DSD 890
User Guide
Model DSD-890

Revision 1
P N 040044-02

DATA SYSTEMS DESIGN

Printed in USA.

WARRANTY

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.

PREFACE

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.

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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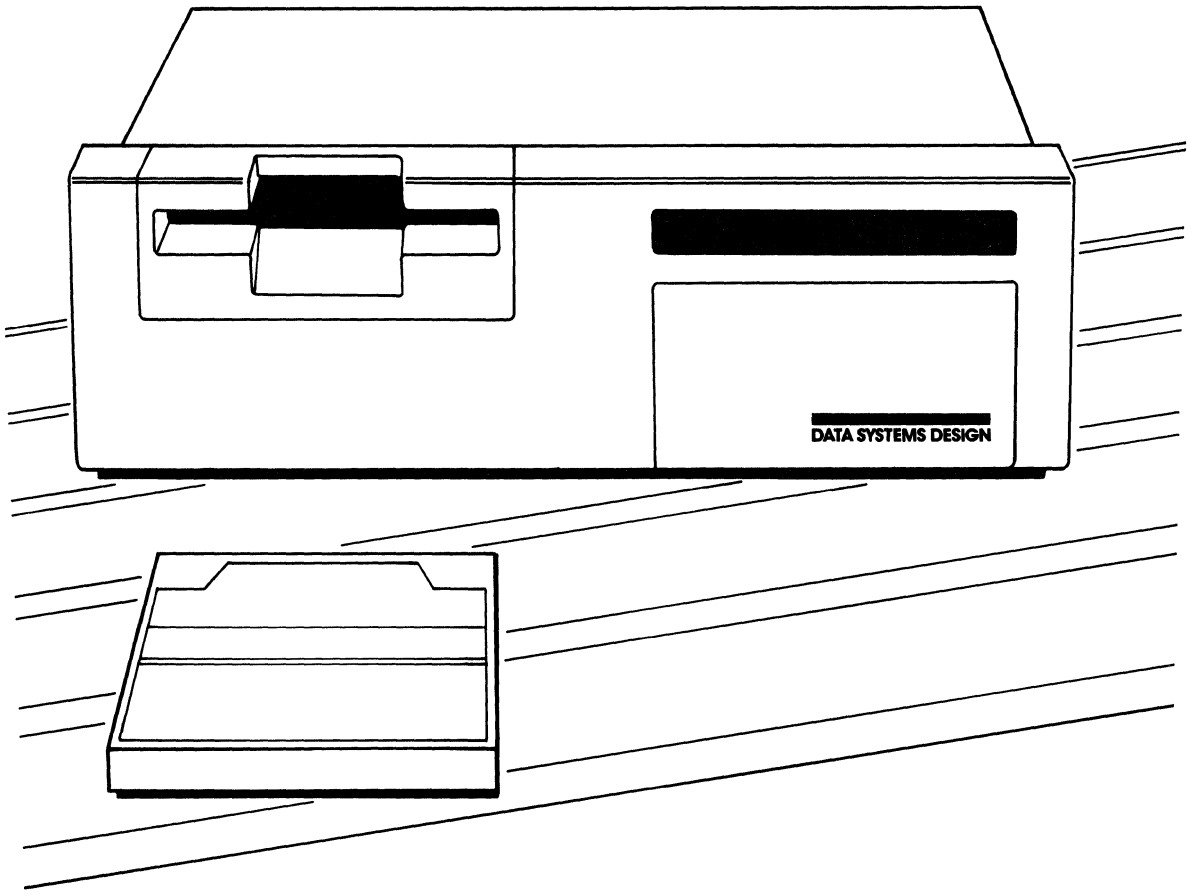

DSD 890 Winchester and Tape Storage System

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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-11 computers via the DSD 8240 Controller board. This quad-wide board is hardware compatible with all DEC LSI-11 bus (Q-Bus) backplanes. The board is, both, a bus interface for the storage cabinet and an intelligent controller that emulates DEC RL02, and TS11/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 HyperDiagnostics 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 HyperDiagnostics 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).

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2 SPECIFICATIONS

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

Module	Part Number
System Cabinet	
Chassis	700267-01
Display Control Board	808945-01
Winchester Disk Drive (60 Hz) or,	900482-01
Winchester Disk Drive (50 Hz)	900482-02
Tape Drive	900473-01
Fan Assembly	900112-01
Power Supply, Linear (100 Watts)	500014
Diagnostic Control Board	808940-01
Computer Interface	
Controller Interface (8240) Board	808240-01
Interface Cable Shipping Kit	900476-01

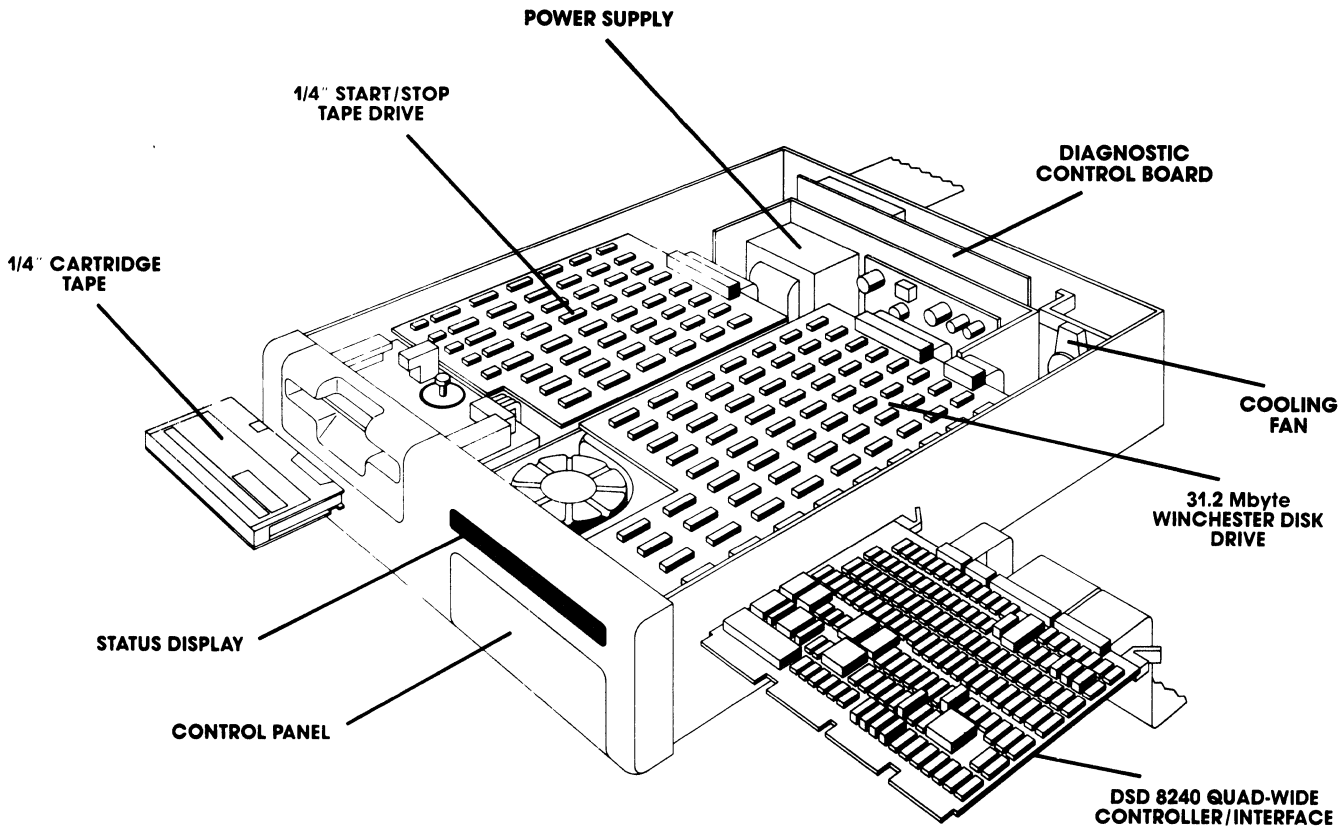

Figure 2-1. System Modules

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

GENERAL		
	WINCHESTER DRIVE	**TAPE DRIVE**
Emulates	Three RL02s	TS-11
Modifications to Operating System Software	None	None
Formatted Capacity	10.4 Mbytes/RL02 image 31.2 Mbytes total	16.25 Mbytes (450 ft. cartridge, 16 Kbyte blocks)
DATA ORGANIZATION		
Recording technique	MFM	GCR
Bytes/disk sector	256	—
Bytes/tape block	—	512-16K
Error detection	Header CRC Data ECC, Transparent Correction	CRC
Flaw management	Spare track assignment is user transparent	—
Recording density	6600 bpi	6400 bpi
Track density	345 tpi	—
Number of read/write heads	8	1
Number of tracks	512	4 (Serpentine)
SPEEDS		
Disk seek time (including head setting)		
Average	65 ms	—
Maximum	100 ms	—
Track-to-track	15 ms	—
Disk head switching time	20 ms	—
Disk average latency	10 ms	—
Disk start-up time	30 sec.	—
Tape speed		30 ips (read/write) 70 ips (rewind)
Tape rewind time		3 minutes max.
Data transfer time	WITHIN A SECTOR / WITHIN A CYLINDER / ACROSS ENTIRE DISK	
Non-interleaved Kbyte/s	542.5 / 396.8 / 352.7	
2-way interleaved Kbyte/s	542.5 / 198.4 / 186.7	
Data transfer length	5.1 Kwords maximum	256 to 8 Kwords
Time to read or write RL02 image (10.4 Mbytes)	25.5 seconds	8.95 minutes
ERROR RATES (W/O ECC)		
Soft read errors	1 per 10^{10} bits read	1 per 10^{10} bits read
Hard read errors	1 per 10^{12} bits read	1 per 10^{11} bits read
Seek Errors	1 per 10^{6} seeks	—

Table 2-3. Cabinet Specifications

CHASSIS OPERATING VOLTAGE AND POWER REQUIREMENTS

POWER LINE FREQUENCY

The DSD 890 is availble in two versions for use on either 50Hz or 60 Hz AC power.

Order DSD 890-A for use of 60 ± 0.5Hz Service
Order DSD 890-B for use on 50 ± 0.5Hz Service

VOLTAGE RANGES

The DSD 890 has four operator selectable AC voltage ranges to cover world wide power distribution conditions. These AC voltage ranges are as follows:

100VAC ± 10%
120VAC ± 10%
220VAC ± 10%
240VAC ± 10%

An AC voltage range is selected by setting the range selector switch on the AC power input receptacle on the rear of the chassis

NOTE: The DSD 890-A (60Hz) will be shipped set for use on 120VAC ± 10%
The DSD 890-B (50Hz) will be shipped set for use on 220VAC ± 10%

POWER REQUIREMENTS

Average power consumed 300 watts
Maximum starting surge power 500 watts, 5 seconds maximum

ENVIRONMENTAL SPECIFICATIONS

	OPERATING	NON-OPERATING
Temperature	10°C to 40°C	– 40°C to 66°C
Relative Humidity, Maximum Wet Bulb	20% to 80% (non-condensing)	
Altitude	10,000 feet maximum	30,000 feet

CHASSIS DIMENSIONS

Overall Dimensions	5.25 in. h x 17.6 in. w x 21.0 in. d (13.34 cm. h x 44.7 cm. w x 53.34 cm. d)
Shipping Carton	10.5 in. h x 24.0 in. w x 33.5 in. d (26.7 cm. h x 61.0 cm. w x 85.1 cm. d)

WEIGHTS

MODEL	SYSTEM WEIGHT	SHIPPING WEIGHT
DSD 890	53 lbs (24 Kg)	65 lbs (29.5 Kg)

Table 2-4. Interface Specifications

LSI-11 INTERFACE	**WINCHESTER DRIVE**	**TAPE DRIVE**
Backplane Requirement	One quad-wide Q-Bus slot in any Q-Bus backplane	
Device Address		
Standard	17774400	17772520
Alternate	17774420	17772530
Interrupt Address		
Standard	160	224
Alternate	150	170
Bootstrap Address		
Standard	17773000	
Alternate	17771000	
POWER REQUIREMENTS	5 VDC (5.5 A) 12 VDC (0.1 A)	

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

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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 TS11/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 89Ø 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 8X3Ø5, 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 89Ø 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 RLØ2 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.

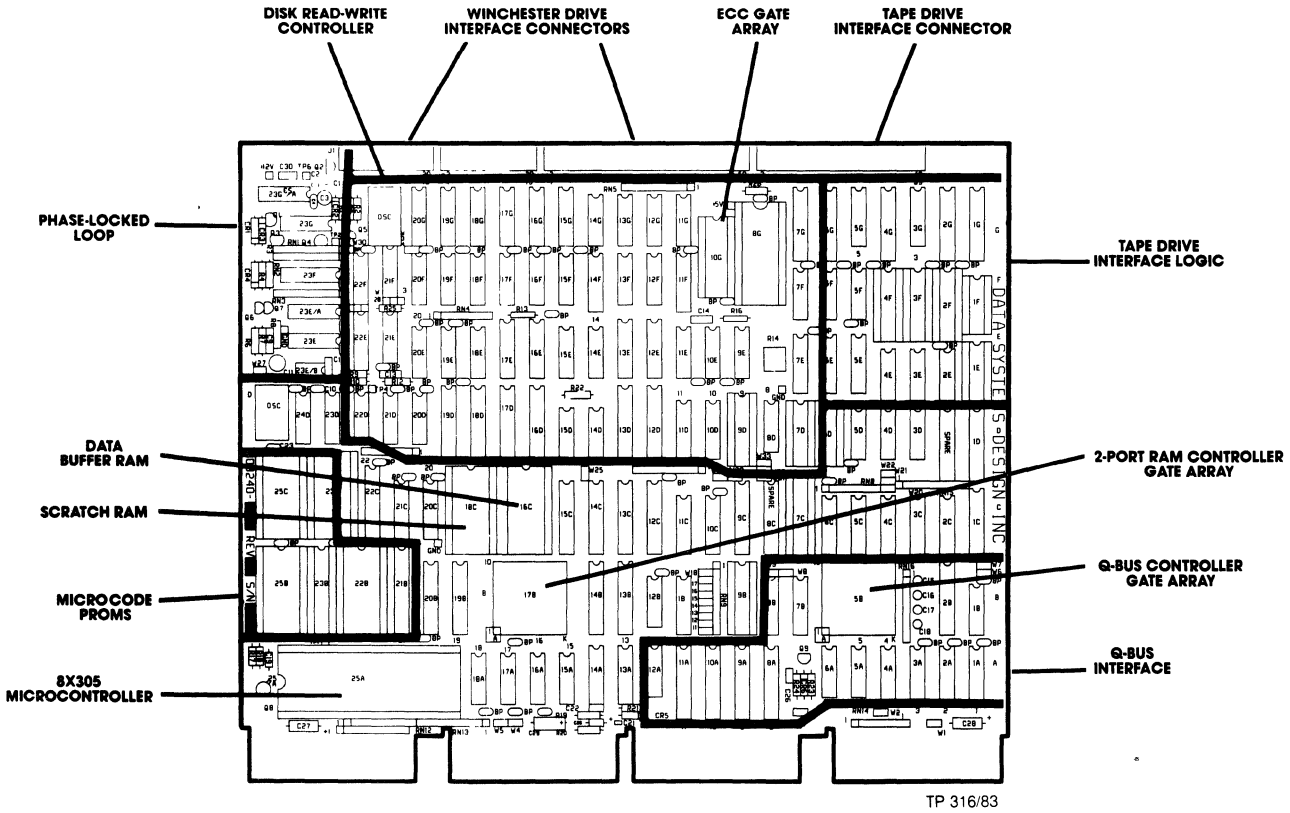

Figure 3-1. DSD 8240 Controller Board

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.

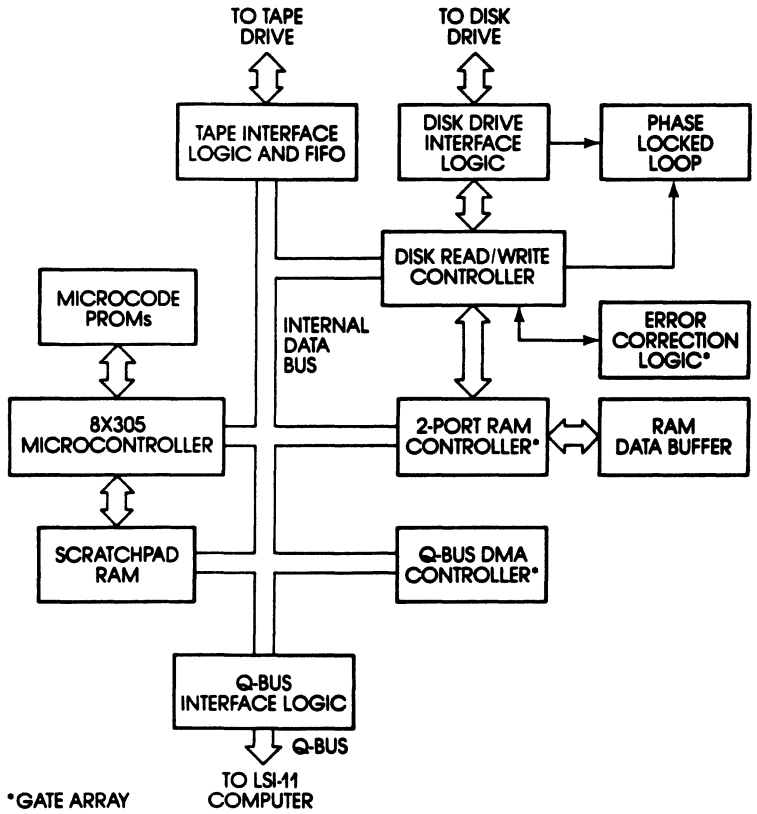

Figure 3-2. Controller Architecture

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-11 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.)

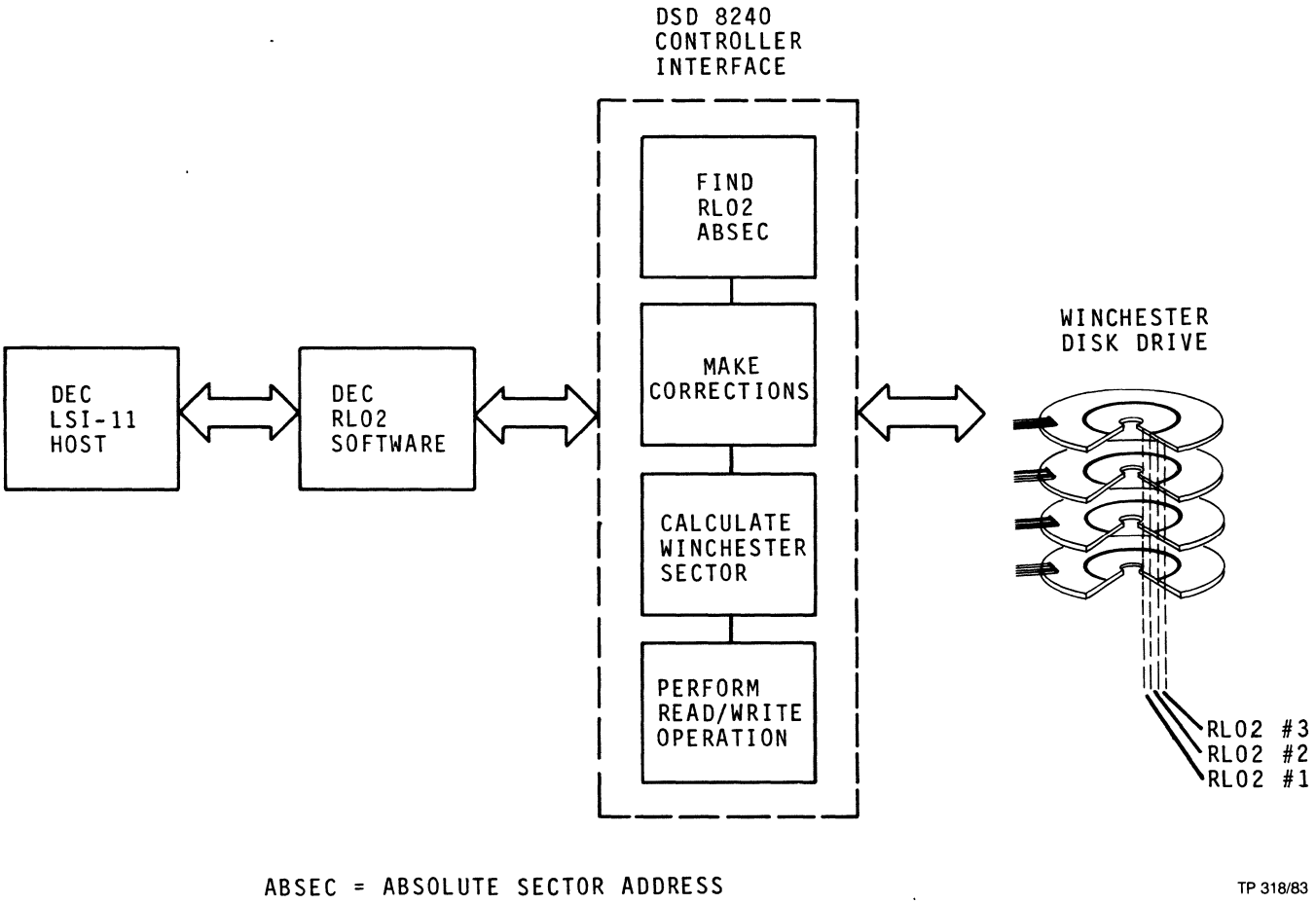

Figure 3-3. DSD Winchester/RLØ2 Emulation

The following paragraphs describe the conversion process used by the Controller:

(1) The absolute sector number (ABSEC) is determined. RLØ2 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 Ø to 1; sector numbers from Ø to 39. The firmware in the microcontroller uses the following formula:

- ABSEC = SEC + (4Ø x HD) + (8Ø x CY)

(2) Corrections are made. An offset is added to identify the RLØ2 being accessed and a correction for flaws is made based on a flaw translation table stored on track Ø 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 RLØ2 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.)

