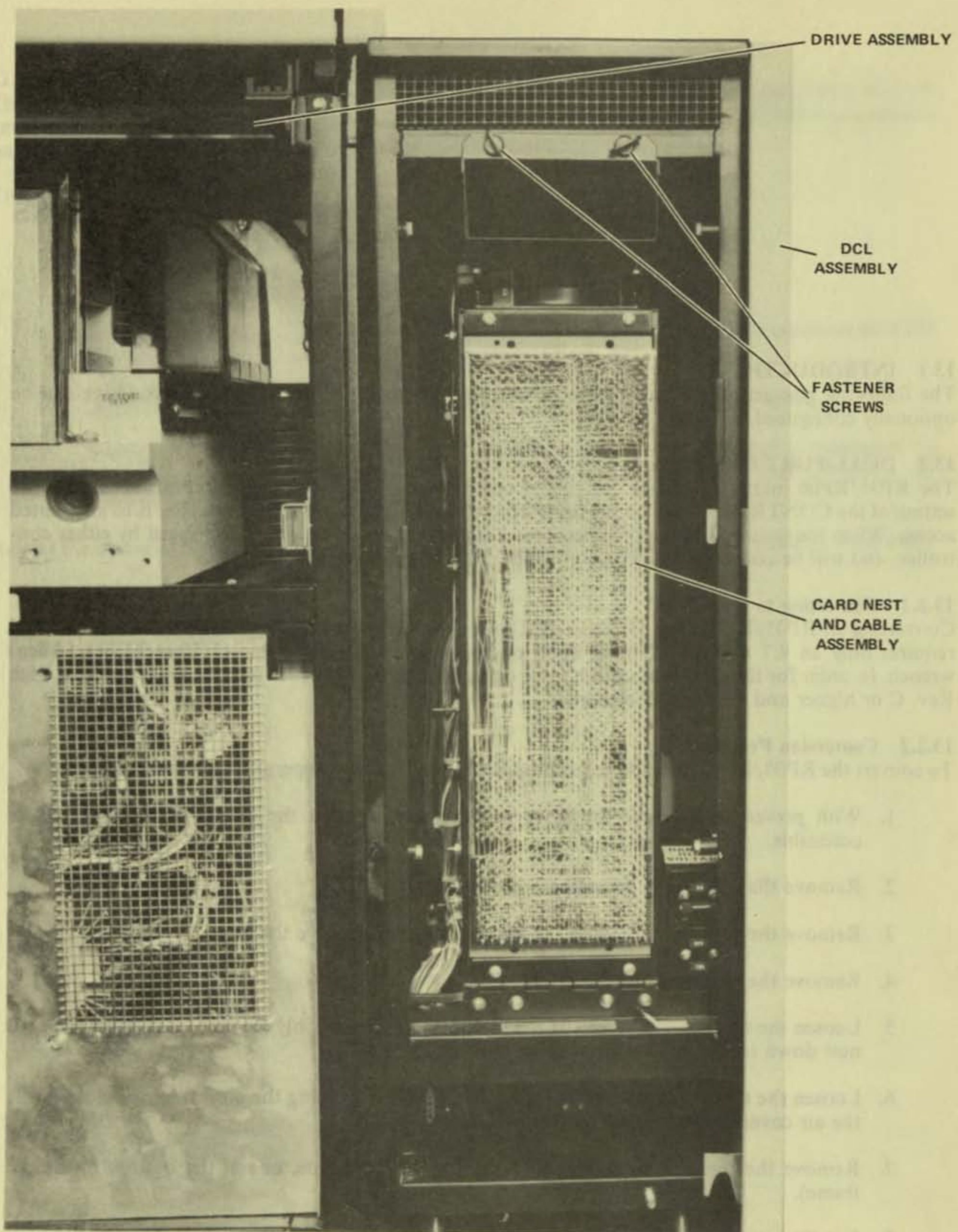


Figure 13-1 Drive and DCL Assemblies Rear View, Rear Panels Removed

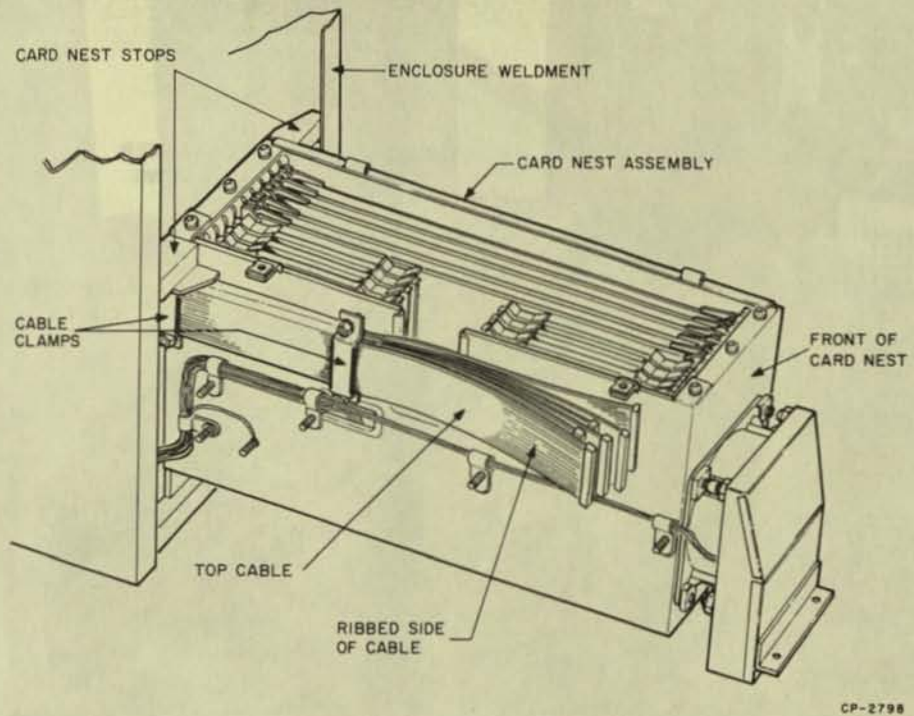


Figure 13-2 Card Nest in Horizontal Position

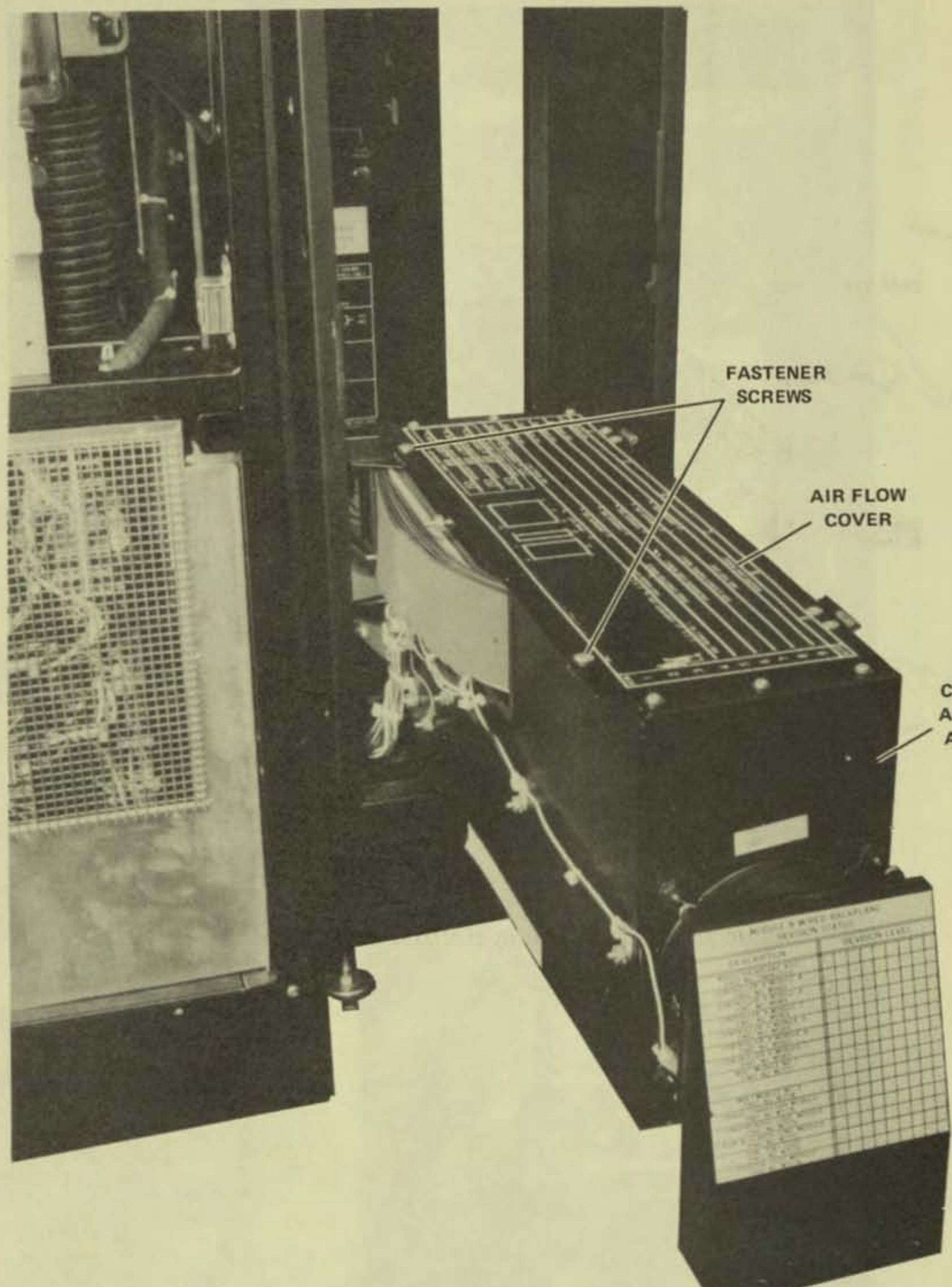


Figure 13-3 DCL Rear View, Card Nest and Cable Assembly Extended

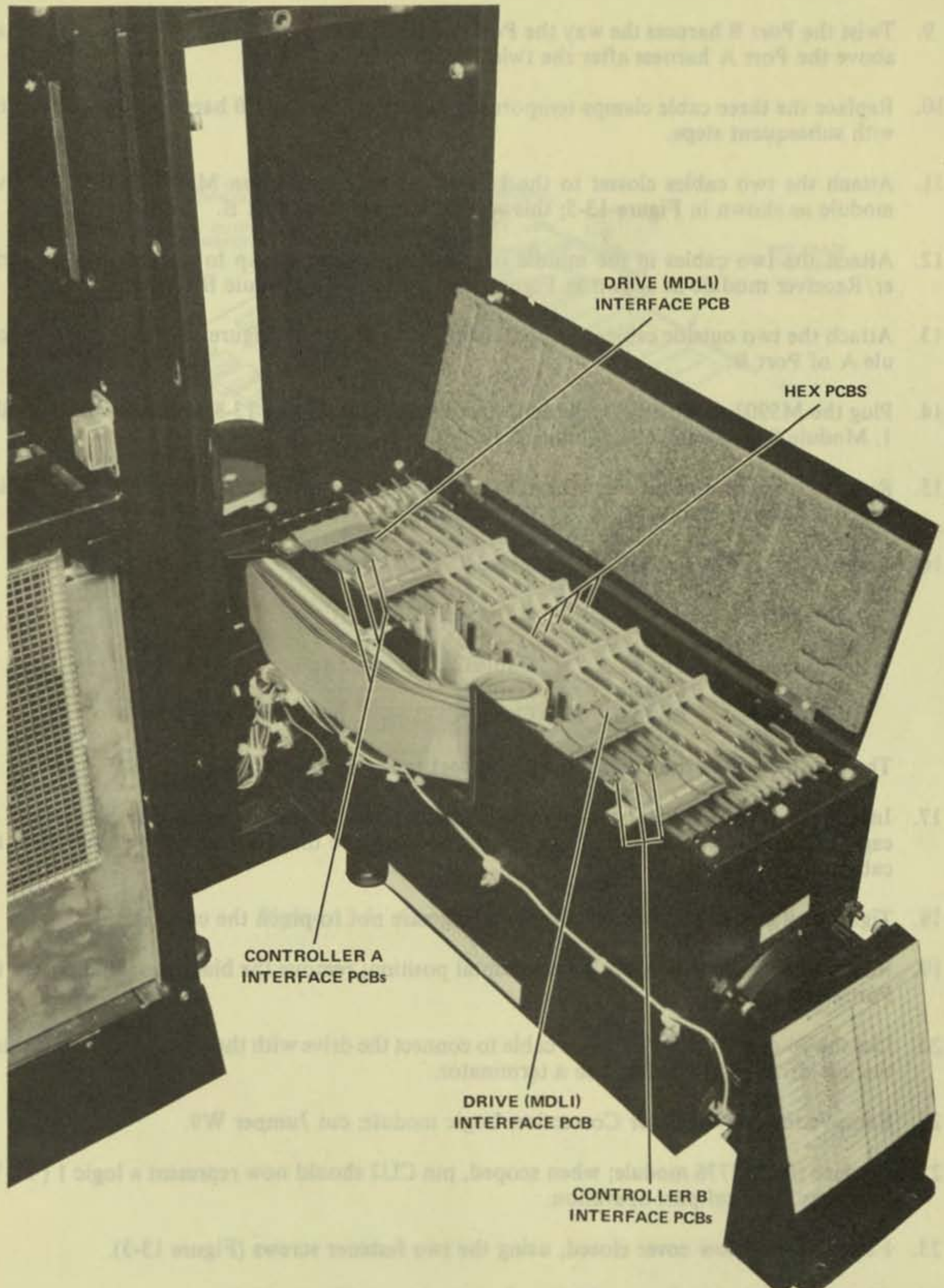


Figure 13-4 Card Nest and Cable Assembly PCB Layout

9. Twist the Port B harness the way the Port A harness is twisted, so that the Port B harness is above the Port A harness after the twist.

10. Replace the three cable clamps temporarily to support the Port B harness while proceeding with subsequent steps.

11. Attach the two cables closest to the side of the card nest to an M5903 Driver/Receiver module as shown in Figure 13-5; this will be Module C of Port B.

12. Attach the two cables in the middle of the Port B cable group to another M5903 Driver/Receiver module as shown in Figure 13-6; this will be Module B of Port B.

13. Attach the two outside cables to another M5903 as shown in Figure 13-7; this will be Module A of Port B.

14. Plug the M5903 modules into the card nest as shown in Figure 13-8, with Module A in Slot 1, Module B in Slot 2, and Module C in slot 3.

15. Run the other end of the Port B cables out through the top two Massbus connector holes, which should be empty.

16. Connect the cables to Massbus connectors, as follows:

B Input		B Output
Cable A	Top	Cable C
Cable B	Middle	Cable B
Cable C	Bottom	Cable A

The red-lined edge should be up with respect to the retainer spring.

17. Install the two Massbus connectors into the appropriate holes, using four hex screws on each; check the reverse side of the connector to ensure that no pins popped out when the cable was secured.

18. Tighten all three of the cable clamps, taking care not to pinch the cable edges.

19. Return the air flow cover to the horizontal position; remove the black tape that covers the Port B decal.

20. Use the 76-cm (30-inch) Massbus cable to connect the drive with the succeeding one; if this is the last drive on the string, use a terminator.

21. Remove the M7776 Error Correction Logic module; cut Jumper W9.

22. Replace the M7776 module; when scoped, pin CU2 should now represent a logic 1 (+3 V), necessary for dual-port operation.

23. Fasten the air flow cover closed, using the two fastener screws (Figure 13-3).

24. Close the card nest; fasten with two fastener screws (Figure 13-1).

25. Replace the rear cover, metal plate, and side cover, and move the drive back into position.

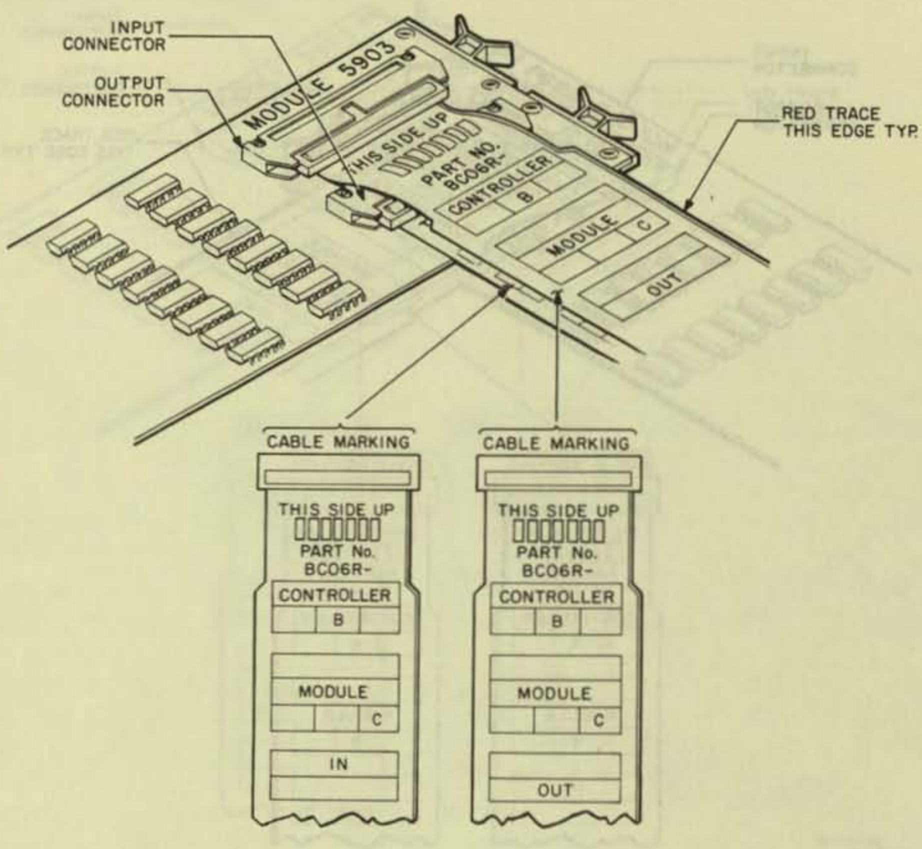


Figure 13-5 Connecting Module C (M5903)

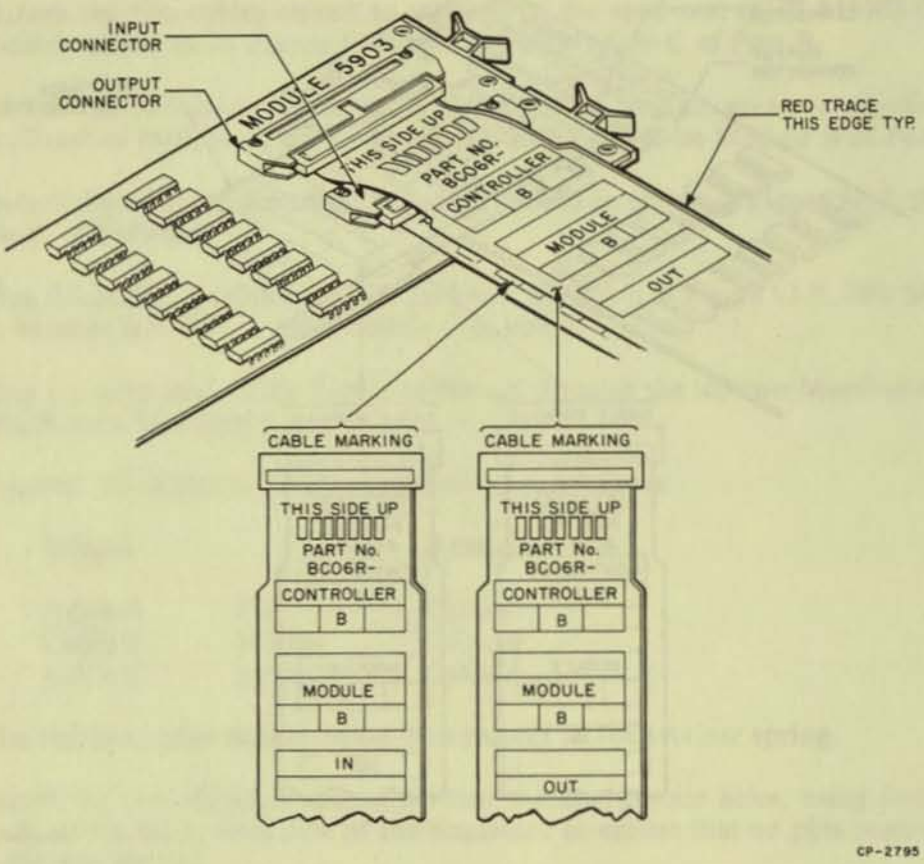


Figure 13-6 Connecting Module B (M5903)

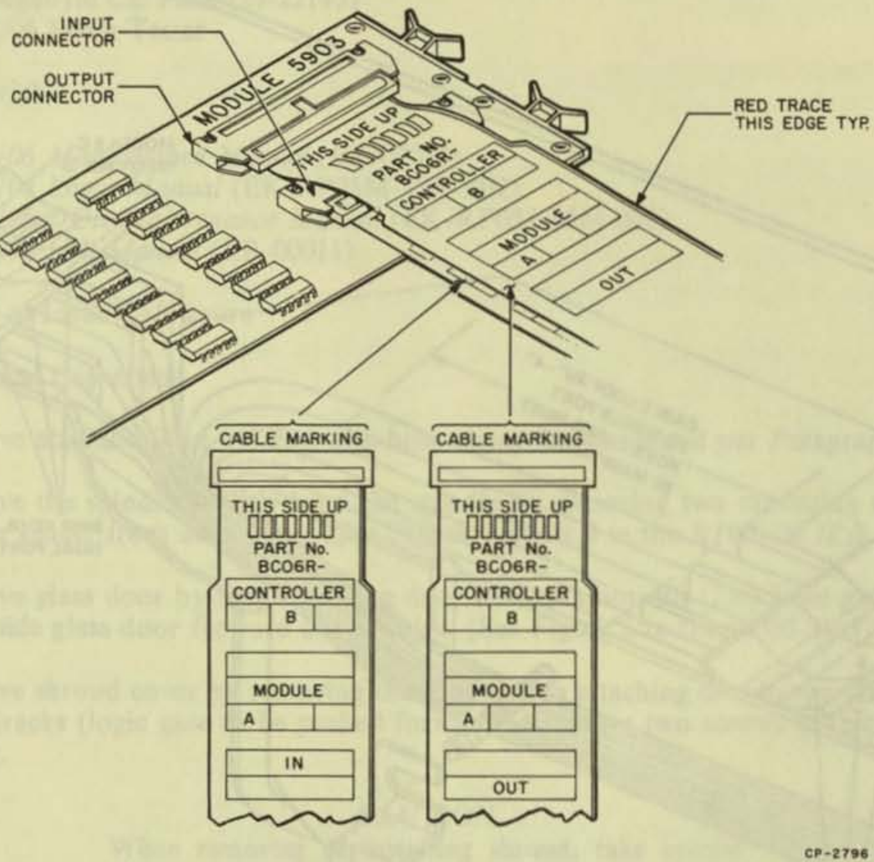


Figure 13-7 Connecting Module A (M5903)

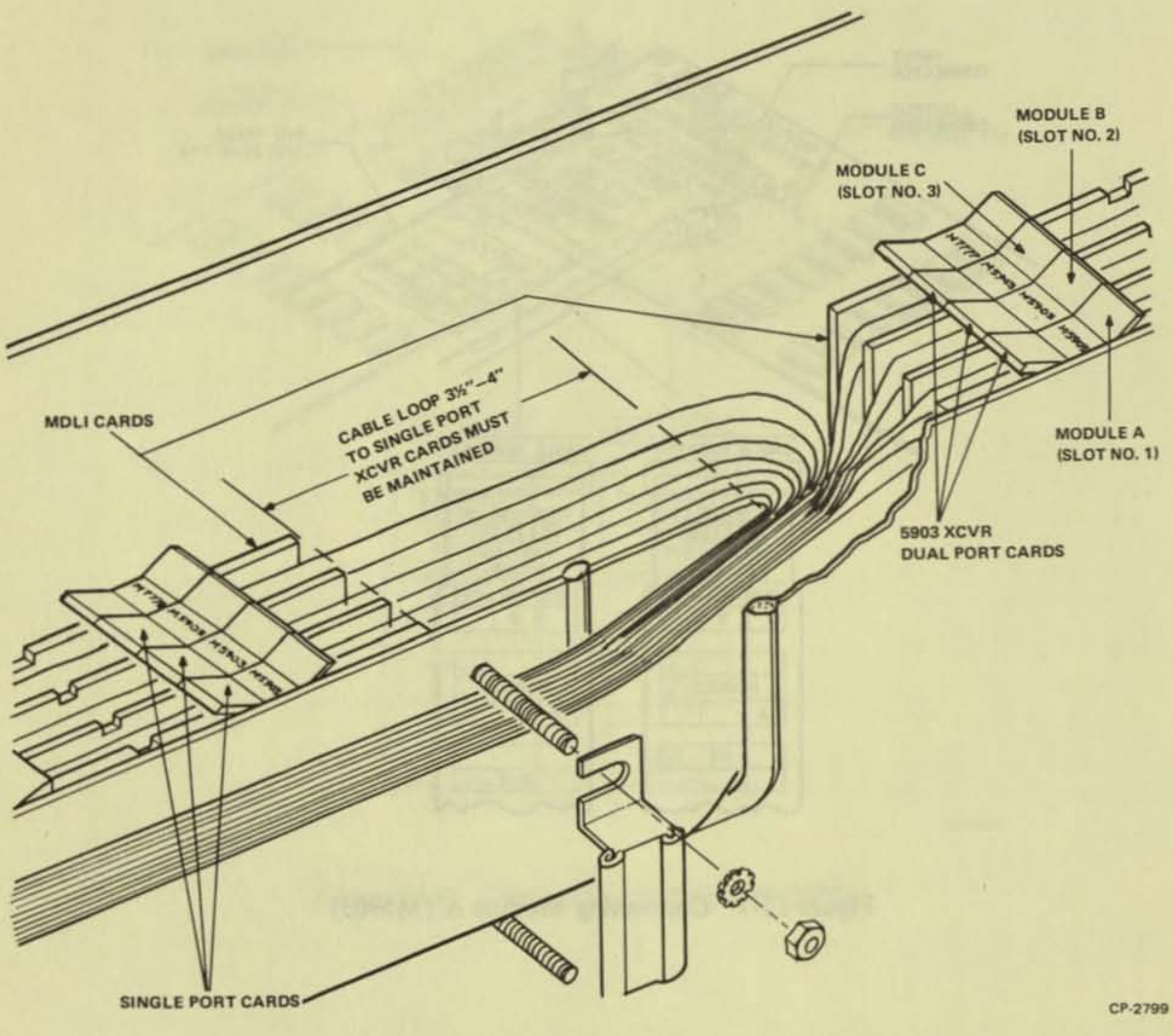


Figure 13-8 Module Locations of M5903S

13.3 UPGRADING THE RP05 TO AN RP06

13.3.1 Introduction

Materials Required

1. RP06-U Upgrade Kit (kit includes RP06-P data pack)
2. 200-megabyte CE Pack (29-22193)
3. RP05/06 Perch Tester

Reference Material

1. *RP05/06 Maintenance Manual* (ER-00012)
2. *RP05/06 Logic Manual* (EK-RP05M-TM-V02)
3. *RP05/06 DCL Maintenance Manual* (EK-RP054-MM-001)
4. *RP05/06 IPB Manual* (ER-00011)

Estimated Time to Install – 8 hours

13.3.2 Mechanical Conversion

1. Remove absolute filter by removing hose clamp under shroud per Paragraph 4.1.2.0.

2. Remove the spindle ground from the spindle by removing two mounting screws and one washer spacer from deck plate. (See Figure 6, sheet 3 in the *RP05/06 IPB Manual*.)

3. Remove glass door by first removing door bumpers/anti-lift (2×) from glass door tracks, then slide glass door forward out of drive. (See Figure 2 in the *RP05/06 IPB Manual*.)

4. Remove shroud cover by removing the four screws attaching the shroud cover to the glass door tracks (logic gate to be pushed forward to remove two screws at the rear of shroud cover).

CAUTION

When removing or installing shroud, take special care not to damage the pack sensor and the pack sensor seal.

5. Remove the shroud by removing six screws. First, remove the two screws located behind shroud air baffle, then remove the four screws at bottom of shroud which attach the shroud to the deck plate. (See Figure 6, sheet 1 in the *RP05/06 IPB Manual*.)

6. Remove the 100-megabyte spindle lock shaft from the spindle by removing the three allen screws, the holding plate, and the conical spring. Then, with one hand prepared to catch the falling lock shaft, carefully tap the top of the lock shaft to release it from the spindle. (See Figure 6, sheet 3 in the *RP05/06 IPB Manual*.)

7. Place all brass shims removed with the 100-megabyte lock shaft on the 200-megabyte lock shaft prior to installation into the spindle (three shims maximum). Lightly coat lock shaft O-ring with Andoc C™ or equivalent. Wipe all excessive oil from lock shaft.

™Andoc C is a trademark of the Esso Oil Company.

8. Install the 200-megabyte lock shaft (Memorex Part No. 215013) by inserting it through the bottom of the spindle. Reinstall the conical spring, holding plate, and the three allen screws removed in step 6.

9. Head conversion: Remove all 100-megabyte heads (all hardware will be re-used).

10. Remove the 1000-megabyte head load cams (2×) (black) from cam towers by removing four screws in each cam.

11. Install the 200-megabyte head load cams (2×) (white, Memorex Part No. 215087), using screws removed in step 10. (See Figure 6, sheet 1 in the *RP05/06 IPB Manual.*

12. Install the shroud, by first engaging the shroud to the locating pin in the cam tower, using screws removed in step 5.

13. Install shroud cover, using screws removed in step 4. (Inspect shroud cover seal for damage. If damage is present, replace shroud cover.)

