Data Systems Design products are warranted against defects in materials and workmanship. For DSD products sold in the U.S.A., this warranty applies for ninety (90) days from date of shipment.* DSD will, at its option, either repair or replace either equipment or components which prove to be defective during the warranty period. This warranty includes labor, parts, and surface travel costs of system modules or components. Freight charges for other than surface travel or for complete systems returned for repair are not included in this warranty. Equipment returned to DSD for repair must be shipped freight prepaid and accompanied by a Material Return Authorization number issued by DSD Customer Service. Repairs necessitated by shipping damage, misuse of the equipment, or by hardware, software, or interfacing not provided by DSD are not covered by this warranty.

No other warranty is expressed or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. DSD shall not be liable for consequential damages and/or loss of data.
This guide provides user information for the Data Systems Design (DSD) 890, Winchester and Tape Storage System, and contains the following information:

• Chapter 1: Brief description and features
• Chapter 2: Specifications and operational requirements
• Chapter 3: Physical and functional descriptions
• Chapter 4: Unpacking instructions, controls and indicators, installation instructions, and acceptance tests
• Chapter 5: Operating instructions
• Chapter 6: User maintenance
• Chapter 7: Field troubleshooting and service information
• Appendix A: GEMEXR Software User Guide
• Appendix B: DSDBR Software User Guide
• Appendix C: TSEXR Software User Guide
• Appendix D: RLEXR Software User Guide
• Appendix E: Bootstrap Program Listing

The material in this manual is subject to change without notice. The manufacturer assumes no responsibility for any errors, which may appear in this manual.

Please note that DEC, LSI-11 (Q-Bus), RL02, TS-11, RT, RSX, and RSTS are registered trademarks of Digital Equipment Corporation. TSX and TSX+ are trademarks of S & H Computer Systems, Inc. Unix is a trademark of Bell Laboratories.
SAFETY

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

Data Systems Design, Inc. will accept no responsibility for injury or damage sustained as a result of operation or maintenance of this equipment with the covers removed and the 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. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. 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 system until you have:

- Released the lock on the Winchester drive (spindle lock).
- Rotated the head lock actuator to RUN position.

Both locks are secured in a locked position before shipment from the factory. See Chapter 4 for detailed procedures covering installation and checkout of equipment.

IMPORTANT

We recommend using tape cartridges that have been certified for 6400 bpi. Using non-certified tape cartridges may result in unrecoverable loss of data.
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DSD 890 Winchester and Tape Storage System
1 INTRODUCTION

1.1. General Information

This chapter briefly describes the DSD 890 Winchester and Tape Storage System and outlines its features. Refer to Chapter 3 for a more comprehensive description.

1.2. System Overview

The DSD 890 is a mass storage system consisting of a main cabinet and an intelligent bus interface board. The system is fully compatible with DEC computers using LSI-11 bus configurations and provides, in a rack-mount package, many value-added features not found in comparable DEC equipment. For example, the cabinet contains:

- An eight-inch Winchester (sealed bubble) disk drive. This drive replaces three DEC RL02 cartridge disk volumes, storing up to 31.2 Mbytes of formatted data.

- A start/stop Tape drive that uses 1/4-inch tape cartridges. This drive stores up to 16.25 Mbytes of formatted data on each cartridge and emulates DEC TS11/TSV05-class subsystems. The DSD Tape drive can be used to obtain backup copies of Winchester disk data, restore the data, or load diagnostic programs distributed by DSD.

In addition, the cabinet contains its own power supply, a built-in bootstrapping program, and cooling fan. Switches and LEDs are conveniently located on the front panel to permit:

- individual write-protection of each of the three Winchester volumes.

- control over Tape cartridge load/unload operations.

- rapid access to comprehensive HyperDiagnostics - a DSD proprietary built-in diagnostic program.
The cabinet is interfaced with DEC LSI-ll computers via the DSD 8240 Controller board. This quad-wide board is hardware compatible with all DEC LSI-ll bus (Q-Bus) backplanes. The board is, both, a bus interface for the storage cabinet and an intelligent controller that emulates DEC RL02, and TSll/TSV05 auxiliary storage subsystems, allowing the user to fully utilize operating systems and application software distributed by DEC.

This board contains a high-speed direct memory access (DMA) microcontroller and three gate arrays that provide non-interleaved disk operations, transparent error correction, and optimum system throughput.

1.3. Features

The following list compiles features of the DSD 890 System:

Winchester Drive

- Emulates three DEC RL02 disk pack subsystems.
- Provides three 10.4-Mbyte storage volumes.
- Contains built-in bootstrapping PROM.
- Supports 22-bit addressing modes.
- Provides HyperDiagnosics via Operator panel.

Tape Drive

- Emulates one DEC TS-11/TSV05 (1/2-inch) tape subsystem.
- Provides up to 16.25 Mbytes of back-up storage on each cartridge.
- Supports 22-bit addressing modes.
- Provides HyperDiagnosics via Operator panel.
- Boots diagnostic software from supplied cartridge.
Controller Interface Board

- Fully emulates DEC peripheral controllers.
- Provides software compatibility with DEC LSI-11 (Q-Bus) computers.
- Provides compatibility with RT, RSX, TSX, TSX+, RSTS, and UNIX operating systems.
- Uses one of two user-selectable methods for transferring disk sector data: Two-way interleaving method afford flexibility, while non-interleaving method results in increased data throughput rate.
- Supports simultaneous disk and tape operations with maximum throughput and minimum degradation of either operation.
- Corrects Winchester drive error bursts up to 11 bits long using error correction coding (ECC) techniques.
- Detects Tape drive random errors using a 16-bit cyclic redundancy coding (CRC) technique.
- Supports DSD diagnostic software for testing storage devices and media.
- Supports DSD software utilities for managing Winchester media, for making backup copies of Winchester volumes on cartridge, and for restoring cartridge data to Winchester volumes.
- Uses state-of-the-art semiconductor technology on single quad-wide controller board.
- Provides increased reliability and serviceability, at reduced cost.
- Complies with LSI-11 bus bandwidth requirements.
- Provides automatic error retry for Winchester disk data.
- Provides access, via computer console, to DEC on-line debugging techniques (ODT).
2.1. General Information

This chapter outlines specifications and operational requirements for the DSD 890 Winchester and Tape Storage System. Specifications include storage capacities, recording characteristics, and data transfer rates. Also provided is a listing of major components and the system physical dimensions.

Requirements include interface cabling, connectors, and power requirements. Environmental limitations are also stated.

2.2. System Modules

The DSD 890 System modules are listed in Table 2-1 and illustrated in Figure 2-1.

Table 2-1. System Modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Cabinet</td>
<td></td>
</tr>
<tr>
<td>Chassis</td>
<td>700267-01</td>
</tr>
<tr>
<td>Display Control Board</td>
<td>808945-01</td>
</tr>
<tr>
<td>Winchester Disk Drive (60 Hz) or,</td>
<td>900482-01</td>
</tr>
<tr>
<td>Winchester Disk Drive (50 Hz)</td>
<td>900482-02</td>
</tr>
<tr>
<td>Tape Drive</td>
<td>900473-01</td>
</tr>
<tr>
<td>Fan Assembly</td>
<td>900112-01</td>
</tr>
<tr>
<td>Power Supply, Linear (100 Watts)</td>
<td>500014</td>
</tr>
<tr>
<td>Diagnostic Control Board</td>
<td>808940-01</td>
</tr>
<tr>
<td>Computer Interface</td>
<td></td>
</tr>
<tr>
<td>Controller Interface (8240) Board</td>
<td>808240-01</td>
</tr>
<tr>
<td>Interface Cable Shipping Kit</td>
<td>900476-01</td>
</tr>
</tbody>
</table>
Figure 2-1. System Modules
2.3. Recording Characteristics

The Winchester drive records data using the modified frequency modulation (MFM) technique. The magnetic tape cartridge drive uses the group code recording (GCR) technique. Product specifications are listed in Tables 2-2 through 2-4.

Table 2-2. System Specifications

<table>
<thead>
<tr>
<th>GENERAL</th>
<th>WINCHESTER DRIVE</th>
<th>TAPE DRIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emulates</td>
<td>Three RL02s</td>
<td>TS-11</td>
</tr>
<tr>
<td>Modifications to Operating System Software</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Formatted Capacity</td>
<td>10.4 Mbytes/RL02 image</td>
<td>16.25 Mbytes (450 ft. cartridge, 16 Kbyte blocks)</td>
</tr>
<tr>
<td></td>
<td>31.2 Mbytes total</td>
<td></td>
</tr>
<tr>
<td>DATA ORGANIZATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recording technique</td>
<td>MFM</td>
<td>GCR</td>
</tr>
<tr>
<td>Bytes/disk sector</td>
<td>256</td>
<td>-</td>
</tr>
<tr>
<td>Bytes/tape block</td>
<td>-</td>
<td>512-16K</td>
</tr>
<tr>
<td>Error detection</td>
<td>Header CRC Data ECC, Transparent Correction</td>
<td>CRC</td>
</tr>
<tr>
<td>Flaw management</td>
<td>Spare track assignment is user transparent</td>
<td>-</td>
</tr>
<tr>
<td>Recording density</td>
<td>6600 bpi</td>
<td>6400 bpi</td>
</tr>
<tr>
<td>Track density</td>
<td>345 tpi</td>
<td>1</td>
</tr>
<tr>
<td>Number of read/write heads</td>
<td>8</td>
<td>4 (Serpentine)</td>
</tr>
<tr>
<td>Number of tracks</td>
<td>512</td>
<td></td>
</tr>
<tr>
<td>SPEEDS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disk seek time (including head setting)</td>
<td>65 ms</td>
<td>-</td>
</tr>
<tr>
<td>Average</td>
<td>100 ms</td>
<td>-</td>
</tr>
<tr>
<td>Maximum</td>
<td>15 ms</td>
<td>-</td>
</tr>
<tr>
<td>Track-to-track</td>
<td>20 ms</td>
<td>-</td>
</tr>
<tr>
<td>Disk head switching time</td>
<td>10 ms</td>
<td>-</td>
</tr>
<tr>
<td>Disk average latency</td>
<td>30 sec.</td>
<td>-</td>
</tr>
<tr>
<td>Disk start-up time</td>
<td></td>
<td>30 ips (read/write)</td>
</tr>
<tr>
<td>Tape speed</td>
<td></td>
<td>70 ips (rewind)</td>
</tr>
<tr>
<td>Tape rewind time</td>
<td></td>
<td>3 minutes max.</td>
</tr>
<tr>
<td>Data transfer length</td>
<td>5.1 Kwords maximum</td>
<td>256 to 8 Kwords</td>
</tr>
<tr>
<td>Time to read or write RL02 image (10.4 Mbytes)</td>
<td>25.5 seconds</td>
<td>8.95 minutes</td>
</tr>
<tr>
<td>ERROR RATES (W/O ECC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft read errors</td>
<td>1 per 10⁹ bits read</td>
<td>1 per 10⁹ bits read</td>
</tr>
<tr>
<td>Hard read errors</td>
<td>1 per 10⁹ bits read</td>
<td>1 per 10⁹ bits read</td>
</tr>
<tr>
<td>Seek Errors</td>
<td>1 per 10⁹ seeks</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 2-3. Cabinet Specifications

<table>
<thead>
<tr>
<th>CHASSIS OPERATING VOLTAGE AND POWER REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POWER LINE FREQUENCY</strong></td>
</tr>
<tr>
<td>The DSD 890 is available in two versions for use on either 50Hz or 60 Hz AC power.</td>
</tr>
<tr>
<td>Order DSD 890-A for use of 60 ± 0.5Hz Service</td>
</tr>
<tr>
<td>Order DSD 890-B for use on 50 ± 0.5Hz Service</td>
</tr>
<tr>
<td><strong>VOLTAGE RANGES</strong></td>
</tr>
<tr>
<td>The DSD 890 has four operator selectable AC voltage ranges to cover world wide power distribution conditions. These AC voltage ranges are as follows:</td>
</tr>
<tr>
<td>100VAC ± 10% by setting the range selector</td>
</tr>
<tr>
<td>120VAC ± 10% switch on the AC power input</td>
</tr>
<tr>
<td>220VAC ± 10% receptacle on the rear of the chassis</td>
</tr>
<tr>
<td><strong>NOTE:</strong> The DSD 890-A (60Hz) will be shipped set for use on 120VAC ± 10%</td>
</tr>
<tr>
<td>The DSD 890-B (50Hz) will be shipped set for use on 220VAC ± 10%</td>
</tr>
<tr>
<td><strong>POWER REQUIREMENTS</strong></td>
</tr>
<tr>
<td>Average power consumed 300 watts</td>
</tr>
<tr>
<td>Maximum starting surge power 500 watts, 5 seconds maximum</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENVIROMENTAL SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OPERATING</strong></td>
</tr>
<tr>
<td>Temperature</td>
</tr>
<tr>
<td>Relative Humidity, 20% to 80% (non-condensing)</td>
</tr>
<tr>
<td>Maximum Wet Bulb, 10,000 feet maximum</td>
</tr>
<tr>
<td>Altitude</td>
</tr>
<tr>
<td><strong>NON-OPERATING</strong></td>
</tr>
<tr>
<td>Temperature, 10°C to 40°C</td>
</tr>
<tr>
<td>Relative Humidity, 20% to 80% (non-condensing)</td>
</tr>
<tr>
<td>Maximum Wet Bulb, 10,000 feet maximum</td>
</tr>
<tr>
<td>Altitude</td>
</tr>
<tr>
<td><strong>CHASSIS DIMENSIONS</strong></td>
</tr>
<tr>
<td>Overall Dimensions, 5.25 in. h x 17.6 in. w x 21.0 in. d</td>
</tr>
<tr>
<td>Shipping Carton, 10.5 in. h x 24.0 in. w x 33.5 in. d</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WEIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODEL DSD 890, 53 lbs (24 Kg)</td>
</tr>
<tr>
<td>SYSTEM WEIGHT, 53 lbs (24 Kg)</td>
</tr>
<tr>
<td>SHIPPING WEIGHT, 65 lbs (29.5 Kg)</td>
</tr>
</tbody>
</table>

Table 2-4. Interface Specifications

<table>
<thead>
<tr>
<th>LSI-11 INTERFACE</th>
<th>WINCHESTER DRIVE</th>
<th>TAPE DRIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backplane Requirement</td>
<td>One quad-wide Q-Bus slot in any Q-Bus backplane</td>
<td></td>
</tr>
<tr>
<td>Device Address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>17774400</td>
<td>17772520</td>
</tr>
<tr>
<td>Alternate</td>
<td>17774420</td>
<td>17772530</td>
</tr>
<tr>
<td>Interrupt Address</td>
<td>160</td>
<td>224</td>
</tr>
<tr>
<td>Standard</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>Alternate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bootstrap Address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>17773000</td>
<td></td>
</tr>
<tr>
<td>Alternate</td>
<td>17771000</td>
<td></td>
</tr>
<tr>
<td><strong>POWER REQUIREMENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 VDC (5.5 A)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 VDC (0.4 A)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.4. Cable and Connector Requirements

The DSD 890 System is furnished with all internal cables installed and configured for proper operation. The DSD 8240 controller interface board is installed at the backplane of the host computer and connected to the system cabinet by three cable assemblies:

(a) A 50-pin Winchester control cable

(b) A 20-pin Winchester data cable

(c) A 40-pin Tape cable

[^]
3 SYSTEM DESCRIPTION

3.1. General Information

This chapter describes the DSD 890 System. Emphasis is given to the DSD 8240 board, which provides computer interfacing and control of all data storage and retrieval operations.

3.2. Introduction

The DSD 890 is a mass storage system that consists of a Winchester drive, a Tape drive, and a DSD 8240 Controller board.

Designed to support the DEC LSI-11 computer product line, the DSD 890 System emulates interface software of DEC RL02 and TSll/TSV05 subsystems.

The LSI-11 (Q-Bus) bus uses 44 lines. These lines are used by the central processing unit (CPU), main memory, and input/output (I/O) devices to communicate with each other.

Most lines are bidirectional and use terminations for maintaining a high (negated) transistor-transistor-logic (TTL) level. Devices are connected to these lines via high impedance bus receivers and open collector drivers. A device can assert a line when its driver places a low TTL logic level on the line.

All devices on the bus communicate with each other in an asynchronous mode. For bus transactions between devices to occur, one device must become master and the other become slave. Some devices, such as main memory are always slave.

A device, such as disk or tape, can become master by asserting a DMA-request signal to request the data section of the bus. The CPU is responsible for arbitrating simultaneous requests and granting the bus to the device with highest priority.

Once master, the device can use various methods to perform the data transfer transaction. DMA is the method used by the DSD 890 System.
This method is most useful when using mass storage devices that move large blocks of data to and from main memory. DMA causes the least intervention from the CPU and it is consequently the most efficient data transfer method.

During DMA, the storage device needs to know the starting address in memory, the starting address in the storage device, the length of the transfer, and the type of operation. DMA starts after the CPU grants bus mastership to the highest priority DMA device requesting the bus.

The DSD 890 contains an intelligent interface controller that uses a microcontroller and three semi-custom designed gate array integrated circuits (IC) for emulating DEC software while providing full compatibility (see Figure 3-1).

The microcontroller, a Signetics 8X305, is a high-speed processing device, which performs and controls all the intelligent functions of the storage system.

The microcontroller receives commands from the LSI-11 computer intended for the specific peripheral devices. These commands are coded into a form compatible with the DSD storage devices and transmitted to them.

Similarly, the microcontroller receives data from the storage devices and codes the data into a format compatible with the LSI-11 operating software.

Gate arrays are large scale integrated (LSI) circuits fabricated by a process, which provides designers with circuits semi-customized to their application. Using gate arrays results in a more efficient and cost-effective product.

The DSD 890 uses three gate array devices to provide several product enhancements. Use of these devices allow the following value-added features:

- Non-Interleaved Disk Operation: Increased data transfer rate, across the entire disk, to 352.7 Kbytes per second - about 12 percent faster than a single RL02 subsystem.
- Transparent Error Correction: Detection of error bursts 22 bits long and correction of 11 bits. These functions are performed transparently.
- Optimum System Throughput: DMA is used to obtain greatest computer throughput without sacrificing compatibility.
Figure 3-1. DSD 8240 Controller Board
The Winchester is a Quantum Q2040 eight-inch Winchester disk drive. The Tape is a Kennedy 6455 1/4-inch start/stop cartridge tape drive.

The Winchester drive stores a maximum of 31.2 Mbytes of formatted data. The data transfer rate within a sector, within a cylinder, or across the entire disk varies with the method used for transferring data (i.e., non-interleaving or two-way interleaving). Refer to Chapter 2, Specifications for more details.

The Tape has four tracks arranged in a serpentine configuration. Data is recorded serially, and reading/writing takes place in both directions with an automatic head switch at the end of the tape. The data transfer rate is 24 Kbytes per second.

Because of recording overhead, the Tape storage capacity is directly related to the block size used in the recording format. The storage capacity ranges from 3.56 Mbytes to 16.25 Mbytes.

3.3. Functional Description

The DSD 8240 Controller consists of a 8X305 microcontroller connected to a high-speed internal data bus, three gate arrays, a disk read/write controller chip, and tape interface logic with first-in-first-out (FIFO) buffers. (See Figure 3-2.)

The 8X305 is a bipolar microcontroller with a cycle time of 200 ns. The 8X305 serves as internal bus master and controls all on-board intelligent functions; for example:

- Monitors and controls Winchester drive, tape drive, and interfacing operations.

- Performs the storage device emulation function.

- Provides read, write, and data transfer functions.

The gate arrays consist of an error correction chip in a 22-pin package, a two-port RAM controller chip, and a Q-Bus DMA chip; the latter two are in 64-pin grid-array packages.
Figure 3-2. Controller Architecture
The disk read/write controller, tape interface logic, two-port RAM controller, and Q-Bus DMA controller act as internal bus slaves. Disk data is synchronized by a phase-locked loop, under control of the read/write controller.

During device operation, the 8X305 produces a status for each device and stores it in RAM. As disk and tape operations proceed, the 8X305 updates and stores various bits of information.

Any read of the I/O registers by the computer software interrupts the 8X305 and causes it to place, within ten microseconds, the selected register data on the Bus. This high speed is required to avoid an abort of the operation by the LSI-II watchdog timer.

The use of intelligence in the DSD 8240 Controller allows a single quad-wide board to emulate two different storage devices, and to provide additional features such as non-interleaved data transfer, transparent error detection and correction, disk flaw management, and on-board diagnostics.

3.3.1. Disk Drive Emulation

The DSD Controller emulates three 10.4-Mbyte RL02 drives using an eight-inch Winchester drive.

The RL02 disk drive has two read/write heads, one on each side of a single disk-platter. Each side of the platter has 512 concentric tracks. Each track contains forty 256-byte sectors.

The DSD Winchester drive has eight read/write heads, one on each side of four platters. Each side of a platter has 512 tracks. Each track contains thirty-one 256-byte sectors.

Because of the physical differences between the two drives, the Controller needs to convert track, head, and sector addresses of the RL02 drives to a form compatible with the Winchester drive.

To emulate the drives, the Controller maps the RL02s vertically as three concentric, three-dimensional cylinders, instead of assigning each Winchester platter a different RL02. (See Figure 3-3.)
Figure 3-3. DSD Winchester/RL02 Emulation
The following paragraphs describe the conversion process used by the Controller:

(1) The absolute sector number (ABSEC) is determined. RL02 disk addresses are re-defined to consist of a cylinder number (CY), a head number (HD), and a sector number (SEC). Head numbers range from 0 to 1; sector numbers from 0 to 39. The firmware in the microcontroller uses the following formula:

\[
\text{ABSEC} = \text{SEC} + (40 \times \text{HD}) + (80 \times \text{CY})
\]

(2) Corrections are made. An offset is added to identify the RL02 being accessed and a correction for flaws is made based on a flaw translation table stored on track 0 of the Winchester drive.

(3) The sector number is calculated. The result obtained above is divided by a constant (248), yielding the Winchester drive cylinder number and a remainder. This remainder is divided by another constant (31), yielding the Winchester drive head number and a another remainder. This second remainder is the Winchester sector number. This number is added to another constant, which identifies the RL02 volume being addressed.

(4) A read or write operation is done. Using the information obtained in the last step, the firmware commands the Winchester drive to position its head over the proper track and read or write.

Using a similar process, responses from the Winchester are converted into the format expected by the LSI-11 operating system. Data is transferred between drive and main memory by DMA.

3.3.2. Non-Interleaved Data Transfer

The Controller is capable of transferring Winchester disk data at an optimum rate by using non-interleaved data transfer techniques; that is, reading or writing a full track of data during one disk revolution.

Non-interleaved data transfer requires a complex data buffering scheme. The DSD Controller uses a 1-Kbyte RAM buffer in a two-port configuration. (See Figure 3-4.)
Figure 3-4. Two-Port RAM Buffer Data Transfer
The control logic for the two-port RAM resides in a semi-custom gate array, which uses 1700 gates to do the equivalent function of 30 TTL devices.

The two-port buffer configuration allows Winchester sector data to be read into one port, while data from the previous sector is transferred to main memory. Figure 3-4 shows the details of the data transfer operation as follows:

1. When buffer A is filled with data from the first Winchester sector, the two-port RAM controller switches to buffer B and begins to fill it with data from the second Winchester sector.

2. As buffer B is being filled, the contents of buffer A are transferred to main memory.

3. When buffer B is filled, the cycle is repeated and data moves continuously, at high speed, between disk drive and main memory.

If the CPU data bus is being used by other high data rate DMA devices, the high data rate transfer obtained by non-interleaved operations may not be desirable. In such cases, the disk can be formatted for interleaved operations and the Controller set to slow down memory accesses for preventing I/O bus overloads.

3.3.3. Error Detection and Correction

A major DSD 8240 Controller feature is detecting and correcting disk errors transparently; that is, in a way not perceived by the operating system.

The Controller contains a proprietary, complementary-MOS (CMOS) gate array that uses 540 silicon gates to provide error detection and correction.

The Controller implements these functions as follows:

1. The 256-byte data record in a Winchester sector is converted to a binary polynomial of degree equal to the bits in the record.

2. This polynomial is divided by a second constant polynomial stored within the error detection and correction chip. The remainder of this division is a 32-bit error correction code (ECC).
(3) The ECC is concatenated (appended) to the disk sector data each time a Winchester sector is written. When a sector is read, data and ECC are shifted through the chip. If no error is present, the remainder in the chip is equal to zero.

(4) If an error is present, the residual remaining in the chip generates an error indication. This indication is used by the 8X305 microcontroller to generate an error pattern and to identify the location of the bit or bits in error.

(5) Once the error location is identified, the 8X305 microcontroller attempts to reread the data record several times before applying error correction.

(6) If the error pattern persists, the 8X305 microcontroller corrects the data in its data buffer before loading it into the host CPU memory, thus providing transparent error detection and correction of error burst up to 11 bits long.

3.3.4. Disk Flaw Management

Winchester disk drives contain permanent hard errors known as flaws. A list of these flaws is provided by the manufacturer with each drive. This list is used by DSD to produce a "bad-track map" table. Several copies of this table are then recorded in track 0 of the disk drive.

When power is applied, the DSD 8240 Controller reads the Winchester drive bad-track map table and stores it in scratch pad RAM.

