FIELD MAINTENANCE

WD800/WD800A Mass Storage System

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April 1985

TEXAS INSTRUMENTS

MANUAL REVISION HISTORY

WD800/WD800A Mass Storage System Field Maintenance (2306142-9701)

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The computers, as well as the programs that TI has created to use with them, are tools that can help people better manage the information used in their business; but tools—including TI computers—cannot replace sound judgment nor make the manager's business decisions.

Consequently, TI cannot warrant that its systems are suitable for any specific customer application. The manager must rely on judgment of what is best for his or her business.

Preface

This manual provides the field-level maintenance and operation information required to service the WD800 and WD800A mass storage systems.

NOTE

The WD800 and WD800A operate in a similar manner. Unless noted otherwise, when this manual refers to the WD800, the information applies to both the WD800 and the WD800A mass storage systems.

The information in this manual is divided into seven sections and three appendixes as follows:

Section

1 Overview — Provides a system overview. Gives component specifications, configurations, and functional descriptions, lists the field-replaceable parts, and describes basic operating procedures.

2 Preventive Maintenance — Describes procedures for routine operator maintenance that the customer representative (CR) performs in case of operator neglect.

3 TPBI/PBI Corrective Maintenance — Contains troubleshooting procedures and removal and replacement procedures. Also included are testing procedures to verify that the TILINE peripheral bus interface (TPBI) board and peripheral bus interface (PBI) cable are operational.

4 WD800/WD800A Troubleshooting — Contains troubleshooting procedures, typical problem areas, chassis self-test functions, DX10 system log interpretation, as well as DOCS tests and troubleshooting flowcharts.

5 WD800 Removal and Replacement Procedures — Contains troubleshooting procedures, as well as component and part removal and replacement procedures, and testing procedures to verify that the WD800 chassis and PBI cable are operational. Also includes the illustrated parts breakdown for the system.

6 WD800A Removal and Replacement Procedures — Contains troubleshooting procedures, as well as component and part removal and replacement procedures, and testing procedures to verify that the WD800A chassis and PBI cable are operational. Also includes the illustrated parts breakdown for the system.

7 S300 PBI Controller Corrective Maintenance — Contains very general maintenance and troubleshooting information for correcting problems with the Business System 300 or 300A PBI.

Appendix

A TPBI Error Status Matrix — Lists the error status codes in matrix form for easy reference.

B AC Voltage/Frequency Conversion — Gives the procedure to convert to a different voltage or frequency.

C Bad Track Mapping (WD800A) - Discusses bad-track mapping on the WD800A only.

The following documents contain additional information related to the WD800 mass storage system.

Title	Part Number
WD800/WD800A Mass Storage System Installation and Operation	2306140-9701
Model WD800/WD800A Disk Units Operator's Guide	2533319-9701
WD800 Mass Storage System Depot Maintenance Manual	2224574-9701
TILINE Peripheral Bus Interface Controller Depot Maintenance Manual	2306143-9701
Model 990/12 Computer Hardware User's Manual	2264446-9701
Model 990/10 Computer System Hardware Reference Manual	945417-9701
Model 990 Computer 990/10 and 990/12 Assembly Language Reference Manual	2270509-9701
Model 990 Computer Family Maintenance Drawings, Volume 4 — TILINE Expansion and Peripherals	945421-9704
Unit Diagnostics Handbook, Volume 1, General Diagnostic Information	945400-9701
Unit Diagnostics Handbook, Volume 3, Diagnostics for 990 Mass Storage Devices	945400-9703
DX10 Operating System Systems Programming Guide, Volume V	946250-9705
DX10 Operating System Error Reporting and Recovery Manual, Volume VI	946250-9706
DX10 Operating System Concepts and Facilities, Volume I	946250-9701

Title	Part Number
DX10 Operating System Operations Guide, Volume II	946250-9702
DNOS Object Installation Guide	2270514-9701
DNOS System Generation Reference Manual	2270511-9701
ROM Loader User's Guide	2270534-9701
Business System 300 System Description	2533308-9701
Business System 300 Field Maintenance Manual	2533309-9701
Business System 300A System Description	2240276-9701
Business System 300A Field Maintenance	2240277-9701
Business System 600/800 Product Instruction Manual	2533308-9701
Business Systems 600/800 Installation	2533308-9701
Business Systems 600/800 Field Maintenance	2311345-9701
Conversion Procedure, Primary/Secondary, 990 WD800	2270843-9701
Conversion Procedure, Primary/Secondary, WD800A	2245246-9701
Modification Procedure, Voltage/Frequency, 990 WD800	2270841-9701
Modification Procedure, Voltage, WD800A	2245247-9701

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Overview

1.1 INTRODUCTION

The WD800 and WD800A mass storage system kits (Figure 1-1) provide random-access mass data storage systems for any Texas Instruments computer with an interface which meets the requirements of the peripheral bus (PBUS), an eight-bit parallel peripheral data bus.

On Model 990 Computers, a TILINE™ peripheral bus interface (TPBI) board is installed to make this interface.

Early models of Business System 300 (S300) computers had a peripheral bus interface controller (PBIC) board installed for that purpose. Later models of S300 and S300A computers have a custom-made integrated circuit mass storage interface controller (MSIC) chip installed on the processor board to control the PBUS interface. In this manual, both the PBIC and the MSIC are referred to as the S300 PBI.

The WD800 and WD800A systems use Winchester disk technology for the primary storage device with removable backup storage provided by a magnetic tape cartridge. Up to four Winchester disk drives with four tape cartridge transports can be connected in a daisy-chained configuration to a single controller installed in the host computer. The host computer can be one of the following:

- Any Model 990 Computer system with an interface meeting the requirements of the PBUS
- A Texas Instruments Business System 300 or Business System 300A

NOTE

The WD800 and WD800A operate in a similar manner. Unless noted otherwise, when this manual refers to the WD800, the information applies to both the WD800 and the WD800A disk units.

The WD800 mass storage system kit includes the following features:

- TPBI board for installation in Model 990 Computers
- Plug compatible with WD500 and WD500A mass storage systems
- Compatibility with 990 and S300/S300A computer systems
- Microprocessor-based controller logic

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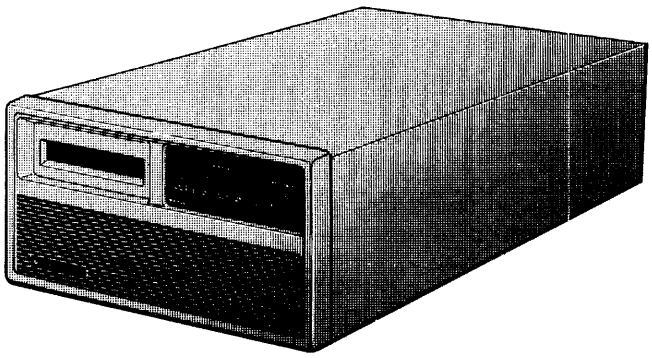
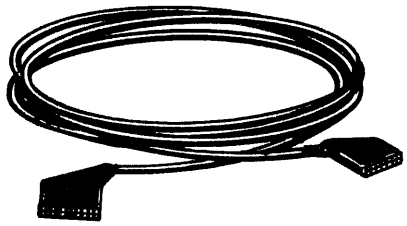
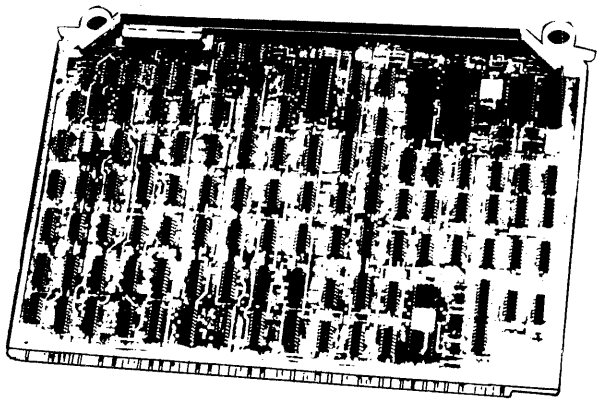


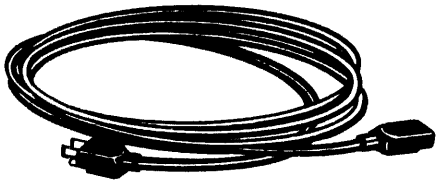
MASS STORAGE SYSTEM



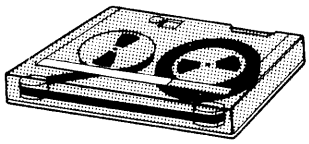
PERIPHERAL BUS
INTERFACE
CABLE



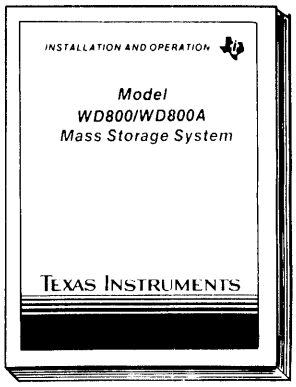
TPBI BOARD
(FOR BUSINESS SYSTEM 600/800 APPLICATIONS)



POWER
CORD



TAPE CARTRIDGE



MASS STORAGE SYSTEM
INSTALLATION AND
OPERATION MANUAL

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Figure 1-1. WD800 System Kit

- Error correcting code (ECC) for error checking and correcting capability
- Mapping of bad tracks to reserved spare tracks (WD800A only)
- Removable cartridge tape
- 0.67 megabyte-per-second (0.800 megabyte-per-second for the WD800A) Winchester disk burst transfer rate
- Integral power supply
- Rackmount configuration
- Support for all standard international voltage/frequency combinations

1.2 KIT COMPONENTS

The WD800 system kit consists of the following major assemblies:

- TPBI board (for interface with 990 computers)
- Peripheral bus cable
- WD800 chassis, which includes the following:
  - — A mechanical Winchester disk drive assembly
  - — An optional magnetic tape cartridge transport assembly
  - — Front panel controls and indicators
  - — A card cage with motherboard and printed circuit boards (PCBs) for the formatter function and the disk and optional tape cartridge electronics
  - — Power supply

Table 1-1 lists major system component part numbers.

Table 1-1. System Component Part Numbers

Component	Part Number
WD800 Storage System Chassis:	
Chassis mount (not shown)	2215801-XXXX[1]
Chassis mount (Figure 1-2)	2213097-XXXX[1]
Table top (Figure 1-1)	2213074-XXXX[1]
WD800A Storage System Chassis:[2]	
Chassis mount	2245216-0037 thru -0072[1]
Table top	2245216-0001 thru -0036[1]
MTC800A (tape only)	
Chassis mount & table top	2245216-0073 thru -0084[1]
Peripheral Bus Cable Assembly:	
S300/S300A system, 2 meters (6.56 ft)	2308633-0002
S660/S800 systems, 5 meters (16.40 ft)	2308633-0003
TPBI Assembly	2270820-0001
Tape Cartridge Media	
137 m (450 ft)	2270391-0001

Notes:

[1] The exact voltage and frequency specifications of the system are indicated by the dash number.

[2] Similar in appearance to the WD800.

1.2.1 TPBI Board

The TPBI occupies one full slot in the 990 chassis and furnishes communication between the 990 system and the formatter in the WD800 system. The TPBI uses the TILINE for host processor communication and the peripheral bus cable for formatter communication.

1.2.2 Peripheral Bus Cable

The peripheral bus cable connects the TPBI/S300 PBI to the WD800 chassis and interconnects daisy-chained chassis. The storage system uses a 40-pin cable connector assembly with a metal backshell to minimize electromagnetic interference (EMI). The maximum cable length is 15 meters (49.2 feet). Cable terminator resistor packs are inside the WD800 chassis. The two cable connectors on the back of the WD800 chassis are electrically identical.

1.2.3 WD800 Chassis

The WD800 chassis (Figure 1-2) contains the Winchester disk drive, the magnetic tape cartridge transport, the front panel controls and indicators, the card cage, and the power supply assembly.

1.2.3.1 Winchester Disk Drive. The mechanical disk drive subassembly of the WD800 consists of a die-cast deck with a sealed area for heads, platters, and servo positioning motor. The spindle motor, spindle motor brake, positioner locking mechanism, and preamp electronics are mounted beneath the sealed housing.

The mechanical disk drive subassembly of the WD800A consists of a sealed housing that encases all of the moving parts. Some disk electronics are located beneath the housing.

1.2.3.2 Magnetic Tape Cartridge Transport. The magnetic tape cartridge transport subassembly is optional. It is mainly used to build a system disk or to provide backup. The tape transport subsystem includes the following items:

- Tape transport drive assembly, consisting of:
  - — Transport (deck, motor, heads, sensors, cables)
  - — Transport mounting brackets
  - — Tape subsystem analog PCB assembly

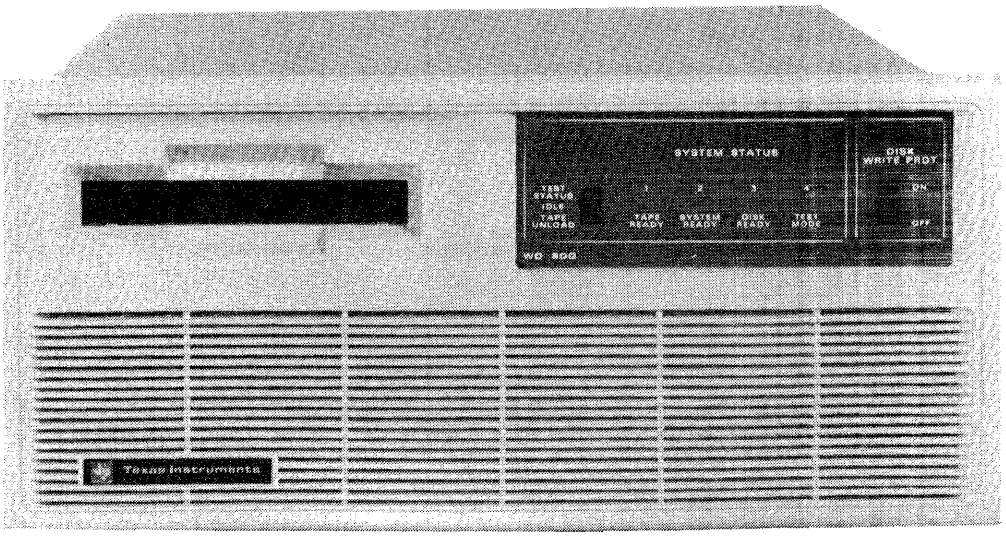

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Figure 1-2. WD800 Chassis

- Tape subsystem analog PCB power cable
- Transport-to-encode/decode PCB cable
- Tape encode/decode PCB assembly
- Tape control PCB assembly

1.2.3.3 Front Panel Controls and Indicators. The WD800 chassis has three controls: the ac power switch, TEST STATUS/TAPE UNLOAD switch, and DISK WRITE-PROTECT switch. The ac power switch is located on the chassis rear panel. Turning it on initializes the system. The other two switches are located on the front panel. The TEST STATUS/TAPE UNLOAD switch, a three-position, spring-loaded rocker switch, selects either test status or tape unload mode. The DISK WRITE-PROTECT switch selects the write-protect mode for the disk when it is set to ON.

The WD800 chassis has four indicator lights on the front panel: a tape status indicator, a storage system indicator, a disk status indicator, and a test mode indicator. These lights perform three functions. Primarily, they display the operational status of the storage system. They can also display detected subassembly faults when the TEST STATUS/TAPE UNLOAD switch is toggled up. During stand-alone power-up initialization, they can also display the unit select address.

1.2.3.4 Card Cage. The card cage of the WD800 contains the PBUS interface board, the processor board, the read/write board, the high-speed digital board, and the servo board.

The card cage of the WD800A contains the PBUS interface board, the processor board, the high-speed digital (HSD) board, and the ST506 interface board.

If the chassis contains the optional tape cartridge transport subsystem, the card cage also contains the tape encode/decode board and the tape control board. A group of processes executed by these boards constitutes the formatter function of the WD800 system.

1.2.3.5 Power Supply. The WD800 chassis power supply consists of an EMI filter and two power supply boards. For the power supply requirements of the WD800 chassis, refer to Table 1-2.

1.3 OPTIONS

The disk drive of a WD800 system can have two or four platters for a storage capacity of approximately 18.5 or 43.2 megabytes. The disk drive of a WD800A system can have three, five, or eight platters for a storage capacity of approximately 38.4, 69.2, or 114.5 megabytes.

The WD800 and WD800A system kit design permits a wide variety of possible chassis configurations (Figure 1-3). The minimum configuration consists of only one chassis with a two-platter WD800 or three-platter WD800A Winchester disk drive and a magnetic tape cartridge transport installed in the chassis for backup. The maximum configuration that can be supported by a TPBI/S300 PBI consists of four daisy-chained chassis, each with a four-platter WD800 or eight-platter WD800A disk drive and a magnetic tape cartridge transport installed for backup. In a daisy-chained configuration, either connector can receive the chain, and either connector can forward the chain, because the connectors (J1, J2) are electrically identical.

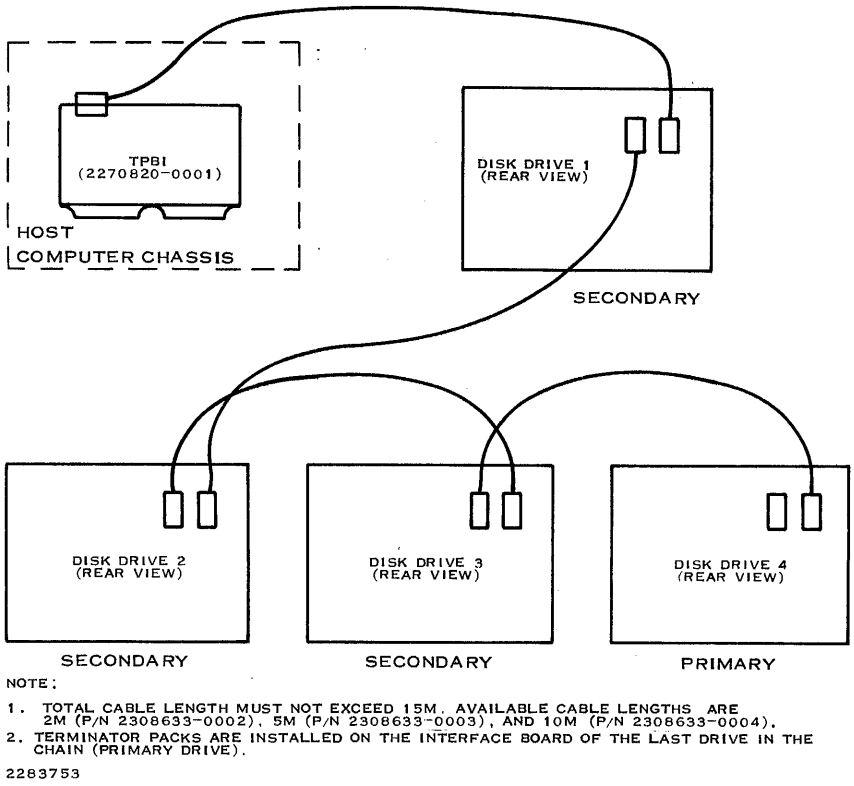

Figure 1-3. WD800 Daisy Chain Maximum Configuration

Total system storage capacity depends on the number of chassis linked together, the size of the disk drives installed, and the number of tape transports installed.

The WD800 system also works with other peripherals. For example, it is possible to mix WD800, WD800A, WD500, and WD500A chassis in the same system. This might occur when expanding the storage capacity of a smaller system by adding a WD800 system kit.

The procedure for converting a unit from secondary to primary and vice versa is detailed in *Conversion Procedure, Primary/Secondary, WD800A* or *Conversion Procedure, Primary/Secondary, 990 WD800.*

1.4 FUNCTIONAL DESCRIPTION

The computer system can consist of a 990 computer (with TPBI) or S300/S300A computer and the WD800 storage system. The WD800 storage system consists of the WD800 chassis with the interface cable. The WD800 chassis contains the formatter, the storage devices, and the power supply. The functioning of the WD800 storage system can be defined in terms of a series of interfaces between these component blocks.

The highest level interface connects the host processor and the storage system. It is implemented by the TPBI in 990 systems and by the S300 PBI in S300 and S300A computers. Within the storage system, the PBUS interconnects the TPBI/S300 PBI to the WD800 chassis. At the lowest level, in the WD800 chassis, the formatter interprets the commands from the TPBI/S300 PBI and controls the storage devices.

1.4.1 General

The functional diagram for the WD800 storage system (Figure 1-4) shows the series of interfaces between component blocks in the system.

The host processor issues commands to and receives status from the TPBI/S300 PBI. The TPBI/S300 PBI interrogates each command received from the host processor. It executes only those commands reserved for itself; it issues all other commands to the formatter in the storage system chassis. The formatter executes the commands and is responsible for controlling the storage devices.

The following paragraphs describe the elements of the host processor to WD800 storage system interface. Then the functions of the formatter in controlling the storage devices are discussed.

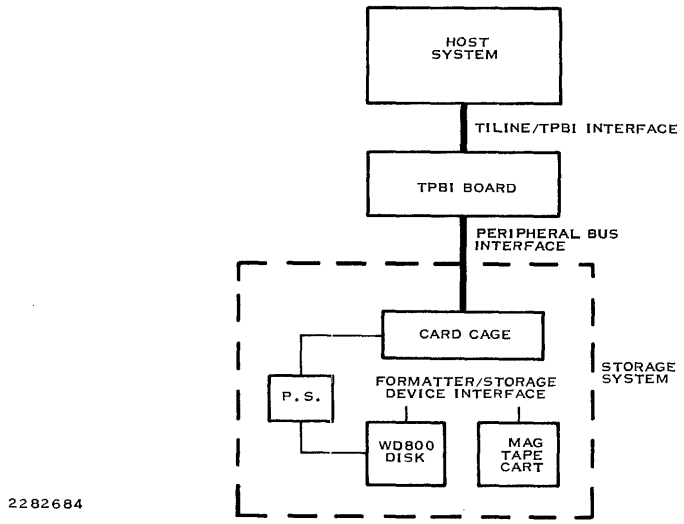

Figure 1-4. WD800 Functional Diagram

1.4.2 Peripheral Bus Interface

The PBI provides the interface arrangement for the TPBI/S300 PBI to communicate with the disk and tape cartridge. The PBI features a byte-oriented command and status structure distributed on two levels between the host processor and the storage device. First, the TPBI/S300 PBI accepts a command or status request from the host processor and filters out those commands or requests that can be handled by the TPBI/S300 PBI. Then it forwards the rest to the formatter function in the WD800 chassis. The formatter function controls the disk drive and cartridge tape transport.

The PBI supports up to eight devices on the bus. Use of the PBI allows the computer system to be upgraded or expanded without replacing existing interface devices.

1.4.3 TILINE Peripheral Bus Interface

The TPBI is a TILINE interface device that furnishes communication between the formatter and the Model 990 Computer. The TILINE is a high speed data bus used by 990 processors for local transfers. The TPBI occupies one full slot in the host 990 chassis. It uses the TILINE for host processor communication and the PBI for formatter communication. The TPBI employs two sets of device control registers and two separate interrupt levels. This allows commands to be interleaved to two devices at the same time. For overlapped operations such as disk-to-tape backup, the dual device control registers provide a significant performance improvement. While one device executes a command to write, a second device can read, write, or seek independently without interfering with the operation in progress. Each device control register set has four device select assignments numbered 0 through 3. Since two independent interrupt levels are provided, the overlapping disk and tape operations can signal completion without requiring elaborate software testing.

1.4.4 S300 Peripheral Bus Interface

The S300 PBI is functionally similar to the 990 TPBI. In early production units it consists of the peripheral bus interface controller board. This board is logically very similar to the 990 TPBI. It connects to the S300/S300A expansion port. Its disk peripheral control space (PCS) is hardwired to address >F800 (the TPBI address is switch selectable). The second PCS is jumper selectable between disk PCS address >F820 and a tape PCS at address >F880 (the jumper must be set for tape when a WD800 mass storage system is connected to the PBI).

NOTE

Values preceded by a right angle bracket (>) are hexadecimal values.

In later model S300s and all S300As, the PBI controller, an integral part of the processor board, replaces the PBIC board. The on-board PBI controller is based on a custom integrated circuit called the mass storage interface controller chip. It has the same capabilities as the PBIC board, although it does not have a jumper to select between tape and disk for the second PCS. The MSIC PBI controller automatically configures its second PCS for disk or tape depending on what types of devices report on the PBI during system power up. For additional information on the S300/S300A PBI controllers, refer to the *Business System 300 System Description* manual or the *Business System 300A System Description* manual.

1.4.5 Formatter Function

The formatter function is performed by components distributed on several PCBs in the card cage in the WD800 chassis. The formatter subsystem consists of a microprocessor, read-only memory (ROM) and random access memory (RAM) for resident software, RAM data storage buffers, a high-speed data transfer device, the controller interface, the disk subsystem, the tape subsystem, and the front panel controls and indicators. Functionally the formatter is responsible for the following:

- Storage system initialization
- Winchester disk operations
  - — Disk head positioning
  - — Disk data encoding and decoding
  - — Disk error detection and correction by means of ECC
- Tape transport operations
  - — Tape positioning
  - — Tape data encoding and decoding
  - — Tape error detection in both read and write operations by means of cyclic redundancy check (CRC) characters
- Status monitoring and reporting

The formatter exercises independent control of the disk drive and tape transport, freeing the host processor and TPBI/S300 PBI for other tasks.

1.4.5.1 System Initialization. The formatter function works with the TPBI/S300 PBI to initialize the storage system after the TPBI/S300 PBI confirms that the interface bus is ready. The formatter tests the bus by sending a data pattern to the TPBI/S300 PBI and then by copying it. If no errors occur, the formatter identifies its dependent devices to the TPBI/S300 PBI and reports their status. Normal operation of the PBI can then proceed.

1.4.5.2 Winchester Disk Operations. The Winchester disk drive performs all data reading and writing functions in response to operational commands exchanged with the formatter. The Winchester drive can be divided functionally into a positioner subsystem, a read/write subsystem, and an error detecting and correcting subsystem.

Media Defect Handling. The Winchester disk used in the WD800 and WD800A will usually have a number of media defects that can cause erratic system operation if they are not removed from the available storage area on the disk. The media defects can consist of both hard and soft defects. For optimum performance, all media defects should be avoided by the operating system. Hard defects always cause an error and are generally easily identified. Soft defects intermittently cause errors that can generally be corrected by retries or by the hardware error correction logic.

The WD800 relies on a track deallocation algorithm that is supported by the TI DNOS and DX10 operating systems. The operating system can deallocate up to 64 bad tracks on 43-megabyte disks and 27 bad tracks on 18-megabyte disks by listing them in a special bad track map. A list of bad track locations is built in two ways:

- The operator can command a surface analysis using the initialize disk surface (IDS) utility, disk build utility, or DOCS DSKSA diagnostic (SA verb).
- The operator can manually enter known media defect locations when invoking the IDS utility, disk build utility, or DOCS DSKSA diagnostic (FC verb).

Typically, a list of known media defects can be found attached to the top of the disk drive. The list identifies the location of the defect by its cylinder and head number. The maximum number of bad tracks which can be deallocated is 64.

The WD800A reserves several cylinders for use as spare track locations. After a bad track list is built either by surface analysis or by operator entry of known media defects, the surface analysis procedure will relocate as many bad tracks as possible to the spare track locations. Any bad tracks that are not relocated to spare locations are deallocated. The maximum number of relocated tracks is equal to the number of spare tracks reserved on the disk (see Table 1-3). The maximum number of deallocated tracks is 64 for all WD800A disk capacities; however, it should be noted that any disk that uses all its spares and requires deallocation has deteriorated to the point that it should be replaced.

Disk Head Positioning Operation. The disk drive electronics control the movement of the head carriage assembly to the desired cylinder by reading a servo surface on one of the disk platters. On the WD800A, the HSD board commands the disk to move the heads the correct number of cylinders in the proper direction. The electronics attached to the disk assembly handle the actual head movement. Head selection, a part of the command parameters, determines the track on the cylinder to be accessed. The WD800 disk drive electronics also provide an index pulse and sector marks. The WD800A provides an index pulse only. Command parameters giving the desired cylinder, head, and sector values are compared to the address field at the beginning of the located sector to verify that they correspond. A timer monitors all seek operations and reports a seek error to the host processor when the time allowed is exceeded.

Disk Read/Write Operations. The encoding system used on the Winchester disk in the WD800 is modified frequency modulation (MFM), with error checking for all data and address fields and error correction for all data fields transferred between the formatter and the disk. The format of the MFM code is shown in the functional specifications provided later in this chapter.

A hardware-generated index mark occurs once each revolution. Each track is divided into 37 sectors (33 sectors for the WD800A) of 256 bytes each. Each sector is composed of an address field and a data field. The address field contains a unique disk address. It is written during format commands and during WD800A bad track relocation commands.

Disk Error Checking and Correction. When data is read from the disk, the ECC logic on the formatter examines the data and determines whether any errors occurred during the data storage process. Certain types of errors are correctable and if these types of errors are found, corrections are made. After an operation, the CPU can read status indicators that show whether errors occurred and whether corrections were made. If ECC is used and no status error is reported, the data transferred is guaranteed. ECC is not attempted when the burst size of the error exceeds the correction capabilities of the ECC. In such cases, data is transferred but data error status is reported.

1.4.5.3 Tape Transport Operations. The storage system uses a DC300XL cartridge tape. The DC300XL provides 137.16 meters (450 feet) of recordable tape on four tracks for an unformatted capacity of over 17 megabytes. For the DC300XL, formatted capacities of over 14 megabytes can be achieved with 9600-byte records, as provided in DX10 backup directory operations (using the block mode option of the Backup Directory command.) The use of smaller records reduces the formatted capacity of the tape cartridge.

The take-up hubs eliminate handling the tape itself and protect it from damage and contamination. One access opening allows the drive motor capstan to contact an internal belt capstan for moving the tape across the heads. Internal tape guides position the tape on the drive heads. A pivot action door permits the drive heads to access the tape when the cartridge is inserted in the drive.

A slotted plug on the upper left corner of the cartridge can be oriented in one of two positions for either SAFE (write-protected) or unprotected operation. Note that only this plug write protects the tape. The WRITE-PROTECT switch on the front panel does not apply to the tape but only to the disk. Tape position is determined by a pattern of holes that identifies the beginning of tape (BOT), End of Tape (EOT), load point, and early warning for EOT.

Tape Positioning Operations. The tape can move in either the forward or the reverse direction. During certain operations, it advances directly to the physical ends of the tape (BOT or EOT) at high speed, 2286 millimeters (90 inches) per second. High-speed positioning operations include tape load (which includes an end-to-end tensioning of the tape), rewind, and unload. Read and write operations (including write forward, write end of file (EOF), and erase) take place at a much slower speed, 762 millimeters (30 inches) per second, as do the record-skip (forward and reverse) operations. Track switching for read, write and skip operations is accomplished at high speed. Full tape positioning occurs within one minute during high-speed operation, while the slower speed takes three minutes.

Tape Read/Write Operations. The tape uses an MFM encoding scheme for data. Unlike the disk, the tape does not use ECC. Instead, tape records are divided into 256-byte data blocks, each with CRC error detection, because very large media flaws (sometimes up to 200 bits long) are more likely on tape. Such flaws exceed the capability of conventional ECC.

The tape is a sequential access device; thus tape records are written from the beginning of the tape each time a tape cartridge is installed. The tape records consist of a concatenation of data blocks, each block containing 256 bytes of data. Each data block also includes header information and CRC for error detection. Write operations feature read-after-write error detection with high analog thresholds to guarantee written data. Record boundaries consist of erased inter-record gaps (IRGs), typically 30 millimeters (1.18 inches) long, between records. Artificial file mark boundaries can also be written on tape by a write EOF command. Typically, an EOF record is used to mark the end of data. Otherwise, writing to the end of the last track forces an EOT error.

Reading the tape, like writing it, starts at the beginning of the tape. Read operations report either EOF records or EOT to inform the user when the end of recorded data is reached on the tape.

Tape Error Checking and Recovery. Errors detected by CRC in reads or writes to tape must be recovered by host processor retries. A retry of read or write errors consists of a record-skip reverse operation followed by a retry of the command that reported the error. Errors reported in read or write operations due to track switching (repositioning the tape to the beginning of the next data track) require a rewind delay followed by a retry of the aborted command.

1.4.5.4 Status Monitoring and Reporting. The formatter function is also responsible for monitoring the disk drive and tape transport and for reporting the status of these devices. The formatter returns the status information to the TPBI/S300 PBI where it can be read by the host processor.

1.5 SPECIFICATIONS

Table 1-2 lists the system specifications for the WD800 mass storage system. Table 1-3 lists the specifications for the disk subsystem. The WD800 is offered with two or four platter disks, and the WD800A is offered with three, five, or eight platter disks. Table 1-4 lists the specifications for the tape subsystem.

Table 1-2. WD800/WD800A Mass Storage System Specifications

	Power Specifications	
Chassis ac power:	**WD800**	**WD800A (typical)**
120 Vac ± 10% 50 or 60 Hz ± 3 Hz	3.0 A running 8 A starting (for 10 sec)	1.6 A running 2.5 A starting (for 10 sec)
or		
220 Vac or 240 Vac ± 10% 50 Hz ± 3 Hz	1.5 A running 4 A starting (for 10 sec)	1.2 A running 1.6 A starting (for 10 sec)
TPBI dc power (from host chassis power supply)	5.0 ± 0.25 Vdc at 3.0 A (maximum)	
	Environmental Specifications[1]	
Operational[2]:		
Ambient temperature	10 to 40° C (41 to 113° F) with a temperature gradient less than 10° C (18° F) per hour	
Relative humidity		
WD800	20 to 80% without condensation	
WD800A	10 to 80% without condensation	
Altitude	0 to 3000 m (0 to 9843 ft)	

Table 1-2. WD800/WD800A Mass Storage System Specifications (Continued)

Nonoperational:	
Ambient Temperature	-40 to 60° C (-40 to 140° F) with a temperature gradient less than 20 degrees C (36° F) per hour
Relative humidity	
WD800	10 to 80% without condensation
WD800A	10 to 95% without condensation
Altitude	
WD800	0 to 12,000 m (0 to 39,372 ft)
WD800A	0 to 3,000 m (0 to 9,843 ft)
Physical Specifications	
Length	68.6 cm (27 in)
Width	48.3 cm (19 in)
Height	22.2 cm (8.75 in)
Weight (maximum)	
WD800	38.5 kg (85 lb)
WD800A	31.3 kg (69 lb)

Notes:

[1] Environmental specifications represent worst-case conditions as determined by the most sensitive components in the storage system.

[2] Lower these temperatures by 2° C (3.6° F) for every 762-m (2500-ft) increase in altitude above mean sea level.

Table 1-3. Disk Subsystem Specifications

Performance Specifications

Capacity:

	2 Platters	4 Platters
WD800		
Unformatted data	22.3M bytes	52.1M bytes
Formatted data*	18.5M bytes	43.2M bytes
Allowance for factory media defect deallocation	189K bytes	397K bytes
Formatted data with maximum tracks deallocated	18.3M bytes	42.8M bytes

WD800A	3 platters	5 platters	8 platters
Unformatted data	48.1M bytes	86.7M bytes	143.4M bytes
Formatted data	38.4M bytes	69.2M bytes	114.5M bytes

Disk-to-PBI burst transfer rate:

WD800	0.67M byte per second maximum
WD800A	0.80M byte per second maximum

Rotational latency:	WD800	WD800A
Average	8.3 ms	8.3 ms
Maximum	17.1 ms	16.8 ms

Seek time (includes settling time):	WD800	WD800A
Track-to-Track	9 ms	8 ms (3- & 5-platter) 5- ms (8-platter)
Average	45 ms	35 ms (3- & 5-platter) 30 ms (8-platter)
Maximum	70 ms	85 ms (3- & 5-platter) 48 ms (8-platter)

Table 1-3. Disk Subsystem Specifications (Continued)

Functional Specifications

	WD800	WD800A
Spindle speed	3600 rpm	3600 rpm
Speed variation	± 3.5%	+ 0.5%, − 1.0%
Track density	478 tpi	960 tpi (3- & 5-platter) 980 tpi (8-platter)

Cylinders:

	Total	User Available	Reserved
WD800			
2-platter	657	651	6 reserved for storage system use (including 2 for diagnostics)
4-platter	657	651	
WD800A			
3-platter	925	911	4 reserved for storage system use (including 2 for diagnostics); 10 reserved to replace bad tracks.
5-platter	925	911	
8-platter	918	904	

Data surfaces:	WD800	WD800A
	3 (2-platter) 7 (4-platter)	5 (3-platter) 9 (5-platter) 15 (8-platter)
User accessible tracks	1953 (2-platter) 4557 (4-platter)	4555 (3-platter) 8199 (5-platter) 13,560 (8-platter)
Tracks reserved for defect mapping	None	50 (3-platter) 90 (5-platter) 150 (8-platter)
Sectors per track	37	33
Data bytes per sector	256	256
Total bytes per sector	313	313

Table 1-3. Disk Subsystem Specifications (Continued)

Sectoring method	Hard Servo-referenced (fixed length)	Soft Servo-referenced
Encoding method	MFM	MFM
Spindle drive motor	AC induction 1/12 hp, 50/60 Hz, capacitor start, thermally protected	Brushless DC
Reliability Specification		
Error rate:		
Recoverable	Less than or equal to 1 in 10^{10} bits read	
Nonrecoverable	Less than or equal to 1 in 10^{12} bits read	
Positioning	Less than or equal to 1 in 10^{6} seeks	

NOTE

Formatted data capacity is the maximum data storage capacity available before bad track data are subtracted. Each WD800 Winchester disk drive can have up to 20 (2-platter) or 42 (4-platter) bad tracks (media defects) when the unit ships from the factory. WD800A factory relocated tracks are transparent to the user.

Table 1-4. Tape Subsystem Specifications

Performance Specifications		
Burst transfer rate	192K bits (24K bytes per second)	
Capacity:		
137 m (450 ft)	14.6M bytes (9.6K bytes per record) 3.9M bytes (256 bytes per record)	
Access time:		
Stop/start	25 ms at 30 ips	
Rewind 137 m (450 ft)	1 min at 90 ips	
Read/write 137 m (450 ft)	3.4 min per track at 30 ips continuously using 9.6K-byte records	
Functional Specifications		
Tape speed	30 ips (recording/playback) 90 ips (rewinding/unloading)	
Heads	4 tracks serial read-after-write with selectable track erase	
Media:		
2270391-0001	DC300XL cartridge 137 m (450 ft) long, 63 mm (0.25 in) wide	
Recording Specifications		
Packing density	252 bpmm (6400 bpi)	
Recording code	MFM	
Reliability Specification		
Error rate:*		
Recoverable	Allowed	less than or equal 1 in 10^8 bits
Nonrecoverable	Allowed	less than or equal 1 in 10^9 bits

Note:

* Errors are detected by CRC. Error recovery is achieved by retries and low read recovery thresholds.

2

Preventive Maintenance

2.1 INTRODUCTION

Preventive Maintenance (PM) consists of cleaning the tape heads and capstan, and cleaning the air filters.

2.2 OPERATOR PREVENTIVE MAINTENANCE

The operator performs all of the PM procedures. If the operator neglects the procedures, the customer representative (CR) can perform them.

2.2.1 Tape Transport Head Cleaning and Capstan Cleaning

Clean tape heads, tape cleaner, and capstan with a cotton swab dampened in ethyl alcohol once a week or more often as necessary.

To gain access to the heads, capstan, and tape cleaner, remove the tape cartridge from the access slot. This exposes the head assembly, tape cleaner, and capstan (Figure 2-1). Insert the cotton swab through the access slot and apply to each assembly. Figure 2-2 identifies the assemblies.

Failure to keep the heads and capstan clean can result in degraded error rates or media interchange problems.

2.2.2 Air Filter Cleaning

The cleanliness of the air that enters the WD800 subsystem chassis affects the lifetime of the subsystem. Keep the chassis and the general area clean and dust-free.

CAUTION

Do not use strong solvents to clean the front panel of the chassis. Use a mild detergent and water on a lint-free cloth.

Cooling air for the disk drive and electronic modules passes through snap-in filters in the front panel. These filters require periodic PM as follows:

- Remove and vacuum the air filters every six weeks.
- Discard the old filters and replace them with new filters as necessary.

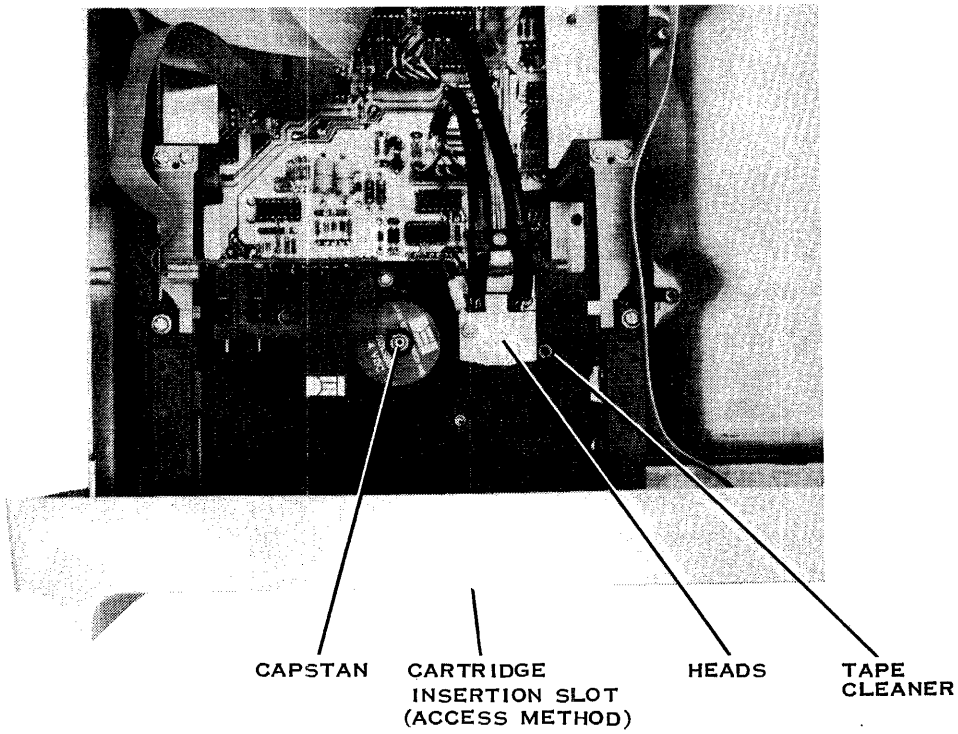

Figure 2-1. Tape Head and Capstan Location

It may be necessary to snap off the front panel to gain access to the filters. The filters snap into and out of the front panel of the WD800 subsystem chassis after the front panel is removed (Figure 2-3).

NOTE

On some models, the filters snap into and out of the front panel cutouts without removing the front panel (Figure 2-4).

2.3 SERVICE CALLS REQUIRED BECAUSE OF PM NEGLECT

Customer neglect of PM can lead to problems that only a service call can solve. If the TI CR corrects the problem by performing PM or corrective maintenance necessitated by neglect of PM, the customer is billed for that call regardless of any maintenance contracts or warranty in force.