14. Install the glass door and door bumper anti-lift (2×), using screws removed in step 3.

15. Install the spindle ground, spacer washer, and screws removed in step 2.

16. Install absolute filter removed in step 1.

17. Logo replacement: Raise indicator panel, remove lamp matrix PCB, then remove the five nuts retaining the trim strip to the indicator panel. Then, remove the logo/dead front by sliding the logo/dead front free of the indicator panel; replace with logo/dead front (Memorex Part No. 215745), in reverse of removal procedure. (See Figure 3 in the *RP05/06 IPB Manual.)*

13.3.3 Head Conversion

CAUTION

Strict adherence to the technical manual is mandatory when installing heads. Improper installation of heads may cause catastrophic head-to-disk interference.

1. Install all 200-megabyte heads, using head installation tool (Memorex Part No. 210105). Using torque tool (Memorex Part No. 210109), torque data heads to initial torque values. Torque servo head to final torque. (Refer to Paragraph 4.6.2 in the *RP05/06 Maintenance Manual.*)

    a. Data Heads Torque

        Initial torque: 2.5 ± 0.5 in-lb
        Final torque: 6.0 ± 1 in-lb

    b. Servo head torque: 6 ± 1 in-lb

2. Observing from the shroud, inspect all heads to ensure they are positioned properly on head load cams.

13.3.4 Electrical Conversion

1. Replace the 100-megabyte VSER PCB (location D14) with 200-megabyte VSER PCB (Memorex Part No. 012476).

2. Replace the 100-megabyte PSER PCB (location D15) with the 200-megabyte PSER PCB (Memorex Part No. 012481).

3. Replace the 100-megabyte WLOG PCB (location D17) with the 200-megabyte WLOG PCB (Memorex Part No. 012746).

4. Rework the input PCB by removing the wire between pins 8 and 9 in location 1-C or location J1 on component side of PCB. Cut trace J1 if necessary.

5. Replace the 100-megabyte matrix PCBs (2×) located on cam tower with the 200-megabyte matrix PCBs (2×) (Memorex Part No. 012491). Then, plug the head connector into the matrix PCB.

6. In DCL, install jumper W3 on seek and search control logic M7786.

7. In DCL, reconfigure drive type number on error correction logic M7776 for one of the following drive types.

Drive Type Number (Octal)	Drive Type
020022	RP06-A (single control)
024022	RP06-B (dual control)

13.3.5 Test Procedure

1. Install double-density scratch pack, non-CE-pack.

2. Power drive up.

3. After drive disk pack has been rotating at 3600 rev/min for 5 minutes, carefully perform hand launch of heads as a precaution to assure that all heads are installed and flying correctly. Then, perform first seek with the lap plug installed. (See Paragraphs 4.3.3.1 to 4.3.3.3.)

CAUTION

During the hand launch of heads or during first seek with lap installed, if there is any high pitch or abrasive sound noticeable from the disk, retract the heads immediately and power drive down and inspect all heads for possible damage.

4. Power drive down and remove disk pack.

5. Install double-density CE pack, start drive, and allow drive temperature to stabilize for one hour.

6. Align heads using model 800 tester and head alignment tool. After heads are aligned, torque all data heads to final torque. (Refer to Paragraph 4.6.3 in the *RP05/06 Maintenance Manual.*)

7. Install data pack RP06-P and perform diagnostic and acceptance tests per field acceptance procedure as described in Chapter 6, 8, 10, or 12.

Reader's Comments

RP05/RP06 DISK DRIVE
INSTALLATION MANUAL
EK-RP056-IN-001

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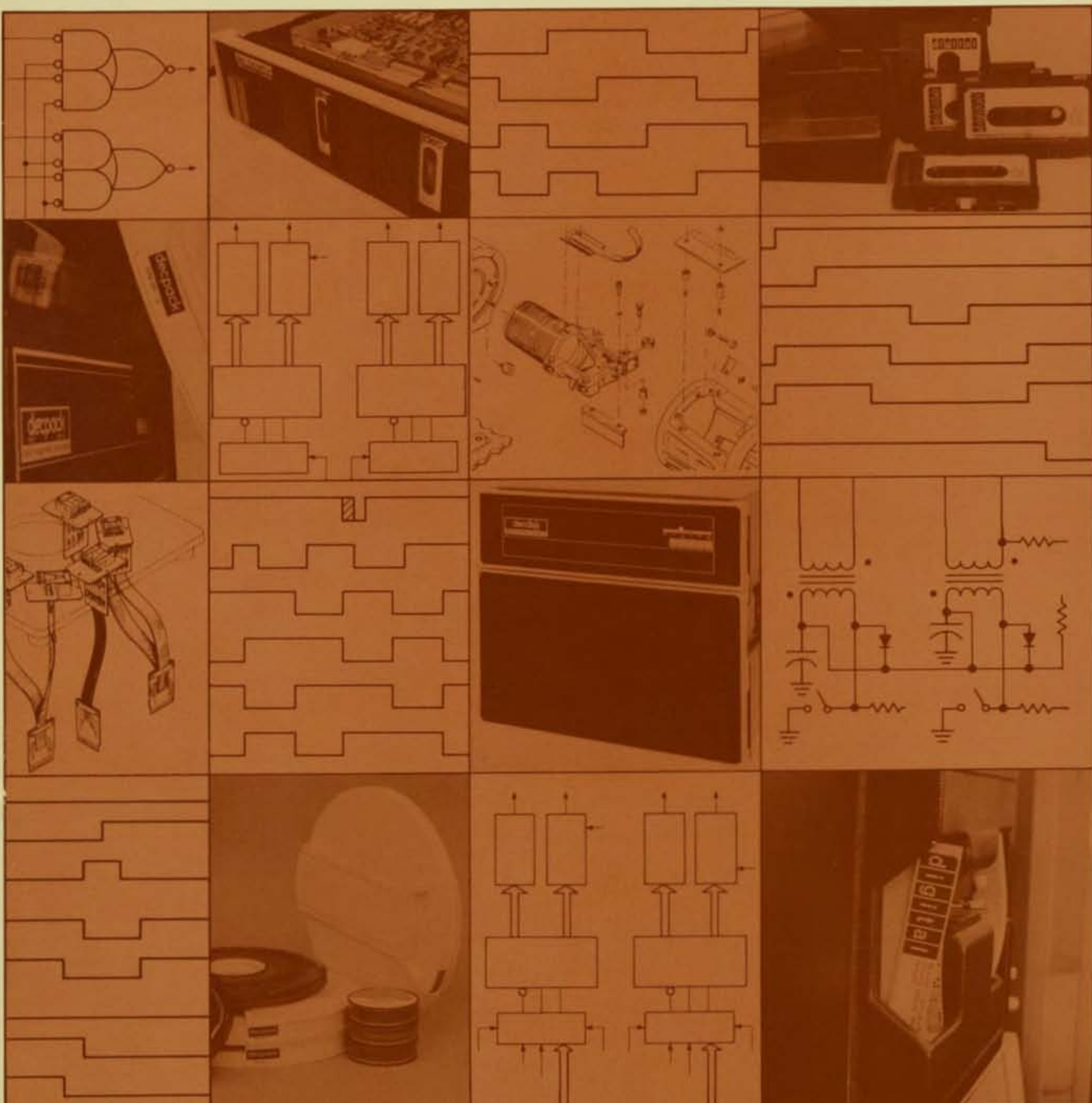

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861-A, -B, -C, -D, -E, -F
power controller
user's manual

EK-861AB-OP-001

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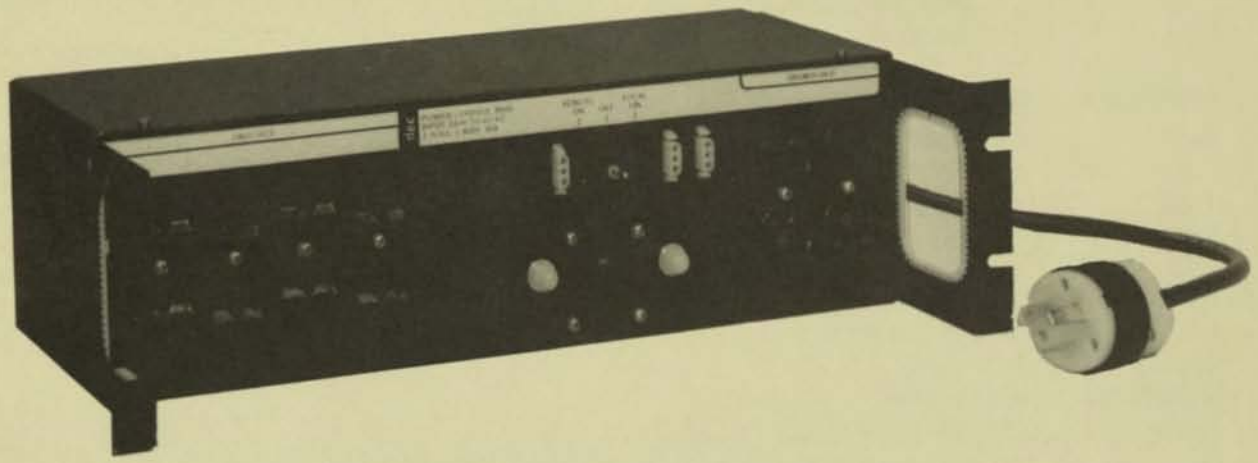
CONTENTS

ILLUSTRATIONS

TABLES

861-A,-B,-C,-D,-E,-F POWER CONTROLLER



6496-5

861-A,-B,-C,-F Power Controller

7570-1

861-D,-E Power Controller

CHAPTER 1
INTRODUCTION

This manual provides information for installing and operating the 861-A, 861-B, 861-C, 861-D, 861-E, and 861-F Power Controllers, designed and manufactured by Digital Equipment Corporation.

1.1 GENERAL DESCRIPTION

The 861 Power Controllers provide a means for controlling and distributing power to data processing equipment.

All versions are contained on panels intended for mounting in racks or cabinets that accept standard 19-inch panels. Each power controller requires 5-3/16 inches of vertical mounting space. The 861-A,-B,-C,-F extends 8-1/4 inches into the mounting rack or cabinet and the 861-D,-E extends 11 inches into the mounting rack or cabinet.

The following versions are available to provide for a variety of input power configurations:

Figures 1-1 and 1-2 are simplified block diagrams of the 861 Power Controllers. Four basic functions are performed:

a. Control of large amounts of power by control signals of small power content.

b. Convenient distribution of primary power to controlled devices.

c. Filtering of primary power to controlled devices.

d. Automatic removal of primary power from controlled devices in case of overload or overtemperature conditions.

1.2 SPECIFICATIONS

The following specifications are included here for reference purposes only and are subject to change without notice.

Version	Voltage	Hertz	Phase
861-A	90-135	47-63	Two (120° or 180° displaced)
861-B	180-270	47-63	Single
861-C	90-135	47-63	Single
861-D	90-132	47-63	Three (120° displaced)
861-E	180-264	47-63	Three (120° displaced)
861-F	90-135	47-63	Single

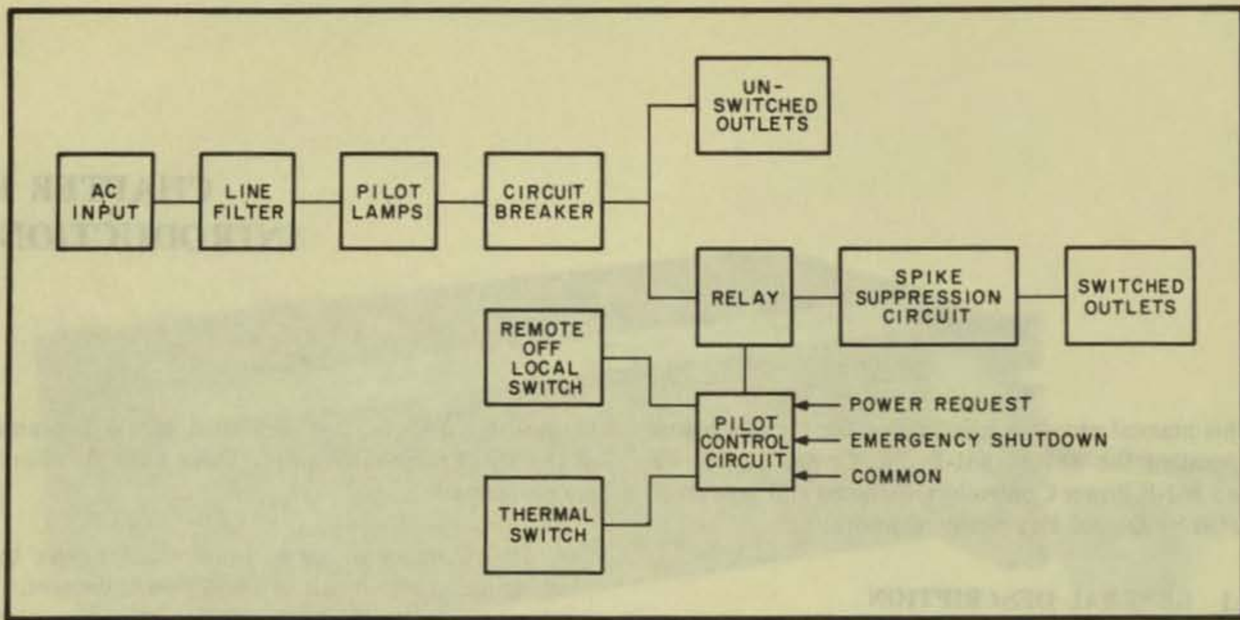


Figure 1-1 Simplified Block Diagram – 861-A,-B,-C,-F

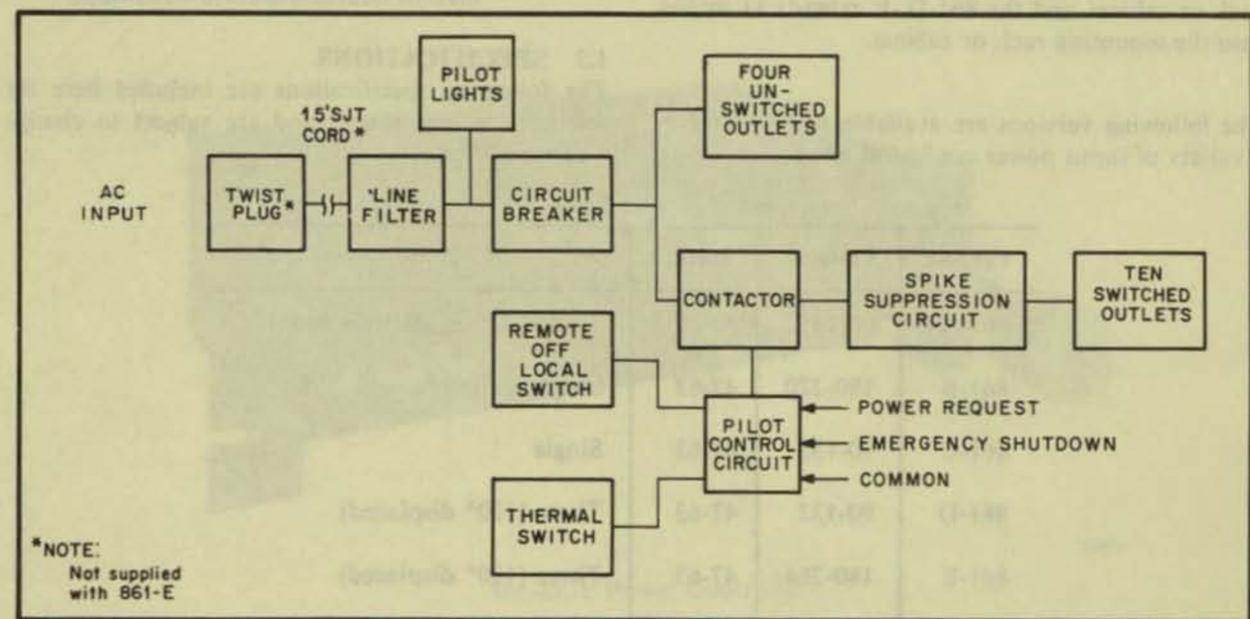


Figure 1-2 Simplified Block Diagram – 861-D,-E

1.2.1 Mechanical And Environmental

Dimensions

861-A,-B,-C,-F: 5 in. h x 19-1/8 in. w x 8 in. d (12.7 cm h x 48.5 cm w x 20.3 cm d)

861-D,-E,: 5 in. h x 19-1/8 in. w x 11 in. d (12.7 cm h x 48.5 cm w x 27.9 cm d)

Weight

861-A,-B,-C,-F: 10 lb (4.54 kg) (approx)
861-D,-E: 27 lb (12.26 kg) (approx)

Cooling Method

Convection

Mounting

Rack (standard 19 in.)

Ambient Temperature

Operating

861-A,-B,-C,-F: 0° to +60° C

861-D,-E: 0° to +70° C

Storage

-40° to 71° C

Relative Humidity

95% max (no condensation)

Altitude

861-A,-B,-C,-F: 10,000 ft (max)
861-D,-E: 8000 ft (max)

1.2.2 Electrical

Input Power

Voltage

861-A,-C,-F: 90 Vac – 135 Vac; 861-B: 180 Vac – 270 Vac; 861-D: 90 Vac – 132 Vac; 861-E: 180 Vac – 264 Vac

Phase

861-A: Two (120° or 180° displaced); 861-B,-C,-F: Single; 861-D,-E: Three (120° displaced)

Frequency

47 Hz – 63 Hz

Current

861-A: 16A per pole; 861-B: 16A per pole; 861-C: 24A per pole; 861-D: 24A per pole; 861-E: 15A per pole; 861-F: 12A per pole.

Power Requirements

Full Load

861-A: 3830 VA; 861-B: 3830 VA; 861-C: 2870 VA; 861-D: 8640 VA; 861-E: 10,800 VA; 861-F: 1435 VA

No Load

861-A,-B,-C,-D,-E,-F: 10 VA

Inrush Current Capability

240 A peak, 1 cycle

Leakage Current

861-D: 1.75 mA max. 861-E: 3.5 mA max.

Input Overvoltage Transient

180/360 V, 1 sec (power controller alone)

Activate Time

20 ms (from switch closing to power out)

Deactivate Time

10 ms (from switch opening to power out)

Input Breaker

861-A,-B,-C: 20 A delayed action, manual reset, magnetic
861-D: 30 A delayed action, manual reset, magnetic
861-E: 15 A delayed action, manual reset, magnetic
861-F: 10 A delayed action, manual reset, magnetic

Thermoswitch

Opens at 160°F, automatically resets at 120° F, 49° C (exposed to ambient air external to controller)

Input Power Connector
861-A: 4-prong twist plug, NEMA* L14-20P; 861-B: 3-prong twist plug NEMA L6-20P; 861-C: 3-prong twist plug NEMA L5-30P; 861-D: 5-prong twist plug, NEMA L21-30P; 861-E: pressure fit terminal block; 861-F: 3-prong standard plug NEMA L5-15P.

Hipot
2.1 kVdc for 60 sec (input and output to chassis).

Remote Switching Control Connectors
3 each: Female, AMP 1-480304-0 (DEC-12 09350-03) with AMP 61117-4 (DEC-12-09379) pins or equivalent that mate with AMP 1-480305-0 (DEC-12-09351) with AMP 61118-4 (DEC-12-09378) pins or equivalent

Input Signal Current Levels
861-A,-B,-C,-F: 0.5 mA (min), 10 mA (max); 861-D,-E: 0.5 mA (min), 40 mA (max) load worst case to each bus signal line when connected to pin 3.

Input Signal Voltage Levels
861-A,-B,-C,-F: 3.0 V max = low; +35 V min = high (open circuit = high); 861-D,-E: +3.0 V max = low; +32 V min = high. Worst case to each bus signal line in relation to pin 3.

Bus Signal Line Overload Capability
125 Vac rms @ 60 Hz, 13 kΩ impedance in relation to pin 3 for two seconds with no damage

Power Control Impedance
Inductive (diode suppressed)

Capacitance
200 pF (max)

Output (861-A,-B,-C,-F)
Outlets (power)
Twelve (8 switched, 4 unswitched)

Outlet Current Ratings
861-A: 12 A per outlet, 16 A per branch circuit, 32 A total; 861-B: 12 A per outlet, 16 A total; 861-C: 12 A per outlet, 16 A per branch circuit, 24 A total; 861-F: 6 A per outlet, 8 A per branch circuit, 12 A total.

Outlet Inrush Current
861-A: 240 A peak per branch circuit (1 cycle), 480 A peak total (1 cycle); 861-B: 240 A peak total (1 cycle); 861-C: 240 A peak per branch circuit (1 cycle), 360 A peak total (1 cycle); 861-F: 120 A peak per branch circuit (1 cycle), 180 A peak total (1 cycle).

Output (861-D,-E)
Outlets (power)
Fourteen (10 switched, 4 unswitched)

Outlet Current Ratings
861-D: 15 A per outlet, 24 A per phase, 72 A total; 861-E: 12 A per outlet, 15 A per phase, 45 A total.

Outlet Inrush Current
240 A peak per branch circuit (1 cycle)

All provisions of Underwriters Laboratories Specification UL-478 have been met in the design and manufacture of the 861-A, 861-B, 861-C, 861-D, 861-E and 861-F Power Controllers.

*National Electrical Manufacturer's Association

CHAPTER 2
INSTALLATION

2.1 SITE CONSIDERATIONS

The dimensions of the 861-A,-B,-C, and -F Power Controllers are identical. Each is contained on a 19-inch panel intended for mounting on a rack or in a cabinet that accepts standard 19-inch panels. Each power controller requires 5-1/4 inches of vertical mounting space and extends approximately 8 inches into the mounting rack or cabinet. For convenience, the power controller should be mounted as close as feasible to the units it controls.

The dimensions of the 861-D and -E Power Controllers are identical. Each is contained on a 19-inch panel intended for mounting on a rack or in a cabinet that accepts standard 19-inch panels. Each power controller requires 5-1/4 inches of vertical mounting space and extends approximately 11 inches into the mounting rack or cabinet. For convenience, the power controller should be mounted as close as feasible to the units it controls.

Ambient temperature at the installation site should not exceed +60°C; for the 861-A,-B,-C,-F or +70° C for the 861-D,-E; relative humidity should remain below 95 percent, with no condensation. For other environmental particulars, refer to Paragraph 1.2.

2.2 CABLES

Each power controller requires the following cables:

a. Input Power (provided with 861-A,-B,-C,-D,-F only)

b. Remote Switching Control, DEC No. 70-08288, 70-10695, or equivalent (not provided)

c. Output Power (provided with controlled units)

These cable assemblies are described in the following paragraphs.

2.2.1 Input Power

The type of input power cable depends on which version of the power controller is being installed. Table 2-1 describes the input power cables. Cables supplied are 15 feet in length and are composed of insulated stranded conductors. (Cables with a grounded shield braid are recommended for EMI/RFI protection.)

The power cable connector types provided also differ depending upon which 861 version is being installed. Table 2-2 lists the plug and receptacle types with NEMA and DEC designations. Figure 2-1 shows the power connector outlines and provides color coding information.

The input power cable connects to the 4-terminal block at the side of the line filter. In 861-A installations, the following connections must be made:

a. Green – N (Earth Ground)
b. Black – C (Phase 2)
c. White – B (Neutral)
d. Red – A (Phase 1)

In 861-B installations the following connections must be made:

a. Green – N (Earth Ground)
b. White – B (Phase or Neutral)
c. Black – C (Phase or Neutral)
d. No Connection – A

Table 2-1
Input Power Cables

Controller	Conductors	Size	Coding
861-A	4	#12 AWG	Green, black, white, red
861-B	3	#14 AWG	Green, black, white
861-C	3	#12 AWG	Green, black, white
861-D	5	#10 AWG	Green/yellow, black, white, red, orange
861-E	5	#14 AWG (Shielded)	Green/Yellow, black, black, brown, blue (not provided)
861-F	3	#14 AWG	Green, black, white

Table 2-2
Input Power Cable Connectors

		NEMA No.	DEC No.
861-A	4-Prong Twist Plug	L14-20P	12-11045
	4-Prong Twist Receptacle	L14-20R	12-11046
861-B	3-Prong Twist Plug	L6-20P	12-11192
	3-Prong Twist Receptacle	L6-20R	12-11191
861-C	3-Prong Twist Plug	L5-30P	12-11193
	3-Prong Twist Receptacle	L5-30R	12-11194
861-D	5-Prong Twist Plug	L21-30P	12-12314
	5-Prong Twist Receptacle	L21-30R	12-12315
861-E	(Not provided)		
861-F	3-Prong Plug	L5-15P	90-08938
	3-Prong Receptacle	L5-15R	12-05351

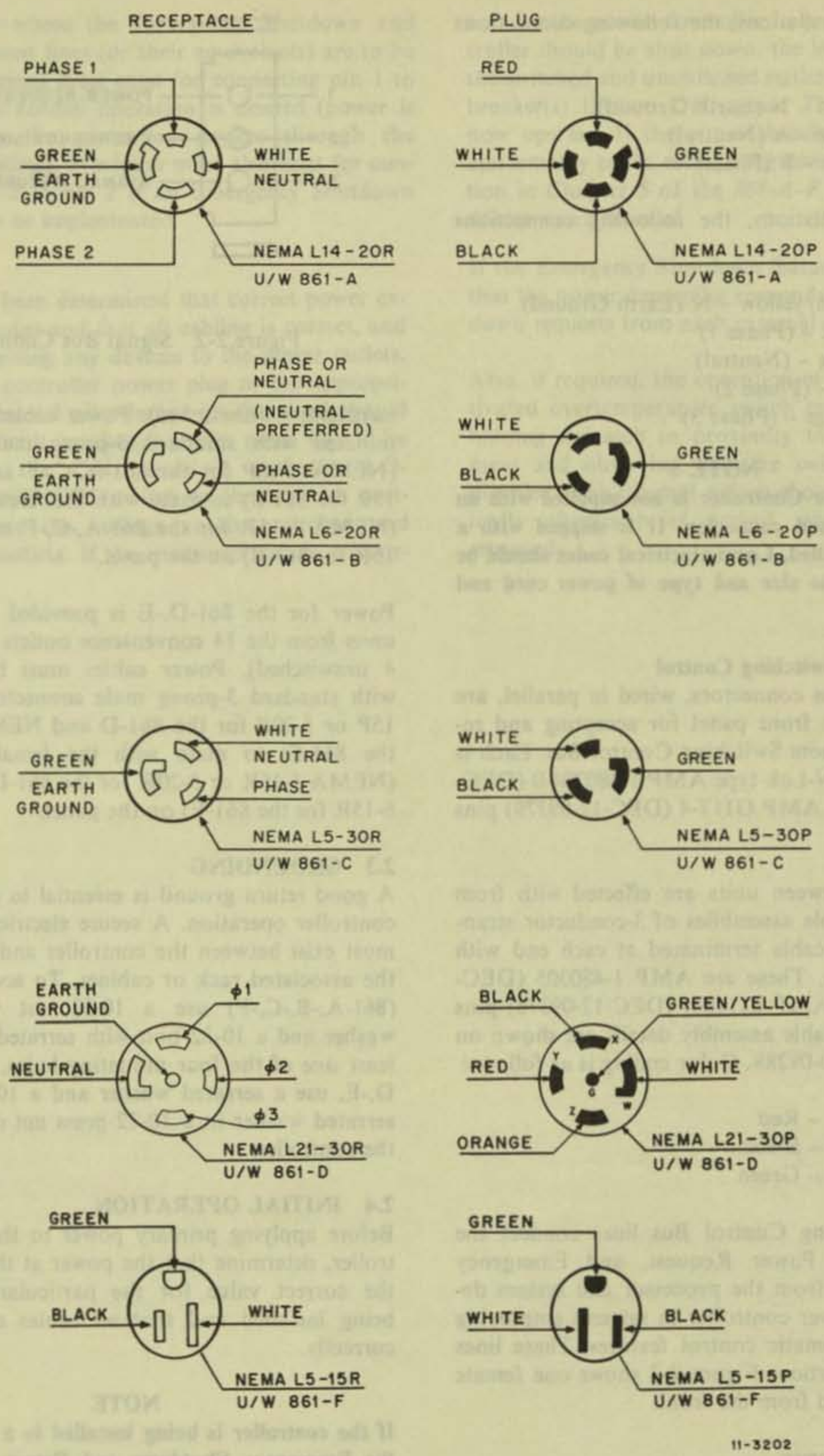


Figure 2-1 Connector Wiring

In 861-C,-F installations, the following connections must be made:

a. Green - N (Earth Ground)
b. White - A (Neutral)
c. Black - B (Phase)

In 861-D installations, the following connections must be made:

a. Green/yellow - N (Earth Ground)
b. Black - (Phase 1)
c. White - (Neutral)
d. Red - (Phase 2)
e. Orange - (Phase 3)

NOTE

The 861-E Power Controller is not supplied with an ac power cord and connector. It is shipped with a strain relief installed. Local electrical codes should be referenced for the size and type of power cord and connector used.

2.2.2 Remote Switching Control

Three female bus connectors, wired in parallel, are provided on the front panel for accepting and rerouting the Remote Switching Control Bus. Each is an AMP Mate-N-Lok type AMP 1-480304-0 (DEC-12-0-350-3) with AMP G117-4 (DEC-12-09379) pins or equivalent.

Connections between units are effected with from one to three cable assemblies of 3-conductor stranded #22 AWG cable terminated at each end with male connectors. These are AMP 1-480305 (DEC-12-09351) with AMP 61118-4 (DEC-12-09378) pins or equivalent. Cable assembly details are shown on drawing DEC-70-08288. Color coding is as follows:

a. Pin 1 - Red
b. Pin 2 - Black
c. Pin 3 - Green

Remote Switching Control Bus lines connect the Signal Return, Power Request, and Emergency Shutdown lines from the processor and system devices to the power controller in systems employing compatible automatic control features. These lines are low for assertion. Figure 2-2 shows one female connector viewed from the front.

2.2.3 Output Power

Power for the 861-A,-B,-C,-F is provided to controlled units from the 12 convenience outlets (8 switched, 4 unswitched). Power cables must be terminated with standard 3-prong male connectors (NEMA 5-15P for the 861-A,-C,-F and NEMA 6-15P for 861-B) to mate with the female connectors (NEMA 5-15R for the 861-A,-C,-F and NEMA 6-15R for 861-B) on the panel.

