EK-RD31A-TD-001

RD31-A Disk Drive

Technical Description

2.8
3.9/.7

digital™

EK-RD31A-TD-001

RD31-A Disk Drive

Technical Description

Prepared by Educational Services
of
Digital Equipment Corporation

First Edition, November 1985

CONTENTS

FIGURES

TABLES

CHAPTER 1
GENERAL INFORMATION

1.1 INTRODUCTION

This manual provides information on installing, operating and maintaining an RD31 5-1/4 inch fixed disk drive (Figure 1-1).

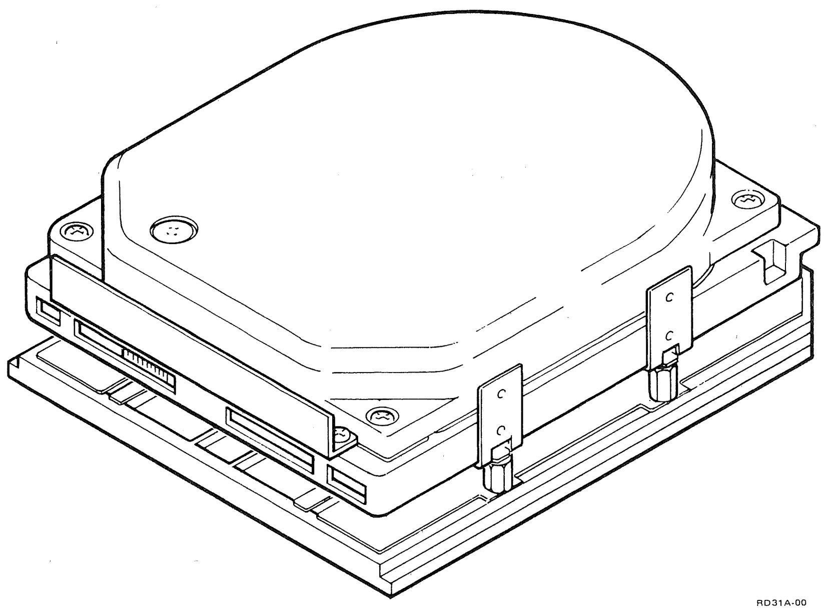


Figure 1-1 RD31-A Fixed Disk Drive

1.2 SCOPE OF MANUAL

This manual is for service personnel, either Field Service engineers or repair technicians in an OEM repair depot. The manual consists of six chapters described as follows.

Chapter 1 -- General Information

This chapter gives introductory information, including a brief description of the RD31 drive and an explanation of the various services offered to you by Digital Equipment Corporation.

Chapter 2 -- Installation

This chapter gives procedures for unpacking and installing the drives. It also gives information on supplying power and the required interface signals to the drives and configuring single- or multi-drive systems.

Chapter 3 -- Mechanical Description

This chapter gives a mechanical description of the drive.

Chapter 4 -- Theory of Operation

This chapter gives a detailed electrical description of the drive, explaining the interface and the circuit boards used.

Chapter 5 -- Maintenance

This chapter gives troubleshooting information and removal and replacement procedures.

- Troubleshooting gives information to help isolate faults to a replaceable assembly.
- Removal and Replacement Procedures gives detailed, step-by-step instructions for the removal and replacement of the field-replaceable units.

Chapter 6 -- Parts List

This chapter lists and illustrates the field-replaceable parts.

1.3 SPECIFICATIONS

1.3.1 Performance Specifications

Seek Time (includes settling time)

Track-to-track	20.0 ms
Average	65.0 ms
Maximum (full stroke ms)	145.0 ms

Rotational Latency

Average	8.33 ms

Start time	24 s max to drive ready
Stop time	30 s max

1.3.2 Functional Specifications

Cylinders	615
Encoding method	MFM
Spindle speed	3600 rpm
Speed variation	$\pm 1.0\%$

1.3.3 Physical Specifications

Drive (without standoff and mounting plate)

Height	41.4 mm (1.63 in)
Width	146.05 mm (5.75 in)
Depth	203.2 mm (8.00 in max)

Drive (with standoff and mounting plate)

Height	52.6 mm (2.07 in)
Width	146.05 mm (5.75 in)
Depth	203.2 mm (8.00 in)

Weight	1.59 kg (3.5 lb) nominal

1.3.4 Capacity

Unformatted

Unit total megabytes	25.67
Megabytes per surface	6.41
Disks	2
Data surfaces	4
Heads (read/write)	4
Cylinders	615
Bytes per track	10,416
Transfer rate (megabits/sec)	5.00

Formatted *

Unit total megabytes	20.15
Bytes per track	8192
Megabytes per surface	5.04
Data cylinders	615

1.3.5 Vibration

Operating

Maximum vibration at the following frequencies without incurring physical damage or degradation in performance.†

Frequency	Vibration
5 -- 22 Hz	0.010 in, double amplitude
22 -- 500 Hz	0.25 G, peak amplitude
500 -- 22 Hz	0.25 G, peak amplitude
22 -- 5 Hz	0.010 in, double amplitude

Nonoperating

Maximum vibration at the following frequencies without incurring physical damage or degradation in performance with the heads positioned in the shipping zone.†

	Frequency	Vibration
Vertical Axis Excitation		
	10 -- 22 Hz	1.40 g
	0 -- 50 Hz	Power spectral density .029 (GxG)/Hz
	50 -- 300 Hz	Power spectral density .029 (GxG)/Hz with 8dB/octave rolloff
Longitudinal and Lateral Axis Excitation		
	10 -- 200 Hz	.68 g overall
	10 -- 50 Hz	Power spectral density .007 (GxG)/Hz
	50 -- 200 Hz	Power spectral density .007 (GxG)/Hz with 8dB/octave rolloff

1.3.6 Shock

Operating

Maximum shock without incurring physical damage or degradation in performance.†

1/2 sinusoidal   10 g peak of 10±3 ms duration (no head/media damage)

Nonoperating

Maximum shock without incurring physical damage or degradation in performance with head positioned in the shipping zone.†

1/2 sinusoidal   20 ms, 40 G

---

* MFM format; see Paragraph 4.3 for format parameters.

† Input levels at the drive mounting screws and drive mounted in the recommended orientation.

1.3.7 Environmental Requirements

	Operating	Storage
Ambient temperature	10°C to 50°C (50°F to 122°F)	-40°C to 66°C (-40°F to 151°F)
Relative humidity	20% to 80% noncondensing	8% to 95% noncondensing
	26°C (78.8°F) maximum wet bulb noncondensing	26°C (78.8°F) maximum wet bulb noncondensing
Altitude	-304.8 meters to 3,048 meters (-1000 ft to 10,000 ft)	-304.8 meters to 9,144 meters (-1000 ft to 30,000 ft)
Temperature gradient	11°C/hour (20°F/hour)	20°C/hour (36°F/hour)

1.3.8 Power Dissipation (Nominal Voltage)

Stand-by	15 W
Positioning	14 W

1.4 DESCRIPTION

The RD31-A fixed disk drive consists of a drive mechanics assembly and one printed circuit board.

1.4.1 Drive Mechanics

The mechanical portion of the RD31-A drive consists of a die-cast frame and a head/disk assembly (HDA). The HDA is suspended within the frame on shock isolators/absorbers. This construction protects the HDA from mechanical shock and stresses associated with mounting the drive in a system enclosure.

The HDA consists of a die-cast base, sealed to form a clean area. This area contains virtually all the drive's mechanical components.

The RD31-A has a captured-air-space filtration system. A 0.3 micron filter maintains filtration within the sealed HDA and requires no maintenance during the life of the drive. A filtered port permits ambient pressure equalization. During normal operation there is no measurable air flow between the HDA and the outside environment.

Inside the clean area are two nonremovable magnetic disks, four recording heads, and a stepper motor. The stepper motor positions the heads. The disks are driven by a dual spindle motor circuit. To ensure sufficient starting power, the motor circuit is run with a set of bipolar motor drives. Once the spindle motor starts spinning, the microprocessor switches the motor from bipolar to unipolar drives. Switching information for the electronic commutator is supplied by the Hall-effect sensors.

1.4.2 Electronics

High reliability is assured through the use of Large Scale Integration (LSI). A single printed circuit board contains all the electronics. The following logic is contained on this board.

- Spindle motor control
- Stepper motor control
- Read circuitry
- Write circuitry
- Fault detection circuitry

1.4.2.1 Spindle Motor Control -- The spindle motor control circuitry contains the logic to quickly get the spindle motor up to speed, sense the motor speed, correct the speed, and brake the spindle motor.

1.4.2.2 Stepper Motor Control -- This circuit is under microprocessor unit (MPU) control. At power on, the MPU initializes the stepper circuits. After a delay time the seek and discrimator routines recalibrate the drive to track zero. The stepper circuit can now await controller signals to position the head at the proper track location.

1.4.2.3 Read Electronics -- The read electronics consist of the following:

- Head select circuitry
- Four heads
- A preamp
- A low pass filter
- A pulse shaper
- A time domain filter
- A line driver.

1.4.2.4 Write Electronics -- The write electronics consist of the following:

- A line receiver
- A pulse generator
- A current source
- A head select circuit.

1.4.2.5 **Fault Detection Electronics** -- The fault detection electronics check the following:

- DC power
- Selection of multiple heads
- Seek Complete (when the Write Gate is active)
- Ready or recovery mode (when the Write Gate is set).

CHAPTER 2
INSTALLATION

2.1 INTRODUCTION

This chapter describes how to install an RD31-A fixed disk drive. The following instructions for unpacking and inspecting the drive are included.

- Determining or establishing the drive configuration
- Installing the drive
- Providing the proper power and interface signals
- Configuring multi-drive systems
- Repacking the drive for shipment

2.2 UNPACKING THE DRIVE

To make sure that static-susceptible components and assemblies are protected from electrostatic discharge (ESD) damage, each drive is sealed in a anti-static wrapper. Unpack and remove the drive (or drives) from the anti-static wrapper at a static-free work station.

CAUTION

Do not subject a packaged drive to mechanical shock greater than 40 G in any axis. A shock greater than this may cause permanent damage.

Inside the shipping carton is an inner wrapper of foam blocks, which provides shock isolation for the inner carton containing the drive.

Use the following procedure to unpack the drive (see Figure 2-1). Be sure to SAVE ALL PACKING MATERIALS in case it is necessary to repack the drive for shipping (refer to Paragraph 2.9).

1. Place the shipping carton on a clean, flat surface at a static-free work station.

2. Slit the sealing tape on the carton top, then open the top flaps.

3. Remove the drive and packing material by sliding everything in the box straight up. Place the contents in a clear spot on the static-free work station.

4. Pull out the flap on the front side of the packing material and open the packing material. This exposes the foam insert and the box containing the drive.

5. Open the three flaps on the box inside and carefully remove the drive (which is in a anti-static wrapper).

6. Move the packaging materials away from the drive.

7. To inspect the drive, slide the drive out of the anti-static wrapper.

8. Now check to make sure the drive is properly configured. All drives are shipped with the DS1 jumper (Drive Address 1) and the terminator resistor pack installed. If the drive is to be configured differently, the configuration may be changed either now or later during system integration.