After converting an RL02 disk address to a Winchester disk address, the 8X305 microcontroller accesses the bad-track map table from memory and compares its entries to the desired Winchester disk address. The microcontroller then makes the necessary corrections to ensure that complete tracks are flagged as defective and are not used.

The corrections made during flaw management are transparent to the host operating system. Also, since RL02 emulation does not use all the available Winchester tracks, there are enough spare tracks to compensate for many flaws.
3.3.5. Tape Drive Emulation

The DSD 8240 Controller emulates a DEC TS-11 or TSV05 magnetic tape system using a start/stop Tape drive.

The TS-11/TSV05 tape drives use standard 1/2-inch, nine-track magnetic tape. The drives read and write at 25 inches per second, with a data transfer rate of 40 Kbytes per second.

The DSD Tape drive uses a smaller 1/4-inch, start/stop magnetic tape cartridge. Data is recorded serially at a transfer rate of 24 Kbytes per second.

The 8X305 microcontroller receives LSI-II commands intended for the DEC drive. These commands are converted into a form compatible with the Tape drive and are transmitted to it. Similarly, the 8X305 converts Tape drive data into the format expected by the computer.

3.3.6. Tape Cartridge Storage Capacity

The DSD 890 Tape drive records data at 6.4 Kbits per inch (800 bytes per inch), using four serial tracks arranged in a serpentine configuration to avoid rewinding at the end of each track. The length of the tape in the cartridge is 450 feet (5400 inches).

The unformatted capacity of a tape cartridge is computed by using the following formula:

\[
\text{Storage Capacity} = \text{Bytes/inch} \times \text{Tracks} \times \text{Length}; \text{ in our case this is: } 800 \times 4 \times 5400 = 17.28 \text{ Mbytes}
\]

In the Tape drive, data is recorded in blocks with an inter-block gap (IBG) of 1.2 inches. The data format on the tape for a single data block consists of the IBG, an 80-bit preamble, a 5-bit sync mark, the data pattern, a 5-bit end mark, a 16-bit CRC, and an 80-bit post-ambale.

The formatted data (except data pattern) and the IBG are considered recording overhead. In our case, 186 bits (0.029) plus 1.2 inches of IBG for a total of 1.229 inches of overhead.

Consequently, the drive storage capacity is directly related to the block size of the recording format. This relationship is shown in Table 3-1. Note that a 2-Kbyte or larger block size is needed for backing up an entire RL02 disk image (10.4 Mbytes).
<table>
<thead>
<tr>
<th>BLOCK SIZE (Bytes)</th>
<th>STORAGE CAPACITY (Mbytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>256</td>
<td>3.56</td>
</tr>
<tr>
<td>512</td>
<td>5.91</td>
</tr>
<tr>
<td>1K</td>
<td>8.80</td>
</tr>
<tr>
<td>2K</td>
<td>11.65</td>
</tr>
<tr>
<td>4K</td>
<td>13.91</td>
</tr>
<tr>
<td>8K</td>
<td>15.40</td>
</tr>
<tr>
<td>16K</td>
<td>16.25</td>
</tr>
</tbody>
</table>
4 INSTALLATION

4.1. General Information

This chapter provides instructions for installing your 890 System, including acceptance test procedures.

The DSD 890 System is fully tested before shipping. Unless there is physical damage from shipment, it can be installed and made operational in a short period of time without any special procedures other than those recommended here.

4.2. Unpacking and Inspection

When your DSD 890 System arrives, inspect the shipping container immediately for evidence of mishandling during transit. If the container is damaged, request the presence of the carrier's agent before opening it.

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

   Ensure that all items are unpacked and none accidentally discarded with the packing material. Note that the DSD 8240 Controller board is packaged in the shipping container separately.

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

   If damage is evident, notify DSD Customer Service Department immediately.

   Retain the shipping container and packing material for examination in the settlement of claims, or for future use.
4.3. Controls and Indicators

The controls and indicators are located on the front bezel of the system cabinet and consist of a Status display panel and an Operator panel.

The only control not accessible from the front bezel is the POWER ON/OFF switch, which is a rocker arm switch located at the rear of the cabinet.

4.3.1. Status Panel

The Status panel is located on the upper right side of the front bezel and becomes visible when the system cabinet is powered-up.

The Status panel shows the status of the Winchester and the Tape drives. It also provides system power on/off and fault indications.

The Status panel indicators are shown in Figure 4-1 and their functions described in Table 4-1.

Table 4-1. Status Panel - Indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER</td>
<td>• Lights to show cabinet is powered-up</td>
</tr>
<tr>
<td>WIN ACTIVE</td>
<td>• Lights to show Winchester drive is active</td>
</tr>
<tr>
<td>WIN WP</td>
<td>• Lights when any WIN VOLUME WRITE PROTECT switch is ON</td>
</tr>
<tr>
<td>FAULT</td>
<td>• Lights to show system fault (see Chapter 7 for details)</td>
</tr>
<tr>
<td>TAPE ACTIVE</td>
<td>• Lights to show Tape drive is active</td>
</tr>
<tr>
<td>UNLOAD</td>
<td>• Lights to show tape cartridge is at unload point and safe to remove from Tape drive</td>
</tr>
</tbody>
</table>
Figure 4-1. Status Panel
4.3.2. Operator Panel

The Operator panel is located on the front bezel lower right side behind a hinged door. This door is opened by applying fingertip pressure near the bottom.

The Operator panel allows the operator to control Winchester write-protect functions, tape load/unload operations, and to start HyperDiagnostics (see Caution below). It also provides diagnostic error code information.

The Operator panel controls and indicators are shown in Figure 4-2 and their functions described in Table 4-2.

Table 4-2. Operator Panel - Controls and Indicators

<table>
<thead>
<tr>
<th>Control/Indicator</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIN VOLUME WRITE PROTECT (0 - 2)</td>
<td>• Each, when set (ON), write-protects corresponding drive volume and lights WIN WP indicator. (See Chapter 7 for other functions.)</td>
</tr>
<tr>
<td>Switches</td>
<td></td>
</tr>
<tr>
<td>TAPE LOAD/UNLOAD Switch</td>
<td>• Setting to LOAD moves cartridge to load point.</td>
</tr>
<tr>
<td></td>
<td>• Setting to UNLOAD moves cartridge to unload point, lights UNLOAD indicator, and allows safe cartridge removal.</td>
</tr>
<tr>
<td>TEST Pushbutton (momentary-action)</td>
<td>• Used for starting HyperDiagnostics. (See Caution below.)</td>
</tr>
<tr>
<td>STATUS Indicator</td>
<td>• Displays zero when system is off-line.</td>
</tr>
<tr>
<td></td>
<td>• Blanks when system is on-line. (For other functions, see Chapter 7)</td>
</tr>
</tbody>
</table>

CAUTION: Some HyperDiagnostics (tests) will destroy Winchester and Tape data. Unless you are completely familiar with this feature, do not press the panel TEST pushbutton. Refer to Chapter 7 for instructions.
Figure 4-2. Operator Panel
4.4. Power Requirements

The DSD 890 System is available in configurations for nominal line voltages of 120 or 240 Vac. The line frequency must be within 0.5 Hz of the required frequency (50 Hz or 60 Hz).

The system voltage and frequency configurations can be field-modified; however, the process requires that mechanical, as well as electrical, adjustments be made.

Should you need to modify the system, contact DSD Customer Service for assistance.

4.5. Mechanical Preparations

The system Winchester drive is shipped with locked spindle and head mechanisms. These mechanisms must be unlocked before installation to avoid damage to the drive motor. Refer to Figure 4-3 and follow these instructions:

1. Remove spindle-lock access panel in bottom cover.
2. Loosen 11/32" hex nut on spindle-lock.
3. Rotate locking clip away from pulley.
4. Tighten 11/32" hex nut.
5. Replace spindle-lock access panel.
6. Unlock head lock by rotating actuator lock counterclockwise to RUN (about 1/2-turn). DO NOT FORCE. The Winchester drive is ready for operation. (See Caution below.)

CAUTION: Never ship the system cabinet or the Winchester drive assembly with the spindle and head mechanisms unlocked. Failure to observe this precaution will result in costly damage and void the Warranty. See Chapter 7 for instructions.
Figure 4-3. Winchester Spindle and Head Lock
4.6. Installation

FCC Compliance Testing

The DSD 890 System has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC rules. The following is a brief description of the test:

- An DSD 8240 controller interface board was mounted inside a DEC MICRO/PDP-11 computer card-cage.

- A DSD 890 cabinet was placed, on a table top, alongside the DEC computer.

- Three shielded ribbon cables were used to connect the DSD 890 cabinet and the DSD 8240 board. These cables were grounded to both, the DEC computer and the DSD 890 chassis.

- Several operational tests were performed using a DEC VT-102 terminal as the system console.

Under the above conditions, it was found that no special enclosures were needed as long as the three cables were shielded and properly grounded. A complete test report is available on request.

Please note that the DSD 890 System is designed for integration into a larger computer system. The final responsibility for compliance with FCC regulations rests with the system integrator. The need for shielded cables in other applications, such as when the DSD 890 System is rack-mounted, can be determined only by proper testing of the final computer system configuration.

* A shielded cable-kit, including necessary hardware, to terminate cable shields to a DEC MICRO/PDP-11 computer is available from DSD. Contact your nearest DSD Sales Representative for price and availability.
Installation Overview

Before installing the DSD 890 System, refer to DEC CPU documentation and power down the LSI-11 computer (see Caution below). The equipment installation consists of:

- cabinet installation
- cabling
- reconfiguring Controller (if necessary)
- mounting Controller
- powering computer
- acceptance testing
- installing operating systems

4.6.1. Cabinet Installation

Because of the interconnecting cable length, the system cabinet must be installed within ten feet of the DSD 8240 Controller board. If the computer operator anticipates frequent tape changes, it may be convenient to locate the cabinet next to the computer console terminal.

The cabinet may be mounted in a standard 19-inch rack, or placed on a table top. The rack installation hardware is included in the shipping carton.

When mounting the cabinet, ensure that there is enough space behind the cabinet fan to permit unrestricted air flow. The temperature of the air entering the cabinet should not exceed 104 degrees F (40 degrees C).

To mount the 890 cabinet in the standard 19-inch instrumentation rack, proceed as follows:

1. If you purchased chassis slides mounting kit, complete kit instructions and return to this procedure. If not, go to next step and remove front bezel.

---

CAUTION: Ensure that line power is off. Do not restore or apply power to either the computer or the DSD 890 System until instructed.
With both hands, apply fingertip pressure at bottom of
bezel. Simultaneously, pull bezel-top away from cabinet
with thumbs. Bezel will detach as illustrated in Figure
4-4.

Gently, insert cabinet into rack. Sudden movements may
damage Winchester disk drive.

Install cabinet retaining screws.

Re-install bezel by locating guide pins and firmly press­
ing until retaining mechanism engages. The system cabinet
is installed.

4.6.2. Cabling

The DSD 890 cabinet has three connectors at the rear of the
unit. These connectors are protected by two cable clamps. One
cable clamp covers the Winchester control connector. The
other, longer, cable clamp covers the Winchester data connec­
tor and the Tape connector. The DSD 8240 controller interface
is a quad-wide printed circuit board, labeled P/N 808240-01.

The system cabinet is interconnected with the DSD 8240
board via three flat ribbon cables shielded to prevent radio­
frequency (RF) emissions. Three 10-foot shielded cables are
provided with your equipment. If you desire to make your own
cables, please read the FCC Compliance Testing statement under
Section 4.6, Installation.

The following procedure assumes that you are using the
cables provided with your equipment. Refer to Figure 4-5 and:

Remove protective cable clamps from cabinet connectors
and set aside.

Set controller board on flat surface, component side up,
as shown in the figure.

Obtain 20-pin Winchester data cable. Note the cable has a
black jacket that covers its shield. On one connector
end, the jacket is notched on both sides. This end plugs
into the cabinet.

Inspect cable connector on notched end and observe a tri­
angular marking etched on one side. This marking identi­
fies pin 1.

Go to rear of cabinet and locate DATA INPUT rear panel
connector. Notice marking identifying pin 1.
Figure 4-4. Front Bezel Removal
(6) Plug Winchester data cable into DATA INPUT. Ensure that pin 1 of cable matches pin 1 of connector.

(7) Plug loose end of cable into 8240-J1. Ensure that pin 1 of cable matches J1-1 as shown in figure.

(8) Obtain 50-pin Winchester control cable. As before, identify end that connects to cabinet (the end with the black jacket notched on both sides). Also, identify pin 1.

(9) Plug cable into WINCHESTER INPUT. Ensure that pins 1 of cable and connector match.

(10) Plug other end of cable into 8240-J3 as shown in figure.

(11) Obtain 40-pin Tape cable. As before identify end that connects to cabinet. Also identify pin 1.

(12) At rear of cabinet, plug one end of cable into TAPE INPUT. Ensure that pins 1 of cable and connector match.

(13) Plug other end of cable into 8240-J4.

(14) Compare cabling just done with the figure. If no errors are found continue this procedure and install the cable clamps.

(15) Note from the detail in Figure 4-5 that the cable clamps are notched on one face. The notched face indicates the bottom part of the clamps.

(16) Install the bottom (longer) clamp first. Ensure the clamp makes good mechanical contact with the exposed shielded parts of both cables. Tighten both captive screws of the clamp.

(17) Set a multimeter to a low ohms scale and measure between chassis ground and the exposed cable shields to ensure good electrical continuity.

(18) Install the top clamp. As before, ensure good mechanical as well as good electrical contact is made between chassis ground and the exposed cable shield.

Ensure that all three cable shields are grounded to the CPU chassis. If you have any questions, contact DSD Customer Service Department.
Figure 4-5. Cabinet and Board Cabling
4.6.3. Configuring Controller Board

The DSD 8240 Controller is configured with jumpers. These jumpers are installed between pairs of pins at various locations on the printed circuit board. It is important that the board is properly configured before it is used with a computer system.

The jumpers on the DSD 8240 Controller board are grouped in five classes:

1. **Bootstrapping Options.** This group provides jumpers to enable or disable the built-in boot program (W16 and W17), select boot address (W10) and boot mode (W31), and control line-time clock (LTC) interrupts (W8 and W9).

2. **Device Options.** The jumpers in this group enable or disable the disk (W15) and select disk address and interrupt vectors (W11). There are also jumpers to enable or disable the tape (W12 and W13), select tape address and interrupt vectors (W18), select tape drive emulation mode (W32), and enable or disable tape drive POCs (W33).

3. **Interrupt Priority Options.** The jumpers in this group select the disk and/or tape interrupt priority level (W20 and W21).

4. **DMA Request Monitor Option.** Two jumpers in this group (W6 and W7) enable or disable the option.

5. **Error Correction Option.** One jumper (W25) enables or disables the option.

Figure 4-6 shows the location of the Controller jumpers. Table 4-3 is a reference chart that lists all jumpers, including those used for testing the board at the manufacturing facility.

The factory configuration is based on the most common applications used by customers. If this "standard" configuration satisfies you, skip the rest of this section, go to the next section, and mount the board.

If you need to reconfigure the board, read the rest of this section and use the flowcharts in Figures 4-7 through 4-11. Each figure is preceded by pertinent information.
Figure 4-6. DSD 8240 Jumpers
Table 4-3. DSD 8240 Jumpers

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Shipped</th>
<th>Option Class</th>
<th>Function (As Shipped)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1</td>
<td>Installed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W2</td>
<td>Installed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W3</td>
<td>Installed</td>
<td>Boot</td>
<td>LTC Disabled</td>
</tr>
<tr>
<td>W4</td>
<td>Installed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W5</td>
<td>Installed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W6</td>
<td>Removed</td>
<td>DMA Request</td>
<td>Monitor Disabled</td>
</tr>
<tr>
<td>W7</td>
<td>Installed</td>
<td>DMA Request</td>
<td>Monitor Disabled</td>
</tr>
<tr>
<td>W8</td>
<td>Removed</td>
<td>Boot</td>
<td>LTC Disabled</td>
</tr>
<tr>
<td>W9</td>
<td>Installed</td>
<td>Boot</td>
<td>LTC Disabled</td>
</tr>
<tr>
<td>W10</td>
<td>Removed</td>
<td>Boot</td>
<td>Boot: Normal Address</td>
</tr>
<tr>
<td>W11</td>
<td>Removed</td>
<td>Device</td>
<td>Disk: Normal Address</td>
</tr>
<tr>
<td>W12</td>
<td>Removed</td>
<td>Device</td>
<td>Tape Enabled</td>
</tr>
<tr>
<td>W13</td>
<td>Installed</td>
<td>Device</td>
<td>Tape Enabled</td>
</tr>
<tr>
<td>W14</td>
<td>Removed</td>
<td>Device</td>
<td>Disk Enabled</td>
</tr>
<tr>
<td>W15</td>
<td>Installed</td>
<td>Device</td>
<td>Disk Enabled</td>
</tr>
<tr>
<td>W16</td>
<td>Installed</td>
<td>Boot</td>
<td>Boot Enabled</td>
</tr>
<tr>
<td>W17</td>
<td>Removed</td>
<td>Boot</td>
<td>Boot Enabled</td>
</tr>
<tr>
<td>W18</td>
<td>Removed</td>
<td>Device</td>
<td>Tape: Normal Address</td>
</tr>
<tr>
<td>Jumper</td>
<td>Shipped</td>
<td>Option Class</td>
<td>Function (As Shipped)</td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
<td>-------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>W21</td>
<td>Removed</td>
<td>Int. Priority</td>
<td>At Level Five</td>
</tr>
<tr>
<td>W19</td>
<td></td>
<td></td>
<td>(Not used on this board)</td>
</tr>
<tr>
<td>W20</td>
<td>Installed</td>
<td>Int. Priority</td>
<td>At Level Five</td>
</tr>
<tr>
<td>W22</td>
<td>Removed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W23</td>
<td>Removed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W24</td>
<td>Removed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W25</td>
<td>Removed</td>
<td>Error Correction</td>
<td>Enabled</td>
</tr>
<tr>
<td>W26</td>
<td></td>
<td></td>
<td>(Not used on this board)</td>
</tr>
<tr>
<td>W27</td>
<td>Installed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W28</td>
<td>Removed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W29</td>
<td>Removed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W30</td>
<td>Installed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W31</td>
<td>Removed</td>
<td>Boot</td>
<td>CM Boot Disabled</td>
</tr>
<tr>
<td>W32</td>
<td>Removed</td>
<td>Device</td>
<td>TSV05 Emulation</td>
</tr>
<tr>
<td>W33</td>
<td>Removed</td>
<td>Device</td>
<td>Tape POCs Enabled</td>
</tr>
<tr>
<td>W34</td>
<td>Installed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
</tbody>
</table>

4.6.3.1. Bootstrapping Options

LSI-11 computers use a "bootstrapping" technique for loading software programs. This technique consists of loading a primary set of instructions into main memory that, when executed, enables the CPU to load a secondary and, slightly longer, set.
The secondary set or bootstrap loader, as it is also known, enables the CPU to load complete operating systems and application programs.

The primary boot is contained in the DSD 890 diagnostic control board. This board contains a program in PROM, which initializes system memory, including parity. It also checks the Controller, Winchester drive, and permits bootstrap loading (second boot) from any Winchester volume, the Tape drive, or a RX02-compatible floppy - such as DS-100/105 subsystems.

This primary boot is enabled or disabled with two jumpers. The program can be selected from starting address 17773000 (DEC normal) or 17771000 (DEC alternate). One jumper selects this address.

Most DEC LSI-11 CPU modules are configured in one of two power-up modes. Some modules may be configured in as many as four power-up modes. Because of these variations, You should consult your DEC documentation for specific details about the CPU module that you are using. As an example, LSI-11/23 modules can be configured to power-up in modes 1 and 2. The DSD 8240 Controller will behave differently depending on the selected power-up mode.

In mode 1, the CPU enters console ODT without attempting to boot. At that point, the user must manually initiate the primary boot by typing the address of the boot device. That is, 17773000 or 17771000 for the DSD Winchester boot PROM, or the address of some other device boot PROM in the system.

In mode 2, power applied to the module causes the CPU to internally generate a bootstrap starting address (17773000) and begin to execute instructions found at that address.

The DSD 8240 Controller provides two secondary boot modes: conversational and non-conversational. The conversational mode prompts the user, via console, to select a device for the secondary boot.

In non-conversational mode, there are, again, differences based on the selected power-up mode. To use the LSI-11/23 example once more:

- In mode 1, the secondary boot device can be selected, via console ODT, by typing the device starting address.
- In mode 2, the secondary boot will be obtained from volume 0 of the Winchester drive.
One frequent problem with DEC CPUs is completing the boot operation while the line-time clock (LTC) is running. This is because some systems use a continuously-running LTC, not enabled by operating software. In such systems, an LTC interrupt may occur during booting - before proper interrupt-handling software is loaded into main memory.

If you are using a StacPac Processor module (DS-400), you will not experience any of these problems. If you are using other "Processor" modules you can also prevent these problems by properly using the functions provided by your DSD 8240 Controller.

The following example assumes you are using a LSI-11/23-PLUS (DEC KDF11-BA) CPU. This illustrates system-dependent considerations that must be taken into account. Refer to DEC documentation for other CPU boards.

The DEC LSI-11/23-PLUS board includes a bootstrap PROM. This PROM tests memory and allows bootstrap loading from several devices. The confidence checks provided by the PROM are oriented towards the CPU and serial communications link.

If your computer CPU is an LSI-11/23-PLUS, you have a choice of using the Winchester boot or the CPU boot. However, you must be aware of the following:

(a) The LSI-11/23-Plus boot PROM and LTC are enabled by a single jumper (J5) on the board. The DEC CPU responds to LTC address: 1777546.

(b) The DSD 8240 Controller contains circuitry to temporarily disable LTC interrupts (clamping Q-Bus signal BEVENT L low), until enabled by interrupt-handling software (i.e., a write to location 1777546 with bit 6 set).

Consequently, if you desire to use the DEC KDF11-BA boot, you must:

- Disable the DSD Controller boot and LTC functions.

Conversely, if you desire to use the DSD 8240 boot, you must:

- Disable the DEC KDF11-BA boot/LTC functions (by grounding J5) and enable these functions on the Controller board.

Consult DEC documentation and use Figure 4-7 to determine the bootstrapping configuration required by your DSD Controller board.
Figure 4-7. Bootstrapping Options
4.6.3.2. Device Options

The DSD 8240 controller supports the Winchester drive and the Tape drive. Either device may be independently enabled or disabled. Standard and alternate device addresses and interrupt vectors are provided for each device.

Most applications require using the standard (DEC standard) device addresses. The alternate addresses may be required if the system contains two DSD 8240 Controllers, or if a DEC RL02 subsystem is also connected to the computer system.

The Winchester disk must be temporarily disabled when copying an operating system from a RL02 onto cartridge tape. This procedure is explained in Section 4.6.7. The disk drive is disabled by moving a jumper from location W15 to location W14.

The Tape must be temporarily disabled when copying an operating system from a TSV05/TS11 onto a Winchester volume. This procedure is explained in Section 4.6.7. The Tape drive is disabled by moving a jumper from location W13 to location W12. In addition, the Tape interface POCs must be disabled by installing a jumper in location W33.

The Tape Drive emulates DEC TS11 and TSV05 magnetic tape systems. Jumpers are provided on the Controller board to select either function. In general, TSV05 emulation should be selected in computer systems using 22-bit addressing modes.

Use Figure 4-8 and select configuration required by your Controller board.

4.6.3.3. Interrupt Priority Options

DEC LSI-11/23 and LSI-11/23-PLUS CPUs provide a multiple-level interrupt scheme, which is fully supported by the DSD 8240 Controller. This scheme permits peripheral devices to have interrupt priorities, which are position-independent, that is, independent of the backplane position occupied by their controllers.
Figure 4-8. Device Options
Priority levels may be set anywhere from level four (lowest) to level seven (highest). DEC normally configures RL02 controllers to operate at level five. This priority level will also work for older LSI-11 processors using level four only.

In the DSD 8240, the disk and tape sections operate at the same interrupt-priority level. The Controller firmware arbitrates disk and tape interrupts to ensure no conflicts.

Use Figure 4-9 to configure your Controller board. We recommend using interrupt-priority level five (5).

4.6.3.4. DMA Request Monitor Option

The DSD 8240 Controller transfers data between the storage drives and main memory using DMA. When slower DMA controllers are used with the DSD 8240, the slower controllers may experience "data late" conditions. A tape controller with a small (one- or two-byte buffer) is an example of such a controller.

To reduce data lates, the DSD 8240 can be jumpered to monitor the Q-Bus DMA Request line (BDRMR L). DMA transfers are monitored in blocks of four words. If during a DMA operation another controller requests the bus, the DSD 8240 temporarily relinquishes the bus and delays the transfer.

Generally, the DMA Request Monitor function does not interfere with non-interleaving disk operations, unless a second controller is using the full bus bandwidth - the spectrum of data transfer speeds acceptable by the bus.

In such heavily loaded systems, Winchester disk performance may be degraded if the Controller cannot complete transfers of disk sectors during one disk revolution. In this case, it is preferable to format the Winchester for two-way interleaving. This procedure is explained in Appendix A (GEMEXR User Guide).