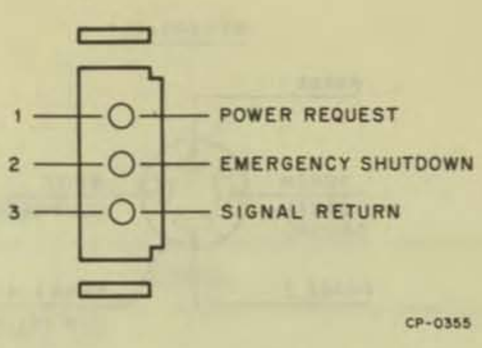


Figure 2-2 Signal Bus Connector

Power for the 861-D,-E is provided to controlled units from the 14 convenience outlets (10 switched, 4 unswitched). Power cables must be terminated with standard 3-prong male connectors (NEMA5-15P or 5-20P for the 861-D and NEMA 6-15P for the 861-E) to mate with the female connectors (NEMA 5-15R or 5-20R for the 861-D and NEMA 6-15R for the 861-E) on the panel.

2.3 GROUNDING

A good return ground is essential to proper power controller operation. A secure electrical connection must exist between the controller and the frame of the associated rack or cabinet. To accomplish this, (861-A,-B,-C,-F) use a 10-32 nut with serrated washer and a 10-32 bolt with serrated washer in at least one of the four mounting holes. For the 861-D,-E, use a serrated washer and a 10-32 bolt with serrated washer in a 10-32 press nut on the rear of the controller.

2.4 INITIAL OPERATION

Before applying primary power to the power controller, determine that the power at the mains is of the correct value for the particular 861 version being installed and that all cables are connected correctly.

NOTE

If the controller is being installed in a system where the Emergency Shutdown and Power Request lines are not in use, the LOCAL/OFF/REMOTE switch must be in the LOCAL position.

In systems where the Emergency Shutdown and Power Request lines (or their equivalents) are to be used, provisions must exist for connecting pin 1 to pin 3 when normal operation is desired (power is supplied to the controlled devices through the switched outlets). Provision must also exist for connecting pin 3 to pin 2 if an Emergency Shutdown feature is to be implemented.

Once it has been determined that correct power exists at the mains and that all cabling is correct, and before connecting any devices to the power outlets, connect the controller power plug to the appropriate receptacle. All pilot lamps on the panel should light. The circuit breaker(s) on the panel should be thrown to the ON position and the LOCAL/OFF/REMOTE switch to the LOCAL position. Measure the voltage at the switched and unswitched outlets. If the measured values are correct for the power controller in use, the power controller should be shut down, the loads connected to the switched and unswitched outlets*, and the circuit breaker(s) thrown ON again. The system should now operate. If the circuit breaker trips, or other abnormality exists, refer to the maintenance information in Chapter 5 of the *861-A-F Power Controller Maintenance Manual.*

If the Emergency Shutdown feature is in use, check that the power controller responds properly to shutdown requests from each external device.

Also, if required, the operation of the thermally-activated overtemperature switch can be checked by holding a match in proximity to the sensing element and observing that the switched outlets are disabled. The thermal switch should reset automatically after a brief period, once the flame is removed.

*Loads should be balanced between circuits.

CHAPTER 3
OPERATION

3.1 CONTROLS AND INDICATORS

Figure 3-1 shows the front panels for the 861-A, 861-B and 861-C Power Controllers. Each version has two pilot lamps, a circuit breaker, a 3-position toggle switch, and several power outlets. Their functions are discussed in the following paragraphs.

Figure 3-2 shows the front and back panels for the 861-D and 861-E Power Controllers. Each version has three pilot lamps, a main circuit breaker, a 3-position toggle switch, and several power outlets. In addition, the 861-D has six branch circuit breakers. Their functions are discussed in the following paragraphs.

Figure 3-3 shows the front panel for the 861-F Power Controller. Controls, indicators and outlets are the same as for the 861-C.

3.1.1 Pilot Lamps

In all 861 Power Controller versions, all pilot lamps are lighted whenever the controller input power cable is connected to the live mains, regardless of the position of the power controller circuit breaker or LOCAL/OFF/REMOTE switch.

3.1.2 Circuit Breaker

Circuit breaker CB1, when ON, provides power to the unswitched outlets, and to the switched outlets when the LOCAL/OFF/REMOTE switch is in the LOCAL position (or in the REMOTE position and a connection exists between pins 1 and 3 of a Remote Switching Control Bus connector*). The circuit breaker opens automatically when an overload condition exists at a power outlet or within the power controller.

*A connection between pins 2 and 3 of the Remote Switching Control Bus disables the switched outlets, regardless of the position of the LOCAL/OFF/REMOTE switch.

The following are the outlet current ratings:

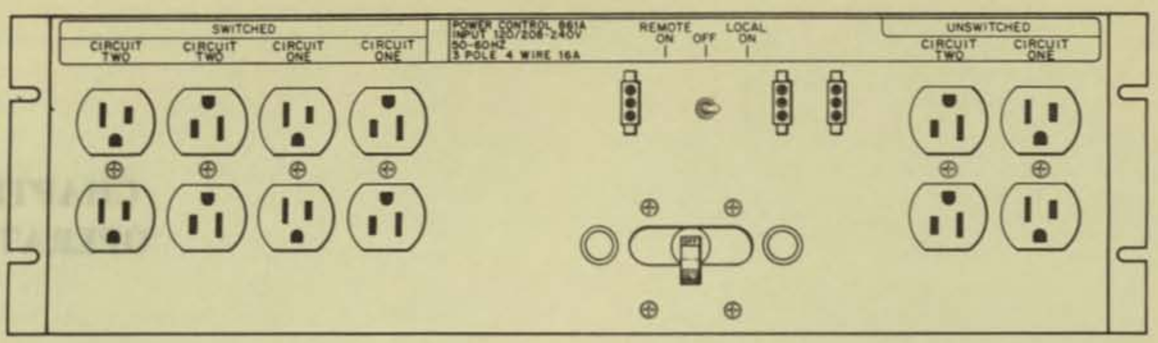
Version	Per Outlet	Per Branch/Phase	Total
681-A	12A	16A	32A
681-B	12A	16A	16A
861-C	12A	16A	24A
861-D	15A	24A	72A
861-E	12A	15A	45A
861-F	6A	8A	12A

3.1.3 LOCAL/OFF/REMOTE Switch

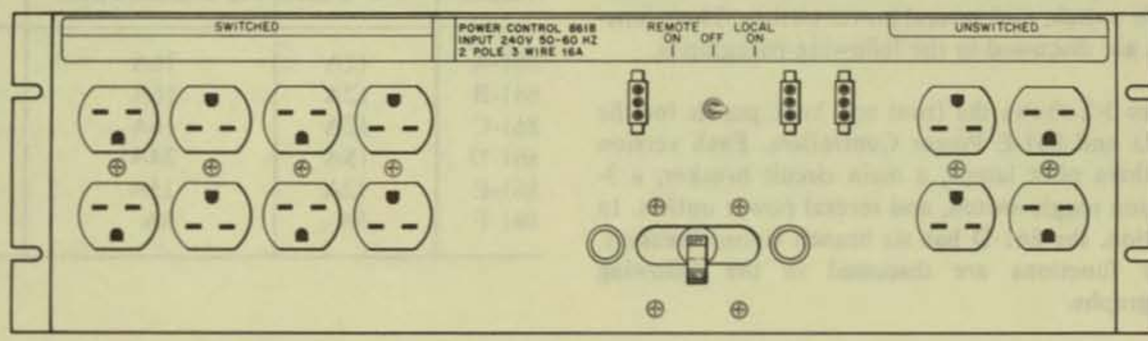
The LOCAL/OFF/REMOTE switch provides the Remote Switching Bus with the means to control the power to the switched outlets. When the power controller is energized and the switch is in the OFF position, the switched outlets are disabled. When in the REMOTE position and connected to a bus where Power Request and Emergency Shutdown are in use (or a means of effecting connection between pin 3 and pins 1 or 2 exists), the switched outlets are enabled or disabled in accordance with conditions on the bus. When in the LOCAL position, the switched outlets are enabled only when the Emergency Shutdown signal is not asserted.

3.1.4 Remote Switching Control Bus Connectors

The three female Signal Bus connectors, adjacent to the LOCAL/OFF/REMOTE switch, are wired in parallel. These connectors provide a means of daisy-chaining the Remote Switching Control Bus between the controller and system devices.



861-A



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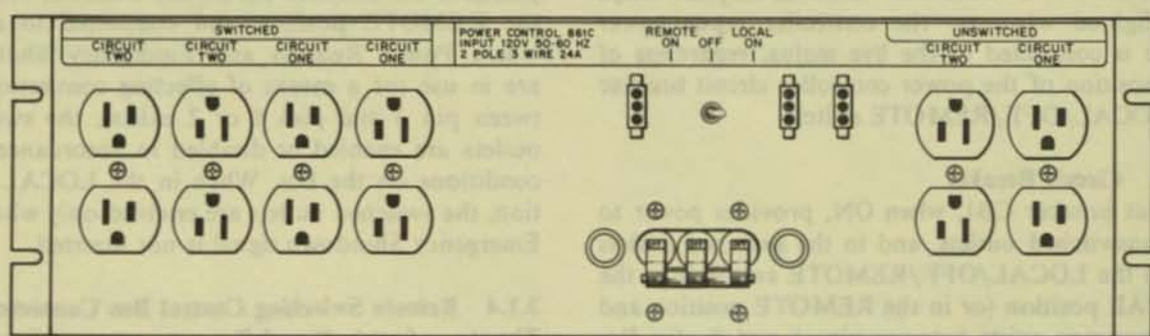
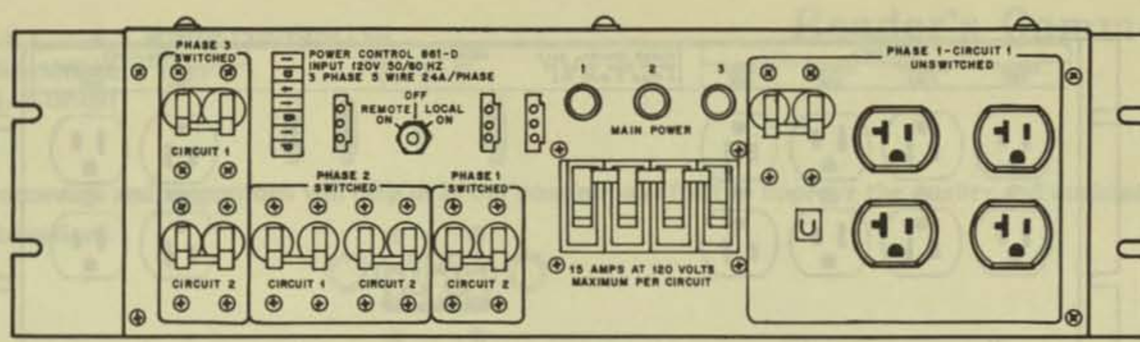
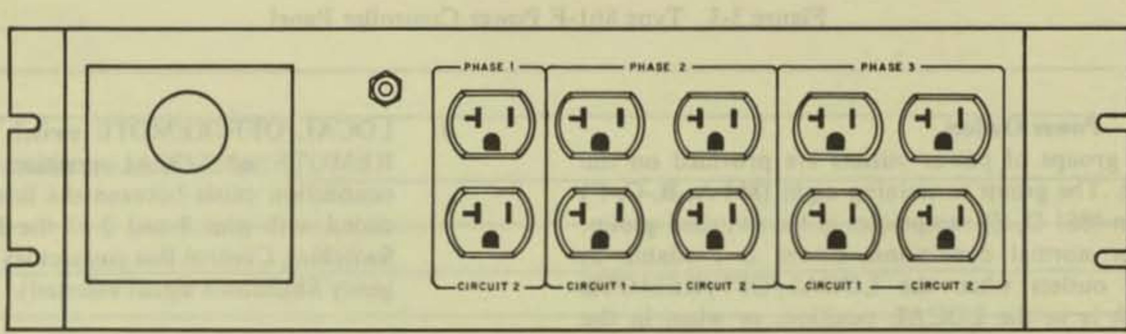


861-C

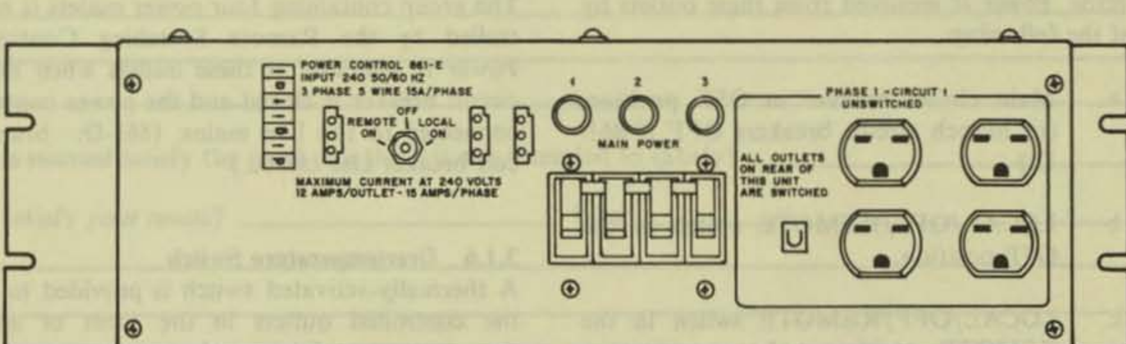
Figure 3-1 Type 861-A,-B,-C Power Controller Panels



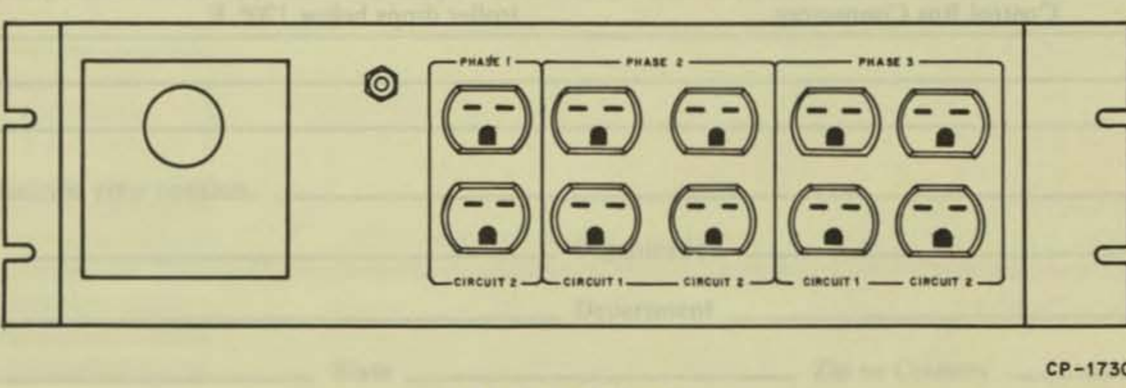
861-D (Front Panel)



861-D (Back Panel)



861-E (Front Panel)



861-E (Back Panel)

Figure 3-2 Type 861-D,-E Power Controller Panels

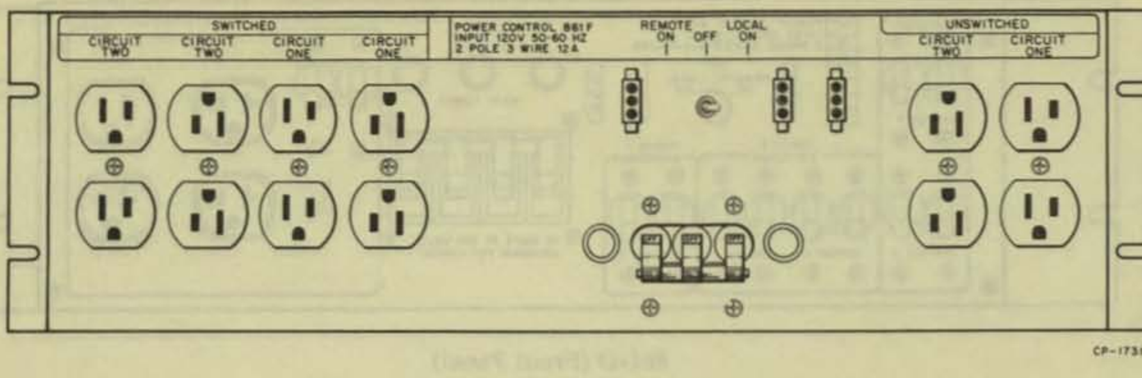


Figure 3-3 Type 861-F Power Controller Panel

3.1.5 Power Outlets

Two groups of power outlets are provided on the panel. The group containing eight (861-A,-B,-C,-F) or ten (861-D,-E) receptacles is the switched group. Under normal conditions, power is available at these outlets when the LOCAL/OFF/REMOTE switch is in the LOCAL position, or when in the REMOTE position and a connection exists between pins 1 and 3 of the Remote Switching Control Bus connector. Power is removed from these outlets by any of the following:

a. Main circuit breaker in OFF position, (or branch circuit breakers OFF if 861-D.)

b. LOCAL/OFF/REMOTE switch in the OFF position.

c. LOCAL/OFF/REMOTE switch in the REMOTE position and no connection exists between the lines associated with pins 1 and 3 of the Remote Switching Control Bus Connectors.

d. LOCAL/OFF/REMOTE switch in the REMOTE or LOCAL position and a connection exists between the lines associated with pins 3 and 2 of the Remote Switching Control Bus connectors (Emergency Shutdown signal asserted).

e. Overtemperature switch closed.

The group containing four power outlets is not controlled by the Remote Switching Control Bus. Power is available at these outlets when the main circuit breaker is closed and the power controller is connected to the live mains. (861-D: branch circuit breaker also closed.)

3.1.6 Overtemperature Switch

A thermally-activated switch is provided to disable the controlled outlets in the event of an overtemperature condition at the power controller. The switch opens at 160° F and resets automatically when the ambient temperature at the power controller drops below 120° F.

861-A, B, C, D, E, F POWER CONTROLLER
USER'S MANUAL
EK-861AB-OP-001

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RA81 USERS

EK-0RA81-UG-001

RA81 Disk Drive User Guide

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EK-0RA81-UG-001

RA81 Disk Drive User Guide

Prepared by Educational Services
of
Digital Equipment Corporation

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- **Class A Computing Devices:**

Notice: This equipment generates, uses, and may emit radio frequency energy. The equipment has been type tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such radio frequency interference when operated in a commercial environment. Operation of this equipment in a residential area may cause interference in which case the user at his own expense may be required to take measures to correct the interference.

CONTENTS

Page

Page

FIGURES (Cont)

TABLES

CHAPTER 1
INTRODUCTION

1.1 PURPOSE AND SCOPE

This manual describes the RA81 Disk Drive and tells how to install, checkout, and operate the equipment.

This manual is written primarily for the RA81 user except for Chapter 2 which is only for qualified field service personnel.

1.2 GENERAL INFORMATION

The RA81 is a random-access, moving-head disk drive with non-removable media using a head/disk assembly (HDA). The HDA, a key feature of this drive, protects data and improves hardware dependability. The RA81 has a data storage capacity of 456 megabytes in 16-bit word format. The RA81 connects to the controller via the Standard Disk Interconnect (SDI) bus and may be used with any controller implementing this bus. Additional disk drives can be connected to a controller to increase the data storage capacity. The RA81 can also be connected in a dual-port arrangement permitting time-shared access by two controllers.

Performance Features

- 17.4 megabit per second peak transfer rate
- 28 ms average positioning rate
- 8.3 ms average rotational latency

Data Integrity

- Protected media
- Microprocessor-controlled servo
- Automatic error correction

Hardware Features

- Simple modular construction
- Rugged design
- Extensive microcode diagnostics

NOTE

Like other fixed-media devices, some method of backup should be used to prevent loss of data in the event of a failure. The following methods are recommended.

File Duplication–Important files should be duplicated often. Usually, this will involve copying the data on a removable medium such as magnetic tape.

Journaling–The use of journaling is recommended in transaction processing applications. This method allows reconstruction of files up to the last checkpoint or backup.

1.3 DRIVE DESCRIPTION

The RA81 is a self-contained disk drive with a built-in cooling system and dc power supply. See Figure 1-1. The drive has optional slide rails and is designed to be inserted into a 19-inch wide RETMA equipment rack. Up to three drives (one fixed mounted and two mounted on slides) can be included in a single cabinet. An RA81 Disk Drive subsystem is made up of an SDI controller (two controllers with the dual-port configuration) and one or more disk drives. Figure 1-2 shows the relationship between the subsystem components.

All RA81 disk logic is included within the drive. Three of the primary circuit modules (servo, microprocessor, and personality) are located directly under the logic access cover on top of the cabinet. These three modules are mounted on hinges for ease of service. See Figure 1-3.

DC operating power for the logic circuits is provided by the drive power supply located inside the back of the drive. Internal fans provide the necessary cooling for the power supply and for other drive components. The RA81 Disk Drive conforms to UL, CSA, FCC, and VDE standards.

1.3.1 Head Disk Assembly

The sealed HDA contains the recording media (four platters), rotary positioner, read/write heads, and preamplifiers. Seven of the platter surfaces are used for recording data. The eighth has dedicated servo information used for positioning the read/write heads. The rotary positioner in the HDA is controlled by a slave microprocessor closed-loop servo system. The RA81 uses both dedicated and embedded servo for head positioning. This dual arrangement allows for coarse cylinder positioning from the dedicated servo surface and fine cylinder positioning from embedded servo bursts which are read preceding each block of data. The dedicated servo surface and the embedded servo data are written on the disk at the time the HDA is manufactured.

1.3.2 Internal Drive Diagnostics

Two groups of internal diagnostics are used in the RA81 to permit error detection and fault isolation. The first group of diagnostics is run automatically during the power-up sequence to validate initial operations. Error codes for this test are displayed by indicators on the operator control panel. The second set of diagnostics is initiated and monitored through a diagnostic terminal as a maintenance function in the off-line mode. These microcode diagnostics are for field service use only and are not part of the normal operating functions.

The RA81 has a dual microprocessor (master and slave) control system. The master is located on the microprocessor module and the slave is located on the servo module. One microprocessor handles real-time functions, such as servo control, while the other controls status checking. Both microprocessors share the diagnostic responsibilities.

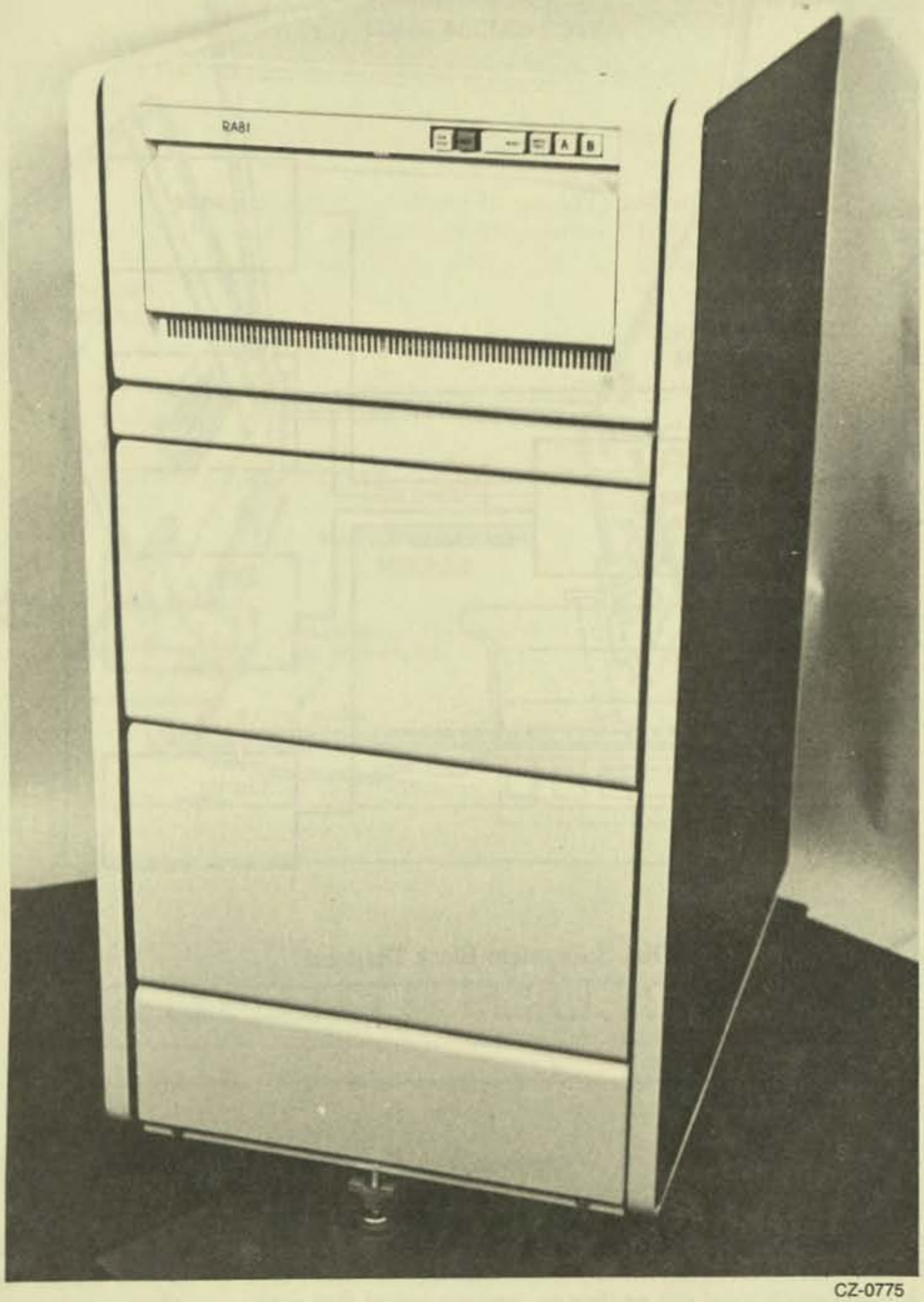

Figure 1-1 The RA81 Disk Drive

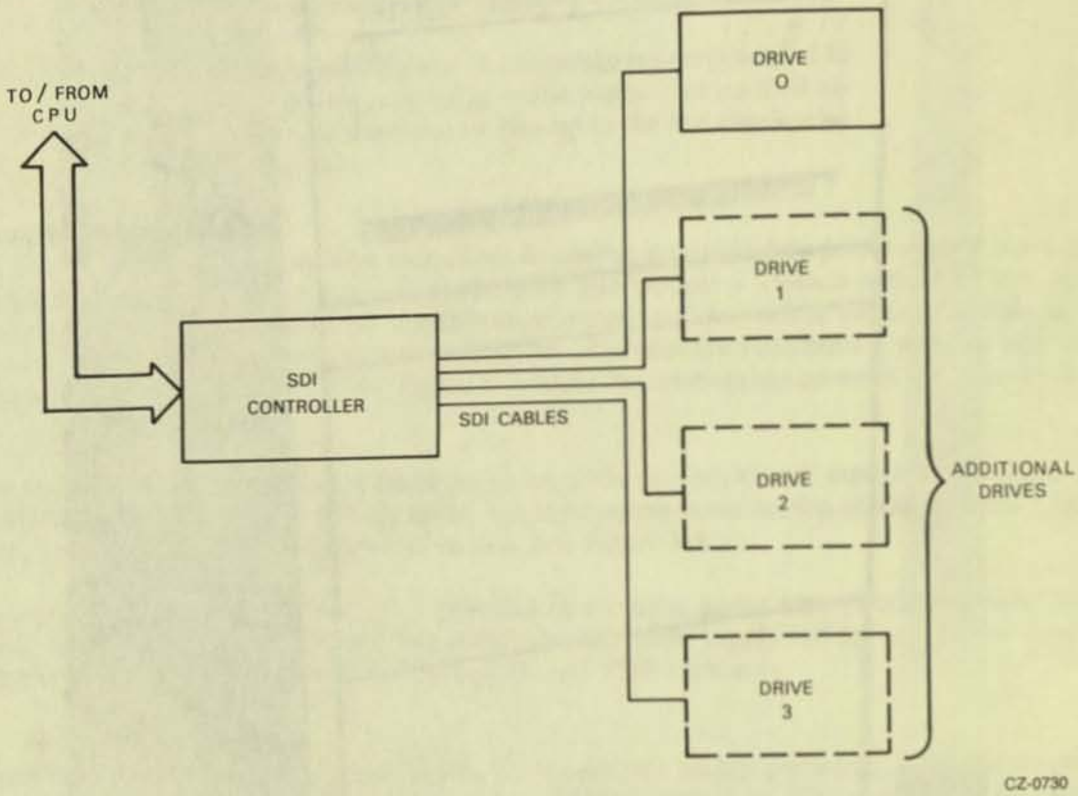

Figure 1-2 Basic RA81 Disk-Subsystem Block Diagram

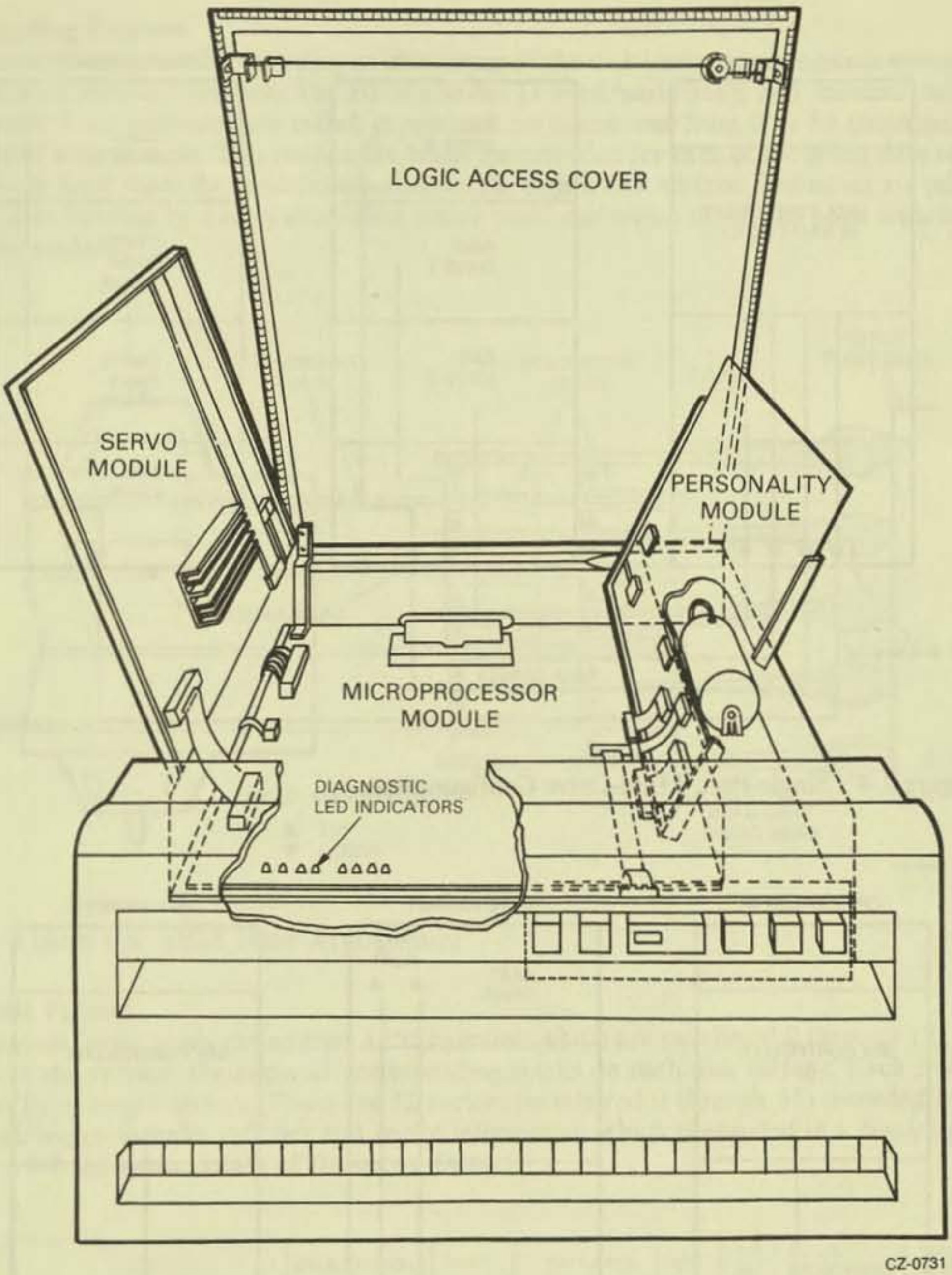

Figure 1-3 Hinged Circuit-Module Arrangement

Except for the read and write operations, the dual microprocessors control and/or monitor all of the primary functions of the disk drive. This includes operation of the front-panel switches and indicators, drive safety monitors, retry conditions, error and status storage, as well as the basic drive control loop.