9. If a configuration change is to be done, refer to Paragraphs 2.3, 2.4, and 2.5.

10. Save all the shipping material and the cartons in case it is necessary to repack the drive for shipping.

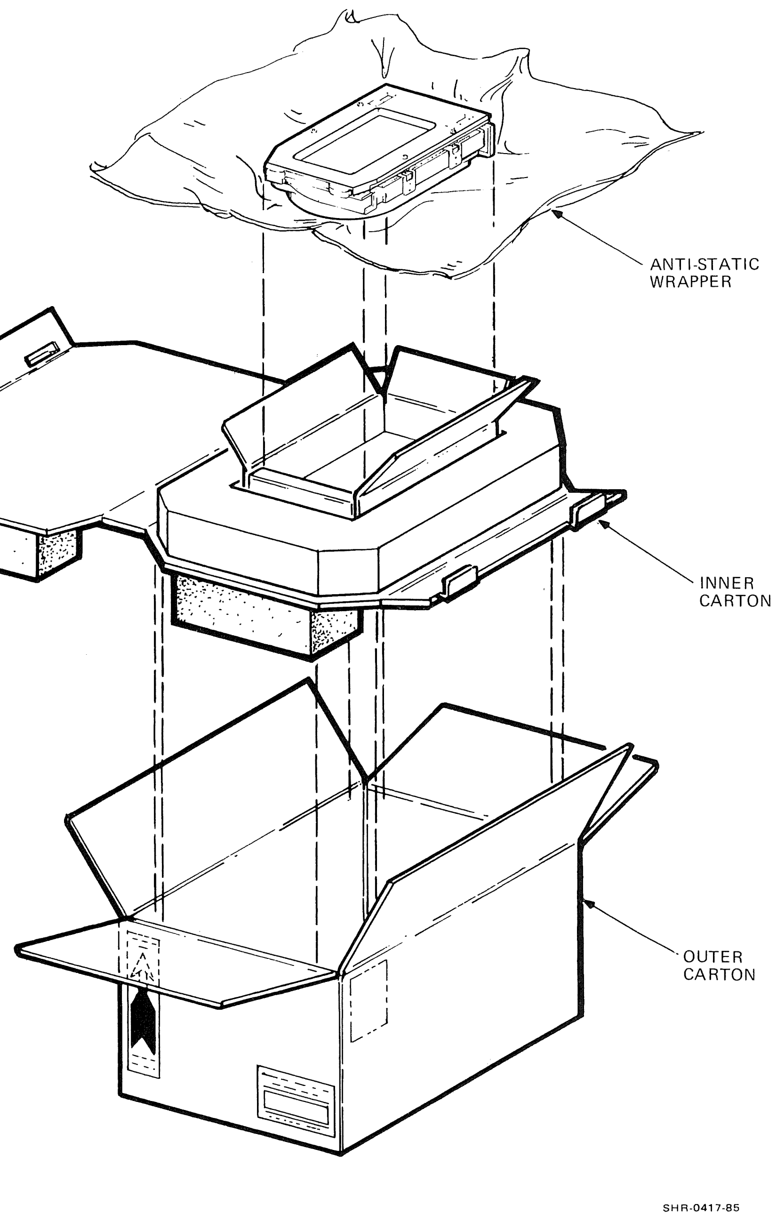


Figure 2-1   Unpacking the Drive

2.3 CONFIGURATION OPTIONS

The specific configuration of the drive is established by the installation or omission of jumpers and components on the device electronics board. These items are shown in Figure 2-2. The drive configuration options are shown in Table 2-1 and Table 2-2.

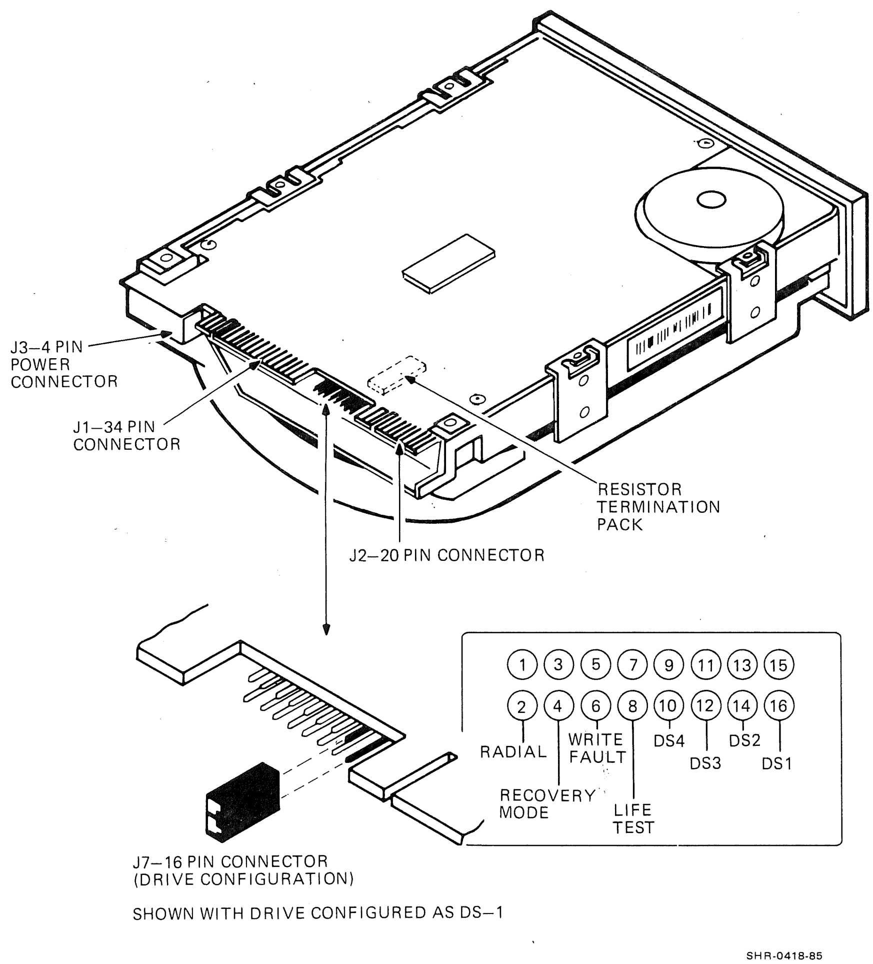


Figure 2-2 Device Electronics Board Configuration Components

Table 2-1 RD31-A Device Electronics Board Configuration Options (Drive Select)

Characteristic	J7 Pin Description	Connector	Option Methodology			
Drive Address			DS1	DS2	DS3	DS4
	Drive 1	15 to 16	X	-	-	-
	Drive 2	13 to 14	-	X	-	-
	Drive 3	11 to 12	-	-	X	-
	Drive 4	9 to 10	-	-	-	X
Pins Jumped	X = Jumper in - = Jumper out					

Table 2-2 RD31-A Device Electronics Board Configuration Options (All Other Configurations)

Characteristic	Jumper Location	Jumper In	Jumper Out
Life test	7 to 8	Factory use only	* normal mode
Write fault	5 to 6	Latched	* normal mode
Recovery mode	3 to 4	Recovery	* normal mode
Radial	1 to 2	Radial mode	* daisy chain

* Normal configuration.

2.4 DRIVE ADDRESSING

The address of each RD31-A drive is set by setting a jumper on the device electronics board. See Table 2-1, Table 2-2 and Figure 2-2 for jumper information and typical Digital configurations.

NOTE

Refer to host system installation instructions for specific drive address selection.

2.5 TERMINATION RESISTORS

RD31-A drives used in most Digital systems have the resistor termination pack installed. For specific exceptions, refer to host system installation instructions. If instructed to remove the terminator resistor, be sure to tape it to the HDA or store it in a safe place to prevent loss.

2.6 DRIVE DIMENSIONS

Figure 2-3 shows the dimensions of the RD31-A fixed disk drive.

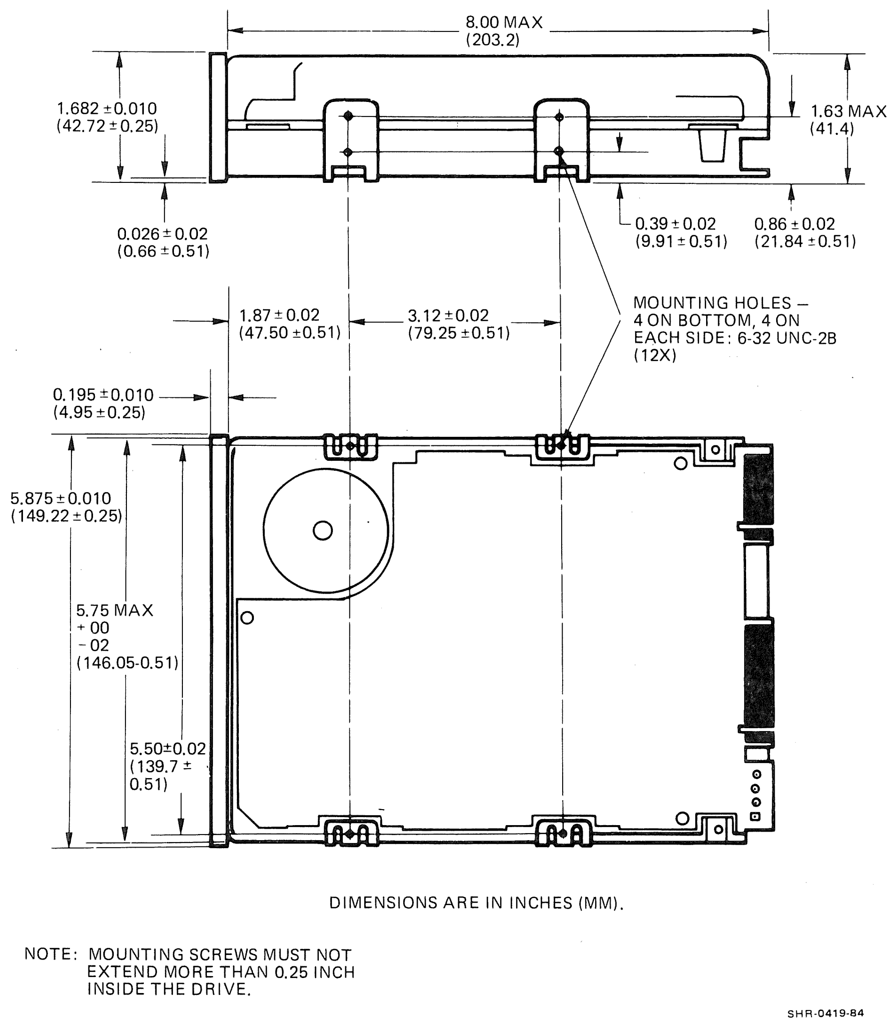


Figure 2-3 Drive Dimensions

2.7 ELECTRICAL INTERFACE

Power and interface connection between the RD31-A drive and the host system is accomplished through three connectors.

1. Control signal connector J1
2. Data transfer connector J2
3. Power connector J3.

Figure 2-4 shows connector locations.

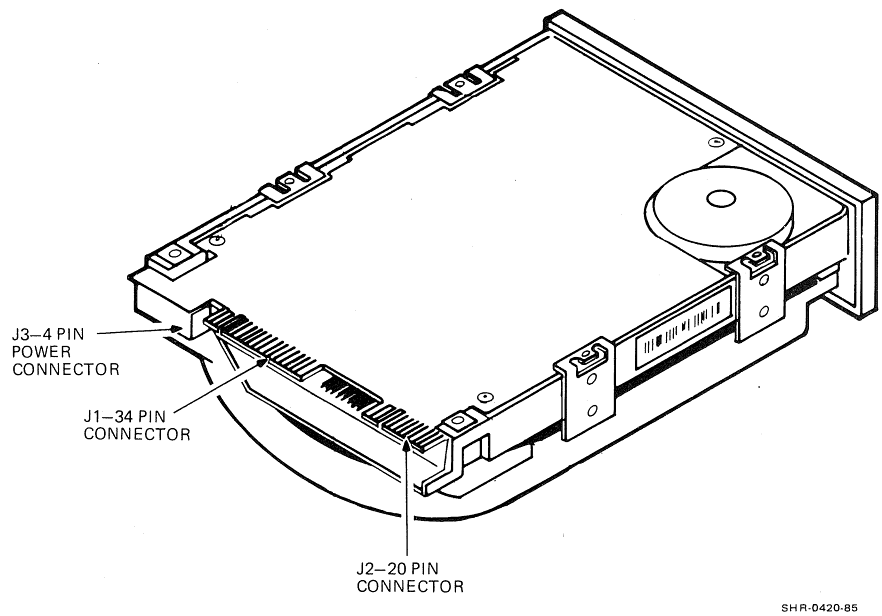


Figure 2-4 Power and Interface Connectors

2.7.1 Power and Ground Requirements/Connections

2.7.1.1 **Power** -- DC power is supplied to the drive at 4-pin keyed Mate-N-Lok connector J3 on the device printed circuit board (see Figure 2-4). Connector J3 is on the component side of the board, with pin 1 toward connector J1. Pin assignments are listed in Table 2-3.

Table 2-3 J3 Power Connections

J3 Pin	Voltage	J3 Pin	Voltage
1	+12 V	3	+5 V return
2	+12 V return	4	+5 V

2.7.1.2 **Ground** -- Chassis ground for the drive is automatically achieved when the drive is mechanically installed.

2.7.2 Signal Pin Assignments

Connectors J1 and J2 are physically part of the device electronics board, and together provide the signal interface to the host system. See Paragraph 4.2.1 for electrical characteristics of the interface drivers/receivers.

2.7.2.1 **Control Signal Connector J1 (Table 2-4)** -- J1 is a 34-pin edge connector. Pin 1 is on the component side of the board, away from Data Transfer Connector J2 (see Figure 2-4).