Use Figure 4-10 to configure your Controller, according to your needs. If you want the Controller to process DMA data transfers at the fastest possible rate, disable the DMA Request Monitor option.

Also, if your system is equipped with a DSD 8836 Controller (DSD 880 Subsystems), it may be desirable to disable the option on both controllers.
Figure 4-9. Interrupt Priority Options
Figure 4-10. DMA Request Monitor Option
4.6.3.5. Error Correction Option

One important function of the DSD 8240 Controller is transparent error correction for the Winchester disk drive. The Controller can detect and correct data field errors recorded on the disk. The errors can be as long as eleven bits.

Disk errors detected during an initial read operation are not immediately corrected. The Controller reports the error to the operating system as a "data CRC error. On sensing the error, the software logs the error to create a history file and re-tries the operation.

The Controller reads the data field again. This time, if the error is correctable, the Controller does the correction without informing the software.

Since DEC does not provide the error detection and correction function, a jumper on the Controller board disables it. This simple operation is shown in Figure 4-11.

4.6.4. Mounting Controller

The Controller board can be inserted into an LSI-II computer card-cage or into a StacPac Processor module. The board makes electrical connections with the backplane via contact fingers on four edge connectors.

Figure 4-12 shows three common LSI-II backplane versions. Refer to your DEC manual for other configurations. If using a Processor module, refer to the Technical Reference manual provided with that unit.

When installing the board, ensure that no opened or unused slots are left in the priority chain between the CPU and the board. It may be necessary to re-arrange dual-wide cards, such as memory boards or serial line units to meet this requirement. To install the board, proceed as follows:
Figure 4-11. Error Correction Option
Figure 4-12. Common LSI-11 Backplanes
(1) At computer, insert board into selected card cage slot.

(2) Ensure board is properly seated on backplane connectors.

(3) Dress subsystem cables to reduce cable stress and allow proper ventilation. The Controller board is properly installed.

4.6.5. System Power-Up

Your system is equipped with a three-prong power cord. The power-up procedure is quite simple:

(1) At the rear of the cabinet, ensure the POWER ON/OFF switch is off.

(2) Locate the three-prong power receptacle. Note the window above it and ensure that it reads the correct ac voltage value.

(3) Connect the female end of the power cord in the receptacle.

(4) Plug the male end of the cord into a three-prong ac power outlet. Ensure that your outlet is properly grounded. If using an adapter, ground the adapter with a pigtail.

(5) Restore power to the LSI-11 computer.

(6) Turn the POWER ON/OFF switch on and wait a few seconds for the system to complete the POCs. If no failures are detected (FAULT LED off), go to the next section and do the acceptance tests. If the FAULT LED stays on, refer to Chapter 7 for instructions.

4.6.6. Acceptance Testing

The DSD 890 acceptance testing consists of running programs stored in the RL/TS Distribution tape cartridge. These programs are also distributed on diskettes (floppy disks).

The programs used for acceptance testing are RLEXR (Winchester exerciser) and TSEXR (tape exerciser). These programs exercise the RL02 and TS11/TSV05 emulation capabilities of the system, and check the Winchester and magnetic tape media.
A user guide for each program is provided in Appendices C and D. Condensed versions are provided in the next two subsections. Do the tests in the sequence provided.

4.6.6.1. Testing With RLEXR

The RLEXR program may destroy any data stored on the Winchester disk volumes, excluding format information. The RLEXR test program is controlled from the system console.

1) Write-protect RL/TS Distribution tape cartridge and insert it into drive.

2) Boot from cartridge to load tape monitor (TMON) program.

3) Select RLEXR from displayed menu.

4) Use SHort Acceptance test to verify all three emulated RL02 volumes. Allow test to run at least two hours or until errors are reported.

5) If no errors are reported, continue with Tape tests provided in next subsection. If errors are reported, go to Chapter 7 for troubleshooting instructions.

4.6.6.2. Testing With TSEXR

The TSEXR program verifies the write-capability of the drive. Therefore, unless you proceed with caution, any data stored on the cartridge may be destroyed. The TSEXR test program is controlled from the system console.

1) Write-protect RL/TS Distribution tape cartridge and insert it into drive.

2) Boot from cartridge to load tape monitor (TMON) program.

3) Select TSEXR from displayed menu.

4) Remove Distribution cartridge from Tape drive and insert write-enabled, blank cartridge, in its place. Ensure cartridge reaches "load" point before beginning tests.

5) Use ACCEPT command to test basic Tape drive read/write functions. A few recoverable errors (TCC4 or TCC5) may occur during normal operations. A function reject error (TCC3) may occur if cartridge is improperly installed, write-protected, or if testing began at wrong tape point.
(6) If excessive errors occur, clean Tape drive head (see Chapter 7) and repeat tests. If after cleaning head, errors persist, refer to Chapter 7 for troubleshooting instructions.

4.6.7. Installing Software Programs

The Winchester drive records data in a soft-sectored format. The drive is preformatted at the factory and ready to use. In most cases, the operating system and application software packages can be transferred from a system device such as an RX02-compatible floppy device, a DEC RLO2 disk subsystem, or a DEC TSV05 tape system. The next three subsections provide examples on how these operations can be done with each device.

4.6.7.1. Transfer Using Floppy

If your computer system is equipped with a RX02-compatible floppy drive, such as the StacPac DS-100 or DS105 subsystem, you can transfer the software to the Winchester, and then to the Tape with the Backup and Restore utility program (DSDBR) stored on the RL/TS Distribution cartridge. Refer to Figure 4-13 and:

(1) Boot from floppy device.

(2) Using your operating system utilities, copy all system files, command files, and disk handler to one Winchester volume.

(3) Insert RL/TS Distribution cartridge into Tape drive.

(4) Using DSDBR, make backup copy of Winchester volume on cartridge tape. Write-protect cartridge and save for future use. A complete user guide for DSDBR is provided in Appendix B. Simplified versions of Backup and Restore procedures are provided in Chapter 5.
1. Use Operating System "Copy" Utility

2. Insert RL/TS Distribution Cartridge and

3. Use DSDBR Utility to Copy to Tape

Figure 4-13. Transferring Software Using Floppy
4.6.7.2. Transfer Using RL02

If you have a DEC RL02 device and DEC RLV11/RLV12 controller available, you can transfer software from the RL02 device to the Tape drive cartridge, and then to the Winchester. Several methods can be used, however; since the RL02 address may be identical to the Winchester drive address some care is required. Refer to Figure 4-14 and:

(1) Disconnect power from processor rack, install DEC RLV11/RLV12 controller and RL02 device at DEC standard address (17774400/160).

(2) Remove DSD 8240 Controller from card cage.

(3) Disable Winchester disk by removing Jumper W15 and installing it in location W14. The Winchester primary boot can still be used.

(4) Mount DSD Controller board and reapply system power.

(5) Insert RL/TS Distribution cartridge into Tape drive.

(6) Boot from Tape drive and load DSDBR.

(7) Remove RL/TS Distribution cartridge from Tape drive.

(8) Insert write-enabled blank cartridge into Tape drive.

(9) Using DSDBR commands, copy RL02 volume to tape cartridge.

(10) Remove recorded cartridge from Tape drive.

(11) Power off processor rack, remove DEC controller, and RL02 device.

(12) Remove DSD 8240 Controller from card cage.

(13) Enable Winchester disk by removing Jumper W14 and installing it in location W15.

(14) Mount DSD Controller board and re-apply system power.

(15) Insert RL/TS Distribution cartridge into Tape drive.

(16) Boot from Tape drive and load DSDBR.

(17) Remove RL/TS Distribution cartridge from Tape Drive.

(18) Insert recorded cartridge into Tape Drive.
(19) Using DSDBR, restore contents of tape cartridge to Winchester volume.

(20) Remove recorded cartridge from Tape drive, write-protect it, and save for future use.

If one DEC RL02 device is permanently installed in the system, the above procedure is slightly different. Instead of disabling the Winchester disk, you can assign the RL02 the normal address and interrupt vector (17774400/160) and the DSD Winchester the alternate address and interrupt vector (17774420/150).

If multiple DEC RL02 devices are permanently installed, you must use the first procedure. That is, you must disable the DSD Winchester drive, during the RL02-to-Tape transfer.

4.6.7.3. Transfer Using TSV05

If your system is equipped with a DEC TSV05 or DEC TS11 tape system and the operating system is configured (sysgened) for multiple tape controllers, you can copy software from the DEC tape to the DSD Winchester using copy utility commands.

If the operating system is not sysgened for multiple tape controllers, refer to Figure 4-15 and:

(1) Power off processor rack.

(2) Remove DSD 8240 Controller from card cage.

(3) Disable tape by removing Jumper W13 and installing it in location W12. Also, install a jumper in location W33 to disable Tape drive POCs.

(4) Mount DSD Controller board and re-apply system power.

(5) Boot from DEC TSV05/TS11 device.

(6) Using utility commands, copy DEC tape to Winchester volume

(7) Power off processor rack.

(8) Remove DSD 8240 Controller from card cage.
1. Load DSDBR in Memory

2. Use DSDBR to Copy to Tape

3. Load DSDBR in Memory

4. Use DSDBR to Restore to Winchester

Figure 4-14. Transferring Software Using RL02
(9) Enable DSD Tape Drive by removing Jumper W12 and installing it in location W13. Also, enable Tape Drive POCs by removing Jumper W33.

(10) Set Tape base address to 175520 by removing jumper W18.

(11) Remove DEC TSV05/TS11 device and controller from system.

(12) Mount DSD Controller board and re-apply system power.

(13) Insert RL/TS Distribution cartridge into Tape drive.

(14) Boot from Tape drive and load DSDBR.

(15) Remove RL/TS Distribution cartridge from Tape drive.

(16) Insert write-enabled cartridge into Tape drive.

(17) Using DSDBR, back up contents of Winchester volume to cartridge.

(18) Remove recorded cartridge, write-protect it, and save it for future use.
Figure 4-15. Transferring Software Using TSV05/TS11
5 OPERATING INSTRUCTIONS

5.1. General Information

This chapter provides instructions for the most frequent system operations. The DSD 890 controls and indicators were described in Chapter 4. If necessary, refer to that chapter.

5.2. Introduction

Your system consists of mechanical drives, printed circuit (PC) boards, and interconnecting cables. The mechanical drives are normally inactive unless an operation is requested from the system console, the Operator panel, or the operating system software.

To extend the life of your system, we recommend that you leave it turned-on most of the time. As a safety measure, it is always a good practice to remove power from equipment which remains unattended for long periods of time.

5.3. Applying Power

The system cabinet is powered by turning the rear power switch to ON. The Controller board receives power from the processor backplane.

When the cabinet and Controller board are powered-up, the Controller automatically does a series of power-on confidence (POC) tests. These POCs are fully described in Chapter 7.

During the POCs, the Tape ACTIVE and WIN ACTIVE LEDs on the Status panels light. At the end of these brief tests, both LEDs go off, and test results are displayed:

- If no failures are found, the STATUS LED displays zero.
- If failures are detected, the FAULT LED is lighted and STATUS displays a two-number error code. Since only one digit is available, the LED flashes one number, blanks
for a short time, flashes a second number, and blanks for a longer time. For example, to display number 41, the LED flashes number four, blanks for a brief time, flashes number one, blanks for a longer time, and repeats the sequence.

If, during the POCs, failures are detected, contact your technical personnel for advice. Troubleshooting instructions are provided in Chapter 7.0.

5.4. Loading the Cartridge

The cartridge used with your system has a file protect indicator on the upper left hand corner (see Figure 5-1). The file protect indicator can be turned with a screwdriver to either of two positions.

When the indicator points to SAFE, it prevents the Tape drive from overwriting data on the tape. This is desired when loading DSD programs from cartridge tape.

When the indicator points away from SAFE, the drive can do read/write operations with the tape. This is necessary for data storage and retrieval operations.

To load the tape cartridge into the drive, proceed as follows:

(1) Open the Operator panel door.
(2) Ensure the LOAD/UNLOAD switch on the panel is set to LOAD.
(3) Insert the tape cartridge into the slot provided in the front panel (see Figure 5-2).
(4) Wait while the drive rewinds the cartridge to the load point. Observe the TAPE ACTIVE indicator is on. Wait for the indicator to go off.
(5) When the TAPE ACTIVE indicator goes off, the Tape drive is ready to use.
Figure 5-1. Magnetic Tape Cartridge

Figure 5-2. Inserting the Cartridge
5.5. Unloading the Cartridge

Before a cartridge is removed from the drive, it is a good practice to rewind the tape to the unload point. This simple precaution will ensure that recorded data is protected from dust or other foreign matter and that the tape in the cartridge is smoothly wound for its next use. Follow these instructions:

(1) Observe the UNLOAD indicator on the Status panel. If the indicator is off, proceed with Step 2. If the indicator is on, go directly to Step 5.

(2) Open the Operator panel door and set the LOAD/UNLOAD switch to UNLOAD.

(3) Wait for the system to complete any tape operations and begin to rewind the cartridge. During the rewind operation, the TAPE ACTIVE indicator lights.

(4) Wait for the TAPE ACTIVE indicator to go off. When it goes off, the UNLOAD indicator lights. (See Caution below.)

(5) Remove the tape cartridge from the drive.

5.6. Bootstrapping

To function, computers need to load at least part of an operating system into main memory. These memories are temporary storage locations, which are erased every time the main processing (CPU) rack is turned off.

If your computer system has been turned off or otherwise lost power, you will need to reload the operating system.

Before you reload the operating system, you will need to load a program, which will enable you to do so. The method of loading this enabling program is known as bootstrapping or booting, for short.

---

**CAUTION:** Before removing cartridge, ensure TAPE ACTIVE is off and UNLOAD is on to prevent unrecoverable loss of data.
The boot method depends on how your computer is set up to power-up. It also depends on how the Controller board was configured during installation. The most common power-up conditions are outlined below:

- The computer will automatically boot from volume 0 of the Winchester drive.
- The computer will prompt you to select a booting device, by displaying a list of available devices.
- The computer will display a special prompt (@). At this point, you can type one of the addresses shown in Table 5-1. Refer to Chapter 4 for more details, or ask your installer what address to use.

Table 5-1. Bootstrap Device Selection

<table>
<thead>
<tr>
<th>To Select:</th>
<th>Type Address:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winchester Volume 0</td>
<td>771000 or 773000</td>
</tr>
<tr>
<td>Winchester Volume 1</td>
<td>771002 or 773002</td>
</tr>
<tr>
<td>Winchester Volume 2</td>
<td>771004 or 773004</td>
</tr>
<tr>
<td>(Reserved)</td>
<td>771006 or 773006</td>
</tr>
<tr>
<td>Tape Cartridge</td>
<td>771010 or 773010</td>
</tr>
<tr>
<td>Floppy at 777170</td>
<td>771012 or 773012</td>
</tr>
<tr>
<td>Floppy at 777150</td>
<td>771014 or 773014</td>
</tr>
<tr>
<td>(Reserved)</td>
<td>771016 or 773016</td>
</tr>
</tbody>
</table>

NOTE: After entering the address, press G (for GO!).

5.7. Backup and Restore Operations

The cartridge tape is an excellent medium on which to store Winchester backup files for later use in restoring lost disk data. There are three methods available for doing backup and restore operations:
(a) Since the Tape drive emulates the DEC TS-11/TSV05 storage system, it is simple to obtain tape copies from disk by using DEC operating system commands. For example, to copy a filename and extension such as "DATA.SAV" under the RT11 operating system, the user enters:

• COPY DL0:DATA.SAV MS0:

(b) Under DEC RSX-11M or similar operating systems, higher-level backup and restore utilities, such as BRU and DSC, are supported. These utilities are supported by the DSD 8240 Controller. Consult your DEC documentation for operating information.

(c) Full disk image backup and restore operations are supported by the DSD backup and restore (DSDBR) program. This program is stored in the RL/TS Distribution cartridge supplied with your equipment. Complete instructions for DSDBR are given in Appendix B. Simplified backup and restore procedures are provided in the next two subsections. See Note below.

5.7.1. Creating Backups

Your Tape drive can be used to make backup copies of all files stored on any of the three Winchester volumes. The backup frequency will be determined by the needs of your organization. Because the operation is somewhat time-consuming, we suggest that backups be done at the end of the working day or before an extended work break. The operation is done from the system console.

(1) Write protect the RL/TS Distribution cartridge and insert it into the tape drive.

(2) Boot from the tape to load the tape monitor (TMON) program.

(3) Select DSDBR from the displayed menu.

(4) Remove the distribution cartridge from the drive.

(5) Insert a write-enabled blank cartridge into the drive.

NOTE: The DSDBR program is RT-11 compatible. It may be copied to the system disk and used as an RT-11 utility.
(6) Select the Winchester volume to be copied. You can backup up to one complete Winchester volume (10 Mbytes) on each cartridge.

(7) After the operation is completed, remove the cartridge from the drive, write protect it, and save it for future use.

5.7.2. Restoring Disk Data

Your Tape drive can be used to restore data from a backup cartridge to any of the three Winchester volumes. As backups, restoring disk data is time-consuming and should be done during times when the drives are not constantly needed. The operation is done from the system console.

(1) Insert the RL/TS Distribution cartridge into the tape drive.

(2) Boot from the tape, to load the tape monitor (TMON) program.

(3) Select DSDBR from the displayed menu.

(4) Remove the distribution cartridge from the drive.

(5) Insert a write-protected backup data cartridge into the drive.

(6) Select the Winchester volume to be restored. You can restore up to one complete Winchester volume (10 Mbytes) from each cartridge.

(7) After the operation is completed, remove the cartridge from the drive.

[^]
6 USER MAINTENANCE

6.1. General Information

This chapter provides maintenance instructions for the daily user of the system. No technical training is needed for using this information, however; observe all suggested precautions to avoid equipment damage, personal injury, or both.

6.2. Proper Ventilation

Your equipment is kept at an ideal operating temperature by vents located at the rear of the modules. The circulating air is propelled by an internal fan. It is important that the cabinet have enough rear space - not less than three inches - for free air flow.

Should the system become hot, turn the power off and inspect the area surrounding the cabinet for obstructing objects. Turn the power on again. If the problem recurs, turn the power off and contact your technical manager or DSD Customer Service for further instructions.

6.3. Cleaning the Cabinet

The cabinet is not waterproof; consequently care should be used when cleaning its surface. Follow these instructions:

- Dust each module surface frequently to keep display panels clean.
- Turn the power off. Pour a small amount of non-abrasive mild detergent solution (such as Windex or equivalent) on a lint-free soft cloth (see Caution below).

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CAUTION: Cleaners containing solvents or abrasive substances can damage the cabinet surface.
• Apply the damp cloth, or paper towel, to the module surface and rub gently until it appears clean. Allow it to dry; reapply, if necessary.

6.4. Quick Troubleshooting Chart

Generally, field equipment problems are due to minor oversights easily correctable by a few simple steps. Table 6-1 contains a chart for aiding the user with these types of problems.

When using the chart, first look under the "Trouble Indication" column and find the signs given by your equipment most closely approximating the chart.

Second, look under the "Possible Cause" column. Examine your equipment to see if the cause of your trouble is in the chart.

Before attempting any corrective action (for example, replacing a blown fuse) turn the cabinet power off and unplug the power cord. Do not attempt repairs that require removing the cabinet covers.

Field maintenance instructions are provided in Chapter 7. That chapter requires technical experience or training.

If unable to correct the problem, contact the technical manager of your organization, your equipment supplier, or DSD Customer Service for further instructions.
<table>
<thead>
<tr>
<th>Indication</th>
<th>Possible Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment &quot;dead&quot;</td>
<td>• Power cord unplugged</td>
</tr>
<tr>
<td>Equipment &quot;dead&quot;</td>
<td>• Blown fuse (See Figure 6-1)</td>
</tr>
<tr>
<td>Equipment &quot;dead&quot;</td>
<td>• Defective power supply</td>
</tr>
<tr>
<td>FLT light always on</td>
<td>• Loose Winchester/Tape drive cable connections</td>
</tr>
<tr>
<td>No Tape drive action</td>
<td>• Loose Tape drive cable at rear connector, or at backplane</td>
</tr>
<tr>
<td>No Tape drive action</td>
<td>• Defective Tape drive</td>
</tr>
<tr>
<td>No Winchester drive action</td>
<td>• Loose Winchester cable at rear connector</td>
</tr>
<tr>
<td>No Winchester drive action</td>
<td>• Defective Winchester drive</td>
</tr>
<tr>
<td>Winchester drive action, but no read/write functions</td>
<td>• Loose Winchester data cable rear connection</td>
</tr>
<tr>
<td>Winchester drive action, but no read/write functions</td>
<td>• Defective Winchester circuits</td>
</tr>
</tbody>
</table>

[^]
Figure 6-1. Fuse Location

- Position A
- Position B
- Spare Fuse
- Voltage Selector Card
- Switch

100V
120V
220V
240V

TP 585/84
7 FIELD TROUBLESHOOTING AND REPAIRS

7.1. General Information

This chapter covers the following topics:

- Preventive maintenance
- Winchester media management information
- Diagnostic tools
- Troubleshooting using flowcharts
- Repair and replacement information

Your equipment passed rigorous factory tests to ensure long periods of trouble-free service. However, if you suspect a malfunction, follow the instructions provided in this chapter. Observe all suggested precautions to avoid equipment damage, personal injury, or both.

7.2. Maintenance Philosophy

Maintenance of the DSD 890 System is an easy task because the equipment was designed with the user in mind. The product maintenance philosophy can be summarized as follows:

- Preventive Maintenance: The equipment requires a minimum number of preventive routines.

- Troubleshooting: Several diagnostic tools are either built into the equipment or loaded from DSD software media. These tools permit rapid diagnosis of persistent malfunctions and help detect intermittent drives and media problems.

- A telephone hot-line, staffed by fully trained DSD technicians, provides diagnostic help with difficult problems.
7.3. Preventive Maintenance

Trouble preventing routines are limited to periodic cleaning of the Tape drive head and capstan rubber wheel. The cleaning frequency is proportional to the amount of use. Refer to Figure 7-1 and follow these instructions:

(1) Turn the DSD 890 cabinet power off.

(2) Visually check the drive for oxide or dirt accumulation on read/write head and capstan rubber wheel.

(3) Use a vacuum cleaner to remove accumulation of dust. Do not allow suction tip of vacuum cleaner to touch read/write head. DO NOT ALLOW METAL PARTS OF VACUUM CLEANER NEAR READ/WRITE HEAD.

(4) Dip a cotton swab in a commercial (90%) solution of isopropyl alcohol. Do not use common isopropyl (rubbing or denatured) alcohols found in drug stores. Allow a few seconds for excess solvent to evaporate. (See Caution below.)

(5) Gently clean head and capstan rubber wheel with cotton portion of cotton swab. Do not allow wooden portion to touch head. Repeat if necessary until head and wheel are clean. Allow solution to evaporate before using drive.

7.4. Winchester Disk Formatting

Data is stored on the Winchester disk in a soft-sectored format. (i.e., a sector position is identified by a header followed by a 256-byte data field). During normal operations, data fields are frequently updated; data headers are not. Formatting is the process of recording headers on the disk.

CAUTION: Do not use excess solution and be extremely careful not to allow solution to penetrate the ball bearings of the capstan motor; it will destroy their lubrication.
CAUTION:
Remove power prior to cleaning. Do not use acetone or lacquer thinners, aerosol sprays, or rubbing alcohol.

Figure 7-1. Tape Drive Cleaning
The Winchester drive is pre-formatted. Generally, it is not necessary to reformat the disk unless the GEMEXR or RLEXR programs show a "header not found" error. The GEMEXR program can be used to reformat the disk; it provides two basic commands:

- FORMAT Command. The entire disk or any consecutive tracks may be formatted. As a default, the entire disk is formatted except cylinder zero, which contains the bad-track map. If cylinder zero is re-formatted, the bad-track map must be re-created.

- RLFMT Command. An individual RL02 logical volume may be formatted using this command.

Formatting destroys data stored on the disk. Also, after a formatting operation, it is necessary to restore DEC-compatible RL02 bad sector files at the end of each RL02 logical volume. These operations can be done with the RLBAD command.

### 7.5. Bad-Track Map Updating

Except for cylinder zero, Winchester manufacturers cannot guarantee the disk media as flaw-free. Consequently, a mechanism must be developed by manufacturers of mass storage systems to deal with flaws.

In the DSD System, a bad-track map is recorded on cylinder zero of the disk before shipment. The map is a list of tracks containing known flaws.

When the system is powered up, the list is read and translated by the controller, which then avoids the bad-tracks.

The specific bad-track map list for your system is provided on a card inside an envelope. This envelope is located inside the Winchester module, in a compartment, right in front of the Winchester drive. We recommend that you return the list to the compartment after each use.

The BADTRK command (GEMEXR) can recreate the bad-track map or add additional tracks. Whenever the bad-track map list is altered, note the necessary corrections on the card.

The bad-track map must be initialized whenever cylinder zero of the Winchester drive is reformatted. Refer to Appendix A, GEMEXR User Guide, for operating instructions.
7.6. Diagnostic Tools

The DSD 890 System provides four distinct types of diagnostic tools:

- **Power-On Confidence (POC) Tests**: Brief but complete self-checks are automatically initiated at power-up. These tests thoroughly check for faults and provide a general and effective evaluation of the equipment.