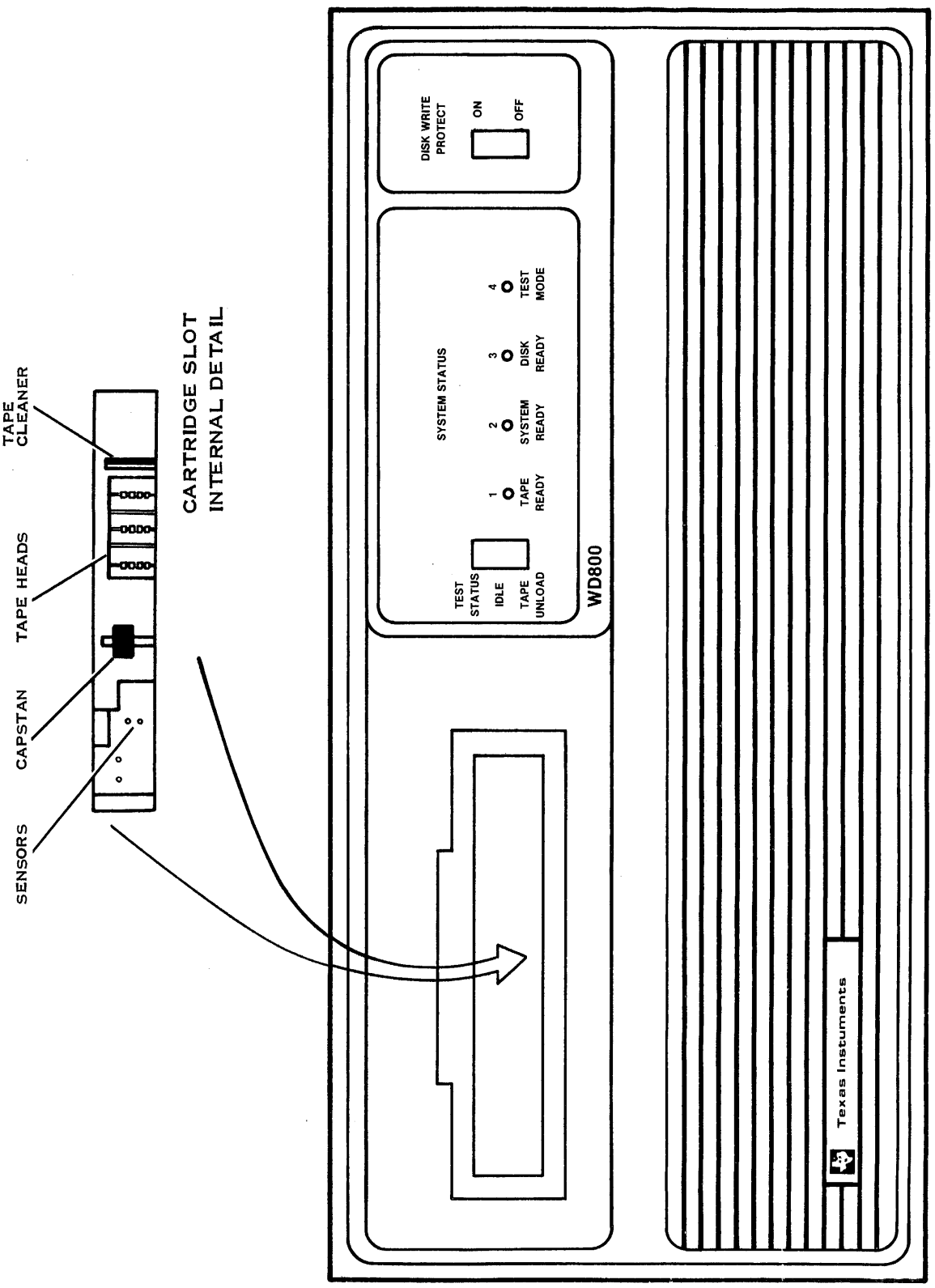

Figure 2-2. Tape Heads, Capstan, Cleaner — Enlargement

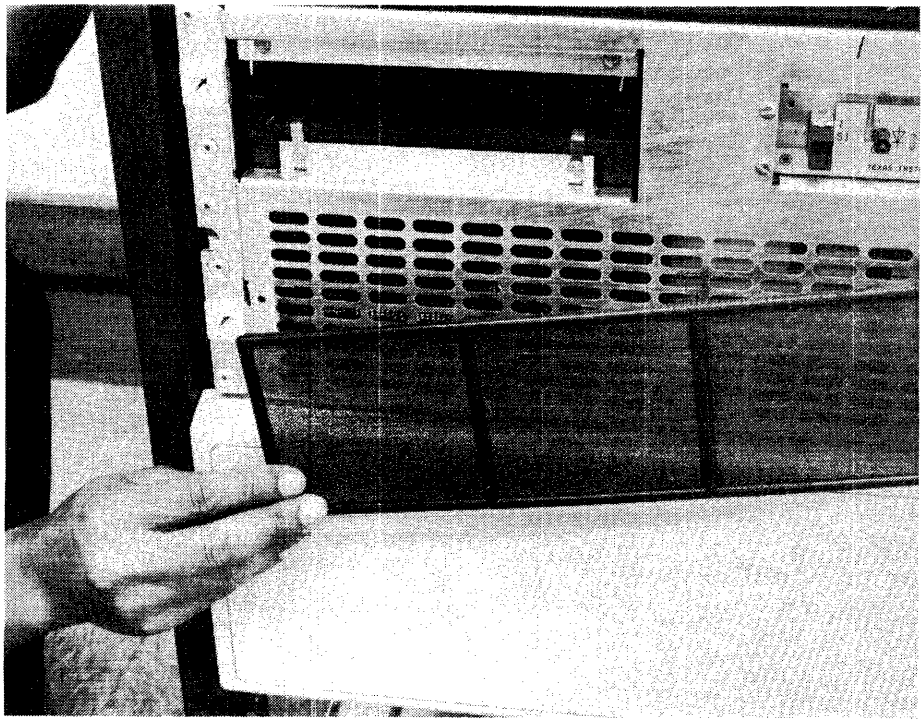

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Figure 2-3. Air Filter Removal

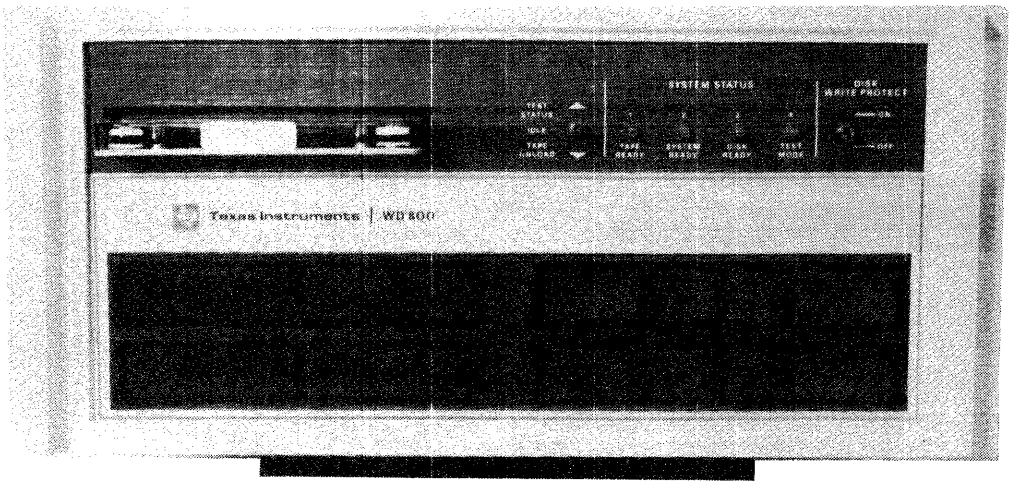

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Figure 2-4. Alternate Front Panel

3

TPBI/PBI Corrective Maintenance

3.1 INTRODUCTION

This section discusses isolating and correcting problems that are the result of a malfunctioning TILINE peripheral bus interface (TPBI) board or peripheral bus interface (PBI) cable on a Model 990 Computer system. There are three categories of corrective maintenance procedures: troubleshooting, removing and replacing components, and verifying problem corrections. Built-in self-tests in the TPBI and diagnostic software routines facilitate troubleshooting and verification after corrective maintenance. The corrective maintenance philosophy for the TPBI board and PBI cable is simply to isolate the failure to a replaceable subassembly, and to replace that assembly. Since you cannot replace or service any components of the TPBI in the field, you must replace the TPBI when any fault occurs in the board. You must also replace the PBI cable as a unit.

3.2 SAFETY AND SPECIAL MAINTENANCE PRECAUTIONS

Observe the following precaution when performing any maintenance on the TPBI board.

CAUTION

When removing or replacing the TPBI board, be sure that power is removed from all the affected units. If power is not removed, the electronic system components can be damaged.

3.3 CORRECTIVE MAINTENANCE SUPPLIES

Table 3-1 lists corrective maintenance tools, equipment, and supplies required to perform procedures in this section.

Table 3-1. Maintenance Tools, Equipment, and Supplies

Item	TI Part No.
Maintenance diagnostic unit	943849-0803
Flat-blade screwdriver	Commercially available
Unit Diagnostics Handbooks, Volumes I through *VIII*	945400-9701 through 94500-9708
TPBI board	2270820-0001
PBI cable, five meters (16.4 ft)	2308633-0003

3.4 TPBI BOARD AND PBI CABLE TROUBLESHOOTING

The following paragraphs describe troubleshooting procedures for the TPBI board and PBI cable when they are installed in any Model 990 Computer system chassis. For PBI troubleshooting on S300/S300A computers, refer to Section 7 of this manual.

3.4.1 TPBI Indicators and Self-Test

There are four indicator LEDs on the TPBI board that help to locate failures in the TPBI, host computer, or chassis. The following paragraphs describe the responses of the indicators to TPBI self-tests that occur on every power-up or system reset. These self-tests are useful both for system tests and TPBI stand-alone tests.

3.4.1.1 FAULT Indicator. The red FAULT LED (Figure 3-1) lights on power-up and extinguishes only after all self-tests complete with no errors. This LED lights any time an error is detected while performing an individual controller self-test, as well as while performing all self-tests in response to an I/O reset. An extinguished LED also indicates that TILINE power reset (TLPRES-) is inactive.

Continuous illumination of the FAULT LED indicates that a fault is detected. The FAULT indicator is set either by the TPBI or by TLPRES-. The fault may not be in the TPBI itself. A host computer fault or TILINE fault can cause this indication.

A blinking FAULT LED indicates that the TPBI board has detected a bus error. Bus errors can be caused by failures in the TPBI board, the PBI cable, or the chassis formatter. If the chassis is powered down and then up while a command is in progress, a bus error (and blinking LED) will result.

3.4.1.2 CLK Indicator. The green CLK LED (Figure 3-1) lights to indicate normal operation of the TILINE access controller on the TPBI. If this indicator does not light, it indicates a TILINE failure or a TPBI fault in the TILINE interface area. Possible causes of this problem are as follows:

- Host computer backpanel configuration problem:
  - — TILINE access granted jumper open or improperly connected
  - — Fault in another TILINE device used in the host computer
- TILINE bus fault
- Host computer backpanel power not up or not reaching the TPBI because the board is not properly seated

3.4.1.3 BUSY LEDs A and B. The green BUSY LEDs (Figure 3-1) light to indicate activity by their respective slave sets. BUSY indicators light when the idle status bit is set to zero due to TPBI command execution.

3.4.2 Troubleshooting Procedure

If the FAULT LED is blinking, which indicates a bus error, perform the following steps:

1. Remove all power from the system.
2. Disconnect the PBI cable from the chassis.
3. Power up the host computer and observe the FAULT LED.

If the TPBI passes self-test, a chassis failure is indicated. Refer to the chassis section for fault analysis procedure.

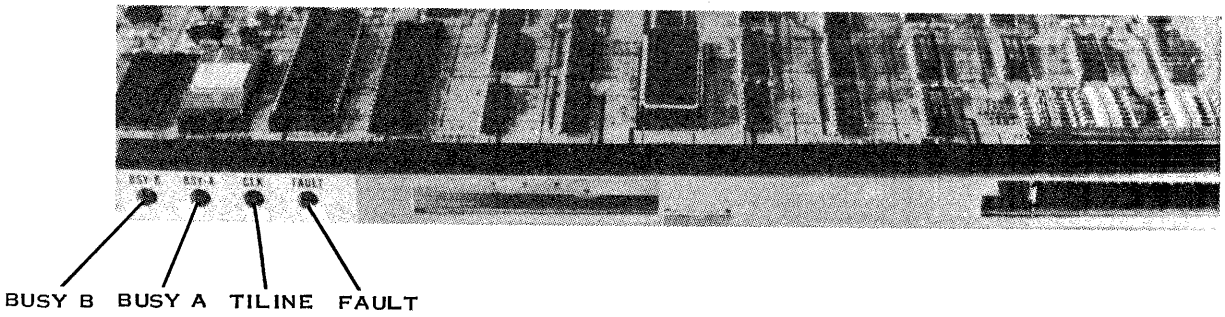


Figure 3-1. TPBI Indicators

If the TPBI still indicates a bus error, perform the following steps:

1. Remove power from the host computer.
2. Disconnect the PBI cable from the TPBI board.
3. Power up the host computer.

If the TPBI passes self-test, the PBI cable is defective. If the TPBI still indicates a bus error, the TPBI is defective.

3.4.3 Troubleshooting Flowchart

The following flowchart (Figure 3-2) diagrams the procedure to isolate TPBI failures.

3.5 REMOVAL AND REPLACEMENT PROCEDURES

The following paragraphs describe removal and replacement of the TPBI board and PBI cable.

3.5.1 Replacement of TPBI Board in 6-Slot or 13-Slot Chassis

When replacing the TPBI board in a 6-slot or 13-slot chassis, perform the following steps:

CAUTION

Always turn off power to the chassis before attempting to install or remove the logic board. Failure to observe this precaution can result in damage to the board since connector pins are temporarily misaligned during board removal and installation.

1. Disconnect the PBI cable from connector P3 on the TPBI.
2. With system power off, remove the TPBI from the assigned slot in the 990 chassis, using the card ejectors on the board edges.
3. Set the switches on the replacement board to match those of the board being removed.
4. Insert the replacement TPBI (component side up) into the same assigned slot in the host computer chassis. Make sure the circuit board edge connectors mate firmly with the backpanel connectors.
5. Perform the stand-alone self-test procedure (paragraph 3.4.3).
6. Reconnect the PBI cable to connector P3 on the TPBI.

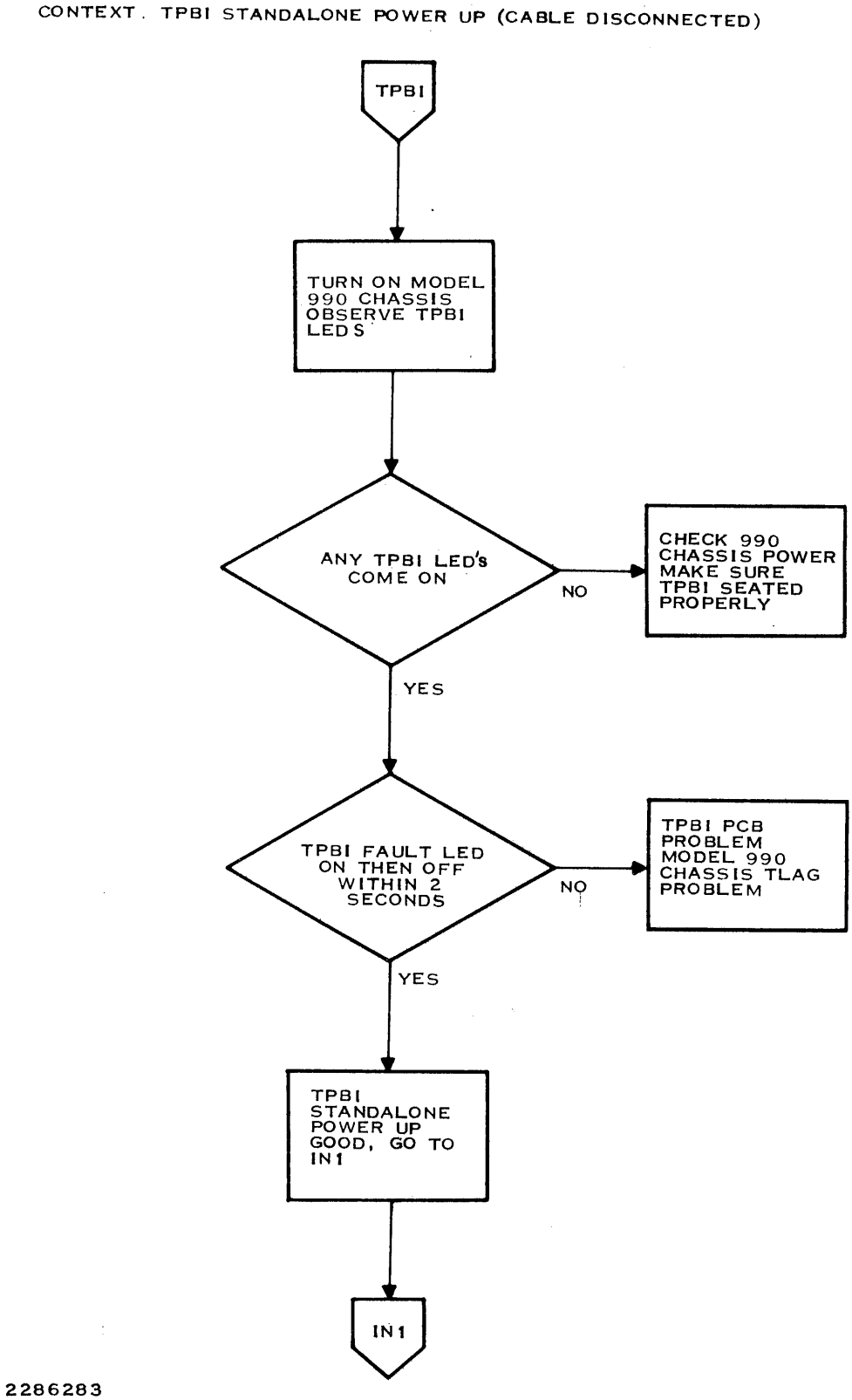


Figure 3-2. TPBI Troubleshooting Flowchart

3.5.2 Replacement of TPBI Board in 17-Slot Chassis

When replacing the TPBI board in a 17-slot chassis, perform the following steps:

1. Turn off power and unplug the host computer chassis ac line cord. Allow about 30 seconds for the power supply bleeders to discharge the power supply capacitors.

CAUTION

Always turn off power to the chassis before attempting to install or remove the logic board. Failure to observe this precaution can result in damage to the board since connector pins are temporarily misaligned during board removal and installation.

2. Push upward on the two release latches at either side of the filter panel assembly. Remove the filter panel assembly from the front of the 17-slot chassis.

3. Remove the filter panel to expose the molded access cover. Using a coin or screwdriver, turn each of six quarter-turn latches on the access cover to release the cover. Remove the access cover to expose the installed logic boards.

4. Slide the PWB retainer (a comb-like, metal structure that holds the board in place) to its leftmost position to gain access to the chassis slots.

5. Disconnect the PBI cable from connector P3 on the TPBI.

6. With system power off, remove the TPBI from the assigned slot in the host computer chassis, using the card ejectors on the board edges.

7. Set the switches on the replacement board to match those of the board being removed.

8. Install the TPBI with the component side to the right. Make sure the circuit board edge connectors mate firmly with the backplane connectors.

9. Slide the PWB retainer to the right so that all the circuit boards are locked in place.

10. Perform the stand-alone self-test procedure (paragraph 3.4.3).

11. Connect the PBI cable to connector P3 on the TPBI. Note that the access cover cannot be placed in its position until the PWB retainer is returned to its rightmost position.

3.5.3 PBI Cable Removal and Replacement

Refer to the cable removal and replacement procedures in the chassis section.

3.6 VERIFICATION TESTS

Use the TILINE peripheral bus interface tests (TPBITS) diagnostic verb EA to verify proper operation after replacement of the TPBI board or PBI cable. Refer to the *Unit Diagnostics Handbook, Volume 1* and *Volume 3*, for additional information on diagnostic testing.

4

WD800/WD800A Troubleshooting

4.1 INTRODUCTION

Corrective maintenance procedures are divided into three categories: troubleshooting, part removal and replacement, and system verification after correcting problems. The most important tools in isolating faults to a field-replaceable assembly are the WD800/WD800A front panel indicators, the PBI fault light-emitting diode (LED) on the controller board in the host computer chassis, the self-test diagnostic LEDs on the S300/S300A processor board, and the system log.

This section covers troubleshooting procedures (outlined in troubleshooting flowcharts). Built-in self-tests in the WD800/WD800A chassis and diagnostic software routines facilitate troubleshooting and operation verification after corrective maintenance. Part removal and replacement and system verification after correction of the problem for the WD800 is covered in Section 5 and for the WD800A in Section 6.

4.2 TROUBLESHOOTING

Troubleshooting is a logical step-by-step analysis of failure symptoms and the elimination of possible causes until the problem is isolated to a field-replaceable unit. After the component is replaced, system verification confirms that the problem is corrected and the system operates properly.

The customer representative (CR) has three powerful tools for fault detection and isolation:

- WD800/WD800A chassis self-tests and LED indicators. All the self-tests are performed during every power-up cycle. A limited self-test is performed on an I/O reset cycle. Error codes (paragraph 4.2.2.1) for any detected subassembly faults are displayed on the front panel LEDs when the chassis is in test status mode. The TILINE peripheral bus interface (TPBI) and peripheral controller bus interface (PBIC) boards each have a PBI fault LED.

- DX10 system log. The system log can be analyzed for the contents of controller status word 7 and WD800/WD800A chassis status word 0 from the control and status block (CSB) (Figures 1-5 and 1-6). These two words aid in detecting and isolating many faults.

- Diagnostic tests. A series of five diagnostic operational control system (DOCS) tests provide fault detection and reinforcement of the fault isolation provided by the LED indicators and system log.

Paragraph 4.2.2.2 gives ready reference tables for interpreting the DX10 system log. Paragraph 4.2.2.1 describes the WD800/WD800A front panel indicators. Use these tools whenever possible, making notes about all information gained from them. This information can be used in conjunction with the fault isolation flowchart to simplify and expedite fault detection and isolation.

4.2.1 Typical Problem Areas

Because the WD800/WD8000A chassis interfaces with other elements in the complete computer system, a failure in an associated unit can appear to originate within the WD800/WD800A. Before assuming a WD800/WD800A chassis fault, verify, as far as possible, proper operation of associated equipment, including the software operating system. Causes of a system malfunction can be one of the following:

- A central processing unit (CPU) failure can appear to be a WD800/WD800A system failure by sending improper commands to the controller or by failing to recognize and respond to an interrupt.
- A TILINE memory failure can appear to be a chassis failure by failing to store or fetch correct data during data transfers.
- If an expansion chassis is used, the TILINE bus wiring or TILINE couplers can cause similar problems with data transfers and computer command transmission.
- The controller switch settings can be incorrect, cabling or connectors can be damaged, or an internal failure can occur.
- The chassis cabling or connectors may be damaged, tape heads may be loose or dirty, the PCBs may be improperly seated or PCB cabling damaged, or a physical or electronic failure may have occurred.
- Operating system failures can mimic WD800/WD800A system failure by sending incorrect commands, handling data incorrectly, or reacting to controller responses improperly.

4.2.2 Troubleshooting Procedures

Troubleshooting procedures are based on the results of the WD800/WD800A chassis self-tests (displayed as error codes on the WD800/WD800A front panel indicators), on the TPBI LEDs (Section 3), on the DX10 system log, and on the DOCS tests specified for the WD800 system. The following paragraphs discuss these tools and provide tables to facilitate their use. Finally, the troubleshooting procedures are presented in flowchart form.

4.2.2.1 WD800/WD800A Chassis Self-Test Functions. The WD800/WD800A chassis consists of three functional subsystems: a formatter, a disk subsystem, and a tape subsystem. At power-up, each subsystem undergoes a series of self-tests. The self-tests require no operator intervention, but you can follow their progress by noting the activity of the front panel status indicators. The status indicators respond to power-up as follows:

- All four indicators turn on for about 5 seconds.
- All the indicators except TEST MODE turn off momentarily, then blink in sequence as the self-tests execute.
- The DISK READY indicator blinks for several seconds, then stays on.
- The TAPE READY indicator blinks, turns on momentarily, and then turns off. (For a more complete description of the different modes of the TAPE READY indicator, see the following paragraph entitled "Tape Subsystem Self-Tests.")
- The SYSTEM READY indicator blinks. If the chassis is cabled to a complete system, the SYSTEM READY indicator turns on, indicating that communication is established with the host computer, and the TEST MODE indicator turns off. If the chassis is not cabled to a complete system, the SYSTEM READY indicator will blink indefinitely and the TEST MODE indicator turns off after about 30 seconds.

Formatter Subsystem Self-Tests. The WD800/WD800A performs a series of diagnostics tests for the formatter at power-up. These self-tests verify that the processor board is fully functional. During this test, all front panel indicators are on. If this self-test fails, all other testing is suspended. If this test passes, all indicators except TEST MODE turn off before the other self-tests begin.

At power-up and after resets, the formatter self-tests also check the interface lines, confirm parity detection, and verify data manipulation. These tests take place after the disk and tape subsystem self-tests.

Disk Subsystem Self-Tests. If the processor passes self-test, the diagnostics go on to the disk subsystem tests, at which point the DISK READY indicator begins to blink. It continues to blink while the disk self-tests are performed and then turns on if the tests pass, or turns off if the tests fail. If the disk WRITE-PROTECT switch is set to ON, the self-tests that perform disk writing do not run and do not return test failure error codes. All disk subassemblies that do not pass self-test are noted. These are displayed by the indicators in the test status mode.

Tape Subsystem Self-Tests. If the disk self-tests pass, the self-test diagnostics go on to the optional tape subsystem. At this point the TAPE READY indicator begins to blink. The formatter then verifies that the tape subsystem is installed. If it is not installed, the TAPE READY indicator turns off. If the tape subsystem is installed and all tape self-tests pass, the TAPE READY indicator turns on momentarily and then turns off. If the tests fail, it simply turns off. All tape subassemblies that do not pass self-test are noted. These are displayed by the indicators in the test status mode. No exercise of an installed tape cartridge occurs at this point in the diagnostics. The cartridge test is performed after the host processor/formatter interface check.

After the power-up self-test completes (the test takes less than 60 seconds), the TEST MODE indicator is ON and the SYSTEM READY indicator is blinking, indicating that the formatter is waiting for the formatter/controller interface check. If the chassis is cabled to a complete system, the formatter performs this check. If it passes, the SYSTEM READY indicator turns on, indicating that communication is established with the host computer; the TEST MODE indicator then turns off.

NOTE

After the WD800/WD800A chassis completes power-up initialization, the computer system is ready to boot software or diagnostics. At this point, the operator must decide whether to use tape or disk as the loading device for the software or diagnostics. If software is to be booted from disk, do *not* install a tape at this time; this is because some 990 loader ROMs automatically boot from an online tape if one is present. Consult the applicable manual (DNOS, DX10, or DOCS) listed in the Preface for a detailed discussion of loading procedures.

If a tape cartridge is installed and the tape subsystem passed the self-test, the tape subsystem runs a media test and loads the tape cartridge to prepare it for use. During this procedure, the TAPE READY indicator blinks.

When the load operation (including media test) is complete on the tape cartridge, the TAPE READY indicator turns on. If the load operation fails, the TAPE READY indicator turns off.

Front Panel LED Codes. The LED indicators on the front panel of the WD800/WD800A chassis provide information about the chassis status both during normal operation and during test mode. Table 4-1 gives the interpretation of the states of the four indicators during normal operation. (The four-place number is position-coded to the four indicators, and the meaning of the value in each digit is defined as follows: 0 equals off, B equals blinking, 1 equals on, and X equals "don't care").

Table 4-1. Front Panel LED Codes — Normal Status

LED Code	Description
0000	Power fault.
XXXB	Peripheral bus fault (TPBI/cable/WD800/WD800A interface board).
XXX1*	Test mode. Wait one minute for the indicator to clear. If it is stuck, the processor board is bad.
X010	Disk ready, but host processor link down.
0B10	Disk ready, but host processor link down.
0110	Disk and system ready; tape offline or unloaded, or failed load.
B110	Disk ready and system ready. Tape loading or unloading.
1110	All WD800/WD800A devices ready.

Note:

* The indicators will all turn on (1111) as they begin to sequence through the tests. However, if they all come on again, there may be a problem with the power supply or processor board.

Table 4-2 gives the interpretation of the front panel indicators in test status mode. In test status mode, the indicators display error codes reporting subassembly faults detected during self-test. (These codes are also position-coded to the front panel LEDs, and the meaning of the value in each digit is defined as follows: 0 equals off and 1 equals on.) The error codes are displayed when the TEST STATUS switch is toggled up. They correspond to hexadecimal values > 0 through > F, and are displayed once, in numerical order, for each toggle of the TEST STATUS switch. Normal status returns automatically after a 30-second delay, or is reached by toggling the TEST STATUS switch up once more after 1111 is displayed.

Table 4-2 also includes other information to aid in fault isolation based on the error codes. This information includes the contents of CSB word 2 (self-test status) that occur for each LED error code, the subassembly that caused the fault indicated by each code, and the color code of the WD800/WD800A PCB (if the failing component is a PCB) that caused the fault.

If Table 4-2 lists more than one fault for a given code, the first one listed is the most likely cause of the fault, the second one listed is the second most likely, and so on.

Table 4-2. Front Panel LED Codes — Test Mode

WD800/WD800A LEDs	CSB W2	Fault	PCB Color Code
0000	XX00	Processor PCB, power supply (also indicated when W2 = XX06 to XX09)	Yellow
0001	XX01	Interface PCB (also indicated when W2 = XX02 to XX05)	Violet
0010	XX3B	Peripheral bus test failed (or TPBI, interface PCB, or cable)	Violet
0011	XX22	Tape control PCB	Green
0100	XX23	Tape encode PCB	Blue
0101	XX24	Tape drive/analog assembly or cables	
0110	XX21	Tape option not present or motherboard	
1000	XX11	Disk high-speed digital (HSD) PCB	Orange
1001	XX10	WD800: Disk servo (or actuator locked) WD800A: Disk interface board (or self-test cylinder has never been initialized)	Red Red
1010	XX12	Disk read problem; Disk drive, disk interface cables, or disk interface PCB	WD800: Brown or red WD800A: Red
1011	XX13	Disk write problem; Disk drive, disk interface cables or disk interface PCB	WD800: Brown or Red WD800A: Red
1100	XXXX	Disk not present	
1110	XXXX	Host cable disconnected or no controller present	
1111	XXXX	No fault (end of list)	

4.2.2.2 DX10 System Log Interpretation. The DX10 system log format and interpretation differ depending on whether it is reporting on a disk or tape device. The following paragraphs describe the system log report format for a disk device and then for a tape device. For further details about DX10 error reporting, refer to the *DX10 Operating System Error Reporting and Recovery Manual.*

DX10 System Log Report for a Disk Device. Table 4-3 shows the system log report format for a disk device. (Refer to Figure 1-5 for a full illustration of the eight-word CSB for the disk.)

Table 4-3. System Log Report for Disk

```
160: 1432+DS01 ERR=18 IID=56 L=04 A=80F0 0600 0000 0000 0006 0B8E 0800 9801
               ST02 RID=57 F=07 B=0001 0040 0000 0000 0006 0B8E 0800 1000
          |
Day  Time Device                    WD0  WD1   WD2      WD4            WD7
          Name                      Disk  Cmd/  Sec#/    Byte Cnt/      Cmd
                                  Status Hd#   S/T#     Special        Status
```

To interpret the system log report for the disk, proceed as follows:

1. On the left side of the report, find the device name that corresponds to the WD800/ WD800A device under suspicion. (If you cannot find a message for the device, the system log cannot be used at this point.)

2. Read across from the device name to word 0, disk status (following A = in Table 4-3). Use Table 4-4 to interpret word 0.

Table 4-4. Disk Word 0 Interpretation

System Log Error Number	Code	Interpretation
1D	04X0	Seek incomplete error
1C	08X0	End of cylinder error
1B	10X0	Disk unsafe error (see word 4 for analysis)
1B	11X0	Disk unsafe and pack change
1A	20X0	Disk write-protected
18	80X0	Disk offline

3. On the same line, read across the log report to word 7, command status. Interpret word 7 according to Table 4-5.

Table 4-5. Disk Word 7 Interpretation

System Log Error Number	Code	Interpretation
10	9100	990 reset occurred; no self-test error detected
—	9001	Look at W0 (disk status) for specific errors
17	9002	Search error; data field address mark in sector not found
13	9004	Command time-out, peripheral bus error, or software error
16	9008	Rate error
11	9010	ID error
—	9020	TILINE time-out
15	9040	Data error
00	9400	Retries used
15	9440	Data error
00	9600	ECC correction used
15	9640	Corrected data error (ECC corrected, no syndrome match)
14	9080	TILINE memory error
1F	90FF	Self-test fault; see W2 status

4. If the code word in disk word 7 is >90FF, then, on the same line, read across the log report to word 2, self-test number. Refer to Table 4-3 to interpret word 2.

5. After learning the fault type from Table 4-4 and Table 4-5, consult the troubleshooting flowchart for the procedure to use for the specific fault.

For reference only, Table 4-6 lists the word 1 disk command codes. Use this information to determine what command was executing when the fault occurred.

Table 4-6. Disk Word 1 Command Codes

Code	Command
X0XX	Store registers
X1XX	Format track
X2XX	Read
X3XX	Write
04XX	Read ID
X5XX	Write unformatted
X6XX	Seek
X7XX	Restore
XAXX	Read with transfer inhibit bit set
84XX	Read unformatted
87XX	Maintenance commands (see word 3)
C1XX*	Absolute format track
41XX*	Bad track relocate
44XX*	Surface analysis assist

Note:

* For WD800A only.

For reference only, Table 4-7 lists the word 3 disk maintenance command codes. Use this information to determine what maintenance command was executing when the fault occurred. Note that a maintenance command must have > 87XX in word 1.

Table 4-7. Disk Word 3 Maintenance Command Codes

Code	Command
00XX	Execute all disk and tape self-tests
01XX	Interface presence self-test
02XX	Interface board data self-test
03XX	Interface board parity self-test
04XX	Processor board ROM CRC self-test
05XX	Processor board RAM self-test
06XX	Processor board CTC self-test
07XX	Processor board PIO self-test
08XX	Processor board DMA self-test
09XX	Processor board WAIT generator self-test
10XX[1]	disk servo subsystem self-test
10XX[2]	ST506 disk interface board self-test
11XX	Disk HSD Board self-test
12XX	Disk read subsystem self-test
13XX	Disk write subsystem self-test
14XX	Execute all disk self-tests
15XX	Reformat disk test cylinders command
16XX[1]	Disk exerciser command
17XX[1]	Activate disk read threshold changing command
17XX[2]	Allow alternate precompensation selection command
18XX[1]	Deactivate disk read threshold changing command
18XX[2]	Return to normal precompensation command
19XX[2]	Initialize bad track table in formatter RAM
1AXX[2]	Read absolute header command
3BXX	PBUS loopback self-test
3CXX	Return disk parameter block command
3DXX	Execute formatter memory command
3EXX	Write formatter memory command
3FXX	Read formatter memory command

Note:

[1] For WD800 only.

[2] For WD800A only.

DX10 System Log Report for a Tape Device. Table 4-8 shows the system log report format for a tape device. (For a full illustration of the eight-word CSB for the tape, see Figure 1-6).

Table 4-8. System Log Report for Tape

```
160: 1432+MT01 ERR=49 IID=08 L=04 A=0070 0000 0000 0000 11FF 15CA 8604 8282
               ST02 RID=49 S=03 B=0000 0040 0000 0000 1FFF 07CA 8604 1000
                |
Day  Time Device                  WD0  WD2                      WD6  WD7
          Name                   Tape  S/T                     Cmd  Cmd
                                Status Status                        Status
```

To interpret the system log report for the tape drive, proceed as follows:

1. On the left side of the report, find the device name that corresponds to the WD800 device under suspicion. (If you cannot find a message for the device, the system log cannot be used at this point.)

2. Read across from the device name to word 0, tape status (following A = in Table 4-8). Use Table 4-9 to interpret word 0.

Table 4-9. Tape Word 0 Interpretation

System Log Error Number	Code	Interpretation
40	01X0	Command time-out, peripheral bus error, or software error
—	02X0	Rewind in progress
44	04X0	Tape write-protected
42	08X0	End of tape (software handles this situation)
—	10X0	End of file mark
—	20X0	End of record error
41	40X0	Beginning of tape
43	80X0	Tape offline or failed to load, or fatal media error

3. On the same line, read across the log report to word 7, command status. Interpret word 7 according to Table 4-10.

Table 4-10. Tape Word 7 Interpretation

System Log Error Number	Code	Interpretation
47	8100	990 reset occurred; no self-test error detecte
—	80FF	TPBI self-test error
—	8201	Tape error; see W0 (tape status)
49	8202	Format error
46	8204	TILINE memory error
4A	8208	Rate error
48	8210	TILINE time-out
45	8220	Data error
45	8240	Corrected data error
45	8280	Read-after-write CRC error
49	8282	Read-after-write dropout error
43	82FF	Tape self-test error; see W2 (self-test status)

4. After learning the fault type from Table 4-9 and Table 4-10, consult the troubleshooting flowchart for the procedure to use for the specific fault.

For reference only, Table 4-11 lists the word 6 tape command codes. Use this information to determine what command was executing when the fault occurred.

Table 4-11. Tape Word 6 Command Codes

Code	Command
X0XX	NOP
X1XX	NOP
X2XX	Write end-of-file
X3XX	Skip reverse
X4XX	Read
X5XX	Skip forward
X6XX	Write
X7XX	Erase
X8XX	Read tape status
X9XX	Read tape status
XAXX	Rewind
XBXX	Unload
XCXX	Write unformatted
XDXX	Read unformatted
XEXX	NOP
XFXX	Maintenance commands (see W3)

4.2.2.3 DOCS Tests. A series of five DOCS tests provides fault detection and reinforcement of the fault isolation done using the LED indicators and system log. These tests are performed in the following order:

1. DSKWD8 — DSKWD8 checks on the operations and status reporting of TI Winchester disks using the PBI.

2. DSKCOM — DSKCOM contains high-level tests for most of the TILINE disk family. It assumes that the test specific to the disk type ran successfully.

3. DSKSA — DSKSA is a verb module that performs disk media analysis; it is not a diagnostic that performs specific hardware tests. It destroys data on the disk.

4. MTCTST — MTCTST tests all possible functions of the tape drive.

5. TPBITS — TPBITS is covered in Section 3.

For detailed descriptions of these tests and instructions about running them, refer to *Unit Diagnostics Handbook, Volume 3, Diagnostics for 990 Mass Storage Devices*. Be sure to consult the most recent revision of the manual.

4.2.2.4 Troubleshooting Flowcharts. The troubleshooting flowcharts provide an orderly and structured procedure for isolating problems to field-replaceable parts or subassemblies. The top-level flowchart establishes the context of a detected fault. It directs you to one of eight second-level flowcharts covering the possible contexts of a failure. If the failure occurs during the diagnostics tests, the flowchart for that context directs you to one of seven third-level flowcharts that isolates the problem. Figure 4-1 shows the relationships among the flowcharts. A flowchart on any given level can direct the user to any other flowchart no matter what its level. The CR starts with the top-level flowchart, CONTEXT, and refers to the more detailed flowcharts as directed by CONTEXT. If the detailed flowchart fails to isolate the fault properly, the CR returns to the top-level flowchart and continues that procedure. Table 4-12 expands the abbreviated names of the flowcharts in Figure 4-1. Figures 4-2 through 4-19 contain the flowcharts.

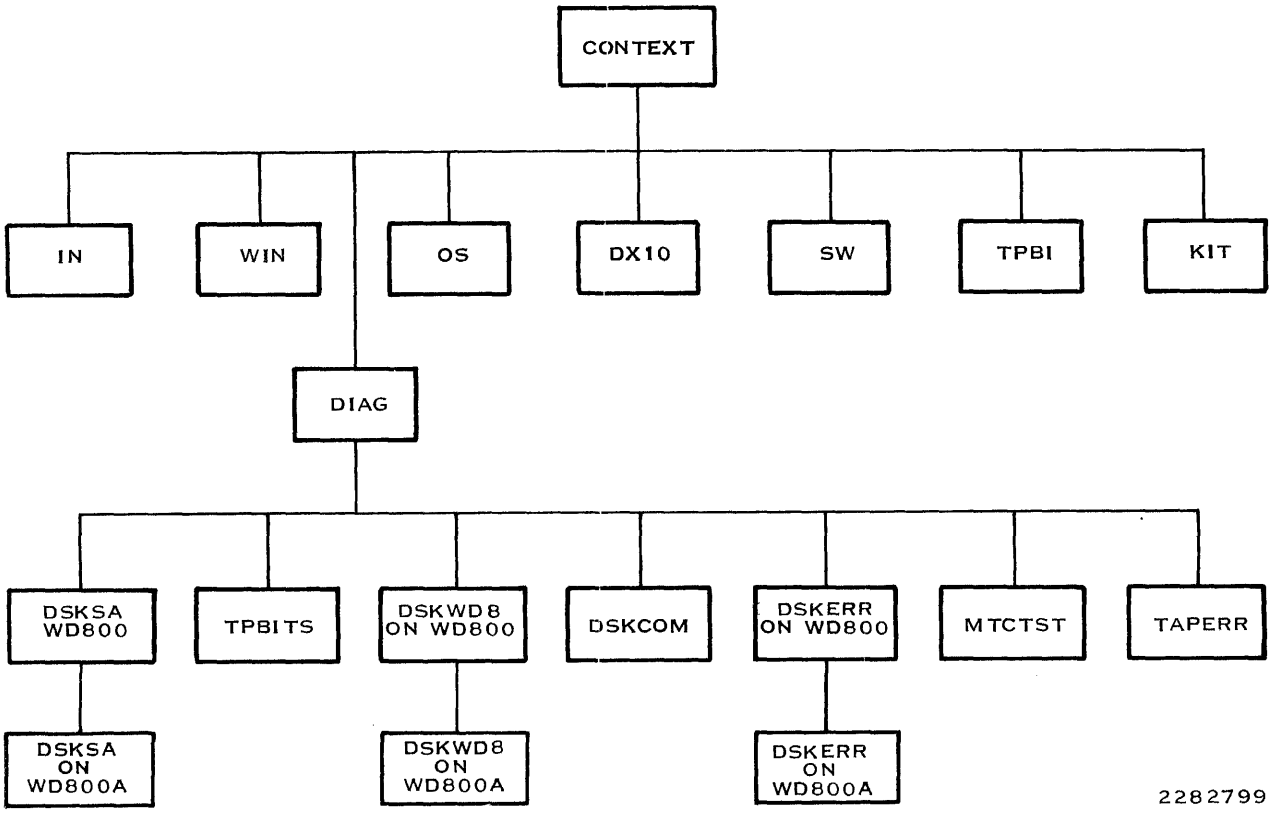


Figure 4-1. Flowchart Structure

Table 4-12. Expanded Flowchart Names

Mnemonic	Expansion
CONTEXT	Establishing the context of a detected fault
IN	Installation
WIN	WD800 power-up (with or without controller board)
DIAG	Diagnostics
OS	Building or booting DX10
DX10	Normal DX10 operation
SW	Using custom software
TPBI	TPBI stand-alone power-up (cable disconnected)
KIT	Kit initialization (WD800/WD800A connected to TPBI)
DSKWD8	Executing DSKWD8 diagnostic test
DSKCOM	Executing DSKCOM diagnostic test
DSKSA	Executing DSKSA diagnostic test
DSKERR	Diagnostic faults on disk
TPBITS	Executing TPBITS diagnostic test
MTCTST	Executing MTCTST diagnostic test
TAPERR	Diagnostic faults on tape