Table 2-4 Control Signal Connector J1 Signal Assignments

J1 Connector Pin Signal	Ground	Signal Name	Source
2	1	Head Select 23/	--
4	3	Head Select 22/	Host
6	5	Write Gate/	Host
8	7	Seek Complete/	Drive
10	9	Track 000/	Drive
12	11	Write Fault/	Drive
14	13	Head Select 20/	Host
16	15	Reserved (to J2 pin 7)	--
18	17	Head Select 21/	Host
20	19	Index/	Drive
22	21	Ready/	Drive
24	23	Step/	Drive
26	25	Drive Select 1/	Host
28	27	Drive Select 2/	Host
30	29	Drive Select 3/	Host
32	31	Drive Select 4/	Host
34	33	Direction In/	Host

2.7.2.2 Data Transfer Connector J2 (Table 2-5) -- J2 is a 20-pin edge connector. Pin 1 is on the component side of the board, toward Control Signal Connector J1 (see Figure 2-4).

Table 2-5 Data Transfer Connector J2 Signal Assignments

J2 Connector Pin Signal	Ground	Signal Name	Source
1	2	Drive Selected/	Drive
3	4	Reserved	--
5	6	Spare	--
7	8	Reserved (to J1 pin 16)	--
9	10	Spare	--
-	11	Ground	--
-	12	Ground	--
13	-	MFM Write Data+	Host
14	-	MFM Write Data-	
-	15	Ground	--
-	16	Ground	--
17	-	MFM Read Data+	Drive
18	-	MFM Read Data-	
-	19	Ground	--
-	20	Ground	--

2.8 DRIVE SYSTEM CONFIGURATIONS

Drive system configurations are host dependent. Refer to the appropriate systems manual for multiple drive installations.

2.9 REPACKING THE DRIVE FOR SHIPMENT

If it is necessary to repack the drive for shipment, the following procedure must be used. Refer to Figure 2-1.

CAUTION
Damage caused by improper packing will void the Digital warranty.

Do not ship the drive except in the original packing or an alternate approved package. If any of the packing material is lost or otherwise unavailable, contact your local Digital Customer Service office for instructions.

To make sure that static-susceptible components and assemblies are adequately protected from electrostatic discharge (ESD) damage, repack the drive at a static-free work station.

CAUTION
A drive is subject to damage if dropped; use care when repacking for shipment.

1. Place the drive into the anti-static wrapper, fold the wrapper over the drive (push out any air so that the wrapper conforms to the shape of the drive).

2. Set the drive on the cardboard inner carton; then wrap the carton around the drive to form a sealed inner package.

3. Align the foam insert with the edges of the inner carton. Close the inner carton and tuck in the flaps.

4. Open the outer carton and smoothly slide in the inner carton. Close the outer carton flaps and tape the carton securely.

CHAPTER 3
MECHANICAL DESCRIPTION

3.1 INTRODUCTION

This chapter describes how the mechanical components of the drive are organized and how they operate.

3.2 DRIVE MECHANICS

The drive mechanics consist of the following components or subassemblies.

- Head/disk assembly (HDA)
  - Magnetic disks and spindle
  - Drive motor
  - Positioner
  - Head assembly
- Outer chassis (frame)

Figure 3-1 shows the general organization of the major components.

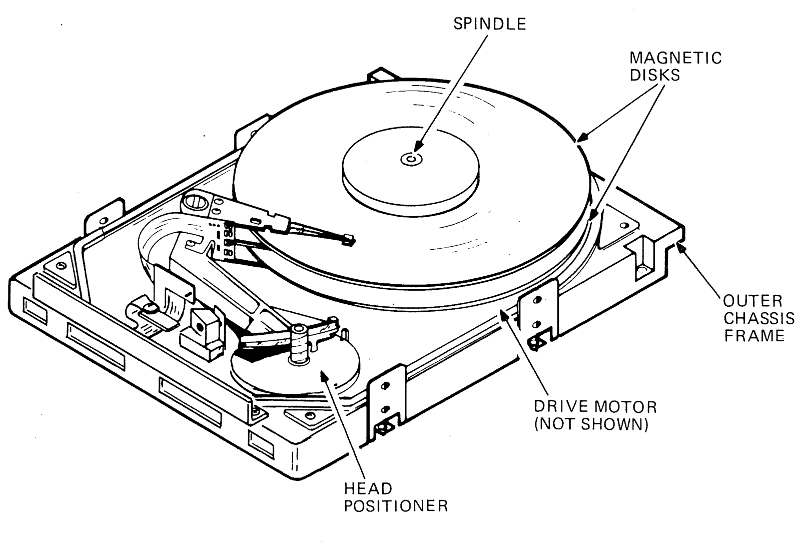


Figure 3-1 Mechanical Organization

3.2.1 Head/Disk Assembly

The HDA consists of a die-cast structure that contains all of the drive's mechanical components. An aluminum cover attaches to the HDA to create a sealed clean area. Components contained in the clean area are the read/write heads, the magnetic disks, and the stepper motor head positioner components.

Air circulates through the clean area by disk rotation induced flow and is filtered by a 0.3 micron absolute filter. The sealed area breathes to the outside with a similar filter.

There are no active electronic parts in the sealed clean area. Electrical connection between the clean area's components and the drive's electronic boards is made through flexible circuits.

The following is a description of the assemblies contained within the disk unit.

1. Disk/Spindle Assembly

   The drive has two magnetic disks mounted on the spindle assembly. The spindle assembly shaft attaches through a bearing structure in the base casting to the spindle drive motor.

2. Spindle Motor Assembly

   A brushless dc motor provides the rotational drive for the disk/spindle assembly. Hall-effect sensors, which are mounted in the drive motor assembly, provide switching information for electronic commutation. Refer to Paragraph 4.4.3 for additional information on the spindle motor.

3. Positioner Assembly

   The RD31 uses a stepper motor mechanism for positioning. The drive accesses the index tracks on power-up for reference information. When the drive reaches the proper speed, the stepper motor circuit sets to Phase Minus A and Phase Minus B.

   The processor then seeks in multiples of eight tracks until it finds Track 617 and Track Minus 1. These are the reference tracks that are written by all four heads. The processor uses these tracks to set its internal track counter.

The drive then steps in one track and sets the Track O signal on the interface. The processor maintains the track count until a recalibration or auto-truncation triggers the set-up routine.

The index tracks (written on cylinder 617 and cylinder minus 1), are written with a unique data pattern that allows for creation of the index and interface signal. The drive has a simple data discriminator that the MPU samples during initialization. By discriminating the unique data pattern on the index/Track O reference tracks, the MPU can set a divide-by-two circuit. The Hall signal is used to generate a reliable index from the spindle motor.

4. Head Assembly

The RD31-A drive has four data heads. The head assembly is an aerodynamic structure that flies over the disk surface on an "air bearing" created by the rotation of the disk. The heads are loaded towards the disk surface at 9.5+1 grams. This is a typical value and allows the required stability in all approved operating conditions.

5. Recording Media

The RD31-A uses two nonremovable, double-sided, 5-1/4 inch disks. This media uses iron-oxide technology. The thickness of the magnetic coating is 20 microinches at the inside diameter and increases linearly to 40 microinches at the outside diameter. The disk surfaces are coated with a fluorocarbon lubricant 25 to 55 Angstroms thick.

4.1 INTRODUCTION

This chapter describes the theory of operation of the RD31-A fixed disk drive. The disk drive consists of mechanical and electrical components necessary to record data on and retrieve data from a magnetic disk.

Figure 4-1 shows the overall organization of the RD31-A fixed disk drive.

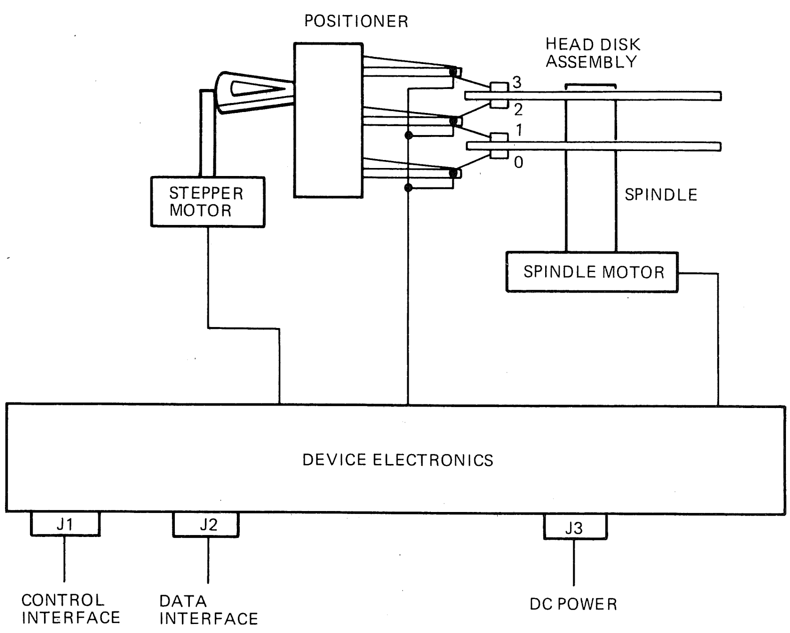


Figure 4-1 RD31-A Drive Organization

The drive consists of the following two major components.

1. Drive mechanics assembly
   - (which includes the HDA and the stepper motor)

2. Drive electronics
   - Device electronics board 29-25527-00 which contains:
     - The Spindle Motor control circuitry
     - The Track Select circuitry
     - The Read circuitry
     - The Write circuitry.

The drive theory of operation is presented in the following sections.

1. Section 4.1, Introduction

2. Section 4.2, Drive Interface

   This section describes the signals present at drive interface connectors J1 and J2 and the power connector J3. The interface signals are used for communication with the host system. The power connector supplies power to the disk system.

3. Section 4.4, Functional Theory of Operation

   This section explains the operation of the drive and shows the interactions between the mechanical components and the various functional elements of the drive electronics.

4.2 DRIVE INTERFACE

4.2.1 Interface Connectors and Electrical Characteristics

There are two drive interface connectors, J1 and J2. The two connectors are physically part of the device electronics board and are used for interfacing the drive to a host controller/formatter. Both connectors are pin and plug compatible with the industry standard configuration for 5-1/4 inch Winchester disk drives.

4.2.1.1 Control Signal Connector J1 -- J1 is a 34-pin, PCBA edge connector. Pin 1 is on the component side of the board, away from Data Transfer Connector J2. Table 4-1 lists the control and status signals on J1.

Table 4-1 Control Signal Connector J1 Signal Assignments

J1 Connector Pin			
Signal	Ground	Signal Name	Source
2	1	Head Select 2^3/	Host
4	3	Head Select 2^2/	Host
6	5	Write Gate/	Host
8	7	Seek Complete/	Drive
10	9	Track 00 0/	Drive
12	11	Write Fault/	Drive
14	13	Head Select 2^0/	Host
16	15	Reserved (to J2 pin 7)	--
18	17	Head Select 2^1/	Host
20	19	Index/	Drive
22	21	Ready/	Drive
24	23	Step/	Host
26	25	Drive Select 1/	Host
28	27	Drive Select 2/	Host
30	29	Drive Select 3/	Host
32	31	Drive Select 4/	Host
34	33	Direction In/	Host

The control signals are driven by a 74LS14 open-collector output stage capable of sinking a maximum of 40 milliamps at logical true, with a maximum voltage of +0.4 V measured at the output. When the line driver is at logical false, the driver transistor (internal to chip) is off; and the collector cut-off current is 250 microamps maximum. Figure 4-2 shows the electrical characteristics of the drivers and receivers used for the control signals.

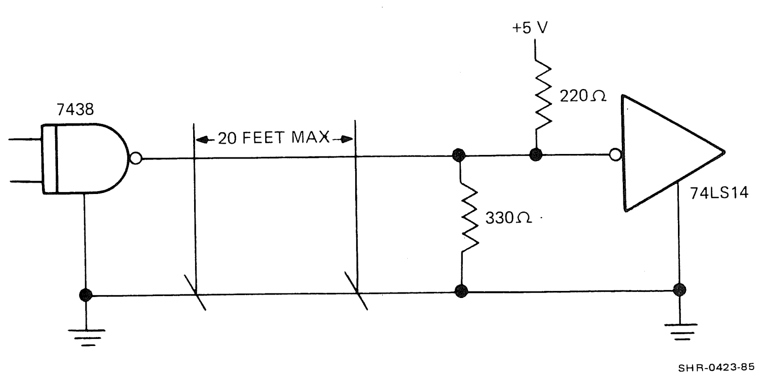


Figure 4-2 Control Signal Electrical Characteristics

4.2.1.2 **Data Transfer Connector J2** -- J2 is a 20-pin, PCBA edge connector. Pin 1 is on the component side of the board, next to drive configuration connector J7. Table 4-2 lists the data signals (and the one status signal) on J2. Figure 4-3 shows the electrical characteristics of the drivers and receivers used for the data transfer signals.