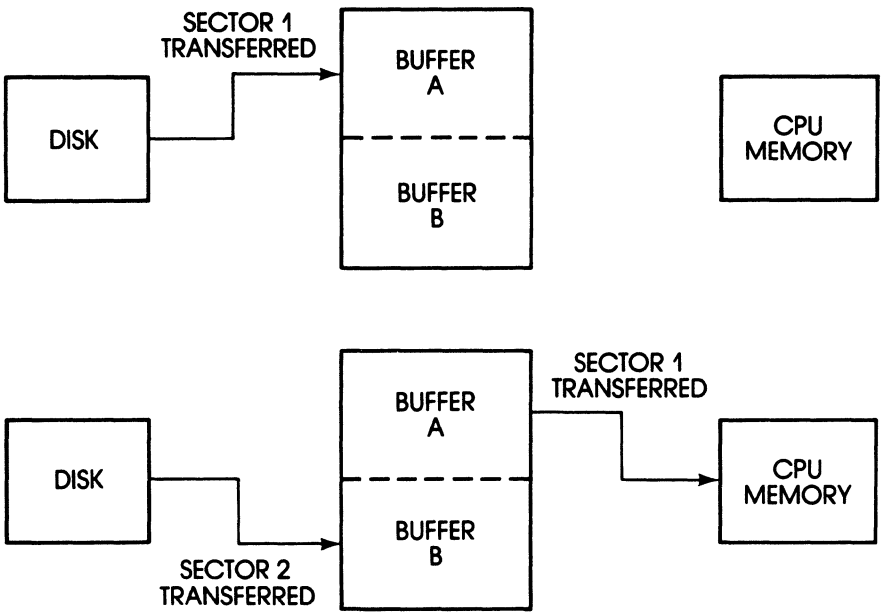

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Figure 3-4. Two-Port RAM Buffer Data Transfer

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-11 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:

- Storage Capacity = Bytes/inch x Tracks x Length; in our case this is: 800 x 4 x 5400 = 17.28 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-amble.

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 3-1. Block Size vs Tape Storage Capacity

BLOCK SIZE (Bytes)	STORAGE CAPACITY (Mbytes)
256	3.56
512	5.91
1K	8.80
2K	11.65
4K	13.91
8K	15.40
16K	16.25

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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

Indicator	Function
POWER	• Lights to show cabinet is powered-up
WIN ACTIVE	• Lights to show Winchester drive is active
WIN WP	• Lights when any WIN VOLUME WRITE PROTECT switch is ON
FAULT	• Lights to show system fault (see Chapter 7 for details)
TAPE ACTIVE	• Lights to show Tape drive is active
UNLOAD	• Lights to show tape cartridge is at unload point and safe to remove from Tape drive

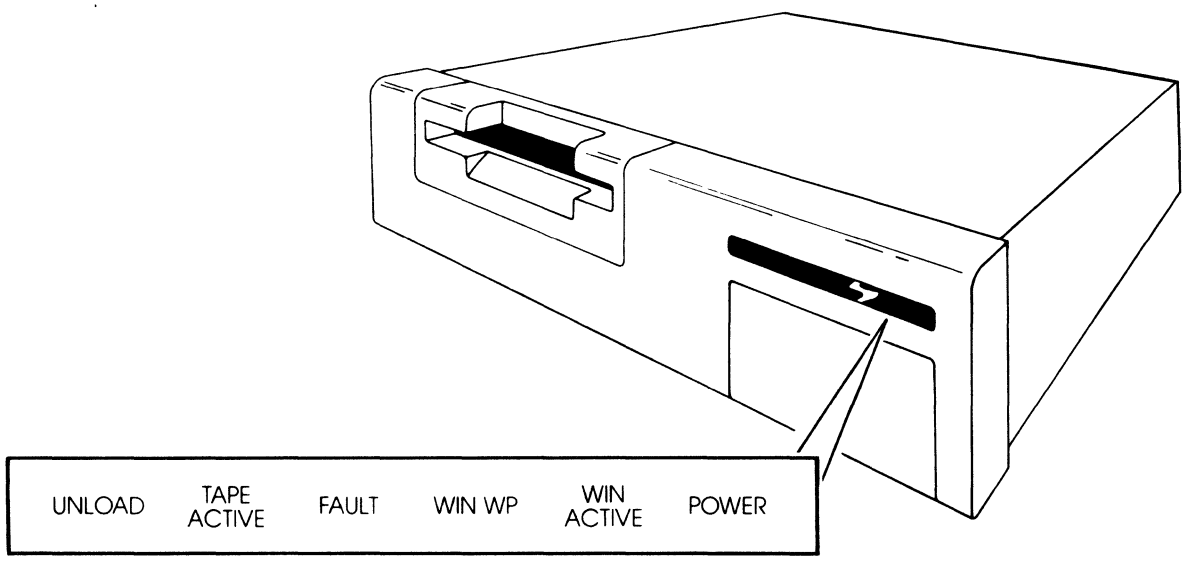

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Figure 4-1. Status Panel

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

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

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.

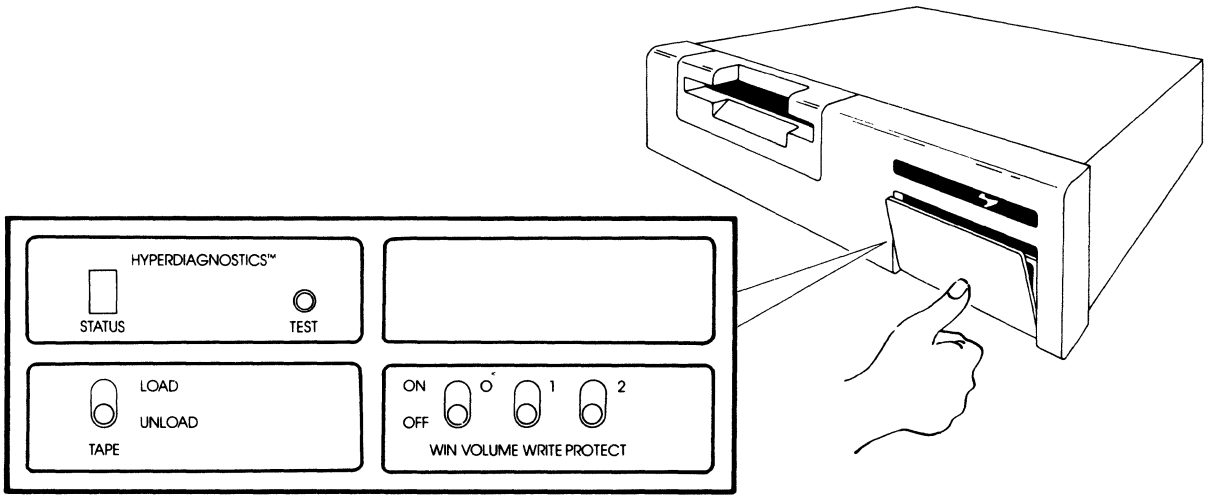

Figure 4-2. Operator Panel

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

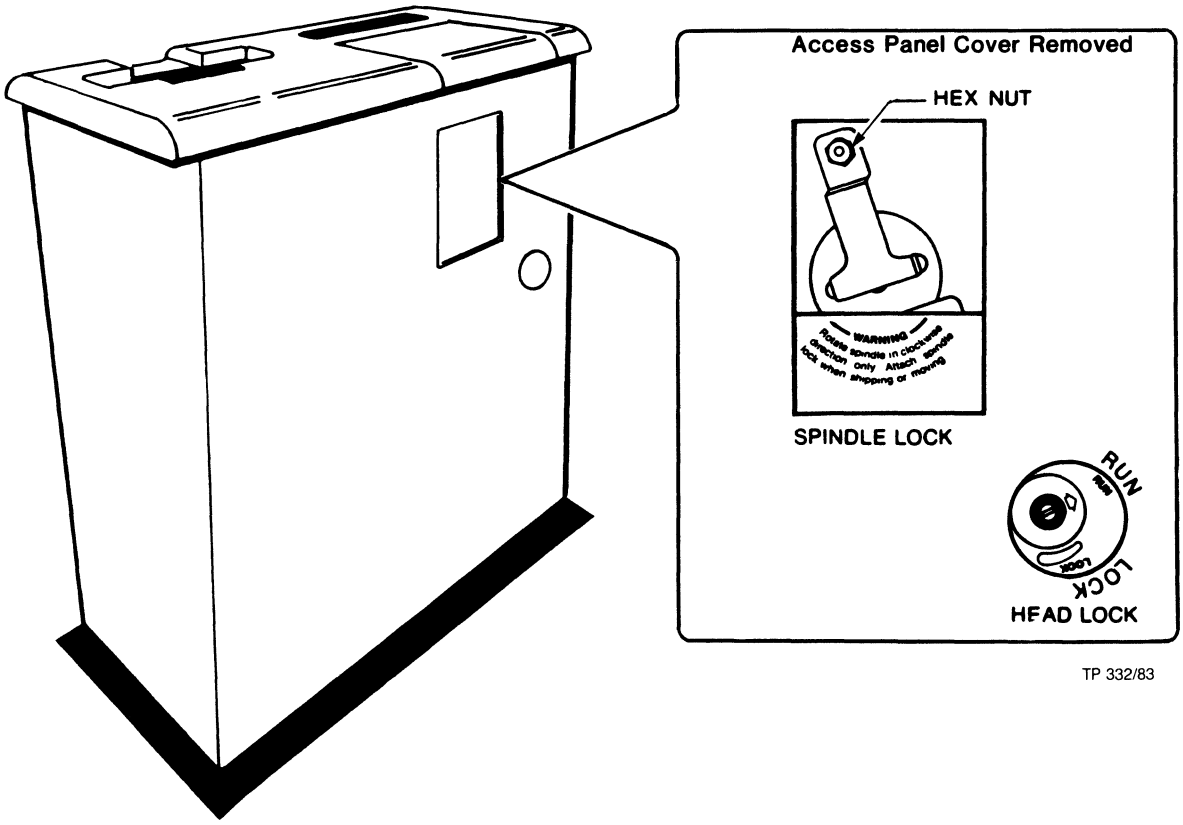

Figure 4-3. Winchester Spindle and Head Lock

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.

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* 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.

(2) 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.

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

(4) Install cabinet retaining screws.

(5) Re-install bezel by locating guide pins and firmly pressing 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 connector 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:

(1) Remove protective cable clamps from cabinet connectors and set aside.

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

(3) 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.

(4) Inspect cable connector on notched end and observe a triangular marking etched on one side. This marking identifies pin 1.

(5) Go to rear of cabinet and locate DATA INPUT rear panel connector. Notice marking identifying pin 1.

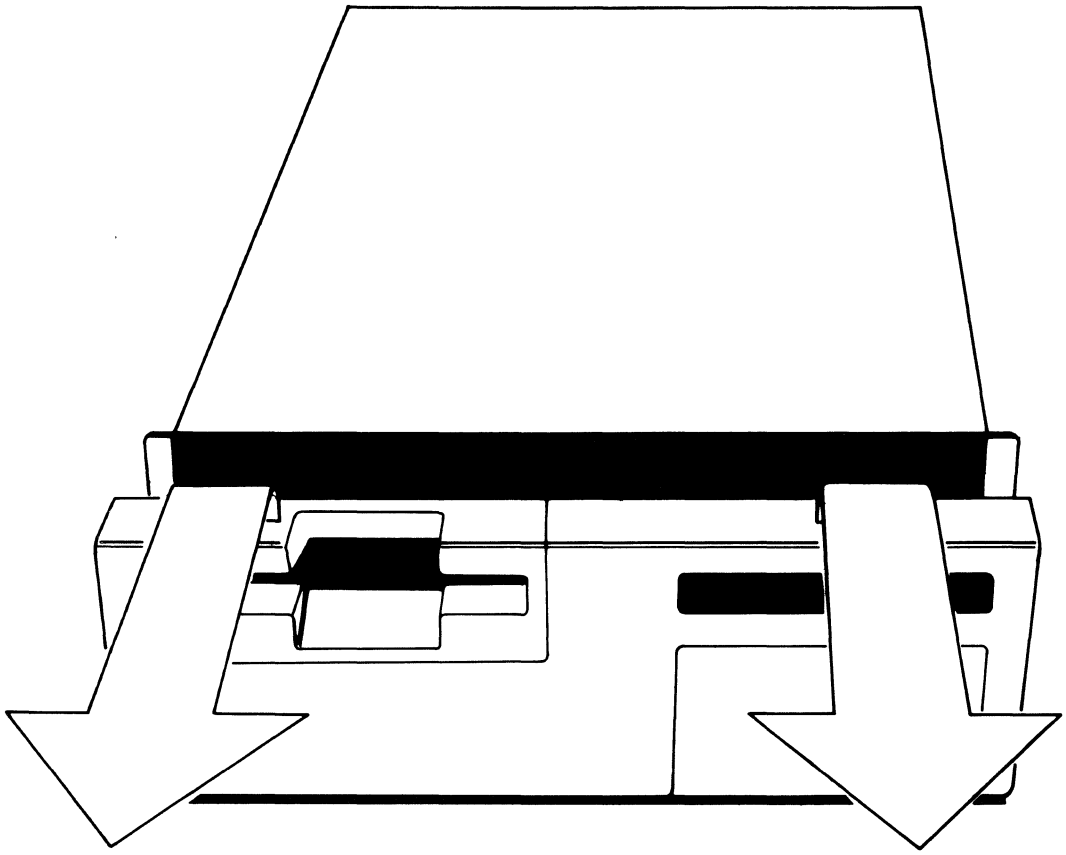

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Figure 4-4. Front Bezel Removal

(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.

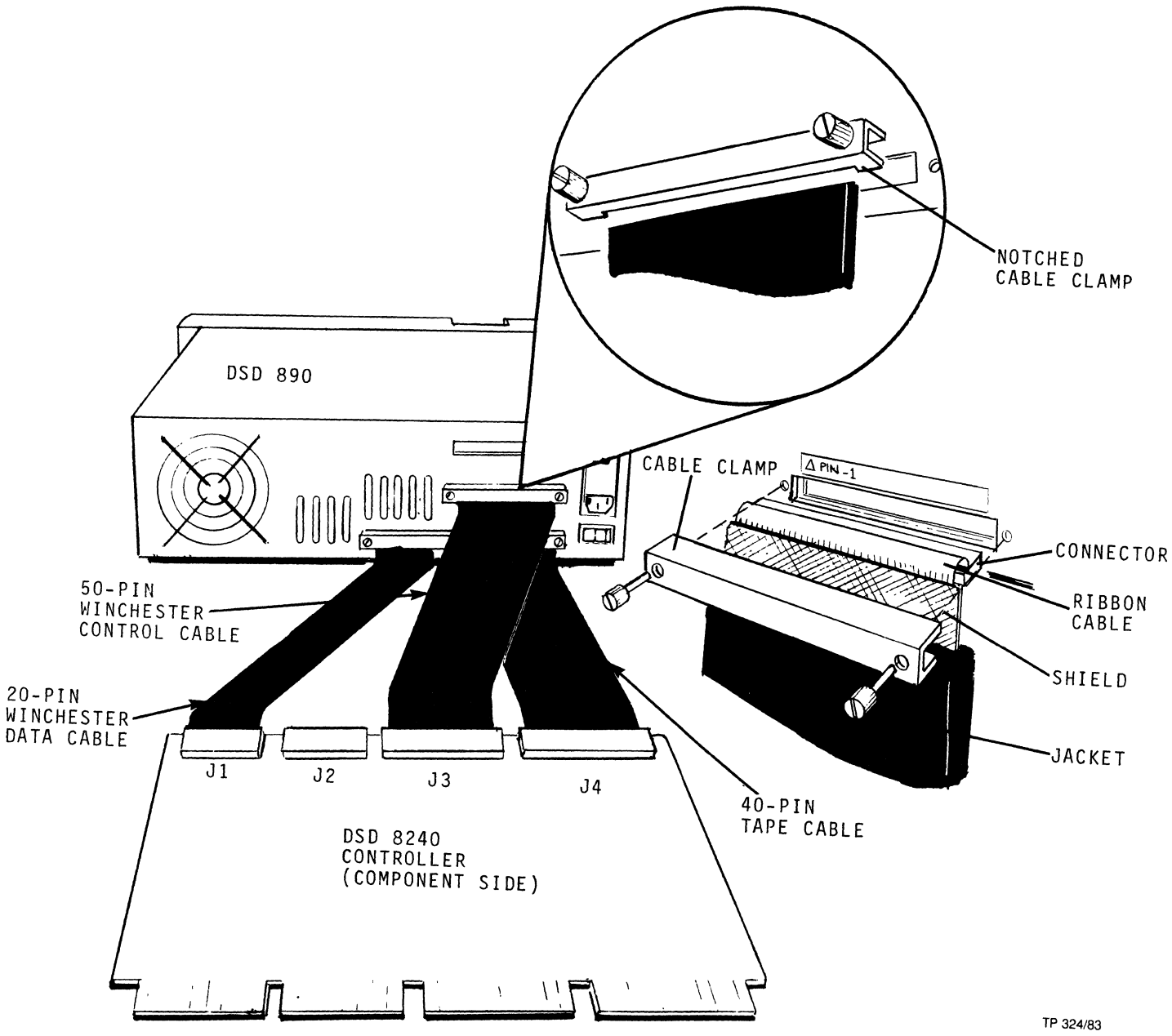

Figure 4-5. Cabinet and Board Cabling

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.

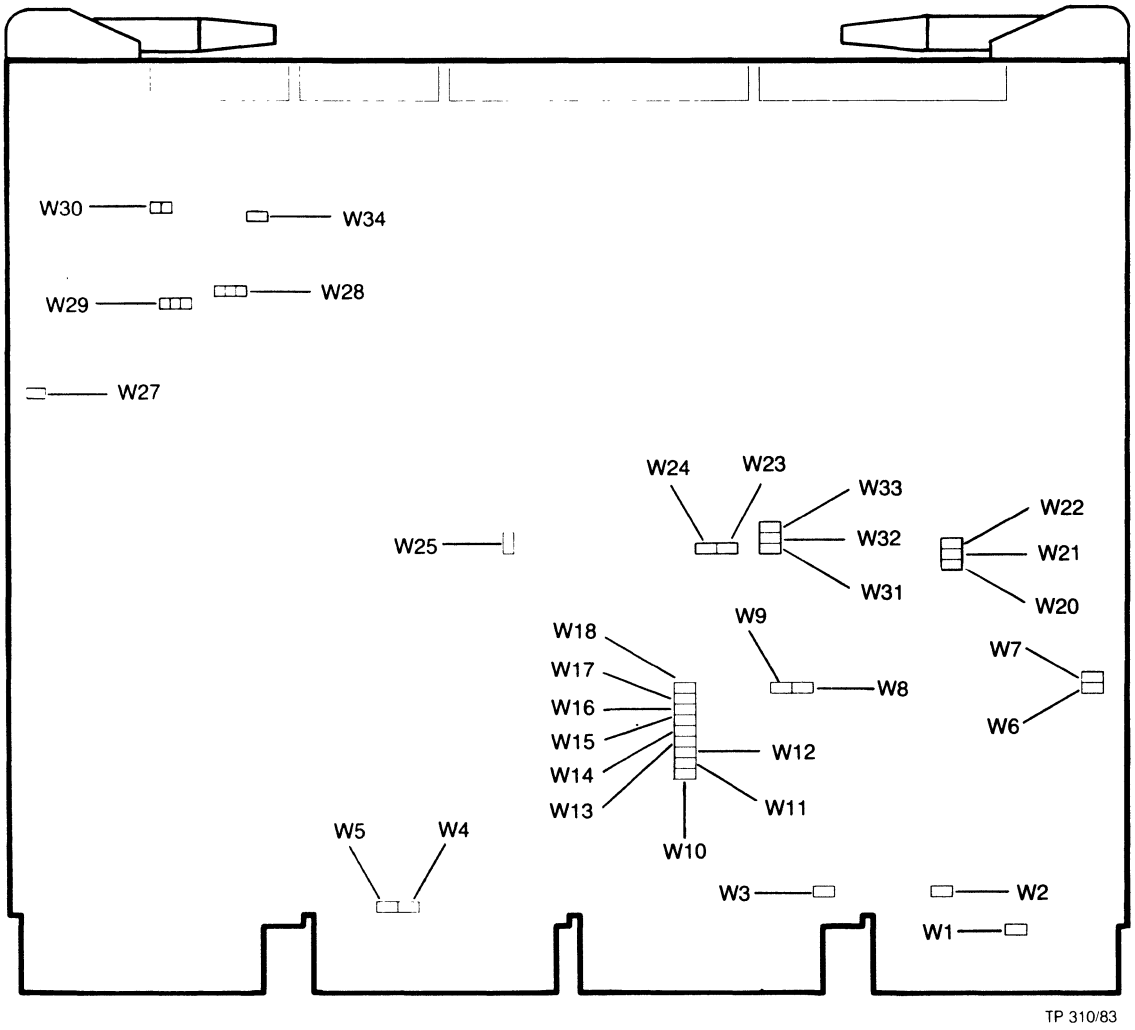

Figure 4-6. DSD 8240 Jumpers

Table 4-3. DSD 8240 Jumpers

Jumper	Shipped	Option Class	Function (As Shipped)
W1	Installed	N/A	Factory use
W2	Installed	N/A	Factory use
W3	Installed	Boot	LTC Disabled
W4	Installed	N/A	Factory use
W5	Installed	N/A	Factory use
W6	Removed	DMA Request	Monitor Disabled
W7	Installed	DMA Request	Monitor Disabled
W8	Removed	Boot	LTC Disabled
W9	Installed	Boot	LTC Disabled
W10	Removed	Boot	Boot: Normal Address
W11	Removed	Device	Disk: Normal Address
W12	Removed	Device	Tape Enabled
W13	Installed	Device	Tape Enabled
W14	Removed	Device	Disk Enabled
W15	Installed	Device	Disk Enabled
W16	Installed	Boot	Boot Enabled
W17	Removed	Boot	Boot Enabled
W18	Removed	Device	Tape: Normal Address

Table 4-3. DSD 8240 Jumpers (Cont)

Jumper	Shipped	Option Class	Function (As Shipped)
W21	Removed	Int. Priority	At Level Five
W19	(Not used on this board)		
W20	Installed	Int. Priority	At Level Five
W22	Removed	N/A	Factory use
W23	Removed	N/A	Factory use
W24	Removed	N/A	Factory use
W25	Removed	Error Correction	Enabled
W26	(Not used on this board)		
W27	Installed	N/A	Factory use
W28	Removed	N/A	Factory use
W29	Removed	N/A	Factory use
W30	Installed	N/A	Factory use
W31	Removed	Boot	CM Boot Disabled
W32	Removed	Device	TSV05 Emulation
W33	Removed	Device	Tape POCs Enabled
W34	Installed	N/A	Factory use

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.

