

# USER GUIDE

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**DSD 430  
470  
4140**

**Data Systems Design**

# **DSD 4140, 430 and 470 Flexible Disk System User's Manual**

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# Preface

This manual describes the features, specifications, and register usage of the DSD 430 and DSD 470 Flexible Disk Data Storage Systems and the DSD 4140 Flexible Disk Controller.

Instructions for DSD 4140/430/470 installation, operation, and elementary troubleshooting are also included in this document.

This manual also provides all the information needed to incorporate the DSD 4140 Controller into a versatile single sided or double sided flexible disk memory system compatible with the DEC RX02.

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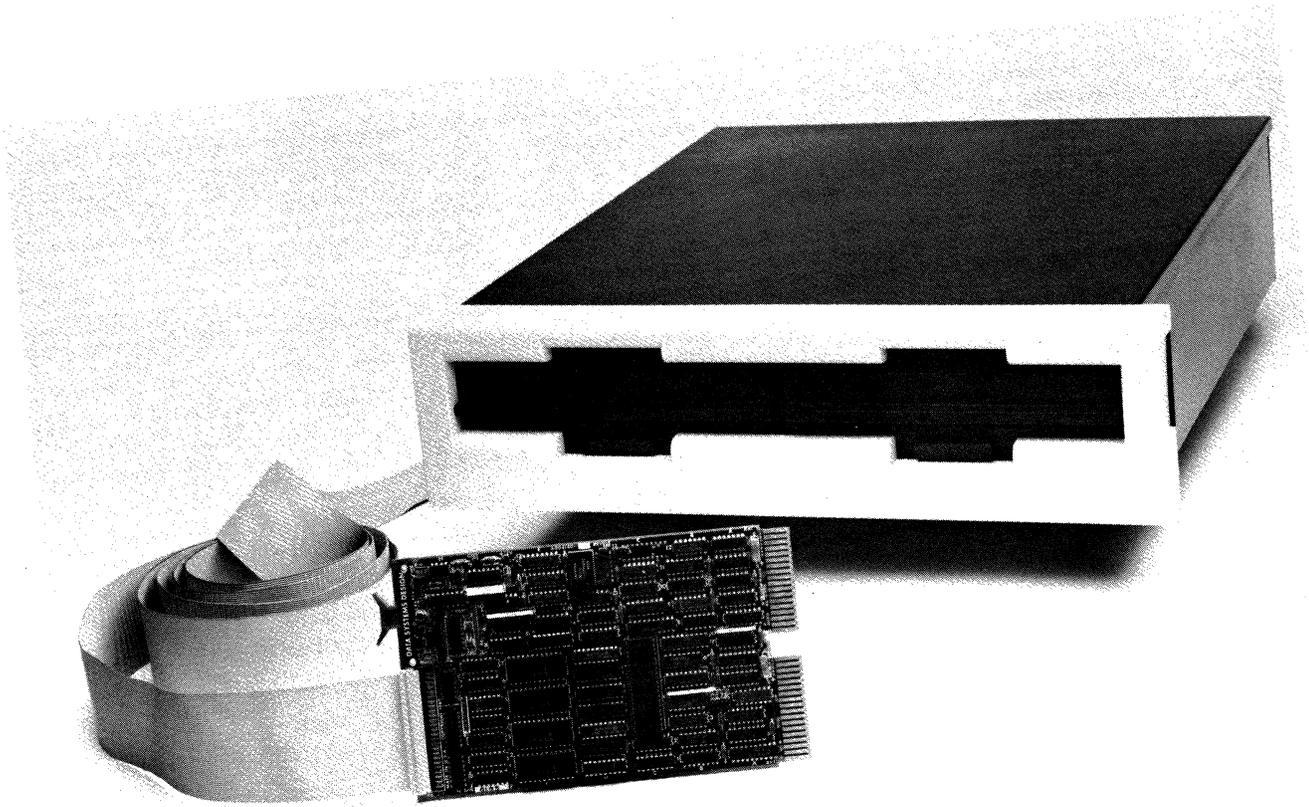
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**Figure 1-1.** The DSD 470

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# 1 Introduction

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## 1.1 GENERAL INFORMATION

This manual provides user information for the DSD 4140 Flexible Disk Controller and the related DSD 430 and the DSD 470 Flexible Disk Data Storage Systems. The 4140 Controller, as utilized in the DSD 430 and DSD 470 Systems provides a maximum of versatility and control in a data storage system backed by the DSD reputation for service and reliability. The 4140 is also available for separate purchase by those customers who wish to incorporate its advanced capability into existing or planned systems.

The DSD 430 and the DSD 470 are part of the Data System Design family of flexible disk data storage systems. The DSD 470 is shown in figure 1-1.

The DSD 470 is furnished with two disk drives capable of utilizing single or double sided flexible diskettes to provide a maximum data storage capacity in a size and cost effective package.

The DSD 430 is furnished with two disk drives utilizing single sided flexible diskettes for those customers who find the added capacity and versatility of double sided diskettes are not required.

All references in this manual to the DSD 4140 are applicable to the DSD 430 and the DSD 470 except where noted.

The DSD 4140/430/470 are further examples of the Data Systems Design dedication to deliverable, cost-effective, quality products, technical leadership, and expert, timely service.

## 1.2 THE FLEXIBLE DISK MEMORY SYSTEM

The flexible disk memory is an electro-mechanical system which stores information and transfers data between the host computer and the flexible disk (diskette).

The flexible disk is a mylar disk coated with magnetic material. It is 7.8 inches in diameter and 0.005 inches thick. It is permanently housed in an 8 inch square flexible envelope. When inserted into the disk drive, the diskette rotates inside the envelope at 360 RPM. In single density format, the diskette can store up to 256,256 bytes of data on each side—and up to 1,025,024 bytes of data on each double density, double sided diskette.

The flexible disk memory system is ideal for applications that require low cost, medium speed, random access data storage. It costs less than large rigid disk systems, and provides faster access times than magnetic tapes. Because flexible disks can be quickly exchanged, an unlimited amount of data is readily available.

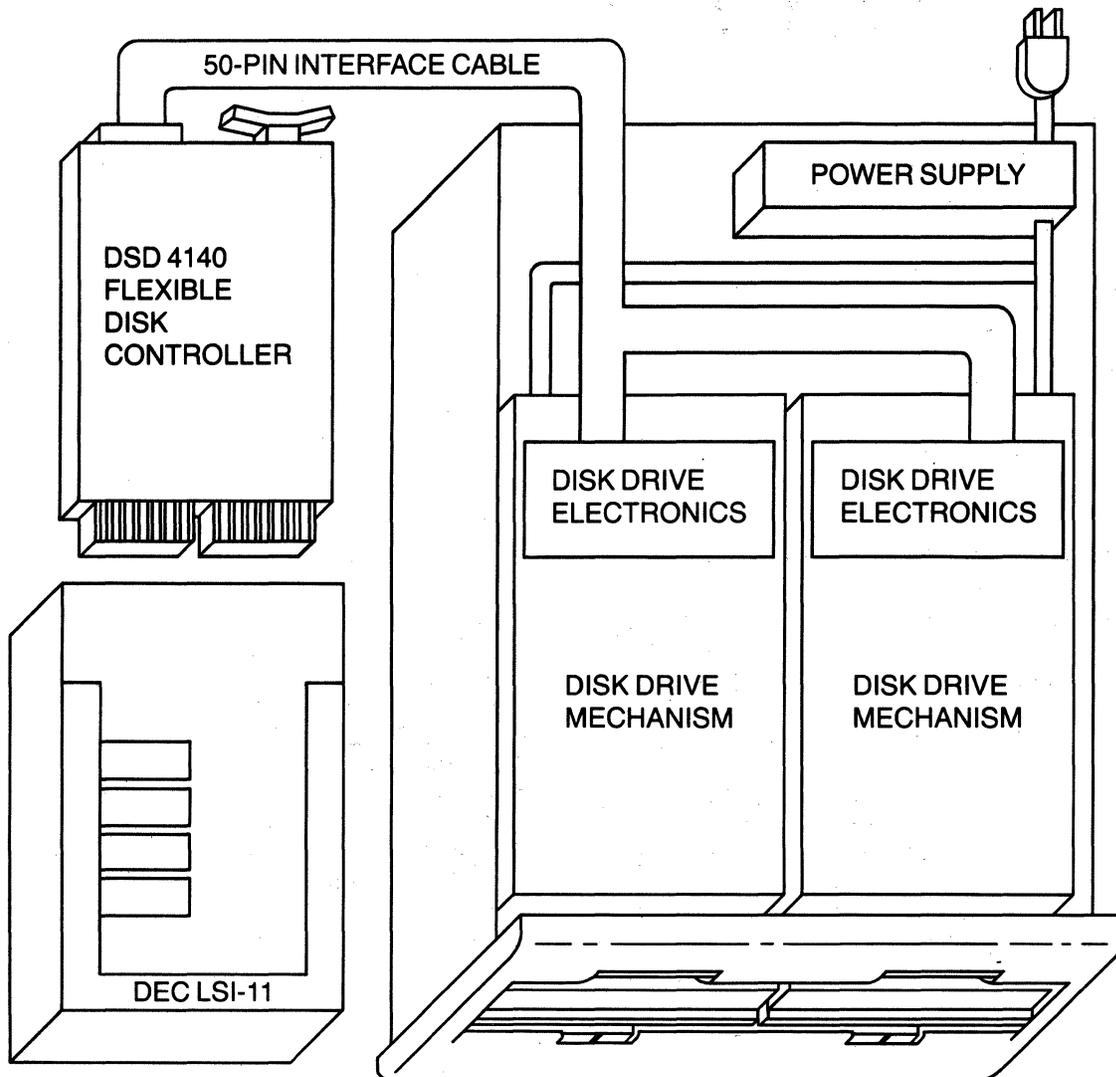
## 1.3 SYSTEM OVERVIEW

The DSD 430 and DSD 470 are compact, double density, flexible disk memory systems for use with LSI-11, LSI-11/2 and LSI-11/23 microcomputer systems (manufactured by Digital Equipment Corporation). Each system consists of the DSD 4140 controller card, two floppy disk drives, a 5¼ inch rack-mount chassis with power supply, and all required user documentation and cabling.

The DSD 430/470 systems are media, software, and diagnostic compatible with the DEC RX02. Because these systems can read and write RX01 compatible diskettes, they provide an excellent, low cost, upgrade path for users of the older single density systems.

All data block transfers are performed using DMA over a full 18 bit address. The DSD 4140/430/470 systems provide an interrupt system that is fully LSI-11/23 compatible.

The DSD 4140 interface/controller card is available separately for those customers who wish to use their own floppy disk drives in custom systems.



**Figure 1-2.** Block Diagram of the DSD 4140/430/470 Flexible Disk System in a Typical Application.

Figure 1-2 provides a block diagram of the 430/470 system in a typical application.

#### 1.4 THE DSD 4140 FLEXIBLE DISK CONTROLLER

The DSD 4140 is designed to control the single sided or double sided flexible disk data storage for the LSI-11, LSI-11/2, or LSI-11/23 microcomputer system.

The DSD 4140 controls the flexible disk memory system through use of a specially programmed processor. The intelligence of the flexible disk memory system resides in the microcode of this four-function controller/formatter/interface/bootstrap card.

As controller, the DSD 4140 executes commands sent from the computer, and controls the operation of one or two disk drives.

As formatter, the DSD 4140 can format diskettes in IBM 3740 single density format or DEC RX02 double density format.

As interface, the DSD 4140 accepts commands from a computer, and transfers data between the computer and the flexible disk.

As bootstrap, the DSD 4140 can automatically load the operating system into main memory and verify proper system operation.

The DSD 4140, combined with single sided or double sided disk drives, power supply and interface cable comprise a powerful, reliable, cost effective flexible disk system.

## 1.5 FEATURES OF THE DSD 4140

When incorporated into a flexible disk memory system, the DSD 4140 is completely compatible in media and software with the DEC RX02, and can fully utilize diagnostics written for the RX02.

In addition, the DSD 4140 performs on-board diagnostics, formats diskettes, and controls double sided disk drives. It provides a microcoded bootstrap and LSI-11/23 compatible position-independent interrupt acknowledgement. The DEC RX02 does not.

To save space, the DSD 4140 control electronics are all located on a single, half-quad sized controller card. The 4140 offers a programmable array of six pairs of wirewrap pins. By installing the appropriate jumpers, the customer can utilize double sided drives, remap drives, choose alternate device addresses, and check for pending high priority interrupts.

## 1.6 DSD 4140/430/470 FEATURE SUMMARY

### 4140 Controller Features

- Single Sided or Double Sided Disk Drive Control
- Single Density or Double Density Data Storage

- Double Density Write Precompensation
- LSI-11/23 Compatible, Position-Independent Interrupt Acknowledgement
- Extended (18 Bit) Main Memory Addressing
- Direct Memory Access (DMA) Data Transfer
- Automatic Self-Testing
- On-Board Diagnostics
- Phase Lock Loop Data Separation
- Emulates RX02 Operation
- DEC Media, Software and Diagnostic Compatible
- Integral Bootstrap
- Supports DSD Diskette Utility Package (FLPEXR)

### 430/470 System Features

- Low Profile 5¼ Inch Chassis
- LED Drive Activity Indicators
- Diskette Write Protection
- Modular Design
- Attractive Molded Front Panel
- Complete Factory Burn-in and Testing
- Total System Compatibility
- Rack Mount Option

# 2 Specifications

## 2.1 GENERAL INFORMATION

This chapter provides the specifications and operational requirements of the DSD 4140/430/470 Flexible Disk Data Storage System.

Specifications include diskette storage capacities, recording characteristics, and data transfer rates. Card size—and height of card components—are also listed.

Requirements include those for the interface cable and connectors, and power requirements. Card operating temperature range and other environmental requirements are listed.

## 2.2 DISKETTE SPECIFICATIONS

The DSD 4140 can control either single sided or double sided disk drives. The diskettes used by these drives are shown in figure 2-1 (a) and figure 2-1 (b). The diskettes used must be soft sector. When rotated inside their envelopes, soft sector diskettes have but one hole which can be seen through the envelope's index mark access hole.

Before use, diskettes must be formatted in accordance with the industry standard—26 sectors per track, 77 tracks per side. Chapter 5 explains how the DSD 4140 can perform this operation. Both single den-

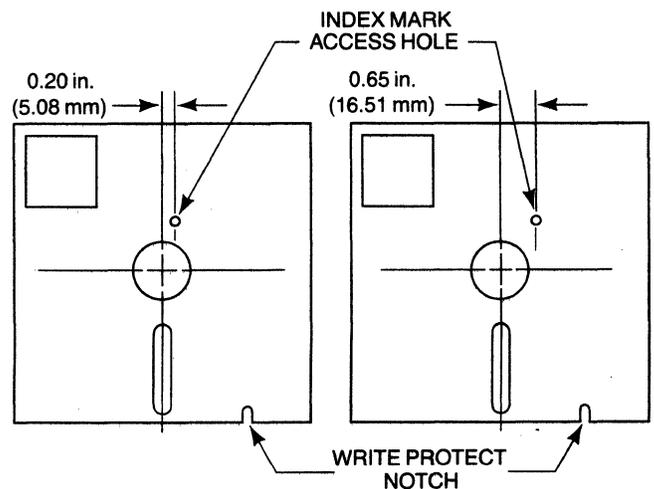


Figure 2-1(a). Single Sided Diskette

Figure 2-1(b). Double Sided Diskette

sity and double density diskette storage capacities are given in table 2-1.

## 2.3 RECORDING CHARACTERISTICS

The DSD 4140 controller utilized in the DSD 430/470 system permits single density data storage in IBM 3740 format, the industry standard. Data are recorded using

Table 2-1. Diskette Storage Capacities

	Single Sided		Double Sided	
	Single Density	Double Density	Single Density	Double Density
Storage Capacity	256,256 Bytes	512,512 Bytes	512,512 Bytes	1,025,024 Bytes
Tracks per Diskette	77	77	154	154
Sectors per Track	26	26	26	26
Bytes per Sector	128	256	128	256

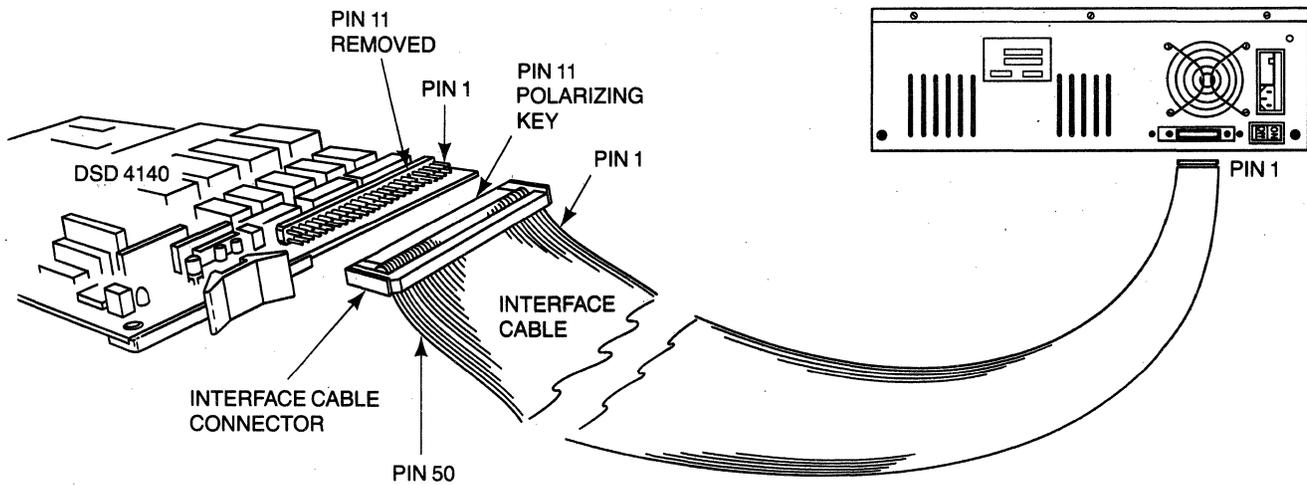


Figure 2-2. Interface Cable and Connectors

the double frequency (FM) code. The DSD 4140 can also store double density data in a format compatible with DEC RX02 operation. This format writes single density headers followed by double density data. Data are recorded using the DEC-modified, modified frequency modulation (MFM) technique. These recording characteristics are shown in table 2-2.

Table 2-2. Recording Characteristics

	Single Density	Double Density
Data Format	IBM 3740	DEC RX02
Recording Technique	Double Frequency (FM)	DEC-Modified MFM

### 2.4 PERFORMANCE SPECIFICATIONS

DSD 430/470 data transfer rates, via the 4140 Controller, are given in table 2-3. Also included are access characteristics for appropriate drives.

Table 2-3. Performance Specifications

Controller Specification	DMA Transfer Rate		43,000 words per second
	Real Throughput	Within Track	20K bytes per second two-way interleave
		Across Diskette	18K bytes per second two-way interleave 7 sector skew
Drive Specifications	Diskette Rotation		360 RPM ± 2%
	Head Step Rate		8 Msec Track-to-Track (DSD 430) 3 Msec Track-to-Track (DSD 470)
	Head Load Time		35 Msec
	Average Access Time		296 Msec (DSD 430) 174 Msec (DSD 470)
	Maximum Access Time		783 Msec (DSD 430) 410 Msec (DSD 470)

Real throughput is the average rate of data transfer which a user may expect during sustained system operation. Note that the DEC software uses two-way sector interleaving with 7 sector track-to-track skew.

The Direct Memory Access (DMA) transfer rate—the rate at which data are moved directly between the flexible disk memory system and the LSI-11 main memory—is also listed.

### 2.5 CABLE AND CONNECTOR REQUIREMENTS

A 50 pin interface cable must be used to connect the DSD 4140 to the disk drives. For lengths up to 12 feet, flat ribbon cable is used. For lengths of 12 to 20 feet, twisted pair ribbon cable is used. The DSD 4140 interface cable must not be longer than 20 feet. A 10 foot, flat ribbon cable is provided with DSD 430/470 systems.