The Read Data and Write Data signals are differential in nature and are connected radially. Status signal Drive Selected/ is TTL.

Table 4-2 Data Transfer Connector J2 Signal Assignments

J2 Connector Pin Signal	Ground	Signal Name	Source
1	2	Drive Selected/	Drive
3	4	Reserved	--
5	6	Spare	--
7	8	Reserved (to J1 pin 16)	--
9	10	Spare	--
-	11	Ground	--
-	12	Ground	--
13	-	Write Data+	Host
14	-	Write Data-	
-	15	Ground	--
-	16	Ground	--
17	-	MFM Read Data+	Drive
18	-	MFM Read Data-	Drive
-	19	Ground	--
-	20	Ground	--

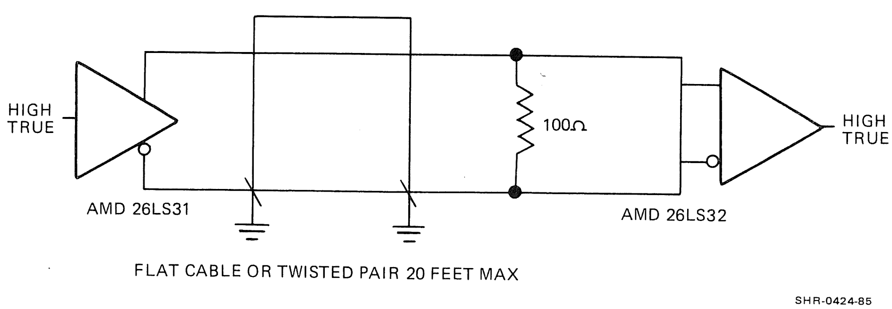


Figure 4-3 Data Transfer Signal Electrical Characteristics

4.2.1.3 DC Power Connector J3 -- J3 is a 4-Pin Mate-N-Lok connector. Pin 1 on J3 is closest to the edge of the printed circuit board. Table 4-3 lists the voltages on J3.

Table 4-3 Power Connector J3 Voltage Assignments

Pin	Power
1	+12 V
2	+12 V return
3	+5 V return
4	+5 V

4.2.2 Drive Interface Signals

4.2.2.1 Connector J1 - Input Signals -- Connector J1 is used for interfacing control and status signals with the host controller/formatter.

Drive Select 1/ through Drive Select 4/

Drive selection depends on which drive select jumper is in place (DS1 -- DS4).

- In a typical single-drive system, drive select jumper DS1 is inserted. The drive is selected when the Drive Select 1/ line is asserted.
- In some multiple-drive systems and certain single-drive systems, drives may be shipped with a configuration other than DS1. Each drive is assigned an address by one of the drive select signals (DS1, DS2, DS3, or DS4) and is selected by a different drive select line. Assertion of one of the drive select lines (to a drive that has the corresponding drive select jumper inserted) selects that drive for operation by the host.

When selected, the drive responds to control and data signals on input lines and provides status and data signals on output lines.

Write Gate/

The active state of the Write Gate/ signal (logical true) enables write data to be written onto the disk provided that Seek Complete is true. Read data is invalid.

The inactive state of Write Gate/ (logical false) inhibits writing and enables the read data (that is read from the selected disk surface) to be transferred to the host system through the Read Data± lines. Read data is valid within eight microseconds after Write Gate/ goes false after a write operation (see Figure 4-8, Read/Write Data Timing).

Direction In/

This signal defines the direction of motion of the heads when the Step line is pulsed.

- A high (logical false) on the input defines the direction of motion as out, away from the center of the disk.

- A low (logical true) on the input defines the direction of motion as in, toward the center of the disk.

Step/

This control signal causes the read/write heads to move in the direction defined by the Direction In/ line.

A seek operation is done by first specifying the direction of motion and then issuing a sequence of Step/ pulses, one pulse for each cylinder to be moved.

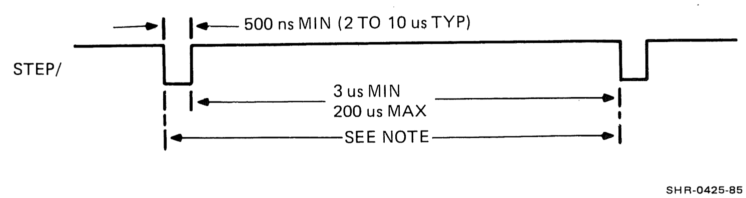
- Any Direction In/ change must be made at least 100 nanoseconds before the leading edge of the first Step/ pulse.

- The Direction In/ line must be stable until after the last pulse of the sequence is issued.

The Step/ pulses should be issued at a constant rate. This rate must be from three microseconds per step to 200 microseconds per step. Figure 4-4 gives Step/ pulse timing.

The Step signal is a 500 nanosecond minimum (2 to 10 microseconds typical) pulse that initiates read/write head motion. The number of pulses issued determines distance traveled. Pulses are edge-detected on the leading edge of the pulse.

The rate of step pulses determines the access method. If the period between pulses is from 3 microseconds to 200 microseconds, the access method will be buffered-step. Slow-step is used if the period between pulses is greater than or equal to 3 milliseconds.



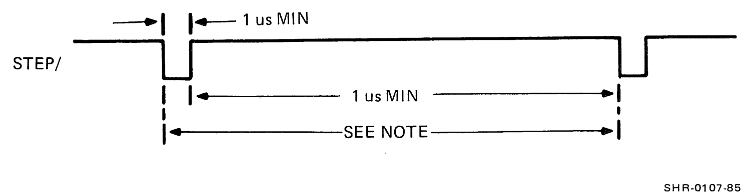


Figure 4-4   Step Pulse Timing

Direction In must be stable 100 nanoseconds before the leading edge of the first step pulse and remain stable for 100 nanoseconds after the last pulse in a string of step pulses. Step pulses issued between 200 microseconds and 3 milliseconds may be lost.

If excessive step pulses are issued, causing a seek beyond cylinder 670 or cylinder zero, the drive enters auto-truncation mode.

NOTE

Step/ pulses with periods between 200 microseconds and three milliseconds are not allowed. Seek operation accuracy is not guaranteed if this restriction is violated.

Seeking is performed in buffered mode. Seek Complete/ goes false upon receipt of the first step pulse, and the drive immediately begins seeking. Additional step pulses received before completion of the seek are buffered into a counter.

After the last step pulse has been sent, the drive select line may be dropped and another drive selected, allowing overlapped seeks. When the drive finishes seeking and settles on the destination track, Seek Complete/ goes true. The drive is now ready to read, write, or accept another seek command. Figure 4-5 gives general seek timing.

Step pulse counts that exceed the cylinder range of the RD31-A drive cause the drive to go into auto-truncation mode. In auto-truncation mode the stepper motor returns the heads to Track 0.

- If the sum of the current cylinder position and number of step pulses received exceeds 670, the positioner automatically recalibrates to Track 0.
- If the sum of the current position and the number of step pulses received is less than zero, the positioner recalibrates to Cylinder 0/ and asserts the Track 0/ interface line.
- To take advantage of the fact that the positioner automatically stops at Cylinder 0/, fast recalibration can be achieved by issuing an outward Step pulse count greater than 670. The positioner then stops at Cylinder 0/. This entire operation is performed within the maximum time of a normal seek and is much faster than the conventional recalibration technique of "step, test for Track 0/, repeat."

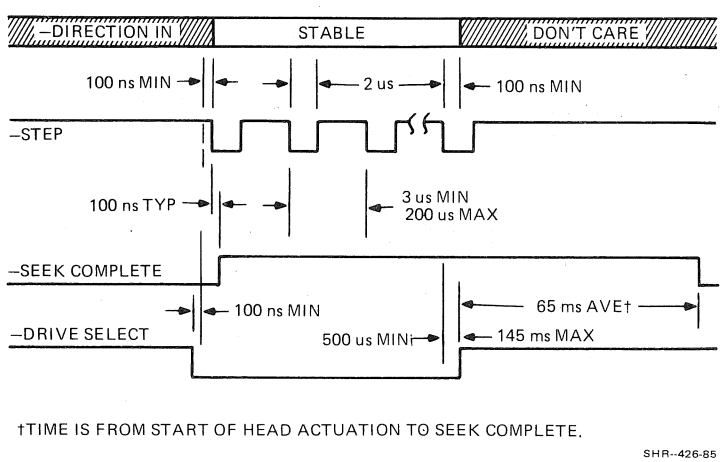


Figure 4-5 General Seek Timing

Head Select $2^{Ø}$/, Head Select 2^{1}/, and Head Select 2^{2}/, and Head Select 2^{3}/

These four lines select each individual read/write head in a binary-coded sequence. Head Select $2^{Ø}$/ is the least significant line. When all four Head Select lines are false, Data Head Ø/ is selected. Table 4-4 shows the head select sequence and Figure 4-6 shows the timing sequences.

Table 4-4 Head Selection

Head Select Line				Data Head Selected
2^3	2^2	2^1	2^0	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3

0 = False, 1 = True

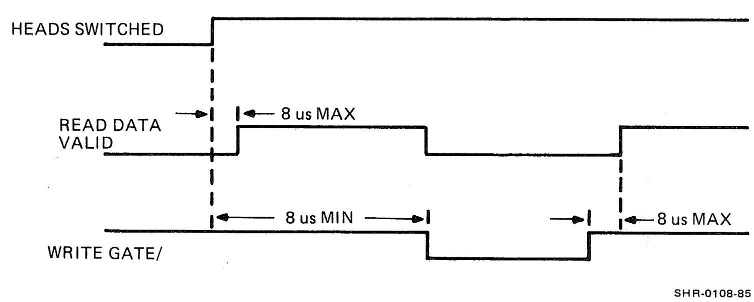


Figure 4-6 Head Selection Timing

4.2.2.2 Connector J1 -- Output Signals

Track 0

This signal indicates a low level, or true state, only when the read/write heads are positioned at cylinder zero (the outermost track). Track 0 is the only cylinder that provides interface recognition. The drive is designed to recalibrate to Track 0 during power-on and truncation operations. Track 0 may also be accessed through conventional buffered-step and slow-step modes. After Track 0 is true, no action may be taken by the controller until Seek Complete is also true.

Index/

This signal is asserted once each disk revolution to indicate the beginning of a track. This signal is normally false and makes the transition to logical true for 200 microseconds. Only the leading edge (the high-to-low transition) of the signal is valid (see Figure 4-7). During power-on Index is not valid until the drive asserts Ready and Seek Complete is true.

Seek Complete/

This signal goes to a low level (true) on the interface when the read/write heads have settled on the final track at the end of a seek. Seeking, reading or writing should not be tried when Seek Complete is false. Seek Complete goes false in the following four cases.

1. A power-up recalibration sequence is under way
2. 500 nanoseconds (maximum) after the leading edge of the first step pulse
3. During normal seek operation
4. Momentary loss of dc power

NOTE
For conditions 1 and 4 Seek Complete may remain false for up to 13 seconds.

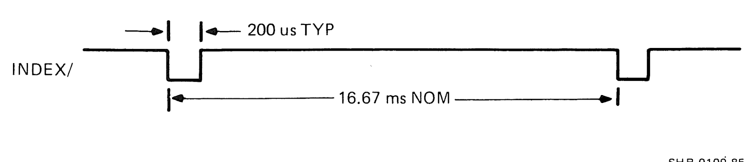


Figure 4-7 . Index Timing

Ready/

This signal, when true together with Seek Complete, indicates that the drive is ready to read, write, or step and that all control input signals are valid. When this line is high, all reading, writing, and stepping is inhibited. Ready will be asserted true within 24 seconds after power-on.

The following three conditions set Ready to false.

1. During power-up, Ready remains false until: the recalibration to Track 0 is complete, spindle speed is stable within ± 1 percent of nominal (only monitored at power-on before Ready becomes true), and drive initialization routines are complete.

2. Write Fault is true.

3. DC voltages are out of tolerance.

Write Fault/

This signal notifies the host system that a condition(s) exists at the drive which, if not detected, causes improper writing on the disk. The controller should edge detect this signal.

With Drive Select active, and one of the following three conditions true, the Write Fault signal is issued to the interface and write current is inhibited.

1. Write Gate true with no write current flowing to the head
2. Write current to the heads with no Write Gate
3. An attempt to write with Recovery Mode active

Any of the following eight conditions causes Write Current to be inhibited when Write Gate is true.

1. Multiple heads selected
2. No heads selected
3. Seek Complete false
4. Ready false
5. Select false
6. DC greater than I/O percent from nominal
7. Step pulses are received
8. An off-track condition is detected

4.2.2.3 **Connector J2** -- Connector J2 is used for interfacing read data, write data, and one status signal with the host controller/formatter.