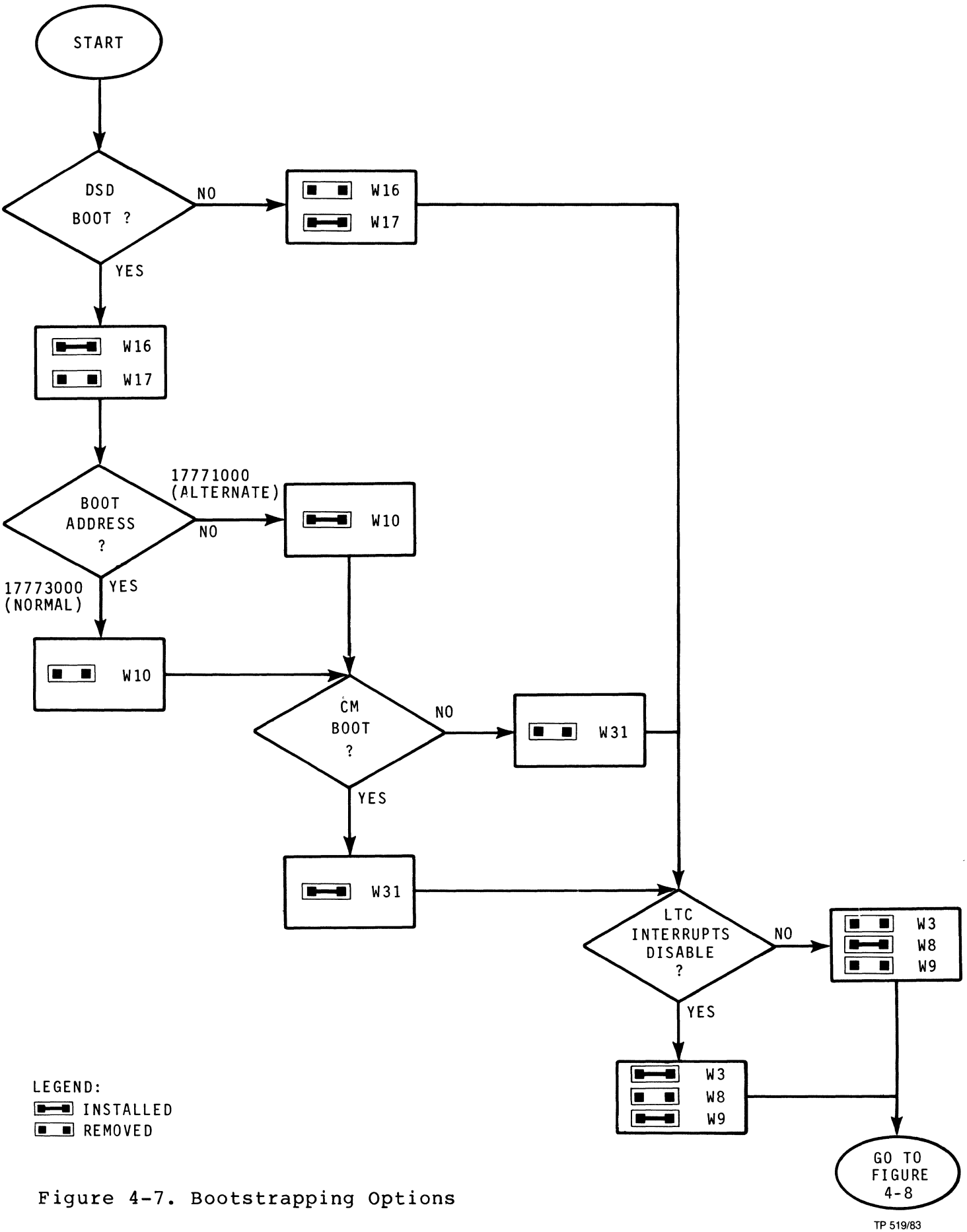

Figure 4-7. Bootstrapping Options

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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.

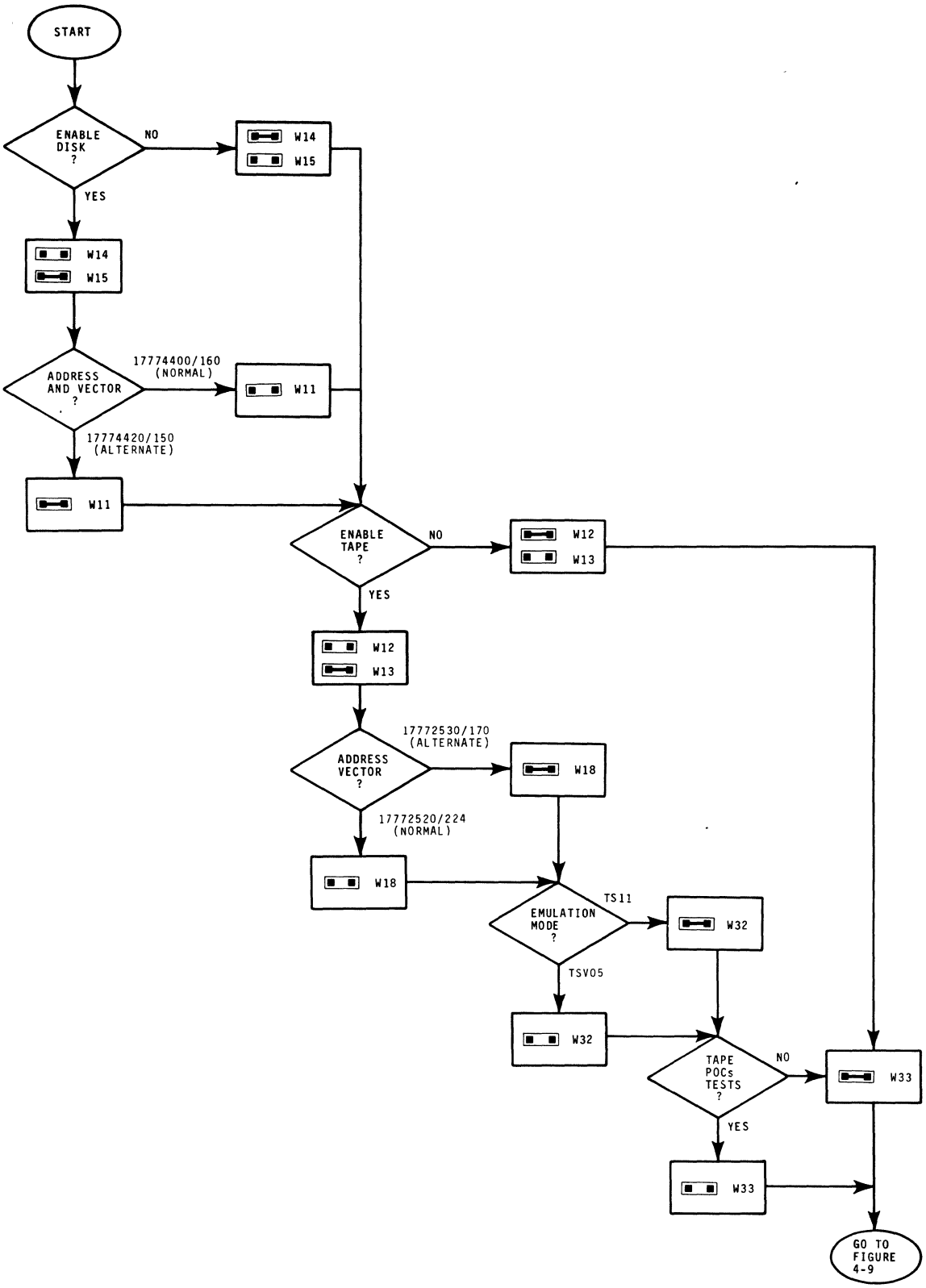

Figure 4-8. Device Options

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Priority levels may be set anywhere from level four (lowest) to level seven (highest). DEC normally configures RLØ2 controllers to operate at level five. This priority level will also work for older LSI-11 processors using level four only.

In the DSD 824Ø, 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 824Ø Controller transfers data between the storage drives and main memory using DMA. When slower DMA controllers are used with the DSD 824Ø, 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 824Ø 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 824Ø 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 4-1Ø 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 88Ø Subsystems), it may be desirable to disable the option on both controllers.

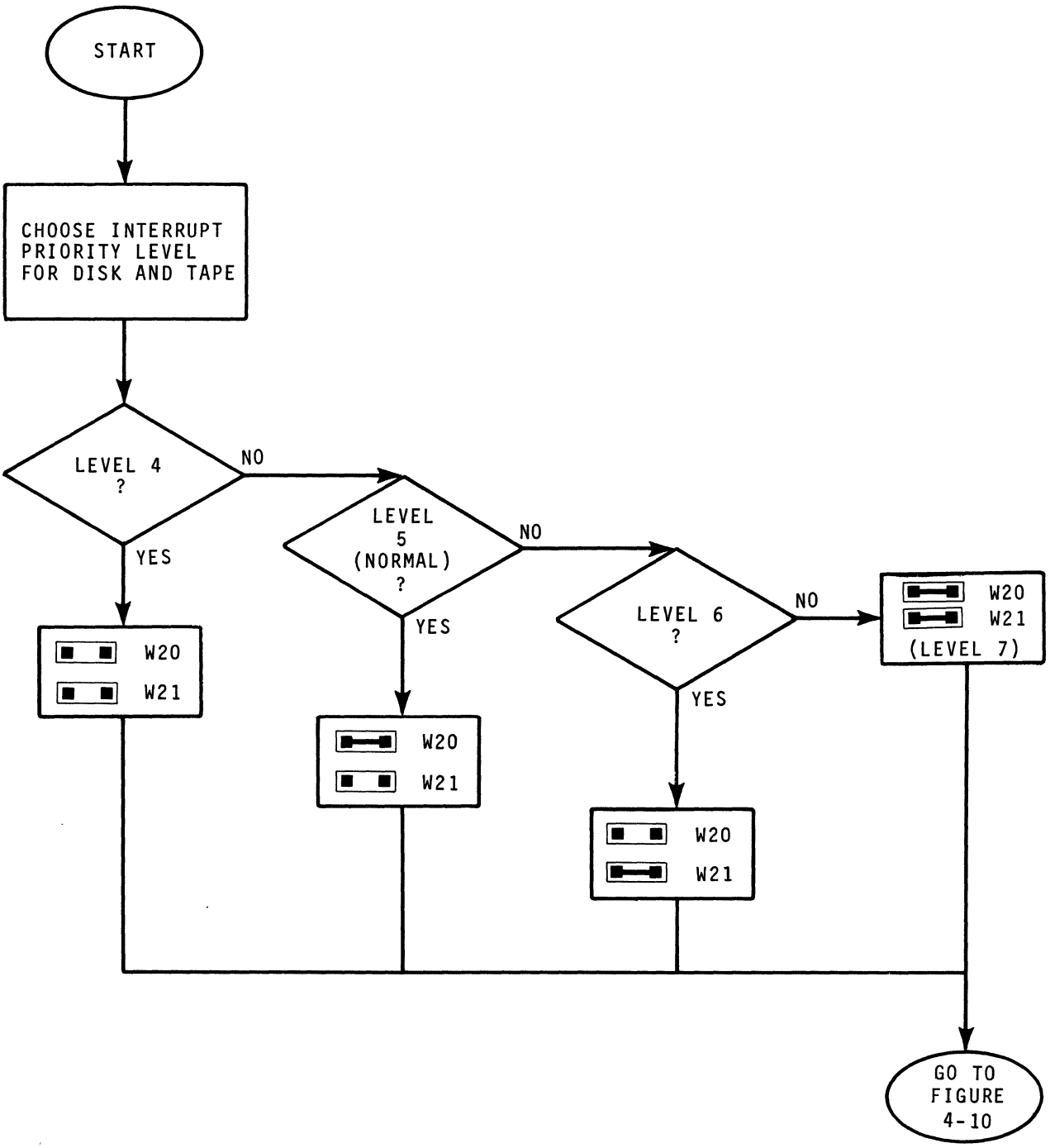

Figure 4-9. Interrupt Priority Options

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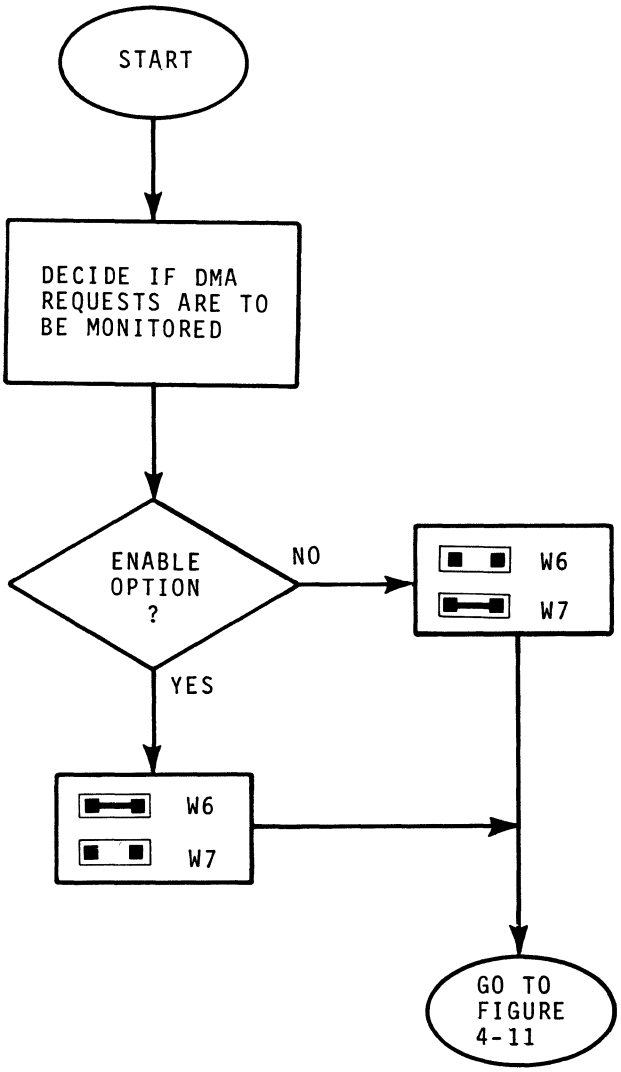


Figure 4-1Ø. DMA Request Monitor Option TP 522/83

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-11 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-11 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:

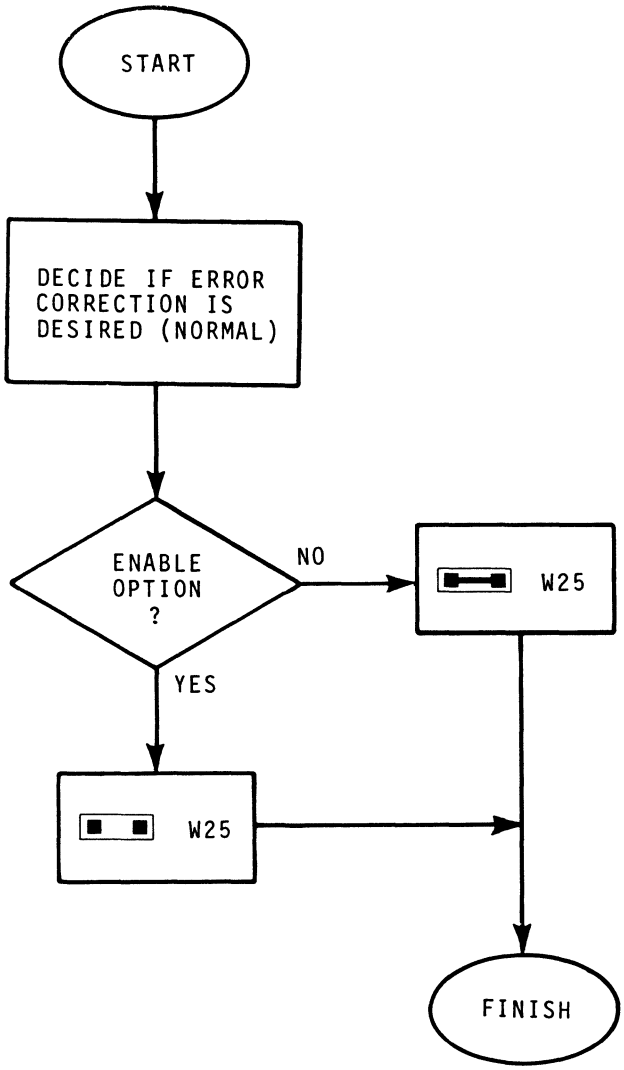
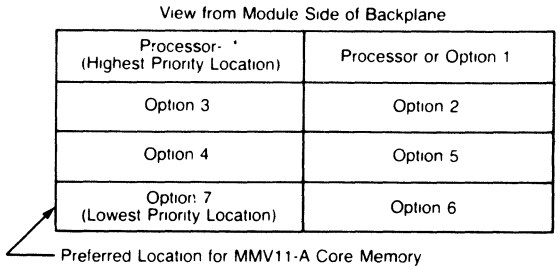
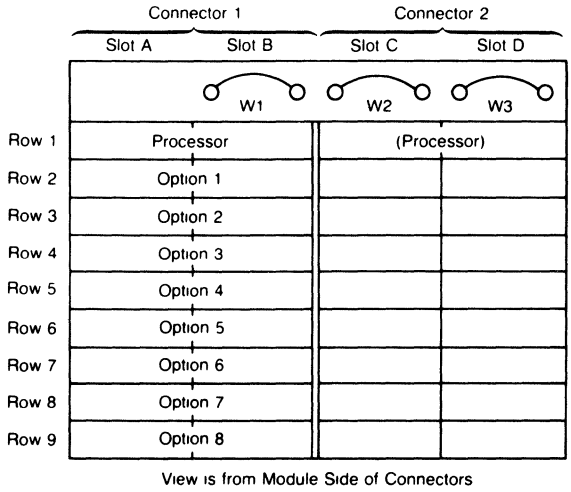


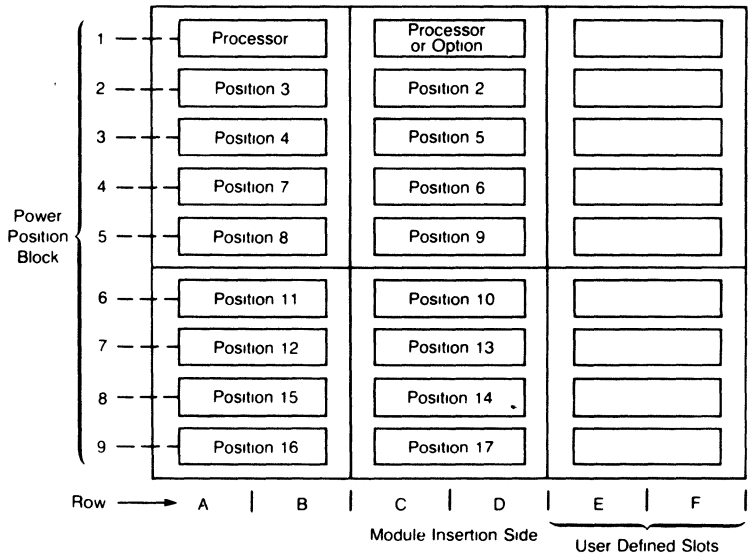
Figure 4-11. Error Correction Option TP 523/83



DEC Backplane H9270



DEC Backplane H9273-A



DEC Backplane DDV11-8

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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 RLØ2 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 RXØ2-compatible floppy device, a DEC RLO2 disk subsystem, or a DEC TSVØ5 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 RXØ2-compatible floppy drive, such as the StacPac DS-1ØØ or DS1Ø5 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.

