USER GUIDE

DSD 880

Data Systems Design

DSD 880

DATA STORAGE SYSTEM

USER'S MANUAL

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PREFACE

This manual describes the features, specifications, and register usage of the DSD 880 Data Storage System.

Instructions for DSD 880 installation, operation, and elementary troubleshooting are included in this manual.

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Please note that DEC, LSI-11, LSI-11/2, LSI-11/23, PDP-11, RSX-11, RX02, RL01, and RL02 are registered trademarks of the Digital Equipment Corporation

SAFETY

Operating and maintenance personnel must at all times observe sound safety practices. Do not replace components, or attempt repairs to this equipment with the power turned on. Under certain conditions, dangerous potentials may exist when the power switch is in the off position, due to charges retained by capacitors. To avoid injury, always remove power before attempting repair procedures.

Data System Design, Inc. will accept no responsibility or liability for injury or damage sustained as a result of operation or maintenance of this equipment with the covers removed and power applied.

WARNING

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions manual, may cause interference to radio communications. As temporarily permitted by regulations, it has not been tested for compliance with the limits for Class A computing devices pursuant to the sub-part J or Part 15 of the FCC rules which are designed to provide reasonable protection against such interference. The operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

CAUTION

Do not operate the DSD 880 without first releasing the winchester drive spindle lock mechanism by removing the spindle lock screw and clamp which is accessible from the bottom of the chassis without removal of the cover. Do not rotate the spindle by hand. Moving the spindle in the wrong direction can cause media damage.

The settings of the option switches on the Interface Board should be checked prior to operation. The settings of those switches may change during shipping or unpacking.

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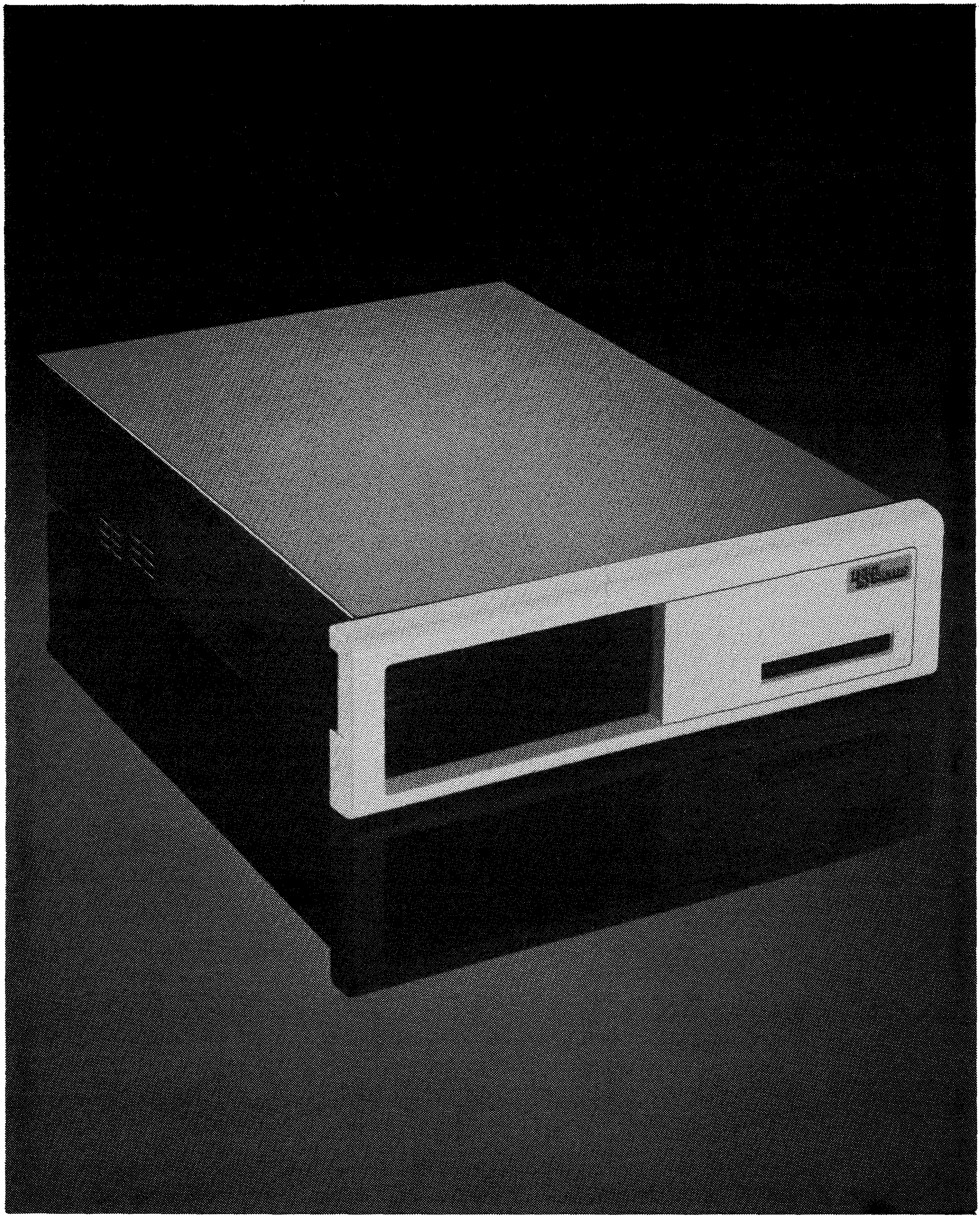

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Figure 1-1. The Data Systems Design 880

1.0 INTRODUCTION

1.1 General Information

This manual provides user information for the DSD 880 data storage system. Coverage provided includes: features, specifications, installation, operation, elementary programming and user level troubleshooting.

1.2 System Overview

The DSD 880 is a compact data storage system combining the advantages of the winchester disk system and the floppy disk system. Designed for use with computers manufactured by Digital Equipment Corporation (DEC), the DSD 880 provides the large capacity, rapid data access, and reliability of winchester disk technology and the low cost versatility of the floppy disk in a compact, system oriented package.

The DSD 880 is shown in Figure 1-1.

1.3 Features

1.3.1 System Architecture

The DSD 880 uses a unique system architecture to achieve the economy and performance available by the combination of winchester and floppy disk technologies. The winchester is configured to be compatible with a high performance disk system (the DEC RL01/RL02) while the double sided floppy disk emulates a floppy disk system (the DEC RX02). The DSD 880 is fully hardware, software and interface compatible with DEC computers. The system provides 8.8 MB of on-line storage (7.8 MB fixed and 3 MB removable).

The DSD 880 is implemented with a controller/formatter that is common in both drives. A single computer interface simplifies system integration. A bit-slice processor on this interface arbitrates device requests and queues pending instructions. Each disk drive responds to a different device address, interrupt priority and interrupt vector.

The DSD 880 controller uses a bit-slice processor which switches roles between the winchester and floppy disk drives. A single phase-lock-loop data separator operates at two clock frequencies to accommodate the different data rates of the two drives.

Although the controller can emulate two devices, it cannot do so simultaneously. The computer interface arbitrates RL01 and RX02 command transfers between the controller and the CPU bus. In addition to command arbitration, the interface also performs the following functions:

1. Emulation of RL01 and RX02 command and status registers.

2. Control of data transfers between the CPU and disk controller—including Direct Memory Access (DMA) transfers.

3. Contains the DSD bootstrap load program.

1.3.2 Off-Line Backup Capability

The use of a common disk controller not only achieves a more economical design, it allows additional interaction between the two disk drives. The DSD 880 controller provides stand alone winchester backup and loading, independent of the CPU. This assures that data will not be lost or destroyed in the event of a computer system failure. Backup and loading are initiated from a unique HyperDiagnostic panel built into the system. The entire winchester contents may be dumped onto floppy disks. When a floppy disk is full, the system pauses and instructs the operator to insert the next one. Reloading is simple and automatic. Each flexible disk is coded with the corresponding winchester track addresses so that it may be inserted in any order, without record keeping. The floppy disks may be single- or double-sided, and single- or double-density.

1.3.3 HyperDiagnostics

With the development and introduction of highly sophisticated computer peripherals comes the need to consider new methods of testing and servicing this equipment. DSD has pursued the philosopohy of designing extensive self-testing and diagnostic capabilities into its products. Since our disk memory systems are controlled by microcomputers, self diagnostic features become a natural extension of the product design. DSD's unique HyperDiagnostics provide the operator or service person with a library of user-selectable diagnostic routines and displays indicating system or error information. These HyperDiagnostics permit system diagnosis, floppy disk formatting, winchester backup and floppy drive alignment in a stand alone configuration without tying up a company's expensive computer or test equipment resources. Subsystem faults are easily isolated to allow for quick servicing. The DSD 880 HyperDiagnostics are initiated from a display panel located behind the removable front bezel. The panel is easily accessed by qualified personnel, but is concealed in normal operation.

1.3.4 Reliability

Winchester technology offers the potential for much greater reliability than flexible disk drives. Since the overall system reliability will be limited to that of its weakest component, new innovations are called for to enhance system reliability.

The DSD 880 reliability is increased by automatically shutting off power to the floppy disk drive when it is not in use. This will save wear on media, bearing, belts and pulleys. Since the floppy disk will be used primarily for winchester backup and loading, the mean time between failures (MTBF) of the floppy disk drive, and hence of the overall system, will be significantly increased.

1.4 Summary

Disk memory systems combining winchesters and floppy disks are opening new application possibilities for small computer systems. Their functionality and performance rival that of large disk systems costing several times as much. When considering a winchester-based disk memory system, the user should look beyond the usual considerations of capacity and backup, and should examine the functionality and capability of the entire system.

DATA SYSTEMS DESIGN has been an industry leader in the design and manufacture of DEC-compatible disk system since 1975. The DSD 880 is a unique, hybrid design which offers a combination of price, features, and performance unavailable from any DEC product. Some of these features are summarized below:

- Cost effective data storage and retrieval
- Large capacity data storage
- Rapid data access
- Simplified system integration
- RL01, RL02, and RX02 emulation
- Off-line backup capability
- Exclusive DSD HyperDiagnostics
- Compact size

2.0 SPECIFICATION

2.1 General Information

This chapter provides specifications and operational requirements for the Data Systems Design 880 Data Storage System.

Specifications include data storage capacities, recording characteristics, and data transfer rates. Also provided is a listing of the major components that comprise the DSD 880 system. Physical dimensions are provided.

Requirements include those for interface cabling and connectors, and power requirements. Operating temperature range and other environmental considerations are given.

2.2 DSD 880 Major Components

Table 2-1 provides a listing of the major components that comprise the DSD 880 Data Storage System.

Table 2-1. DSD 880 Major Components

Component	Part Number
Main Chassis	700006-01
Winchester Disk Drive	SA 1004
Flexible Disk Drive	SA 850
Controller/Formatter Card (8840)	808840-01
PDP 11 Interface Card (8830)	808830-01
LSI-11 Interface Card (8832)	808832-01
Diagnostic Panel (8833)	808833-01
Power Supply Assembly 115 Volt	900230-01
Power Supply Assembly 230 Volt	900230-02

2.3 Recording Characteristics

The winchester drive furnished with the DSD 880 data storage system records data using the modified frequency modulation technique (MFM).

The floppy disk system of the DSD 880 is capable of recording data in single-density using the industry standard IBM 3740 format, double frequency (FM) code as well as the double-density DEC RX02 format using the DEC-modified modified frequency (MFM) technique. Product specifications are given in Table 2-2.

2.4 Cable and Connector Requirements

The DSD 880 is furnished with all internal cables installed and configured for proper operation. A 10-foot long, 26-pin interface cable is supplied for connecting the DSD 880 main chassis to the DSD 8832 or 8830 computer interface card which is installed at the backplane of the host computer.

2.5 Power Specifications

Input Voltage	100 Vac or 120 Vac $\pm$ 10% 220 Vac or 240 Vac $\pm$ 10%	
	50 Hz $\pm$ 1 Hz 60 Hz $\pm$ 1 Hz	
Chassis Current (maximum)	120V/60 Hz	220V/50 Hz
Busy	6A	3A
Starting Current	28A Max @ 115 Vac 14A Max @ 230 Vac	
Heat Dissipation (BTU/HR)	Normal	Maximum
Chassis	1055	1175
Fuse Ratings (All Slo - Blo)	Main	Winchester
	4A @ 120 Vac 2A @ 220 Vac	2A @ 120 Vac 1A @ 220 Vac

INTERFACE

	LSI-11 (Q-Bus)	PDP-11 (Unibus)
Current Consumption (+5V)		
Nominal	2.5A	2.8
Maximum	3A	3.3
Heat Dissipation (BTU/HR)		
Nominal		43
Maximum		52

2.6 Physical Specifications

CHASSIS

Size	Chassis	5.25"H X 17.6"W X 23.74"D (13.3CM X 44.7CM X 76.2 CM)	
	Shipping Carton	12.5"H X 24.5"W X 30.0"D (31.75CM X 62.2CM X 76.2CM)	
Weight	Chassis	56.6 lbs.	(25.7 Kg)
	System Packed for Shipping	80 lbs.	(36.3 Kg)
Mounting	Rack Slides	Fits in standard DEC rack	

2.7 Environmental Requirements

All 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.

2.7.1. Environmental Specifications

TEMPERATURE			
	Operating	Chassis	41°F to 104°F (5°C to 40°C)
		Diskettes	50°F to 120°F (10°C to 51° C)
		Diskette Maximum Rate of Change	(15°/HR)
	Non-Operating	Chassis	-40°F to 150°F (-40°C to 66°C)
		Diskettes	-40°F to 120°F (-40°C to 51°C)
HUMIDITY		Chassis	10% to 78% (non-condensing)
		Diskettes	8% to 80% (With a maximum wet bulb temperature of 78°F (25.5°C)
ALTITUDE		Chassis (operating)	6000 feet maximum

2.7.2 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 880 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.

Table 2-2. DSD 880 Product Specifications

	Winchester Drive		Floppy Drive			
	Normal Mode	Extended Mode	Single-Sided Mode		Double-Sided Mode	
GENERAL:						
Mode Switch Selectable?	Yes	No	No		No	
Emulates	Full RL01	RL02	RX02		'Extended RX02'	
Modifications to DEC Operating Software	None	Chapter 5	None		See Chapter 5	
Diskettes used	---	---	Single-Sided		Single- and Double-Sided	
			Single-Density	Double-Density	Single- and Density up to	Double-Density up to
Formatted Capacity	5.2 Mbytes	7.8 Mbytes	256 Kbytes	512 Kbytes	512 Kbytes	1 Mbyte
DATA ORGANIZATION:						
Recording format	---	---	IBM 3740	DEC RX02	IBM 3740	DEC RX02
Recording technique	MFM	MFM	Double Frequency	DEC Modified MFM	Double Frequency	DEC Modified MFM
Bytes/Sector	256	256	128	256	128	256
Data Integrity	Header CRC/Data CRC		Header CRC/Data CRC			
Bad Track Management	Spare Track Assignment is User Transparent					
SPEEDS:						
Access Times:						
Average	47 Millisecs	70 Millisecs	174 Millisecs			
Maximum	107 Millisecs	150 Millisecs	410 Millisecs			
Track-to-Track	19 Millisecs		18 Millisecs			
Head Load Time	---		50 Millisecs			
Head Switching Time	20 Microsecs		100 Microsecs			

Table 2-2. DSD 880 Product Specifications (Cont)

	Winchester Drive		Floppy Drive	
	Normal Mode	Extended Mode	Single-Sided Mode	Double-Sided Mode
Start/Stop Time	5 seconds for disk to reach 95% of nominal speed 2 minutes maximum for thermal stabilization		2 seconds for diskette rotational speed stabilization	
Nominal Rotational Speed	3125 RPM ± 3%		360 RPM ± 2%	
Average Latency	9.6 Millisecs		83 Millisecs	
Data Transfer Rate:				
Within a track	142.2 Kbytes/second		20 Kbytes/second	
across entire disk	106.7 Kbytes/second		18 Kbytes/second	
burst rate	4 microsec/word plus DMA Overhead		4 microsec/word plus DMA Overhead	
Data Transfer Length	5.1K words max in normal mode	64K words max in extended mode	---	
<u>LSI-11 INTERFACE</u> Backplane Requirement	One dual wide Q-bus slot in <u>any</u> Q-bus backplane.			
Device Addresses:				
Standard (as shipped)	774400		777170	
Alternate**	774410, 774420, 774370		777160, 777150, 777140	
Hardward Bootstrap Start Address:				
Standard (as shipped)	773000			
Alternate**	771000, 766000			
**Jumper Selectable				

Table 2-2. DSD 880 Product Specifications (Cont)

	Winchester Drive	Floppy Drive
Interrupt Vector: Standard (as shipped) Alternate**	 160 150, 320, 330	 264 274, 270, 254
PDP-11 INTERFACE Backplane Requirement	1 quad wide Small Peripheral Controller (SPC) slot in any Unibus backplane.	
Device Address Options Standard (as shipped)	760000 - 777770 at 10 increments (8) 774400	760000 - 777770 at 10 increments (8) 777170
Bootstrap Base Address Options Standard (as shipped)	760000 - 777000 at 1000 increments (8) 771000	
Interrupt Vector Standard (as shipped)	000-774 at 4 increments (8) 160	000-774 at 4 increments (8) 264

3.0 INSTALLATION

3.1 General Information

This chapter provides information on unpacking and inspection, installation, configuration, and initial check out of your DSD 880 Data Storage System.

3.2 Unpacking and Inspection

When your DSD 880 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, or for future use. Retain the cardboard shipping disk which is installed in the flexible disk drive.

3.3 Power Requirements

The DSD 880 is available in configurations for nominal line voltages of either 120 or 240 Vac. The line frequency must be within 1 Hz (cycles per second) of either 50 or 60 Hz.

NOTE

> The voltage and frequency configuration of the DSD 880 cannot be field modified.

3.4 Installing the DSD 880 Chassis

The DSD 880 chassis must be installed within 10 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 880 may be either mounted in a standard 19-inch rack or placed on a table top. The rack installation hardware consists of the items listed in Table 3-1.

Table 3-1. Rack Installation Hardware

Quantity	Item
1	Chassis Slide, Left
1	Chassis Slide, Right
2	Slide Mtg. Bracket, Rear
12	Screw, 10-32 X 1/2" Phillips Pan Hd.
4	Screw, 8-32 X 38" Flat Hd. 100"
2	Screw, 8-32 X 1/4" Phillips Pan Hd.
8	Nut, #10 Retainer
4	Hex Nut, 10-32
12	Washer, #10 Flat
4	Washer, #10 Star, External Tooth
2	Washer, #8 Star, External Tooth
2	Captive Screw, 10-32 X 5/8"

The DSD 880 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 104°F (40°C).

NOTE

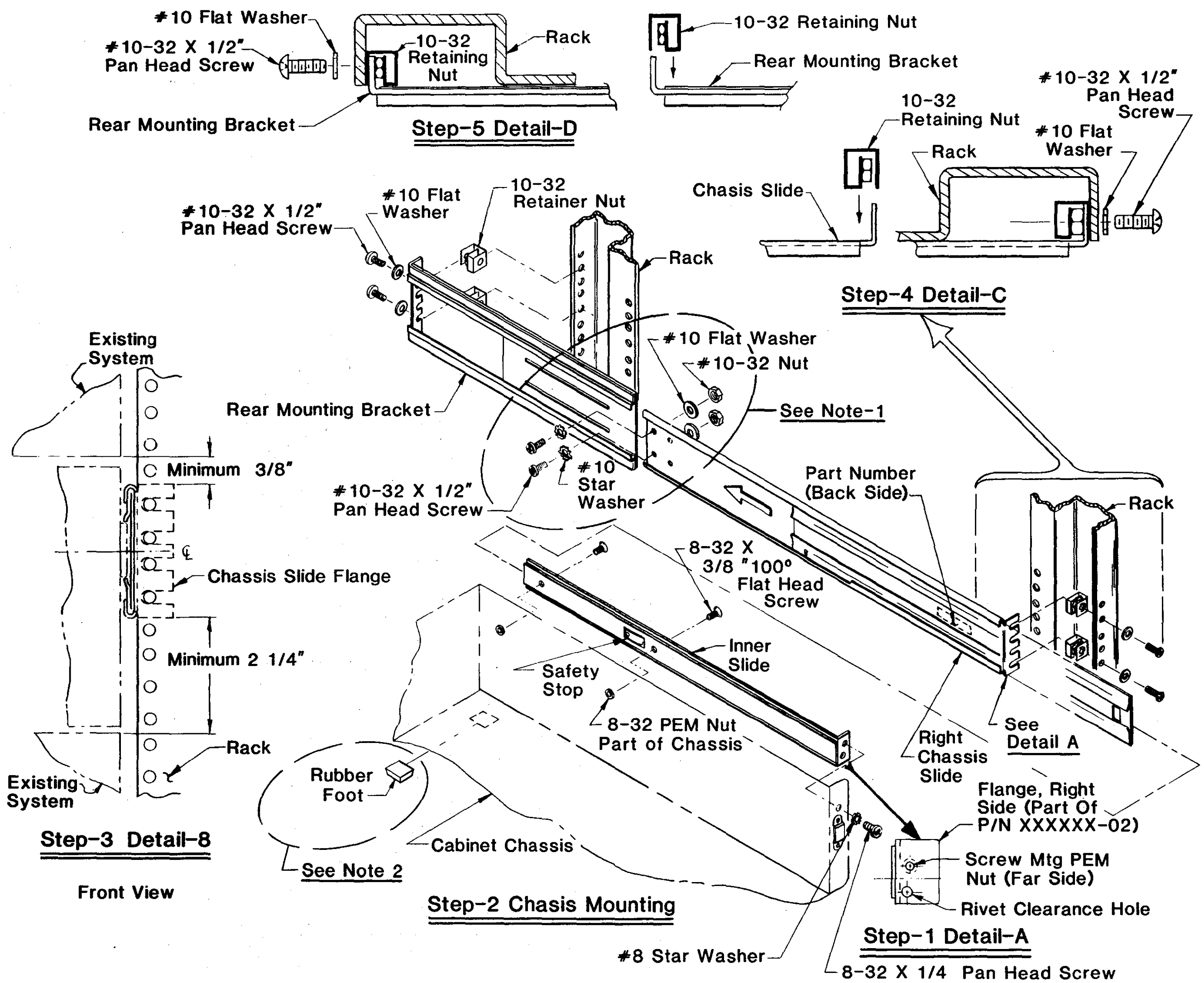
The winchester drive furnished as a part of the DSD 880 system is shipped with a "spindle lock mechanism" which is in the locked position to prevent shipping damage. Prior to installation and operation, this lock must be removed. The drive motor can be damaged if power is applied while the spindle is locked.

NOTE

If the DSD 880 is to be rack mounted, the user should ascertain that the 8840 controller card is configured to meet the desired operating parameters before rack installation is made. The DSD 880 is shipped properly configured for the disk drives furnished with the system, and with the flexible disk drive automatic power on/off option selected.

The following procedure should be used to mount the DSD 880 in the standard 19-inch instrumentation rack:

1) Attach the chassis slides to the rack using the hardware supplied. Note that the left and right rear extender brackets are not interchangeable. Figure 3-1 illustrates the correct relationship of the rack mounting components.



ASSEMBLY INSTRUCTIONS

STEP-1. Unpack your chassis slide kit and identify the right and left chassis slide by the stamped part no: Left is P/N XXXXXX-01, Right is P/N XXXXXX-02. (See detail-A.)

2. After identifying the right and left chassis slides (see chassis mounting), remove the inner slides by fully extending the slides and then releasing the safety stop. Assemble the inner slides to chassis using the fasteners shown.

3. To position the chassis slides, use the recommended dimensions (see detail-B). The positioning is contingent upon mounting your new system underneath or above the existing system. Align the flange of the chassis slide with the two nearest mounting holes of the rack.

4. After determining which two holes/slots will be used, slide the retaining nuts into the appropriate slots on the mounting flange of the chassis slides (see detail-C). Fasten the chassis slides to the rack using the fasteners shown.

5. Slide the rear mounting bracket over the chassis slide until the flange meets the back of the rack. Align the bracket with the two nearest mounting holes on the rack. It is important to keep the slide and rear bracket level.

NOTE-1. For the extra long racks, additional hardware has been supplied for stiffening the assy.

2. Remove rubber feet from system before installing into rack.

NOTE: The rear has the same slot spacing relative to the center of the chassis slide. Slide the retainer nuts into the appropriate mounting slots, re-align the bracket to the holes and fasten with the hardware shown. (See detail-D)

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Figure 3-1. Installing Chassis Slides

2) Insert the DSD 880 into the chassis slides and push the unit into the rack.

3) Remove the front bezel from the DSD 880 and install the retaining screws.

4) Replace the bezel by locating the guide pin and pressing firmly until the retaining mechanism engages firmly.

3.5 Interface Module and Cable Installation

3.5.1 Preparation

WARNING

- Ensure that system power is off before installing the interface module and cable.
- Ensure that system power is off before changing the interface switch positions.

The DSD 880 LSI interface card is a dual width card, labeled P/N 808832. The DSD 8832 is shown in Figure 3-2.

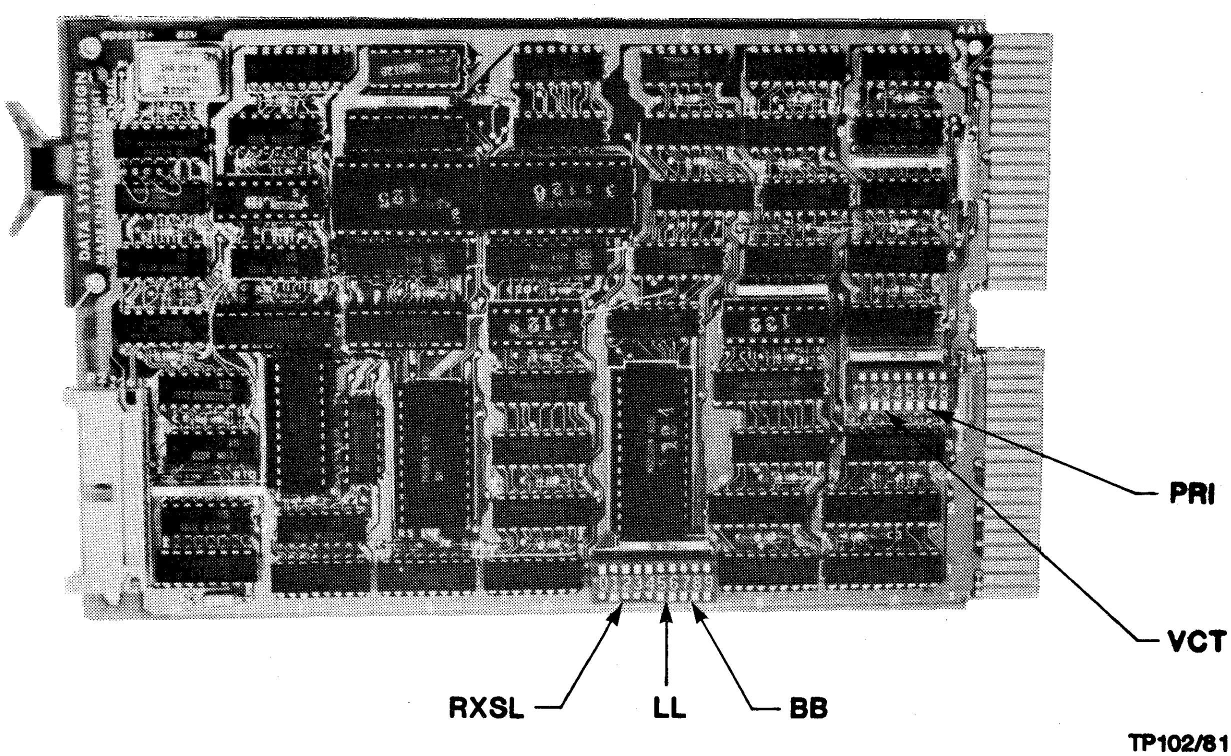


Figure 3-2. DSD 8832 Computer Interface Card

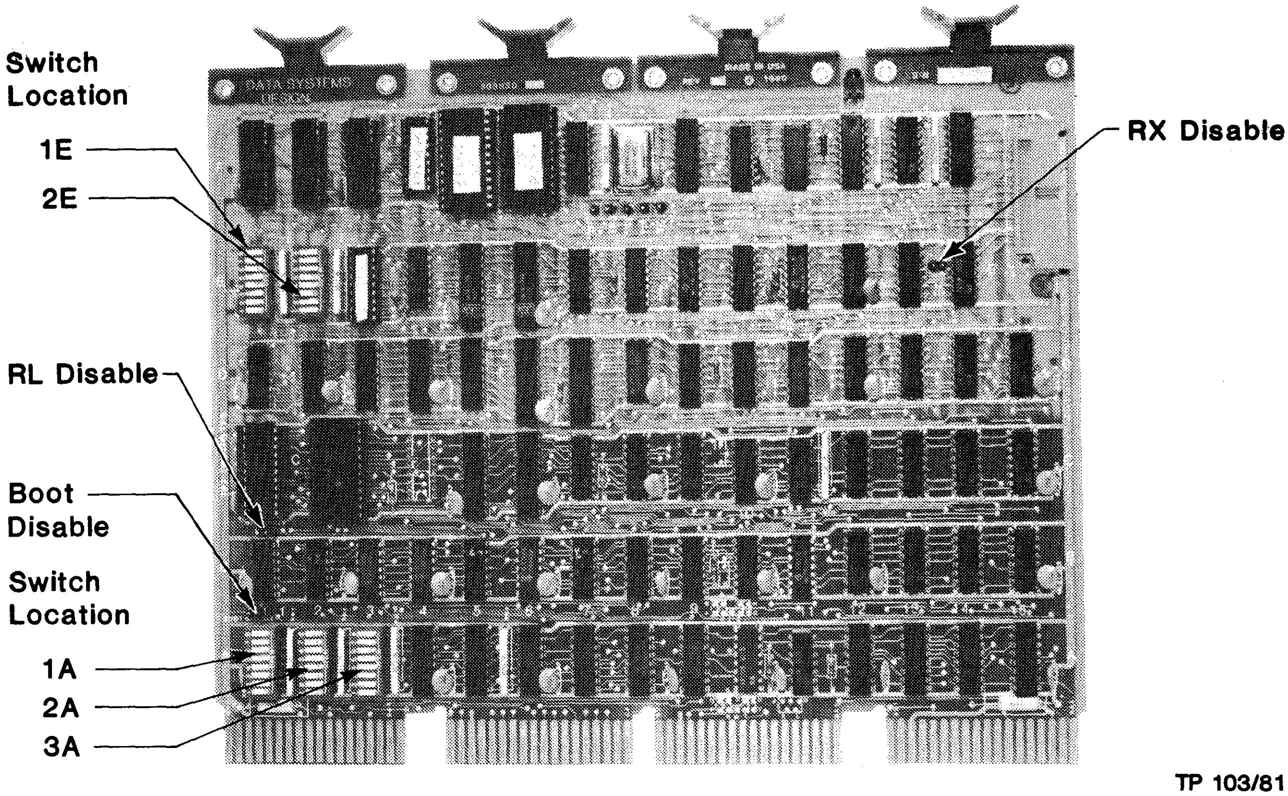


Figure 3-3. DSD 8830 Computer Interface Card

The DSD 880 PDP-11 interface card is a quad-wide card, P/N 808830. The DSD 8830 is shown in Figure 3-3.

The DSD 8832 interface card provides for both the winchester and floppy disk selection of one of four device register addresses, one of three bootstrap PROM (programmable read only memory) starting addresses, and one of four interrupt vector addresses. The DSD 8832 also allows the user to disable the RX02 and bootstrap response, enabling the user to supply his own.

Table 3-2 lists the standard and alternate addresses for the device registers and the bootstrap PROM's starting addresses. The DSD 8832 is shipped in the standard configurations.

It should be noted that the switch position number referred to in Table 3-2 indicates the number on the PCB Board silk screen.

The DSD 8830 interface card can emulate both RX02 and RL01 device registers according to DEC standards. Since the 880 controller can only operate on one device at a time, the 8830 arbitrates between sending the latest RL command and the latest RX command without violating device register protocols. An onboard bootstrap eliminates the need for a DEC bootstrap board. Finally, five switch packs allow the user to select any of the possible boot addresses, device register addresses, or vector addresses.

Tables 3-3, 3-4, and 3-5 provide the switch settings and jumper options for the selection of device addresses, boot addresses, vector addresses, and interrupt priority settings for the DSD 8830 interface card.

Table 3-2. DSD 8832 Standard and Alternate Address Configuration
(Refer to Figure 3-2 for Jumper Location)

Switch/Jumper	Address
RXSL (RX Device)	
01234	
0000S	177150 Alternate
000S0	177140 Alternate
00S00	177160 Alternate
0S000	177170 Standard
S0000	RX Disable
LL (RL Device)	
01	
00	774410 Alternate
0S	774420 Alternate
S0	774370 Alternate
SS	774400 Standard
BB (Boot Base)	
01	
00	166000 Alternate
0S	171000 Alternate
S0	Boot Disable
SS	173000 Standard
VCT (RX Vectors)	
1234	
—00	274 Alternate
—0S	254 Alternate
—S0	270 Alternate
—SS	264 Standard
00— (RL Vectors)	150 Alternate
0S—	330 Alternate
S0—	320 Alternate
SS—	160 Standard
PRI (RL01 Priority)	
4321	
SSS0	PRI 7 Standard
SS0S	PRI 6 Alternate
S0SS	PRI 5 Alternate
0SSS	PRI 4 Alternate

S = Short
0 = Open
- = NA

NOTE

Switch position numbers referred to in Table 3-2 indicates the number on the PCB silk screen.

Table 3-3. DSD 8830 Standard and Alternate Address Selection

NOTE: For switch or jumper selectable bits

Bit = 1 = Switch or jumper open
Bit = 0 = Switch or jumper closed

CAUTION: When selecting an address other than the standard address, make sure an unused address is selected that will cause no interruption of normal computer operation.

DEVICE	BIT CONFIGURATION			RESULTANT ADDRESS
	17 → 13	12 → 3	2 → 0	
RX Address	Fixed Bits	Switch Selectable Bits	Fixed Bits	
	1 1 1 1 1	1 1 1 1 0 0 1 1 1 1	0 0 0	777170 Standard
	1 1 1 1 1	1 1 1 1 0 0 1 1 1 0	0 0 0	777160 Alternate
	1 1 1 1 1	1 1 1 1 0 0 1 1 0 1	0 0 0	777150 Alternate
	1 1 1 1 1	1 1 1 1 0 0 1 1 0 0	0 0 0	777140 Alternate
	Switch Position	8 7 8 7 6 5 4 3 2 1		
	Switch Location	1A (8 7), 2A (8 7 6 5 4 3 2 1)		
RL Address	Fixed Bits	Switch Selectable Bits	Fixed Bits	
	1 1 1 1 1	1 1 0 0 1 0 0 0 0 0	0 0 0	774400 Standard
	1 1 1 1 1	1 1 0 0 1 0 0 0 0 1	0 0 0	774410 Alternate
	1 1 1 1 1	1 1 0 0 1 0 0 0 1 0	0 0 0	774420 Alternate
	1 1 1 1 1	1 1 0 0 1 0 0 0 1 1	0 0 0	774430 Alternate
	Switch Position	6 5 8 7 6 5 4 3 2 1		
	Switch Location	1A (6 5), 3A (8 7 6 5 4 3 2 1)		

Table 3-3. DSD 8830 Standard and Alternate Address Selection (Cont)

DEVICE	BIT CONFIGURATION			RESULTANT ADDRESS
Boot Address	Fixed Bits	Switchable Bits	Fixed Bits	
	1 1 1 1 1	1 0 0 1	0 0 0 0 0 0 0 0 0	771000 Standard
	1 1 1 1 1	1 0 1 0	0 0 0 0 0 0 0 0 0	772000 Alternate
	1 1 1 1 1	1 1 0 1	0 0 0 0 0 0 0 0 0	775000 Alternate
	1 1 1 1 1	1 1 1 0	0 0 0 0 0 0 0 0 0	776000 Alternate
	Switch Position	4 3 2 1		
	Switch Location	1A		
RX Vector	Fixed Bits	Switchable Bits	Fixed Bits	
	0 0 0 0 0 0 0 0 0	0 1 0 1 1 0 1	0 0	264 Standard
	0 0 0 0 0 0 0 0 0	0 1 0 1 1 0 0	0 0	260 Alternate
	0 0 0 0 0 0 0 0 0	0 1 0 1 0 1 1	0 0	254 Alternate
	0 0 0 0 0 0 0 0 0	0 1 0 0 1 1 0	0 0	230 Alternate
	Switch Position	7 6 5 4 3 2 1		
	Switch Location	1E		
RL VECTOR	Fixed Bits	Switchable Bits	Fixed Bits	
	0 0 0 0 0 0 0 0 0	0 0 1 1 1 0 0	0 0	160 Standard
	0 0 0 0 0 0 0 0 0	0 0 1 1 0 1 1	0 0	154 Alternate
	0 0 0 0 0 0 0 0 0	0 0 1 1 0 1 0	0 0	150 Alternate
	0 0 0 0 0 0 0 0 0	0 0 1 1 0 0 1	0 0	144 Alternate
	Switch Position	7 6 5 4 3 2 1		
	Switch Location	2E		

Table 3-4. 8830 Interrupt Priority Settings

Connections	Standard*			
	Priority 5	Priority 4	Priority 6	Priority 7
N to J	Open	Closed	Open	Open
N to K	Closed	Open	Open	Open
N to L	Open	Open	Closed	Open
N to M	Open	Open	Open	Closed
O to P	Closed	Open	Closed	Closed
Q to R	Open	Closed	Closed	Closed
S to T	Closed	Closed	Open	Closed
U to V	Closed	Closed	Closed	Open
W to P	Open	Closed	Open	Open
W to R	Closed	Open	Open	Open
W to T	Open	Open	Closed	Open
W to V	Open	Open	Open	Closed
A to B	Closed	Open	Closed	Closed
C to D	Open	Closed	Closed	Closed
E to F	Closed	Closed	Open	Closed
G to H	Closed	Closed	Closed	Open
I to A	Open	Closed	Open	Open
I to C	Closed	Open	Open	Open
I to E	Open	Open	Closed	Open
I to G	Open	Open	Open	Closed

*NOTE: 8830's are shipped fabricated to Priority 5.