Read Data+ and Read Data- (Output)

The data recovered from the selected surface is transmitted to the host system through the differential pair of read data lines. While Write Gate/ is inactive, a transition of the Read Data+ line going more positive than the Read Data- line represents a flux reversal on the track of the selected head (see Figure 4-8).

NOTE

Read Data pulse width will be from 25 nanoseconds to 115 nanoseconds and represents the time duration that the +MFM Read Data signal is more positive than the -MFM Read Data signal.

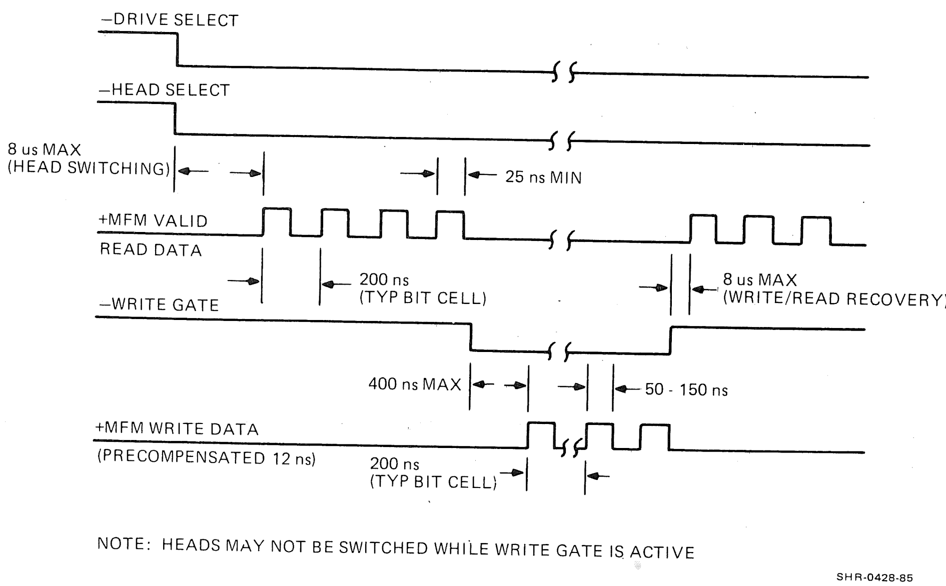


Figure 4-8 Read/Write Data Timing

Write Data+ and Write Data- (Input)

Write Data is transmitted by a differential pair which defines the transitions to be written on the disk. The +MFM Write Data line going more positive than the -MFM Write Data line is the active transition. This signal must be driven to an inactive state when in read mode.

Table 4-5 indicates the bit patterns and the direction to be compensated. An X denotes a "don't care state."

As data is written to the inner cylinders, the bits are written closer together and the Write Current is necessarily reduced to prevent any pulse crowding.

To ensure data integrity at the error rate specified, the write data presented by the host must be precompensated on cylinders 256 through 614. Data patterns that cause a large amount of bit shift have appropriate data bits shifted early or late with respect to the nominal bit cell position. Bit shift compensation, whether early or late with respect to the nominal bit cell position, is 12 nanoseconds. Table 4-5 describes which bit patterns are precompensated.

Table 4-5 Precompensation Pattern

Previous		Sending	Next	Timing
X	0	1	1	Write Data Late
X	1	1	0	Write Data Early
1	0	0	0	Write Clock Late
0	0	0	1	Write Clock Early

X denotes a don't care state.

Drive Selected/

Drive Selected/ is a TTL status line that informs the host system of the selection status of the drive. The line is driven by a TTL open-collector gate. The signal is active only when the following two conditions are satisfied at the same time.

1. The drive is programmed as Drive X (where X is 1, 2, 3, or 4) by proper placement of the drive select jumper (DS1 -- DS4).

2. Drive Select X/ at J1 is activated by the host.

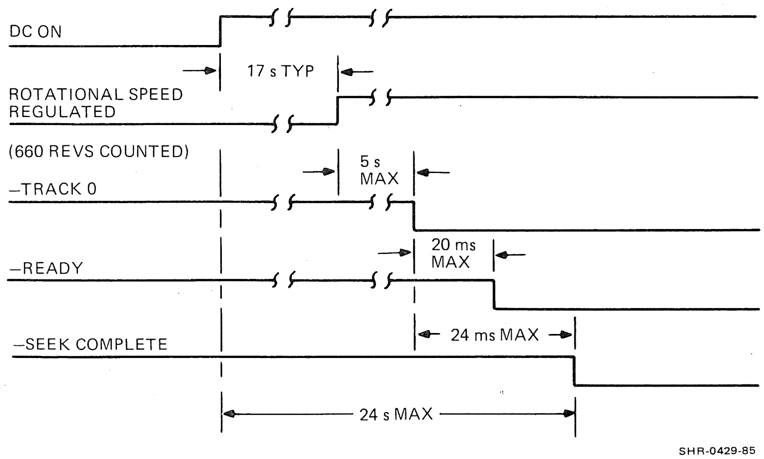


Figure 4-9 General Timing

4.2.3 General Timing Requirements

The general timing shown in Figure 4-9 specifies the sequence of events and related timing restrictions for proper operation of the drive. Specific timing requirements are given with the signal descriptions in Paragraph 4.2.2.

4.3 SYSTEM REQUIREMENTS

4.3.1 Track Format

NOTE

The material in this section is presented for informational purposes only. The actual formatting is performed by the host adapter.

The purpose of a track format is to organize data into smaller, sequentially numbered blocks called sectors. The RD31-A drive is designed to use a soft-sectored format where the beginning of each sector is defined by information that is recorded on the disk. This recorded information is referred to as the Identification (ID) field of the sector and typically contains the physical sector address, the cylinder address, and the head address. Other information such as flags for defect handling may also be included. The ID field is followed by the user data field.

4.3.2 Media Defect Handling

All media defects identified during the manufacturing process are reported on a defect (bad block) map. This map is supplied with each drive. Defective areas are identified by head address, cylinder number, and number of bytes from index. The host system uses this information to skip these defective locations.

4.3.2.1 Bad Block Data (FCT) Field Format -- The format for the bad block data field is as follows.

```
----------------------------------------------------------------------------
| "A1" (4 bytes) | "A2 to "A64" (252 bytes) | (2 bytes) CRC | (272 bytes 0's |
----------------------------------------------------------------------------
```

"A1":

First data word = byte offset ($\pm$5 bytes) from index of first defect

```
Bit number   | 1 1 1 1 1 1 9 8 7 6 5 4 3 2 1 0 |
             | 5 4 3 2 1 0                     |
             |---------------------------------|
             |  Offset High   |  Offset Low    |
             |---------------------------------|
             |    Byte 1      |    Byte 2      |
```

Second data word - First 4 bits = head of first defect
Last 12 bits = cylinder of first defect

```
Bit number   | 1 1 1 1 1 1 9 8 7 6 5 4 3 2 1 0 |
             | 5 4 3 2 1 0                     |
             |---------------------------------|
             |   Cyl High   | Cyl low | Head   |
             |---------------------------------|
             |   Byte 1     |     Byte 0       |
```

NOTE

All data fields are right justified and numbers are positive integers. All unused bits are filled with 0's.

The data fields are written on the disk in the following order:

```
|v-first bit on media                                      last bit on media -v|
 7 6 5 4 3 2 1 0 1 1 1 1 1 1 9 8 | 7 6 5 4 3 2 1 0 1 1 1 1 1 1 9 8 |
                 5 4 3 2 1 0     |                 5 4 3 2 1 0     |
--------------------------------------------------------------------------------
    Offset Lo     |   Offset Hi    | Cyl Lo | Head |      Cyl Hi
--------------------------------------------------------------------------------
      Byte 0      |     Byte 1     |      Byte 2   |      Byte 3
```

"A2" to "A64":

Last 63 data words - Locations of remaining defects for that surface using same format as "A1". All unused words "An" are filled with 0's.

Cyclic Redundancy Character (CRC):

2 bytes using the fire code defined by the expression:

XE16 + XE12 + XE5 + 1

NOTE

This is a standard CRC for controllers requiring a standard format (for example WD1010 based controllers). These controllers must set the sector size equal to 256 to read the bad block data. The RD31 can read the data from its normal 512 byte format.

4.3.2.2 Bad Block Sector Format -- The bad block data field format (Paragraph 4.3.2.1) is repeated for each of the 16 sectors in the bad block track.

NOTE

When computing the bad block using the byte from index, you must allow for a ±110 byte offset because of the 1 percent speed tolerance of the drive. This means once you go through your algorithm and if you are within 110 bytes from the edge of the sector you must also bad block the adjacent sector.

4.4 FUNCTIONAL THEORY OF OPERATION

This section describes the operation of the disk drive from a functional viewpoint. The functional elements (see Figure 4-10) discussed in this section are:

1. Stepper circuit
2. Spindle motor and control
3. Read/write channel.

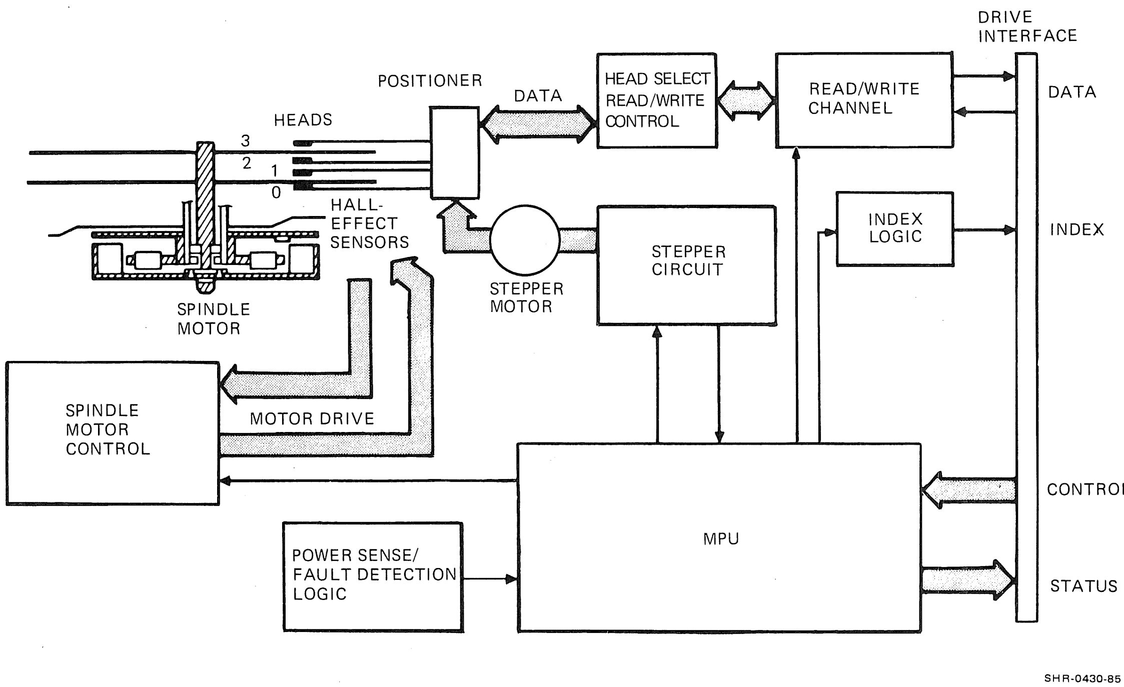


Figure 4-10 Drive Functional Elements

4.4.1 Functional Overview

When power is applied to the drive, a power-on reset signal presets the drive's microprocessor and clears selected control logic circuits. The spindle motor is accelerated to 3600 rpm (nominal speed). The microprocessor then performs a restore operation, which calibrates the stepper motor and positions the data heads over Track 0/. At this point, the drive goes ready and can be selected by the host controller.

The host controller selects the drive by asserting the appropriate drive select signal (see Paragraph 4.2.2.1 for options). While selected, the host controller can direct the drive to perform seek, write, or read operations.

- **Seek**

  The drive performs a seek operation upon receipt of one or more step pulses from the host controller. The positioner moves the heads one track for each step pulse in the direction specified by the interface direction in signal (from Track 0/ initially or from the previous track).

- **Write**

  When the host controller asserts the Write Gate signal (assuming that the drive is not seeking and that no write unsafe condition exists), the drive goes into the write mode. Write data from the host is received by the drive through a differential pair of data lines that define the transitions (bits) to be written on the disk. Each transition then reverses the direction of current flowing in the head windings, thereby recording a flux reversal on the disk (on the track under the head).

- **Read**

  If Write Gate is not asserted and a seek is not being performed, the drive automatically is in the read mode. The drive's read electronics sense the flux reversals on the track under the specified data head. That read signal is amplified, filtered, detected, and fed out to the host controller through a differential pair of data lines. The read data is nominally identical in timing to the original write data. All data encoding and decoding is performed by the host controller.