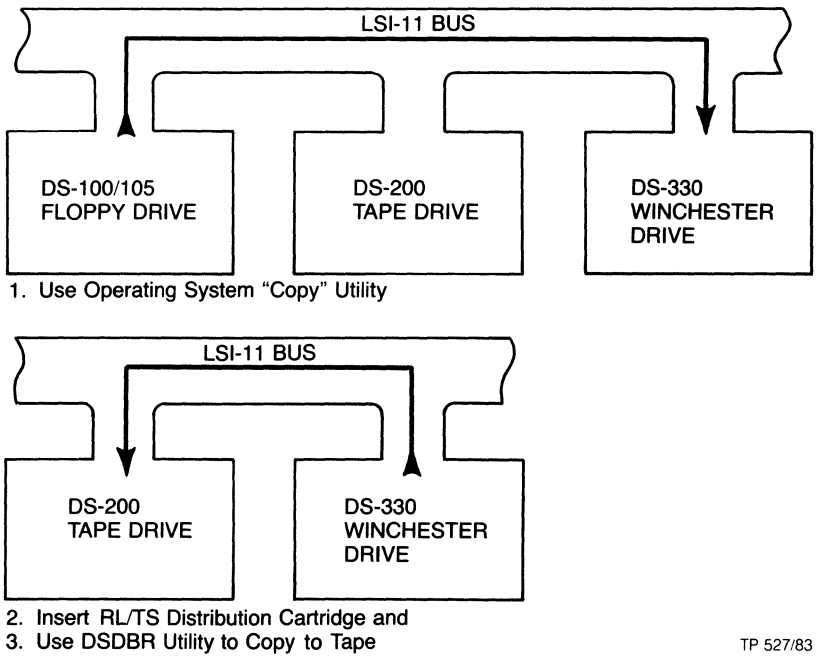

Figure 4-13. Transferring Software Using Floppy

4.6.7.2. Transfer Using RLØ2

If you have a DEC RLØ2 device and DEC RLV11/RLV12 controller available, you can transfer software from the RLØ2 device to the Tape drive cartridge, and then to the Winchester. Several methods can be used, however; since the RLØ2 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 RLØ2 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 RLØ2 volume to tape cartridge.

(10) Remove recorded cartridge from Tape drive.

(11) Power off processor rack, remove DEC controller, and RLØ2 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.

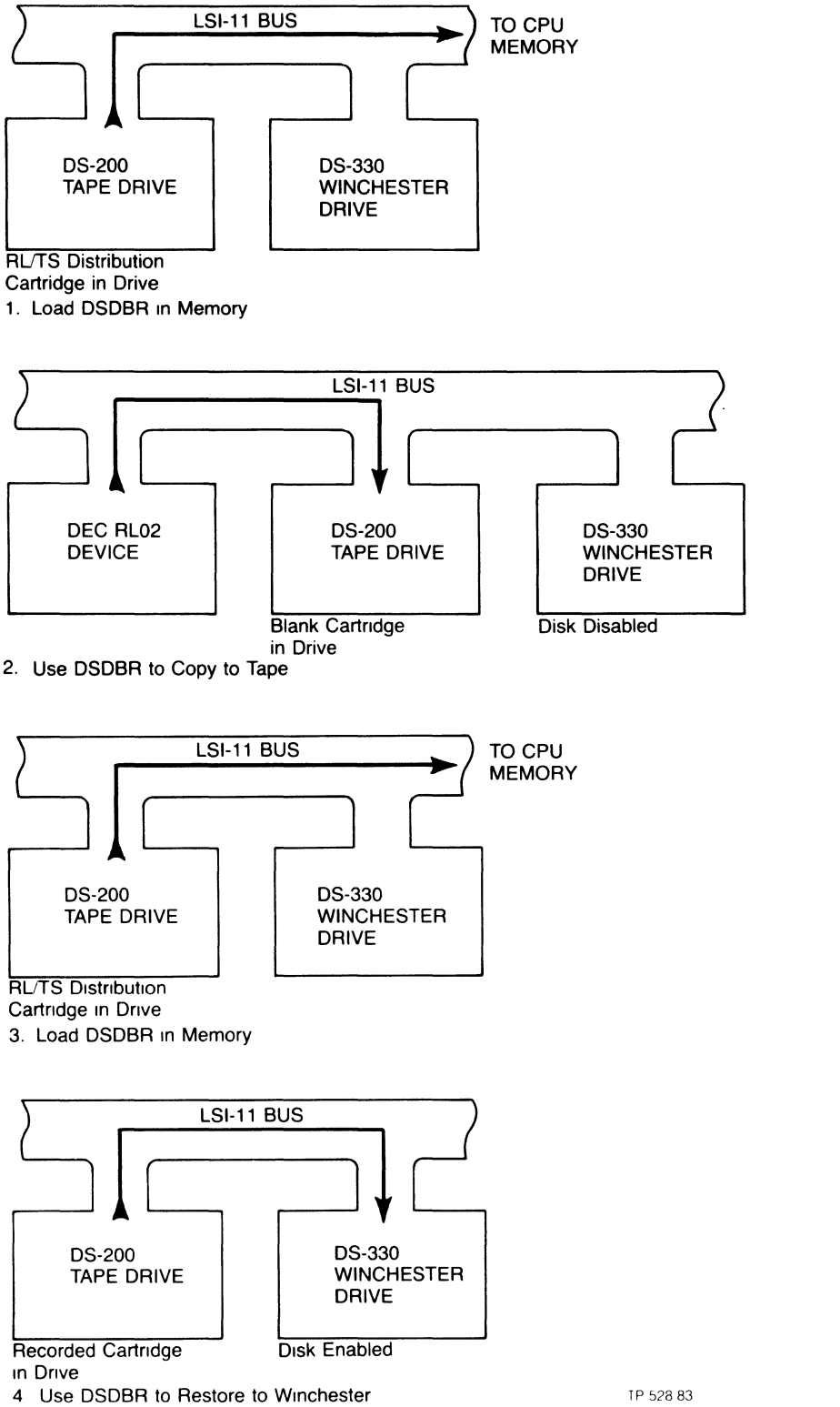

Figure 4-14. Transferring Software Using RLØ2

(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.

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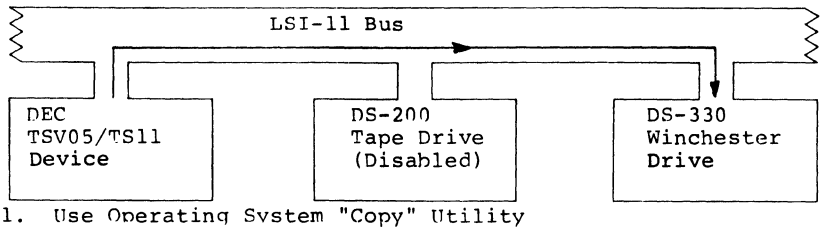
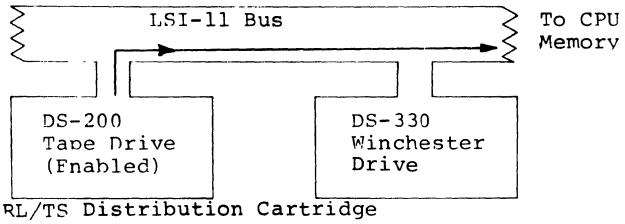
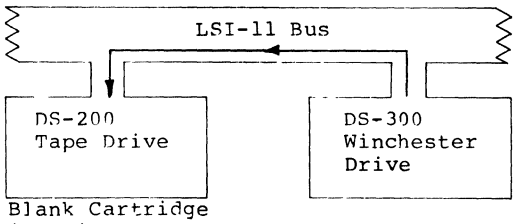


1. Use Operating System "Copy" Utility



RL/TS Distribution Cartridge
in Drive

2. Load DSDBR in Memory



Blank Cartridge
in Drive

3. Use DSDBR to Copy to Tape

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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.

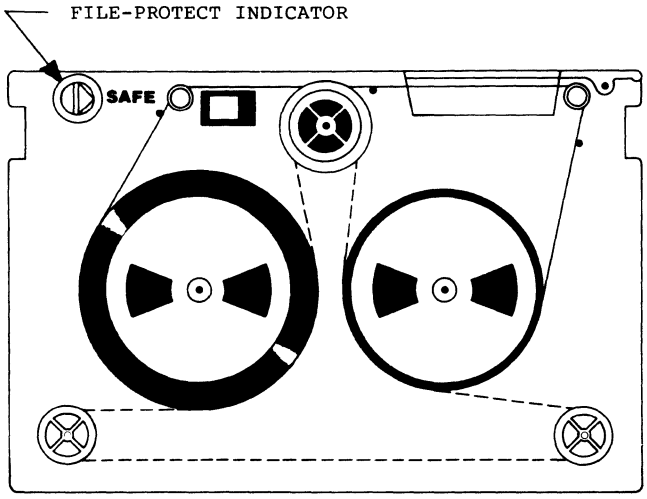

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Figure 5-1. Magnetic Tape Cartridge

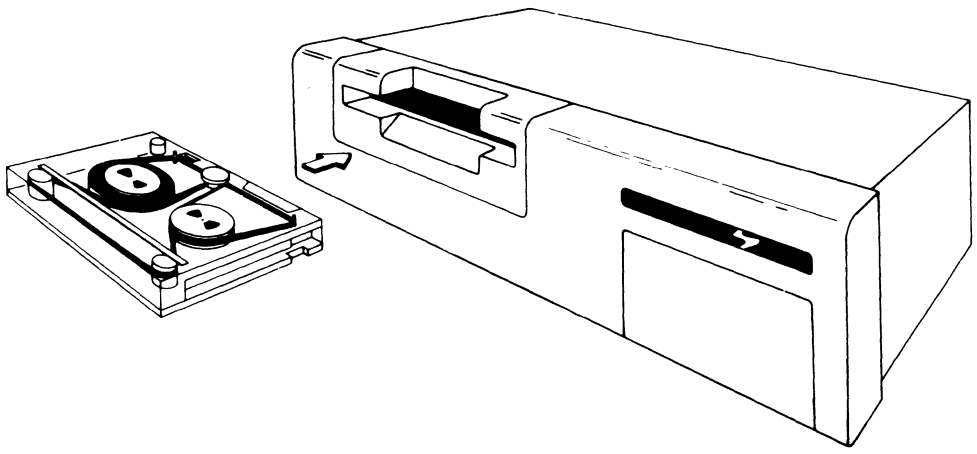

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Figure 5-2. Inserting the Cartridge

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 Ø 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

To Select:	Type Address:
Winchester Volume Ø	771ØØØ or 773ØØØ
Winchester Volume 1	771ØØ2 or 773ØØ2
Winchester Volume 2	771ØØ4 or 773ØØ4
(Reserved)	771ØØ6 or 773ØØ6
Tape Cartridge	771Ø1Ø or 773Ø1Ø
Floppy at 777170	771Ø12 or 773Ø12
Floppy at 777150	771Ø14 or 773Ø14
(Reserved)	771Ø16 or 773Ø16

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.

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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 the 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).

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 6-1. Quick Troubleshooting Chart

Indication	Possible Cause
Equipment "dead"	• Power cord unplugged
Equipment "dead"	• Blown fuse (See Figure 6-1)
Equipment "dead"	• Defective power supply
FLT light always on	• Loose Winchester/Tape drive cable connections
No Tape drive action	• Loose Tape drive cable at rear connector, or at backplane
No Tape drive action	• Defective Tape drive
No Winchester drive action	• Loose Winchester cable at rear connector
No Winchester drive action	• Defective Winchester drive
Winchester drive action, but no read/ write functions	• Loose Winchester data cable rear connection
Winchester drive action, but no read/ write functions	• Defective Winchester circuits

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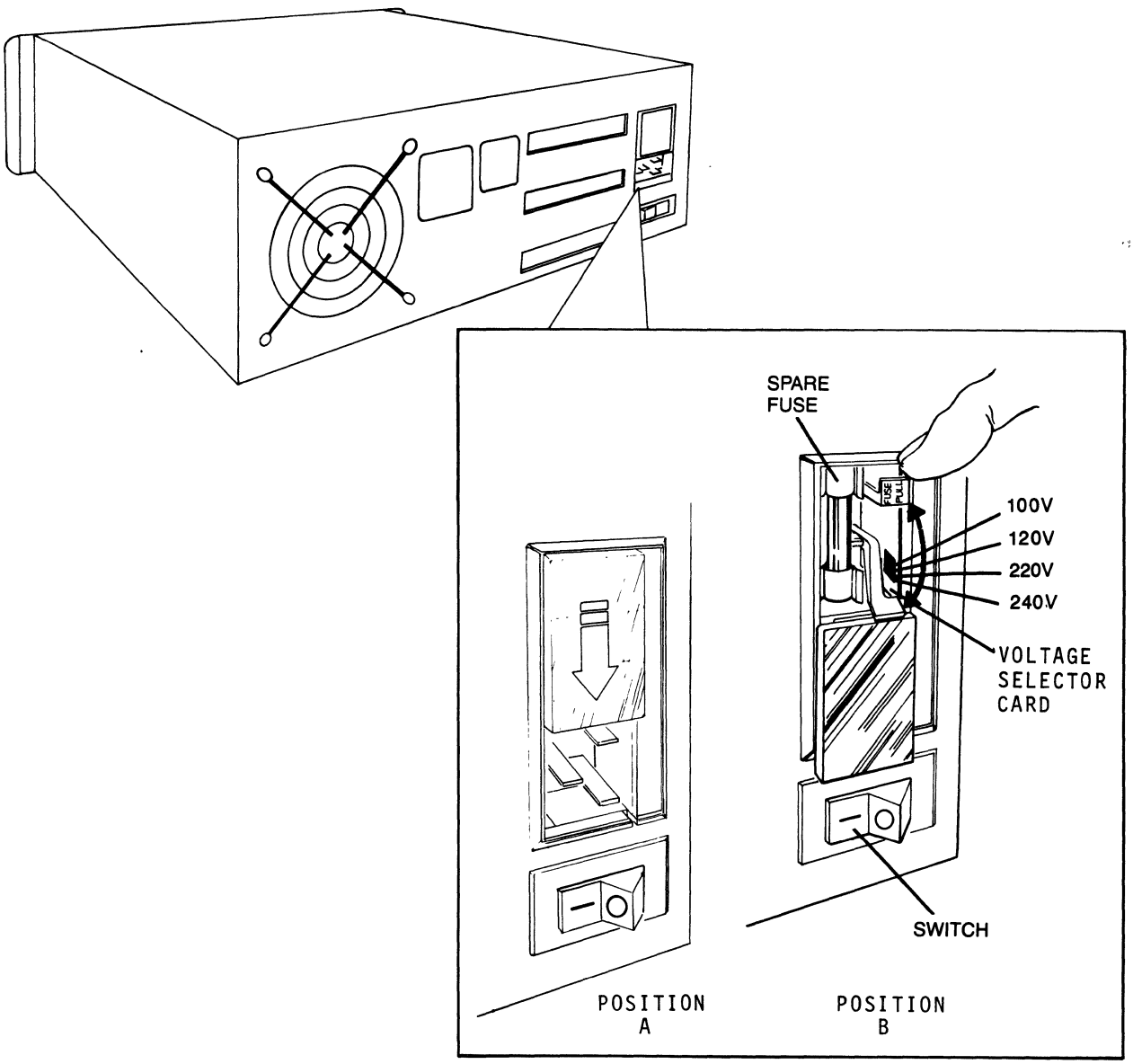

Figure 6-1. Fuse Location

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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.

- A Rapid Module Exchange policy allows the user to receive a replacement unit shortly after the faulty one is identified.

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.

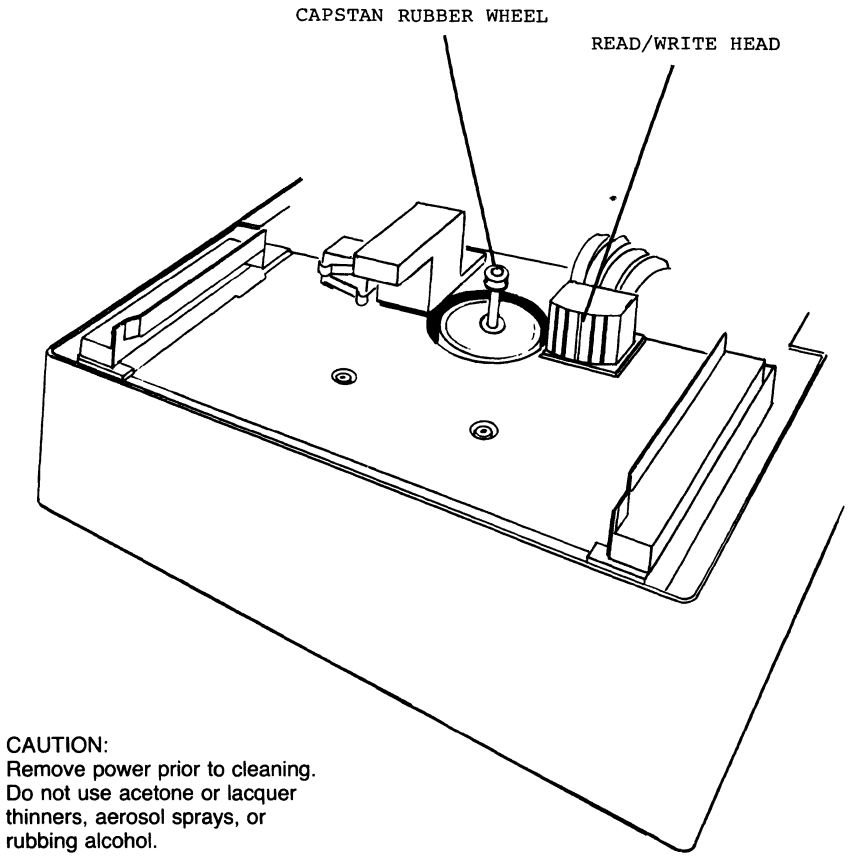


Figure 7-1. Tape Drive Cleaning

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 RLØ2 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 RLØ2 bad sector files at the end of each RLØ2 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 (Ø 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.

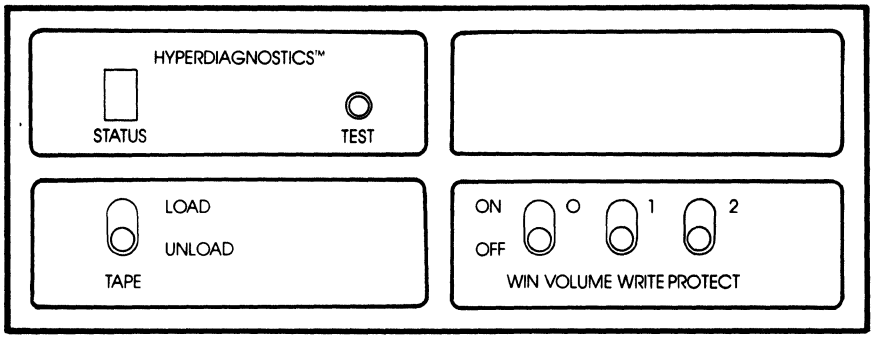
Table 7-1. HyperDiagnostics Tests

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

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.



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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.
WPØ through WP2 Switches	• Operate as three-digit binary switch. • Select up to eight (Ø 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 Ø, 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 Ø 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 1Ø 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 Ø 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.

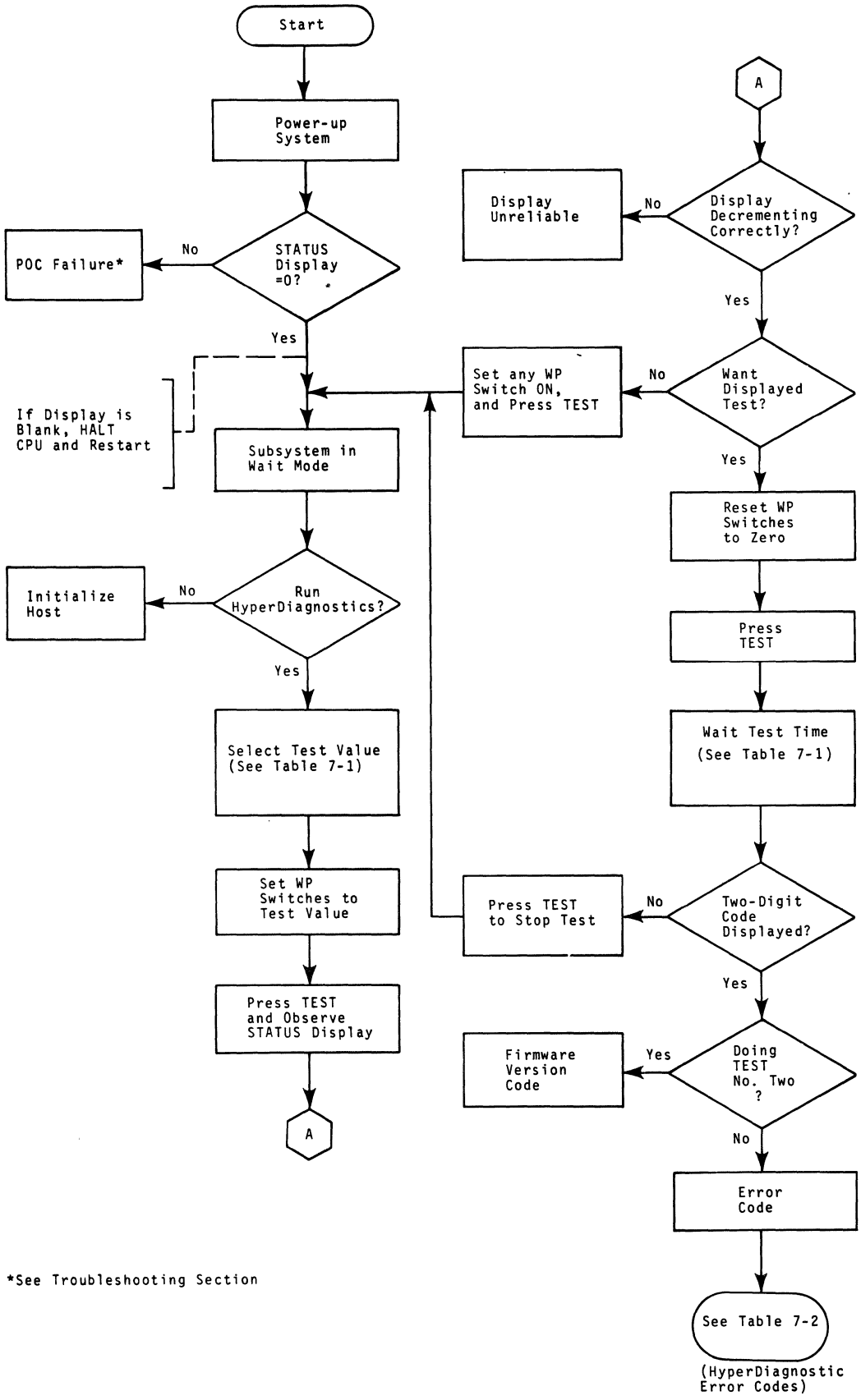
(7) If test fails, FAULT lights and STATUS displays error code.