Use at any other priority requires the following:

1. Cut required connections open.
2. Insert .025" square wire-wrap pins at appropriate connection points.
3. Wire wrap required connection closed.

Table 3-5. 8830 Jumper Configurations

8830 jumpers are shipped configured for a standard configuration where RX, RL, and BOOT are enabled and RXCS address bit is fixed at D.

Jumper		Function	In	Out	Shipped
Number	Location				
1-2	13E	RXCS address bit 2	0	1 or 0	In
3-4	13E	RX Disable	Disable	Enable	Out
5-6	1C	RL Disable	Disable	Enable	Out
7-8	1B	BOOT Disable	Disable	Enable	Out

3.6 AC Power Cord Installation

To install the ac power cord:

A. Ensure that the DSD 880 power on/off switch is in the off position.

B. Plug the female end of the power cord into the connector on the back of the DSD 880 chassis.

C. Plug the male end of the power cord into an ac power receptable that provides the proper ac input voltage for the DSD 880 (90 to 130V rms, on domestic models, or 198-250V rms on international models configured for the higher voltage.)

3.7 Initial Checkout and Acceptance Testing

After installation of the DSD 880, an initial power-up and testing sequence should be completed prior to placing the system into regular service. Be sure the winchester spindle lock has been removed prior to operation. DSD recommends the following procedure be followed:

NOTE

Prior to applying power and performing acceptance testing, the operator should familiarize himself with the normal operating procedures of Chapter 4 and the use of DSD HyperDiagnostics tests in Chapter 7 of this manual.

A. Remove the DSD 880 front bezel by grasping the bezel and pulling forward. Removal of the front bezel will allow access to the HyperDiagnostics panel.

B. Assure either that power is applied to the host computer, or that the interface cable is not connected.

C. Apply power to the DSD 880 using the power on/off switch on the rear panel of the chassis.

D. Insert a blank, write enabled, FORMATTED floppy disk into the floppy disk drive.

NOTE

Any data present on the floppy disk used in the following sequence of tests will be destroyed during the tests.

E. Perform the DSD 880 HyperDiagnostic Switch and Light Test using the procedure that follows:

1. Place the FLOPPY and WINCHESTER WRITE PROTECT switches in the OFF position, select MODE = 3, CLASS = 0 and depress the EXECUTE pushbutton. Verify that 30 is displayed by the 7 segment displays.

2. Observe the FAULT, WINCHESTER READY, FLOPPY FAULT, WINCHESTER FAULT, and FLOPPY WRITE PROTECT indicators. Verify that each illuminates and extinguishes independently of the other indicators before proceeding.

3. Rotate the MODE switch through positions 0 - 7, verify that the switch position is displayed by the left digit of the 7 segment displays.

4. Rotate the CLASS switch through positions 0 - 7, verify that the switch position is displayed by the right digit of the 7 segment displays.

5. Place the FLOPPY WRITE PROTECT switch in the ON position, verify that the FLOPPY WRITE PROTECT and FLOPPY FAULT indicators illuminate, and that the value 88 is flashing in the 7 segment displays.

6. Place the FLOPPY WRITE PROTECT switch in the OFF position and the WINCHESTER WRITE PROTECT switch in the ON position. Verify that the WINCHESTER WRITE PROTECT and WINCHESTER FAULT indicators illuminate, and that the value 99 is flashing in the 7 segment displays.

7. Place the WINCHESTER WRITE PROTECT switch in the OFF position.

F. If no malfunctions are detected during the 880 Switch and Light test, perform the DSD 880 HyperDiagnostic Sequential Scan Floppy Disk (50) and Sequential Scan Fixed Disk (54) tests as given in Section 7 of this manual.

If no errors are detected during the test cycle, the DSD 880 will halt with 00 displayed in the seven sector display. If an error is detected during any portion of the test sequence, the DSD 880 will halt with an error code flashing in the seven sector display. For an explanation of each of the tests and for the meanings of any error codes displayed refer to Chapter 7 of this manual.

G. Select the desired normal operating mode and class (see Table 4-2), then depress the Execute pushbutton momentarily. The selected mode and class will be displayed while the execute pushbutton is depressed. Upon release of the Execute pushbutton, verify that the code 00 is displayed, indicating that both the floppy and winchester drives were successfully initialized.

H. Reconnect the interface cable and apply power to the host computer if necessary.

3.8 DSD 880 Initial Program Installation

This section provides a description of the DSD supplied software available and guidance in the integration of the DSD 880 into the user's operating system.

3.8.1 DSD Supplied Programs

The DSD 880 is shipped from the factory preformatted with bad track and bad sector file information on the winchester. A floppy diskette is included which contains the DSD supplied programs and command files. Several of these programs are also shipped on the winchester as an aid in initial testing of the DSD 880. Appendix A contains a directory listing of these devices/diskettes.

The main programs supplied are:

FLPEXR - a stand alone diagnostic/utility program for operations on the floppy drive. See Appendix C.

FIXEXR - a stand alone diagnostic program for operations on the winchester drive in RL emulation mode. See Apendix D.

SATEST - a stand alone diagnostic/utility program for operations on the winchester drive in direct access mode and for disk formatting and bad track mapping. See Appendix E.

DSDMON - a bootable diagnostic monitor that allows the user to select one of the diagnostic programs for execution. See paragraph 3.8.3.

3.8.2 Command Files

Command files are supplied for the main operations necessary to utilize the extended features of the DSD 880 and to assist the user in the initial loading of the operating system onto the DSD 880. A full listing of each command file is contained in Appendix B of this manual. Usage of each command file is described in the appropriate section of the manual.

Command files are also provided to facilitate backup and restores of the DSD 880 winchester. These command files should be considered as representative only; individual users should tailor the commands to their particular needs. These files are called 88XFLP.COM, FLPX88.COM.

3.8.3 Use of DSDMON

DSDMON is the DSD diagnostic monitor program that allows the user to select which diagnostic program is to be executed from the distribution diskette. It is a secondary bootstrap program that loads RT-11 format files into memory and initiates execution of that program. Although DSDMON accesses files through an RT-11 type format, RT-11 is not required to run DSDMON.

To initiate a program, boot the diskette through the hardware bootstrap procedures. The program will output on the console:

DSD DIAGNOSTIC MONITOR PROGRAM V3A

DSDMON>

The program to be initiated is specified by typing:

R filename <CR>

DSDMON assumes an extention type of .SAV. If the file is not found on the diskette, DSDMON will output:

FILE NOT FOUND

If the file is found on the diskette, it will be brought into memory and execution begun. DSDMON also supports the following commands:

T	filename<CR>	-	Types the specified file contents on the console terminal
H	<CR>	-	Types a Help file on the console terminal
R	filename<CR>	-	Load and Run specified program
L	filename<CR>	-	Load specified file then return control to DSDMON

DSD supplied diagnostics are configured such that, if they are initiated from an RT-11 system, control can be returned to RT-11. If invoked from DSDMON, they will still prompt for "RETURN TO RT-11?", however, such return is not possible and a Y (yes) reply will cause the diagnostic to be reinitialized. In order to run a different diagnostic, DSDMON must be booted again. DSDMON can be restarted at the last location in memory (for a 28KW system, this address is 157776).

3.8.4 Transfer of RT-11 to DSD 880

A. Transfer of RT-11 V3B to the 880 winchester:

1. Procure a DY bootable RT-11 distribution diskette with a DL handler (DL.SYS) on it.

2. Boot this diskette and prepare to copy all files onto the 880 winchester.

NOTE

The 880 winchester as shipped contains an RT-11 directory and all the DIAGNOSTIC DISKETTE files. These may be retained by skipping the following step.

INIT DL0:/NOQ<CR>

3. Copy all the RT-11 files on the distribution disk onto the 880 winchester.

   COPY/SYS DY0:*.* DL0:<CR>

4. If the bootable RT-11 V3B distribution diskette does not contain a DL monitor, then it must be copied from one of the other distribution diskettes (#2 or #3).

   This can be done most easily if another device is available to use as a system device. If only the DSD 880 is available, then proceed as follows:

   a) .SET USR NOSWAP <CR>
   .R DIR<CR>
   *
   Remove the bootable system disk.
   Write protect the floppy drive using the front panel switch. Insert the other distribution disks one at a time and type.

   *DY0:/B/E<CR>

   Determine the disk containing DLMNSJ.SYS and note the starting block number and length.

Example:

DLMNSJ.SYS 74 150

Where 74 is the length and 150 is the starting block number.

5. Make the 880 winchester hardware bootable:

   COPY/BOOT DL0:DLMNSJ.SYS DL0:<CR>

   or

   COPY/BOOT DL0:DLMNFB.SYS DL0:<CR>

   Remove the distribution disk containing DLMNSJ.SYS.
   Reinsert the bootable disk first booted on.
   Unprotect the floppy drive using the front panel switch.

   Type: <CTRL C>
   .LOA DL:<CR>
   .R DUP <CR>
   *DL0:DLMNSJ.SYS=/C:4000.:64.<CR>
   *DL0:A=DY0:/I: (starting read block):(starting read block & length of file):(starting write block)=4000.

   For example, with the starting block and length given in the directory example:

   *DL0:DLMNSJ.SYS/I:150.:214.:4000./W<CR>

   The system will ask "CONTINUE?"
   Remove the bootable system disk and insert the diskette containing DLMNSJ.SYS found above.

   Type: Y <CR>
   The system will copy the blocks specified on the 880 winchester and type: "INSERT SYSTEM DISK, ARE YOU READY?"

   Remove the other distribution diskettes and insert the bootable system diskette.

   Type: Y <CR>

   There should now be a copy of the DL monitor (DLMNSJ.SYS) on DL0.

3.8.5 Transfer of RT-11 V4 to the 880 Winchester

1. Boot the bootable distribution diskette in DY0:.

2. Prepare to copy the RT-11 V4 distribution diskette contents onto the winchester.

NOTE

The DSD 880 winchester is shipped with a copy of the DSD diagnostic disk on the winchester.

These contents may be retained by skipping the following step:

Type: INIT DL0:/NOQ<CR>

3. Copy all files from the floppy to the 880 winchester.

   .COPY/SYS DY0:*.* DL0:<CR>

4. Bind the device monitor to the DL handler to make it bootable.

   .COPY/BOOT DL0:RT11SJ DL0:<CR>

5. Bootstrap the RT-11 on the 880 winchester.

   .BOOT DL0:<CR>

3.8.6 Double-Sided Support Under RT-11 (Version 3B)

Double-sided support under RT-11 V38 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 double-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 SYSGEN, 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 SYSGEN, the DSD handler DYDSD.MAC (found on the DSD diagnostic diskette) must first 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.

Note that the actual monitors (DYMNSJ.SYS or DYMNFB.SYS) must reside on side 0 in order to boot initially.

DOUBLE SIDED SUPPORT UNDER RT-11 V3B

A. Nonsystem for side 1.

   The file DYDSD.SYS on the diagnostic disk is an RT-11 V3B handler compatible with the distribution kit monitors that can be copied over to the winchester for use.

   1. Boot RT-11 V3B on the 880 winchester.

   2. Insert the diagnostic disk into DY0:.

3. Copy the RTV3B DY handler over to the winchester.

.COPY DY0:DYDSD.*/SYS DL0:DY.*<CR>

4. Reboot the DL monitor.

.BOOT DL0:<CR>

This installs the double sided handler.

3.8.7 The DSD Monitor Patch Program For RT-11 V3B

The Monitor Patch Program takes a DYMNSJ or DYMNFB 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 the user's system.

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

The DYMNSJ or DYMNFB monitor may be generated from the first or second release of RT-11 V3B. The distribution DYMNSJ or DYMNFB 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-Mar-78
DYMNFB.SYS	AS-5781B-BC	11-Mar-78

Second DX KIT Release of RT-11 V3B	Disk Label No.	Dated
DYMNSJ.SYS	AS-5783C-BC	27-Mar-79
DYMNFB.SYS	AS-5783C-BC	27-Mar-79

or either DY KIT release may be used.

To use the DSD monitor patch procedure on the DSD 880:

1. Boot RT-11 V3B on the 880 winchester. Note: The default device DK: should be the system device floppy.

2. Copy the desired DY monitors from the DEC floppy distribution kit onto the 880 winchester (DYMNSJ.SYS and DYMNFB.SYS).

3. Copy the PAT files from the DSD diagnostic diskette onto the winchester.

   Insert the diagnostic diskette and type:

   .@DY0:PATSET<CR>

4. Put a blank diskette in DY0: and set to double density. Note: the DEC format program only supports the standard device addresses. Use DSDFMT if an alternate address is to be used.

   .R FORMAT
*<CTRL C>

5. Determine which double sided monitor is to be generated. Type:

   .@PATSJ<CR>

   to put a single job monitor on DY0: or type:

   .@PATFB<CR>

   to put a foreground/background monitor on DY0:.

   Note: Both steps 4 and 5 should be repeated if both double sided monitors are to be created.

   This procedure will copy a minimal system over to the floppy in DY0:, then patch the monitor and then boot that monitor. This diskette then contains the selected RT-11 V3B monitor with double sided support and should be used as a master for generating other double sided bootable diskettes.

NOTE

RT-11 V3B will not boot a floppy with the selected monitor on the second side.

3.8.8 Double Sided Floppy Support Under RT-11 V4

A command documentation file DYV4DS.DOC is provided which applies the difference to the DEC distribution DY.MAC given in DYV4DS.DIF.

To update the RT-11 V4 DY handler:

1. Boot up RT-11 on the 880 winchester.

2. Copy DY.MAC from the DEC distribution kit onto the winchester.

3. Copy DYV4DS.* from the DSD diagnostic disk onto the winchester.

4. Type @DYV4DS.DOC.

An updated DY.SYS and an updated handler source DYV4DS.MAC will be generated. This handler includes full double sided support and allows booting with the system files on side one.

3.8.9 Extended Mode Winchester Support

The DSD 880 operates in either RL01 compatible mode or extended mode which is a subset of an RL02. No changes to the RT-11 system are required to use the RL01 compatible mode. By using the RT-11 FILE.BAD capability to mask the unavailable disk area, extended mode can also be used without any operating system patches. If the FILE.BAD approach is not acceptable, then only a few minor patches to the DL handler will allow the extended mode operations.

Command file DLV388.DOC contains the procedures to be followed to enable extended support for RT-11 version 3B. For RT-11 version 4, command files DLV488.DIF and DLV488.DOC contain the changes to be applied to the RT-11 distribution handler sources using the SLP program.

3.8.10 Transfer of RSX-11M to DSD 880 Winchester

In order to bring up RSX-11M on the DSD 880, a host machine capable of reading the DEC distribution kit is required. There are several methods of transfer from this machine/disk onto the DSD 880:

1. SYSGEN with DSD 880 attached as an RL01/2 to the host machine.

2. SYSGEN with floppy drive and RL01/2 attached to the host machine.

3. SYSGEN on host system with only floppy drive available as an intermediary device.

The remainder of this section describes these methods in more detail.

SYSGEN with DSD 880 attached as an RL01/2 to the host machine

This is the most convenient method in that standard SYSGEN procedures can be followed for generating a target system. If the DSD 880 is in extended mode the host monitor device size table should be updated before running BAD and INI on the DSD 880. (See RSX-11M extended support section for details.)

SYSGEN with floppy drive and RL01/2 attached to host machine

Perform a SYSGEN with the RL01/2 as the target device. If only a RL01 is available and the end target is an extended DSD 880, run BAD while in RL01 mode, then apply the device size updates before performing INI. Set the directory to the middle (default case) or beginning of the volume. After performing the software boot, change the device size in the new monitor before doing the SAV/WB. Alternatively, use DSC for the final expansion to the final device size as above. The RSX system image can be transferred to the DSD 880 using either of the methods described below.

3.8.11 RSX-11M Double Sided Floppy Support

RSX-11M as distributed has almost all the support needed for RX03 type floppy systems. There are, however, some glitches which are detailed below and in command file RSX11M.DOC.

1. BUG in extended memory cross field transfers. This is documented in the June 1980 SOFTWARE DISPATCH. The correction is also contained in the file RSX11M.DOC on the DSD distribution diskette.

2. BUG in track/sector calculation algoritm in 11,10 DYDRV.MAC and 12,10 SAVSPC.MAC used in 1,20 or 1,24 SAV.OLB. This causes a hard error return from the handler whenever block numbers (double density, double sided) greater than 1664 are accessed. A fix for the handler is included in file RSX11M.DOC on the DSD distribution diskette. If the SAV.OLB is not rebuilt prior to SYSGEN then any tasks that SAV accesses when saving the RSX-11M system image must reside below block 1663. If not, it will be impossible to make a floppy bootable RSX-11M system image.

3.8.12 RSX-11M DSD 880 Extended Suppport

The DSD 880 operates in either RL01 compatible mode or extended mode which is a subset of an RL02. The RSX-11 monitor must be informed of this difference in device sizes in RL02/extended mode.

The system keeps a record of device sizes in the Unit Control Block (UCB) at the word offset (U.CW2,U.CW3) relative to the UCB entrance .DLx (.DL0 or .DL1) depending on the logical unit number. The default value of 10240. (= 24000 octal) is placed at that location at SYSGEN time. This corresponds to an entire RL01 disk pack. This value is accessed during INI, BAD and SAV functions and is doubled before use if the device is an RL02 instead of an RL01. Thus to initialize a DSD 880 in extended mode, the value of one half the size of the extended disk (7776. = 17140 octal) should be entered into U.CW3 for the 880 winchester unit.

If a SAV is done onto an RL02, the doubled value is left in U.CW3 and will be seen whenever that system image is booted (refer to DLSET: in 12,10 SAVSUB.MAC). Therefore, the U.CW3 value should be modified using PATCH and the SYSTEM MAP before doing the final SAV/WB command.

If RT-11 Version 4 is available, generate a system supporting the RL01/2 and floppy drive. Bring up this RT-11 system. Copy the RSX system image (on RL01/2) out onto multiple floppies then onto the DSD 880 using the RT-11 V4 indirect command files provided (88XFLP.COM and FLPX88.COM) on the DSD distribution diskette. After these diskettes are copied onto the DSD 880, the DSD 880 will contain an image copy of the original RL01/2 and can be hardware booted into RSX-11M.

If the DSD copy utility is available, copy the RSX system image onto multiple floppies. These floppies can then be loaded onto the DSD 880 by using the DSD 880 restore mode of operation. After these diskettes are loaded, the DSD 880 will contain a image copy of the original RL01/2 and can be hardware booted into RSX-11M.

SYSGEN on host system with only floppy drive available

This method requires generating a floppy diskette containing a RSX-11M system which is then booted using the DSD 880 floppy drive to produce an operational floppy based RSX-11M nucleus. The DSD 880 winchester drive is then setup from this nucleus and booted. The floppy can then be used to transer the remaining files onto the winchester.

This procedure is most easily done in one SYSGEN if both floppy drive and RL01/2 handlers are set as loadable. This allows the final usable RSX11M.SYS images to be brought up by simply interchanging the LOA DL: and LOA DY: commands to VMR.

NOTE

> The handler for the physical volume to be VMR'd upon must be the first file structured handler to be loaded. If not, then when tasks are to be installed, the message
>
> INSTALL DEVICE NOT LBO:
>
> will be output independent of any assignment command.

This procedure requires either a double-sided, double-density diskette on the DSD 880, or two single-sided, double-density diskette/drives.

The following are the minimum complement of files required for DL volume initialization: (602. blocks total)

RSX11M.SYS	258. blocks
FCPMD1.TASK	62.
COT.TSK	24.
INI.TSK	34.
BAD.TSK	50.
UFD.TSK	7.
MOU.TSK	24.
MCR.TSK	28.
LOA.TSK	29.
PIP.TSK	69.
DYDRV.TSK	5.
DYDRV.STB	1.
DLDRV.TSK	4.
DLDRV.STB.	1.

The following files are required for the VMR phase and can be copied over individually as necessary.

RSX11M.STB	11. blocks
RSX11M.TSK	130.
LDR.TSK	5.

TTDRV.TSK	18.
TTDRV.STB	5.
SAV.TSK	65.
BOO.TSK	22.
INS.TSK	27.
VMR.TSK	142.
IND.TSK	101.

Appendix A contains a directory listing of a double-sided, double-density floppy diskette that includes all files needed for both booting from the DY: and the final VMR of the DSD 880 winchester.

Once the DL volume is initialized and UFDs have been created, additional files can be transfered from the floppy to the winchester as necessary. Appendix B contains a command files to perform this transfer (DLRSX.CMD, DYRSX.CMD).

When the files are transferred onto the winchester, install VMR and IND, then perform the final VMR phase. Appendix B contains command files to setup and perform the VMR (DLSYSV.CMD, DYSYSV.CMD).

After the VMR is complete, the system image can be booted and run.

4.0 OPERATION

4.1 General Information

This chapter provides information on the operation of the DSD 880 Data Storage System. Included are operating parameters, mode/class selection, system initialization, bootstrapping, diskette formatting, and backup operation.

4.2 Power On Self Tests

When power is applied to the DSD 880, the controller automatically performs four self-tests:

a. ALU Test
b. Internal RAM Memory Test
c. CRC Logic Test
d. PLL Test

If any of these tests fail, an error code will be displayed on the HyperDiagnostics panel identifying the failure. If the tests are successfully passed, both the floppy disk and winchester drives are homed. The winchester drive will be write-protected for 2 minutes following a power on to allow thermal stabilization and the Winchester Ready Light will flash during this period. It is possible to read or boot from the winchester drive during this period.

4.3 Mode and Class Selection

DSD 880 mode and class of operation selection is made on the HyperDiagnostics panel. To gain access to the HyperDiagnostics panel, remove the front bezel by grasping the bezel on each side and pulling forward. Figure 4-1 shows the HyperDiagnostics control panel switches and indicators, and their location and function. Table 4-1 provides a summary of the indicators on the DSD 880 HyperDiagnostics panel and their purpose. Table 4-2 provides a summary of the mode and class setting available on the DSD 880.

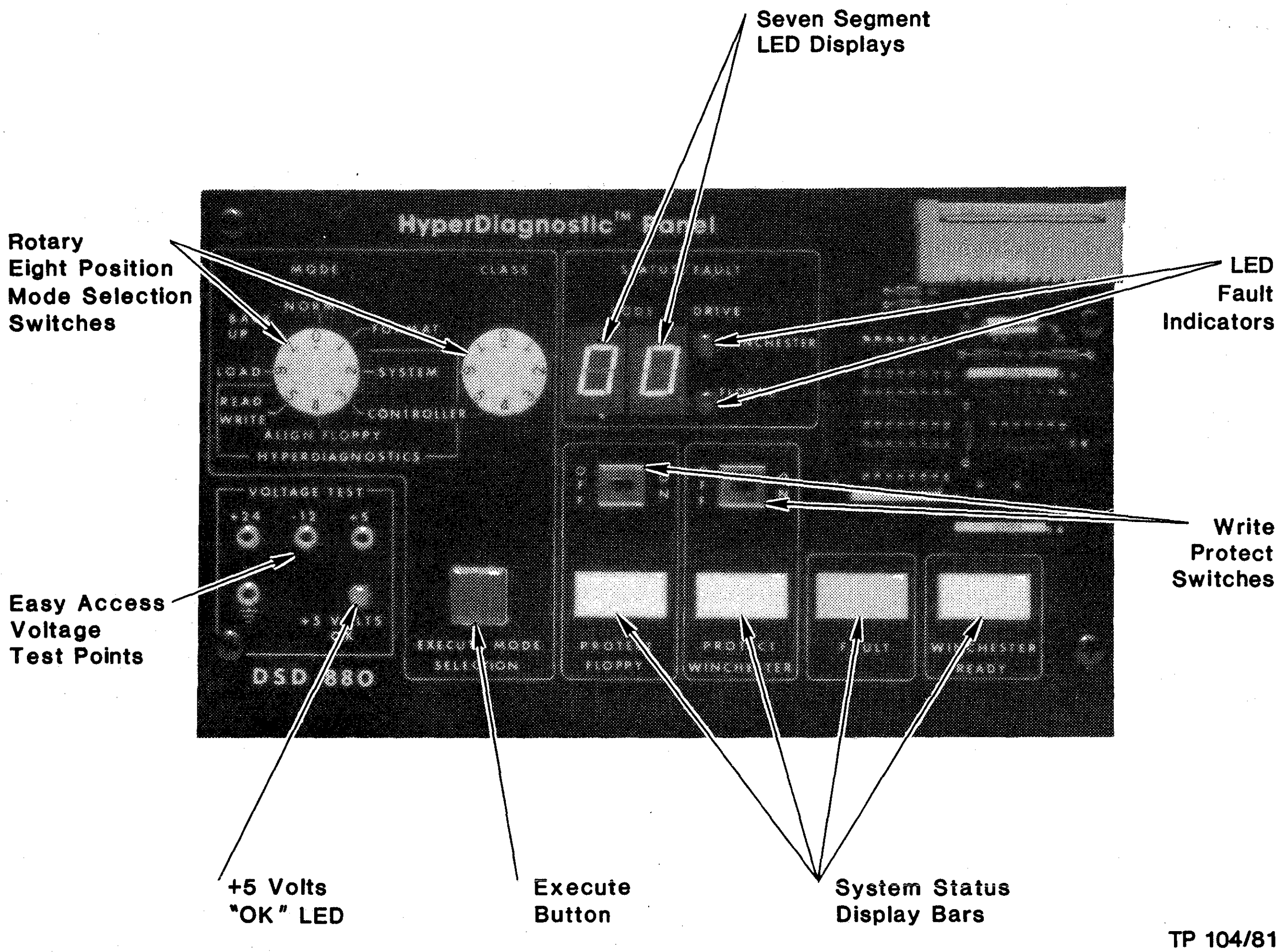


Figure 4-1. DSD 880 HyperDiagnostic Panel

Table 4-1. DSD 880 Indicators

Indicator	Purpose
Floppy Activity LED: (Located on the floppy disk drive front bezel)	This indicator illuminates whenever the head of the floppy disk drive is loaded. If the drive has a door lock mechanism, the door will be locked when the head is loaded.
Winchester Drive Ready LED: (Visible without removal of front bezel)	This indicator has several modes of operation. a. The indicator will flash for approximately 2 minutes after power is applied to the DSD 880. During this time, the winchester drive will be write protected. This time is required to allow the media and drive to thermally stabilize.

Table 4-1. DSD 880 Indicators (Cont)

Indicator	Purpose
	b. Approximately 2 minutes after power is applied to the unit the indicator will stop flashing and remain illuminated, if the bad track map has been read successfully, indicating that the drive is fully operational. c. Each time the winchester drive is accessed via a read or write command the indicator will flicker, indicating that the drive is busy (not ready). d. If a drive fault occurs which causes the winchester disk drive to be inoperative, the indicator will be extinguished until the fault is cleared.
Floppy Write Protect LED:	This indicator is illuminated whenever the floppy disk drive is write protected, either by the write protect switch on the front panel, or by the presence of a write protected floppy disk.
Winchester Drive Write Protect LED: (Visible without removal of front bezel)	This indicator is illuminated whenever the winchester disk drive is write protected by the write protect switch on the front panel.
Fault LED: (Visible without removal of front bezel)	This indicator flashes for approximately 1 minute after an error occurs during the execution of a command. After approximately 1 minute, the indicator will cease flashing and illuminate steadily until the current error is cleared. If another error occurs before the original error is cleared, the indicator light will again flash for approximately 1 minute from the occurrence of that error. The indicator will be immediately extinguished by a bus initialize from the host processor.
Floppy Error LED:	This indicator flashes whenever the error being displayed by the 7 segment displays occurred on the floppy disk drive.
Winchester Error LED:	This indicator flashes whenever the error being displayed by the 7 segment displays occurred on the winchester disk drive.

Table 4-1. DSD 880 Indicators (Cont)

Indicator	Purpose
Seven Segment Error Displays (2):	These indicators flash the definitive error code for the most recent error. The error is flashed from the time the error occurs until approximately 1 minute after the error is cleared. A bus initialize from the host processor will immediately clear all errors. When there are no errors present, the code 00 will be displayed. NOTE During HyperDiagnostics tests, the selected test code will be displayed until either the test completes without error (00 displayed), or an error occurs (definitive error code flashing). If errors exist on both winchester and floppy drives, the 7 segment error displays will indicate the most recent error, and the appropriate floppy or winchester error LED will flash. The other (earlier) error LED will be on continuously. If the "most recent" error is cleared, the 7 segment error displays will begin to flash the error for the other drive.
5 Volts OK LED:	This indicator will be illuminated when the main 5 volt power supply of the DSD 880 is operating within specification.

Table 4-2. DSD 880 Mode and Class Options

Switch Settings Mode	Class	Descriptions
0	0	In this mode, called the "Normal" mode, the winchester drive emulates a single RL01. User has access to 5.3 MB of storage on the winchester drive. The RL01 emulation is totally software compatible with DEC.
0	1	In this mode, called the "Extended" mode, the winchester drive emulates a "diminished" RL02. User has access to 7.8 MB of storage on the winchester drive. For required modification to DEC software, see Chapter 5 of this manual. NOTE In both the above modes, the flexible disk drive emulates an RX02. Double sided operation may be activated by incorporating the procedures outlined in Capter 5 of this manual.
0	2	This mode is called the "Direct Access" mode and allows the user to access each physical track on the winchester drive. This mode is used for maintenance purposes.
1	0	FORMAT DOUBLE-DENSITY - formats entire floppy disk in DEC double-density.
1	1	FORMAT SINGLE-DENSITY - formats entire floppy disk in DEC/IBM single-density.
1	2	SET MEDIA DOUBLE-DENSITY - sets the floppy media to double-density.
1	3	SET MEDIA SINGLE-DENSITY - sets the floppy media to single-density.
1	4	SET MEDIA DOUBLE-DENSITY AND SCAN - writes all data feeds in DEC double-density format, then scans the disk looking for errors.
1	5	SET MEDIA SINGLE-DENSITY AND SCAN - writes all data fields in DEC/IBM single-density format, then scans the disk looking for errors.

Table 4-2. DSD 880 Mode and Class Options (Cont)

Switch Settings		Descriptions
Mode	Class	
2	0	FLOPPY DISK EXERCISER WITH WRITE FORMAT - runs the following sequence of HyperDiagnostics tests on the floppy drive only: a. Hardware Self-Tests b. Single Density Write Format c. Sequential Scan All Sectors d. Butterfly Read Headers e. Sequential Write/Read All Sectors f. Set Media Double Density g. Sequential Scan All Sectors h. Butterfly Read Headers i. Sequential Write/Read All Sectors j. Set Media Single Density
2	1	FLOPPY DISK EXERCISER WITHOUT WRITE FORMAT - runs the same sequence of tests as the floppy disk exerciser described previously with the exception of the single density write format.
2	2	FIXED DISK EXERCISER - runs the following sequence of HyperDiagnostics tests on the fixed disk drive only: a. Hardware Self-Tests b. Sequential Scan All Sectors c. Butterfly Read Headers d. Sequential Write/Read All Sectors
2	3	GENERAL EXERCISER WITH FLOPPY DISK WRITE FORMAT - runs the floppy disk general exerciser then runs the fixed disk exerciser tests.
2	4	SINGLE PASS GENERAL EXERCISER WITH FLOPPY WRITE FORMAT - runs a single pass of the floppy and fixed disk exercisers.
2	5	SINGLE PASS GENERAL EXERCISER WITHOUT FLOPPY WRITE FORMAT - runs a single pass of the floppy and fixed disk exercisers without formatting the floppy disk.
2	6	GENERAL EXERCISER WITHOUT FLOPPY WRITE FORMAT AND FIXED READ/WRITE TESTS - runs the floppy disk general exerciser without formatting the floppy disk, then runs the fixed disk exerciser without executing the sequential write/read tests.

Table 4-2. DSD 880 Mode and Class Options (Cont)

Switch Settings		Descriptions
Mode	Class	
2	7	FIXED DISK EXERCISER WRITE ENABLE - permits sequential write operations on the winchester disk. (For tests 2,3,4,5.)
3	0	CONTROLLER SWITCH AND INDICATOR TEST - tests the various controller switches and indicators.
3	1	GENERAL CONTROLLER HARDWARE TEST - runs the following controller hardware diagnostics: a. ALU test b. Memory test c. CRC logic test d. PLL test
3	2	ALU LOGIC TEST - tests the operation of the arithmetic - logic unit.
3	3	MEMORY TEST - tests the operation of the RAM buffer memory.
3	4	CRC LOGIC TEST - tests the operation of the CRC logic.
3	5	PLL TEST - tests the operation of the phase locked loop.
3	6	MICROCODE VERSION - displays the microcode version number.
3	7	not defined.
		NOTE The following floppy disk drive alignment tests can be run without media in the floppy drive.
4	0	FLOPPY DISK TRACK 00 DETECTOR ADJUSTMENT - loads floppy head and repeatedly seeks between track 00 and 01 every 100 ms.
4	1	FLOPPY DISK SEEK TRACK 01 AND LOAD HEAD - seeks floppy head to track 01 and loads it.
4	2	FLOPPY DISK SEEK TRACK 02 AND LOAD HEAD - seeks floppy head to track 02 and loads it.

Table 4-2. DSD 880 Mode and Class Options (Cont)

Switch Settings: Mode	Class	Descriptions
4	3	FLOPPY DISK SEEK TRACK 38 AND LOAD HEAD - seeks floppy head to track 38 and loads it.
4	4	FLOPPY DISK SEEK TRACK 76 AND LOAD HEAD - seeks floppy head to track 76 and loads it.
4	5	FLOPPY DISK HEAD LOAD TIMING ADJUSTMENT - seeks floppy head to track 00 then alternately loads and unloads head every 100 ms.
5	0	SINGLE PASS SEQUENTIAL SCAN FLOPPY DISK - scans entire floppy disk for CRC errors and valid disk headers only once.
5	1	BUTTERFLY SEEK TEST FLOPPY DISK DRIVE - steps head of floppy disk drive using butterfly pattern then seeks tack 00. NOTE This test can be run without media in the floppy drive.
5	2	BUTTERFLY READ HEADERS ON FLOPPY DISK - steps head of floppy disk driving using butterfly pattern, checking for correct disk headers.
5	3	SEQUENTIAL WRITE/READ FLOPPY DISK - sequentially writes then reads the entire floppy disk checking for data or header errors.
5	4	SEQUENTIAL SCAN FIXED DISK - scans entire fixed disk for CRC errors and valid disk headers.
5	5	BUTTERFLY READ HEADERS ON FIXED DISK - steps head of fixed disk drive using butterfly pattern, checking for correct disk headers.
5	6	SEQUENTIAL WRITE/READ FIXED DISK - sequentially writes then reads the entire winchester disk.
5	7	FIXED DISK WRITE ENABLE - permits sequential write operation on the winchester disk. (For test 6.)

Table 4-2. DSD 880 Mode and Class Options (Cont)

Switch Settings		Descriptions
Mode	Class	
6	0	RELOAD WINCHESTER FROM BACKUP FLOPPY DISKS - copies the data from valid backup floppy disks onto the winchester disk.
6	1	RELOAD AND VERIFY WINCHESTER FROM BACKUP FLOPPY DISKS - copies the data from valid backup floppy disks onto the winchester disk, verifies that each backup disk was copied correctly.
7	0	BACKUP WINCHESTER ONTO FLOPPY DISKS - copies the data on the winchester disk onto backup floppy disks.
7	1	BACKUP WITH VERIFY WINCHESTER ONTO FLOPPY DISKS - copies the data on the winchester disk onto backup floppy disks. Verifies that the data was written correctly onto each floppy disk.
7	2	BACKUP WINCHESTER ONTO FLOPPY DISKS WITH DOUBLE-DENSITY FORMAT - formats the floppy disk in double-density, then copies the data on the winchester disk onto the floppy disk.
7	3	BACKUP WINCHESTER ONTO FLOPPY DISKS WITH DOUBLE-DENSITY FORMAT AND VERIFY - formats the floppy disks in double-density, copies the winchester data onto the floppy disks, then verifies that the data was written correctly onto each floppy disk.
7	4	BACKUP WITH SINGLE-DENSITY FORMAT - formats the floppy disks in single-density then copies the data on the winchester disk onto the floppy disk.
7	5	BACKUP WITH SINGLE-DENSITY FORMAT AND VERIFY - formats the floppy disks in single-density, copies the winchester data onto the floppy disks, then verifies that the data was written correctly onto each floppy disk.