The microprocessor in the drive's control logic constantly monitors various possible fault conditions. If a fault is detected, the drive's status is indicated to the controller through the interface Write Fault/ line. In this manner, any illegal operation or hardware failure is prevented from destroying data.

4.4.2 Positioner Servo System

Data is recorded on a specified disk surface at one of 615 discrete radial locations, referred to as tracks. The data heads are positioned to the desired track by the stepper motor and its associated control electronics.

4.4.2.1 Servo Information -- The read/write heads must be accurately positioned over the data tracks to ensure that reliable data storage and retrieval occurs. Because of the track density used, the position information (which defines the track positions) must be derived from the disk itself.

Two types of information are recorded.

1. Radial Position -- The flying area of the disk is partitioned into three major zones.

   a. Shipping zone (cylinder 615 to 670)
   b. Data zone
   c. Index tracks (written on cylinder 617 and cylinder minus 1)

2. Rotational (Circumferential) Position -- A once-per-revolution index position is encoded.

4.4.2.2 Positioner Servo Channel (Figure 4-11)

Typical Seek Operation

A seek operation is initiated upon receipt of a step pulse (which may be the first in a series of step pulses). In real time, the microprocessor in the drive's control logic computes the desired track as a displacement from the previous track position. The reference is computed by taking the difference between the current track and the desired track.

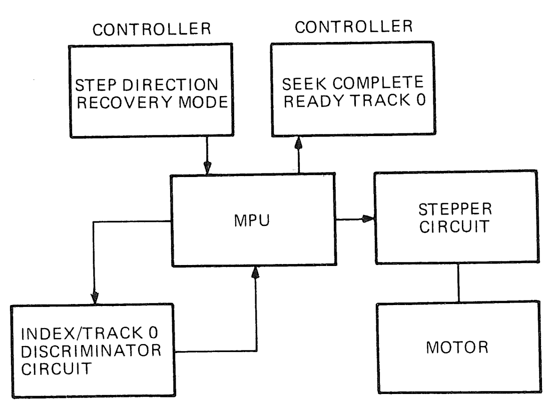


Figure 4-11 Positioner Servo Channel

Stepping is accomplished by the MPU controlling the direction and mode of the custom stepper circuit. Pulses are sent to the stepper chip, which does the actual phase commutations.
Acceleration/deceleration are determined by the varied frequency of the pulses and the use of the direction line. The circuit provides both a current source and sink to the motor windings.

Upon completion of a seek operation, settling time is calculated based on the length of the seek and the interface line activated in the specified time period. With Seek Complete, the MPU returns to the idle mode.

The microprocessor monitors and controls the internal drive functions and the host interface lines. The processor measures the period of the index signal to make sure that the drive is up-to-speed before the recalibration routine begins.

The MPU sets Phase Minus A and Phase Minus B on the stepper chip and then executes the seek and discriminator routines to recalibrate the drive to Track 0, properly divide index, give Ready and Seek Complete. The drive is then ready to accept inputs from the controller.

Upon receiving a step pulse, the MPU pauses for 250 microseconds to allow for additional pulses before executing the seek operation. Every incoming pulse resets the 250 microsecond timer. The seek does not begin until the last pulse is received.

When seeking, the MPU counts the number of tracks to be covered and uses the most efficient step algorithm to reach the target track.

4.4.3 Spindle Motor and Control

A spindle bipolar motor rotates the disks at 3600 rpm.

4.4.3.1 Spindle Motor -- The rotating part of the motor is attached directly to the spindle shaft, which drives the spindle hub and the magnetic disks clamped to the hub. The motor construction is bipolar. This ensures sufficient starting power. The motor circuit runs by a set of bipolar drivers. Once the spindle motor has started spinning, the microprocessor switches the motor circuit from bipolar to unipolar drivers. This significantly lowers the required running current. See Figure 4-12 for the description that follows.

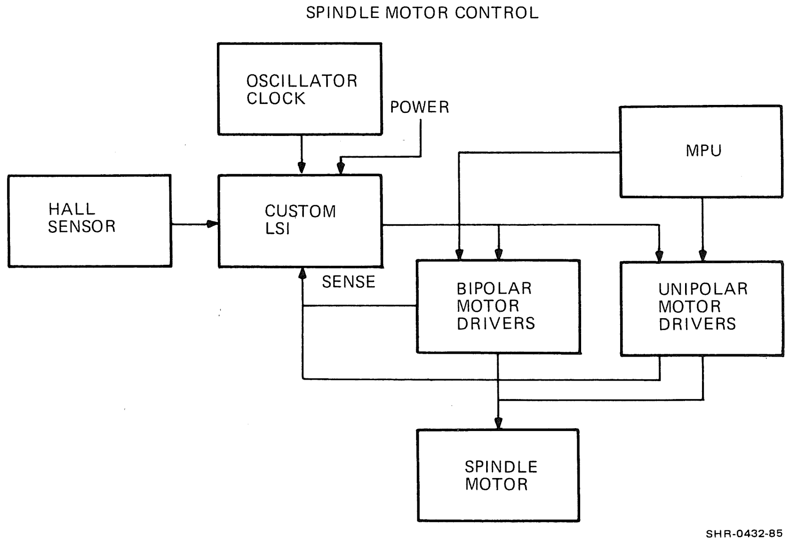


Figure 4-12 Spindle Motor Circuit

Primary control functions are incorporated within the custom spindle circuit and are detailed as follows.

1. The spindle circuit monitors the Hall signal from the spindle motor. The circuit uses the Hall transitions to commutate the motor phases. The circuit regulates the motor speed by measuring the Hall period and comparing it to the oscillator clock period.

2. The circuit uses a sense line to regulate the start current and execute a current limit shutoff.

3. The circuit monitors the power supply for output driver shutoff. When the power is off, the output drivers become self-biased on, to brake the motor using the back electromagnetic force (EMF).

4. The Locked Rotor Protection monitors the time from the first Hall transition. If the motor does not spin up, the drivers are disabled to avoid overheating the circuit. This Hall signal is generated by a transducer in the spindle motor hub. Two complete square waves are generated during each complete revolution.

4.4.4 Read/Write Channel

The RD31-A disk drives use Winchester-technology heads and disks for data storage and retrieval. The design of the heads and media provides for a linear bit density of 9827 flux reversals per inch (FRPI) at the inner track.

4.4.4.1 Magnetic Recording/Playback Process -- This section describes how data is written to and read from a magnetic disk.

Magnetic Recording

When writing, the center tap of the head winding is connected to a positive voltage source. Current is switched between the two halves of the center-tapped head winding.

- When current is passed through one-half of the head winding, a magnetic induction field is created in the head. At the point where the head gap breaks the magnetic circuit, some of the magnetic flux bridges the gap; but most of the flux leaks out around the gap and through the magnetic coating on the disk. That leakage field across the head gap saturates the area of the magnetic disk passing under the head.

- When current is passed through the other half of the head winding, magnetic flux flows through the head, across the gap, and through the media in the opposite direction.

- Reversing the current in the head causes magnetic dipoles to be recorded on the disk. When the disk is moved relative to the head, the area of the disk surface passing under the head is left magnetized in the same direction as the leakage flux.

Each time current is switched between the two windings, the magnetic field reverses; and a magnetic dipole is recorded in the magnetic coating of the disk (see Figure 4-13). Each magnetic dipole creates a magnetic field that is external to the magnetic coating itself. The flux of this magnetic field alternates in sign at each switch point. In practice, the changeover is not immediate. Rather, finite switching times cause the flux reversals to be less well defined.

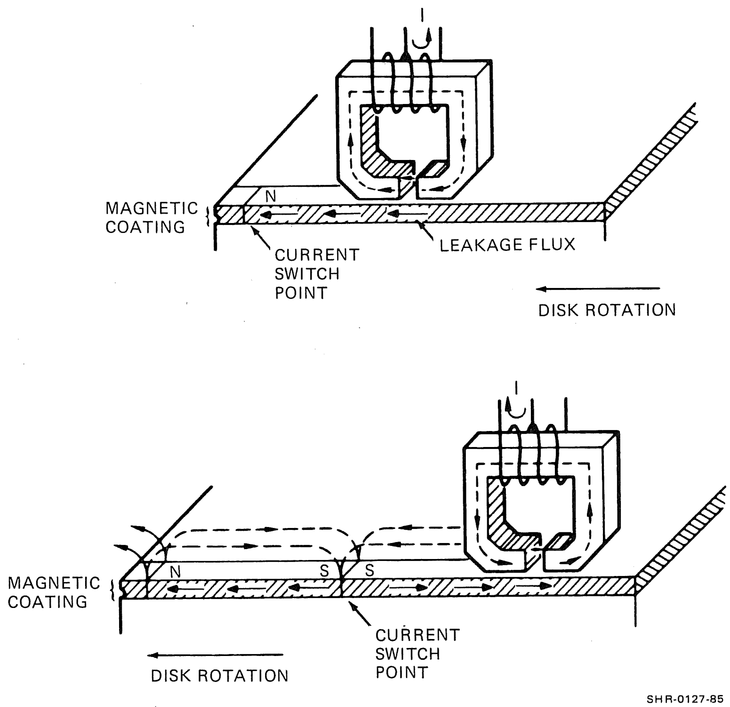


Figure 4-13 Magnetic Recording Process

Magnetic Playback

In the read-back process, the center tap of the head is grounded and the head windings are connected to an amplifier. The head acts as a collector of magnetic flux. As the magnetized surface of the disk passes under the head, alternate-direction fields in the magnetic dipoles produce a changing magnetic flux in the head. The head functions as a differentiator; that is, a voltage is induced across the head windings which is proportional to the rate of change of flux in the head. Figure 4-14 represents the output of one winding of the head. The output of the other head winding is identical in amplitude but opposite in phase.

The head output is a sequence of pulses where the peak of each pulse corresponds spatially with the point at which the recording current is switched. This read signal processing produces a stream of read data pulses nominally identical in timing to the original write data stream.

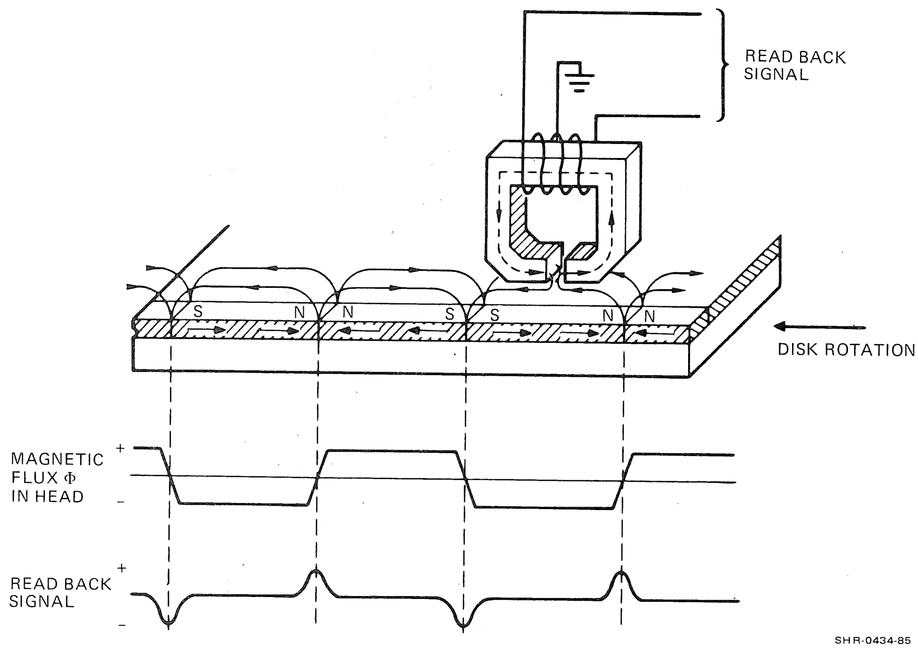


Figure 4-14 Magnetic Playback Process

4.4.4.2 Read/Write Functional Description

Read/Write Control

Writing is permitted only if it is safe to do so. Read/write control logic generates the Write Enable signal when all of the following five conditions exist.

1. Write Fault inactive
2. Drive Select active
3. Ready active
4. Seek Complete active
5. Write Gate active

If any of these conditions is not met, write control logic in the drive asserts the Write Fault/ signal on the interface, and writing is inhibited.

Figure 4-15 is a block diagram of the write operation.