(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.



*See Troubleshooting Section

Figure 7-3. HyperDiagnostics Procedure

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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.

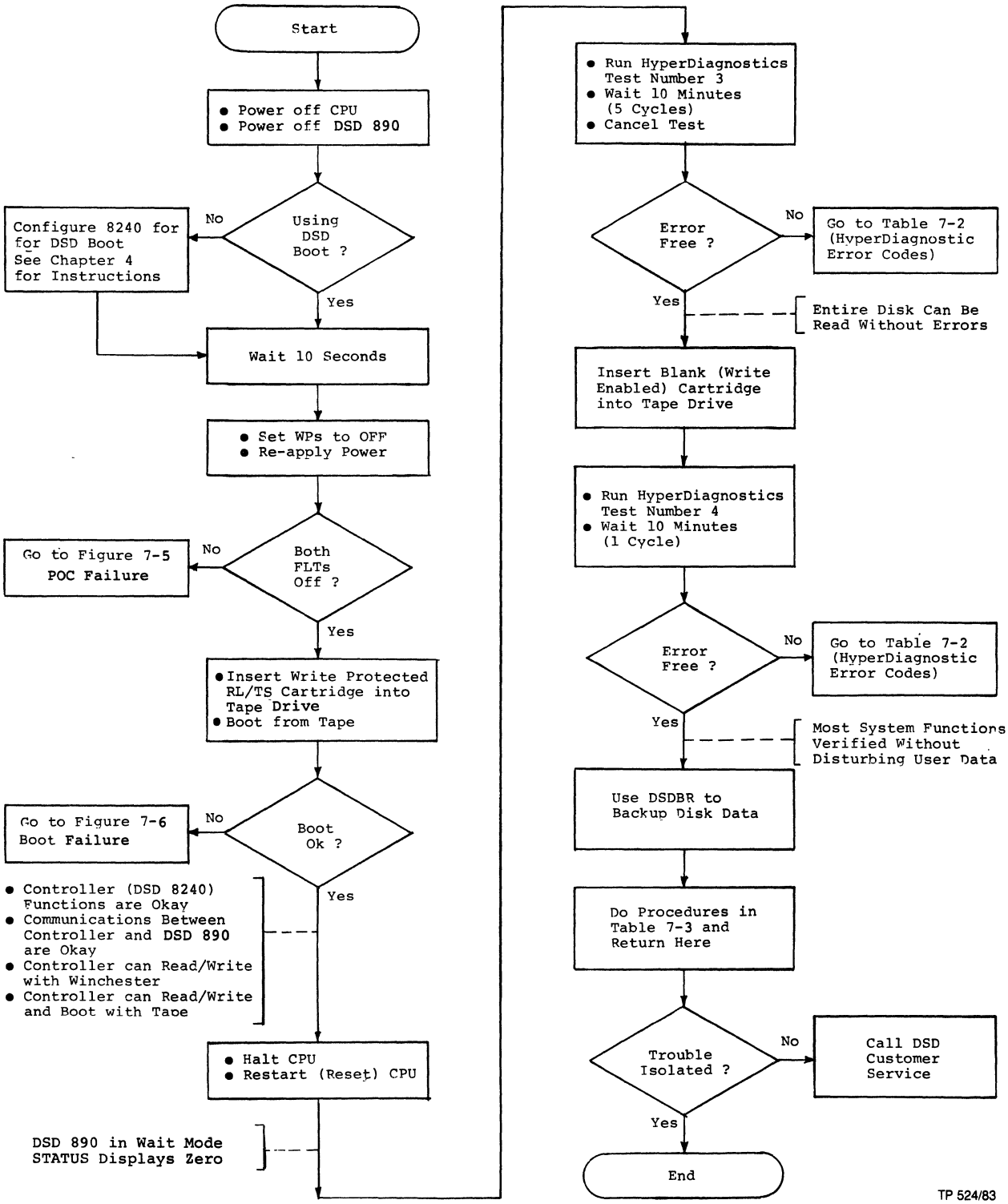

Figure 7-4. Main Troubleshooting Path.

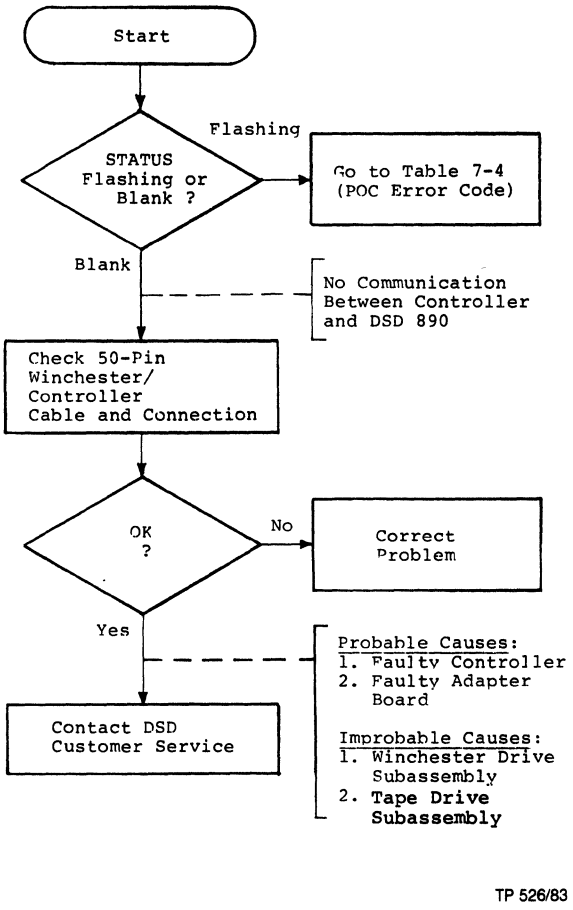

Figure 7-5. POC Failure

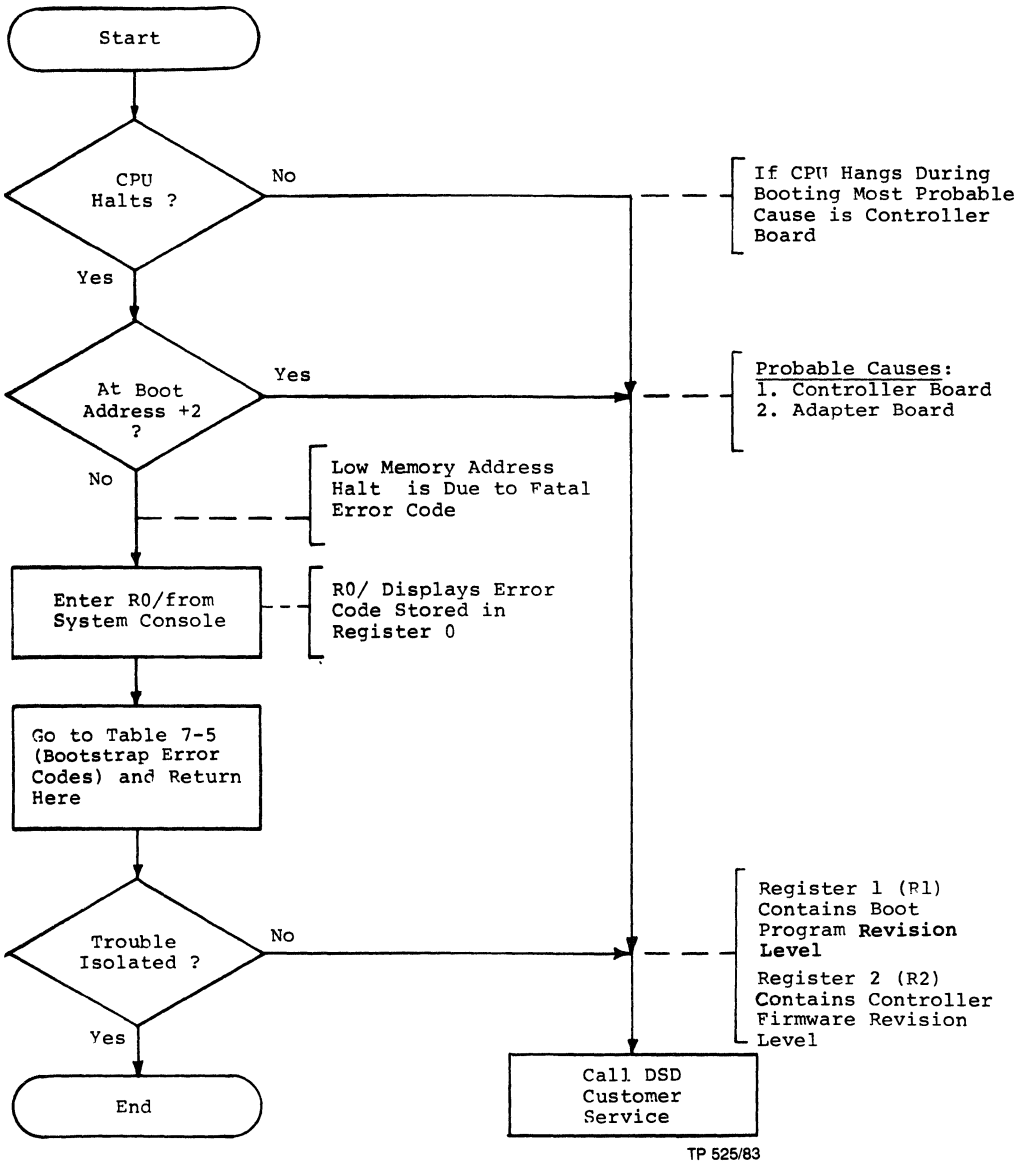

Figure 7-6. Bootstrapping Failure.

Table 7-2 HyperDiagnostics Error Codes

ERROR CODE	MEANING	PROBABLE CAUSE
Ø1	Disk Drive Home Error. No track Ø, and/or seek complete, and/or drive ready.	1. Head lock not removed during installation. 2. Faulty Winchester drive.
Ø6	Timeout waiting for seek complete from disk during seek operation.	1. Head lock not removed during installation. 2. Faulty Winchester drive.
Ø7	Desired disk header not found during read/write, or write check operation.	1. Winchester disk needs reformatting. See note 2. 2. Faulty 824Ø controller. 3. Faulty Winchester disk drive.
1Ø	Disk write protect violation.	1. Attempt to write while disk volume was write protected. Check the write protect switches.
14	Disk header CRC error detected during header search;rest of header appeared correct.	1. Winchester disk needs reformatting. See note 2. 2. Faulty 824Ø controller. 3. Faulty Winchester disk drive.
15	Disk seek error. Head selection error,or head on wrong cylinder.	1. Faulty Winchester disk drive. 2. Faulty 824Ø controller.
17	Unable to find disk data field address mark during read or write check operation.	1. Corrupted data field, can usually be corrected by rewriting the data. See note 2. 2. Faulty 824Ø controller. 3. Faulty Winchester disk drive.
2Ø	Disk data field ECC error. Note: Error correction is not attempted during POC or HyperDiagnostics.	1. Corrupted data field, can usually be corrected by rewriting the data. See note 2. 2. Faulty 824Ø controller 3. Faulty Winchester disk drive.

Table 7-2 HyperDiagnostics Error Codes (continued)

ERROR CODE	MEANING	PROBABLE CAUSE
21	Write fault error reported by disk drive during write operation.	1. Faulty 8240 controller. 2. Faulty Winchester disk drive.
24	Disk read/write controller failure.	1. Faulty 8240 controller.
30	Data compare error during disk write check operation.	1. Faulty 8240 controller. 2. Faulty Winchester disk drive.
31	Invalid disk bad-track map.	1. Rewrite bad-track map using GENEXR diagnostic program. 2. Faulty 8240 controller. 3. Faulty Winchester disk drive.
36	Disk drive not ready.	1. Head lock not removed during installation. 2. Faulty Winchester disk drive.
41	Disk timer failure.	1. Faulty 8240 controller.
45	Invalid data field ID byte found in disk data field during read or write check operation.	1. Corrupted or missing data field, can usually be corrected by rewritting the data. See note 2. 2. Faulty 8240 controller.
90	Tape data read did not match data written during Hyper-Diagnostics.	1. Faulty tape drive. 2. Faulty 8240 controller.
91	Tape timer failure.	1. Faulty 8240 controller.
92	Tape write file mark failure during HyperDiagnostics.	1. Faulty tape drive. 2. Faulty 8240 controller.
93	No tape cartridge or can't find BOT during rewind operation.	1. No tape installed. 2. Faulty tape drive.
94	Tape space record or file mark error (forward or back-ward) during HyperDiagnostics.	1. Faulty tape drive. 2. Faulty 8240 controller.

Table 7-2 HyperDiagnostics Error Code (continued)

ERROR CODE	MEANING	PROBABLE CAUSE
95	Unable to detect tape FIFO data overflow.	1. Faulty 8240 controller
96	Tape read/write error during HyperDiagnostics.	1. Tape cartridge write protected. 2. Worn-out tape cartridge. 3. Dirty tape head. 4. Faulty tape drive.
97	Tape interface test failure.	1. No power to tape drive. 2. Tape cable incorrectly installed. 3. Faulty tape drive. 4. Tape cartridge removed during initialization.

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 7-3 Software Diagnostic Procedures

FAULT SYMPTOM	STEP	DIAGNOSTIC AND CORRECTIVE ACTION
Procedure A.	1.	Load RLEXR Diagnostic Program.
Any disk subsystem problem suspected. This procedure is also used for acceptance testing.	2.	Use the short acceptance test to verify all three emulated RL-Ø2 volumes. Test should be allowed to run at least two hours, or until errors are reported.
CAUTION: this procedure will destroy data stored on the disk.	3.	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.
	4.	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.

Table 7-3 Software Diagnostic Procedures (continued)

FAULT SYMPTOM	STEP	DIAGNOSTIC AND CORRECTIVE ACTION
Procedure B.	1.	Load GEMEXR Diagnostic Program.
HyperDiagnostics, operational software or RLEXR diagnostic report disk write or read errors. CAUTION: this procedure will destroy data stored on the disk.	2.	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.
	3.	Use VERIFY command and WRTREAD subcommand to test disk over all heads and cylinders 1 through 777 for at least ten passes.
	4.	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.

Table 7-3 Software Diagnostic Procedures (continued)

FAULT SYMPTOM	STEP	DIAGNOSTIC AND CORRECTIVE ACTION
		IF data CRC errors, or header not found errors are being found on a few tracks and tend to repeat from pass to pass, assume that a flaw has developed on the disk surface. Use the INCLUDE subcommand under BADTRK to add the flaw to the Bad Track Map. VERY IMPORTANT--also add the new bad tracks to the record inside the drive module. If many random errors are being reported which do not seem associated with particular tracks: 1. Most likely cause is disk drive. 2. Next most likely cause is 8240 controller.
Procedure C Any problem suspected with the Tape Subsystem. CAUTION: this procedure will destroy data recorded on the tape cartridge. Use a scratch tape.	1. 2. 3. 4.	First run the tests in Procedure A. 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. Load TSEXR Diagnostic Program. Install scratch tape in the tape drive.

Table 7-3 Software and Diagnostic procedures (continued)

FAULT SYMPTOM	STEP	DIAGNOSTIC AND CORRECTIVE ACTION
	5.	Use ACCEPT command to test basic tape read and write functions. This test does not check the entire tape (see Procedure D). 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)

FAULT SYMPTOM	STEP	DIAGNOSTIC AND CORRECTIVE ACTION
Procedure D. Problems suspected with a specific tape cartridge. CAUTION: this procedure will destroy data recorded on the tape cartridge.	1.	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.
	2.	Load TSEXR Diagnostic Program.
	3.	Install tape to be tested in the tape drive.
	4.	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.
	5.	Use the MEDIA command to test the tape cartridge.
	6.	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. If function reject (TCC3) errors occur, check that tape cartridge is properly installed, is at the lead point, and is not write protected. If unrecoverable errors (TCC6) occur, the tape cartridge should be replaced.

Table 7-4 POC Error Codes

ERROR CODE	MEANING	PROBABLE CAUSE (POC TESTS)
Ø1	Disk drive home error. No track Ø, and/or seek complete, and/or drive ready.	1. Head lock not removed during installation 2. Faulty Winchester drive.
Ø6	Timeout waiting for seek complete from disk during seek operation.	1. Head lock not removed during installation. 2. Faulty Winchester drive.
Ø7	Desired disk header not found during read,write or write check operation.	1. Winchester disk needs re-formatting. See note 2. 2. Faulty Winchester disk drive. 3. Faulty 824Ø controller.
14	Disk header CRC error detected during header search; rest of header appeared correct.	1. Winchester disk needs re-formatting. See note 2. 2. Faulty Winchester disk drive. 3. Faulty 824Ø controller.
15	Disk seek error. Head Selection error or head on wrong cylinder.	1. Faulty Winchester disk drive. 2. Faulty 824Ø controller.
17	Unable to find disk data field address mark during read or write check operation.	1. Cylinder Ø of Winchester disk needs re-formatting; bad-track map must be re-written. See note 2. 2. Faulty Winchester disk drive. 3. Faulty 824Ø controller.
2Ø	Disk data field ECC error.	1. Cylinder Ø of Winchester disk needs re-formatting; bad-track map must be re-written. See note 2. 2. Faulty Winchester disk drive 3. Faulty 824Ø controller.
21	Write fault error reported by disk drive during write operation.	1. Faulty 824Ø controller. 2. Faulty Winchester disk drive.
24	Disk read/write controller failure.	1. Faulty 824Ø controller.

Table 7-4 POC Error Codes (continued)

ERROR CODES	MEANING	PROBABLE CAUSE (POC TESTS)
30	Data compare error during disk write check operation.	1. Faulty 8240 controller. 2. Faulty Winchester disk drive.
31	Invalid disk bad-track map.	1. Rewrite bad-track map using GEMEXR diagnostic program. 2. Faulty 8240 controller. 3. Faulty Winchester disk drive.
36	Disk drive not ready.	1. Head lock not removed during installation. 2. Faulty Winchester disk drive.
41	Disk timer failure.	1. Faulty 8240 controller.
45	Invalid data field ID byte found in disk data field during read or write check operation.	1. Cylinder 0 of Winchester disk needs re-formatting; bad-track map must be re-written. See note 2. 2. Faulty Winchester drive. 3. Faulty 8240 controller.
50	Scratch RAM failure during POC.	1. Faulty 8240 controller.
51	Buffer RAM failure during POC.	1. Faulty 8240 controller.
52	QBC gate array failure during POC.	1. Faulty 8240 controller.
53	Error reading drive data simulator during POC.	1. 20-pin Winchester data cable problem. 2. Faulty 8240 controller. 3. Faulty adapter board.
54	ECC circuitry failure during POC.	1. Faulty 8240 controller. 2. Faulty adapter board.
91	Tape timer failure.	1. Faulty 8240 controller.

Table 7-4 POC Error Codes (continued)

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

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

BOOT ERROR CODE IN RØ	MEANING	PROBABLE CAUSE
ØØØØØ1	Memory test error. Address is in register R3.	1. Faulty system memory.
ØØØØØ2	No response from designated disk I/O register. Address is in register R3.	1. 824Ø incorrectly jumpered. 2. Faulty 824Ø controller.
ØØØØØ3	No response from designated tape I/O register. Address is in register R3.	1. 824Ø incorrectly jumpered. 2. Faulty 824Ø controller.
ØØØØØ4	No response from designated floppy I/O register. Address is in register R3.	1. Floppy controller not present or incorrectly jumpered.
ØØØØØ5	Winchester disk read/write test error.	1. Faulty Winchester disk drive. 2. Faulty 824Ø controller.
ØØØØØ6	Error reading boot block from designated boot device.	1. Boot device (Winchester,tape,or floppy) is faulty. 2. Faulty drive. 3. Faulty 824Ø controller.
ØØØØØ7	Invalid boot block read from designated boot device.	1. No boot on volume.

Notes: 1. Probable causes are listed in decreasing order of probability.

2. These codes appear in CPU register RØ after a bootstrap error halt.

Table 7-6 Error Code Summary

ERROR CODE	MEANING
ØØ	No error.
Ø1	Disk drive home error. No track Ø and/or seek complete, and/or drive ready during home operation.
Ø2	Non-existent logical drive (DL3) selected by software.
Ø6	Timeout waiting for seek complete from disk during seek operation.
Ø7	Desired disk header not found during read, write, or write check operation.
1Ø	Disk write protect violation.
14	Disk header CRC error detected during header search; rest of header appeared correct.
15	Disk seek error. Head selection error or head on wrong cylinder.
17	Unable to find disk data field address mark during read or write check operation.
2Ø	Disk data field ECC error.
21	Write fault error reported by disk drive during write operation.
23	Invalid disk word count specified by software.
24	Disk read/write controller failure.
25	Invalid format keyword issued by software during format operation.
26	Data late condition during disk format operation.
27	GAP 4 timeout failure during disk format operation.
3Ø	Data compare error during disk write check operation.