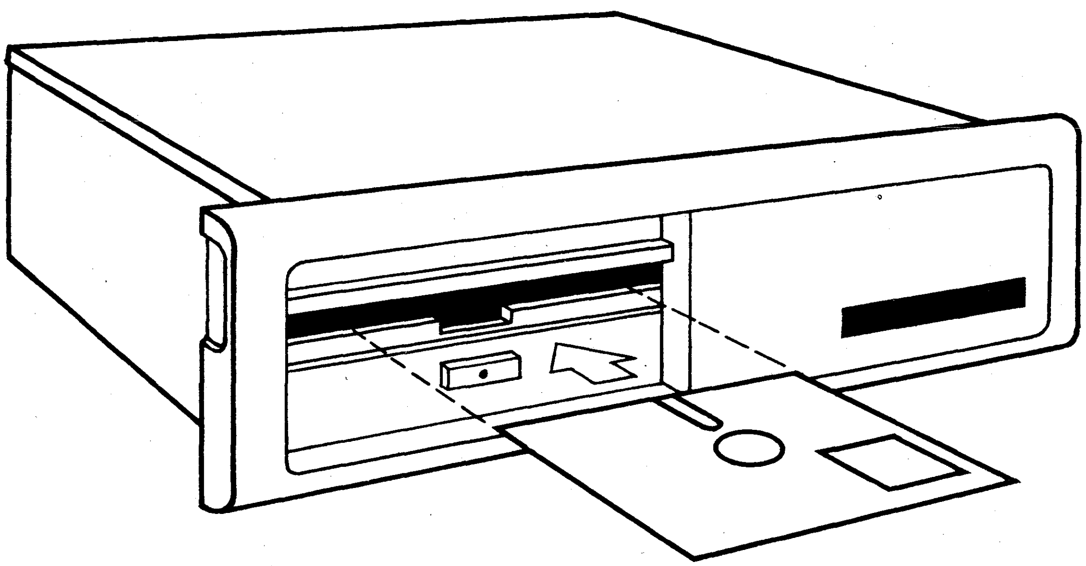
4.4 Normal Operation

Prior to placing the DSD 880 into operation, insert a diskette into the floppy disk drive. Ensure the diskette is a soft sectored, eight-inch diskette (see Figure 4-2 for diskette orientation for insertion). Close the drive door. Select mode of operation that matches the operating system parameters (refer to Table 4-2 for DSD 880 Mode and Class option).

CAUTION

If the DSD 880 is not in the Normal mode at the time a Bus Init is generated by the host processor, the DSD 880 controller will terminate any HyperDiagnostic test which may be occurring, force the mode and class to 0 and then initialize (home) the floppy and winchester disk drives.

If the mode is 0 (Normal) at the time of a Bus Init, the DSD 880 controller will determine if the class is a valid Normal class (0-2). If the class is invalid, the controller will force the class to be 0.



TP 105/81

Figure 4-2. Proper Orientation of Diskette for Insertion

4.4.1 System Bootstrapping

A hardware bootstrap is built into the DSD 880 LSI-11 and PDP-11 interfaces, eliminating the need to buy the expensive DEC bootstrap options (BDV11 bootstrap card or MXV11 multifunction card for LSI-11 or LSI 11/23 systems, MR11EA bootstrap PDP-11 systems).

The 880 system can boot using either the winchester drive or the flexible disk drive.

For LSI-11 systems, the 880 system can be bootstrapped in either power up mode. In power up mode 1, the LSI-11 processor enters console ODT immediately on power up. The user may select the bootstrap device by entering the appropriate starting address at the console. For example, if the standard bootstrap base address is used, bootstrapping on the winchester may be initiated by entering "773000G". Entering "7730020G" initiates bootstrap on the floppy disk.

In power up mode 2, the LSI-11 Program Counter is automatically set at 173000 on power up. Hence, the sytem automatically attemps to boot on the winchester. If the winchester is not bootable, the system loops at 773210 to 773274. The user may force bootstrapping on the floppy disk by entering the appropriate address at the console. For the LSI-11/23, the mode 2 power up address is user programmable. The DSD 880 hardware bootstrap automatically performs certain operations and conducts tests to verify correct operation of the interface, the controller and the processor memory. The operation is illustrated in the flow chart of Figure 4-3. A listing is provided in Table 4-6.

The DSD880 bootstrap program consists of 3 or 4 procedures, depending on the device to be booted:

Determines the selected Bootstrap device (RL or RX).

Sizes memory, then checks memory for failing data or address bits.

RL BOOT - Reads Block 0 from RL unit 0, then starts at location 0.

RX BOOT - Performs fill-empty test on DSD880 RX02 device which verifies operation of available DMA address lines and RX02 sector buffer.

RX BOOT - Reads Block 0 from RX unit 0, then starts at location 0.

Table 4-3 provides a listing of the DSD 880 interface bootstrap program starting address and device addresses.

After completion of a successful system bootstrap, the DSD 880 will have completed an initialization sequence, assumed the mode of operation selected and be ready to complete data storage and retrieval tasks as directed by the host computer.

Table 4-3. DSD 880 Interface Bootstrap Program Starting Addresses and Device Addresses

Bootstrap Offset	Standard Bootstrap Address		Bootstrap Device	Device Address
	PDP-11	LSI-11		
+ 0	771000	773000	Winchester	774400
+ 10	771010	773010	Winchester	774410
+ 20	771020	773020	Floppy	777170
+ 30	771030	773030	Floppy	777150
+ 36	771036	773036	— User Defined —	

4.5 Bootstrap Failure Procedure

At each stage in the bootstrap there are locations where failures will cause the bootstrap routine either to halt, or loop waiting for an action to occur.

Processor Halts - The processor RUN indicator will be extinguished on PDP-11 and LSI-11 front panels.

On processors with ODT and a console terminal, there will be an ODT prompt on the console.

Program Loops - The processor RUN indicator will be illuminated on PDP-11 and LSI-11 front panels.

Program Loops can be halted by typing "BREAK" on the console terminal, if ODT is available, and halt on "BREAK" is enabled. On PDP-11s without ODT enter CONTROL HALT from the front panel.

4.5.1 Troubleshooting Bootstrap Failures

If the program is stuck in a loop (i.e., not halted though not booted after approximately 30 seconds), manually halt the program via the console or front panel. Note the address at which the program halts and any error reported by the DSD 880 front panel. Tables 4-4 and 4-5 provide a listing of bootstrap belt location, the possible cause of the halt, and procedure for solving the problem.

If you are unable to manually halt the program, or a PDP-11 "BUS ERROR" occurs:

Verify the DSD 880 interface jumper configuration.
Verify the backplane jumpers for DMA and INTERRUPT grants.
Verify correct installation of the DSD 880 interface in the backplane.

Table 4-4. Program Halt Locations
(Referenced to Bootstrap Base Address)

XXX002	Fault:	Bootstrap does not respond
	Possible cause:	DSD 880 Bootstrap not enabled Bootstrap starting address incorrectly configured Defective DSD 880 interface Memory address range extends into bootstrap area
	Troubleshooting:	Verify configuration of DSD 880 interface jumpers Verify ability to access bootstrap starting address without error (should contain 12737)
XXX244	Fault:	RL device reported error following READ SECTOR operation
	Possible cause:	Unable to read sector from RL Defective DSD 880 controller Defective winchester disk drive
	Troubleshooting:	Verify integrity of DSD 880 winchester bad track map Service DSD 880 controller PCB assembly Service winchester disk drive assembly
XXX276	Fault:	Processor memory error (at location R4 , Read R0 expected R4)
	Possible cause:	Defective host processor memory Defective host processor Refresh for dynamic memory board defective
	Troubleshooting:	Verify ability to access failing memory location Verify dynamic memory refresh (deposit 125252, wait 2 minutes, verify contents unchanged) Use DEC memory diagnostics to verify failure Replace failing memory module
XXX324	Fault:	Processor memory error (at location -2 R4 , Read R0 expected 0)
	Possible cause:	Defective host processory memory Defective host processor Refresh for dynamic memory board defective
	Troubleshooting:	Verify ability to access failing memory location Verify dynamic memory refresh (deposit 125252, wait 2 minutes , verify contents unchanged) Use DEC memory diagnostics to verify failure Replace failing memory module

Table 4-4. Program Halt Locations (Cont)
(Referenced to Bootstrap Base Address)

XXX372	Fault:	Processor memory error (if R5-Boot Base address + 112, R6=5002) Fill-Empty error (if R5=Boot Base address + 522, R6=5000)
	Possible cause:	KD11-F processor is being used to refresh external RAM Defective host processor memory Defective DSD 880 controller if fill-empty error
	Troubleshooting:	If KD11-F uses REV-11 or on board memory refresh Use DEC memory diagnostics to verify failure Replace failing memory module Service DSD 880 controller PCB assembly
XXX436	Fault:	Error flag in RXCS set following bus initialize
	Possible cause:	Interface cable not properly installed AC power to DSD 880 chassis not turned on Unable to read sector from floppy disk DSD 880 controller failed initialize test sequence Defective DSD 880 controller
	Troubleshooting:	Verify installation of DSD 880 interface cable Verify ac power to DSD 880 chassis Verify controller passes initialize test sequence Verify that floppy drive is properly configured for operating voltage and frequency Replace floppy disk media Service DSD 880 controller PCB assembly
XXX452	Fault:	RXCS does not latch appropriate bits (5460)
	Possible cause:	Interface defective
	Troubleshooting:	Service interface PCB assembly
XXX474	Fault:	RXDB does not latch appropriate bits (1420, 173767)
	Possible cause:	Interface defective
	Troubleshooting:	Service interface PCB assembly

Table 4-4. Program Halt Locations (Cont)
(Referenced to Bootstrap Base Address)

XXX614	Fault:	RX02 device reported error following READ SECTOR operation (Definitive error code in R6)
	Possible cause:	Disk not inserted in floppy drive Floppy disk door open Double-sided floppy disk in single-sided drive Defective floppy disk media Incorrectly configured floppy disk drive (ac voltage and frequency) Defective floppy disk drive Defective DSD 880 controller
	Troubleshooting:	Verify installation of floppy disk media in drive Replace floppy disk media Verify drive configuration Service floppy disk drive Service DSD 880 controller PCB assembly

Table 4-5. Program Loops
(Referenced to Bootstrap Base Address)

XXX152-156	Fault:	RL controller not ready following bus initialize
	Possible cause:	Interface cable not properly installed DSD 880 controller failed initialization test sequence AC power to DSD 880 chassis not turned on
	Troubleshooting:	Verify installation of DSD 880 interface cable Verify ac power to DSD 880 chassis Verify controller passes intialization test sequence Service DSD 880 controller PCB assembly
XXX154	Fault:	Interface does not respond to RLCS address
	Possible cause:	Incorrectly configured RL device address jumpers Incorrectly specified bootstrap starting address Defective interface
	Troubleshooting:	Verify interface jumper configuration Verify interface response at expected device addresses Service interface PCB assembly
XXX172-174	Fault:	RL controller not ready following GET STATUS command
	Possible cause:	Defective DSD 880 controller Defective interface
	Troubleshooting:	Service DSD 880 controller PCB assembly Service interface PBC assembly
XXX210-212	Fault:	RL controller not ready following SEEK command
	Possible cause:	Defective DSD 880 controller Defective interface
	Troubleshooting:	Service DSD 880 controller PCB assembly Service interface PBC assembly
XXX232-234	Fault:	RL controller not ready following READ SECTOR command
	Possible cause:	Defective DSD 880 controller Defective interface
	Troubleshooting:	Service DSD 880 controller PCB assembly Service interface PBC assembly

Table 4-5. Program Loops (Cont)
(Referenced to Bootstrap Base Address)

XXX426	Fault:	Interface does not respond to RXCS address
	Possible cause:	Incorrectly configured RX device address jumpers Incorrectly specified bootstrap starting address Defective interface
	Troubleshooting:	Verify interface jumper configuration Verify interface response at expected device address Service interface PCB assembly
XXX506-510 XXX514-516	Fault:	Transfer request error during RX02 fill buffer test
	Possible cause:	Defective interface Defective DSD 880 controller
	Troubleshooting:	Service interface PCB assembly Service DSD 880 controller PCB assembly
XXX536-540 XXX544-546	Fault:	Transfer request error during RX02 empty buffer test
	Possible cause:	Defective interface Defective DSD 880 controller
	Troubleshooting:	Service interface PCB assembly Service DSD 880 controller PCB assembly
XXX646-650 XXX654-656	Fault:	Transfer request error during RX02 READ SECTOR command
	Possible cause:	Defective interface Defective DSD 880 controller
	Troubleshooting:	Service interface PCB assembly Service DSD 880 controller PCB assembly
XXX724-726 XXX734-736	Fault:	Transfer request error during RX02 EMPTY BUFFER command
	Possible cause:	Defective interface Defective DSD 880 controller
	Troubleshooting:	Service interface PCB assembly Service DSD 880 controller PCB assembly

Table 4-5. Program Loops (Cont)
(Referenced to Bootstrap Base Address)

XXX770-774	Fault:	DONE flag error during RX02 command
	Possible cause:	Defective interface Defective DSD 880 controller
	Troubleshooting:	Service interface PCB assembly Service DSD 880 controller PCB assembly

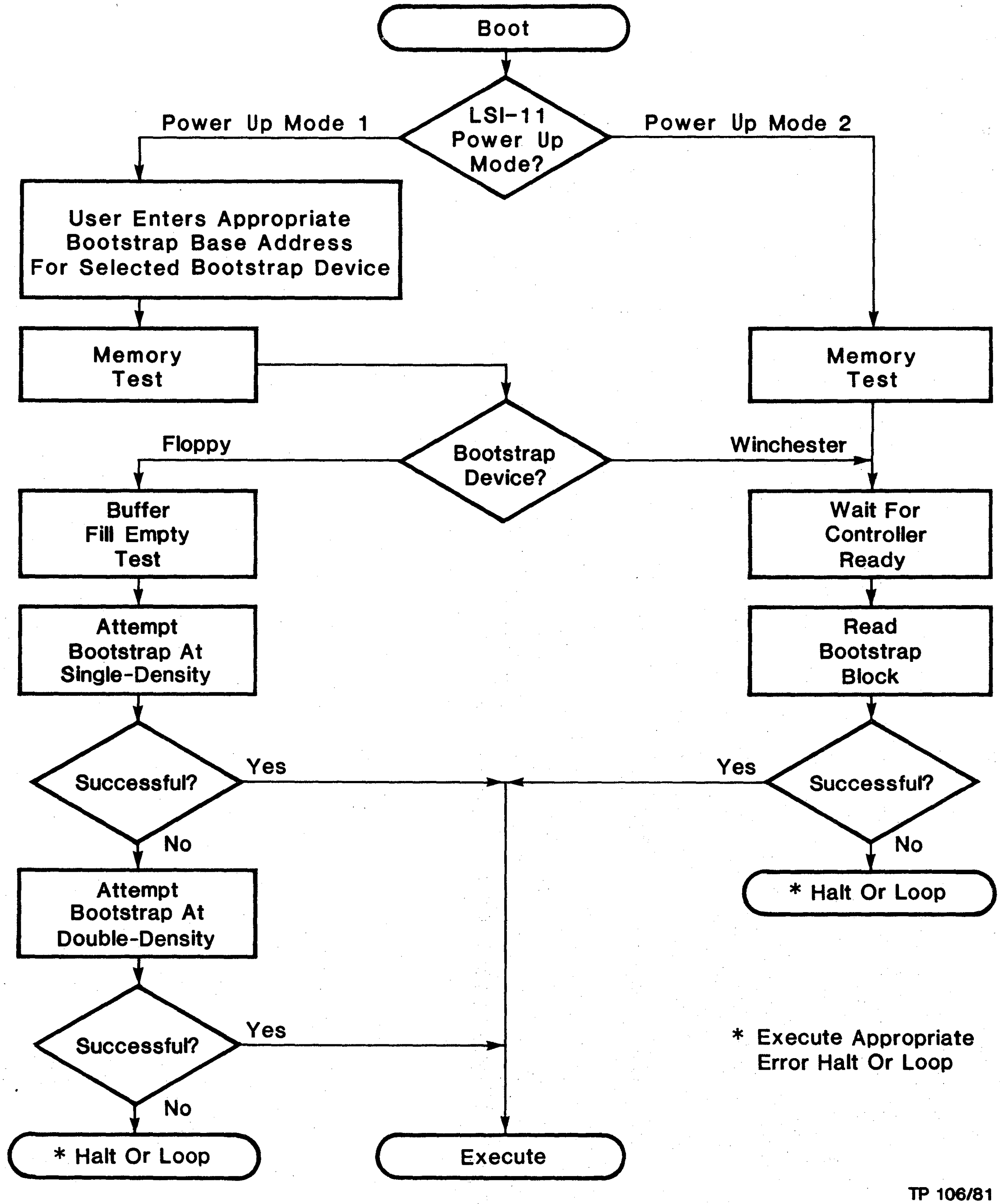


Figure 4-3. Bootstrap Flow Diagram

4.6 Off-Line Operation

In addition to normal computer controlled operations, the DSD 880 is capable of various supplemental operations under internal control. These operations include Format, Reload, Backup, and HyperDiagnostics. Table 4-2 gives the mode and class switch settings for selection of the options available under each type of operation.

CAUTION

> To ensure operating system integrity, no attempt to access the DSD 880 from the host computer should be made while using the DSD 880 off-line capabilities.

Performance of a DSD 880 off-line function is achieved by first ensuring no DSD 880 computer controlled operation is taking place, selection of the desired function on the mode and class switches on the DSD 880 control panel, and pushing the Execute button once. At the completion of the selected operation, return the mode and class switches to the desired normal operating mode and push the Execute button once to return to normal computer controlled operation.

4.6.1 Format Mode

The Format Mode (mode 1, class 0) is used to format the entire floppy disk in DEC double-density format or (mode 1, class 1) to format the entire floppy disk in DEC/IBM single-density format.

4.6.2 Backup and Reload Modes

The DSD 880 Data Storage System provides the user with the facility to transfer data between the nonremovable winchester disk and floppy disks without the intervention of a host processor. The resulting Backup floppy disks are physical images of the winchester and may be used to regenerate the winchester disk data on the original or any other DSD 880 winchester disk.

Data integrity may be verified by selecting a Backup or a Reload routine which includes a verify pass. The verify routine will be executed following the reload or backup routine and compares the data on the backup floppy to the data on the winchester. If data does not compare, a 30 error will be reported and the verify routine will terminate.

CAUTION

> There are several precautions which should be observed when using the DSD 880 BACKUP and RELOAD facilities.

Backup

Since the Backup routine cannot determine the extent of valid data on the winchester disk, it is designed to copy the entire winchester disk onto the backup floppy disks. Each time a backup is initiated a unique version number is recorded on the backup floppy disks along with the disk number.

The entire winchester disk should be backed up, regardless of the actual amount of disk space used. Therefore, continue the Backup process until the code 00 is displayed by the 7 segment displays.

A complete winchester backup requires the following numbers of floppy disks:

Single-Density, Single-Sided	- 36
Single-Density, Single-Sided	- 18
Double-Density, Double-Sided	- 18
Double-Density, Double-Sided	- 9

If an unrecoverable floppy disk errors occurs during the backup, try another disk. The Backup routine will restart at the beginning of the floppy disk on which the failure occurred.

The error recovery abilities of the Backup routine are limited. Therefore, it is highly recommended that the Backup process be done regularly, prior to any winchester disk failures. It is not possible to backup a winchester disk with hard read errors. However, if the winchester disk has soft header or data CRC errors, the Backup routine will retry 16 times before declaring the sector's data invalid.

If the Backup routine retries 16 times and is unsuccessful in reading a winchester sector with CRC errors, it will flag the floppy data with a deleted data mark and continue to the next sector. In this manner, it is possible to successfully backup a winchester disk with hard CRC errors; however, the data for that sector stored on the backup floppy disk may be invalid.

The Backup routine takes bad tracks into account. Therefore, it is possible to transfer winchester disk images between winchester disk drives with different bad track maps.

Reload

The Reload routine does not keep track of how many Backup disks have been reloaded onto the winchester. For this reason, it is necessary that the operator conscientiously reload the entire complement of backup floppy disks. Record keeping will be aided by the display of the Backup disk number on the 7 segment indicators.

Since each backup disk is uniquely identified as to backup version number, it is not possible to intermix the disks of backups which were done at different times.

The Reload routine is limited in its error recovery abilities. If a hard read or write error is encountered, the routine will terminate.

CRC error on the floppy or winchester disks will be retried 16 times before the Reload routine aborts.

If a deleted data mark is detected on the backup floppy disk in the course of reloading, a 45 error will be displayed by the 7 segment indicators. The user should be aware that one or more winchester sectors were unrecoverable at the time of the backup.

4.6.3 Backing up the Winchester Disk onto Floppy Disks

There are 6 possible backup classes which may be selected on the DSD 880.

Mode	Class	Description
7	0	Backup without format or verify
7	1	Backup without format, with verify
7	2	Backup with double-density format, without verify
7	3	Backup with double-density format and verify
7	4	Backup with single-density format, without verify
7	5	Backup with single-density format and verify

Select the appropriate backup class and set the MODE and CLASS switches accordingly, insert a floppy disk into the floppy drive, close the door, and momentarily depress the EXECUTE pushbutton.

The 7 segment displays will echo the switch setting for as long as the EXECUTE pushbutton is depressed.

When the execute button is released, the controller will display the current floppy disk volume number (starting from 1), lock the door of the floppy drive, and write a unique disk identifier on track 00 of the floppy disk. The disk identifier contains the disk volume number, backup version number starting winchester disk address of the data, and number of sectors of winchester data contained on the floppy.

The controller will then copy the appropriate winchester data onto the floppy from the winchester.

When the operation is complete the controller will unlock the door of the floppy drive. When the door of the floppy drive is opened, the controller will increment the disk volume number being displayed.

Repeat the preceding steps until the 7 segment display again displays 00 indicating that the winchester drive has been successfully backed up.

Select the desired operating mode of the DSD 880, set the switches accordingly, and momentarily depress the EXECUTE pushbutton. The 7 segment display will indicate the selected MODE and CLASS until the pushbutton is released and execution begins.

Error Reporting During Backup

1. If a hard error occurs on the floppy drive while the controller is writing to the floppy disk, the operation will terminate. To continue backup, remove the bad disk from the floppy drive and replace it with a new one, then close the door and momentarily depress the execute pushbutton again. The controller will attempt to recopy the data onto the new disk and continue where it left off.

2. If header and errors occur while copying the floppy, the operator may either insert a new disk into the drive and continue as above, or may select one of the backup classes which will format the floppy before attempting to copy from the winchester and use the same disk again.

3. If unrecoverable CRC errors occur on the winchester drive during the backup procedure, the controller will write deleted data marks on the floppy for the length of the unrecoverable error code on the 7 segment displays. The controller will continue writing deleted data on the floppy until recoverable winchester data is found or the floppy is full.

4.6.4 Reloading the Winchester Disk from Floppy Disks

There are two possible classes which may be selected on the DSD 880.

Mode	Class	Description
6	0	Reload without verify
6	1	Reload with verify

Insert the first disk to be reloaded into the floppy disk drive and close the drive door.

Start the reload program by selecting the desired MODE and CLASS, and momentarily depressing the EXECUTE pushbutton.

The 7 segment displays will echo the switch setting for as long as the EXECUTE pushbutton is depressed.

When the execute botton is released, the controller will lock the door of the floppy drive and read the disk identifier. If the identifier is valid, the controller will display the disk volume number in the 7 segment displays and proceed to copy the contents of the floppy disk onto the winchester disk.

When the controller has successfully copied the contents of the floppy onto the winchester, it will unlock the door of the floppy drive and display 00 on the 7 segment displays.

Repeat steps A and B until all the floppy disks have been reloaded.

Select the desired operating mode of the DSD 880, set the switches accordingly, and momentarily depress the EXECUTE pushbutton. The 7 segment displays will indicate the selected MODE and CLASS until the pushbutton is released and execution begins.

Error Reporting During Reload

1. If a hard error occurs during reading the floppy, the same disk may be retried by depressing the EXECUTE pushbutton again. If the error occurs again, the disk may be skipped entirely by removing it and inserting the next disk to be reloaded before depressing the EXECUTE pushbutton.

2. If a disk with an invalid disk identifier is detected, the controller will report an error. The invalid disk must be removed and a valid disk inserted before depressing the EXECUTE pushbutton.

3. If a hard error occurs while the controller is writing to the winchester, the controller will report an error and terminate the reload procedure.

4. An error is indicated by flashing the appropriate error code in the 7 segment displays and illuminating the fault and appropriate drive error indicators.

5. If a deleted data mark is detected on the floppy disk during the reload operation, the reload routine will report a deleted data error and continue to copy the questionable data onto the winchester disk.

4.6.5 HyperDiagnostics Mode

The DSD 880 HyperDiagnostics may be used to verify system integrity, troubleshooting and fault isolation. An expanded description of the HyperDiagnostics and their use is provided in Chapter 7 of this manual.

Table 4-6. DSD 880 Bootstrap Program Listing

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00
TABLE OF CONTENTS

    1-   8       LSI-11 VERSION
    3-   1       RL COMPATIBLE BOOT
```

Table 4-6. DSD 880 Bootstrap Program Listing (Cont)

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00 PAGE 1

                .TITLE  DSD 880 BOOTSTRAP PROM
                ; BOT880.MAC    30-JUL-80-1
 .SBTTL LSI-11 VERSION
; BOOTSTRAP FOR DSD880 FLOPPY / WINCHESTER DISK CONTROLLER
; BOOTS EITHER SINGLE OR DOUBLE DENSITY FLOPPIES
; NOTE - THE DISKETTE BEING BOOTED MUST HAVE THE CORRECT MONITOR
;       FOR THE EXISTING HARDWARE CONFIGURATION.
;**  NOTE ON BOOTING WHILE REAL TIME CLOCK IS ENABLED. **
; THIS BOOT CAN BE STARTED WITH A RUNNING REAL TIME CLOCK IN 2 WAYS.
; 1) ENSURING THAT THE STACK IS POINTING TO NON-EXISTANT MEMORY THUS
;    FORCING A DOUBLE BUS ERROR ON ANY INTERRUPT AND TYPING
;    "773000G"  AND TYPING "P" IF HALTS OCCUR DUE TO ATTEMPTED INTERRUPTS.
; 2)  BY SETTING THE PSW AHEAD OF TIME TO DISABLE INTERRUPTS BY TYPING
;     "$S/ 340<CR>" AND "R7/ 773000<CR>" AND HITTING "P".

; THE BOOTSTRAP PROCEEDS IN 4 STEPS
; 1)     SELECT DEVICE    DETERMINES DEVICE TO BE BOOTED
; 2)     RAM TEST         CHECKS ALL AVAILABLE MEMORY FOR STUCK BITS
;                         ON BOTH DATA AND ADDRESS LINES. <0-30K>
;                         DOES BOTH DATA = ADDRESS AND PATTERN TESTS
;                         1) CLEARS MEMORY TO 0'S AND SIZES MEMORY
;                         2) LOADS MEMORY = ADDRESS AND CHECKS
;                         3) LOADS MEMORY = ADDRESS COMPLEMENT, CHECKS
;                         4) LOADS MEMORY WITH THE REPEATING PATTERN OF
;                            131617, 154707, 166343, 173161, 175470
; 3-WINCHESTER  READ IN BLOCK 0, START AT LOC 0.
; 3-DY  FILL-EMPTY        CHECKS DSD880 - PROCESSOR DATA PATH FOR
;                         SYNTAX AND DATA ERRORS.  ALSO INSURE'S ALL
;                         AVAILABLE ADDRESS LINES TOGGLE UNDER DMA.
;                         CHECKS FILL-EMPTY WITH BUFFERS AT 774,
;                         17700, 37676, 77704, 137700 IF MEMORY EXISTS.
; 4-DY  BOOTSTRAP         READS IN BLOCK 0 FROM DISKETTE IN CORRECT
;                         DENSITY AND STARTS AT LOC 0

; ERROR HALTS OR HANG UP LOOPS  (ADDRESSES RELATIVE TO BOOT BASE ADDR)
; 152-6 LOOP  RL CONTROLLER NOT READY
; 154   HANG    RL CONTROLLER NOT RESPONDING AT ADDRESS
; 172-174, 210-212, 232-234      RL TYPE CONTROLLER HUNG
; 276      HALT  MEMORY ERROR AT LOC -2(R4), READ R0, EXPECT ZERO
; 324      HALT  MEMORY ERROR AT -2(R4), READ R0, EXPECT 0
; 372      HALT  1) FILL-EMPTY ERROR IF R5=BOOT+522, SP=5000
;                2) MEMORY ERR IF R5=BOOT+112, SP=5002
; 426      LOOP   DY DEVICE ADDRESS SELECTED FOR BOOTING DOESN'T RESPOND
; 436      HALT  ERROR FLAG IN RXCS SET AFTER INIT
; 452      HALT  RXCS INTERFACE REGISTER STUCK BIT PROBLEM
; 474      HALT  RXDB INTERFACE LATCH PROBLEM, NOTE C(RXDB)
; 506-510, 514-516      TRANSFER REQUEST HANGUP  (FILL-EMPTY)
; 536-540, 544-546      TRANSFER REQUEST HANGUP  (FILL-EMPTY)

; 614    HALT      FLOPPY READ ERROR, PROCEED TO RETRY
;                  C(SP) = DEFINITIVE ERROR STATUS
;                  C(R5) = SECTOR # WITH PROBLEM
;       THIS USUALLY HAPPENS WITH A BAD DISKETTE AND MAY OCCUR
;       IF AN UN-BOOTABLE DISKETTE IS IN DRIVE 0.
; 646-650, 654-656      TRANSFER REQUEST HANGUP  (BOOTSTRAP)
; 724-726, 734-736      TRANSFER REQUEST HANGUP  (BOOTSTRAP)
; 770-774  LOOP DSD880 FLAG WAIT ROUTINE HANGUP
```

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00 PAGE 1-1
LSI-11 VERSION


        ; START ADDRESSES
        ; BOOT+0    (TYPICALLY 173000)  BOOTS RL DEVICE WITH RLCS AT 174400
        ; BOOT+10   (TYPICALLY 173010)  BOOTS RL DEVICE WITH RLCS AT 174410
        ; BOOT+20   (TYPICALLY 173020)  BOOTS DY DEVICE WITH RXCS AT 177170
        ; BOOT+30   (TYPICALLY 173030)  BOOTS DY DEVICE WITH RXCS AT 177150
        ; BOOT+36   (TYPICALLY 173036)  GENERAL DEVICE ENTRANCE - USER
        ;                 SET'S  LOCATION 0 = DESIRED RLCS OR RXCS
        ;                 NOTE: THE BIT OF VALUE 1000 MUST BE SET FOR RX BOOTING
        ;                         IF REAL TIME CLOCK MUST BE LEFT ON THEN SET
        ;                         $S/ 340<CR> AND R7/ 173040<CR> AND PROCEED

        ; A "BOOT" ON AN 11/04 OR 11/34 PRINTS R0, R4, SP, R7 ON THE TERMINAL.
        ; IF AN ERROR HALT OCCURS AT BOOT+774 WHILE BOOTING THEN
        ; BOOTING AGAIN ON AN 11/04 OR /34 PRINTS OUT THE FOLLOWING.
        ;       R0 = CURRENT DRIVE # BEING BOOTED FROM.
        ;       R4 = LOAD ADDRESS WHERE ERROR OCCURRED
        ;       SP = DEFINITIVE STATUS OF ERROR
        ;       R7 = ERROR HALT ADDR+2

        ; NOTE - A HALT OR HANGUP OCCURRING BETWEEN 742-746 THAT WILL NOT
        ;    RESPOND TO BREAK OR HALT IS GENERALLY DUE TO LACK OF DMA GRANT
        ;    CONTINUITY ON THE BUS. USER SHOULD PUT DSD880 INTERFACE CARD
        ;    CLOSER TO THE PROCESSOR AND ENSURE GRANT CONTINUITY.