The interface cable and connectors are shown in figure 2-2. Cable and connector requirements are listed

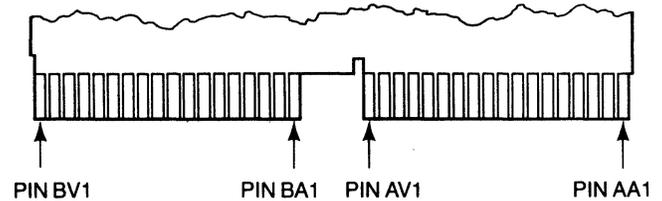
**Table 2-4. Cable and Connector Requirements**

Interface Cable	3M 3365/50 flat ribbon cable or equivalent (up to 12 ft. in length)
	Twisted pair ribbon cable or equivalent (12 ft. to 20 ft. maximum length)
Interface Cable Connector	3M 3425-3000 or equivalent 3M 3435-0000 polarizing key in pin 11
DSD 4140 Connector	SAE CHD6950W1R or equivalent
Programmable Jumper Array	0.025 in. square wirewrap pin Wirewrap to fit pin

**Table 2-5. Interface Cable Pin Assignments**

Pin Number	Signal Name
1	GND
2	TRACK > 43
3	GND
4	NOT USED
5	GND
6	NOT USED
7	GND
8	NOT USED
9	GND
10	TWO SIDED
11	KEY
12	NOT USED
13	GND
14	SIDE SELECT
15	GND
16	NOT USED
17	GND
18	HEAD LOAD
19	GND
20	INDEX
21	GND
22	NOT USED
23	GND
24	NOT USED
25	GND
26	DRIVE SELECT 1
27	GND
28	DRIVE SELECT 2
29	GND
30	NOT USED
31	GND
32	NOT USED
33	GND
34	DIRECTION SELECT
35	GND
36	STEP
37	GND
38	WRITE DATA
39	GND
40	WRITE GATE
41	GND
42	TRACK 00
43	GND
44	WRITE PROTECT
45	GND
46	READ DATA
47	GND
48	NOT USED
49	GND
50	NOT USED

in table 2-4. Requirements for the programmable jumper array are also given. Card edge pin designations are shown in figure 2-3. Table 2-5 lists interface cable pin assignments. Table 2-6 lists DSD 4140 card edge pin assignments.



**Figure 2-3. Card Edge Pin Designations (Component Side)**

**Table 2-6. Card Edge Pin Assignments**

Component Side		Solder Side	
Pin Number	Signal Name	Pin Number	Signal Name
AA1	BIRQ5 L	AA2	+5
AB1	BIRQ6 L	AB2	NOT USED
AC1	BDAL16 L	AC2	GND
AD1	BDAL17 L	AD2	+12
AE1	NOT USED	AE2	BDOUL
AF1	NOT USED	AF2	BRPLY L
AH1	NOT USED	AH2	BDIN L
AJ1	GND	AJ2	BSYNC L
AK1	MSPARE A	AK2	BWTBT L
AL1	MSPARE A	AL2	BIRQ4 L
AM1	GND	AM2	BIAKI L
AN1	BDMR L	AN2	BIAKO L
AP1	BHALT L	AP2	BBS7 L
AR1	NOT USED	AR2	BDMGI L
AS1	NOT USED	AS2	BDMGO L
AT1	GND	AT2	BINIT L
AU1	NOT USED	AU2	BDAL0 L
AV1	NOT USED	AV2	BDAL1 L
BA1	NOT USED	BA2	+5
BB1	NOT USED	BB2	NOT USED
BC1	NOT USED	BC2	GND
BD1	NOT USED	BD2	+12
BE1	NOT USED	BE2	BDAL2 L
BF1	NOT USED	BF2	BDAL3 L
BH1	NOT USED	BH2	BDAL4 L
BJ1	GND	BJ2	BDAL5 L
BK1	MSPARE B	BK2	BDAL6 L
BL1	MSPARE B	BL2	BDAL7 L
BM1	GND	BM2	BDAL8 L
BN1	BSACK L	BN2	BDAL9 L
BP1	BIRQ 7	BP2	BDAL10 L
BR1	NOT USED	BR2	BDAL11 L
BS1	NOT USED	BS2	BDAL12 L
BT1	GND	BT2	BDAL13 L
BU1	NOT USED	BU2	BDAL14 L
BV1	+5	BV2	BDAL15 L

## 2-4

### 2.6 POWER CONSUMPTION

4140 Controller Card	+5 Volts DC @ 2.7 amperes (nominal) 3.7 amperes (maximum)
AC Power (Chassis) Line Frequency	50/60 Hz $\pm$ 1.0 Hz
Selectable Input Voltages	100 or 120 V RMS $\pm$ 10% (Domestic Models) (2A Slo-Blo Fuse) 220 or 240 V RMS $\pm$ 10% (International model) (1A Slo-Blo Fuse)

### 2.7 HEAT DISSIPATION (IN BTU'S PER HOUR)

Controller Card	45 (Nominal)
Single Drive Chassis	219 (Idle), 372 (Busy)
Dual Drive Chassis	317 (Idle), 471 (Busy)
Dual Drive Chassis, 2 Sided	275 (Idle), 400 (Busy)

### 2.8 PHYSICAL SPECIFICATIONS

#### Dimensions

Controller Card	8.84" H by 5.187" W by 0.5" D (22.7 CM by 13.1 CM by 1.3 CM)
Chassis	5.25" H by 17.6" W by 21.0" D (13.3 CM by 44.7 CM by 53.3 CM)
Shipping Carton	12.5" H by 24.5" W by 30.0 D (31.75 CM by 62.2 CM by 76.2 CM)

#### Weight

Chassis	50 lbs. (22.7 Kg)
System, Packaged for Shipment	74 lbs. (33.6 Kg)

### 2.9 ENVIRONMENTAL REQUIREMENTS

UL Listing	EDP Equipment, UL 478 Standard
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#### Operating Temperatures

Controller Card	0 to 50 degrees C (32 to 122 degrees F)
Drive Chassis	0 to 40 degrees C (32 to 104 de- grees F)
Diskettes	10 to 52 degrees C (50 to 125 degrees F)
Diskette Maximum rate of change	15 degrees F per hour

#### Non Operating Temperatures

Controller Card	- 40 to 66 degrees C (- 40 to 150 degrees F)
Chassis	- 40 to 66 degrees C (- 40 to 150 degrees F)
Diskettes	- 40 to 52 degrees C (- 40 to 125 degrees F)

#### Humidity

Controller Card & Chassis	10% to 95% (Non-Condensating)
Diskettes	8% to 80% with a maximum wet bulb temperature of 29.4 degrees C (85 degrees F)

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# 3 Circuit Description

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## 3.1 GENERAL INFORMATION

This chapter provides circuit descriptions for the DSD 430/470 Flexible Disk Data Storage Systems. Emphasis is given to the DSD 4140 Controller which provides interface and functional control for all operations of the system.

## 3.2 DSD 4140 CIRCUIT FUNCTIONS

The major circuits of the DSD 4140 comprise three primary circuit groups. Each circuit group has specific functions which enable the flexible disk memory system to store and retrieve data.

- Processor Group
- LSI-11 (Q-Bus) Interface Group
- Disk Drive Interface Group

The processor group, LSI-11 interface group and disk drive group each consist of a number of major circuits. The locations of these circuits on the DSD 4140 are shown on figure 3-1.

The DSD 4140 reports LSI-11 and disk drive status, reads and writes data, performs bootstrapping and DMA transfers, and handles interrupts. Figure 3-2 shows how the DSD 4140 communicates the addresses, signal, and data needed to perform these operations.

### 3.2.1 Processor Group

The processor is the heart of the DSD 4140. Its bit-slice pipelined architecture results in fast LSI-11 response time and improved throughput. Use of this single, centralized processor also simplifies DSD 4140 troubleshooting.

The processor monitors the status of the flexible disk memory system. It accepts LSI-11 commands

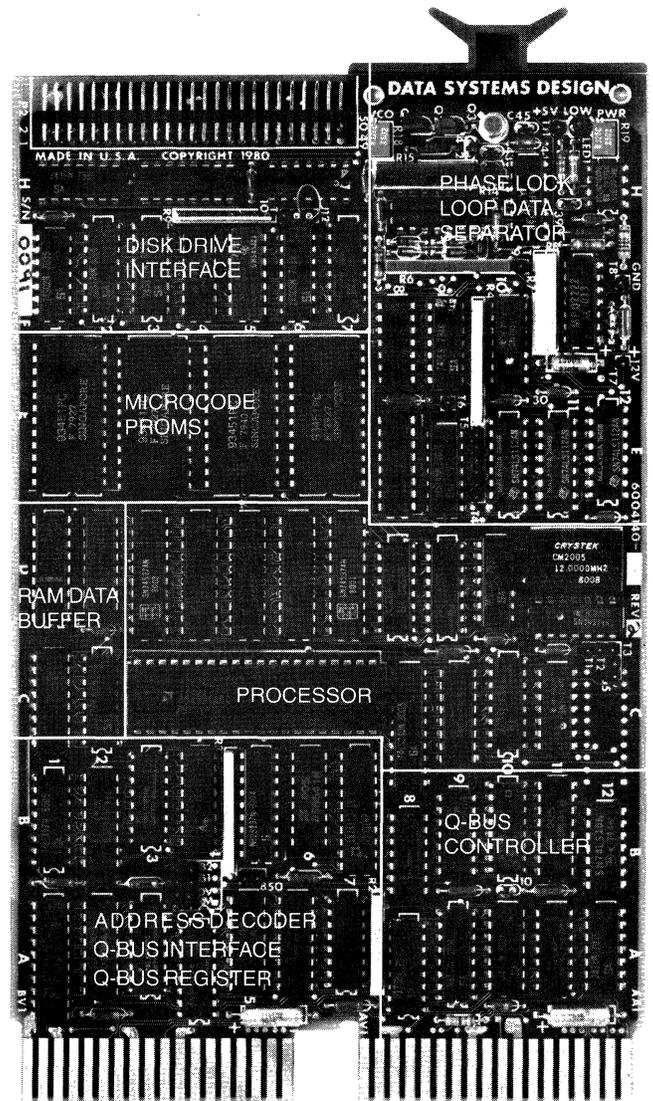


Figure 3-1. Major Circuits of the DSD 4140

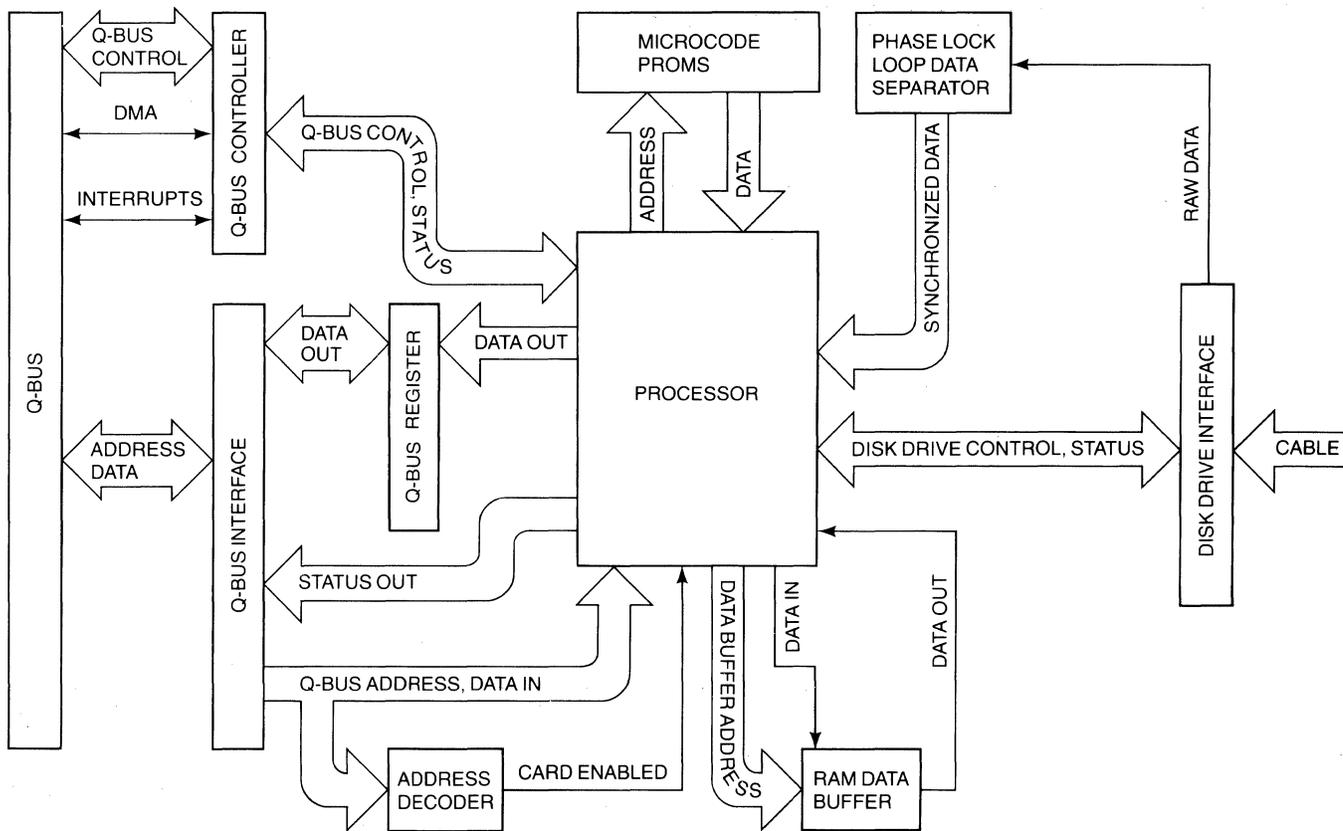


Figure 3-2. Block Diagram of the DSD 4140

from the Q-Bus interface, and controls disk drive operation.

Executing six million instructions per second, the processor reads and writes data, formats diskettes, runs diagnostic tests, and performs bootstrapping and DMA data transfers. The RAM data buffer and microcode PROMs are associated with the processor.

The RAM data buffer stores and transmits data. It can buffer a full 256-byte data sector at one time. The data buffer also stores various internal variables.

The microcode PROMS store instructions—up to 2,048 16-bit words—for use by the processor.

### 3.2.2 LSI-11 Interface Group

The LSI-11 interface group controls the communication between the LSI-11 computer and the DSD 4140. It consists of the address decoder, Q-Bus interface, Q-Bus controller, and the Q-Bus register.

The address decoder identifies the addresses to which LSI-11 commands and data are sent, and notifies the processor when the LSI-11 is addressing it.

The Q-Bus Interface buffers LSI-11 commands and data, and holds them for the processor. It passes disk drive status information and data to the LSI-11.

The Q-Bus Controller directs DMA transfers, handles interrupts, and informs the processor of Q-Bus operations in progress.

The Q-Bus Register holds data, addresses, and other information during their transfer from the processor to the Q-Bus Interface.

### 3.2.3 Disk Drive Interface Group

The disk drive interface group permits communication between the disk drives and the DSD 4140. It consists of the disk drive interface circuit and phase lock loop (PLL) data separator.

The Disk Drive Interface circuit directs disk drive status information to the processor, and diskette data to the phase lock loop data separator. It also passes control signals from the processor to the disk drives.

The Phase Lock Loop Data Separator decodes the raw data stream from the diskette, separating the data from the clock information. It then synchronizes the data stream to the processor's timing.

## 3.3 CIRCUIT OPERATION

The DSD 4140 stores and retrieves data by executing commands sent from the LSI-11 computer via the processor's device registers. These DSD 4140 device registers are described in Chapter 6.

Each DSD 4140 operation is initiated by loading a command—and required data—into either the processor's RX2CS register address, or its RX2DB register address. The selected register address is identified by the address decoder. The command and data are buffered by the Q-Bus interface and transferred to the processor.

When each DSD 4140 operation is completed, the Done status bit (bit 5) of the RX2CS register is set to one to indicate this. The contents of the RX2ES register address are then available to the Q-Bus interface, and to the LSI-11 computer.

### 3.3.1 Reporting Status

The DSD 4140 regularly makes disk drive and processor status information available to the LSI-11 computer.

Disk drive status information is sent to the disk drive interface, and read by the DSD 4140 processor. When requested, the processor sends this information to the Q-Bus register, which transfers it to the LSI-11 via the Q-Bus.

The RX2ES register reports disk drive status at the conclusion of each DSD 4140 operation. Processor status can be displayed by the RX2CS register at any time.

### 3.3.2 Reading Data

Data read from the diskette are first sent to the phase lock loop data separator. The phase lock loop (PLL) quickly locks onto the raw data stream and transforms it to conform to the processor's timing. The PLL then modifies its operation to maintain a steady, reliable data stream. This data stream is interpreted by the processor and stored in the RAM data buffer. The phase lock loop data separator tolerates variations in diskette rate of spin, and shifting of data bits which is characteristic of high recording densities. The PLL is factory adjusted for the widest range of operating conditions, including temperature and voltage fluctuations.

### 3.3.3 Writing Data

Data stored in the RAM buffer are written onto the diskette under the direct control of the processor. The processor transfers these data from the RAM data buffer to the disk drive interface and disk drives. In order to detect inaccurate data, the processor calculates an error code word (CRC) and attaches it to the end of each data block. The processor also establishes the amount of (double-density) write precompensation needed for accurate high-density recording.

### 3.3.4 Bootstrapping

Bootstrapping transfers the operating program from a system diskette to LSI-11 memory. The flexible disk memory system may bootstrap automatically, under microprogram control. This occurs when the address

decoder receives an instruction fetch from the bootstrap starting address.

### 3.3.5 Transferring Data via DMA

All data transfers between the RAM data buffer and LSI-11 main memory are performed by Direct Memory Access (DMA). DMA maximizes data transfer speed and frees the LSI-11 computer for other tasks. DMA data transfers can be initiated by a FILL BUFFER, EMPTY BUFFER, or READ EXTENDED STATUS command. These transfers are directed by the Q-Bus controller of the DSD 4140. The Q-Bus controller notifies the LSI-11 computer that the Q-Bus is needed for a DMA transfer. Then the LSI-11 computer informs the DSD 4140 Q-Bus controller that the Q-Bus is available, data are transferred directly between the RAM data buffer addresses and the LSI-11 memory addresses supplied by the processor.

If LSI-11 main memory does not respond to the Q-Bus controller's request with 10 microseconds, the operation is halted and an error is reported. The Q-Bus controller notifies the LSI-11 computer when the DMA data transfer is completed.

### 3.3.6 Handling Interrupts

Interrupts are initiated by the DSD 4140 Q-bus controller—at the completion of the command in progress—when the Interrupt Enable bit (bit 6) of the RX2CS register is set to one.

The Q-Bus controller requests an interrupt from the LSI-11 computer. After the LSI-11 acknowledges the Q-Bus controller's request, the DSD 4140 verifies the absence of pending higher priority interrupts. This conforms with the multiple level interrupt protocol recommended by Digital Equipment Corporation for systems such as the LSI-11/23.

If there are no pending higher priority interrupts, the Q-Bus controller's request is granted. The DSD 4140 then provides an interrupt vector address to the computer. This address directs the LSI-11 computer to the service routine to be performed. After executing the service routine, the LSI-11 computer returns to the program which was interrupted.

## 3.4 DISK DRIVES

The two disk drives supplied in DSD 430/470 Systems are used to rotate the diskette media within its envelope, position the read/write mechanism to the desired position, control the actual recording and playback of information on the diskette and provide various status indicators such as whether the diskette is write-protected or if the index hole is sensed. The drives consist of the read/write and control electronics, the drive mechanism, the positioning mechanism, and the read/write head assembly.

## 3-4

### 3.4.1 Read/Write and Control Electronics

All of the circuitry required to perform the read/write and control functions of the drive are mounted on a single attached printed circuit board. Included are circuits to buffer the interface signals from the DSD 4140 controller card. This printed circuit board supports a variety of jumper options for different applications, therefore, the drives must be correctly configured before use.

### 3.4.2 Diskette Drive Mechanism

When the diskette is inserted into the drive, it is centered on the drive spindle by a registration hub. As the door is closed, the diskette is securely connected to the spindle by a clamp actuated by the latch handle. An AC drive motor rotates the spindle and diskette at 360 RPM through a belt drive system. Selection of 50 or 60 Hz power is accomplished by changing the drive pulley and belt.

### 3.4.3 Head Positioning

The read/write heads are accurately positioned by a stepping motor actuator system. For each step operation the motor will advance the head assembly by one track. The stepping rate is faster for double-sided drives which use a more sophisticated metal band actuator assembly.

### 3.4.4 Read/Write Heads

All reading and writing on the media is performed by ceramic heads, with integral erase elements to provide erased areas between tracks. The read/write heads are mounted on a carriage which is positioned by the actuator. Double sided drives, such as are used in the DSD 470, have two heads to access both sides of a

diskette, while the DSD 430 uses a single head per drive.

The heads are loaded against the diskette by a head load solenoid, which places the heads in direct contact with the diskette. The head surface has been designed to obtain maximum signal transfer to and from the magnetic surface of the diskette with minimum head or diskette wear.

## 3.5 POWER SUPPLY

The DC power supply utilized in the DSD 430/470 systems provides the DC voltages required by the disk drive electronics. Also provided at the input to the power supply on the DSD 430/470 main chassis are AC input voltage selection and the AC source for the disk drive motors.

This power is distributed to the disk drives and disk drive electronics by a power distribution board mounted on the main chassis. It provides an easy point of power cable connection and voltage measurement.

Specifications for the DC power supply are listed in table 3-1. For further discussion of AC input voltage selection, refer to Chapter 4, Installation.