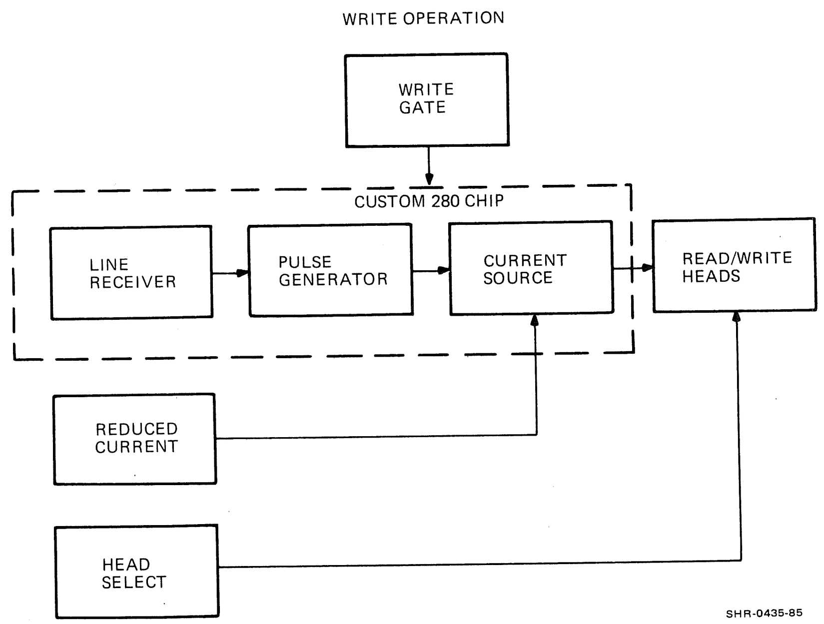


Figure 4-15 Write Operation

Write Gate

A write sequence is initiated when Write Gate is activated, which causes the Read/Write LSI to apply +12 V to the center tap of the selected head; data is sent to the line receiver at the same time.

Line Receiver

Differential Write data, which is precompensated MFM, is received from the controller and changed to single line. It is then fed into the pulse generator which changes square wave data to pulse data.

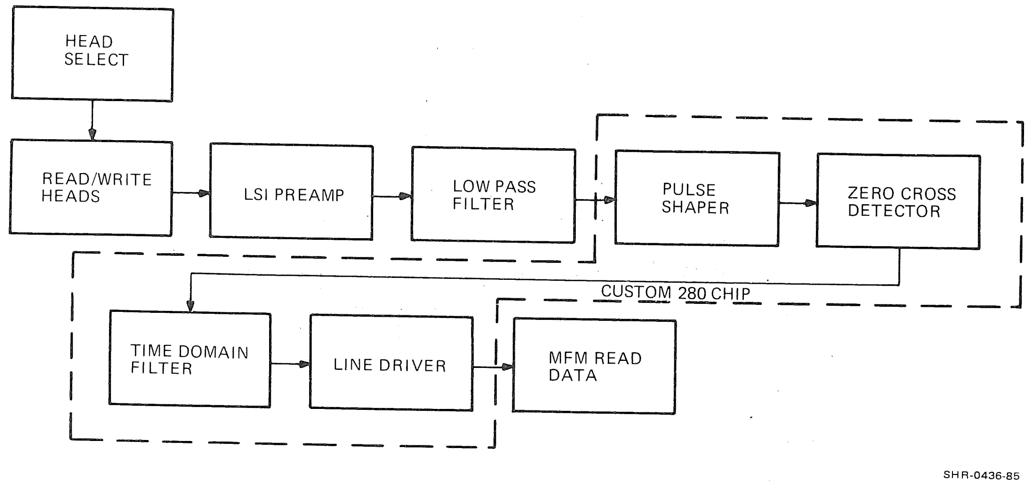


Figure 4-16 Read Operation

Read Operation (Figure 4-16)

When the drive is selected, data from the selected head is processed by the read channel into read data. This data is passed to the drive interface on balanced, differential data lines Read Data+ and Read Data-.

Head Select

The binary decoder selects the desired head based on the status of the head select lines. If the dc voltages are too low (possibly causing an inaccurate write operation), the logic forces the decoder to choose a nonexistent head. By referencing 0 to +5 V actual ground appears as -5 V. This eliminates the necessity of a negative power source normally required by the LSI preamp.

LSI Preamp

With the head center tap active, data from the selected head flows into the preamp. This preamp amplifies the Read signal and also acts as a high pass filter.

The head center tap voltages are monitored and controlled by the custom 280 chip. This chip monitors the Write Gate line and sets the appropriate level on its Voltage Center Tap (VCT) line for read or write mode.

Low Pass Filter

This filter network attenuates high frequency noise, which is outside the normal data signal range.

Phase Shifter

Amplified data enters the circuit and is shifted 90 degrees so peak data, which is detected over a fairly broad range, is now moved to a highly sloped, accurately detectable position at the zero crossing point.

Zero Cross Detector

This element detects bit positions as the slope of the Read data signals crosses the zero threshold. At this point, analog data are changed to digital data.

Time Domain Filter

When a high resolution head reads a low frequency pattern, there is a tendency for the head signal to decay between bits. If this decay falls below the zero cross threshold, a spurious data bit is generated. Such false bits are ignored by delaying the clocking data bit past the potential point of highest drop.

Line Driver

At this point, raw digital data is changed to differential data providing immunity to common mode noise during transmission.

The read/write control circuit controls up to four data heads. The following five functions are included in the circuit.

1. Head selection matrix
2. Read/write switching logic
3. Read preamplifier
4. Write drivers
5. Fault detection logic

The head address (determined by four head select lines) is decoded by the read/write control circuit.

$HS2^3$	$HS2^2$	$HS2^1$	$HS2^Ø$	Head Selected
Ø	Ø	Ø	Ø	Ø
Ø	Ø	Ø	1	1
Ø	Ø	1	Ø	2
Ø	Ø	1	1	3

HS = Head Select

Special Modes of Operation

Auto-Truncation Mode

The drive enters auto-truncation mode when the controller has issued an excessive number of step pulses which places the read/write heads beyond Track 0 or Cylinder 670. In auto-truncation, the drive ignores additional step pulses, takes control of the stepper motor, and returns the heads to Track 0 (see Figure 4-17).

CAUTION

If the controller is still issuing slow-step pulses after the RD31-A issues Seek Complete from auto-truncation mode the drive either re-enters auto-truncation mode with Direction In false, or steps the remaining cylinders with Direction In true.

Fault Detection Mode

Any combination of the following events causes a Write Fault condition and prevents the drive from writing (see Figure 4-18).

1. Multiple heads selected

2. Seek Complete, ready or recovery mode active when Write Gate is active

A dc-unsafe condition causes microprocessor reset. This prohibits writing, but does not directly cause a write fault. A Write Fault would be activated by having Seek Complete False while Write Gate is active.

Voltage Comparator

The Read/write LSI continually monitors the +5 and +12 V lines for a low voltage condition. If the +5 V supply is lower than 15 percent of +5 V, and if the +12 V supply is lower than 20 percent of +12 V, Write Current will be disabled; the interface and the MPU is reset.

Head Select Comparators

When only a single head is selected (normal operation), VCT is high.

If multiple heads are selected, the voltage increases at Voltage Head Safe (VHS), forcing its output low. Less than one head selected decreases the voltage at the comparator, forcing its output low. A low on either comparator disables the write circuitry and sends a Write Fault to the interface.

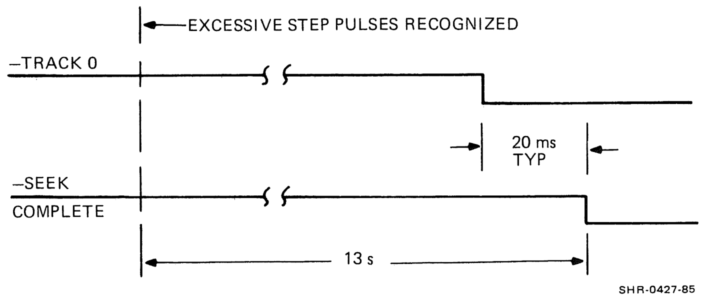


Figure 4-17 Auto Truncation Timing

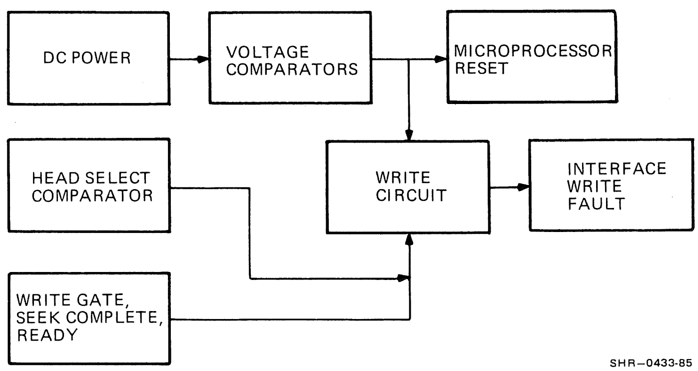


Figure 4-18 Fault Detection Block Diagram

CHAPTER 5
MAINTENANCE

5.1 INTRODUCTION

The RD31-A fixed disk drives are designed for trouble-free operation. Since most maintenance procedures require a high degree of technical sophistication, proper training, and proper equipment, nontechnical end users MUST NOT perform corrective maintenance. Improper maintenance procedures may void your warranty.

5.1.1 Preventive Maintenance

The RD31-A drives are designed so that preventive maintenance during normal use is not needed.

5.1.2 Corrective Maintenance

CAUTION

There are no field-replaceable components in the sealed clean area. Clean-area integrity MUST NOT be violated. Therefore, the user or service engineer must not remove any screws securing the cover/filter assembly, the bracket sealing the exit of the head flex cables from the clean area, or any screws holding the head positioner in place.

The RD31-A disk drives are designed for easy access for corrective maintenance (except, of course, clean area components). The printed circuit board (PCBA) is designed for easy removal.

5.2 TROUBLESHOOTING

Figure 5-1 is a troubleshooting flowchart. It will help you isolate the malfunction.

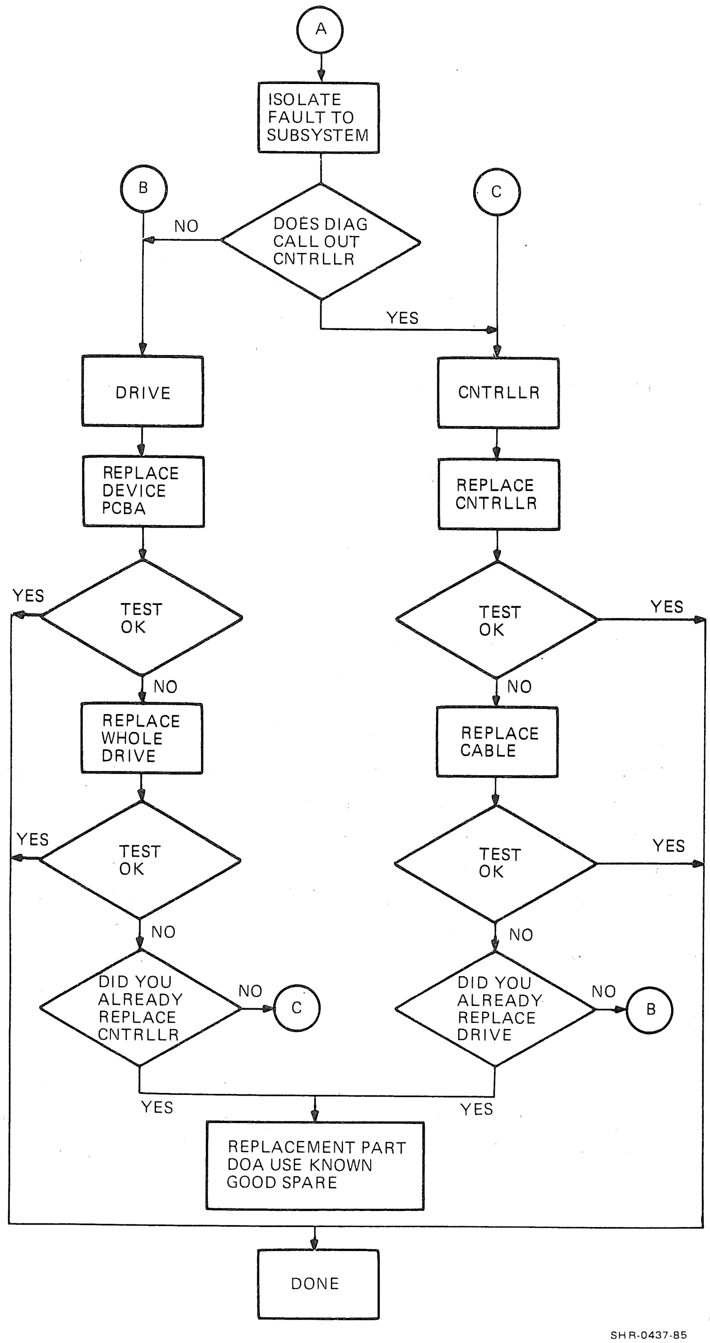


Figure 5-1 Troubleshooting Flowchart

5.3 REMOVAL AND REPLACEMENT PROCEDURES

This section includes removal and replacement procedures for the field-replaceable units of the RD31-A fixed disk drive. The procedures must be followed exactly to prevent damage to the drive. Do not perform any of the procedures in this section without the proper tools.