1.3.3 Multi-Drive and Dual-Port Capability

Multiple disk drives (the number depends on the type of controller used) can be operated from a single controller for added storage capacity (Figure 1-4). Also, a dual-port feature permits a second controller to be connected to permit time-shared access of the subsystem between the two controllers. See Figure 1-5.

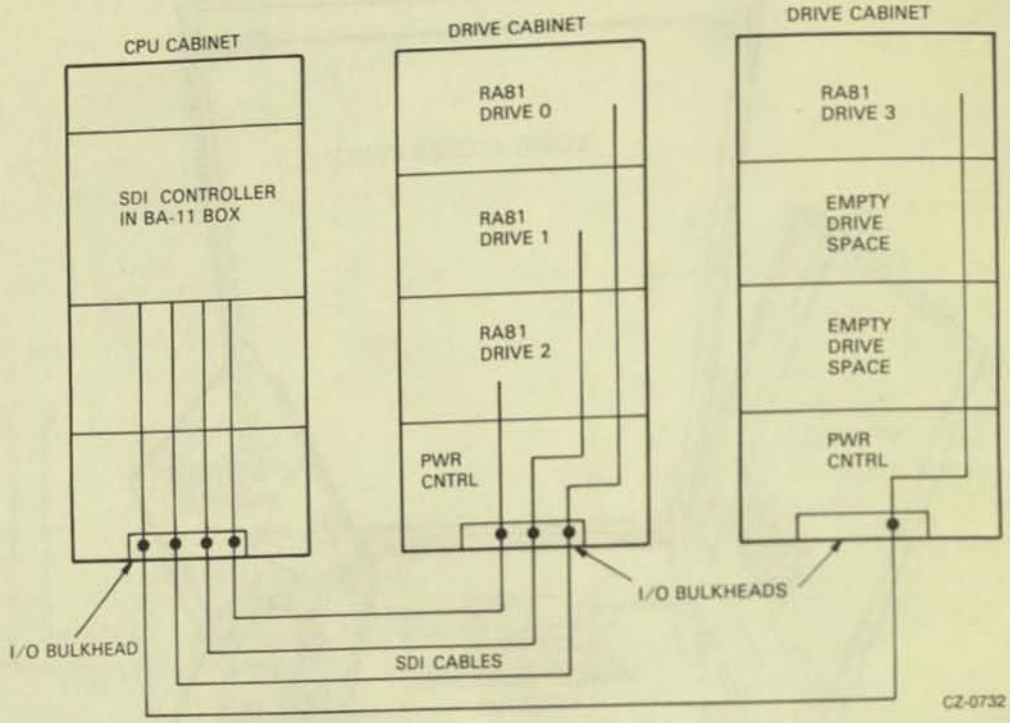

Figure 1-4 Single-Port, Multi-Drive Configuration

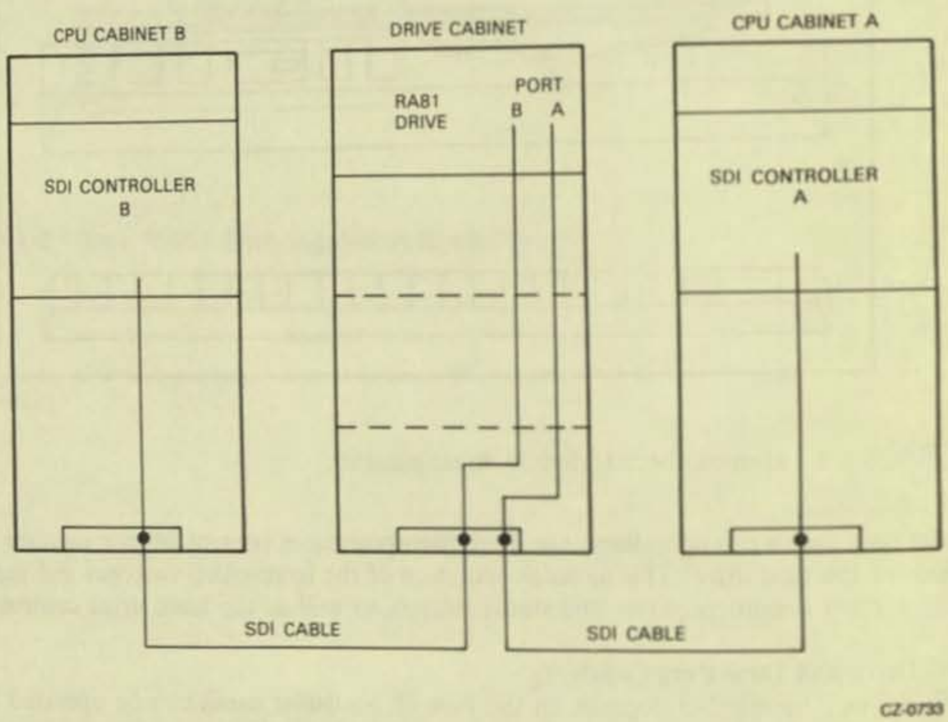

Figure 1-5 Dual-Port Configuration

1.3.4 Recording Features

Four disk platters comprise the recording media. Seven of the disk surfaces are for data storage; the eighth contains encoded servo information. The HDA also has 14 read/write heads and one read-only servo head. The read/write head addresses are called groups and are numbered from 0 to 13 (decimal). Figure 1-6 shows the head arrangement. Two read/write heads are provided for each of the seven data surfaces and a single read-only head reads the servo information on the eighth disk surface. The heads are positioned over the desired data location by a servo-controlled rotary positioner which moves the head arms in an arc over the recording surface.

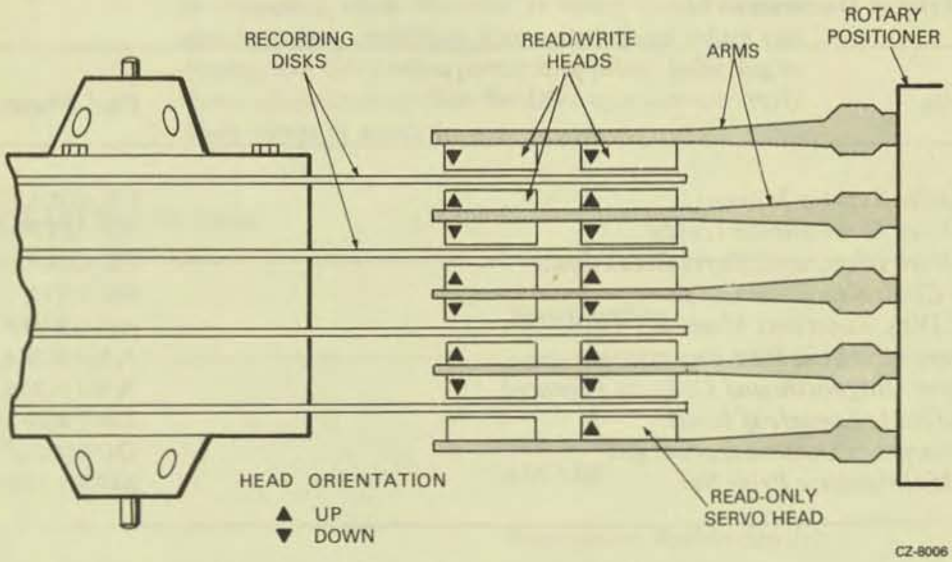

Figure 1-6 HDA Head Arrangement

1.3.5 Media Format

Each of the read/write heads can address 1258 cylinders which are numbered 0 through 1257. A cylinder is made up of the vertical alignment of corresponding tracks on each disk surface. Each track, in turn, is divided into fixed-length sectors. There are 52 sectors (numbered 0 through 51) recorded in 16-bit word format. Each sector includes cylinder and sector information which is encoded in a header preceding the data. Figure 1-7 shows the details of the sector format.

SECTOR PULSE	HEADER			DATA PREAMBLE	SYNC	DATA FIELD	EDC	ECC + FILL	DATA POSTAMBLE	READ-TO-WRITE RECOVERY
1 WORD OF ZEROS	PREAMBLE 12 WORDS OF ZEROS	SYNC CHAR 1 WORD	HEADER 2 WORDS 4 TIMES (8 WORDS)	19 WORDS OF ZEROS	DATA SYNC CHAR 1 WORD	256 WORDS (16-BIT FORMAT)	1 WORD	11 WORDS	1 WORD OF ZEROS	UNDEFINED DATA 37 WORDS

CZ-0734

Figure 1-7 RA81 Sector Format

The RA81 uses a sector offset method to reduce rotational latency. With this method, the controller determines the rotational position of the disk by reading from the header the sector address as well as the head (group) and cylinder address. The sectors are reassigned to optimize the data transfer rate when it becomes necessary to perform a seek during a data transfer.

1.4 RELATED DOCUMENTATION

Table 1-1 lists documents that will add to the information in this user guide. Digital customers may order the following RA81 related manuals from the Accessories and Supplies Group.

Outside the United States, consult local Digital offices. Internal Digital Equipment Corporation customers should order the *RA81 Disk Drive Service Manual* directly from Printing and Circulation Services, 444 Whitney Street, Northboro, MA. 01532. The *RA81 Maintenance Guide* should be ordered from the Software Distribution Center, 20 Forbes Road (NR4), Northboro, MA. 01532.

Table 1-1 Related Documentation

Document Title	Part Number
RA81 Disk Drive Service Manual	EK-ORA81-SV
RA81 Disk Drive Maintenance Guide	AA-M879A-TC
RA81 Disk Drive Illustrated Parts Breakdown	EK-ORA81-IP
UDA50 Disk Controller User Guide	EK-UDA50-UG
MSCP Basic Disk Functions Manual	AA-L619A-TK
Storage System UNIBUS Port Description	AA-L621A-TK
Storage System Diagnostic and Utilities Protocol	AA-L620A-TK
Maintenance Guide Looseleaf Binder	AV-L980A-TK
UDA50 Maintenance Documentation Kit	QP904-GZ *
RA81 Field Maintenance Print Set	MP-01359

* This kit consists of a small looseleaf binder, the *UDA50 Maintenance Guide*, and the current maintenance guides for disks that operate on the UDA50 controller.

Digital customers in the United States may order the above manuals and accessories from the Accessories and Supplies Group over toll free number 800-258-1710. Orders by mail should be addressed to one of the following primary distribution centers.

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1.5 RA81 SPECIFICATIONS

Table 1-2 gives the primary performance, power, environmental, and physical characteristics of the RA81 Disk Drive.

NOTE

The term *operating*, under the specification section of the table, indicates those values that must not be exceeded while the drive is operational. The term *non-operating* indicates those values that must not be exceeded when the drive is being stored or in a non-operating condition. Exceeding these values can damage the drive when power is applied. Adhering to these values ensures that the drive operates correctly when power is applied.

Table 1-2 RA81 Specifications

Characteristic	Specification
Data storage capacity	
(Single drive)	
16-bit word format	456 MB
Media type	Winchester double density
Head disk assembly(HDA)	
Number of disks	4
Disk surfaces	7 data, 1 servo
Number of heads (groups)	14 data, 1 servo
Heads per disk surface	2
Cylinders per head	1258 (numbered 0 through 1257)
Sectors per track	
16-bit word format	52
Servo system	Dedicated and embedded
Performance characteristics	
Disk encoding method	3/2
Linear bit density	11,400 bpi, 8550 flux changes per inch at inner group
Bytes per track (unformatted)	36,352
Transfer rate	17.4 megabits per second
Bit cell period	57 ns (nominal)
Read initialization time	
Write-to-read recovery	10 microseconds (excluding data separator sync)

Table 1-2 RA81 Specifications (Cont)

Characteristic	Specification
Read-to write recovery	1 microsecond
Data separator synchronization	10 microseconds
Rotational latency	
Rotational speed	3600 rpm, +2.5%, −3.5%
Average rotational latency	8.33 ms
Maximum rotational latency	16.66 ms
Head switch latency (switch on a given cylinder)	6 ms maximum
Average seek	28 ms maximum
One cylinder	7 ms maximum
Maximum seek	50 ms (1258 cylinders)
Disk rotation start/stop times	
Start time	20 seconds maximum
Stop time	20 seconds maximum
Maximum start/stop frequency	6 (3 minutes between cycles with drive powered up and ready during one of the 3-minute cycles)
Physical characteristics (Drive only)	
Width (nominal)	44.5 centimeters (17.50 in.)
Depth (nominal)	67.3 centimeters (26.50 in.)
Height (nominal)	26.4 centimeters (10.38 in.)
Weight (approx.)	67.1 kilograms (148 pounds)
Environmental limits	
Temperature	
Operating	10 to 40 degrees C (50 to 104 degrees F) with a temperature gradient of 20 degrees C/hour (36 degrees F/hour)
Non-operating	−40 to +60 degrees C (−40 to +140 degrees F)
Relative humidity	
Operating	10% to 85% (non-condensing) with a maximum wet bulb temperature of 28 degrees C (82 degrees F) and a minimum dew point of 2 degrees C (36 degrees F)

Table 1-2 RA81 Specifications (Cont)

Characteristic	Specification
Shipping and storage	10% to 85% with no condensation
Heat dissipation	644 watts (nominal)
Altitude	
Operating	Sea level to 2400 meters (8000 feet) above sea level. Note: Maximum allowable temperatures are reduced by a factor of 1.8 degrees C/1000 meters (1 degree F/1000 feet) for operation at higher altitude sites
Non-operating and shipping	300 meters (1000 feet) below sea level to 9000 meters (30000 feet) above sea level (actual or by means of cabin pressurization)
Power	
Voltage requirements (Single phase)	
120 volt, 60 Hz drives	90-128 volts ac, 60 plus or minus 1 Hz
220-240 volt, 50 drives	184-256 volts ac, 50 plus or minus 1 Hz
Current requirements	
Starting current for 120 volt ac drives	35 ampere peak surge for 4 seconds
Running current for 120 volt ac drives	7.8 amperes rms at 120 volts
Starting current for 220-240 volt ac drives	18 ampere peak surge for 4 seconds
Running current for 220-240 volt ac drives	3.5 amperes rms at 240 volts
Power requirements	
Starting power for 120 volt ac drives	4200 watts at 120 volts

Table 1-2 RA81 Specifications (Cont)

Characteristic	Specification
Running power for 120 volt ac drives	644 watts at 120 volts
Starting power for 220-240 volt ac drives	4320 watts at 240 volts
Running power for 220-240 volt ac drives	496 watts at 240 volts
Power factor	0.9
Line cord length (from cabinet)	259 cm (8.5 feet)
Plug type	
120 volts,60 Hz	Hubbel No.2611 NEMA No.L5-30P DEC No.12-11193 (See Figure 2-1)
240 volts, 50Hz	Hubbel No.2321 NEMA No.L6-20P DEC No.12-11192 (See Figure 2-1

1.6 RA81 OPTIONS

Table 1-3 lists the RA81 options.

All RA81 options in Table 1-3 include a 12-foot, shielded, inter-cabinet cable. If a longer cable is required because of the dual-access feature, order cable BC06V-12 (12 feet), BC06V-25 (25 feet), BC06V-50 (50 feet),or BC06V-80 (80 feet).

Table 1-3 RA81 Options

Option	Description
RA81-AA	456 MB drive,120 VAC, 60 Hz, no cabinet
RA81-AD	456 MB drive,240 VAC, 50 Hz, no cabinet
RA81-CA	RA81-AA, H9642-AP cabinet, 60 Hz
RA81-CD	RA81-AD, H9642-AR cabinet, 50 Hz
RA81-EA	(3) RA81-AA, H9642-AP cabinet, 60 Hz
RA81-ED	(3) RA81-AD, H9642-AR cabinet, 50 Hz
RUA81-AA	RA81-AA, UDA50, no cabinet
RUA81-AD	RA81-AD, UDA50, no cabinet
RUA81-CA	RA81-CA, UDA50, cabinet
RUA81-CD	RA81-CD, UDA50, cabinet
RUA81-EA	RA81-EA, UDA50, cabinet
RUA81-ED	RA81-ED, UDA50, cabinet
RUA81-JA	RA81-CA, (2) UDA50, cabinet
RUA81-JD	RA81-CD, (2) UDA50, cabinet

CHAPTER 2
INSTALLATION

2.1 SITE PREPARATION AND PLANNING

A certain amount of preparation and planning is necessary before installing the RA81 Disk Drive. The paragraphs that follow discuss some of the points that should be considered.

2.1.1 Environmental Considerations

The RA81 is designed to operate in a business or light industrial environment. Temperature, humidity, and altitude limits must be considered before the drive is installed. Refer to Table 1-2 for figures on environmental characteristics.

2.1.2 Cleanliness

Because the RA81 has a sealed HDA, dust particles should not be able to enter the area where the recording media is located. However, it is still desirable that the equipment be operated in the cleanest environment possible.

2.1.3 Floor Loading

The weight of one RA81 cabinet and disk drive is approximately 148.8 Kg (328 lb) with each additional drive weighing approximately 67.1 Kg (148 lbs). A completely loaded RA81 cabinet (approximately 283 Kg or 624 lbs) should not place any abnormal stress on a raised computer room floor. However, the weight of existing equipment should be considered before installing additional drives.

2.1.4 Heat Dissipation

The heat dissipation of each RA81 may reach approximately 2200 Btu/hour. The approximate cooling requirements for the complete system can be computed by multiplying this figure by the number of drives, adding the heat dissipation figures of the other system components, and then adjusting the total figure to allow for cooling system efficiency and any other factors.

2.1.5 Power and Safety Precautions

WARNING

Hazardous voltages are present inside this equipment. Installation and servicing should be performed by a qualified and trained service person. Bodily injury or equipment damage may result from incorrect servicing. Refer to the *RA81 Service Manual* for proper instructions.

The RA81 will not cause any unusual fire or safety hazards to other computer equipment. The ac power wiring in the computer system should be carefully checked, however, to be sure there is adequate capacity for future expansion. The circuit breaker on the back of the power controller regulates the power to every drive within the cabinet.

2.1.6 AC Power Wiring

The wiring used by Digital Equipment Corporation conforms to UL and other standards listed in Paragraph 1.3. This means the wire used as equipment ground is green and yellow. The ground wire carries no load current (except in an emergency), but does carry leakage current. All equipment is shipped with a grounding connection on its frame. The ac return line (also called the identified conductor, neutral, common, and cold lead) is blue. The ac return line must not be used to ground equipment since its purpose is to conduct current.

The ac input line (brown wire) is also called the hot wire. Its purpose is to supply current to the system. The ac plugs and receptacles used on the RA81 are shown in Figure 2-1.

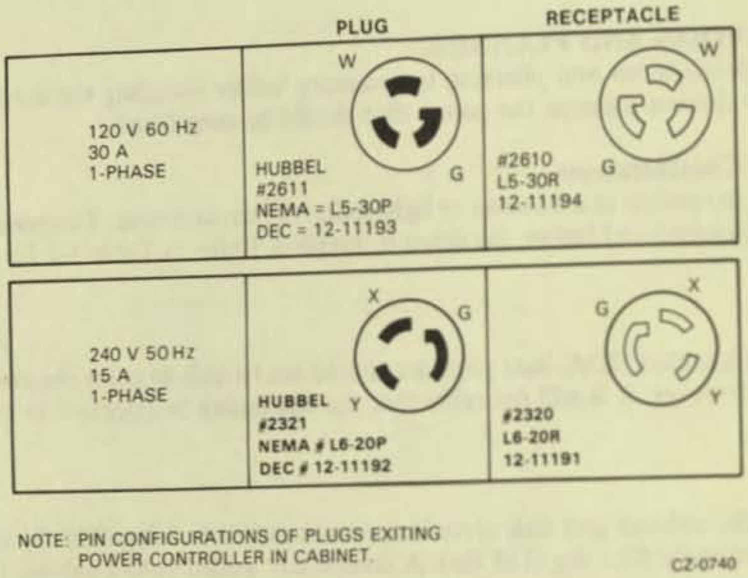

Figure 2-1 RA81 Electrical Plugs and Receptacles

2.2 EQUIPMENT UNPACKING AND EXTERNAL INSPECTION

When delivered, the RA81 equipment is packed in a cardboard container attached to a shipping skid or pallet. Refer to Figure 2-2.

Before unpacking the equipment, check for external shipping damage. Report any damage to the DIGITAL Field Service or Sales Office and to the local carrier. Keep all packing material and receipts when a damage claim is filed.

2.2.1 Unpacking the System on a Shipping Pallet

To unpack the equipment and remove it from the pallet, proceed as follows using Figure 2-2 as a guide.

1. Remove all packing materials.

2. Remove the four shipping bolts that fasten the drive cabinet to the pallet. Refer to the inset in Figure 2-2.

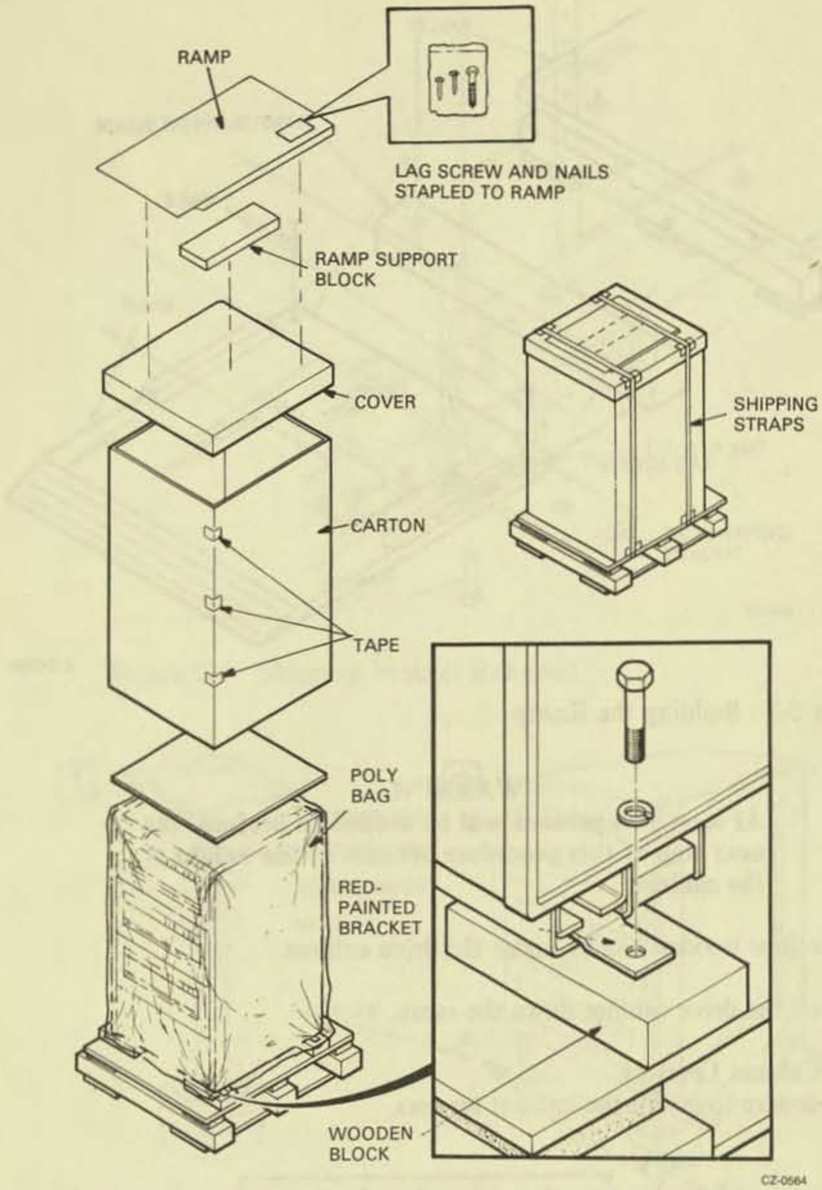

Figure 2-2 Unpacking a System on a Shipping Pallet

3. Build the ramp (Figure 2-3) to aid in rolling the disk drive off the pallet.
   1. Remove the plastic package containing the lag screw and nails from the bottom of the ramp.
   2. Connect the ramp support block to the front of the shipping pallet with the lag screw.
   3. Nail the ramp to the top of its support block using the two nails provided.

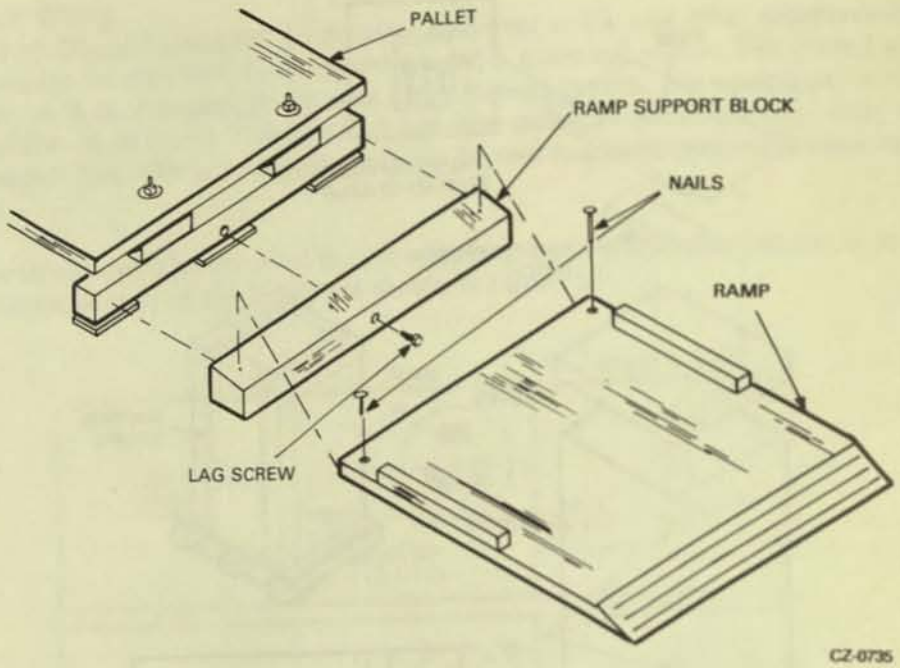

Figure 2-3 Building the Ramp

WARNING
At least two persons will be needed to perform the next step of this procedure because of the weight of the cabinet.

4. Remove the four wooden blocks under the drive cabinet.

5. Carefully roll the drive cabinet down the ramp.

2.2.2 Installing the Cabinet Levelers

Use the following procedure to install the cabinet levelers.

1. Wheel the equipment cabinet to the correct location before installing the levelers.

2. Unbolt and remove the four red shipping brackets and leveler nuts as shown in Figure 2-4.

3. Assemble the four levelers as shown in Figure 2-5. Screw each leveler through the nut until it may be positioned into place without raising the cabinet. See inset in Figure 2-5.