**Table 3-1. Power Supply Specifications**

AC Input	100/120/220/240 Vac $\pm$ 10%, 47 - 63 Hz
DC Output	+5Vdc at 2.5A, OVP at $6.2 \pm 0.4$ Vdc +24Vdc at 3A AVG., 3.4A PK -16Vdc at 0.5A Unregulated
Line Regulation	$\pm$ 0.05% for a 10% Line Change
Load Regulation	$\pm$ 0.05% for a 50% Load Change
Output Ripple	5mV PK-PK, Maximum
Overvoltage Protection	Built-In on 5V Output

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# 4 Installation

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## 4.1 GENERAL INFORMATION

This chapter provides information on unpacking and inspection, installation, configuration, and initial check-out of your DSD 430/470 Flexible Disk Data storage system, including the DSD 4140 controller.

## 4.2 UNPACKING AND INSPECTION

When your DSD 430/470 shipment arrives, inspect the shipping container immediately for evidence of mishandling during transit. If the container is damaged, request that the carrier's agent be present when the package is opened.

Compare the packing list attached to the shipping container against your purchase order to verify that the shipment is correct.

Unpack the shipping container and inspect each item for external damage such as broken controls and connectors, dented corners, bent panels, scratches and loose components.

If any damage is evident, notify DATA SYSTEMS DESIGN Customer Service immediately.

Retain the shipping container and packing material for examination in the settlement of claims for future use. Retain the cardboard shipping disk which is installed in each disk drive (DSD 470 systems only).

## 4.3 POWER REQUIREMENTS

The DSD 430/470 is available in configurations for nominal line voltages of either 120 or 240 AC volts. The line frequency must be within 1 Hz (cycles per second) of either 50 or 60 Hz.

The AC Power Connector assembly on the back of the DSD 430/470 chassis contains a small printed circuit (PC) board. Figure 4-1 is a diagram of the Connector assembly. You can make conversions between the two low line voltages (100 VAC or 115/120 VAC) by pulling out this board, changing its orientation and rein-

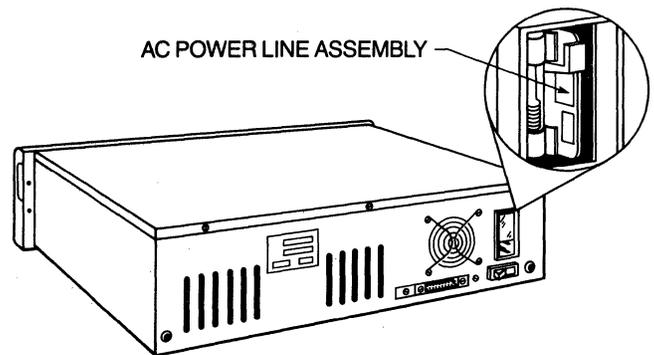


Figure 4-1. AC Power Connector Assembly

serting it. You can convert the DSD 430/470 between the two high line voltages (220 VAC or 230/240 VAC) using a similar procedure.

Although the board allows for voltage deviations of more than 10% of 120 VAC and 240 VAC, you should NEVER use this card to change between a 115/120 VAC and a 230/240 VAC system.

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## CAUTION

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**The procedure required to convert between a low line voltage (100–120 VAC) and a high line voltage (220–240 VAC) is far more complicated than just changing the position of the printed circuit board. This conversion requires changing the fan, the two AC spindle motors in the disk drives, the motor capacitors associated with the spindle motors, and the fuse. NEVER change the position of the printed circuit board from low line voltages (100–120 Volts) to high line voltages (200–240 Volts) without changing the AC motors. These motors will be damaged if operated at the wrong voltage.**

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## 4.4 OPERATIONAL ENVIRONMENT

All flexible disk systems manufactured by DATA SYSTEMS DESIGN perform efficiently in a normal computer room environment. Temperature, humidity, and cleanliness are three environmental considerations that can affect the reliability of diskette use.

### 4.4.1 Temperature

The allowable operating temperature range for diskettes is shown in table 4-1. The DSD 430/470 chassis should be installed where the temperature range does not exceed these limits.

**Table 4-1. Temperature Range for Diskettes**

Operating Temperature Range	10°C to 52°C (50°F to 125°F)
Storage Temperature Range	-40°C to 52°C (-40°F to 125°F)
Maximum Thermal Gradient	8°C (15°F) Degrees/Hour

### 4.4.2 Humidity

The operating relative humidity range is 8 to 80 percent with maximum wet bulb temperature of 29.40°C (85°F). At a low humidity (dry air), static electricity can be generated when the read/write head contacts the diskette. When the electrical potential becomes high enough to cause a discharge, soft (non-repetitive) data errors may occur.

At a high humidity, the mylar diskettes absorb moisture from the air. This can move the centerline of a previously recorded track away from the centerline of the read/write head. The result will be an increase in the data error rate.

### 4.4.3 Cleanliness

Cleanliness is important wherever diskettes are to be stored, handled, and used. Store the diskettes in areas free of dust and corrosive chemicals. The storage area should also be free of strong magnetic fields which might damage the recorded data. When handling a diskette, never touch the exposed magnetic media.

If the DSD 430/470 is operated in an environment which has a high concentration of abrasive airborne particles, the useful life of the diskettes will be reduced and the data error rate increased.

## 4.5 INSTALLING THE DSD 430/470 CHASSIS

The DSD 430/470 chassis must be installed within ten feet of the interface module's location to accommodate the length of the interconnecting cable. If the computer system operator will be changing diskettes often, it

may be convenient to install the chassis close to the console terminal.

The DSD 430/470 may be either mounted in a standard 19-inch rack or installed on a table top. The optional rack installation hardware consists of the items listed in table 4-2.

**Table 4-2. Rack Installation Hardware**

Quantity	Item
10	#10 x 32 Retainer Nuts
2	#8 x 32 x 3/8 Allen Screws
2	#10 Lock Washers
2	#10 x 32 x 5/8 Captive Screws
14	#10 x 32 x 1/2 BH Machine Screws
16	#10 Star Washers
18	#10 Flat Washers
6	#10 x 32 Hex Nuts

The DSD 430/470 chassis should be mounted in such a way that the air flow behind the fan is unrestricted. The temperature of the air entering the chassis should *not* exceed 40°C (104°F).

The following procedure should be used to mount the DSD 430/470 in a standard 19-inch instrumentation rack:

1. Attach the slim-line chassis mounts to your rack using the hardware supplied with the mounts. Note that the left and right rear extender brackets are not interchangeable. Figure 4-2 illustrates the correct relationship of the rack mounting components.
2. Slide the DSD 430/470 chassis on the mounts until the two bullets at the rear of the chassis mounts engage the corresponding holes in the rear of the chassis as shown in figure 4-3.
3. Remove the molded front "pop" panel from the chassis by pulling out the top of the panel.
4. Secure the chassis in the rack by bolting the front flange to the front rail of the rack, as shown in figure 4-4.

You may now replace the "pop" panel by pushing it straight back onto the two "head locks."

## 4.6 DSD 4140 CONTROLLER INSTALLATION

Configuration and installation of the DSD 4140 controller card should be accomplished in the following order:

First, the drive electronics of each disk drive is configured for DSD 4140 control.

Next, user selectable options are programmed by installing or not installing up to six jumpers on the controller card.

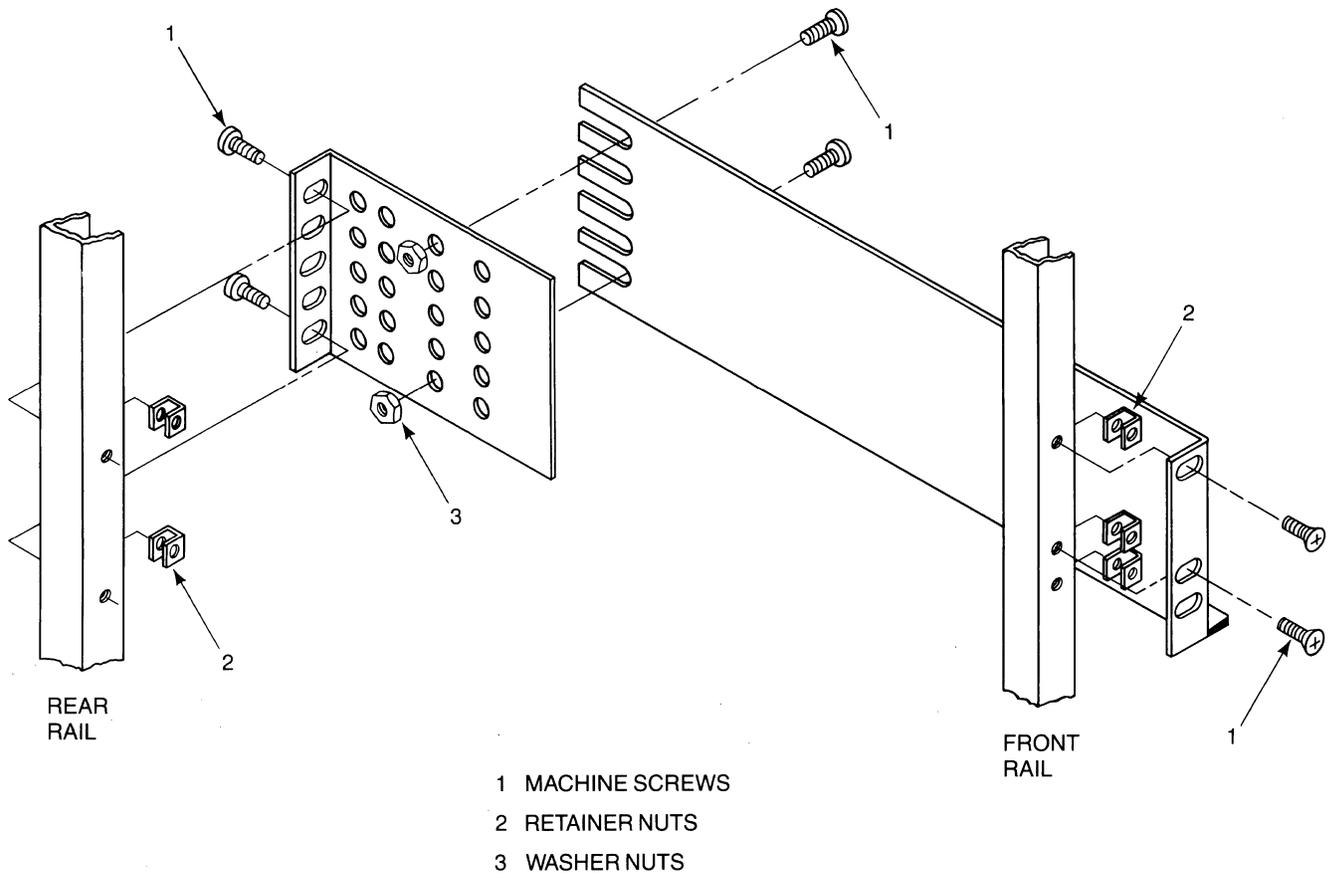


Figure 4-2. Installing Chassis Mounts

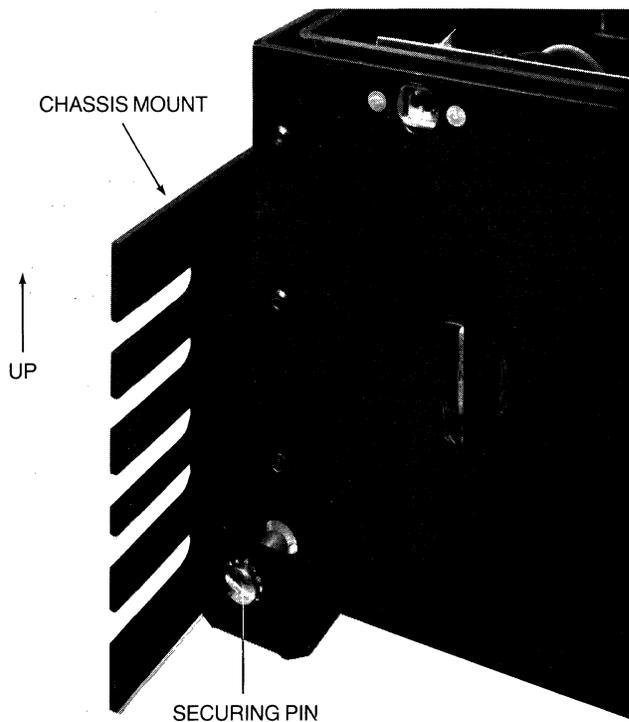


Figure 4-3. Securing Chassis

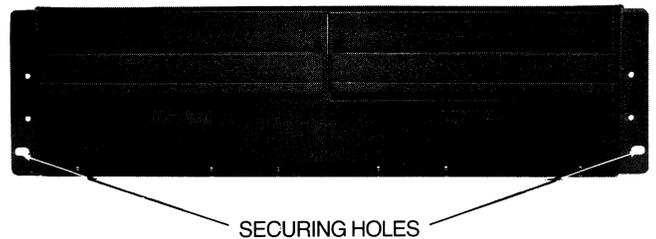


Figure 4-4. Front View of Chassis with Front Panel Removed to Show Securing Holes

Finally, the interface cable is attached to the DSD 4140, the DSD 4140 is plugged into the LSI-11 chassis, and the interface cable is attached to the disk drives.

#### 4.6.1 Disk Drive Configuration

Note: The information given for disk drive configuration is provided to show the versatility of the DSD 4140 Controller. The drives used with the DSD 430/470 systems are configured for proper operation prior to shipment in accordance with appendix A or B.

## 4-4

The DSD 4140 can accommodate a variety of industry-standard disk drives. Either single sided drives or double sided drives can be used.

For normal DSD 4140 use, the performance specifications of the disk drives must match those of table 4-3.

The configuration of the disk drives must be in accordance with DSD 4140 requirements. By adding jumpers to or removing jumpers from the drives' own controller cards—and by plugging or leaving open selected I/O pins—necessary changes can be implemented.

Two appendices describe the configuration of the Shugart Associates SA800 and SA850 disk drives. Other industry-standard disk drives—whose performance specifications match those of table 4-3—must be configured in a similar manner for use with the DSD 4140. Follow the instructions in the disk drive user's manual to configure the I/O signals of those industry-standard drives in accordance with either table A-1 (single sided disk drives) or table B-1 (double sided disk drives).

**Table 4-3.** Disk Drive Performance Requirements

Rate of Spin		360 RPM $\pm$ 2%
Head Type		Straddle Erase or Tunnel Erase
Head Load Time		35 msec or less
Head Setting Time		15 msec or less
Head Step Rate	Single Sided	8 msec track-to-track or less
	Double Sided	3 msec track-to-track or less

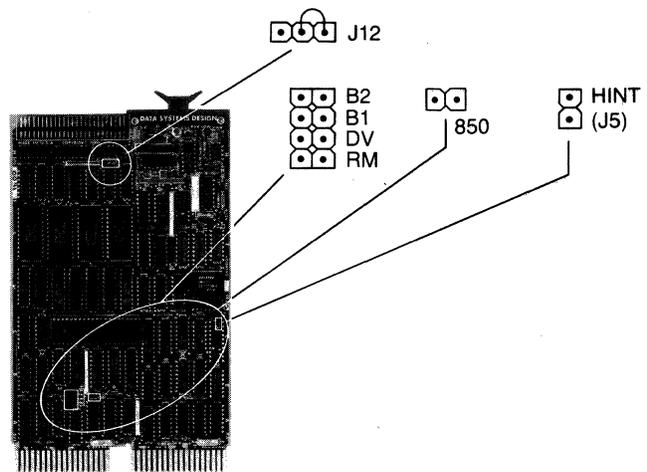
### 4.6.2 DSD 4140 Jumper Programming

The DSD 4140 provides an array of six wirewrap jumpers which the customer may install. This array can configure the DSD 4140 to the customer's requirements.

The location of the jumper array is shown in figure 4-5. As indicated in table 4-4, the DSD 4140 is shipped with all jumpers open (not installed). If these jumpers are to be installed, use only proper wirewrap tools & standard wirewrap techniques. In addition, the DSD 4140 is equipped with a number of wirewrap jumpers which are for factory testing ONLY. Of these, only jumper J12 is shipped in the closed (installed) position.

### CAUTION

**Removal of Jumper J12 will cause loss of Diskette data.**



**Figure 4-5.** DSD 4140 Jumper Locations

**Table 4-4.** DSD 4140 Configuration As Shipped

Jumper	Configuration	Programmed Operation
850	Open	Single sided drives only
RM	Open	Configured drive 0 = Addressed drive 0
DV	Open	Device (RX2CS) address = 777170 Interrupt vector = 264
B1	Open	Bootstrap starting address = 773000
B2	Open	
HINT (J5)	Open	Single level interrupt only

### 4.6.3 Double Sided Drive Selection

If jumper 850 is open (not installed), all disk drives must be single sided. Only double sided drives may be used if jumper 850 is closed (installed).

### 4.6.4 Drive Remapping

If jumper RM is open, the disk drive configured as drive 0 is addressed as drive 0, and the disk drive configured as drive 1 is addressed as drive 1.

If jumper RM is closed, the disk drive configured as drive 0 is addressed as drive 1, and the disk drive configured as drive 1 is addressed as drive 0.

### 4.6.5 Device Address/Vector Selection

If jumper DV is open, the device address (RX2CS) is 777170 and the interrupt vector is 264.

If jumper DV is closed, the device address (RX2CS) is 777150 and the interrupt vector is 270.

### 4.6.6 Bootstrap Starting Address Selection

As shown in table 4-5, jumpers B1 and B2 can select three different bootstrap starting addresses. The bootstrap is disabled if both jumpers are closed.

**Table 4-5.** Bootstrap Starting Address Selection

Jumper B1	Jumper B2	Bootstrap Starting Address
Open	Open	773000
Open	Closed	775000
Closed	Open	771000
Closed	Closed	Disabled

### 4.6.7 Interrupt Verification

If jumper HINT (labeled J5 on earlier boards) is open, the DSD 4140 must be used with a single level interrupt computer system only.

If jumper HINT (J5) is closed, the DSD 4140 may be used with multiple level interrupt computer systems such as the LSI-11/23. The DSD 4140 verifies the absence of higher priority interrupts before accepting an interrupt acknowledgement. This conforms with the multiple level interrupt protocol recommended by Digital Equipment Corporation.

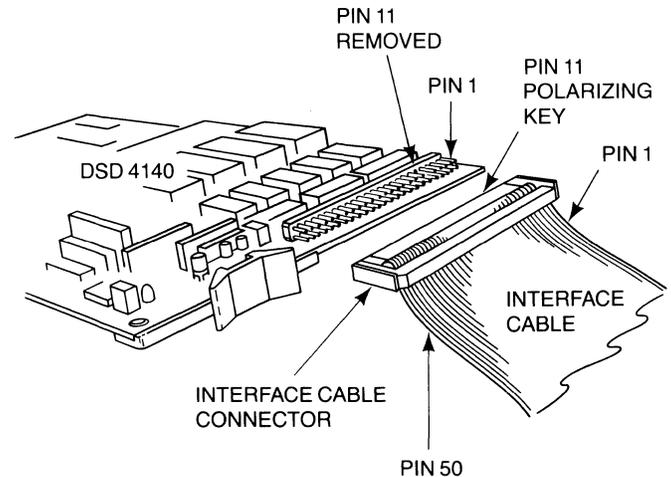
### 4.6.8 Card Mounting Procedure

The DSD 4140 Flexible Disk Controller plugs into one LSI-11 Q-Bus location. To install the DSD 4140, follow the procedure below.

#### CAUTION

**Make sure that the computer system power is off. Make sure that the disk drive power is off.**

1. Confirm that the drive electronics cards are correctly configured. The configuration procedure is explained in section 4.6.1.
2. Make sure that the DSD 4140's array of six wire-wrap jumpers is correctly programmed. The programming procedure is explained in section 4.6.2.
3. Plug the 50-conductor interface cable into the DSD 4140 connector. This is shown in figure 4-6. Match pin 1 of the interface cable to pin 1 of the DSD 4140 connector. Pin 11 of the DSD 4140 connector has been removed in order to accommodate an interface cable key. Interface requirements are given in section 2.5, as are DSD 4140 connector pin numbers and signal names.
4. Follow the instructions given in any volume of the DEC Microcomputer Handbook Series to determine flexible disk memory system priority and proper DSD 4140 location in the LSI-11 backplane. Be sure to maintain both DMA continuity and interrupt continuity to the DSD 4140.

**Figure 4-6.** Connecting the DSD 4140

5. Position the DSD 4140 so that its mounting key is facing the LSI-11 backplane. The DSD 4140 is inserted with the same component side/solder side orientation as the LSI-11 computer card already inserted in the chassis. This is shown in figure 4-7.
6. Insert the DSD 4140 into the Q-Bus location inside the LSI-11 chassis. Make sure that the DSD 4140 is properly seated in the Q-Bus slot, and that its components are not in contact with adjacent cards. DSD 4140 card edge pin designations, pin numbers, and signal names are given in section 2.5.