Table 7-6 Error Code Summary (continued)

ERROR CODE	MEANING
31	Invalid bad-track map. Read check sum or keyword error.
35	Non-existent memory found during disk or tape DMA.
36	Disk drive not ready.
40	Bootstrap (drive data simulator) read error.
41	Disk timer failure.
43	Invalid disk RLDAR value loaded by software.
45	Invalid ID byte found in disk data field during read or write check operation.
50	Scratch RAM failure during POC.
51	Buffer RAM failure during POC.
52	QBC gate-array failure during POC.
53	Error reading drive data simulator during POC.
54	ECC circuitry failure during POC.
80	Tape termination code 0 (normal)
81	Tape termination code 1 (attention)
82	Tape termination code 2 (status alert)
83	Tape termination code 3 (function reject)
84	Tape termination code 4 (recoverable error)
85	Tape termination code 5 (recoverable error)
86	Tape termination code 6 (non-recoverable error)
87	Tape termination code 7 (fatal error)

Table 7-6 Error Code Summary (continued)

ERROR CODE	MEANING
90	Tape data read did not match data written during HyperDiagnostics.
91	Tape timer failure.
92	Tape write file mark failure during HyperDiagnostics.
93	No tape cartridge or can't find BOT during rewind operation.
94	Tape space record or file mark error (forward or backward) during HyperDiagnostics.
95	Unable to detect tape FIFO data overflow during HyperDiagnostics.
96	Tape read/write error during HyperDiagnostics.
97	Tape interface test failure.

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.

(1Ø) 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".

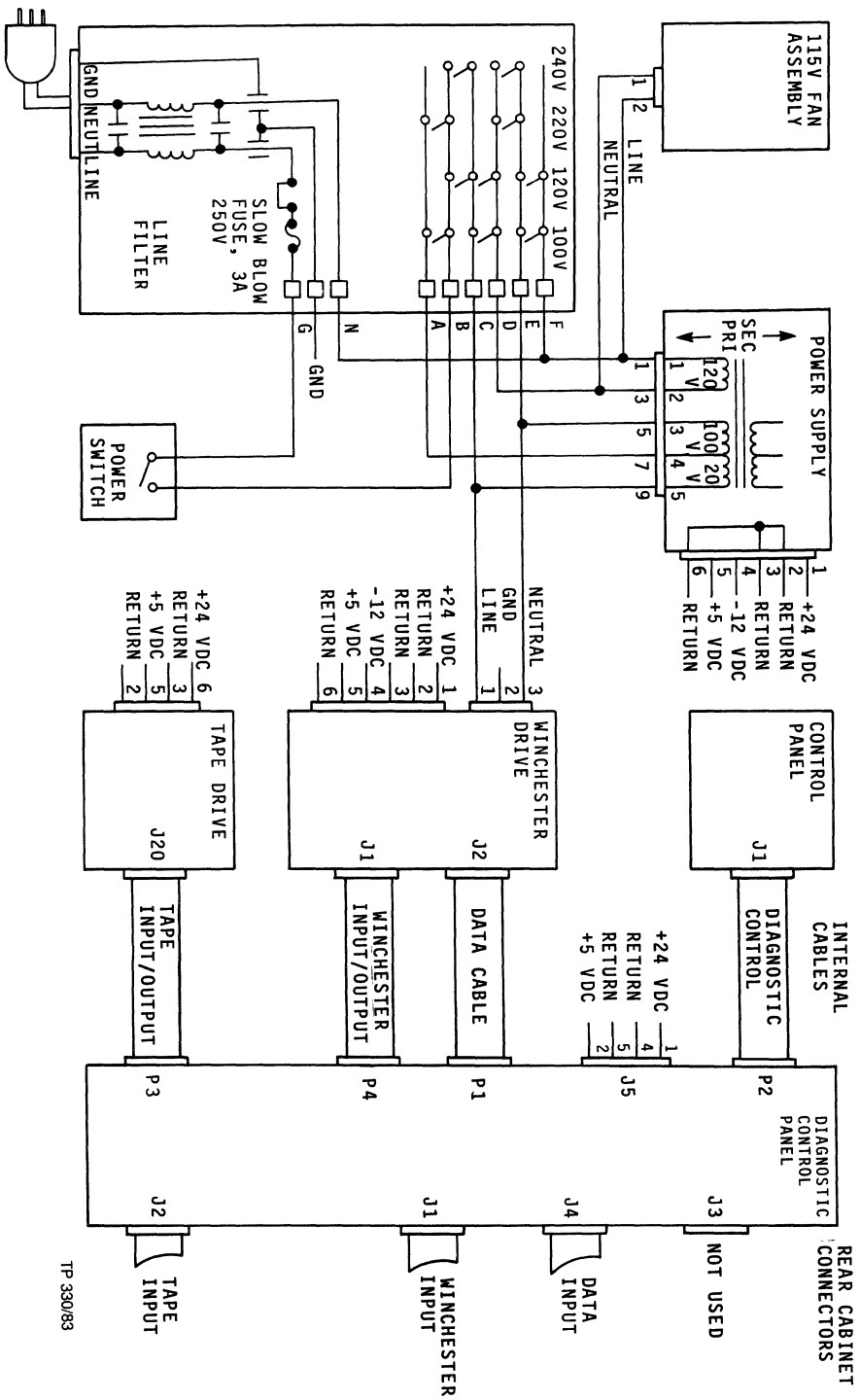

Figure 7-7. Power Distribution Diagram

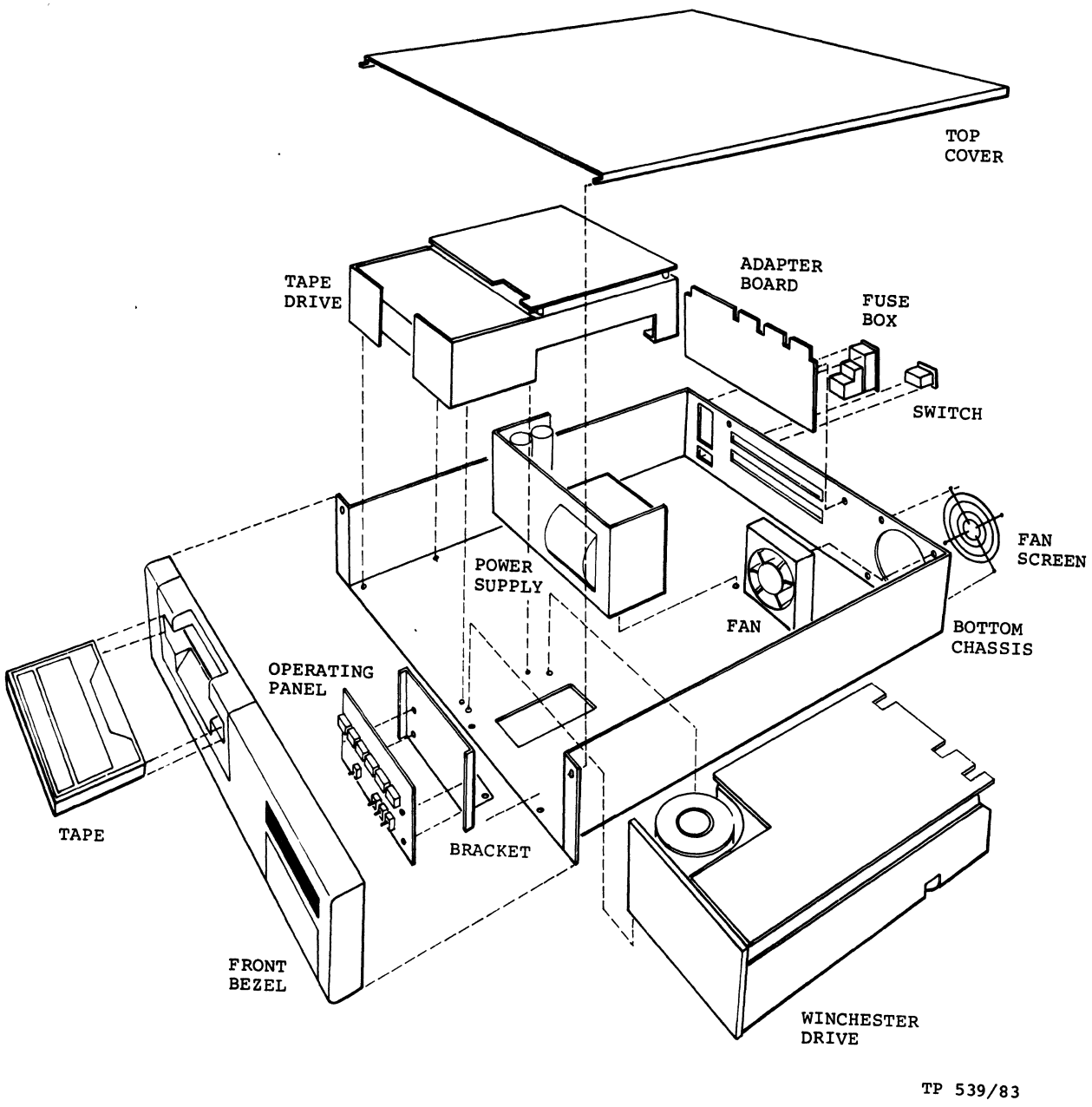

Figure 7-8. Cabinet Exploded View

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.

Western Region Service
2241 Lundy Avenue
San Jose, CA 95131
(408) 946-5800
TWX: 910-338-0249

Central Region
Sales and Service
5050 Quorum Drive
Suite 339
Dallas, TX 75240
(214) 980-4884

North Central Region
Sales and Service
2311 West 22nd St.
Suite 110
Oakbrook, Il 60521
(312) 920-0444

Eastern Region
Sales and Service
51 Morgan Drive
Norwood, MA 02062
(617) 769-7620
TWX: 710-336-0120

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APPENDIX A: GEMEXR UTILITY PROGRAM

1.1. INTRODUCTION

All DSD subystems 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-11 computer, and at least 24K words of memory. Loading GEMEXR can be accomplished either from an RT-11 compatible operating system, or from the monitor provided on the DSD distribution media. To run GEMEXR from an RT-11 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 sub-commands available with the program. GEMEXR also recognizes various control inputs, and these are listed in Table 2.

Table 1. GEMEXR Commands.

Commands	Description
QUIT	Exit from GEMEXR
FORMAT	Formats DSD Winchester disk
RLFMT	Formats individual RL volumes
BADTRK	Flaw management for Winchester disk. A DSD bad track file is required on Winchester for proper operation.
Sub-Commands:	
EXIT	Exit from badtrack routines
CREATE	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 "Y" to the prompt "INSERT BAD TRACKS [Y/N]:", and enter the bad tracks. A carriage return <CR> alone on any input line, ends the input. If there is an error in the bad track input, answer "Y" to the prompt, "EDIT BAD TRACK FILE [Y/N]:". Every time a new DSD bad track file is written to the disk, The RL Bad Sectors file is automatically written.

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.

ACCEPT	Performs a "WRTREAD" followed by a "SCAN".
STAT	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.
DUMP	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, "EXIT DUMP? [Y/N]" appears after each sector is displayed. An affirmative answer will return to the VERIFY menu, otherwise the next sequential sector will be displayed.
CHAR	Sets certain program operation characteristics. An affirmative answer to the prompt "SKIP BAD TRACKS [Y/N]:", allows the following tests to ignore tracks already in the DSD bad track file.
CONFIG	Displays the status of the control panel switches and certain 8240 controller jumpers.
H	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 "CHAR" command.

Table 2. Contol Key Functions.

Input	Description
CTRL-C	Stops execution and returns to monitor.
CTRL-R	Asks "ABORT OPERATION [Y/N]:". Answer "Y" to quit current operation and return to GEMEXR command

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 vol- ume 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 1. DSDBR Commands.

Command	Description
H	The H (help) command lists program version, current device configuration, and main command menu.
BACKUP	Rewinds tape, asks which unit is to be backed up, and begins backup.
VERIFY	After backup, checks and verifies the tape image with original disk data.
RESTORE	Rewinds tape, asks which unit is to be restored, and begins restoration.
BACKV	Performs "BACKUP" followed by "VERIFY".
RESTV	Performs "RESTORE" followed by "VERIFY".

TEST	Continuously runs "BACKUP" and "VERIFY".
QUIT	Exit backup/restore utility program.

Table 2. Control Key Functions.

Input	Function
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-C	Abort program and return to monitor.
CTRL-D	Show current tape and disk control registers.
CTRL-R	Interrupts execution of a command and asks if the user wishes to abort operation. If answer is yes ("Y"), the current operation is aborted and program continues at command menu.
<LF>	Displays current operation name, and current disk position.

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 oeration 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:

Curren 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:

TCCØ: 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 occured on the transport (off-line, on-line).

TCC2: Tape status alert. Change in tape status has occured [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 occured, 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 commmand. Refer to fatal class codes that follow.

Fatal Class Codes:

FCCØ: 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.

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.

Command	Description
QUIT	Exit from TSEXR.
H	The "H" (help) command lists commands and configuration. Also lists current value of parameters set up in the CHAR command.
EXER	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, "MODIFY DEFAULT SEQUENCE [Y/N]". If this is done, the first command in the new sequence should be an "SCH" (set characteristics) command. All valid command mnemonics are listed below, and the user input is terminated by an "END" command. When an opcode mnemonic is entered, the user is prompted for a "count". This is the BYTE/RECORD/FILE count in the command packet. The prompt "repetitions" 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

```
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:

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

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 execution parameters:

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

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.

Input	Function
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-C	Stops execution and returns to monitor.
CTRL-D	Lists TS command packet values.
CTRL-R	Asks, "ABORT OPERATION [Y/N]". Type "Y" to quit current operation and return to the command menu within TSEXR.
<LF>	Lists number of reads, writes, errors and retries.

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, y 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):

TCCØ: 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 occured on the transport (off-line, on-line).

TCC2: Tape status alert. Change in tape status has occured [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 occured, 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):

FCCØ: 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'

TYPE	DEVICE
0	880X/8
1	880X/20
2	880X/30
3	890

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.

Command	Description
Comprehensive Tests:	
• (A)cceptance	General Exerciser
• (SH)ort acceptance	Short Exerciser
Individual Tests:	
• (INTE)rface test	Interface test
• (INTR) test	Interrupt test
• (SC)an	Scan
• (SEE)k range	Seek
• (E)xtended mode test	Extended mode test
• (SEQ W)/r test	Sequential write/read test
NOTE	
The following three tests require a sequential write pass.	
• (SEQ R)ead	Sequential read test
• (RANDOM R/)w	Random read/write test
• (RANDOM RE)ad	Random read test
Program Control Utilities:	
• (SET D)evice	Set device
• (SET U)nit	Display selected units
• (SET T)rack	Set track
• (SET I)nterrupt status	Set interrupt status
• (SET M)ode	Set mode
Program Status:	
• (H)elp	Provides list of commands

- (M)ap address — Memory and device map
- (ST)atus — Display status information
- (SA)ve status — Save status
- (RES)et status — Clear status
- (DUMP C)ir buffer — Display content of circular buffer
- (REC)over status — Retrieve status

Data Utilities:

- (RD) without header — Read without header
- (DUMP S)ector — Display disk sectors

Table 2. Control Inputs.

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

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 10 (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:

Type	Device	Limit
0	880X/8-normal mode	376
0	880X/8-extended mode	576
1	880X/20	776
2	880X/30	776
3	890	776

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 nonexistant drive unit was selected (all tests).

13 *Spin Error*

DEV UNIT RLCS

17XXXX XXXX XXXX

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

14 *Nonexistant 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 nonexistant 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)RFACE 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 (^ = outward). A ! will be printed at the conclusion of each pass. This test will run until terminated by a CTRL-R.

  Example:
  ```
  # COMMAND:  SEE<CR>
  SEEK LENGTH (1):  3  THROUGH (40):  7
  COVERING TRACKS (0):  10  THROUGH (776):  40
  ```

- (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.

- (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.

  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.

- (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.

- (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.

- (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:

- (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 Ø through 576 (octal) and is selected in normal mode, class 1. Normal mode (normal switch, class Ø) allows access to tracks Ø through 376 (octal). After setting class select switch to Ø 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 Ø. The default upper track limits are as follows:

Type	Device	Limit
Ø	88ØX/8 - normal mode	376
Ø	88ØX/8 - extended mode	576
1	88ØX/2Ø	776
2	88ØX/3Ø	776
3	89Ø	776

  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 (88Ø) or GEMEXR (89Ø) 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)NTERRUPT 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@Ø:. 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
  USØ indicates this device contains a drive unit Ø

  USØ, US1, US2, and US3 do an implicit set unit function when set.

  Example:
```
# COMMAND:  SET D<CR>
SET THE DEVICE FLAGS FOR EACH SYSTEM AS FOLLOWS
 1Ø: ENABLE UNIT Ø ON CURRENT DEVICE
 2Ø: ENABLE UNIT 1 ON CURRENT DEVICE
 4Ø: ENABLE UNIT 2 ON CURRENT DEVICE
RLCS @ 174400:  INT @ 160 INTVEC=160  FLAGS: 7Ø
RLCS @ Ø:
```

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.

- (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 #Ø  #BAD=3  #RD/WRT=2Ø49  B-DATA=Ø
  B-TRACK=Ø
  # 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 Ø, 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)?  O<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 MACRO M1113 25-MAR-83 14:34
TABLE OF CONTENTS


```
                        .TITLE DSD 890 BOOTSTRAP PROGRAM

                ; BOOTSTRAP 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. CHECKS THAT THE 8240 CONTROLLER REGISTERS RESPOND WITH REASONABLE DATA.
                ; 3  PERFORM DIRECT ACCESS MODE READ WRITE TEST ON CYLINDER ZERO HEAD TWO.
                ; 4  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.
                ; 5. READ IN BOOT BLOCK FROM SELECTED DEVICE AND TRANSFERS CONTROL TO LOCN 0.
                ;
                ; ABNORMAL TERMINATION ERROR CODES - LOCATED IN REGISTER 0 AFTER SYSTEM HALT.
                ;       R1 CONTAINS BOOTSTRAP PROGRAM REVISION LEVEL AND R2 HAS CONTROLLER
                ;       MICROCODE REVISION LEVEL.
                ;
                ; 1     MEMORY TEST ERROR -
                ;           OFFSET ADDRESS OF OFFENDING ADDRESS IN R3.  PAGE
                ;           (IF APPLICABLE) IS IN APR 6.
                ; 2     WINCHESTER Q-BUS REGISTER ERROR -
                ;           NO RESPONSE FROM DESIGNATED WINCHESTER REGISTER.  REGISTER
                ;           ADDRESS IN R3.
                ; 3.    TAPE Q-BUS REGISTER ERROR -
                ;           NO RESPONSE FROM DESIGNATED TAPE REGISTER. REGISTER ADDRESS IN R3.
                ; 4     FLOPPY Q-BUS REGISTER ERROR-
                ;           NO RESPONSE FROM DESIGNATED FLOPPY REGISTER. REGISTER ADDRESS IN R3.
                ; 5     WINCHESTER READ/WRITE TEST ERROR -
                ;           DEVICE ADDRESS IN R3.
                ; 6     BOOT READ ERROR -
                ;           ERROR READING BOOT BLOCK. DEVICE ADDRESS IN R3.
                ; 7.    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 890 BOOTSTRAP PROGRAM       MACRO M1113  25-MAR-83 14:34  PAGE 2
BOOTSTRAP DEFINITIONS

                        .SBTTL BOOTSTRAP DEFINITIONS
                        ;
                        ; RL01 / RL02 COMPATIBLE HARDWARE DEFS.
                        ;
000002                   .RLBA= 2               ; BUS ADDRESS OFFSET
000004                   .RLDA= 4               ; DISK ADDRESS OFFSET
000006                   .RLMP= 6               ; MULTI PURPOSE OFFSET
000010                   .RLBAE=10              ; BUS ADDRESS EXTENSION OFFSET
000012                   .RLCS2=12              ; CS2 OFFSET
                        ;
                        ; I/O REGISTER ADDRESSES
                        ;
177560  TKS =    177560          ; KEYBOARD STATUS
177562  TKB =    177562          ; KEYBOARD DATA
177564  TPS =    177564          ; OUTPUT STATUS
177566  TPB =    177566          ; OUTPUT DATA
                        ;
                        ;MEMORY MANAGEMENT UNIT ADDRESSES
                        ;
177572  MMUSR0  =        177572  ; MMU STATUS REGISTER 0
172516  MMUSR3  =        172516  ; MMU STATUS REGISTER 3
172300  KPDR0   =        172300  ; KERNAL PAGE DESCRIPTOR 0
172340  KPAR0   =        172340  ; KERNAL PAGE ADDRESS REGISTER 0
172354  KPAR6   =        172354  ; KERNAL PAGE ADDRESS REGISTER 6
                        ;
                        ;REGISTER USAGE IN CONFIGURATION AND MEMORY TEST SECTION
                        ;
000003  MMU=     %3      ; R3    BOOLEAN MMU FLAG.  ZERO = NOT PRESENT
000005  CFW=     %5      ; R5    CONFIGURATION WORD
                        ;
                        ;COMMAND CODES
                        ;
000002  WCK     =        2               ; WRITE CHECK
000004  GES     =        4               ; GET STATUS
000006  SEEK    =        6               ; SEEK
000010  RDH     =        10              ; READ HEADER
000012  WRT     =        12              ; WRITE DATA
000014  RD      =        14              ; READ DATA
                        ;
                        ;CONFIGURATION CONSTANTS
                        ;
000400  WADJMP  =        400             ; WINCHESTER ADDRESS JUMPER
001000  TADJMP  =        1000            ; TAPE ADDRESS JUMPER
010000  TINJMP  =        10000           ; TAPE INSTALLED JUMPER
020000  PROMPT  =        20000           ; PROMPTING ENABLED
003002  MTBEG   =        3002            ; START OF MEMORY TO TEST
000000  BTREV   =        0               ; BOOT PROGRAM REVISION #
111000  EMENTER =        111000          ; CODE TO ENTER EXTENDED MODE
101000  EMOKAY  =        101000          ; CS2 RESPONSE TO EMENTER
020000  RWADD   =        20000           ; DISK ADDRESS FOR R/W TEST
                        ;
                        ;ABNORMAL TERMINATION CODES.  LOCATED IN R0 AFTER SYSTEM HALT
                        ;
000001  MTE =   1       ; MEMORY TEST ERROR - OFFSET OF MEM LOCN (INTO APR 6) IN R1
000002  WQE =   2       ; WINCHESTER Q-BUS REGISTER ERROR - DEVICE ADDR IN R1
000003  TQE =   3       ; TAPE Q-BUS REGISTER ERROR     -  "
000004  FQE =   4       ; FLOPPY Q-BUS REGISTER ERROR   -  "