        ; DSD880 - RX02 REGISTER SYNTAX DEFS
        RXCS=   177170
        ; ERR  INI XM XM  X02 ?? SID  DEN TRQ IEN  DON UN1 FUN  FUN FUN GO
                ;       100000   ; ERR   ERROR FLAG
                ;        40000   ; INI   LOAD INTO RXCS TO INITIALIZE
                ;        30000   ; XM    EXTENDED MEMORY SELECT BITS
                ;        4000    ; X02   = 1 FOR RX02 MODE SYNTAX
                ;        400     ; DEN   SET = 1 FOR DOUBLE DENSITY
                ;        200     ; TRQ   TRANSFER REQUEST - DATA TO/FROM RXDB
                ;        16      ; FUN   FUNCTION <0-7> - SET "GO" TO EXEC

        RXDB=RXCS+2              ; RXES ERROR BIT LAYOUT
        ;         NXM  WCV SID   DRV DRV DEL   DSK DEN ACL   INT SID CRC
        ;              OVF  #1    #1 RDY DAT   DEN ERR LOW   DON RDY ERR

        ; REGISTER USAGE IN BOT880 SECTION
        XCS=    %1        ; R1     POINTER TO RXCS
        XDB=    %2        ; R2     POINTER TO RXDB
                          ; R3     READ COMMAND VAL WITH DENSITY BIT
        LDP=    %4        ; R4     LOAD POINTER
        SCT=    %5        ; R5     CURRENT SECTOR # (1, 3, 5, 7)
                          ; (SP)   WORD COUNT FOR CURRENT DENSITY
```

Table 4-6. DSD 880 Bootstrap Program Listing (Cont)

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00 PAGE 2
LSI-11 VERSION

        ; RL01 / RL02 COMPATIBLE HARDWARE DEFS.
        RLCS=    174400  ; RL COMMAND STATUS REGISTER
        ; ERR  DE  NXM DLT  DCRC OPI DS1  DS0 CRDY IE  A17 A16 F2  F1 F0 DRDY
        ;               HNF  HCRC OPI
        ; RO   RO  RO  RO   RO   RO  R/W  R/W R/W  R/W R/W R/W RW  RW RW RO
        ; 15   14  13  12   11   10  09   08  07   06  05  04  03  02 01 00
        ;
        ; FUNCTIONS      0 0 0   00      NOOP
        ;                0 0 1   02      WRITE CHECK
        ;                0 1 0   04      GET STATUS
        ;                0 1 1   06      SEEK
        ;                1 0 0   10      READ HEADER
        ;                1 0 1   12      WRITE DATA
        ;                1 1 0   14      READ DATA
        ;                1 1 1   16      READ DATA - NO HEADER CHECK

        ; RLBA  = 174402        - BUS ADDRESS REGISTER
         .RLBA  = 2        ; OFFSET

        ; RLDA= 174404  - DISK ADDRESS REGISTER (SEEK)
         .RLDA= 4
        ; DF8  DF7 DF6 DF5  DF4 DF3 DF2  DF1 DF0 000  000 HS  000 DIR 000 001
        ;      DF7 - DF0       CYCLINDER DIFFERENCE TO SEEK
        ;      HS              SET = LOWER SIDE, CLEAR = UPPER
        ;      DIR             SET = SEEK INWARDS TOWARD SPINDLE
        ;                      CLR = SEEK OUTWARDS

        ; RLDA= 174404  - DISK ADDRESS DURING READ/WRITE DATA COMMANDS
        ; CA8  CA7 CA6 CA5  CA4 CA3 CA2  CA1 CA0 HS   SA5 SA4 SA3  SA2 SA1 SA0

        ;               - DISK ADDRESS DURING GET STATUS COMMAND
        ; 000  000 000 000  000 000 000  000 000 000  000 000 RST  000 000 000

        ; RLMP= 174406  - MULTI-PURPOSE REGISTER
         .RLMP= 6
        ; WDE  HCE WLK SKTO  SPE WGE VC  DSE 000 HS  CO  HO  BH   ST2 ST1 ST0


                                   ; START HERE FOR RL01 TYPE BOOT - @ 174400
   000000  012737  BOTW00: MOV     #RLCS, @#0       ; DO RL BOOT ON POWER UP
           174400
           000000
   000006  000413          BR      BOTENT

   000010  012737  BOTW10: MOV     #RLCS+10, @#0    ; DO ALTERNATIVE RL BOOT
           174410
           000000
   000016  000407          BR      BOTENT

   000020  012737  BOT170: MOV     #177170, @#0     ; DO STANDARD FLOPPY BOOT
           177170
           000000
   000026  000403          BR      BOTENT

   000030  012737  BOT150: MOV     #177150, @#0     ; DO ALTERNATIVE FLOPPY BOOT
           177150
           000000
```

Table 4-6. DSD 880 Bootstrap Program Listing (Cont)

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00 PAGE 2-1
LSI-11 VERSION

 000036  011706  BOTENT: MOV     (PC), SP         ; SET STACK TO 12700
 000040  012700          MOV     #340, R0         ; LOCK OUT LINE TIME CLOCK
         000340
 000044  106400          MTPS    R0               ; BY SETTING TO PRIORITY 7.
 000046  000240          NOP                      ; SO SAME SIZE IN PDP-11 VERSION
                                                  ; ABOVE 2 WORDS BECOME
                                                  ; MOV   R0, @#177776
 000050  004467          JSR     R4, MEMHGH       ; GET POINTER TO TRAP ROUTINE
         000010

                 ; TRAP PROCESSOR FOR NON-EXISTANT MEMORY TIMEOUT
                 ; SETS CARRY AND RETURNS ON NON-EXISTANT MEMORY TRAP

 000054  012766  TRAP4:  MOV     #341, 2(SP)      ; SETS CARRY ON TRAP TO 4
         000341
         000002
 000062  000002          RTI                      ; ALSO SETS CURRENT PRIORITY HIGH


                 ; NOW TEST FROM 10 TO TOP OF AVAILABLE CONTIGUOUS MEMORY
                 ; INIT VECTORS AND SET LOW TEST LIMIT TO 10
 000064  012701  MEMHGH: MOV     #4, R1           ; SET LOW MEM POINTER
         000004
 000070  010421          MOV     R4, (R1)+        ; LOAD TRAP VECTOR
 000072  010021          MOV     R0, (R1)+        ; LOAD TRAP PSW VALUE = 340
 000074  010102          MOV     R1, R2           ; INIT TO LOW MEMORY = 10

                 ; FIND TOP OF AVAILABLE MEMORY
 000076  005022  2$:     CLR     (R2)+            ; FIND TOP OF MEMORY
 000100  103403           BCS     4$              ; CARRY SET BY TRAP TO 4
 000102  020227          CMP     R2, #160000      ; AT END OF PDP-11 ADDR SPACE?
         160000
 000106  103773           BLO    2$
 000110  005042  4$:     CLR     -(R2)            ; SET POINTER TO LAST LOCATION+2
 000112  004567          JSR     R5, MEMCHK       ; TEST TO TOP OF MEMORY
         000136

 000116  005000          CLR     R0               ; INIT FOR LATER
 000120  011001          MOV     (R0), R1         ; GET R*CS POINTER
 000122  032701          BIT     #1000, R1        ; RX02 OR RL01 DEVICE?
         001000
 000126  001411           BEQ    BOTRL            ; BOOT VIA RX02 MODE IF 1000 BIT SET

                 ; FILL EMPTY TEST - DONE AT MULTIPLE BUFFER ADDRESSES IN ORDER
                 ; TO TOGGLE ALL ADDRESS BITS IN SYSTEM MEMORY
 000130  004567          JSR     R5, FILEMP       ; DO FILL-EMPTY BUFFER TEST
         000252
 000134  000774          10+<5*100.>      ; START FILL AT BEGINNING OF
 000136  017700          10+<5*1624.>     ; PATTERN REPETITION LEFT BY RAM TEST
 000140  037676          10+<5*3262.>     ; DO DMA TEST ACROSS ALL ADDRESS BITS
 000142  077704          10+<5*6540.>     ; THAT CAN BE SET IN AVAILABLE MEMORY
                 ;       10+<5*9816.>     ; SO ALL BITS TOGGLE OK
 000144  000000           0       ; ADDRESS TERMINATOR
 000146  000167          JMP     BOT880           ; DO RX02 TYPE BOOT.
         000442
```

Table 4-6. DSD 880 Bootstrap Program Listing (Cont)

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00 PAGE 3
RL COMPATIBLE BOOT

                        .SBTTL  RL COMPATIBLE BOOT
                        ; BOOT USING RL01 PROTOCOL (UNOTE 063)
                        ; DISPATCH WITH R0 = 0, R1 = RLCS

  000152  105711  BOTRL:  TSTB    (R1)              ; CHECK CONTROLLER READY
  000154  103777           BCS    .                 ; HANG IF NO BUS RESPONSE TO DEVICE
  000156  100375           BPL    BOTRL             ; ELSE WAIT FOR CONTROLLER RDY
  000160  012761          MOV     #13,    .RLDA(R1) ; DO RESET ON GET STATUS
          000013
          000004
  000166  012711          MOV     #4,     (R1)      ; LOAD GET STATUS FUNCTION
          000004
  000172  105711          TSTB            (R1)      ; WAIT FOR CONTROLLER READY
  000174  100376           BPL    .-2
  000176  012761          MOV     #177601,.RLDA(R1); SET MAXIMAL LENGTH SEEK OUTWARDS
          177601
          000004
  000204  012711          MOV     #6,     (R1)      ; LOAD RL01 SEEK COMMAND
          000006
  000210  105711          TSTB            (R1)      ; WAIT FOR CONTROLLER READY
  000212  100376           BPL    .-2
  000214  012761          MOV     #-400,.RLMP(R1)   ; SET WORDCOUNT FOR 1 BLOCK
          177400
          000006
  000222  010061          MOV     R0,     .RLDA(R1) ; LOAD A 0 INTO DISK ADDRESS REGISTER
          000004
  000226  012711          MOV     #14,    (R1)      ; ISSUE READ FUNCTION
          000014
  000232  105711          TSTB    (R1)              ; CONTROLLER READY?
  000234  100376           BPL    .-2
  000236  005711          TST     (R1)              ; ERROR?
  000240  100001           BPL    .+4
  000242  000000            HALT
  000244  021027          CMP     (R0), #240        ; LOC 0 MUST BE NOP
          000240
  000250  001340           BNE    BOTRL             ; JUST TRY AGAIN
  000252  005007          CLR     PC                ; DISPATCH TO LOC 0.
```

Table 4-6. DSD 880 Bootstrap Program Listing (Cont)

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00 PAGE 4
RL COMPATIBLE BOOT

                          ; ROUTINE TO TEST MEMORY FROM C(R1) = LOW LIMIT
                          ; TO C(R2) = UPPER LIMIT BEYOND TEST
                          ; IF ERROR FOUND HALTS WITH R4 POINTING TO ERROR LOC, OR 2 BEYOND.
                          ; R0 = DATA READ

000254  010104   MEMCHK: MOV     R1, R4          ; GET STARTING ADDRESS
000256  010400   2$:     MOV     R4, R0          ; KILL Z FLAG <MOV R4, (R4)+>
000260  010024           MOV     R0, (R4)+       ; LOAD CONTENTS = ADDRESS
000262  020402           CMP     R4, R2          ; AT END OF TEST?
000264  103774            BLO    2$
000266  024404   CHKADP: CMP     -(R4), R4       ; CHECK BACK DOWN TO START ADDR
000270  001402            BEQ    NCKADP
000272  011400             MOV   (R4), R0        ; DATA READ IN ERROR IN R0
000274  000000             HALT                  ; STUCK BIT IN DATA OR ADDRESS!!
000276  020401   NCKADP: CMP     R4, R1
000300  101372            BHI    CHKADP          ; CONTINUE TILL AT START ADDR

000302  005124   SETCOM: COM     (R4)+           ; MAKE LOC = ADDR COMPLEMENT
000304  020402           CMP     R4, R2          ; AT END OF TEST?
000306  103775            BLO    SETCOM

000310  010104           MOV     R1, R4          ; START AT BEGINNING
000312  060414   CHKCOM: ADD     R4, (R4)        ; SHOULD BE ALL 1'S
000314  005214           INC     (R4)
000316  012400           MOV     (R4)+, R0       ; DATA SHOULD = ALL ZEROES
000320  001401            BEQ     NCKCOM
000322  000000             HALT                  ; STUCK DATA BIT IF NO HALT AT +156
000324  020402   NCKCOM: CMP     R4, R2
000326  103771            BLO    CHKCOM

                          ; SET UP TO LEAVE A PATTERN OF 1 011 001 110 001 111 B ROTATED
                          ; RIGHT INTO 4 SUCCESSIVE WORDS
                          ; USED AS MEM BACKGROUND AND FILL-EMPTY DATA.

000330  010104           MOV     R1, R4          ; SET INITIAL ADDRESS
000332  012703   SETPAT: MOV     #131617, R3     ; SET INITIAL PATTERN
        131617
000336  020402   4$:     CMP     R4, R2          ; END OF ADDRESS RANGE?
000340  103004            BHIS   CHKPAT          ; GO CHECK DATA IF AT END
000342  010324           MOV     R3, (R4)+       ; CARRY SET BY CMP INSTRUCTION.
000344  006203           ASR     R3              ; ROTATE AND LOAD AGAIN
000346  103773            BCS    4$
000350  000770            BR     SETPAT

000352  010104   CHKPAT: MOV     R1, R4          ; SET INITIAL ADDRESS
000354  012703   CHKPTL: MOV     #131617, R3
        131617
000360  020324   3$:     CMP     R3, (R4)+       ; DATA OK?
000362  001403            BEQ    4$
000364  016400             MOV   -2(R4), R0      ; SET DATA READ FOR LOOKING
        177776
000370  000000             HALT                  ; PATTERN SENSITIVITY ERROR
000372  020402   4$:     CMP     R4, R2          ; AT END OF ADDRESS RANGE?
000374  103003            BHIS   FILEXT          ; YES - EXIT
000376  006203           ASR     R3              ; CARRY SET BY CMP INSTRUCTION
000400  103767            BCS    3$
000402  000764            BR     CHKPTL
000404  000205   FILEXT: RTS     R5
```

Table 4-6. DSD 880 Bootstrap Program Listing (Cont)


```
                        ; FILL - EMPTY BUFFER TEST

 000406  012504  FILEMP: MOV     (R5)+, R4          ; GET BUFFER ADDRESS
 000410  001775          BEQ     FILEXT
 000412  005764          TST     404(R4)            ; DOES MEMORY EXIST?
         000404
 000416  103773          BCS     FILEMP             ; NO - STEP TO END OF LIST
 000420  010102          MOV     XCS, XDB           ; INIT FOR RXDB
 000422  004767          CALL    WTFLAG             ; WAIT FOR DONE FLAG UP
         000342
 000426  103777          BCS     .                  ; LOOP IF NO BUS RESPONSE
 000430  005711          TST     (R1)               ; RX02 ERROR SET?
 000432  100001          BPL     .+4                ; HALT IF ERROR
 000434  000000          HALT                       ; INTERFACE SETUP ERROR

                        ; DSD880 - RX02 INTERFACE LATCHED BIT TEST

 000436  012722          MOV     #1420, (XDB)+      ; LOAD INTO RXCS
         001420
 000442  022711          CMP     #5460, (XCS)       ; DID THEY LATCH OK?
         005460
 000446  001401          BEQ     .+4
 000450  000000          HALT                       ; STUCK BITS IN RXCS
 000452  022712          CMP     #1420, (XDB)       ; LATCHED OK IN RXDB?
         001420
 000456  001005          BNE     RXHALT             ; NO - BAD INTERFACE.

 000460  012712  RXDBTS: MOV     #173767, (XDB)     ; CHECK RXDB LATCH
         173767
 000464  022712          CMP     #173767, (XDB)     ; DID THEY LATCH
         173767
 000470  001401          BEQ     .+4
 000472  000000  RXHALT: HALT                       ; HALT IF INCORRECT BIT LATCHUP

 000474  010102  RXFIEM: MOV     XCS, XDB           ; SET UP RXDB POINTER
 000476  012746          MOV     #200, -(SP)        ; SAVE THE WORD-COUNT
         000200
 000502  012722          MOV     #401, (XDB)+       ; DO FILL COMMAND
         000401
 000506  105711          TSTB    (XCS)              ; WAIT FOR TRREQ
 000510  100376          BPL     .-2
 000512  011612          MOV     (SP), (XDB)        ; WORDCOUNT (=200)
 000514  105711          TSTB    (XCS)              ; WAIT FOR TRREQ
 000516  100376          BPL     .-2
 000520  010412          MOV     R4, (XDB)          ; BUFFER ADDR
 000522  004767          CALL    WTFLAG             ; WAIT FOR DONE OR TRREQ
         000242

                        ; NOW EMPTY SECTOR BUFFER AND CHECK DATA VALIDITY

 000526  022424  EMPBFT: CMP     (R4)+, (R4)+       ; BUMP EMPTY BUFFER ADDR
                                                    ; SO ERROR IF NO DATA TRANSFER.
 000530  012711          MOV     #403, (XCS)        ; DO EMPTY BUFFER COMMAND
         000403
 000534  010403          MOV     R4, R3             ; SAVE BUFFER START ADDRESS
 000536  105711          TSTB    (XCS)              ; WAIT FOR TRREQ
 000540  100376          BPL     .-2
```

Table 4-6. DSD 880 Bootstrap Program Listing (Cont)

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00 PAGE 5-1
RL COMPATIBLE BOOT

   000542  011612            MOV    (SP), (XDB)       ; LOAD WORD COUNT
   000544  105711           TSTB    (XCS)             ; WAIT FOR TRREQ
   000546  100376            BPL    .-2
   000550  010412            MOV    R4, (XDB)         ; AND FILL BUFFER ADDR+2
   000552  004767           CALL    WTFLAG            ; WAIT FOR ERROR, DONE OR TRREQ
           000212

   000556  006316  CHKEMP:  ASL     (SP)     ; MAKE WORD COUNT INTO BYTE COUNT
   000560  010402           MOV     R4, R2
   000562  062602           ADD     (SP)+, R2         ; SET R2 = END ADDR TO CHECK
   000564  004567           JSR     R5, CHKPTL        ; DO DATA CHECK
           177564
   000570  000706           BR      FILEMP            ; DO NEXT FILL-EMPTY
```

Table 4-6. DSD 880 Bootstrap Program Listing (Cont)

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00 PAGE 6
RL COMPATIBLE BOOT

                      ; BOOT THE DEVICE IN R1, REGISTERS USED AS INDICATED BELOW
                                      ; R0    SET TO 0
        000001  XCS=      %1          ; R1    POINTER TO RXCS
        000002  XDB=      %2          ; R2    POINTER TO RXDB
                                      ; R3    READ COMMAND VALUE WITH DENSITY BIT
        000004  LDP=      %4          ; R4    LOAD POINTER
        000005  SCT=      %5          ; R5    CURRENT SECTOR # (1, 3, 5, 7)
                                      ; (SP)  WORD COUNT FOR CURRENT DENSITY

                      ; LOADS DEFINITIVE ERROR CODE INTO STACK POINTER = SP
                      ; THEN HALTS.  A PROCEED WILL ATTEMPT TO BOOT THE NEXT DRIVE.

000572  012711  DEFNST: MOV     #17, (XCS)       ; DO DEFINITIVE ERROR STATUS
        000017
000576  105711  DEFNWT: TSTB    (XCS)            ; WAIT FOR TRREQ OR DONE
000600  001776            BEQ   .-2
000602  100002            BPL   DEFNRD
000604  010412             MOV  LDP, (XDB)       ; STATUS UPWARDS FROM LOAD ADDR
000606  000773            BR    DEFNWT

000610  011406  DEFNRD: MOV     (LDP), SP        ; SHOW DEFINITIVE STATUS IN SP.
000612  000000          HALT                     ; EXAMINE SP VALUE IF HERE

000614  005000  BOT880: CLR     R0               ; USE AS 0
000616  011706  BOOTR1: MOV     (PC), SP         ; INIT STACK POINTER
000620  005004          CLR     LDP              ; INIT LOAD ADDRESS POINTER
000622  012703          MOV     #7, R3           ; GET INITIAL COMMAND
        000007
000626  012746          MOV     #100, -(SP)      ; SET LOW DENSITY WORDCOUNT
        000100
000632  012705          MOV     #1, SCT          ; INIT SECTOR TO READ
        000001

000636  004767  RDLP:   CALL    WTFLAG           ; WAIT FOR DONE FLAG SET?
        000126
000642  010102          MOV     XCS, R2          ; COPY RXCS POINTER
000644  010322          MOV     R3, (R2)+        ; LOAD READ COMMAND
000646  105711          TSTB    (XCS)            ; WAIT FOR TRREQ
000650  100376            BPL   .-2
000652  010512          MOV     SCT, (XDB)       ; LOAD SECTOR
000654  105711          TSTB    (XCS)
000656  100376            BPL   .-2
000660  012712          MOV     #1, (XDB)        ; LOAD TRACK
        000001
000664  004767          CALL    WTFLAG           ; WAIT FOR DONE
        000100
000670  005711          TST     (XCS)            ; CLUDGE SINCE DEC RX02 SETS ERROR
                                                 ; BEFORE IT SETS DONE
000672  100010            BPL   EMPBUF           ; EMPTY IF NO ERROR
000674  032712             BIT  #20, (XDB)       ; IS ERROR A DENSITY ERROR?
        000020
000700  001734              BEQ DEFNST           ; NO- DO DEFINITIVE STATUS
000702  052703             BIS  #400, R3         ; SET COMMAND TO DOUBLE DENSITY
        000400
000706  012716             MOV  #200, (SP)       ; SET TO D.D. WORD COUNT
        000200
000712  000751             BR   RDLP             ; AND TRY READING AGAIN
```

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00 PAGE 6-1
RL COMPATIBLE BOOT

   000714  010346  EMPBUF: MOV    R3, -(SP)        ; GET COMMAND COPY
   000716  042716          BIC    #4, (SP)         ; MAKE INTO AN EMPTY BUFFER COMMAND
           000004
   000722  012611          MOV    (SP)+, (XCS)     ; AND EXECUTE
   000724  105711          TSTB   (XCS)            ; WAIT FOR FIRST TRREQ
   000726  100376           BPL   .-2
   000730  011612            MOV  (SP), (XDB)      ; LOAD THE WORD COUNT
   000732  105711          TSTB   (XCS)
   000734  100376           BPL   .-2
   000736  010412            MOV  LDP, (XDB)       ; AND XFER ADDRESS
   000740  004767          CALL   WTFLAG           ; WAIT FOR DONE OR TRREQ
           000024
   000744  121027  EMPDON: CMPB   (R0), #240       ; INSURE FIRST INSTRUCT IS A NOP.
           000240
   000750  001322           BNE   BOOTR1           ; NO - NOT VALID DATA AT LOC 0
                                                   ; C(SP) = WORD COUNT
   000752  061604          ADD    (SP), LDP        ; BUMP LOAD ADDRESS FOR NEXT SECT
   000754  061604          ADD    (SP), LDP        ; ADD ACTUAL BYTE COUNT
   000756  122525          CMPB   (SCT)+, (SCT)+   ; BUMP SECTOR # BY 2
   000760  020427          CMP    LDP, #1000       ; FINISHED LOADING?
           001000
   000764  002724           BLT   RDLP             ; READ NEXT SECTOR

   000766  005007          CLR    PC               ; GO DISPATCH


                   ; WAIT FOR FLOPPY FLAGS, DONE, ERROR, TRREQ

   000770  032711  WTFLAG: BIT    #240, (XCS)      ; WAIT FOR DONE OR TRREQ
           000240
   000774  001775           BEQ   WTFLAG           ; CAN'T TEST RX02 ERROR HERE
   000776  000207          RETURN

   001000          BOTLST::

           000020'         .END   BOT170
```

Table 4-6. DSD 880 Bootstrap Program Listing (Cont)

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00 PAGE 6-2
SYMBOL TABLE

BOOTR1  000616R      002 DEFNST  000572R      002 RXDB   = 177172
BOTENT  000036R      002 DEFNWT  000576R      002 RXDBTS  000460R      002
BOTLST  001000RG     002 EMPBFT  000526R      002 RXFIEM  000474R      002
BOTRL   000152R      002 EMPBUF  000714R      002 RXHALT  000472R      002
BOTW00  000000R      002 EMPDON  000744R      002 SCT    =%000005
BOTW10  000010R      002 FILEMP  000406R      002 SETCOM  000302R      002
BOT150  000030R      002 FILEXT  000404R      002 SETPAT  000332R      002
BOT170  000020R      002 LDP    =%000004          TRAP4   000054R      002
BOT880  000614R      002 MEMCHK  000254R      002 WTFLAG  000770R      002
CHKADP  000266R      002 MEMHGH  000064R      002 XCS    =%000001
CHKCOM  000312R      002 NCKADP  000276R      002 XDB    =%000002
CHKEMP  000556R      002 NCKCOM  000324R      002 .RLBA = 000002
CHKPAT  000352R      002 RDLP    000636R      002 .RLDA = 000004
CHKPTL  000354R      002 RLCS   = 174400          .RLMP = 000006
DEFNRD  000610R      002 RXCS   = 177170

. ABS.  000000      000
        000000      001
BOOT    001000      002
ERRORS DETECTED:  0

VIRTUAL MEMORY USED:  8192 WORDS  ( 32 PAGES)
DYNAMIC MEMORY AVAILABLE FOR  64 PAGES
DY0:BOT880,DY0:BOT880/L:TTM/C=BOT880
```

Table 4-6. DSD 880 Bootstrap Program Listing (Cont)

```
DSD 880 BOOTSTRAP PROM  MACRO V04.00  23-OCT-80 11:15:00 PAGE S-1
CROSS REFERENCE TABLE (CREF V04.00 )