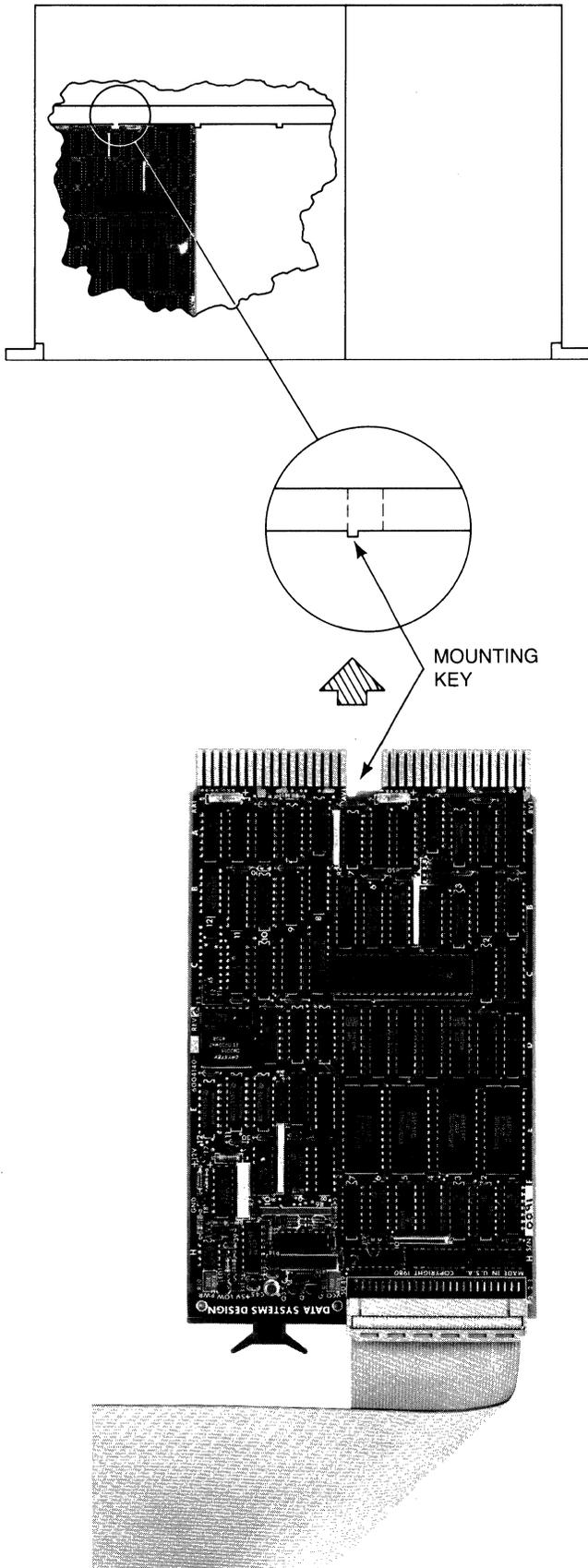
#### CAUTION

**Backward insertion will cause severe and permanent damage to the DSD 4140.**

## 4.7 DSD 430/470 CHASSIS CONNECTIONS

The following procedure describes the installation of the AC power cord and the interface bus cable:

1. Verify line power is off.
2. Plug the female end of the power cord into the connector on the back of the chassis.
3. Plug the other end into an AC power receptacle.
4. Route the free end of the interface bus cable over to the rear of the chassis.
5. Attach the interface cable to the disk drive assembly. Be sure to match pin 1 of the interface cable to pin 1 of the mating connector.



The procedure to power up the flexible disk memory is explained in section 5.2. Successful power-up indicates that the DSD 4140 is correctly installed. If difficulties arise, consult section 5.9.

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**Note**

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*All DSD 470 Systems are shipped with a cardboard shipping disk installed in the disk drives as a protection against head damage during shipping. This shipping disk should be removed prior to applying power to the system. Save this shipping disk for use in the event of any future shipment of the disk drive.*

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Figure 4-7. Inserting the DSD 4140

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# 5 Operation

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## 5.1 GENERAL INFORMATION

This chapter explains how to operate the DSD 430/470 system. First, AC power is applied to the flexible disk memory system and the LSI-11 computer. Next, the disk drives are initialized. The diskette bootstrap program may then be transferred to LSI-11 main memory. Finally, diskettes may be checked for errors, formatted, or write-protected.

## 5.2 POWERING UP

The flexible disk memory system can operate only when AC power is applied to both the LSI-11 computer and the disk drive chassis.

It is preferable to first power up the disk drive chassis, but the reverse order is allowable. The LSI-11 may be powered up or powered down without fear of writing on any diskette which may be loaded.

The LSI-11 supplies nominal +5 volt DC power to the DSD 4140 controller card. The recommended DSD 4140 operating voltage is +5.1 volts, measured at the computer backplane.

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### Note

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*The DSD 4140 is equipped with a Power Low light emitting diode (LED) indicator. If the DC voltage from the LSI-11 does not rise above +4.8 volts, the Power Low indicator will remain lit, and no disk drive operations will be allowed.*

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## 5.3 INITIALIZATION

There are four different ways to initialize the flexible disk memory system.

1. When the nominal +5 volts power supplied by the LSI-11 rises above +4.8 volts, the DSD 4140 automatically initializes the disk drives for operation.
2. The disk drives can be initialized at any time by using the INIT switch on the LSI-11 front panel.
3. The disk drives can be initialized by pulsing the Q-Bus BINIT line.
4. By loading 40000 into the RX2CS register address.

The initialization sequence is as follows:

1. The DSD 4140 executes self-testing diagnostics on its internal circuitry. These diagnostics require approximately 100 msec.
2. Drive 1 seeks to track 0. Then, drive 0 seeks to track 0.
3. When diskettes are properly loaded, the DSD 4140 reads track 1, sector 1, of drive 0 into the data buffer. The drive's read/write head makes an audible click as it loads.
4. Drive 0 is deselected.

## 5.4 BOOTSTRAPPING

The DSD 4140 can bootstrap the flexible disk memory system only when a system diskette is properly loaded. See figure 5-1.

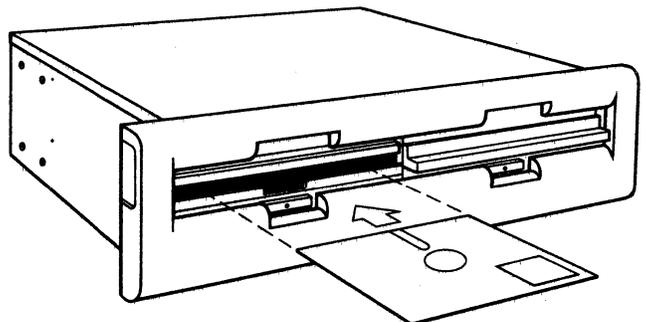


Figure 5-1. Orientation of Diskette for Insertion

The bootstrap program may be initiated from any of three different LSI-11 main memory locations. As explained in section 4.6.5 of this manual, two wirewrap jumpers are used to select the bootstrap starting address. The bootstrapping sequence is as follows:

1. As initialization begins, the DSD 4140 places a JUMP-TO-SELF (000777) instruction into the bootstrap starting address.
2. Following the initialization, the DSD 4140 verifies that the LSI-11 is attempting to execute the bootstrap program.
3. As bootstrapping begins, 1024 bytes of data—from the first two or four sectors of the diskette, beginning with track 1, sector 1—are transferred to the lowest LSI-11 main memory address via DMA. The number of sectors transferred depends on the density of the diskette.
4. The DSD 4140 replaces the JUMP-TO-SELF instruction with a CLEAR PC(005007) instruction.
5. The bootstrap program is executed, beginning at location 0, and the diskette operating program is transferred to LSI-11 main memory.

Reading the bootstrap starting address at any time displays an arbitrary value—but does not execute the bootstrap program. To execute the bootstrap function, type 773000G on the console terminal, while in ODT.

## 5.5 ACCEPTANCE TESTING AND DIAGNOSTICS

The DSD 4140 can verify the reliable operation of the flexible disk memory system through the use of diagnostic programs designed for the RX02, including those supplied by DEC.

DSD also supplies a comprehensive system test program, FLPEXR, which is described in Appendix C.

In addition, two powerful on-board diagnostics are available which can check diskettes for errors and exercise the drive mechanisms—without the use of system software. These two on-board diagnostics, SCAN DISK and SEEK TEST, are described in the following paragraphs.

Refer to table 5-1 which provides a summary of the most common DSD 4140 register functions available from ODT, including the SCAN TEST, SEEK TEST and FORMAT functions. The arrows shown on table 5-1 indicate that the value specified is loaded into the listed register. The address locations for the RX2CS and RX2DB registers are 777170 and 777172 respectively, unless the DV jumper is installed.

### 5.5.1 The SCAN DISK Diagnostic Function

The purpose of the SCAN DISK diagnostic is to check a diskette for errors. This is done by reading every sector of the diskette and verifying that the checkword

**Table 5-1.** DSD 4140 Register Functions

OPERATION	DRIVE 0	DRIVE 1
INITIALIZE DRIVES	RX2CS ← 40000	
SCAN TEST	RX2CS ← 11 RX2DB ← 7100	RX2CS ← 31 RX2DB ← 7100
SEEK TEST (Terminated by an initialize)	RX2CS ← 11 RX2DB ← 7110	RX2CS ← 31 RX2DB ← 7110
SET MEDIA DENSITY*		
SINGLE DENSITY	RX2CS ← 11 RX2DB ← 111	RX2CS ← 31 RX2DB ← 111
DOUBLE DENSITY	RX2CS ← 411 RX2DB ← 111	RX2CS ← 431 RX2DB ← 111
FORMAT DISKETTE*		
SINGLE DENSITY	RX2CS ← 5 RX2DB ← 154 RX2DB ← 0	RX2CS ← 25 RX2DB ← 154 RX2DB ← 0
DOUBLE DENSITY	RX2CS ← 5 RX2DB ← 155 RX2DB ← 0	RX2CS ← 25 RX2DB ← 155 RX2DB ← 0
READ STATUS		
SINGLE DENSITY	RX2CS ← 13	RX2CS ← 33
DOUBLE DENSITY	RX2CS ← 413	RX2CS ← 433
READ EXTENDED STATUS	RX2CS ← 17 RX2DB ← Starting address of 4 word memory block	

read for each data block agrees with the calculated value. SCAN DISK halts when an error is detected, when the system is initialized, or after every sector has been checked. If a double sided diskette is installed, both sides are verified.

Upon completion, the Error bit (bit 15) of the Command and Status (RX2CS) Register is set if an error was detected; if there were no errors, the Error bit will be cleared. The RX2CS register is described in section 6. More specific information regarding the cause of an error can be obtained using the READ EXTENDED STATUS command, described in section 6. The SCAN DISK diagnostic can be executed in either drive as follows:

Note: Addresses given are default values.

1. Using ODT, from a console terminal, load the value 11 (selecting drive 0) or 31 (selecting drive 1) into the RX2CS register address (777170).
2. The DSD 4140 will respond by setting the Transfer Request bit (bit 7) of the RX2CS register to one, in order to request a key word. This key word determines whether an on-board diagnostic or a SET MEDIA DENSITY operation (see section 6) is to occur.
3. Load the key word for the SCAN DISK diagnostic—7100—into the RX2DB register address (777172).
4. The SCAN DISK diagnostic function now begins. When the diagnostic function completes, the read/

write head will lift and the disk drive activity light will be extinguished. This normally takes 25 seconds for a single sided diskette or 40 seconds for a double sided diskette.

### 5.5.2 The SEEK TEST Diagnostic Function

The SEEK TEST diagnostic function is designed to thoroughly exercise the positioning mechanism of either disk drive. This is accomplished by stepping between the innermost track (track 76 decimal) and every other track in a "ping-pong" fashion. Track position is verified at each excursion, thus assuring that the drive is operating properly.

The SEEK TEST function will continue exercising the drive indefinitely unless an error is detected or the controller is initialized. In the case of an error, the Error bit (bit 15) of the RX2CS register will be set to one. Otherwise, this bit will be cleared. The RX2CS register is described in section 6. More specific information regarding the cause of an error can be obtained using the READ EXTENDED STATUS command described in section 6. The SEEK TEST diagnostic can be performed on either drive as follows:

1. Using ODT, from a console terminal, load the value 11 (selecting drive 0) or 31 (selecting drive 1) into the RX2CS register address (777170).
2. The DSD 4140 will respond by setting the Transfer Request bit (bit 7) of the RX2CS register to one, in order to request a key word. This key word determines whether an on-board diagnostic or a SET MEDIA DENSITY operation (see section 6) is to occur.
3. Load the key word for the SEEK TEST diagnostic—7110—into the RX2DB register (777172).
2. The SEEK TEST diagnostic function now begins on the selected drive.

## 5.6 FORMATTING THE DISKETTE

The DSD 4140 can format the diskette in either IBM 3740 single density format or DEC RX02 double density format through use of FORMAT, a special micro-code function. The FORMAT function reformats an entire single sided or double sided diskette.

---

### CAUTION

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**Use of this command will cause loss of diskette data.**

---

The FORMAT protocol is as follows. (DSD 4140 device registers and device functions are described in section 6.)

1. Using ODT from a console terminal, load the value 5 (selecting drive 0) or 25 (selecting drive 1) into

the RX2CS register address (777170). Refer to table 5-1.

2. The DSD 4140 clears the RX2ES register and sets the Done bit (bit 5) of the RX2CS register to zero.
3. The DSD 4140 sets the Transfer Request bit (bit 7) of the RX2CS register to one, in order to request a sector address.
4. Using ODT from a console terminal, load the special sector address value 154 (single density) or 155 (double density) into the RX2DB register address (777172). Refer to table 5-1.
5. The DSD 4140 sets the Transfer Request bit (bit 7) of the RX2CS register to one, in order to request a starting track address.
6. The starting track address—normally, track 0—is loaded into the RX2TA register (RX2DB register address 777172).
7. The header fields of each track of the diskette—beginning with selected track—are written in sequential order, and the data fields are written in the selected density.

The FORMAT function proceeds, one track at a time. The function halts when the designated tracks have been reformatted, at which time the read/write head is unloaded and the activity light is extinguished. The entire operation takes 40 seconds for a single sided diskette, or 65 seconds for a double sided diskette.

---

### CAUTION

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**Do not disturb the controller while the format operation is in progress or an invalid format will result.**

---

## 5.7 WRITE PROTECTING THE DISKETTE

Write protecting the diskette protects the data and programs stored on it from being rewritten—deliberately or accidentally.

The diskette can be write protected only if it has a write protect notch on its sealed envelope. To write protect the diskette, uncover the write protect notch as shown in figure 5-2.

## 5.8 TROUBLESHOOTING

The installation, power-up, and operation of the DSD 4140/430/470 normally proceeds smoothly and successfully. On occasion, however, difficulties may arise. As an aid in such circumstances, a guide to the elementary troubleshooting of the flexible disk memory system is provided in section 7 of this manual.

## 5-4

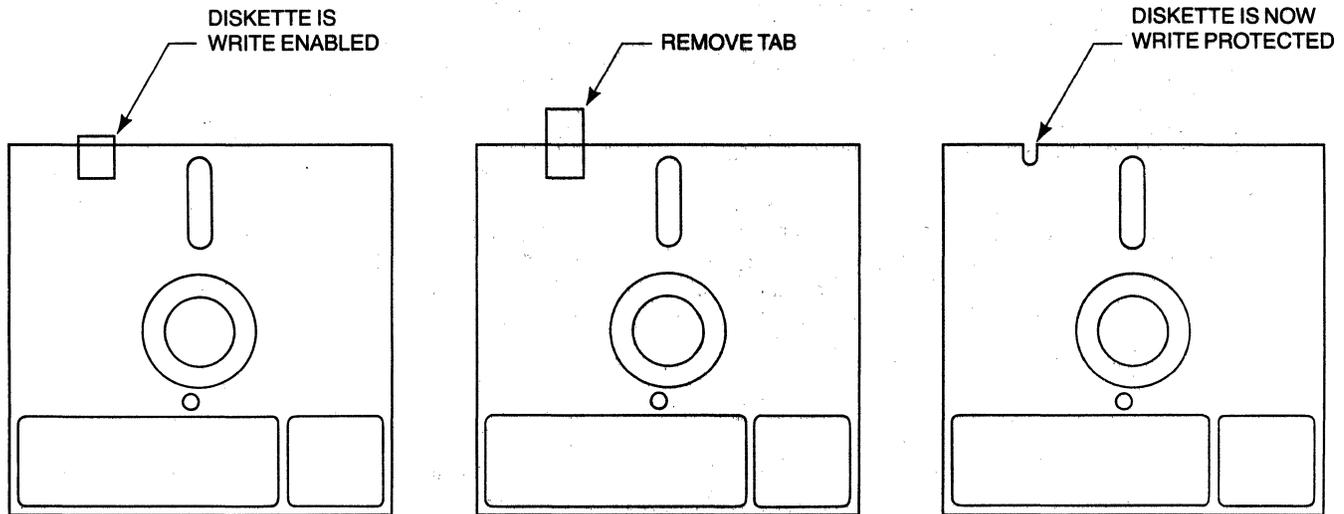


Figure 5-2. Write Protecting the Diskette

## 5.9 CREATION OF A DOUBLE SIDED MONITOR

To fully utilize the double sided capabilities of the DSD 4140 on certain of the DEC operating systems, it may be necessary to modify the existing monitor program or in certain cases, to create a new monitor program. A full explanation of the required procedure and use of the resultant monitor program is given in Appendix D.

# 6 Controller Registers, Function and Format

## 6.1 GENERAL INFORMATION

Chapter 6 explains how the DSD 430/470 Flexible Disk Systems utilize the device registers of the 4140 controller to store and retrieve data from the flexible disk. Proper understanding of the material contained in this chapter should enable a programmer to achieve full benefit of the capabilities built into your DSD 430/470 System.

The names and bit assignments utilized by the 4140 controller are identical to those of DEC RX02. There are two primary registers:

- Command and Status (RX2CS) Register
- Data (RX2DB) Register

The DSD 4140 communicates with the LSI-11 computer through these two registers. The RX2CS register is normally accessed through Q-Bus address 777170. The RX2DB register is normally accessed through Q-Bus address 777172. The address of the RX2DB register is always two greater than the address of the RX2CS register.

There are also six logical registers which are accessed through the RX2DB register address:

- Data Buffer (RX2DB) Register
- Track Address (RX2TA) Register

- Sector Address (RX2SA) Register
- Word Count (RX2WC) Register
- Bus Address (RX2BA) Register
- Error and Status (RX2ES) Register

The Data Register and the logical Data Buffer are both termed RX2DB.

The device registers are usually accessed by loading the appropriate bits into the RX2CS register address and following the corresponding protocol. Data are then written or read via the RX2DB register address, the general purpose data path.

## 6.2 COMMAND AND STATUS (RX2CS) REGISTER

The contents of the Command Status (RX2CS) Register control the operation of the flexible disk memory system.

RX2CS provides important status information and error indications. This register also selects the disk drive function to be executed.

The format of the Command and Status (RX2CS) Register is shown in figure 6-1. Bit assignments are given in table 6-1. Table 6-2 lists the disk drive functions selected by the RX2CS.