DSD 890 BOOTSTRAP PROGRAM       MACRO M1113  25-MAR-83 14:34  PAGE 2-1
BOOTSTRAP DEFINITIONS

000005  WRW =   5       ; WINCHESTER R/W TEST ERROR     -  "
000006  BRE =   6       ; BOOT READ ERROR               -  "
000007  IBB =   7       ; INVALID BOOT BLOCK            -  "
```

```
DSD 890 BOOTSTRAP PROGRAM       MACRO M1113  25-MAR-83 14:34  PAGE 3
22 BIT MEMORY TEST

    112                 .SBTTL 22 BIT MEMORY TEST
    113 000000           CSECT
    114                 ;
    115                 ;
    116                 ;
    117 000000  013705  START:  MOV     @#3000,CFW      ; GET CONFIG WORD. KEEP IN R5
                003000
    118 000004  011706          MOV     (PC), SP        ; SET STACK TO 12700
    119 000006  012700          MOV     #340, R0        ; LOCK OUT LINE TIME CLOCK
                000340
    120 000012  106400          MTPS    R0              ; BY SETTING PRIORITY TO 7
    121 000014  004467          JSR     R4, MEMCHK      ; R4 POINTS TO TRAP ROUTINE
                000010
    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
                000001
                000002
    128 000026  000002          RTI
    129                 ;
    130                 ;       MEMORY TEST SECTION
    131                 ;
    132 000030  012701  MEMCHK: MOV     #4, R1          ; SET LOW MEM POINTER
                000004
    133 000034  010421          MOV     R4, (R1)+       ; LOAD TRAP VECTOR
    134 000036  010021          MOV     R0, (R1)+       ; LOAD PSW = 340
    135 000040  030527          BIT     CFW,#PROMPT     ; IS PROMPTING ENABLED ?
                020000
    136 000044  001414          BEQ     MTINIT          ; IF NOT GOTO MEM TEST INIT
    137 000046  004167          JSR     R1,PRINT        ; LOAD R1 WITH POINTER TO "TESTING MEMORY"
                001702
    138                 .NLIST BIN
    139 000052  TSTMSG: .ASCIZ <15><12>/TESTING MEMORY /<15><12>
    140                 .EVEN
    141                         .LIST BIN
    142 000076  012704  MTINIT: MOV     #MTBEG, R4      ; R4 POINTS TO LOCN TO BE TESTED
                003002
    143 000102  005003          CLR     MMU             ; INITIALIZE MMU FLAG TO FALSE
    144 000104  012737          MOV     #0,@#MMUSR0     ; DISABLE MEMORY MANAGEMENT UNIT
                000000
                177572
    145 000112  103446          BCS     MEMTST          ; IF NO MMU PRESENT START TEST
    146 000114  005203          INC     MMU             ; SET MMU FLAG TO TRUE
    147 000116  012700          MOV     #10, R0         ; USE R0 TO COUNT MMU RESISTERS
                000010
    148 000122  012701          MOV     #KPDR0, R1      ; START WITH KERNAL PDR 0
                172300
    149 000126  012721  10$:    MOV     #77406, (R1)+   ; INIT PDR = 4K WDS, UPWARD EXP., R/W
                077406
    150 000132  077003          SOB     R0, 10$         ; LOOP UNTIL DONE
    151 000134  012702          MOV     #7, R2          ; REINITIALIZE COUNTER (DON'T INCLUDE IO PAGE)
                000007
    152 000140  012701          MOV     #KPAR0, R1      ; SET POINTER TO APRS
                172340
```

```
DSD 890 BOOTSTRAP PROGRAM        MACRO M1113  25-MAR-83 14:34  PAGE 3-1
22 BIT MEMORY TEST

    153 000144  010021  20$:    MOV     R0, (R1)+       ; APR = BASE ADDRESS (START R0 = 0)
    154 000146  062700          ADD     #200, R0        ; INCREMENT BY 128 BLOCKS (4K WORDS)
                000200
    155 000152  077204          SOB     R2, 20$         ; LOOP UNTIL DONE
    156 000154  012711          MOV     #177600, (R1)   ; APR 7 = I/O PAGE
                177600
    157 000160  005237          INC     @#MMUSR0        ; ENABLE MMU
                177572
    158 000164  005037          CLR     @#0             ; CLEAR LOCATION 0 TO SEE IF MEM > 18 BITS
                000000
    159 000170  012702          MOV     #KPAR6, R2      ; USE R2 AS POINTER TO KERNAL APR  6
                172354
    160 000174  012712          MOV     #10000,(R2)     ; SET AT BEGINNING OF 19 BIT MEM SPACE
                010000
    161 000200  005237          INC     @#140000        ; INCREMENT LOCN
                140000
    162 000204  103406          BCS     30$             ; IF NXM BRA
    163 000206  005737          TST     @#0             ; SEE IF LOCN 0 CHANGED
                000000
    164 000212  001003          BNE     30$             ; IF SO IMPLIES SHADOWING
    165 000214  012737          MOV     #20,@#MMUSR3    ; ENABLE 22-BIT ADDR
                000020
                172516
    166 000222  052704  30$:    BIS     #140000, R4     ; INITIALIZE TO APR 6
                140000
    167 000226  005012          CLR     (R2)            ; START WITH APR 6 = 0
    168 000230          MEMTST:
    169 000230  000241  10$:    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  005224          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  062712          ADD     #200, (R2)      ; BUMP APR CONTENTS
                000200
    183 000270  012704          MOV     #140000, R4     ; START AGAIN WITH OFFSET 0 INTO APR6
                140000
    184 000274  000755          BR      10$             ; BRANCH FOREVER (TRAP 4 EXITS)
    185 000276  012700  MTERR.  MOV     #MTE,R0         ; MEMORY TEST ERROR CODE
                000001
    186 000302  010401          MOV     R4,R1           ; OFFSET OF ERROR LOCATION
    187 000304  000167          JMP     BOOTERR
                001070
    188 000310  000000  TOPOFF: .WORD   0
    189 000312  000000  TOPAPR: .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       MACRO M1113  25-MAR-83 14:34  PAGE 3-2
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  REGCHK: CLR     R0              ; USE AS PTR FOR STD CONFIG STORAGE
    197 000332  012701          MOV     #174420,R1      ; LOAD ALT ADDR
                174420
    198 000336  032705          BIT     #WADJMP,CFW     ; RCSR SELECT = STD ?
                000400
    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)+        ; SAV SELECTED RL @ LOCN 0
    202 000352  005721          TST     (R1)+           ; RLCSR
    203 000354  103561          BCS     WERR            ; BRANCH IF NO RESPONSE
    204 000356  012702          MOV     #-1,R2          ; R2 HAS ALL 1'S
                177777
    205 000362  010211          MOV     R2,(R1)         ; RLBA SHOULD RESPONDS WITH ALL 1'S
    206 000364  020221          CMP     R2,(R1)+        ;
    207 000366  001154          BNE     WERR            ; 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 000400  010211          MOV     R2,(R1)         ; ALL ONES TO BAE
    213 000402  022711          CMP     #77,(R1)        ; SHOULD ONLY RESPOND WITH BITS 0-5
                000077
    214 000406  001144          BNE     WERR
    215 000410  005021          CLR     (R1)+           ; RESET BAE
    216 000412  012711          MOV     #EMENTER,(R1)   ; WRITE EMENTER CODE TO RLCS2
                111000
    217 000416  012711          MOV     #111333,(R1)    ; SECOND WORD OF EMENTER
                111333
    218 000422  011100          MOV     (R1),R0         ; COPY OF RLCS2
    219 000424  001535          BEQ     WERR            ; SHOULD BE NON ZERO
    220 000426  105000          CLRB    R0
    221 000430  000300          SWAB    R0              ; 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,R0
    225 000444  062700          ADD     #6,R0           ; R0 HAS ADDRESS OF ACTIVE RLMPR
                000006
```

```
DSD 890 BOOTSTRAP PROGRAM       MACRO M1113  25-MAR-83 14:34  PAGE 4
WINCHESTER READ WRITE TEST

    227                 .SBTTL WINCHESTER READ WRITE TEST
    228                 ;
    229                 ;
    230          000001 LCS = %1;
    231 000450          RWTST:
    232                 ;INCLUDE CODE TO SKIP RW TEST IF ALL UNITS WRITE PROTECT
    233 000450  030527          BIT     CFW,#170        ; IS DRIVE WRITE PROTECTED
                000170
    234 000454  001523          BEQ     TSCHK           ; IF SO SKIP READ/WRITE TEST
    235 000456  012761          MOV     #EMENTER,.RLCS2(LCS) ; RE ENTER EXTENDED MODE
                111000
                000012
    236 000464  012761          MOV     #111333,.RLCS2(LCS) ;
                111333
                000012
    237 000472  005046          CLR     -(SP)           ; SECTOR FOR RW TEST
    238 000474  012761          MOV     #RWADD,.RLDA(LCS)
                020000
                000004
    239 000502  012703          MOV     #SEEK,R3        ; SET UP SEEK COMMAND
                000006
    240 000506  004767          JSR     PC,RLEX         ; ISSUE SEEK COMMAND
                000162
    241 000512  005723          TST     (R3)+           ; TURN INTO READ HEADER COMMAND
    242 000514  004767          JSR     PC,RLEX         ; ISSUE READ HEADER COMMAND
                000154
    243 000520  021027          CMP     (R0),#RWADD     ; SEEK SUCCESSFUL ?
                020000
    244 000524  001075          BNE     WERR            ; BRANCH IF NOT
    245 000526  005061          CLR     .RLBAE(LCS)     ; START AT SECTOR 0
                000010
    246 000532  012703  AGN:    MOV     #RD,R3          ; READ DATA COMMAND
                000014
    247 000536  004767          JSR     PC,RLEX         ; READ ONE SECTOR TO BUFFER
                000132
    248 000542  011661          MOV     (SP),.RLBAE(LCS) ; SECTOR TO CHECK
                000010
    249 000546  012703          MOV     #WCK,R3         ; WRITE CHK
                000002
    250 000552  004767          JSR     PC,RLEX         ;
                000116
    251 000556  005711          TST     (LCS)           ; TEST FOR WRITE CHK ERROR
    252 000560  100435          BMI     RTRY            ; BRANCH IF ERROR
    253 000562  012703          MOV     #200,R3         ; USE R3 AS COUNTER FOR COMPLEMENT
                000200
    254 000566  010446          MOV     R4,-(SP)        ; PUSH R4
    255 000570  012704          MOV     #MTBEG,R4       ; POINTER TO BUFFER
                003002
    256 000574  005124  10$:    COM     (R4)+           ; INVERT WORD
    257 000576  077302          SOB     R3,10$          ; DO WHOLE BUFFER
    258 000600  012604          MOV     (SP)+,R4        ; RESTORE R4
    259 000602  012703          MOV     #WCK,R3         ; ANOTHER WRITE CHECK
                000002
    260 000606  004767          JSR     PC,RLEX         ; EXECUTE
                000062
    261 000612  005711          TST     (LCS)           ; EXPECT ERROR THIS TIME
    262 000614  100017          BPL     RTRY            ; RETRY IF NOT AN ERROR
```

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DSD 890 BOOTSTRAP PROGRAM       MACRO M1113  25-MAR-83 14:34  PAGE 4-1
WINCHESTER READ WRITE TEST

    263 000616  012703          MOV     #WRT,R3          ; WRITE DATA COMMAND
                000012
    264 000622  004767          JSR     PC,RLEX          ; EXECUTE
                000046
    265 000626  005711          TST     (LCS)            ; WRITE DATA ERROR ?
    266 000630  100411          BMI     RTRY             ; TRY AGAIN IF SO
    267 000632  012703          MOV     #WCK,R3          ; DO ANOTHER WRITE CHK
                000002
    268 000636  004767          JSR     PC,RLEX
                000032
    269 000642  005711          TST     (LCS)            ; ERROR ?
    270 000644  100403          BMI     RTRY             ; THEN TRY AGAIN
    271 000646  005061          CLR     .RLCS2(LCS)      ; EXIT EXTENDED MODE
                000012
    272 000652  000424          BR      TSCHK            ; OK NOW CHECK TS REGISTERS
    273 000654  062716  RTRY:   ADD     #400,(SP)        ; BUMP SECTOR
                000400
    274 000660  031627          BIT     (SP),#4000       ; CHECK IF REPEATED 7 TIMES
                004000
    275 000664  011661          MOV     (SP),.RLBAE(LCS)
                000010
    276 000670  001413          BEQ     WERR
    277 000672  000717          BR      AGN              ; IF NOT REPEAT
    278 000674  012761  RLEX:   MOV     #MTBEG, RLBA(LCS); USE 3002 AS BUFFER
                003002
                000002
    279 000702  012761          MOV     #-200,.RLMP(LCS) ; ONE SECTOR WORD COUNT
                177600
                000006
    280 000710  010311          MOV     R3,(LCS)         ; ISSUE COMMAND
    281 000712  105711  RLWT:   TSTB    (LCS)            ; WAIT FOR DONE
    282 000714  100376          BPL     RLWT
    283 000716  000207          RTS     PC               ; RETURN
    284 000720  005037  WERR:   CLR     @#0              ; ZERO @ LOCN 0 MEANS NO WINCH
                000000
    285 000724  012700  TSCHK:  MOV     #2,R0
                000002
    286 000730  005010          CLR     (R0)             ; ZERO @ LOCN 2 MEANS NO TAPE
    287 000732  032705          BIT     #TINJMP,CFW      ; IS TAPE INSTALLED ?
                010000
    288 000736  001013          BNE     DECODE           ; BRANCH IF NOT
    289 000740  012701          MOV     #172530,R1       ; LOAD ALT ADDR
                172530
    290 000744  032705          BIT     #TADJMP,CFW      ; TSSR SELECT = STD ?
                001000
    291 000750  001402          BEQ     3$               ; IF NOT BRANCH
    292 000752  012701          MOV     #172520,R1       ; LOAD STD ADDR
                172520
    293 000756  010120  3$:     MOV     R1,(R0)+         ; SAV STD TAPE
    294 000760  005721          TST     (R1)+            ; CHECK FOR RESPONSE
    295 000762  005711          TST     (R1)             ;  "     "
    296 000764  103572          BCS     TQERR            ; 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       MACRO M1113  25-MAR-83 14:34  PAGE 4-2
WINCHESTER READ WRITE TEST

             177770
    302 000774  001073          BNE     10$             ; JUMP IF NOT BASE ADDRESS
    303 000776  032705          BIT     #PROMPT,CFW     ; IF IT IS SEE IF PROMPTING ENABLED
                020000
    304 001002  001470          BEQ     10$             ; BRANCH IF NOT
    305 001004  004167  5$.     JSR     R1,PRINT        ; LOAD R1 WITH POINTER TO PROMPT MSG
                000744
    306                 .NLIST BIN
    307 001010          .ASCII <15><12>/BOOT DEV/<15><12>
    308 001024          .ASCII <40>/(0=DL0, 1=DL1, 2=DL2, 3=TAPE, 4=FLP 177170, 5=FLP 177150)/
    309 001116          .ASCIZ <15><12>/?/
    310                 .EVEN
    311                 .LIST BIN
    312 001122  004767          JSR     PC,GETCHR       ; GET ANSWER
                000550
    313 001126  022700          CMP     #15,R0          ; IS IT A CARRIAGE RETURN
                000015
    314 001132  001003          BNE     7$              ; BRANCH IF NOT
    315 001134  005000          CLR     R0              ; DEFAULT IS DL0
    316 001136  000167          JMP     BOOTRL          ; GO BOOT IT
                000032
    317 001142  162700  7$:     SUB     #'0,R0          ; MAKE INTO NUMBER
                000060
    318 001146  020027          CMP     R0,#5           ; MAKE SURE VALID ENTRY
                000005
    319 001152  003314          BGT     5$              ; TRY AGAIN IF NOT
    320 001154  020027          CMP     R0,#2           ; IT IS WINCHESTER ?
                000002
    321 001160  003405          BLE     BOOTRL          ; IF SO GO TO DISPATCH
    322 001162  005200          INC     R0              ; IF NOT INC TO OFFSET FOR RESERVED WINCH 3
    323 001164  022700  10$:    CMP     #4,R0           ; IS IT TAPE ?
                000004
    324 001170  001513          BEQ     BOOTTS          ; BRANCH IF SO
    325 001172  003542          BLE     BOOTRX
```

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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 = %1
    330                  ;DISK BOOT, DETERMINE RLCSR BASE ADDRESS
    331 001174   013701  BOOTRL: MOV     @#0,LCS          ; STD DISK ADDR AT LOCN 0
                 000000
    332 001200   005701          TST     LCS              ; IF ZERO MEANS WINCH R/W ERROR
    333 001202   001460          BEQ     RWERR            ; DON'T ALLOW BOOT FROM WINCH
    334 001204   105711  2$:     TSTB    (LCS)            ; CHECK CONTROLLER READY
    335 001206   103464          BCS     WGERR            ; HANG IF NO BUS RESPONSE TO DEVICE
    336 001210   100375          BPL     2$               ; ELSE WAIT FOR CONTROLLER RDY
    337 001212   012761          MOV     #3, .RLDA(LCS)   ; DO RESET CONTROLLER ON GET STATUS
                 000003
                 000004
    338 001220   010003          MOV     R0,R3
    339 001222   000303          SWAB    R3
    340 001224   052703          BIS     #4,R3
                 000004
    341 001230   010311          MOV     R3,(LCS)         ; LCS - LOAD GET STATUS FUNCTION
    342 001232   105711  3$:     TSTB    (LCS)            ; WAIT FOR CONTROLLER READY
    343 001234   100376          BPL     3$
    344 001236   012761          MOV     #177601,.RLDA(LCS) ; SET MAXIMAL LENGTH SEEK OUTWARDS
                 177601
                 000004
    345 001244   012703          MOV     #6*400, R3       ; SEEK COMMAND
                 003000
    346 001250   050003          BIS     R0, R3           ; WITH UNIT BITS
    347 001252   000303          SWAB    R3               ; BACK TO UN  UN CR IE  DF DF FN  FN FN GO
    348 001254   010311          MOV     R3,(LCS)         ; LOAD RL01 SEEK COMMAND
    349 001256   105711  4$.     TSTB    (LCS)            ; LCS - WAIT FOR CONTROLLER READY
    350 001260   100376          BPL     4$
    351 001262   012761          MOV     #-400,.RLMP(R1) ;RLWC - SET WORDCOUNT FOR 1 BLOCK
                 177400
                 000006
    352 001270   005061          CLR     .RLDA(R1)        ; LOAD A ZERO INTO DISK ADDRESS REG
                 000004
    353 001274   005061          CLR     .RLBA(R1)        ; LOAD A ZERO INTO BUS ADDRESS REG
                 000002
    354 001300   062703          ADD     #6, R3           ; MAKE SEEK INTO A READ COMMAND
                 000006
    355 001304   010311          MOV     R3,(LCS)         ; ISSUE READ FUNCTION
    356 001306   105711  5$:     TSTB    (LCS)            ; CONTROLLER READY?
    357 001310   100376          BPL     5$
    358 001312   005711          TST     (LCS)            ; ERROR?
    359 001314   100003          BPL     CHKNOP
    360 001316   012700          MOV     #BRE,R0          ; BOOT READ ERROR CODE
                 000006
    361 001322   000426          BR      BOOTERR
    362 001324           CHKNOP:
    363 001324   023727          CMP     @#0,#240         ; IS FIRST WORD NO-OP
                 000000
                 000240
    364 001332   001403          BEQ     1$               ; BRANCH IF SO
    365 001334   012700          MOV     #IBB,R0          ; INVALID BOOT BLOCK CODE
                 000007
    366 001340   000417          BR      BOOTERR          ; BRANCH TO COMMON ERROR ROUTINE
    367 001342   005007  1$:     CLR     PC               ; DISPATCH TO LOC 0.
```

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DSD 890 BOOTSTRAP PROGRAM       MACRO M1113  25-MAR-83 14:34  PAGE 5-1
WINCHESTER BOOT SECTION

    368                 ;
    369                 ; ERROR HANDLER
    370                 ;
    371 001344  012700  RWERR:  MOV     #WRW,R0         ; WINCHESTER READ WRITE ERROR
                000005
    372 001350  000413          BR      BOOTERR
    373 001352  012700  TQERR:  MOV     #TQE,R0         ; TAPE REGISTER ERROR
                000003
    374 001356  000410          BR      BOOTERR
    375 001360  012700  WQERR.  MOV     #WQE,R0         ; WINCHESTER REGISTER ERROR
                000002
    376 001364  000405          BR      BOOTERR
    377 001366  012700  FQERR:  MOV     #FQE,R0         ; FLOPPY REGISTER ERROR
                000004
    378 001372  000402          BR      BOOTERR
    379 001374  012700  BRERR:  MOV     #BRE,R0         ; BOOT READ ERROR
                000006
    380                 ;
    381                 ; COMMON BOOT ERROR HALT
    382                 ;
    383 001400          BOOTERR:
    384 001400  010103          MOV     R1,R3           ; PARM IN R3
    385 001402  012701          MOV     #BTREV,R1       ; BOOT PROG REVISION
                000000
    386 001406  013702          MOV     @#10,R2         ; PROM REV
                000010
    387 001412  105002          CLRB    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                 .SBTTL TAPE BOOT SECTION
    392                 ;
    393                 ; TAPE BOOT SECTION
    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     TQERR           ; 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$:    ADD     #2,R1           ; R1=TSDB+2
                000002
    403 001440  010102  BTRTRY: MOV     R1,R2           ; R2 = TSSR
    404 001442  005000          CLR     R0
    405 001444  105711  1$:     TSTB    (R1)            ; WAIT FOR SSR
    406 001446  100376          BPL     1$
    407 001450  010704          MOV     PC,R4           ; OFFSET = "SM" + 20
    408
    409 001452  010103          MOV     R1,R3           ; R3=TSSR
    410 001454  062703          ADD     #1,R3           ; BOOT REQUIRES WRITE TO BASE + 3 (172523)
                000001
    411 001460  112713          MOVB    #200,(R3)       ; TSV05 IMPLIED BOOT
                000200
    412 001464  005242          INC     -(R2)           ; WRITE INTO TSDB
    413 001466  105711  2$:     TSTB    (R1)            ; WAIT FOR SSR
    414 001470  100376          BPL     2$
    415 001472  005711          TST     (R1)            ; TEST FOR ERROR
    416 001474  100761          BMI     BTRTRY          ; RETRY IF SC
    417 001476  005007          CLR     PC              ; JUMP TO ZERO
```