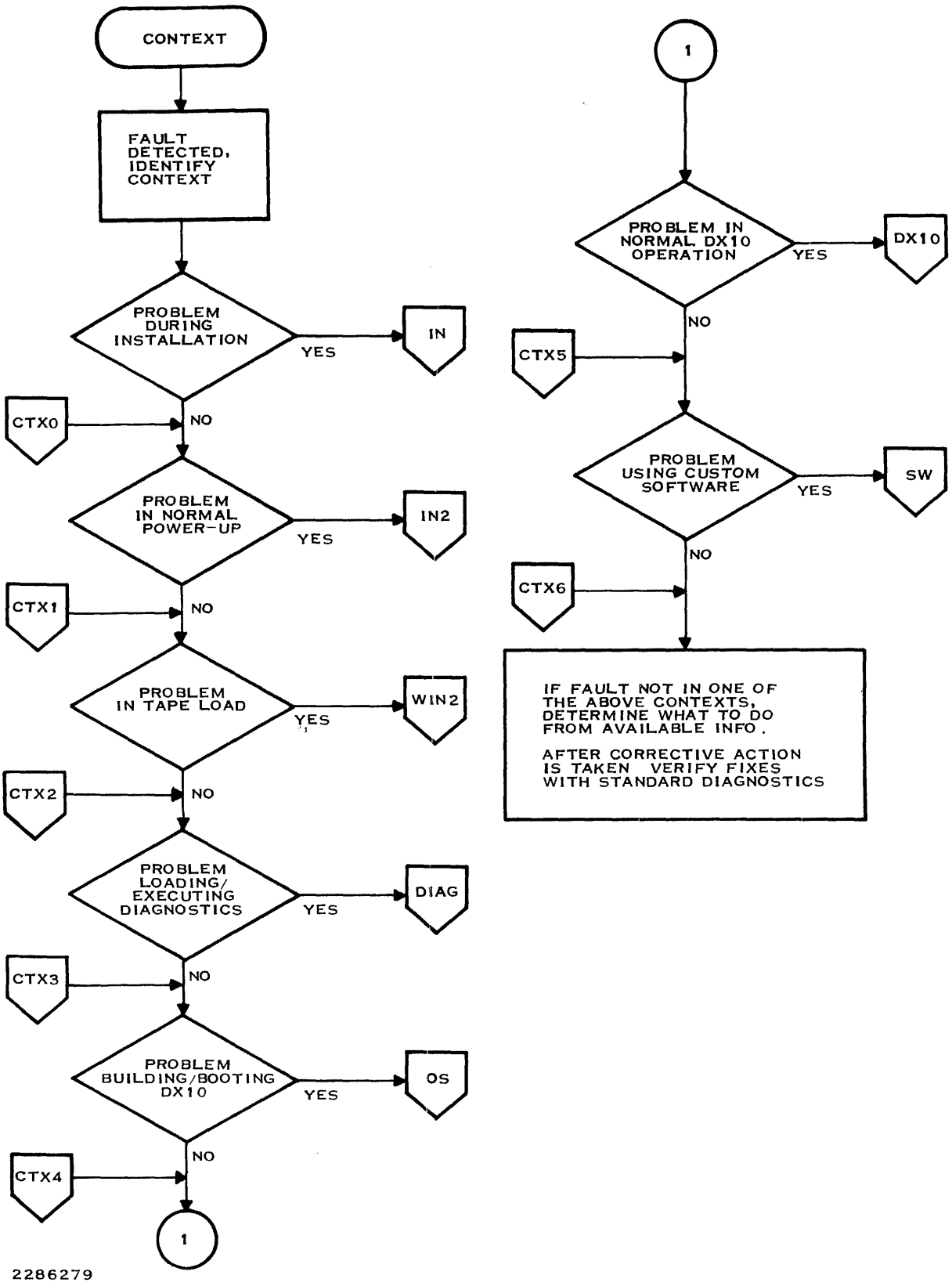


Figure 4-2. CONTEXT Troubleshooting Flowchart

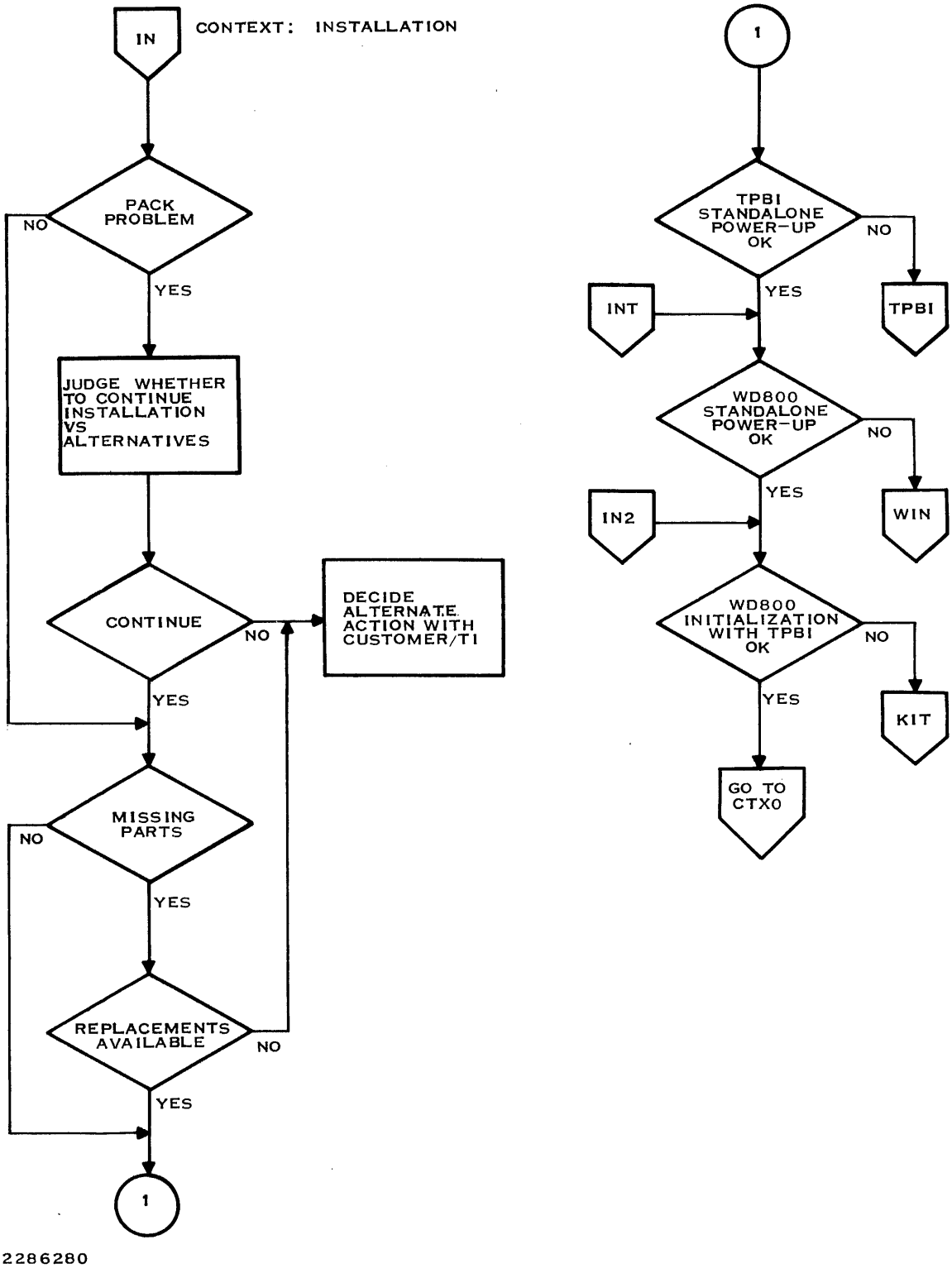


Figure 4-3. IN Troubleshooting Flowchart

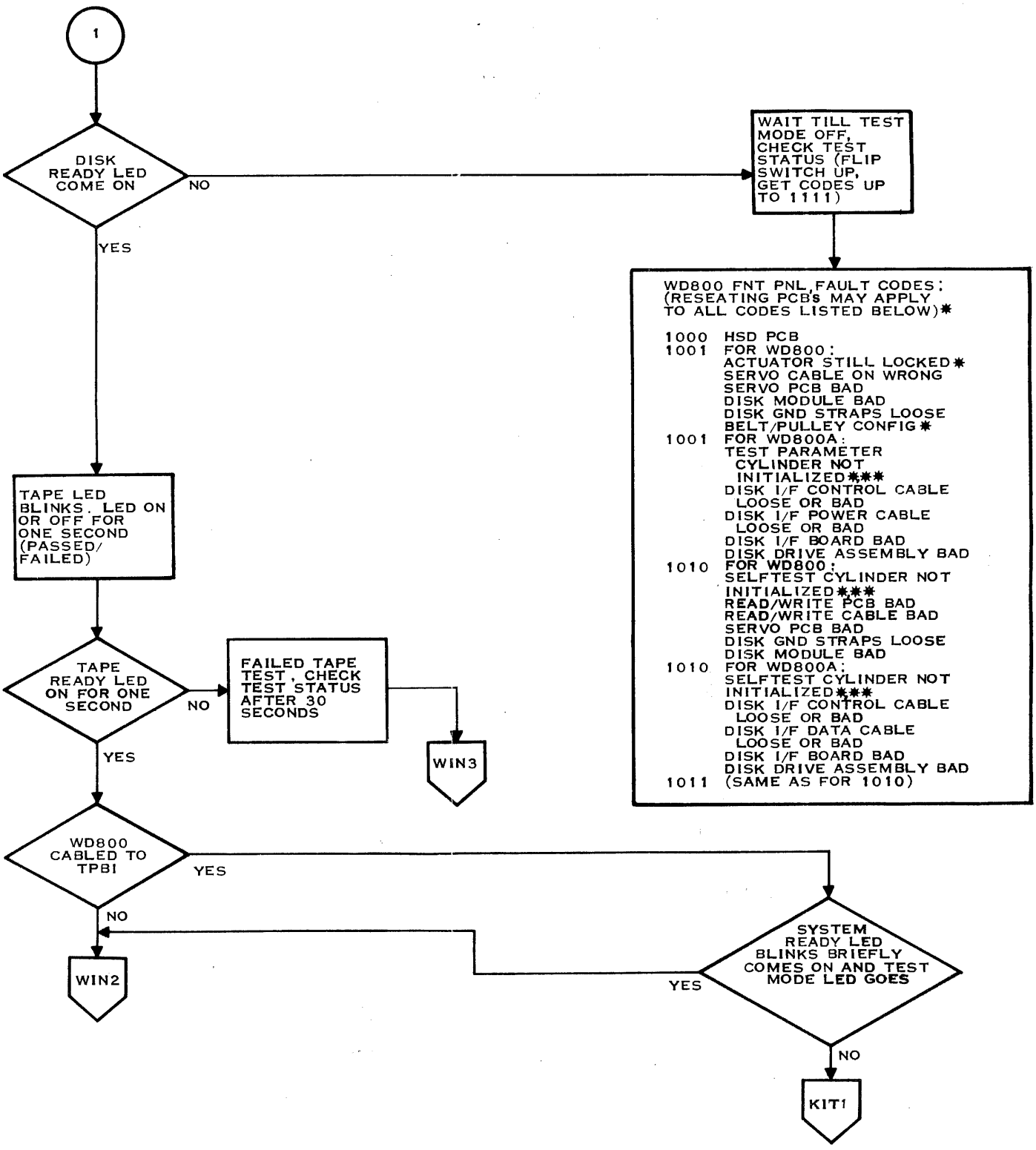
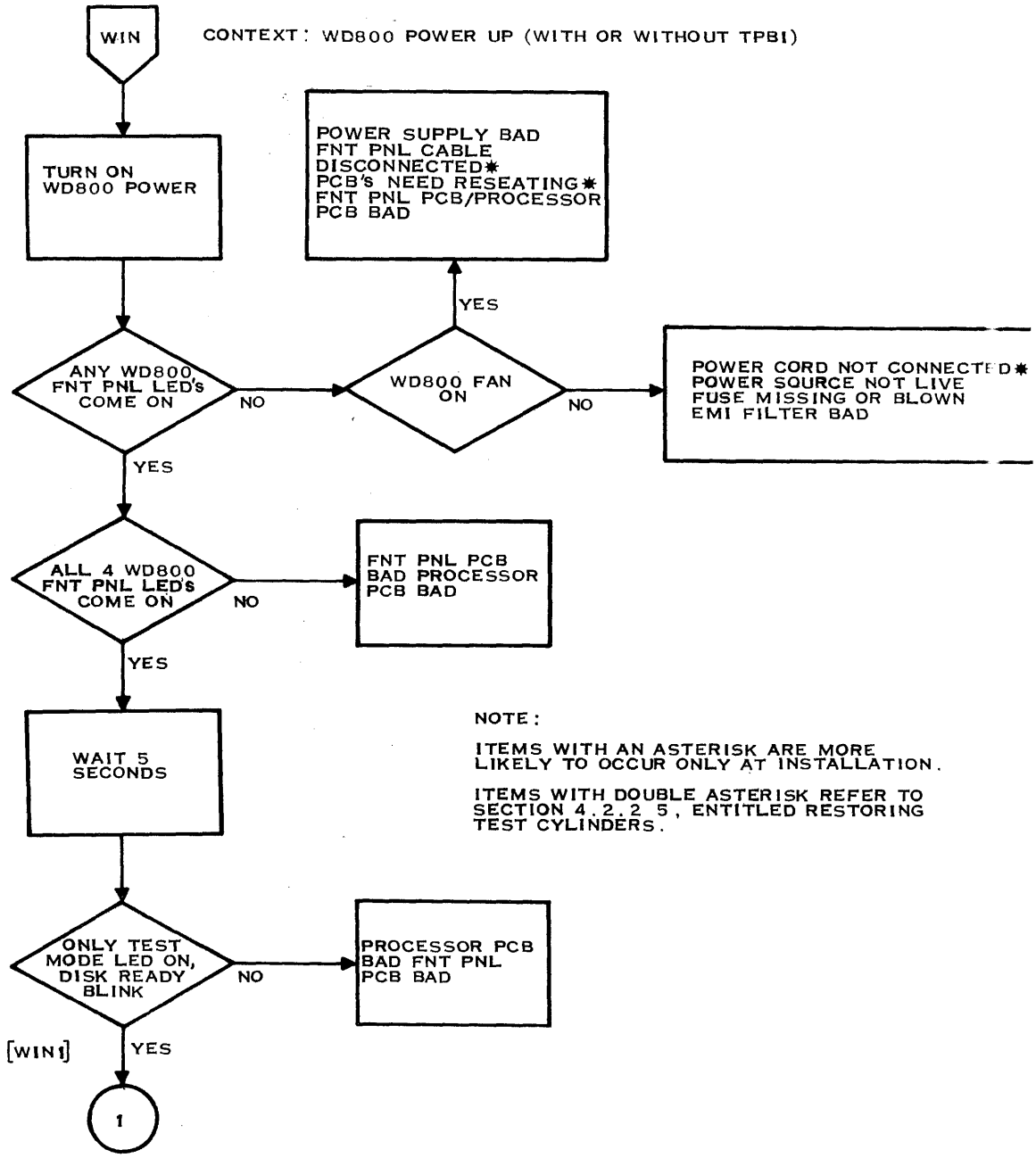


Figure 4-4. WIN Troubleshooting Flowchart (Sheet 1 of 2)


WIN
CONTEXT: WD800 POWER UP (WITH OR WITHOUT TPBI)
TURN ON WD800 POWER
POWER SUPPLY BAD
FNT PNL CABLE DISCONNECTED*
PCB's NEED RESEATING*
FNT PNL PCB/PROCESSOR PCB BAD
YES
ANY WD800, FNT PNL LED's COME ON
NO
WD800 FAN ON
NO
POWER CORD NOT CONNECTED*
POWER SOURCE NOT LIVE
FUSE MISSING OR BLOWN
EMI FILTER BAD
YES
ALL 4 WD800 FNT PNL LED's COME ON
NO
FNT PNL PCB BAD PROCESSOR PCB BAD
YES
WAIT 5 SECONDS
NOTE:
ITEMS WITH AN ASTERISK ARE MORE LIKELY TO OCCUR ONLY AT INSTALLATION.
ITEMS WITH DOUBLE ASTERISK REFER TO SECTION 4.2.2 5, ENTITLED RESTORING TEST CYLINDERS.
ONLY TEST MODE LED ON, DISK READY BLINK
NO
PROCESSOR PCB BAD FNT PNL PCB BAD
[WIN1]
YES
1

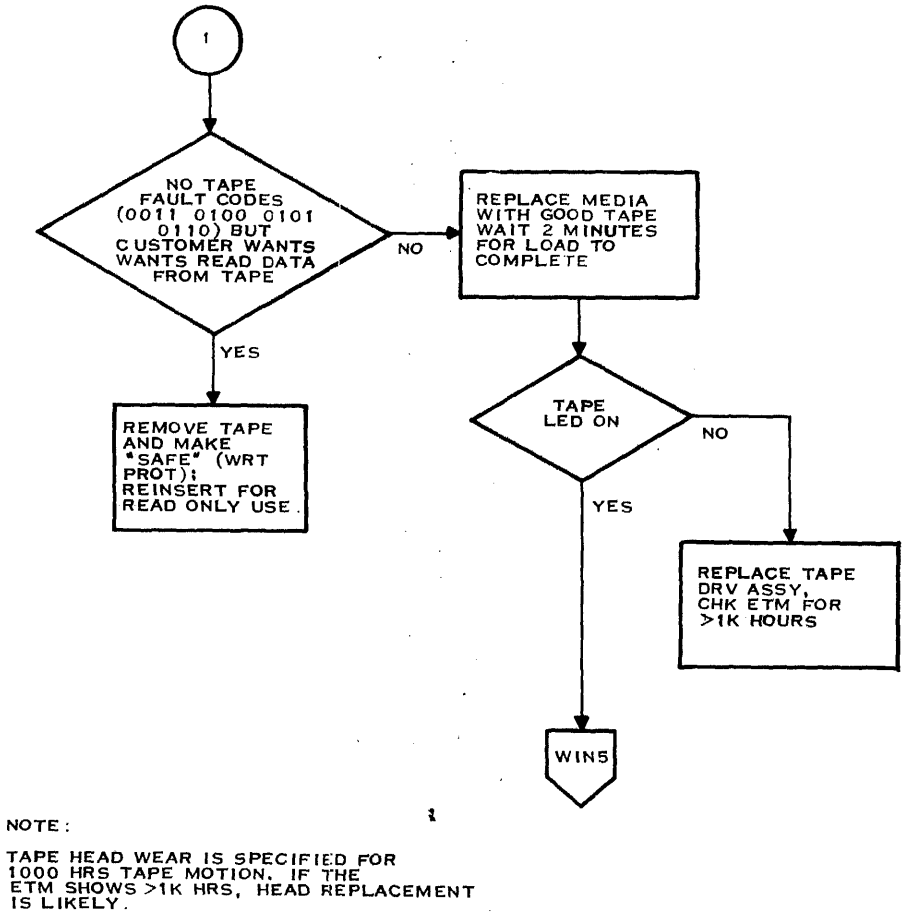
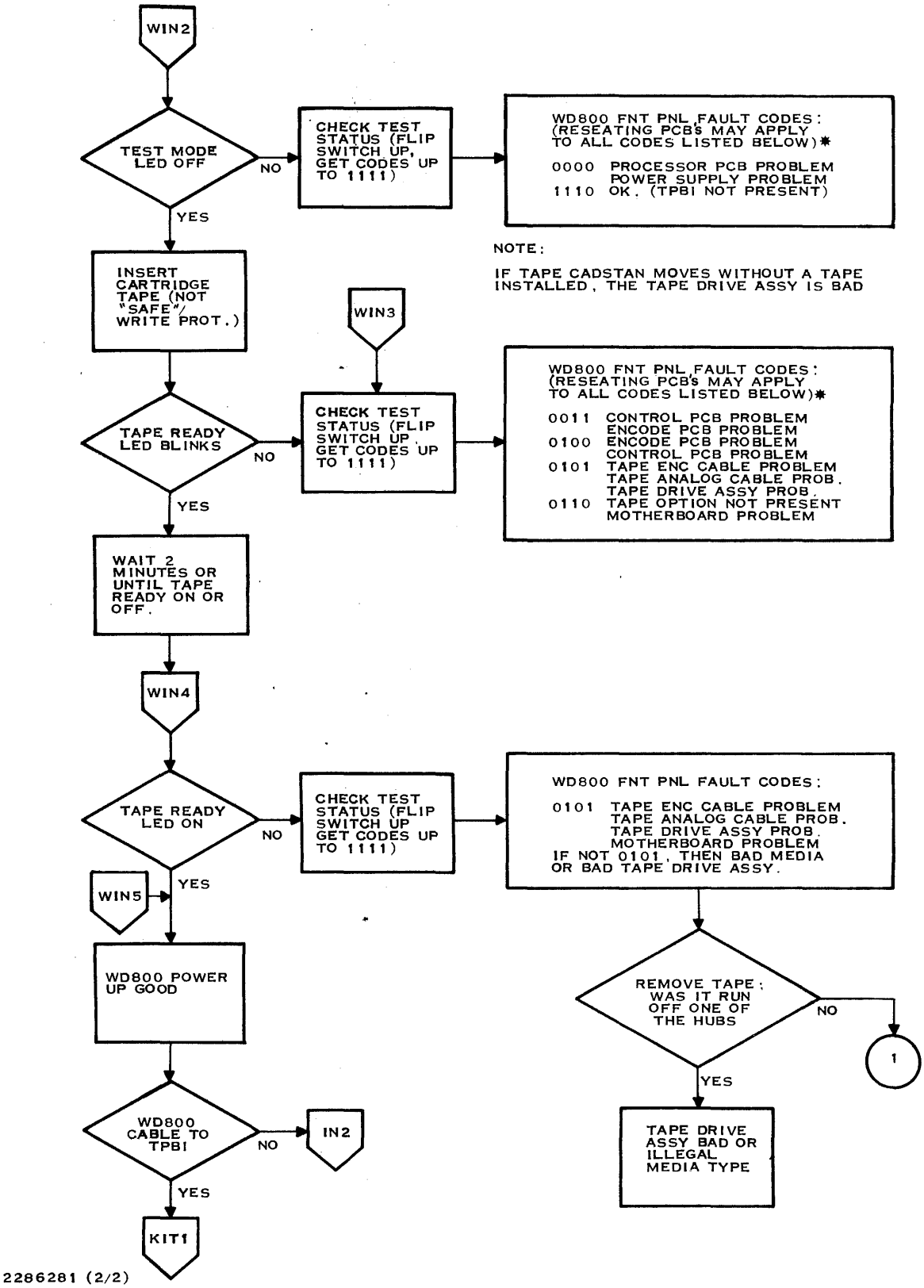


Figure 4-4. WIN Troubleshooting Flowchart (Sheet 2 of 2)


WIN2
TEST MODE LED OFF
NO
CHECK TEST STATUS (FLIP SWITCH UP, GET CODES UP TO 1111)
WD800 FNT PNL FAULT CODES: (RESEATING PCB's MAY APPLY TO ALL CODES LISTED BELOW)*
0000 PROCESSOR PCB PROBLEM
POWER SUPPLY PROBLEM
1110 OK. (TPBI NOT PRESENT)
YES
NOTE:
IF TAPE CADSTAN MOVES WITHOUT A TAPE INSTALLED, THE TAPE DRIVE ASSY IS BAD
INSERT CARTRIDGE TAPE (NOT "SAFE"/ WRITE PROT.)
WIN3
TAPE READY LED BLINKS
NO
CHECK TEST STATUS (FLIP SWITCH UP GET CODES UP TO 1111)
WD800 FNT PNL FAULT CODES: (RESEATING PCB's MAY APPLY TO ALL CODES LISTED BELOW)*
0011 CONTROL PCB PROBLEM
ENCODE PCB PROBLEM
0100 ENCODE PCB PROBLEM
CONTROL PCB PROBLEM
0101 TAPE ENC CABLE PROBLEM
TAPE ANALOG CABLE PROB.
TAPE DRIVE ASSY PROB.
0110 TAPE OPTION NOT PRESENT
MOTHERBOARD PROBLEM
YES
WAIT 2 MINUTES OR UNTIL TAPE READY ON OR OFF.
WIN4
TAPE READY LED ON
NO
CHECK TEST STATUS (FLIP SWITCH UP GET CODES UP TO 1111)
WD800 FNT PNL FAULT CODES:
0101 TAPE ENC CABLE PROBLEM
TAPE ANALOG CABLE PROB.
TAPE DRIVE ASSY PROB.
MOTHERBOARD PROBLEM
IF NOT 0101, THEN BAD MEDIA OR BAD TAPE DRIVE ASSY.
WIN5
YES
WD800 POWER UP GOOD
REMOVE TAPE; WAS IT RUN OFF ONE OF THE HUBS
NO
1
YES
TAPE DRIVE ASSY BAD OR ILLEGAL MEDIA TYPE
WD800 CABLE TO TPBI
NO
IN2
YES
KIT1

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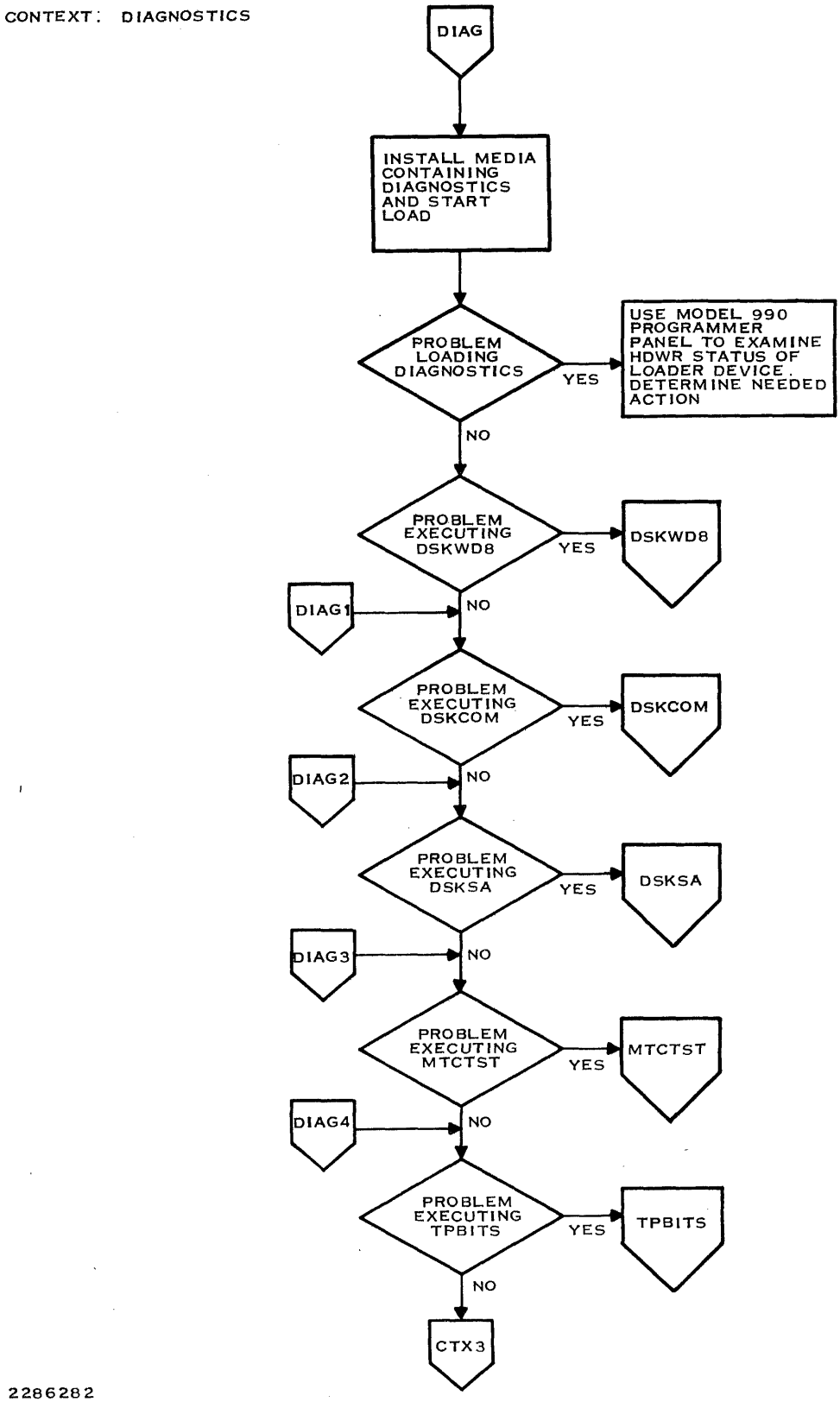

Figure 4-5. DIAG Troubleshooting Flowchart

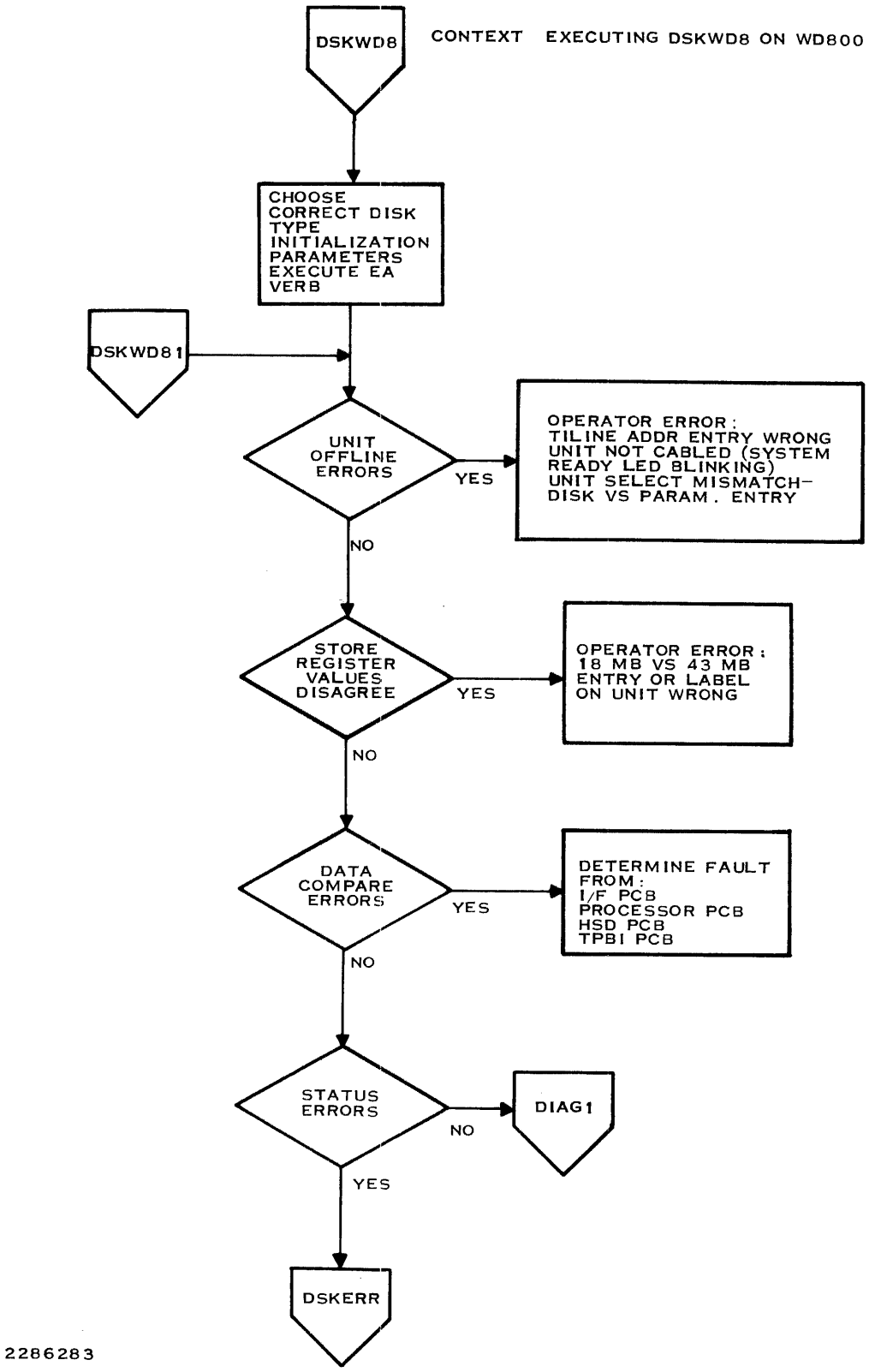

Figure 4-6. DSKWD8 on WD800

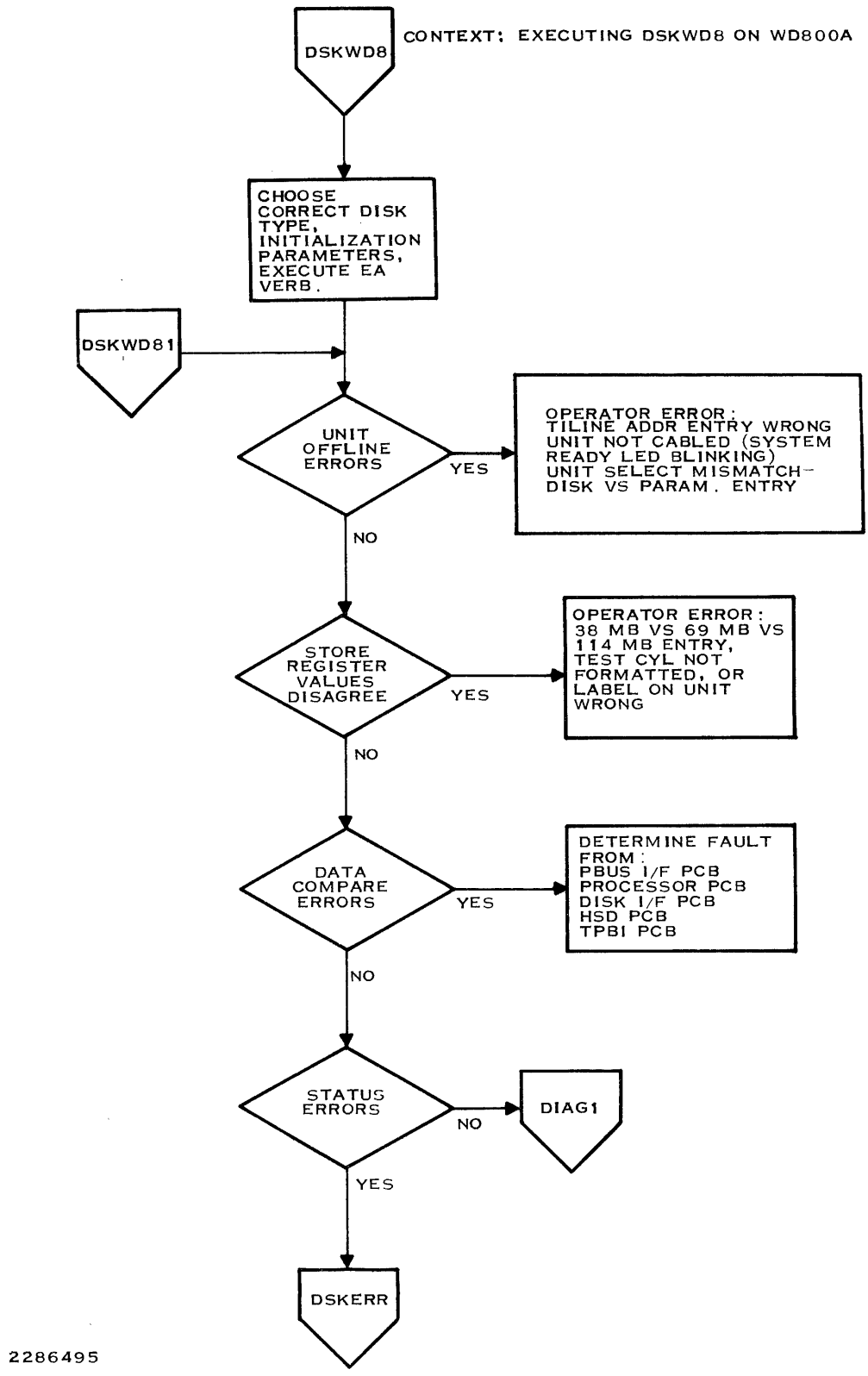

Figure 4-7. DSKWD8 on WD800A

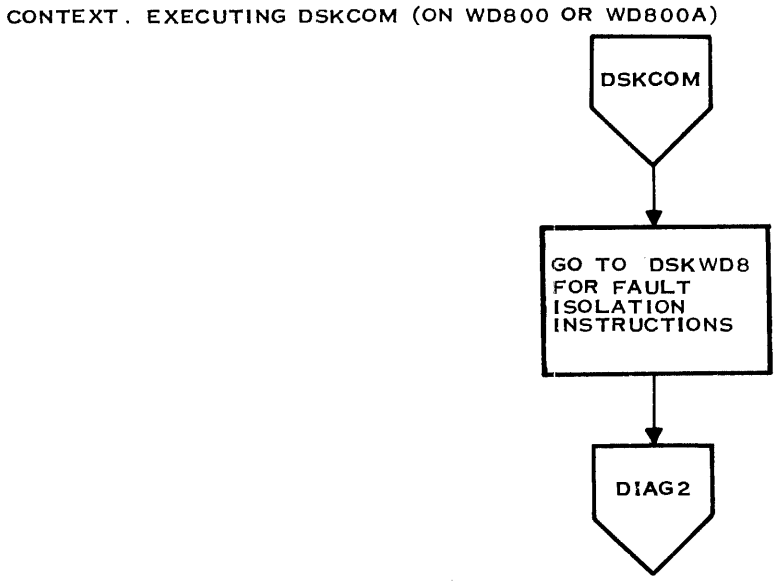

Figure 4-8. DSKCOM on WD800 or WD800A

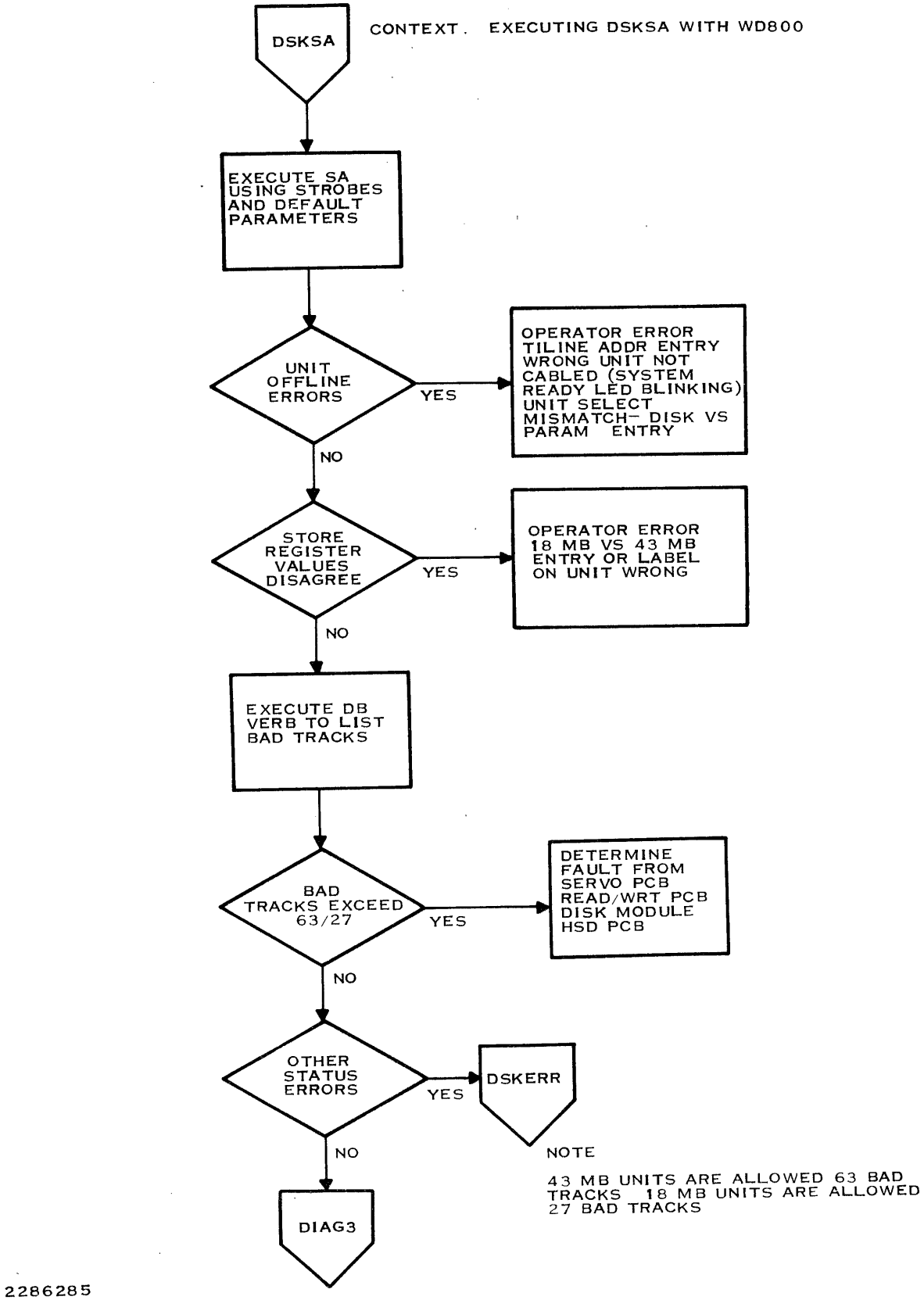

Figure 4-9. Executing DSKSA with WD800

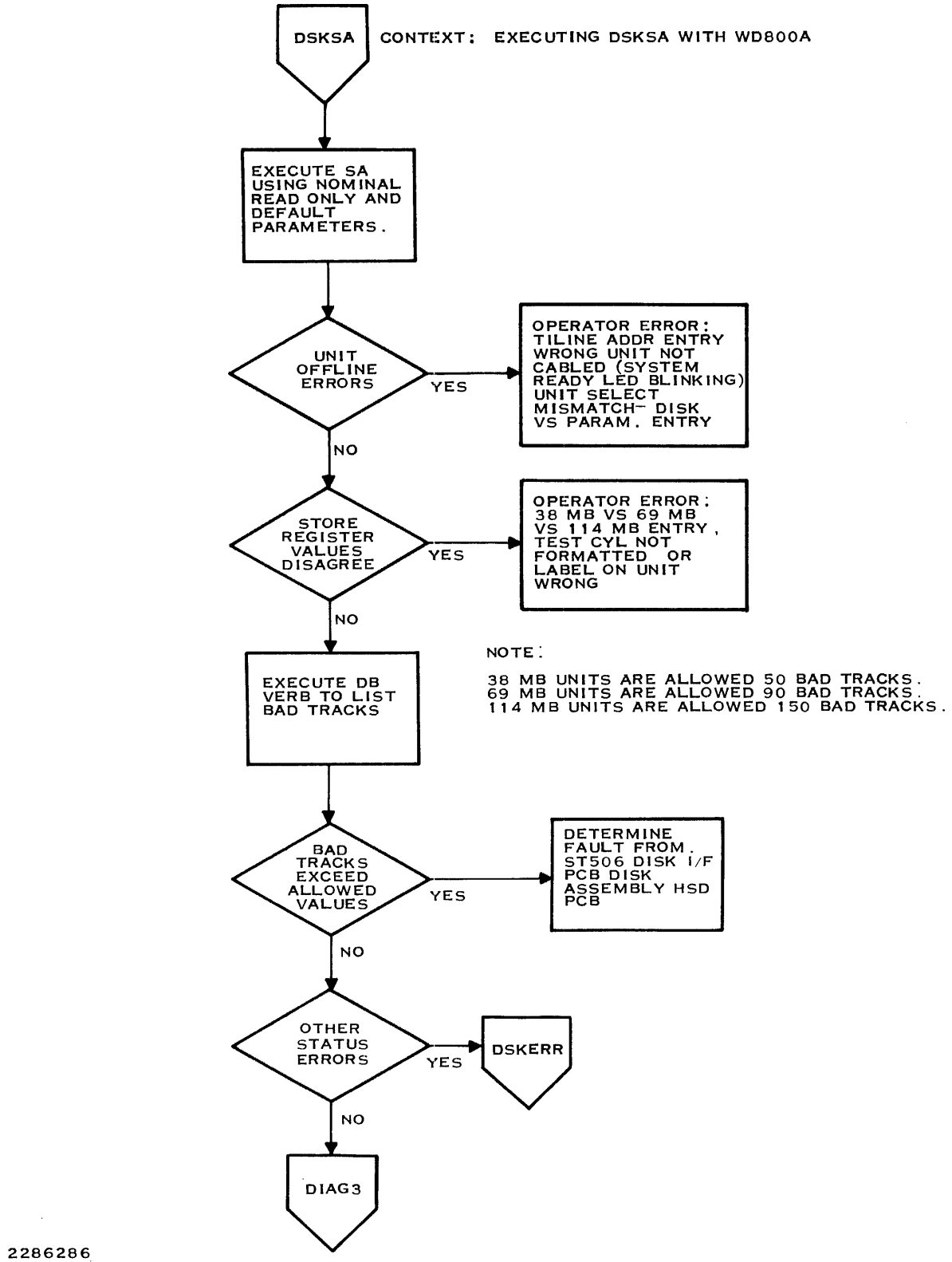

Figure 4-10. Executing DSKSA with WD800A

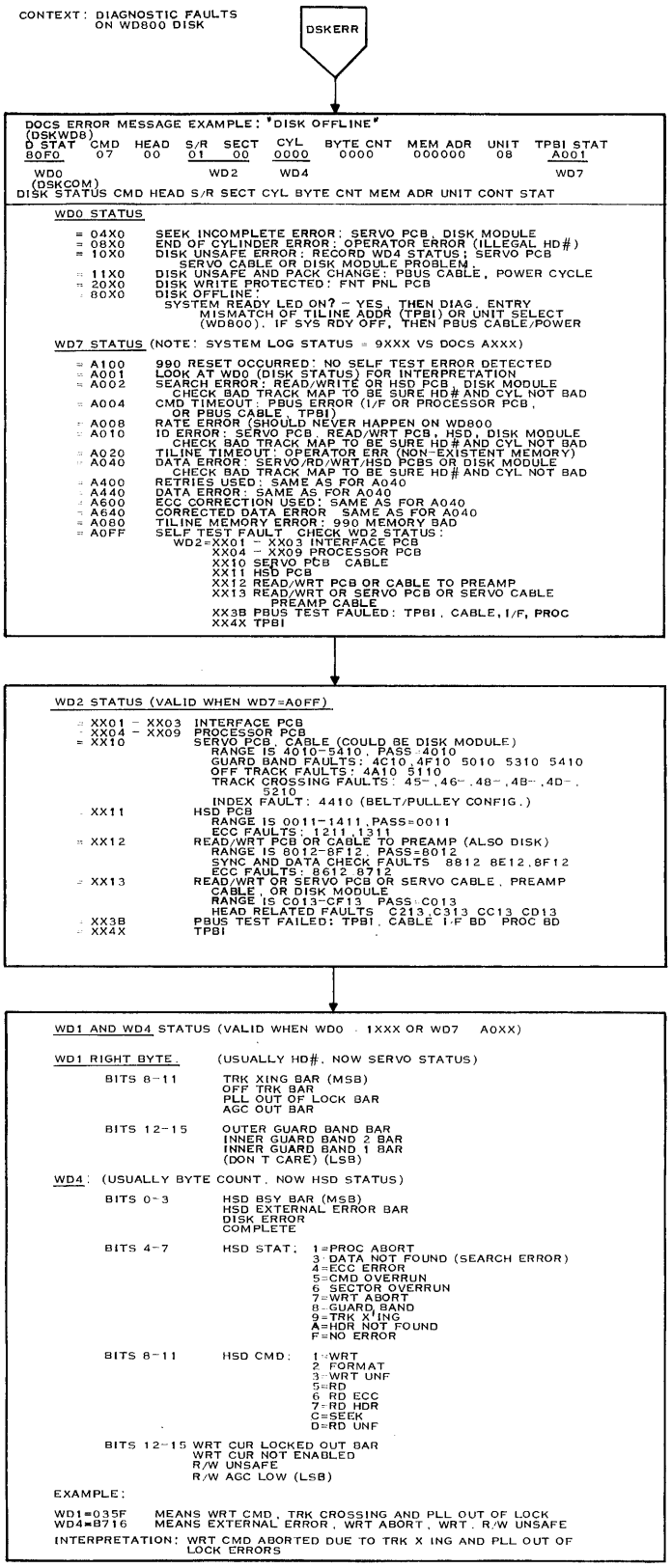

Figure 4-11. DSKERR on WD800

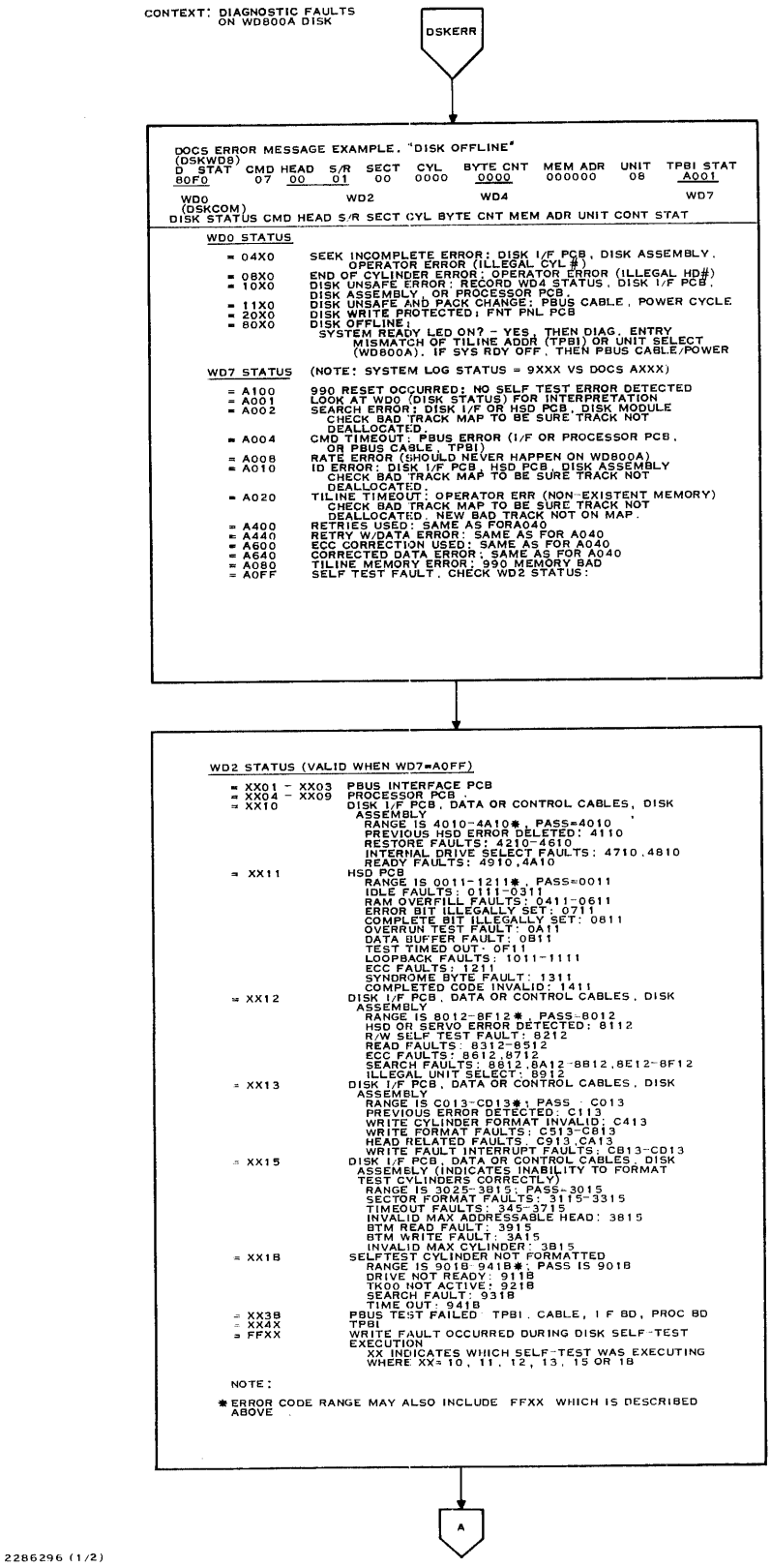

Figure 4-12. DSKERR on WD800A (Sheet 1 of 2)