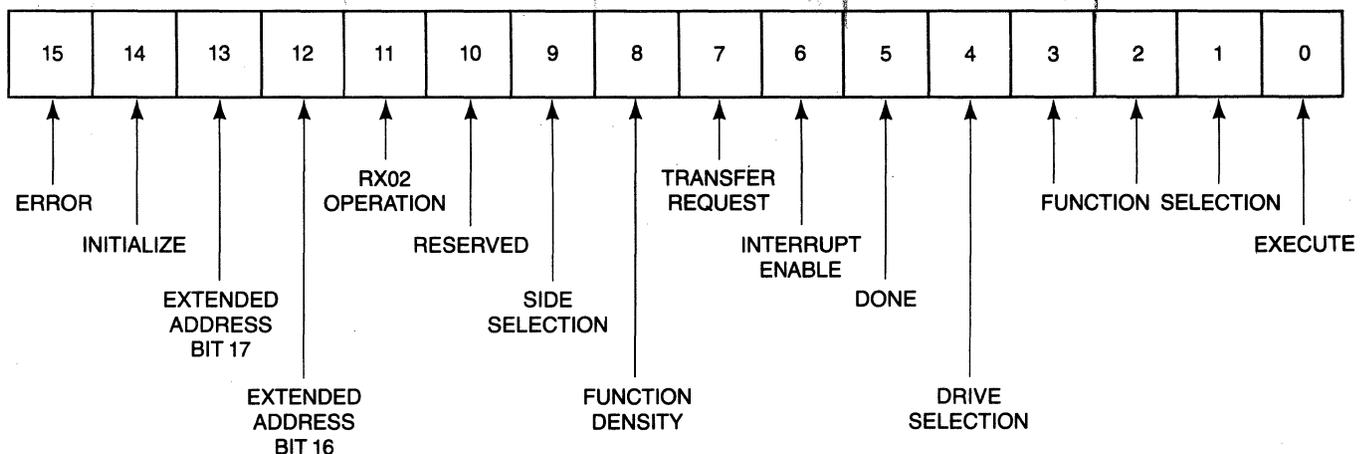


Figure 6-1. Command and Status (RX2CS) Register Format

**Table 6-1.** Command and Status (RX2CS) Register Bit Assignments

Bit Number	Bit Type	Bit Name	Bit Meaning	
			0	1
15	Read only	Error	—	Error detected.
14	Write only	Initialize	—	Begin initialization.
13	Write only	Extended Address Bit 17	0	1
12	Write only	Extended Address Bit 16	0	1
11	Read only	RX02 Operation	—	RX02 operation.
10	RESERVED			
9	Read/Write	Side Selection	Side 0 selected.	Side 1 selected.
8	Read/Write	Function Density	Single density selected.	Double density selected.
7	Read only	Transfer Request	RX2DB not ready for data transfer.	RX2DB ready for data transfer.
6	Read/Write	Interrupt Enable	Interrupt not enabled.	Interrupt enabled.
5	Read only	Done	Operation in progress.	Operation completed.
4	Read/Write	Drive Selection	Drive 0 selected.	Drive 1 selected.
3,2,1	Write only	Function Selection	SEE TABLE 6-2.	
0	Write only	Execute	Does not execute the function selected by bits 1-3.	Executes the function selected by bits 1-3.

**Table 6-2.** RX2CS Function Selection

Setting	Bit			Function Selected
	3	2	1	
	0	0	0	FILL BUFFER
	0	0	1	EMPTY BUFFER
	0	1	0	WRITE SECTOR <sup>1</sup>
	0	1	1	READ SECTOR
	1	0	0	SET MEDIA DENSITY <sup>2</sup>
	1	0	1	READ STATUS
	1	1	0	WRITE DELETED SECTOR
	1	1	1	READ EXTENDED STATUS

1. Also used by FORMAT program.  
 2. Also used by SCAN DISK and SEEK TEST programs.

### 6.3 DATA (RX2DB) REGISTER

The contents of the Data (RX2DB) Register provide the general purpose communication link between the LSI-11 computer and flexible disk memory system. Six different logical registers may be accessed through the RX2DB register address. The protocol of the disk drive function being executed determines which of these registers is accessed.

### 6.3.1 Data Buffer (RX2DB) Register

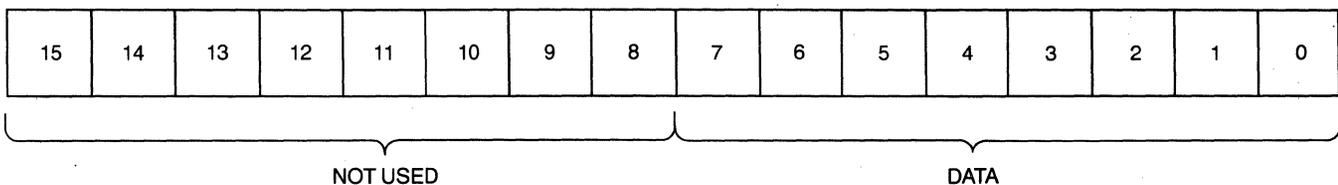
Bits 0-7 of the logical Buffer (RX2DB) Register transfer data to and from the diskette. The read/write RX2DB register may be accessed through the Data (RX2DB) Register address. The format of the Data Buffer register is shown in figure 6-2.

### 6.3.2 Track Address (RX2TA) Register

Bits 0-7 of the logical Track Address (RX2TA) Register specify the track upon which the selected function is to be executed. Track address 0-114 (octal) are valid. The write only RX2TA register may be accessed through the RX2DB register address. The format of the Track Address Register is shown in figure 6-3.

### 6.3.3 Sector Address (RX2SA) Register

Bits 0-7 of the logical Sector Address (RX2SA) Register specify the sector upon which the selected function is to be executed. Sector Addresses 1-32 (octal) are valid. The write only RX2SA register may be accessed through the RX2DB register address. The format of the Sector Address Register is shown in figure 6-4.



**Figure 6-2.** Data Buffer (RX2DB) Register Format

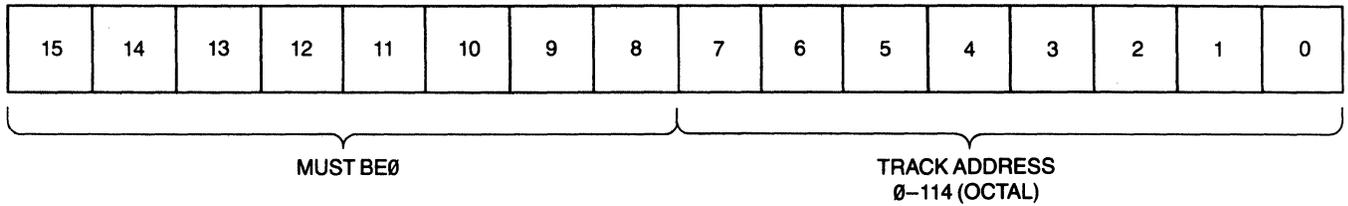


Figure 6-3. Track Address (RX2TA) Register Format

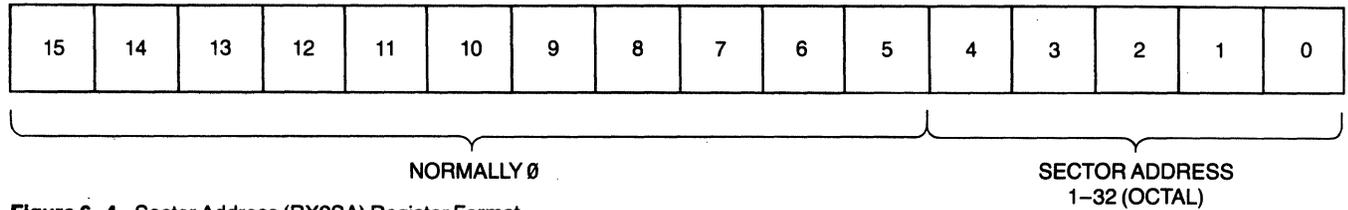


Figure 6-4. Sector Address (RX2SA) Register Format

### 6.3.4 Word Count (RX2WC) Register

Bits 0-7 of the logical Word Count (RX2WC) Register specify the number of words transferred during each DMA operation. Single density word counts 1-100 (octal) are valid. Double density word counts 1-200 (octal) are valid. The write only RX2WC register may be accessed through RX2DB register address. The format of the Word Count Register is shown in figure 6-5.

### 6.3.5 Bus Address (RX2BA) Register

The contents of the logical Bus Address (RX2BA) register specify the lower 16 bits of the Q-Bus address to

which data are transferred during each DMA operation. The write only RX2BA register may be accessed through the RX2DB register address.

### 6.3.6 Error and Status (RX2ES) Register

The contents of the logical Error and Status (RX2ES) Register provide current status information and error indications for the selected disk drive. The read-only RX2ES register may be accessed through the RX2DB register address. The format of the Error and Status Register is shown in figure 6-6. Bit assignments are given in table 6-3.

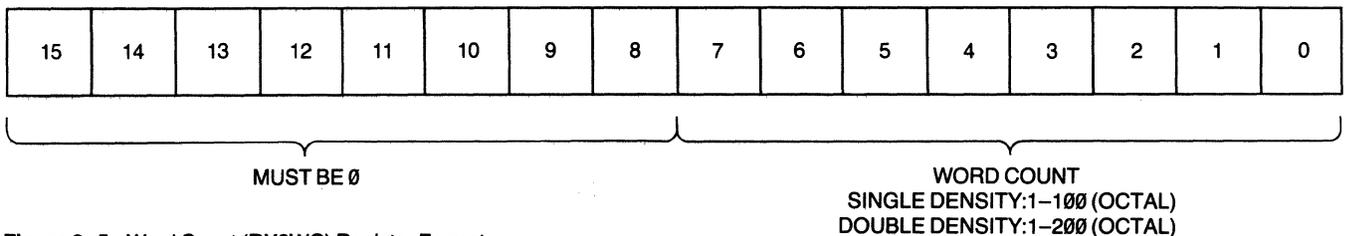


Figure 6-5. Word Count (RX2WC) Register Format

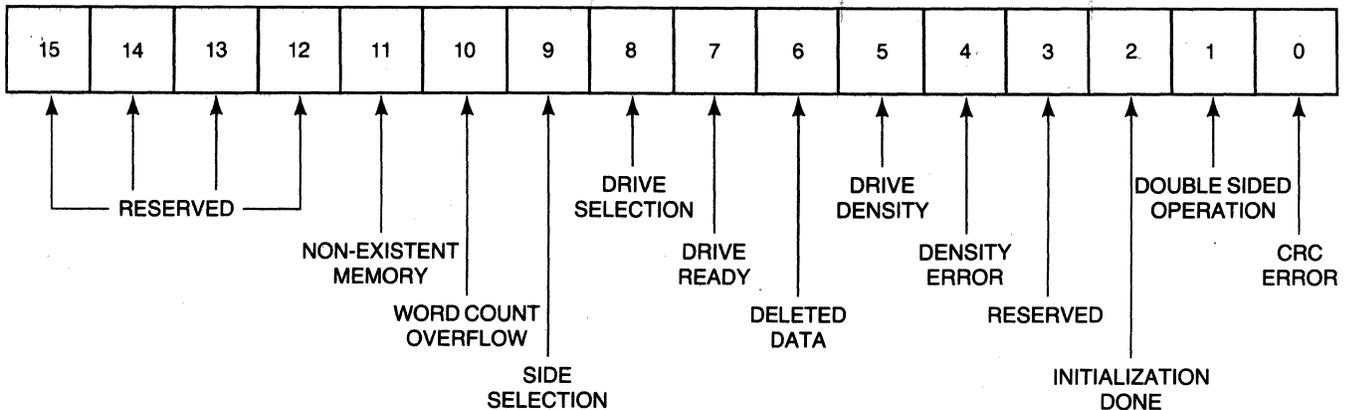


Figure 6-6. Error and Status (RX2ES) Register Format

**Table 6-3.** System Error and Status (RX2ES) Register Bit Assignments

Bit Number	Bit Name	Bit Meaning	
		0	1
15,14,13,12	RESERVED		
11	Non-Existent Memory	—	DMA attempted to or from non-existent memory.
10	Word Count Overflow	—	Word count too large for sector size specified.
9	Side Selection	Side 0 selected.	Side 1 selected.
8	Drive Selection	Drive 0 selected.	Drive 1 selected.
7	Drive Ready	—	Selected drive is installed and up to speed.
6	Deleted Data	—	Deleted data address mark found or previous command was WRITE DELETED SECTOR.
5	Drive Density	Single density diskette installed in selected drive.	Double density diskette installed in selected drive.
4	Density Error	—	Diskette density does not match RX2CS function density bit.
3	RESERVED		
2	Initialization Done	—	Initialization sequence is completed.
1	Double Sided Operation	—	If bit 7 is set to 1, double sided diskette is installed.
0	Cyclic Redundancy Check (CRC) Error	—	Inaccurate data detected by CRC.

## 6.4 DEVICE FUNCTIONS

Actual storage and retrieval of data is accomplished by utilizing the eight device functions of the DSD 4140 controller.

The names and protocols of six of these device functions are identical to those of the DEC RX02. These six functions are:

- FILL BUFFER
- EMPTY BUFFER
- READ SECTOR
- READ STATUS
- WRITE DELETED SECTOR
- READ EXTENDED STATUS  
(also called READ ERROR CODE)

Two DSD 4140 device functions—WRITE SECTOR and SET MEDIA DENSITY—offer capabilities beyond those found in the DEC RX02. WRITE SECTOR can be used to format diskettes. SET MEDIA DENSITY is executed on both sides of double sided diskettes, and can also be used to perform DSD 4140 on-board diagnostics. (Refer to sections 5.5 and 5.6)

### 6.4.1 Fill Buffer

The Fill Buffer command transfers data from LSI-11 main memory to the data buffer of the DSD 4140.

The Command and Status (RX2CS) Register is loaded with a Fill Buffer command. The LSI-11 waits until the Transfer Request bit (bit 7) of the RX2CS register is asserted, and then loads the Word Count Register. The LSI-11 again waits for Transfer Request, and

then loads the Bus Address (RX2BA) Register. The data are then transferred via DMA. The LSI-11 tests the Done bit (bit 5) of the RX2CS register until the bit is asserted. This signals the completion of the command.

The contents of the data buffer may then be written onto the diskette by a WRITE SECTOR command. Or, they may be returned to LSI-11 main memory by an EMPTY BUFFER command.

### 6.4.2 Empty Buffer

The Empty Buffer command transfers the contents of the data buffer to LSI-11 main memory. These data are in the buffer as the result of a Fill Buffer or Read Sector command.

The Command and Status (RX2CS) Register is loaded with an Empty Buffer command. The Word Count (RX2WC) Register is loaded after the Transfer Request bit (bit 7) of the RX2CS register is asserted. When transfer Request is set for a second time, the Bus Address (RX2BA) Register is loaded. The data are transferred via DMA. The Done bit (bit 5) of the RX2CS register signals completion of the command.

### 6.4.3 Write Sector

The Write Sector command transfers the contents of the data buffer to a selected sector and track of the diskette. These data are not modified by the Write Sector command.

A Write Sector command is loaded into the Command and Status (RX2CS) Register. The assertion of the Transfer Request bit (bit 7) of the RX2CS register signals that the DSD 4140 is ready to accept a new

sector in the Sector Address (RX2SA) register. After Transfer Request is asserted for the second time the Track Address (RX2TA) register should be loaded with a new track. The data contained in the DSD 4140 data buffer are written onto the appropriate diskette track and sector. The Done bit of RX2CS register signals completion of the operation.

The Write Sector command can also be used to format diskettes. This command protocol is explained in chapter 5 of this manual.

#### 6.4.4 Read Sector

The Read Sector command transfers data from a selected sector and track of the diskette to the DSD 4140 data buffer.

The LSI-11 loads a Read Sector command into the Command and Status (RX2CS) register. The LSI-11 waits for the Transfer Request bit (bit 7) of the RX2CS register to be asserted, and then loads the Sector Address (RX2SA) register. The LSI-11 again waits for Transfer Request, and Loads the Track Address (RX2TA) register. The DSD 4140 reads the appropriate diskette track and sector, leaving the data in the data buffer. The LSI-11 tests the Done bit (bit 5) of the RX2CS register to determine completion of the command.

#### 6.4.5 Set Media Density

The Set Media Density command reassigns the entire single sided or double sided diskette to a specified density, writes new data address marks, and zeroes all data fields.

To initiate the Set Media Density command, the LSI-11 loads the command into the Command and status (RX2CS) register. The LSI-11 waits for the Transfer Request bit (bit 7) of the RX2CS register to be asserted, and loads the Set Media Density keyword, octal 111, into the RX2DB register address. If the Function Density bit (bit 8) of the Command and Status register is set to 0, the diskette is rewritten to single density. The diskette is rewritten to double density if this bit is set to 1.

The Set Media Density operations requires approximately 26 seconds for completion. Upon completion, the Done bit (bit 5) of the RX2CS register is set.

The Set Media Density command can also be used to perform DSD 4140 on-board diagnostics. This command protocol is explained in chapter 5 of this manual.

#### 6.4.6 Read Status

The Read Status command reports the drive readiness of, and density of the diskette inserted into a selected disk drive.

The LSI-11 loads a Read Status command into the Command and Status (RX2CS) register. The Drive Selection bit (bit 6) of the RX2CS register specifies the drive whose status is requested. When the DSD 4140 controller asserts the Done bit (bit 5) of the RX2CS reg-

ister, the RX2DB register address contains the Error and Status (RX2ES) register. Drive readiness is reported by the Drive Ready bit (bit 7), and diskette density by the Drive Density bit (bit 5), of the RX2ES register.

#### 6.4.7 Write Deleted Sector

The Write Deleted Sector command transfers the contents of the DSD 4140 data buffer to a selected sector and track of the diskette—as does the Write Sector command. However, instead of writing a standard data address mark just before the data field, the Write Deleted Sector command writes a deleted data address mark in that location.

#### 6.4.8 Read Extended Status

The Read Extended Status command transfers the four words of “internal scratch pad memory” to LSI-11 main memory via DMA.

The LSI-11 initiates the Read Extended Status command by loading the command into the Command and Status register. The LSI-11 waits until the Transfer Request bit (bit 7) of the RX2CS register is asserted, and then loads the Bus Address (RX2BA) register with the address of an unused memory area. Four words of data are transferred via DMA to LSI-11 RAM memory. When this transfer is complete, the Done bit (bit 5) of the RX2CS register is asserted.

Bits 0–7 of the first word of “internal scratch pad memory” comprise the DSD 4140 definitive error code. This error code may be used to determine the cause of an error. The definitive error codes—and their meanings—are listed in table 6–4.

The meanings of the other words transferred to memory are as follows:

WORD 1—LO BYTE	DEFINITIVE ERROR CODE (SEE TABLE 6–4)
WORD 1—HI BYTE	WORD COUNT REGISTER
WORD 2—LO BYTE	CURRENT TRACK ADDRESS OF DRIVE 0
WORD 2—HI BYTE	CURRENT TRACK ADDRESS OF DRIVE 1
WORD 3—LO BYTE	TARGET TRACK OF CURRENT DISK ACCESS
WORD 3—HI BYTE	TARGET SECTOR OF CURRENT DISK ACCESS
WORD 4—BIT 0	DENSITY OF READ ERROR REGISTER COMMAND
WORD 4—BIT 4	DRIVE DENSITY OF DRIVE 0
WORD 4—BIT 5	HEAD LOAD BIT
WORD 4—BIT 6	DRIVE DENSITY OF DRIVE 1
WORD 4—BIT 7	UNIT SELECT BIT
WORD 4—HI BYTE	TRACK ADDRESS OF SELECTED DRIVE

**Table 6-4. Definitive Error Codes**

<i>Octal Code</i>	<i>Code Meaning</i>
000	No error found.
010	No drive 0 found. Or, drive 0 failed to find track 0 during initialization.
020	No drive 1 found. Or, drive 1 failed to find track 0 during initialization.
030	Track 0 unexpectedly found during initialization.
040	Controller received invalid track address.
050	Track 0 found before selected track found.
060	Error found during self-test.
070	Selected sector not found during two revolutions.
100	Attempt made to write or format write-protected diskette.
110	No read data signal found. (Or, no diskette loaded.)
120	No preamble found. (Or, no diskette loaded.)
130	Preamble found, but no address mark found within window.
140	CRC error found on what appeared to be header.
150	Track address in good header did not match selected track.
160	Too many attempts to find address mark.
170	Address mark not found in time allotted after preamble.
200	CRC error found on data field.
230	Invalid word count selected.
240	Diskette density does not match selected function density.
250	Invalid key word selected for SET MEDIA DENSITY.
260	Diskette density can not be determined.
350	Non-existent memory location addressed during DMA transfer.
360	Drive not ready during format or bootstrap operation.

# 7 Maintenance and Troubleshooting

## 7.1 GENERAL INFORMATION

This chapter provides information on the maintenance of the DSD 4140/430/470 Flexible Disk Data Storage System. The first part discusses the routine procedures required to maintain the equipment at its peak efficiency. The second part provides basic troubleshooting and fault-isolation techniques to be utilized in quickly locating the portion of the system causing a problem.

## 7.2 PREVENTIVE MAINTENANCE

The DSD 4140/430/470 is designed to minimize the amount of periodic maintenance required. The prime factor in maintaining electronic equipment is ensuring it is operated within its design parameters and specified environmental limits (See Chapter 2.). Cleanliness should be considered as part of the environmental requirement.

During any routine or scheduled maintenance, the first step should always be a visual inspection. Check for corrosion, dirt, and undue wear on moving parts. Check all connector assemblies for proper and firm installation.

### 7.2.1 Disk Drive Maintenance

Preventative maintenance schedules for the disk drives furnished in the DSD 430/470 System are given in table 7-1.

During preventative maintenance, perform only those operations listed for that preventative maintenance period. Maintenance and adjustments beyond those listed items, such as head alignments, should be attempted only by qualified technicians using the procedures provided in the Service Manual.