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DSD 890 BOOTSTRAP PROGRAM       MACRO M1113  25-MAR-83 14:34  PAGE 7
FLOPPY BOOT SECTION

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

001500  012701  BOOTRX: MOV     #177170,XCS     ; STD FLPY ADDRESS
        177170
001504  020027          CMP     R0,#6           ; WAS ALTERNATE SPECIFIED ?
        000006
001510  001002          BNE     1$              ; BRANCH IF NOT
001512  012701          MOV     #177150,XCS     ; LOAD ALTERNATE ADDRESS
        177150
001516  012703  1$:     MOV     #7,R3
        000007
001522  005004          CLR     LDP             ; INIT LOAD ADDRESS POINTER
001524  012746          MOV     #100, -(SP)     ; SET LOW DENSITY WORDCOUNT
        000100
001530  012705          MOV     #1, SCT         ; INIT SECTOR TO READ
        000001
001534  005000          CLR     R0              ; ONLY UNIT 0 ALLOWED FOR FLPY
001536  004767  RDLP:   CALL    WTFLAG          ; WAIT FOR DONE FLAG SET?
        000124
001542  010102          MOV     XCS, XDB        ; COPY RXCS POINTER
001544  010322          MOV     R3, (XDB)+      ; LOAD READ COMMAND AND BUMP XDB TO RXDB
001546  105711  1$:     TSTB    (XCS)           ; WAIT FOR TRREQ
001550  103706          BCS     FQERR           ; BRANCH TO ERROR IF NO RESPONSE
001552  100375          BPL     1$
001554  010512          MOV     SCT, (XDB)      ; LOAD SECTOR
001556  105711  2$:     TSTB    (XCS)
001560  100376          BPL     2$
001562  012712          MOV     #1, (XDB)       ; LOAD TRACK
        000001
001566  004767          CALL    WTFLAG          ; WAIT FOR DONE
        000074
001572  005711          TST     (XCS)           ; KLUDGE SINCE DEC RX02 SETS ERROR
                                                ; BEFORE IT SETS DONE
001574  100010          BPL     EMPBUF          ; EMPTY IF NO ERROR
001576  032712          BIT     #20, (XDB)      ; IS ERROR A DENSITY ERROR?
        000020
001602  001674          BEQ     BRERR           ; NO- FLOPPY READ ERROR
001604  052703          BIS     #400, R3        ; SET COMMAND TO DOUBLE DENSITY
        000400
001610  012716          MOV     #200, (SP)      ; SET TO D.D. WORD COUNT
        000200
001614  000750          BR      RDLP            ; AND TRY READING AGAIN

001616  010346  EMPBUF: MOV     R3, -(SP)       ; GET COMMAND COPY
001620  042716          BIC     #4, (SP)        ; MAKE INTO AN EMPTY BUFFER COMMAND
        000004
001624  012611          MOV     (SP)+, (XCS)    ; AND EXECUTE
```

```
DSD 890 BOOTSTRAP PROGRAM       MACRO M1113  25-MAR-83 14:34  PAGE 7-1
FLOPPY BOOT SECTION

    463 001626  105711  1$:     TSTB    (XCS)           ; WAIT FOR FIRST TRREQ
    464 001630  100376          BPL     1$
    465 001632  011612          MOV     (SP), (XDB)     ; LOAD THE WORD COUNT
    466 001634  105711  2$:     TSTB    (XCS)
    467 001636  100376          BPL     2$
    468 001640  010412          MOV     LDP, (XDB)      ; AND XFER ADDRESS
    469 001642  004767          CALL    WTFLAG          ; WAIT FOR DONE OR TRREQ
                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    (SCT)+, (SCT)+  ; 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          JMP     CHKNOP          ; CHECK LOC 0 = NOP AND DISPATCH
                177436
    477
    478
    479                 ; WAIT FOR FLOPPY FLAGS, DONE, ERROR, TRREQ
    480
    481 001666  032711  WTFLAG  BIT     #240, (XCS)     ; WAIT FOR DONE OR TRREQ
                000240
    482 001672  001775          BEQ     WTFLAG          ; CAN'T TEST RX02 ERROR HERE
    483 001674  000207          RETURN
```

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

    485                 .SBTTL I/O SUPPORT SECTION
    486                 ;
    487                 ; I/O SUPPORT SECTION
    488                 ;
    489                 ; GETCHR - RETURNS CHAR VALUE IN R0, LSTCHR
    490                 ; CLEARS PARITY BIT
    491
    492 001676  105737  GETCHR: TSTB    @#TKS
                177560
    493 001702  100375         BPL     GETCHR
    494 001704  113700         MOVB    @#TKB, R0
                177562
    495 001710  042700         BIC     #^C177, R0
                177600
    496                 ;
    497                 ; FALL THROUGH TO OUTCHR TO ECHO INPUT
    498                 ;
    499                 ; OUTCHR PRINTS CHAR IN R0
    500                 ;
    501 001714  105737  OUTCHR: TSTB    @#TPS
                177564
    502 001720  100375         BPL     OUTCHR
    503 001722  110037         MOVB    R0, @#TPB
                177566
    504 001726  105737         TSTB    @#TKS           ; CHAR READY?
                177560
    505 001732  100007         BPL     10$
    506 001734  113746  4$:    MOVB    @#TKB, -(SP)
                177562
    507 001740  042716         BIC     #^C177, (SP)    ; STRIP PARITY
                177600
    508 001744  122627         CMPB    (SP)+, #'S-100  ; CTRL S? REQUIRED FOR HIGH SPEED TERMINALS
                000023
    509 001750  001771         BEQ     4$
    510 001752  000207  10$:    RTS     PC
    511                 ;
    512                 ; PRINT STRING POINTED AT BY R1 (TERMINATED BY 0 BYTE)
    513                 ;
    514 001754          PRINT:
    515 001754  112100  10$:    MOVB    (R1)+,R0        ; TO R0 FOR OUTCHR
    516 001756  105700         TSTB    R0              ; AT END OF STRING ?
    517 001760  001403         BEQ     20$             ; EXIT IF YES
    518 001762  004767         JSR     PC,OUTCHR       ; OUTPUT (R0)
                177726
    519 001766  000772         BR      10$             ; LOOP
    520 001770  000201  20$:    RTS     R1
    521 001772          BOTLST:.
    522         000001         .END
```

```
DSD 890 BOOTSTRAP PROGRAM       MACRO M1113  25-MAR-83 14:34  PAGE 8-1
SYMBOL TABLE

AGN     000532R         MEMEND  000314R         TKB    = 177562
BOOTER  001400R         MEMTST  000230R         TKS    = 177560
BOOTRL  001174R         MMU    =%000003         TOPAPR  000312R
BOOTRX  001500R         MMUSR0= 177572          TOPOFF  000310R
BOOTTS  001420R         MMUSR3= 172516          TPB    = 177566
BOTLST  001772RG        MTBEG  = 003002         TPS    = 177564
BRE    = 000006         MTE    = 000001         TQE    = 000003
BRERR   001374R         MTERR   000276R         TQERR   001352R
BTREV  = 000000         MTINIT  000076R         TRAP4   000020R
BTRTRY  001440R         OUTCHR  001714R         TSCHK   000724R
CFW    =%000005         PRINT   001754R         TSTMSG  000052R
CHKNOP  001324R         PROMPT= 020000          WADJMP= 000400
DECODE  000766R         RD     = 000014         WCK    = 000002
EMENTE= 111000          RDH    = 000010         WERR    000720R
EMOKAY= 101000          RDLP    001536R         WQE    = 000002
EMPBUF  001616R         REQCHK  000330R         WQERR   001360R
FQE    = 000004         RLEX    000674R         WRT    = 000012
FQERR   001366R         RLWT    000712R         WRW    = 000005
GES    = 000004         RTRY    000654R         WTFLAG  001666R
GETCHR  001676R         RWADD  = 020000         XCS    =%000001
IBB    = 000007         RWERR   001344R         XDB    =%000002
KPAR0  = 172340         RWTST   000450R         .RLBA  = 000002
KPAR6  = 172354         SCT    =%000005         .RLBAE= 000010
KPDR0  = 172300         SEEK   = 000006         .RLCS2= 000012
LCS    =%000001         START   000000R         .RLDA  = 000004
LDP    =%000004         TADJMP= 001000          .RLMP  = 000006
MEMCHK  000030R         TINJMP= 010000

. ABS.   000000      000
         001772      001
ERRORS DETECTED.  0

VIRTUAL MEMORY USED.  848 WORDS  ( 4 PAGES)
DYNAMIC MEMORY.  2822 WORDS  ( 10 PAGES)
ELAPSED TIME:  00.00.23
B890X2,B890X2/LI:TTM/-SP=B890X2
```

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.

ALOGY

2241 Lundy Avenue
San Jose, CA 95131
408/946-5800
TWX 910-338-0249

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 IOX 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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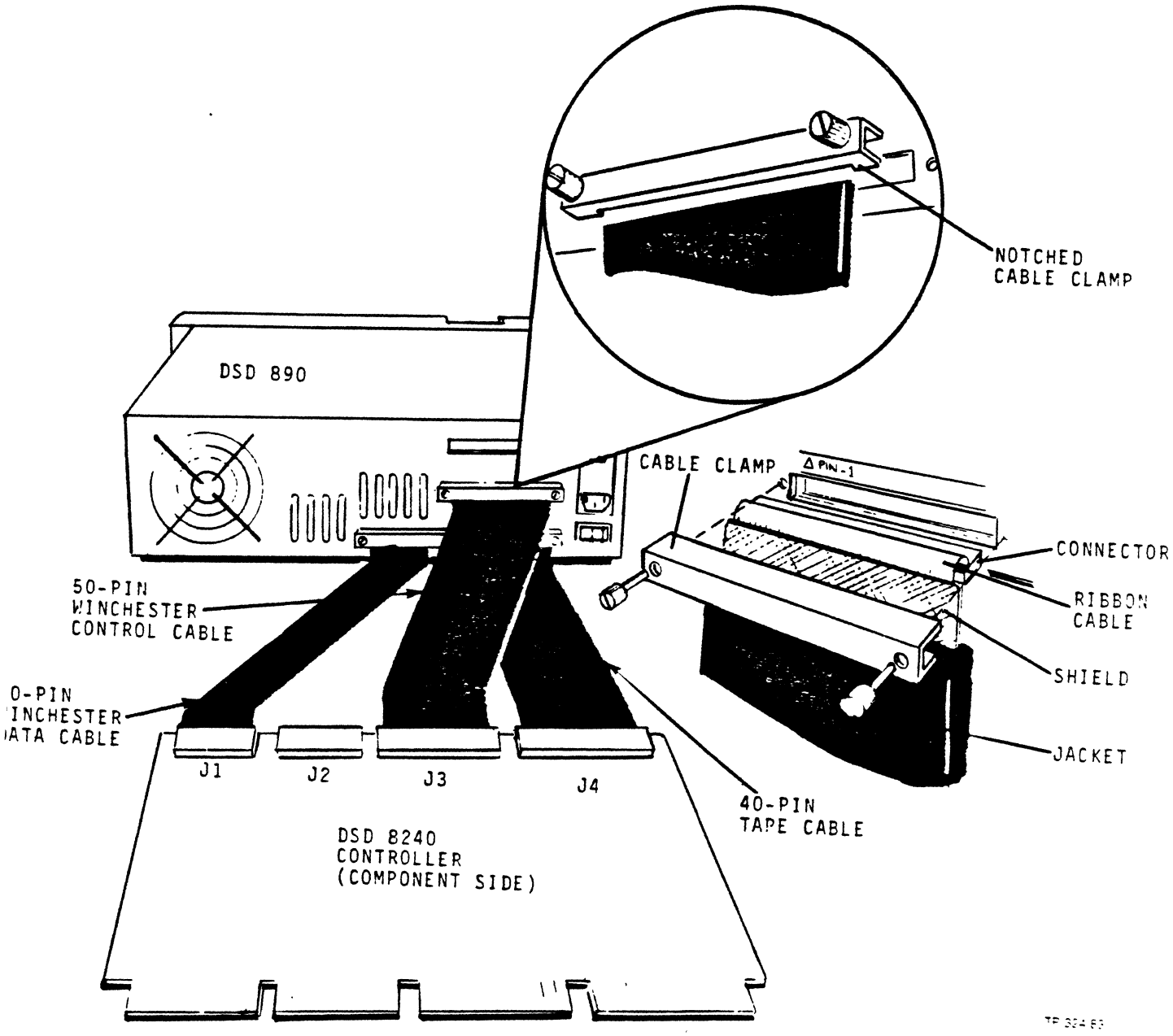


Figure 4-5. Cabinet and Board Cabling

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)

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

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.

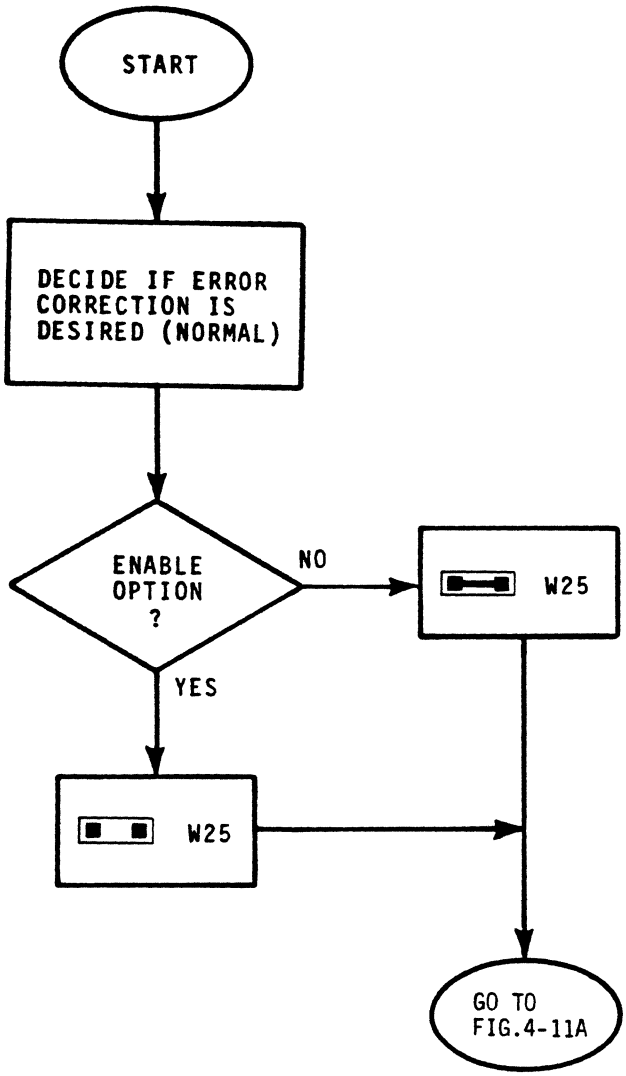


Figure 4-11. Error Correction Option TP 523 83

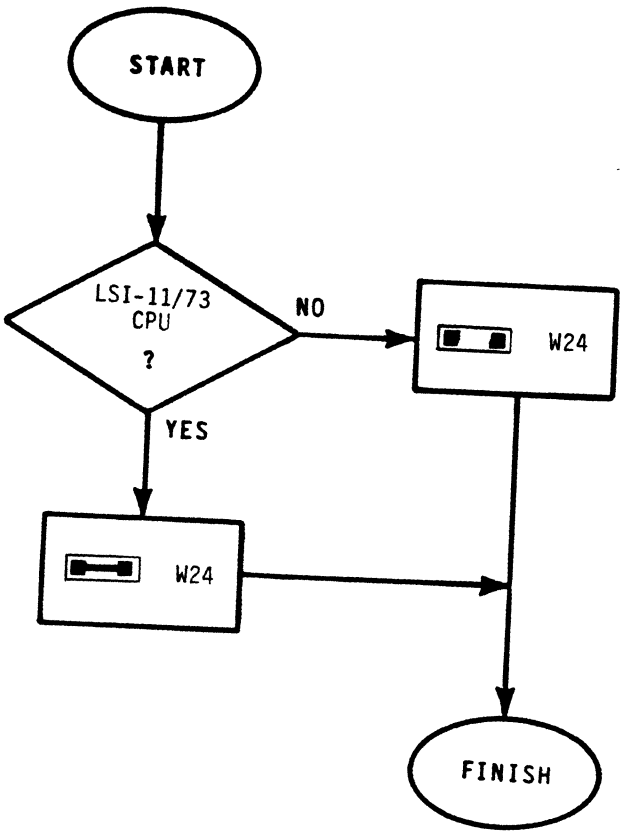
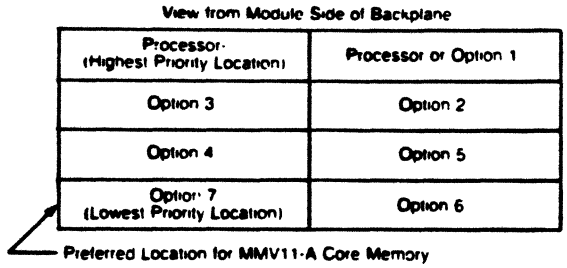
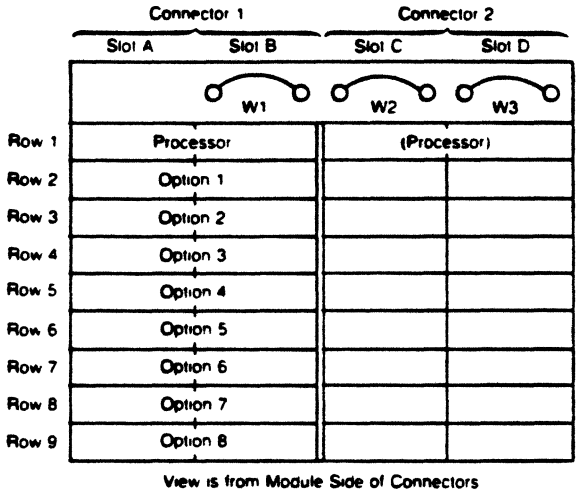


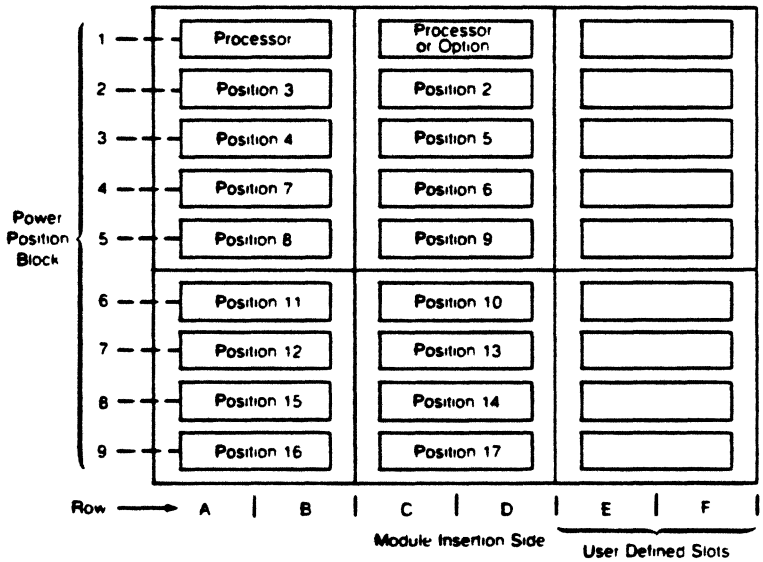
Figure 4-11A. CPU Option



DEC Backplane H9270



DEC Backplane H9273-A



DEC Backplane DDV11-8

TP 312/83

Figure 4-12. Common LSI-11 Backplanes