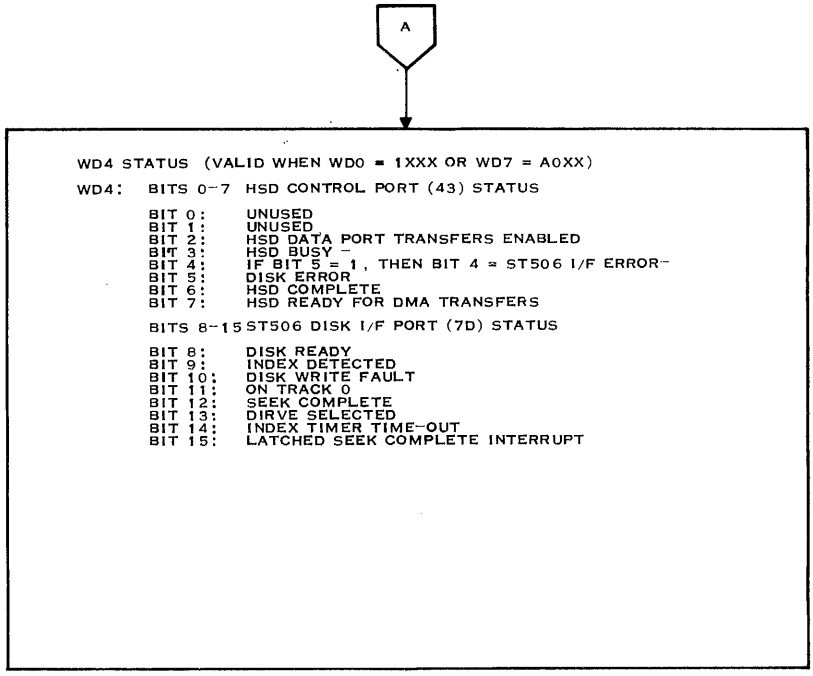

Figure 4-12. DSKERR on WD800A (Sheet 2 of 2)

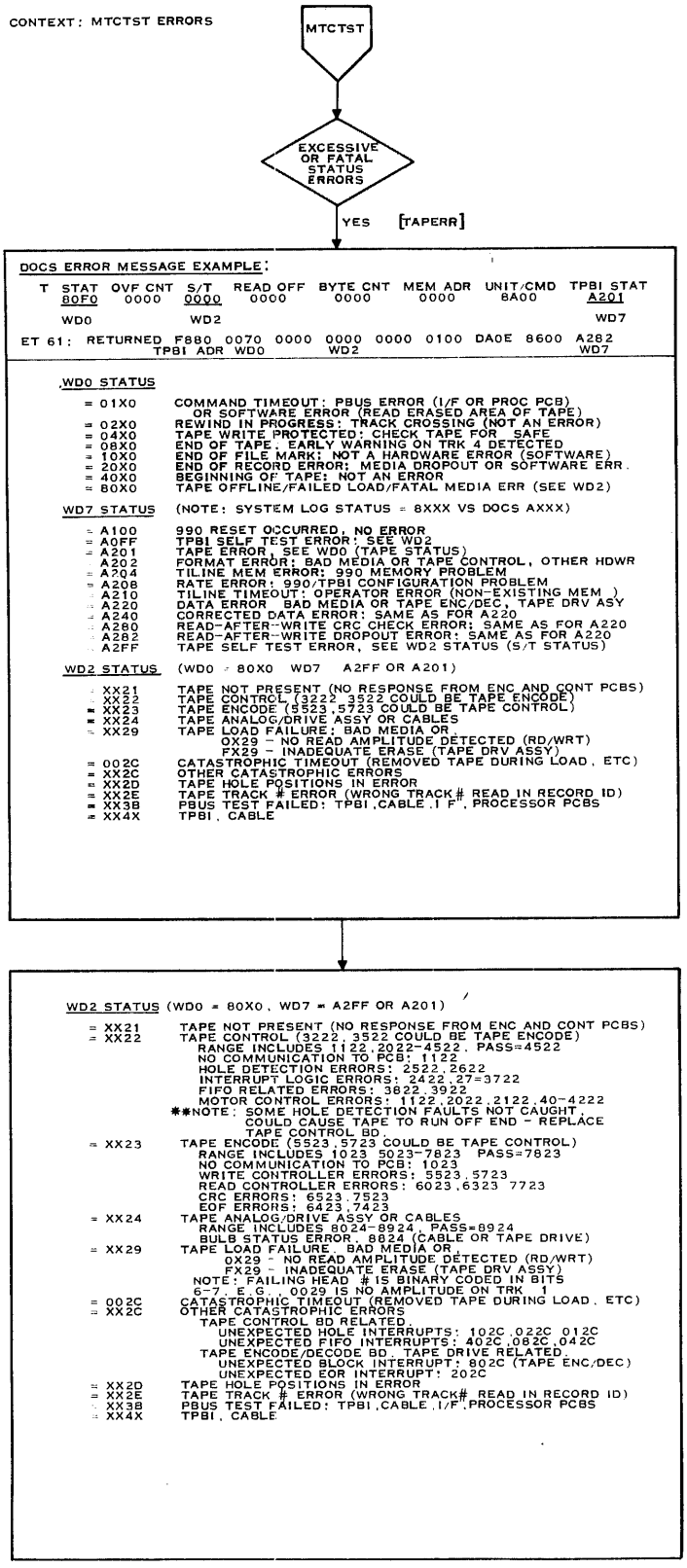

Figure 4-13. MTCTST and MCTTST Tape Errors

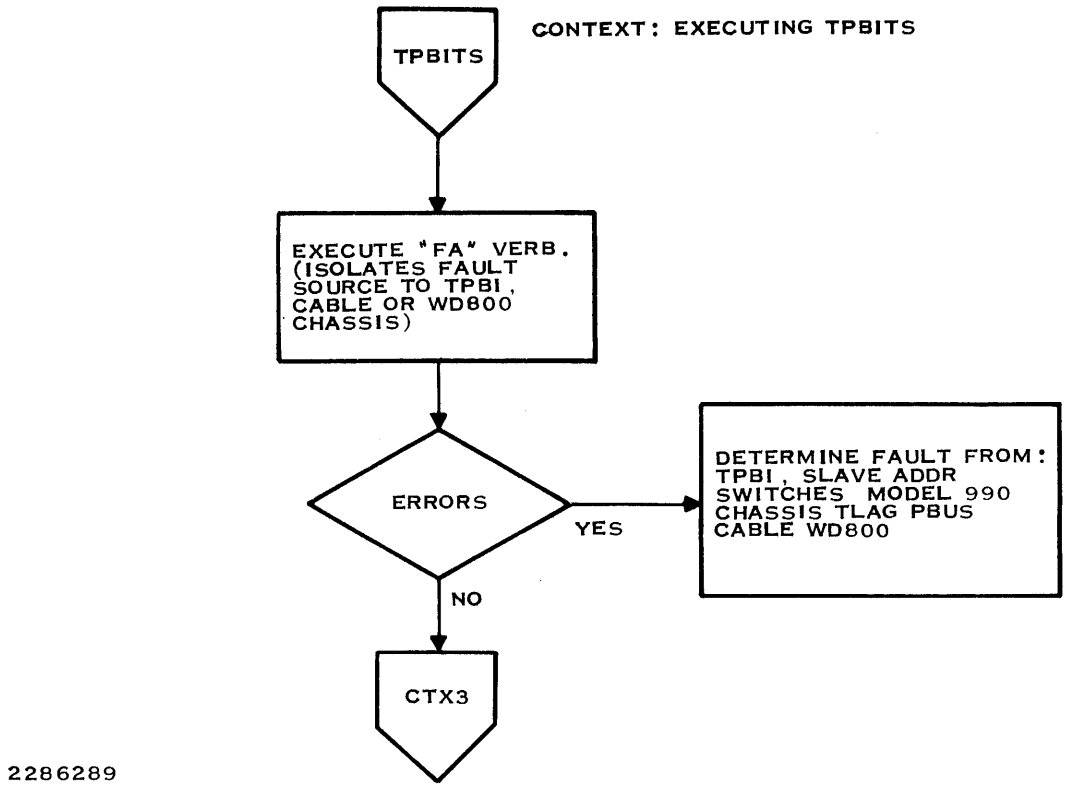

Figure 4-14. TPBITS to Isolate TPBI Cable Faults

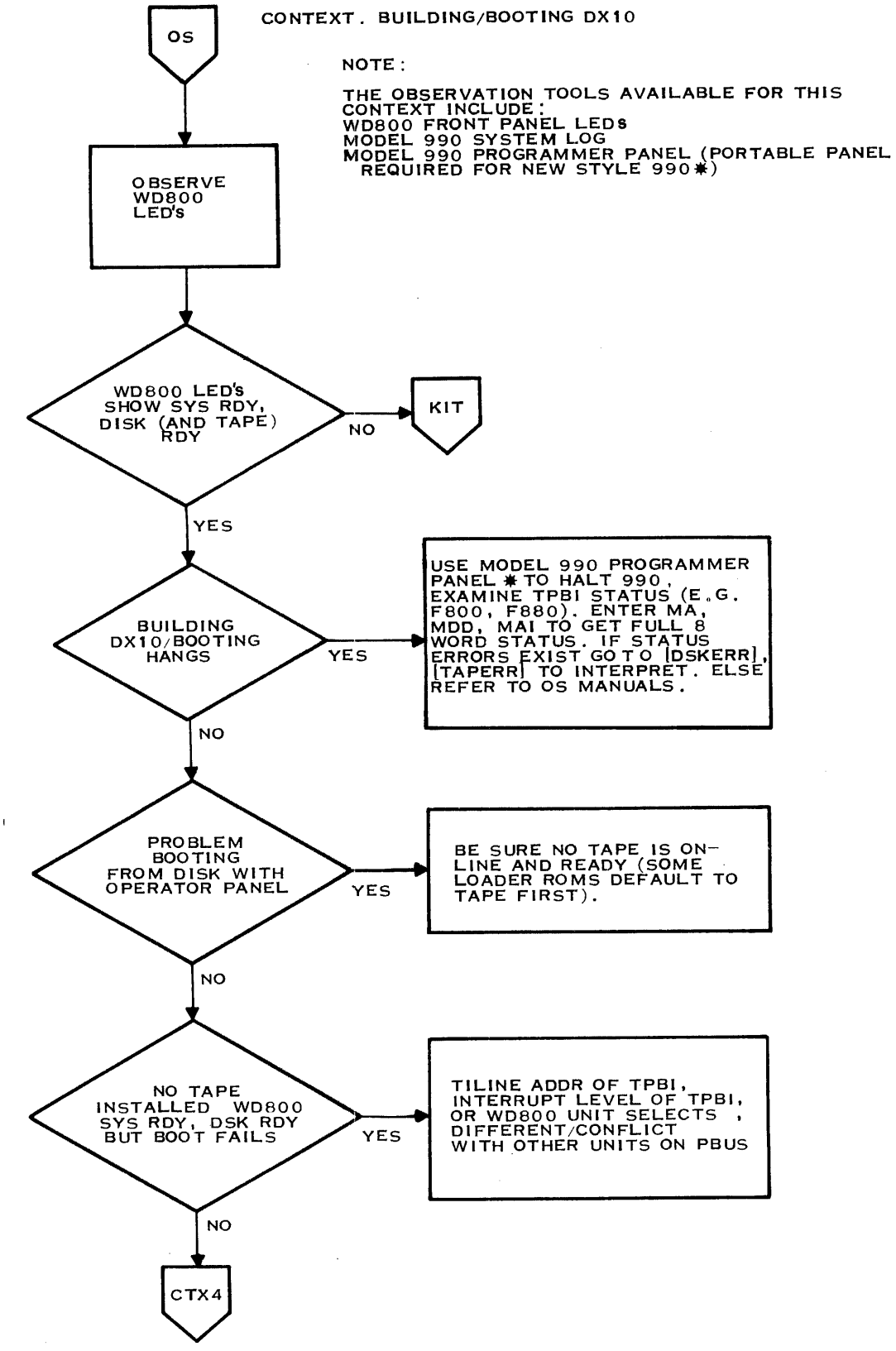

Figure 4-15. OS Troubleshooting Flowchart

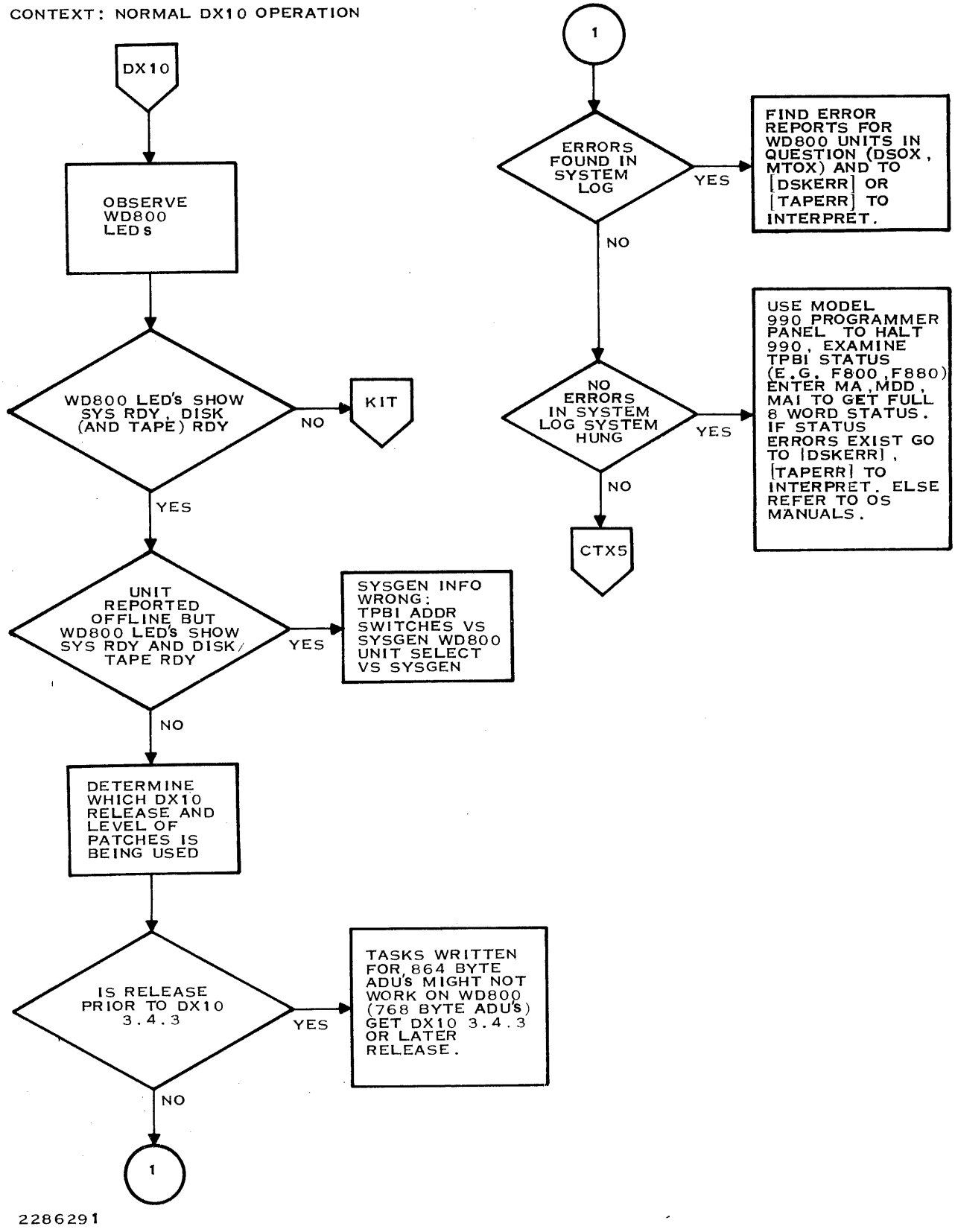

Figure 4-16. DX10 Troubleshooting Flowchart

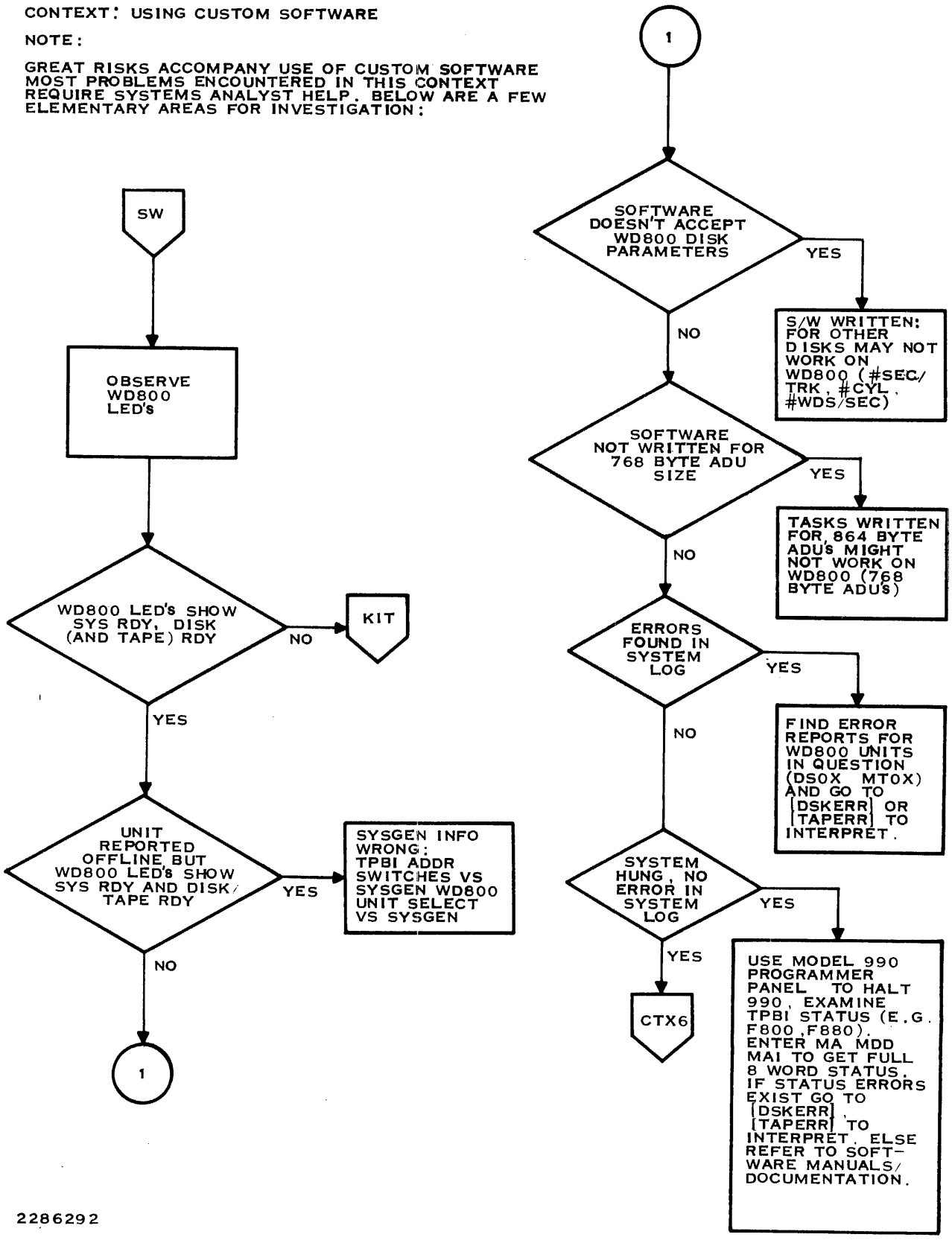

Figure 4-17. SW Troubleshooting Flowchart

CONTEXT. TPBI STANDALONE POWER UP (CABLE DISCONNECTED)

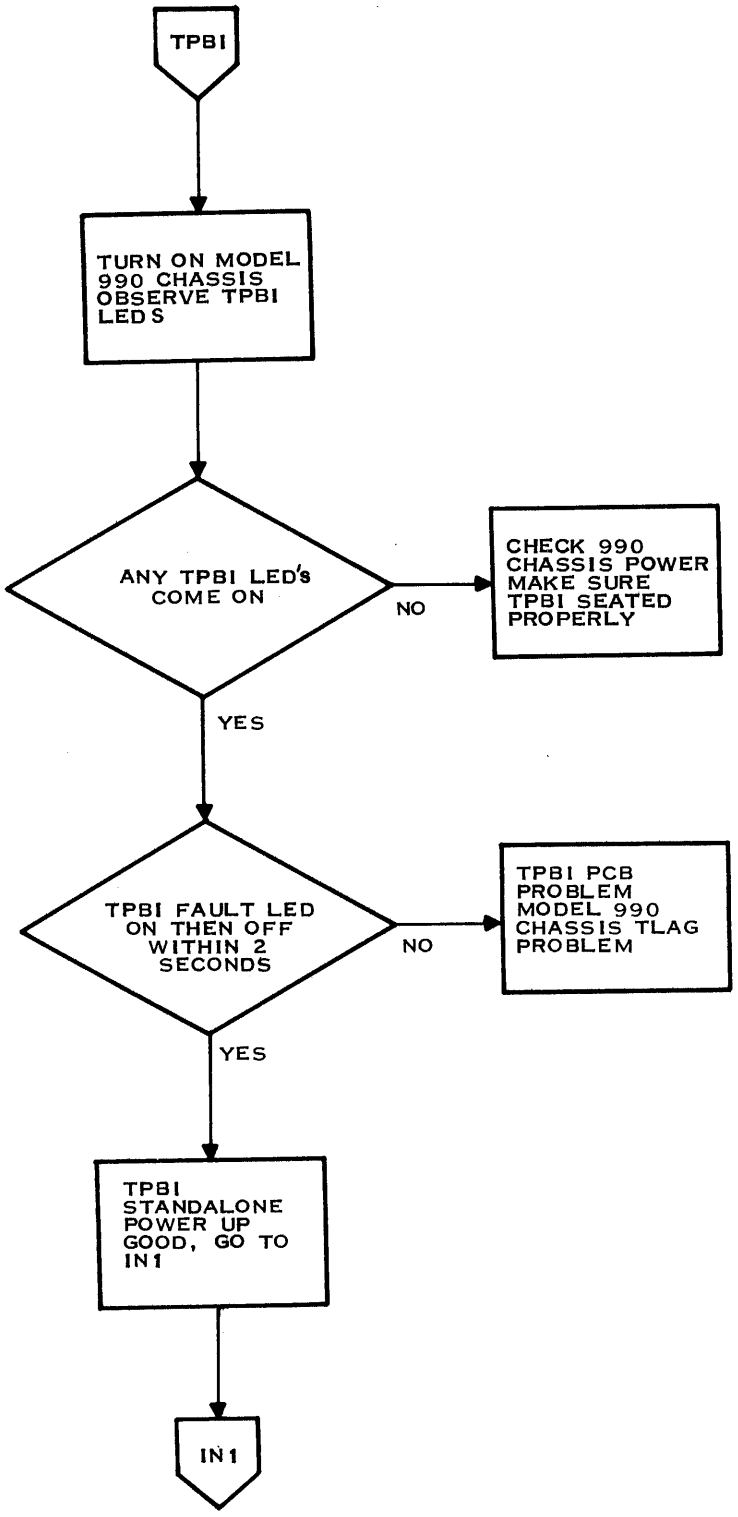

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Figure 4-18. TPBI Troubleshooting Flowchart

CONTEXT: KIT INITIALIZATION (WD800 CONNECTED TO TPBI)

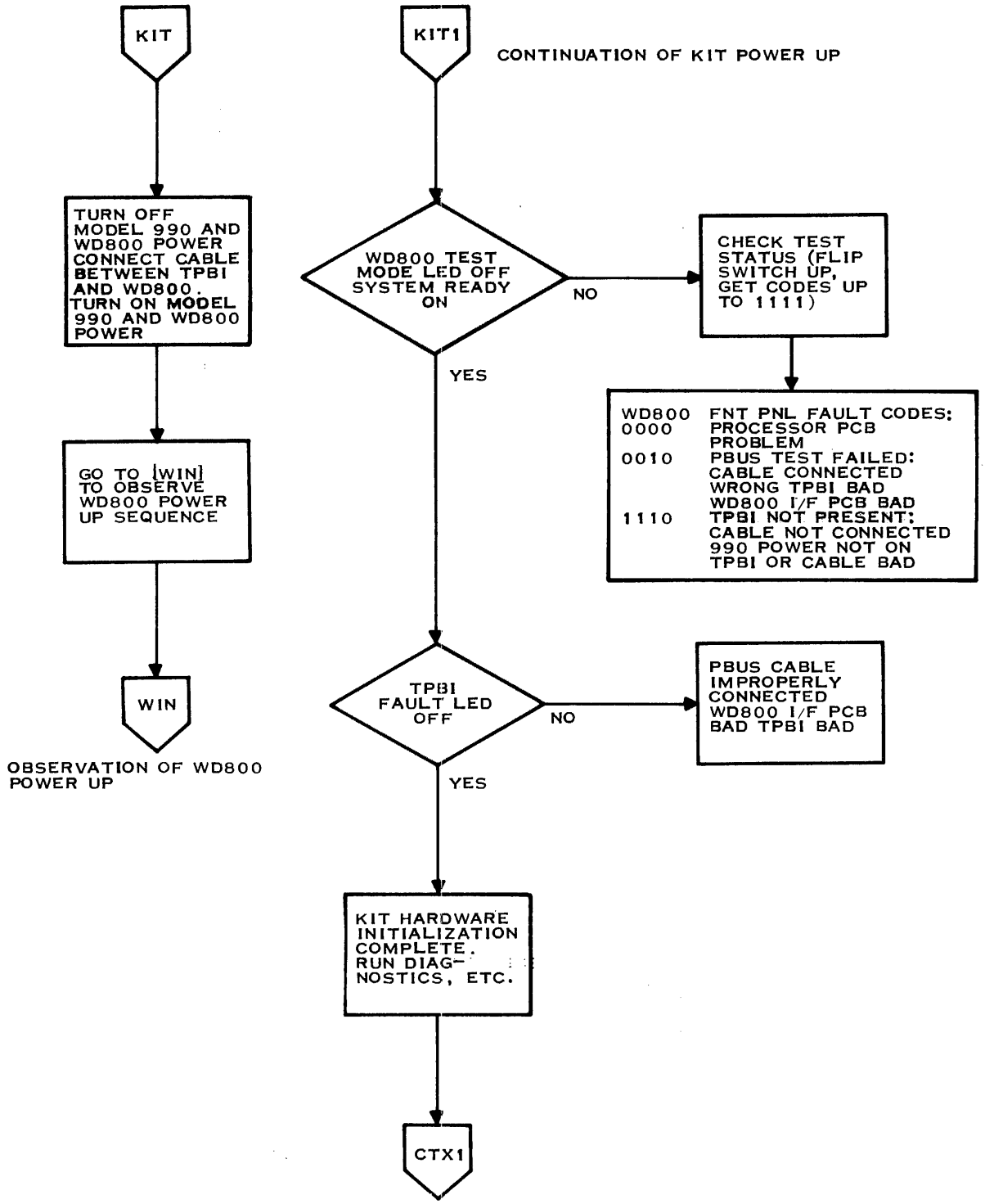

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Figure 4-19. KIT Troubleshooting Flowchart

The CR starts with the top-level flowchart, CONTEXT, and refers to the more detailed flowcharts as directed by CONTEXT. If the detailed flowchart fails to isolate the fault properly, the CR returns to the top-level flowchart and continues that procedure.

4.2.2.5 Restoring Test Cylinders on WD800 Only. During the self-test sequence, the WD800 diagnostics test the read and write test cylinders. If these cylinders have been destroyed or never formatted, they must be formatted using the following procedures:

1. Load the system diagnostic test DSKWD8. Note the end-of-test memory address displayed before test initialization. Initialize DSKWD8 for the WD800 under repair.

2. Enter the Display Parameters (DP) verb.

3. The fourth word displayed is labeled with a block offset of >0006. The block entry value is also the address of the command-inhibit variable. The contents of this variable are shown by the value under the parameter column. A successful self-test will display all zeros for the command-inhibit variable. If the value is not >0000, commands to the disk will be inhibited.

4. Record the command-inhibit variable address. The address should be near >C120 for the WD800.

5. Select an address in the main memory of the computer that is past the range of memory occupied by DSKWD8. The end of the DSKWD8 address is displayed immediately after a successful load. Use the Modify Memory (MM) verb to ensure that the selected address contains all zeros.

6. Use the Write Memory (WM) verb to write two bytes of >00 to the command-inhibit variable address. When the following prompts appear on your screen, answer by entering the associated response:

Prompt	Response
INTERNAL PERIPHERAL ADDRESS? DEF = 0000 -	Enter the command-inhibit variable address.
NO. OF BYTES? DEF = 0100 -	Enter 2.
HOST MEMORY ADDRESS? DEF = 00DA98	Enter the host processor memory address selected in step 5.

7. The WD800 status LEDs will indicate that the disk and system are ready.

8. Enter the Reset (RS) verb. This will clear the pack change and unsafe bits from the WD800 controller and allow commands to be executed.

9. Use the Build Command (BC) verb to construct the following command, using the address selected in step 5 as the starting address of the block.

Input Word #	Value	Description	Parameter Values
0	0000		
1	87XX	Max head addr	XX = 02 for 2-platter XX = 06 for 4-platter
2	0000		
3	1500	Format Test Cylinders cmd	
4	0000		
5	0000		
6	0X00	Unit select	X = 8 for unit 0 X = 4 for unit 1 X = 2 for unit 2 X = 1 for unit 3
7	0000		

10. Use the Issue Command (IC) verb to execute the command that was constructed in step 9. This will restore the test-cylinder format and store register information to the WD800 under test.

4.2.2.6 Restoring Test Cylinders On WD800A Only. During the self-test sequence, the WD800A diagnostics test the read and write test cylinders. The write test cylinder is > 0399 for the 3-platter and 5-platter disks and > 0392 for the 8-platter disk. The read test cylinder is > 039B for the 3-platter and 5-platter disks and > 0394 for the 8-platter disk. If these cylinders have been destroyed or were never formatted, they must be formatted using one of the procedures described below.

The first procedure allows you to format the write test cylinder without affecting the specially formatted read test cylinder. This is important if it is necessary to preserve the data on the disk. It is also a time-saver, because once the read test cylinder is formatted, you must run a complete surface analysis to create a working bad track map. Procedure A should be used to format the write test cylinder if the disk write self-test fails with a ""header not found on write test cylinder" error (subtest error code > C4), which indicates that the cylinder format has been destroyed.

Procedure A — Restoring write test cylinder on WD800A only

1. Turn off to power-down the WD800A.

2. Write protect the disk. (Write-protect switch set to UP position.) This will cause the power-up diagnostics to skip the write tests.

3. Power-up the WD800A. When the TEST MODE indicator turns off, turn the Write-protect switch to the down (OFF) position. The WD800A status LEDs will indicate that the disk and system are ready.

4. Load the system diagnostic test DSKSA. Initialize DSKSA for the WD800A under repair.

5. Enter the Surface Analysis (SA) verb. Respond as follows:

Prompt	Response
WANT TO SPECIFY PARAMETERS? DEF = 0	Enter 1
# OF DATA PATTERNS? (MAX = 6) DEF = 2 -	Enter 1
PATTERN 1? DEF = 6DB6 -	Accept default value
# OF WRITE/PATTERN? DEF = 0002 -	Enter 1
READ WITH NOMINAL STROBE? DEF = 1 -	Accept default value
BEGIN CYL ADDR? DEF = 0000 -	Enter 921 for 3- and 5-platter disks Enter 914 for 8-platter disk
ENDING CYL ADDR? DEF = 0XXX -	Enter 921 for 3- and 5-platter disks Enter 914 for 8-platter disk
BEGIN HED ADDR? DEF = 000 -	Accept default value
ENDING HED ADDR? DEF = 0XX -	Accept default value
SHOULD INCOMING QUALITY CONTROL TERMINATION PARMS BE USED?(DEF = 0) -	Enter 0

6. The SA verb will take only a few seconds to complete. The SA verb may report that a successful retry occurred when formatting the write test cylinder. The retry is expected. The SA verb may report format errors indicating that media defects occur on the write test cylinder. These can be ignored. Media defects are allowed on this cylinder.

7. When the SA verb completes, cycle power on the WD800A making sure the disk is not write-protected. The WD800A should now pass self-tests.

In procedure B, both the read and write test cylinders are formatted. Several error symptoms indicate that the read test cylinder is either destroyed or formatted incorrectly. All these errors can be caused by a faulty HSD board, a faulty ST506 disk interface board, or faulty disk interface cables. If it is important to preserve data on the disk, these boards and cables should be checked before attempting to restore the test cylinders. The read test cylinder must be formatted if any of the following errors occur:

- Self-test fails on power-up with front panel LED code of > 9 (see Table 4-2). Execute the maintenance command described next.

- Test-all maintenance command (code > 14) fails. Register 2 of CSB (> 931B) indicates that the read test cylinder could not be found. This failure occurs if the read test cylinder has never been formatted.

- Errors in read self-test at power-up or during maintenance command execution indicate that the cylinder contains bad data.

- Formatter mapping errors. These errors indicate that the formatter relocation map is invalid. A formatter mapping error is indicated by a > FCFF in register 4 of CSB during an unsafe condition (bit 3 of register 0 is set).

CAUTION

On the WD800A, restoring the read test cylinder destroys the formatter's relocation map. Once this map has been destroyed, you cannot recreate the map without destroying data stored on the spare tracks. Therefore, procedure B should only be used when you are reasonably certain that the read test cylinder has been destroyed or when it is unneccessary to preserve data on the disk.

Procedure B — Restoring read and write test cylinders on WD800A only.

1. Load the system diagnostic test DSKWD8. Initialize DSKWD8 for the WD800A under repair.

2. Enter the New Disk Initialization (ND) verb and respond to the prompts.

3. The ND verb automatically executes four commands in the following order:

   a. Write Peripheral Memory (extended command >3E). This command clears the command inhibit flag of the formatter. It takes the place of steps 2 through 7 of Procedure A.

   b. Restore. This clears the pack change and unsafe bits from the WD800A controller and allows commands to be executed.

   c. Initialize Bad-Track Map (extended command > 19). This command creates a null bad-track map in formatter RAM.

   d. Format Test Parameter Cylinder (extended command > 15). This command writes a unique format to the test parameter cylinder. Data written to this cylinder includes several copies of the formatter bad-track map (taken from formatter RAM), the drive store register values, and special patterns used for self-tests. This command also formats diagnostic cylinder 1, which is used for the disk write self-test.

4. The ND verb takes several seconds to complete. First, the DISK READY indicator turns on and then it turns off for several seconds. When it turns on again, the ND verb will be complete. The WD800A status LED's will indicate that the disk and system are ready. The WD800A can now pass disk subsystem self-tests.

5. The ND verb creates a null formatter relocation table. It is now necessary to create a working bad-track map by running the SA verb (DSKSA diagnostics) or IDS utility.

5

WD800 Removal and Replacement Procedures

5.1 INTRODUCTION

Corrective maintenance for the WD800 mass storage system chassis (Figure 5-1) and peripheral bus interface (PBI) is based on replacing the faulty peripheral bus cable or subassembly within the WD800 chassis and verifying the operation.

This section covers the required maintenance supplies, part/subassembly replacement procedures, and verification procedures for the WD800 mass storage system.

5.2 SAFETY AND SPECIAL MAINTENANCE PRECAUTIONS

Before proceeding with any maintenance, become familiar with the following maintenance precautions and safety warnings.

CAUTION

To access the disk actuator lock on the bottom of the chassis, you must tilt the chassis on its side. The chassis is unstable in this position. Be careful to brace it against a stable surface or stabilize it by holding it in place.

If the chassis is mounted in a rack, access the disk actuator lock on the bottom of the chassis by extending the chassis out of the rack as far as possible. The chassis is also unstable in this position. Be careful to stabilize the rack so that it does not tip over, and be careful not to pull the chassis completely out of the rack.

When reconfiguring the system, remove power from all the affected units. This is especially important when cabling units together. If power is not removed, the electronics of the system components can be damaged.

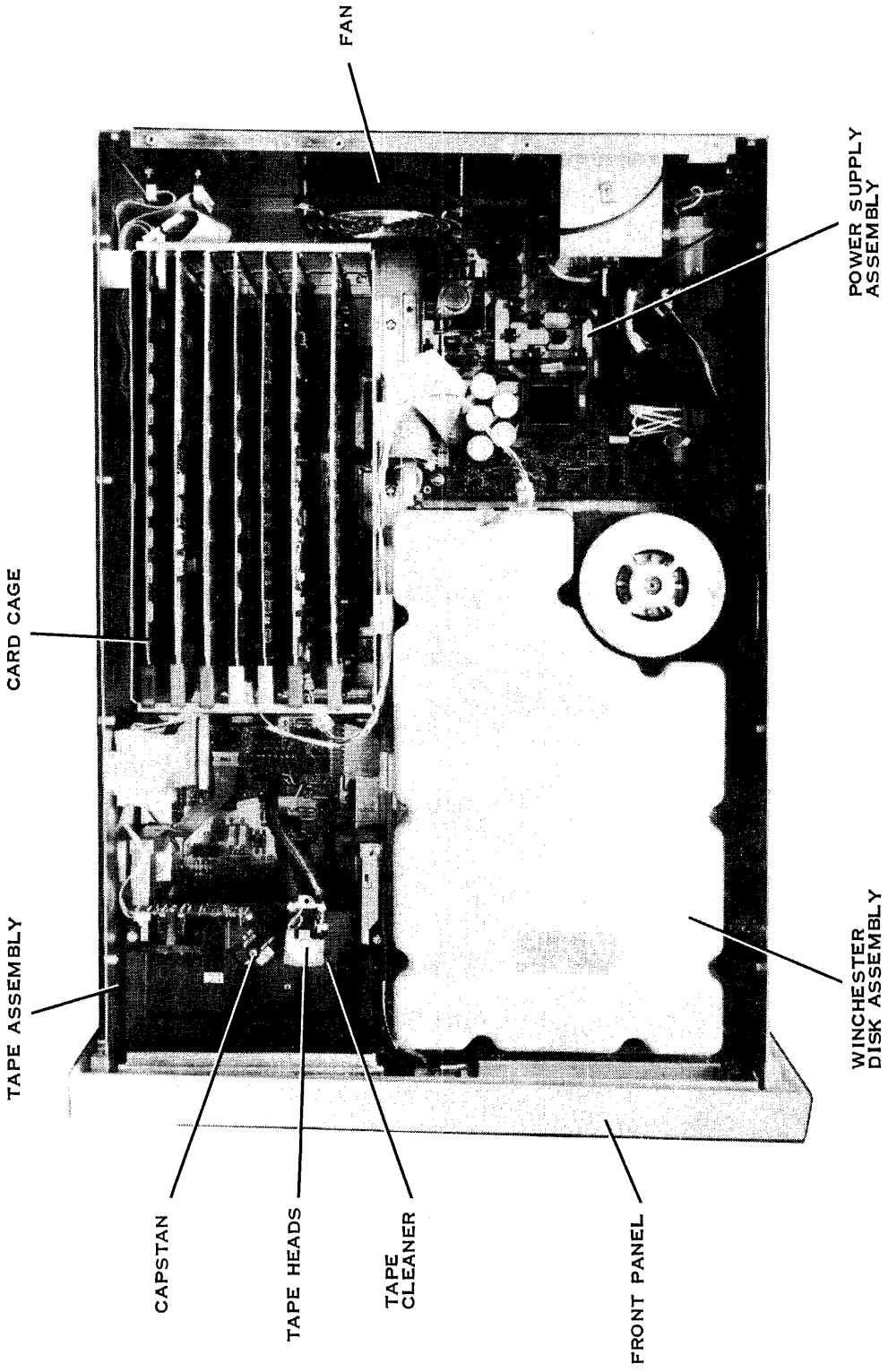

Figure 5-1. WD800 Chassis, Top View

WARNING

When removing the cover of the chassis in rackmounted units, it may be necessary to extend the chassis as far out of the rack as it can go, which defeats the safety stop mechanism. Pull the chassis far enough beyond the safety point to allow access to the screws on the back edge of the cover. Be very careful not to pull the chassis completely out of the rack. As soon as you remove the screws and lift the lid off the chassis, push the chassis back into the rack to engage the safety stop mechanism.