### CAUTION

**Do not lubricate the drives, oil will allow dirt and dust to accumulate. To prevent damage, the read/write heads should not be cleaned or touched in the DSD 470 system.**

**Table 7-1A. Disk Drive Preventative Maintenance DSD 430**

<i>Unit</i>	<i>Months</i>	<i>Action</i>	<i>Observe</i>
Read/Write Head	12	Clean Read/Write Head ONLY IF NECESSARY	Oxide build up
R/W Head Load Button	12*		Replace
Stepper Motor and Lead Screw	12	Clean off all oil, dust, and dirt	Inspect for nicks and burns
Belt	12	Replace if worn	Frayed or weakened areas
Base	12	Clean base	Inspect for loose screws, connectors, and switches

**Table 7-1B. Disk Drive Preventative Maintenance DSD 470**

<i>Unit</i>	<i>Freq Months</i>	<i>Action</i>	<i>Observe</i>
Read/Write Heads	N/A	No Maint. Req'd.	Do not clean or touch
Actuator band	12	Clean all oil, dust & dirt only if necessary	
Belt	12	Replace if worn	Frayed or weakened areas
Base	12	Clean base	Inspect for loose screws, connectors and switches

## 7.3 TROUBLESHOOTING AND FAULT ISOLATION

Table 7-2 is furnished as a guide for user level fault isolation on the DSD 4140/430/470. This guide should be utilized before any extensive maintenance procedures are attempted.

**Table 7-2.** Troubleshooting Guide

<i>Trouble Indication</i>	<i>Possible Cause</i>
DSD 4140 Power Low LED remains lit	<ul style="list-style-type: none"> <li>• DC voltage from the LSI-11 has not risen above + 4.8 volts.</li> </ul>
Disk Drives do not operate	<ul style="list-style-type: none"> <li>• Power cord is disconnected.</li> <li>• Interface cable is loose.</li> <li>• Fuse is blown.</li> <li>• Circuit breaker is open.</li> <li>• Disk drive incorrectly configured. See section 4.6.</li> <li>• Power supply failure.</li> </ul>
Disk drive activity lights do not light. Disk drives do not initialize.	<ul style="list-style-type: none"> <li>• Disk drive door open.</li> <li>• Diskette is improperly loaded.</li> <li>• Improper drive configuration.</li> </ul>
Both disk drive activity lights remain lit. Disk drives do not initialize.	<ul style="list-style-type: none"> <li>• Interface cable pin 1 does not match connector pin 1. See section 4.6.</li> </ul>
One disk drive activity light remains lit. Disk drives do initialize.	<ul style="list-style-type: none"> <li>• DMA continuity or interrupt continuity not maintained (check backplane configuration)</li> </ul>
Bootstrapping can not be performed. Disk drives do initialize.	<ul style="list-style-type: none"> <li>• Diskette is blank.</li> <li>• No bootstrap program on diskette.</li> <li>• Bootstrap on diskette is not RX02 compatible.</li> <li>• Double sided diskette loaded in single sided disk drive.</li> <li>• HALT switch on LSI-11 front panel is set to ON.</li> <li>• Diskette data damaged.</li> <li>• Diskette format is damaged.</li> <li>• Diskette is worn.</li> <li>• Diskette mounting hole is not concentric.</li> <li>• Possible drive malfunction.</li> </ul>

## 7.4 DIAGNOSTIC AIDS

The DSD 4140 controller provides diagnostic aids in the form of two on-board functions, called SCAN DISK and SEEK TEST. Use of these functions is covered in section 5.5

Added diagnostic help is available through the use of the FLPEXR program. Use of the FLPEXR program is covered in Appendix C of this manual.

## 7.5 FAULT ISOLATION

If the troubleshooting guide, table 7-2, fails to locate the cause of a system malfunction, the next step is to

isolate the problem to a replaceable sub-system (4140 controller, disk drive, power supply, interface cable).

1. Check to see if the controller responds to the RX2CS and RX2DB addresses (normally 777170 and 777172).
2. Check to see if the error bit of the RX2CS is set or if any error is indicated in one of the status bits of the RX2ES (see chapter 6). Additional error information can be obtained using the Read Extended Status command (RX2CS = 17, RX2DB = memory address) for a further explanation of this command see 6.4.8. Table 7-3 provides a listing of the Definitive Error Codes and their meanings. A controller failure is indicated if the controller registers do not respond or if they return illegal values, such as reading a "1" in a write-only bit position of RX2CS.
3. As a next step disconnect the drive interface cable. Load 40000 into the RX2CS register to perform an initialize operation. If the results in RX2CS is not 104040, a controller problem is indicated. Performing a Read Extended Status operation will show a Definitive Error Code of 10, with the other three words being 0.
4. If the controller appears to be working correctly, remove the top cover of the 430/470 and check the +5, +24, and -16 volt unregulated supply voltages on the power distribution board.
5. Inspect all cables and connections within the disk drive chassis.
6. If a drive problem is suspected, use the remap option on the 4140 controller to logically reverse the drive addressing and see if the problem moves to the opposite drive.
7. Blank diskettes can be reformatted and scanned to check read and write functions (See section 5.6 on FORMAT and section 5.5 for SCAN TEST).

## 7.6 SUB-SYSTEM REPLACEMENT

After it has been determined that a hardware malfunction exists and the problem has been isolated to a sub-system, repair can be accomplished by replacement of the faulty sub-system. All sub-systems can be replaced without the use of special tools or soldering.

Repairs to the individual sub-systems should only be attempted by qualified maintenance technicians on a bench set-up or at the factory.

**Table 7-3.** Definitive Error Codes

<i>Octal Code</i>	<i>Code Meaning</i>
000	No error found.
010	No drive 0 found. Or, drive 0 failed to find track 0 during initialization.
020	No drive 1 found. Or, drive 1 failed to find track 0 during initialization.
030	Track 0 unexpectedly found during initialization.
040	Controller received invalid track address.
050	Track 0 found before selected track found.
060	Error found during self-test.
070	Selected sector not found during two revolutions.
100	Attempt made to write or format write-protected diskette.
110	No read data signal found. (Or, no diskette loaded.)
120	No preamble found. (Or, no diskette loaded.)
130	Preamble found, but no address mark found within window.
140	CRC error found on what appeared to be header.
150	Track address in good header did not match selected track.
160	Too many attempts to find address mark.
170	Address mark not found in time allotted after preamble.
200	CRC error found on data field.
230	Invalid word count selected.
240	Diskette density does not match selected function density.
250	Invalid key word selected for SET MEDIA DENSITY.
260	Diskette density can not be determined.
350	Non-existent memory location addressed during DMA transfer.
360	Drive not ready during format or bootstrap operation.

## 7.7 MAINTENANCE ASSISTANCE

Data Systems Design maintains a fully staffed Customer Service Department. If at any time during inspection, installation or operation, you encounter a problem, contact one of the offices listed below. Our trained staff can help you diagnose the cause of a failure, and if necessary, speed replacement parts to you. Any time you need to return a product to the factory, please contact Customer Service to obtain a Material Return Authorization Number.

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### Note

*If at any time, a double sided disk drive is to be shipped, a cardboard shipping disk should be inserted into the drive prior to shipment. This prevents head damage during shipment.*

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### DATA SYSTEM DESIGN

#### Customer Service

(West Coast)  
2241 Lundy Ave.  
San Jose, CA 94131  
408/946-5800

(East Coast)  
51 Morgan Drive  
Norwood, MA 02026  
617/769-7620

For products sold outside the United States, contact your local Data Systems Design distributor for parts and customer service assistance.

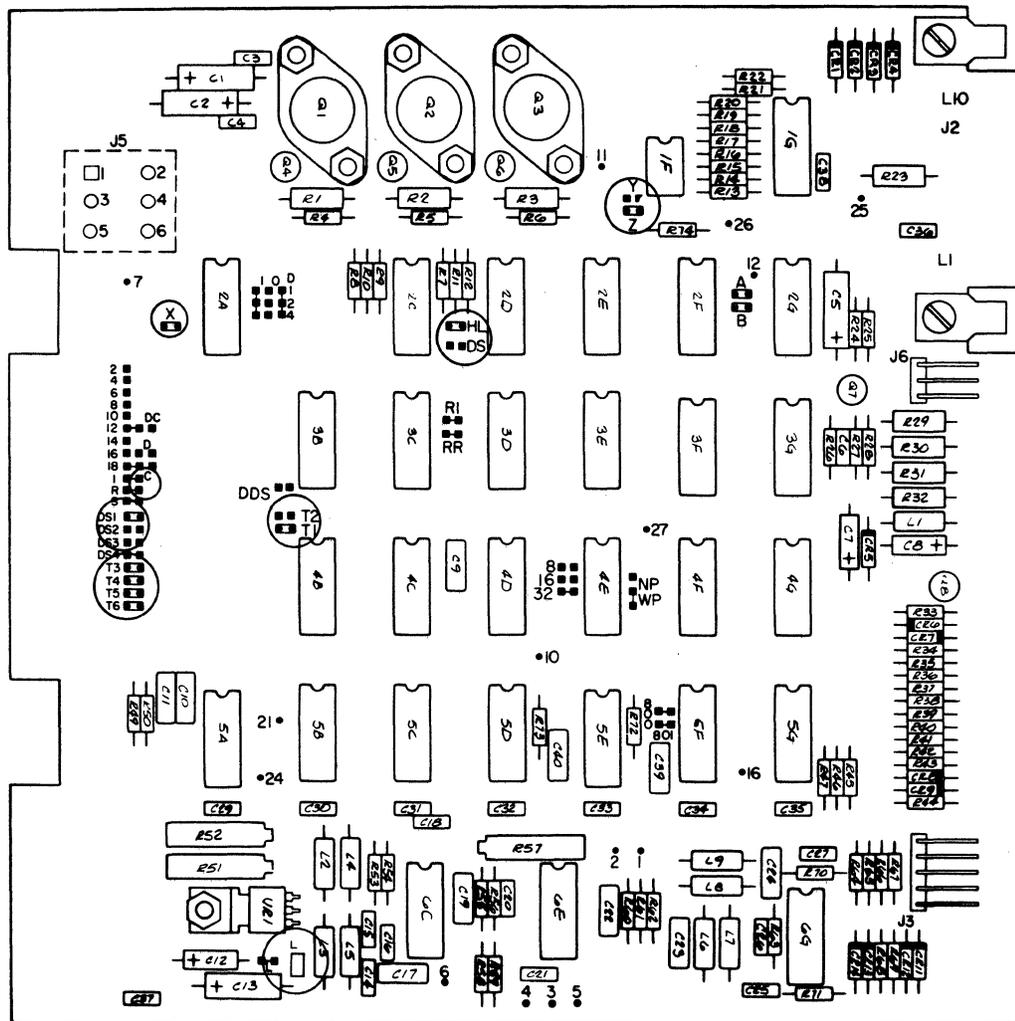
# Appendix A: Configuring the Shugart Associates SA 800 Disk Drive

## Note

While the physical layout of the board supplied with the drives in your system may vary from the diagram shown, the electrical operation and the information given in the jumper configuration table is accurate.

Be sure to disconnect AC power and all cables leading to the Shugart Associates SA800 before configuring the controller card.

The controller card of the SA800 is normally located on the bottom of this single sided drive. The card is shown in figure A-1. Jumpers and pins requiring reconfiguration are circled.



Jumpers and pins requiring reconfiguration are circled.

Figure A-1. The Controller Card of the Shugart Associates SA800 Disk Drive

## A-2

Table A-1 lists jumpers and pins of the SA800 controller card, and indicates their configurations—both as shipped by Shugart Associates and as required for use with the DSD 4140.

**Table A-1.** Configuring the Controller Card of the Shugart Associates SA800 Disk Drive

Jumper or Pin	Description	Configuration As Shipped		Configuration As Required Drive 0		Configuration As Required Drive 1	
		Open	Closed	Open	Closed	Open	Closed
A,B	Radial Head Load		X		X		X
C	Alternate Input—Head Load	X			X		X
D	Alternate Input—In Use	X		X		X	
D1,D2,D4, DDS	Decode Drive Select Option	X		X		X	
DC	Alternate Output—Disk Change	X		X		X	
DS	Stepper Power from Drive Select	X			X		X
DS1	Drive Select Input Pin		X		X	X	
DS2	Drive Select Input Pin	X		X			X
DS3,DS4	Drive Select Input Pins	X		X		X	
HL	Stepper Power from Head Load		X	X		X	
L	Negative Voltage Supply	- 5	- 15	Configure for voltage available			
NP	Allow Write when Write Protected	X		X		X	
R,I,S	Ready, Index, Sector Alternate Output Pads		X		X		X
RI	Radial Index and Sector		X		X		X
RR	Radial Ready		X		X		X
T1	Terminator for Drive Select		X	X			X
T2	Spare Terminator for Radial Head Load	X			X		X
T3,T4,T5,T6	Terminations for Multiplexed Inputs		X	X			X
WP	Inhibit Write when Write Protected		X		X		X
X	Radial Head Load		X	X		X	
Y	In Use from Head Load	X			X		X
Z	In Use from Drive Select		X	X		X	
2,4,6,8,10, 12,14,16,18	Alternate I/O Pins	X		X		X	

Open = No Jumper or Plug Installed

Closed = Jumper or Plug Installed

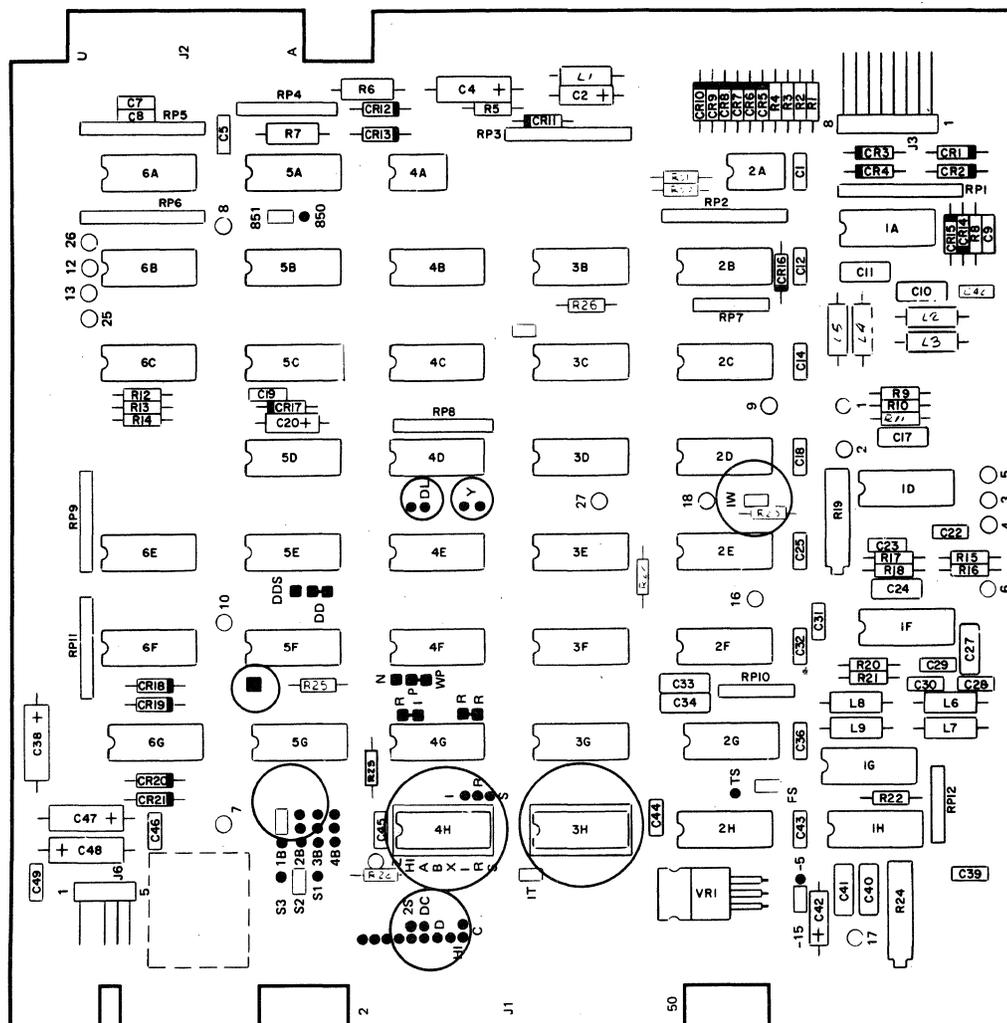
# Appendix B: Configuring the Shugart Associates SA850 Disk Drive

## Note

While the physical layout of the board supplied with drives in your system may vary from the diagram shown, the electrical operation and the information given in the jumper configuration table is accurate.

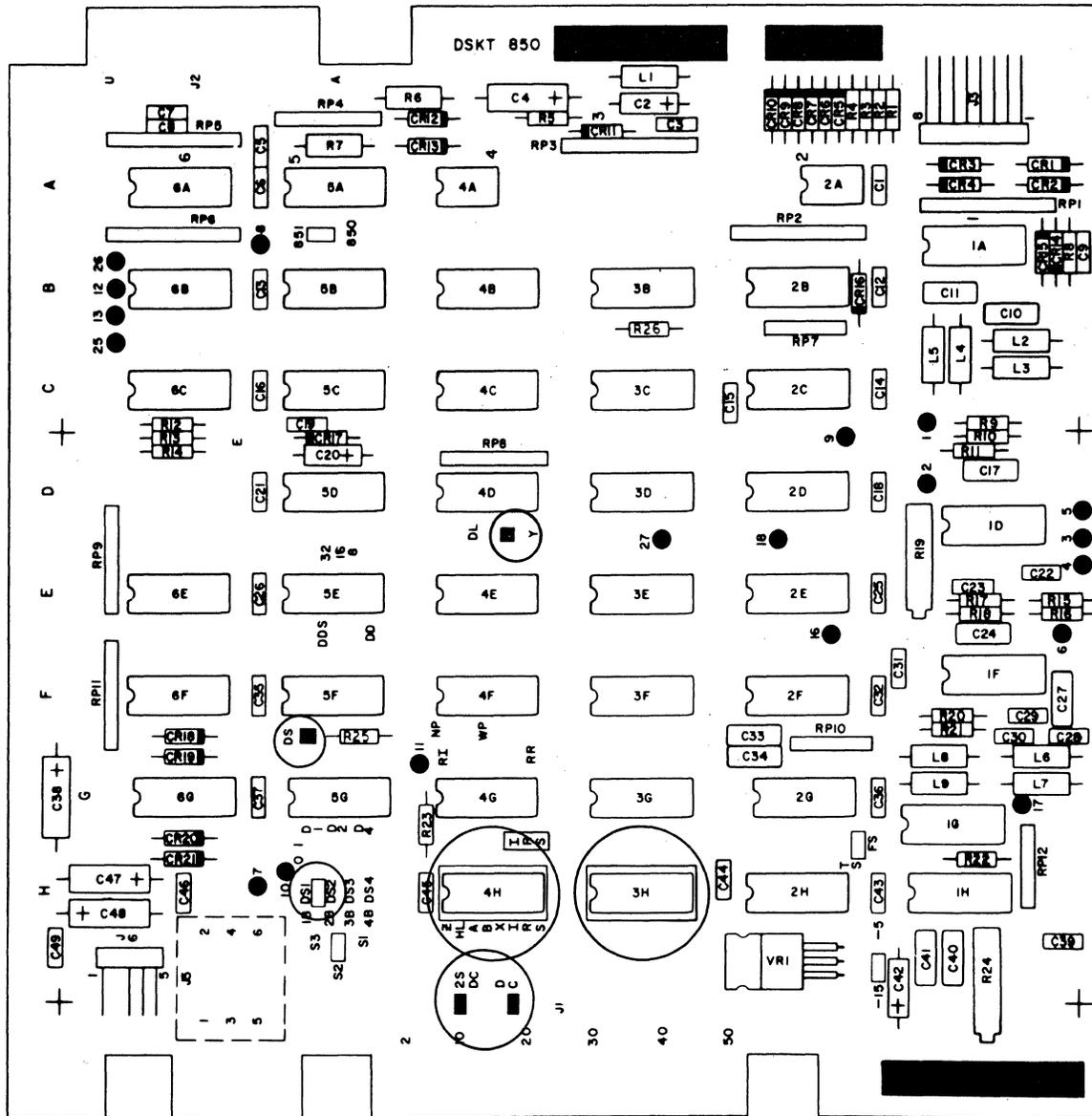
Be sure to disconnect AC power and all cables leading to the Shugart Associates SA850 before configuring the controller card.

The controller card of the SA850 is normally located on the bottom of this double sided drive. Either of two controller cards may be used. These cards are shown in figure B-1 and figure B-2. The programmable shunt, and jumpers and pins requiring reconfiguration, are circled.



Jumpers and pins requiring reconfiguration are circled.