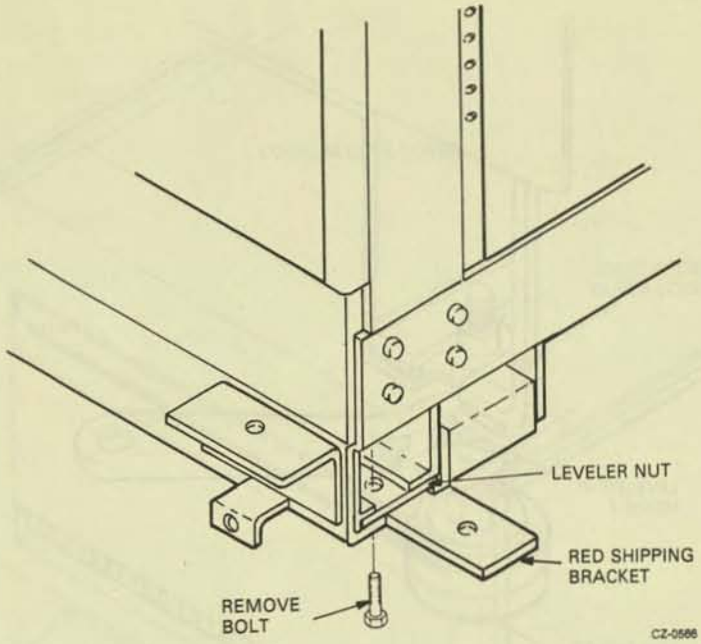

Figure 2-4 Shipping Bracket Removal

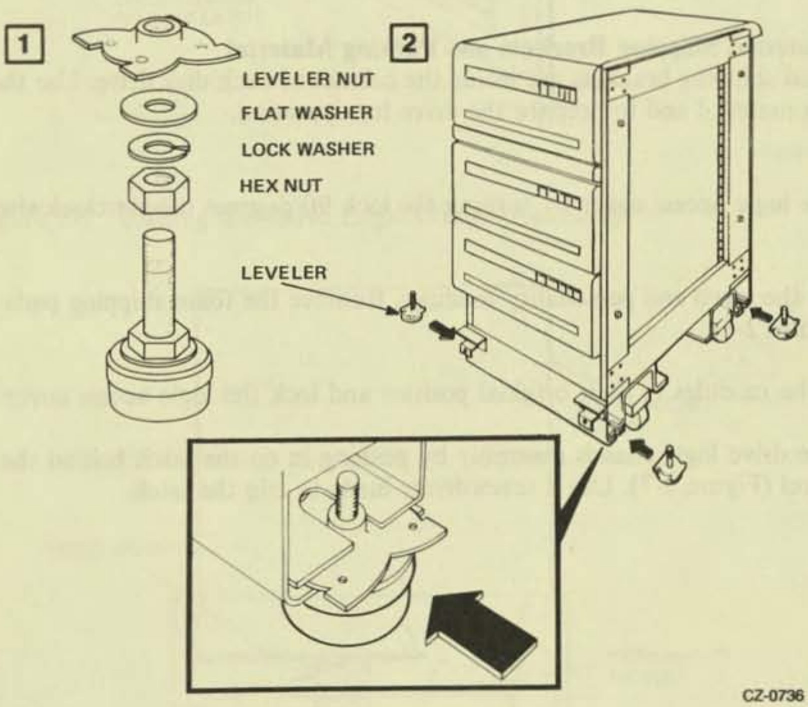

Figure 2-5 Cabinet Leveler Installation

4. Slide the leveler into the slots in the cabinet as shown. Screw the leveler down until solid contact is made with the floor. See Figure 2-6.

5. Adjust until the cabinet is level.

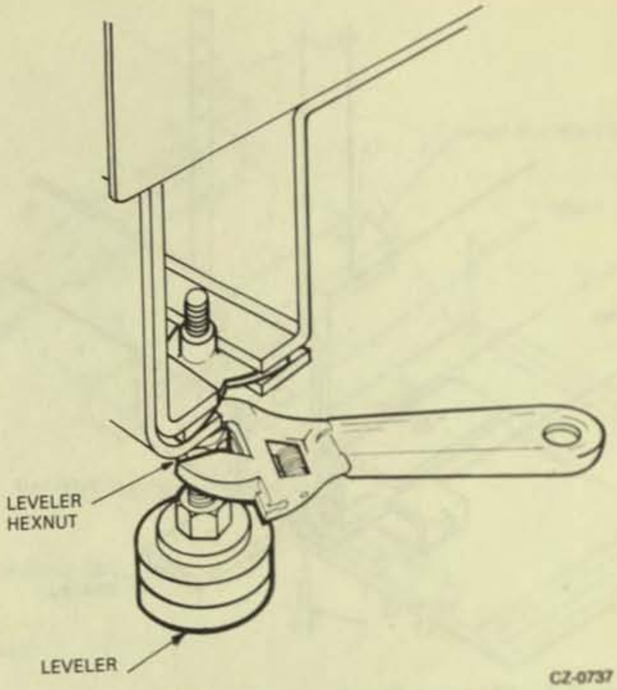

Figure 2-6 Leveler Adjustment

2.2.3 Removing Internal Shipping Brackets and Packing Material

Packing material and shipping brackets are inside the cabinet of each disk drive. Use the following procedure to remove this material and to prepare the drive for operation.

1. Raise the logic access cover by turning the lock 90 degrees counterclockwise. Refer to Figure 2-7.

2. Fold out the servo and personality modules. Remove the foam shipping pads between the modules (Figure 2-8).

3. Return the modules to their original position and lock the logic access cover back in place.

4. Raise the drive logic chassis assembly by pushing in on the latch behind the center slot in the front bezel (Figure 2-7). Use a screwdriver blade to trip the latch.

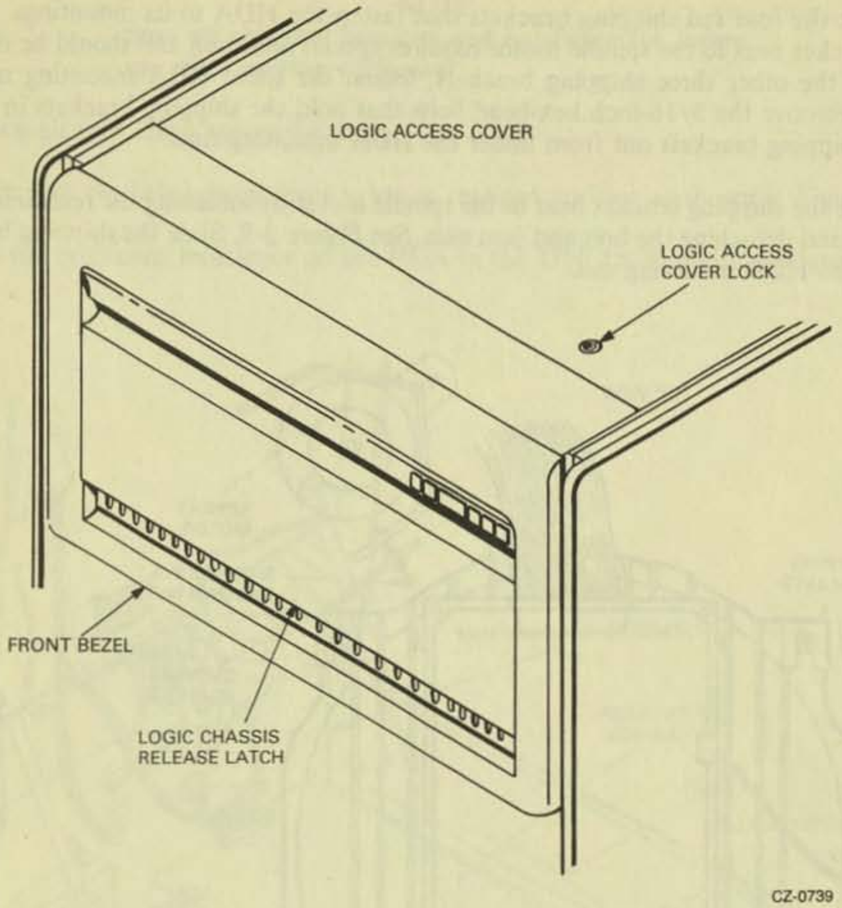

Figure 2-7 Raising the Drive Logic Chassis Assembly

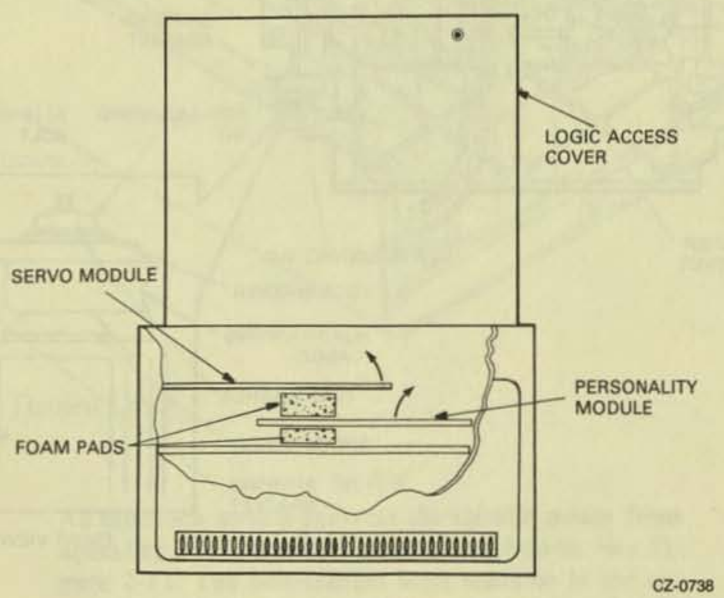

Figure 2-8 Foam Pad Removal

5. Remove the four red shipping brackets that fasten the HDA to its mountings. See Figure 2-9. The bracket next to the spindle motor requires special attention and should be removed last. To remove the other three shipping brackets, loosen the three HDA mounting nuts. Also, completely remove the 5/16-inch hex-head bolts that hold the shipping brackets in place. Slide the three shipping brackets out from under the HDA mounting nuts.

6. Remove the shipping bracket next to the spindle motor by loosening the remaining HDA mounting nut and detaching the bolt and jam nuts. See Figure 2-9. Slide the shipping bracket out from under the HDA mounting nut.

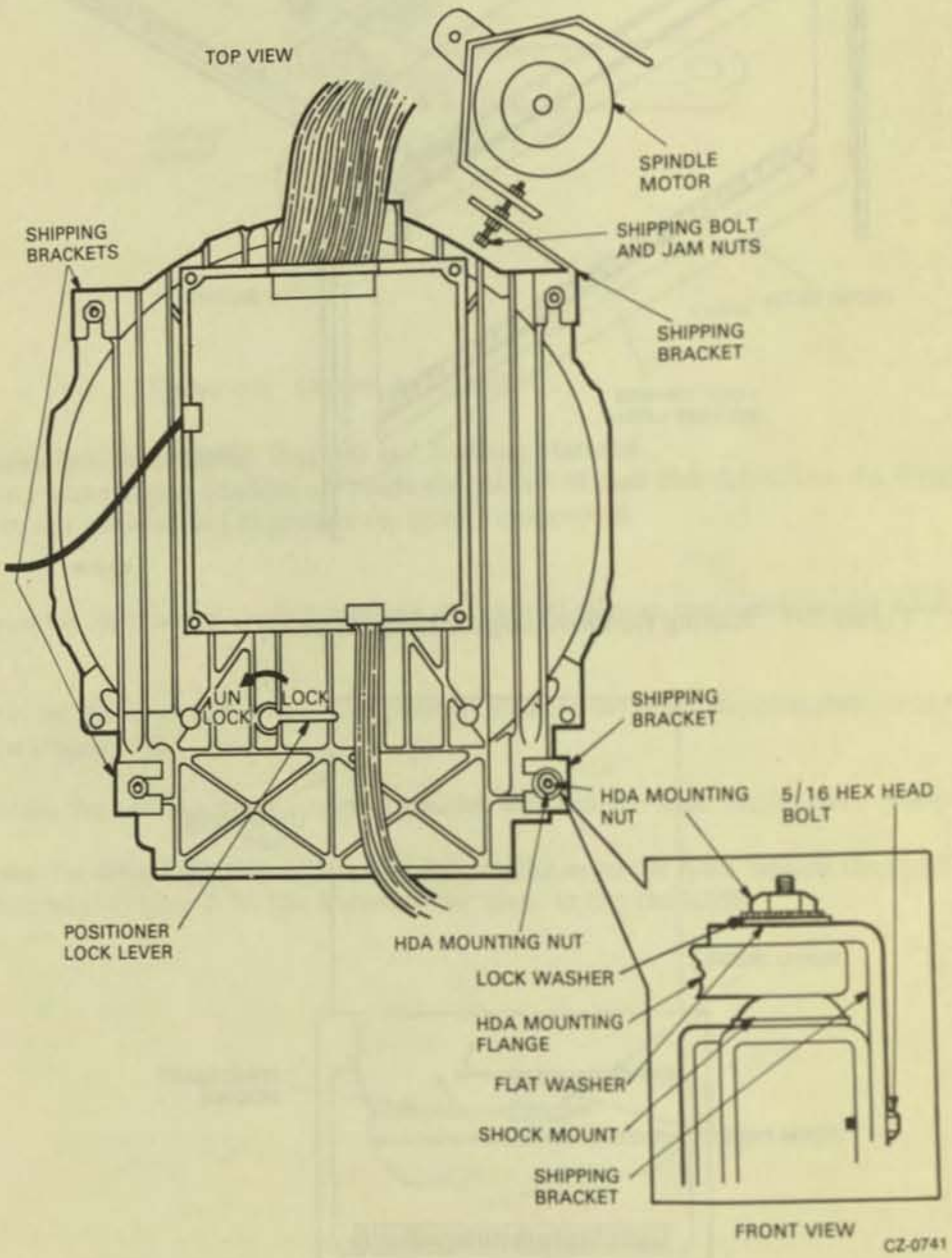

Figure 2-9 HDA Details

NOTE
Save all shipping brackets and hardware for future use when moving equipment.

7. Tighten all four HDA mounting nuts.

8. Ensure that the belt-tension lever is in the engaged position as shown in Figure 2-10.

9. Place the positioner lock lever on the HDA in the UNLOCK position (Figure 2-9).

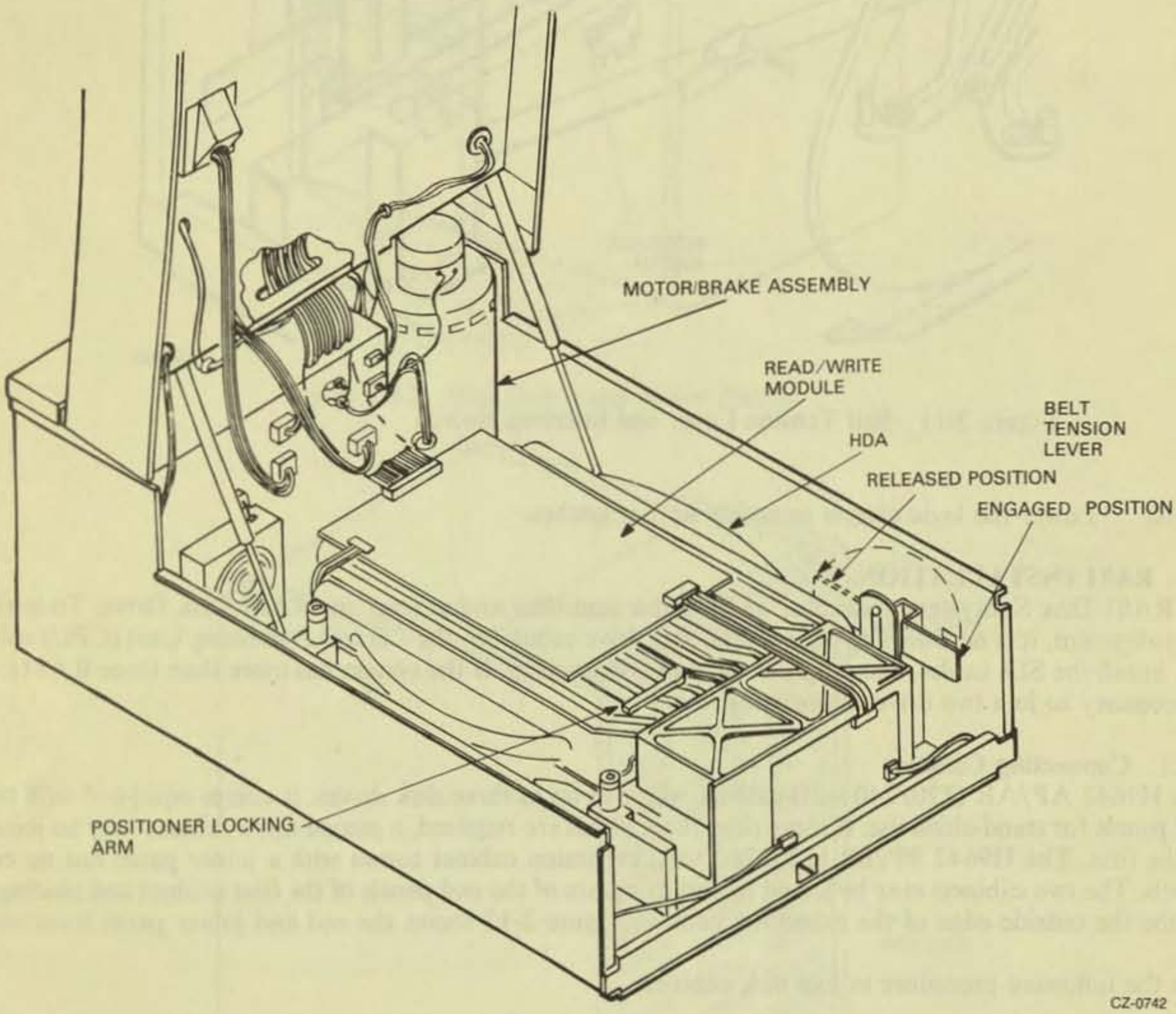

Figure 2-10 Belt Tension Lever

NOTE
An interlock switch prevents the spindle motor from operating while the belt tension is released. See Figure 2-11. The belt-tension lever must be in the engaged position for spin-up.

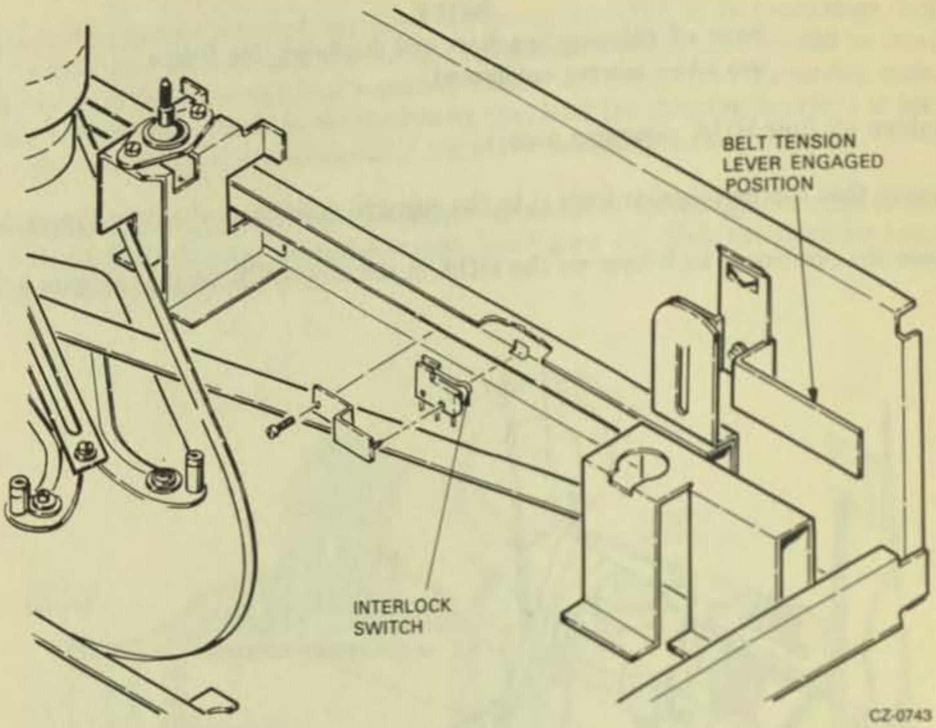

Figure 2-11 Belt Tension Lever and Interlock Switch

10. Lower the logic chassis assembly until it latches.

2.3 RA81 INSTALLATION

An RA81 Disk Subsystem consists of an SDI disk controller and at least one RA81 Disk Drive. To install the subsystem, it is necessary to connect the disk drive cabinet to the Central Processing Unit (CPU) cabinet, install the SDI cables, and program the unit address plug. If the system has more than three RA81s, it is necessary to join two drive cabinets together.

2.3.1 Connecting Cabinets

The H9642 AP/AR (120/240 volt) cabinet will hold up to three disk drives. It comes equipped with two end panels for stand-alone use. If more than three drives are required, a second drive cabinet may be joined to the first. The H9642 BP/BR (120/240 volt) expansion cabinet comes with a joiner panel but no end panels. The two cabinets may be joined by removing one of the end panels of the first cabinet and placing it on the the outside edge of the expansion cabinet. Figure 2-12 shows the end and joiner panel locations.

Use the following procedure to join disk cabinets.

1. Open the back door on the cabinet with the end panels by turning the hex lock counterclockwise. Refer to Figure 2-13.

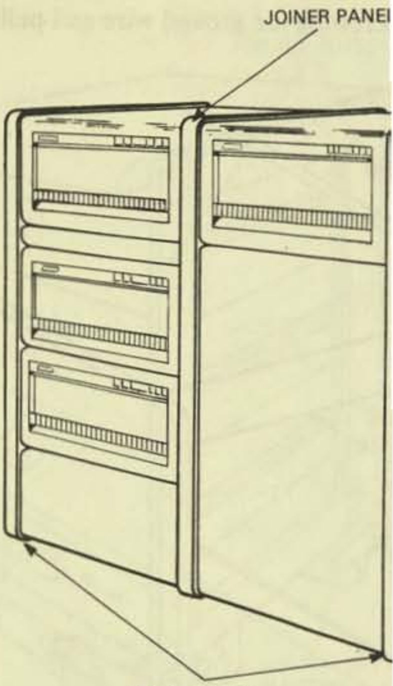

Figure 2-12 End Panels and Joi

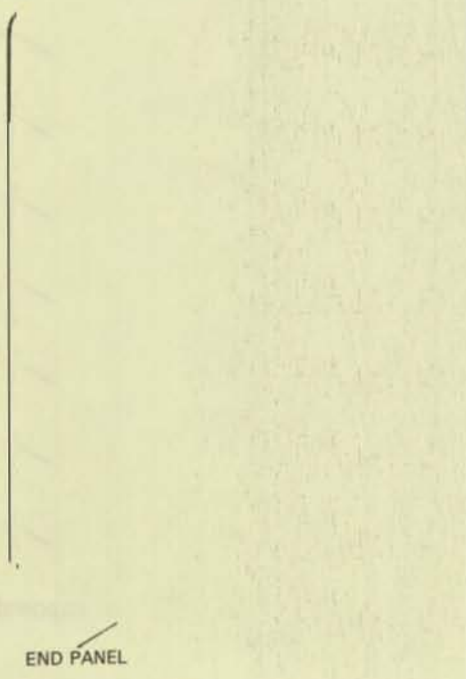

Figure 2-13 Opening the Back Door

2. Remove the back cabinet door by unscrewing the ground wire and pulling down on the top door latch. See Figure 2-14.

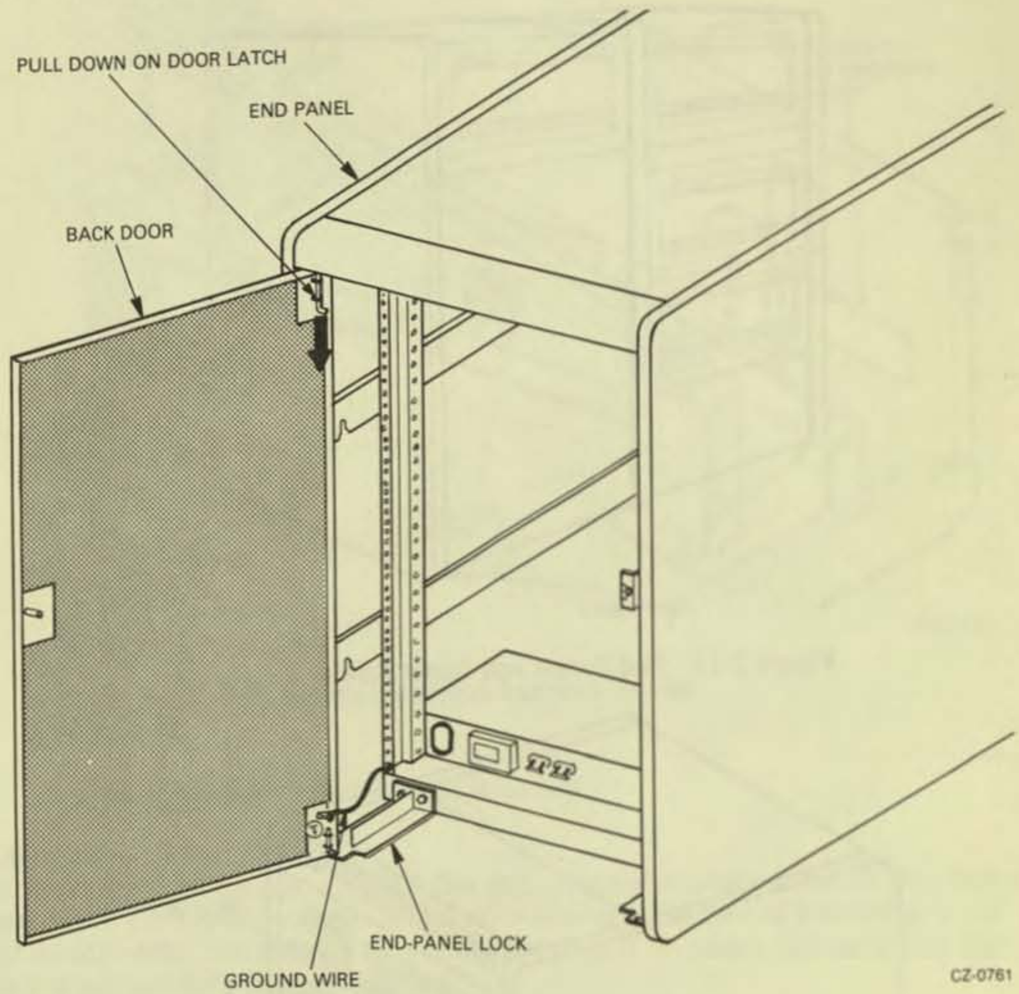

Figure 2-14 Back Door and End-Panel Lock Removal

3. Lift the door off the bottom end panel lock.

4. Loosen the two hex screws and remove the end panel lock from the base of the cabinet.

5. Lift the end panel vertically to disengage it from the four key buttons on the side of the cabinet frame. Refer to Figure 2-15.

6. Unscrew the ground wire attached to the end panel.

7. Remove the back end-panel lock from the expansion cabinet.

8. Attach the ground wire just removed from the first cabinet to the exposed side frame of the expansion cabinet.

9. Attach the other end of the ground wire to the end panel just removed from the first cabinet.

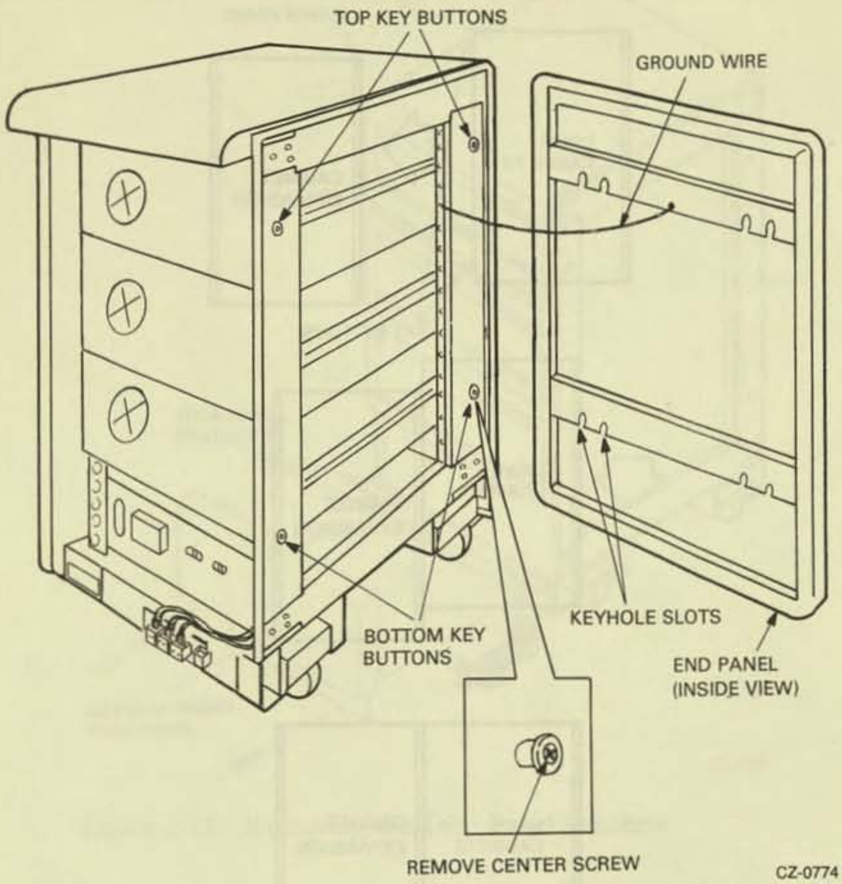

Figure 2-15 End-Panel Bottom Key-Button Removal

10. Lower the end panel over the keyhole buttons on the expansion cabinet.

11. Secure the end panel by replacing the back end-panel lock.

12. Remove the screws in the center of the two lower key buttons from the first drive cabinet.

13. Engage the top two key buttons on the first drive cabinet (Figure 2-16) into the keyhole slots on the expansion cabinet joiner panel.

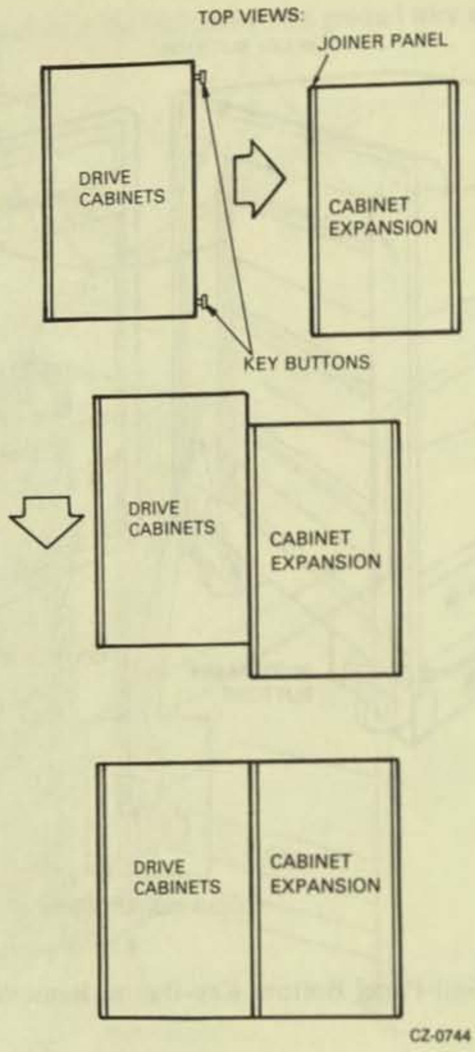

Figure 2-16 Connecting the Cabinets

14. Adjust the cabinets until their fronts are flush.

15. Remove the bottom trim panels from the front of the cabinets by removing the two screws at their base. Refer to Figure 2-17.