$PDP11   1-8      1-9      2-57
.RLBA    2-18#
.RLDA    2-21#    3-8*     3-12*    3-17*
.RLMP    2-35#    3-16*
BOOTR1   6-24#    6-60
BOT150   2-53#
BOT170   2-50#    6-79
BOT880   2-104    6-23#
BOTENT   2-45     2-48     2-51     2-55#
BOTLST   6-77#
BOTRL    2-93     3-5#     3-7      3-25
BOTW00   2-44#
BOTW10   2-47#
CHKADP   4-11#    4-16
CHKCOM   4-23#    4-29
CHKEMP   5-53#
CHKPAT   4-38     4-44#
CHKPTL   4-45#    4-54     5-56
DEFNRD   6-16     6-20#
DEFNST   6-13#    6-44
DEFNWT   6-14#    6-18
EMPBFT   5-41#
EMPBUF   6-42     6-49#
EMPDON   6-59#
FILEMP   2-97     5-3#     5-6      5-57
FILEXT   4-51     4-55#    5-4
LDP      1-109#   6-6#     6-17     6-20     6-25*    6-57     6-62*
         6-63*    6-65
MEMCHK   2-88     4-6#
MEMHGH   2-66     2-77#
NCKADP   4-12     4-15#
NCKCOM   4-26     4-28#
RDLP     6-30#    6-47     6-66
RLCS     2-2#     2-44     2-47
RXCS     1-91#    1-101
RXDB     1-101#
RXDBTS   5-23#
RXFIEM   5-28#
RXHALT   5-21     5-26#
SCT      1-110#   6-7#     6-28*    6-35     6-64     6-64
SETCOM   4-18#    4-20
SETPAT   4-36#    4-42
TRAP4    2-71#
WTFLAG   5-8      5-37     5-51     6-30     6-39     6-58     6-73#
         6-74
XCS      1-106#   5-7      5-17     5-28     5-31     5-34     5-43*
         5-45     5-48     6-3#     6-13*    6-14     6-31     6-33
         6-36     6-40     6-51*    6-52     6-55     6-73
XDB      1-107#   5-7*     5-16*    5-20     5-23*    5-24     5-28*
         5-30*    5-33*    5-36*    5-47*    5-50*    6-4#     6-17*
         6-35*    6-38*    6-43     6-54*    6-57*
```

5.0 BASIC PROGRAMMING INFORMATION

5.1 General Information

This chapter provides basic programming and register usage information for the DSD 880 System.

5.2 Operating Modes

The DSD 880 has three operating modes: Normal, Extended, and Direct Access. The floppy disk drive of the 880 emulates a DEC RX02 with double-sided capability in standard or extended mode. The 880 winchester disk drive emulates a DEC RL01 in standard mode and provides RL01 operation with increased capacity in extended mode. The RX02 and RL01 emulations in standard mode are fully hardware and software compatible with DEC operating systems.

The Direct Access mode is intended for use as a diagnostic aid only. The Direct Access mode provides additional features not available on the DEC RX02 or RL01. The HyperDiagnostics and microcode routines for stand alone self-testing and detailed disk system status reporting

5.2.1 Single-Sided Operation

The floppy disk drive in the DSD 880 operates as a single-sided disk drive, with single-sided diskettes, and provides a true emulation of the DEC RX02.

5.2.2 Double-Sided Operation

The DSD 880 floppy disk drive is configured for double-sided operation either through standard (single-sided) RSX-11 system options or by using the DSD monitor patch program.

5.2.3 Programming Interface

The system interface for the DSD 880 varies according to both the host computer type and the operational mode for which the system is configured. The DSD 880 operating characteristics are embedded in the DSD 880 controller.

5.3 DSD 880 Floppy Disk Operation and Programming

Data are transferred to and from the diskette in fixed-length blocks called sectors. A sector contains 64, 16-bit, words when the system is in single-density mode, and 128, 16-bit, words in double-density mode.

The programmer can direct the DSD 880 controller to perform several tasks. Each of these tasks facilitates the storage and retrieval of information on a diskette.

For example, two operations are needed to move a sector of data from main memory to a particular sector on a diskette. The first operation, a Fill Buffer, moves the data from computer main memory to a RAM buffer internal to the disk controller. The second operation, Write Sector, positions the read/write head of the flexible disk drive over the specified portion of the diskette and writes the data from the controller sector buffer onto the diskette.

The handler communicates the task requirements to the DSD 880 controller through two physical peripheral device registers which are addressable as though they are in computer memory. The control and status register is normally located at address 777170 octal. The data buffer register is normally located at address 777172 octal.

There are a total of seven logical registers described in this chapter. These registers represent such information as data, controller status, track addresses, and sector addresses. The handler always reads and writes logical registers through the data buffer register, which is a physical register.

Writing a specific bit pattern to the control and status register initiates a task. Each task is associated with a specific protocol, a set of rules which determines the parameters, or data the computer should pass through the data buffer register during the execution of a task.

For example, operations which move the read/write head in the disk drive require a track address and a sector address. The protocol for these functions is as follows:

1. The command is written to the control and status register.

2. The sector address is written to the data buffer register when the controller requests it.

3. The track address is written to the data buffer register when the controller requests it.

Programmed I/O is used to transfer parameters, but direct memory access (DMA) is used to transfer data between the controller and main memory.

5.3.1 Addressable Registers in RX02-Compatible Operation

Programs communicate with the DSD 880 through two physical registers, the comand and status register (RX2CS), and the data buffer register (RX2DB).

The peripheral device registers reside in the top 4K-words memory address space in DEC-11 computers. The registers are addressed as memory, and any instruction that operates on a memory location can operate on a peripheral device register in the same way; except that certain bits may indicate read only or write only.

Note that the data buffer register, a physical register acts as a multiple-use logical register as explained under "Data Buffer Register (RX2DB)".

5.3.2 Command and Status Register

This register is normally at location 777170 (octal) in the memory address space. The bits of this physical register control the DSD 880 floppy disk. The format for this register is shown in Figure 5-1. The RX2CS register also provides the user program with status information and error indications.

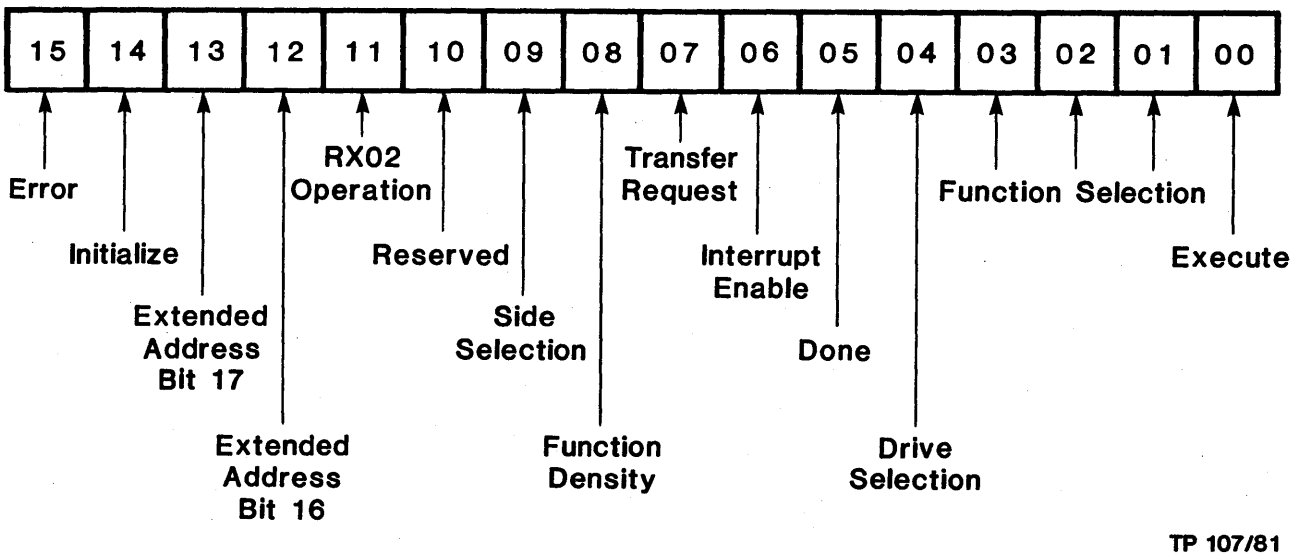


Figure 5-1. Command and Status Register

BIT 15 - ER - Error

This Read-only bit is set by the RX02 to indicate that an error has occurred during an attempt to execute a command. It is cleared by the initialize bit (bit 14) hardware Bus Init or by issuing a new command.

BIT 14 - IN - Initilize the DSD 880 floppy disk system

The DONE flag is reset. The controller resets some internal variables and executes the self-test microcode. The disk floppy drive goes to the home position (track 0).

If the controller is operating in the normal mode, and the drive is ready, it reads track 1 sector 1 of the diskette in drive 0. Attempting the Read Sector operation sets the initialize done bit in the command and status register. Bit 14 is a write-only bit.

BIT 13 - A17 - Extended address bit 17

This write-only bit is asserted on UNIBUS or Q-BUS address line 17 (A17) when the DSD 880 transfers data by DMA. An initialize bit clears this bit. A17 toggles if A01 through A16 are all ones and the bus address register increments.

BIT 12 - A16 - Extended address bit 16

This write-only bit is asserted on UNIBUS or Q-BUS address line 16 (A16) when the DSD 880 transfers data by DMA. An initialize bit clears this bit. A16 toggles if A01 through A15 are all ones and the bus address register increments.

BIT 11 - RX02 system identification bit

The software normally uses this read-only bit to differentiate RX01 systems from RX02 systems. The DSD 880 always sets this bit.

BIT 10 - XX - Reserved for possible future use

BIT 9 - HS - Head select bit

This read/write bit selects side 0 or side 1 (lower head or upper head). It is set to select side 1, and cleared to select side 0.

BIT 8 - DEN Density of function

This read/write bit specifies the density for the function encoded in bits 1, 2, and 3. This bit specifies high density when it is set.

NOTE

Even though the Fill Buffer and Empty Buffer functions do not use magnetic media, a valid density bit is required for the controller to evaluate the validity of the word count parameter.

BIT 7 - TR - Transfer request flag

This read-only bit indicates to the program that the data buffer register is empty and needs loading, or is loaded and needs emptying.

BIT 6 - IE - Interrupt enable bit

This read/write bit, when set, allows an interrupt to be generated whenever the DONE flag is set.

BIT 5 - DN - Done flag

This read-only bit indicates the completion of an operation. The bit works in conjunction with the interrupt enable (IE) bit to generate interrupts.

BIT 4 - UNI - Unit select bit

This read/write bit selects floppy drive 0 or drive 1. In the DSD 880, the floppy drive selected is always drive 0. Drive selection occurs only if a drive-related function is executed.

BITS 3 through 1 - F2, F1, F0 - Function select

The binary encoding of these write-only bits selects the function to be performed by the DSD 880 system as indicated below:

F2	F1	F0	Command Specified	Octal Function Code
0	0	0	Fill Buffer	0
0	0	1	Empty Buffer	1
0	1	0	Write Sector	2
0	1	1	Read Sector	3
1	0	0	Set Media Density	4
1	0	1	Read Status	5
1	1	0	Write Deleted Data Sector	6
1	1	1	Read Error Code	7

BIT 0 - EX - Function execute

This bit controls the execution of the function encoded in bits 1 through 3 of this register. This is a write-only bit.

5.3.3 Data Buffer Register (RX2DB)

The RX2DB data buffer register provides the communication link between the host processor and the DSD 880 system. The register transfers data to and from the controller data buffer. The logical register information passing through the register depends on a predetermined protocol.

If the DSD 880 is not executing a command, the RX2DB can be modified without risk of adverse effects. However, during the execution of an instruction, the RX2DB register provides or accepts information (according to the RX2DB protocol) whenever the TRANSFER REQUEST flag is set.

CAUTION

Data may be lost if an incorrect protocol is followed.

The following descriptions explain the various logical register formats of the physical Data Register (RX2DB).

Disk Track Address Register (RX2TA at 777172) - During commands such as Write Sector and Read Sector, which require a track number (or a cylinder number) during double-sided operation, the number is written into the physical RX2DB register. Track or cylinder numbers from 0 to 76 (decimal) are valid.

Disk Sector Address Register (RX2SA at 777172) - During commands such as Write Sector and Read Sector, which require a sector address, the address is written into the physical RX2DB register. Sectors addresses from 1 to 26 (decimal) are valid. Bits 6 and 7 of RX2SA are masked to zero.

Word Count Register (RX2WC at 777172) - The word count register specifies the number of words for DMA transfer between the controller sector buffer and main memory. For a double-density sector, the maximum word count is 128 (decimal), or 256 bytes. For single-density sector, the maximum word count is 64 (decimal), or 128 bytes. In each case, the programmer loads the actual word count, not the two's complement of the word count, into the word count register.

Bus Address Register (RX2BA at 777172) - This register specifies the bus address for the data transfer during a DMA operation. It increments by two following each data transfer.

The bus address register is write-only. It should always be loaded with the starting memory address of a data buffer at the appropriate time during the Fill Buffer, Empty Buffer, or Read Extended Status operations.

System Error and Status Register (RX2ES) - The RX2ES register is another logical register implemented using the physical RX2DB register. It provides error and status information about the drive specified by bit 4 of the (physical) RX2CS register. At the completion of a command, the controller places the contents of the RX2ES register into a data buffer register (RX2DB = 777172) so the host processor can check the status and error results of the most recent operation. When the controller completes an operation that does not select a drive (e.g., Fill Buffer, Empty Buffer), the RX2ES unit select and drive density bits remain unmodified. All the other RX2ES bits are cleared at the initiation of each new function. See Figure 5-2 for the format of this register.

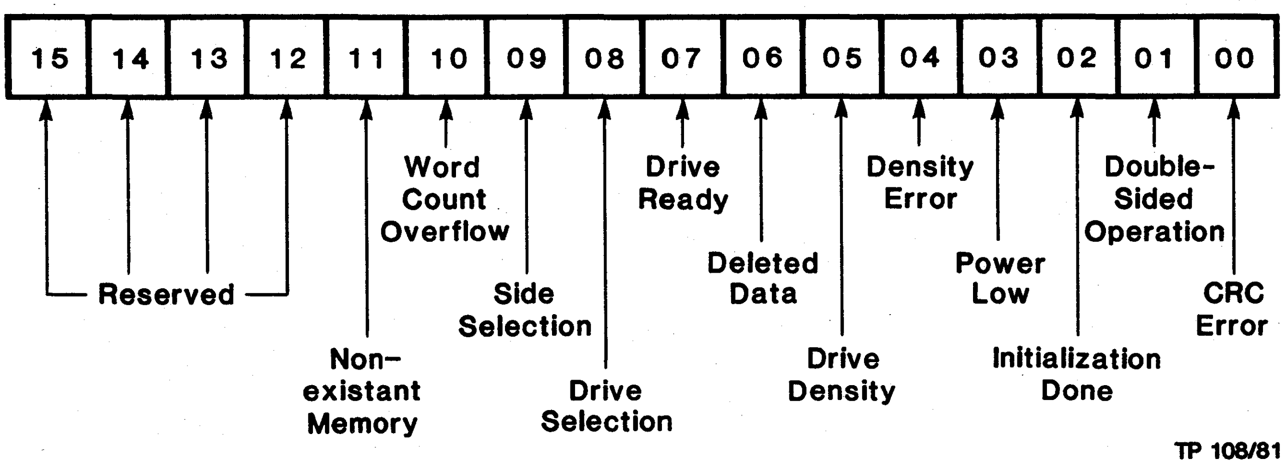


Figure 5-2. System Error and Status Register Bit Format

BITS 15 through 12 - Not used

BIT 11 - NXM - Nonexistent memory error

This bit sets if, during a DMA cycle, the interface does not receive a bus reply when it tries to write or read a word to or from memory. Usually no bus reply means that the address in the RX2BA or the extended address bits in the RX2CS are invalid. The operation terminates and error and done bits are set. To recover from this error condition, generate either a bus INIT or a programmed INIT.

BIT 10 - WC OVFL - Word count overflow

This bit sets if the word count specified during a Fill or Empty Buffer command is too large for the sector size indicated by the density bit. At a word count overflow, the operation terminates, and the error and done bits are set.

BIT 9 - HD SEL - Head selected

This bit indicates the read/write head selected during the most recent Read or Write operation. It sets to indicate the upper head, and clears to indicate the lower head.

BIT 8 - UNIT SEL - Unit select

This bit indicates the disk drive head selected during the most recent Read or Write operation. It sets to indicate drive 1 and clears to indicate drive 0.

BIT 7 - DRV READY - Drive ready

This bit, when set, indicates that the selected disk drive has a diskette correctly installed and up to speed. The drive ready bit is valid immediately following the Read Status function. This bit is also valid for drive 0 immediately following an initialization. (See BIT 1 "SDI RDY")

BIT 6 - DD - Deleted data

This bit indicates that a deleted data address mark was found during the most recent Read Sector operation, or that the most recently executed command was Write Deleted Data Sector.

BIT 5 - DRV DEN - Drive density

This bit indicates the density of the diskette in the drive indicated by bit 8. Bit 5 is updated during a Read or Write Sector operation.

BIT 4 - DEN ERR - Density error

This bit indicates that during a Read Sector, Write Sector, Write Deleted Data Sector, or Read Status operation the diskette density and the density indicated by the density bit of the RX2CS do not match. Any operation terminates, and the error and done bits are set.

BIT 3 - PWR LO - Power low

This bit indicates a power failure in the controller/drive subsystem. It also sets if the interface cable disconnects. Any operation terminates, and error and done bits are set.

BIT 2 - ID - Initialize done

This bit indicates that the controller/drive has completed an initialization sequence. This sequence may be initiated by a power failure, a bus INIT, or a programmed INIT.

BIT 1 - SDI RDY - Side 1 ready

Bit 1 and bit 7 are both set when a double-sided diskette is correctly installed and up to speed. When bit 7 is set but bit 1 is clear, a single-sided diskette is installed and up to speed. A single-sided diskette is restricted to side 0 functions only.

BIT 0 - CRC - Cyclic redundancy check error

This bit indicates that a cyclic redundancy check error was detected during the most recent Read Sector operation. The operation terminates, and the error and done bits are set.

5.3.4 Floppy Disk Controller Command Protocols

The following sections describe the protocol for each command that can be sent to the controller. Failure to adhere to the correct protocol results in lost or incorrect data.

Function Code 0 - Fill Sector Buffer Command

The Fill Sector Buffer command fills a storage buffer in the DSD 880 with 128 or 256, eight-bit bytes of data from computer memory. To write the data to the diskette or transfer it back to memory, use other functions.

When the Fill Sector Buffer command is given, the DSD 880 responds by clearing the DONE flag (RX2CS bit 5). The controller then requests a word count by setting the TRANSFER REQUEST flag. The program should respond by writing a valid RX2WC (word count) into the RX2DB. When the controller again asserts TRANSFER REQUEST, the program should respond by writing a valid starting memory address (RX2BA) into the RX2DB.

Loading RX2BA clears TRANSFER REQUEST, and it remains clear for the duration of the Fill Sector Buffer. The data bytes transfer directly from memory to the controller sector buffer. The DONE flag sets when the word count is decremented to zero and the controller has zero-filled the remainder of the sector buffer (if necessary). Also, if interrupts are enabled (RX2CS bit 6 is set) when the DONE flag sets, an interrupt request occurs. The contents of the RX2ES register are left in the RX2DB at the completion of the operation.

NOTE

Bit 4 of the RX2CS does not affect this function because no disk drives are selected. The density bit, RX2CS bit 8, must be set correctly because the controller uses this bit in evaluating the validity of the word count.

Function Code 1 - Empty Sector Buffer Command

The Empty Sector Buffer command transfers the contents of the floppy sector buffer to main memory. The sector buffer is loaded from a previous Fill Sector Buffer or Read Sector command.

The controller responds to an Empty Sector Buffer command by clearing the DONE flag (RX2CS bit 5). The controller then sets the TRANSFER REQUEST flag (RX2CS bit 7) to request the contents of the word count register. The program should respond by loading a valid word count into the data buffer register.

When TRANSFER REQUEST is asserted again, the program responds by loading the starting memory address into the data buffer register. The controller than clears the TRANSFER REQUEST flag which remains clear for the rest of the operation.

The data in the sector buffer is transferred to memory one word at a time, decrementing the contents of the word count register at each transfer, until the word count becomes zero. When the data transfer is completed, the controller places the contents of RX2ES into the data buffer register and sets the DONE flag. If the interrupt enable bit is set, setting the DONE flag initiates an interrupt request.

The information above, which applies to the Fill Buffer command, applies equally to the Empty Sector Buffer command. Note that the Empty Buffer operation does not modify the contents of the sector buffer.

<u>Function Code 2 - Write Sector Command</u> - (Bit 9 selects side 0/side 1)

The Write Sector Command transfers the contents of the sector buffer to a specified track and sector of the diskette.

When the Write Sector command is given, the controller clears the logical RX2ES register and the DONE flag.

Next, the TRANSFER REQUEST flag (RX2CS register bit 7) is set to request the sector address (RX2SA) from the CPU. When the sector address is received, the TRANSFER REQUEST flag is removed. The TRANSFER REQUEST flag is then set to request the desired track address (RX2TA) from the CPU. When the track address is written to the RX2TA, the TRANSFER REQUEST flag is cleared.

After the track address is received, the controller makes the selected drive seek the desired track. TRANSFER REQUEST is left reset for the remainder of the operation. The heads are loaded against the media and positioned over the specified track. If the controller does not know the density and format of the media, it reads a random sector on the target track to determine the density.

If the media density does not agree with the command density (RX2CS bit 8), the operation terminates and bit 4 of the RX2ES register indicates a density error. If the densities agree, the controller checks the track address and looks for the specified sector address. If the correct track and sector are found, the controller writes either 128 bytes of single-density data or 256 bytes of double-density data from the sector buffer to the diskette. Two CRC bytes are written immediately after the data.

If the controller finds an invalid track address, the extended status error code is set to 40. If the contents of RX2TA does not match the track address from the header, the Extended Status Error Code is set to 150. If the specified sector cannot be found within the two diskette revolutions, the extended status error code is set to 70. Either of these error conditions or a density error terminates the operation. The ERROR flag (RX2CS bit 15) and the DONE flag (RX2CS bit 5) are asserted when the function terminates due to an error condition. As with the error free termination, an interrupt request is generated if the interrupt enable bit is set when the DONE flag becomes true. The extended error status can only be read by the Read Extended Status command (17_8).

NOTE

> The contents of the sector buffer are not modified by the Write Sector function. If the contents of the sector buffer are modified as a result of a power failure or the initialize command, users must be sure that valid data are written back into the sector buffer. This is especially true before executing the Write Sector command. If a sector number of 154 or 155 is written to the RX2SA, the Write Sector function turns into a Write Format Track function.

Function Code 3 - Read Sector Command (Bit 9 selects side 0 or side 1)

The Read Sector command locates a specified track and sector of a diskette and transfers the contents of the data filed into the sector buffer in the controller.

The controller clears the logical RX2ES register and the DONE flag when the Read Sector command is given. Next, the TRANSFER REQUEST flag sets (RX2CS bit 7) to request a sector address. The program responds by writing the desired sector address (RX2SA) into the data buffer register, RX2DB (at 177172 typically), which clears the TRANSFER REQUEST. After receiving the sector address, the TRANSFER REQUEST flag is again set to request the track address. The program responds by writing the desired track address into the RX2TA (at 177172, typically). When the RX2TA is received, the TRANSFER REQUEST flag is again cleared.

After receiving the track address, the controller causes the selected drive to seek the desired track. TRANSFER REQUEST is left reset for the remainder of the operation.

The controller loads the heads against the media and determines the density of the media if the density is unknown. If the diskette density does not agree with the command density (RX2CS bit 8), an error is reported and the operation terminates. If the densities agree, the controller looks for the specified sector. When the correct sector is located, the controller looks for the appropriate data or deleted data address mark.

If a data address mark is found, the controller transfers the next 128 bytes (single-density) or 256 bytes (double-density) into the sector buffer followed by the two CRC bytes. An error free read is indicated if the address mark, data bytes, and two CRC bytes produce a zero residue when passed sequentially throughout the CRC checker hardware circuits. As soon as the data are available in the buffer, the controller terminates the operation by writing the contents of RX2ES to the data buffer register and setting the DONE flag. An interrupt request is generated if the interrupt enable bit is set when DONE becomes true.

If a deleted data address mark is detected, the controller sets the DELETED DATA flag. This flag appears in the Error/Status register (as RX2ES bit 6). If a CRC error is detected, the controller sets RX2ES bit 0 and the ERROR flag (RX2CS bit 15). Seek errors and missing-sector errors are reported as in the Write Sector command.

Function Code 4 - Set Media Density Command

This command initializes an entire DEC-formatted diskette to a specified density. When the Set Media Density command is executed, the controller attempts to write zeroes in every field on the diskette. Bit 8 of the RX2CS determines the recording density and the type of data address mark to be written in each data field. No sector headers are written when the Set Media Density command is executed.

When the Set Media Density command is received, the controller clears the DONE flag. Next, the controller sets the TRANSFER REQUEST flag. The program responds by writing a key byte into the physical register RX2DB. If the key byte is an ASCII I (111 in octal), the Set Media Density function is executed. If the key byte written into the RX2DB is not an I1, the DONE and ERROR flags are set and the operation terminates. The extended error status register is then loaded with 250 to indicate an invalid key byte. The purpose of the key byte is to make accidental erasure of the data on a diskette difficult.

As soon as the safety character I is received, the controller moves the heads to track 0. When sector 1 is found, the controller starts writing. If bit 8 of the RX2CS is a 0, a single-density data address mark and 128 FM-format zeroes are written. If bit 8 of the RX2CS is a 1, a double-density data address mark and 256 DEC-MFM-format zeroes are written. After writing all 26 sectors on the track 0, the controller seeks track 1, track 2, etc., writing all 26 sectors on each track. If the disk is two sided, the second is done automatically. The write continues until either every sector has been written through track 76: sector 26 or a bad header is found. The ERROR and DONE flags are set if the operation terminates due to a bad header.

The Set Media Density command requires approximately 27 seconds for a single-sided disk, and 54 seconds for a double-sided disk, depending on the sector interleave. Never interrupt the Set Media Density command before it is completed. If the function does not terminate normally, an illegal diskette with data address marks of both densities may be created. In this case, completely rewrite the diskette. If the Set Media Density command is incomplete due to an unreadable header, use the Track Format procedure to rewrite the incorrect header information.

Function Code 5 - Read Status Command

The Read Status command determines the current status of the drive selected by RX2CS bit 4. The information returned consists of the drive readiness status and the density of the diskette currently in the drive.

Issuing the Read Status command clears the DONE flag. The controller checks that the door of the selected drive is closed, a diskette is inserted, and the diskette is up to speed. Diskette speed is determined by measuring the amount of time between successive index pulses. Because this measurement takes an average of 250 milliseconds, excessive use of the Read Status function causes reduced throughput. If the drive is ready, the controller sets bit 7 (Drive Ready) of the RX2ES, then loads the heads and reads the first sector it finds. If the disk is double-sided, bit 1 of the RX2ES is set to 1.

If a double-density address mark is detected, bit 5 (drive density) of the RX2ES is set. If a single-density mark is found, bit 5 is cleared. The controller terminates the function by shifting the contents of the RX2ES to the RX2DB and setting the DONE flag. An interrupt request is generated if the interrupt enable bit, RX2CS bit 6, is set when DONE becomes true.

Function Code 6 - Write Deleted Data Sector Command

This command performs the same task as the Write Sector command, except that it writes a deleted data address mark just before the data field. The standard Write Sector command writes a regular data address mark. Reading a sector written with a deleted data address mark sets bit 6 of the logical RX2ES Register.

The density bit associated with this function (RX2CS bit 8) determines whether a single- or double-density deleted data address mark is written.

Function Code 7 - Read Extended Status Command

The Read Extended Status command retrieves information from several internal controller registers, including the error register, as shown below. These registers are transferred to memory using DMA. As soon as the command is loaded into the RX2CS, the DONE flag clears. The controller then asserts the TRANSFER REQUEST flag.

The program then loads a starting memory address into the RX2DB. The controller transfers four words directly to memory. When the words are in memory, the controller asserts DONE, generating an interrupt request if interrupts are enabled.

The words transferred to memory are as follows:

Word 1	:	BITS	0 - 7	Error Code (See Table 5-1)
	:	BITS	8 - 15	Word Count Register
Word 2	:	BITS	0 - 7	Current Track Address of Drive 0
	:	BITS	8 - 15	All 0's
Word 3	:	BITS	0 - 7	Target Track of Current Disk Access
	:	BITS	8 - 15	Target Sector of Current Disk Access
Word 4	:	BIT	0	Density of Read Error Register Command
	:	BITS	1, 2, 3	Unused
	:	BIT	4	Drive Density of Drive 0
	:	BIT	5	Head Load Bit
	:	BIT	6	0
	:	BIT	7	0
	:	BITS	8 - 15	Track Address of Selected Drive

Table 5-1. Error Register Codes for RX2ES
(Function Code 7)

Octal Code	Description
000	No errors
010	Drive failed to home on initialize
020	Nonexistent drive

Table 5-1. Error Register Codes for RX2ES (Cont)
(Function Code 7)

Octal Code	Description
030	Track 00 found while stepping in on initialize
040	Invalid RX02 track address
050	Track 00 found before desired track while stepping in
070	Requested sector not found in 2 revolutions
100	Write protect violation
120	No preamble found
130	Preamble found but no address mark within window
140	CRC error on what appeared to be a header
150	Address in header did not match desired track
160	Too many tries for an ID address mark
170	Data address mark not found in allotted time
200	CRC error on data field
240	Media density did not match desired density (RX02 only)
250	Wrong key in set media density command
260	Indeterminate media density (RX02 only)
270	Write format failure
350	Nonexistent memory error during DMA
360	Drive not ready (door open, speed error, absent media)
370	Low ac power caused abort of write activity

5.3.5 Diskette Formatting

CAUTION

This procedure allows repair of magnetically damaged diskettes.

When configured for RX02 operation, the DSD 880 can format diskettes in the two formats shown in Table 5-2. The entire diskette is formatted.

NOTE

The DEC RX02 does not support the command protocol described below. It is a special feature which is unique to the DSD 880.

1) The program issues the Write Sector function code (010) to the controller using the command and status register. The density bit (bit 9) is ignored. The side bit is also ignored.

2) The controller then clears the DONE flag and sets the TRANSFER REQUEST flag (bit 7 RX2CS).

3) The user must then write an octal value corresponding to the desired format into the data buffer (RX2DB). The controller sets TRANSFER REQUEST flag again. The user then writes 0 into RX2DB. Table 5-2 lists the available formats. When the operation is completed, the controller sets the DONE flag. An interrupt occurs if bit 6 (interrupt enable) is set prior to the format command.

Table 5-2. Diskette Format Codes

ID Code	Description	Density	# Sectors/ Track	Track #
154_8	Format the entire disk with FM-coded single density. Both sides of a double sided diskette are formatted	Single	26	0 to 76
155_8	Format the entire disk with DEC-modified MFM, double-density. Both sides of a double-sided disk are formatted.	Double	26	0 to 76

5.3.6 Power Fail

When a power failure occurs, or dc power to the DSD 880 is interrupted, the controller gradually drains the filter capacitors and stops executing microcode. The DONE and ERROR bits set in the RX2CS and the PWR LOW bit sets in the RX2DB to signal to the program that the controller/drive subsystem has lost power.

When power is restored, the DSD 880 controller initiates the following sequence:

1) Clears DONE.

2) Executes the hardware self-tests.

3) Positions drive to track 00.

4) Clears RX2ES of all active error bits.

5) Reads sector 1, track 1 of the floppy disk into the floppy buffer, if the drive is ready, and leaves floppy head at track 1.

6) Sets bit 2 of RX2ES (initialize done).

7) Updates bits 7 (drive ready) and 5 (drive density) of RX2ES according to the status of drive 0.

At the end of this sequence, the controller sets RX2CS bit 5 (the DONE flag).

5.3.7 Common Programming Mistakes

Use the following descriptions of common programming mistakes and hints to avoid data loss and/or error conditions.

1) Sending an illegal track or sector address to the controller. Note that the valid sectors are 1 through 26 (decimal), and the valid tracks are 0 through 76 (decimal).

2) Providing an incorrect word count for the length of a variable length sector/density set in the fill or empty command.

3) Underestimating the duration of the Read Status command. The Read Status command requires up to two revolutions of the disk to complete. To avoid excessive delays, use this command only when necessary.

4) Not checking the initialize done bit following a read or write operation. A short power outage will set the DONE flag without any error indication. After reading or writing, check the initialize done (RX2ES bit 2) for an indication of power failure.

5) Decoding the drive select bit during Fill Buffer and Empty Buffer operations. The drive select bit, RX2CS bit 4, may not be decoded by the controller during Fill Buffer and Empty Buffer functions.

6) Using a one-sector interleave. Use a two-sector interleave (sectors 1, 3, 5, etc.) for optimal data transfer rate.

7) Using the incorrect type of diskette. For both single-density and double-density recording, use only a 26 sector per track diskette. Do not use a hard sectored disk (multiple sector/index holes).

8) Typically a Fill Buffer command precedes a Write Sector command. Similarly, a Read Sector command precedes an Empty Buffer command.

5.3.8 Interrupts

The interface module requests an interrupt whenever the interrupt enable and DONE flag bits of the RX2CS both become set. The standard interrupt vector address is location 264 octal.

5.4 DSD 880 Winchester Disk Operation and Programming

The DSD 880 winchester disk drive has two operating modes. In the normal mode, the drive emulates a single DEC RL01 with a formatted capacity of 5.2 megabytes. In the extended mode, the drive operates as a diminished RL02 with the formatted capacity increased to 7.8 megabytes. The two operating modes are selected by means of the DSD HyperDiagnostics panel mode switch as described in Chapter 4 of this manual.

5.4.1 Bad Track Mapping

The winchester drive used in the DSD 880 provides 256 cylinders, with four tracks per cylinder and 32 sectors per track. Each sector contains 256 bytes, so the total capacity of the winchester drive is 32,768 sectors or 8,388,608 bytes.

The current state of the art in the production of winchester recording media is such that it is not possible to guarantee a flawless recording surface; it is expected that there will be a certain number of defects on the disk. The locations of these defects are recorded at the factory in a bad track map, located on physical cylinder 0 of the winchester drive. The DSD 880 controller automatically reads this bad track map when power is first applied, and subsequent accesses of the winchester disk are adjusted automatically by the controller to avoid the flawed areas. Fifteen tracks per head, or 60 tracks in all, are reserved as spares.

It is possible to add entries to the bad track map, by use of a special diagnostic program (SATEST) supplied by DSD. Its use is described in an appendix to this manual. The winchester disk should be backed-up onto floppy disks prior to use of the SATEST program. A hard-copy record is made at the factory of the data entered into the bad track map. This record is stored in an envelope on the front of the winchester drive, just behind the HyperDiagnostic panel. Changes to the bad track map should be noted on the record.

The bad track map and spare tracks are not available for user data storage. The maximum usable capacity of the winchester disk is 240 cylinders, with 4 tracks per cylinder and 32 sectors per track, or 30,720 sectors (7,864,320 bytes).

5.4.2 Normal Mode (RL01 Emulation)

The DEC RL01 provides 256 cylinders, with two heads (tracks) per cylinder and 40 sectors per track, for a total of 20,480 sectors. Each sector contains 256 data bytes. The total capacity of the RL01 is 5,242,880 bytes. In Normal mode, the DSD 880 controller converts RL01 cylinder, head, and sector addresses into a form compatible with the winchester drive. Corrections for bad tracks are totally transparent.

5.4.3 Extended Mode

In Normal (RL01 emulation) mode, 10,240 sectors (2,621,440 bytes) of available winchester storage is inaccessible to the user. Extended mode makes this capacity available by emulating a "diminished" RL02 (an RL02 provides 10.4 megabytes of storage, greater than the capacity of the winchester drive). In this mode, the DSD 880 controller converts RL02 cylinder, head, and sector addresses into a form compatible with the winchester drive, and corrections are automatically made for bad tracks. The last available sector is RL02 cylinder 577 (octal), head 1, sector 47 (octal). An error will be reported if an attempt is made to access a higher sector, except that the last track of the RL02 (bad block map) is mapped onto the winchester disk.

Extended mode also provides a "spiral read/write/write check" capability. The DEC RL02 requires that a seek command be issued to position the heads, followed by a read, write, or write check command to do the data transfer. The read, write, or write check command must specify the same cylinder and head set up by the seek command. If the word count exceeds the capacity of a single track, an error will result. In extended mode, the DSD 880 will seek to the specified cylinder and head on receipt of a read, write, or write check command, and will seek again if the word count exceeds the capacity of a single track; it is actually not necessary to use seek commands at all. DEC software does not support this feature, but it may be useful when special handlers are being planned.

5.4.4 DEC Bad Block Map

DEC provides a method of flagging bad blocks (one block is two sectors) in the RL01 and RL02 by providing a list of bad blocks on the last track of the disk pack (cylinder 377 octal, head 1 for the RL01 and cylinder 777 octal, head 1 for the RL02). This technique is fully supported by the DSD 880 since the bad block maps are present on the winchester disk and the correction for bad blocks is handled by DEC software. The DSD SATEST diagnostic which updates the bad track map also writes valid (empty) bad block data into the appropriate sectors.

DEC provides utility programs to add entries into the bad block area. These may be used with the DSD 880. The bad block data will be saved on floppy disks during a backup operation, and will be restored during the reload operation. This should be taken into consideration if the backup and reload functions are used to transfer a disk image between different DSD 880s.

5.4.5 Addressable Registers

The DSD 880 winchester disk drive (RL01 emulation) provides the following four types of physical, addressable registers:

Control Status Register
Bus Address Register
Disk Address Register
Multipurpose Register

These registers are described below.

5.4.6 Control Status Register

The 16-bit control status (CS) register has a base address of 774400. As shown in Figure 5-3, bits 1 through 9 and read/write bits (bit 0 and 10 through 15) are read-only.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
ERR	DE	NXM	DLT	DCRC	DP1	DS1	DS0	CRDY	1E	BA17	BA16	F2	F1	F0	DRDY
			HNF	HCRC	DP1										
Read Only						Read/Write									Read Only

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Figure 5-3. Control Status (CS) Register Format

A Bus Initialize (BINIT L) sets bits 7 and 0 (continuously) and clears bits 1 through 6 and 8 through 13.

The start of each controller command clears the error indicating bits (10 through 13). The completion of each controller command sets bit 7. Note that the detection of an error during command execution also sets bit 7. The function of the control status register bits is detailed below.

BIT 15 - ER - Composite error bit

When set, this bit indicates that at least one of the error detection bits (bits 10 through 14) is set. Note that if an error occurs when the interrupt enable bit (bit 6) is set, the current operation terminates and interrupt occurs.

BIT 14 - DE - Drive error bit

This bit is set if a winchester drive related error occurs. The execution of a Get Status command identifies the source of the drive error. Clear this bit by correcting the drive error or by executing the Get Status command with bits 3, 0, and 1 of the data address register set.

BIT 13 - NXM - Nonexistent memory bit

During a DMA data transfer, bit 13 set specifies that no memory response was received with 10 to 20 μs.

BIT 12 - DLT/HNF - Data late or header not found

The function of this bit is explained as follows:

OPI (Operation Incomplete) (bit 10)	DLT/HNF (bit 12)	Indication
Set	Set	Header not found: controller search for the correct read or write sector exceeded the 200 ms timeout limit.

BIT 11 - DCRC/HCRC - Data or header cyclic redundancy check (DCRC or HCRC)

This bit indicates data and header cyclic redundancy check errors as follows:

OPI (Operation Incomplete) (bit 10)	DCRC/HCRC (bit 11)	Indication
Cleared	Set	Data CRC error
Set	Set	Header CRC error

NOTE

On a Write Check command, DCRC/HCRC set and OPI clear indicates that the CRC error is a write check error.

BIT 10 - OPI - Operation incomplete

OPI sets when an error occurs which prevents transfer of data.

BITS 8, 9 - DS0, DS1 - Drive select bits

These bits specify which drive communicates with the controller. Note that the DSD 880 currently supplies a single rigid disk drive (DS0). Selecting DS1 causes an error. (Both DS0 and DS1 should be 0.)

BIT 7 - CRDY - Controller ready bit

The software clears this bit to initiate the execution of the command in bits 1 through 3. When this bit is set, the controller is ready to accept another command.

BIT 6 - IE - Interrupt enable bit

When this bit is set (by software), the controller will interrupt the processor at the normal or error caused termination of a command.

BITS 4, 5 - BA16, BA17 - Bus address extension bits

These bits function as the two high-order address bits of the bus address register, but are read and written as bits in the control status register.

BITS 1, 2, 3 - F2, F1, F0 - Function bits

These bits specify the command to be executed according to the following:

F2	F1	F0	Command Specified	Octal Code
0	0	0	NOP (clear errors)	0
0	0	1	Write Check	1
0	1	0	Set Status	2
0	1	1	Seek	3
1	0	0	Read Header	4
1	0	1	Write Data	5
1	1	0	Read Data	6
1	1	1	Read Data Without Header Check	7

BIT 0 - DRDY - Drive ready bit

When bit 0 is set, the drive is ready to receive a command.

5.4.7 Bus Address Register

The 16-bit bus address (BA) register has a base address of 774402. The BA register (Figure 5-4) specifies the memory location for the data transfer of a normal read or write operation. At the transfer of each word between the disk drive and the processor bus, the BA register contents increment by two. The BA register may be read only when bit 7 (CRDY) of the CS register is set.

Bit 0 in the BA register is always zero. All 16 bits are read/write bits. To clear the register, execute a BUS INIT or load the register with zeroes. Note that the BA register expands to an 18-bit register with bits 4 and 5 of the control status register becoming BA16 and BA17.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
BA15	BA14	BA13	BA12	BA11	BA10	BA9	BA8	BA7	BA6	BA5	BA4	BA3	BA2	BA1	0

Read/Write

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Figure 5-4. Bus Address Register Format

5.4.8 Disk Address Register

The 16-bit disk address (DA) register, at address 774404, is a three function register. The function depends upon the current command as explained below. The DA register may be read only when bit 7 (CRDY) of the CS register is set.

1. Disk Address Register for a Seek Command

During a seek operation, the DA register provides the drive with the head direction, head select, and cylinder address difference as shown in Figure 5-5 and described below:

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
DF8	DF7	DF6	DF5	DF4	DF3	DF2	DF1	DF0	0	0	HS	0	DIR	0	1

Extended Mode Only

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Figure 5-5. Disk Address Register Format During a Seek Command

BITS 7 through 15

These bits provide the cylinder address difference, which is the number of cyclinders the heads must move for the seek.

BITS 5, 6 - Reserved

BIT 4 - HS - Head Select

This bit specifies upper (HS clear) or lower (HS set) head (and disk surface) for the seek operation.

BIT 3 - Must be 0

BIT 2 - DIR - Direction for the seek operation

Bit 2 set specifies head movement toward the spindle. The head movement is away from the spindle if bit 2 is clear.

BIT 1 - Must be 0

BIT 0 - Must be 1

2. Disk Address Register for a Read or Write Command

For a read or write operation, the DA register initially contains the address of the first sector for the read or write. The contents of the register increment by one with each sector transfer. Figure 5-6 shows the DA register format for standard mode operation. The contents are described below.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
CA8	CA7	CA6	CA5	CA4	CA3	CA2	CA1	CA0	HS	SA5	SA4	SA3	SA2	SA1	SA0

Set For Extended Mode Only

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Figure 5-6. Disk Address Register Format for a Read or Write Command

SA0 through SA5 - Sector Address for one of the 40 sectors on the track. (Valid sectors are 0 through 39).

HS - Head select specifies the head (disk surface) for the read or write: upper (clear) or lower (set).

CA0 through CA8 - Cylinder address of one of the 256 cylinders. CA8 is used for extended mode only.

3. Data Address Register for a Get Status Command

The contents of the DA register for a Get Status command are shown in Figure 5-7 and explained below.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
X	X	X	X	X	X	X	X	0	0	0	0	RST	0	GS	1

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Figure 5-7. Disk Address Register Format for a Get Status Command

BITS 8 through 15 - Not used

BITS 4 through 7 - Must be 0

BIT 3 - RST - Reset bit

When the bit is set, the drive first clears the error bits, then sends the status word to the controller.

BIT 2 - Must be 0

BIT 1 - GS - Get status

This bit must be a 1 to request the status word from the drive and to direct the drive to ignore bits 8 through 15. As soon as the Get Status command is completed, the controller multipurpose register (described below) is loaded with the drive status word.

BIT 0 - Must be a 1

5.4.9 Multipurpose Register

The 16-bit multipurpose (MP) register, like the disk address register, is a triple-function register. The function depends on the command used.

1. Multipurpose Register for a Get Status Command

When a status word is returned to the controller following execution of a Get Status command, the MP register contents are as pictured in Figure 5-8 and explained below. The MP Register may be Read only when bit 7 (CRDY) of the CS register is set.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WDE	HCE	WL	SKTO	SPE	WGE	VC	DSE	0	HS	CO	HO	SH	STC	STB	STA

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Figure 5-8. Multipurpose Register Format for a Get Status Command

BIT 15 Always 0
BIT 14 Head current error - write current was detected in the heads when the write gate was not asserted
BIT 13 Write lock - winchester drive is write protected
BIT 12 Seek timeout - winchester drive did not complete a seek in the allotted time
BIT 11 Speed Error - winchester drive not ready
BIT 10 Write Gate Error - set when write fault is set in winchester drive
BIT 9 Always 0

BIT 8	Drive Select Error - attempt was made to select a non-existent drive
BIT 7	Set if DSD 880 is in Extended Mode
BIT 6	Head Select - this bit specifies the head currently selected (0 or 1)
BIT 5	Always 0
BIT 4	Heads out - Always 1
BIT 3	Always 1
BITS 0 - 2	STA, STB, and STC - States A, B, and C

These bits define the current state of the winchester drive as follows:

C	B	A	State Specified
0	0	0	Load
1	0	0	Seek
1	0	1	Lock On

2. Multipurpose Register During a Read Header Command

Execution of a Read Header command loads three words into the MP register. The first word contains the sector address, head select, and cylinder address information. The second word is all zeroes; the third word contains the header CRC data. Figure 5-9 shows the format for each word. The MP register may be Read Only when bit 7 (CRDY) of the CS Register is set.

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
1ST Word	CA8	CA7	CA6	CA5	CA4	CA3	CA2	CA1	CA0	HS	SA5	SA4	SA3	SA2	SA1	SA0

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
2ND Word	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
3RD Word	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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Figure 5-9. Multipurpose Register Format for a Read Header Command

3. Multipurpose Register for a Read/Write Data Command

The multipurpose register acts as a word counter when the drive is reading or writing data. Initially, the MP register is loaded with the two's complement of the number of words to be transferred. Word counter overflow normally terminates the Read or Write operation. Figure 5-10 shows the MP register during a Read/Write Data command in both standard and extended operating modes. The largest valid word count for the Normal Mode is 5120 words. The longest valid word count for the Extended Mode (where a Spiral Read/Write is allowed) is 65536 words.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WC15	WC14	WC13	WC12	WC11	WC10	WC9	WC8	WC7	WC6	WC5	WC4	WC3	WC2	WC1	WC0

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Figure 5-10. Multipurpose Register Format for a Read/Write Data Command

5.4.10 Winchester Controller Commands

The winchester disk drive commands to the controller are specified by bits 1, 2 and 3 of the control status (CS) register.

Function Code 0 - NOP

The drive clears errors (except for a drive error, DE in the CS register), sets the controller ready (CRDY) bit in the CS register, and causes an interrupt if interrupts are enabled (IE is set).

Function Code 1 - Write Check Command

Write Check verifies that data were accurately written on the disk in the following manner. The Write command writes a block of data from the data buffer in main memory onto the disk. Then the Write Check reads that block of data from the disk and serially compares it with the original data in the data buffer. Note that this comparison occurs in the controller which requires a source data transfer from memory into the controller data buffer.

Before executing the Write Check command, initialize the bus address (BA), multipurpose (word count), and disk address registers as follows:

Register	Contents
Bus Address	Address of first data block in main memeory
Word Count (Multipurpose)	Length of the data block
Disk Address	Starting disk address location

Immediately, the DMA transfer of data from the main memory data buffer to the controller begins. The logical RL01 disk address is mapped onto a physical winchester disk address and header address words, read from the disk, are compared to the starting physical address.

As soon as the starting address is found, the controller is monitored until it contains a complete sector. If there are no header cyclic redundancy check (HCRC) errors, the data (128 words) are then read from the disk and compared to the data in the Controller's data buffer. An error in this comparison, or in the data cyclic redundancy check, sets the DCRC bit in the Control Status Register.

Function Code 2 - Get Status Command

Upon execution of the Get Status command, the drive sends the drive status word to the controller if the Get Status bit (bit 1) in the disk address (DA) register is set. The Get Status command loads the drive status word into the multipurpose (MP) register. The controller sets CRDY (controller ready) and causes an interrupt, if interrupts are enabled (IE set). Note that if bit 3 (RST, the reset bit) of the DA register is set, the drive first clears the error bits then sends the status word.

If the Get Status bit in the DA register is clear, the Get Status command is undefined and an error is repeated.

Function Code 3 - Seek Command

On executing the Seek command, if DAO in the DA register is set and DA1 is clear, then on receiving the seek information the controller sets CRDY and, if interrups are enabled (IE set), causes an interrupt. The seek information includes the head direction, head select, and cylinder address difference. When the drive receives the seek information from the controller, it seeks and/or selects a new read/write head. DA0 must be set and DA1 clear for a Seek Command; any other combinations are undefined, and an error is repeated.

If the size of the cylinder address difference would move the heads beyond permissable limits (inside the innermost track or beyond track 0), the head stops at the limit track. A maximum length seek out may therefore be used as Restore Command.

Function Code 4 - Read Header Command

This command finds the current location on the disk as follows. If CRDY (controller ready) is clear, a Read Header command causes the controller to read the current disk location into the multipurpose (MP) register. The controller then sets CRDY and, if interrupts are enabled (IE is set), causes an interrupt. To obtain the two header words, the software can then read the MP register contents for the current cylinder, head, or sector location of the drive and can then calculate the cylinder address difference for a Seek operation.

The header cyclic redundancy check (HCRC) word enters the silo behind the two header words, to be available from the MP register for diagnostic use.

Function Code 5 - Write Data Command

This command moves the head to the correct location and writes the required data as follows. If CRDY is clear, a Write Data command causes the controller to map the logical RL01 disk address onto a physical winchester disk address. It then reads and compares successive header words with the physical disk address (DA) register until an address match is found. Then the header cyclic redundancy check (HCRC) occurs and, if there is no HCRC error, the data specified by the bus address (BA) register are written into the sector. If the data does not fill the sector, zeroes are written in the remaining locations.

If the amount of data requires any additional sectors, the sector address in the DA increments when the current sector is full, then the write continues in the next sector. Completion of the data transfer sets CRDY and, if interrupts are enabled (IE is set), causes an interrupt.

Function Code 6 - Read Data Command

This command moves the head to the correct location and reads the required data as follows. If CRDY is clear, the Read Data command causes the controller to map the logical RL01 disk address onto a physical winchester disk address and read and compare successive header words with the required disk address (DA) word in the DA register until a match occurs. If there are no header cyclic redundancy check (HCRC) errors, the data in the sector are read into the location specified by the contents of the bus address (BA) register. A data cyclic redundancy check (DCRC) occurs. If there are no errors, the contents of the DS increment by one. If the word count (the contents of the multipurpose [MP]) register overflows, CRDY sets. If interrupts are enabled (IE is set), an interrupt occurs. If the MP register does not overflow, the Read continues with the next sector.

Function Code 7 - Read Data Without Header Check Command

If CRDY is clear, a Read Data Without Header Check command reads the data from the next sector to the location specified by the contents of the bus address (BA) register. The data cyclic redundancy check (DCRC) occurs at the end of the sector. Then, if the word count (in the multipurpose register) has not overflowed, the read continues at the next sector. The word count overflow sets CRDY and, if interrupts are enabled, an interrupt occurs.

Note that the header is not compared or checked for cyclic redundancy errors with this command. The Read Data Without Header Check Command is normally used by issuing Read Header commands until the sector prior to the desired sector is found, then issuing the Read Data Without Header Check Command.

6.0 BASIC CIRCUIT DESCRIPTION

6.1 General Information

This chapter provides a basic, block diagram level description of the DSD 880 circuitry.

6.2 DSD 8832 Interface Board

The DSD 8832 is the interface between the DSD 880 System and the DEC LSI-11 processor. The DSD 8832 Interface Board performs several functions, the primary ones being:

a. Emulation of RL01 and RL02 control and status registers.

b. Control of the data transfer between the DSD 880 Interface bus and the LSI-11 Q-bus.

c. Contains the user selectable RL01 and RX02 bootstrap program.

d. Arbitrates RL01 and RX02 command transfers between the DSD 880 controller and the LSI-11 Processor.

The unique capability of the DSD 880 to emulate both a RL01 and a RX02 in a single cost effective package is due in part to the ability of the interface to arbitrate between RL01 and RX02 commands.

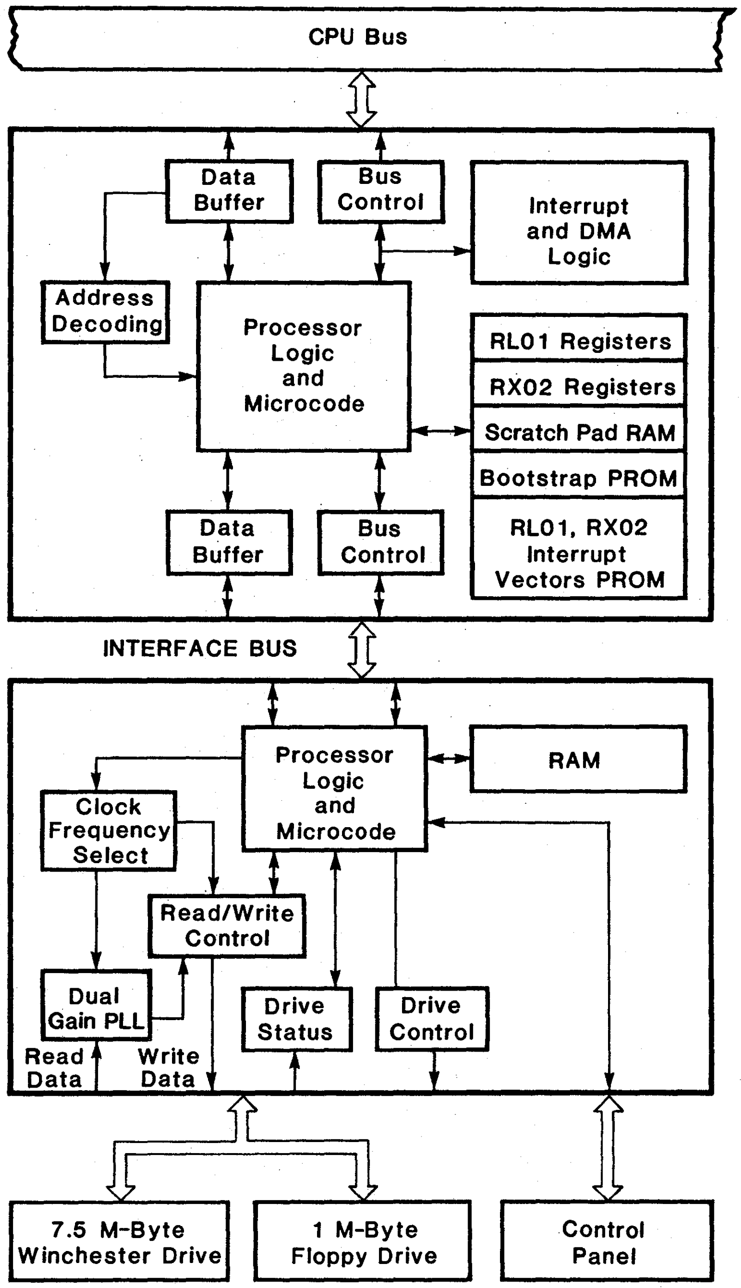
Although the DSD 880 system controller emulates both a single drive RL01 and a single drive RX02 disk system, it cannot do so simultaneously. In order to maintain system compatibility and resolve device conflicts, the DSD 8832 interface arbitrates command transfers in the following manner.

Assume that, initially, neither the RL01 or RX02 is executing a command and a command is received by the interface for the RX02 device. The command will immediately be sent to the DSD 880 controller for execution and the DONE bit in the RX2CS will be cleared. If a command is received for the RL01 device before the RX02 command has completed execution, the interface will accept the command, place it in a 1 level queue for transfer to the controller, and clear the CONTROLLER READY bit in the CSR. At this point, both devices will appear busy.

When the RX02 device completes execution, the interface will set the DONE bit in the RX2CS register and immediately send the queued RL01 command to the controller for execution. If a new command is received for the RX02 device before the RL01 command completes execution, it will be placed in the 1 level queue and the DONE bit will be cleared.

When the controller completes execution of the RL01 command the interface will set the CONTROLLER READY bit in the CSR. If a command is in the queue for the RX02 device, it will be executed. Otherwise, both devices will be ready to accept new commands.

The DSD 8832 interface has been implemented using bipolar technology in order to provide the desired fast LSI-11 response time and DMA throughput. Refer to the block diagram and the DSD 880 shown in Figure 6-1. Note the logic of the interface can be divided into 3 major subsections; Processor and associated Logic LSI-11 Q-bus interface and DSD 880 Interface bus (I-BUS) interface.



CPU INTERFACE

- Emulates RL01 and RX02 command and status registers
- Arbitrates RL01 and RX02 command transfers between DSD880 controller and CPU
- Controls data transfer between DSD 880 controller and CPU
- Contains user selectable RL01 and RX02 bootstrap programs
- Contains DMA and interrupt logic

DSD 880 CONTROLLER/FORMATTER

- Directy emulates RL01 and RX02 hardware and software operations
- Controls data transfer to and from disk drives
  - Encoding decoding
  - Formatting
  - Implied seeks
  - Multiple sector transfers
  - Bad track remapping
- Executes self diagnostics

CONTROL PANEL

- Selection display
  - Diskette formatting
  - Backup loading
  - Fault indication
  - Write protection
  - System diagnostics

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Figure 6-1. DSD 880 Block Diagram

The PROCESSOR subsection forms the intelligent heart of the interface. It consists of the Processor logic (ALU, Sequencer, etc.), the microcode PROM, and the RAM data buffer. The processor subsection controls data and command transfer between the LSI-11 Q-Bus and the DSD 880 Controller I-Bus, implements the device registers, and performs RL01 and RX02 command queing. Note that the command and status reqisters for the RL01 and RX02 devices are implemented in software using the RAM data buffer rather than as discrete hardware registers.

The LSI-11 Q-BUS INTERFACE subsection consists of the device address decorder, the interrupt logic, Q-Bus register, and Q-Bus buffers. This subsection controls the transfer of data between the processor subsection and LSI-11 Q-Bus. The address decoder recognizes jumper selectable RX02 and RL01 device and bootstrap addresses. The Q-Bus register stores data, and address and status information while it is being transferred to the LSI-11 processor via the Q-Bus. The interrupt request logic and interrupt vector PROM control the interrupt of the LSI-11 processor by the processor subsection. The desired interrupt vector and level are jumper selectable.

The DSD 880 I-BUS INTERFACE subsection consists of the I-Bus register, I-Bus controller, and I-Bus buffers. This subsection controls the transfer of data between the processor subsection and the DSD 880 controller I-Bus. The I-Bus register allows the transfer of data between the controller and interface to be as rapid as possible without exceeding the capability of either. The I-Bus controller coordinates the transfer of data into and out of the I-Bus register while the I-Bus buffers match the I-Bus cable to the logic requirements of the I-Bus interface.

6.3 DSD 8830 Interface Board

The DSD 8832 Interface Board is available for those customers utilizing the DSD 880 Data Storage System with the DEC PDP-11 processor. The DSD 8832 controls data transfer between the PDP-11 Unibus and the DSD 880 Interface Bus. A block diagram of the 8830 is given in Figure 6-2.

The 8830 can emulate both RX02 and RL01 device registers according to DEC standards. Since the 880 controller can only operate on one device at a time, the 8830 arbitrates between sending the latest RL command the bootstrap eliminates the need for a DEC bootstrap board. Finally, five switch packs allow the user to select any of the possible boot addresses, device register addresses, or vector addresses.

Basically, the 8830 is a simple bit slice or nibble machine. A straight forward micro instruction set can be derived since the ALU A input is designated for straight 128X4 RAM nibbles. The ALU B input is selected through the ALU MUX, the ALU F output is latched into the RAM (AO register) and/or buffer register A. The 2911 based micro instruction sequencer allows JMP, JSR, and RTS type branches. A high 880 to Unibus throughput rate during DMA is enhanced by the two 16-bit data buffer registers A and B which can be parallel loaded, or nibble shifted, in a way that allows the 880 to read or write data through register B while the rest of the 8830 operates through register A.

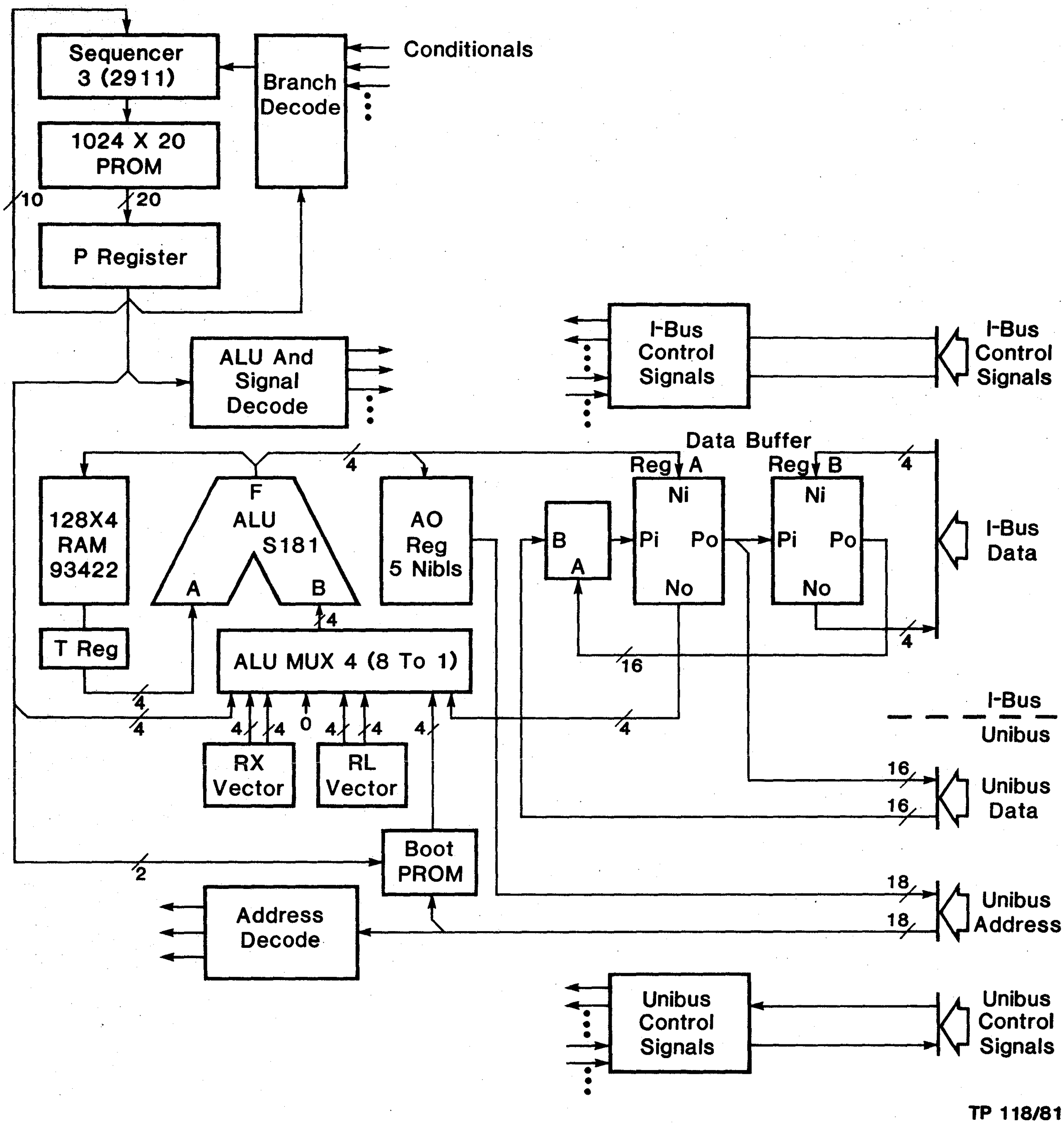

Figure 6-2. DSD 8830 Interface Board Block Diagram

6.4 DSD 880 Controller/Formatter Board

The processor logic, which is the heart of the DSD 880 Controller is made up of 2901 bit slice logic circuitry. It performs the following basic functions:

- Handles the I-Bus protocol between the interface and the controller.
- Executes DEC compatible RL01 and RX02 command sets.
- Executes Seek, Head Load, Read, Write, and other disk drive related functions.
- Handles data flow from and to the interface and the Read/Write circuitry.
- Provides format control.
- Controls the diagnostic front panel.
- Executes HyperDiagnostics.

The Phase Lock Loop circuitry consists of dual front-end phase comparators with their associated low pass filters and a common voltage controlled oscillator. The use of a dual gain approach provides extended margins of acquisition and tracking range. It is used to:

- Discriminate preamble for winchester data.
- Reconstruct clock and data margins from raw data.

A sophisticated clock system is used to synchronize the processor logic with the Read/Write Format control circuitry. The system uses three clock sources:

- A 6 Mhz crystal for floppy Write and system housekeeping functions.
- A 17.36 Mhz crystal for floppy Read, winchester Write and other critical timing functions.
- A VCO for floppy and winchester Read.

The heart of the Read/Write Format control circuitry is a 82S100 FPLA. The circuitry is used to:

- Encode and decode FM and DEC-Modified MFM formats for the floppy disk.
- Encode and decode MFM format for the winchester disk.
- Check the CRC of Header and Data fields.
- Provide proper precompensation for both the floppy and winchester drives.

The DSD 8840 is shown in Figure 6-3.

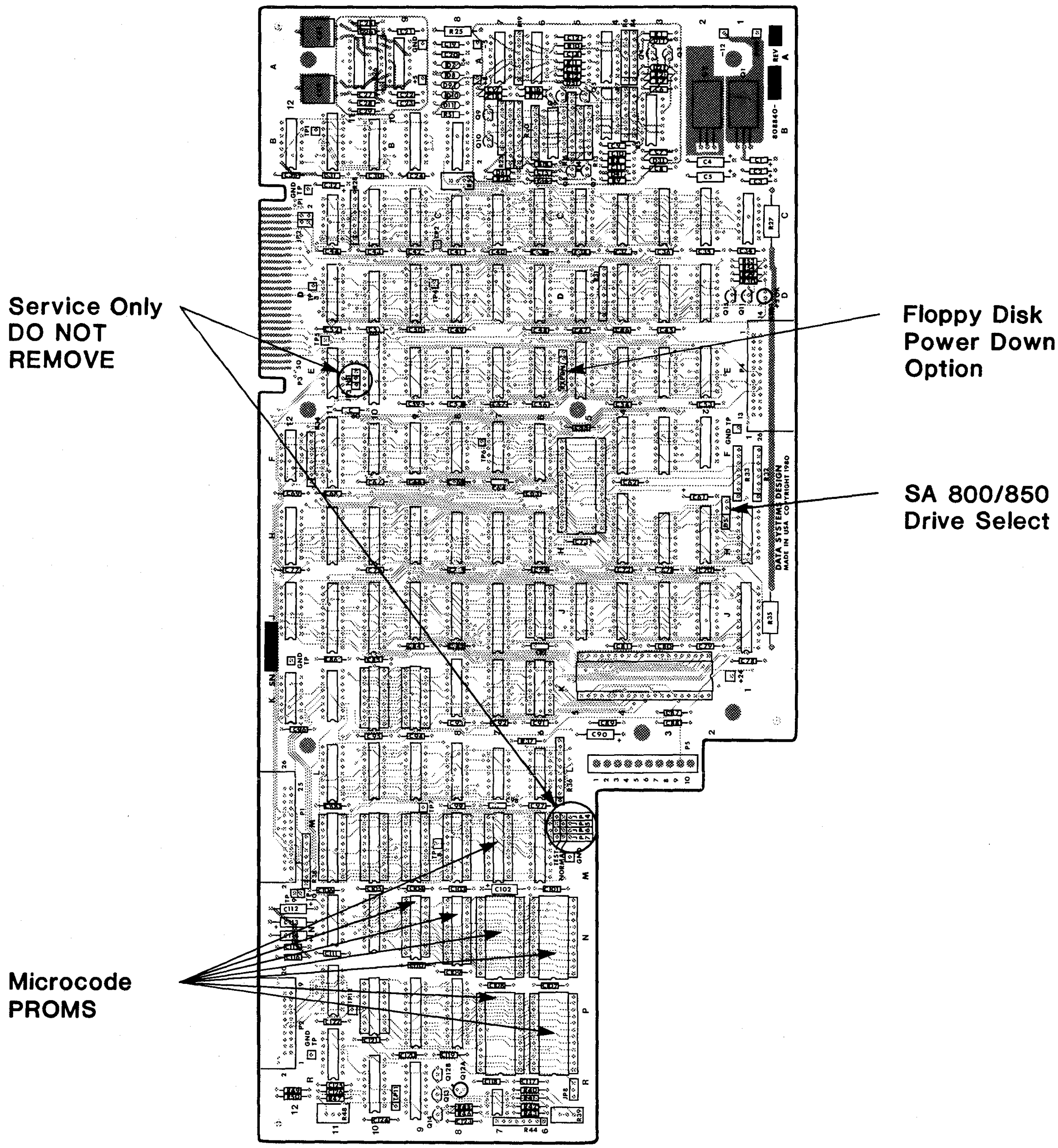

Figure 6-3. DSD 8840 Controller/Formatter Board

6.5 DSD 8833 HyperDiagnostic Panel

The DSD 8832 HyperDiagnostic panel provides user access to controller functions and status indicators. These functions include:

- System mode selection.
- Backup and load operations.
- Diskette formatting.
- Write protection for both the floppy and winchester drives.
- HyperDiagnostic test selection.
- Fault and status indication.

7.0 USER LEVEL MAINTENANCE

7.1 General Information

This chapter provides information on the maintenance of the DSD 880 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 Preventative Maintenance

The DSD 880 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 floppy disk drive furnished in the 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 for the drive.

CAUTION

> Do not lubricate the drive; oil will allow dirt and dust to accumulate.
>
> To prevent damage, the read/write heads should not be cleaned or touched in the DSD 880 system.
>
> The SA1000 Winchester Disk Drive furnished with the DSD 880 requires no routine maintenance.

Table 7-1. Floppy Disk Drive Preventative Maintenance

Unit	Months Freq.	Action	Observe
Read/Write Heads	N/A	No maintenance required	Do not clean or touch
Actuator band	12	Clean all oil, dust & dirt if necessary	
Belt	12	Replace if damaged	Inspect for 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 for initial, user level, fault isolation on the DSD 880. This guide should be used as a preliminary check list prior to any extensive maintenance procedures.

Table 7-2. Preliminary Troubleshooting Guide

Trouble Indication	Possible Cause
DSD 880 floppy disk and/or winchester disk will not operate	• Power switch not turned on • Power cord is disconnected • Interface cable improperly installed • Fuse blown • Overheat condition
Floppy disk drive activity lights do not light. Disk drives do not initialize	• Power supply failure • Floppy disk drive door open • Diskette improperly loaded into floppy disk drive
Floppy disk drive activity light remains lit at all times	• Defective drive or empty drive • Defective controller
Disk drive will not initialize	• Defective interface, Power supply, controller, or drive. HALT switch on computer ON
Bootstrapping cannot performed	• Interface cable improperly installed • Interface cable improperly installed at computer backplane • Defective interface • HALT switch on computer front panel is set to ON • Possible drive malfunction

7.4 Diagnostic Aids

The DSD 880 provides diagnostic aid in the form of the built-in, microcoded, HyperDiagnostic mode of operation. Added diagnostic assistance is available through use the the DSD FIXEXR & FLPEXR programs.

7.5 Fault Isolation

If the preliminary troubleshooting guide, Table 7-2, fails to locate the cause of the system malfunction, the built-in diagnostic capabilities of the DSD 880 should be used to isolate the fault to a replaceable subsystem (interface card, controller board, floppy disk drive, winchester disk drive, interface cable, or power supply).

7.5.1 Use of DSD 880 HyperDiagnostics

The DSD 880 Data Storage System provides the user with extensive built-in self test features, HyperDiagnostics, which permit testing of the system without requiring the use of a computer. The HyperDiagnostics are a series of routines in microcode which self-test the 8840 controller and exercise both the floppy and winchester disk drives. The tests are initiated and monitored from the HyperDiagnostic panel, located behind the front bezel.

The following "Modes" may be selected:

0 On-line operating modes, requiring use of host processor.

1 Floppy disk format routines, used to format the floppy disk in single or double density, with or without rewriting headers, and with or without scan verification.

2 General exerciser tests of the floppy disk, the winchester disk, or both; used to verify proper system operation.

3 Controller hardware tests, which do not exercise the drives.

4 Floppy disk alignment routines.

5 Individual tests of the floppy and winchester drives, used mostly for troubleshooting.

6 Reload winchester disk from backup floppy disks.

7 Backup winchester disk data onto floppy disks.

CAUTION

Any test that causes data to be written on the winchester disk can cause loss of data that is on the disk prior to testing.

7.5.2 HyperDiagnostic Operation

DSD 880 HyperDiagnostics are initiated by selecting the appropriate mode and class switch settings and momentarily depressing the EXECUTE pushbutton. The selected mode and class is echoed by the 7 segment displays while the execute button is depressed.

If a floppy disk is required for the HyperDiagnostic, it must be inserted prior to inititating the test. Otherwise, a drive error (36) will be reported. Likewise, if the HyperDiagnostic includes a write operation, the appropriate drive(s) must be write enabled. Otherwise, a write protect error (10) will be reported.

Most HyperDiagnostics display the selected class and mode while the test is running. If the test fails, the appropriate error code and fault indicators will be flashing. If the selected HyperDiagnostics is a single pass test, the code 00 will be displayed upon successful completion. If the HyperDiagnostic selected is repetitive, the code 00 will be displayed for 1 sec. between each pass.

Most HyperDiagnostics can be terminated at any time by selecting the new HyperDiagnostic test code and depressing the execute pushbutton. The floppy disk format HyperDiagnostics cannot be terminated via the execute pushbutton and must be allowed to complete before selecting a new test.

Since the HyperDiagnostics are controlled by microcode, the microprocessor in the DSD 880 must be at least partly functioning before any tests can be run. HyperDiagnostics do not perform any tests on the interface board or on the I-bus cable. It is not necessary to have the I-bus cable connected while running HyperDiagnostics, and in most cases it is better to disconnect the I-bus cable to prevent computer system activity from affecting test results. In particular, bus INITS from the computer will always abort HyperDiagnostics.

7.5.3 Error Reporting During HyperDiagnostics

Errors are indicated by displaying the appropriate error code in the 7 segment displays and illuminating the composite and appropriate drive fault indicators located on the HyperDiagnostic panel. Table 7-3 lists the DSD 880 definitive error codes. Paragraph 7-6 provides an expanded definition of the error codes.

Errors other than HEADER or DATA CRC (14 or 20) errors will cause the HyperDiagnostics routine to terminate immediately upon their occurrence. Each occurrence of the CRC error is logged and a running total kept. The HyperDiagnostic will terminate when a total of 16 (decimal) CRC errors have occurred since the HyperDiagnostic was initiated.

NOTE

> Failure of ALU LOGIC TEST will cause the controller to cease responding to interface commands and the execute pushbutton. The composite fault indicator will be illuminated; the error code displayed by the seven segment displays will not be flashing and should be disregarded. The ac power must be cycled to restart the controller if the ALU LOGIC TEST fails.

Table 7-3. Definitive Error Codes

These errors are flashed on the HyperDiagnostic panel when the indicated error occurs:

CODE Displayed	Description
00	No errors - operation complete (HyperDiagnostics only)
01	Drive failed to home on initialize
02	Nonexistent drive
03	Track 00 found while stepping in on initialize
04	Invalid RX02 track address
05	Track 00 found before desired track while stepping
06	Seek timeout while stepping (RL01 only)
07	Requested sector not found in 2 revolutions
10	Write protect violation
11	Not defined
12	No preamble found
13	Preamble found but no address mark within window
14	CRC error on what appeared to be a header
15	Address in header did not match desired track
16	Too many tries for an ID address mark
17	Data address mark not found in allotted time
20	CRC error on data field
21	Write gate error (RL01 only)
22	VCO failure during read operation (RL01 only)
23	Invalid word count specified
24	Media density did not match desired density (RX02 only)
25	Invalid key for set media density or format command (RX02 only)
26	Indeterminate media density (RX02 only)
27	Write format failure
30	Data compare error (RL01 & RD/WRT HyperDiagnostics)
31	Invalid bad track map detected during INIT (RL01 only)
32	Bad track map checksum did not match stored value
33	Not defined
34	Not defined
35	Nonexistent memory (NXM) error during DMA transfer
36	Drive not ready (door open, speed error, absent media)
37	Low ac power caused abort of write activity
40	Invalid disk used for reload (RL01 reload only)
41	Multiple reload disk versions used (RL01 reload only)
42	Invalid class selected (HyperDiagnostics only)
43	Invalid winchester disk address
44	Winchester disk word count overflow
45	Deleted data mark encountered on reload floppy (RL01 reload only)
46	Not defined
47	Not defined
51	Memory test failure
52	CRC test failure
53	PLL test failure

7.5.4 Winchester Write Enable

HyperDiagnostics which include a winchester disk sequential write operation must be write enabled prior to initiating the test. Write enable is accomplished by selecting class 7 of the appropriate mode (2 or 5), then depressing the execute button. The selected mode will then be write enabled and will remain so until a new mode is selected. Note that winchester read/write HyperDiagnostics destroy data on the winchester disk.

7.5.5 Floppy Disk Format Routines (Mode 1)

The floppy disk format routines are entered by setting the MODE switch to position 1 (FORMAT), selecting the desired CLASS, and depressing the EXECUTE pushbutton. These routines affect only the floppy disk drive; it is not possible to format the winchester drive from the HyperDiagnostic panel. The FLOPPY WRITE PROTECT switch must be off, and a write enabled floppy disk must be placed in the drive. All data on the floppy disk will be lost. Either single- or double-sided disks may be used. Unlike most HyperDiagnostics, it is not possible to interrupt the operation by pressing the EXECUTE pushbutton during the test. This prevents mixed-density diskettes from being created.

The following "Classes" may be selected:

0 FORMAT DOUBLE-DENSITY - Formats the entire floppy disk in DEC double-density format. Headers are rewritten.

1 FORMAT SINGLE-DENSITY - Formats the entire floppy disk in DEC/IBM single-density format. Headers are rewritten.

2 SET MEDIA DOUBLE-DENSITY - Writes all data fields in DEC double-density format, with all data bytes =0. Headers are not rewritten.

3 SET MEDIA SINGLE-DENSITY - Writes all data fields in DEC/single-density format, with all data bytes =0. Headers are not rewritten.

4 SET MEDIA DOUBLE-DENSITY AND SCAN - Writes all data fields in DEC double-density format and scans the disk looking for errors.

5 SET MEDIA SINGLE-DENSITY AND SCAN - Writes all data fields in DEC/single-density format and scans the disk looking for errors.

7.5.6 System Tests (Mode 2)

The System Tests are entered by setting the MODE switch to position 2 (SYSTEM), selecting the desired CLASS, and depressing the EXECUTE pushbutton. The tests are normally used to verify that the 880 system is working correctly, rather than for troubleshooting. The tests exercise the 8840 controller and one or both disk drives, but do not test the interface card or the I-bus cable. These tests are useful for verifying system operation during incoming inspection and after site installation of the system.

The following "Classes" may be selected:

0 FLOPPY DISK EXERCISER WITH WRITE FORMAT - runs the following sequence of HyperDiagnostic tests on the floppy drive only:

a. Single-Density Write Format
b. Sequential Scan All Sectors
c. Butterfly Read Headers
d. Sequential Write/Read All Sectors
e. Set Media Double-Density
f. Sequential Scan All Sectors
g. Butterfly Read Headers
h. Sequential Write/Read All Sectors
i. Set Media Double-Density

1 FLOPPY DISK EXERCISER WITHOUT WRITE FORMAT - runs the same sequence of tests as the floppy disk exerciser described previously with the exception of the single-density write format.

2 FIXED DISK EXERCISER - runs the following sequence of HyperDiagnostic tests on the fixed disk drive only:

a. Sequential Scan All Sectors
b. Butterfly Seek Test
c. Sequential Write/Read All Sectors

3 GENERAL EXERCISER WITH FLOPPY DISK WRITE FORMAT - runs the floppy disk general exerciser, then runs the fixed disk exerciser tests.

4 SINGLE PASS GENERAL EXERCISER WITH FLOPPY WRITE FORMAT - runs a single pass of the floppy and fixed disk exercisers.

5 SINGLE PASS GENERAL EXERCISER WITHOUT FLOPPY WRITE FORMAT - runs a single pass of the floppy and fixed disk exercisers without formatting the floppy disk.

6 GENERAL EXERCISER WITHOUT FLOPPY WRITE FORMAT AND FIXED READ/WRITE TESTS - runs the floppy disk general exerciser without formatting the floppy disk, then runs the fixed disk exerciser without executing the sequential write/read tests.

7 FIXED DISK EXERCISER WRITE ENABLE - permits sequential write operations on the winchester disk. (For tests 2, 3, 4, and 5.)

7.5.7 Controller Tests (Mode 3)

The Controller Tests are entered by setting the MODE switch to position 3 (CONTROLLER), selecting the desired CLASS, and depressing the EXECUTE pushbutton. The tests are intended for troubleshooting the controller logic to determine if a problem is drive related.

The following "Classes" may be selected:

SWITCH AND INDICATOR TEST - tests the various controller switches and indicators on the diagnostic panel for proper operation.

Setting the FLOPPY WRITE PROTECT switch to the ON position will illuminate the FLOPPY WRITE PROTECT and FLOPPY FAULT indicators, and cause the digits 88 to flash in the 7 segment displays.

Setting the WINCHESTER WRITE PROTECT switch to the ON position will illuminate the WINCHESTER WRITE PROTECT and WINCHESTER FAULT indicators, and cause the digits 99 to flash in the 7 segment displays.

If neither the FLOPPY or WINCHESTER WRITE PROTECT switches are in the ON position, the WINCHESTER FAULT, FLOPPY FAULT, FLOPPY WRITE PROTECT, COMPOSITE FAULT, and WINCHESTER READY indicators will be sequentially illuminated one at a time. In addition, the position of the CLASS and MODE switches will be echoed in the 7 segment displays.

1 GENERAL CONTROLLER HARDWARE TEST - runs the following controller hardware diagnostics:

a. ALU logic test
b. RAM memory test
c. CRC logic test
d. PLL logic test

This test verifies the controller hardware and is useful in localizing failure to a specific functional block

2 ALU LOGIC TEST - tests the operation of the arithmetic logic unit.

3 RAM MEMORY TEST - tests the operation of the RAM buffer memory.

4 CRC LOGIC TEST - tests the operation of the CRC logic.

5 PLL LOGIC TEST - tests the operation of the Phase Locked Loop circuit.

6 MICROCODE VERSION - displays microcode version number.

7.5.8 Floppy Disk Alignment Routines (Mode 4)

The Floppy Disk Alignment routines are entered by setting the MODE switch to position 4 (ALIGN FLOPPY), selecting the desired CLASS, and depressing the EXECUTE pushbutton. These routines affect only the floppy disk drive and are intended for use by qualified service personnel when an alignment disk (DYSAN p.n 360-2A or DSD p.n. 530003) is used to adjust the drive.

The following "Classes" may be selected:

0 FLOPPY DISK TRACK 00 DETECTOR ADJUSTMENT - loads floppy head and repeatedly seeks between tract 00 and 01 every 100 ms.

1 FLOPPY DISK SEEK TRACK 01 AND LOAD HEAD - seeks floppy head to track 01 and loads it.

2 FLOPPY DISK SEEK TRACK 02 AND LOAD HEAD - seeks floppy head to track 02 and loads it.

3 FLOPPY DISK SEEK TRACK 38 AND LOAD HEAD - seeks floppy head to track 38 and loads it.

4 FLOPPY DISK SEEK TRACK 76 AND LOAD HEAD - seeks floppy head to track 76 and loads it.

5 FLOPPY DISK HEAD LOAD TIMING ADJUSTMENT - seeks floppy head to track 00 then alternately loads head for 100 ms and unloads head for 200 ms.

7.5.9 Read/Write Tests (Mode 5)

The read/write tests are entered by setting the MODE switch to position 5 (READ/WRITE), selecting the desired CLASS, and depressing the EXECUTE pushbutton. These routines are intended for troubleshooting of problems encountered during computer system operation, or during the System mode HyperDiagnostics. They consist of individual read, write, scan, and seek tests on both the floppy and winchester drives. Write protect switches should be off. A disk must be inserted in the floppy disk drive if tests are being performed on that drive. Single or double sided floppy disks of either density may be used. Data on the effected disk will be lost if the sequential write/read test is run.

The following "Classes" may be selected:

0 SINGLE PASS SEQUENTIAL SCAN FLOPPY DISK - scans the entire disk for CRC errors and valid disk headers. Data on the floppy disk is not affected. This test is extremely useful, if a system disk cannot be booted, to check for errors on the disk. The test stops after one pass is made.

1 BUTTERFLY SEEK TEST FLOPPY DISK DRIVE - steps head of floppy disk drive using a butterfly pattern, then seeks track 00.

NOTE

This test can be run without media in the floppy drive.

This test is used to detect head positioning problems in the floppy disk drive. The test runs until halted.

2 BUTTERFLY READ HEADERS ON FLOPPY DISK - steps head of floppy disk drive using a butterfly pattern, checking for correct disk headers. This test is similar to the Butterfly seek test except that head positioning is verified by comparing the track number, in the disk header, to a expected track number. The test runs until halted.

3 SEQUENTIAL WRITE/READ FLOPPY DISK - sequentially writes then reads the entire floppy disk checking for data or header errors. This test exercises the read/write circuitry of the controller and floppy disk drive and is useful in diagnosing problems in this area. The test runs until halted.

4 SEQUENTIAL SCAN FIXED DISK - scans entire fixed disk for CRC errors and valid disk headers. Data on the disk is not changed by this test. This test is useful in verifying the winchester disk media when intermittant CRC errors occur during operation. The test runs until halted.

5 BUTTERFLY SEEK TEST FIXED DISK - steps head of fixed disk drive using butterfly pattern, then seeks to cylinder 00 and verifies that it is there. This test is useful in detecting head positioning problems in the winchester disk drive. The test runs until halted.

6 SEQUENTIAL WRITE/READ FIXED DISK - sequentially writes then reads the entire winchester disk checking for data or header errors. This test exercises the read/write circuitry of the controller and winchester disk drive and is useful in diagnosing problems in this area. The test runs until halted.

7 FIXED DISK WRITE ENABLE - permits sequential write operations on the winchester disk. (For test 6.)

7.6 DSD 880 Error Code Interpretation

This section details the error codes reported by the DSD 880 controller, their possible causes, and troubleshooting tips. Note that the error code displayed by the 7 segment LED displays is the same as the octal error code reported by the RX02 read error code command with the trailing zero deleted. There is no provision for reporting winchester numeric prior codes to the host processor.

Errors are indicated by displaying the error code in the 7 segment displays, and illuminating the composite and appropriate drive fault indicators. Note that some errors are applicable to the winchester drive, some to the floppy drive, some to either drive, and some non drive related.

When operating in NORMAL MODE, the occurrence of any error will cause the current operation to terminate and the error to be reported. When an error occurs during a HyperDiagnostic routine, it is checked to determine if it is a DATA or HEADER CRC error (14 or 20). If it isn't, the current operation will terminate and the error will be reported. If the error was a CRC error, it is logged in a totalizing counter and the operation is retried. When the total number of CRC errors encountered since the start of the HyperDiagnostic reaches 16 (decimal), the HyperDiagnostic will terminate.

UNLESS OTHERWISE INDICATED ALL ERRORS APPLY TO EITHER DRIVE

ERROR CODE = XX (X = blank 7 segment display)

NON DRIVE RELATED

Fault: Controller failed to complete hardware initialize

Possible cause: Defective +5 volt power supply
Defective front panel display
Interface is forcing controller to initialize continuously
Interface cable may be plugged in backwards

Troubleshooting: Observe +5 volts OK indicator
Measure +5 volt power supply at front panel test point
Run switch and light HyperDiagnostic
Remove interface cable, check orientation

ERROR CODE = 00 (000 octal)

Fault: None, this is the normal operating condition

ERROR CODE = 01 (010 octal)

Fault: Drive failed to home on initialize

Possible cause: WINCHESTER: Winchester head retainer not removed during installation

FLOPPY: Incorrect installation of SA800/SA850 jumper on controller

EITHER: No drive in system
Incorrect drive select jumpering
Defective +24 volt power supply
Defective drive

Troubleshooting: WINCHESTER: Remove winchester drive head retainer

FLOPPY: Check installation of SA800/SA850 jumper on controller board

EITHER: Check head movement during initialize. If head does not move, the drive select may be incorrectly jumpered.
Measure +24 volt power supply at front panel test point

ERROR CODE = 02 (020 octal)

Fault: Nonexistent drive selected.

Possible cause: Software attempted to access nonexistent drive

Troubleshooting: Verify software operation

ERROR CODE = 03 (030 octal)

Fault: Track 00 found while stepping inwards (toward hub) during initialize.

Possible cause: Drive head may have been out beyond track zero before initialize
Incorrect drive select jumpering
Incorrect installation of drive cable
Defective drive

Troubleshooting: Retry initialize operation
Check drive select jumpering
Check installation of drive cable

<u>ERROR CODE = 04 (040 octal)</u>

Fault: Invalid cylinder address

Possible cause: Software attempting to access nonexistent cylinder

Troubleshooting: Verify software

<u>ERROR CODE = 05 (050 octal)</u>

Fault: Track 00 found while stepping

Possible cause: Defective drive

Troubleshooting: Service drive

<u>ERROR CODE = 06 (not reported to host processor)</u>

<u>WINCHESTER ONLY</u>

Fault: SA1004 seek did not complete when expected

Possible cause: Defective SA1004

Troubleshooting: Service drive

<u>ERROR CODE = 07 (070 octal)</u>

Fault: Requested sector not found in two revolutions

Possible cause: Desired sector header has a hard CRC error
Disk headers incorrectly formatted
Software requested nonexistent sector address

Troubleshooting: Check disk headers for validity and reformat if necessary
Verify applications software operation

<u>ERROR CODE = 10 (100 octal)</u>

Fault: Write protect violation (attempted to write on write protected disk)

Possible cause: <u>WINCHESTER:</u> Winchester disk write protected via front panel switch
Winchester disk not stabilized (2 minutes from power up)
Winchester disk Write/Read HyperDiagnostics not write enabled

	<u>FLOPPY:</u> Floppy disk write enable tab missing or not opaque Floppy disk write protected via front panel switch Defective drive
Troubleshooting:	<u>WINCHESTER:</u> Write enable winchester disk from front panel Wait 2 minutes until winchester disk stabilizes (drive ready - stops flashing) Write enable winchester disk Write/Read HyperDiagnostics
	<u>FLOPPY:</u> Install or replace floppy disk write enable tab Write enable floppy disk from front panel Service drive
	<u>EITHER:</u> Check operation of front panel write protect switches via switch and light HyperDiagnostic

<u>ERROR CODE = 12 (120 octal)</u>

Fault:	Unable to find preamble of disk header (could not identify preamble independently of PLL).
Possible cause:	<u>WINCHESTER:</u> SA1004 data cable reversed
	<u>FLOPPY:</u> Floppy disk head not loaded Incorrect installation of head load jumper
	<u>EITHER:</u> Incorrect installation of -5 volt jumper on affected drive Defective -12 volt power supply Defective media
Troubleshooting:	<u>WINCHESTER:</u> Check SA1004 data cable
	<u>FLOPPY:</u> Check floppy disk head load Check floppy disk load jumper
	<u>EITHER:</u> Check installation of -5 volt jumper on affected drive Measure -12 volt power supply at front panel test point Reformat disk media

<u>ERROR CODE = 13 (130 octal)</u>

Fault:	Preamble found but no disk ID address mark within window (preamble continues forever)
Possible cause:	Defective media
Troubleshooting:	Reformat disk media

ERROR CODE = 14 (140 octal)

Fault:	CRC error on what appeard to be a header (found preamble)
Possible cause:	Floppy disk head load defective Incorrect headed CRC Defective media
Troubleshooting:	Check floppy disk head load Reformat disk headers Run sequential Write/Read HyperDiagnostics to verify disk media

ERROR CODE = 15 (150 octal)

Fault:	Address in header did not match expected track (CRC code of ID sector field was correct; track or head specified in ID field did not match expected value)
Possible cause:	FLOPPY: Incorrect installation of SA850/SA800 jumper on controller board EITHER: Defective drive Incorrect disk headers
Troubleshooting:	FLOPPY: Check installation of SA850/SA800 jumper on controller board EITHER: Check disk headers and reformat if necessary Check head positioning by running butterfly HyperDiagnostics

ERROR CODE = 16 (160 octal)

Fault:	Too many tries to find good ID address mark (found preamble)
Possible cause:	Phase locked loop defective Defective drive
Troubleshooting:	Check read channel signal on good track or diskette Check operation of PLL by running PLL HyperDiagnostic Service drive

ERROR CODE = 17 (170 octal)

Fault:	Data address mark not found in allotted time (correct sector ID and valid data premble found, but no data address mark followed)
Possible cause:	Incorrectly formatted media Defective media

Troubleshooting:	Check read operation on good track or diskette Reformat disk media if necessary

ERROR CODE = 20 (200 octal)

Fault:	CRC error on data field
Possible cause:	Defective media Encountering excessive radiated or conducted electrical interference
Troubleshooting:	Examine media for excessive wear Attempt to reread affected data Replace drive

ERROR CODE = 21 (210 octal)

WINCHESTER ONLY

Fault:	Write gate error
Possible cause:	SA1004 sensed write current in head without write gate active
Troubleshooting:	Replace SA1004 disk drive

ERROR CODE = 22 (not reported to host processor)

WINCHESTER ONLY

Fault:	VCO failed during read operation
Possible cause:	Defective PLL circuit on controller (8840)
Troubleshooting:	Check operation of PLL by running PLL HyperDiagnostic Replace controller

ERROR CODE = 23 (230 octal)

Fault:	Invalid word count specified
Possible cause:	Software specified a word count inconsistant with sector size (64 words for single density, 128 words for double density)
Troubleshooting:	Verify software

ERROR CODE = 24 (240 octal)

FLOPPY ONLY

Fault:	Media density did not match density of read or read status command.
Possible cause:	Incorrect disk density specified Disk incorrectly formatted with mixed densities
Troubleshooting:	Correct specified density Reformat disk to desired density

ERROR CODE = 25 (250 octal)

Fault:	WINCHESTER: Invalid key word specified during seek, get status or format command FLOPPY: Invalid key word specified for set media density or format command
Possible cause:	Software specified invalid key word for command (111 octal for set media density, 154 or 155 octal for format)
Troubleshooting:	Verify software

ERROR CODE = 26 (260 octal)

FLOPPY ONLY

Fault:	Indeterminate floppy media density (controller was unable to determine the density of the media)
Possible cause:	Incorrectly formatted diskette (may be IBM 2D) Defective drive
Troubleshooting:	Check disk density in a known good drive and reformat if necessary Service drive

ERROR CODE = 27 (270 octal)

Fault:	Write format failure
Possible cause:	Index did not appear in allotted time during write format
Troubleshooting:	Check drive spindle pulley for correct size Replace drive

ERROR CODE = 30 (300 octal)

Fault: Data compare error (data CRC was valid but disk data did not match sector buffer data)

Backup floppy data does not match winchester data read or written

Possible cause: Defective controller

Troubleshooting: Check sector buffer by running RAM test HyperDiagnostic
Check Read/Write channels and media by running WRT/RD HyperDiagnostic

ERROR CODE = 31 (310 octal)

WINCHESTER ONLY

Fault: Invalid bad track map detected during initialize (able to read data, but data was not a valid bad track map)

Possible cause: Bad track map overwritten

Troubleshooting: Use DSD supplied support software to rewrite bad track map

ERROR CODE = 32 (320 octal)

WINCHESTER ONLY

Fault: Checksum of bad track map did not match stored value.

Possible cause: Defective controller

Troubleshooting: Reinitialize SA1000 drive
Replace controller

ERROR CODE = 35 (350 octal)

NON DRIVE RELATED

Fault: Nonexistent memory error occurred during DMA

Possible cause: Programming error (starting address and word count was inconsistant with available memory)
Defective DSD 880 interface board
Defective host processor memory

Troubleshooting: Verify software
Use DSD supplied support software to test host processor memory and DSD 880 interface board

ERROR CODE = 36 (360 octal)

Fault:	Drive not ready
Possible cause:	WINCHESTER: Winchester spindle lock not removed Unable to initialize SA1004 FLOPPY: No floppy disk in drive Floppy door open Floppy drive not up to speed following automatic power down Side 1 of single-sided floppy disk selected by software EITHER: Drive not within speed tolerance (incorrect drive spindle pulley) Incorrect drive select jumpering Defective drive ready or index signals
Troubleshooting:	WINCHESTER: Remove winchester spindle lock Restore SA1004 bad track map FLOPPY: Check installation of media, close floppy drive door Verify software selection of floppy side Check operation of automatic power down solid state relay EITHER: Check drive spindle pulley size Check drive cables Replace drive

ERROR CODE = 37 (370 octal)

Fault:	Low ac (primary) power caused abort of write operation
Possible cause:	Temporary loss of primary power caused controller to abort the specified write operation
Troubleshooting:	Retry write operation Check if primary power is within specifications

ERROR CODE = 40 (not reported to host processor)

NON DRIVE RELATED

Fault:	Invalid disk was used for reload
Possible cause:	Invalid disk identifier was detected on a disk used for reload
Troubleshooting:	Use correct reload disk

ERROR CODE = 41 (not reported to host processor)

NON DRIVE RELATED

Fault:	Multiple backup disk versions detected during reload
Possible cause:	Version number of disk used for reload did not match the version number of the first valid disk.
Troubleshooting:	Use correct reload disk

ERROR CODE = 42 (not reported to host processor)

NON DRIVE RELATED

Fault:	Invalid class selected
Possible cause:	Nonexistent HyperDiagnostic test selected
Troubleshooting:	Reposition Class switch to correct postion Check operation of Class and Mode switches by running the switch and indicator HyperDiagnostic

ERROR CODE = 43 (not reported to host processor)

WINCHESTER ONLY

Fault:	Invalid winchester disk address (header not found)
Possible cause:	Invalid winchester sector address specified Requested cylinder address was different from the current cylinder at which the head was positioned (implied seek)
Troubleshooting:	Verify software operation If implied seeks are desired, extended mode must be selected

ERROR CODE = 44 (not reported to host processor)

WINCHESTER ONLY

Fault:	Winchester disk word count overflow
Possible cause:	Multiple sector read or write operation caused SA1004 cylinder address to overflow (greater than 256 cylinders)
Troubleshooting:	Verify software operation Limit maximum RX02 cylinder to 383 decimal

ERROR CODE = 45 (not reported to host processor)

NON DRIVE RELATED

Fault:	Deleted data mark was encountered on reload floppy
Possible cause:	Reload routine encountered a deleted data sector on backup floppy
Troubleshooting:	None required Note that one or more sectors on the winchester disk following the backup may have invalid data

ERROR CODE = 46 (not reported to host processor)

Fault:	This error code is not defined for the DSD 880

ERROR CODE = 47 (not reported to host processor)

Fault:	This error code is not defined for the DSD 880

ERROR CODE = 51 (not reported to host processor)

NON DRIVE RELATED

Fault:	RAM failed hardware test HyperDiagnostic
Possible cause:	Defective controller
Troubleshooting:	Service controller

ERROR CODE = 52 (not reported to host processor)

NON DRIVE RELATED

Fault:	CRC logic failed hardware test HyperDiagnostic
Possible cause:	Malfunctioning 8840 controller
Troubleshooting:	Service controller

ERROR CODE = 53 (not reported to host processor)

NON DRIVE RELATED

Fault:	PLL failed hardware test HyperDiagnostic
Possible cause:	Defective 8840 controller
Troubleshooting:	Service controller

ERROR CODE = XX (XXX = undefined error code)

NON DRIVE RELATED

Fault:	Defective front panel interface
Possible cause:	Defective front panel interface logic Defective front panel logic Defective front panel cable
Troubleshooting:	Check operation of front panel by running switch and indicator HyperDiagnostic Check operation of SERDES by running ALU test Hyper-Diagnostic Replace controller PC board assembly

7.7 Subsystem Replacement

After it has been determined that a hardware malfunction exists and the problem has been isolated to a subsystem, repair can be accomplished by replacement of the faulty subsystem. All subsystems can be replaced without the use of special tools.

Repairs to the individual subsystems should only be attempted by qualified maintenance technicians on a bench setup, or at the factory.

7.8 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.

NOTE

If at any time, a floppy 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. If the winchester drive is being shipped, install the head and spindle locks to prevent damage.

Data Systems Design
Customer Service

(West Coast)	(East Coast)
2241 Lundy Avenue	51 Morgan Drive
San Jose, CA 95131	Norwood, MA 02026
(408) 946-5815	(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

DISKETTE DIRECTORIES