Lethal voltages are present on the power supply assembly. Before accessing the electronics inside the chassis, be sure that the ac power cord is disconnected and that the ac switch has been off for at least 30 seconds and remains off. The only procedure requiring the removal of the top cover with power applied is the procedure for checking the power supply boards. Use special care when checking the power supply test points with power applied.

If power must be on with the top cover removed, be careful to avoid the tape analog board and power supply area. Access the power supply test points carefully, avoiding high-voltage circuits.

When working with the cover removed, also be careful to keep your fingers and any tools you are using away from the moving blades of the fan.

5.3 CORRECTIVE MAINTENANCE SUPPLIES

Table 5-1 lists corrective maintenance tools, equipment, and supplies required to perform procedures in this section.

Table 5-1. Maintenance Tools, Equipment, and Supplies

Item	Source
Oscilloscope	Tektronics
Extender card (for international use only)	TI part number 2213071-0001
Maintenance diagnostic unit (MDU) box	
115-Volt	TI part number 946710-0001
230-Volt	TI part number 946710-0002
Voltmeter	Commercially available
Scratch cartridge	TI part number 2270391-0001
Ordinary hand tools	Commercially available
Flat-blade screwdriver	Commercially available
Hex driver, 1/4 inch	Commercially available
Phillips screwdriver, small	Commercially available
Phillips screwdriver, large	Commercially available
Allen wrench, 9/64 inch	Commercially available
Ethyl alcohol	Commercially available
Cotton swabs	Commercially available
Model 990 Diagnostic kit on cassette tape media (with DOCS diagnostics including those specifically for WD800)	TI part number 2250534-1305
Unit Diagnostics Handbook, Volume 1, General Diagnostic Information	TI part number 945400-9701
Unit Diagnostics Handbook, Volume 3, Diagnostics for 990 Mass Storage Devices	TI part number 945400-9703

5.4 WD800 REMOVAL AND REPLACEMENT PROCEDURES

After the fault is isolated to a field-replaceable assembly, correct the problem by replacing the faulty part or subassembly. The following paragraphs describe the removal and replacement procedure for each field-replaceable component of the WD800.

First, the component fault symptoms are summarized, and then the removal/replacement procedure is detailed. To make it easier and faster to locate the applicable description, Table 5-2 lists the paragraph number of the discussion of each field-replaceable component. (For a description of each field-replaceable component, see paragraph 1.6.)

Table 5-2. Removal and Replacement Procedures

Replaceable Unit Name	Paragraph Number
Disk drive assembly with preamp board, surface analyzed and formatted, 43-megabyte	5.4.1
Disk drive assembly with preamp board, surface analyzed and formatted, 18-megabyte	5.4.1
Drive belt	5.4.2
Static eliminator, brush assembly	5.4.2
Spindle motor assembly	5.4.3
Motor start capacitor	5.4.3
Capacitor mounting bracket	5.4.3
End cap	5.4.3
Preamp assembly	5.4.4
Motor start relay	5.4.5
Tape drive assembly with tape analog board and mounting brackets	5.4.6
Tape cartridge media	5.4.7
TPBI assembly	5.4.8
Peripheral bus cable assembly	5.4.9
Power supply assembly (Horizontal power supply board)	5.4.10
Power supply assembly (Vertical (filter) power supply board)	5.4.10
Processor board	5.4.11
High-speed digital control board	5.4.15
Servo board	5.4.14

Table 5-2. Removal and Replacement Procedures (Continued)

Replaceable Unit Name	Paragraph Number
Interface board	5.4.12
Read/write board	5.4.13
Tape control board	5.4.16
Tape encode/decode board	5.4.17
Motherboard assembly with power cable	5.4.18
EMI filter assembly	5.4.19
Front panel board	5.4.20
Internal I/O cable	5.4.21
AC fan cable	5.4.22
Front panel cable	5.4.23
Tape analog power cable	5.4.24
Tape encode/decode cable	5.4.25
Servo twisted pair	5.4.26
Disk data cable (preamp)	5.4.27
Power cord	5.4.28
Fuse, AC	5.4.29
Voltage-change jumper plug 100–115 Vac	5.4.10
Cooling fan	5.4.31

5.4.1 WD800 Disk Drive Assembly Removal and Replacement

The following paragraphs discuss the disk drive/preamp assembly fault symptoms and the removal/replacement procedure.

If the disk drive has developed more bad tracks than allowed it needs to be replaced. For the WD800, the 18-megabyte drive is allowed 27 bad tracks while the 43-megabyte drive is allowed 63 bad tracks.

Internal faults can cause power supply resets; this condition is indicated when all the front panel LEDs turn on.

Table 5-3 lists additional symptoms displayed by a faulty disk drive assembly.

Table 5-3. Disk Drive Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails power-up self-test, front panel code = 1001	Actuator locked
Fails power-up self-test, front panel code = 1001	Servo cable or preamp cable loose
Fails power-up self-test, front panel code = 1010	Preamp cable loose; reformat test cylinders (See paragraph 4.2.2.5)
Fails power-up self-test, front panel code = 1001	Drive belt on wrong pulley or disk not up to speed
Fails power-up self-test, front panel code = 1011	Reformat test cylinders (See paragraph 4.2.2.5)

Self-Test Failures

Failure	Front Panel	CSB Word 2
Servo failure	1001	XX10
Read failure	1010	XX12
Write failure	1011	XX13

Model 990 System Log Errors

CSB Codes	Error
W0 = 04X0	Seek incomplete error
= 10X0	Disk unsafe error; check W4 for analysis
W7 = 9001	Unit error; see W0
= 9002	Search error; data field address mark in sector not found
= 9010	ID error
= 9040	Data error
= 9400	Retries used
= 9440	Data error
= 9640	Corrected data error (ECC corrected, no syndrome match)
= 90FF	Self-test fault; see W2 status

To disconnect the disk assembly, proceed as follows:

1. Unplug the chassis power cord and wait 30 seconds.

2. Lock the actuator, which is accessible from the bottom of the chassis (Figure 5-2).

   a. To gain access to the bottom panel, slide the chassis as far forward in the rack as it will go.

   b. Slide the flat blade of a screwdriver under the edge of the round, plug-in actuator-lock access cover on the bottom of the chassis and pry it off.

   c. Using an Allen wrench, loosen the 10-32, 9/64-inch socket-head cap screw a maximum of one and one-half turns.

CAUTION

Do not loosen the screw more than one and one-half turns. If turned too far, it can fall out and be lost.

   d. Insert the flat blade of a screwdriver into the slot in the center of the actuator-lock positioner, and turn it counterclockwise to lock the actuator lock.

   e. Tighten the socket-head cap screw in the new position.

   f. Replace the actuator-lock access cover.

3. Remove the top cover of the chassis using the following procedure:

   a. Slide the chassis forward until the chassis meets the safety stop.

   b. Defeat the safety stop mechanism, and carefully pull the chassis forward until you have access to the screws on the top back edge of the chassis.

   c. Remove the screws. Slide the top cover back to release the lip of the cover from underneath the front panel edge and remove the cover.

   d. Push the chassis back into the rack until you hear the safety stop mechanism click.

4. Disconnect the preamp cable from the motherboard. To gain access to the connection, remove the read/write board (brown ejector), the servo cable (a twisted pair connected below the ejector tab on the servo board), and the servo board (red ejector). The preamp cable has blue ejector tabs on the sides of the connector; of the two cables on the motherboard, the preamp cable is the one attached closer to the chassis front panel.

5. Disconnect the motor cable from the power-supply filter board. The motor cable is the nine-pin connector nearest the EMI filter; it is installed in J3 on the filter board. Remove the cable from the clamps located directly above the motor.

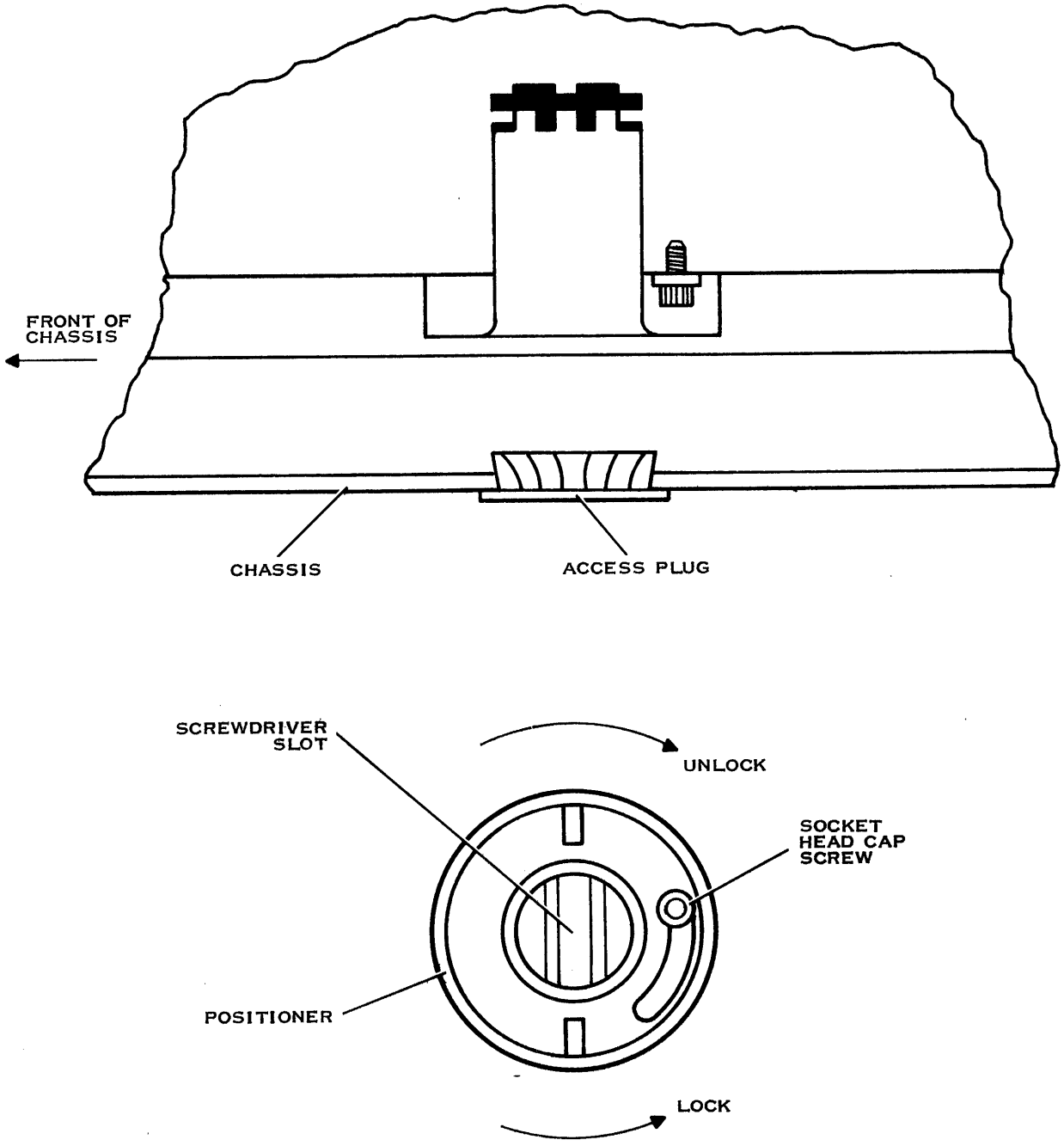

Figure 5-2. Actuator Lock Mechanism

6. Disconnect the servo cable from the disk. (The servo cable is a twisted pair located under the disk housing by the preamp.)

7. Unplug all three grounding straps. One is on the front center bottom of the disk (accessible through the bottom front panel filter hole), and one is on each of the back two corners.

8. Remove the front panel cable from the cable clamp on the side of the disk closest to the tape drive.

9. Using a large Phillips screwdriver, loosen all four screws holding the disk. The screws are accessible only from the underside of the chassis. They are located at each corner of the disk, one inside each shock mount (Figure 5-3).

The disk is now disconnected from the rest of the system. To remove it from the chassis, grip it firmly at the front and back and move it back slightly toward the power supply so that you can get your hands under it. With both hands under it, lift it straight up. The disk is fragile; place the removed disk upside down on foam or other cushion. Record the serial number of the disk drive assembly on a service ticket for TI service calls.

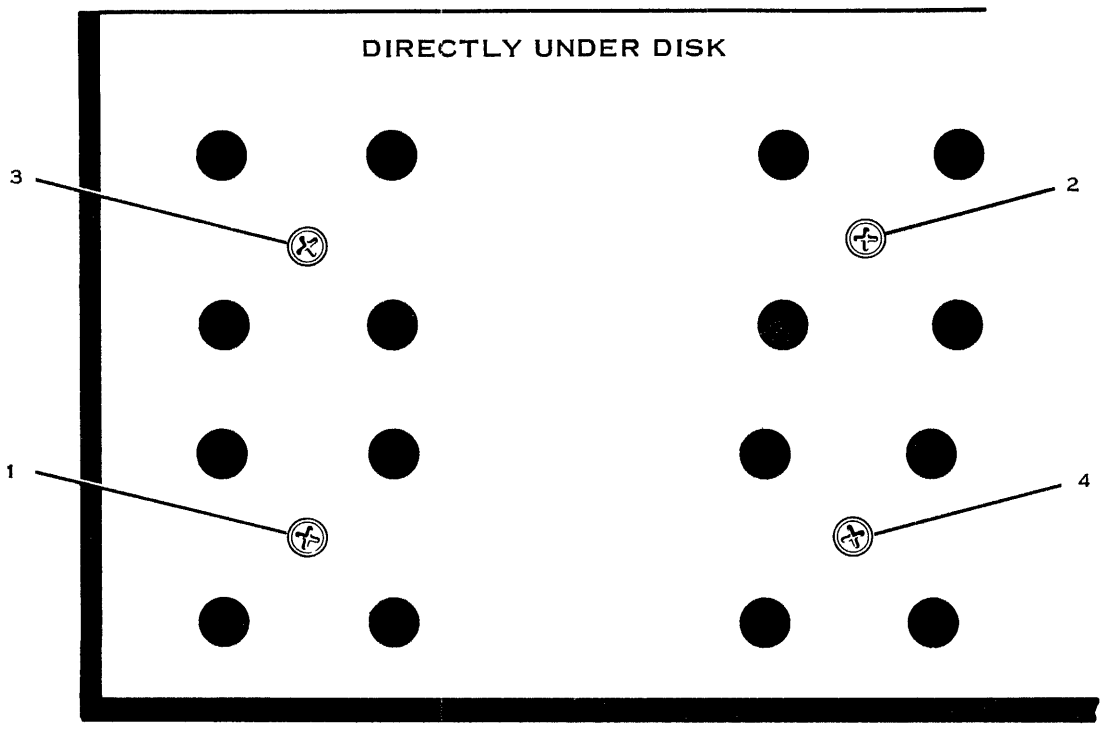

Figure 5-3. Disk Screws

To replace a disk drive assembly in the WD800 chassis, proceed as follows:

1. Make sure that the power cord is unplugged and power has been removed from the chassis for at least 30 seconds.

2. Lower the disk into the chassis and rest it on the shock mounts.

3. There is a an indentation machined into each corner of the disk mounting plate that mates with each of the shock mounts. The disk mounting screw holes are aligned when the shock mounts fit into the indentation. Gently move the disk housing around on the shock mounts until you feel the indentations settle over the shock mounts.

4. Using a large Phillips screwdriver, tighten all four screws holding the disk. The screws are accessible only from the underside of the chassis. They are located at each corner of the disk, one inside each shock mount (Figure 5-3).

5. Replace the front panel cable in the cable clamp on the side of the disk closest to the tape drive.

6. Plug in all three grounding straps: one on the front center bottom of the disk (accessible through the bottom front panel filter hole), and one on each of the back two corners.

7. Reinstall the servo cable. (The servo cable is a twisted pair located under the disk housing by the preamp; see the servo cable removal/replacement procedures.)

8. Reinstall the motor cable in the power supply filter board. The motor cable is the nine-pin connector nearest the EMI filter; it is installed in J3 on the filter board. Replace the cable in the clamps located directly above the motor.

9. Reinstall the preamp cable in the motherboard. The preamp cable has blue ejector tabs on the sides of the connector; of the two cables on the motherboard, the preamp cable is the one attached closer to the chassis front panel. Reinstall the boards removed in step 4. Be sure to match them to the correct slot.

10. Replace the top cover of the chassis using the following procedure:

    a. Slide the chassis forward until the chassis meets the safety stop.

    b. Defeat the safety stop mechanism and carefully pull the chassis forward until you have access to the screws on the top back edge of the chassis.

    c. Replace the cover. Reinsert the screws and tighten them.

    d. Push the chassis back into the rack until you hear the safety stop mechanism click.

11. Unlock the actuator which is accessible from the bottom of the chassis (Figure 5-2).

    a. To gain access to the bottom panel, slide the chassis as far forward in the rack as it will go before the safety mechanism stops it.

b. Slide the flat blade of a screwdriver under the edge of the round plug-in actuator-lock access cover on the bottom of the chassis, and pry it off.

c. Using an Allen wrench, loosen the 10-32, 9/64-inch socket-head cap screw a maximum of one and one-half turns.

CAUTION

Do not loosen the screw more than one and one-half turns. If turned too far, it can fall out and be lost.

d. Insert the flat blade of a screwdriver into the slot in the center of the actuator-lock positioner and turn it clockwise to unlock the actuator lock.

e. Tighten the socket-head cap screw in the new position.

f. Replace the actuator-lock access cover.

5.4.2 Drive Belt Removal and Replacement

A failure of the self-test subtest that indicates that the drive is not up to speed can mean that the drive belt is faulty. A drive belt fault is indicated when WD7 equals > A0FF and at the same time WD2 equals > 4410. (A drive not up to speed can also cause a servo self-test failure; in this case the front panel indicators equal 1001.) For more details about these tests, see the diagnostics handbooks listed in the Preface. Also, make a visual inspection of the drive belt (Figure 5-4) to see if it is missing, frayed, worn, or loose.

To remove the drive belt, proceed as follows:

1. Power-down the chassis and wait at least 30 seconds.

2. Remove the disk (see the disk removal and replacement procedure). Turn it bottom up, so that you are looking at the bottom of the disk drive.

3. Remove the spindle ground brush with a 9/64-inch Allen wrench.

4. Using a flat-blade screwdriver, remove the rear drive mounting plate that covers part of the drive motor pulley.

5. Without rotating the spindle or spindle motor, slide the drive belt off the spindle pulley and remove from the motor pulley.

To replace the drive belt for the 60-hertz configuration, proceed as follows:

NOTE

Both the spindle and motor pulleys have two sections: a smaller-diameter portion at the top of the pulley cylinder, and a slightly larger-diameter portion just beneath it. Be careful to install the drive belt around the proper portion of the pulley cylinder.

1. Install one end of the drive belt around the smaller-diameter portion of the motor pulley, and the other end around the larger-diameter portion of the spindle pulley.

2. Rotate the spindle pulley clockwise (as you look straight down at the bottom of the drive) to allow the drive belt to go completely around the pulley. The belt must be even on both pulleys.

CAUTION

Rotate the spindle pulley only in the clockwise direction as you look straight down at the underside of the disk. Rotating it in the other direction may result in head damage.

3. Using a 9/64-inch Allen wrench, replace the spindle grounding brush on the spindle pulley.

4. Using a flat-blade screwdriver, replace the rear drive mounting plate.

To replace the drive belt for the 50-hertz configuration, proceed as follows:

1. Install one end of the drive belt around the larger-diameter portion of the motor pulley, and the other end around the smaller-diameter portion of the spindle pulley.

2. Rotate the spindle pulley clockwise as you look straight down at the bottom of the drive to allow the drive belt to go completely around the pulley. The belt must be even on both pulleys.

CAUTION

Rotate the spindle pulley only in the clockwise direction. Rotating it in the other direction may result in head damage.

3. Using a 9/64-inch Allen wrench, replace the spindle grounding brush on the spindle pulley.

4. Using a flat-blade screwdriver, replace the rear drive mounting plate.

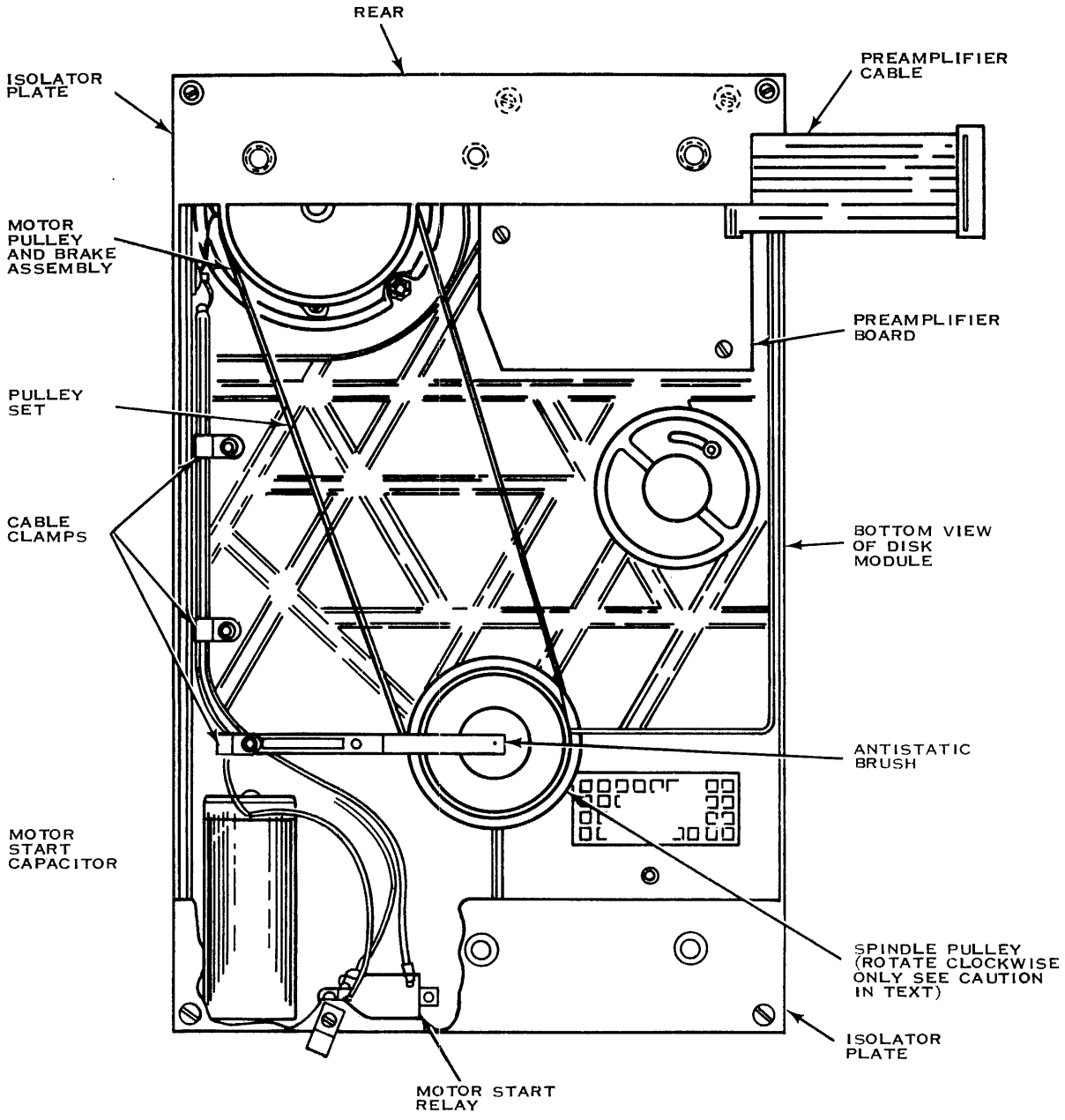

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Figure 5-4. Motor, Spindle Pulleys and Drive Belt Assembly (Bottom View)

5.4.3 Removal and Replacement of Drive Motor, Pulley, and Brake Assembly

A failure of the self-test subtest indicates that the drive is not up to speed. This may mean that the drive motor pulley and brake assembly are faulty.

To remove the drive motor, pulley, and brake assembly proceed as follows:

1. Power-down the chassis and wait at least 30 seconds.
2. Remove the disk from the chassis (see the disk removal and replacement procedure).
3. With the disk drive module lying upside down on a padded surface, remove the front and rear isolator plates.
4. Clip the cable tie holding the brake assembly wires.
5. Remove the drive belt from the motor pulley, using the drive belt removal procedure in the preceding paragraph.
6. Disconnect the three wire terminals (noting hookup) from the motor start relay.
7. Remove the motor start capacitor end cap from the bracket, using a flat-bladed screwdriver to pry up from under the capacitor. The end cap on the capacitor (wire end) is easily removed from the capacitor, leaving the two wires visible for disconnecting.
8. Disconnect the two wires and remove the cables from the three cable clamps, using a 9/64 Allen wrench. Use an 11/32 socket drive to remove the motor start assembly hardware to facilitate removal of the motor assembly.

To replace the drive motor, pulley, and brake assembly, proceed as follows:

1. Reverse the order of removal in the preceding paragraph, and make sure to tie-wrap the brake cables to clear the drive pulley and belt.
2. To install the drive belt, see the replacement procedure in the preceding paragraph.
3. When replacing the capacitor, reconnect the proper wires to the capacitor and position the end cap. Mount the capacitor in its bracket, making sure the raised bosses in the end caps are properly engaged in the holes in the brackets.
4. After installing the isolator plates, install the disk drive module, using the replacement procedure described in paragraph 4.1.

5.4.4 Preamplifier Board Removal and Replacement

Fault symptoms for the disk preamp board are listed with the fault symptoms for the disk drive assembly in paragraph 5.4.1.

The preamp board should be tested on a test bench, using a signal generator to supply an ac signal in place of DX and DY signals. Once driven with an ac signal, the board may be probed to determine the faults.

To remove the preamp board, proceed as follows:

1. Power-down the chassis and wait at least 30 seconds.
2. Remove the disk from the chassis (see the disk removal and replacement procedure).
3. With the disk drive module lying upside down on a padded surface, remove the isolator plate covering the preamplifier board.
4. Using a flat-bladed screwdriver, remove the four preamplifier board mounting screws.
5. Lift the board up vertically to disconnect the in-line connector from the sealer board on the sealed disk drive module.

To replace the preamplifier board, proceed as follows:

1. Carefully align the preamplifier board connector with the in-line connector on the sealer board, and apply even pressure on the preamplifier board until the connectors are seated firmly in place. If mounting holes do not line up, the in-line connectors are not properly aligned.
2. Be careful not to damage the board by overtightening the mounting screws.
3. Install the isolator plate covering the preamp board.
4. Install the disk-drive module using the replacement procedure described in paragraph 5.4.1.

5.4.5 Motor Start Relay Removal and Replacement

The motor start relay mounts in the disk drive subassembly. The motor start relay switches the starting capacitor and motor starting winding into the spindle motor circuit to bring the spindle rotation up to normal operating speed. The motor start relay is suspect when the disk drive does not come up to speed.

To remove the motor start relay, proceed as follows:

1. Power-down the chassis and wait at least 30 seconds.
2. Remove the disk from the chassis (see the disk removal and replacement procedure).
3. With the disk-drive module lying upside down on a padded surface, remove the isolator plate covering the motor start relay (Figure 5-4).
4. Remove the three wires from the relay (note hookup).
5. Using a 7/64 Allen wrench, remove the two relay mounting screws.
6. Lift the relay straight up from the disk module.

To replace the motor start relay, proceed as follows:

1. Reverse the removal order in the preceding steps.
2. Install the isolator plate covering the motor start relay.
3. Install the disk-drive module, using the replacement procedure described in paragraph 5.4.1.

5.4.6 Tape Drive Assembly Removal and Replacement

Table 5-4 lists the symptoms displayed by a faulty tape drive assembly.

Table 5-4. Tape Drive Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails power-up self-test, front panel = 0101	Tape analog power cable Tape encode/decode cable

Self-Test Failures

Failure	Front Panel	CSB Word 2
Tape drive assembly	0101	XX24

Tape Load Failures

CSB Codes	Error
W2 = FX29	Erase channel bad
= 0X29	Write or read channel bad

Model 990 System Log Errors

W0 = 80X0	Tape offline or failed load
W7 = 8201	Tape error; see W0 (tape status)
= 8282	Data dropout error (excessive number of occurrences)
= 82FF	Tape failed self-test; see W2

Other symptoms include the following:

- Tape capstan motor turns without a tape inserted
- Tape drive runs tape off one of the internal cartridge hubs

- Capstan damages plastic cartridge housing
- Tape drive fails to recognize write-protected tape
- Tape drive does not try to load tape upon insertion of the tape cartridge (TAPE READY does not blink)
- Tape drive fails MTCTST test 41

To disconnect the tape assembly, proceed as follows:

1. Power-down the chassis and wait at least 30 seconds. Remove the chassis top cover (see paragraph 5.4.1, disk removal procedure step 3).
2. Unplug the power cable on the rear righthand side (nearest the disk) of the analog board.
3. Unplug the encode ribbon cable (on the left rear) from the analog board.
4. Locate and remove the six slotted screws holding the tape mounting brackets to the underside of the chassis.
5. Tilt up the front of the tape drive assembly to make it easier to handle. Lift the tape drive out of the chassis by the tape deck mounting legs.

To replace a tape drive assembly, proceed as follows:

1. Lower the tape drive into the chassis. Insert the six slotted screws that hold the tape mounting brackets to the chassis. Do not tighten them at this point.
2. Test the alignment of the tape drive by inserting a cartridge into the cartridge insertion slot. Be sure that it does not drag or touch on any side. If the tape drive is sitting too low, add washers between the chassis and the tape brackets.
3. After aligning the tape drive, tighten the screws.
4. Plug the encode ribbon cable (on the left rear) into the analog board. Be sure pin 1 is to the rear. The cable has a red stripe corresponding to pin 1; a 1 is printed on the board next to pin 1.
5. Plug in the power cable on the right side (rear) of the analog board. The power cable is keyed to prevent installing it backwards. Be sure that the pins are not offset at insertion.
6. After installing the tape drive, clean the head, tape cleaner, and capstan using denatured alcohol and cotton swabs. Clean the head first, then the tape cleaner. Clean the capstan last, using up and down scrubbing motions around the entire surface.
7. Replace the chassis top cover (see paragraph 5.4.1, disk replacement step 10).

CAUTION

Alignment of the tape drive to the front panel opening is crucial to proper operation of the tape drive. Before proceeding, ensure that a tape cartridge can be installed with adequate clearance from the edges of the front panel opening. If necessary, the tape transport mounting can be slightly realigned to achieve a better fit in the chassis.

NOTE

When installing the tape drive in a chassis with the alternate front panel (Figure 2-4), you may have to move the drive assembly back on its mounting brackets. Follow the instructions given on the side of the tape assembly.

5.4.7 Tape Cartridge Media

The following paragraphs discuss the tape cartridge media fault symptoms. A description of removal and replacement procedures is not required.

Table 5-5 lists the symptoms displayed by a faulty tape cartridge.

Table 5-5. Tape Cartridge Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails tape load, gets excessive errors after load	Tape media bad (If only reading from tape is needed, write-protect and reinsert.)

Tape Load Failures

CSB Codes	Error
W2 = XX29	Bad media (to read, write-protect the tape)

Table 5-5. Tape Cartridge Fault Symptoms (Continued)

Model 990 System Log Errors

W0 = 04X0	Tape is write-protected
= 20X0	End-of-record error (media bad)
= 80X0	Tape offline or failed load, or fatal media error
W7 = 8201	Tape error; see W0 (tape status)
= 8220	Data error
= 8240	Corrected data error
= 8280	Read-after-write CRC error
= 8282	Read-after-write dropout error

Other Failures

Fails MTCTST 41 (EW/EOT hole tests)

Fails MTCTST 61 (incoming test for dropouts)

Fails MTCTST TI (incoming test for ISV)

5.4.8 TPBI Assembly Removal and Replacement

Section 3 of this manual discusses the fault symptoms and the removal and replacement of the TPBI assembly.

5.4.9 Peripheral Bus Cable Assembly Removal and Replacement

Table 5-6 lists the symptoms displayed by a faulty peripheral bus cable assembly.

Table 5-6. Peripheral Bus Cable Fault Symptoms

Problem	Explanation
SYSTEM READY blinks or remains off	Cable plugged in wrong or WD800 connector pins bent

Self-Test Failures

Failure	Front Panel	CSB Word 2
No CTLPRES signal	1110	XXXX (not reported)

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Disk offline
= 11X0	Unsafe, pack change (temporary disconnect)
W7 = 9001	Unit error; see W0
= 9004	Command time-out (peripheral bus error)
= 90FF	Self-test fault; see W2 status

To remove the peripheral bus cable, disconnect it from the controller in the 990 chassis and from the I/O port on the back panel of the WD800 chassis. Working from the end installed in the controller toward the end installed in the chassis, release the cable from each cable tie that is restraining it. After releasing the peripheral bus cable, fasten the cable ties back around any other cables that they hold.

To replace the peripheral bus cable, use the following procedure:

1. Make sure all power is off.

2. Ensure that one end of the cable is attached to the controller connector P3 (Section 3). The ends are interchangeable, and the metal backshell on the connector prevents installing it upside down.

CAUTION

Make sure that the pins are not bent at either connection.

3. Dress the cable toward the back of the rack and onto the cable carrier, allowing some slack. Attach the cable to the cable carrier, using cable ties. Allow some slack in the ties for the moment. Do not cut off the cable tie ends; tuck them back under the tie to keep them from interfering with cable carrier operation.

4. To guide the cable around the hinge of the cable carrier, place a cable tie in the bottom hole of the carrier nearest the hinge on the first side of the carrier. Place a second cable tie in the top hole nearest the hinge on the second (back) side of the carrier. Attach the cable smoothly (without loops or twists), using these two cable ties.

CAUTION

The cable requires a minimum bend radius of 33 millimeters (1.3 inches) to avoid being damaged by stress. The cable must not be too tight across the cable carrier hinge, and must be dressed from the carrier bottom edge to top edge as described in step 4.

5. Dress the cable across the back side of the cable carrier, and tie it down loosely with cable ties.

6. Route the cable along the outside of the left rail of the rack to the back of the WD800 chassis and gather the excess length in a service loop.

7. Plug the cable connector into the mating connector on the right of the chassis back panel (as seen from the rear). Adjust the cable so that there is enough slack to permit sliding the chassis all the way forward on the rails.

8. After adjusting the cable in the ties to ensure that enough slack is left to allow the WD800 chassis to slide forward to the full extent, tighten all the cable ties.

9. Use cable ties along the rail of the rack to ensure that the cables in the rack do not become tangled.

5.4.10 Power Supply Assembly Removal and Replacement

A faulty power supply assembly can display the following symptoms:

- The tape transport bulb is off (visible from the front panel opening)
- The chassis fails power-up self-test and one or more of the following are true:
  - — The front panel LEDs are all on.
  - — The front panel LEDs are all off.
  - — The front panel LEDs cycle all on, some off, all on, and so on.
  - — The front panel LEDs = 1001 (servo test failure).

To trace power supply assembly faults to a single component, refer to Table 5-7.

WARNING

The tests described in Table 5-7 involve lethal voltage sources. Ensure that only qualified personnel perform these tests. Do not conduct these tests with power on unless specifically instructed to do so. Be extremely careful to avoid contact with live circuits.

Table 5-7. Power Supply Fault Isolation

Problem	Procedure
Input power fuse blown	1. Disconnect the fan motor and disk motors from the filter (vertical) PCB. 2. Replace the fuse and turn on the power. If the fuse does not blow, either the disk or the fan is at fault. 3. If the fuse still blows after steps 1 and 2, replace the filter PCB. 4. If the fuse blows after step 3, replace the EMI filter.
Input fuse good, but the power supply has no output	1. With power on, use a digital voltmeter (DVM) to measure the voltages on the test points provided on the filter board as follows: • TP3(+) to TP4(-) = 16 to 26 Vdc • TP1(+) to TP2(-) = 225 to 375 Vdc 2. If the high voltage is good, but the low voltage is below normal, replace the horizontal power supply. If this does not correct the problem, replace the filter board. 3. If the high voltage is wrong or or if both voltages are wrong, replace the filter board. 4. If both voltages are right, replace the horizontal power supply board. 5. If the problem still exists, disconnect the 15-pin connector (to the motherboard) and the 9-pin connector (to the analog board) that go to the power supply. Recycle input power, and measure between TP8 (+) and TP7 (-) for +5.1 volts. If the voltage is right, then a short or overload exists in the loads. 6. If none of the above restores the power, replace the EMI filter.

Table 5-7. Power Supply Fault Isolation (Continued)

Problem	Procedure
Disk brake or motor operates improperly	1. Verify that the programming plug (J4 on the filter board) is the correct type for the type of input power in use, as follows: • 2231510-0001 — 90 to 132 Vac • 2231510-0002 — 200 to 250 Vac **CAUTION:** **Verify that the wiring is in good condition.** 2. If step 1 does not reveal a problem, replace the filter board.

To remove the power supply assembly, proceed as follows:

WARNING

Lethal voltages can be present on the power supply assembly. Before accessing the electronics inside the chassis, be sure that the ac power cord is disconnected and the ac switch has been off for at least 30 seconds.

1. Remove chassis top cover (see paragraph 5.4.1, disk removal procedure step 3).
2. Remove all cables from the filter PCB assembly and the horizontal power supply PCB.
3. Remove the programming plug from J4 on the filter board, and save it to install on the replacement board.
4. Remove the three #6-32 × 5/8-inch slotted screws from the mounting holes on the filter PCB. (Two are at the top corners and one is at the middle bottom edge of the board.) The screw at the corner of the board nearest the disk anchors a disk grounding strap.
5. Unplug the filter PCB from the horizontal power supply PCB, and remove it from the chassis. If you are removing only the filter PCB, omit the next two steps, and continue with the replacement procedures that follow.
6. Remove the four #6-32 × 7/8-inch pan-head screws from the mounting holes in the chassis base. (Remove them from inside the chassis.)
7. Lift the horizontal power supply PCB out of the chassis.

To replace the power supply assembly, proceed as follows:

1. Install the horizontal power supply PCB, using the following procedure:

   a. Place a #6 lock and #6 flat washer on the four #6-32 × 7/8-inch pan-head screws and set them aside.

CAUTION

Be sure to move all cables out of the way before installing the horizontal power supply PCB. Do not allow cables to be caught underneath the PCB.

   b. Position the horizontal power supply PCB on the bottom of the chassis base assembly, directly behind the disk drive. The two four-pin connectors on the PCB must be on the wall side of the chassis base.

   c. Align the four stand-offs attached to the PCB with the four mounting holes in the chassis base. Install the four #6-32 × 7/8-inch pan-head screws reserved in step 1a into the mounting holes and tighten them with a #1/4 torque driver (10.1 inch-pounds).

2. Install the vertical filter PCB assembly, using the following procedure:

   a. Position the filter PCB against the inside wall of the chassis base (over the horizontal power supply PCB).

NOTE

The component side of the filter PCB must face the operator.

   b. Locate the two female connectors on the bottom of the filter PCB, and plug them into the two male connectors on the horizontal power supply PCB.

   c. Align the three stand-offs on the back of the filter PCB to the three mounting holes in the chassis base. Position one #6 tab (SR250) between the chassis base wall and the top right stand-off on the filter PCB. (This tab serves as the ground strap lug for the disk drive.)

NOTE

The tab must point toward the disk drive.

   d. Install the three #6-32 × 5/8-inch slotted screws into the mounting holes on the filter PCB and tighten with a #1/4 torque driver (10.1 inch-pounds).

3. Cable the power supply assembly, using the following procedure:

CAUTION

Be sure that pin 1 on all connectors corresponds to pin 1 on the PCBs.

a. Locate the connector (J4) on the filter PCB, and plug the reserved jumper plug into it.

b. Locate the ground braid that extends from the disk drive isolator plate, and plug it into the ground tab at the top right on the filter PCB.

c. Pick up the fan cable assembly, and plug the black connector into the two-pin connector on the fan. Plug the other end of the fan cable assembly into the connector (J2) on the filter PCB.

d. Plug the connector from the EMI filter assembly into location J1 on the filter PCB assembly.

e. Locate the nine-pin connector that extends from the disk drive motor. Plug it into location J3 at the top of the filter PCB assembly.

f. Locate the gray ribbon cable that extends from the motherboard. Plug it into the 15-pin connector J5 on the horizontal power supply PCB. This cable is keyed to prevent incorrect insertion.

g. Pick up the analog power supply cable assembly, and locate the connector marked J6. Plug this connector into the nine-pin header, J6, on the horizontal power supply PCB. Plug the connector on the other end of the cable (P-46) into the nine-pin header (J46) on the tape analog PCB. This cable is also keyed to prevent reverse insertion.

4. Replace the chassis top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.11 Processor Board Removal and Replacement

Table 5-8 lists the symptoms displayed by a faulty processor board.

NOTE

To work on a board in the card cage, first remove the card stabilizer (a black bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

Table 5-8. Processor Board Fault Symptoms

Correctable Symptoms

Problem	Explanation
No LEDs illuminate on the front panel	Internal cable

Self-Test Failures

Failure	Front Panel	CSB Word 2
Processor PCB	0000	XX04 XX05 XX06 XX07 XX08 XX09
Processor PCB	1111	XXXX (front panel locked — all LEDs on)

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Disk offline
W7 = 9001	Unit error; see W0
= 90FF or 82FF	Self-test fault; see W2 status

Other Symptoms

Data verification errors can occur.

To remove the processor board, proceed as follows:

1. Power-down the WD800 chassis and remove the chassis top cover (see paragraph 5.4.1, disk removal procedure step 3).

2. Locate the processor board. Counting from the outside wall of the card cage toward the inside of the chassis, it is in the fourth slot, and is the fourth board if the tape drive boards are all present. The processor board has a yellow ejector tab.

3. Remove the cable (near the ejector tab) from the processor board.

4. To remove the processor board, lift the yellow ejector tab and slide the board out of the card cage.

To install a processor board, proceed as follows:

1. Make sure that the WD800 chassis is powered-down.

2. Slide the board into the fourth slot in the card cage counting from the side nearest the outside of the chassis and press the yellow ejector tab down.

3. Install the cable (under ejector tab) on the board. Be sure that pin 1 on the connector corresponds to pin 1 on the PCB (with the red edge of the cable down).

4. Replace the chassis top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.12 PBUS Interface Board Removal and Replacement

Table 5-9 lists the symptoms displayed by a faulty PBUS interface board.

NOTE

To work on a board in the card cage, first remove the card stabilizer (a black bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

To remove the PBUS interface board, proceed as follows:

1. Power-down the WD800 chassis. Remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Locate the PBUS interface board. Counting from the outside wall of the card cage toward the inside of the chassis, it is in the first slot. The PBUS interface board has a violet ejector tab.

3. Remove the cable from the PBUS interface board. The cable is the 40-pin cable from the I/O port on the rear of the chassis.

4. To remove the PBUS interface board, lift the violet ejector tab, and slide the board out of the card cage.

NOTE

To find out how the terminator packs are configured on the PBUS interface board in a particular WD800 chassis, check their position on the removed board, or check the configuration label. Install terminator packs in the functioning position only in the primary chassis, because the chassis at the end of the daisy chain is in a multichassis configuration.

Table 5-9. PBUS Interface Board Fault Symptoms

Correctable Symptoms

Problem	Explanation
SYSTEM READY blinks; front panel = 1110	Internal cable or peripheral bus cable
SYSTEM READY blinks; front panel = 0010	Terminators incorrect

Self-Test Failures

Failure	Front Panel	CSB Word 2
PBUS Interface PCB	0001	XX01 XX02 XX03
Peripheral bus test failed	0010	XX3B
No CTLPRES	1110	XXXX (CSB not reported)

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Disk offline
W7 = 9001	Unit error; see W0
= 90FF	Self-test fault; see W2 status

Other Symptoms

Data verification errors can occur.

Use the following procedure to move the terminator packs:

1. Locate the terminator pack positions on the PCB (Figure 5-5).
2. Move the terminator packs as required to either the storage position or the functioning position.

CAUTION

Orient the terminator packs as shown in the illustration. (The dot on the pack indicates the location of pin 1.) Each terminator pack is a dual inline resistor pack. Improper orientation can destroy the packs, or can cause damage to other equipment.

3. After installing the packs, check carefully that they are seated properly.

   a. Make sure the packs are oriented properly.

   b. Make sure that none of the pins are bent under the packs.