5.3.1 Field Procedures

The following tools are required for field removal and replacement procedures.

Number two phillips screwdriver
1/4-inch flat-blade screwdriver

CAUTION
Do not remove any of the screws that secure the cover (cover/filter assembly) to the base casting. Removing any of the screws violates the clean area.

5.3.1.1 Device Electronics Board

1. Remove the four phillips screws securing the skid plate and attached ground clip to the frame (Figure 5-2). Remove the plate and set aside.

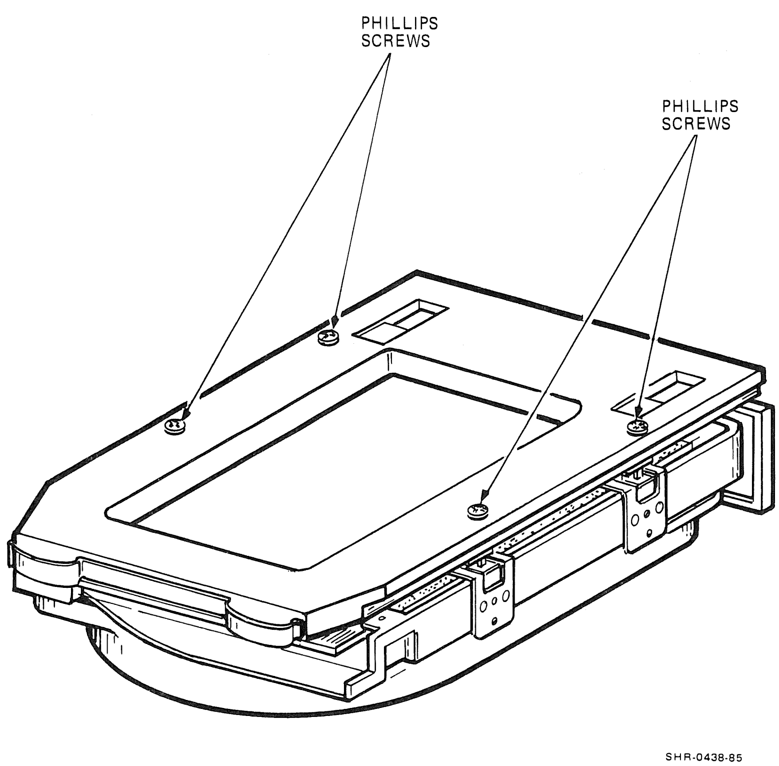


Figure 5-2 Skid Plate Removal

2. Remove the three flathead screws that hold the device electronics board in place (Figure 5-3).

CAUTION

Make sure you replace the insulating washer at the rear of the unit.

CAUTION

Flexible circuit material is fragile and requires careful handling to avoid damage.

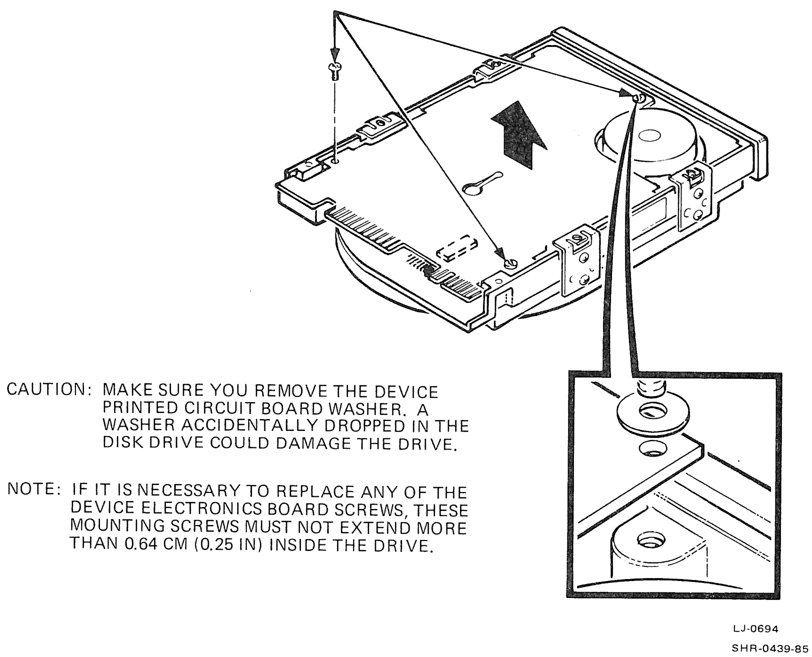


Figure 5-3 Screws Holding Device PCBA

3. Disconnect PCBA plugs from the device electronics board at J4, J5, and J6 (see Figure 5-4). All connectors and cables are fragile -- handle them with care.

4. The board is now free and can be replaced with a new PCBA.

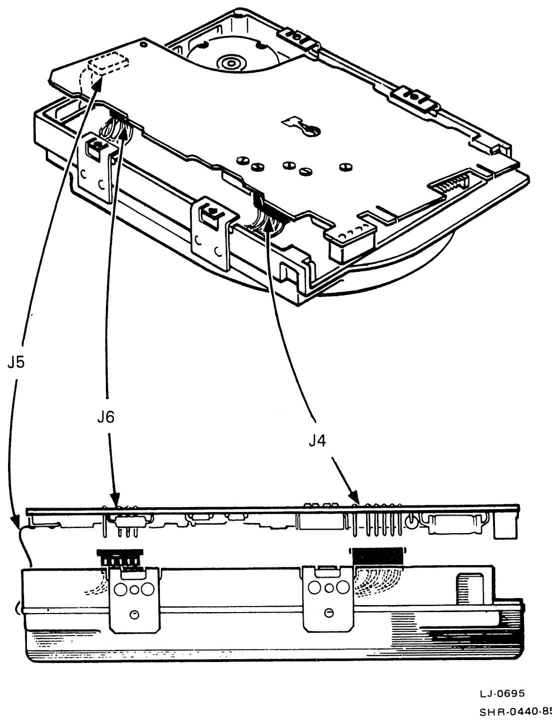


Figure 5-4 Plugs

5. Replace the replacement device electronics board by reversing the above procedure. See Paragraph 2.3 to verify or change the configuration of the replacement device electronics board.

CAUTION

When connecting plug 5 to jack 5, notice that jack 5 has nine pairs of pins while plug 5 has eight pairs of slots. This plug does not have a key and may be replaced incorrectly. Refer to Figure 5-5 and note that the pairs of pins on jack J5 closest to the LED should not be used.

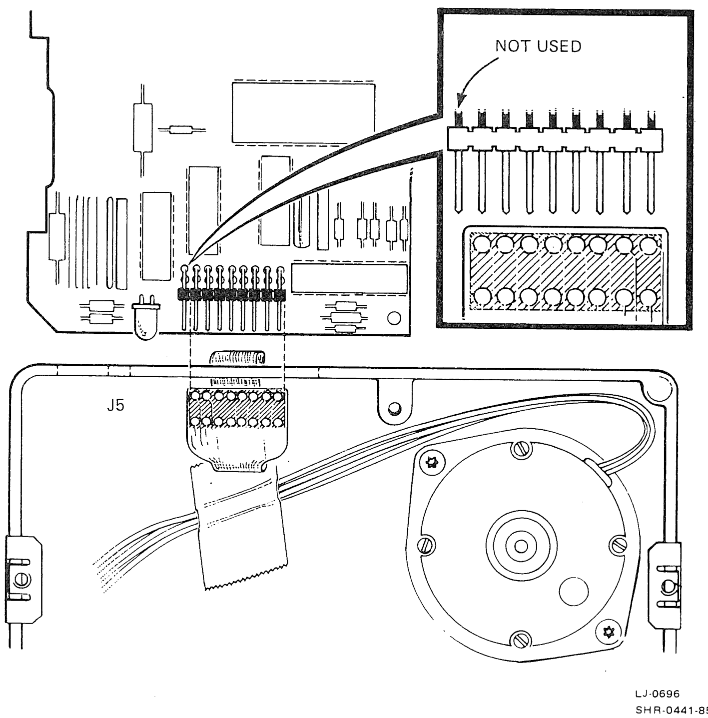


Figure 5-5 Plug 5

6.1 INTRODUCTION

Field replaceable parts are included in Table 6-1 and are shown in Figure 6-1.

CAUTION
DO NOT remove any of the screws securing the drive's top cover (cover/filter assembly).

Table 6-1 Field Parts List

Item	Qty	Part Number	Description
1	1	29-25527-00	Device electronics PCB
2	1	RD31-A	20 M fixed disk
3	1	12-14314-00	Jumper
4	1	90-00001-39	Stand off

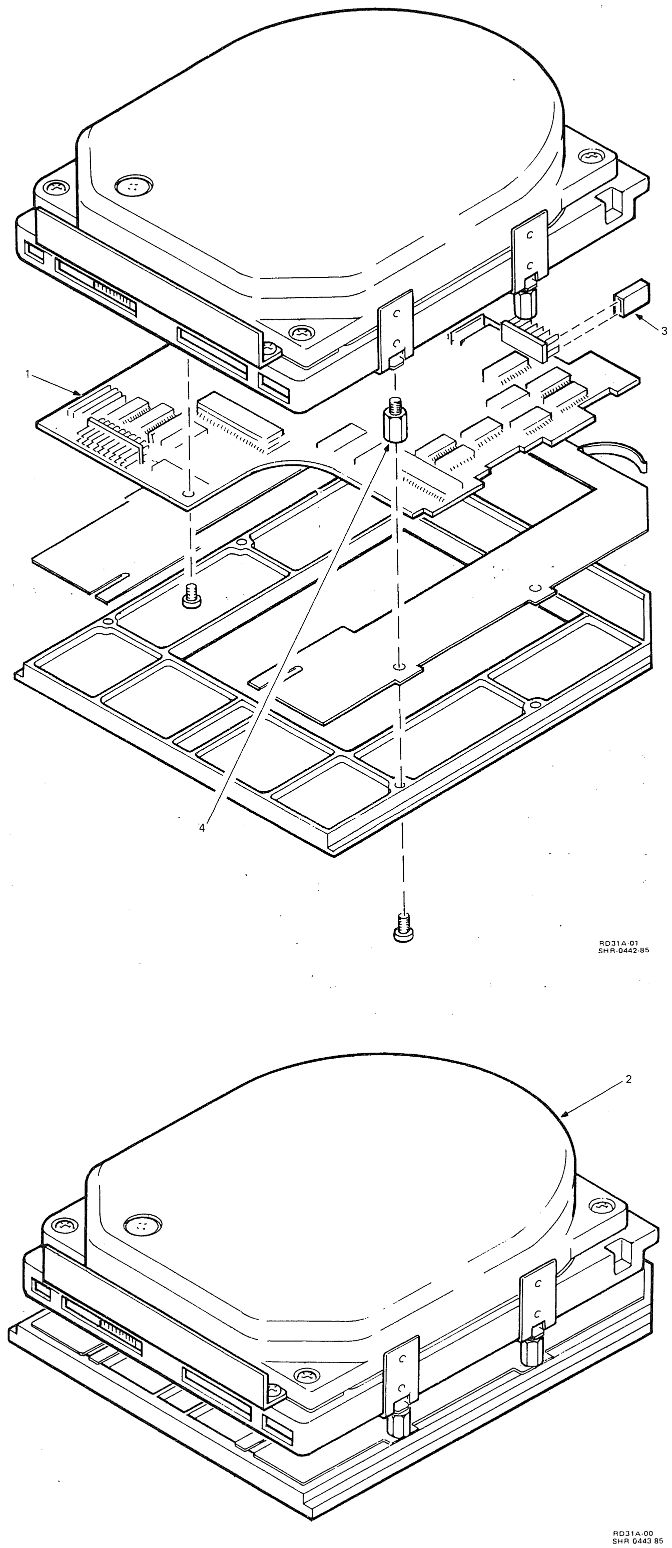


Figure 6-1 Field Replaceable Components

E

F

G

H

I

J

K

L

M

Digital Equipment Corporation • Shrewsbury MA 01545