**Figure B-1.** The Controller Card of the Shugart Associates SA850 Disk Drive (Part Number 25150/25151)

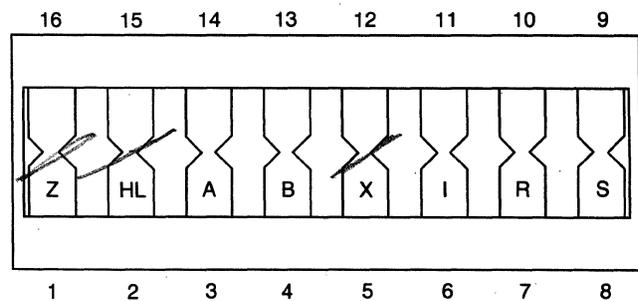


Jumpers and pins requiring reconfiguration are circled.

**Figure B-2.** The Alternate Controller Card of the Shugart Associates SA850 Disk Drive (Part Number 25067/25068)

Table B-1 lists the jumpers and pins of the SA850 controller cards, and indicates their configurations—both as shipped by Shugart Associates and as required for use with the DSD 4140.

Shugart Associates provides a 16-pin programmable shunt at card location 4H for the eight most commonly selected options. This shunt is shown in figure B-3. It is shipped with all positions closed (unbroken). Positions HL, X, and Z must be broken for use with the DSD 4140.



**Figure B-3.** Shugart Associates' 16-Pin Programmable Shunt

**Table B-1.** Configuring the Controller Card of the Shugart Associates SA850 Disk Drive

Jumper or Pin	Description	Configuration As Shipped		Configuration As Required Drive 0		Configuration As Required Drive 1	
		Open	Closed	Open	Closed	Open	Closed
A,B (Shunt 4H)	Radial Head Load		X		X		X
C	Alternate Input—Head Load	X			X		X
D	Alternate Input—In Use	X		X		X	
D1,D2,D4	Decode Drive Select Option	X		X		X	
DDS							
DC	Disk Change Option	X		X		X	
DD	Standard Drive Select Enable		X		X		X
DL	Door Lock Latch Option		X	X		X	
DS	Stepper Power from Drive Select	X			X		X
DS1	Drive Select Input Pin		X		X	X	
DS2	Drive Select Input Pin	X		X			X
DS3,DS4	Drive Select Input Pins	X		X		X	
<sup>2</sup> F	Read Post Compensate	X			X		X
<sup>1</sup> HI	Head Load or In Use to In Use Circuit	X		X		X	
<sup>1</sup> HL (Shunt 4H)	Stepper Power from Head Load		X	X		X	
<sup>1</sup> HLL	Head Load Latch	X		X		X	
I (Shunt 4H)	Index Output		X		X		X
IT	In Use Terminator		X		X		X
<sup>1</sup> IW	Write Current Switch		X	X		X	
<sup>2</sup> M	Write Current Level	X		X		X	
NP	Allow Write when Write Protected	X		X		X	
R (Shunt 4H)	Option Shunt for Ready Output		X		X		X
RI	Radial Index and Sector		X		X		X
<sup>1</sup> RM	Ready Modified	X		X		X	
RR	Radial Ready		X		X		X
<sup>1</sup> RS	Ready Standard		X		X		X
S (Shunt 4H)	Sector Output		X		X		X
S1	Side Select Option using Direction Select	X		X		X	
S2	Standard Side Select Input		X		X		X
S3	Side Select Option using Drive Select	X		X		X	
TS,FS	True/False Data Separation	True	False	True	False	True	False
WP	Inhibit Write when Write Protected		X		X		X
X (Shunt 4H)	Radial Head Load		X	X		X	
Y	In Use from Head Load	X			X		X
Z (Shunt 4H)	In Use from Drive Select		X	X		X	
8,16	Sectors	X		X		X	
32	Sectors		X		X		X
<sup>1</sup> B, <sup>2</sup> B, <sup>3</sup> B, <sup>4</sup> B	Side Select Option using Drive Select	X		X		X	
3H	Resistor Pack Termination for Multiplexed Inputs		X	X			X
2S	Two Sided Status Output	X			X		X
850/851	Hard/Soft Sector Option Enable	851	850	851	850	851	850
-15, -5	Negative Voltage Supply	-5	-15	Configure for voltage available			

<sup>1</sup>HI, HLL, IT, IW, RM, and RS are found on the controller card (part number 25150/25151) and later assemblies only.

Open = No Jumper or Plug Installed

Closed = Jumper or Plug Installed

<sup>2</sup>F and M Jumpers are found on 25189 and later assemblies.

F Jumper changed to AF-NF on assemblies 25201 and later.

Install on NF position on both drives.

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# Appendix C: FLPEXR Users Manual

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INTRODUCTION  
PROGRAM LOADING  
PROGRAM EXIT  
PROGRAM COMMANDS  
PROGRAM INPUT/OUTPUT  
PROGRAM STATUS AND ERROR DISPLAYS  
DETAILED DESCRIPTION OF COMMANDS

- Comprehensive Tests
- Individual Tests
- Media Modification
- Program Control Values
- Program Status
- Data Utilities

## INTRODUCTION

All DSD flexible disk systems with an LSI-11 or PDP-11 interface board are shipped with a diskette containing an interactive diagnostic program called FLPEXR. The manual explains the operation of this comprehensive set of tests and utility programs. This manual assumes the user is familiar with floppy diskette operations and terminology.

FLPEXR supports the full product line of floppy disk drive products and multiple drive systems with 1 through 4 drives per system. It is a standalone program, capable of being bootstrapped into the processor. It performs auto configuration of certain control parameters, determining both disk and CPU characteristics. It supports both hard copy and video display terminals with full x-on, x-off output control. In order to facilitate unattended testing, terminal output is also retained in a circular buffer autoconfigured to the full

available memory; commands are also provided to display and reset the circular buffer. Commands are also provided for diskette formatting, examination, duplication, and comparison. Test commands fully exercise system capabilities with operational parameters being user selectable through commands. The acceptance test and verify commands are suitable for both incoming quality control checks and system exercise/burn-in.

## PROGRAM LOADING

FLPEXR requires a standard console device, an LSI-11 or PDP-11 computer and at least 12K words of memory. Loading FLPEXR can be accomplished by two methods. One method is to bootstrap the diagnostic diskette. This loads FLPEXR into memory automatically. The other method requires an RT-11 operating system. The FLPEXR diagnostic diskette has an RT-11 compatible directory and file space. The files on the diagnostic diskette can be accessed using standard RT-11 procedures. For example, FLPEXR can be run from an RT-11 system by typing.

```
RU DEV: FLPEXR <CR>
```

where <DEV:> might be DX0:, DX1:, DY0:, DY1: as appropriate.

On a system running other operating systems (e.g., RSX11M, IAS, RSTS, etc.), the distribution diskette must be bootstrapped into memory.

Since both bootstrap and diagnostic programs handle RX01 and RX02 protocols, FLPEXR diagnostic diskette may be used with any DEC compatible disk system.

Once the FLPEXR diagnostic program has been loaded into memory, the diagnostic diskette may be used with any DEC compatible disk system.

Once the FLPEXR diagnostic program has been loaded into memory, the diagnostic diskette should be removed from the drive so it is not erased.

Two high quality, write-enabled formatted diskettes of the same type (density and number of sides) should be installed in the FLPEXR drives before proceeding with any of the tests.

After FLPEXR is loaded into memory, a brief description is displayed on the terminal which includes a memory map, preliminary usage instructions, and a prompt for selection of device type.

The memory map indicates the ranges of the address space which responds with SSYNC (or BRPLY) when accessed by the host computer. The figure below shows the text initially output:

```
<Memory map>
Remove distribution diskette.
DSD floppy disk diagnostic with format capability.
Type 'V' to do verify/acceptance test on two drives.
  This will do a set media and short verify.
  Then go into a regular acceptance test.
Type 'H' for a list of valid commands.
Type 'FO' to format a diskette.
CTRL-C returns to mode.
CTRL-R aborts function and returns to mode.
All numeric inputs/outputs are in octal.
Insert test diskettes (both must be of same density).
Enter device type (0 to 7) or 'H' for list of types.
```

The device type specification is used by FLPEXR to set up internal control values that tailor the program's operation to specific DSD product capabilities. An input of 0 will select a default value that is applicable for all products. The device flag (which is the major control value set by the device type specification) can be modified during program operation by the 'SET DEVICE' command. An 'H' input in response to the device type prompt will output the list of types as shown below:

Type	Device
0	Default
1	110
2	210
3	430
4	440
5	470
6	480
7	880

Which type of device? (0 to 7):

After the device type is selected, FLPEXR will output the device flag being used, as shown below.

Device flag being used is: XXXX  
Use set device command to modify flag

FLPEXR then outputs the name and version number of the program.

DSD FLPEXR V2A

FLPEXR types "<CRLF> #" when starting, and the program then attempts an INIT (initialize) instruction. When the INIT cycle is successful, the program types the prompt word: "DD COMMAND:" or "COMMAND:". This prompt string allows the operator to input a command. The "DD" indicates that the program is accessing double density diskettes. A list of all the available commands may be obtained by typing an 'H' (HELP).

### PROGRAM EXIT

If FLPEXR was loaded via the bootstrap, the operating system must be rebooted.

If FLPEXR was loaded via the RT-11 operating system, direct return to the operating system may be possible. A control input of 'CTRL C' will cause FLPEXR to output "EXIT TO RT-11?". A 'Y' response will cause the return to the RT-11 monitor. Exit to the monitor may not function if:

1. There is insufficient memory available.
2. The system device is not located at 177170.
3. The system device or diskette is not available.

If the direct monitor exit is not possible, the operating system must be rebooted.

### PROGRAM COMMANDS

Legal responses to "COMMAND:" are listed in Table 1, grouped by class of command. Only the characters enclosed in parenthesis need to be typed. The parenthesis should NOT be typed. When the typed string is recognized, the terminal "BELL" will sound at which time <CR> should be typed. The program will fill in the remaining characters and then proceed to execute the function.

FLPEXR also recognizes various control inputs. Table 2 lists the control input and the associated action. This input can be performed at any time, even while a test is in progress.

**Table 1. FLPEXR Commands**

Command	Description
<b>Comprehensive Tests</b>	
• (V)ERIFY	General Exerciser
• (SH)ORT VERIFY	Short Exerciser
<b>Individual Tests</b>	
• (FI)LL EMPTY	Fill/Empty Buffer Test
• (SEQW)/R	Sequential Write/Read Test
• (SEQ)READ	Sequential Read
• (RA)NDOM R/W	Random Read/Write
• (REA)D RANDOM	Read Random
• (SC)AN	Scan
• (SEE)K RANGE	Seek Range
<b>Media Modification</b>	
• (SET M)EDIA DENSITY	Set Media Density
• (FO)RMAT	Format Diskette
<b>Program Control Values</b>	
• (SET U)NIT	Set Unit
• (SET T)RACK	Set Track Limits
• (SEC)TOR INCREMENT	Specify Sector Inteleave
• (I)NTERRUPT	Set Interrupt Status
• (DE)NSITY LOCKUP	Lock Density to Current Density
• (SET D)EVICE	Set Device
• (H)ELP	Output List of Commands
<b>Program Status</b>	
• (M)AP ADDRESS	Memory and Device Map
• (ST)ATUS	Display Status Information
• (RES)ET STATUS	Change Status
• (SA)VE STATUS	Save Status on Diskette
• (DUMP C)IR BUFFER	Display Circular Output Buffer
• (REC)OVER STATUS	Retrieve
<b>Data Utilities</b>	
• (DUP)LICATE	Duplicate
• (CO)MPARE	Compare by Sector
• (DUMP O)CTAL	Data Dump in Octal Format
• (DUMP B)YTE	Data Dump in Byte Format
• (DUMP A)SCII	Data Dump in ASCII Format

FLPEXR has several restart addresses that can be used to restart the program if necessary. They are:

1104	—Normal start-restart address
1110	—Start address from monitor call
1114	—Start at command prompt, without performing INIT on device
1100	—Return address from ODT after CTRL D dispatch

## PROGRAM INPUT/OUTPUT

All data input and output is in octal format unless otherwise specified.

The 'DEL' or 'RUB' key may be used during input to remove the previously input character. On some output devices, the cursor will be backspaced one position for each 'DEL'; on other devices, a '/' will be output followed by the characters being deleted. Normal input may be resumed at any time.

**Table 2. Control Inputs**

Input	Meaning	Notes
CTRL R	Aborts current test, restarts at command	
CTRL S	Freezes terminal output until another character is typed	
CTRL O	Throws away all output until another character is typed	
CTRL P	Throws away all output except errors until another character is typed	
CTRL Q	Causes output to resume	1
<LF>	Types current track and sector and status counts	4
CTRL C	Asks 'EXIT TO RT-11?' if RT-11 monitor is available. Type Y to exit. If RT-11 monitor not available, action is similar to CTRL R. If in ODT, may return control to program	
CTRL D	Causes control transfer to ODT	2,3
CTRL T	Causes control transfer to ODT with stack trace	2,3
CTRL L	Toggles extended error printout formats	
RUB or DEL	Deletes previous character in input string	

### Notes:

1. Actually, any character being input will perform this function.
2. Exit to monitor and control transfer to debug may not function if there is not enough memory available or if booted from a device other than 177170.
3. Control transfer from ODT back into FLPEXR is accomplished by 'CTRL C'. If this does not work, the program may be restarted by XXXX'G, where XXXX is the appropriate restart address (see below).
4. This command always functions; however, for some tests, the track and sector information should be disregarded (e.g., fill-empty test).

The program fully supports X-on, X-off protocol (i.e., CTRL S, CTRL O and CTRL X) to enable output to be suspended and restarted.

Diskette data is accessed via a combined address unit #, side #, track #, and sector #. Various commands are provided to specify the limits of the address components to be used for tests. These values are set to default values when the device type is selected following initial program load.

Input is typically terminated by either a <CR> or <SP>. Validation input (e.g., Y or N) typically does not require termination.

## PROGRAM STATUS AND ERROR DISPLAYS

FLPEXR types out error and status information under a wide variety of circumstances. All printouts to the console terminal are sent to a circular buffer in memory as well. The buffer size is determined by available memory. The circular buffer is useful if a hard copy console terminal is not being used and error printouts no longer on the face of the CRT screen need to be examined. The display output buffer (DUMP C) function is used to examine messages in the circular buffer. The status

## C-4

variables that might appear on the console terminal are explained below:

DEV XXX	Is printed only when running multiple controllers. XXX are the last 3 octal digits of the RXCS address for the system whose error/status data is being displayed.
UN U	U represents the logical drive unit number for which the error/status data is being displayed.
TRACK = TK	Track address at time of status/error printout.
SECTOR = SC	Sector address at the time of status/error printout.
RXCS = XY	Shows the contents of the command and status register.
RXDB = XY	Shows the contents of the data buffer register. It should normally be 0 or 214 octal following an INIT.
INTERRUPT ERROR: X	If X is less than 0, this indicates that an expected interrupt failed to occur. If X is greater than 0, this indicates that more than one interrupt occurred.
#BAD = XX	This variable indicates the number of status errors detected.
#RD/WRT = XX	This variable indicates the number of sectors that were transferred error-free.
#XFERS = XX	This variable indicates the number of fill/empty command cycles that were completed successfully.
B-DATA = XX	Number of data errors where a byte or word of data did not compare with the value the program was expecting. This is different than a CRC error, which would be

DEFSTT = DEFINITIVE  
ERROR STATUS

SIDE 1

counted as bad status. There can be up to 128 data errors in 1 sector.

Error code associated with the error currently being displayed. The meaning of each error code can be found in the unit users manual.

Indicates an error has occurred on side 1 (second side of a diskette). Error messages not specifying side 1 relate to side 0. Single sided products display only side 0.

### EXPANDED ERROR DISPLAYS

If in RX02 compatible mode, and CTRL L has been typed to select expanded error printout mode, the following additional status variables appear in the error printout:

D0@TK = TK	Track address of drive 0
D1@TK = TK	Track address of drive 1
CURTK = TK	Track address of the current selected logical unit
CSCT = SC	Sector address of the current selected logical unit
DSTT = XX	Drive status byte—each of the bits in this status byte is used to encode some information about one or both of the flexible disk drives and/or the media presently installed. The bits get decoded into words which are displayed with the other status. These words are explained below.
US0	Drive 0 is currently selected
US1	Drive 1 is currently selected
DN0L	Drive 0 currently contains a single density diskette
DN0H	Drive 0 currently contains a double density diskette
DN1L	Drive 1 currently contains a single density diskette
DN1H	Drive 1 currently contains a double density diskette
HDUP	Head on currently selected unit is up (unloaded)
HDL D	Head on currently selected unit is loaded

TRKRD = TK Track address read from a sector header. This number would only be useful following a DEFSTT = 150 error.

DEF - RXDB = XX Contents of the RXDB following a definitive error status command.

## ERROR ACTIVITY CODES

A number of 2-character activity codes are displayed in the context of error printouts. The codes listed below indicate what the diagnostic was doing when the error was detected.

Activity	Code	Meaning
FILL-EMPTY	FB	Problem loading sector buffer
FILL-EMPTY	E1, E2	Sector buffer data did not check during an empty buffer operation
FILL-EMPTY	FL, EL	DMA fill or empty error to low mem. buffer
FILL-EMPTY	FD, ED	DMA fill or empty error to cir. mem. buffer
FILL-EMPTY	FH, EH	DMA fill or empty error to high mem. buffer
SEQ. WRITE	SW, CW	Problem during sequential write
SEQRD	SR	Problem during sequential read
RANDOM	RW, RC, RR	Random (write, check, read) activity when error was detected
ANY READ RETRY	XE	Empty buffer check before retrying read
DUP UTILITY	IN	Error reading the source diskette
DUP UTILITY	CW	Error checking what was just written
DELETED DATA	DW, DR	Deleted data flag failure

## EXAMPLES OF ERROR OUTPUT

The following printouts are examples of what the FLPEXR diagnostic program outputs to the console under varying circumstances.

EXAMPLE 1: Operator requests status of currently selected drive during a test by typing LF.

```
UN 0 TRACK=0 SECTOR=4
BAD=0 RD/WRT=0 XFERS=0
B-DATA=0
```

EXAMPLE 2: Operator requests status of both drives using the "STATUS"

```
UN 0 BAD=0 RD/WRT=0
XFERS=0 B-DATA=0
UN 1 BAD=0 RD/WRT=0
XFERS=0 B-DATA=0
```

EXAMPLE 3: Disk was write protected.

```
Error detected on drive #1 at track
#1, sector #1
error code was 100
#BAD=1 #RD/WRT=2002
#XFERS=0 B-DATA=0
```

EXAMPLE 4: Read on drive with no disk installed.

```
Error detected on drive #0 at track
#1, sector #11
error code was 110
#BAD=3 #RD/WRT=2049
XFERS=0 B-DATA=0
```

## COMPREHENSIVE TEST COMMANDS

- VERIFY—(V)ERIFY

The VERIFY test does one pass of a SHORT ACCEPTANCE TEST, on the first 7 tracks and then resets the limit variables back to the normal default values. It then induces an automatic "CTRL P" to inhibit all but error printout and initiates the long verify test. This test will run until terminated by a "CTRL R."

### EXAMPLE

```
#DD COMMAND : VERIFY
SCRATCH DISKS INSTALLED? (Y, N) : Y
SET DENSITY TO (S, D) : S
ARE YOU SURE? (Y, N) : Y
VERIFY TEST NOW STARTING
SCAN CRC CHECKED WRITING READING
INTERRUPTS ENABLED
WRITING READING
```

- SHORT VERIFY—(SH)ORT VERIFY

This interactive program changes the track range used by the VERIFY TEST so that only the first 9 tracks of each selected drive are tested. This test will run until terminated by a CTRL R.

## INDIVIDUAL TESTS

- **SCAN—(SC)AN**

The SCAN test reads all sectors on all selected drives sequentially and checks for CRC errors. It also determines media density. No direct data checking takes place in this test. Only status is checked. After all units are scanned once, the "COMMAND:" prompt is displayed on the console.

### EXAMPLE

```
#COMMAND: SCAN
CRC CHECKED
#COMMAND:
```

- **SEEK RANGE—(SE)EK RANGE**

The SEEK RANGE function is a versatile drive test that performs all possible seeks within the operator specified track and seek length boundaries. It specifies a read on the first sector that can be read on the destination track after compensating for step and head load times. Thus it is a worst case test of the drive stepper motor and head setting. Status information will be continuously displayed during execution of this test indicating the seek length currently being used ( x ) and direction of seek ( [ ^ ] = outward). An '!' will be output at the conclusion of each pass. This test will run continuously until terminated by a CTRL R.