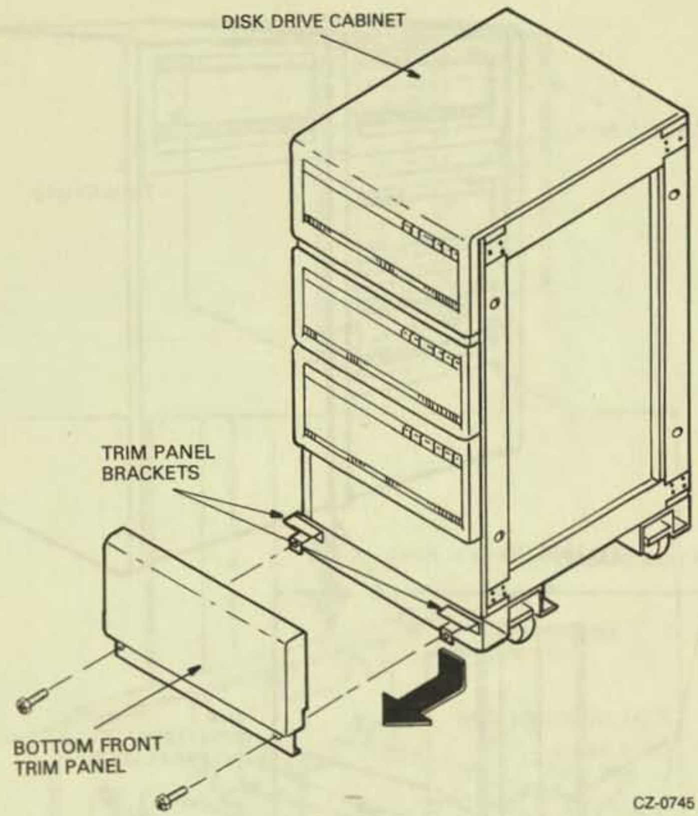

Figure 2-17 Removing the Trim Panel Brackets

16. Remove the two screws that hold the two retainer trim brackets nearest the side where the two cabinets are joined. Refer to Figure 2-18.

17. Place the front locking bracket over the retainer trim brackets.

18. Bolt the two cabinets together with the four bolts, as shown.

19. Replace the two bottom trim panels.

20. Open the back door of the cabinets.

21. Loosen the screws that hold the two back end-panel locks nearest the side where the two cabinets are joined.

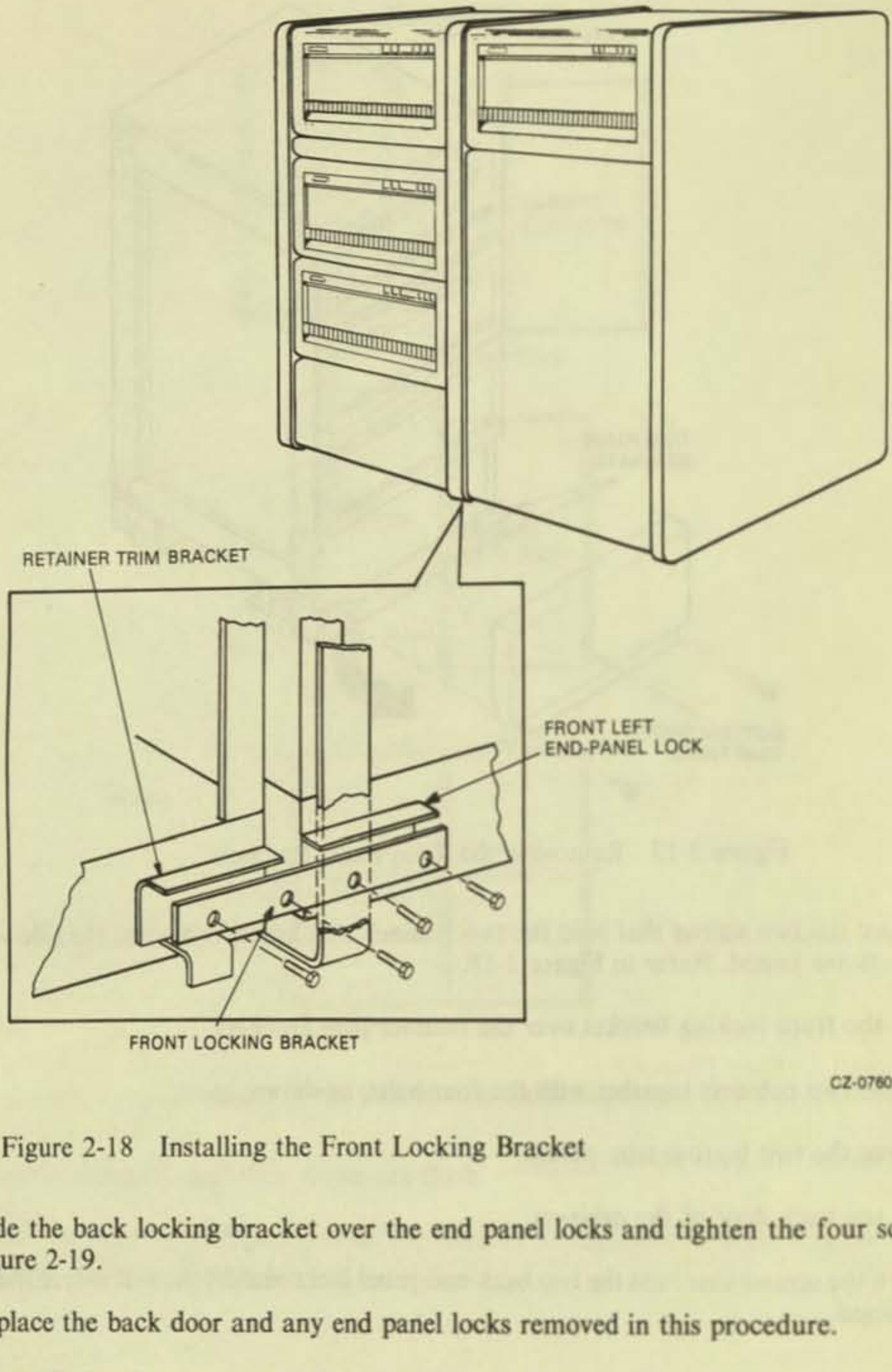

Figure 2-18 Installing the Front Locking Bracket

22. Slide the back locking bracket over the end panel locks and tighten the four screws. Refer to Figure 2-19.

23. Replace the back door and any end panel locks removed in this procedure.

24. Lower the levelers until the cabinets are raised off their casters.

25. Adjust the levelers.

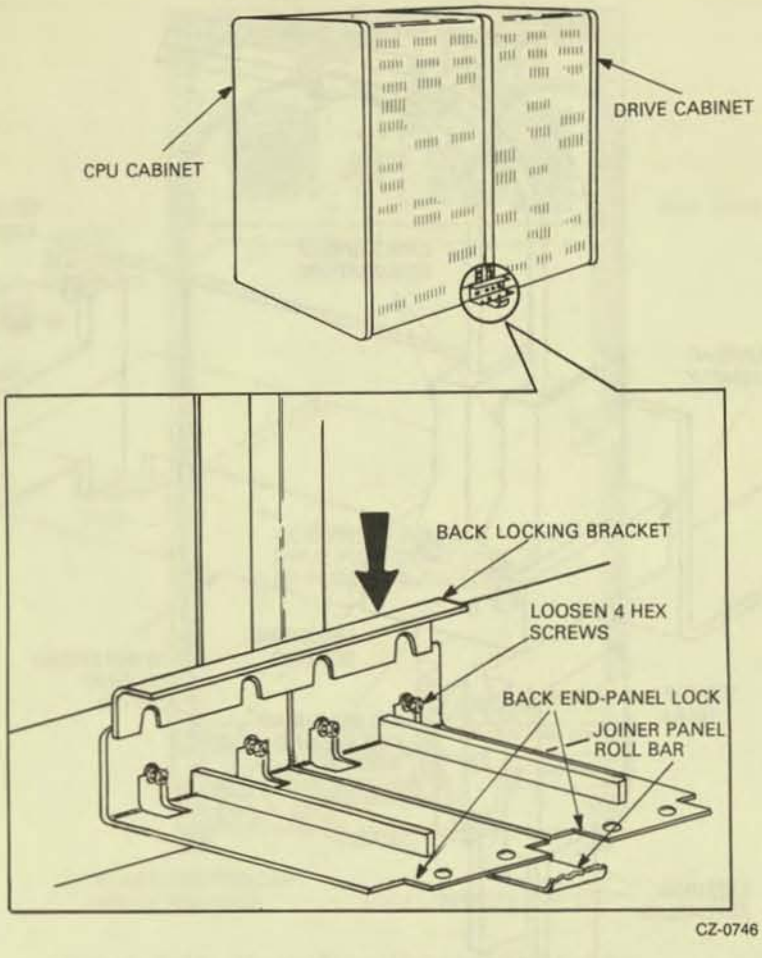

Figure 2-19 Installing the Back Locking Brackets

2.3.2 External SDI Cabling Procedure

Both internal and external SDI cables are mounted in the I/O bulkhead assembly. Internal SDI cables connect to the top of the bulkhead and external cables connect to the bottom. Refer to Figures 2-20 and 2-21. The procedure for connecting the internal SDI cables is discussed in Paragraph 2.4.7.

The external SDI cables must be installed between the central processing unit (CPU) cabinet, I/O bulkhead connector, and the drive cabinet I/O bulkhead connector. The CPU I/O bulkhead connector should have already been installed. If not, refer to the installation procedure in the appropriate disk drive controller user guide. When the CPU cabinet I/O bulkhead connector has been installed, follow the instructions in the appropriate disk controller user guide to install the SDI cables at the CPU cabinet. Use the following procedure to install the external SDI cables.

1. Plug the external SDI cable into the Port A receptacle on the bulkhead. External SDI cables enter from the bottom.

2. Install the two screws that hold the SDI cable shield terminator in place and tighten them. Refer to Figure 2-20.

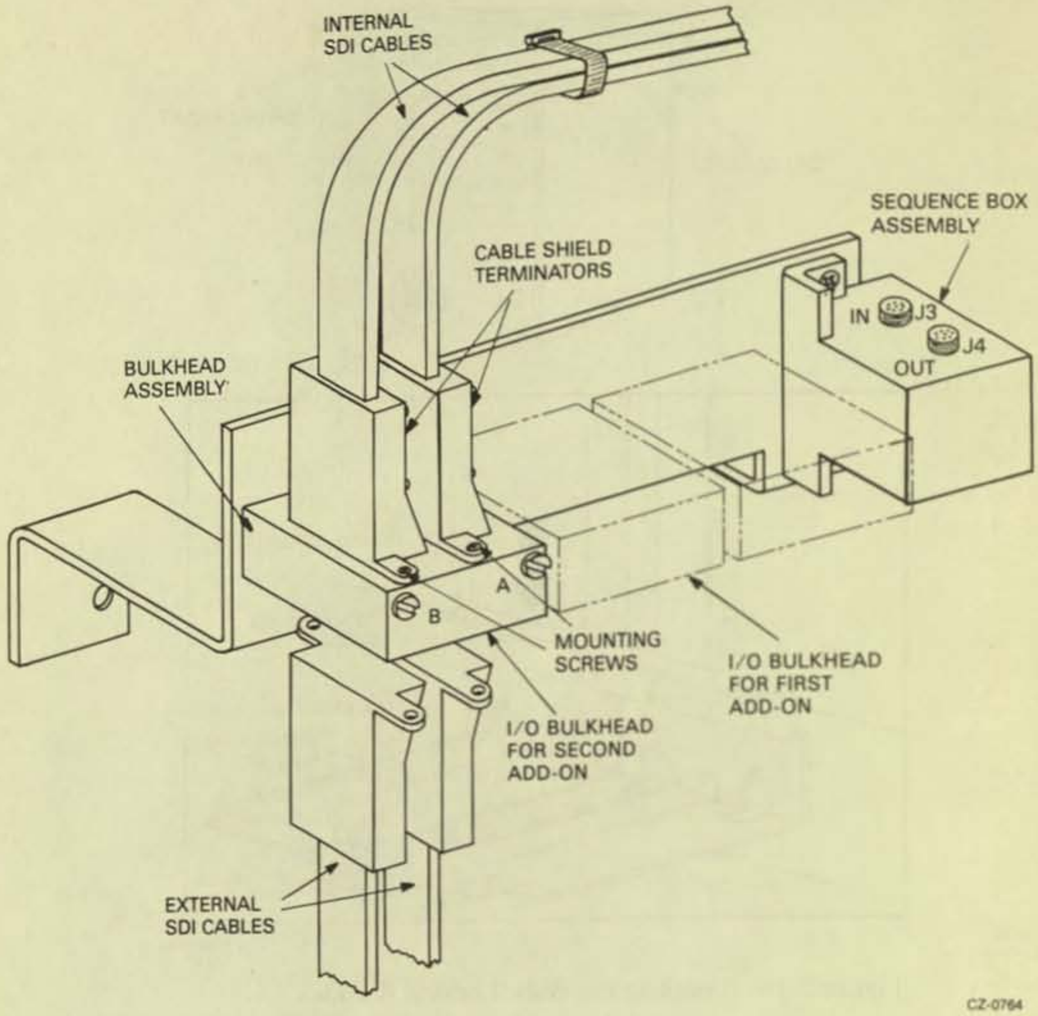

Figure 2-20 SDI Cable Shield Terminator Installation

3. Clamp the external SDI cables to the cable entry retainers below the I/O bulkheads with either a hose clamp or tie wrap. Refer to Figure 2-21.

4. If more than one drive is mounted in the cabinet, more SDI cables must be installed. Refer to the RA81 add-on installation procedure (Paragraph 2.4) for instructions.

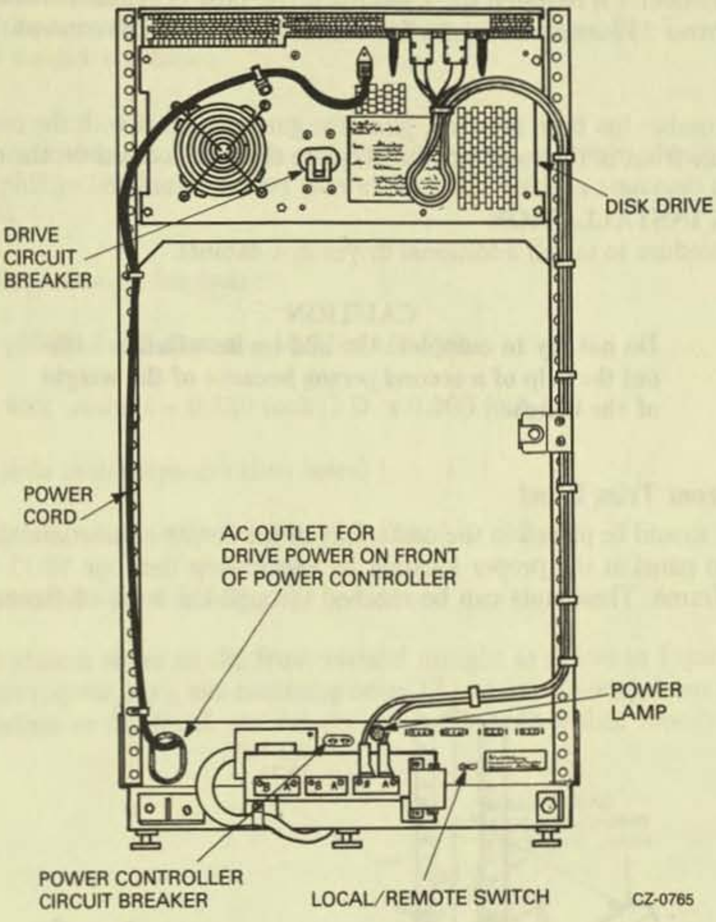

Figure 2-21 Single Drive External SDI Cables

2.3.3 Programming the Drive Unit Address Plug

The READY cover on the operator control panel is also the drive unit address plug. The drive unit numbers between 0 and 251 must be programmed into this plug. The plug comes as "Unit 0". To set up a drive unit number other than zero, remove the READY switch cover from the control panel and cut off the tabs that add up to the required number. Figure 2-22 shows the binary value represented by each tab.

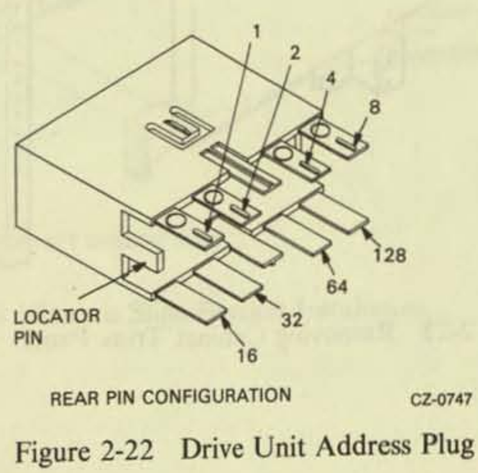

Figure 2-22 Drive Unit Address Plug

For example, if unit number 7 is required for a specific drive, tabs 1, 2, and 4 would have to be cut off the switch cap. If unit number 113 is required, tabs 64, 32, 16, and 1 must be removed. Leave all tabs on if unit number 0 is required.

After the drive unit number has been selected, place the gummed label with the corresponding number in the recessed area on the front of the switch cover. Replace the switch cover on the operator control panel.

2.4 RA81 ADD-ON INSTALLATION

Use the following procedure to install additional drives in a cabinet.

CAUTION

Do not try to complete the add-on installation without the help of a second person because of the weight of the drives.

2.4.1 Remove the Front Trim Panel

The first add-on drive should be placed in the center bay of the RA81 cabinet and the second in the bottom bay. Remove the trim panel at the proper location by unscrewing the four 10-32 hex nuts that hold the panel to the cabinet frame. These nuts can be reached through the back of the cabinet. Refer to Figure 2-23.

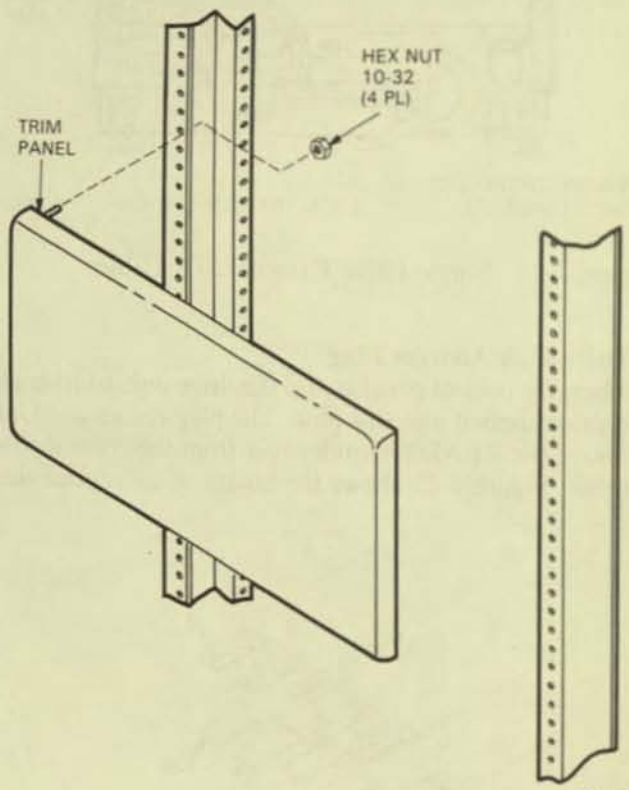

Figure 2-23 Removing Cabinet Trim Panel

2.4.2 Install the Slide Assembly

Each RA81 add-on drive must be mounted in the cabinet on a slide assembly. Use the following procedure to install the slides in the drive cabinet.

1. Screw a chassis slide bracket on to each end of the left and right chassis slides. Use two 8-32 x 5/16 inch phillips head sems screws (screws with star washers attached) to mount each. Refer to Figure 2-24.

2. Set aside the following hardware:

   - Four phillips head screws - 10-32 x 5/8 inch
   - Four lock washers - 0.380 inch O.D. x 0.200 inch I.D.
   - Two slide mount spacers (two holes)
   - Four phillips head sems screws - 10-32 x 1/2 inch
   - Four nut bars (four holes)

3. Mount the chassis slides to the front vertical upright as shown in Figure 2-25. If this is a first add-on drive (center bay), use mounting holes 27 and 31, counting from the bottom. Notice that this installation to the front vertical upright needs both a slide mount spacer and a nut bar.

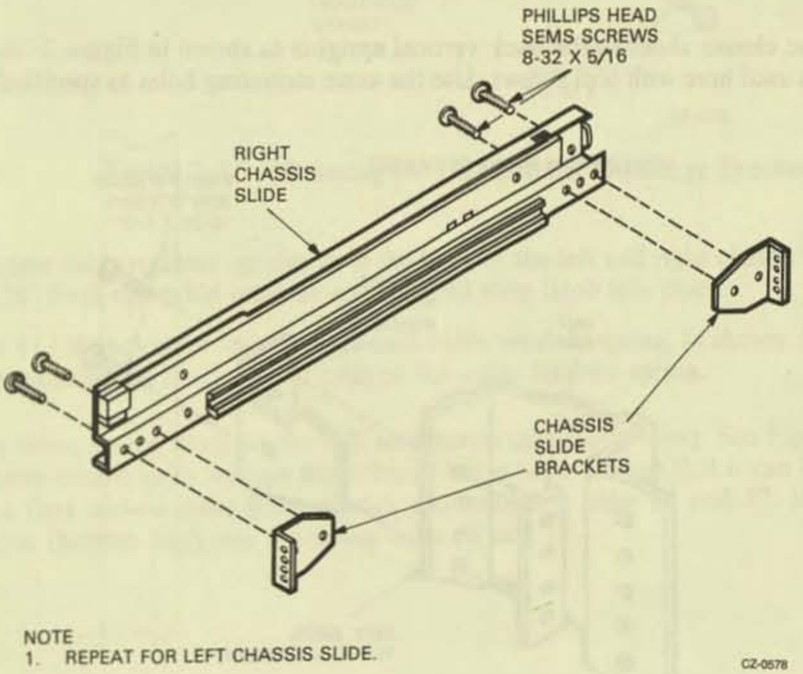

Figure 2-24 Chassis Slide Bracket Installation

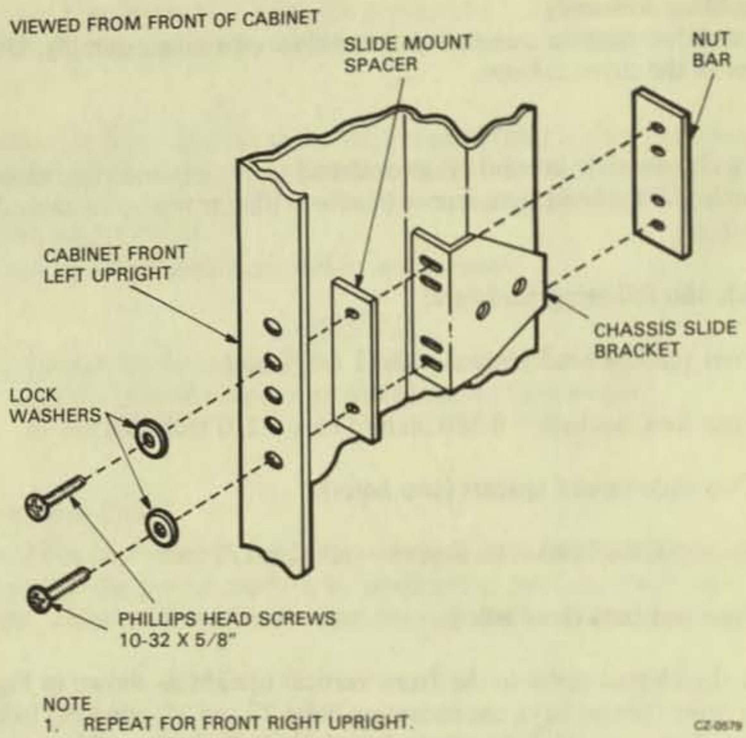

Figure 2-25 Mounting Chassis Slide to Front Upright

4. Mount the chassis slides to the back vertical uprights as shown in Figure 2-26. Note that only a nut bar is used here with sem screws. Use the same mounting holes as specified in Step 3 above.

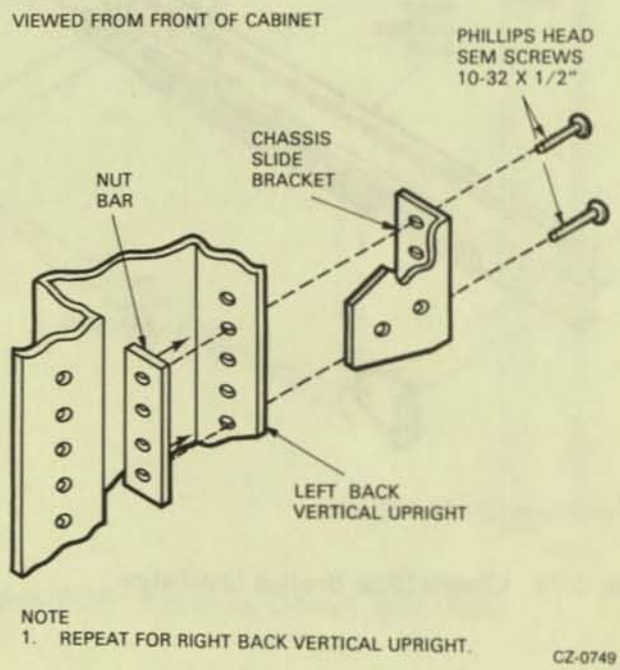

Figure 2-26 Mounting Chassis Slide to Back Upright

5. Mount the electrostatic discharge bracket over the chassis slide bracket on the back left vertical upright. Pass the two sem screws through the two center holes of the chassis slide bracket and fasten them to the nut bar inside. Refer to Figure 2-27. If this is the first add-on drive (center bay), use mounting holes 28 and 30. If this is the second add-on drive (bottom bay), use mounting holes 10 and 12.

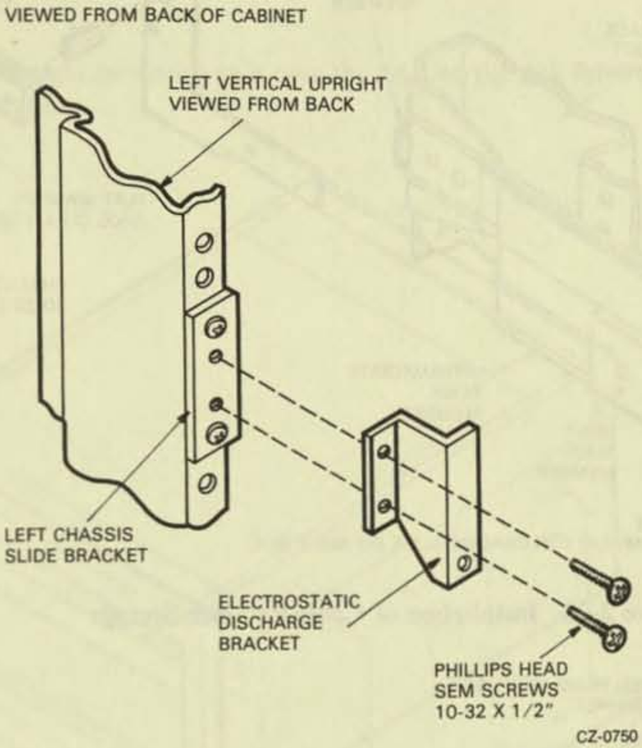

Figure 2-27 Mounting the Electrostatic Discharge Bracket

6. Insert the two cable retainer springs in to the back of the left and right chassis slides as shown in Figure 2-28. Push the cable retainer springs until they latch into place.

7. Mount an 11/16-inch cable clamp on to each cable retainer spring, as shown. Each cable clamp should be mounted on inside (drive side) of the cable retainer spring.

8. Install the drive detent latch on the left vertical upright (back view). See Figure 2-29. Ensure that the drive detent latch will not move freely but is loose enough that it can be adjusted later. If this is a first add-on drive (center bay), use mounting holes 36 and 37. If this is a second add-on drive (bottom bay), use mounting holes 18 and 19.