To install a PBUS interface board, proceed as follows:

1. Make sure that the WD800 chassis is powered-down.
2. Slide the board into the first slot in the card cage, counting from the side nearest the outside of the chassis, and press the ejector tab down.
3. Install the cable on the board. Be sure that pin 1 on the connector corresponds to pin 1 on the PCB (red mark down).
4. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

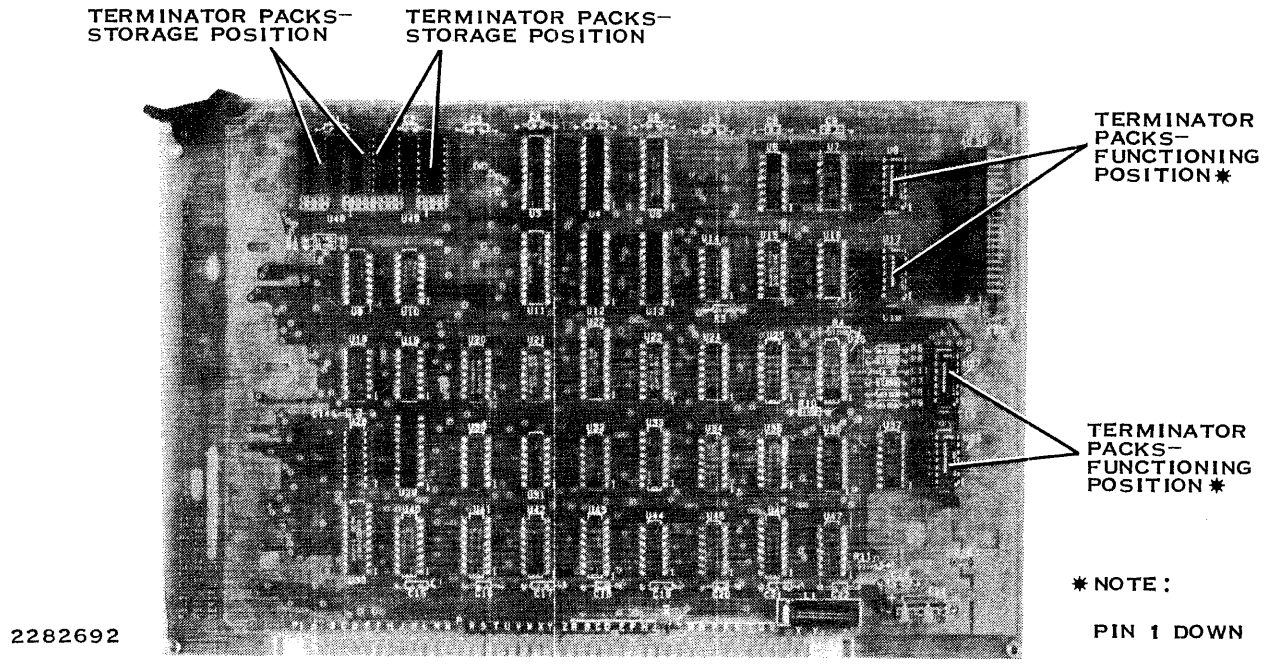

Figure 5-5. Location of WD800/WD800A Terminator Packs

5.4.13 Read/Write Board Removal and Replacement

Table 5-10 lists the symptoms displayed by a faulty read/write board.

NOTE

To work on a board in the card cage, first remove the card stabilizer (a black bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

Table 5-10. Read/Write Board Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails power-up self-test, front panel = 1010	Read/write preamp cable; test parameter cylinder not formatted
Fails power-up self-test, front panel = 1011	Write test cylinder not formatted

Self-Test Failures

Failure	Front Panel	CSB Word 2
Read failure	1010	XX12
Write failure	1011	XX13

Model 990 System Log Errors

CSB Codes	Error
W0 = 10X0	Disk unsafe; check W4 for analysis
W7 = 9001	Unit error; see W0
= 9002	Search error; data field address mark in sector not found
= 9010	ID error
= 9040	Data error
= 9400	Retries used
= 9440	Data error
= 9640	Corrected data error (ECC corrected; no syndrome match)
= 90FF	Self-test fault; see W2 status

To remove the read/write board, proceed as follows:

1. Power-down the WD800 chassis, and remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Locate the read/write board. Counting from the outside wall of the card cage toward the inside of the chassis, it is in the seventh slot, and is the seventh board if all the tape drive boards are present. The read/write board has a brown ejector tab.

3. To remove the read/write board, lift the brown ejector tab, and slide the board out of the card cage.

To install a read/write board, proceed as follows:

1. Power-down the WD800 chassis.

2. Slide the board into the seventh slot in the card cage, counting from the side nearest the outside of the chassis, and press the ejector tab down.

3. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.14 Servo Board Removal and Replacement

Table 5-11 lists the symptoms displayed by a faulty servo board.

NOTE

To work on a board in the card cage, first remove the card stabilizer (a black bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

To remove the servo board, proceed as follows:

1. Power-down the WD800 chassis. Remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Locate the servo board. Counting from the outside wall of the card cage toward the inside of the chassis, it is in the sixth slot, and is the sixth board if all the tape drive boards are present. The servo board has a red ejector tab.

3. Lift the connector lever, and remove the twisted pair cable under the ejector tab from the servo board.

4. To remove the servo board, lift the red ejector tab and slide the board out of the card cage.

Table 5-11. Servo Board Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails power-up self-test, front panel = 1001	Servo cable or preamp cable

Self-Test Failures

Failure	Front Panel	CSB Word 2
Servo failure	1001	XX10
Write failure	1011	XX13

Model 990 System Log Errors

CSB Codes	Error
W0 = 04X0	Seek incomplete
= 10X0	Disk unsafe; check W4 for analysis
W7 = 9001	Unit error; see W0
= 9010	ID error
= 9040	Data error
= 9400	Retries used
= 9440	Data error
= 9640	Corrected data error (ECC corrected; no syndrome match)
= 90FF	Self-test fault; see W2 status

To install a servo board, proceed as follows:

1. Make sure that the WD800 chassis is powered-down.
2. Slide the board into the sixth slot in the card cage, counting from the side nearest the outside of the chassis, and press the ejector tab down.
3. Install the cable on the board. Be sure that pin 1 on the connector corresponds to pin 1 on the PCB, and that the pins are not offset. The notched side of the connector catches under the connector clip (side away from the board).

4. Install the servo cable in the cable clip on the card cage. Make sure that it does not touch the tape analog board.

5. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.15 High-Speed Digital (HSD) Board Removal and Replacement

Table 5-12 lists the symptoms displayed by a faulty HSD board.

NOTE

To work on a board in the card cage, first remove the card stabilizer (a black bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

Table 5-12. HSD Board Fault Symptoms

Self-Test Failures

Failure	Front Panel	CSB Word 2
HSD failure	1000	XX11

Model 990 System Log Errors

CSB Codes	Error
W0 = 10X0	Disk unsafe; check W4 for analysis
W7 = 9001	Unit error; see W0
= 9010	ID error
= 9040	Data error
= 9440	Data error
= 90FF	Self-test fault; see W2 status

Other Symptoms

Data verification errors can occur.

To remove the HSD board, proceed as follows:

1. Power-down the WD800 chassis, and remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Locate the HSD board. Counting from the outside wall of the card cage toward the inside of the chassis, it is in the fifth slot, and is the fifth board if all the tape drive boards are present. The HSD board has an orange ejector tab.

3. To remove the HSD board, lift the orange ejector tab and slid the board out of the card cage.

To install an HSD board, proceed as follows:

1. Make sure that the WD800 chassis is powered-down.

2. Slide the board into the fifth slot in the card cage, counting from the side nearest the outside of the chassis, and press the ejector tab down.

3. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.16 Tape Control Board Removal and Replacement

Table 5-13 lists the symptoms displayed by a faulty tape control board.

NOTE

To work on a board in the card cage, first remove the card stabilizer (a black bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

Table 5-13. Tape Control Board Fault Symptoms

	Self-Test Failures	
Failure	**Front Panel**	**CSB Word 2**
Tape control	0011	XX22
Tape encode or tape control	0100	5523
Tape analog or tape control	0101	8824

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Tape offline
W7 = 8201	Tape error; see W0 (tape status)
= 82FF	Self-test fault; see W2 status

Other symptoms include the following:

- System does not try to load tape upon insertion (TAPE READY does not blink).
- System runs tape off cartridge hub during load.
- WD800 is hung — The only symptom is SYSTEM READY blinking.

To remove the tape control board, proceed as follows:

1. Make sure that the WD800 chassis is powered-down. Remove the top cover (see paragraph 5.4.1, disk removal step 3).
2. Locate the tape control board. Counting from the outside wall of the card cage toward the inside of the chassis, it is in the third slot. The tape control board has a green ejector tab.
3. To remove the tape control board, lift the green ejector tab and slide the board out of the card cage.

To install a tape control board, proceed as follows:

1. Power-down the WD800 chassis.
2. Slide the board into the third slot in the card cage, counting from the side nearest the outside of the chassis, and press the ejector tab down.
3. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.17 Tape Encode/Decode Board Removal and Replacement

Table 5-14 lists the symptoms displayed by a faulty tape encode/decode board.

NOTE

To work on a board in the card cage, first remove the card stabilizer (a black bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

Table 5-14. Tape Encode/Decode Board Fault Symptoms

Self-Test Failures

Failure	Front Panel	CSB Word 2
Tape control or tape encode	0011	3222 3522
Tape encode	0100	XX23
Tape analog or tape encode	0101	8824

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Tape offline or failed load
W7 = 8201	Tape error; see W0
= 8220	Data error
= 8240	Corrected data error
= 8280	Read-after-write CRC error
= 82FF	Tape failed self-test; see W2

Note:

Another symptom is that the system does not try to load tape upon insertion (TAPE READY does not blink).

To remove the tape encode/decode board, proceed as follows:

1. Power-down the WD800 chassis and remove the top cover (see paragraph 5.4.1, disk removal step 3).
2. Locate the tape encode/decode board. Counting from the side of the card cage nearest the outside of the chassis, it is in the second slot. The tape encode/decode board has a blue ejector tab.
3. Remove the cable (under the ejector tab) from the tape encode/decode board.
4. To remove the tape encode/decode board, lift the blue ejector tab, and slide the board out of the card cage.

To install a tape encode/decode board, proceed as follows:

1. Power-down the WD800 chassis.

2. Slide the board into the second slot in the card cage, counting from the side nearest the outside of the chassis, and press the ejector tab down.

3. Install the cable on the board. Be sure that pin 1 on the connector corresponds to pin 1 on the PCB. In this case, the red mark on the cable must be on the top edge. Be sure the pins are not offset at the connection. Insert the cable in the cable clip on the card cage; ensure that it is not resting on the tape analog board.

4. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.18 Motherboard Removal and Replacement

A faulty motherboard causes the apparent failure of one or more of the boards in the card cage. If faults in the boards cannot be fixed by replacing boards or cables, the motherboard is suspect.

To remove the motherboard, proceed as follows:

1. Power-down the WD800 chassis. Remove the top cover (see paragraph 5.4.1, disk removal step 10).

2. Remove the cables on the PBUS interface board, tape encode/decode board, processor board, and servo board.

3. Remove all the boards in the card cage by lifting the ejector tab on each of them and sliding each board out of the card cage. The motherboard is the horizontal board now exposed at the base of the card cage.

4. Disconnect the motherboard cable (the 15-pin cable) from the power supply. Push the cable and connector into the card cage enclosure.

5. Remove the disk data cable (see disk data cable removal and replacement procedure). Push the disk data cable out of the card cage enclosure.

6. The motherboard has six #6 screws with flat and lock washers, three on both the left and right edges (as viewed from the long side nearest the power supply). Locate these six screws and remove them. Do not lose the washers; attach them to the screws so that they can be replaced just as they were.

7. There are also three plastic locking-spears fixed to the floor of the chassis that point up through the motherboard, with three tabs on the head of each spear to hold the board in place. Squeeze the tabs together on each spear to release the board. Remove the board.

To install a motherboard, proceed as follows:

1. Be sure the WD800 is powered-down.

2. Line up the motherboard so that the three plastic locking spears that hold the board in place align with the holes in the motherboard. Push the motherboard down over the spears into place.

3. Insert two #6 screws and flat and lock washers in the center hole of the left and right edge of the motherboard. Insert the remaining four #6 screws and washers in the corner holes. Do not tighten them at this point.

4. Align the slots in the motherboard with the board guide slots in the card cage. Test the alignment by inserting one of the boards. When you get a clean insertion, tighten the screws.

5. Reattach the motherboard cable to the power supply. Be sure that pin 1 on the cable connector matches pin 1 on the PCB. This cable is keyed to prevent reverse insertion.

6. Reattach the disk preamp cable (see the disk preamp cable removal and replacement procedure).

7. Reinsert the PCBs in the card cage, being sure to insert them in the right order (they are color-keyed to the card cage). Consult the replacement procedure for each.

8. Reinstall the cable on the PBUS interface board, tape encode/decode board, processor board, and servo board.

9. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

NOTE

Note that the red mark on the encode/decode cable is on the top edge. On the other three cables, the red mark is on the bottom edge. Do not confuse the orientation of the marks on these cables.

5.4.19 EMI Filter Assembly Removal and Replacement

For the EMI fault symptoms, refer to the power supply assembly procedure, paragraph 5.4.10.

To remove the EMI filter assembly, use the following procedure:

1. Turn off all power to the chassis, and wait at least 30 seconds. Remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Disconnect the ac input line at J1 on the filter board.

3. Unscrew the grounding strap located between the fan and EMI filter. Be sure not to drop or lose the hardware.

4. Remove the four screws at the corners and lift the EMI filter out of the chassis.

To replace an EMI filter assembly, follow these steps:

1. Make sure the chassis is powered-down.

2. Align the holes in the corners of the filter with the holes in the chassis. Insert the screws.

3. Reattach the grounding strap located between the fan and EMI filter. Make sure to account for all the hardware from the removal process.

4. Reconnect the ac input line at J1 on the filter board.

5. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.20 Front Panel Board Removal and Replacement

If the front panel LEDs do not come on, come on at inappropriate times, or are dim while the front panel cable and the processor board are good, then the front panel board is suspect.

To remove the front panel board, proceed as follows:

1. Power-down the chassis and remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Disconnect the front panel cable; for the moment, insert it in a cable clip to keep it away from the tape analog board.

3. Working from the front of the chassis with needlenose pliers, unscrew the nuts at the base of the TEST STATUS/TAPE UNLOAD and DISK WRITE-PROTECT switches. Be careful not to scratch the front panel surface.

NOTE

For units with the alternate front panel, unsnap the front plastic bezel. Unscrew the front panel board from inside the chassis. (It may be necessary to remove the disk to do so; in this case, see paragraph 5.4.1.)

4. Slide the front panel board out of the chassis.

To replace the front panel board, proceed as follows:

1. Make sure the chassis is powered-down.

2. Align the front panel board with the holes for the TEST STATUS/TAPE UNLOAD switches. Insert and tighten the nuts for the switches, being careful not to mar the surface of the front panel.

NOTE

For units with the alternate front panel, no alignment is necessary. Screw in the front panel. If you removed the disk during front panel board removal, replace it at this time (see paragraph 5.4.1).

3. If the front panel cable is stored in a cable clamp, remove it. Reinsert it at the top corner of the board nearest the tape drive; be sure pin 1 on the connector matches pin 1 on the board.

4. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.21 Internal I/O Cable Removal and Replacement

The internal I/O cable fault symptoms are the same as those for the peripheral bus cable, paragraph 5.4.9.

To remove the internal I/O cable, proceed as follows:

1. Power-down the chassis and wait 30 seconds. Remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Remove the two connectors from the card cage side of the I/O ports on the back wall of the chassis.

3. Remove the connector on the other end of the cable from the PBUS interfaceboard. Lift the cable out of the chassis.

To replace the internal I/O cable proceed as follows:

1. Make sure the chassis is powered-down.

2. Attach the single end of the cable to the PBUS interface board. Make sure that pin 1 on the connector matches pin 1 on the board. The red mark on the cable must be on the bottom edge of the cable.

3. Without twisting the cable, install the two connectors in the two I/O ports on the back inside wall of the chassis.

4. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.22 AC Fan Cable Removal and Replacement

If the fan does not turn when the power is on and there is nothing obstructing it, replace the fan cable.

To remove a faulty fan cable, proceed as follows:

1. Power-down the chassis and wait 30 seconds. Remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Unplug the fan cable at J2 on the filter board.

3. Unplug the fan cable on the fan assembly.

To replace the fan cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Plug the fan cable into the fan assembly, making sure that pin 1 on the connector matches pin 1 on the fan.

3. Plug the fan cable into J2 on the filter board. Make sure that pin 1 on the connector matches pin 1 on the board.

4. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.23 Front Panel Cable Removal and Replacement

If the front panel lights are out or the wrong lights are on and power is applied to the chassis, the front panel cable is suspect.

To remove a faulty front panel cable, proceed as follows:

1. Power-down the chassis, and wait 30 seconds. Remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Unplug the front panel cable from the edge of the front panel board.

3. Unplug the front panel cable from the processor board in the card cage (yellow ejector tab).

4. Remove the cable from the cable clips, and lift it out of the chassis.

To replace the front panel cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Insert connector P16 in the front panel board at the top corner nearest the tape drive.

NOTE

The front panel cable is not interference-keyed. Pin 1 of the cable must be oriented toward the bottom of the chassis on both ends of the cable (red mark down).

3. Insert connector P26 in the processor board. Be sure pin 1 on the connector matches pin 1 on the board (red mark down). Be sure the connector is not offset from the pins.

4. Insert the cable in the cable clip on the disk drive. It lies flat in this clip.

5. Insert the cable in the clip on the card cage. Fold the cable, and insert the fold in this clip.

6. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

NOTE

Be sure that the clips keep the front panel cable from touching the tape analog board.

5.4.24 Tape Analog Power Cable Removal and Replacement

Table 5-15 lists the symptoms displayed by a faulty tape analog power cable.

Table 5-15. Tape Analog Power Cable Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails power-up self-test, front panel = 0101	Cable not connected properly

Self-Test Failures

Failure	Front Panel	CSB Word 2
Tape drive assembly	0101	8824

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Tape offline or failed load
W7 = 8201	Tape error; see W0
= 82FF	Tape failed self-test; see W2

Other symptoms include the following:

- System does not try to load tape upon insertion (TAPE READY does not blink).
- Tape runs off end.

To remove the tape analog power cable, proceed as follows:

1. Power-down the chassis, and wait 30 seconds. Remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Remove the cable from the analog board. It is attached at the back right, as viewed from the front of the chassis.

3. Remove the other end of the cable from the power supply. Be careful to avoid touching any circuits that might retain current.

To replace the analog power cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Attach cable connector P46 to J46 on the analog board. The cable is keyed to prevent reverse insertion, but be careful not to insert the connector offset from the pins.

3. Attach cable connector P6 to J6 on the power supply. The cable is keyed to prevent reverse insertion, but be careful not to insert the connector offset from the pins.

4. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.25 Tape Encode/Decode Cable Removal and Replacement

Table 5-16 lists the symptoms displayed by a faulty tape encode/decode cable.

Table 5-16. Tape Encode/Decode Cable Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails power-up self-test, front panel = 0101	Cable not connected properly

Self-Test Failures

Failure	Front Panel	CSB Word 2
Tape drive assembly	0101	8824

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Tape offline or failed load
W7 = 8201	Tape error; see W0
= 82FF	Tape failed self-test; see W2

Note:

Another symptom is that the system does not try to load tape upon insertion (TAPE READY does not blink).

To remove the tape encode/decode cable, proceed as follows:

1. Power-down the chassis and remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Disconnect the cable from the analog board.

3. Remove the cable from the clip above the analog board.

4. Disconnect the cable from the encode/decode board in the card cage.

To replace the tape encode/decode cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Install connector P45 of the cable into J45 of the analog board. Be sure pin 1 of the connector corresponds to pin 1 on the board. Be careful not to insert the connector off-set from the pins.

3. Install connector P25 of the cable on J25 of the encode/decode board. Be sure pin 1 of the connector corresponds to pin 1 on the board; the red mark is the top edge of the cable. Be careful not to insert the connector offset from the pins.

4. Fold the excess length of cable, and insert the fold into the cable clip above the analog board. Do not allow the cable to rest on the analog board.

5. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.26 Servo Twisted Pair Removal and Replacement

The fault symptoms for the servo twisted pair are the same as the fault symptoms for the servo board.

To remove the servo twisted pair cable, proceed as follows:

1. Power-down the chassis, and wait 30 seconds. Remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Remove the cable from the servo board by pinching the locking head to release it.

3. Remove the other end of the cable from the back of the disk housing. This end also has a locking clip.

To replace the servo twisted pair, proceed as follows:

1. Make sure the chassis is powered-down.

2. Insert the cable into the connector on the servo board (under the ejector tab). Be sure that the locking head ridge on the cable connector is pointing away from the board; it slides under the locking clip.

3. Insert the other end of the twisted pair cable in the back of the disk housing. The locking head ridge on this connector must point down; it also slides under a locking clip. Be careful not to insert the connector offset from the pins; during the procedure, your view is blocked.

4. Guide the twisted pair cable through the cable clip on the side of the disk.

5. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.27 Disk Preamp Cable Removal and Replacement

The fault symptoms for the disk preamp cable are the same as those for the disk drive.

To remove the disk preamp cable, proceed as follows:

1. Power-down the chassis and remove the top cover (see paragraph 5.4.1, disk removal step 3).

2. Remove the cable from the servo board according to the servo twisted pair procedure.

3. Remove the read/write board and the servo board according to the procedures for these boards.

4. The disk preamp cable is now exposed. It is the cable with the blue ejector tabs, closer to the front of the chassis. Release the cable from the motherboard by pressing out on the ejector tabs.

5. Remove the preamp cable from the card cage.

6. Remove the disk unit by following the disk removal procedure.

7. The pin for the disk preamp cable is on the bottom of the disk housing. Remove the disk preamp cable.

To replace the disk preamp cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Replace the disk preamp cable on the bottom of the disk chassis, making sure that pin 1 on the connector matches pin 1 on the disk unit pin.

3. Replace the disk drive unit according to the disk replacement procedure.

4. Install the disk preamp cable on the motherboard. Make sure that pin 1 on the connector matches pin 1 on the motherboard.

5. Replace the servo and read/write boards, and reinstall the servo twisted pair according to the procedures for these components.

6. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.4.28 Power Cord Removal and Replacement

A bad power cord prevents power from reaching the chassis, the fan, and the lights. If these assemblies do not work, the power cord is suspect.

To remove the ac power cord, proceed as follows:

1. Power-down the chassis.
2. Unplug the power cord from the receptacle in the switch plate cutout on the back of the chassis.
3. Unplug the other end of the ac power cord from the power strip on the rack.
4. Loosen cable ties as necessary along the length of the cable and remove the cable.

To replace the ac power cord, perform the following steps:

1. Make sure that the ac power switch is turned to OFF.
2. Connect the female end of the ac power cord to the ac cord receptacle located in the switch plate cutout on the rear of the WD800 chassis.
3. Dress the cord out to the left vertical rack rail, and tie it down (below the level of the chassis) on the inside of the rail.

CAUTION

If the ac power cord is not routed as indicated, it can get caught between the ball stud and ball stud receptacle. The resulting stress can damage the cord and possibly the system.

4. Plug the other end of the cord into an available ac outlet on the rail.

5.4.29 Fuse Removal and Replacement

For the fault symptoms pertaining to the fuse, refer to the discussion of the power supply fault symptoms, paragraph 5.4.10.

To remove the fuse, proceed as follows:

1. Disconnect the power cord, and wait 30 seconds.
2. Locate the round fuse on the switch plate cutout on the back of the chassis.
3. Place a flat-blade screwdriver in the fuse slot. Push in slightly, and turn one-half turn counterclockwise to remove the fuse.

To replace the fuse, proceed as follows:

1. Make sure the chassis power is disconnected.
2. Insert the fuse.
3. Place a flat-blade screwdriver in the fuse slot. Push in slightly and turn one-half turn clockwise to install the fuse.

5.4.30 Voltage Change Jumper Plug Removal and Replacement

For a discussion of the voltage change jumper plug fault symptoms and removal and replacement procedures, refer to the discussion on power supply removal and replacement (paragraph 5.4.10).

5.4.31 Cooling Fan Removal and Replacement

If the fan does not turn and it is not obstructed, the fan assembly is suspect.

To remove the fan, proceed as follows:

1. Disconnect the power from the chassis. Remove the top cover (see paragraph 5.4.1, disk removal step 3).
2. Disconnect the fan cable from the fan.
3. Being careful not to drop any of the hardware, remove the four screws at the corners of the fan assembly. This releases the fan, the wire guards, and the clips and screws.
4. Lift the fan assembly out of the chassis.

To replace the fan assembly, proceed as follows:

1. Make sure the chassis is powered-down.
2. Being careful to control all the associated hardware, align the fan assembly with the holes in the chassis back wall.
3. Insert the fan screws.
4. Reinstall the fan cable on the fan.
5. Replace the top cover (see paragraph 5.4.1, disk replacement step 10).

5.5 VERIFICATION TESTS

To verify that the system is functional after all faulty parts are replaced, use the standard diagnostics described in the diagnostics handbooks listed in the Preface.

5.6 ILLUSTRATED PARTS BREAKDOWN

Figure 5-6 shows an exploded view of the WD800 mass storage system.

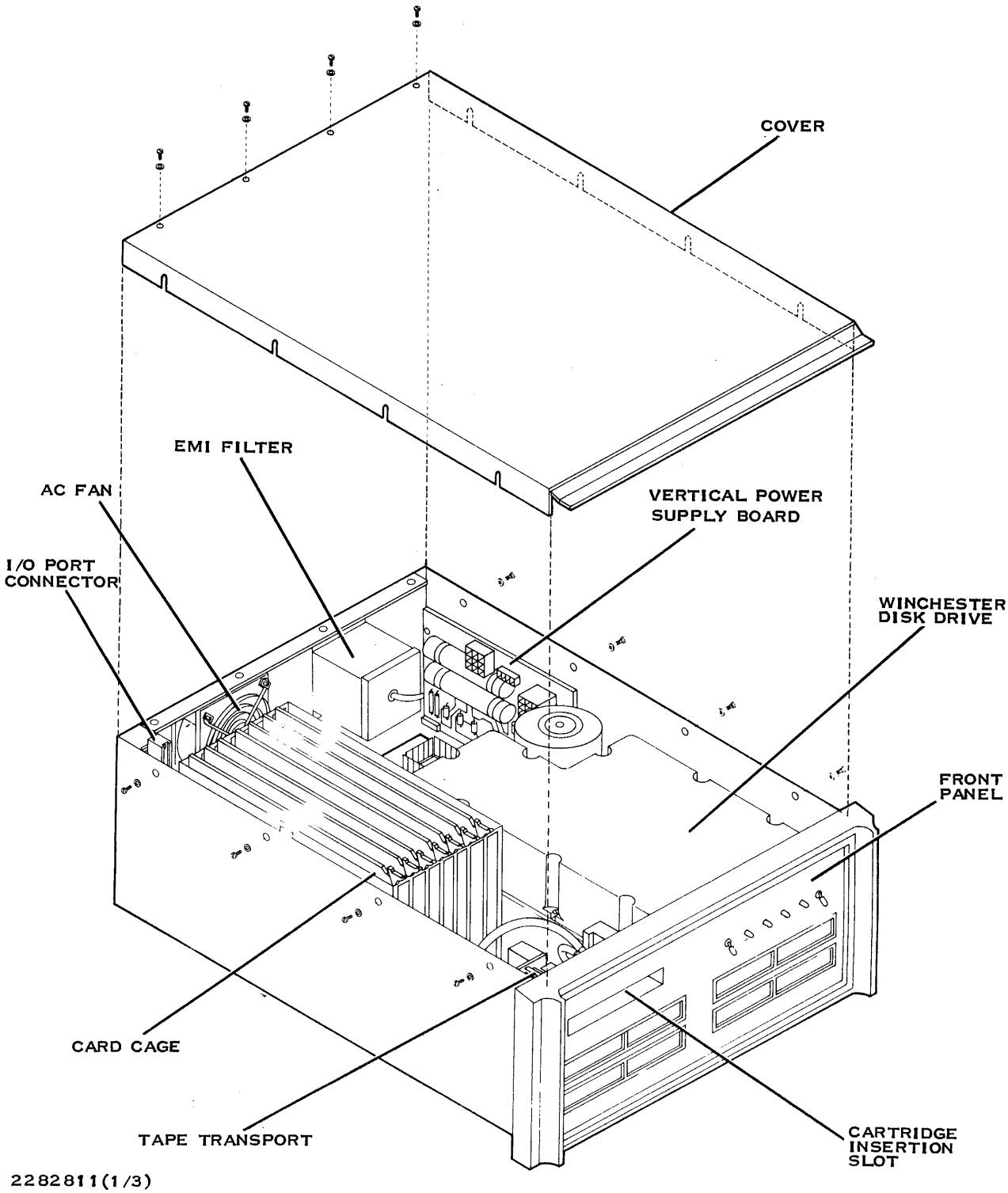

Figure 5-6. WD800 Mass Storage System — Exploded View (Sheet 1 of 3)

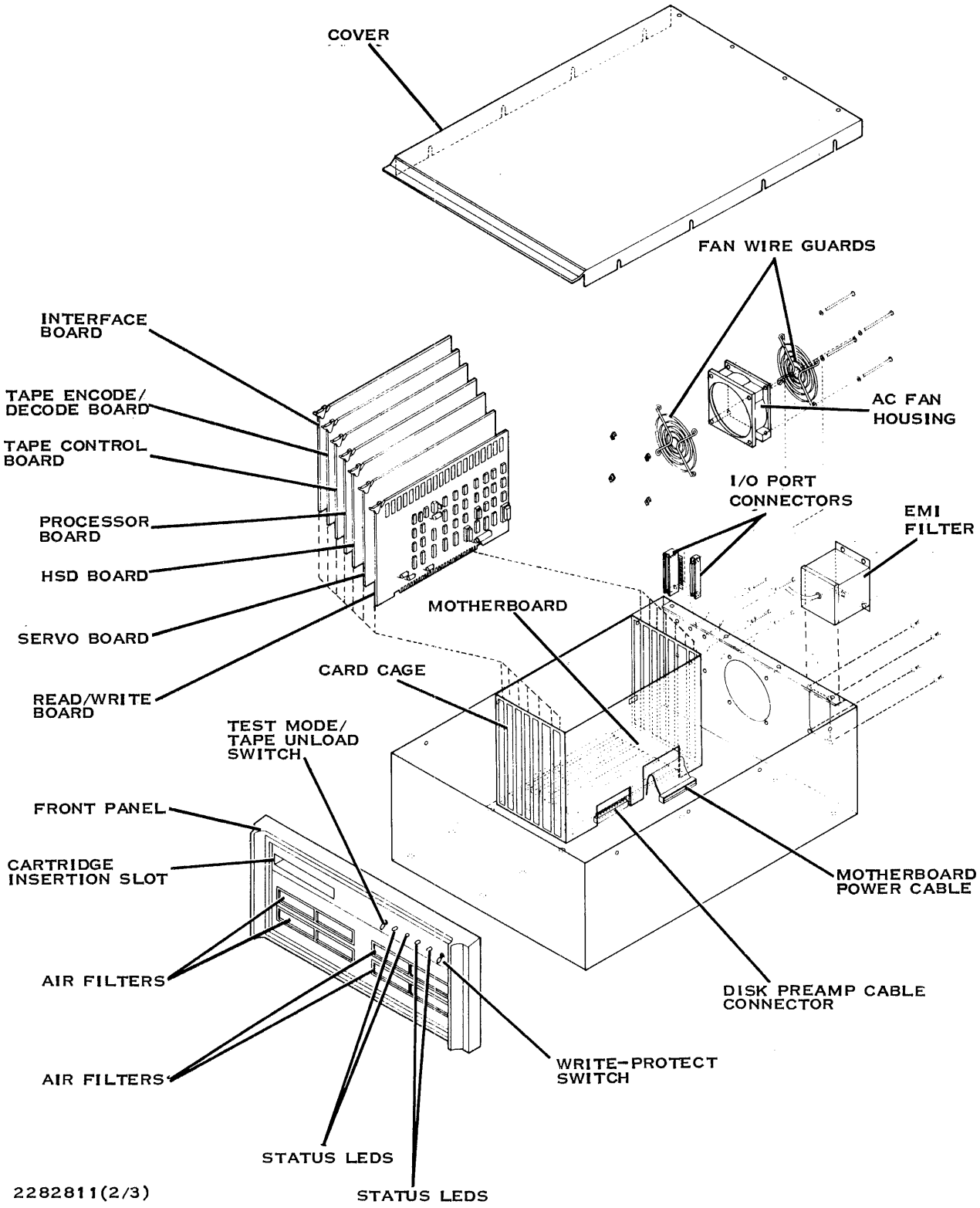

Figure 5-6. WD800 Mass Storage System — Exploded View (Sheet 2 of 3)

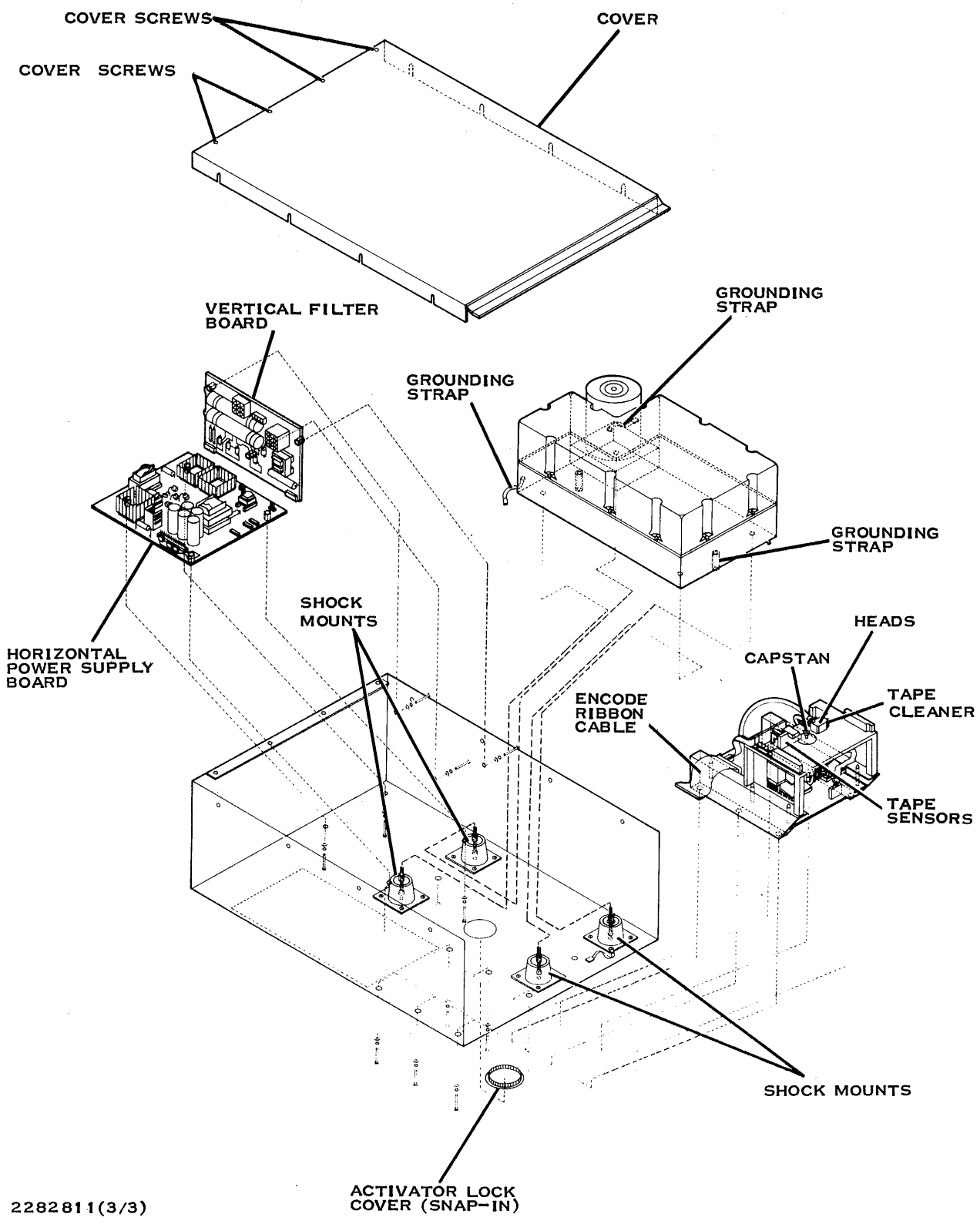

Figure 5-6. WD800 Mass Storage System — Exploded View (Sheet 3 of 3)

6

WD800A Removal and Replacement Procedures

6.1 INTRODUCTION

Corrective maintenance for the WD800A mass storage system chassis (Figure 6-1) and peripheral bus interface (PBI) is based on replacing the faulty peripheral bus cable or subassembly within the WD800A chassis and verifying the operation.

This section covers the required maintenance supplies, part/subassembly replacement procedures, and verification procedures for the WD800A mass storage system.

6.2 SAFETY AND SPECIAL MAINTENANCE PRECAUTIONS

Before proceeding with any maintenance, become familiar with the following safety warning:

WARNING

When removing the cover of the chassis in rackmounted units, it may be necessary to extend the chassis as far out of the rack as it can go, which defeats the safety stop mechanism. Pull the chassis far enough beyond the safety point to allow access to the screws on the back edge of the cover. Be very careful not to pull the chassis completely out of the rack. As soon as you remove the screws and lift the lid off the chassis, push the chassis back into the rack to engage the safety stop mechanism.

Lethal voltages are present on the power supply assembly. Before accessing the electronics inside the chassis, be sure that the ac power cord is disconnected and that the ac switch has been off for at least 30 seconds and remains off. The only procedure requiring the removal of the top cover with power applied is the procedure for checking the power supply boards. Use special care when checking the power supply test points with power applied.

If power must be on with the top cover removed, be careful to avoid the power supply area. Access the power supply test points carefully, avoiding high-voltage circuits.

When working with the cover removed, also be careful to keep your fingers and any tools you are using away from the moving blades of the fan.

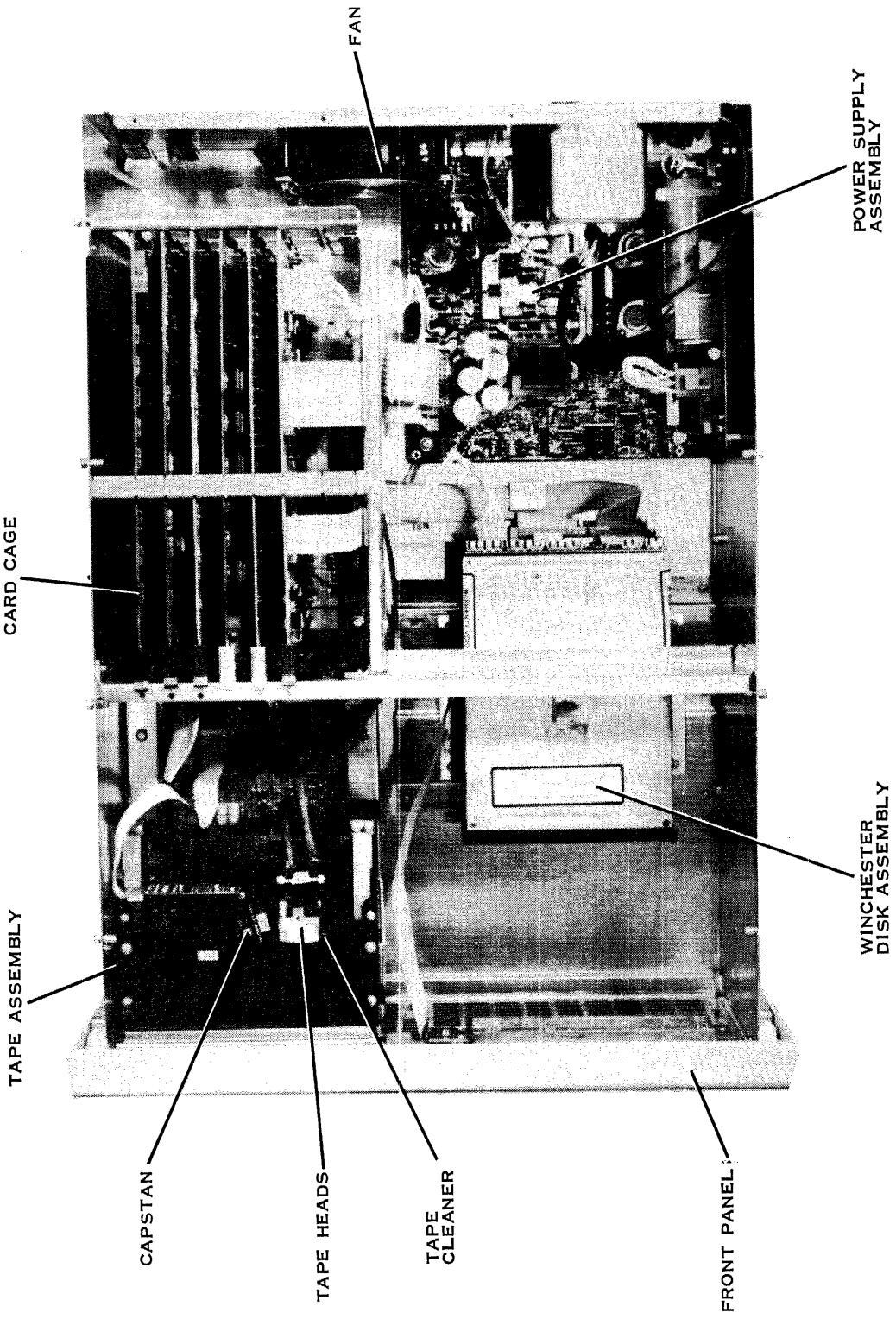

Figure 6-1. WD800A Mass Storage System Chassis, Top View

6.3 CORRECTIVE MAINTENANCE SUPPLIES

Table 6-1 lists corrective maintenance tools, equipment, and supplies required to perform procedures in this section.

Table 6-1. Maintenance Tools, Equipment, and Supplies

Item	Source
Oscilloscope	Tektronics
Extender card (for international use only)	TI part number 2213071-0001
Maintenance diagnostic unit (MDU) box	
115-Volt	TI part number 946710-0001
230-Volt	TI part number 946710-0002
Voltmeter	Commercially available
Scratch cartridge	TI part number 2270391-0001
Ordinary hand tools	Commercially available
Flat-blade screwdriver	Commercially available
Hex driver, 1/4 inch	Commercially available
Phillips screwdriver, small	Commercially available
Phillips screwdriver, large	Commercially available
Allen wrench, 9/64 inch	Commercially available
Ethyl alcohol	Commercially available
Cotton swabs	Commercially available
Diagnostic kit, Model 990 on cassette tape media (with DOCS diagnostics including those specifically for WD800 and WD800A)	TI part number 2250534-1305
Unit Diagnostics Handbook, Volume 1, General Diagnostic Information	TI part number 945400-9701
Unit Diagnostics Handbook, Volume 3, Diagnostics for Model 990 Mass Storage Devices	TI part number 945400-9703

6.4 WD800A REMOVAL AND REPLACEMENT PROCEDURES

After the fault is isolated to a field-replaceable assembly, correct the problem by replacing the faulty part or subassembly. The following paragraphs describe the removal and replacement procedure for each field-replaceable component of the WD800A.

First, the component fault symptoms are summarized, and then the removal and replacement procedure is detailed. To make it easier and faster to locate the applicable description, Table 6-2 lists the paragraph number of the discussion of each field-replaceable component. (For a description of each field-replaceable component, see paragraph 1.6.)

Table 6-2. Removal and Replacement Procedures

Replaceable Unit Name	Paragraph Number
Disk drive assembly formatted, 114 MB	6.4.1
Disk drive assembly formatted, 69 MB	6.4.1
Disk drive assembly formatted, 38 MB	6.4.1
Tape drive assembly with tape analog board and mounting brackets	6.4.2
Tape cartridge media	6.4.3
TPBI assembly	6.4.4
Peripheral bus cable assembly	6.4.5
Power supply assembly (Horizontal power supply board)	6.4.6
Power supply assembly (Vertical (filter) power supply board)	6.4.6
Processor board	6.4.7
PBUS Interface board	6.4.8
High-speed digital control board	6.4.9
ST506 disk interface board	6.4.10
Tape control board	6.4.11
Tape encode/decode board	6.4.12
Motherboard assembly with ground	6.4.13
Motherboard power cable	6.4.14
EMI filter assembly	6.4.15

Table 6-2. Removal and Replacement Procedures (Continued)

Replaceable Unit Name	Paragraph Number
Front panel board	6.4.16
Internal I/O cable	6.4.17
Front panel cable	6.4.18
Tape analog power cable	6.4.19
Tape encode/decode cable	6.4.20
ST506 disk interface control cable	6.4.21
ST506 disk interface data cable	6.4.22
ST506 disk interface power cable	6.4.23
Power cord	6.4.24
Voltage-change jumper plug 100-115 Vac	6.4.25
Cooling fan	6.4.26
Fuse, ac	6.4.27

6.4.1 WD800A Disk Drive Assembly Removal and Replacement

The following paragraphs discuss the disk drive/preamp assembly fault symptoms and the removal/replacement procedure. Table 6-3 lists the symptoms displayed by a faulty disk drive assembly.