```
 Volume ID: 060025 REV B
 Owner    : 30-APR-81
DSDMON.SYS      4  12-Mar-81
FLPEXR.SAV     46  13-Jan-81
FIXEXR.SAV     59  13-Mar-81
SATEST.SAV     62  22-Apr-81
DYDSD .MAC     31  22-Apr-81
DYDSD .SYS      3  22-Apr-81
DLV488.DIF      1  10-Nov-80
DLV488.DOC      3  30-Apr-81
DLV388.DOC      3  30-Apr-81
DLRSX .CMD      4  18-Mar-81
DLSYSV.CMD      3  18-Mar-81
DYRSX .CMD      4  18-Mar-81
DYSYSV.CMD      3  18-Mar-81
88XFLP.DOC      3  18-Mar-81
DSDFMT.SAV      3  30-Dec-80
PATCH .SAV     10  01-Feb-80
PATFB .COM      9  30-Dec-80
PATSTR.COM      1  30-Dec-80
PATERR.TXT      1  30-Dec-80
PAT2  .TXT      1  30-Dec-80
PAT3  .TXT      1  30-Dec-80
DYV4DS.DIF      3  30-Dec-80
PATSET.COM      1  30-Dec-80
DYV4DS.DOC      5  30-Dec-80
PAT1  .TXT      3  30-Dec-80
PATSJ .COM      8  30-Dec-80
RSX11M.DOC     13  05-Jan-81
FLBT88.COM      1  10-Nov-80
FLPX88.COM      2  10-Nov-80
88XFLP.COM      2  10-Nov-80
FLPX88.TXT      1  10-Nov-80
FLPY88.TXT      1  10-Nov-80
FLT881.TXT      1  10-Nov-80
88TFLA.TXT      1  10-Nov-80
88TFLB.TXT      1  10-Nov-80
88TFL1.TXT      1  10-Nov-80
88TFL2.TXT      1  10-Nov-80
88TFL3.TXT      1  10-Nov-80
88TFL4.TXT      1  10-Nov-80
88TFL5.TXT      1  10-Nov-80
88TFL6.TXT      1  10-Nov-80
88TFL7.TXT      1  10-Nov-80
88TFL8.TXT      1  10-Nov-80
88TFL9.TXT      1  10-Nov-80
DSDFMT.MAC      7  30-Dec-80
BOT880.MAC     30  13-Jan-81
HELP  .TXT      2  13-Jan-81
RELEAS.DOC      8  30-Apr-81
INDEX .DOC      6  30-Apr-81
< UNUSED >    126
 49 Files, 360 Blocks
 126 Free blocks
```