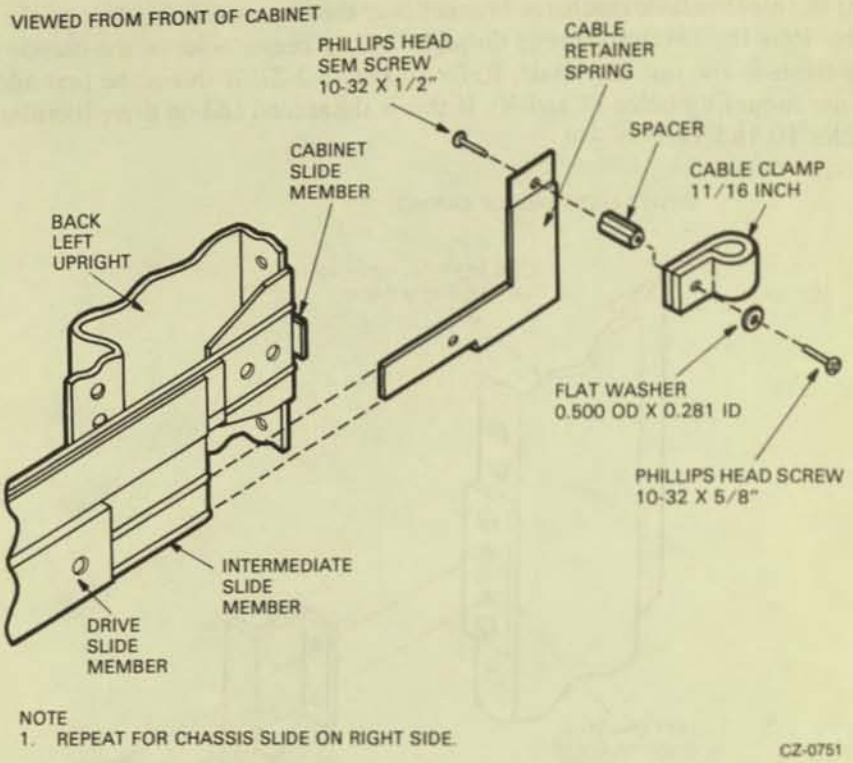

Figure 2-28 Installation of Cable Retainer Springs

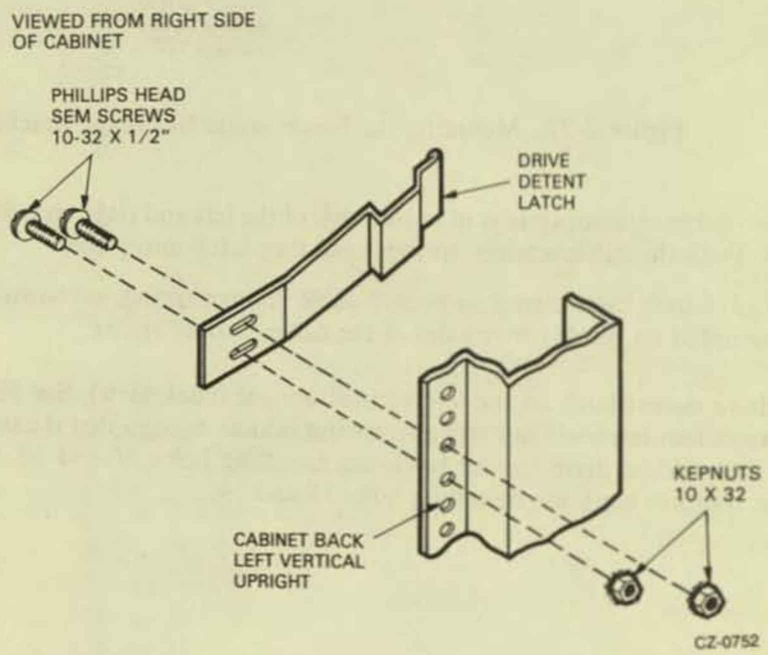

Figure 2-29 Installation of Drive Detent Latch

2.4.3 Remove the Internal Shipping Brackets and Packing Material

Remove the shipping brackets and packing material from inside the drive using the procedure described previously in Paragraph 2.2.3.

2.4.4 Mount the RA81 on the Slides

Use the following procedure to mount the drive on its slides.

1. Install the left and right mounting rails onto the sides of the disk drive as shown in Figure 2-30 using ten 6-32 kep nuts.

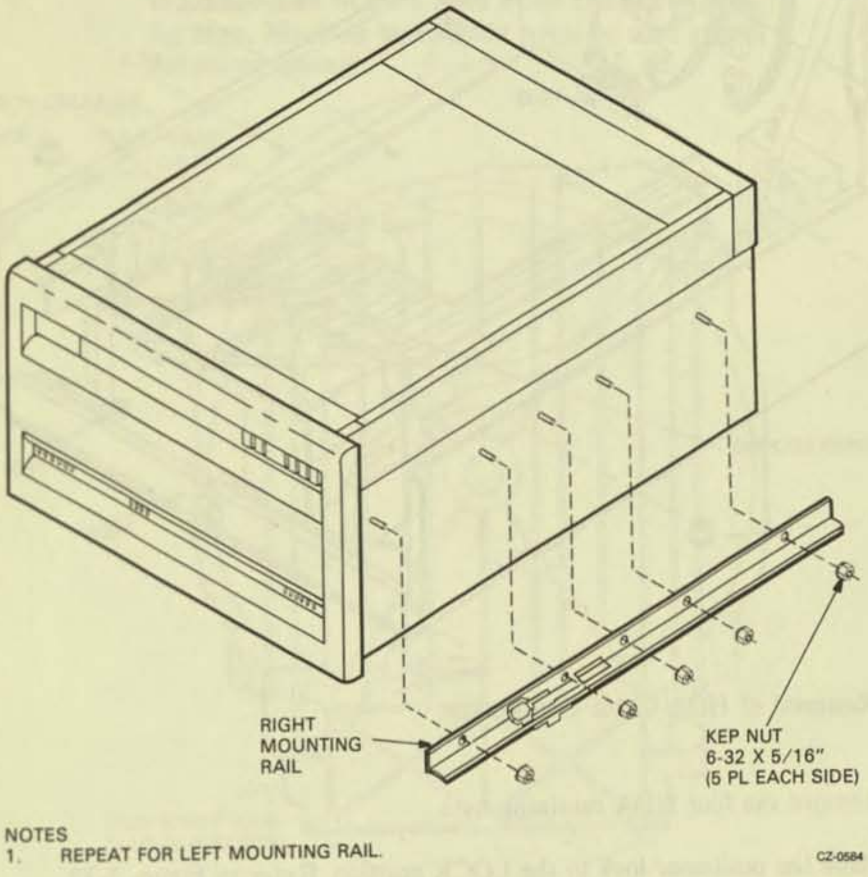

Figure 2-30 Installation of Drive Mounting Rails

2. Remove the HDA to reduce the weight of the drive using the following procedure. Refer to Figures 2-31 and 2-32.

   1. Raise the drive logic chassis. Refer to Paragraph 2.2.3, Step 4.

   2. Unplug connector P502 from the read/write module. See Figure 2-31.

   3. Unplug connectors P602 and P603 from the preamplifier module. Refer to Figure 2-31.

   4. Place the belt tension lever in the release position. Refer to Figure 2-31

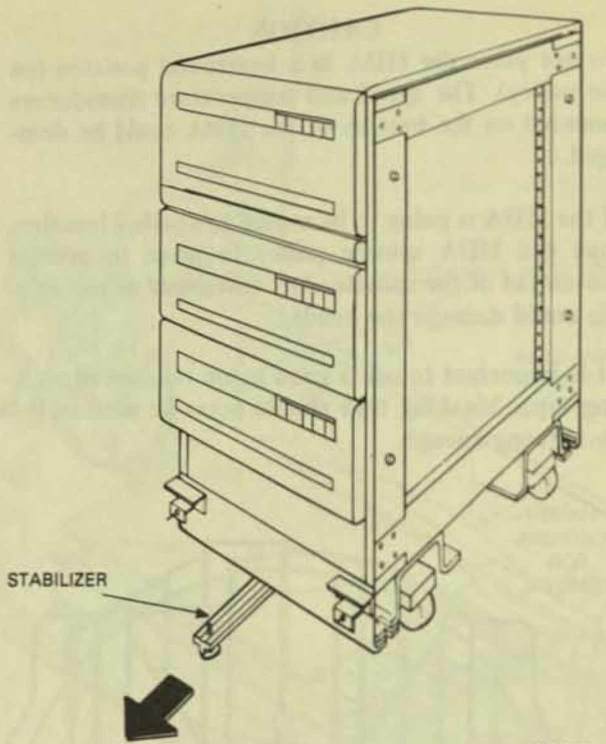

Figure 2-33 Extending Cabinet Stabilizer

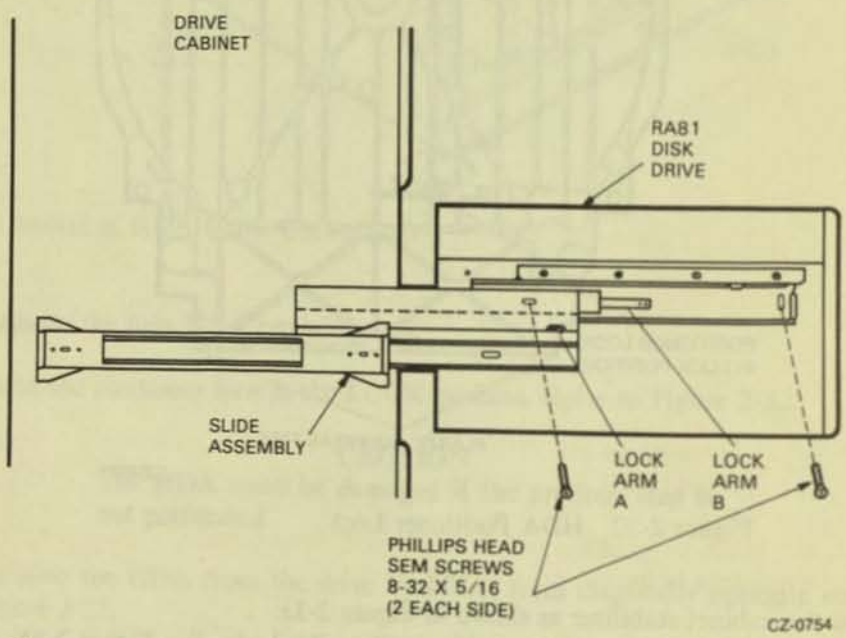

Figure 2-34 Extending the Chassis Slides

5. With the help of a second person, lift the drive and place it on top of the chassis slides as shown in Figure 2-34. Push the drive toward the back of the cabinet until its mounting rails touch the stop.

6. Fasten the drive to the chassis slides using four 8-32 x 5/16 inch phillips head sem screws, as shown.

7. Extend the drive forward on the slides.

8. Replace the HDA using the following procedure.

   1. Ensure that the drive belt is centered on the motor pulley. The other end of the belt should be even with the top of the nylon rollers on the wing pivot assembly. See Figure 2-35.

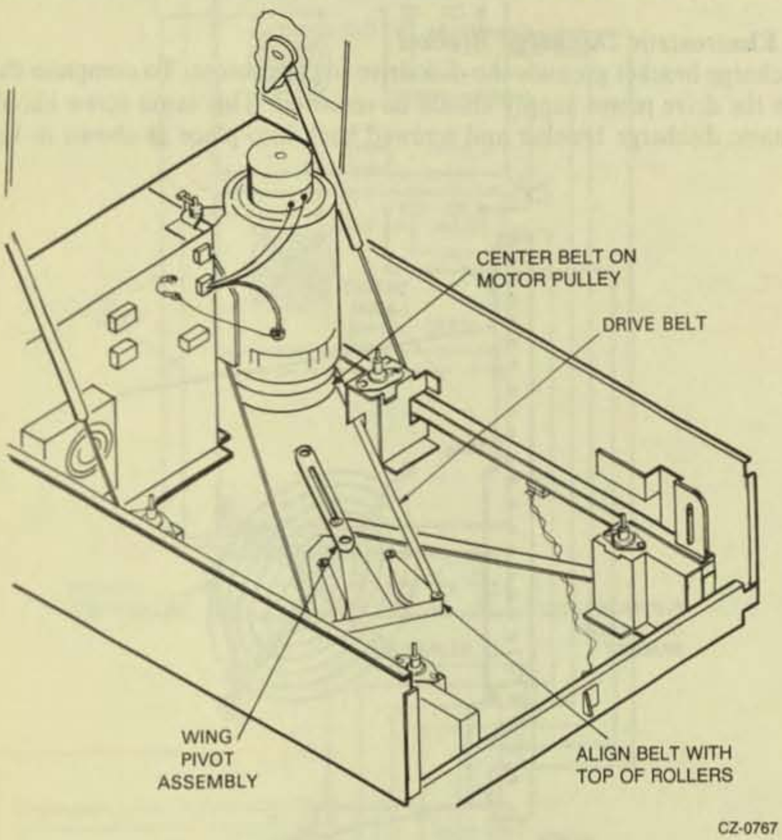

Figure 2-35 Wing Pivot Assembly

CAUTION
Damage to the HDA, drive belt, or nylon rollers could result if the drive belt is not aligned correctly.

   2. Lift the HDA by grasping two diagonally opposite corners, then lower the HDA over the four mounting bolts.

   3. Replace the four nuts and washers on the HDA.

   4. Connect P602 and P603 to the read preamplifier module on the front of the HDA.

   5. Connect P502 to the read/write module.

   6. Place the belt tension lever in the engaged position. See Figure 2-10.

7. Turn the HDA positioner lock counterclockwise to the unlocked position.

9. Slide the drive back into the cabinet.

10. Adjust the drive detent latch so that it prevents the drive from sliding forward and tighten the latch screws.

2.4.5 Program the Drive Unit Address Plug

Program the drive unit address plug using the procedure described previously in Paragraph 2.3.3.

2.4.6 Connect the Electrostatic Discharge Bracket

The electrostatic discharge bracket grounds the disk drive to the cabinet. To complete this ground path, the bottom left screw on the drive power supply should be removed. This same screw should then be inserted through the electrostatic discharge bracket and screwed back into place as shown in Figure 2-36.

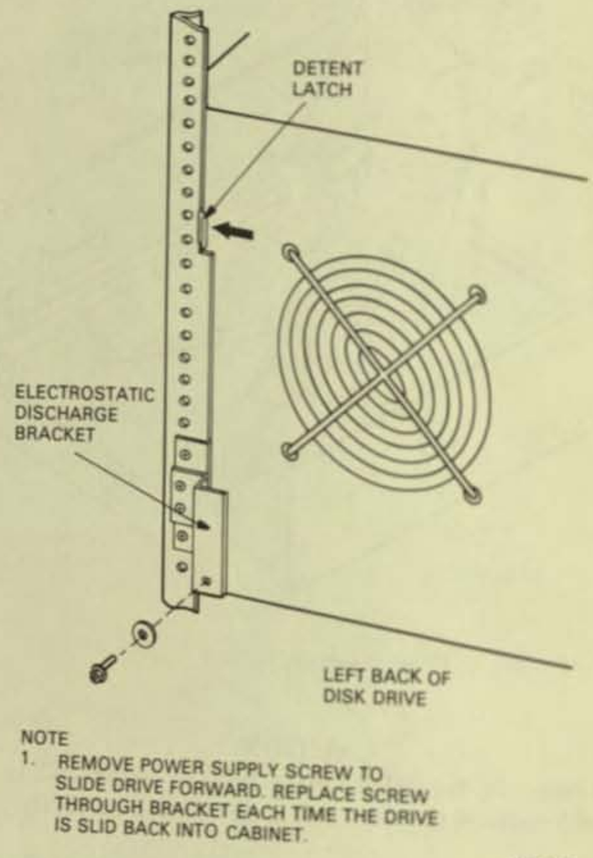

Figure 2-36 Electrostatic Discharge Bracket Details

CAUTION
This ground connection must always be made before the drive is operated.

To slide the drive forward, remove the screw that holds the electrostatic discharge bracket to the power supply and push on the drive detent latch. Remember to reconnect the electrostatic discharge bracket each time the drive is pushed back into the cabinet.

2.4.7 Install the Internal SDI Cables

The two internal SDI cables that exit from the back of the add-o
I/O bulkhead assembly. The external SDI cable that connects t
be mounted on the bottom of the I/O bulkhead assembly. If two
tion), a second external SDI cable must be installed. The SDI c
head before the bulkhead is connected to the drive cabinet. F
wiring for add-on disk drives. Use the following procedure to i

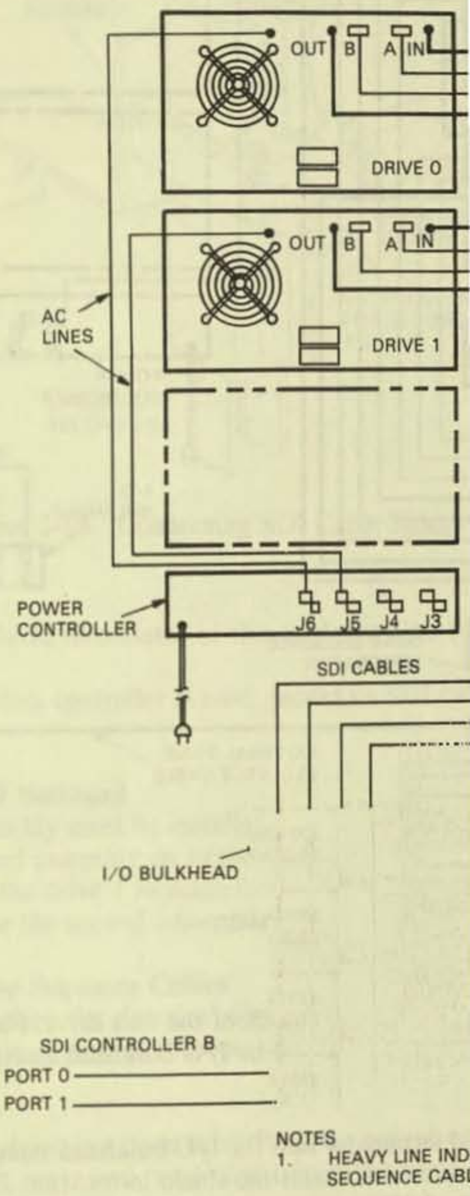

Figure 2-37 Cabling for a Two-Drive

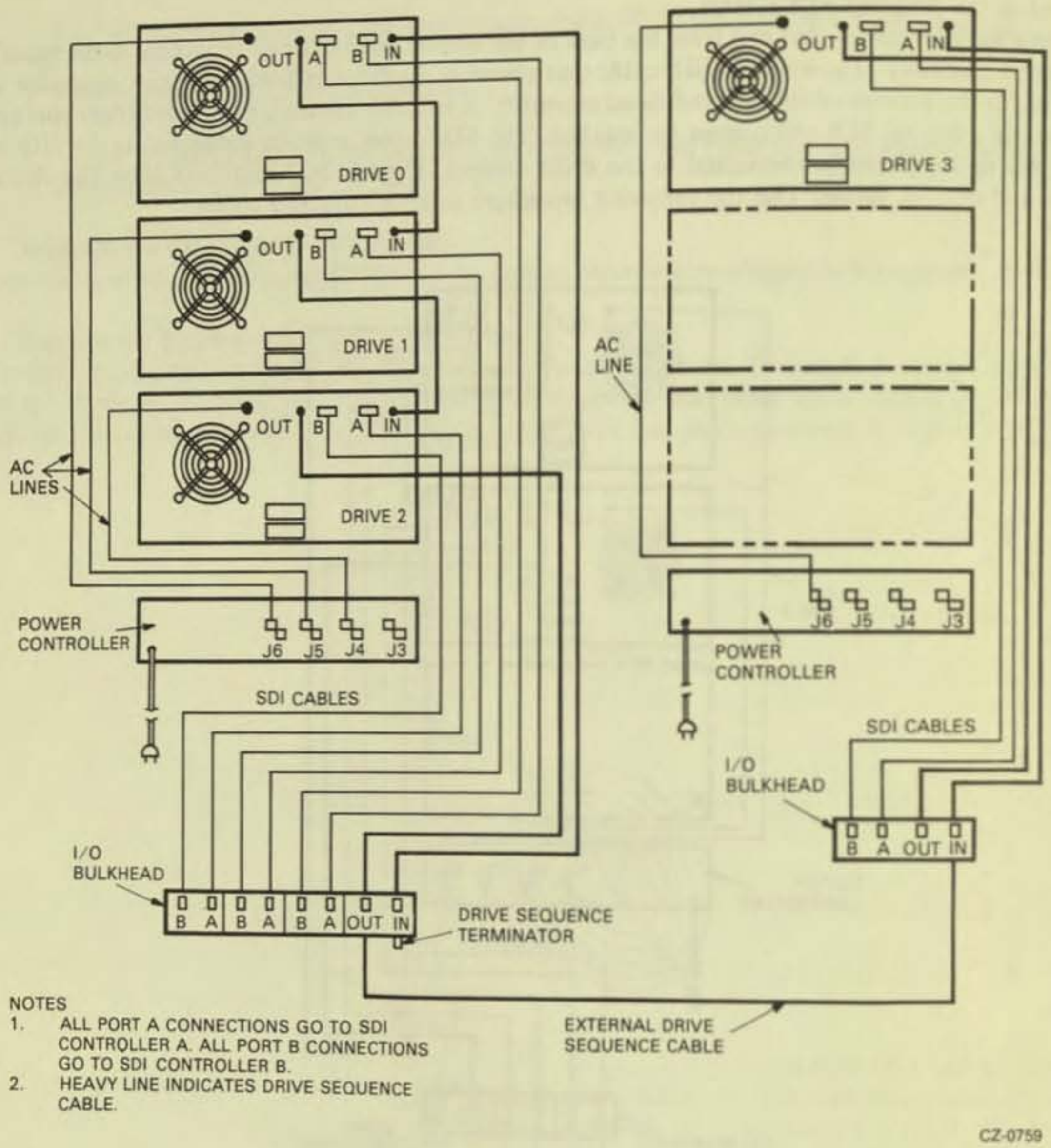

Figure 2-38 Cabling for a Three- and Four-Drive System

1. Locate the Port A SDI cable where it exits the back of the disk drive. Find the end of the cable and plug the connector into Port A on the top of the I/O bulkhead assembly. Note the orientation key.

2. Screw the Port A SDI cable shield terminator into the I/O bulkhead assembly. Early versions of the disk drive will need separate screws to mount the shield terminator. Later versions will have captive hardware. Refer to Figure 2-39.

3. Repeat Steps 1 and 2 for the Port B SDI cable.

4. Plug the SDI cable from the first disk controller into the Port A connector on the bottom of the I/O bulkhead assembly. Note the orientation key.

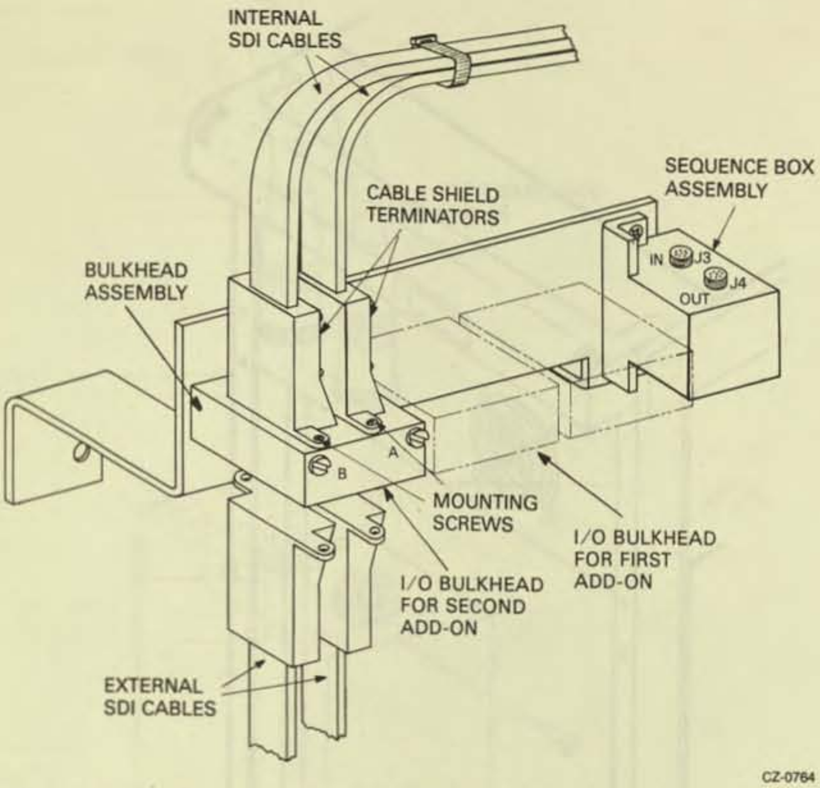

Figure 2-39 Connecting SDI Cable Shield Terminators

5. Screw the shield terminator of this cable into the I/O bulkhead assembly as in Step 2.

6. If a second disk controller is used, mount its SDI cable into Port B on the I/O bulkhead assembly.

2.4.8 Mount the I/O Bulkhead

An I/O bulkhead assembly must be installed on the back base of the drive cabinet for each add-on drive. Screw the I/O bulkhead assembly on to the back of the cabinet as shown in Figure 2-40. Mount the I/O bulkhead assembly in the drive 1 location for the first add-on drive. Mount the I/O bulkhead assembly in the drive 2 location for the second add-on drive.

2.4.9 Install the Drive Sequence Cables

Figures 2-37 and 2-38 show the electrical wiring diagrams for add-on drives. Use them as a reference when installing drive sequence cables, as follows.

1. Unplug the drive sequence cable from the output connector on drive 0 (top drive) done by raising the back cover and removing it from the cable clamp. Refer to Figure 2-41.

2. Plug the drive sequence cable described in Step 1 into the output connector on drive 1 for one add-on, or into the output connector on drive 2 for two add-ons.

3. Install the new 8-foot cable between the output connector of drive 0 and the input connector on drive 1. If a second add-on drive has been installed, connect another 8-foot drive sequence cable between the output connector of drive 1 and the input connector of drive 2.

2.4.10 Connect AC Power

Plug the ac power cord from each add-on into the ac receptical on the power controller at the base of the cabinet. Refer to Figure 2-42.

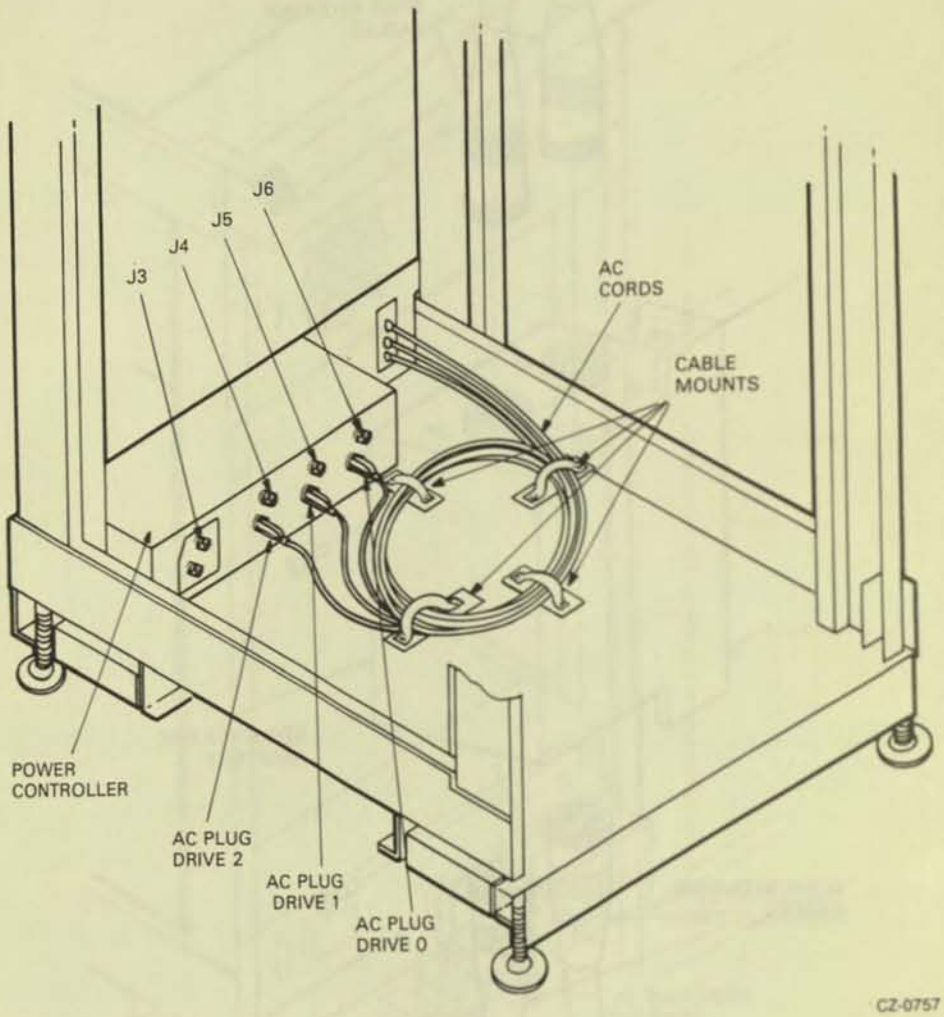

Figure 2-42 Power Controller AC Receptacles

2.4.11 Route and Clamp the Cables

The cables from the add-on drives must now be routed and clamped to allow the drive to be extended on the slide rails. Route and clamp the cables as follows.

1. Mount the spacers and cable clamps into the back vertical uprights as shown in Figure 2-43. If this is the first add-on drive (center bay), mount the cable clamps in hole 44 of the left and right vertical uprights. If this is the second add-on drive (bottom bay), mount the cable clamps in mounting hole 23 of the left and right vertical uprights.

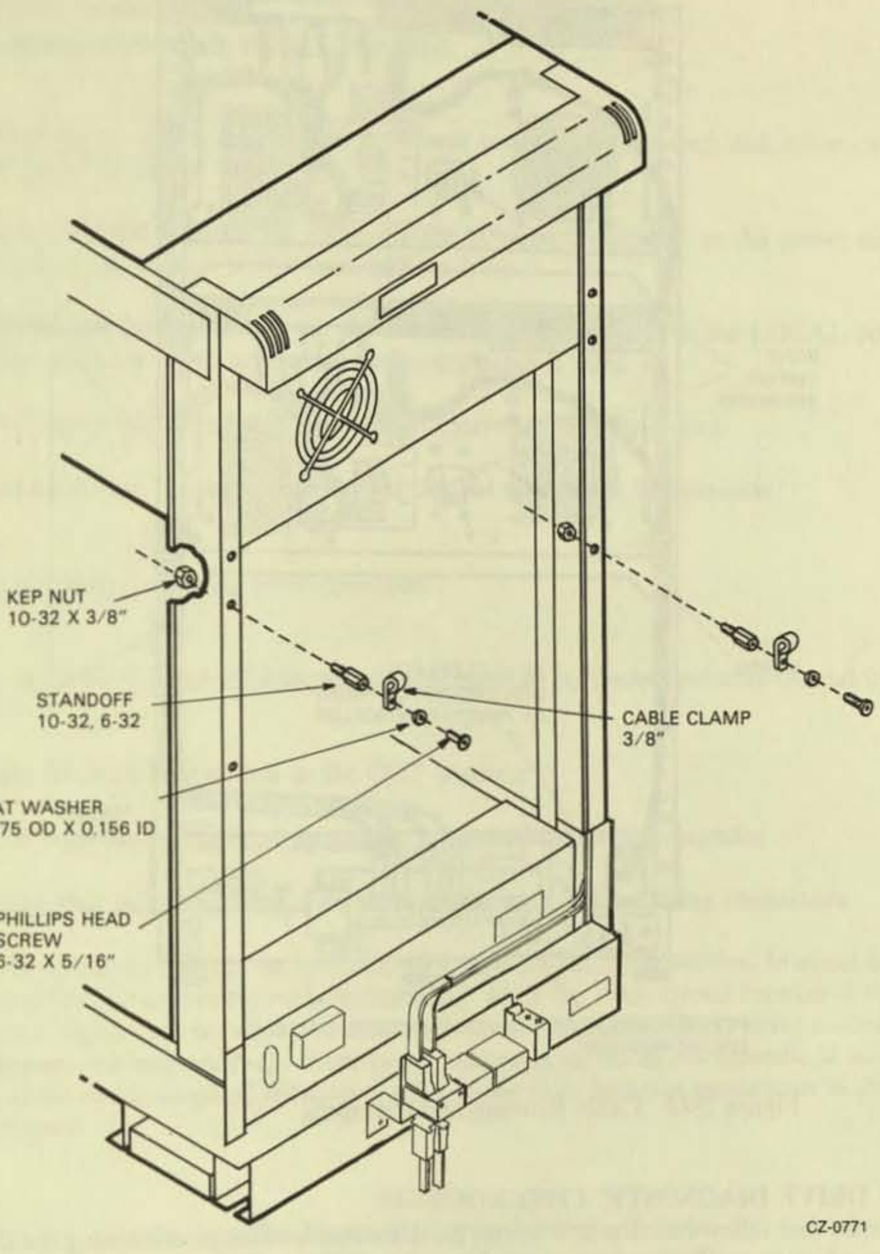

Figure 2-43 Connecting Cable Clamps to Uprights

2. Use the 15 cable ties provided with each add-on to route and tie the cables where indicated in Figure 2-44. Three cable ties are used on the ac power cord and seven ties are used on the SDI and drive sequence cables.