### EXAMPLE

```
#DD COMMAND SEEK RANGE
NOTE: ALL TIMES ARE GIVEN IN 'OCTAL'
      TENTHS OF MSEC
SEEK LENGTH ( 1 ): 3 THROUGH ( 27 )
: 7
850 SEEK TIME ( 36 ):
850 SECTOR OFFSET: ( 4 ):
COVERING TRACKS ( 1 ): THROUGH
( 114 ): [ 3 ][ ^ ][ 4 ][ ^ ][ 5 ][ 6 ]
[ ^ ][ 7 ][ ^ ] ! [ 3 ][ ^ ][ 4 ][ ^ ]...
```

- **FILL-EMPTY—(FI)LL EMPTY**

The FILL-EMPTY test checks the FILL BUFFER and EMPTY BUFFER controller commands. If the controller under test is configured in the RX01 compatible mode, then the test involves only programmed I/O. If the controller is configured as an RX02, the controller does FILL/EMPTY into three different buffers so as to verify proper operation of all possible address bits. FILL/EMPTY are done in both densities covering all possible word counts. Since this test does not manipulate the drives, the system will oper-

ate in silence. This test continues until the operator types a 'CTRL R'.

- **SEQUENTIAL WRITE/READ—(SEQW)/R**

The SEQUENTIAL WRITE / READ test writes pseudo-random data sequentially on all selected drives. The test then reads all the data and checks it. The message "WRITING" is typed on the console terminal when the test first starts writing. The message "READING" is typed when the test starts reading. This test continues until the operator types "CTRL R". It also performs a set media density operation if the diskette is not of the expected density.

---

### Note

---

*The following three tests require a SEQUENTIAL WRITE pass be done first in order to initialize the pseudo-random data. Data compare errors are reported if this is not done. FLPEXR prompts 'IS DISKETTE SEQUENTIAL WRITTEN? (Y, N)' at the start of each test. A 'Y' response will initiate the test; a 'N' response will return to the command prompt.*

---

- **SEQUENTIAL READ—(SEQ) READ**

The SEQUENTIAL READ test reads the data on all selected drives sequentially and compares the data pattern against what was written. The program types "READING" at the beginning of each pass. This test continues until the operator types "CTRL R".

- **RANDOM READ/WRITE—(RA)NDOM R/W**

The RANDOM READ/WRITE test selects a random sector of a selected drive, then reads or writes it. It checks data when appropriate. This test continues until the operator types "CTRL R".

- **READ RANDOM—(REA)D RANDOM**

The READ RANDOM test reads randomly selected sectors. Data is checked following each read. This test continues until the operator types "CTRL R".

## MEDIA MODIFICATION COMMANDS

- **REFORMAT—(FO)RMAT**

This function is used to rewrite diskette headers, as well as all the other data on a particular diskette. It also prompts for confirmation, unit, and sequential or interleaved format. Either the entire diskette (Formats 2 through 8) or just a portion of the diskette (Format 0 through 1) may be formatted. If a partial format is selected, the track range to be formatted is specified by the set track command. The sides to be formatted can also be specified.

## EXAMPLE (for 480)

```

#COMMAND: FORMAT
SEQUENTIAL SECTOR FORMAT?
(Y OR N) : Y

Density                Type  Supported
                        Type  On
DEC SD (IBM SD 2-128)  0    480
                        440
                        210
                        110
DEC DD                  1    480
                        440
DEC SD (ALL OF DISK)   2    880, 480,
                        470, 430,
                        4140
DEC DD (ALL OF DISK)   3    880, 480,
                        470, 430,
                        4140
IBM SD (92-256)        4    480
IBM SD (2-512)         5    480
IBM DD (2D-256)        6    480
IBM DD (2D-512)        7    480
IBM DD (2D-1024)       8    480
DESIRED SELECTION? (0 to 8) : 4
DO YOU WISH TO DO SIDE #0? (Y OR N) : Y
DO YOU WISH TO DO SIDE #1? (Y OR N) : Y
ARE YOU SURE? (Y OR N) : Y
# COMMAND:

```

FLPEXR is designed to support the full range of formats available throughout the product line. However, not all units are capable of writing all formats. If an inappropriate format is selected, an error message will be output. If the unit is not capable of IBM format modes, they will not be output in the selection menu.

Typically, the operator should format new diskettes by Formats 2 for single density diskettes and 3 for double density diskettes.

- SET MEDIA DENSITY (SET M)EDIA DENSITY

This function enables the operator to initialize a diskette to single density or double density format. The function prompts for function confirmation, unit, and desired density. To select single density, respond with an "S". Type "D" to select double density.

The SET MEDIA DENSITY command is used to implement this function, therefore, no headers are rewritten. The prompt is issued when this function is complete. This function causes any status saved on track 0, sector 1 to be erased.

#COMMAND: SET MEDIA DENSITY

```

DO A SET MEDIA ON ALL DEVICES? (Y OR N) :
N
UNIT: 1: SET DENSITY TO (S,D) : S
ARE YOU SURE? (Y, N) : Y

```

## PROGRAM CONTROL VALUE COMMANDS

- SET UNIT—(SET U)NIT

This command enables the operator to specify which drives are to be accessed by the various test functions. The default drives are units 0 and 1. The currently selected units are printed first. It prompts with "UNIT:", expecting a number between 0 and 3, inclusive. Unit numbers are accepted as long as they are valid. When a non-number is typed to a unit request, the units currently selected are prompted and FLPEXR returns to command prompt.

---

Note

- 1 If using a two drive system, then selection of units 2 and 3 is invalid and may cause an error.
  - 2 If units are selected by "SET DEVICE", they will override "SET UNIT". See the "SET DEVICE" command for more information.
-

EXAMPLE

```
"SET DEVICE" overriding "SET UNIT"
#DD COMMAND: SET UNIT
— LOADED BY SET DEVICE FLAGS
UNITS SELECTED 1
```

• SET TRACK—(SET T)RACK

This command enables the operator to specify lower and upper track limits for all other test functions. The default lower track limit is track 1 and upper track limit is track 76. The "COMMAND" prompt is issued after the entry of valid new limits. The lower limit must not exceed the upper limit.

EXAMPLE

```
"SET TRACK" used to set track range from
track 1 to track 10
#COMMAND: SET TRACK
FROM 1: THROUGH 14: 10
```

• SECTOR INCREMENT—(SEC)TOR INCREMENT

This command enables the operator to specify the sector increment value. The number is added to the present sector address to determine the next sector address in the functions that read multiple sectors on a single track. If this number were 1 and the diskette did not have an interleaved format, an entire revolution would be required to read each sector. On LSI-11 processors, the default increment value is 3. On PDP-11 processors, the default increment value is 2. The "MODE:" prompt is issued after the new value has been entered.

```
#DD COMMAND: SECTOR INCREMENT
= 3 - 2
#DD COMMAND: SECTOR INCREMENT
= 2 - 3
```

• SET INTERRUPT STATUS—(I)NTERRUPT

The SET INTERRUPT STATUS command enables the operator to test the disk system with interrupts either enabled or disabled. If interrupts are enabled, the FLPEXR ensures that an interrupt occurs whenever it is appropriate. The operator enters a D to disable interrupts and an E to enable interrupts. This function is also used in ACCEPTANCE and VERIFY to set "Interrupts Enabled" and "Interrupts Disabled".

EXAMPLE

```
#DD COMMAND: INTERRUPT
CURRENTLY INTERRUPTS ARE DISABLED
(D)
INPUT NEW STATUS (ENABLE OR
DISABLE)
(E OR D) : D
```

• DENSITY LOCKUP—(DE)NSITY LOCKUP

The "DENSITY LOCKUP" function allows the operator to lock the current disk density during the various tests. This feature is useful when testing for a problem that occurs in one density only, or when the disk density cannot be changed by a SET MEDIA DENSITY function.

EXAMPLE

```
#DD COMMAND: DENSITY LOCKUP
DENSITY IS CURRENTLY UNLOCKED
DO YOU WISH TO LOCK THE DENSITY (Y
OR N): Y
#DD COMMAND:
```

• SET DEVICE—(SET D)EVICE

This function facilitates testing controllers that are not configured at the standard device I/O address and interrupt vector. It also enables the FLPEXR test program to simultaneously exercise multiple controllers. The function protocol asks you for device address, interrupt vector, and flag word. If a space is typed, the program steps past that field, leaving it intact. Return to "COMMAND:" is by input of a "CR" (carriage return) in response to "RXCS:". The flag word is organized as follows:

15	14	13	12	11	10	09	08
				DMA	D85	DBS	DDN
07	06	05	04	03	02	01	00
	US3	US2	US1	US0			

When set to a 1, the bit labeled:

- DMA indicates the device should be tested as an RX02.
  - D85 indicates 850 timing should be used (else 800 timing).
  - DBS indicates that double sided operation is enabled.
  - DDN indicates double density operation is enabled.
  - US3 indicates this device contains a drive unit 3.
  - US2 indicates this device contains a drive unit 2.
  - US1 indicates this device contains a drive unit 1.
  - US0 indicates this device contains a drive unit 0.
- US0, US1, US2, US3 do an implicit "SET UNIT" function when set. The normal flag variable for RX02 mode is 4400 (octal). The normal flag variable for RX01 is 0000 (octal). The normal flag for double sided RX02 operation is 7400 (octal).

## EXAMPLE SET DEVICE

```
#COMMAND: SET DEVICE
SET THE DEVICE FLAGS FOR EACH SYSTEM AS FOLLOWS:
4000: ENABLES DMA OPERATION IF AVAILABLE
2000: SETS 850 TIMING (ELSE 800)
1000: ENABLES DOUBLE SIDED OPERATION IF DOUBLE SIDED DRIVE AND DISK USED
400: ENABLE DENSITY SWITCHING IF RX02/440/480
20: ENABLE UNIT #1 ON CURRENT DEVICE
10: ENABLE UNIT #0 ON CURRENT DEVICE
RXCS @ 177170: INT @ 264 INTVEC = 264
FLAGS: 4400 6410
RXCS @ 0:
```

- HELP

The HELP command causes all the valid "MODE:" responses to be displayed on the console terminal. The "MODE:" prompt is typed when this function is complete.

## PROGRAM STATUS COMMANDS

- MAP ADDRESS—(M)AP ADDRESS

The MAP ADDRESS command causes a memory and device address map of the system to be displayed on the console terminal. This is the same map displayed when the FLPEXR program is first loaded. In addition, the interrupt vector address associated with each disk interface is displayed. The "COMMAND:" prompt is typed when this function is complete.

## EXAMPLE

```
#DD COMMAND: MAP ADDRESS
(0-157776)
(160100-160106)
(165000-165776)
(171000-171776)
(172300-172316)
(172340-172356)
(172520-172536)
(173000-173776)
(176700-176746)
(177170-177172)
(177510-177516)
(177546-177546)
(177560-177616)
(177640-177656)
(177776)
DEV: 177170 INT @ 264
```

## Note

*This example indicates that a device is installed at location 177170 with interrupt vector at location 264.*

- STATUS—(S)TATUS

The STATUS function causes all the current status information including hardware errors, data errors, and pass counts to be displayed on the console terminal. Displaying status information does not reset the status counts. The "COMMAND:" prompt is typed when this function is complete.

## EXAMPLE

```
#COMMAND: STATUS
UNIT #0 #BAD = 3 #RD/WRT = 2049
#XFERS = 0 B - DATA = 0 ST = 110 # = 3
```

- RESET STATUS—(R)ESET STATUS

The RESET STATUS function first displays all the available status counts. Next, the display will ask whether all of the status counts need resetting. A "Y" will cause all of the error, pass, etc. counts to be reset to zero. The "COMMAND:" prompt is output when this function is complete.

- SAVE STATUS—(S)AVE STATUS

The SAVE STATUS command causes all the status counts associated with a particular drive to be written on track 0, sector 1 of the diskette in that drive. Only the SET MEDIA DENSITY commands overwrite track 0, so the status data associated with each drive can be safely stored away. This function is used by the acceptance test so that it can survive a loss of main computer CPU memory without any loss of cumulative error data. The "COMMAND:" prompt is typed when this function is complete.

- RECOVER STATUS—(R)ECOVER STATUS

The RECOVER STATUS routine performs the opposite function performed by the SAVE STATUS function. The status data stored away on track 0, sector 1 of the diskette in each drive is transferred back from the diskette to the status/counter variables in memory. The "COMMAND:" prompt is displayed when this function is complete.

- DISPLAY CIRCULAR OUTPUT BUFFER—(D)UMP C)IR BUFFER

The DUMP C function is used to display the output buffer associated with all console terminal output. This function is useful on systems where the console terminal is CRT. Messages previously output can be re-examined on the console. The buffer can be cleared after it is displayed by this function.

**DATA UTILITIES COMMANDS**

---

*Note*

---

*The SECTOR INCREMENT function may be used to specify sector sequencing for the duplicate and compare commands. For the dump commands, a sector increment of 1 is always assumed.*

---

- **DUPLICATE—(DUPLICATE)**

The DUPLICATE command enables the operator to make a duplicate copy of a diskette. The function prompts for a source drive unit number and a destination drive unit number. For each possible sector address, the function performs a READ SOURCE SECTOR, WRITE DESTINATION SECTOR, READ DESTINATION SECTOR, and COMPARE DATA.

**EXAMPLE**

```
#DD COMMAND: DUPLICATE
SOURCE UNIT: 0
TO DESTINATION UNIT: 1
#DD COMMAND:
```

- **COMPARE—(COMPARE)**

The COMPARE command enables the operator to compare two diskettes starting at a specific address. The function prompts for: SOURCE UNIT, STARTING TRACK, STARTING SECTOR, NUMBER OF SECTORS, and DESTINATION UNIT. Any differences in data will be output.

**EXAMPLE**

```
#DD MODE: DUMP OCTAL
SOURCE UNIT: 0 TRACK: 0 SECTOR: 1 #
SECTORS: 2
[DDEN DRIVE #0 AT TRACK 0, SECTOR 1,
SIDE 0]
SC = 1
```

- **OCTAL DUMP BY SECTORS—(DUMP OCTAL)**

This command enables the operator to cause an octal dump of specified sectors to the console terminal. The function prompts for: UNIT, STARTING TRACK, STARTING SECTOR, SIDE, and NUMBER OF SECTORS.

```
0: 00037760000
20: 00000000
40: 00000000
60: 00000000
100: 00000000
120: 00000000
140: 00000000
160: 00000000
200: 00037220000
220: 00000000
240: 00000000
260: 00000000
300: 00000000
320: 00000000
340: 00000000
360: 00000000
[DDEN DRIVE #0 AT TRACK #0, SECTOR
#2 SIDE #0]
SC = 2
0: 00000000
20: 00000000
40: 00000000
60: 00000000
100: 00000000
120: 00000000
140: 00000000
160: 00000000
200: 00000000
220: 00000000
240: 00000000
260: 00000000
300: 00000000
320: 00000000
340: 00000000
360: 00000000
```

- **BYTE DUMP BY SECTORS—(DUMP BYTE)**

This command enables the operator to cause an octal dump of specified sectors to the console terminal. The function prompts for: UNIT, STARTING TRACK, STARTING SECTOR, SIDE, and NUMBER OF SECTORS.

- **ASCII DUMP BY SECTORS—(DUMP ASCII)**

This utility command enables the operator to cause an ASCII dump of specified sectors to the console terminal. The function prompts for: UNIT, STARTING TRACK, STARTING SECTOR, SIDE, and NUMBER OF SECTORS.

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# Appendix D: Creation and Use of a Double Sided Monitor Program

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## SINGLE SIDED OPERATION

Double sided disk drives, such as those in the DSD 470, will operate with single sided diskettes. Thus if desired, DSD double sided systems can provide true emulations of the DEC RX02.

## DOUBLE SIDED OPERATION

By activating double sided support in the DEC system monitor, the user may take full advantage of the extra capacity offered by double sided drives. Under double sided operation, bit 9 of the device COMMAND AND STATUS REGISTER (RXCS) is used to select diskette side 1 for reading or writing, and bit 1 of the ERROR AND STATUS REGISTER (RXES) is used to indicate "side 1 Ready".

The resulting RT-11 or RSX-11 monitor is fully DEC compatible. The operating system will function properly with DEC hardware (RX02) and all DEC utilities and applications programs. The procedure for implementing double sided support in the DEC RT-11 and RSX-11 system monitors is described below.

After double sided support has been installed in the monitor, the operating system will automatically check for the presence of double sided diskettes, and performs appropriate directory and housekeeping functions to make double or single sided operation fully software transparent. All system utilities (PIP, DUP, DIR, etc.) will function correctly with single or double sided diskettes.

For example, when a double sided diskette is initialized using "DUP" under RT-11, the monitor will recognize that the diskette is double sided. If the diskette is

double density, there will be 1962 free blocks. If the disk is single density and double sided, there will be 974 free blocks.

If the user inserts a single sided diskette into the system, the monitor and floppy controller will recognize that the diskette is single sided and function properly.

---

### Note

---

*Double sided diskettes will not function properly in a single sided drive such as those used in the DSD 430.*

---

## DOUBLE SIDED SUPPORT UNDER RT-11

Double sided support under RT-11 V3B may be "activated" by one of two methods. DSD supplies a software device handler which is equivalent to the DEC device handler with appropriate flags and conditionals enabled for doubled sided support. This handler may be assembled into the RT-11 DY monitor (FB or SJ) by following the system generation procedure as supported by DEC. Alternately, to save the effort required to perform a "sys gen", DSD supplies a command file which will automatically patch the RT-11 V3B monitor to activate the two sided features.

If the user elects to perform a sys gen, the DSD handler DYDSD.MAC (found on the DSD diagnostic diskette) must be renamed to DY.MAC and substituted for the MACRO-11 source file, DY.MAC provided by DEC. The DSD handler, containing double sided support may then be installed into the RT-11 monitor by following the procedure described in the RT-11 System Generation Manual supplied by DEC.

## DOUBLE SIDED SUPPORT UNDER RSX-11M

The DSD diagnostic diskette contains a file, RSX11.DOC, with instructions for creating an SLP (source language patch) to implement double sided support in the RSX-11M V3.2 monitor. The DEC RSX-11M release package provides instructions for installing SLP programs into the operating system.

DIR. SAV  
PIP. SAV  
DUP. SAV  
FORMAT. SAV  
TT. SYS  
EDIT. SAV  
DUMP. SAV

## THE DSD MONITOR PATCH PROGRAM FOR RT-11

The Monitor Patch Program takes a DYMNSJ or DYMNFBS monitor from the DEC RT-11 V3B system distribution and replaces the DY handler currently in the distribution monitor with a double sided DY handler. The new monitor has the same characteristics as the original monitor, such as batch support, 60 Hz line time clock, all handlers supported by the distribution monitor, and no error logging.

The monitor patch program would be used under the following conditions:

1. The distribution Rt-11 V3B monitor provided by DEC is sufficient for the user's normal applications except for not having double sided support.
2. The user does not wish to perform a System Generation.
3. The user has not changed the normal distribution monitor with customized patches, relating to the user's system.

If these conditions are not met, a System Generation may be required.

The DYMNSJ or DYMNFBS monitor may be generated from the first or second release of RT-11 V3B. The distribution DYMNSJ or DYMNFBS monitor that will be modified can be found on the distribution diskette shown below:

First DX KIT Release of RT-11 V3B	Disk Label No.	Dated
DYMNSJ. SYS	AS-5781B-BC	11 March 78
DYMNFBS. SYS	AS-5781B-BC	11 March 78
Second DX KIT Release of RT-11 V3B	Disk Label No.	Dated
DYMNSJ. SYS	AS-5783C-BC	27 March 79
DYMNFBS. SYS	AS-5783C-BC	27 March 79

or either DY KIT release may be used.

To use the DSD Monitor Patch Program, the following are required:

1. A minimal DY-bootable system diskette with the following files:  
SWAP.SYS  
DYMNSJ. SYS from the Rt-11  
DYMNFBS. SYS distribution diskette

---

### Note

---

- This diskette must have a minimum of 100 free blocks and may be either single or double density.
  - Be sure to copy the bootstrap onto the diskette using the COPY/BOOT command.
  - The monitors used on this system diskette will be patched and placed on another diskette.
  - Copy the files from the distribution disk. Don't use the originals.
- 

2. A blank/initialized (zeroed directory) diskette.
3. The DSD Diagnostic Diskette with the required DSD patch files.

The actual patch process is accomplished as follows:

1. Insert the system diskette into drive DY0 (drive 0).
2. Insert the DSD Diagnostic Diskette into drive DY1 (drive 1). Leave Diagnostic Disk write protected to insure no errors.
3. Boot the DY0 system diskette in drive 0.
4. Run the indirect command file PATSET.COM on DY1.

To run the indirect command file, type:

@DY1: PATSET

This indirect command file will copy the required patch program pieces onto the system diskette in drive 0 (DY0).

5. Remove the DSD Diagnostic Diskette from DY1 (drive 1).
6. Insert the blank/initialized diskette into DY1 (drive 1).
7. To create a DYMNSJ.SYS monitor with double sided support, type:

@DY0: PATSJ

To create a DYMNFBS.SYS monitor with double sided support, type:

@DY0: PATFB

These indirect files will create a new system monitor (DYMNSJ or DYMNFBS) on drive 1, then will copy the necessary support files from DY0 to DY1, and then will boot the system diskette in DY1. This diskette can then be modified as desired and used as the new master for double sided monitors.