- **Bootstrapping Sequence**: If the Controller boot is selected, its sequence can be used to isolate malfunctions. The bootstrapping program is listed in Appendix E.

- **HyperDiagnostics** - a DSD proprietary internal program - can be used to further diagnose problems.

- **Comprehensive software programs** - distributed on cartridge tape or diskette - exercises disk and tape drives/media to help isolate intermittent or random problems. These programs can also be used for acceptance testing of new modules and for verifying repairs.

7.6.1. Power-On Confidence Tests

The firmware enabling the POCs reside in the Controller. The tests consist of two categories: Winchester and Tape drive POCs.

7.6.1.1. Winchester POCs

The functions of the Winchester POCs are listed below:

- Read on-board jumpers and front panel switches
- Reset the disk drive
- Test the controller scratch RAM and buffer RAM
- Test internal controller logic
- Perform a READ/ECC test on the drive data simulator located in the Diagnostic Control board.
- Read the disk bad-track map file and validate its contents
Initialize all I/O registers and scratch RAM contents

7.6.1.2. Tape Drive POCs

The functions of the Tape Drive POCs are listed below.

- Check tape timer
- Initialize interface, drive, and registers
- Verify drive interrogation protocols

7.6.1.3. POCs Results

While the POCs are running, the Tape and Winchester ACTIVE LEDs light. At completion, both LEDs go off and:

- For no failures, STATUS displays zero.
- For failures, FAULT lights and STATUS displays a two-number code.

A list of codes is provided in the Troubleshooting section. The codes are in octal (0 through 7). Also, codes having identical numbers are not used (for example, 66, 77, etc.)

NOTE:

Since STATUS has one digit, the two-number code is implemented by flashing the most significant digit, the least significant digit, and then blanking the display for one second. This cycle is repeated until ended with TEST.

7.6.2. HyperDiagnostics

This section identifies the controls and indicators used with HyperDiagnostics, outlines the test sequence, and describes the tests.
7.6.2.1. Controls and Indicators

The DSD 890 System provides a series of tests known as Hyper-Diagnostics. These tests are controlled from the Operator panel (see Figure 7-2):

---

CAUTION:

Tests one, four, and five destroy data contained on the device under test. Winchester formatting and bad-track information, however, is preserved.

---

<table>
<thead>
<tr>
<th>Number</th>
<th>WP0</th>
<th>WP1</th>
<th>WP2</th>
<th>Test</th>
<th>Minutes/Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>Re-enter Wait Mode</td>
<td>--</td>
</tr>
<tr>
<td>1</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>Disk Write/Read</td>
<td>7.5</td>
</tr>
<tr>
<td>2</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>Display Firmware Version</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>Disk Read-Only</td>
<td>2.0</td>
</tr>
<tr>
<td>4</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>Tape Write/Read</td>
<td>10.0</td>
</tr>
<tr>
<td>5</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>Tape and Disk Write/Read</td>
<td>10.0</td>
</tr>
<tr>
<td>6</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>Re-enter Wait Mode</td>
<td>--</td>
</tr>
<tr>
<td>7</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>Display Last Error Code</td>
<td>--</td>
</tr>
</tbody>
</table>

---

7.6.2.2. Description

After a CPU power-up or after a bus initialization, the system enters a "wait" mode. In this mode, STATUS displays a steady zero.

In wait, either CPU or user can gain system control. If the host issues a command, STATUS "blanks" (goes dark) and the system enters emulation mode, disabling TEST.
Control/Indicator | Function
--- | ---
STATUS LED | • Lights when system is ready to enter HyperDiagnostics.  
• Displays test number and test results.
TEST Pushbutton: | • Initiates or cancels any test.
WP0 through WP2 Switches | • Operate as three-digit binary switch.  
• Select up to eight (0 through 7) decimal numbers. For example, when all are ON (up), number "seven" is selected. See Table 7-1.

Figure 7-2. HyperDiagnostics Controls and Indicators

To select a test, the user sets the write-protect switches to the test number combination and presses TEST. STATUS counts down from nine to zero, and displays the test number. The test can be canceled by pressing TEST, or confirmed by setting the switches down and pressing TEST.
Once started, a test runs until canceled with TEST or until an error is found. If canceled, the system re-enters the wait mode.

If an error is found, FAULT lights and STATUS displays an error code. Error codes are listed in the Troubleshooting section (Section 7.7).

The eight possible combinations of the write-protect switches, during test selection, are listed below.

**ZERO:**

This is not a test. It allows the user to re-enter the wait mode.

**ONE:**

This is a disk write/read test. It writes, checks, and reads a test pattern, which contains a sector address, an incrementing data (pass) byte, and an incrementing pattern. This test takes 7.5 minutes for a complete pass.

Test one begins at cylinder 0, head 6 and continues to cylinder 777, head 7 (octal). At that time a POC is done and the test repeats. If an error is found, the bad-track map file is checked to verify if the error occurred on a mapped track. This type of error is ignored. If the error did not occur on a mapped track, the sequence is retried before displaying a fatal error code.

---

**CAUTION:**

During test one, data stored on the disk is destroyed. Bad-track information, mapped on heads 0 through 5 of cylinder 4 are untouched.

---

**TWO:**

This combination displays the system firmware version code.
THREE:

This is a disk read-only test. It operates on the same sector range as test one. Test three checks for headers-not-found and ECC errors. Error correction is suppressed during retries to avoid masking media defects. Disk data is not affected by this test. This test takes 2 minutes for a complete pass.

FOUR:

This is a tape write/read test. It verifies tape function by performing the sequence below. This test takes 10 minutes for a complete pass.

1. Issues tape rewind command and verifies cartridge is at beginning of tape (BOT)

2. Switches drive to track two, writes one record, and rewinds

3. Writes incrementing data pattern on track zero. Each record is between 4000 bytes and 4255 bytes - depending on record number

4. Writes one record in track one

5. Switches to track three, writes one record, and one file mark

6. Reads all tracks and verifies data pattern previously written

7. Verifies space record, forward and backwards, over file mark

8. Verifies skip file mark, forwards and backwards, over file mark

During test four, a maximum of nine re-tries per record are allowed for correctable tape errors. For non-correctable errors, one re-try per pass is attempted.
CAUTION:

During test four, all data stored on the tape is destroyed.

FIVE:

This is both a tape and a disk write/read test. It does, simultaneously, the same checks as one and four. The displayed error code, if any, is assigned to the first device detecting an unrecoverable error. This test takes 10 minutes for a complete pass.

CAUTION:

During test five, data stored on both devices is destroyed. Winchester formatting and bad-track information remains untouched.

SIX:

This is not a test. This combination, when confirmed, allows the user to re-enter the wait mode.

SEVEN:

This is not a test. This combination displays the contents of an error-save location that contains the last system error code. This location is cleared only at Controller power-up and it is retained across bus initializations.

If no error code occurred since the last power-up, a flashing zero is displayed. Some RT-11 systems may display code 23 (invalid word count). This is a normal code stored during the computer bootstrapping operation. Operating systems may cause other software-related error codes.
7.6.2.3. Operation

The Hyperdiagnostics sequence of operation is shown in Figure 7-3. This procedure exemplifies the most significant steps.

(1) Apply subsystem power and observe STATUS. It should display zero. If not, halt CPU and operate Reset (Restart) switch.

(2) Select test number from Table 7-1.

(3) Set write-protect switches to test number.

(4) Press TEST and observe STATUS. It counts down from 9 to 0 and then displays test number.

(5) Reset switches to OFF and press TEST to confirm. While test is running, STATUS displays test number.

(6) Wait for test to complete desired number of test cycles.

(7) If test fails, FAULT lights and STATUS displays error code.

(8) To end test, press TEST. The system returns to wait mode, ready for next test.

7.7. Troubleshooting

This section provides a methodic diagnostic technique for troubleshooting your equipment. Before using this technique perform the following preliminary checks:

- Observe the Status panel to verify that the cabinet is on. If not, ensure the power switch is on, and the fuse is not blown.

- Observe the front panel for obvious mistakes. For example, trying to write a write-protected disk volume or cartridge tape.

- Check system ventilation.

- Ensure that all cables between the cabinet and the Controller board are properly mated.
Figure 7-3. HyperDiagnósticos Procedure

*See Troubleshooting Section

(Firmware Error Codes)
After the routine checks are completed, proceed to Figure 7-4. This figure contains a main flowchart that will lead you to other figures or tables.

While troubleshooting, it is essential to follow the exact sequence provided by the flowcharts - correct interpretation of each test depends on the results obtained from previous ones.

The complete set of troubleshooting figures and tables is listed below:

- Figure 7-4. Main Troubleshooting Path.
- Figure 7-5. POC Failure
- Figure 7-6. Bootstrapping Failure.
- Table 7-2. HyperDiagnostics Error Codes.
- Table 7-3. Software Diagnostic Procedures.
- Table 7-4. POC Error Codes.
- Table 7-5. Bootstrap Error Codes.

In addition, Table 7-6 provides a summary of all codes that can be displayed by the STATUS LED.

Figure 7-4. Main Troubleshooting Path.
Figure 7-5. POC Failure
Figure 7-6. Bootstrapping Failure.
Figure 7-4. Main Troubleshooting Path.
Figure 7-5. POC Failure
Start

CPU Halts?

Yes

At Boot Address +2?

Yes

Low Memory Address
Halt is Due to Fatal
Error Code

Enter R0/from
System Console

Go to Table 7-5
(Bootstrap Error
Codes) and Return
Here

Trouble Isolated?

Yes

No

End

If CPU Hangs During
Booting Most Probable
Cause is Controller
Board

Probable Causes:
1. Controller Board
2. Adapter Board

Register 1 (R1)
Contains Boot
Program Revision
Level
Register 2 (R2)
Contains Controller
Firmware Revision
Level

Call DSD
Customer
Service

Figure 7-6. Bootstrapping Failure.
<table>
<thead>
<tr>
<th>ERROR CODE</th>
<th>MEANING</th>
<th>PROBABLE CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Disk Drive Home Error. No track 0, and/or seek complete, and/or drive ready.</td>
<td>1. Head lock not removed during installation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty Winchester drive.</td>
</tr>
<tr>
<td>06</td>
<td>Timeout waiting for seek complete from disk during seek operation.</td>
<td>1. Head lock not removed during installation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty Winchester drive.</td>
</tr>
<tr>
<td>07</td>
<td>Desired disk header not found during read/write, or write check operation.</td>
<td>1. Winchester disk needs reformatting. See note 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8240 controller.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>10</td>
<td>Disk write protect violation.</td>
<td>1. Attempt to write while disk volume was write protected. Check the write protect switches.</td>
</tr>
<tr>
<td>14</td>
<td>Disk header CRC error detected during header search; rest of header appeared correct.</td>
<td>1. Winchester disk needs reformatting. See note 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8240 controller.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>15</td>
<td>Disk seek error. 'Head selection error, or head on wrong cylinder.</td>
<td>1. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8240 controller.</td>
</tr>
<tr>
<td>17</td>
<td>Unable to find disk data field address mark during read or write check operation.</td>
<td>1. Corrupted data field, can usually be corrected by rewriting the data. See note 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8240 controller.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>20</td>
<td>Disk data field ECC error. Note: Error correction is not attempted during POC or HyperDiagnostics.</td>
<td>1. Corrupted data field, can usually be corrected by rewriting the data. See note 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8240 controller.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>ERROR CODE</td>
<td>MEANING</td>
<td>PROBABLE CAUSE</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------------------------------------------------------------</td>
<td>----------------------------------------------------</td>
</tr>
<tr>
<td>21</td>
<td>Write fault error reported by disk drive during write operation.</td>
<td>1. Faulty 8240 controller.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>24</td>
<td>Disk read/write controller failure.</td>
<td>1. Faulty 8240 controller.</td>
</tr>
<tr>
<td>30</td>
<td>Data compare error during disk write check operation.</td>
<td>1. Faulty 8240 controller.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>31</td>
<td>Invalid disk bad-track map.</td>
<td>1. Rewrite bad-track map using GENEXR diagnostic program.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8240 controller.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>36</td>
<td>Disk drive not ready.</td>
<td>1. Head lock not removed during installation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>41</td>
<td>Disk timer failure.</td>
<td>1. Faulty 8240 controller.</td>
</tr>
<tr>
<td>45</td>
<td>Invalid data field ID byte found in disk data field during read or write check operation.</td>
<td>1. Corrupted or missing data field, can usually be corrected by rewriting the data. See note 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8240 controller.</td>
</tr>
<tr>
<td>90</td>
<td>Tape data read did not match data written during HyperDiagnostics.</td>
<td>1. Faulty tape drive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8240 controller.</td>
</tr>
<tr>
<td>91</td>
<td>Tape timer failure.</td>
<td>1. Faulty 8240 controller.</td>
</tr>
<tr>
<td>92</td>
<td>Tape write file mark failure during HyperDiagnostics.</td>
<td>1. Faulty tape drive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8240 controller.</td>
</tr>
<tr>
<td>93</td>
<td>No tape cartridge or can't find BOT during rewind operation.</td>
<td>1. No tape installed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty tape drive.</td>
</tr>
<tr>
<td>94</td>
<td>Tape space record or file mark error (forward or backward) during HyperDiagnostics.</td>
<td>1. Faulty tape drive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8240 controller.</td>
</tr>
<tr>
<td>ERROR CODE</td>
<td>MEANING</td>
<td>PROBABLE CAUSE</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------------------------</td>
<td>----------------------------------------------------</td>
</tr>
<tr>
<td>95</td>
<td>Unable to detect tape FIFO data overflow.</td>
<td>1. Faulty 8240 controller</td>
</tr>
<tr>
<td>96</td>
<td>Tape read/write error during HyperDiagnostics.</td>
<td>1. Tape cartridge write protected.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Worn-out tape cartridge.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Dirty tape head.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Faulty tape drive.</td>
</tr>
<tr>
<td>97</td>
<td>Tape interface test failure.</td>
<td>1. No power to tape drive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Tape cable incorrectly installed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Faulty tape drive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Tape cartridge removed during initialization.</td>
</tr>
</tbody>
</table>

Notes: 1. The probable cause portion of this table applies only to error codes reported during HyperDiagnostics. Probable causes are listed in decreasing order of probability.

2. In case of recurring disk errors, use the GEMEXR diagnostic program to locate the flaw and add to the bad-track map.

3. CAUTION: HyperDiagnostics may overwrite data stored on the disk and/or tape.
<table>
<thead>
<tr>
<th>FAULT SYMPTOM</th>
<th>STEP</th>
<th>DIAGNOSTIC AND CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure A.</td>
<td>1.</td>
<td>Load RLEXR Diagnostic Program.</td>
</tr>
<tr>
<td>Any disk subsystem problem suspected. This procedure is also used for acceptance testing.</td>
<td>2.</td>
<td>Use the short acceptance test to verify all three emulated RL-02 volumes. Test should be allowed to run at least two hours, or until errors are reported.</td>
</tr>
<tr>
<td>CAUTION: this procedure will destroy data stored on the disk.</td>
<td>3.</td>
<td>Go to Procedure B. If read/write errors, header CRC errors, data compare errors, write check errors, or header not found errors are being reported. These errors indicate problems reading or writing disk data.</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>The 8240 controller is the most likely cause of failure if no bus response errors, no interrupt errors, time out errors or ac power low errors are being reported.</td>
</tr>
<tr>
<td>Fault Symptom</td>
<td>Step</td>
<td>Diagnostic and Corrective Action</td>
</tr>
<tr>
<td>---------------</td>
<td>------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Procedure B.</td>
<td>1.</td>
<td>Load GEMEXR Diagnostic Program.</td>
</tr>
<tr>
<td>HyperDiagnosics, operational software or RLEXR diagnostic report disk write or read errors.</td>
<td>2.</td>
<td>Use BADTRK command and PRINT subcommand to list contents of bad-track map. Compare to form inside DS-330 module. If there are differences, or if the message INVALID BAD TRACK MAP is reported, rewrite the bad-track map using CREATE subcommand under BADTRK. Note: It is important that the map on the disk match the form in the drive module.</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>Use VERIFY command and WRTREAD subcommand to test disk over all heads and cylinders 1 through 777 for at least ten passes.</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>Carefully examine any errors reported during the WRTREAD tests, noting especially whether errors seem to repeat for given cylinder and head numbers, or are randomly scattered over the disk surface. If header not found errors are being reported, cylinders 1 through 777 should be reformatted. Then rerun the WRTREAD test.</td>
</tr>
</tbody>
</table>
Table 7-3 Software Diagnostic Procedures (continued)

<table>
<thead>
<tr>
<th>FAULT SYMPTOM</th>
<th>STEP</th>
<th>DIAGNOSTIC AND CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure C</td>
<td>1.</td>
<td>First run the tests in Procedure A.</td>
</tr>
<tr>
<td>Any problem suspected with the Tape Subsystem.</td>
<td>2.</td>
<td>Note: The following steps will destroy any data recorded on the tape. If it is important to save data, first try to copy tape to an unused area of the disk, using the normal operating system.</td>
</tr>
<tr>
<td>CAUTION: this procedure will destroy data recorded on the tape cartridge. Use a scratch tape.</td>
<td>3.</td>
<td>Load TSEXR Diagnostic Program.</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>Install scratch tape in the tape drive.</td>
</tr>
<tr>
<td>FAULT SYMPTOM</td>
<td>STEP</td>
<td>DIAGNOSTIC AND CORRECTIVE ACTION</td>
</tr>
<tr>
<td>----------------</td>
<td>-----</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>5. Use ACCEPT command to test basic tape read and write functions. This test does not check the entire tape (see Procedure D).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A few recoverable errors (TCC4 or TCC5) will not usually cause problems in normal use. If many recoverable errors are reported, clean the tape head and repeat the test. If errors persist, the tape cartridge should be replaced. If errors still persist, the tape drive should be replaced.

If function reject (TCC3) errors occur, check that tape cartridge is properly installed, is at the load point, and is not write protected.

If repeated unrecoverable (TCC6) or fatal (TCC7) errors, most likely cause is tape drive. Next most likely cause is 8240 Controller.

If tape bus parity errors are being reported, most likely cause is 40-pin tape cable. Next most likely cause is 8240 controller or tape drive.
### Table 7-3 Software Diagnostic Procedures (continued)

<table>
<thead>
<tr>
<th>FAULT SYMPTOM</th>
<th>STEP</th>
<th>DIAGNOSTIC AND CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure D.</td>
<td>1.</td>
<td>Note: The following steps will destroy any data recorded on the tape. If it is important to save data, first try to copy tape to an unused area of the disk, using the normal operating system.</td>
</tr>
<tr>
<td>Problems suspected with a specific tape cartridge.</td>
<td>2.</td>
<td>Load TSEXR Diagnostic Program.</td>
</tr>
<tr>
<td>CAUTION: this procedure will destroy data recorded on the tape cartridge.</td>
<td>3.</td>
<td>Install tape to be tested in the tape drive.</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>Use ACCEPT command to test basic tape read and write functions. This test does not check the entire tape. Go to step 6 if any errors are reported.</td>
</tr>
<tr>
<td></td>
<td>5.</td>
<td>Use the MEDIA command to test the tape cartridge.</td>
</tr>
<tr>
<td></td>
<td>6.</td>
<td>Carefully examine any errors reported during steps 4 or 5. A few recoverable errors (TCC4 or TCC5) will not usually cause problems in normal use. If many recoverable errors are reported, clean the tape head and repeat the test. If errors persist, the tape cartridge should be replaced.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If function reject (TCC3) errors occur, check that tape cartridge is properly installed, is at the lead point, and is not write protected.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If unrecoverable errors (TCC6) occur, the tape cartridge should be replaced.</td>
</tr>
<tr>
<td>ERROR CODE</td>
<td>MEANING</td>
<td>PROBABLE CAUSE (POC TESTS)</td>
</tr>
<tr>
<td>-----------</td>
<td>---------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>01</td>
<td>Disk drive home error. No track 0, and/or seek complete, and/or drive ready.</td>
<td>1. Head lock not removed during installation 2. Faulty Winchester drive.</td>
</tr>
<tr>
<td>06</td>
<td>Timeout waiting for seek complete from disk during seek operation.</td>
<td>1. Head lock not removed during installation. 2. Faulty Winchester drive.</td>
</tr>
<tr>
<td>07</td>
<td>Desired disk header not found during read, write, or write check operation.</td>
<td>1. Winchester disk needs re-formatting. See note 2. 2. Faulty Winchester disk drive. 3. Faulty 8240 controller.</td>
</tr>
<tr>
<td>14</td>
<td>Disk header CRC error detected during header search; rest of header appeared correct.</td>
<td>1. Winchester disk needs re-formatting. See note 2. 2. Faulty Winchester disk drive. 3. Faulty 8240 controller.</td>
</tr>
<tr>
<td>15</td>
<td>Disk seek error. Head Selection error or head on wrong cylinder.</td>
<td>1. Faulty Winchester disk drive. 2. Faulty 8240 controller.</td>
</tr>
<tr>
<td>17</td>
<td>Unable to find disk data field address mark during read or write check operation.</td>
<td>1. Cylinder 0 of Winchester disk needs re-formatting; bad-track map must be re-written. See note 2. 2. Faulty Winchester disk drive. 3. Faulty 8240 controller.</td>
</tr>
<tr>
<td>20</td>
<td>Disk data field ECC error.</td>
<td>1. Cylinder 0 of Winchester disk needs re-formatting; bad-track map must be re-written. See note 2. 2. Faulty Winchester disk drive 3. Faulty 8240 controller.</td>
</tr>
<tr>
<td>21</td>
<td>Write fault error reported by disk drive during write operation.</td>
<td>1. Faulty 8240 controller. 2. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>24</td>
<td>Disk read/write controller failure.</td>
<td>1. Faulty 8240 controller.</td>
</tr>
<tr>
<td>ERROR CODES</td>
<td>MEANING</td>
<td>PROBABLE CAUSE (POC TESTS)</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>30</td>
<td>Data compare error during disk write check operation.</td>
<td>1. Faulty 8249 controller. 2. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>31</td>
<td>Invalid disk bad-track map.</td>
<td>1. Rewrite bad-track map using GEMEXR diagnostic program.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8249 controller. 3. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>36</td>
<td>Disk drive not ready.</td>
<td>1. Head lock not removed during installation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty Winchester disk drive.</td>
</tr>
<tr>
<td>41</td>
<td>Disk timer failure.</td>
<td>1. Faulty 8249 controller.</td>
</tr>
<tr>
<td>45</td>
<td>Invalid data field ID byte found in disk data field during read or write check operation.</td>
<td>1. Cylinder 0 of Winchester disk needs re-formatting; bad-track map must be re-written. See note 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty Winchester drive. 3. Faulty 8249 controller.</td>
</tr>
<tr>
<td>50</td>
<td>Scratch RAM failure during POC.</td>
<td>1. Faulty 8249 controller.</td>
</tr>
<tr>
<td>51</td>
<td>Buffer RAM failure during POC.</td>
<td>1. Faulty 8249 controller.</td>
</tr>
<tr>
<td>52</td>
<td>QBC gate array failure during POC.</td>
<td>1. Faulty 8249 controller.</td>
</tr>
<tr>
<td>53</td>
<td>Error reading drive data simulator during POC.</td>
<td>1. 20-pin Winchester data cable problem.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Faulty 8249 controller. 3. Faulty adapter board.</td>
</tr>
<tr>
<td>54</td>
<td>ECC circuitry failure during POC.</td>
<td>1. Faulty 8249 controller. 2. Faulty adapter board.</td>
</tr>
<tr>
<td>91</td>
<td>Tape timer failure.</td>
<td>1. Faulty 8249 controller.</td>
</tr>
</tbody>
</table>
Table 7-4 POC Error Codes (continued)

<table>
<thead>
<tr>
<th>ERROR CODE</th>
<th>MEANING</th>
<th>PROBABLE CAUSE (POC TESTS ONLY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>Unable to detect tape FIFO data overflow.</td>
<td>1. Faulty 8240 controller.</td>
</tr>
<tr>
<td>97</td>
<td>Tape interface test failure.</td>
<td>1. No power to tape drive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Tape cable incorrectly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>installed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Faulty tape drive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Tape cartridge removed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>during initialization.</td>
</tr>
</tbody>
</table>

Notes: 1. The probable cause portion of this table applies only to error codes reported during the power-on confidence (POC) tests, which run when power is first applied to the 8240 controller. Probable causes are listed in decreasing order of probability.