```
DIRECTORY DY0:[1,54]
30-APR-81 15:33

RSX11M.SYS;1        258.    C  07-JAN-81 21:23
RSX11M.TSK;1        130.    C  07-JAN-81 21:24
RSX11M.STB;4        11.        07-JAN-81 21:24
DYDRV.STB;6         1.         07-JAN-81 21:24
DYDRV.TSK;6         5.      C  07-JAN-81 21:24
DLDRV.STB;4         1.         07-JAN-81 21:24
DLDRV.TSK;4         4.      C  07-JAN-81 21:24
LDR.TSK;3           5.      C  07-JAN-81 21:24
TTDRV.STB;4         5.         07-JAN-81 21:24
TTDRV.TSK;4         18.     C  07-JAN-81 21:24
LPDRV.STB;5         1.         07-JAN-81 21:24
LPDRV.TSK;5         4.      C  07-JAN-81 21:24
DRDRV.STB;5         1.         07-JAN-81 21:24
DRDRV.TSK;5         5.      C  07-JAN-81 21:24
FCPMD1.TSK;3        62.     C  07-JAN-81 21:24
COT.TSK;4           24.     C  07-JAN-81 21:25
LOA.TSK;4           29.     C  07-JAN-81 21:25
MCRMU.TSK;3         28.     C  07-JAN-81 21:25
SAV.TSK;4           65.     C  07-JAN-81 21:25
SHF.TSK;3           12.     C  07-JAN-81 21:25
ACS.TSK;4           15.     C  07-JAN-81 21:25
BOO.TSK;4           22.     C  07-JAN-81 21:25
IND.TSK;4           101.    C  07-JAN-81 21:25
DMO.TSK;4           13.     C  07-JAN-81 21:26
ERF.TSK;3           4.      C  07-JAN-81 21:26
ERL.TSK;3           30.     C  07-JAN-81 21:26
INI.TSK;4           34.     C  07-JAN-81 21:26
INS.TSK;5           27.     C  07-JAN-81 21:26
MOU.TSK;4           24.     C  07-JAN-81 21:26
SYS.TSK;3           78.     C  07-JAN-81 21:26
TKN.TSK;4           16.     C  07-JAN-81 21:26
UFD.TSK;4           7.      C  07-JAN-81 21:26
UNL.TSK;4           23.     C  07-JAN-81 21:26
HEL.TSK;3           33.     C  07-JAN-81 21:27
BYE.TSK;3           6.      C  07-JAN-81 21:27
ACNT.TSK;4          57.     C  07-JAN-81 21:27
PIP.TSK;2           69.     C  07-JAN-81 21:27
TEC.TSK;1           63.     C  07-JAN-81 21:27
BAD.TSK;2           50.     C  07-JAN-81 21:27
VMR.TSK;2           142.    C  07-JAN-81 21:27
MAC.TSK;1           81.     C  07-JAN-81 21:28
DMP.TSK;2           57.     C  07-JAN-81 21:28
BRO.TSK;3           25.     C  07-JAN-81 21:28

TOTAL OF 1646./1646. BLOCKS IN 43. FILES


DIRECTORY DY0:[1,2]
30-APR-81 15:34

DLSYSVMR.CMD;2      3.         02-FEB-81 02:19
DYRSXDSK.CMD;4      4.         02-FEB-81 02:26
DLRSXDSK.CMD;2      4.         02-FEB-81 02:27
DYSYSVMR.CMD;7      3.         09-JAN-81 00:08
STARTUP.CMD;11      1.         02-FEB-81 00:59

TOTAL OF 15./23. BLOCKS IN 5. FILES


DIRECTORY DY0:[5,1]
30-APR-81 15:34


TOTAL OF 0./0. BLOCKS IN 0. FILES

GRAND TOTAL OF 1661./1669. BLOCKS IN 48. FILES IN 3. DIRECTORIES
```

APPENDIX B

COMMAND FILE LISTINGS

```
! COMMAND AND DOCUMENTATION FILE TO UPDATE THE DISTRIBUTION RT11-V4 HANDLER
!   DYV4DS.DOC  30-DEC-80       880 VERSION

! THIS FILE BOTH DOCUMENTS THE PROCEDURE AND CONTAINS THE COMMANDS
! REQUIRED TO MODIFY THE DEC RT11-V4 RX02 HANDLER TO SUPPORT DOUBLE
! SIDED OPERATION.
!
! SETUP FOR DUAL FLOPPY SYSTEM
! ----- --- ---- ------ ------
!
! FIRST MAKE A COPY OF THE RX02 BOOTABLE DISTRIBUTION DISKETTE.
! THEN BOOT THIS DISK IN DY0: (LEFT HAND DRIVE)
! THEN COPY THE FILES (DYV4DS.DOC AND DYV4DS.DIF) FROM THE DSD DIAGNOSTIC DISK
! TO THE BOOTED RT-11 V4 DISKETTE IN DY0:.
!
! NOTE: THERE SHOULD BE AT LEAST 40. CONTIGUOUS FREE BLOCKS ON THIS DISK.
!       AND IT MUST CONTAIN DY.MAC, MACRO.SAV, LINK.SAV, SYSMAC.SML AND DUP.SAV
!
! SETUP FOR SINGLE FLOPPY SYSTEM (DSD880)
! ----- --- ------ ------ ------ --------
!
! 1)    COPY THE BOOTABLE RT-11 DISTRIBUTION DISKETTE ONTO THE WINCHESTER DRIVE
!           INSERT THE BOOTABLE RT-11 DISTRIBUTION DISK INTO DY0: AND BOOT IT.
!               INIT DL0:
!               COPY /SYS DY0:*.* DL0:
!               COPY /BOOT DL0:RT11SJ DL0:
!               BOOT DL0:
! 2)    COPY DY.MAC FROM THE DRIVER SOURCE DEC DISTRIBUTION DISKETTE TO DL0:
!               COPY DY0:DY.MAC DL0:
!
! 3)    COPY THE DYV4 FILES FROM THE DSD DIAGNOSTIC DISKETTE TO DL0:
!               COPY DY0:DYV4*.* DL0:
! COMMON UPDATE PROCEDURE FOR ALL HARDWARE CONFIGURATIONS.
! ------ ------ --------- --- --- -------- ---------------


!
!
! THE USER SHOULD THEN TYPE THE QUOTED COMMAND TO THE MONITOR PROMPT.
! ."@DYV4DS.DOC<CR>"
!
! UPDATE THE DY.MAC SOURCE FILE USING SLP (SOURCE LANGUAGE PATCHER)
R SLP
DYV4DS.MAC,=DY.MAC,DYV4DS.DIF

!THIS PRODUCES A REVISED HANDLER SOURCE THAT WILL NOW BE ASSEMBLED
!
R MACRO
DYV4DS,=DYV4DS

!
! SAVE THE DEC STANDARD HANDLER BY RENAMING IT.
!
RENAME /SYS/NOPROTECT DY.SYS DY.SYS
RENAME /SYS DY.SYS DY.DEC
!
! GENERATE THE NEW DY.SYS HANDLER FILE
!
R LINK
DY.SYS=DYV4DS

!
! THE NEW HANDLER SHOULD BE BOUND TO A MONITOR ON THE FLOPPY USING COPY/BOOT
!       INSERT A BOOTABLE RT-11 V4 FLOPPY INTO DY0: FOR HANDLER UPDATE

COPY /SYS DY.SYS DY0:DY.SYS
COPY/BOOT DY:RT11SJ.SYS DY:
! OR FOR THE FOREGROUND/BACKGROUND MONITOR
! COPY/BOOT DY0:RT11FB.SYS DY:
BOOT DY:
```

```
! DOCUMENTATION FILE TO UPDATE THE DISTRIBUTION RT11-V3B RL01/RL02 HANDLER
!   DLV388.DOC  30-APR-81

! THIS FILE BOTH DOCUMENTS THE PROCEDURE AND CONTAINS THE COMMANDS
! REQUIRED TO MODIFY THE DEC RT11-V3 RL01 HANDLER TO SUPPORT THE DSD880
! OPERATING IN EXTENDED MODE.
! FIRST MAKE A COPY OF THE RL01 BOOTABLE DISTRIBUTION DISK
! THEN BOOT THIS DISK IN DL0:
!
!       THE RTV3 DISTRIBUTION DL.SYS CAN ALTERNATIVELY BE MODIFIED BY
!       PATCHING DL.SYS AS FOLLOWS
!       R PATCH
!       *DL.SYS/A
!       1124/ 35600<CR>  WAS 47742
!       1466/ 35600<CR>  WAS 47742
!       2136/ 35600<CR>  WAS 47742

!       THE RT-11V3B DISTRIBUTION CAN BE PATCHED SIMILARLY
!       R PATCH
!       *DL.SYS/A
!       0050/ 35600<CR>  WAS 47742
!
!       DLMNSJ.SYS/A
!       44160/ 35600<CR>  WAS 47742
!
!       *DLMNFB.SYS/A
!       54630/ 35600<CR>  WAS 47742
!
!       NOTE: THESE LOCATIONS HOLD FOR ALL RT-11 V3B DISTRIBUTIONS

! SUPPORT FOR DSD-880 IN SYSGENED MONITORS.
! ------- --- ------- -- --------- --------
! NOTE - THE DEFINITION OF DLDSI2 SHOULD BE CHANGED IN DL.MAC BEFORE SYSGEN
! TO    DLDSI2  = <382.*20*2>-20-DLNBAD
! WAS   DLDSI2  = <512.*20*2>-20-DLNBAD  IN STANDARD DISTRIBUTION

!       THIS REFLECTS THE DIFFERENT NUMBER OF AVAILABLE RL CYLINDERS
```

```
! COMMAND AND DOCUMENTATION FILE TO UPDATE THE DISTRIBUTION RT11-V4 HANDLER
!   DLV488.DOC  30-APR-81

! THIS FILE BOTH DOCUMENTS THE PROCEDURE AND CONTAINS THE COMMANDS
! REQUIRED TO MODIFY THE DEC RT11-V4 RL01 HANDLER TO SUPPORT THE DSD880
! OPERATING IN EXTENDED MODE.
! FIRST MAKE A COPY OF THE RL01 BOOTABLE DISTRIBUTION DISK
! THEN BOOT THIS DISK IN DL0:
! THEN COPY THE FILES (DLV488.DOC AND DLV488.DIF) FROM THE DSD DIAGNOSTIC DISK
! TO THE BOOTED RT-11 V4 IN DL0: AND FOLLOW THE PROCEDURE BELOW.
!
!       THE RT-11 V4 DISTRIBUTION DL.SYS CAN ALTERNATIVELY BE MODIFIED BY
!       PATCHING DL.SYS AS FOLLOWS
!       R PATCH
!       *DL.SYS/A
!       1124/ 35600<CR>  WAS 47742
!       1466/ 35600<CR>  WAS 47742
!       2136/ 35600<CR>  WAS 47742


! NOTE: THERE SHOULD BE AT LEAST 40. CONTIGUOUS FREE BLOCKS ON THIS DISK.
!       AND IT MUST CONTAIN DL.MAC, MACRO.SAV, LINK.SAV, SYSMAC.SML AND DUP.SAV
!
!
! THE USER SHOULD THEN TYPE THE QUOTED COMMAND TO THE MONITOR PROMPT.
! ."@DLV488.DOC<CR>"
!
! UPDATE THE DL.MAC SOURCE FILE USING SLP (SOURCE LANGUAGE PATCHER)
R SLP
DLV488.MAC,=DL.MAC,DLV488.DIF

!THIS PRODUCES A REVISED HANDLER SOURCE THAT WILL NOW BE ASSEMBLED
!
R MACRO
DLV488,=DLV488

!
! SAVE THE DEC STANDARD HANDLER BY RENAMING IT.
!
RENAME /SYS/NOPROTECT DL.SYS DL.SYS
RENAME /SYS DL.SYS DL.DEC
!
! GENERATE THE NEW DL.SYS HANDLER FILE
!
R LINK
DL.SYS=DLV488

!
! THE NEW HANDLER SHOULD NOW BE BOUND TO A MONITOR USING COPY /BOOT
!
COPY/BOOT DL:RT11SJ.SYS DL:
BOOT DL:
```

```
; 88XFLP.DOC - DOCUMENTATION FOR RT-11 V4 BACKUP COMMAND FILES
88XFLP IS A COMMAND FILE THAT ALLOWS BACKING UP A DSD-880 WINCHESTER
ONTO MULTIPLE DOUBLE DENSITY DOUBLE SIDED DISKETTES.

        BACKUP IS DONE BY COPYING SUCCESSIVE CHUNKS OF THE WINCHESTER (1951 BLKS)
ONTO NAMED FILES (88BAK1.IMG ...  88BAK9.IMG) ON SUCCESSIVE DOUBLE DENSITY
DOUBLE SIDED DISKETTES.  NO ASSUMPTIONS ARE MADE ABOUT FILE ORGANIZATION SO
AN RSX11 OR DLDP+ TYPE DISK MAY BE BACKED UP.

        THE BACKUP PROCESS IS STARTED BY EXECUTING THE COMMAND FILE 88XFLP.COM.
TYPE @88XFLP<CR> AFTER COPYING THE BACKUP FILE SET ONTO AN RT-11V4 DISKETTE
WITH DOUBLE SIDED FLOPPY SUPPORT. (SEE DYV4DS.DOC)
        A RESTORE IS DONE BY EXECUTING FLPX88.COM WHICH ASKS FOR THE SECOND DISKETTE
FIRST UP THROUGH THE LAST DISKETTE.  THE FIRST DISKETTE IS LOADED LAST.

        CAUTION: IF A NON RT DISK IS TO BE BACKED UP THEN RT-11
MUST BE RUN FROM A SYSTEM DEVICE OTHER THAN THE RL01 OR DY0 AND THE
HANDLER MUST BE PATCHED IN ORDER TO NOT DO BAD BLOCK REMAPPING AS
DIRECTED BY THE BLOCK 1 ERROR MAP (FIRST 12 LOCATIONS).  OTHER OPERATING
SYSTEMS MAY NOT DO THE SAME STYLE OF BAD BLOCK HANDELING.
        THUS PATCH LOCATION 2500 WAS 177777 TO 0
                            2502 WAS 177777 TO 0 IN DL.SYS DISTRIBUTION.
```

```
! FLPX88.COM FLOPPY TO 880 WINCHESTER MULTI DISK NON-FILE STRUCTURED RESTORE

TYPE FLPX88.TXT
INIT WIN:
!COPY/DEV/NOQ SY: DL0:
!SQ DL0:/NOQ
!COPY /BOOT DL0:RT11SJ.SYS DL0:
!COPY FLPY88.COM DL0:STARTS.COM
CREATE WIN:/START:1000./ALLOCATE:949.
!BOOT WIN:

TYPE 88TFL2.TXT
COPY/WAIT FLP:88BAK2.IMG WIN:

TYPE 88TFL3.TXT
COPY/WAIT FLP:88BAK3.IMG WIN:

TYPE 88TFL4.TXT
COPY/WAIT FLP:88BAK4.IMG WIN:

TYPE 88TFL5.TXT
COPY/WAIT FLP:88BAK5.IMG WIN:

TYPE 88TFL6.TXT
SET ERROR NONE
COPY/WAIT FLP:88BAK6.IMG WIN:

!TYPE 88TFL7.TXT
!COPY/WAIT FLP:88BAK7.IMG WIN:

!TYPE 88TFL8.TXT
!COPY/WAIT FLP:88BAK8.IMG WIN:

TYPE FLPY88.TXT
COPY/WAIT FLP:88BAK1.IMG WIN:
```

```
!88XFLP.COM  COMMAND FILE TO BACK UP 880 WINCHESTER WITHOUT REGARD TO FILES
! CAN BE USED FOR RSX-11 BACKUP IF NO BAD BLOCKS ARE TO BE MAPPED AND IF
! THE DL HANDLER IS PATCHED TO IGNORE BLOCK 1 BAD BLOCK MAPPING.

! ASSUMES USE OF DOUBLE SIDED DOUBLE DENSITY DISKETTES

ASS DY0: FLP:
ASS DL0: WIN:

TYPE DY1:88TFL1.TXT
INIT FLP:
COPY/DEV/FILES DL0:/START:0/END:1950. FLP:88BAK1.IMG

TYPE 88TFL2.TXT
INIT FLP:
COPY/DEV/FILES DL0:/START:1950./END:3900. FLP:88BAK2.IMG

TYPE 88TFL3.TXT
INIT FLP:
COPY/DEV/FILES DL0:/START:3900./END:5850. FLP:88BAK3.IMG

TYPE 88TFL4.TXT
INIT FLP:
COPY/DEV/FILES DL0:/START:5850./END:7800. FLP:88BAK4.IMG

TYPE 88TFL5.TXT
INIT FLP:
COPY/DEV/FILES DL0:/START:7800./END:9750. FLP:88BAK5.IMG

TYPE 88TFL6.TXT
INIT FLP:
COPY/DEV/FILES DL0:/START:9750./END:11700. FLP:88BAK6.IMG

TYPE 88TFL6.TXT
INIT FLP:
COPY/DEV/FILES DL0:/START:11700./END:13650. FLP:88BAK7.IMG

TYPE 88TFL6.TXT
INIT FLP:
COPY/DEV/FILES DL0:/START:13650./END:15600. FLP:88BAK8.IMG
```

```
! DLRSX.CMD - COMMAND FILE TO INITIALIZE AN 880-WINCHESTER WITH RSX-11 TASKS
!  GENERATES A BOOTABLE RSX11M SYSTEM ON WINCHESTER AFTER FINAL VMR PHASE
! 16-MAR-81    -     SETS UP READY FOR VMR SYSGEN PHASE

BAD DL0:
ALL DL0:
INI DL0:DYRSXSYS
MOU DL0:DYRSXSYS
UFD DL0:[1,54]
UFD DL0:[1,2]
SET /UIC=[1,54]
PIP DL0:RSX11M.SYS/CO/BL:494.=RSX11M.TSK
PIP DL0:RSX11M.TSK/CO=RSX11M.TSK
PIP DL0:=RSX11M.STB
PIP DL0:=DYDRV.*
PIP DL0:=DLDRV.*
PIP DL0:=LDR.*
PIP DL0:=TTDRV.*
PIP DL0:=LPDRV.*
PIP DL0:=DRDRV.*
PIP DL0:=FCPMD1.TSK
PIP DL0:=COT.TSK
PIP DL0:=LOA.TSK
PIP DL0:=MCRMU.TSK
PIP DL0:=SAV.TSK
PIP DL0:=SHF.TSK
PIP DL0:=ACS.TSK
PIP DL0:=BOO.TSK
PIP DL0:=IND.TSK
PIP DL0:=DMO.TSK
PIP DL0:=ERF.TSK
PIP DL0:=ERL.TSK
PIP DL0:=INI.TSK
PIP DL0:=INS.TSK
PIP DL0:=MOU.TSK
PIP DL0:=SYS.TSK
PIP DL0:=TKN.TSK
PIP DL0:=UFD.TSK
PIP DL0:=UNL.TSK
PIP DL0:=HEL.TSK
PIP DL0:=BYE.TSK
PIP DL0:=ACNT.TSK
!
PIP DL0:=PIP.TSK
PIP DL0:=TEC.TSK
PIP DL0:=BAD.TSK
PIP DL0:=VMR.TSK
!
SET /UIC=[1,2]
PIP DL0:=STARTUP.CMD
!
!
! SETUP TO TRANSFER COMMAND FILES
!
SET /UIC=[5,1]
UFD DL0:[5,1]
PIP DL0:=DLRSX.CMD
PIP DL0:=DYRSX.CMD
PIP DL0:=DLSYSVMR.CMD
PIP DL0:=DYSYSVMR.CMD
!
! SETUP TO TRANSFER UTILITIES
! NOTE:  ADDITIONAL UTILITIES AND LIBRARIES MAY BE DESIRED
SET /UIC=[1,54]
PIP DL0:=MAC.TSK
PIP DL0:=DMP.TSK
PIP DL0:=BRO.TSK
!PIP DL0:=TKB.TSK
!PIP DL0:=CRF.TSK
!
! TRANSFER SYSLIB.OLB
!
!UFD DL0:[1,1]
!SET /UIC=[1,1]
!PIP DL0:=SYSLIB.OLB
!
!
! SECTION TO SET UP FOR FINAL VMR PHASE
! TYPE "VMR @[5,1]DYSYSVMR.CMD<CR>"
!
SET /UIC=[1,54]
INS SY0:VMR
ASN DL0:=LB0:
ASN DL0:=SY0:
ALL LB0:
```

```
! DYRSX.CMD  -  COMMAND FILE TO INITIALIZE A DISKETTE WITH RSX-11 TASKS
! FOR TRANSFER OVER TO DSD-880 WINCHESTER.
! REQUIRES A DOUBLE SIDED DOUBLE DENSITY DISKETTE
!  GENERATES A BOOTABLE RSX11M DISKETTE AFTER FINAL VMR PHASE
! 16-MAR-81   -    SETS UP READY FOR VMR SYSGEN PHASE