Table 6-3. Disk Drive Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails power-up self-test, front panel code = 1001	Self-test cylinder not initialized
Fails power-up self-test, front panel code = 1001	Disk interface control or power cable loose
Fails power-up self-test, front panel code = 1010	Disk interface data cable loose
Fails power-up self-test, front panel code = 1011	Disk interface data cable loose

Self-Test Failures

Failure	Front Panel	CSB Word 2
Disk interface failure	1001	XX10
Read failure	1010	XX12
Write failure	1011	XX13

Model 990 System Log Errors

CSB Codes	Error
W0 = 04X0	Seek incomplete error
= 10X0	Disk unsafe error; check W4 for analysis
W7 = 9001	Unit error; see W0
= 9002	Search error; data field address mark in sector not found
= 9010	ID error
= 9040	Data error
= 9400	Retries used
= 9440	Data error
= 9640	Corrected data error (ECC corrected, no syndrome match)
= 90FF	Self-test fault; see W2 status

Other symptoms include the following:

- If the disk drive has developed more bad tracks than allowed, it needs to be replaced. For the WD800A, the 38-megabyte drive is allowed a total of 50 bad tracks, the 69-megabyte drive is allowed a total of 90 bad tracks, and the 114-megabyte drive is allowed a total of 150 bad tracks. Note that the allowable bad tracks refer to reallocated tracks. The number of bad tracks that are reallocated can be determined from the Display Bad Track Map (DB) verb using DSKSA, DSKCOM, or DSKWD8 while under DOCS. Another way of determining if the allowable number of bad tracks has been exceeded is to look at the DX10/DNOS bad-track map on cylinder 0, head 0, sector 1 (track 0, sector 1). Any entries on this map indicate that all the spares have been used and the disk should be replaced.

- Internal faults can cause power supply resets; this condition is indicated when all the front panel LEDs turn on.

- Unrecoverable faults, internal to the disk drive, can occur on the 38-megabyte or 69-megabyte units. The unrecoverable faults are indicated by a flashing red LED on the disk drive front panel. This LED cannot be seen from outside the WD800A chassis. The flashing LED mode does not apply to the 114-megabyte unit.

To disconnect the disk assembly, proceed as follows:

1. Unplug the chassis power cord, and wait 60 seconds.

2. Remove the top cover of the chassis, using the following procedure:

   a. Slide the chassis forward until the chassis meets the safety stop.

   b. Defeat the safety-stop mechanism, and carefully pull the chassis forward until you have access to the screws on the top back edge of the chassis.

   c. Remove the screws. Slide the top cover back to release the lip of the cover from underneath the front panel edge and remove the cover.

   d. Push the chassis back into the rack until you hear the safety stop mechanism click as it engages.

3. Disconnect the power cable at the back of the disk drive. The power cable is a four-conductor cable that comes from the disk interface board.

4. Disconnect the control cable and the data cable at the back of the disk drive. The control and data cables are 34-pin and 20-pin flat ribbon cables, respectively, that come from the disk interface board.

5. The disk drive is attached to a mounting plate via four screws underneath the drive assembly. To remove these screws, it is first necessary to loosen the mounting plate from the chassis. Using a 1/4-inch hex nut driver, loosen the four screws that hold the drive mounting plate to the chassis. (See Figure 6-2.)

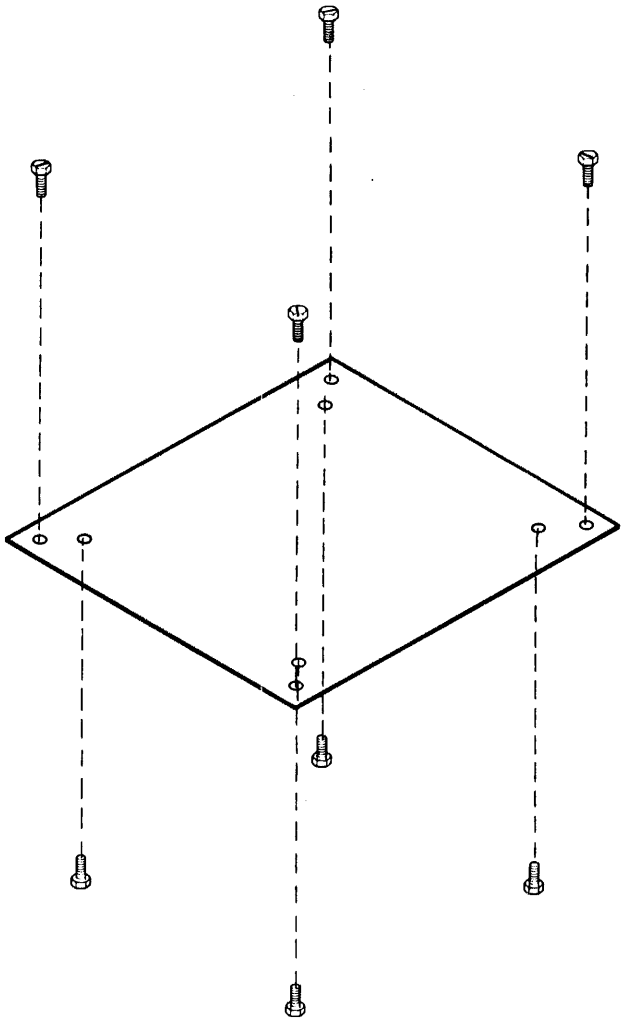

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Figure 6-2. WD800A Disk Mounting Plate/Chassis Screws

6. The disk drive, plus mounting plate, is now disconnected from the rest of the system. To remove the disk drive from the chassis, grip it firmly at the sides, and move it foward (toward the front panel) so that it clears the metal baffle. With both hands, lift the disk drive straight up. The disk is fragile; place the removed disk upside down on foam or other cushion. Using a hex nut driver, loosen the four screws that attach the mounting plate to the disk drive. (See Figure 6-2.) Record the serial number of the disk drive assembly on a service ticket for TI service calls.

To replace a disk drive assembly in the WD800A chassis, proceed as follows:

1. Make sure that the power cord is unplugged, and power has been removed from the chassis for at least 30 seconds.

2. The disk is fragile; place the disk upside down on foam or other cushion. Place the mounting plate on the drive, lining up the four inner mounting holes. Use a hex nut driver to tighten the four screws on the plate.

3. Lower the disk (with mounting plate attached) into the chassis from the front side of the metal baffle. Slide the drive towards the power supply until mounting plate holes line up to the four holes on the bottom of the chassis. Use a 1/4-inch hex nut driver to install the four screws.

4. Reconnect the 20-pin data cable and the 34-pin control cable to the disk. Both of these flat ribbon cables are keyed and will only attach in one way. When connected, pin 1 of each cable will be on the side closest to the card cage.

5. Reconnect the four-conductor power cable. The connector is keyed, and can only be installed in one way.

6. Replace the top cover of the chassis, using the following procedure:

   a. Slide the chassis forward until the chassis meets the safety stop.

   b. Defeat the safety stop mechanism, and carefully pull the chassis forward until you have access to the screws on the top back edge of the chassis.

   c. Replace the cover. Reinsert the screws and tighten them.

   d. Push the chassis back into the rack until you hear the safety-stop mechanism click.

6.4.2 Tape Drive Assembly Removal and Replacement

Table 6-4 lists the symptoms displayed by a faulty tape drive assembly.

Table 6-4. Tape Drive Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails power-up self-test, front panel = 0101	Tape analog power cable Tape encode/decode cable

Self-Test Failures

Failure	Front Panel	CSB Word 2
Tape drive assembly	0101	XX24

Tape Load Failures

CSB Codes	Error
W2 = FX29	Erase channel bad
= 0X29	Write or read channel bad

Model 990 System Log Errors

W0 = 80X0	Tape offline or failed load
W7 = 8201	Tape error; see W0 (tape status)
= 8282	Data dropout error (excessive number of occurrences)
= 82FF	Tape failed self-test; see W2

Other symptoms include the following:

- Tape capstan motor turns without a tape inserted
- Tape drive runs tape off one of the internal cartridge hubs
- Capstan damages plastic cartridge housing
- Tape drive fails to recognize write-protected tape
- Tape drive does not try to load tape upon insertion of the tape cartridge (TAPE READY does not blink)
- Tape drive fails MTCTST test 41

To disconnect the tape assembly, proceed as follows:

1. Power-down the chassis, and wait at least 30 seconds. Remove the chassis top cover (see paragraph 6.4.1, disk removal procedure step 2).

2. Unplug the power cable on the rear right-hand side (nearest the disk) of the analog board.

3. Unplug the encode ribbon cable (on the left rear) from the analog board.

4. Locate and remove the six slotted screws (noting which set of holes is used) holding the tape mounting brackets to the underside of the chassis.

5. Remove the two screws on the side of the chassis that hold the adjustable tape mounting bracket.

6. Tilt up the front of the tape-drive assembly to make it easier to handle. Lift the tape drive out of the chassis by the tape deck mounting legs.

To replace a tape-drive assembly, proceed as follows:

1. Lower the tape drive into the chassis. Insert the two screws on the side of the chassis that hold the adjustable tape mounting bracket. Do not tighten them at this point.

2. Insert the six slotted screws that hold the tape mounting brackets to the chassis. Do not tighten them at this point.

3. Test the alignment of the tape drive by inserting a cartridge into the cartridge-insertion slot. Be sure that it does not drag or touch on any side. If the tape drive is too low, add washers between the chassis and the tape brackets.

4. After aligning the tape drive, tighten the screws.

5. Plug the encode ribbon cable (on left rear) into the analog board. Be sure pin 1 is to the rear. The cable has a red stripe corresponding to pin 1; a 1 is printed on the board next to pin 1.

6. Plug in the power cable on the right side (rear) of the analog board. The power cable is keyed to prevent installing it backwards. Be sure that the pins are not offset at insertion.

7. After installing the tape drive, clean the head, tape cleaner, and capstan, using denatured alcohol and cotton swabs. Clean the head first, then the tape cleaner. Clean the capstan last, using up and down scrubbing motions around the entire surface.

8. Replace the chassis top cover (see paragraph 6.4.1, disk replacement step 6).

CAUTION

Alignment of the tape drive to the front panel opening is crucial to proper operation of the tape drive. Before proceeding, ensure that a tape cartridge can be installed with adequate clearance from the edges of the front panel opening. If necessary, the tape transport mounting can be slightly realigned to achieve a better fit in the chassis.

NOTE

When installing the tape drive in a chassis with the alternate front panel (Figure 2-4), you may have to move the drive assembly back on its mounting brackets. Follow the instructions given on the side of the tape assembly.

6.4.3 Tape Cartridge Media

The following paragraphs discuss the tape cartridge media fault symptoms. No description of removal and replacement procedures is required.

Table 6-5 lists the symptoms displayed by a faulty tape cartridge.

Table 6-5. Tape Cartridge Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails tape load, gets excessive errors after load	Tape media bad (If only reading from tape is needed, write-protect and reinsert.)

Tape Load Failures

CSB Codes	Error
W2 = XX29	Bad media (to read, write-protect the tape)

Model 990 System Log Errors

W0 = 04X0	Tape is write-protected
= 20X0	End-of-record error (media bad)
= 80X0	Tape offline or failed load, or fatal media error
W7 = 8201	Tape error; see W0 (tape status)
= 8220	Data error
= 8240	Corrected data error
= 8280	Read-after-write CRC error
= 8282	Read-after-write dropout error

Other Failures

Fails MTCTST 41 (EW/EOT hole tests)

Fails MTCTST 61 (incoming test for dropouts)

Fails MTCTST TI (incoming test for ISV)

6.4.4 TPBI Assembly Removal and Replacement

Section 3 of this manual discusses the fault symptoms and the removal and replacement of the TPBI assembly.

6.4.5 Peripheral Bus Cable Assembly Removal and Replacement

Table 6-6 lists the symptoms displayed by a faulty peripheral bus cable assembly.

Table 6-6. Peripheral Bus Cable Fault Symptoms

Correctable Symptoms

Problem	Explanation
SYSTEM READY blinks or remains off	Cable plugged in wrong or WD800A connector pins bent

Self-Test Failures

Failure	Front Panel	CSB Word 2
No CTLPRES signal	1110	XXXX (not reported)

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Disk offline
= 11X0	Unsafe, pack change (temporary disconnect)
W7 = 9001	Unit error; see W0
= 9004	Command time-out (peripheral bus error)
= 90FF	Self-test fault; see W2 status

To remove the peripheral bus cable, disconnect it from the controller in the 990 chassis and from the I/O port on the back panel of the WD800A chassis. Working from the end installed in the controller toward the end installed in the chassis, release the cable from each cable tie that is restraining it. After releasing the peripheral bus cable, fasten the cable ties back around any other cables that they hold.

To replace the peripheral bus cable, use the following procedure:

1. Make sure all power is off.

2. Ensure that one end of the cable is attached to the controller connector P3 (Section 3). The ends are interchangeable, and the metal backshell on the connector prevents installing it upside down.

CAUTION

Make sure that the pins are not bent at either connection.

3. Dress the cable toward the back of the rack and onto the cable carrier, allowing some slack. Attach the cable to the cable carrier, using cable ties. Allow some slack in the ties for the moment. Do not cut off the cable tie ends; tuck them back under the tie to keep them from interfering with cable carrier operation.

4. To guide the cable around the hinge of the cable carrier, place a cable tie in the bottom hole of the carrier nearest the hinge on the first side of the carrier. Place a second cable tie in the top hole nearest the hinge on the second (back) side of the carrier. Attach the cable smoothly (without loops or twists), using these two cable ties.

CAUTION

The cable can tolerate a minimum bend radius of 33 millimeters (1.3 inches) to avoid being damaged by stress. The cable must not be too tight across the cable carrier hinge, and must be dressed from the carrier bottom edge to the top edge as described in step 4.

5. Dress the cable across the back side of the cable carrier, and tie it down loosely with cable ties.

6. Route the cable along the outside of the left rail of the rack to the back of the WD800A chassis, and gather the excess length in a service loop.

7. Plug the cable connector into the mating connector on the right of the chassis back panel (as seen from the rear). Adjust the cable so that there is enough slack to permit sliding the chassis all the way forward on the rails.

8. Tighten all the cable ties.

9. Use cable ties along the rail of the rack to ensure that the cables in the rack do not become tangled.

6.4.6 Power Supply Assembly Removal and Replacement

A faulty power supply assembly can display the following symptoms:

- The tape transport bulb is off (visible from the front panel opening)
- The chassis fails power-up self-test and one or more of the following are true:
  - — The front panel LEDs are all on
  - — The front panel LEDs are all off
  - — The front panel LEDs cycle all on, some off, all on, and so on
  - — The front panel LEDs = 1001 (servo-test failure)

To trace power supply assembly faults to a single component, refer to Table 6-7.

WARNING

The tests described in Table 6-7 involve lethal voltage sources. Ensure that only qualified personnel perform these tests. Do not conduct these tests with power on unless specifically instructed to do so. Be extremely careful to avoid contact with live circuits.

Table 6-7. Power Supply Fault Isolation

Problem	Procedure
Input power fuse blown	1. Disconnect the fan motor from the vertical filter PCB. 2. Replace the fuse and turn on the power. If the fuse does not blow, the fan is at fault. 3. If the fuse still blows after steps 1 and 2, replace the filter PCB. 4. If the fuse blows after step 3, replace the EMI filter
Input fuse good but the power supply has no output P.S H/Z. TP 7 = GND 1 = +5 AC 2 = +5V AC 3 = +5.1 4 = +24V 5 = -13V 6 = -24V 8 5.1 9 +13V	1. With power on, use a digital voltmeter (DVM) to measure the voltages on the test points provided on the filter board as follows: • TP3 (+) to TP4 (–) — 16 to 26 Vdc • TP1 (+) to TP2 (–) — 225 to 375 Vdc 2. If the high voltage is good, but the low voltage is below normal, replace the horizontal power supply. If this does not correct the problem, replace the filter board. 3. If the high voltage is wrong or if both voltages are wrong, replace the filter board. 4. If both voltages are right, replace the horizontal power supply board. 5. If the problem still exists, disconnect the 15-pin connector (to the motherboard) and the 9-pin connector (to the analog board) that go to the power supply. Recycle input power and measure between TP8 (+) and TP7 (–) for +5.1 volts. If the voltage is right, then a short or overload exists in the loads. 6. If none of the above restores the power, replace the EMI filter.

P.S VENT.
TP1 + TP2 300VDC
3 + 4 24DC

To remove the power supply assembly, proceed as follows:

WARNING

Lethal voltages can be present on the power supply assembly. Before accessing the electronics inside the chassis, be sure that the ac power cord is disconnected, and that the ac switch has been off for at least 30 seconds.

1. Remove chassis top cover (see paragraph 6.4.1, disk removal procedure step 2).
2. Remove all cables from the filter PCB assembly and the horizontal power supply PCB.
3. Remove the programming plug from J4 on the filter board, and save it to install on the replacement board.
4. Remove the three #6-32 × 5/8-inch slotted screws from the mounting holes on the filter PCB. (Two are at the top corners and one is in the middle at the bottom edge of the board.)
5. Unplug the filter PCB from the horizontal power supply PCB, and remove it from the chassis. If you are removing only the filter PCB, omit the next two steps and continue with the replacement procedures that follow.
6. Remove the four #6-32 × 7/8-inch pan-head screws from the mounting holes in the chassis base. (Remove them from inside the chassis.)
7. Lift the horizontal power supply PCB out of the chassis.

To replace the power supply assembly, proceed as follows:

1. Install the horizontal power supply PCB, using the following procedure:
   a. Place a #6 lock and #6 flat washer on each of the four #6-32 × 7/8-inch pan-head screws and set them aside.

CAUTION

Be sure to move all cables out of the way before installing the horizontal power supply PCB. Do not allow cables to be caught underneath the PCB.

   b. Position the horizontal power supply PCB on the bottom of the chassis base assembly, directly behind the disk drive. The two four-pin connectors on the PCB must be on the wall side of the chassis base.

c. Align the four stand-offs attached to the PCB with the four mounting holes in the chassis base. Install the four #6-32 × 7/8-inch pan-head screws reserved in step 1a into the mounting holes, and tighten them with a #1/4 torque driver (10.1 inch-pounds).

2. Install the vertical filter PCB assembly, using the following procedure:

a. Position the filter PCB against the inside wall of the chassis base; this is located over the horizontal power supply PCB.

NOTE

The component side of the filter PCB must face the operator.

b. Locate the two female connectors on the bottom of the filter PCB, and plug them into the two male connectors on the horizontal power supply PCB.

c. Align the three stand-offs on the back of the filter PCB to the three mounting holes in the chassis base. Install the three #6-32 × 5/8-inch slotted screws into the mounting holes on the filter PCB, and tighten with a #1/4 torque driver (10.1 inch-pounds).

3. Cable the power supply assembly using the following procedure:

CAUTION

Be sure that pin 1 on all connectors corresponds to pin 1 on the PCBs.

a. Locate the connector (J4) on the filter PCB, and plug the reserved jumper plug into it.

b. Plug the end of the fan cable assembly into the connector (J2) on the filter PCB.

c. Plug the connector from the EMI filter assembly into location J1 on the filter PCB assembly.

d. Locate the ribbon cable that extends from the motherboard. Plug it into the 15-pin connector J5 on the horizontal power supply PCB. This cable is keyed to prevent incorrect insertion.

e. Pick up the analog power supply cable assembly, and locate the connector marked J6. Plug this connector into the nine-pin header (J6) on the horizontal power supply PCB. Plug the connector on the other end of the cable (P-46) into the nine-pin header (J46) on the tape analog PCB. This cable is also keyed to prevent reverse insertion.

4. Replace the chassis top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.7 Processor Board Removal and Replacement

Table 6-8 lists the symptoms displayed by a faulty processor board. Figure 6-3 shows the location of the PC boards in the WD800A mass storage system.

NOTE

To work on a board in the card cage, first remove the PWB spacer (a silver bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

Table 6-8. Processor Board Fault Symptoms

Correctable Symptoms

Problem	Explanation
No LEDs illuminate on the front panel	Internal cable

Self-Test Failures

Failure	Front Panel	CSB Word 2
Processor PCB	0000	XX04 XX05 XX06 XX07 XX08 XX09
Processor PCB	1111	XXXX (front panel locked — all LEDs on)

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Disk offline
W7 = 9001	Unit error; see W0
= 90FF or 82FF	Self-test fault; see W2 status

Note:

Another symptom is that data verification errors can occur.

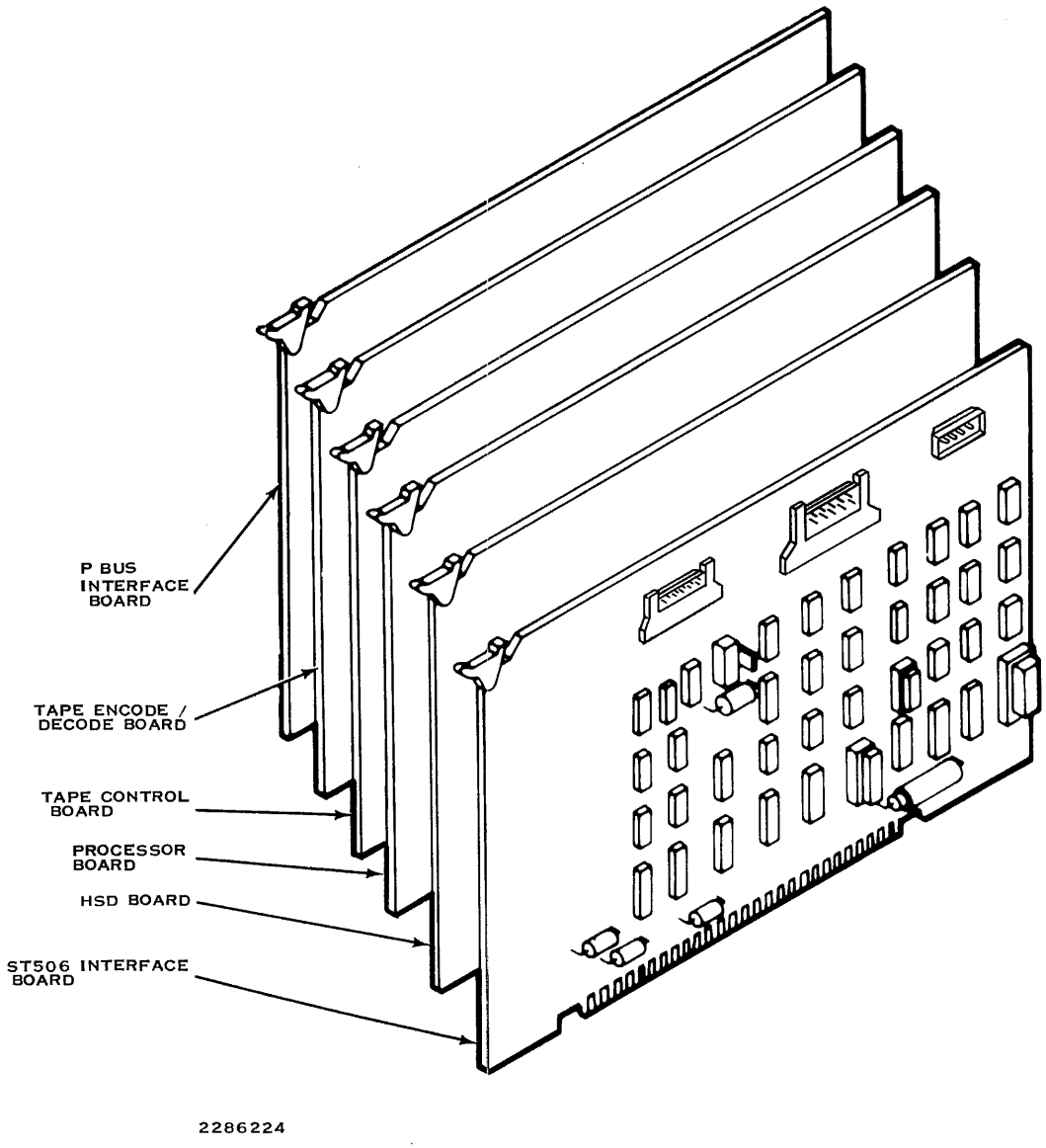

Figure 6-3. Location of PC Boards in WD800A

To remove the processor board, proceed as follows:

1. Power-down the WD800A chassis and remove the chassis top cover (see paragraph 6.4.1, disk removal step 2).

2. Locate the processor board. Counting from the outside wall of the card cage toward the inside of the chassis, it is in the fourth slot; it is the fourth board if the tape drive boards are all present. The processor board has a yellow ejector tab.

3. Remove the cable (near the ejector tab) from the processor board.

4. To remove the processor board, lift the yellow ejector tab and slide the board out of the card cage.

To install a processor board, proceed as follows:

1. Make sure that the WD800A chassis is powered-down.

2. Slide the board into the fourth slot in the card cage counting from the side nearest the outside of the chassis and press the yellow ejector tab down.

3. Install the cable (under ejector tab) on the board. Be sure that pin 1 on the connector corresponds to pin 1 on the PCB (with the red edge of the cable down).

4. Replace the chassis top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.8 PBUS Interface Board Removal and Replacement

Table 6-9 lists the symptoms displayed by a faulty PBUS interface board (see Figure 6-3).

NOTE

To work on a board in the card cage, first remove the PWB spacer (a silver bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

Table 6-9. PBUS Interface Board Fault Symptoms

Correctable Symptoms

Problem	Explanation
SYSTEM READY blinks; front panel = 1110	Internal cable or peripheral bus cable
SYSTEM READY blinks; front panel = 0010	Terminators incorrect

Self-Test Failures

Failure	Front Panel	CSB Word 2
PBUS Interface PCB	0001	XX01 XX02 XX03
Peripheral bus test failed	0010	XX3B
No CTLPRES	1110	XXXX (CSB not reported)

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Disk offline
W7 = 9001	Unit error; see W0
= 90FF	Self-test fault; see W2 status

Note:

Another symptom is that data verification errors can occur.

To remove the PBUS interface board, proceed as follows:

1. Power-down the WD800A chassis. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Locate the PBUS interface board. Counting from the outside wall of the card cage toward the inside of the chassis, it is in the first slot. The PBUS interface board has a violet ejector tab.

3. Remove the cable from the PBUS interface board. The cable is the 40-pin cable from the I/O port on the rear of the chassis.

4. To remove the PBUS interface board, lift the violet ejector tab, and slide the board out of the card cage.

To find out how the terminator packs are configured on the PBUS interface board in a particular WD800A chassis, check their position on the removed board or check the configuration label. Install terminator packs in the functioning position in the primary chassis because the chassis at the end of the daisy chain is in a multichassis configuration.

Use the following procedure to move the terminator packs:

1. Locate the terminator pack positions on the PCB (Figure 5-5).

2. Move the terminator packs, as required, to either the storage position or the functioning position.

CAUTION

Orient the terminator packs as shown in the illustration. (The dot on the pack indicates the location of pin 1.) Each terminator pack is a dual inline resistor pack. Improper orientation can destroy the packs or can cause damage to other equipment.

3. After installing the packs, check carefully that they are seated properly, as follows:

   a. Make sure the packs are oriented properly.

   b. Make sure that none of the pins are bent under the packs.

To install a PBUS interface board, proceed as follows:

1. Make sure that the WD800A chassis is powered-down.

2. Slide the board into the first slot in the card cage, counting from the side nearest the outside of the chassis, and press the ejector tab down.

3. Install the cable on the board. Be sure that pin 1 on the connector corresponds to pin 1 on the PCB (red mark down).

4. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.9 High-Speed Digital (HSD) Board Removal and Replacement

Table 6-10 lists the symptoms displayed by a faulty HSD board.

NOTE

To work on a board in the card cage, first remove the PWB spacer, which is a silver bar across the tops of the boards. Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

Table 6-10. HSD Board Fault Symptoms

Self-Test Failures

Failure	Front Panel	CSB Word 2
HSD failure	1000	XX11

Model 990 System Log Errors

CSB Codes	Error
W0 = 10X0	Disk unsafe; check W4 for analysis
W7 = 9001	Unit error; see W0
= 9010	ID error
= 9040	Data error
= 9440	Data error
= 90FF	Self-test fault; see W2 status

Note:

Another symptom is that data verification errors can occur.

To remove the HSD board, proceed as follows:

1. Power-down the WD800A chassis and remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Locate the HSD board. Counting from the outside wall of the card cage toward the inside of the chassis, it is in the fifth slot and is the fifth board if the tape drive boards are present. The HSD board has an orange ejector tab.

3. To remove the HSD board, lift the orange ejector tab and slide the board out of the card cage.

To install an HSD board, proceed as follows:

1. Make sure that the WD800A chassis is powered-down.
2. Slide the board into the fifth slot in the card cage, counting from the side nearest the outside of the chassis, and press the ejector tab down.
3. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.10 ST506 Disk Interface Board Removal and Replacement

Table 6-11 lists the symptoms displayed by a faulty disk interface board.

NOTE

To work on a board in the card cage, first remove the PWB spacer (a silver bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

Table 6-11. ST506 Disk Interface Board Fault Symptoms

Self-Test Failures

Failure	Front Panel	CSB Word 2
Disk interface failure	1001	XX10

Model 990 System Log Errors

CSB Codes	Error
W0 = 10X0	Disk unsafe; check W4 for analysis
W7 = 9001	Unit error; see W0
= 9010	ID error
= 9040	Data error
= 9440	Data error
= 9640	Data error
= 90FF	Self-test fault; see W2 status

Other Symptoms

Data verification errors can occur.

To remove the disk interface board, proceed as follows:

1. Power-down the WD800A chassis and remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Locate the disk interface board. Counting from the outside wall of the card cage toward the inside of the chassis, it is in the sixth slot and is the sixth board if the tape drive boards are present. The disk interface board has a red ejector tab.

3. Disconnect the control, data, and power cables from the disk interface board.

4. To remove the disk interface board, lift the red ejector tab and slide the board out of the card cage.

To install a disk interface board, proceed as follows:

1. Make sure that the WD800A chassis is powered-down.

2. Slide the board into the sixth slot in the card cage, counting from the side nearest the outside of the chassis, and press the ejector tab down.

3. Reconnect the 20-pin and 34-pin flat ribbon connectors to the board. The red mark should be on the side closest to the front panel. Make sure the header tabs fully lock onto connectors.

4. Reconnect the 4-pin power cable. This connector can only be installed in one way. Make sure the connector tabs fully lock on.

5. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.11 Tape Control Board Removal and Replacement

Table 6-12 lists the symptoms displayed by a faulty tape control board.

NOTE

To work on a board in the card cage, first remove the PWB spacer (a silver bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

Table 6-12. Tape Control Board Fault Symptoms

Self-Test Failures

Failure	Front Panel	CSB Word 2
Tape control	0011	XX22
Tape encode or tape control	0100	5523
Tape analog or tape control	0101	8824

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Tape offline
W7 = 8201	Tape error; see W0 (tape status)
= 82FF	Self-test fault; see W2 status

Other symptoms include the following:

- Does not try to load tape upon insertion (TAPE READY does not blink).
- Runs tape off cartridge hub during load.
- WD800A hung (the only symptom is SYSTEM READY blinking).

To remove the tape control board, proceed as follows:

1. Make sure that the WD800A chassis is powered-down. Remove the top cover (see paragraph 6.4.1, disk removal step 2).
2. Locate the tape control board. Counting from the outside wall of the card cage toward the inside of the chassis, it is in the third slot. The tape control board has a green ejector tab.
3. To remove the tape control board, lift the green ejector tab, and slide the board out of the card cage.

To install a tape control board, proceed as follows:

1. Power-down the WD800A chassis.
2. Slide the board into the third slot in the card cage, counting from the side nearest the outside of the chassis, and press the ejector tab down.

3. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.12 Tape Encode/Decode Board Removal and Replacement

Table 6-13 lists the symptoms displayed by a faulty tape encode/decode board.

NOTE

To work on a board in the card cage, first remove the PWB spacer (a silver bar across the tops of the boards). Each board is color-keyed to the slot it occupies by a colored dot on the card cage that matches the color of its ejector tab. For those boards that have cables attached, avoid inserting the connector with the pins offset.

Table 6-13. Tape Encode/Decode Board Fault Symptoms

Self-Test Failures

Failure	Front Panel	CSB Word 2
Tape control or tape encode	0011	3222 3522
Tape encode	0100	XX23
Tape analog or tape encode	0101	8824

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Tape offline or failed load
W7 = 8201	Tape error; see W0
= 8220	Data error
= 8240	Corrected data error
= 8280	Read-after-write CRC error
= 82FF	Tape failed self-test; see W2

Note:

Another symptom is that the system does not try to load tape upon insertion (TAPE READY does not blink).

To remove the tape encode/decode board, proceed as follows:

1. Power-down the WD800A chassis and remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Locate the tape encode/decode board. Counting from the side of the card cage nearest the outside of the chassis, it is in the second slot. The tape encode/decode board has a blue ejector tab.

3. Remove the cable (under the ejector tab) from the tape encode/decode board.

4. To remove the tape encode/decode board, lift the blue ejector tab and slide the board out of the card cage.

To install a tape encode/decode board, proceed as follows:

1. Power-down the WD800A chassis.

2. Slide the board into the second slot in the card cage, counting from the side nearest the outside of the chassis, and press the ejector tab down.

3. Install the cable on the board. Be sure that pin 1 on the connector corresponds to pin 1 on the PCB. In this case, the red mark on the cable must be on the top edge. Be sure the pins are not offset at the connection. Insert the cable in the cable clip on the card cage; ensure that it is not resting on the tape analog board.

4. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.13 Motherboard Removal and Replacement

A faulty motherboard causes the apparent failure of one or more of the boards in the card cage. If faults in the boards cannot be fixed by replacing boards or cables, the motherboard is suspect.

To remove the motherboard, proceed as follows:

1. Power-down the WD800A chassis. Remove the top cover (see paragraph 6.4.1, disk removal step 6).

2. Remove the cables on the PBUS interface board, tape encode/decode board, processor board, and disk interface board.

3. Remove all the boards in the card cage by lifting the ejector tab on each of them and sliding each board out of the card cage. The motherboard is the horizontal board now exposed at the base of the card cage.

4. Disconnect the motherboard cable (the 15-pin cable) from the power supply. Push the cable and connector into the card cage enclosure.

5. The motherboard has six #6 screws with lock washers, three on both the left and right edges (as viewed from the long side nearest the power supply). Locate these six screws, and remove them. Do not lose the washers; attach them to the screws so that they can

be replaced just as they were. Note that the four corner screws have nonconductive washers, while the two middle screws have metal washers. Also note that the four corner screws are of a different type than the two center screws. Do not confuse them. This configuration is necessary to maintain the correct chassis ground-logic ground scheme.

6. There are also three plastic locking-spears fixed to the floor of the chassis that point up through the motherboard. All of them have three tabs on the head of each spear to hold the board in place. Squeeze the tabs together on each spear to release the board. Remove the board.

To install a motherboard, proceed as follows:

1. Be sure the WD800A is powered-down.

2. Line up the motherboard so that the three plastic locking spears that hold the board in place align with the holes in the motherboard. Push the motherboard down over the spears into place.

3. Insert the two #6 hex head screws and #8 conductive lock washers in the center holes of the left and right edge of the motherboard. Insert the remaining four #6 screws and nylon washers in the corner holes. The washers on these screws are nonconductive. Do not tighten the screws at this point.

4. Align the slots in the motherboard with the board guide slots in the card cage. Test the alignment by inserting one of the boards. When you get a clean insertion, tighten the screws.

5. Reattach the motherboard cable to the power supply. Be sure that pin 1 on the cable connector matches pin 1 on the PCB. This cable is keyed to prevent reverse insertion.

6. Reinsert the PCBs in the card cage, being sure to insert them in the right order (they are color-keyed to the card cage). Consult the removal and replacement procedure for each.

7. Reinstall the cables on the PBUS interface board, tape encode/decode board, processor board, and disk interface board.

8. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

NOTE

Note that the red mark on the encode/decode cable is on the top edge. On the PBUS interface board and processor board, the red mark is on the bottom edge. On the disk interface board, the red marks on the two flat ribbon cables are on the side closest to the front panel. Do not confuse the orientation of the marks on these cables.

6.4.14 Motherboard Power Cable Removal and Replacement

Power is supplied to the motherboard through this cable. If faults cannot be traced to a particular board in the card cage or to the motherboard itself, this cable is suspect.

To remove the motherboard power cable, use the following procedure:

1. Turn off all power to the chassis, and wait at least 30 seconds. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Disconnect the motherboard cable (the 15-pin cable) from the power supply.

3. Disconnect the other end of the cable from the motherboard. There should be enough room to disconnect this end from outside the card cage without having to remove any of the card cage PCBs.

To replace a motherboard power cable, follow these steps:

1. Make sure the chassis is powered-down.

2. Reattach the motherboard cable to the power supply. Be sure that pin 1 on the cable connector matches pin 1 on the PCB. This cable is keyed to prevent reverse insertion.

3. Reattach the cable to the motherboard. Be sure that the orange marking for pin 1 is on the side closest to the front panel.

4. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.15 EMI Filter Assembly Removal and Replacement

For the EMI fault symptoms, refer to the power supply assembly procedure, paragraph 6.4.6.

To remove the EMI filter assembly, use the following procedure:

1. Turn off all power to the chassis, and wait at least 30 seconds. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Disconnect the ac input line at J1 on the filter board.

3. Unscrew the grounding strap located between the fan and EMI filter. Be sure not to drop or lose the hardware.

4. Remove the four screws at the corners, and lift the EMI filter out of the chassis.

To replace an EMI filter assembly, follow these steps:

1. Make sure the chassis is powered-down.

2. Align the holes in the corners of the filter with the holes in the chassis. Insert the screws.

3. Reattach the grounding strap located between the fan and EMI filter. Make sure to account for all the hardware from the removal process.

4. Reconnect the ac input line at J1 on the filter board.

5. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.16 Front Panel Board Removal and Replacement

If the front panel LEDs do not come on, come on at inappropriate times, or are dim while the front panel cable and the processor board are good, then the front panel board is suspect.

To remove the front panel board, proceed as follows:

1. Power-down the chassis. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Disconnect the front panel cable; for the moment, insert it in a cable clip to keep it away from the tape analog board.

3. Unsnap the front plastic bezel.

4. Unscrew the front panel board from the outside of the chassis, being careful not to allow the board to fall when the last screw is removed. Remove the board.

To replace the front panel board, proceed as follows:

1. Make sure the chassis is powered-down.

2. Align the front panel board stand-offs with the three chassis holes, and install the screws.

3. Reinsert the front panel cable at the top corner of the board nearest the tape drive; be sure pin 1 on the connector matches pin 1 on the board.

4. Snap on the front plastic bezel.

5. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.17 Internal I/O Cable Removal and Replacement

The internal I/O cable fault symptoms are the same as those for the peripheral bus cable, paragraph 6.4.5.

To remove the internal I/O cable, proceed as follows:

1. Power-down the chassis and wait 30 seconds. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Remove the two connectors from the card cage side of the I/O ports on the back wall of the chassis.

3. Remove the connector on the other end of the cable from the PBUS interface board. Lift the cable out of the chassis.

To replace the internal I/O cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Attach the single end of the cable to the PBUS interface board. Make sure that pin 1 on the connector matches pin 1 on the board. The red mark on the cable must be on the bottom edge of the cable.

3. Without twisting the cable, install the two connectors in the two I/O ports on the back inside wall of the chassis.

4. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.18 Front Panel Cable Removal and Replacement

If the front panel lights are out, or the wrong lights are on and power is applied to the chassis, the front panel cable is suspect.

To remove a faulty front panel cable, proceed as follows:

1. Power-down the chassis and wait 30 seconds. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Unplug the front panel cable from the edge of the front panel board.

3. Unplug the front panel cable from the processor board in the card cage (yellow ejector tab).

4. Remove the cable from the cable clips, and lift it out of the chassis.

To replace the front panel cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Insert connector P16 in the front panel board at the top corner nearest the tape drive.

NOTE

The front panel cable is not interference-keyed. Pin 1 of the cable must be oriented toward the bottom of the chassis on both ends of the cable (red mark down).

3. Insert connector P26 in the processor board. Be sure pin 1 on the connector matches pin 1 on the board (red mark down). Be sure the connector is not offset from the pins.

4. Insert the cable in the clip on the card cage. Fold the cable and insert the fold in this clip.

5. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

NOTE

Be sure that the clips keep the front panel cable from touching the tape analog board.

6.4.19 Tape Analog Power Cable Removal and Replacement

Table 6-14 lists the symptoms displayed by a faulty tape analog power cable.

Table 6-14. Tape Analog Power Cable Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails power-up self-test, front panel = 0101	Cable not connected properly

Self-Test Failures

Failure	Front Panel	CSB Word 2
Tape drive assembly	0101	8824

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Tape offline or failed load
W7 = 8201	Tape error; see W0
= 82FF	Tape failed self-test; see W2

Other symptoms include the following:

- Does not try to load tape upon insertion (TAPE READY does not blink)
- Runs tape off end

To remove the tape analog power cable, proceed as follows:

1. Power-down the chassis and wait 30 seconds. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Remove the cable from the analog board. It is attached at the back right, as viewed from the front of the chassis.

3. Remove the other end of the cable from the power supply. Be careful to avoid touching any circuits that might retain current.

To replace the analog power cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Attach cable connector P46 to J46 on the analog board. The cable is keyed to prevent reverse insertion, but be careful not to insert the connector offset from the pins.

3. Attach cable connector P6 to J6 on the power supply. The cable is keyed to prevent reverse insertion, but be careful not to insert the connector offset from the pins.

4. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.20 Tape Encode/Decode Cable Removal and Replacement

Table 6-15 lists the symptoms displayed by a faulty tape encode/decode cable.

Table 6-15. Tape Encode/Decode Cable Fault Symptoms

Correctable Symptoms

Problem	Explanation
Fails power-up self-test, front panel = 0101	Cable not connected properly

Self-Test Failures

Failure	Front Panel	CSB Word 2
Tape drive assembly	0101	8824

Model 990 System Log Errors

CSB Codes	Error
W0 = 80X0	Tape offline or failed load
W7 = 8201	Tape error; see W0
= 82FF	Tape failed self-test; see W2

Note:

Another symptom is that the system does not try to load tape upon insertion (TAPE READY does not blink).

To remove the tape encode/decode cable, proceed as follows:

1. Power-down the chassis. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Disconnect the cable from the analog board.

3. Disconnect the cable from the encode/decode board in the card cage.

To replace the tape encode/decode cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Install connector P45 of the cable into J45 of the analog board. Be sure pin 1 of the connector corresponds to pin 1 on the board. Be careful not to insert the connector offset from the pins.

3. Install connector P25 of the cable on J25 of the encode/decode board. Be sure pin 1 of the connector corresponds to pin 1 on the board; the red mark is on the top edge of the cable. Be careful not to insert the connector offset from the pins.

4. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.21 ST506 Disk Interface Control Cable Removal and Replacement

The fault symptoms for the disk interface control cable are the same as those for the disk drive which are listed in paragraph 6.4.1.

To remove the disk interface control cable, proceed as follows:

1. Power-down the chassis. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Disconnect the cable from the disk drive.

3. Disconnect the cable from the disk interface board.

4. Remove the cable from the cable clips and then remove the cable from the chassis by pulling it out through top of the card cage.

To replace the disk interface control cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Drop the cable through the top of the card cage, and pull disk connector end P2 through the slot that runs along the bottom half of the front of the card cage. Connect P1 of the cable to J2 of the disk interface board. Pin 1 of the cable (marked in red) should be on the side closest to the front of the chassis.

3. Route the other end of the cable underneath the disk interface data cable, so that it pins the data cable to the inside wall of the card cage. Connect P2 of the cable to the disk drive. Connector P2 is keyed to prevent incorrect installation. Pin 1 will be on the side closest to the card cage.

4. Insert the cable into the two cable clips located on the inside wall of the card cage. Also, insert the cable into the clip located on the bottom of the chassis along with the data cable.

5. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.22 ST506 Disk Interface Data Cable Removal and Replacement

The fault symptoms for the disk interface data cable are the same as those for the disk drive which are listed in paragraph 6.4.1.

To remove the disk interface data cable, proceed as follows:

1. Power-down the chassis. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Disconnect the cable from the disk drive.

3. Disconnect the cable from the disk interface board.

4. Remove the cable from the cable clips. Disconnect the cable from the disk interface board and remove the cable from the chassis.

To replace the disk interface data cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Drop the cable through the top of the card cage and pull disk connector end P2 through the slot that runs along the bottom half of the front of the card cage. Connect P1 of the cable to J1 of the disk interface board. Pin 1 of the cable (marked in red) should be on the side closest to the front of the chassis.