2. POC tests operate only on Cylinder 0 of the Winchester disk. Errors on this cylinder require reformatting Cylinder 0 and rewriting the bad-track map, using the GEMEXR program.
Table 7-5  Bootstrap Error Codes

<table>
<thead>
<tr>
<th>BOOT ERROR CODE IN R0</th>
<th>MEANING</th>
<th>PROBABLE CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>000001</td>
<td>Memory test error. Address is in register R3.</td>
<td>1. Faulty system memory.</td>
</tr>
<tr>
<td>000002</td>
<td>No response from designated disk I/O register. Address is in register R3.</td>
<td>1. 8240 incorrectly jumpered. 2. Faulty 8240 controller.</td>
</tr>
<tr>
<td>000003</td>
<td>No response from designated tape I/O register. Address is in register R3.</td>
<td>1. 8240 incorrectly jumpered. 2. Faulty 8240 controller.</td>
</tr>
<tr>
<td>000004</td>
<td>No response from designated floppy I/O register. Address is in register R3.</td>
<td>1. Floppy controller not present or incorrectly jumpered.</td>
</tr>
<tr>
<td>000005</td>
<td>Winchester disk read/write test error.</td>
<td>1. Faulty Winchester disk drive. 2. Faulty 8240 controller.</td>
</tr>
<tr>
<td>000006</td>
<td>Error reading boot block from designated boot device.</td>
<td>1. Boot device (Winchester, tape, or floppy) is faulty. 2. Faulty drive. 3. Faulty 8240 controller.</td>
</tr>
<tr>
<td>000007</td>
<td>Invalid boot block read from designated boot device.</td>
<td>1. No boot on volume.</td>
</tr>
</tbody>
</table>

Notes: 1. Probable causes are listed in decreasing order of probability. 2. These codes appear in CPU register R0 after a bootstrap error halt.
<table>
<thead>
<tr>
<th>ERROR CODE</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>No error.</td>
</tr>
<tr>
<td>01</td>
<td>Disk drive home error. No track 0 and/or seek complete, and/or drive ready during home operation.</td>
</tr>
<tr>
<td>02</td>
<td>Non-existent logical drive (DL3) selected by software.</td>
</tr>
<tr>
<td>06</td>
<td>Timeout waiting for seek complete from disk during seek operation.</td>
</tr>
<tr>
<td>07</td>
<td>Desired disk header not found during read, write, or write check operation.</td>
</tr>
<tr>
<td>10</td>
<td>Disk write protect violation.</td>
</tr>
<tr>
<td>14</td>
<td>Disk header CRC error detected during header search; rest of header appeared correct.</td>
</tr>
<tr>
<td>15</td>
<td>Disk seek error. Head selection error or head on wrong cylinder.</td>
</tr>
<tr>
<td>17</td>
<td>Unable to find disk data field address mark during read or write check operation.</td>
</tr>
<tr>
<td>20</td>
<td>Disk data field ECC error.</td>
</tr>
<tr>
<td>21</td>
<td>Write fault error reported by disk drive during write operation.</td>
</tr>
<tr>
<td>23</td>
<td>Invalid disk word count specified by software.</td>
</tr>
<tr>
<td>24</td>
<td>Disk read/write controller failure.</td>
</tr>
<tr>
<td>25</td>
<td>Invalid format keyword issued by software during format operation.</td>
</tr>
<tr>
<td>26</td>
<td>Data late condition during disk format operation.</td>
</tr>
<tr>
<td>27</td>
<td>GAP 4 timeout failure during disk format operation.</td>
</tr>
<tr>
<td>30</td>
<td>Data compare error during disk write check operation.</td>
</tr>
<tr>
<td>ERROR CODE</td>
<td>MEANING</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>31</td>
<td>Invalid bad-track map. Read check sum or keyword error.</td>
</tr>
<tr>
<td>35</td>
<td>Non-existent memory found during disk or tape DMA.</td>
</tr>
<tr>
<td>36</td>
<td>Disk drive not ready.</td>
</tr>
<tr>
<td>40</td>
<td>Bootstrap (drive data simulator) read error.</td>
</tr>
<tr>
<td>41</td>
<td>Disk timer failure.</td>
</tr>
<tr>
<td>43</td>
<td>Invalid disk RLDAR value loaded by software.</td>
</tr>
<tr>
<td>45</td>
<td>Invalid ID byte found in disk data field during read or write check operation.</td>
</tr>
<tr>
<td>50</td>
<td>Scratch RAM failure during POC.</td>
</tr>
<tr>
<td>51</td>
<td>Buffer RAM failure during POC.</td>
</tr>
<tr>
<td>52</td>
<td>QBC gate-array failure during POC.</td>
</tr>
<tr>
<td>53</td>
<td>Error reading drive data simulator during POC.</td>
</tr>
<tr>
<td>54</td>
<td>ECC circuitry failure during POC.</td>
</tr>
<tr>
<td>80</td>
<td>Tape termination code 0 (normal)</td>
</tr>
<tr>
<td>81</td>
<td>Tape termination code 1 (attention)</td>
</tr>
<tr>
<td>82</td>
<td>Tape termination code 2 (status alert)</td>
</tr>
<tr>
<td>83</td>
<td>Tape termination code 3 (function reject)</td>
</tr>
<tr>
<td>84</td>
<td>Tape termination code 4 (recoverable error)</td>
</tr>
<tr>
<td>85</td>
<td>Tape termination code 5 (recoverable error)</td>
</tr>
<tr>
<td>86</td>
<td>Tape termination code 6 (non-recoverable error)</td>
</tr>
<tr>
<td>87</td>
<td>Tape termination code 7 (fatal error)</td>
</tr>
<tr>
<td>ERROR CODE</td>
<td>MEANING</td>
</tr>
<tr>
<td>------------</td>
<td>---------</td>
</tr>
<tr>
<td>90</td>
<td>Tape data read did not match data written during HyperDiagnostics.</td>
</tr>
<tr>
<td>91</td>
<td>Tape timer failure.</td>
</tr>
<tr>
<td>92</td>
<td>Tape write file mark failure during HyperDiagnostics.</td>
</tr>
<tr>
<td>93</td>
<td>No tape cartridge or can't find BOT during rewind operation.</td>
</tr>
<tr>
<td>94</td>
<td>Tape space record or file mark error (forward or backward) during HyperDiagnostics.</td>
</tr>
<tr>
<td>95</td>
<td>Unable to detect tape FIFO data overflow during HyperDiagnostics.</td>
</tr>
<tr>
<td>96</td>
<td>Tape read/write error during HyperDiagnostics.</td>
</tr>
<tr>
<td>97</td>
<td>Tape interface test failure.</td>
</tr>
</tbody>
</table>

**Note:** This table gives a summary of all error and status codes which may be displayed on the HyperDiagnostic panel status display.
7.8. Replacement Procedures

The following modules (or boards) can be replaced by the field technician after obtaining DSD Customer Service approval:

- Controller Interface (8240) Board
- Winchester Drive Module
- Magnetic Tape Drive Module
- Power Supply Module
- Fan Module
- Diagnostic Control Board
- Display Control Board

Before replacing a module follow the instructions provided in the next subsection, then go to the actual replacement procedures.

7.8.1. Preparation

Before replacing any of the modules previously listed, follow these instructions:

1. Remove power from system cabinet and controller interface board and disconnect system cables. If the 8240 board is at fault, return it to the factory as instructed by Customer Service. If the faulty module is inside the cabinet, proceed with the next step.

2. Snap off front bezel and remove rack retaining screws.

3. Gently, remove cabinet from rack. Abrupt movements may damage the Winchester drive assembly. Set cabinet on side.

4. Lock head mechanism by rotating actuator lock (clockwise) to LOCK.

5. Remove spindle lock access panel.

6. Loosen 11/32" hex nut on spindle locking clip and position clip over pulley. Ensure that pulley is locked and tighten nut.
(7) Replace spindle lock access panel.

(8) Set cabinet in a normal upright position and remove top cover.

(9) Reapply power to the cabinet.

(10) Refer to power distribution diagram shown in Figure 7-7 and use a digital multimeter to ensure suspected module is receiving proper DC voltage levels. If not, remove power and check internal cabling for electrical continuity.

(11) If voltage levels are correct, remove power from cabinet and refer to next subsection.

7.8.2. Replacing Modules

When replacing any module or internal board follow these steps:

(1) Complete preparation instructions previously provided.

(2) Inside cabinet, disconnect ac, dc, and other internal cables.

(3) Refer to Figure 7-8 and identify screws holding faulty unit.

(4) Remove retaining screws and faulty unit.

(5) Remove replacement unit from box and re-install.

(6) Carefully pack faulty unit using material shipped with replacement unit. INCLUDE RETURN AUTHORIZATION NUMBER ON BOX.

(7) Refer to Chapter 4, Installation. Beginning with "Mechanical Preparations", follow installation procedures provided in that chapter until you have completed "Acceptance Tests".

7-34
Figure 7-8. Cabinet Exploded View
7.9. Maintenance Assistance

Data Systems Design maintains a fully staffed Customer Service Department. If at any time during inspection, installation, or operation of the equipment you encounter a problem, contact your nearest DSD Customer Service office.

Our trained staff can help you diagnose the cause of failure, and if necessary, rush replacement parts to you. Any time you need to return a product to the factory, please contact Customer Service for a Material return Authorization Number.

Customer Service offices in the United States are listed below. For service outside the U.S.A., contact your local distributor.

<table>
<thead>
<tr>
<th>Region</th>
<th>Address</th>
<th>Phone</th>
<th>TWX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Region Service</td>
<td>2241 Lundy Avenue</td>
<td>(408) 946-5800</td>
<td>910-338-0249</td>
</tr>
<tr>
<td></td>
<td>San Jose, CA 95131</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(312) 920-0444</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Central Region</td>
<td>51 Morgan Drive</td>
<td>(617) 769-7620</td>
<td>710-336-0120</td>
</tr>
<tr>
<td></td>
<td>Norwood, MA 02062</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Region</td>
<td>5050 Quorum Drive</td>
<td>(214) 980-4884</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dallas, TX 75240</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern Region</td>
<td>51 Morgan Drive</td>
<td>(617) 769-7620</td>
<td>710-336-0120</td>
</tr>
<tr>
<td></td>
<td>Norwood, MA 02062</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX A: GEMEXR UTILITY PROGRAM

1.1. INTRODUCTION

All DSD subsystems are shipped with a tape cartridge containing an interactive program called GEMEXR. This manual explains the operation of this comprehensive media management utility program, and assumes that the user is familiar with DSD subsystem operations and technology.

GEMEXR is a general media management utility program designed for the DSD Winchester disk drive. Routines are provided for format initialization, media flaw management, and for verification of media integrity. GEMEXR runs as a standalone program, with bootstrap.

1.2. PROGRAM LOADING

GEMEXR requires a standard console device, an LSI-II computer, and at least 24K words of memory. Loading GEMEXR can be accomplished either from an RT-II compatible operating system, or from the monitor provided on the DSD distribution media. To run GEMEXR from an RT-II system, issue the command:

```
RU <DEV:>GEMEXR <CR>
```

On a system running other operating systems, the distribution media (tape cartridge) must be bootstrapped into memory. When the program is in memory, the following will appear on the screen:

```
DSD TAPE MONITOR V3A
TMON>
```

to run the GEMEXR program, type:

```
R GEMEXR <CR>
```

When GEMEXR is in memory, the program title and main command menu will be displayed on the console device. If more than one RL compatible device is in the system configuration, the user will be prompted to select one device for GEMEXR functions. GEMEXR uses direct access mode so only DSD devices can be selected.
1.3. PROGRAM EXIT

There is one command and two control keys that may be used to exit GEMEXR, and these are detailed in Tables 1 and 2. At the main command level, issuing a "QUIT" command will cause an exit from GEMEXR. During program execution; a "CTRL-C" will terminate the program and exit from GEMEXR, a "CTRL-R" will also stop the execution of a command, but will return to the command menu within GEMEXR.

1.4. PROGRAM COMMANDS

Table 1, GEMEXR Commands, lists all the main commands and subcommands available with the program. GEMEXR also recognizes various control inputs, and these are listed in Table 2.

Table 1. GEMEXR Commands.

<table>
<thead>
<tr>
<th>Commands</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUIT</td>
<td>Exit from GEMEXR</td>
</tr>
<tr>
<td>FORMAT</td>
<td>Formats DSD Winchester disk</td>
</tr>
<tr>
<td>RLFMT</td>
<td>Formats individual RL volumes</td>
</tr>
<tr>
<td>BADTRK</td>
<td>Flaw management for Winchester disk. A DSD bad track file is required on Winchester for proper operation.</td>
</tr>
</tbody>
</table>

Sub-Commands:

<table>
<thead>
<tr>
<th>Commands</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXIT</td>
<td>Exit from badtrack routines</td>
</tr>
<tr>
<td>CREATE</td>
<td>Allows creation of bad track file on the Winchester. This command should be issued each time cylinder zero of the Winchester is formatted or otherwise written. If the Winchester has bad tracks, as indicated by the factory bad sector list, answer &quot;Y&quot; to the prompt &quot;INSERT BAD TRACKS [Y/N]:&quot;, and enter the bad tracks. A carriage return &lt;CR&gt; alone on any input line, ends the input. If there is an error in the bad track input, answer &quot;Y&quot; to the prompt, &quot;EDIT BAD TRACK FILE [Y/N]:&quot;. Every time a new DSD bad track file is written to the disk, The RL Bad Sectors file is automatically written.</td>
</tr>
</tbody>
</table>
EDIT

Allows modification of the existing bad track file. Tracks may be added or deleted and the bad track list printed during the editing session. ANY CHANGES TO THE BAD TRACK FILE WILL CAUSE THE LOSS OF INFORMATION ON DISK SUBSEQUENT TO TRACK CHANGE.

INCLUDE

Takes the list of tracks flagged as bad from verification tests performed in the current GEMEXR session, and permanently adds them to the DSD bad track file. To examine this list, issue the "STAT" sub-command in the "VERIFY" command menu.

PRINT

Prints the DSD bad track file to the console device.

XFORM

Transforms emulated RL disk addresses to an actual Winchester cylinder, head, and sector

RLBAD

Writes DEC compatible RL bad sectors file to each RL volume. Since internal DSD bad track mapping presents an apparent flaw free drive to the operating system, this file will have no bad sector entries but it MUST be present.

VERIFY

verifies integrity of the Winchester media.

Sub-commands: NOTE: All verify sub-commands allow the selection of a range of tracks and a number of passes, after the sub-command is issued.

EXIT

Returns to main menu.

WRITE

Writes a pattern to all tracks within the selected range.

READ

Reads all tracks within the selected range and compares with the desired pattern. A "WRITE" command MUST have been previously issued.

WRTREAD

Does a "WRITE" followed by a "READ" over the selected range.

SCAN

Reads every track in the selected range to verify header information.
<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCEPT</td>
<td>Performs a &quot;WRTREAD&quot; followed by a &quot;SCAN&quot;.</td>
</tr>
<tr>
<td>STAT</td>
<td>Reports the status of verification tests. Prints the number of reads, writes, and errors, followed by list of tracks (if any) flagged as bad by verification tests.</td>
</tr>
<tr>
<td>DUMP</td>
<td>Dumps contents of individual Winchester sectors to the console. User selects either word, or byte dump, and the absolute starting cylinder, head, and sector. The prompt, &quot;EXIT DUMP? [Y/N]&quot; appears after each sector is displayed. An affirmative answer will return to the VERIFY menu, otherwise the next sequential sector will be displayed.</td>
</tr>
<tr>
<td>CHAR</td>
<td>Sets certain program operation characteristics. An affirmative answer to the prompt &quot;SKIP BAD TRACKS [Y/N]&quot; allows the following tests to ignore tracks already in the DSD bad track file.</td>
</tr>
<tr>
<td>CONFIG</td>
<td>Displays the status of the control panel switches and certain 8240 controller jumpers.</td>
</tr>
<tr>
<td>H</td>
<td>The H (help) command lists program version number, device addresses, interrupt vectors, and command menu. Also lists current value of parameters set up in the &quot;CHAR&quot; command.</td>
</tr>
</tbody>
</table>

**Table 2. Control Key Functions.**

<table>
<thead>
<tr>
<th>Input</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTRL-C</td>
<td>Stops execution and returns to monitor.</td>
</tr>
<tr>
<td>CTRL-R</td>
<td>Asks &quot;ABORT OPERATION [Y/N]&quot;:. Answer &quot;Y&quot; to quit current operation and return to GEMEXR command</td>
</tr>
</tbody>
</table>
menu.

CTRL-B  Puts program in debug mode. Additional device status is displayed and execution pauses are inserted to aid in debugging. Exit debug mode by re-entering "CTRL-B". Recommended for factory use only.

CTRL-D  Lists Winchester device registers.

<LF>  Displays current Winchester cylinder and head.

1.5. ERROR MESSAGES

Table 3 contains a list of the error messages reported by the GEMEXR program and a brief description of each. If an error is detected by the program, it will attempt to complete the current operation. If successful, the program will wait until the operation is complete to print the error information. If the error is considered fatal, the operation will terminate and the error information will be displayed immediately. The error information contains the error message (see Table 3) followed by the current cylinder, current head, and the starting (first) sector for the operation.

Table 3. GEMEXR Error Messages.

Error Messages:

Spin Error:

Indicates that drive was not up to speed during current operation.

Seek Time Out Error:

A seek time out did not occur in 200 milliseconds.

Write Data Error:

Data read from disk did not compare to that originally written.

Operation Incomplete:

Current command could not be completed by the controller.
Data CRC Error:

A CRC error was detected during a data transfer.

Header CRC Error:

CRC error detected in header that otherwise appeared correct.

Header Not Found:

Correct header could not be found after approximately 550 milliseconds.

Non-Existant Memory:

During a DMA transfer, the memory location addressed did not respond within 10 microseconds.

Parity Error:

Memory parity error detected during attempt to read a memory location. Current operation is aborted.

Extended Mode Entry Error:

Command issued with other than a DSD device specified.

Status Error:

Indicates an error was detected that did not fit into the parameters for other error messages. Drive is in an unknown state. This is a default error condition, and will not normally be seen.
APPENDIX B: DSDBR UTILITY PROGRAM

1.1. INTRODUCTION

All DSD subsystems are shipped with a tape cartridge containing an interactive program called DSDBR. This manual explains the operation of this backup and restore utility program, and assumes that the user is familiar with subsystem operations and technology.

The DSD backup and restore utility program allows backup of a 10 Mbyte RL volume to TS cartridge, and restoration of an RL volume from TS cartridge.

Data transfers are image transfers and are written to tape in 5120 byte blocks. Automatic error correction is attempted when a correctable tape write or read error is detected, and the number of retries necessary to recover the record is reported to the display. A large number of correctable tape errors indicates a possible defective tape.

1.2. PROGRAM LOADING

DSDBR requires a standard console device, an LSI-11 computer, and at least 24K words of memory. Loading DSDBR can be accomplished either from an RT-11 compatible operating system, or from the monitor provided on the DSD distribution media. To run DSDBR from an RT-11 system, issue the command:

```
RU <DEV:>DSDBR <CR>
```

On a system running other operating systems, the distribution media (tape cartridge) must be bootstrapped into memory. When the program is in memory, the following will appear on the screen:

```
DSD TAPE MONITOR V3A
TMON>
```

to run the DSDBR program, type:

```
R DSDBR <CR>
```
After DSDBR is loaded into memory, the program title and main command menu will be displayed on the console device. If there is more than one RL or TS compatible device in the system configuration, the user will be prompted to select one device for DSDBR functions.

Remove the distribution tape cartridge, to prevent accidental loss of the monitor program. If a backup function is desired, load a blank, write enabled cartridge. If a restore function is desired, load a previously recorded Winchester disk image prior to issuing a restore command.

1.3. PROGRAM EXIT

There is one command and two control key inputs that may be used to exit from the DSDBR program. These are detailed in Tables 1 and 2. At the main command level, issuing a "QUIT" command will cause an exit from DSDBR. During execution of a command; a "CTRL-C" will terminate the function and exit from DSDBR, and a "CTRL-R" will also halt the execution of a command, but will return to command menu.

1.4. PROGRAM COMMANDS

Table 1 lists all the commands available in the DSDBR utility program, and Table 2 lists the control functions used with DSDBR.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>The H (help) command lists program version, current device configuration, and main command menu.</td>
</tr>
<tr>
<td>BACKUP</td>
<td>Rewinds tape, asks which unit is to be backed up, and begins backup.</td>
</tr>
<tr>
<td>VERIFY</td>
<td>After backup, checks and verifies the tape image with original disk data.</td>
</tr>
<tr>
<td>RESTORE</td>
<td>Rewinds tape, asks which unit is to be restored, and begins restoration.</td>
</tr>
<tr>
<td>BACKV</td>
<td>Performs &quot;BACKUP&quot; followed by &quot;VERIFY&quot;.</td>
</tr>
<tr>
<td>RESTV</td>
<td>Performs &quot;RESTORE&quot; followed by &quot;VERIFY&quot;.</td>
</tr>
</tbody>
</table>
Continuously runs "BACKUP" and "VERIFY".

Exit backup/restore utility program.

---

**Table 2. Control Key Functions.**

<table>
<thead>
<tr>
<th>Input</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTRL-B</td>
<td>Puts program in debug mode. Additional device status is displayed, and execution pauses are inserted to aid in debugging. Exit debug mode by re-entering &quot;CTRL-B&quot;. Recommended for factory use only.</td>
</tr>
<tr>
<td>CTRL-C</td>
<td>Abort program and return to monitor.</td>
</tr>
<tr>
<td>CTRL-D</td>
<td>Show current tape and disk control registers.</td>
</tr>
<tr>
<td>CTRL-R</td>
<td>Interrupts execution of a command and asks if the user wishes to abort operation. If answer is yes (&quot;Y&quot;), the current operation is aborted and program continues at command menu.</td>
</tr>
<tr>
<td>&lt;LF&gt;</td>
<td>Displays current operation name, and current disk position.</td>
</tr>
</tbody>
</table>

---

1.5. ERROR MESSAGES

During the execution of backup or restore functions errors may develop that will be reported by the system. The reported errors will be the same ones reported for the Winchester drive as listed in the GEMEXR program manual, or for the Tape drive as listed in the TSEXR program manual. These error listings are reproduced here in Table 3, Winchester Error Messages and Table 4, Tape Error Messages.

Table 3 contains a list of error messages related to the Winchester drive system, and a brief description of each. If an error is detected by the program, it will attempt to complete the current operation. If successful, the program will wait until the operation is completed before displaying the error information. If the error is considered fatal, the operation will terminate and the error information will be displayed immediately. The error information contains the error message, followed by the current cylinder, current head, and the first sector where the operation began.
Table 3. Winchester Drive Error Messages.

Error Messages:

Spin Error:
Indicates that drive was not up to speed during current operation.

Seek Time Out Error:
A seek time out did not occur in 200 milliseconds.

Write Data Error:
Date read from disk did not compare to that originally written.

Operation Incomplete:
Current command could not be completed by the controller.

Data CRC Error:
A CRC error was detected during a data transfer.

Header CRC Error:
CRC error detected in header that otherwise appeared normal.

Header Not Found:
Correct header could not be found after approximately 550 milliseconds.

Non-Existant Memory:
During a DMA transfer, the memory location addressed did not respond within 10 microseconds.

Parity Error:
Memory parity error detected during attempt to read a memory location. Current operation was aborted.

Extended Mode Error:
Command issued with other than a DSD device specified.
Status Error:

Indicates an error was detected that did not fit into the parameters for other error messages. Drive is in an unknown state. This a default error condition, and will not normally be seen.

The tape drive system error messages are divided into three general areas. First, are the termination class codes (TCC), second are the fatal class codes (FCC), and finally there are the error messages related to memory. Table 4 lists these error messages and gives a brief description of each.

Table 4. Tape System Error Messages.

Termination Class Codes:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCC0</td>
<td>Undefined special condition. The special condition bit was set in the tape system status register (TSSR), but no other error condition was detected.</td>
</tr>
<tr>
<td>TCC1</td>
<td>Attention condition. Status change has occurred on the transport (off-line, on-line).</td>
</tr>
<tr>
<td>TCC2</td>
<td>Tape status alert. Change in tape status has occurred [tape mark (TMK), end of tape (EOT), record length short (RLS), or record length long (RLL)].</td>
</tr>
<tr>
<td>TCC3</td>
<td>Function reject. Command was not executed due to a fault condition [off-line (OFL), volume check (VCK), beginning of tape (BOT), write lock error (WLE), illegal command (ILC), or illegal address (ILA)].</td>
</tr>
<tr>
<td>TCC4</td>
<td>Recoverable error. A recoverable error has occurred, and retries are attempted unless inhibited.</td>
</tr>
<tr>
<td>TCC5</td>
<td>Recoverable error. Same as TCC4.</td>
</tr>
<tr>
<td>TCC6</td>
<td>Unrecoverable error. Tape position has been lost. Recovery is not possible.</td>
</tr>
<tr>
<td>TCC7</td>
<td>Fatal subsystem error. Subsystem is incapable of reliably executing command. Refer to fatal class codes that follow.</td>
</tr>
</tbody>
</table>
Fatal Class Codes:

FCC0: Capstan runaway.
FCC1: Main CROM parity error.
FCC2: I/O silo parity error.
FCC3: AC power fail detected.

Other Error Messages:

Q-Bus Parity Error:

Memory parity error detected during data transfer.

Tape Bus Parity Error:

Parity error detected on the bus between controller and tape drive.

Register Modification Refused:

TSDB has been loaded with a command pointer before subsystem ready (SSR).

Non-Existant Memory:

Host processor memory does not respond to a read or write operation.

Need Buffer Address:

A command was issued before a valid buffer address was sent to transport by a set characteristics command.
APPENDIX C: TSEXR UTILITY PROGRAM

1.1. INTRODUCTION

All DSD subsystems are shipped with a tape cartridge containing an interactive diagnostic program called TSEXR. This manual explains the operation of this comprehensive tape exerciser program, and assumes that the user is familiar with DSD subsystem operation and technology.