ALL DY0:
INI DY0:DYRSXSYS
MOU DY0:DYRSXSYS
UFD DY0:[1,54]
UFD DY0:[1,2]
SET /UIC=[1,54]
PIP DY0:RSX11M.SYS/CO/BL:258.=RSX11M.TSK
PIP DY0:RSX11M.TSK/CO=RSX11M.TSK
PIP DY0:=RSX11M.STB
PIP DY0:=DYDRV.*
PIP DY0:=DLDRV.*
PIP DY0:=LDR.*
PIP DY0:=TTDRV.*
PIP DY0:=LPDRV.*
PIP DY0:=DRDRV.*
PIP DY0:=FCPMD1.TSK
PIP DY0:=COT.TSK
PIP DY0:=LOA.TSK
PIP DY0:=MCRMU.TSK
PIP DY0:=SAV.TSK
PIP DY0:=SHF.TSK
PIP DY0:=ACS.TSK
PIP DY0:=BOO.TSK
PIP DY0:=IND.TSK
PIP DY0:=DMO.TSK
PIP DY0:=ERF.TSK
PIP DY0:=ERL.TSK
PIP DY0:=INI.TSK
PIP DY0:=INS.TSK
PIP DY0:=MOU.TSK
PIP DY0:=SYS.TSK
PIP DY0:=TKN.TSK
PIP DY0:=UFD.TSK
PIP DY0:=UNL.TSK
PIP DY0:=HEL.TSK
PIP DY0:=BYE.TSK
PIP DY0:=ACNT.TSK
!
PIP DY0:=PIP.TSK
PIP DY0:=TEC.TSK
PIP DY0:=BAD.TSK
PIP DY0:=VMR.TSK
!
SET /UIC=[1,2]
PIP DY0:=STARTUP.CMD
!
!
SET /UIC=[5,1]
UFD DY0:[5,1]
PIP DY0:=DYRSX.CMD
PIP DY0:=DLRSX.CMD
PIP DY0:=DYSYSVMR.CMD
PIP DY0:=DLSYSVMR.CMD
!
SET /UIC=[1,54]
PIP DY0:=MAC.TSK
PIP DY0:=DMP.TSK
PIP DY0:=BRO.TSK
! ADDITIONAL UTILITIES MAY BE COPIED HERE
!PIP DY0:=MAC.TSK
!PIP DY0:=TKB.TSK
!PIP DY0:=CRF.TSK
!
!UFD [1,1]
!PIP DY0:[1,1]=[1,1]SYSLIB.OLB
!
! SECTION TO SET UP FOR FINAL VMR PHASE
! TYPE "VMR @[5,1]DYSYSVMR.CMD<CR>"
!
INS SY0:VMR
ASN DY0:=LB0:
ASN DY0:=SY0:
ALL LB0:
```

```
! DYSYSVMR.CMD - VMR A RSX11M SYS ON FLOPPY 8-JUN-80 - PART 2
! INDIRECT COMMAND STREAM TO VMR
SET /POOL=1000
SET /MAIN=LDRPAR:*:24:TASK
INS LDR
FIX ...LDR
SET /MAIN=TTPAR:*:200:TASK
LOA TT:
SET /MAIN=SYSPAR:*:100:TASK
SET /MAIN=FCPPAR:*:240:TASK
SET /MAIN=GEN:*:*:SYS
LOA DY:
LOA DL:
INS FCPMD1          ! INSTALL FILE SYSTEM
INS COT             ! INSTALL CO DRIVER TASK
INS ACS             ! INSTALL ALLOCATE CHECKPOINT FILE
INS BOO             ! INSTALL BOOT
INS DMO             ! INSTALL DISMOUNT
INS ERF             ! INSTALL ERROR OFF
INS ERL             ! INSTALL ERROR LOGGER
INS IND             ! INSTALL INDIRECT FILE PROCESSOR
INS INI             ! INSTALL INITVOL
INS INS             ! INSTALL INSTALL
! INS PMD/PAR=GEN           ! INSTALL POST-MORTEM DUMPER
INS LOA             ! INSTALL LOAD
INS MCRMU           ! INSTALL MULTI-USER MCR
INS HEL             ! INSTALL LOGIN PROCESSOR
INS BYE             ! INSTALL LOGOUT PROCESSOR
INS MOU             ! INSTALL MOUNT
INS SAV             ! INSTALL SAVE
INS SHF             ! INSTALL SHUFFLER
INS SYS             ! INSTALL SYSTEM DISPLAY PART OF MCR
INS TKN             ! INSTALL TASK TERMINATION TASK
INS UFD             ! INSTALL USER FILE DIRECTORY BUILDER
INS UNL             ! INSTALL UNLOAD
SET /UIC=[1,54]:TT0:
;
SET /POOL
;
PAR
;
TAS
;
DEV
```

```
! DLSYSVMR.CMD - VMR A RSX11M SYS ON RL01 13-FEB-81
! INDIRECT COMMAND STREAM TO VMR
SET /POOL=1000
SET /MAIN=LDRPAR:*:24:TASK
INS LDR
FIX ...LDR
SET /MAIN=TTPAR:*:200:TASK
LOA TT:
SET /MAIN=SYSPAR:*:100:TASK
SET /MAIN=FCPPAR:*:240:TASK
SET /MAIN=GEN:*:*:SYS
LOA DL:
LOA DY:
LOA DR:
INS FCPMD1       ! INSTALL FILE SYSTEM
INS COT          ! INSTALL CO DRIVER TASK
INS ACS          ! INSTALL ALLOCATE CHECKPOINT FILE
INS BOO          ! INSTALL BOOT
INS DMO          ! INSTALL DISMOUNT
INS ERF          ! INSTALL ERROR OFF
INS ERL          ! INSTALL ERROR LOGGER
INS IND          ! INSTALL INDIRECT FILE PROCESSOR
INS INI          ! INSTALL INITVOL
INS INS          ! INSTALL INSTALL
INS PMD/PAR=GEN  ! INSTALL POST-MORTEM DUMPER
INS LOA          ! INSTALL LOAD
INS MCRMU        ! INSTALL MULTI-USER MCR
INS HEL          ! INSTALL LOGIN PROCESSOR
INS BYE          ! INSTALL LOGOUT PROCESSOR
INS MOU          ! INSTALL MOUNT
INS SAV          ! INSTALL SAVE
INS SHF          ! INSTALL SHUFFLER
INS SYS          ! INSTALL SYSTEM DISPLAY PART OF MCR
INS TKN          ! INSTALL TASK TERMINATION TASK
INS UFD          ! INSTALL USER FILE DIRECTORY BUILDER
INS UNL          ! INSTALL UNLOAD
SET /UIC=[1,54]:TT0:
;
SET /POOL
;
PAR
;
TAS
;
DEV
```

APPENDIX C

FLPEXR USER'S MANUAL

Appendix C: FLPEXR Users Manual

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 capa-
   bility.
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 Ø 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 'CRTL 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
Comprehensive Tests	
• (V)ERIFY	General Exerciser
• (SH)ORT VERIFY	Short Exerciser
Individual Tests	
• (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
Media Modification	
• (SET M)EDIA DENSITY	Set Media Density
• (FO)RMAT	Format Diskette
Program Control Values	
• (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
Program Status	
• (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
Data Utilities	
• (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 0 and CTRL O) 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 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 counted as bad status. There can be up to 128 data errors in 1 sector.
DEFSTT= DEFINITIVE ERROR STATUS	Error code associated with the error currently being displayed. The meaning of each error code can be found in the unit users manual.
SIDE 1	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)
HDLD	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 ([ˆ] = 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 ][ ˆ ][ 4 ][ ˆ ][ 5 ][ 6 ]
           [ ˆ ][ 7 ][ ˆ ]  !  [ 3 ][ ˆ ][ 4 ][ ˆ ]...
```

- 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/EMPTIES into three different buffers so as to verify proper operation of all possible address bits. FILL/EMPTIES are done in both densities covering all possible word counts. Since this test does not manipulate the drives, the system will operate 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
                                 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 SYS-
TEM AS FOLLOWS:
  4000: ENABLES DMA OPERATION IF
        AVAILABLE
  2000: SETS 850 TIMING (ELSE 800)
  1000: ENABLES DOUBLE SIDED OPERA-
        TION 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—(ST)ATUS

  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—(RES)ET 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—(SA)VE 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 over-write 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—(REC)OVER 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—(DUMP 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—(DUP)LICATE

  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—(CO)MPARE

  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.

- OCTAL DUMP BY SECTORS—(DUMP O)CTAL

  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.

EXAMPLE

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

```
  0: 0 0 0 3776 0 0 0 0
 20: 0 0 0 0 0 0 0 0
 40: 0 0 0 0 0 0 0 0
 60: 0 0 0 0 0 0 0 0
100: 0 0 0 0 0 0 0 0
120: 0 0 0 0 0 0 0 0
140: 0 0 0 0 0 0 0 0
160: 0 0 0 0 0 0 0 0
200: 0 0 0 3722 0 0 0 0
220: 0 0 0 0 0 0 0 0
240: 0 0 0 0 0 0 0 0
260: 0 0 0 0 0 0 0 0
300: 0 0 0 0 0 0 0 0
320: 0 0 0 0 0 0 0 0
340: 0 0 0 0 0 0 0 0
360: 0 0 0 0 0 0 0 0
[DDEN DRIVE #0 AT TRACK #0, SECTOR
#2 SIDE #0]
SC=2
  0: 0 0 0 0 0 0 0 0
 20: 0 0 0 0 0 0 0 0
 40: 0 0 0 0 0 0 0 0
 60: 0 0 0 0 0 0 0 0
100: 0 0 0 0 0 0 0 0
120: 0 0 0 0 0 0 0 0
140: 0 0 0 0 0 0 0 0
160: 0 0 0 0 0 0 0 0
200: 0 0 0 0 0 0 0 0
220: 0 0 0 0 0 0 0 0
240: 0 0 0 0 0 0 0 0
260: 0 0 0 0 0 0 0 0
300: 0 0 0 0 0 0 0 0
320: 0 0 0 0 0 0 0 0
340: 0 0 0 0 0 0 0 0
360: 0 0 0 0 0 0 0 0
```

- BYTE DUMP BY SECTORS—(DUMP B)YTE

  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 A)SCII

  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.

APPENDIX D

FIXEXR USER'S MANUAL

FIXEXR USER'S MANUAL

INTRODUCTION

All DSD 880 systems with an LSI-11 or PDP-11 interface board are shipped with a diskette containing an interactive diagnostic program called FIXEXR. This manual explains the operation of this compehensive set of tests and utility programs. This manual assumes the user is familiar with DSD 880 operations and terminology.

FIXEXR is designed to test and verify total functionality of the DSD 880 winchester drive subsystem in normal mode. It runs as a stand-alone program (with bootstrap) and is capable of handling multiple drives and systems. Both video and hard copy terminals with full X-on, X-off output control are supported. To facilitate unattended operation, all terminal output is retained in a circular text buffer autoconfigured to use all available memory. This buffer may be displayed or reset at any time by use of a single command. Test commands fully exercise system functions while detecting and reporting any specific faults or bad disk areas. The acceptance test and verify commands provide total reliability testing and are suitable for both system burn-in/exercise and quality control checks.

PROGRAM LOADING

FIXEXR requires a standard console device, an LSI-11 or PDP-11 computer, and at least 16K words of memory. Loading FIXEXR can be accomplished by two methods. One method is to bootstrap the diagnostic diskette. This loads FIXEXR into memory automatically. The other method requires an RT-11 operating system. The FIXEXR diagnostic diskette has an RT-11 compatible directory and file structure. The files on the diagnostic diskette can be accessed using standard RT-11 procedures. For example, FIXEXR can be run from an RT-11 system by typing:

RU<DEV:>FIXEXR <CR>

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

On a system running other operating systems (e.g., RSX-11M, IAS, PSTS, etc.), the distribution diskette must be bootstrapped into memory.

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

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

One high quality, write-enabled formatted diskette, single- or double-density, single- or double-sided, should be installed in the FIXEXR drives before proceeding with any of the tests.

After FIXEXR is loaded into memory, a brief description is displayed on the terminal which includes a memory map and preliminary usage instructions.

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

PROGRAM EXIT

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

If FIXEXR was loaded via RT-11 operating system, direct return to the operating system may be possible. A control input of "CTRL C" will cause FIXEXR 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 is not available

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

PROGRAM COMMANDS

Legal responses to "COMMAND" are listed in Table 1 and 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.

FIXEXR 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.

<MEMORY MAP>

Remove distribution diskette

Type "A" to do acceptance/verify test. This will do a short verify followed by a full acceptance test. Type "H" for a list of valid commands.

CTRL-C returns to command prompt

CTRL-R aborts function and returns to command prompt

All numeric inputs/outputs are in octal

Insert one test diskette per system

Full or Partial testing? Type F for full, type P for partial.

Set mode to Normal or Extended? Type N for normal, type E for extended.

Set class switch, push execute button and type a character, Enable Halt on error (Y or N)?

Table 1. FIXEXR Commands

Command	Description
Comprehensive tests	
(A)CCEPTANCE	General Exerciser
(SH)ORT VERITY	Short Exerciser
Individual tests	
(INTE)RFACE TEST	Interface Test
(INTR) TEST	Interrupt Test
(SEQ W)/R	Sequential Write/Read Test
(SEQ R)EAD	Sequential Read
(RA)NDOM R/)W	Random Read/Write
(RA)NDOM RE)AD	Read Random
(SC)AN	Scan
(SEE)K TEST	Seek Test
(E)XTENDED MODE TEST	Extended Mode Test
Program Control Values	
(SET U)NIT	Set Unit
(SET T)RACK	Set Track Limits
(SET I)INTERRUPT STATUS	Set Interrupt Status
(SET D)EVICE	Set Device
(SET M)ODE	Set Mode
Program Status	
(M)AP ADDRESS	Memory and Device Map
(ST)ATUS	Display Status Information
(RES)ET STATUS	Clear Status
(SA)VE STATUS	Save Status on Diskette
(DUMP C)IR BUFFER	Display Circular Output Buffer
(REC)OVER STATUS	Retrieve
Data Utilities	
(RD)W/O HDR	Read Without Header
(H)ELP	Help! List of Commands

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	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	2
CTRL D	Causes control transfer to ODT	2,3
CTRL T	Causes control transfer to ODT with stack trace	2,3
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 a 177170.

3. Control transfer from ODT back into FIXEXR 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., interface test).

Full testing will set the lower track limit to 0 and partial testing will set it to 10 (octal). Partial testing is recommended if diagnostics or other files are already on the RL. If system files (RT-11, RSX-11, etc.) are on the RL and you do not wish to destroy them, the lower track limit should be set much higher. The default upper track limit is 376 (or 576 in extended mode). Selection of the next higher track (377 or 577) may result in the bad block map being destroyed. It may be rewritten by using "SATEST" utility. A description of the remaining queries may be found in "SET MODE".

FIXEXR then outputs the name and version number of the program. DSD FIXEXR v7B. FIXEXR types "<CRLF>#" when starting, the program then attempts an INIT (initialize) instruction. When the INIT cycle is successful, the program types the prompt word: "COMMAND". This prompt allows the operator to input a command. A list of all the available commands may be obtained by typing an "H" (HELP).

FIXEXR 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 except status counters 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.

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

Disk data is accessed via a combined address of unit #, side #, track # and sector #. Various commands are provided to specify the limits of the address components to be used by tests. Default values are preset following the 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

FIXEXR 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 are longer than the face of the CRT screen. The display output buffer (DUMP C) function is used to examine messages in the circular buffer. The status variables that might appear on the console terminal are explained below:

DEV XXX	Is printed only when running multiple controllers. XXX are the 6 octal digits of the CS 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
SIDE I	Indicates status or error relates to side I (first or second side of the disk)
RLCS= XY	Shows the contents of the command and status register
RXCS= XY	Shows the contents of the floppy control and status register
#BAD= XX	This variable indicates the number of status errors detected
#RD/WRT= XX	This variable indicates the number of read and write operations performed error free
B-TRACK= XX	This variable indicates the number of bad tracks detected
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 counted as bad status. There can be up to 128 data errors in one sector

ERROR MESSAGES AND MEANINGS

-1 * NO BUS RESPONSE *

ADDRESS

17XXXX

Indicates no SSYN acknowledge to memory access within 200 msec (interface test only).

-2 * STATUS ERROR *

DEV RLCS RLBA RLDA RLMP STATUS

17XXXX XXXX XXXX XXXX XXXX XXXX

Indicates fault or error during operation indicated in RLCS. Parameters in address registers and status should give exact nature of error (all tests).

-3 * NO INTERRUPT *

DEV RLCS RLBA RLDA RLMP STATUS

17XXXX XXXX XXXX XXXX XXXX XXXX

An expected interrupt after completion of the function in RLCS did not occur (INTR test).

-4 * READ/WRITE ERROR *

ADDR READ EXPECTED

17XXXX XXXX XXXX

Data read did not match expected value (data written) at the address indicated (interface test).

-5 * BUS RESET ERROR *

ADDR READ EXPECTED

17XXXX XXXX XXXX

A bus reset instruction did not clear all expected bits in a specific register at address indicated (interface test).

-6 * SEEK ERROR *

RLCS RLBA RLDA RLMP STATUS

17XXXX XXXX XXXX XXXX XXXX

An error occurred during, or after, a seek operation (all tests).

-7 * HEADER CRC ERROR *

DEVICE SECTOR SIDE TRACK EXPECT CALC

17XXXX XXXX XXXX XXXX XXXX XXXX

The CRC calculated by software did not compare to that written by hardware during a format operation (SCAN).

-8 * NON CONSECUTIVE HEADER ERROR *

DEVICE PREV PRES SIDE TRACK

17XXXX XXXX XXXX XXXX XXXX

Sector header information for two adjacent sectors was incorrect (SCAN).

-9 *DATA COMPARE ERROR *

DEVICE SIDE TRACK SECTOR EXPECT READ

17XXXX XXXX XXXX XXXX XXXX

During a sequential or random read, data read did not match that expected (written). Multiple errors may indicate a bad sector or track (see SA1000 User Guide).

-10 * BAD TRACK DETECTED *

DEVICE SIDE TRACK

17XXXX XXXX XXXX

Results from multiple data compare errors on the same track (see SA1000 User Guide).

-11 * WRITE PROTECT ERROR *

DEVICE

17XXXX

Drive was write protected during a write operation (SEQ + RND R/W).

-12 * IMPLIED SEEK ERROR *

RLCS RLBA RLDA

XXXX XXXX XXXX

Implied seek to a new track or side not occur (extended test).

-13 * DRIVE SELECT ERROR *

RLCS RLBA RLDA RLMP STATUS

XXX XXX XXX XXX XXX

A nonexistent drive unit was selected (all tests).

-14 * SPIN ERROR *

DEV RLCS

174XXX XXXX

Indicates drive was not up to speed during operation in RLCS (all tests).

-15 * NONEXISTENT MEMORY *

DEV RLC5 RLBA

174XXX XXXX XXXX

Data transfer was terminated due to insufficient memory (all tests).

-16 * SEEK TIME OUT *

DEV RLCS

174XXX XXXX

A seek operation did not complete in 200 milliseconds (all tests).

-17 * WRITE CHECK ERROR *

RLCS RLBA RLDA RLMP STATUS

XXXX XXXX XXXX XXXX XXXX

Data read from disk did not compare to that originally written. Usually indicative of a bad block or track (SEQ W/R).

-18 * HEADER NOT FOUND *

DEV RLDA

174XXX XXXX

Seek to sector and track in RLDA could not be completed in 200 milliseconds due to invalid or nonexistent disk address (all tests).

-19 * DATA CRC ERROR *

DEV RLCS RLBA RLDA

174XXX XXXX XXXX XXXX

A CRC error was perfected during a data transfer (SCAN, SEQ W/R, and RANDOM W/R).

-20 * AC POWER LOW *

RLCS

XXXX

AC voltage is below normal or interface cable is not connected (all tests).

EXAMPLES OF ERROR OUTPUT

The following are examples of what the FIXEXR 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    BAD=0      RD/WRT=0    B-TRACK=0  B-DATA=0
```

Example 2: Operator requests status of both drives using the "STATUS" command.

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

Example 3: Disk was write protected.

```
* WRITE PROTECT ERROR *
DEVICE
174XXX
```

Example 4: Bad block found during read/write test.

```
* DATA COMPARE ERROR *

DEVICE  SIDE   TRACK  SECTOR  EXPECT   READ
 174400   1     207     31     14761   14561
```

COMPREHENSIVE TESTS COMMANDS

- ACCEPTANCE (A)CCEPTANCE

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:

```
COMMAND VERIFY CR
SCRATCH DISKS INSTALLED? (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. 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 TEST — (SEE)K TEST

The SEEK TEST function is a versatile drive test that performs all possible seeks within the operator specified track and seek length boundaries. 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: #COMMAND: SEEK TEST

SEEK LENGTH (1): 3 THROUGH (27): 7
COVERING TRACTS (0): 1 THROUGH (377); 3 5
6 7 ! 3 4 ...

- SEQUENTIAL WRITE/READ — (SEQ W)/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".

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.

- SEQUENTIAL READ — (SEQ R)EAD

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 — (RANDOM 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".

- RAMDOM READ — (RANDOM RE)AD

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

- SET MODE — (SET M)ODE

This allows selection of normal or extended operational modes. Extended mode will allow access of tracks 0-577 (octal) and is selected in normal mode, class 1, normal mode (normal switch, class 0) allows access of tracks 0-377 (octal). All tests may be run in either mode (except "extended test" which will not execute in normal mode). After setting class select switch to 0 or 1, push mode select pushbutton BEFORE typing a character. After typing a character it prompts "Allow Halt on ERROR?" If an error occurs the error message will be printed followed by "* HE *". This allows the LED to continue flashing the current error.

- EXTENDED MODE TEST — (E)XTENDED MODE TEST

  Checks implied seek capability of controller during large inter-track data transfers. This test will not execute if "SET MODE" has not selected "EXTENDED" test mode. Test returns to command prompt upon completion.

- SET UNIT — (SET U)NIT

  This comand enables the operator to specify which drives are to be accessed by the various test functions. The default drive is unit 0. 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 the FIXEXR 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"

#COMMAND: SET UNIT CR

-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 0, and upper track limit is track 376 in normal mode and track 576 in extended mode. If the last physical track is selected (377 or 577), the bad block map may be destroyed and have to be rewritten (see "SATEST" User Guide). A warning message will remind you if this happens. Nothing will be destroyed until testing begins (should you wish to change it). 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 0: 1 THROUGH 14: 10

- SET INTERRUPT STATUS — (SET 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, FIXEXR ensures that an interrupt occurs whenever it is appropriate. The opearator 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:

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

- 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 FIXEXR 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 "RLCS:". The flag word is organized as follows:

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

When set to a 1, the bit labeled:

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.

Example:

```
#COMMAND: SET DEVICE
SET THE DEVICE FLAGS FOR EACH SYSTEM AS FOLLOWS:
 20: ENABLE UNIT #1 ON CURRENT DEVICE
 10: ENABLE UNIT #0 ON CURRENT DEVICE
RLCS 174400 INT@ 160 INTVEC = 160
RXCS 177170 FLAGS: 10
```

- HELP

The HELP command causes all the valid "COMMAND" responses to be displayed on the console terminal. The "COMMAND" 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 FIXEXR 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: "MAP ADDRESS"

```
#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: 174400 INT @ 160
```

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
B-DATA 0  B-TRACK 0
```

- RESET STATUS — (RES)ET 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. "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 — (SA)VE 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 system. 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 — (REC)OVER 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 — (DUMP 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 a CRT. Messages previously output can be re-examined on the console. The buffer can be cleared after it is displayed by this function.

APPENDIX E

SATEST USER'S MANUAL

CAUTION

Do not utilize the SATEST program (Appendix E) unless directed to do so by the DSD factory service organization. Improper usage of the SATEST program may cause erasure of the winchester disk bad track map and/or the DEC bad block map at the end of the emulated RL01 and RL02 disk.

SATEST USER'S MANUAL

INTRODUCTION

All DSD 880 flexible disk systems with an LSI-11 or PDP-11 interface board are shipped with a diskette containing an interactive diagnostic program called SATEST. This manual explains the operation of this set of utility programs. This manual assumes the user is familiar with DSD 880 operations and terminology.

SATEST supports the direct access mode of the DSD 880 and bad track map generation. It is a stand alone 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 auto configured to the full available memory; commands are provided to display and reset this circular buffer. Commands are also provided for disk formatting, bad track mapping, and examination. Test commands fully exercise system capabilities with operational parameters being user selectable through commands. The acceptance test, drive test, and verify commands are suitable for both incoming quality control checks and system exercise/burn in.

PROGRAM LOADING

SATEST requires a standard console device, an LSI-11 or PDP-11 computer and at least 16K words of memory. Loading SATEST can be accomplished by two methods. One method is to bootstrap the diagnostic diskette. This loads DSDMEN. The other method requires an RT-11 operating system. The SATEST 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, SATEST can be run from the RT-11 system by typing.

RU DEV: SATEST <CR>

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

On a system running other operating systems (e.g., RSX-11M, IAS, RSTS, etc.), the distribution diskette must be bootstrapped into memory.

After SATEST is loaded into memory, a brief description is displayed on the terminal which includes a memory map and preliminary usage instructions. The memory map indicates the ranges of the address space which responds with SSYNC (or BRPLY) when accessed by the host composter.

After the device type is selected, SATEST will output the device flag being used as shown below:

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

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

DSD SATEST

SATEST types "<CRLF> #" when starting the program, and then attempts an INIT (initialize) instruction. When the INIT cycle is successful, the program types the prompt word "Command". This prompt string allows the operator to input a command. A list of all the available commands may be obtained by typing an "H" (HELP).

PROGRAM EXIT

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

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

PROGRAM COMMANDS

Legal responses to "COMMAND" are listed in Table 1 and 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 to function.

Table 1. SATEST Commands

Commands	Description
COMPREHENSIVE TESTS	
• (V)ERIFY	General Exerciser
• (A)CCEPTANCE TEST	General Exerciser
• (D)RIVE TEST	Drive Exerciser
INDIVIDUAL TESTS	
• (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
MEDIA MODIFICATION	
• (RE-)FORMAT RL	Reformat Disk
• (B)AD TRACK MAPPING	Entry of Bad Track Map
• (P)RINT BAD TRACK MAP	Output Bad Track Map
• (T)RANSFORM	Transform RL Address to SA address
• (RL) BAD SECTOR	Recover RL Bad Sector
• (DISC)OVERED BACK TRACKS	Output All the Discovered Bad Track
PROGRAM CONTROL VALUES	
• (SET U)NIT	Set Unit
• (SET T)RACK	Set Track Limits
• (SET S)ECTOR INCREMENT	Specify Sector Interleave
• (SET D)EVICE	Set Device
• (H)ELP	Output List of Commands
• (SET P)RINTING	Printing Control
PROGRAM STATUS	
• (M)AP ADDRESS	Memory and Device Map
• (ST)ATUS DISPLAY	Display Status Information
• (RES)ET STATUS	Change Status
• (SA)VE STATUS	Save Status on Diskette
• (DUMP C)IR BUFFER	Display Circuit Output Buffer
• (REC)OVER STATUS	Retrieve
DATA UTILITIES	
• (DUMP O)CTAL	Data Dump in Octal Format
• (DUMP B)YTE	Data Dump in Byte Format
• (DUMP A)SCII	Data Dump in ASCII Format

SATEST 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 2. Control Inputs

Input	Meaning	Notes
CTRL R	Aborts current test, restarts at command	
CTRL S	Freeze 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	2
CTRL D	Causes control transfer to ODT	2,3
CTRL T	Causes control transfer to ODT with stack trace	2,3
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 a 177170.
3. Control transfer from ODT back into SATEST 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).

SATEST 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 "DEC" 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.

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

Disk data is accessed via a combined address of unit #, head #, 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 the 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

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

DEV XXX	Is printed only when running multiple controllers. XXX are the 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.
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 more difficult than a CRC error, which would be counted as bad status. There can be up to 128 data errors in 1 sector.
DEFSTT= DEFINITIVE ERROR STATUS	Error code associated with the error currently being displayed. The meaning of each error code can be found in the unit user's manual.

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 memory buffer
FILL-EMPTY	FD,ED	DMA fill or empty error to center memory buffer
FILL-EMPTY	FH,EH	DMA fill or empty error to high memory 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

COMPREHENSIVE TESTS COMMANDS

- VERIFY — (V)ERIFY

  The VERIFY test does one pass of a SHORT ACCEPTANCE TEST on the first 7 tracks, 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 acceptance test. This test will run until terminated by a "CTRL R".

Example: #DD COMMAND: VERIFY<CR>

VERIFY TEST NOW STARTING
WRITING - PASS CODE= 0 READING - PASS CODE = 0 RANDOM RD/WRT
READING - PASS CODE = 0
PASS FINISHED

- ACCEPTANCE TEST - (A)CCEPTANCE

  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. 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 — (SEE)K 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 time. 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 head, the seek length currently being used (x), and direction of seek (^) = outward). A ! 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 TRACTS ( 0 ): 1 THROUGH ( 114 ); (HEAD: 0)
3   4 S 6 7 ! 3 4 ...
```

- FILL-EMPTY — (FI)LL EMPTY

  The FILL-EMPTY test checks the FILL BUFFER and EMPTY BUFFER controller commands. The controller does FILL/EMPTIES into three different buffers so as to verify proper operation of all possible address bits. FILL/EMPTIES are done to cover the drives; the system will operate in silence. This test continues until the operator types a "CTRL R".

- SEQUENTIAL WRITE/READ — (SEQW) /R

  The SEQUENTIAL WRITE/READ test writes the pseudo-random data sequentially on all selected tracks. The test then reads all the data and checks it. The message "WRITING" is typed on the console terminal when the test starts writing. The message "READING" is typed when the test starts reading. This test continues until the operator types "CTRL R".

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. SATEST prompts "is diskette sequentially 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 tests 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".

- DISCOVERED BAD TRACKS - (DI)SCOVERED BAD TRACKS

  The command will accumulate information for bad tracks discovered during test execution.

  Any "discovered bad tracks" should be verified by specific tests and the bad track map updated.

  This data is reset each time the program is initiated.

- RL BAD SECTOR — (RL) BAD SECTOR

  This command is used to rewrite the RL Bad Sector data in case it has become corrupted. In normal operation, the data should not be corrupted; however, diagnostic testing may have modified the data.

Example:

```
#COMMAND: (RL) BAD SECTOR
WRITE RL BAD SECTOR: (Y,N) Y
WRITING RL BAD SECTOR
RL BAD SECTOR COMPLETED.
#COMMAND:
```

- 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

- BAD TRACK MAPPING - (B)AD TRACK MAPPING

  This command enables the operator to input the bad tracks or update the bad track map. The input prompt is issued after the operator selects decimal or octal input. <CR> will terminate input mode. The operator is allowed to do editing on new bad tracks. It also allows formatting of the disk before writing the bad track map and the RL bad sector on the disk.

Example:

```
#COMMAND:  BAD TRACK MAPPING

ENTRY OF NEW BAD TRACK MAP?  (Y,N) Y
ARE YOU SURE?  (Y,N) Y
DSD 880 BAD TRACK MAP
LATEST UPDATE:  26-NOV-80
DRIVE SN:  1234567890
DATE FIRST ENTERED:  26-NOV-80

DECIMAL/OCTAL INPUT?  (D,O)  OCTAL
***OCTAL INPUT***

TRACK:  1       HEAD:  1
TRACK:  2       HEAD:  2
TRACK:  101     HEAD:  3
TRACK:  202     HEAD:  2
TRACK:  303     HEAD:  3
TRACK: <CR>     HEAD:  3
ANY MORE INPUT?  (Y,N)  N
```

TRACK DECIMAL	TRACK OCTAL	—HEAD	TRACK DECIMAL	TRACK OCTAL	—HEAD	TRACK DECIMAL	TRACK OCTAL	—HEAD
1	1	1	2	2	1	65	101	3
130	202	2	195	303	3			

Example:

```
EDIT INPUT?  (Y,N)  Y
DECIMAL/OCTAL INPUT?  (D,0) DECIMAL
***DECIMAL INPUT***

ADD (Y,N) Y

TRACK:  10      HEAD:  1
TRACK: <CR>
ANY MORE INPUT?  (Y,N) N

DELETE (Y,N) Y

TRACK:  1       HEAD:  1
TRACK: <CR>
EXIT EDITING?  (Y,N) Y
```

TRACK DECIMAL	TRACK OCTAL	—HEAD	TRACK DECIMAL	TRACK OCTAL	—HEAD	TRACK DECIMAL	TRACK OCTAL	—HEAD
2	2	1	65	101	3	130	202	2
195	303	3	10	12	1			

EDIT INPUT? (Y,N) N

TRACK DECIMAL	OCTAL	—HEAD	TRACK DECIMAL	OCTAL	—HEAD	TRACK DECIMAL	OCTAL	—HEAD
2	2	1	10	12	1	65	101	3
130	202	2	195	303	3			

Example: WRITE BAD TRACK FORMAT DISK? (Y,N)
MAP ON DISK? (Y,N) Y

WRITING RL BAD SECTOR

BAD TRACK MAP COMPLETED

PRINT BAD TRACK MAP — (PR)INT BAD TRACK MAP

This command prints the existing Bad Track Map on the CRT or printer.

Example: #COMMAND: PRINT BAD TRACK MAP

DSD 880 BAD TRACK MAP
LATEST UPDATE: 16-DEC-80
DRIVE SN: A10533
DATE FIRST ENTERED: 16-DEC-80
FORMAT: 1

TRACK DECIMAL	OCTAL	—HEAD	TRACK DECIMAL	OCTAL	—HEAD	TRACK DECIMAL	OCTAL	—HEAD
8	10	3	9	11	3	10	12	3
24	30	1	24	30	2	25	31	0
25	31	1	25	31	2	26	32	0
26	32	1	26	32	2	27	33	0
27	33	2	28	34	2			

- REFORMAT RL — (RE)FORMAT RL

  This command allows the user to reformat the winchester disk without losing the bad track and bad block maps. These maps are reloaded on the disk after the FORMAT operation is completed. The user can select full format (Headers and Data) or Fast Format. A limited range of tracks to be formatted may be selected. If the range is including tracks 0, a warning message is sent to the terminal. Do not use "CTRL R" to abort format, as the Bad Track Map will be lost.

- TRANSFORM — (T)RANSFORM

  This command is used to map cylinder, surface, and sector between the physical formats of the RL01/02 and SA1004 winchester disk drives.

The computed SA1004 cylinder and surface must now be adjusted to take bad tracks into account. Scanning the bad track map for bad surface up to and including the target surface. Each bad surface encountered causes the target surface and cylinder to increment by one surface.

Example: (Default no bad track)

RL TRACK: 12	RL HEAD: 3	RL SECTOR: 4
SA TRACK: 10	SA HEAD: 0	SA SECTOR: 34

RL TRACK: <CR>

COMMAND:

PROGRAM CONTROL VALUES 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 drive is unit 2. 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 SATEST returns to command prompt.

NOTE

Single winchester 880 systems default to unit 2 and does not allow unit selection.

- SET TRACK — (SET T)RACK AND HEAD

This command enables the operator to specify lower and upper track limits for all other test functions. The default lower track limit is track 0 and upper track limit is track 377. The COMMAND prompt is issued after the entry of valid new limits. The low limit must not exceed the upper limit.

Example: "SET TRACK" used to set track range from track 1 to track 100 on heads 1 and 2.

#COMMAND: SET TRACK
FROM 0: 1 THROUGH 377: 100
HEAD FROM 0: 1 THROUGH 3: 2

- 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. The prompt is issued after the new value has been entered.

Example: #COMMAND: SET SECTOR INCREMENT IS 7 SECTORS. ENTER NEW INCR: 6

- 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 SATEST 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 the field, leaving it intact. Return to "COMMAND" is by input of a "CR" (carriage return) in response to "RXCS:".

- HELP

  The HELP command causes all the valid COMMAND responses to be displayed on the console terminal. The "COMMAND" 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 SATEST 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: "MAP ADDRESS"

```
#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: ST̲ATUS

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

- RESET STATUS — (RES)ET 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 — (SA)VE 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 over write 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 cummulative error data. The "COMMAND" prompt is typed when this function is complete.

- RECOVER STATUS — (REC)OVER STATUS

  The RECOVER STATUS routing 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 — (DUMP 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 a 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.

OCTAL DUMP BY SECTORS — (DUMP O)CTAL

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, and NUMBER OF SECTORS.

Example:

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

0:	0	0	0	3776	0	0	0	0
20:	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0
60:	0	0	0	0	0	0	0	0
100:	0	0	0	0	0	0	0	0
120:	0	0	0	0	0	0	0	0
140:	0	0	0	0	0	0	0	0
160:	0	0	0	0	0	0	0	0
200:	0	0	0	3722	0	0	0	0
220:	0	0	0	0	0	0	0	0
240:	0	0	0	0	0	0	0	0
260:	0	0	0	0	0	0	0	0
300:	0	0	0	0	0	0	0	0
320:	0	0	0	0	0	0	0	0
360:	0	0	0	0	0	0	0	0

DDEN DRIVE #0 AT TRACK 0, SECTOR #2, SIDE 0
SC = 2

0:	0	0	0	0	0	0	0	0
20:	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0
60:	0	0	0	0	0	0	0	0
100:	0	0	0	0	0	0	0	0
120:	0	0	0	0	0	0	0	0
140:	0	0	0	0	0	0	0	0
160:	0	0	0	0	0	0	0	0
200:	0	0	0	0	0	0	0	0
220:	0	0	0	0	0	0	0	0
240:	0	0	0	0	0	0	0	0
260:	0	0	0	0	0	0	0	0
300:	0	0	0	0	0	0	0	0
320:	0	0	0	0	0	0	0	0
360:	0	0	0	0	0	0	0	0

BYTE DUMP BY SECTORS — (DUMP B)YTE

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

ASCII DUMP BY SECTORS — (DUMP A)SCII

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, and NUMBER OF SECTORS.