3. Route the other end of the cable between the disk interface control cable and the inside wall of the card cage. Connect P2 of the cable to the disk drive. Connector P2 is keyed to prevent incorrect installation. Pin 1 will be on the side closest to the card cage.

4. Insert the cable into the cable clip located on the bottom of the chassis. This cable clip is used for the data and control cables.

5. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.23 ST506 Disk Interface Power Cable Removal and Replacement

The fault symptoms for the disk interface power cable are the same as those for the disk drive which are listed in paragraph 6.4.1.

To remove the disk interface power cable, proceed as follows:

1. Power-down the chassis. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Disconnect the cable from the disk drive.

3. Remove the cable from the cable clips. Disconnect the cable from the disk interface board and remove it from the chassis.

To replace the disk interface power cable, proceed as follows:

1. Make sure the chassis is powered-down.

2. Insert the locking connector of the cable in J3 of the disk interface board.

3. Route the cable underneath the tape DC power cable and insert it into the two cable clips located on the left and right sides of the card cage.

4. Connect the other end of the cable to the disk drive. This connector is keyed to prevent incorrect installation. Make sure the power cable is not draped across the horizontal power supply board.

5. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.24 Power Cord Removal and Replacement

A bad power cord prevents power from reaching the chassis, the fan, and the lights. If these assemblies do not work, the power cord is suspect.

To remove the ac power cord, proceed as follows:

1. Power-down the chassis.

2. Unplug the power cord from the receptacle in the switch plate cutout on the back of the chassis.

3. Unplug the other end of the ac power cord from the power strip on the rack.

4. Loosen cable ties as necessary along the length of the cable, and remove the cable.

To replace the ac power cord, perform the following steps:

1. Make sure that the ac power switch is turned to OFF.

2. Connect the female end of the ac power cord to the ac cord receptacle located in the switch plate cutout on the rear of the WD800A chassis.

3. Dress the cord out to the left vertical rack rail and tie it down (below the level of the chassis) on the inside of the rail.

CAUTION

If the ac power cord is not routed as indicated, it can get caught between the ball stud and ball stud receptacle. The resulting stress can damage the cord and possibly the system.

4. Plug the other end of the cord into an available ac outlet on the rail.

6.4.25 Voltage Change Jumper Plug Removal and Replacement

For a discussion of the voltage change jumper plug fault symptoms and removal and replacement procedures, refer to the discussion on power supply removal and replacement (paragraph 6.4.6).

6.4.26 Cooling Fan and Cable Removal and Replacement

If the fan does not turn and it is not obstructed, the fan and cable assembly is suspect.

To remove the fan and cable assembly, proceed as follows:

1. Disconnect the power from the chassis. Remove the top cover (see paragraph 6.4.1, disk removal step 2).

2. Disconnect the fan cable from the power supply.

3. Being careful not to drop any of the hardware, remove the four screws at the corners of the fan assembly. This releases the fan, the wire guards, and the clips and screws.

4. Lift the fan and cable assembly out of the chassis.

To replace the fan and cable assembly, proceed as follows:

1. Make sure the chassis is powered-down.

2. Being careful to control all the associated hardware, align the fan assembly with the holes in the chassis back wall.

3. Insert the fan screws.

4. Reconnect the fan cable to the power supply.

5. Replace the top cover (see paragraph 6.4.1, disk replacement step 6).

6.4.27 Fuse Removal and Replacement

For the fault symptoms pertaining to the fuse, refer to the discussion of the power supply fault symptoms, paragraph 6.4.6.

To remove the fuse, proceed as follows:

1. Disconnect the power cord, and wait 30 seconds.

2. Locate the round fuse on the switch plate cutout on the back of the chassis.

3. Place a flat-blade screwdriver in the fuse slot. Push in slightly, and turn one-half turn counterclockwise to remove the fuse.

To replace the fuse, proceed as follows:

1. Make sure the chassis power is disconnected.
2. Insert the fuse.
3. Place a flat-blade screwdriver in the fuse slot. Push in slightly and turn one-half turn clockwise to install the fuse.

6.5 VERIFICATION TESTS

To verify that the system is functional after all faulty parts are replaced, use the standard diagnostics described in the diagnostics handbooks listed in the Preface.

6.6 ILLUSTRATED PARTS BREAKDOWN

Figure 6-4 shows an exploded view of the WD800A mass storage system.

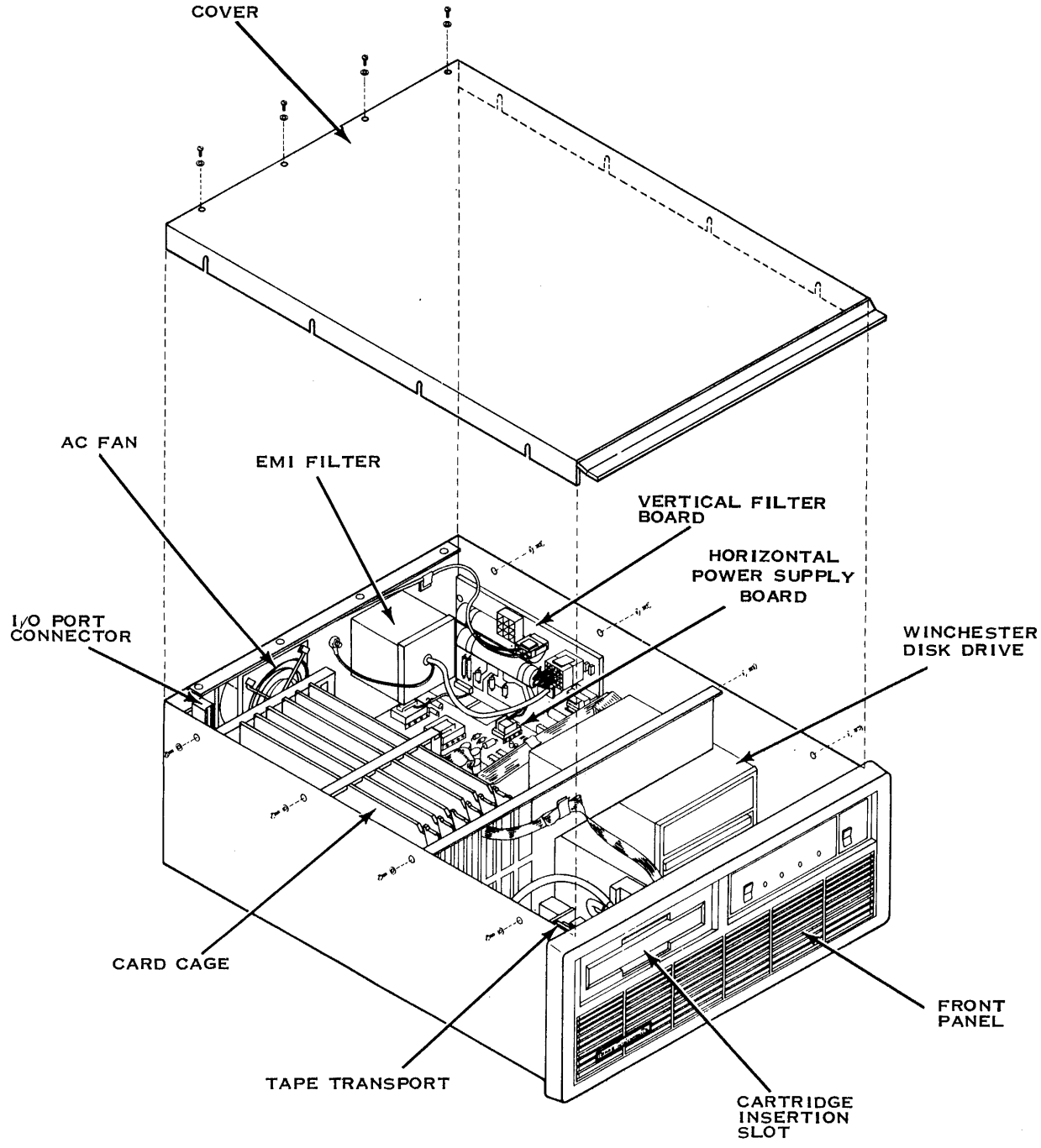

Figure 6-4. WD800A Mass Storage System — Exploded View (Sheet 1 of 3)

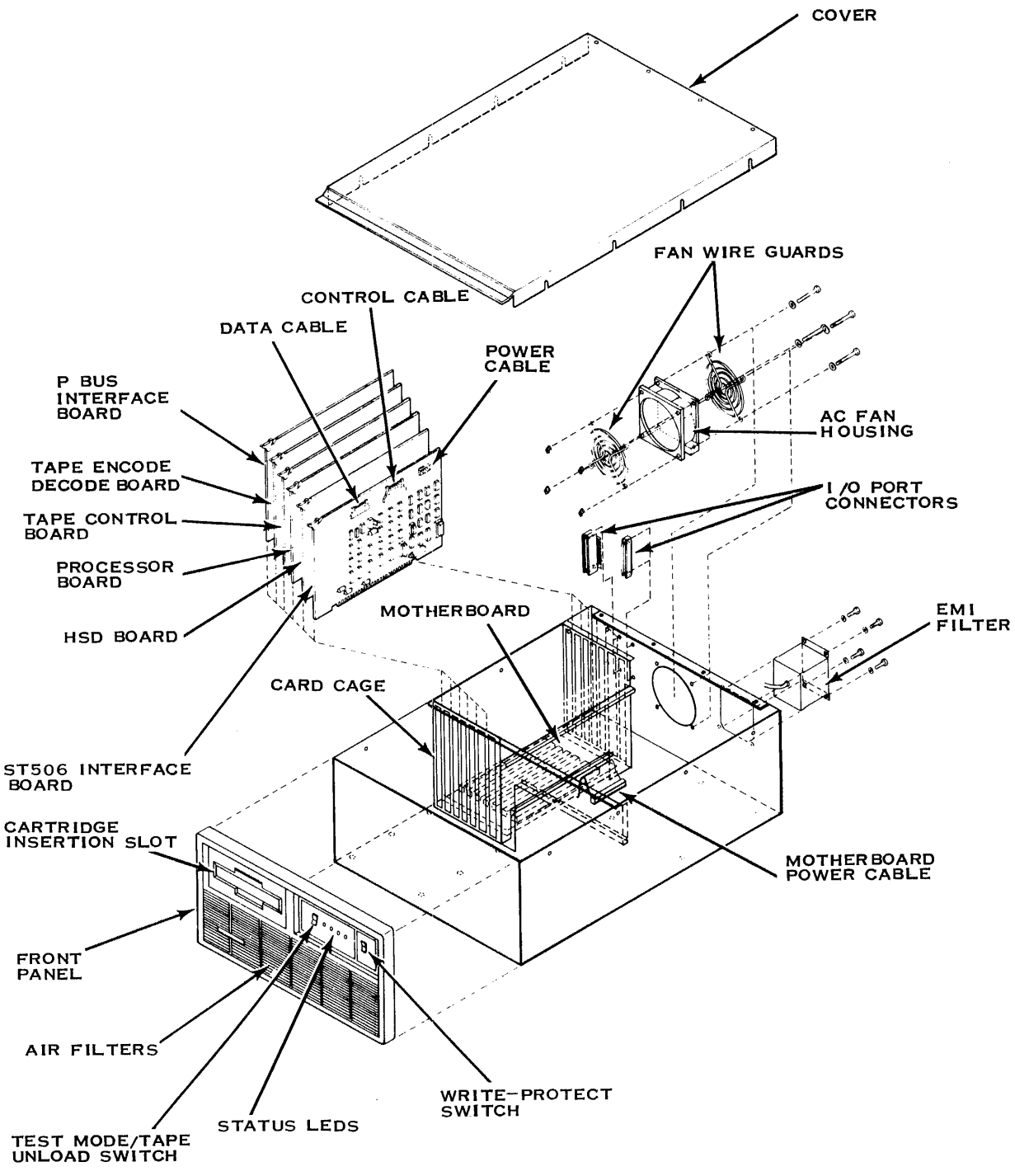

Figure 6-4. WD800A Mass Storage System — Exploded View (Sheet 2 of 3)

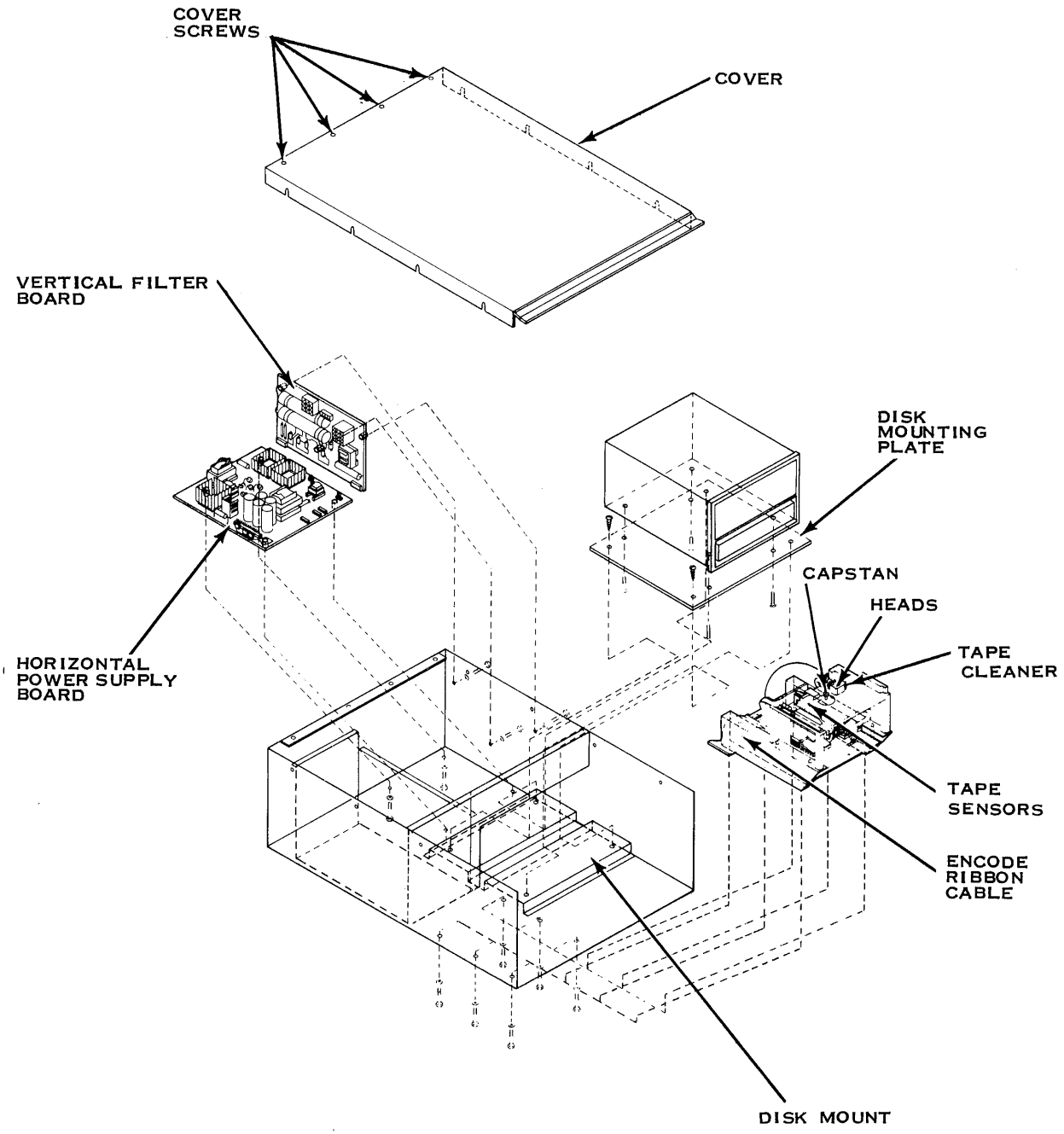

Figure 6-4. WD800A Mass Storage System — Exploded View (Sheet 3 of 3)

7

S300 PBI Controller Corrective Maintenance

7.1 GENERAL

Corrective maintenance procedures are divided into three categories: troubleshooting, component removal and replacement, and verification after correcting the problem. Built-in self-tests in the Business System 300 (S300) or Business System 300A, as well as diagnostic software routines, facilitate troubleshooting and verification after corrective maintenance. The corrective maintenance philosophy for the S300 PBI controller and PBI cable is to isolate the failure to a replaceable subassembly and replace that subassembly.

7.2 SAFETY AND PRECAUTIONS

CAUTION

When removing or replacing S300 or S300A assemblies, be sure that power is removed from all system units. If power is not removed, electronic components can be damaged.

7.3 CORRECTIVE MAINTENANCE SUPPLIES

Table 7-1 lists corrective maintenance supplies required to perform the procedures in this section.

Table 7-1. S300/S300A Maintenance Tools, Equipment, and Supplies

Item	TI Part Number
Maintenance diagnostic unit (MDU) or Alternative diagnostic loading device	946710-0001 (115 Vac) 946710-0002 (230 Vac)
Flat-blade screwdriver	Commercially available
Diagnostic kit (diskette media)	937782-0021
S300 PBIC board	2532840-0001
S300 processor board	2532810-0001
S300A processor board	2232020-0001
PBI cable, 2 meters	2308633-0002

7.4 TROUBLESHOOTING

The following paragraphs describe how to troubleshoot the S300 PBI controller.

7.4.1 PBI Controller Types

The S300/S300A computers use two different PBI controllers. Early model S300s use the PBIC board, which is very similar to the TPBI board. Later model S300s use a custom mass storage interface controller (MSIC) chip to implement the PBI controller function. The MSIC is located on the processor board, whereas the PBIC is a separate board.

7.4.2 Self-Test Indicators

When troubleshooting the S300 PBI controller, a fault can typically be isolated to a defective assembly by using the self-test results from the S300/S300A processor and/or PBIC.

7.4.2.1 PBIC Indicator. The PBIC board has one red LED fault indicator. This LED comes on at power up and is turned off after all PBIC self-tests have completed with no errors. The error LED will remain on whenever a PBIC self-test error is encountered. The self-test process also can be initiated by a reset from the processor.

The PBIC self-test interacts with the processor and the formatter. Because of this, a PBIC fault can indicate a PBIC, processor, PBI cable, or formatter fault.

The PBIC fault LED is turned on by a processor reset which can come from the power supply. A defective reset circuit on the power supply or processor can cause the PBIC LED to always remain on; in this case, the processor LEDs would also remain on.

A blinking fault LED indicates that the PBIC has detected a PBI error. Bus errors may be caused by failures in the PBIC, PBI cable, or the formatter. If a mass storage system is powered down and then up while a command is in progress, a PBI error (blinking LED) will result.

7.4.2.2 Processor Indicators. The S300/S300A processor board has eight LEDs that report the results of its self-test. These results can indicate a PBIC failure in systems with a PBIC. In systems where the processor has an MSIC-based PBI controller, the LEDs also indicate the results of the MSIC self-test and PBI loopback test.

The processor LED self-test codes associated with the PBI controller are as follows:

LED Indicator Number*								
L1	L2	L3	L4	L5	L6	L7	L8	
G	R	R	R	R	R	R	R	**Fault Description**
0	1	0	1	1	0	0	0	Major PBI controller fault (PBIC or MSIC)
1	0	0	1	1	0	0	1	PBIC or MSIC internal self-test fault
1	0	0	1	1	0	1	0	Memory write fault (MSIC versions only)
1	0	0	1	1	0	1	1	Level 9 interrupt fault (2nd PCS space)
1	0	0	1	1	1	0	0	Level 13 interrupt fault (1st PCS space)
1	0	0	1	1	1	0	1	PBI loopback fault (MSIC versions only)

Note:

*G = green LED; R = red LED.

If other S300/S300A self-test LEDs are on, other S300/S300A errors have been detected. These errors must be resolved before continuing mass storage failure analysis.

If the PBI cable connection to the S300/S300A is broken or intermittent, erratic operation may result. Make sure the unit has a spring-latch clip on the S300 PBI connector to secure the PBI cable. The spring-latch clip is required on all S300/S300A installations.

For additional information on the S300/S300A and its self-test, and for troubleshooting procedures to isolate S300/S300A PBI controller failures, refer to the *Business System 300 Field Maintenance Manual* or the *Business System 300A Field Maintenance Manual.*

7.5 REMOVAL AND REPLACEMENT PROCEDURES

Refer to the *Business System 300 Field Maintenance Manual* or the *Business System 300A Field Maintenance Manual* for removal and replacement procedures for S300/S300A components.

7.6 VERIFICATION TESTS

The S300/S300A system and WD800/WD800A diagnostics should be used to verify proper operation after replacement of an S300/S300A component. Refer to the appropriate *Unit Diagnostics Handbook* for test details.

Appendix A

TPBI Error Status Matrix

The tables in this appendix show the contents of the TILINE peripheral control space (TPCS) registers word 0 and word 7 for various commands and status conditions. Table A-1 shows the register contents for disk use, and Table A-2 shows the register contents for tape use. Figures A-1 and A-2 show the disk and tape control/status blocks.

The tables in this appendix use the following abbreviations:

- S = Set (1)
- C = Clear (0)
- X = Bit checked by formatter and action taken if set (1)
- P = Bit presented according to present state

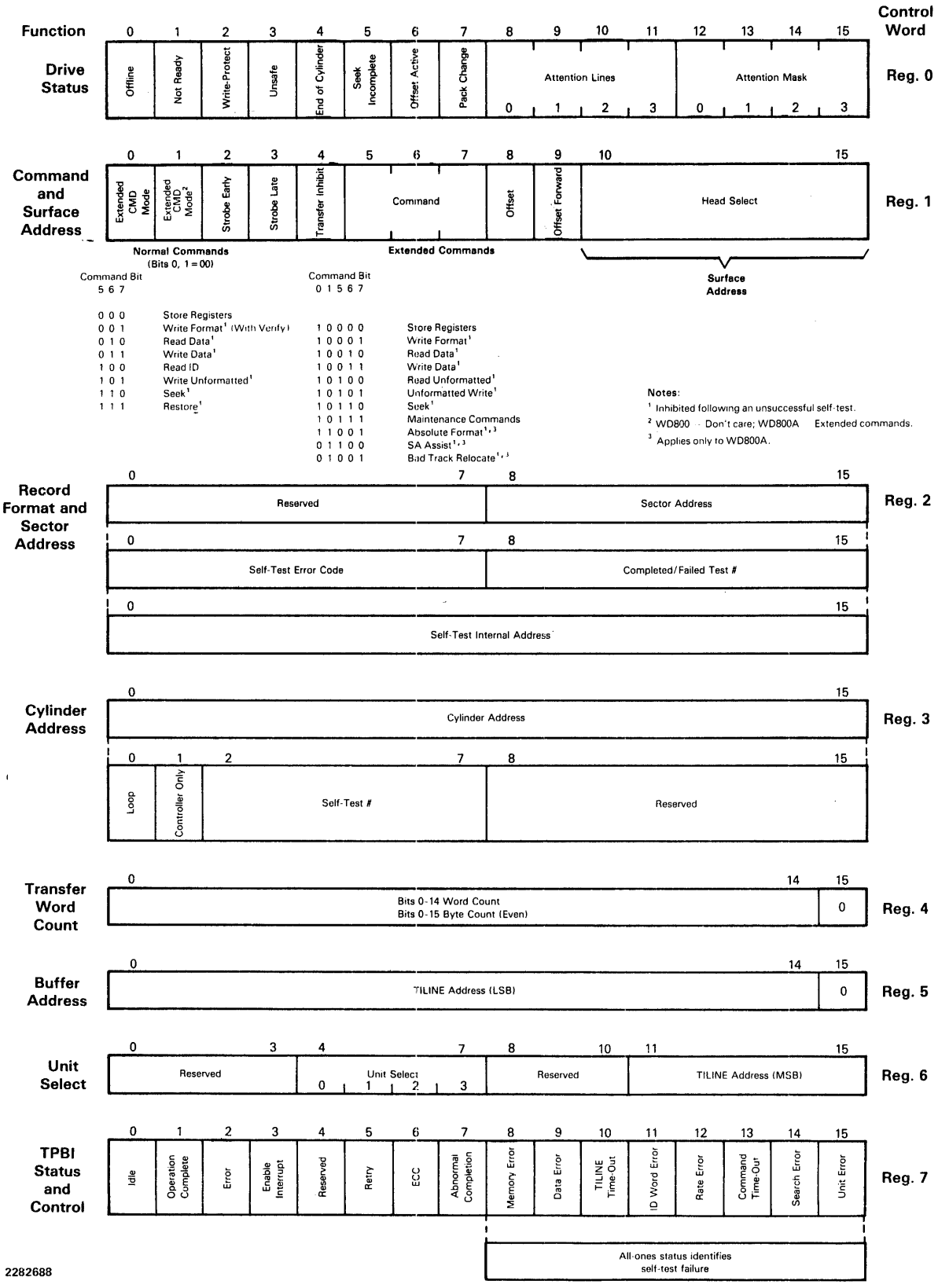

Figure A-1. Disk Contol and Status Block

Table A-1. TPBI Disk Error Status Matrix

Bit Number	Device Register 0							Device Register 7								
	0	1	2	3	4	5	7	5	6	7	8	9	10	11	12	13	14	15
Condition	OFLI	NORD	WTPR	UNSA	ENDCYL	SKIN	PKCG	RET	EC	ABCM	MEER	DAER	TLTO	IDER	RAER	CMTO	SEER	UNER
Power-up status																		
Self-test passed																		
Media present	C	C		S	C	C	S											
Media absent	S			C			C											
Self-test failed	C	C		S	C	C	C											
Controller present																		
Media absent	S	C	C	C	C	C	C											
Loss status				S			S											
Self-test failed	C	C	C	S	C	C	C											
Catastrophic error																		
CSB is present	C	C	C	S	C	C	C											S
CSB not present	C	C	C	S	C	C	C											
Store registers **	X	X		X		X												S
Bus transfer fault										S								
Format track	X	X		X		X	X											S
Write protected			X															S
Transfer fault										S								
Invalid cylinder						S												S
Invalid head					S													S
Write fault				S														S
Surface anal fail												S						

Table A-1. TPBI Disk Error Status Matrix (Continued)

Bit Number	Device Register 0							Device Register 7								
	0	1	2	3	4	5	7	5	6	7	8	9	10	11	12	13	14	15
Condition	OFLI	NORD	WTPR	UNSA	ENDCYL	SKIN	PKCG	RET	EC	ABCM	MEER	DAER	TLTO	IDER	RAER	CMTO	SEER	UNER
Read data	X	X		X		X	X											S
Transfer fault										S								
Sector # too big																S		
ID not found								S						S				
Data not found								S									S	
Data with ECC cor								S	S									
Data error/no cor								S				S						
Rem N/Match W/ECC C								S	S			S						
Invalid cylinder						S												S
Invalid head					S													S
Media removed During command	S																	
Write data	X	X		X		X	X											S
Write protected			X															S
Sector # too big																S		
Transfer fault										S								
ID not found								S						S				
Invalid cylinder						S												S
Invalid head					S													S
Write fault				S														S
Media removed During command	S																	
Read ID	X	X		X		X	X											S
Transfer fault										S								
Unformatted write	Not supported in WD500 chassis															S		

Table A-1. TPBI Disk Error Status Matrix (Continued)

Bit Number	Device Register 0							Device Register 7									
	0	1	2	3	4	5	7	5	6	7	8	9	10	11	12	13	14	15
Condition	OFLI	NORD	WTPR	UNSA	ENDCYL	SKIN	PKCG	RET	EC	ABCM	MEER	DAER	TLTO	IDER	RAER	CMTO	SEER	UNER
Seek	X	X		X		X	X											S
CMD cycle comp to cyl 0		S																
Cyl other than 0 to destination																		
Miss destination		S																
Completion Without error		C																
With error		C				S												
Invalid cylinder						S												S
Restore	X	X		X*														S
Initiate		S		C		C	C		C									
Completion		C																
Store registers extended	Same as Store Registers																	
Format track extended	Same as Format Track																	
Read data extended	Same as Read Data																	
Write data extended	Same as Write Data																	
Unformatted write extended	Same as Unformatted Write																	
Seek extended	Same as Seek																	
Absolute format command <C1	Same as Format Track																	

Table A-1. TPBI Disk Error Status Matrix (Continued)

Bit Number	Device Register 0							Device Register 7									
	0	1	2	3	4	5	7	5	6	7	8	9	10	11	12	13	14	15
Condition	OFLI	NORD	WTPR	UNSA	ENDCYL	SKIN	PKCG	RET	EC	ABCM	MEER	DAER	TLTO	IDER	RAER	CMTO	SEER	UNER
Read unformatted	X	X		X		X	X											S
Transfer fault										S								
Sector # too big																S		
ID not found								S						S				
Data not found								S									S	
Invalid cylinder						S												S
Invalid head					S													S
Maintenance Commands																		
Self-test																		
Pass tests																		
Fail tests ***				S							S	S	S	S	S	S	S	S
Others	As defined by specific device																	

- All bits of R7 LSB will be cleared in the command decoder

+ All bits of R7 LSB will be set on test failure

* The unsafe bit will be cleared, depending on the status of the self-test results

** If the indicated (X) condition bits are set, the return status will have the unit error (UN ER) bit set after the command executes

*** If a self-test fails, the test number and subtest number can be determined from device register 2 as follows:

'-Device Register 2'
MSBYTE = subtest error code
LSBYTE = self-test number

Priority of device states:

1. Device fault (self-test fail)
2. Offline
3. Pack change
4. Not ready

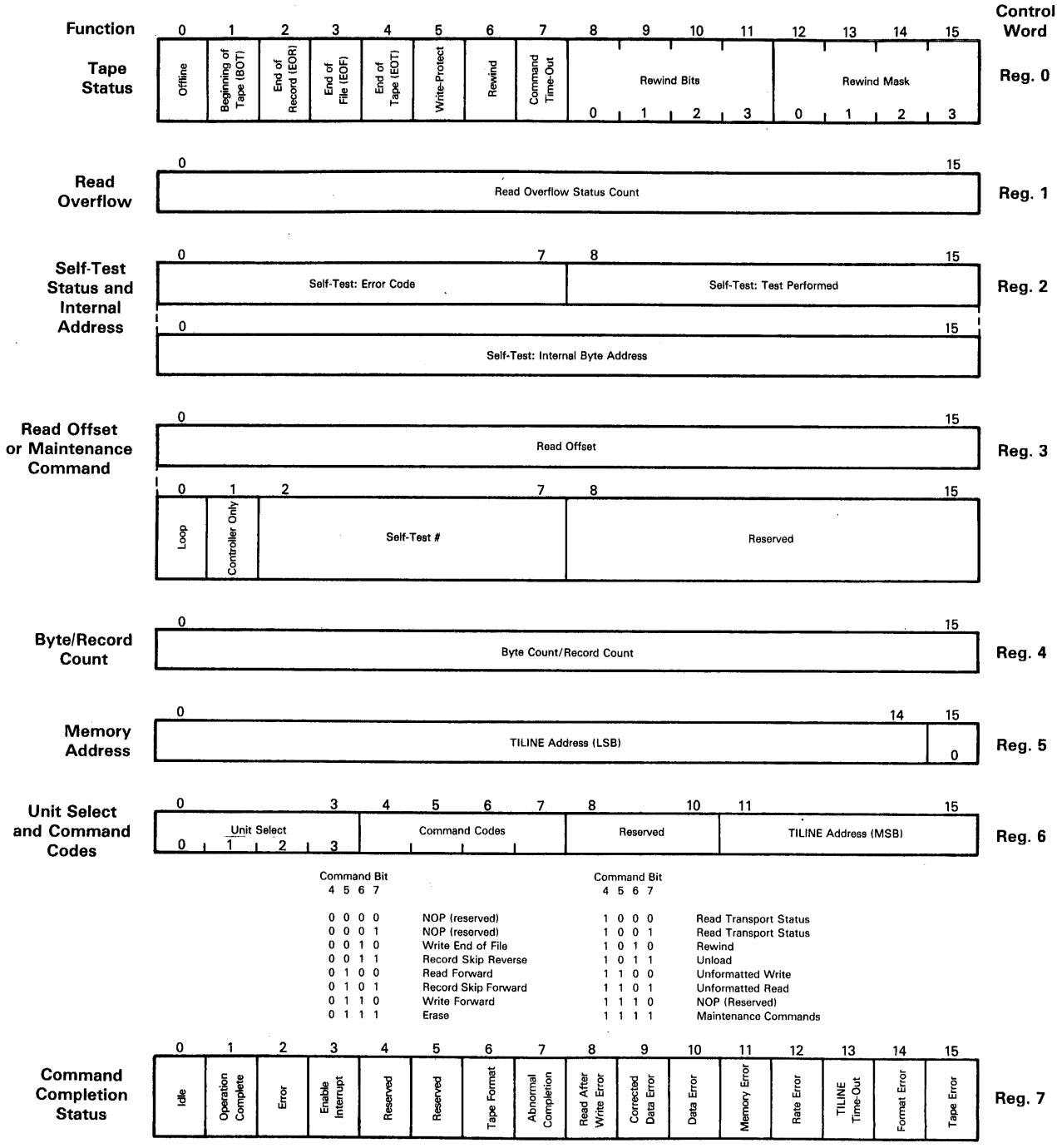

Figure A-2. Tape Control and Status Block

Table A-2. TPBI Tape Error Status Matrix

	Device Register 0								Device Register 7								
Bit Number	0	1	2	3	4	5	6	7	7	8	9	10	11	12	13	14	1
Condition	OL	BT	ER	EF	ET	WP	RW	CT	AC	RA	CE	DE	*	RE	*	FE	EE
Power-up status																	
Self-test passed																	
Media loading	S	C	C	C	C	C	C	C									
Load complete	C	S	C	C	C	C	C	C									
Self-test failed or media load failed	S	C	C	C	C	C	C	C									
Device fault sensed																	
CSB active	S	C	C	C	C	C	C	C									S
CSB not active	S	C	C	C	C	C	C	C									
PBI transfer fault with CSB active									S								
Media removed																	
CSB active	S	C	C	C	C	C	C	C									S
CSB not active	S	C	C	C	C	C	C	C									
Formatter receives CSB																	
Self-test failed (and not maint. command)	S	C	C	C	C	C	C	C	C	S	S	S	S	S	S	S	S
Self-test passed (or maint. command)		C	C	C	C	C		C	C	C	C	C	C	C	C	C	C
NOP and Read Transport Status command entry	X	P	P	P	P	P	P	P									S

Table A-2. TPBI Tape Error Status Matrix (Continued)

	Device Register 0								Device Register 7								
Bit Number	0	1	2	3	4	5	6	7	7	8	9	10	11	12	13	14	15
Condition	OL	BT	ER	EF	ET	WP	RW	CT	AC	RA	CE	DE	*	RE	*	FE	TE
Write EOF command																	
Entry	X						X										S
Write protected						S											S
End of tape marker					S												S
Track switching							S										S
Verify error												S					
Failsafe timer								S									S
Tape format error																S	
Skip Reverse																	
Entry	X						X										S
Failsafe timer								S									S
Beginning of tape		S															S
End of file mark				S													S
Read Data Forward																	
Entry	X						X										S
End of tape marker					S												S
Track switching							S										S
Failsafe timer								S									S
End of record		S															S
End of file read				S													S
Data error detected																	
No err in data xfr											S						
Error in data xfr												S					
Data overrun														S			
Data format faulty																S	

Table A-2. TPBI Tape Error Status Matrix (Continued)

	Device Register 0								Device Register 7								
Bit Number	0	1	2	3	4	5	6	7	7	8	9	10	11	12	13	14	15
Condition	OL	BT	ER	EF	ET	WP	RW	CT	AC	RA	CE	DE	*	RE	*	FE	TE
Skip Forward Entry	X						X										S
Failsafe timer								S									S
End of tape marker					S												S
End of file mark				S													S
Write Data Forward Entry	X						X										S
Write protected						S											S
End of tape marker					S												S
Track switching							S										S
Data verify error										S							
Verify format error										S						S	
Data underrun														S			
Failsafe timer								S									S
Erase Entry	X						X										S
Write protected						S											S
End of tape marker					S												S
Failsafe timer								S									S
Track switching							S										S
Failure to erase																S	

Table A-2. TPBI Tape Error Status Matrix (Continued)

	Device Register 0								Device Register 7							
Bit Number	0	1	2	3	4	5	6	7	7	8	9	10	11	12	13	14	15
Condition	OL	BT	ER	EF	ET	WP	RW	CT	AC	RA	CE	DE	*	RE	*	FE	TE
Rewind Entry	X						X										S
Starts ok							S										
Completes ok		S					C										
Failsafe timer	S																S
Unload Entry	X						X										S
Starts ok							S										
Completes ok	S						C										
Failsafe timer	S																S
Unformatted Write Entry	X						X										S
Write protected						S											S
End of tape marker				S													S
Track switching							S										S
Failsafe timer								S									S
Amplitude dropout										S						S	

Table A-2. TPBI Tape Error Status Matrix (Continued)

Bit Number	Device Register 0								Device Register 7								
	0	1	2	3	4	5	6	7	7	8	9	10	11	12	13	14	15
Condition	OL	BT	ER	EF	ET	WP	RW	CT	AC	RA	CE	DE	*	RE	*	FE	TE
Unformatted Read Entry	X						X										S
End of tape marker					S												S
Track switching							S										S
Amplitude dropout			S														S
Data overrun														S			
No data found								S									S
Maintenance Commands Entry	P																
Other status as required by specific device																	
Unload Switch Start unload							S										
Completion	S						C										

Appendix B

AC Voltage/Frequency Conversion

B.1 AC VOLTAGE/FREQUENCY CONVERSION

To convert to a different ac input voltage and/or frequency, use the following procedure:

1. Using the information in Tables 1-5 and 1-6, obtain the components required for the selected voltage/frequency. The components include:

   a. Voltage selection jumper plug (120 volts or 220 volts/240 volts)

   b. Power cord (120 volts, 220 volts, or 240 volts)

   c. Fuse (fuse size/type differs depending on voltage and configuration)

   d. Fuse holder (120 volts or 220 volts/240 volts)

   e. Fan, tubeaxial, with cable and connector (120 volts or 220 volts/240 volts)

2. Using the removal and replacement procedures in Sections 5 and 6, exchange the voltage/frequency selection components as required.

3. Modify the Winchester disk drive belt position (WD800 only) to match the frequency of the disk unit to the frequency available at your site. Refer to paragraph 5.4.2 for instructions on how to change the belt position.

4. Modify the power rating label and the fuse rating label on the back panel to reflect the new voltage and/or frequency.

5. More detailed information is provided in the *Modification Procedure, Voltage/Frequency, 990 WD800* and in the *Modification Procedure, Voltage, WD800A*. For quick reference, Table B-1 has been provided for the WD800A.

Table B-1. WD800A Voltage Conversion Chart

Component	120 volts	220 volts	240 volts
Line cord	0996289-1	0996290-1	2211739-1
Fan	2239645-1	2239645-2	2239645-2
Power jumper	2231510-1	2231510-2	2231510-2
Fuseholder	2210402-3	2210402-2	2210402-2
Fuse	0416434-603	2220531-6	2220531-6
Fuse rating label	2218098-1	2218098-3	2218098-3
Fuse (tape only units)	0416434-203	22250531-4	22250531-4
Fuse rating label (tape only units)	2218098-5	2218098-4	2218098-4
ID/SN label	Depends on dash number		

Appendix C

Bad-Track Mapping (WD800A)

The following discussion of bad-track mapping refers only to the WD800A.

Bad tracks found during the surface analysis of a WD800A are either remapped (relocated) or mapped out (deallocated). The WD800A reserves ten spare cylinders for use as replacement track locations. The surface analysis procedure will relocate as many bad tracks as possible to the replacement track locations. The maximum number of relocated tracks is equal to the number of spare tracks reserved on the disk. Any bad tracks that are not relocated to spare locations are deallocated. The maximum number of deallocated tracks is 64.

Bad-track mapping is implemented through the use of tables containing the bad-track addresses. The WD800A stores three types of bad-track map tables. One type of bad-track map is used for DNOS and DX10 operating systems. It contains the addresses of deallocated tracks only. The second type of map is the diagnostic bad-track map, which contains the addresses of all relocated and deallocated tracks. This map does not list spare tracks used for reallocation. The third type of map is the internal bad-track map, also referred to as the formatter bad-track map. This map contains the address of each bad track that is relocated along with the spare track address it was relocated to. The formatter bad-track map does not contain any deallocated tracks. The three types of bad-track tables are listed in Table C-1.

Table C-1. WD800A Bad-Track Maps

Bad-Track Map Type	Deallocated Track Address	Relocated Track Address	Spare Track Address
DNOS/DX10 Operating System	Yes	No	No
Diagnostic Bad-Track Map	Yes	Yes	No
Internal Bad-Track Map (Formatter Bad-Track Map)	No	Yes	Yes

Relocated tracks are transparent to DX10 and DNOS. When a command that includes a seek or implied seek is issued to the WD800A, the formatter searches its bad-track map table to determine whether the requested track has been relocated. If the requested track address matches one listed in the bad-track map, the formatter substitutes the replacement track physical address in performing the seek operation.

When a bad track is relocated, the addresses of the bad track and the replacement track are added to the internal bad-track map. The bad track is reformatted with all of its sector addresses equal to >FF. The data fields on the bad track are filled with a repeating pattern of the replacement track address. The replacement track is then formatted with the logical track address of the bad track. This procedure causes the replacement track to appear exactly as the bad track for all commands that access logical track addresses.

Several copies of the internal bad-track map are stored on each track of the test parameter cylinder. The formatter determines a valid map by comparing the copies until it finds two identical ones. The maps stored on the disk are updated in the following ways:

- The SA Assist command (command >44) deletes a track from the map, if it is listed, before executing the surface analysis.
- The Absolute Format command (command >C1) deletes a track from the map, if it is listed, before formatting the track.
- The Relocate command (command >41) adds a bad track to the map.
- The Format Test Parameter Cylinder command (extended command >15) copies the bad-track map stored in formatter RAM onto the disk.

A copy of the formatter bad-track map is also stored in formatter RAM. The formatter RAM map is the formatter working copy and is used for all read/write operations. The RAM map is updated in the following ways:

- During the power-up procedure the bad-track map is copied from the test parameter cylinder.
- The initialized Bad-Track Map command (extended command >19) creates a null map in formatter RAM.
- The SA Assist command (command >44) deletes a track from the map, if it is listed, before executing the surface analysis.
- The Absolute Format command (command >C1) deletes a track from the map, if it is listed, before formatting the track.
- The Relocate command (command >41) adds a bad track to the map.
- The Format Test Parameter Cylinder command (extended command >15) rewrites the map in RAM if the existing map in RAM has an invalid table structure. This is explained further in the next paragraph.

When the test parameter cylinder is formatted (extended command > 15), the copy of the bad-track map in formatter RAM is written to the test parameter cylinder. Before reformatting the test parameter cylinder, the formatter determines whether the bad-track table in RAM is valid. This check only tests for the presence of the correct table structure; it does not check the validity of data in the table. If the table structure is valid, the formatting continues. Otherwise, the formatter attempts to read the map from the test parameter cylinder. If the formatter succeeds in reading a valid map from the disk, diagnostics cylinder 1 is formatted, which completes the command. If the formatter cannot read a valid map from the disk, the test track format operation fails with the error code > 3915 in word 2.

CAUTION

Do not use extended self-test command > 19 without running extended command > 15 immediately afterwards. Command > 19 will initialize the bad-track map in formatter RAM while leaving the existing maps untouched on the disk. This would cause discrepancies between disk and RAM map tables unless extended command > 15 is used immediately to write the contents of the RAM table to the disk.

Index

This index lists key topics of this manual and specifies where each topic appears, as follows:

- Sections — Section references appear as *Section n*, where *n* represents the section number.
- Appendixes — Appendix references appear as *Appendix Y*, where *Y* represents the appendix letter.
- Paragraphs — Paragraph references appear as alphanumeric characters separated by decimal points. The first character refers to the section or appendix containing the paragraph, and any other numbers indicate the sequence of the paragraph within the section or appendix. For example:
  - *3.5.2* refers to Section 3, paragraph 5.2.
  - *A.2* refers to Appendix A, paragraph 2.
- Figures — Figure references appear as *Fn-x* or *FY-x*, where *n* represents the section and *Y* represents the appendix containing the figure; *x* represents the number of the figure within the section or appendix. For example:
  - *F2-7* refers to the seventh figure in Section 2.
  - *FG-1* refers to the first figure in Appendix G.
- Tables — Table references appear as *Tn-x* or *TY-x*, where *n* represents the section and *Y* represents the appendix containing the table; *x* represents the number of the table within the section or appendix. For example:
  - *T3-10* refers to the tenth table in Section 3.
  - *TB-4* refers to the fourth table in Appendix B.
- See and See also references — *See* and *See also* direct you to other entries in the index. For example:

  Logical Unit Number ..... *See* LUNO

  Device ..... *See also* individual device names or numbers

Page numbers that correspond to these index references appear in the Table of Contents.

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