The TSEXR program tests the basic functions and the data reliability of the DSD cartridge tape drive. In addition, the program will execute a sequence of user selected commands. TSEXR runs as a standalone program, with bootstrap.

1.2. PROGRAM LOADING

TSEXR requires a standard console device, an LSI-11 computer, and at least 24K words of memory. Loading TSEXR can be accomplished either from an RT-11 compatible operating system, or from the monitor provided on the DSD distribution media. To run TSEXR from an RT-11 system, issue the command:

RU <DEV:>TSEXR <CR>

On a system running other operating systems, the distribution media (tape cartridge) must be bootstrapped into memory. When the program is in memory, the following message will be displayed:

DSD TAPE MONITOR V3A

TMON>

to run the TSEXR program, type:

R TSEXR <CR>

After TSEXR is loaded into memory, the program title and main command menu will be displayed on the console device. At this time, remove the distribution cartridge tape, and replace it with a blank, write enabled tape cartridge.

DSD TSEXR UTILITY PROGRAM, Rev 2    April 1983
If there is more than one TS compatible device in the system configuration, the user will be prompted to select one device for TSEXR functions.

1.3. PROGRAM EXIT

There is one command and two control key functions that may be used to exit TSEXR, and these are detailed in Tables 1 and 2. At the main command level, a "QUIT" command will cause an exit from the TSEXR program. During command execution; a "CTRL-C" will halt the program and exit to the monitor, and a "CTRL-R" also stops the program, but will return to the command menu within TSEXR.

1.4. PROGRAM COMMANDS

Table 1, TSEXR Command Structure, defines the commands and lists the sequence of tests performed by the commands. TSEXR also recognizes certain control inputs, and these are listed in Table 2.

Table 1. TSEXR Command Structure.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUIT</td>
<td>Exit from TSEXR.</td>
</tr>
<tr>
<td>H</td>
<td>The &quot;H&quot; (help) command lists commands and configuration. Also lists current value of parameters set up in the CHAR command.</td>
</tr>
<tr>
<td>EXER</td>
<td>Performs a list of tape commands designed to exercise the transport section of the DSD tape drive. The list of commands may be discarded by the user, and a new sequence of commands entered by answering 'Y' to the prompt, &quot;MODIFY DEFAULT SEQUENCE [Y/N]&quot;. If this is done, the first command in the new sequence should be an &quot;SCH&quot; (set characteristics) command. All valid command mnemonics are listed below, and the user input is terminated by an &quot;END&quot; command. When an opcode mnemonic is entered, the user is prompted for a &quot;count&quot;. This is the BYTE/RECORD/FILE count in the command packet. The prompt &quot;repetitions&quot; refers to the number of times the command is to be executed. For example, to read four records of 2000 bytes each, respond to the prompts as follows: tape cmd: RDF</td>
</tr>
</tbody>
</table>
count (1): 2000
repetitions (1): 4

or to rewind the tape:
  tape cmd: RWD
count (1): <CR>
repetitions (1): <CR>

Note that this routine is an exerciser designed to
test the physical transport mechanism, and that no
data checking is performed.

Valid Commands:

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRI</td>
<td>Drive Initialization</td>
</tr>
<tr>
<td>RDF</td>
<td>Read Forward</td>
</tr>
<tr>
<td>RDR</td>
<td>Read Reverse</td>
</tr>
<tr>
<td>WRT</td>
<td>Write Data</td>
</tr>
<tr>
<td>SRF</td>
<td>Skip Records Forward</td>
</tr>
<tr>
<td>SRR</td>
<td>Skip Records Reverse</td>
</tr>
<tr>
<td>RNR</td>
<td>Read Next Reverse</td>
</tr>
<tr>
<td>RNF</td>
<td>Read Next Forward</td>
</tr>
<tr>
<td>RPF</td>
<td>Read Previous Forward</td>
</tr>
<tr>
<td>RWD</td>
<td>Rewind</td>
</tr>
<tr>
<td>MBR</td>
<td>Message Buffer Release</td>
</tr>
<tr>
<td>WTM</td>
<td>Write Tape Mark</td>
</tr>
<tr>
<td>SFF</td>
<td>Skip Files Forward</td>
</tr>
<tr>
<td>SFR</td>
<td>Skip Files Reverse</td>
</tr>
<tr>
<td>GES</td>
<td>Get Status</td>
</tr>
<tr>
<td>ERS</td>
<td>Erase</td>
</tr>
<tr>
<td>UNL</td>
<td>Unload</td>
</tr>
<tr>
<td>CLN</td>
<td>Clean</td>
</tr>
<tr>
<td>SCH</td>
<td>Set Characteristics</td>
</tr>
<tr>
<td>END</td>
<td>End Sequence</td>
</tr>
</tbody>
</table>

**FUNCT**

Verifies all functions of the DSD tape drive by performing the following sequence:

1. Set characteristics
2. Get tape status
3. Rewind tape
4. Rewind tape at BOT
5. Write 4 records forward
6. Rewind
7. Read 4 records forward and verify
8. Write tape mark
9. Write 3 records forward
10. Skip 1 record reverse
11. Erase 10 times
12. Write record forward
13. Write tape mark
14. Write tape mark reverse
15. Skip 2 files reverse
16. Skip 2 files forward
17. Repeat steps 15 and 16
18. Rewind
19. Skip 1 file forward
20. Skip 1 record reverse
21. Skip 1 record forward
22. Read and verify record
23. Skip 2 records reverse
24. Read reverse and verify
25. Rewind
26. Skip record forward
27. Read reverse and verify
28. Read next reverse and verify
29. Read forward and verify
30. Skip record forward
31. Read previous forward and verify
32. Read previous reverse and verify
33. Rewind
34. Write 2 records forward
35. Write 1 record reverse
36. Read previous forward and verify
37. Issue clean command
38. Rewind
39. Skip 2 files forward
40. Write 3 even length records forward
41. Write 4 odd length records forward
42. Set swap bytes flag in command word
43. Write 3 even length records forward
44. Write 4 odd length records forward
45. Reset swap bytes flag in command word
46. Read 2 records reverse and verify
47. Set swap bytes flag in command word
48. Read 4 records reverse and verify
49. Reset swap bytes flag in command word
50. Read 4 records forward and verify
51. Rewind.

Note. A "Y" response to the prompt, "PAUSE BEFORE EACH COMMAND [Y/N]", will cause execution to be interrupted prior to each tape command. Enter <CR> when asked "CMD --- ABORT [Y/N]" to continue the command sequence.

ACCEPT Performs 2 passes of EXER and 2 passes of FUNCT commands.

MEDIA Tape cartridge media tests.
Subcommands:

SEQWRT  Writes sequential pattern to entire tape.
SEQRD   Reads tape pattern from tape and compares each
        record to the pattern expected from "SEQWRT".
SEQWRD  Does a "SEQWRT" followed by a "SEQRD".
RANWRT  Writes records of varying length to entire tape.
RANRD   Reads tape pattern from tape and compares each
        record to the pattern expected from "RANWRT".
RANWRD  Does a "RANWRT" followed by a "RANRD".
COR     Tests the tape performance at the track switch
        areas.
CHAR    Allows selection of the following program execu-
        tion parameters:

<table>
<thead>
<tr>
<th>Prompt</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reset tape stats</td>
<td>Sets number of reads, writes, and errors to zero.</td>
</tr>
<tr>
<td>Enable interrupts</td>
<td>Enables interrupts on all tape operations.</td>
</tr>
<tr>
<td>Ignore RFC errors?</td>
<td>If set, the program does not issue an error message when BYTE/RECORD/FILE count is other than what was expected.</td>
</tr>
<tr>
<td>Disable error recovery?</td>
<td>If error recovery is disabled, no retries are attempted.</td>
</tr>
<tr>
<td>Enable extended error reporting?</td>
<td>Enables additional error reporting.</td>
</tr>
<tr>
<td>Number base?</td>
<td>Allows specification of number base for all input/output.</td>
</tr>
</tbody>
</table>

The default number base is octal. All the other prompts are worded so that the default value is NO.

STAT    Shows the state of the status register, command
        packet, and message packet. Also shows number of
        reads, writes, retries, and errors.
Table 2. Control Input Functions.

<table>
<thead>
<tr>
<th>Input</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTRL-B</td>
<td>Puts program in debug mode. Additional device status is displayed and execution pauses are inserted to aid in debugging. Exit debug mode by re-entering &quot;CTRL-B&quot;. Recommended for factory use only.</td>
</tr>
<tr>
<td>CTRL-C</td>
<td>Stops execution and returns to monitor.</td>
</tr>
<tr>
<td>CTRL-D</td>
<td>Lists TS command packet values.</td>
</tr>
<tr>
<td>CTRL-R</td>
<td>Asks, &quot;ABORT OPERATION [Y/N]&quot;. Type &quot;Y&quot; to quit current operation and return to the command menu within TSEXR.</td>
</tr>
<tr>
<td>&lt;LF&gt;</td>
<td>Lists number of reads, writes, errors and retries.</td>
</tr>
</tbody>
</table>

1.5. ERROR MESSAGES

The TSEXR error messages are divided into three general areas. First, are the termination class codes (TCC), second are the fatal class codes (FCC) associated with TCC7, there are the error messages related to memory. Table 3, TSEXR Error Messages, lists these error messages and a short description of each.

Table 3. TSEXR Error Messages.

Termination Class Codes (TCC):

- **TCC0**: Undefined special condition. The special condition bit was set in the tape system status register (TSSR) but no other error condition was detected.
- **TCC1**: Attention condition. Status change has occurred on the transport (off-line, on-line).
- **TCC2**: Tape status alert. Change in tape status has occurred [tape mark (TMK), end of tape (EOT), record length short (RLS), or record length long (RLL)].
- **TCC3**: Function reject. Command was not executed due to a fault condition [off-line (OFL), volume check (VCK)],
beginning of tape (BOT), write lock error (WLE), illegal command (ILC), or illegal address (ILA)].

**TCC4:** Recoverable error. A recoverable error has occurred, and retries are attempted unless inhibited.

**TCC5:** Recoverable error. Same as TCC4.

**TCC6:** Unrecoverable error. Tape position has been lost. Recovery is not possible.

**TCC7:** Fatal subsystem error. Subsystem is incapable of reliably executing commands. Refer to Fatal Class Codes below.

**Fatal Class Codes (FCC):**

- **FCC0:** Capstan runaway.
- **FCC1:** Main CROM parity error.
- **FCC2:** I/O Silo parity error.
- **FCC3:** AC power fail detected.

**Other Error Messages:**

- **Q-Bus Parity Error:**
  Memory parity error detected during data transfer

- **Tape Bus Parity Error:**
  Parity error detected on the bus between the controller and the tape drive.

- **Register Modification Refused:**
  TSDB has been loaded with a command pointer before subsystem ready (SSR).
Nonexistant Memory:

Host processor memory does not respond to a read or write operation.

Need Buffer Address:

A command was issued before a valid buffer address was sent to transport by a set characteristics command.
APPENDIX D: RLEXR USER GUIDE

1.1. INTRODUCTION

All DSD systems having an LSI-11 or PDP-11 interface board are shipped with a diskette or tape cartridge containing an interactive diagnostic program called RLEXR. This manual explains the operation of this comprehensive set of tests and utility programs. The manual assumes the user is familiar with DSD 880 and/or DSD 890 (StacPac) operations and technology.

The information contained in this manual is generally the same for both the DSD 880, a Winchester/Floppy system, and the DSD 890, a Winchester/Tape drive system. Where procedures or instructions differ, separate information will be provided for both systems. The user of this manual may then ignore those small portions not applicable to his system.

RLEXR is designed to test and verify all functions of the DSD 880 and DSD 890 Winchester drive subsystems in normal and extended modes (if applicable). It runs as a standalone program (with bootstrap) and is capable of handling multiple drives and systems. Both display console 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 that is configured 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 faults or bad disk areas. The acceptance tests provide total reliability testing and are suitable for both system burn-in/exercise and quality control checks.

1.2. PROGRAM LOADING

RLEXR requires a standard console device, an LSI-11 or PDP-11 computer, and at least 16K words of memory. Loading RLEXR can be accomplished by two methods. One method is to bootstrap the diagnostic diskette or tape cartridge. This loads RLEXR into memory automatically. The other method requires an RT-11 compatible directory and file structure. The files on the diagnostic diskette or tape cartridge can be accessed using standard RT-11 procedures. RLEXR can be run from an RT-11 system by typing:

RU <DEV:> RLEXR <CR>
On a system running other operating systems (e.g., RSX-11M, IAS, RSTS, etc.), the distribution diskette or tape cartridge must be bootstrapped into memory. Once the program has been bootstrapped into memory, the following appears on the screen:

For DSD 880:

DSD DIAGNOSTIC MONITOR V3A

DSDMON>

to run RLEXR program, type:

R RLEXR <CR>

For DSD 890:

DSD TAPE MONITOR V2A

TMON>

to run RLEXR program, type:

R RLEXR <CR>

When the RLEXR diagnostic program has been loaded into memory, the diagnostic diskette or tape cartridge should be removed to prevent inadvertent damage to the files. After RLEXR is loaded into memory, a brief description is displayed on the terminal that includes a memory map and preliminary usage instructions. The memory map indicates the ranges of address space which responds with SSYNC or BRPLY when accessed by the host computer. The following example shows the text initially output.

After you have run RLEXR by typing:

R RLEXR <CR>

Text similar to the following example will be displayed:

(000000 - 157776)
(171000 - 171776)
(172300 - 172316)
(172340 - 172356)
(172516 - 172516)
(173000 - 173776)
(174400 - 174406)
(177150 - 177152)
(177170 - 177172)
(177560 - 177566)
(177572 - 177616)
(177640 - 177656)
(177776)

Remove the distribution diskette or tape cartridge.

Type:  A to do an acceptance test. This will do a short acceptance test 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.

Enter device type (0 - 3) or 'CR' for list.

Type: 'CR'

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DEVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>880X/8</td>
</tr>
<tr>
<td>1</td>
<td>880X/20</td>
</tr>
<tr>
<td>2</td>
<td>880X/30</td>
</tr>
<tr>
<td>3</td>
<td>890</td>
</tr>
</tbody>
</table>

Enter device type (0 - 3) or 'CR' for list.

Make choice and enter.

Another memory map similar to the following example is printed:

DSD RLEXR V7A

(000000 - 157776)
(171000 - 171776)
(172300 - 172316)
(172340 - 172356)
(172516 - 172516)
(173000 - 173776)
(174400 - 174406)
(177150 - 177152)
(177170 - 177172)
(177560 - 177566)
(177572 - 177616)
(177640 - 177656)
(177776)
Full or partial testing (F,P)?

This option is asking whether to run the diagnostic over the entire disk, or only part of the disk. Partial testing preserves tracks 00 through 10 so that testing can be performed without wiping out the diagnostic programs.

Make choice and enter.

Set class switch to 0 (DSD 880 systems only)
Push button and enter a character.

This means set the switch marked CLASS on the HyperDiagnostic panel to 0 and depress the EXECUTE pushbutton. Type any character on the keyboard to signal the program to proceed. This step does not appear on 890 systems.

Enable halt on error (Y/N) ?

A yes answer means that the program will halt on the first error encountered. A no answer means the program will store all error messages in a circular buffer. These messages can be recovered using the DUMP C command.

Make choice and enter.

# COMMAND:

1.3. PROGRAM EXIT

If RLEXR was loaded via the RT-11 operating system, DSDMON, or TMON, direct return to the monitor may be possible. A CTRL-C input will cause RLEXR to output, EXIT TO RT-11?. A yes response will cause the return to 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.
1.4. PROGRAM COMMANDS

The valid responses to the command prompt are listed in Table 1 and are 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 the <CR> should be entered. The program will fill in the remaining characters and then proceed to execute the function.

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

Table 1. RLEXR Commands.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive Tests:</td>
<td></td>
</tr>
<tr>
<td>• (A)cceptance</td>
<td>General Exerciser</td>
</tr>
<tr>
<td>• (SH)ort acceptance</td>
<td>Short Exerciser</td>
</tr>
<tr>
<td>Individual Tests:</td>
<td></td>
</tr>
<tr>
<td>• (INTE)rface test</td>
<td>Interface test</td>
</tr>
<tr>
<td>• (INTR) test</td>
<td>Interrupt test</td>
</tr>
<tr>
<td>• (SC)an</td>
<td>Scan</td>
</tr>
<tr>
<td>• (SEE)k range</td>
<td>Seek</td>
</tr>
<tr>
<td>• (E)xtended mode test</td>
<td>Extended mode test</td>
</tr>
<tr>
<td>• (SEQ W)/r test</td>
<td>Sequential write/read test</td>
</tr>
</tbody>
</table>

NOTE

The following three tests require a sequential write pass.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>• (SEQ R)ead</td>
<td>Sequential read test</td>
</tr>
<tr>
<td>• (RANDOM R/)w</td>
<td>Random read/write test</td>
</tr>
<tr>
<td>• (RANDOM RE)ad</td>
<td>Random read test</td>
</tr>
</tbody>
</table>

Program Control Utilities:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>• (SET D)evice</td>
<td>Set device</td>
</tr>
<tr>
<td>• (SET U)nit</td>
<td>Display selected units</td>
</tr>
<tr>
<td>• (SET T)rack</td>
<td>Set track</td>
</tr>
<tr>
<td>• (SET I)nterrupt status</td>
<td>Set interrupt status</td>
</tr>
<tr>
<td>• (SET M)ode</td>
<td>Set mode</td>
</tr>
</tbody>
</table>

Program Status:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>• (H)elp</td>
<td>Provides list of commands</td>
</tr>
</tbody>
</table>

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• (M)ap address  
• (ST)atus  
• (SA)ve status  
• (RES)et status  
• (DUMP C)ir buffer  
• (REC)over status  

Memory and device map  
Display status information  
Save status  
Clear status  
Display content of circular buffer  
Retrieve status  

Data Utilities:

• (RD) without header  
• (DUMP S)ector  

Read without header  
Display disk sectors  

Table 2. Control Inputs.

<table>
<thead>
<tr>
<th>Input</th>
<th>Meaning</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTRL-R</td>
<td>Aborts current test, restarts at command</td>
<td></td>
</tr>
<tr>
<td>CTRL-S</td>
<td>Freeze terminal output until another character is typed</td>
<td></td>
</tr>
<tr>
<td>CTRL-O</td>
<td>Throws away all output until another character is typed</td>
<td></td>
</tr>
<tr>
<td>CTRL-P</td>
<td>Throws away all output, except errors, until another character is typed</td>
<td></td>
</tr>
<tr>
<td>CTRL-Q</td>
<td>Causes output to resume</td>
<td>1</td>
</tr>
<tr>
<td>&lt;LF&gt;</td>
<td>Types current track and sector status</td>
<td>2</td>
</tr>
<tr>
<td>CTRL-C</td>
<td>Asks, EXIT TO RT-ll?. If RT-ll monitor is available, type Y to exit. If RT-ll monitor not available, action is similar to CTRL-R. If in ODT, may return control to program</td>
<td>3</td>
</tr>
<tr>
<td>CTRL-D</td>
<td>Causes control transfer to ODT</td>
<td>3,4</td>
</tr>
<tr>
<td>CTRL-T</td>
<td>Causes control transfer to ODT with stack trace</td>
<td>3,4</td>
</tr>
<tr>
<td>RUB or DEL</td>
<td>Deletes previous character in input string</td>
<td></td>
</tr>
</tbody>
</table>

NOTES

1. Actually, any character input will perform this function.
2. This command always functions; however, for some tests, the track and sector information should be disregarded (such as, fill/empty test).

3. Exit to monitor and control transfer to debug may not function if there is not enough memory or if booted from a device other than a 177170.

4. Control transfer from ODT back to RLEXR 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.

Full testing will set the lower track limit to 0. Partial testing will set it to ₫ (octal). Partial testing is recommended if diagnostics or other files are already on the RL. If system file RT-11 is on the RL, the lower track limit should be set much higher. The default upper track limits are:

<table>
<thead>
<tr>
<th>Type</th>
<th>Device</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>880X/8-normal mode</td>
<td>376</td>
</tr>
<tr>
<td>0</td>
<td>880X/8-extended mode</td>
<td>576</td>
</tr>
<tr>
<td>1</td>
<td>880X/2Ø</td>
<td>776</td>
</tr>
<tr>
<td>2</td>
<td>880X/3Ø</td>
<td>776</td>
</tr>
<tr>
<td>3</td>
<td>89Ø</td>
<td>776</td>
</tr>
</tbody>
</table>

Selection of the next higher tracks (377, 577, 777) may result in the bad block map being destroyed. The bad block map may be rewritten by using the WINEXR (880) or GEMEXR (890) utility programs. The set mode command may only be executed by the 880X/8 (type 0) device to change modes from normal to extended mode, or from extended mode to normal mode.

RLEXR then prints the name and version number of the program, DSD RLEXR V7A. RLEXR then prints <CRLF>$ when starting, and then attempts an initialize sequence. When the initialize instruction is successfully completed, the program prints 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 H<CR> (Help command).

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

1104 - Normal start/restart address

1110 - Start address for monitor call
1114 - Start at command prompt without performing an initialize sequence on the device

1100 - Return address from ODT after CTRL-D dispatch

1.5. PROGRAM INPUT/OUTPUT

All data input and output (except status counters) are 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 deletion. On others, 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, (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 values. Various commands are provided to specify the limits of the address components to be used by the tests. Default values are preset following the initial program load.

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

1.6. STATUS AND ERROR DISPLAYS

RLEXR 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 the error printouts are longer than can be displayed on the CRT screen. The display output buffer function (DUMP C) is used to examine messages in the circular buffer.

Status Variables Displayed:

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 six 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 error/status printout.

SECTOR=SC  Sector address at time of error/status printout.

SIDE 1  Indicates the status or error relates to side one (first or second side of disk).

RLCS=XY  Shows content of the command and status register.

#BAD=XX  Indicates number of status errors detected.

#RD/WRT=XX  Indicates number of read/write operations performed error free.

B-TRACK=XX  Indicates 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 from the 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

This indicates no SSYN acknowledge to memory access within 200 milliseconds (interface test only).

2  *Status Error*

RLCS  RLBA  RLDA  RLMP  STAT

XXXX  XXXX  XXXX  XXXX  XXXX

This 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*

RLCS  RLBA  RLDA  RLMP  STAT
XXXX  XXXX  XXXX  XXXX  XXXX

An expected interrupt did not occur after completion of the function in RLCS (interrupt test).

4 *Read/Write Error*

ADDR  READ  EXPECTED
17XXXX  XXXX  XXXX

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 *Time Out Error*

RLCS
XXXX

Indicates that a function was not completed within the required time.

7 *Header CRC Error*

DEVICE  UNIT  SECTOR  SIDE  TRACK  EXPECT  CALC
17XXXX  XXXX  XXXX  XXXX  XXXX  XXXX  XXXX

The CRC calculated by software did not compare to that written by hardware during a format operation (scan test).
8 *Non Consecutive Header Error*

DEVICE  UNIT  PREV  PRES  SIDE  TRACK
17XXXX  XXXX  XXXX  XXXX  XXXX  XXXX

Sector header information for two adjacent sectors was incorrect (scan test).

9 *Data Compare Error*

DEVICE  UNIT  SIDE  TRACK  SECTOR  EXPECT  READ  WD #
17XXXX  XXXX  XXXX  XXXX  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. Refer to WINEXR (880) or GEMEXR (890) utility programs for rewriting the bad track map.

10 *Bad Track Detected*

DEVICE  UNIT  SIDE  TRACK
17XXXX  XXXX  XXXX  XXXX

Results from multiple data compare errors on the same track.

11 *Write Protect Error*

DEVICE  UNIT
17XXXX  XXXX

Drive was write protected during a write operation (sequential or random write tests).

12 *Drive Select Error*

RLCS  RLBA  RLDA  RLMP  STATUS
XXXX  XXXX  XXXX  XXXX  XXXX

A nonexistent drive unit was selected (all tests).

DSD RLEXR UTILITY PROGRAM, Rev 2

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13 *Spin Error*

DEV UNIT RLCS
17XXXX XXXX XXXX

Indicates drive not up to speed during operation in RLCS (all tests).

14 *Nonexistent Memory*

DEV UNIT RLCS RLBA
17XXXX XXXX XXXX XXXX

15 *Seek Time Out*

DEV UNIT RLCS
17XXXX XXXX XXXX

A seek operation did not complete in 200 milliseconds (all tests).

16 *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 indicates a bad block or track (sequential read/write test).

17 *Header Not Found*

DEV UNIT HEAD TRACK SECTOR
17XXXX XXXX XXXX XXXX XXXX

Seek to sector and track in RLDA could not be completed in 200 milliseconds due to invalid or nonexistent disk address (all tests).
18 *Header CRC Error*
DEV UNIT RLCS RLDA
17XXXX XXXX XXXX XXXX
A CRC error was detected on the header field (scan test).

19 *Data CRC Error*
DEV UNIT RLCS RLBA RLDA
17XXXX XXXX XXXX XXXX XXXX
A CRC error was detected during a data transfer (scan, sequential write/read, and random write/read tests).

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 the RLEXR diagnostic program outputs to the console under varying circumstances:

Example 1: Operator requests status of currently selected drive during a test by typing, <LF>.