3. Tie wrap the cables to the clamp mounted previously on the back of the chassis slides.

4. Form a service loop approximately eight inches in diameter in the cables as shown in Figure 2-44. Fasten the output of the service loop with the cable clamps installed on the vertical uprights in Step 1 above.

5. Tie wrap the cables at the bottom of the cabinet to the cable clamp at mounting hole 14.

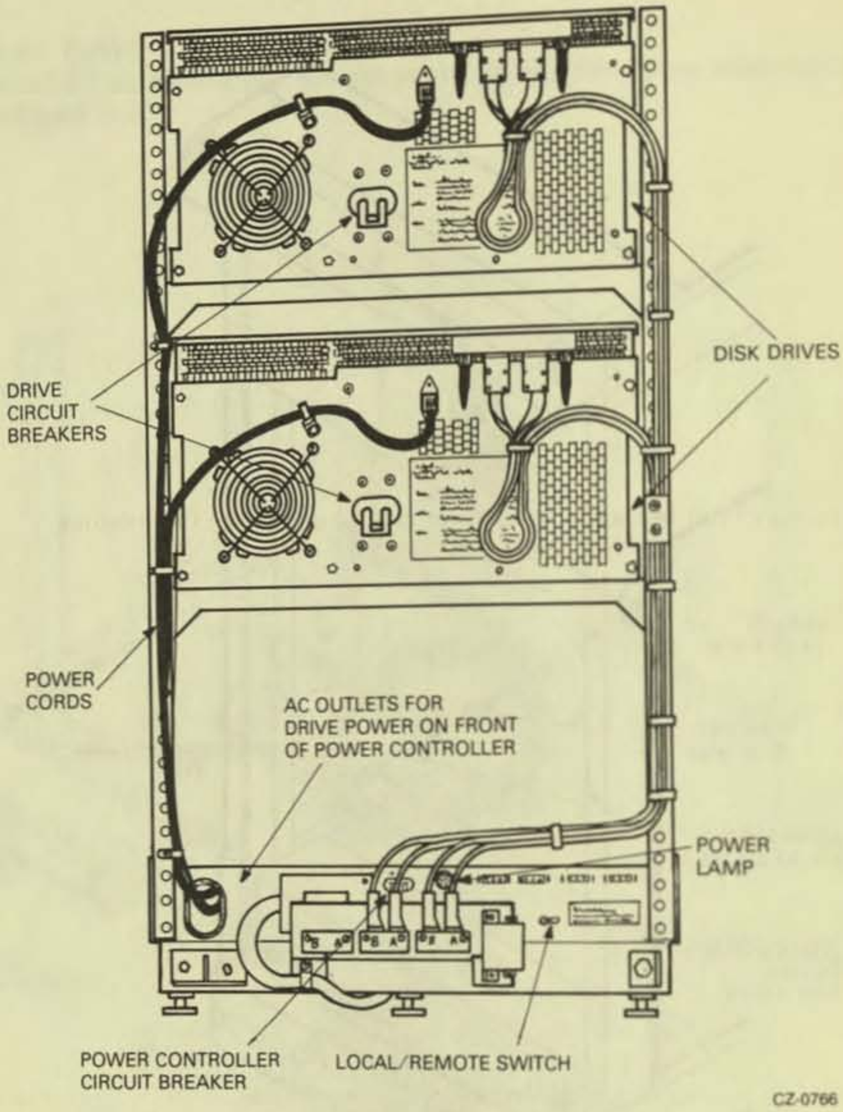

Figure 2-44 Cable Routing and Clamping

2.5 RA81 DRIVE DIAGNOSTIC CHECKOUT

The paragraphs that follow describe how to run the drive-resident diagnostics using the diagnostic terminal. Use this procedure to verify the proper operation of each RA81 Disk Drive after installation.

NOTE

Checkout procedures should be used only by trained maintenance personnel.

2.5.1 The Diagnostic Terminal

A field service diagnostic terminal used to communicate with the RA81 is stocked with every spares kit. The diagnostic terminal utilizes a standard ASCII keyboard and an RS232 interface. Any EIA-compatible terminal set at 300 baud can be used to communicate with the drive to run the diagnostic tests. See Appendix A for instructions on how to use this terminal.

2.5.2 Applying Power to the Drive

Use the following procedure to apply power to the drive.

1. Verify that the ac circuit breakers on the power control unit and each disk drive are in the OFF position. Refer to Figure 2-44.

2. Plug the ac power cord from the drive into the ac power receptacle on the power control unit at the bottom of the cabinet if this is an add-on drive.

3. The LOCAL/REMOTE switch on the power controller must be in the LOCAL position to ensure drive operation since no power sequencing cable is used.

4. Plug the control unit ac power cord into an external ac power source.

5. Place the ac circuit breaker on the power control unit in the ON position.

2.5.3 Checkout

Use the following procedure to verify drive operation.

1. Ensure the drive is in the off-line state by placing both port select switches (A and B) in the OUT position.

2. Place the RUN/STOP switch in the OUT position.

3. Open the logic access cover and raise the servo and personality modules.

4. Make sure that all cable connectors are firmly seated in the mating connectors.

5. Place the ac circuit breaker on the back of the drive in the ON position. Internal drive diagnostics (hardcore test sequence) run automatically when the drive circuit breaker is turned on. All front-panel lights turn on while the drive runs these diagnostics. If the drive successfully passes the hardcore test sequence, the front-panel indicators go off in 3-4 seconds. If an error code is displayed on the front-panel indicators, refer to the fault isolation procedures in the *RA81 Service Manual*.

NOTE

Do not have the diagnostic terminal connected to the drive at this time. Doing so could cause the hardcore tests to fail.

6. The drive idle loop tests start automatically about 30 seconds following the end of the hardcore test sequence. Allow about 30 seconds for the execution of these tests. Observe the microprocessor LEDs for a display of a hexadecimal E7 after a successful completion. Errors are indicated by a fault code in the front-panel lights. Refer to the fault isolation procedures in the *RA81 Service Manual*.

7. Connect the diagnostic terminal to the RS232 port connector in the drive. Refer to Figure 2-45.

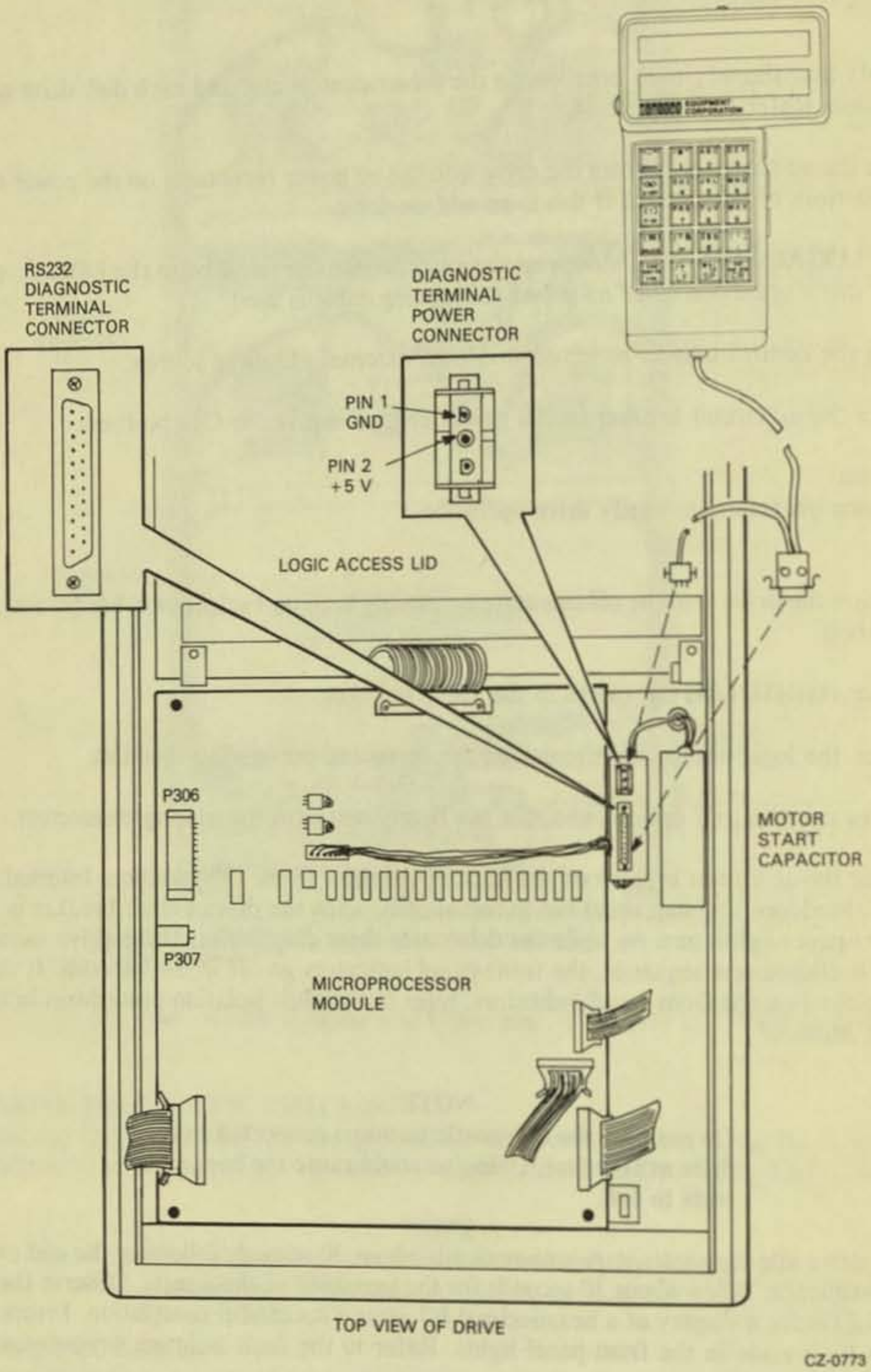

Figure 2-45 Diagnostic Terminal Connections

8. Key in a CTRL C (↑C) on the terminal keyboard to place the drive in the diagnostic monitor mode. A diagnostic prompt (RA81>) is then displayed by the terminal.

NOTE

The drive idle loop test sequence is repeated continuously until a CTRL C (↑C) is input. The test will complete the current sequence before displaying the RA81> prompt.

9. Depress the continue (CONT) key on the terminal. This disables the automatic X-On, X-Off feature of the terminal allowing the testing to be continuous.

10. Run the entire drive sequence test with the drive spun down by typing RUN DIAG on the terminal. As the sequence is executed, the following messages are displayed by the terminal:

```
%RA81-COMPLETED TEST:DIAG SUBTEST:xx
%RA81-COMPLETED TEST:DIAG SUBTEST:xx
%RA81-COMPLETED TEST:DIAG SUBTEST:xx
          --     --     --
          --     --     --
          --     --     --
%RA81-COMPLETED TEST:DIAG SUBTEST:xx
RA81>
```

The microprocessor LEDs increment and then settle on a hexadecimal E7 while the sequence is being executed. The display of the prompt indicates successful completion of the test sequence.

The following terminal display means that one of the tests has failed. When a test fails, refer to the fault isolation procedures in the *RA81 Disk Drive Service Manual.*

```
%RA81-TEST:DIAG SUBTEST:xx ERROR:xx UNITxxx
%RA81-FRU-xxxx,xxxx,xxxx
```

11. After passing the above test, spin up the drive by pushing the RUN/STOP switch to the IN position. The drive should respond with the following message:

```
FRONT PANEL FUNCTION IN PROGRESS
```

A diagnostic sequence is automatically executed during spin-up.

The microprocessor LEDs remain off while the drive spins up. When it is up to speed, the LEDs display the E7 code and the terminal displays the following:

```
%RA81-COMPLETED TEST:DIAG SUBTEST:xx
%RA81-COMPLETED TEST:DIAG SUBTEST:xx
%RA81-COMPLETED TEST:DIAG SUBTEST:xx
          --          --      --
          --          --      --
          --          --      --
%RA81-COMPLETED TEST:DIAG SUBTEST:xx
RA81>
```

The terminal displays the most likely FRU to replace if an error condition is noted during the above sequence. The diagnostic takes about 45 seconds to complete. Do not proceed to the next step until the prompt is displayed.

12. Type RUN DIAG to initiate the entire drive sequence test with the drive spun up. The terminal should display messages similar to those when the drive was spun down. If an error is indicated during this test, the terminal will display the most likely FRU to replace. The microprocessor LEDs increment and then settle on a hexadecimal E7 while the sequence is being executed (about 7 minutes).

13. When the RA81> prompt is displayed, respond by typing in SET DIAG LOOP=HALT to place the drive in a continuous loop mode, halting only on an error.

14. As soon as the drive returns with the RA81> prompt, respond by typing RUN DIAG. The entire drive sequence diagnostics are once again initiated. Run this test sequence for 25 minutes. If any errors occur during this time, the terminal will indicate the most likely failing FRU. Refer to the *RA81 Service Manual* for the list of FRUs.

15. After the above test has run for 25 minutes without an error, key in CTRL C (↑C) to terminate the loop mode and the test.

16. As soon as the drive returns an RA81> prompt, type EXIT to exit the diagnostic monitor mode.

NOTE
CTRL Z (↑Z) can also be used to exit the monitor mode. One or both of the port select switches can be pushed in to accomplish the same.

17. Push in the desired port select button to place the drive in an available state.

18. Run the main system diagnostics.

19. Upon completion of all tests on each drive, disconnect the diagnostic terminal, fold the servo and personality modules back into their proper positions, and then close and secure the logic access cover on the drive.

CHAPTER 3
OPERATING INSTRUCTIONS

3.1 CONTROL PANEL SWITCHES AND INDICATORS

Each switch on the operator control panel has an indicator light displaying the drive conditions. The RA81 panel has the following:

- RUN/STOP
- FAULT
- UNIT/READY
- WRITE PROT
- A port
- B port

Figure 3-1 shows the arrangement of these controls on the front panel of the drive, and Table 3-1 lists the conditions that control the indicator lights. The paragraphs that follow describe the functions of the switches and indicators in more detail.

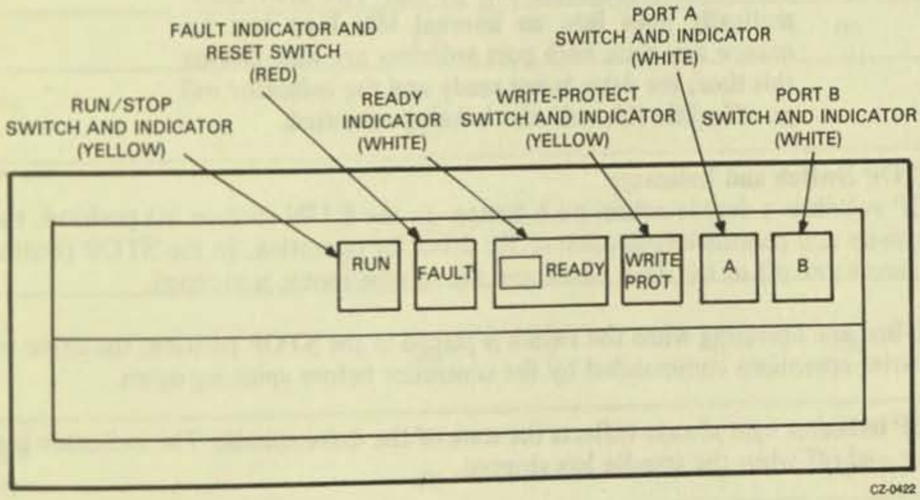

Figure 3-1 Front-Panel Controls and Indicators

Table 3-1 Indicator Conditions

Indicator	Turned On	Turned Off
RUN/STOP	When disk is turning	When disk has stopped
FAULT	When drive detects a serious fault	When no faults are detected
READY	When drive is on-cylinder and ready to process host request.(RUN light must be on)	When drive can not process host requests or is not on cylinder. (See note below)
WRITE PROT	When drive is physically or logically write protected	When drive is write enabled
A	When drive is on-line to controller A	When drive is not on-line to controller A
B	When drive is on-line to controller B	When drive is not on-line to controller B

NOTE

If both port select switches (A and B) are placed in the OUT position while the READY indicator is on, the READY indicator will go off. The drive automatically goes into an internal idle loop test sequence any time both port switches are out. During this time, the drive is not ready and the indicator will go off while this self test is being executed.

3.1.1 RUN/STOP Switch and Indicator

The RUN/STOP switch is a double-action push button. In the RUN (button in) position, the switch requests a drive spin-up and permits intialization of the drive for operation. In the STOP (button out) position, the heads are moved off of the data bands and the spindle motor is stopped.

If the drive is on-line and operating when the switch is placed in the STOP position, the drive will complete all outstanding write operations commanded by the controller before spinning down.

The RUN/STOP indicator light always reflects the state of the drive spindle. The indicator is on while the spindle is turning and off when the spindle has stopped.

If the RUN/STOP switch is in the RUN position on power up, spin-up will occur by the controller or by manually toggling the RUN/STOP switch.

NOTE

A minimum three-minute delay is recommended between each start and restart to prevent opening the thermal circuit breaker associated with the spindle motor.

3.1.2 FAULT Switch and Indicator

The FAULT light indicates an error condition within the drive, and the FAULT reset switch is used to correct errors.

When the disk drive detects an error, the FAULT light is turned on. The drive stays in its current operating state until the condition is corrected. Some faults are corrected automatically and the light will go off. If the fault condition is not corrected automatically, the light will stay on and the FAULT button will have to be pushed. If a fault occurs during a spin-up try, the spin-up will be aborted.

The FAULT button is a momentary contact switch. When pushed the first time, the switch causes the drive to enter an off-line state (relative to the controller) and to assume control of all front-panel indicator lights in order to display a blinking error code. Refer to Table 3-2 for identification of faults and indicator light combinations. The drive stays off-line as long as the fault code is being displayed. When the FAULT switch is pushed the second time, the drive tries to clear the error condition, stores the error code, enters the available operating state, and returns the front-panel indicators to their normal service. Up to 16 error codes can be stored for later use in troubleshooting the drive.

Table 3-2 Drive Front-Panel Fault Identification Codes

FAULT CONDITION	RUN/ STOP	FAULT	RDY	WRITE PROT	A	B
Spin error		on				on
Microprocessor fault		on			on	
SDI error		on			on	on
Master/slave error		on		on		
Servo fine positioning error		on		on		on
Servo coarse positioning error		on		on	on	
Spindle motor interlock error		on		on	on	on
Servo or HDA overtemp error		on	on			

3.1.5 A and B Port Select Switches

The RA81 Disk Drive has two port select push button switches. These double-action switches (A and B) have built-in lights that indicate the port through which the drive is being accessed. If the drive is equipped with dual-port abilities, any one of three modes can be selected with the A and B switches.

- Port A operation only
- Port B operation only
- Port A/B (programmable) operation

When the Port A button is pushed in and the Port B button is out, only Port A can be accessed by the controller. During the opposite condition, only Port B can be accessed. However, when both push buttons are in at the same time, either Port A or Port B can be accessed by the controller. When either or both buttons are out, the drive is off-line to the port or ports indicated.

The drive will indicate that it is on-line to controller A by lighting the A switch, on-line to controller B by lighting the B switch, or not on-line to either controller by leaving both lights off. During normal operation, the indicator lights will never be on at the same time. The on/off conditions of the port indicator lights do not always follow changes in switch positions immediately. For example, if the drive is on-line to controller A, the indicator light for A will be on. If the switches are then reset for access by controller B, the A indicator will stay on until the drive is actually on-line to controller B. Then and only then will the indicator lights change state.

3.2 CIRCUIT BREAKERS

Each disk drive has a circuit breaker on the back panel as well as a breaker on the back of the power controller in the bottom of the cabinet. Access to these breakers is through the back door of the cabinet. The breakers on the drive control the application of ac power to the drive dc power supply, the cooling fans, and the spindle motor. This breaker must be on before the drive will operate.

The power controller breaker regulates the application of ac power to all assemblies within the RA81 cabinet and must be turned on before the drive breaker can be effective.

3.3 DRIVE OPERATION

3.3.1 Spin-Up

Push in the RUN/STOP button on the drive front panel to spin-up the drive. The RUN indicator will light immediately and the READY indicator will come on as soon as the drive has completed the spin-up cycle.

3.3.2 Spin-Down

Release the RUN/STOP button (out position) on the drive front panel to stop the drive. The READY indicator will go off immediately and the RUN indicator will go off as soon as disk rotation stops.

3.3.3 Removing RA81 Power

Do a spin-down as described above. After the RUN indicator has gone off, turn the drive breaker on the back panel off and disconnect the cord going to the power controller. This will remove all power to the drive.

3.4 CUSTOMER CARE

The air filter in the logic chassis assembly should be inspected and cleaned every six months.

3.4.1 Air-Filter Removal

To remove the air filter, proceed as follows:

1. Pull down the access door on the front bezel of the drive. Refer to Figure 3-3.

NOTE
The hinge mechanism can be damaged if tools are placed on the open access door or if it is leaned on.

2. Take hold of the filter material and pull outward until it is free of the bezel.

3.4.2 Cleaning

1. Wash the foam air filter in warm water using a mild detergent.

2. Rinse the filter material with clear water and then allow to dry.

3.4.3 Replacement

1. Slide the filter into place inside the bezel.

2. Close the access door.

NOTE
Replace the filter by ordering DIGITAL part no. 7422816-00.

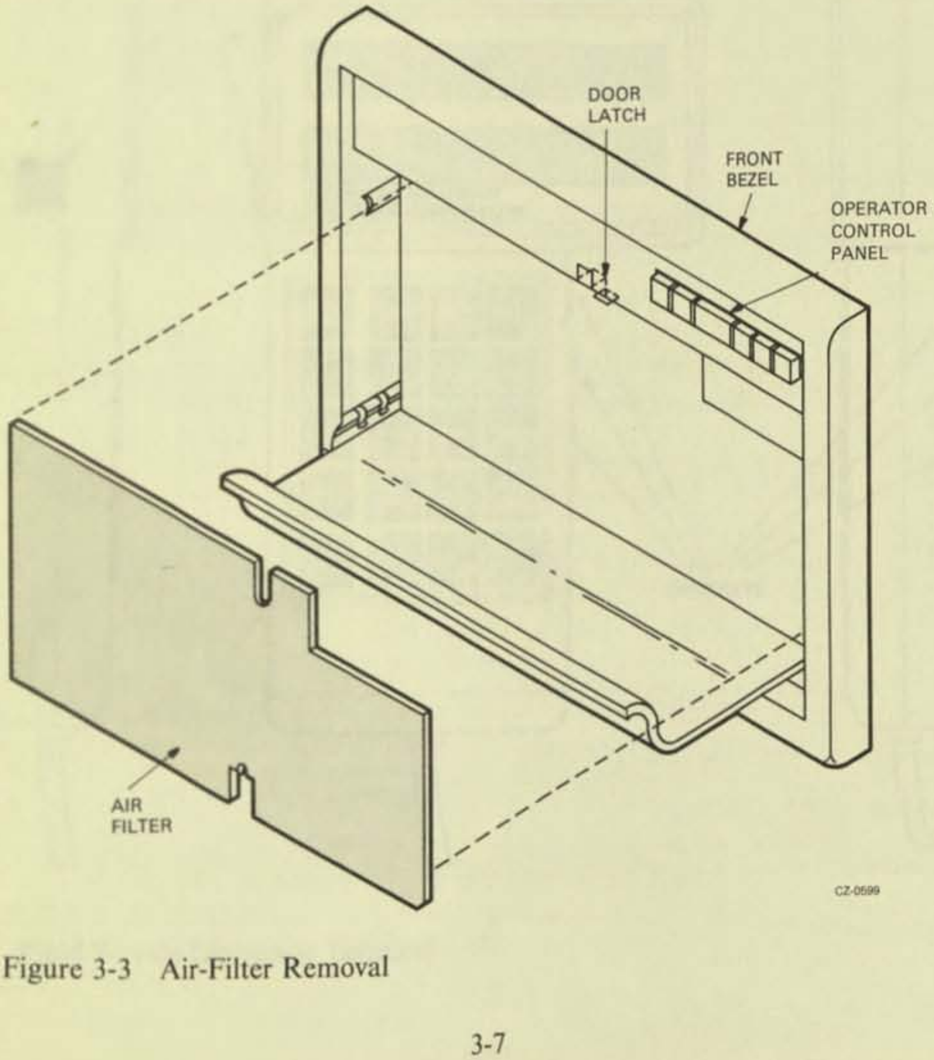

Figure 3-3 Air-Filter Removal

APPENDIX A
DIAGNOSTIC TERMINAL INSTRUCTIONS

This appendix provides instructions on how to use the field service diagnostic terminal.

A.1 INTRODUCTION
Refer to Figure A-1. The terminal contains a two-level LED display and a keyboard. The display holds a maximum of 32 characters at a time while an internal buffer stores 2K characters for the display. The keyboard contains a standard ASCII set of alphanumeric characters. The larger character on each keybutton is the default character displayed when the button is pushed.

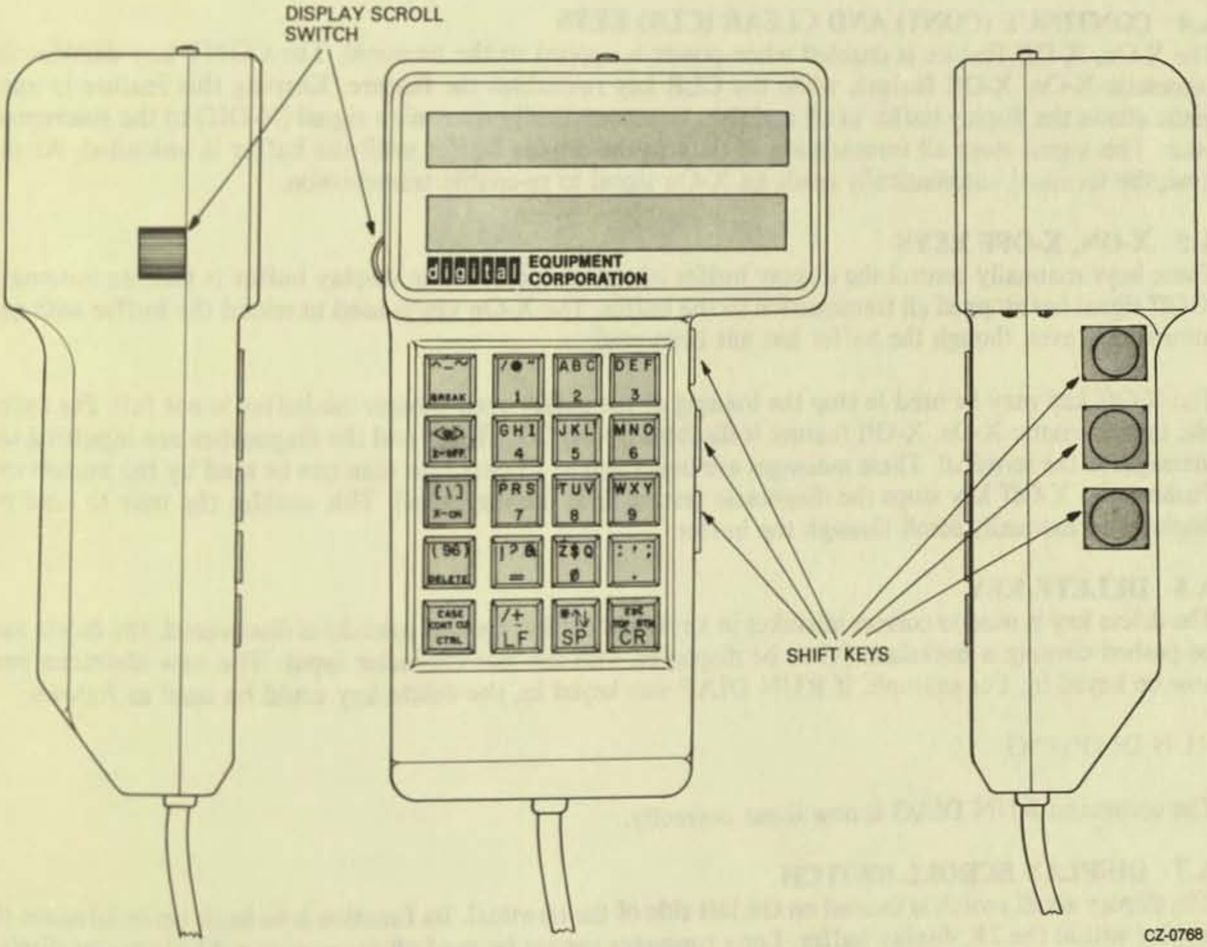

Figure A-1 Field Service Diagnostic Terminal

RA81 USER GUIDE
EK-ORA81-UG-001

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