DRIVE #0 SIDE 0 AT TRACK 155 SECTOR 0 # BAD=0
# RD/WRT=0 B-TRACK=0 B-DATA=0

Example 2: Operator requests status of both drives using the status command.

UNIT#0 #BAD=0 #RD/WRT=0 B-TRACK=0 B-DATA=0
UNIT#1 #BAD=0 #RD/WRT=0 B-TRACK=0 B-DATA=0
Example 3: Disk was write protected.

*Write Protect Error*

DEVICE UNIT

174400 1

Example 4: Bad block found during read/write test.

*Data Compare Error*

DEVICE UNIT SIDE TRACK SECTOR EXPECT READ

174400 1 1 207 31 14761 14561

WD #

2

1.7. DETAILED DESCRIPTION OF COMMANDS

Comprehensive Tests:

- (A)CCEPTANCE

This test does one pass of a short acceptance test on the first seven tracks and then resets the limit variables back to the default values. It then induces an automatic CTRL-P to inhibit all but error printout, and initiates the longer test. This test will run until terminated by a CTRL-R.

Example:

$ COMMAND: A<CR>
SCRATCH DISKS INSTALLED? (Y/N)? Y
TEST NOW STARTING
SCAN CRC CHECKED WRITING READING
INTERRUPTS ENABLED
WRITING READING

- (SH)ORT ACCEPTANCE

This interactive program changes the track range used by the acceptance so that only the first seven tracks of each selected drive are tested. This test will run until halted by a CTRL-R.
Individual Tests:

- **(INTE)FACE TEST**
  
  Checks for response of all interface registers and issues a response error if a bus time out occurs. All read/write bits in each register are verified to be individually set and cleared without affecting other bits. A no-op or a maintenance-op code is checked along with bus reset.

- **(INTR) INTERRUPT TEST**
  
  All RL op codes (except write) are executed with interrupts enabled. If an interrupt does not occur, and interrupt error message will appear. This test runs until terminated by a CTRL-R.

- **(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.

- **(SEE)K RANGE**
  
  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 the test indicating the seek length currently being used (x) and direction of seek (A = outward). A ! will be printed at the conclusion of each pass. This test will run until terminated by a CTRL-R.

Example:  

```bash  
# COMMAND:  SEE<CR>
SEEK LENGTH (1):  3 THROUGH (40):  7
COVERING TRACKS -(0):  10 THROUGH (776):  40
```
• \textbf{(SEQ W)/R TEST}

The sequential write/read test writes pseudo-random data sequentially on all selected tracks. The test then reads and checks all the data. The message "WRITING" is displayed on the console terminal when the test starts writing the data. The message "READING" is displayed when the test starts reading the data. This test continues until the operator enters a CTRL-R.

• \textbf{(E)XTENDED MODE TEST}

checks implied seek capability of controller during large inter-track data transfers. This test will not execute if the 880X/8 device (type 0) has been selected, and if the extended mode was selected.

\textbf{NOTE}

The following three tests require a sequential write pass be done first in order to initialize the pseudo-random data. If this is not done, data compare errors are reported.

• \textbf{(SEQ R)EAD}

This test reads all 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. Test is halted by entering a CTRL-R.

• \textbf{(RANDOM R)/W}

This test selects a random sector of a selected drive, then reads or writes it. It checks data when appropriate. The test will continue until terminated by a CTRL-R.

• \textbf{(RANDOM RE)AD}

This test reads randomly selected sectors. Data is checked after each read. Test continues until halted by a CTRL-R.

Program Control Utilities:

• \textbf{(SET M)ODE}

This test may be executed only on an 880X/8 device. The test allows selection of normal or extended mode of opera-
tion. Extended mode will allow access of tracks 0 through 576 (octal) and is selected in normal mode, class 1. Normal mode (normal switch, class 0) allows access to tracks 0 through 376 (octal). After setting class select switch to 0 or 1, depress EXECUTE pushbutton before typing a character. After typing a character, it prompts, "ENABLE HALT ON ERROR?" If an error occurs, the error message will be printed and followed by *HR*. This allows the LED to continue flashing the current error.

- (SET U)NIT

This command will cause the console terminal to display the currently selected drives that are to be accessed by test functions. Refer to the set device command for procedure to change the selected drive units.

- (SET T)RACK

This command allows the operator to specify the lower and upper track limits for all other tests. The default lower track limit is 0. The default upper track limits are as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Device</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>880X/8 - normal mode</td>
<td>376</td>
</tr>
<tr>
<td>0</td>
<td>880X/8 - extended mode</td>
<td>576</td>
</tr>
<tr>
<td>1</td>
<td>880X/20</td>
<td>776</td>
</tr>
<tr>
<td>2</td>
<td>880X/30</td>
<td>776</td>
</tr>
<tr>
<td>3</td>
<td>890</td>
<td>776</td>
</tr>
</tbody>
</table>

If the last physical track is selected (377, 577, or 777), the bad block map might be destroyed and would have to be rewritten (Refer to WINEXR (880) or GEMEXR (890) User Guides for procedures). A warning message will be output if this happens. Nothing will be destroyed until testing begins. The command prompt is issued after the entry of valid new limits. The lower limit must not exceed the upper limit.

- (SET I)NTERUPT STATUS

This command enables the operator to test the disk system with interrupts enabled or disabled. If interrupts are enabled, the program ensures that an interrupt occurs when appropriate. This test is also used in the acceptance tests to set interrupts enabled or disabled. A <CR> response is no answer.
Example:  # COMMAND: SET 1<CR>
CURRENTLY INTERRUPTS ARE DISABLED (D)
ENABLE INTERRUPTS (Y/N)?

* (SET D)EVICE

This function facilitates testing controllers that are not configured at the standard device input/output address and interrupt vector. It also enables the 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 the command prompt is by input of a <CR> in response to RLCS@9:. 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 labelled
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


Example:  # COMMAND: SET D<CR>
SET THE DEVICE FLAGS FOR EACH SYSTEM AS FOLLOWS
10: ENABLE UNIT 0 ON CURRENT DEVICE
20: ENABLE UNIT 1 ON CURRENT DEVICE
40: ENABLE UNIT 2 ON CURRENT DEVICE
RLCS @ 174400: INT @ 160 INTVEC=160 FLAGS: 70
RLCS @ 0:

Program Status Commands:

* (H)ELP

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

DSD RLEXR UTILITY PROGRAM, Rev 2  April 1983
• (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 RLEXR program is first loaded. In addition, the interrupt vector address associated with each disk interface is displayed. The command prompt is printed when this function is complete.

• (ST)ATUS

The status command 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 printed when this function is complete.

Example:

COMMAND: ST<CR>
UNIT #0  #BAD=3  #RD/WRT=2049  B-DATA=0
B-TRACK=0
# COMMAND:

• (RES)ET STATUS

This command first displays all the available status counts. Next, the display will ask whether all status counts need resetting. A yes answer will cause all of the error, pass, etc., counts to be reset to zero. The command prompt is output when this function is complete.

• (SA)VE STATUS

This command causes all the status counts associated with a particular drive to be written on track 0, sector 1 of the respective Winchester RL unit. This function is used by the acceptance test so that it can survive a loss of main memory without a loss of cumulative error data. The command prompt is displayed when this function is complete.

• (REC)OVER STATUS

This command performs the opposite function performed by the save status command. The stored data is recovered from the Winchester and transferred back to the status/counter variables in memory. The command prompt is displayed when the function is completed.
• (DUMP C)IR BUFFER

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

Data Utilities Commands:

• (DUMP S)ECTOR

This command enables the operator to cause an octal, or ASCII dump, at a specified sector, to the console terminal. The function prompts for unit, cylinder, sector, side, ASCII or octal format, and exit from this function.

Example:

```
# COMMAND: DUMP S<CR>
ALL PARAMETERS ARE IN OCTAL
UNIT (0,2)? 2<CR>
CYLINDER (0, 776)? 23<CR>
SECTOR (0, 47)? 5<CR>
SIDE (0,1)? 1<CR>
DUMP IN ASCII OR OCTAL FORMAT (A, O)? 0<CR>
........
EXIT (Y/N)? Y
```

• (RD)WITHOUT HEADER

This command performs the same function as the dump sector command.
APPENDIX E
BOOTSTRAP PROGRAM LISTING
DSD 890 BOOTSTRAP PROGRAM

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DSD 890 BOOTSTRAP PROGRAM

1. TITLE
2. BOOTSTRAP DEFINITIONS
3. 22 BIT MEMORY TEST
4. WINCHESTER READ WRITE TEST
5. WINCHESTER BOOT SECTION
6. TAPE BOOT SECTION
7. FLOPPY BOOT SECTION
8. I/O SUPPORT SECTION

BOOTSTRAP PROGRAM FOR DSD 890 WINCHESTER / TAPE CONTROLLER.
BOOTS FROM RL VOLUMES. SINGLE OR DOUBLE DENSITY FLOPPY OR TAPE.

BOOT PROCEDURE:
1. SIZES. TESTS AND INITIALIZES MEMORY OVER THE FULL 22-BIT RANGE.
   AVOIDING THE BOOT AREA AND I/O PAGE.
2. PERFORM DIRECT ACCESS MODE READ WRITE TEST ON CYLINDER ZERO HEAD TWO.
3. IF PROMPTING IS ENABLED (BY JUMPER ON CONTROLLER BOARD) AND BOOT ADDRESS
   BITS 0 - 7 ARE ZERO. THEN PROMPT AND ACCEPT USER INPUT TO DETERMINE BOOT
   DEVICE. OTHERWISE, DECODE BOOT DEVICE FROM CONFIGURATION WORD.
4. READ IN BOOT BLOCK FROM SELECTED DEVICE AND TRANSFERS CONTROL TO LOCN 0.
5. ABNORMAL TERMINATION ERROR CODES - LOCATED IN REGISTER 0 AFTER SYSTEM HALT.
   R1 CONTAINS BOOTSTRAP PROGRAM REVISION LEVEL AND R2 HAS CONTROLLER
   MICROCODE REVISION LEVEL.
6. MEMORY TEST ERROR - OFFSET ADDRESS OF OFFENDING ADDRESS IN R3. PAGE
7. WINCHESTER Q-BUS REGISTER ERROR - NO RESPONSE FROM DESIGNATED WINCHESTER REGISTER.
   REGISTER ADDRESS IN R3.
8. TAPE Q-BUS REGISTER ERROR - NO RESPONSE FROM DESIGNATED TAPE REGISTER.
   REGISTER ADDRESS IN R3.
9. FLOPPY Q-BUS REGISTER ERROR - NO RESPONSE FROM DESIGNATED FLOPPY REGISTER.
   REGISTER ADDRESS IN R3.
10. WINCHESTER READ/WRITE TEST ERROR - DEVICE ADDRESS IN R3.
11. BOOT READ ERROR - ERROR READING BOOT BLOCK. DEVICE ADDRESS IN R3.
12. INVALID BOOT BLOCK - BLOCK READ INTO MEMORY NOT A VALID BOOT BLOCK.

BOOT ADDRESSES -
77X000 WINCHESTER VOLUME 0 (DL0)
77X002 WINCHESTER VOLUME 1 (DL1)
77X004 WINCHESTER VOLUME 2 (DL2)
77X006 RESERVED
77X010 TAPE
77X012 FLOPPY AT 777170
77X014 FLOPPY AT 777150
77X016 RESERVED
DSD 990 BOOTSTRAP PROGRAM

BOOTSTRAP DEFINITIONS

50 .SBTTL BOOTSTRAP DEFINITIONS
51 
52 / RLO1 / RLO2 COMPATIBLE HARDWARE DEFS.
53 
54 000002 .RLBA= 2: BUS ADDRESS OFFSET
55 000004 .RLDA= 4: DISK ADDRESS OFFSET
56 000006 .RLMP= 6: MULTI PURPOSE OFFSET
57 000010 .RLBAE=10: BUS ADDRESS EXTENSION OFFSET
58 000012 .RCS2=12: CS2 OFFSET
59 
60 / I/O REGISTER ADDRESSES
61 
62 177560 TK5 = 177560: KEYBOARD STATUS
63 177562 TK6 = 177562: KEYBOARD DATA
64 177564 TP5 = 177564: OUTPUT STATUS
65 177566 TP6 = 177566: OUTPUT DATA
66 
67 / MEMORY MANAGEMENT UNIT ADDRESSES
68 
69 177572 MMUSR0 = 177572: MMU STATUS REGISTER 0
70 172516 MMUSR3 = 172516: MMU STATUS REGISTER 3
71 172300 KPDR0 = 172300: KERNAL PAGE DESCRIPTOR 0
72 172340 KPDR6 = 172340: KERNAL PAGE ADDRESS REGISTER 6
73 
74 / REGISTER USAGE IN CONFIGURATION AND MEMORY TEST SECTION
75 
76 000003 MMU= X3: R3 BOOLEAN MMU FLAG, ZERO NOT PRESENT
77 000003 CFW= X5: R5 CONFIGURATION WORD
78 
79 / COMMAND CODES
80 
81 000002 WCK = 2: WRITE CHECK
82 000004 GES = 4: GET STATUS
83 000006 SEEK = 6: SEEK
84 000010 RDH = 10: READ HEADER
85 000012 WRT = 12: WRITE DATA
86 000014 RD = 14: READ DATA
87 
88 / CONFIGURATION CONSTANTS
89 
90 000400 WADJMP = 400: WINCHESTER ADDRESS JUMPER
91 001000 TAJMP = 1000: TAPE ADDRESS JUMPER
92 010000 TINJMP = 10000: TAPE INSTALLED JUMPER
93 020000 PROMPT = 20000: PROMPTING ENABLED
94 030000 MTBEG = 30002: START OF MEMORY TO TEST
95 000000 BTREV = 0: BOOT PROGRAM REVISION #
96 111000 EMENTER = 111000: CODE TO ENTER EXTENDED MODE
97 101000 EMOKAY = 101000: EMENTER RESPONSE
98 020000 RWADD = 20000: DISK ADDRESS FOR R/W TEST
99 
100 / ABNORMAL TERMINATION CODES. LOCATED IN RO AFTER SYSTEM HALT
101 
102 000001 MTE = 1: MEMORY TEST ERROR - OFFSET OF MEM LOCN (INTO APR 6) IN R1
103 000002 WGE = 2: WINCHESTER 0-BUS REGISTER ERROR - DEVICE ADDR IN R1
104 000003 TGE = 3: TAPE 0-BUS REGISTER ERROR - "
105 000004 FGE = 4: FLOPPY 0-BUS REGISTER ERROR - "
106 

DSD 990 BOOTSTRAP PROGRAM

BOOTSTRAP DEFINITIONS

107 000005 WRW = 5: WINCHESTER R/W TEST ERROR - "
108 000006 BRE = 6: BOOT READ ERROR - "
109 000007 IBH = 7: INVALID BOOT BLOCK - "
110 

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DSD 890 BOOTSTRAP PROGRAM

22 BIT MEMORY TEST

112 SBTL 22 BIT MEMORY TEST
113 000000 CSECT
114
115
116
117 000000 013705 START: MOV •• 3000.CFW ; GET CONFIG WORD. KEEP IN R5
118 000004 011706 MOV (PC), SP ; SET STACK TO 12700
119 000006 012700 MOV •340., R0 ; LOCK OUT LINE TIME CLOCK
120 000012 104000 MTPS R0 ; BY SETTING PRIORITY TO 7
121 000014 004467 JSR R4, MEMCHK ; R4 POINTS TO TRAP ROUTINE
122
123 ; TRAP PROCESSOR FOR NXM TIMEOUT
124 ; SETS CARRY AND RETURNS ON NON-EXISTANT MEMORY TRAP
125
126 000020 TRAP4:
127 000020 052766 BIS •1., 2(SP) ; SET CARRY BIT ON TRAP TO 4
128 000026 000001 000002 RTI
129
130 ; MEMORY TEST SECTION
131
132 000030 012701 MEMCHK: MOV •4., R1 ; SET LOW MEM POINTER
133 000034 010421
134 000036 010021
135 000040 030527
136 000044
137 000046
138
139 000052 TSTMSG: .ASCIZ <15><12>/TESTING MEMORY /<15><12>
140 .EVEN
141
142 000076 012704 MTINIT: MOV •MTBEG., R4 ; R4 POINTS TO LOCN TO BE TESTED
143 000102 005003
144 000104 012737
145 000112 103446
146 000114 005203
147 000116 012700
148 000122 012701
149 000126 012721
150 000132 007700
151 000134 012702
152 000140 012701
DSD 890 BOOTSTRAP PROGRAM

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22 BIT MEMORY TEST

153 000144 010021 20$: MOV R0, (R1)+ ; APR = BASE ADDRESS (START R0 = 0)
154 000146 062700 ADD #200, R0 ; INCREMENT BY 128 BLOCKS (4K WORDS)
155 000152 077204 SBB R2, 20$ ; LOOP UNTIL DONE
156 000154 012711 MOV $177600, (R1) ; APR 7 = I/O PAGE
157 000160 005237 INC @MMUSRO ; ENABLE MMU
158 000164 005037 CLR @0 ; CLEAR LOCATION 0 TO SEE IF MEM > 18 BITS
159 000170 001772 MOV #KPAR6, R2 ; USE R2 AS POINTER TO KERNEL APR 6
160 000174 012712 MOV #100000, (R2) ; SET AT BEGINNING OF 19 BIT MEM SPACE
161 000200 005237 INC @140000 ; INCREMENT LOCN
140000
162 000204 103403 BCS 30$ ; IF NXM BRA
163 000206 005737 TST @0 ; SEE IF LOCN 0 CHANGED
164 000212 012767 BNE 30$ ; IF SO IMPLIES SHADOWING
165 000214 012737 MOV $20, @MMUSR3 ; ENABLE 22-BIT ADDR
000020
172354
166 000222 052704 30$: BIS #140000, R4 ; INITIALIZE TO APR 6
140000
167 000226 005012 CLR (R2) ; START WITH APR 6 = 0
168 000230 000241 METHST:
169 000230 000241 CLC
170 000232 010414 MOV R4, (R4) ; (ADDR) = ADDR
171 000234 103427 BCS MEMEND ; CARRY MEANS TRAP 4
172 000236 020414 CMP R4, (R4) ; CHECK IF SAME AS WRITTEN
173 000240 001016 BNE MTERR ; IF NOT MEM TEST ERROR ROUTINE
174 000242 005114 COM (R4) ; COMPLEMENT MEMORY LOCATION
175 000244 060414 ADD R4, (R4) ; CHECK (SHOULD = 177777)
176 000246 077224 INC (R4)+ ; MAKE = 0 AND GOTO NEXT LOCN
177 000250 001012 BNE MTERR ; BRANCH IF ERROR
178 000252 005703 TST MMU ; IS MMU PRESENT
179 000254 001765 BEQ 10$ ; IF NOT KEEP LOOPING
180 000256 020427 CMP R4, $160000 ; END OF 4K BANK?
160000
181 000262 001362 BNE 10$ ; LOOP IF NOT
182 000264 040712 ADD #200, (R2) ; BUMP APR CONTENTS
000200
183 000270 012704 MOV #14000000, R4 ; START AGAIN WITH OFFSET 0 INTO APR6
140000
184 000274 000759 BR 10$ ; BRANCH FOREVER (TRAP 4 EXITS)
185 000276 012700 MTERR. MOV #MTE.R0 ; MEMORY TEST ERROR CODE
000000
186 000302 001401 MOV R4, R1 ; OFFSET OF ERROR LOCATION
187 000304 00167 JMP BOOTERR
001070
188 000310 TOPOFF: .WORD 0
189 000312 .WORD 0
190 000314 010467 MEMEND: MOV R4, TOPOFF ; HOLDS TOP OF MEMORY OFFSET
177770
191 000320 011267 MOV (R2), TOPAPR ; HOLDS TOP OF MEMORY APR
177766
DSD 890 BOOTSTRAP PROGRAM

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22 BIT MEMORY TEST

192 000324 005037 CLR @MMUSR0 ; DISABLE MMU
    177572

193

194 ; CHECK THAT ALL 890 REGISTERS RESPOND CORRECTLY

195

196 000330 005000 REDCHK: CLR RO ; USE AS PTR FOR STD CONFIG STORAGE
197 000332 012701 MOV @174420.R1 ; LOAD ALT ADDR
    174420
198 000336 003205 BIT #WADJMP.CFW ; RCSR SELECT = STD?
199 000342 001402 BEQ 1$ ; IF NOT STANDARD
200 000344 012701 MOV @174400.R1 ; LOAD STD ADDR
    174400
201 000350 010120 1$ MOV R1,(R0)+ ; SAVE SELECTED RL @ LOCN 0
202 000352 005721 TST (R1)+ ; RCSR
203 000354 103561 BCS WRR ; BRANCH IF NO RESPONSE
204 000356 012702 MOV #1.R2 ; R2 HAS ALL 1’S
205 000362 010211 MOV R2,(R1) ; RLBA SHOULD RESPOND WITH ALL 1’S
206 000364 020221 CMP R2,(R1)+ ;
207 000366 001154 BNE WRR ; BRANCH IF NOT EQ.
208 000370 010211 MOV R2,(R1) ; SAME WITH RLDA
209 000372 020221 CMP R2,(R1)+ ;
210 000374 001151 BNE WERR ;
211 000376 005721 TST (R1)+ ; SKIP RLMPR
212 000380 010211 MOV R2,(R1) ; ALL ONES TO BAE
213 000382 022711 CMP #77.(R1) ; SHOULD ONLY RESPOND WITH BITS 0-5
    000077
214 000390 001144 BNE WERR ;
215 000398 010501 CLR (R1)+ ; RESET BAE
216 000400 012711 MOV @EMENTER.(R1) ; WRITE EMENTER CODE TO RLCS2
    111000
217 000408 012711 MOV @111333.(R1) ; SECOND WORD OF EMENTER
    111333
218 000416 011100 MOV (R1),RO ; COPY OF RLCS2
219 000424 001535 BEQ WERR ; SHOULD BE NON ZERO
220 000426 105000 CLR RO ;
221 000430 000300 SWAB RO ; MICROCODE REV LEVEL TO LOW BYTE
222 000432 010037 MOV R0,##10 ; SAVE AT LOCATION 10
    000010
223 000436 162701 SUB #12.R1 ; RESET R1 TO RLCS
    000012
224 000442 010100 MOV R1,RO ; RO HAS ADDRESS OF ACTIVE RLMPR
225 000444 062700 ADD #6.R0 ; RO HAS ADDRESS OF ACTIVE RLMPR
DSD 890 BOOTSTRAP PROGRAM

WINCHESTER READ WRITE TEST

227 .SBTTL WINCHESTER READ WRITE TEST
228 ;
229 00001 LCS = %1;
230 000450 RWTST:
231 ;INCLUDE CODE TO SKIP RW TEST IF ALL UNITS WRITE PROTECT
232 ;
233 000450 030527 BIT CFW.#170 IS DRIVE WRITE PROTECTED
234 000454 01523 BEQ TSCHK ; IF SO SKIP READ/WRITEx TEST
235 000456 012761 MOV #EMENTER, RLCS2(LCS) ; RE ENTER EXTENDED MODE
236 111000
237 000012
238 000464 012761 MOV #111333..RLCS2(LCS);
239 111333
240 000012
241 000472 003046 CLR -(SP) ; SECTOR FOR RW TEST
242 000474 012761 MOV #RWADD..RLDA(LCS)
243 000000
244 000502 012703 MOV #SEEK.R3 ; SET UP SEEK COMMAND
245 000506 004767 JSR PC.RLEX ; ISSUE SEEK COMMAND
246 000512 005723 TST (R3)+ ; TURN INTO READ HEADER COMMAND
247 000514 004767 JSR PC.RLEX ; ISSUE READ HEADER COMMAND
248 000520 021027 CMP (RO), #RWADD ; SEEK SUCCESSFUL ?
249 000524 001079 BMF WERR ; BRANCH IF NOT
250 000526 005061 CLR .RLBAE(LCS) ; START AT SECTOR 0
251 000532 012703 AGN: MOV #RD.R3 ; READ DATA COMMAND
252 000536 004767 JSR PC.RLEX ; READ ONE SECTOR TO BUFFER
253 000542 011661 MOV (SP),..RLBAE(LCS) ; SECTOR TO CHECK
254 000546 012703 MOV #WCK.R3 ; WRITE CHK
255 000550 004767 JSR PC.RLEX ;
256 000552 000116
257 000556 005711 TST (LCS) ; TEST FOR WRITE CHK ERROR
258 000560 100435 BMI RTRY ; BRANCH IF ERROR
259 000562 012703 MOV #200.R3 ; USE R3 AS COUNTER FOR COMPLEMENT
260 000566 010446 MOV R4,-(SP) ; PUSH R4
261 000570 012704 MOV #MTSEG.R4 ; POINTER TO BUFFER
262 000574 005124 10*: CMP (R4)+ ; INVERT WORD
263 000576 077302 SOB R3.104 ; DO WHOLE BUFFER
264 000600 012604 MOV (SP)+,R4 ; RESTORE R4
265 000602 012703 MOV #WCK.R3 ; ANOTHER WRITE CHECK
266 000606 000002
267 000606 004767 JSR PC.RLEX ; EXECUTE
268 000612 005711 TST (LCS) ; EXPECT ERROR THIS TIME
269 000614 100017 BPL RTRY ; RETRY IF NOT AN ERROR
DSD 890 BOOTSTRAP PROGRAM
WINCHESTER READ WRITE TEST

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263 000616 012703 MOV #WRIT.R3 ; WRITE DATA COMMAND
264 000622 004767 JSR PC.RLEX ; EXECUTE
265 000626 005711 TST (LCS) ; WRITE DATA ERROR ?
266 000630 100411 BMI RTRY ; TRY AGAIN IF BD
267 000632 012703 MOV #WCK.R3 ; DO ANOTHER WRITE CHK
268 000636 004767 JSR PC.RLEX
269 000642 005711 TST (LCS) ; ERROR ?
270 000644 100403 BMI RTRY ; THEN TRY AGAIN
271 000646 005061 CLR .RLCS2(LCS) ; EXIT EXTENDED MODE
272 000652 000424 BR TSCHK OK NOW CHECK TS REGISTERS
273 000654 062716 RTRY: ADD #400.(SP) ; BUMP SECTOR
274 000660 031627 BIT (SP).#4000 ; CHECK IF REPEATED 7 TIMES
275 000664 011661 MOV (SP) •. RLBAE(LCS)
276 000670 005010 CLR (RO) ZERO @ LOCN 2 MEANS NO TAPE
277 000672 005010 CLR (RO) ZERO @ LOCN 2 MEANS NO TAPE
278 000676 012761 RLEX: MOV #MTBEQ. RLBA(LCS); USE 3002 AS BUFFER
279 000682 012761 MOV #200..RLBAE(LCS) ; ONE SECTOR WORD COUNT
177600 000006
280 000698 010311 MOV R3, (LCS) ; ISSUE COMMAND
281 00069A 105711 RLWT: TSTB (LCS) ; WAIT FOR DONE
282 0006A7 100376 BPL RLWT
283 0006A9 000207 RTS PC ; RETURN
284 0006A9 005037 WERR: CLR @0 ; ZERO @ LOCN 0 MEANS NO WINCH
285 0006BA 012700 TSCHK: MOV #2.R0
000002
286 0006C9 005010 CLR (RO) ; ZERO @ LOCN 2 MEANS NO TAPE
287 0006CE 010000 BIT # Tin.JMP, CFW ; IS TAPE INSTALLED ?
288 0006D2 010120 BNE DECODE ; BRANCH IF NOT
289 0006D5 012701 MOV #172530.R1 ; LOAD ALT ADDR
172530
290 0006DA 032705 BIT #TAD.JMP,CFW ; TSR SELECT = STD ?
000100
291 0006E2 011402 BEQ # ; IF NOT BRANCH
292 0006E4 012701 MOV #172520.R1 ; LOAD STD ADDR
172520
293 0006E8 010120 #: MOV R1,(RO)+ ; SAV STD TAPE
294 0006F0 005721 TST (R1)+ ; CHECK FOR RESPONSE
295 0006F2 005711 TST (R1) ; " "
296 0006F4 103572 BCS TGERR ; BRANCH IF NO RESPONSE
297 ;
298 ; DECODE CONFIGURATION WORD
299 ;
300 000766 010500 DECODE: MOV CFW.R0 ; MAKE A COPY
301 000770 042700 BIC #177770.R0 ; MASK UNIT & TAPE BITS
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DSD 890 BOOTSTRAP PROGRAM

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WINCHESTER READ WRITE TEST

\[
\begin{array}{ll}
302 & 000774 001073 \quad \text{BNE 10$\%$} \quad \text{JUMP IF NOT BASE ADDRESS} \\
303 & 000776 032705 \quad \text{BIT #PROMPT.CFW} \quad \text{IF IT IS SEE IF PROMPTING ENABLED} \\
304 & 001002 001470 \quad \text{BEQ 10$\%$} \quad \text{BRANCH IF NOT} \\
305 & 001004 004167 5$\%$. \quad \text{JSR R1.PRINT} \quad \text{LOAD R1 WITH POINTER TO PROMPT MSG} \\
306 & 000744 \quad \text{NLIST BIN} \\
307 & 001010 \quad \text{ASCII <15><12>/BOOT DEV/<15><12>} \\
308 & 001024 \quad \text{ASCII <40>/0=DLO, 1=DL1, 2=DL2, 3=TAPE, 4=FLP 177170, 5=FLP 177150>/} \\
309 & 001116 \quad \text{ASCII <15><12>/?/} \\
310 & \text{EVEN} \\
311 & \text{LIST BIN} \\
312 & 001122 004767 \quad \text{JSR PC.GETCHR} \quad \text{GET ANSWER} \\
313 & 001126 022700 \quad \text{CMP #15.R0} \quad \text{IS IT A CARRIAGE RETURN} \\
314 & 000015 \\
315 & 001132 001003 \quad \text{BNE 7$\%$} \quad \text{BRANCH IF NOT} \\
316 & 001134 005000 \quad \text{CLR R0} \quad \text{DEFAULT IS DLO} \\
317 & 001136 000167 \quad \text{JMP BOOTRL} \quad \text{GO BOOT IT} \\
318 & 000032 \\
319 & 001142 162700 7$\%$. \quad \text{SUB #0.R0} \quad \text{MAKE INTO NUMBER} \\
319 & 000060 \\
320 & 001146 020027 \quad \text{CMP R0,#5} \quad \text{MAKE SURE VALID ENTRY} \\
321 & 000003 \\
322 & 001152 003214 \quad \text{BGT 5$\%$} \quad \text{TRY AGAIN IF NOT} \\
323 & 001154 020027 \quad \text{CMP R0,#2} \quad \text{IT IS WINCHESTER ?} \\
324 & 000002 \\
325 & 001160 003405 \quad \text{BLE BOOTRL} \quad \text{IF SO GO TO DISPATCH} \\
326 & 001162 005200 \quad \text{INC R0} \quad \text{IF NOT INC TO OFFSET FOR RESERVED WINCH 3} \\
327 & 001164 022700 10$\%$. \quad \text{CMP #4.R0} \quad \text{IS IT TAPE ?} \\
328 & 000004 \\
329 & 001170 001513 \quad \text{BEQ BOOTTS} \quad \text{BRANCH IF SO} \\
330 & 001172 003542 \quad \text{BLE BOOTRX} \\
\end{array}
\]
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DSD 890 BOOTSTRAP PROGRAM    MACRO M1113 25-MAR-83 14:34 PAGE 5
WINCHESTER BOOT SECTION

327  SBTTL WINCHESTER BOOT SECTION
328
329  000001 LCS = X1
330  D: DISK BOOT, DETERMINE RLCSR BASE ADDRESS
331  001174 013701 BOOTRL: MOV •• 0.LCS ; EXT DISK ADDR AT LOCN 0
332  000000
333  001200 005701 TST LCS ; IF ZERO MEANS WINCH R/W ERROR
334  001204 105711 2$: TSTB (LCS) ; CHECK CONTROLLER READY
335  103464 BCS WRERR ; HANG IF NO BUS RESPONSE TO DEVICE
336  100375 BPL 2$ ; ELSE WAIT FOR CONTROLLER RDY
337  101210 012761 MOV #3. RLDA(LCS) ; DO RESET CONTROLLER ON GET STATUS
338  000003
339  000004
340  001220 001200 MOAB R0.R3
341  001222 000120 SWAB R3
342  001224 002700 BIS #.R3
343  001230 010311 MOV R3.(LCS) ; LCS - LOAD GET STATUS FUNCTION
344  012761 TSTB (LCS) ; WAIT FOR CONTROLLER READY
345  100376 BPL 3$ ;
346  100378 012761 MOV #177601..RLDA(LCS) ; SET MAXIMAL LENGTH SEEK OUTWARDS
347  177601 000004
348  001244 012700 MOV #6#400. R3 ; SEEK COMMAND
349  000000
350  001250 005003 BIS R0. R3 ; WITH UNIT BITS
351  001252 000303 SWAB R3 ; BACK TO UN UN CR IE DF DF FN FN GO
352  001254 010311 MOV R3.(LCS) ; LOAD RLO1 SEEK COMMAND
353  012761 TSTB (LCS) ; LCS - WAIT FOR CONTROLLER READY
354  100376 BPL 4$ ;
355  100378 012761 MOV #400. RLMP(R1) ; RLWC - SET WORDCOUNT FOR 1 BLOCK
356  177400 000006
357  000561 CLR .RLDA(R1) ; LOAD A ZERO INTO DISK ADDRESS REG
358  000004
359  001274 000561 CLR .RLBA(R1) ; LOAD A ZERO INTO BUS ADDRESS REG
360  000002
361  001300 027203 ADD #6. R3 ; MAKE SEEK INTO A READ COMMAND
362  000006
363  010311 MOV R3.(LCS) ; ISSUE READ FUNCTION
364  010314 105711 5$: TSTB (LCS) ; CONTROLLER READY?
365  100376 BPL 5$ ;
366  100378 TST (LCS) ; ERROR?
367  100376 BPL CHKNOP ;
368  100378 MOV #0'RE.RO ; BOOT READ ERROR CODE
369  100003
370  000426 BR BOOTERR ;
371  000132 CHKNOP:
372  001324 022727 CMP ••#0. #240 ; IS FIRST WORD NO-OP
373  000000
374  001332 001403 BEQ 1$ ; BRANCH IF SO
375  001334 012700 MOV #1BB.RO ; INVALID BOOT BLOCK CODE
376  000007
377  001340 000417 BR BOOTERR ; BRANCH TO COMMON ERROR ROUTINE
378  001342 005007 1$: CLR PC ; DISPATCH TO LOC 0.
DSD 890 BOOTSTRAP PROGRAM  MACRO M1113  25-MAR-83  14:34  PAGE 5-1
WINCHESTER BOOT SECTION

368  ; ERROR HANDLER
369
370
371 001344 012700  RWERR:  MOV  #WRW.R0  ; WINCHESTER READ WRITE ERROR
      000005
372 001350 000413  BR  BOOTERR
373 001352 012700  TGERR:  MOV  #TGE.R0  ; TAPE REGISTER ERROR
      000003
374 001356 000410  BR  BOOTERR
375 001360 012700  WGERR:  MOV  #WGE.R0  ; WINCHESTER REGISTER ERROR
      000002
376 001364 000409  BR  BOOTERR
377 001366 012700  FGERR:  MOV  #FGE.R0  ; FLOPPY REGISTER ERROR
      000004
378 001372 000402  BR  BOOTERR
379 001374 012700  BRERR:  MOV  #BRE.R0  ; BOOT READ ERROR
      000006
380
381
382
383 001400  BOOTERR:
384 001400 010103  MOV  R1,R3  ; PARM IN R3
385 001402 012701  MOV  #BREV.R1  ; BOOT PROG REVISION
      000000
386 001406 013702  MOV  #10.R2  ; PROM REV
      000010
387 001412 105002  CLR  R2  ; PUT IN LOW ORDER BITS
388 001414 000302  SWAB  R2
389 001416 000000  HALT  ; AND STOP

DSD 890 BOOTSTRAP PROGRAM  MACRO M1113  25-MAR-83  14:34  PAGE 6
TAPE BOOT SECTION

391  ; SBTL TAPE BOOT SECTION
392
393
394
395  ; SETUP R1 TO TSSR ADDRESS
396 001420 013701  BOOTTS:  MOV  #2.R1  ; LOCN 2 HOLDS SELECTED TAPE
      000002
397 001424 005701  TST  R1  ; CHECK IF R1 = 0
398 001426 001751  BEQ  TGERR  ; IF SO NO TAPE
399 001430 000401  BR  10$  ; NEXT WORD MUST BE AT FIXED OFFSET
400 001432 046523  .WORD  46523  ; DEVICE "MS" ID BACKWARDS
401
402 001434 062701 10$:  ADD  #2.R1  ; R1=TSDB+2
      000002
403 001440 010102  BTRTRY:  MOV  R1,R2  ; R2 = TSSR
404 001442 005000  CLR  RO
405 001444 105711 1$:  TSTB  (R1)  ; WAIT FOR SSR
406 001446 100376  BPL  1$  ; OFFSET = "SM" + 20
407 001450 010704  MOV  PC,R4
408
409 001452 010103  MOV  R1,R3  ; R3=TSRR
410 001454 062703  ADD  #1.R3  ; BOOT REQUIRES WRITE TO BASE + 3 (172523)
      000001
411 001460 112713  MOVV  #200.(R3)  ; TSV05 IMPLIED BOOT
      000200
412 001464 005242  INC  -(R2)  ; WRITE INTO TSDB
413 001466 105711 2$:  TSTB  (R1)  ; WAIT FOR SSR
414 001470 100376  BPL  2$  ; TEST FOR ERROR
415 001472 005711  TST  (R1)  ; RETRY IF SC
416 001474 100761  BMI  BTRTRY  ; RETRY IF SC
417 001476 005007  CLR  PC  ; JUMP TO ZERO
.SBTTL FLOPPY BOOT SECTION

BOOT THE DEVICE IN R1. REGISTERS USED AS INDICATED BELOW

XCS= %1 R1 POINTER TO RXCS
XDB= %2 R2 POINTER TO RXDB
LDP= %4 R4 LOAD POINTER
SCT= %5 R5 CURRENT SECTOR # (1, 3, 5, 7)

R1: MOV #177170.XCS ; STD FLPY ADDRESS
    177170
R2: CMP R0, #6 ; WAS ALTERNATE SPECIFIED ?
R3: BNE 1$ ; BRANCH IF NOT
R4: MOV #177150.XCS ; LOAD ALTERNATE ADDRESS
    177150
R5: MOV #7.R3
    000007

CLR LDP ; INIT LOAD ADDRESS POINTER
    000100

MVI #100. -(SP) ; SET LOW DENSITY WORDCOUNT
    000001

MVI #1, SCT ; INIT SECTOR TO READ

CLR R0 ; ONLY UNIT 0 ALLOWED FOR FLPY
RDLP: CALL WTFLAG ; WAIT FOR DONE FLAG SET?

MVI XCS, XDB ; COPY RXCS POINTER

MVI R3, (XDB)+ ; LOAD READ COMMAND AND BUMP XDB TO RXDB

MVI 105711 1$ ; TSTB (XCS) ; WAIT FOR TRREQ
    105711

MVI 100376 2$ ; TSTB (XCS) ; LOAD TRACK
    100376

MVI #1, (XDB) ; LOAD COMMAND

MVI #04767 CALL WTFLAG ; WAIT FOR DONE
    000001

MVI 001572 005711 TSTB (XCS) ; KLUDGE SINCE DEC RX02 SETS ERROR

MVI 100010 BPL EMBUF ; EMPTY IF NO ERROR

MVI 000020 BIT #20, (XDB) ; IS ERROR A DENSITY ERROR?

MVI 01674 BEQ BRERR ; NO- FLOPPY READ ERROR

MVI 052703 BIS #400, R3 ; SET COMMAND TO DOUBLE DENSITY
    000000

MVI #200. (SP) ; SET TO D.D. WORD COUNT
    000001

BR RDLP ; AND TRY READING AGAIN

MVI 012610 012716 MOV (SP)+, (XCS) ; AND EXECUTE
DSD 890 BOOTSTRAP PROGRAM

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FLOPPY BOOT SECTION

463 001626 105711 1$: TSTB (XCS) ; WAIT FOR FIRST TRREG
464 001630 100376 BPL 1$ ; LOAD THE WORD COUNT
465 001632 011612 MOV (SP). (XDB) ; AND XFER ADDRESS
466 001634 105711 2$: TSTB (XCS)
467 001636 100376 BPL 2$ ; AND XFER ADDRESS
468 001640 010412 MOV LDP. (XDB) ; AND XFER ADDRESS
469 001642 004767 CALL WTFLAG WAIT FOR DONE OR TRREG
000020
470 001646 061604 ADD (SP). LDP ; BUMP LOAD ADDRESS FOR NEXT SECT
471 001650 061604 ADD (SP). LDP ; ADD ACTUAL BYTE COUNT
472 001652 122525 CMPB (SCTl+. (SCTl+ BUMP SECTOR # BY 2
473 001654 020427 CMP LDP. #1000 ; FINISHED LOADING?
001000
474 001660 002726 BLT RDLP ; READ NEXT SECTOR
475
476 001662 000167 177436
477
478
479 ; WAIT FOR FLOPPY FLAGS. DONE, ERROR, TRREG
480
481 001666 032711 WTFLAG BIT #240. (XCS) ; WAIT FOR DONE OR TRREG
000240
482 001672 001775 BEQ WTFLAG ; CAN'T TEST RX02 ERROR HERE
483 001674 000207 RETURN


E-13

DSO 890 BOOTSTRAP PROGRAM  MACRO M1113  25-MAR-83 14:34 PAGE 8
I/O SUPPORT SECTION

485  .SBTL I/O SUPPORT SECTION
486  
487  ; I/O SUPPORT SECTION
488  
489  ; GETCHR - RETURNS CHAR VALUE IN RO. LSTCHR
490  ; CLEARS PARITY BIT

492  105737 GETCHR: TSTB @@KS
          177560
493  001702 100375 BPL GETCHR
494  113700 MDVB @@TKB. RO
          177562
495  042700 BIC @-C177. RO
          177600

496  
497  ; FALL THROUGH TO OUTCHR TO ECHO INPUT
498  
499  ; OUTCHR PRINTS CHAR IN RO

500  

501  105737 OUTCHR: TSTB @@TPS
          177564
502  100375 BPL OUTCHR
503  110037 MDVB RO. @@TPB
          177566
504  105737 TSTB @@KS
          177560
505  100007 BPL 10%
506  113746 MDVB @@TKB. -(SP)
          177562
507  042716 BIC @-C177. (SP) ; STRIP PARITY
          177600
508  122627 CMPB (SP)+, '#S-100 ; CTRL B? REQUIRED FOR HIGH SPEED TERMINALS
          000023
509  001771 BEQ 4%
510  000207 10%: RTS PC
511  
512  ; PRINT STRING POINTED AT BY R1 (TERMINATED BY 0 BYTE)

513  

514  PRINT:
515  112100 MDVB (R1)+.RO ; TO RO FOR OUTCHR
516  105700 TSTB RO ; AT END OF STRING?
517  000140 BEQ 20%
518  004767 JSR PC.OUTCHR ; OUTPUT (RO)
519  000772 BR 10% ; LOOP
520  000201 RTS R1
521  001772 BOTLST: 
522  000001 .END
VIRTUAL MEMORY USED: 848 WORDS (4 PAGES)
DYNAMIC MEMORY: 2622 WORDS (10 PAGES)
ELAPSED TIME: 00.00.23
BB90X2.BB90X2/LI:TTM/-SP=BB90X2
SPECIAL SUPPLEMENT

For

LSI-11/73 Compatibility

1.0 SCOPE

This special supplement affects the DSD 890 User Guide only when used with the LSI-11/73 computer.

The DSD 890 System utilizes the 8240 controller, and release three of the microcode permits use of the system with the LSI-11/73. The information contained in this supplement is intended to facilitate system use with this computer device.

The material is arranged into change pages that can be slipped into the manual in place of the standard cited pages.

2.0 ACTION

Replace the manual pages with the change pages attached to this supplement only if your intended use of your system is with the LSI-11/73 CPU. No action is required if used with other compatible computer devices.
November 21, 1984

808240-03 RELEASE NOTE

The purpose of this note is to document the known problems and work-around solutions with the 808240-03 controller being shipped with your system.

1. TSX and TSX-Plus will hang when exiting the TSX monitor to RT-11. The work-around solution is to re-boot the system.

2. In RSX-11M-Plus, Shadow Mode Recording is not supported when one unit is powered-down.

3. In all operating systems, operating in Power-up Mode 0 (battery backup) is not supported.

Problems resolved on the 808240-03 controller from the 808240-02 controller are:

1. All 11/73-compatible problems with RSX-11M and RSX-11M-Plus appear to be resolved as long as RSX-11M has had Autopatch C or greater applied and in RSX-11M-Plus as long as Autopatch D or greater has been applied. BRU, BRU64K, and IDX all function properly.

2. A time-out has been added for initializing brand new tapes under RSTS/E.

3. Due to DEC modifications to the latest 11/73 processor, a problem has been corrected where the bootstrap hangs when booting.
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Figure 4-5. Cabinet and Board Cabling
4.6.3. Configuring Controller Board

The D8240 controller is configured with jumpers. These jumpers are installed between pairs of pins at various locations on the printed circuit board. It is important that the board is properly configured before it is used with a computer system.

The jumpers on the D8240 controller board are grouped in six classes:

1. **Bootstrapping Options.** This group provides jumpers to enable or disable the built-in boot program (W16 and W17), select boot address (W10) and boot mode (W31), and control line-time clock (LTC) interrupts (W8 and W9).

2. **Device Options.** The jumpers in this group enable or disable the disk (W15) and select disk address and interrupt vectors (W11). There are also jumpers to enable or disable the tape (W12 and W13), select tape address and interrupt vectors (W18), select tape drive emulation mode (W32), and enable or disable tape drive POCs (W33).

3. **Interrupt Priority Options.** The jumpers in this group select the disk and/or tape interrupt priority level (W20 and W21).

4. **DMA Request Monitor Option.** Two jumpers in this group (W6 and W7) enable or disable the option.

5. **Error Correction Option.** One jumper (W25) enables or disables the option.

6. **CPU Option.** One jumper (W24) changes this option.

Figure 4-6 shows the location of the controller jumpers. Table 4-3 is a reference chart that lists all jumpers, including those used for testing the board at the manufacturing facility.

The factory configuration is based on the most common applications used by customers. If this "standard" configuration satisfies you, skip the rest of this section, go to the next section, and mount the board.

If you need to reconfigure the board, read the rest of this section and use flowcharts Figures 4-7 through 4-11 and Figure 4-11A. Each figure is preceded by pertinent information.
Table 4-3. D8240 Jumpers (Cont)

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Shipped</th>
<th>Option Class</th>
<th>Function (As Shipped)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W21</td>
<td>Removed</td>
<td>Int. Priority</td>
<td>At Level Five</td>
</tr>
<tr>
<td>W19</td>
<td>(Not used on this board)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W20</td>
<td>Installed</td>
<td>Int. Priority</td>
<td>At Level Five</td>
</tr>
<tr>
<td>W22</td>
<td>Removed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W23</td>
<td>Removed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W24</td>
<td>Removed</td>
<td>CPU</td>
<td>11/2, 11/23, 11/23+ CPU</td>
</tr>
<tr>
<td>W25</td>
<td>Removed</td>
<td>Error Correction</td>
<td>Enabled</td>
</tr>
<tr>
<td>W26</td>
<td>(Not used on this board)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W27</td>
<td>Installed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W28</td>
<td>Removed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W29</td>
<td>Removed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W30</td>
<td>Installed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
<tr>
<td>W31</td>
<td>Removed</td>
<td>Boot</td>
<td>CM Boot Disabled</td>
</tr>
<tr>
<td>W32</td>
<td>Removed</td>
<td>Device</td>
<td>TSV05 Emulation</td>
</tr>
<tr>
<td>W33</td>
<td>Removed</td>
<td>Device</td>
<td>Tape POCs Enabled</td>
</tr>
<tr>
<td>W34</td>
<td>Installed</td>
<td>N/A</td>
<td>Factory use</td>
</tr>
</tbody>
</table>

4.6.3.1. Bootstrapping Options

LSI-11 computers use a "bootstrapping" technique for loading software programs. This technique consists of loading a primary set of instructions into main memory that, when executed, enables the CPU to load a secondary and, slightly longer, set.
The secondary set or bootstrap loader, as it is also known, enables the CPU to load complete operating systems and application programs.

The primary boot is contained in the DSD 890 diagnostic control board. This board contains a program in PROM, which initializes system memory, including parity. It also checks the Controller, Winchester drive, and permits bootstrap loading (second boot) from any Winchester volume, the Tape drive, or a RX02-compatible floppy—such as DS-100/105 subsystems.

This primary boot is enabled or disabled with two jumpers. The program can be selected from starting address 17773000 (DEC normal) or 17771000 (DEC alternate). One jumper selects this address.

Most DEC LSI-11 CPU modules are configured in one of two power-up modes. Some modules may be configured in as many as four power-up modes. Because of these variations, you should consult your DEC documentation for specific details about the CPU module that you are using. As an example, LSI-11/23 modules can be configured to power-up in modes 1 and 2. The DSD 8240 Controller will behave differently depending on the selected power-up mode.

In mode 1, the CPU enters console ODT without attempting to boot. At that point, the user must manually initiate the primary boot by typing the address of the boot device. That is, 17773000 or 17771000 for the DSD Winchester boot PROM, or the address of some other device boot PROM in the system.

In mode 2, power applied to the module causes the CPU to internally generate a bootstrap starting address (17773000) and begin to execute instructions found at that address.

The DSD 8240 Controller provides two secondary boot modes: conversational and non-conversational. The conversational mode prompts the user, via console, to select a device for the secondary boot.

In non-conversational mode, there are, again, differences based on the selected power-up mode. To use the LSI-11/23 example once more:

- In mode 1, the secondary boot device can be selected, via console ODT, by typing the device starting address.
- In mode 2, the secondary boot will be obtained from volume 0 of the Winchester drive.
Figure 4-11. Error Correction Option
Figure 4-11A. CPU Option
Figure 4-12. Common LSI-11 Backplanes